UPDATED SECOND EDITION

MINIMAL ACCESS SURGERY

Guidelines and Recommendations

INDIAN ASSOCIATION OF GASTROINTESTINAL ENDO SURGEONS

MINIMAL ACCESS SURGERY
Guidelines and Recomendations

UPDATED SECOND EDITION

Dedicated to
the monumental efforts of
the pioneer surgeons who brought
the art of Minimal Access Surgery
to its present threshold,
the industry that nurtured its growth
and the patients who placed their implicit
trust in this remarkable revolution.

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BYWORD BOOKS™

INDIAN ASSOCIATION OF GASTROINTESTINAL ENDO SURGEONS
IAGES
1993

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Foreword

"All improvements are transient and illusionary if knowledge, experience and skills cannot be transmitted to future generations of practitioners of the art and science of surgery."

— Ambroise Paré 1510–1599

What Paré wrote over five centuries ago was the inspiration for the creation of the Indian Association of Gastrointestinal Endosurgeons (IAGES) to form a body to ensure that the succeeding generations of Laparoscopic Surgeons would be initiated, trained and qualified to be, in their turn, master MAS surgeons and pass the baton to the next generation. Surgeons are by nature individualistic, innovative, independent – attributes indispensable for surgical progress, but which need curbing, regimentation and discipline in day-to-day surgery.

It was Dr Pradeep Chowbey, his team at Sir Ganga Ram Hospital and a cluster of prominent IAGES master surgeons, who brought out the First Edition of Minimal Access Surgery Guidelines and Recommendations. Dr Chowbey's deep commitment and capacity to enthuse personal involvement of all contributors to the first edition, and the quality of content of that edition makes it a sine qua non that Dr Chowbey wears the mantle for coordinating and ensuring the quality and success of the overdue second edition. Under his stewardship the Second edition, with hand-picked contributors, who are internationally acknowledged masters in their area of expertise, will be an improvement and credit to the first edition. Minimal Access Surgery is undoubtedly a great success story of Indian Surgery. Laparoscopic Cholecystectomy was criticized when first carried out in India by English surgeons in Indian journals as being 'inappropriate in developing countries' and by Indian surgeons in English journals as '. . . brings into question the ethics of those who promote key-hole surgery'. The Indian surgeon, with innovation, ingenuity, conviction that with early return to work and productivity MAS is especially ideal for poor countries, has ensured the growth and spread of MAS, to elevate Indian surgery to a recognized elevated position in the world of MAS. These new Guidelines and Recommendations will inevitably further help in strengthening and streamlining of the performance of MAS at the national level.

The only truth in surgery is change. With improvement in technology, equipment, change in pathology, today's guidelines may need redefining over a few years, hence the need for this edition as also future ones.

The foundation of MAS is 'Primum non Nocere' – Above all do no harm. And this is the raison d'etre of these Guidelines and Recommendations. They summarize and embody the vast experience and well thought wisdom of some of the cream of Indian MAS surgeons. Within these Guidelines and Recommendations are defined the essentials of safety, quality, empathy, advance, efficiency, cost-effective optimal patient care. Criteria laid down on the banks of the Ganges at Kashi, now Varanasi, by Sushruta a few millinnia back, as being the signature of the Indian surgeon.

TEHEMTON E. UDWADIA
Founder President – IAGES

Introduction

We are witness to an unprecedented progress in the practice of surgery in the past three decades. Minimal Access Surgery has grown roots far and wide and we are fortunate to be in the midst of what promises to be an era that transformed surgical practice. Minimal Access Surgery has taken a giant leap and is reflected in the new concepts of surgical delivery across the world. The new revolution has taken place and we are in the phase of *renaissance* – a period of new growth in minimal access surgery in the country. This academic venture is our unwavering commitment to create an inspiring environment for the surgeons to keep abreast of knowledge and skills in minimal access surgery for the benefit of patients.

In the year 2000, a set of recommendatory guidelines for introduction and safe practice of Minimal Access Surgery in India were prepared by the Indian Association of Gastrointestinal Endo Surgeons (IAGES). Those guidelines were prepared on the request of the Ministry of Health and Family Welfare, the Indian Council of Medical Research (ICMR), the Indian Medical Association (IMA) and the Medical Council of India (MCI). It was on Monday, 15 July 2002 at Rashtrapati Bhawan, New Delhi where the first edition of *Minimal Access Surgery: Guidelines and Recommendations* was released by the former President of India, Shri K.R Narayanan (1951–2005).

Guidelines describe the current, best possible standard in diagnostics and therapy. In this context, guidelines have to be evidence-based and should be formulated by a panel of experts who are able to grade the recommendations (level of evidence) according to established criteria of evidence-based medicine (EBM). A surgeon who has not been trained in this specific area finds it increasingly difficult to determine the best treatment option. Guidelines can solve this problem. The fundamental condition for reliable guidelines is the availability of superior quality, published studies ranking high in the classification of EBM. We now have sufficient information and the literature available to frame protocols and guidelines for safe laparoscopic surgery in India.

We had two collective meetings of acknowledged experts, which were held in New Delhi to deliberate on and give final shape to the revised *Minimal Access Surgery: Guidelines and Recommendations* on the basis of published clinical evidence.In the first meeting, the two-day session continued with exhaustive interactive discussions and presentations. The methodology for the development of revised national guidelines were the following:

1. A national panel of experts based on their publications in peer-review journals was identified. They constituted the IAGES Guideline Group.
2. Four experts from the assembled group addressed one specific topic. Each topic was compiled after discussion among the four experts. The intensive discussions were held among themselves through emails, whatsapp, skype to formulate the guidelines.
3. One coordinator from among the four experts delivered the initial draft during our first meeting held on 18 March 2018.
4. There was complete transparency of the process used in formulating the guidelines and clear communication was exchanged between the assembled group of experts.
5. A second consensus meeting was held on 16 June 2018 where the final version of the revised guidelines was discussed, deliberated upon and completed.

A large number of experts from across the country were invited to participate in these meetings. The topics for the guidelines for laparoscopic surgery were identified, and 65 surgeons declared their willingness to formulate drafts for the respective guidelines. The published manuscript was graded according to the **Oxford hierarchy** of evidence as outlined below.

1a. Systematic review of randomized clinical trials (RCTs) (with consistent results from individual studies)
1b. RCTs (of good quality)
2a. Systematic review of 2b studies (with consistent results from individual studies)
2b. Prospective and comparative studies (or RCTs of poorer quality)
2c. Outcome studies (e.g. analyses of large registries, population-based data)

3.	Retrospective and comparative studies, case–control studies
4.	Case series (i.e. studies without a control group)
5.	Expert opinion, animal or lab experiments

For the recommendations, the following grading scale has been used:

Grade A	– Consistent level 1 studies: strict recommendations ('standard', 'surgeons must do it')
Grade B	– Consistent level 2 or 3 studies or extrapolations from level 1 studies: less strict wording ('recommended', 'surgeons should do it')
Grade C	– Level 4 studies or extrapolations from level 2 or 3 studies: vague wording ('option', 'surgeons can do it')
Grade D	– Level 5 evidence or worryingly inconsistent or inconclusive studies at any level (no recommendation at all)

As Chairman of the IAGES Guideline Group, I gratefully acknowledge the constant and professional expertise, scientific contribution of all my colleagues from across the country. I really appreciate the financial support by the IAGES for bringing this vision into reality. The entire group of minimal access pioneer surgeons from across the country have spent long hours compiling and streamlining.They burnt the midnight oil in editing the scientific content of this manuscript. This national platform provided a valuable networking opportunity and set the stage for further cooperation among all the stalwarts in the field of minimal access surgery from India to formulate the revised Minimal Access Surgery: Guidelines and Recommendations. This venture would provide a new horizon for minimal access surgery and aim to open new gates of opportunities for young and not-so-young laparoscopic surgeons.

Dr PRADEEP CHOWBEY
Chairman – IAGES Guidelines Core Group
Chairman – Institute of Minimal Access, Metabolic and Bariatric Surgery
Chairman – Surgery and Allied Surgical Specialities
Executive Vice Chairman – Max Healthcare
Max Super Speciality Hospital, Saket, New Delhi, India

Message

I am delighted that the latest version of 'Minimal Access Surgery: Guidelines and Recommendations' for the year 2022 is being published under Dr Pradeep Chowbey's leadership. He has been part of numerous landmark guidelines from international societies like IEHS and IFSO. He has brought together eminent surgeons from different parts of our country to formulate these guidelines in an evidence-based manner for which Dr Pradeep Chowbey deserves all appreciation.

Minimal access surgical technique adoption is growing at a rapid rate and many surgical techniques are described for the same condition. It is imperative now more than ever to have robust guidelines and recommendations to guide the surgeons on decision-making in challenging situations. This publication will greatly aid in standardizing patient care and improving outcomes for our patients.

I have no doubt that these guidelines will be widely used by our surgical colleagues in India and members from our neighbouring countries.

Dr L.P. THANGAVELU
President–IAGES
(2022–23)

Message

It is indeed my great joy and privilege as IAGES President, to write for this Revised Indian Guidelines for MAS. First such guidelines were published by IAGES under the leadership of Professor Pradeep Chowbey almost two decades ago. Revision of these Guidelines was very much required due to the tremendous advances in the Minimal Access Surgery (MAS) over past two decades. There is no better person to do the honours than Dr Chowbey himself. Eminent MAS Surgeons from India got together under the leadership of Dr Chowbey and held several brainstorming sessions for the Revision of these Guidelines. This was a herculean task and required all the help from eminent MAS Faculties and Dr Chowbey's academic team.

IAGES has been at the forefront of academic activities in the field of MAS and GI Endoscopy for the past three decades. IAGES has trained more than 4000 Surgeons in the Essentials of Laparoscopic Surgery, more than 2000 Surgeons in the Advanced Laparoscopic Subspecialities and more than 1000 Surgeons in GI Endoscopy. IAGES is providing Travelling Fellowship and Academic Awards, such as Best Indian Original Article in JMAS, Best Indian Researcher, Best PG Thesis Award, Best Abstracts Award for Free Paper, Video and E-Poster. IAGES is promoting both online and onsite academic activities and has done academic tie-ups with many foreign associations including ALSGBI. These academic collaborations are promoting excellent academic activities across the nations and continents.

I am immensely pleased to see that these Guidelines are being published now so that every Surgeon can be benefited in his/her practice of MAS and will eventually benefit the patients.

Professor Dr SUNIL POPAT
President – IAGES
(2021–22)

Message

I am pleased to learn that the 2020 version of *Minimal Access Surgery: Guidelines and Recommendations* has once again been published under Dr Pradeep Chowbey's guidance. This major activity of the Indian Association of Gastrointestinal Endo Surgeons (IAGES) has been completed over multiple brainstorming sessions of clinical leaders from all over the country. Due to technological advancements and new learnings, we need to periodically update this information and I am grateful that senior members assigned with this task have willingly cooperated to complete this task.

IAGES is known for its dedicated academic activities sensitive to MAS surgeons' requirements with the publication of JMAS, *Recent Advances in Laparoscopic Surgery*, *Recent Advances in Endoscopic Procedures* and *Minimal Access Surgery: Guidelines and Recommendations* besides knotting and suturing courses, fellowship courses in basic laparoscopy (FIAGES), advanced laparoscopy (FALS), basic GI Endoscopy (EFIAGES) and in advanced Endoscopy (FAGIE).

Guidelines and recommendations are essential for standardized clinical care by its practitioners, i.e. MAS surgeons. These not only provide direction to surgeons but re-assure patients of quality care by members of our association. I hope IAGES members from India and abroad will find it useful for years to come.

I take this opportunity to appreciate work done by Dr Pradeep Chowbey's team at Max Hospital in bringing this activity to fruition.

Dr RAMEN GOEL
President – IAGES
(2020–21)

Message

The first edition of *Minimal Access Surgery: Guidelines and Recommendations* was released on 15 July 2002 by the then Hon'ble President of India His Excellency Shri K.R. Narayanan. Since then, 18 years have passed and Minimal Access Surgery has seen tremendous advancements. The second edition of this book was long overdue. Dr Pradeep Chowbey and his team took up this great effort on behalf of IAGES. Separate teams comprising eminent surgeons of India were formed to research and brainstorm each topic and give their recommendations and guidelines. This was a Herculean task and every one worked tirelessly and spent endless hours to bring out this much needed book, which will go a long way in formulating the guidelines and recommendations specially pertaining to India.

I hope that every surgeon will follow these guidelines to practice safe Minimal Access Surgery which will benefit both the surgeon and the patient.

Dr SAYENDEVDAS GUPTA
President – IAGES
(2019–20)

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Abbreviations and acronyms

AACE	American Association of Clinical Endocrinologists
AAES	American Association of Endocrine Surgeons
AAGBI	Association of Anaesthetists of Great Britain and Ireland
AAST	American Association for the Surgery of Trauma
ACC	adreno-cortical carcinoma
ACCP	American College of Clinical Pharmacy
ACTH	adrenocorticotropic hormone
ADA	American Diabetes Association
AGC	advanced gastric cancer
AHPBA	American Hepato-Pancreato-Biliary Association
AI	adrenal incidentaloma
AL	alimentary limb
ALP	alkaline phosphatase
AM	adrenal metastasis
AMA	American Medical Association
AMP	antimicrobial prophylaxis
APP	abdominal perfusion pressure
APTT	activated partial thromboplastin time
ASA	American Society of Anesthesiologists
ASBS	American Society of Bariatric Surgery
ASMBS	American Society for Metabolic and Bariatric Surgery
ASCRS	American Society of Colon and Rectal Surgeons
ASHP	American Society of Health-System Pharmacists
ASIS	anterior superior iliac spine
ATA	anterior transabdominaladrenalectomy
BAI	bilateral adrenal incidentaloma
BDI	bile duct injury
BMI	body mass index
BPL	biliopancreatic limb
BSA	bi-stapled anastomosis
CAD	coronary artery disease
CBD	common bile duct
CC	conversion cholecystectomy
CCD	charged couple device

CECT	contrast-enhanced computerized tomography
CO	carbon monoxide
CO_2	carbon dioxide
COPD	chronic obstructive pulmonary disease
CP	Child Pugh
CRC	colorectal cancer
CRT	cathode ray tube
CSA	circular-stapled anastomosis
CT	computed tomography
CVS	critical view of safety
DGB	distal gastric bypass
DLT	double-lumen tube
DM	diabetes mellitus
DVT	deep venous thrombosis
EAES	European Association of Endoscopic Surgery
ECG	echocardiography
ECS	endoscopic component separation
EHS	European Hernia Society
EMR	endoscopic mucosal resection
ePTFE	expanded polytetrafluoroethylene
ERAS	enhanced recovery after surgery
ERCP	endoscopic retrograde cholangiopancreatography
$etCO_2$	end-tidal carbon dioxide
FDA	Food and Drug Administration
FNAC	fine-needle aspiration cytology
GA	general anaesthesia
GB	gallbladder
GBC	gallbladder carcinoma
GER	gastro-oesophageal reflux
GERD	gastro-oesophageal reflux disease
GFR	glomerular filtration rate
GI	gastrointestinal
GIST	gastrointestinal stromal tumour
GJ	gastrojejunostomy
GnRH	gonadotropin-releasing hormone
HCC	hepatocellular carcinoma
HD	high definition
HGIN	high-grade intraepithelial neoplasia
HgIn	mercury–indium
HIDA	hepatobiliaryiminodiacetic acid
HIV/AIDS	human immunodeficiency virus infection and acquired immune deficiency syndrome

HLD	high-level disinfection
HSA	hand-sewn anastomosis
IAP	intra-abdominal pressure
ICC	intrahepatic carcinoma
ICG	indocyanine green
ICP	iatrogenic colonoscopic perforation
IDF	International Diabetes Federation
IDSA	Infectious Diseases Society of America
IM	intramuscular
IMC	intramucosal carcinoma
IND	indefinite for dysplasia
INR	international normalized ratio
IOC	intraoperative cholangiography
IPOM	intraperitoneal onlay mesh
IVC	inferior vena cava
JJA	jejuno-jejunal anastomosis
LADG	laparoscopic-assisted distal gastrectomy
LAPS	laparoscopic pancreatic surgery
LATG	laparoscopic-assisted total gastrectomy
LC	laparoscopic cholecystectomy
LDP	laparoscopic distal pancreatectomy
LESS	laparo-endoscopic single site
LGIN	low-grade intraepithelial neoplasia
LHM	laparoscopic heller myotomy
LIVHR	laparoscopic incisional and ventral hernia repair
LMGB-OAGB	laparoscopic minigastric-one anastomosis gastric bypass
LMWH	low molecular weight heparin
LoE	level of evidence
LoS	length of stay
LPA	lateral retroperitoneoscopicadrenalectomy
LPC	laparoscopic partial cholecystectomy
LPD	laparoscopic pancreatoduodenectomy
LRYGB	laparoscopic Roux en Y gastric bypass
LSA	linear-stapled anastomosis
LSG	laparoscopic sleeve gastrectomy
LTA	lateral transabdominal adrenalectomy
LUQ	left upper quadrant
LUS	laparoscopic ultrasound
LVHR	laparoscopic ventral hernia repair
MAP	mean arterial pressure
MBP	mechanical bowel preparation
MELD	model for end-stage liver disease

MI	myocardial infarction
MIC	minimum inhibitory concentration
MIE	minimal invasive oesophagectomy
MRCP	magnetic resonance cholangiopancreatography
MRI	magnetic resonance imaging
NIBP	non-invasive blood pressure (monitoring)
NICE	National Institute for Health and Care Excellence
NIH	National Institutes of Health
NIR	near infrared
NOM	non-operative management
NOTES	natural orifice transluminal endoscopic surgery
NSAIDs	non-steroidal anti-inflammatory drugs
NTM	non-tuberculous mycobacteria
NT-proANP	N-terminal proatrial natriuretic peptide
OA	open appendectomy
OCS	open component separation
OLV	one-lung ventilation
OPA	ortho-phthalaldehyde
OR	operating room
OT	operation theatre
PA (A)	physician assistant (anaesthesia)
PACU	post-anaesthesia care unit
PCWP	pulmonary capillary wedge pressure
PDT	photodynamic therapy
PHC	perihilar carcionma
POEM	peroral endoscopic myotomy
PONV	postoperative nausea and vomiting
PPI	proton-pump inhibitor
PPNAD	primary pigmented nodular adrenocortical disease
PRA	posterior retroperitoneoscopic adrenalectomy
PSG	Polish Society of Gastroenterology
PSS	Polish Society of Surgery
PT	prothrombin time
PVDF	polyvinylidene fluoride or polyvinylidenedifluoride
QoL	quality-of-life
RCT	randomized controlled trial
RFA	radiofrequency ablation
SAGES	Society of American Gastrointestinal and Endoscopic Surgeons
SCD	sickle cell disease
SCS	subclinical Cushing syndrome
SGPT	serum glutamic pyruvic transaminase
SHEA	Society for Healthcare Epidemiology of America

SILA	single-incision laparoscopic appendectomy
SIS	Surgical Infection Society
SL	staging laparoscopy
SLN	sentinel lymph node
SOGC	Society of Obstetricians and Gynaecologists of Canada
SSALA	single-site access laparoscopic appendectomy
SSHSA	single-stapled + hand-sewn anastomosis
SSI	surgical site infection
STDGB	standard or proximal gastric bypass
SVR	systemic vascular resistance
TAP	transverse abdominis plane
TAPP	transabdominal preperitoneal
TEE	trans-oesophageal echocardiography
TEP	totally extra peritoneal
TIVA	total intravenous anaesthesia
TLE	thoracoscopic laparoscopic oesophagectomy
TME	total mesorectal excision
TPLA	three-port laparoscopic appendectomy
TSA	tri-stapled anastomosis
TVUS	transvaginal ultrasound`
UDT	undescended testis
UH	unfractionated heparin
US	ultrasound
USG	ultrasonography
VAS	visual analogue scale
VATS	video-assisted thoracoscopic surgery
VBG	vertical banded gastroplasty
Vd	volume of distribution
VTE	venous thromboembolism

1

Anaesthesia for Laparoscopic Surgeries

Laparoscopic techniques and minimal access surgery have established themselves as a routinely sought after option for several procedures. The benefits offered by these techniques can be spelled as better cosmesis, faster recovery, earlier discharge readiness and much more. The validated cardiovascular risk calculators and American Heart Association/American College of Cardiology perioperative guidelines do not incorporate the laparoscopic approach when characterizing operative risk.[1] Risk prediction in laparoscopic patients has not been published as yet.[2]

Complex procedures involving greater challenges in terms of comorbid conditions, extremes of position and longer duration are now being subjected to laparoscopy to achieve best outcomes. Such challenges and risks are specific to the patient, procedure, techniques and to the creation of a carboperitonium. Continuous advancements in the anaesthetic techniques, devices and agents demand modification of the existing guidelines (LoE 1b).[3,4]

ADVANTAGES OF LAPAROSCOPY

Multiple factors have contributed to the success of laparoscopy: these include lesser incidence of postoperative nausea and vomiting (PONV) and ileus due to minimum handling of the bowel. Patients can resume oral intake more rapidly than in the case of open surgical techniques, thus lowering the need for intravenous fluids. Fluids are associated with greater tissue oedema, slower healing that may further delay healing. Laparoscopy is particularly beneficial in obese patients and those with severe respiratory disease; however, some specific considerations need to be borne in mind (LoE 2c).[5]

Contraindications to laparoscopy

- Pre-existing raised intracranial pressure
- Severe uncorrected hypovolaemia, and patients with known right-to-left cardiac shunts or patent foramen ovale

Normal and pathological intra-abdominal pressure values

The pressure within the abdomen at any given time is determined by the elasticity of the abdominal walls and the contents which are non-compressible. The abdomen is a closed box with walls that are rigid (costal arch, spine, and pelvis) or flexible (abdominal wall and diaphragm). Intra-abdominal pressure (IAP) is therefore defined as the steady-state pressure concealed within the abdominal cavity. It increases with inspiration (diaphragmatic contraction) and decreases with expiration (diaphragmatic relaxation).

IAP ranges from sub-atmospheric values to zero mmHg (LoE 2b).[6] Physiological conditions such as morbid obesity or pregnancy have chronically elevated values of IAP of up to 10–15 mmHg and these patients adapt with an absence of significant pathophysiological consequences (LoE 1b,2b).[7,8] Children commonly have low IAP values (LoE 1b).[7] The clinical importance of any IAP must be assessed on the basis of the baseline steady-state IAP for individual patients.

Intra-abdominal hypertension: Persistent IAP values >20 mmHg

Abdominal perfusion pressure

Abdominal perfusion pressure (APP) is determined by the mean arterial pressure and it is a predictor of visceral perfusion, and is calculated as the difference between mean arterial pressure (MAP) and IAP.[6–9]

RISKS ASSOCIATED WITH LAPAROSCOPY

Laparoscopic procedures have a lower risk of morbidity and mortality compared with surgeries requiring an open access. However, with the establishment and acceptance of laparoscopy the anaesthesiologists are facing more challenges because patients with increasing complexity and coexisting comorbidities are opting for laparoscopic procedures.

The existing preoperative risk scores and guidelines may not adequately cover the risks of laparoscopy in such patients. The cardiorespiratory consequences of hypercarbia and raised IAP may adversely affect the outcome. Haemodynamic insults following increased IAP include increased afterload and preload and decreased cardiac output, whereas ventilatory consequences include increased airway pressures, hypercarbia and decreased pulmonary compliance. In patients with cardiovascular disease, these effects may get exaggerated. The choice of anaesthetic

Conditions demanding attention during laparoscopy

- congestive heart failure
- coronary artery disease
- valvular heart disease
- congenital heart disease
- pulmonary hypertension

technique needs to be guided by thorough discussions between the surgeon and the anaesthesiologist so that these patients are not deprived of the benefits of laparoscopy. The same process needs to be followed to prevent cardiorespiratory complications. This needs a thorough understanding of various haemodynamic and physiological consequences of laparoscopy. Patients who are at a greater risk due to increase in IAP can be identified by a complete understanding of various effects of IAP on physiology.

Intra-abdominal pressure and carboperitoneum

Carbon dioxide (CO_2) remains the ideal gas for pneumoperitoneum due to its properties of low combustibility and high blood solubility which reduces the chances of embolism (0.0014%–0.6%). IAP is most commonly raised to 12–15 mmHg. Accidental placement of a trochar into a major vessel or a vascular injury can lead to the possibility of CO_2 gas embolism and blood loss. The stage of gas embolism can be assessed by trans-oesophageal echocardiography.[10–13]

RECOMMENDATIONS

Grade A

- Trans-oesophageal echocardiography (TEE) based on filling of the right-sided heart chambers[11]
- **Preferable:** Patients prone to embolism may be referred to centres with provision of TEE[11–13]

Cardiorespiratory risks and carboperitoneum

Cardiovascular risks are the most prominent and noteworthy patho-

Management of CO_2 embolism

- Immediate cessation of surgery
- Cessation of carboperitoneum
- Placement of the patient in the left lateral decubitus position
- Administration of 100% FiO_2

physiological effects of carboperitoneum and are an interplay of *IAP, patient's position on the operating table, presence of comorbidities* and *duration of surgery.*

Carboperitoneum can lead to hypercarbia (and subsequently acidosis) and raised IAP.[14–21] These physiological insults are well tolerated even in the elderly and severely sick patients with marginal increase in the incidence of cardiac arrhythmias provided the end-tidal CO_2 ($etCO_2$) levels are controlled within an acceptable range by the judicious use of ventilatory strategies. There are important pathophysiological changes in the respiratory system, including hypercarbia, hypoxaemia and barotrauma. These occur very rarely provided effective ventilation and monitoring techniques are applied.

Effects of raised IAP on vital organs

The effects of raised IAP on splanchnic perfusion and hence on organ dysfunction are directly proportional to the duration of carboperitoneum and the IAP. The pathophysiological effects of raised IAP on consecutive organ dysfunctions can be minimized by limiting the pressures to <12 mmHg particularly in longer durations of carboperitoneum because at these pressures the effects are minimal and transient and do not influence the outcome.[14–18]

In general, laparoscopic surgery commences at IAP values of 12–15 mmHg. However, CO_2 insufflation impacts the cardiovascular, respiratory and other vital systems such as the renal system by raising IAP and causing hypercarbia. Carboperitoneum produces a rise in systemic vascular resistance (SVR) and MAP in the first 5 minutes of abdominal insufflation due to mechanical effects of abdominal aortic compression and neuroendocrine effects (LoE 5,2b,2b,2b,2b).[14–18]

There is elevation in plasma norepinephrine, epinephrine, cortisol, vasopressin, atrial naturetic peptide, renin and aldosterone levels (LoE 2b).[18] There is a biphasic response in cardiac output at IAP >15–20 mmHg, showing an early rise in cardiac output (an increase in preload), followed by a fall in cardiac output (reduced venous return and increased afterload) (LoE 2b,2b).[17,18]

Further increases in IAP ≥15 mmHg (proven by TEE calculations) will decrease cardiac output. These findings define the critical IAP threshold as 15 mmHg (LoE 2b,2b,1b).[19–21] These changes *return to baseline after 30 minutes of insufflation* in healthy individuals ASA I and II (LoE 2b).[15] However, these initial 30 minutes might be very vital in patients with pre-existing compromised cardiorespiratory functions.[18–25] The peritoneum stretch due to abdominal insufflation increases the vagal tone and can lead to bradyarrhythmias and asystole; its incidence is 14%–27%. *Patients on beta-blockers have a greater risk of bradyarrhythmias.*

RECOVERY FROM A LAPAROENDOSCOPIC PROCEDURE

Desufflation and post-anaesthesia care unit

Following desufflation, at the conclusion of laparoendoscopic procedure, minute ventilation requirements may remain elevated, as up to 120 L of CO_2 may remain stored in the body (depending on the duration of the procedure). It is accomplished by the lungs and renal proton excretion. Haemodynamic parameters return to baseline soon after desufflation in ASA I and II patients, whereas in patients with cardiovascular disease, it may take more than 65 minutes.

Desufflation has been associated with an increase in the heart rate, cardiac index, left ventricular stroke work index, ejection fraction and decrease in SVR in the elderly. Twenty percent elderly with cardiovascular disease can develop heart failure with significant drop in cardiac index within 3 hours after the procedure.

RECOMMENDATIONS

It is imperative to keep a close watch for up to 3 hours postoperatively in these patients for signs of myocardial infarction (MI) and heart failure following desufflation.

Grade A

Lower pressures (8–12 mmHg) are a better suggestion for high cardiovascular and respiratory risk even for a brief surgery or procedure (LoE 2c).[22]

Effects of elevated IAP

- Aortocaval compression
- Decreased splanchnic blood flow
- Decreased renal blood flow
- Diaphragmatic displacement[14]

Anaesthesia workstation and environment

Laparoscopic procedures have been applied in multiple surgical disciplines and need to be applied with caution while ensuring more patient comfort and safety.

It becomes extremely vital to have anaesthesia workstation equipped with efficient ventilator and monitors. A thorough knowledge and understanding of all technicalities of the anaesthesia workstation, ventilation, airway devices and monitors used remains the key to a safe and successful performance of any laparoendoscopic procedure. In the absence of suitable infrastructure the procedures, which might appear to have smaller incidence of adverse events, can lead to disastrous consequences.

The anaesthetic technique should offer an economical option without compromising patient care and without jeopardizing the environment of the operation theatre. Low flow anaesthesia is a preferred option for laparoendoscopic procedures as it minimizes theatre pollution and offers improved pulmonary dynamics of the anaesthetic gases, increased mucocilliary clearance, maintains body temperature and reduces fluid loss (LoE 1).[26] Less anaesthesia gas consumption leads to significant savings up to 75%, and decrease of greenhouse gas emissions and lower impact on the ozone layer. It further provides protection to the heat and humidity of the respiratory system, while minimizing cost and preventing air pollution.[27,28]

Benefits of low flow anaesthesia workstation

- More haemodynamic stability
- Improved lung functions
- More economical
- Less pollution in theatre

STATEMENT AND RECOMMENDATION

Statements

- End-tidal (et) CO_2 concentrations reach the maximum value in 40 minutes of CO_2 insufflation if ventilation is kept constant; thereafter, CO_2 accumulates in the body. Respiratory acidosis and high CO_2 output last for up to one hour postoperatively in ASA I/II patients (LoE 2b).[29,30]
- Patients with limited pulmonary reserves are at risk of postoperative hypercarbia and acidosis when on spontaneous breathing. Measured $etCO_2$ values may not correlate with arterial $PaCO_2$ low flow anaesthesia (LoE 1a).

Recommendations

Grade A

- Anaesthesia workstation: equipped with suitable ventilation modalities
- Anaesthesia workstation with provision for low flow anaesthesia
- General anaesthesia is anaesthesia of choice for patients with COPD or depleted respiratory reserves
- Suspected subcutaneous emphysema to be monitored for extended period in post-anaesthesia care unit (PACU)

Impact of IAP on pulmonary function

- Effects of IAP on pulmonary function are exaggerated in the Trendelenburg position
- Fall in pulmonary compliance
- Increase in peak and plateau airway pressures
- Decrease in functional residual capacity
- Ventilation–perfusion mismatch, leading to hypoxaemia (LoE 2a, 2b).[10,31,32]

Pulmonary consequences

Hypercarbia

- Systemic vasodilatation
- Arrhythmias
- Myocardial depression
- Exacerbation of pulmonary hypertension

- Hypoxaemia
- Reduction in pulmonary compliance
- Subcutaneous emphysema (LoE 5)[29,30]

Recommendation

Ventilatory strategy: maintain acceptable $etCO_2/pCO_2$ concentrations.

Risk factors for development of subcutaneous emphysema

- Prolonged surgery >3.5 hours
- IAP >15 mmHg
- Placement of cannulas outside the peritoneal cavity
- Disruption of fascial planes
- $etCO_2$ >50 mmHg
- Use of >5 cannulas
- Use of high gas flow rates

STATEMENT AND RECOMMENDATION

Statement

Suspect subcutaneous emphysema if $etCO_2$ continues to rise after the first 30 minutes (LoE 2a).[10]

Recommendations

Grade A

- Anaesthesiologists to ensure adequate removal of CO_2 in the presence of intraoperative hypercarbia
- Significant postoperative pain can be referred to the left shoulder and can mimic cardiac chest pain
- Caution needs to be exercised in the presence of COPD or other lung pathology

Recommendations for patients with respiratory disease
Grade A, B

- Close monitoring of $etCO_2$ concentrations intraoperatively: **Mandatory**
- Low flow anaesthesia workstations: **Preferable**
- Arterial monitoring[30,31] in longer surgeries: **Preferable**
- Longer postoperative monitoring (>1 hour in PACU): **Preferable**

Impact of IAP on renal function

There is significant compromise on hepatic and renal perfusion with increasing IAP, which defines the risks in patients with existing disease when suitability is determined for laparoscopic surgery. Laparoscopy poses an increased risk of acute kidney injury in patients with chronic kidney disease. Persistent IAPs >20 mmHg will cause a reduction in mesenteric and gastrointestinal mucosal blood flow by up to 40% with progressive tissue acidosis developing as pressure increases. IAP is an independent cause of adverse renal effects of carboperitoneum. The glomerular filtration rate (GFR) drops by 25% at IAP of 20 mmHg. There is impaired renal perfusion gradient due to additive effects of reduced renal afferent flow (impaired cardiac output) and reduced efferent flow due to elevated renal venous pressure. The inability to tolerate pneumoperitoneum may require conversion to open laparotomy. Bradycardia must be recognized and treated promptly because this condition can be an early predictor of cardiac arrest, which occurs infrequently.[7,33–37]

STATEMENT AND RECOMMENDATION

Recommendations to minimize adverse events

Grade A

ASA II/IV patients

- Slower insufflation
- Lower IAP
- Premedication with glycopyrrolate to attenuate the vagal response

During bradycardia

- Open the ports to decrease IAP
- Give fluid bolus
- Discussion between the surgeon and the anaesthesiologist

Effect of position

Surgeons may request for an extreme low head position during some procedures to facilitate visualization of the lower abdomen and pelvis during gynecological or urological (Trendelenburg) procedures. On the other hand, the reverse Trendelenburg position is preferred for upper abdominal surgeries.

In the Trendelenburg position, the diaphragm and abdominal contents move cephalad, which reduces pulmonary compliance and increases peak airway pressures. However, there is increase in venous return, which prevents the fall in the cardiac output after abdominal insufflation (LoE 2a,2b,2b).[38–40]

The Trendelenburg position is associated with neuroendocrine response associated with an increase in noradrenaline levels and an increase in plasma NT-proANP (N-terminal proatrial natriuretic peptide), which suggests increased atrial stretch caused by increased venous return (LoE 2b).[40]

On the contrary, the reverse Trendelenburg position produces favourable ventilatory changes but unfavourable cardiovascular changes (LoE 1). The head-up position reduces venous return and right atrial pressure (RAP), pulmonary capillary wedge pressure (PCWP) and CO (LoE 2b,2b,1b).[24,39,40] There is elevation of plasma noradrenaline levels by the reverse Trendelenburg position, which increases SVR and further reduces CO (LoE 2b).[40]

With the haemodynamic changes seen during laparoscopic surgery, it is important to assess the patient's intravascular fluid volume status during preoperative assessment.

Intravascular fluid volume status and hence venous return and ventricular preload are the key determinants of CO. A decrease in CO is accentuated by hypovolaemia and attenuated by hypervolaemia.[24,38–40]

RECOMMENDATIONS

Grade A, B

Minimizing the duration of fasting, adequate preoperative hydration, and the use of IAP <15 mmHg may minimize the fall in cardiac output, particularly in patients with cardiovascular and respiratory compromise.

Specific clinical situations

It is critical to identify patients who are vulnerable to adverse haemodynamic and ventilatory changes to create a comprehensive operative plan with the preoperative consultant, anaesthesiologist and surgeon.

Laparoscopic surgery increases the preload and afterload and decreases CO. This can be further accentuated or attenuated by intraoperative patient positioning, intravascular fluid volume status, and underlying cardiovascular conditions such as congestive heart failure, ischaemic heart disease, valvular heart disease, congenital heart disease, pulmonary disease and obesity. In patients with cardiovascular disease, laparoscopic surgery can cause substantially higher elevations in RAP and PCWP and a decrease in CO.[1,10–13,31,38,41–43]

> **RECOMMENDATIONS**
>
> Mechanisms to counterbalance these changes should be identified preoperatively, including adequate hydration, positioning, use of lowest IAP feasible, and haemodynamic monitoring.

Preoperative counselling

Preoperative counselling which targets expectations about surgical and anaesthetic procedures may diminish fear and anxiety and enhance postoperative recovery and discharge. Abstinence from smoking and alcohol and its benefits in the postoperative recovery should be explained to the patient in detail. The patient should be counselled about early postoperative mobilization, pain control and respiratory physiotherapy.

> **STATEMENT AND RECOMMENDATION**
>
> **Statement**
>
> All patients should receive preoperative counselling (LoE 5)[44,45]
>
> **Recommendation**
>
> Preoperative counselling: Grade A[44,45]

Preoperative fasting

Clear liquids may be ingested for up to 2 hours before procedures requiring general anaesthesia, regional anaesthesia, or procedural sedation and analgesia. These liquids should not include alcohol (LoE 1a).[46]

Antiemetics may be preoperatively administered to patients at increased risk of PONV (LoE 1a).[47]

> **RECOMMENDATIONS**
>
> - Clear fluids can be allowed 2 hours prior to surgery (clear fluids do not include alcohol) (Grade A).[46,47]
> - Antiemetics may be administered prophylactically in all patients undergoing laparoscopic surgery (Grade A).[46,47]

Guidelines on criteria of age

Laparoscopy has been successfully conducted in all age groups right from the neonate to the octogenarian population (LoE 1a).[48–50]

In infants and young children, insufflation pressures of 4–12 mmHg typically suffice to visualize intraperitoneal structures and create the operating space as the prepubertal abdominal wall is more pliable and the peritoneal cavity is smaller than that in adults (LoE 2b).[49,50]

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic surgery can be safely performed in all age groups right from the neonate to the octogenarian population (LoE 1a).[48–50]

Recommendations

- Laparoscopic surgery is safe in all age groups (Grade A)[48–50]
- Insufflation pressure
  - Infants and young children: 4–12 mmHg
  - Older children: 12–15 mmHg (Grade B)[49,50]
  - Geriatric patients: (ASA I, II) 12–15 mmHg (Grade B)[49,50]

Preoperative investigations

As per the National Institute for Health and Care Excellence (NICE) guidelines 1, preoperative testing is based on the age of the patient, presence of comorbidities, and the complexity of the intended surgery. Intra-abdominal surgeries are considered as major surgeries.

Recommended baseline tests (LoE 5)[51,52]

1. Complete haemogram in all patients undergoing invasive surgeries
2. The coagulation parameters (PT, APTT and INR) are required only in patients with chronic liver disease or those on anticoagulants
3. Kidney function tests are required only in patients at risk of acute kidney injury
4. Echocardiography (ECG) is indicated in all laparoscopic surgeries
5. ECG in patients with abnormalities in the ECG, and those with known cardiovascular disease or having murmurs
6. X-ray chest history of breathlessness, respiratory diseases and smoking
7. Arterial blood gas analysis: suspected respiratory diseases
8. Pulmonary function tests: respiratory diseases

9. Pregnancy testing: female patients of childbearing age; results would alter the patient's management

Timing of the tests

Test results obtained from the medical record within 6 months of surgery are generally acceptable if the patient's medical history has not changed substantially. More recent test results may be desirable when the medical history has changed or when a test result may play a role in the selection of a specific anaesthetic technique (e.g. regional anaesthesia in the setting of anticoagulation therapy) (LoE 5).[52]

RECOMMENDATION

The tests shown in Table 1 can be recommended as baseline tests in patients undergoing laparoscopic surgery (Grade B).

Table 1. Laboratory investigations prior to laparoscopy

	Mandatory	**Optional**
Complete haemogram	√	
Coagulation profile		Chronic kidney disease Patient on anticoagulants
Renal function tests		History of previous kidney injury, impending acute renal disorder
Echocardiography (ECG)	√	
ECG		ECG changes, history of heart disease
X-ray chest		History suggestive of respiratory disorder
Arterial blood gas analysis		√
Pulmonary function tests		√
Pregnancy test	Women of child-bearing age	
In the absence of any change in medical history, these tests are valid up to 6 months		

Monitoring during anaesthesia

A – Induction and maintenance of anaesthesia (LoE 1)[53]

Mandatory

- Pulse oximeter
- Non-invasive blood pressure (NIBP) monitor

- Electrocardiograph
- Airway gases: oxygen, carbon dioxide and vapour
- Airway pressure

B – Recovery from anaesthesia (LoE 1)[53]
A high level of intense monitoring should be maintained until the patient is fully recovered from anaesthesia. Clinical observations must be supplemented by the following monitoring devices.

- Pulse oximeter
- NIBP monitor

C – The following must also be immediately available:

- Capnography
- Electrocardiograph
- Nerve stimulator
- Means of measuring temperature

D – Regional techniques
Appropriate monitoring should include a minimum of the following devices:

- Pulse oximeter
- NIBP monitor
- Electrocardiograph

An anaesthetist of appropriate experience, or fully trained Physician Assistant (Anaesthesia) PA (A) under the supervision of a consultant anaesthetist, must be present throughout the conduct of general anaesthesia using both clinical skills and monitoring equipment.

RECOMMENDATIONS

Grade A[53]

- Minimum standards of monitoring are uniform regardless of duration, location or mode of anaesthesia.
- An anaesthetist must be present and care for the patient throughout the conduct of an anaesthetic.
- Minimum monitoring devices (as defined in the recommendations) must be attached before induction of anaesthesia and continued until the patient has recovered from the effects of anaesthesia (Grade A) (Local and Regional).[53]

Additional monitoring

Some patients will require additional monitoring, for example intravascular pressures, cardiac output or biochemical or haematological variables depending on the patient and surgical factors. The use of additional monitoring is at the discretion of the anaesthetist.

RECOMMENDATIONS

Grade A

- A summary of information provided by all monitoring devices should be recorded on the anaesthetic record (Grade B).[53]
- The anaesthetist must ensure that all anaesthetic equipment, including relevant monitoring equipment, has been checked before use. Alarm limits for all equipment must be set appropriately before use. The appropriate audible alarms should be enabled during anaesthesia (Grade A).[54]
- These recommendations describe the monitoring devices that are essential ('minimum' monitoring) and those that must be immediately available during anaesthesia. If it is absolutely necessary to continue anaesthesia without an essential monitor, the anaesthetist should note the reasons in the anaesthetic record (Grade A).[53]
- Additional monitoring may be necessary as considered appropriate by the anaesthetist (Grade A).[53]
- Minimum monitoring should be used during the transfer of anaesthetized patients (Grade A).[53]
- Provision, maintenance, calibration and renewal of equipment are the responsibilities of the institution in which anaesthesia is delivered. The institution should have processes for taking advice from departments of anaesthesia in matters of procurement and maintenance of equipment.
- All patient monitoring equipment should be checked before use in accordance with the Association of Anaesthetists of Great Britain and Ireland (AAGBI) Guideline Checking Anaesthetic Equipment 2012 (Grade A).[54]

Table 2. Monitoring standards for general anaesthesia

	Induction	Maintenance	Recovery
Mandatory	Pulse oximeter	Pulse oximeter	Pulse oximeter
	NIBP	NIBP	NIBP
	ECG	ECG	ECG
	Capnography ($etCO_2$)	Capnography ($etCO_2$)	
Preferable	Airway gases: oxygen, carbon dioxide and vapour	Airway gases: oxygen, carbon dioxide and vapour	Capnography ($etCO_2$)
		Airway pressure	
		Temperature	
Miscellaneous	Invasive monitoring		
	Biochemical		
	Haematological		

Thromboprophylaxis

Very few prospective randomized trials are available in the literature which address venous thromboembolism (VTE) prophylaxis in minimal invasive surgery. A meta-analysis on laparoscopic cholecystectomy (LC) indicated that routine use of VTE chemoprophylaxis was likely to be unnecessary and suggested considering its use only in higher risk patients based on risk stratification (LoE 1a).[55]

Elderly patients, those with higher body mass index (BMI), patients undergoing laparoscopic bariatric surgery and those with angina as well as bed-ridden patients had an increased risk of VTE (LoE 1a).[56]

Based on the American College of Clinical Pharmacy (ACCP) guidelines, low molecular weight heparin (LMWH), unfractionated heparin (UH), or mechanical prophylaxis with IPC are recommended (LoE 1a).[57]

Patients at a higher risk for DVT

- Elderly age group
- Bed-ridden
- Thrombophilia
- Undergoing bariatric surgery
- Prolonged surgery
- Surgery in Loyed Davis or lithotomy position
- Concomitant malignancy/chemotherapy

Multimodal regimens for thromboprophylaxis

Combination of

- Adequate hydration
- Early ambulation
- Sequential compression devices
- Low molecular weight heparin (Grade A)[57]

RECOMMENDATIONS

- Pharmacological thromboprophylaxis is not recommended for all patients undergoing laparoscopic surgery (Grade A).[55]
- Patients at a higher risk for deep venous thrombosis (DVT) need multimodal regimens for prevention of DVT. Early ambulation plays a crucial role in the prevention of DVT following laparoscopic surgery (Grade A).[57]

Role of nitrous oxide

Maintenance of anaesthesia with nitrous oxide is controversial, as it causes bowel distension and altered laparoscopic view. Nitrous oxide does not produce clinically important bowel distension in procedures of short duration. Abdominal distension following nitrous oxide was observed only in surgeries of longer duration, i.e. more than 3–3.5 hours, but it did not prolong the duration of surgery or hospital stay (LoE 1a).[58]

An increase in PONV with nitrous oxide anaesthesia probably occurs only after gynaecological laparoscopic procedures but not after other forms of laparoscopic surgery.[59]

STATEMENT AND RECOMMENDATION

Statement

For laparoscopic surgery of long duration, nitrous oxide is not favourable (LoE 1a).[58]

Recommendations

Grade A[58]

- Nitrous oxide can be safely administered in laparoscopic surgeries of short duration
- Nitrous oxide should be avoided in laparoscopic surgeries due to its potential for causing PONV and bowel distension

Postoperative pain relief after laparoscopic surgeries

Postoperative pain relief is an essential component of ERAS (enhanced recovery after surgery) protocols of laparoscopy and has a significant role in facilitating early ambulation. Multimodal analgesia (i.e. the concurrent use of analgesics with different modes of action) has proven to be efficacious in post-surgical management of pain (LoE 1).[60]

Route of administration

Oral medications are the preferred option whenever feasible. The intramuscular (IM) route for the administration of analgesics for management of postoperative pain is discouraged due to inconsistent results and erratic absorption. Other routes for administration of medication are intravenous rectal or topical (LoE 1).[60]

Opioids

Though opioids have remained the gold standard in the past, the current practice suggests opioid-free or opioid-restricted analgesia. The benefits of opioids have to be balanced against their unpleasant side-effects; namely nausea and vomiting, sedation, pruritus, respiratory depression, constipation, urinary retention and delayed emergence. Shorter-acting opioids, such as fentanyl, may be preferred for day-case surgery because of lesser incidence of post-discharge nausea and vomiting compared with morphine. Multimodal analgesia is preferable and the indiscriminate use of long-acting opioids is discouraged (LoE 1).[60]

COX inhibitors

The panel of experts recommends that clinicians consider giving a preoperative dose of oral celecoxib in adult patients without contraindications (strong recommendation, moderate-quality evidence) (LoE 1).[60,61]

Non-steroidal anti-inflammatory drugs (NSAIDs)

The panel of experts recommends that clinicians provide adults and children with acetaminophen and/or non-steroidal anti-inflammatory drugs (NSAIDs) as part of multimodal analgesia for management of postoperative pain in patients without contraindications. As the onset of action is longer compared with opioids, NSAIDs should be administered preoperatively or early during surgery to allow time for the peak analgesic effect.

The postoperative use of non-selective NSAIDs or the more selective cyclo-oxygenase-2 inhibitors during the first 3 days has been shown to provide good analgesia after laparoscopic procedures, reduce the need for opioid-containing analgesia, and facilitate a faster recovery compared with opioid-based analgesia (LoE 1).[60]

Commonly used antiemetics

- 5 HT-3 antagonist gold standard (ondansetron 4 mg) administered soon after the induction of anaesthesia
- Dexamethasone
- Droperidol

Role of pre-emptive analgesia

The gabapentins and alpha-2 adrenergic agonists (dexmedetomidine) effectively reduce the analgesic requirements in the intra- and postoperative period, and provide haemodynamic stability and sedation without producing respiratory depression. But they may be occasionally associated with dizziness, thus delaying mobilization and discharge. Gabapentin oral in a dose of 600 to 1200 mg (LoE 1)[60] as a part of premedication has been suggested for multimodal analgesia.

Wound infiltration

The use of subcutaneous infiltration with long-acting local anaesthetics at the surgical site has been shown to be effective as a component of multimodal analgesia in several surgical procedures.[62]

A meta-analysis of randomized controlled trials (RCTs) reported improved pain scores when pre-incisional infiltration of bupivacaine was compared with saline (LoE 2).[63–65]

Intravenouas lidocaine

Infusion of intravenous lidocaine significantly reduces postoperative pain scores and opioid consumption after laparoscopic cholecystectomy (LoE 1).[66]

Role of intraperitoneal local anaesthetic

Intraperitoneal bupivacaine 0.125% 20–40 ml with epinephrine 1 in 200,000 units instilled under the right semi-diaphragm at the end of surgery alleviates the postoperative and shoulder tip pain (LoE 1).[67]

TAP block as a strategy for multimodal analgesia

A transverse abdominis plane (TAP) block is a feasible option for pain relief following endoscopic repair of abdominal wall hernias. It produces markedly improved pain scores and promotes early ambulation leading to greater patient satisfaction and earlier discharge (LoE 1a).[68–70]

Shoulder tip pain

Prophylactic NSAID patches have been effective for the relief of shoulder tip pain (LoE 2b).[71]

STATEMENT AND RECOMMENDATION

Statement

It is possible to achieve enhanced recovery after laparoscopic surgeries, and opioid-free analgesia should be adapted whenever possible to achieve early ambulation.

Recommendations

Grade A

- Liberal use of local anaesthesia wherever possible.
- Multimodal analgesia is the modality of choice.

Layout of the operation theatre

Laparoscopic rooms ideally have piped carbon dioxide (CO_2) to inflate the abdomen so that personnel do not need to handle a CO_2 tank.

Laparoscopic and robotic surgery rooms

Laparoscopic rooms should preferably be equipped with piped CO_2 to inflate the abdomen so that personnel are not wasted in handling a CO_2 tank. Robotic surgery requires a 5 ft × 5 ft space at the foot of the table where the robot is placed. The console for the surgeon controls is set off to the periphery, either on one side or behind the anaesthesia workstation, and requires a space of 6 ft × 6 ft.

Ceiling- or wall-mounted screens allow comfortable visualization of laparoscopic or robotic images and reduce the need to move rolling carts with screens.

One screen should be used as a slave for the anaesthesia monitor to enhance the anaesthesiologist's performance and enable visualization of anaesthesia data without turning. Additional supports are required for the ceiling-mounted equipment. Lighting systems should be able to switch between normal room-lighting pattern and coloured fluorescent lights. Installations can have an integrated equipment, including lights and monitors, voice-activated audio control of equipment.

Computer feeds from the hospital can interface with operating room systems, allowing patient information, like X-ray images, to be displayed at the OR table. All users of the operating room need to be involved to maximize the capabilities of the room.

Postoperative nausea and vomiting

Laparoscopic surgeries are associated with a higher incidence of PONV when compared with general surgery (LoE 2).[72]

Female gender is consistently the strongest risk factor for PONV with female to male ratio of 3:1 (LoE 2b).[73]

Total intravenous anaesthesia (TIVA) is better than inhalation anaesthetics as far as PONV is concerned (LoE 2b).[74]

Evidence strongly suggests that a combination of antiemetics is more effective than a single dose therapy (LoE 1).[74,75]

Patients who receive combination therapy consisting of at least two prophylactic pharmacological antiemetic agents of different classes preoperatively or intraoperatively are more likely to prevent PONV (LoE 1).[74,75]

Timing of administration: It is better to give antiemetics prophylactically pre- and intraoperatively to prevent PONV (LoE 1).[74,75]

Dexamethasone

The corticosteroid dexamethasone effectively prevents nausea and vomiting after surgery. A prophylactic dose of 4–5 mg IV for patients at increased risk for PONV is recommended after anaesthesia induction rather than at the end of surgery (LoE 1).[76–79]

Role of oxygen

Two meta-analyses have addressed the impact of intraoperative supplemental oxygen on the incidence of PONV. There is no convincing evidence that high inspired oxygen fraction reduces PONV (LoE 1, 2b).[80,81]

RECOMMENDATIONS

Grade A

- Multimodal approach is strongly recommended[74,75]
- Prophylactic antiemetics is effective[72–75]
- Combination of dexamethasone with 5 HT-3 antagonist is an effective combination to prevent PONV[74,75]

Pregnancy

- Due to restrictions on performing RCTs among pregnant women, there are no data to allow for a specific recommendation. Evidence (though low) can improve the care and outcome of obstetric patients.

- Laparoscopic surgery can be performed in any trimester of pregnancy.
- Elective surgeries should preferably be performed in the second trimester (LoE 5).
- No anaesthetic agent has any teratogenic effects when used in standard concentrations at any gestational age.
- Adequate precautions to be taken.

When to perform surgery during pregnancy?

Strong evidence suggests that laparoscopic surgery can be performed safely in any trimester of pregnancy (LoE 5).[82,83]

Positioning of the obstetric patient during surgery

A slight left lateral tilt helps in uterine displacement leading to improved venous blood flow through the inferior vena cava, thus maintaining adequate foetal perfusion (LoE 5).

Pneumoperitoneum pressure

- The insufflation pressure is recommended in the range of 12–15 mmHg (LoE 5).
- The theory of foetal acidosis because of pneumoperitoneum has been refuted as there are no studies on detrimental effects on the human foetus due to pneumoperitoneum.

Monitoring

- Mandatory CO_2 monitoring during laparoscopy (LoE 1a)
- No evidence to suggest an arterial blood gas monitoring during these surgeries

Foetal monitoring

- Routine preoperative and postoperative foetal monitoring
- No role of intraoperative foetal monitoring
- It is important for a physician to obtain an obstetric consultation before performing a non-obstetric surgery.

Thoracoscopy

Minimal invasive video-assisted thoracoscopic surgery (VATS) have almost replaced thoracotomy in several centres. It has enabled fast tracking and shorter hospital stay. RCTs documenting the benefit of VATS over

Anaesthetic techniques for VATS[84,85]

- Local anaesthesia (limited indication)
- Regional techniques (limited indication)[86]
- General anaesthesia with one-lung ventilation (gold standard)

conventional thoracotomy are lacking.

Non-intubated VATS is a recent, emerging modality though meta-analyses reveals no big advantage over general anaesthesia.[85,86] The main disadvantage of local and regional anaesthesia is that the patient is required to breathe spontaneously. Open pneumothorax in a non-intubated patient can compromise on oxygenation and ventilation. Thoracic epidural anaesthesia, intercostal blocks and paravertebral blocks have been used for VATS.[86]

Most VATS procedures are preferred under general anesthesia utilizing one-lung ventilation (OLV) techniques, to get better exposure and secure airway in the lateral decubitus position. The use of double-lumen tubes (DLTs) has been considered the gold standard for achieving OLV. The use of inhalation agents is indicated for maintenance of anaesthesia in reducing pro-inflammatory cytokines, according to a meta-analysis.[87]

Fluids should be judiciously administered during thoracoscopic surgery to prevent shunting and subsequently pulmonary oedema of the dependent lung. The need for invasive monitoring depends on the clinical condition of the patient and cannot be generalized. There are very few meta-analyses on this subject. Detailed recommendations are beyond the scope of this chapter.

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2

Role of Prophylactic Antibiotics in Laparoscopic Surgery

Prophylaxis refers to the prevention of an infection and can be characterized as primary prophylaxis, secondary prophylaxis, or eradication. Primary prophylaxis refers to the prevention of an initial infection.[1] Surgical antimicrobial prophylaxis is the use of antibiotics before, during or after a diagnostic, therapeutic or surgical procedure to prevent complications of infections.[2] The goal of perioperative antimicrobial prophylaxis is to ensure that adequate antibiotic levels are maintained above the minimum inhibitory concentration (MIC) from the time of incision and throughout the procedure.[1]

These recommendations focus on primary perioperative prophylaxis, also called surgical antimicrobial prophylaxis (AMP) for laparoscopic abdominal surgeries.

Various lacunae remain concerning infections after laparoscopic surgery. Most of these patients are discharged early in daycare settings resulting in poor post-discharge surveillance. It is estimated that one-third surgical site infections (SSIs) will be missed in the absence of post-discharge surveillance.

These guidelines have been framed after reviewing the following peer-reviewed literature:[3]

S. No.	Type of study	Number of articles retrieved	Number of patients/studies reviewed
Literature favouring of prophylactic antibiotics			
1	RCT in favour of prophylactic antibiotics	1 (2007–2013)	1037

(continued)

S. No.	Type of study	Number of articles retrieved	Number of patients/studies reviewed
2	Meta-analysis in favour of the use of two doses of antibiotics	1 (comprising 21 RCTs) (1997–2014)	21 RCT (5207 pts)
3	Review in favour of high-risk elective laparoscopy AMP In favour of AMP before laparoscopic hysterectomy	2 (2013) (2015)	NA
Literature against use of prophylactic antibiotics			
4	RCT against the use of prophylactic antibiotics	3 (2004–2008) (2013–2014)	 417 200
5	Meta-analysis against the use of prophylactic antibiotics	3 (1966–2010) (1997–2015) (1997–2006)	 12 RCT (n=1937) 19 RCT (n=5259) 09 RCT (n=1437)
6	Single-centre clinical studies against the use of prophylactic antibiotics	3 (2004) (2011) (2015)	 419 221 471
7	Review against AMP in lap gynaecological surgery	1 (2012)	 806
8	Prospective cohort against AMP in lap gynaecological surgery	1	300

Recommendations of various institutions in the world:

Institution	Surgical antibiotic prophylaxis
WHO 2016	Yes Strong recommendation, low quality of evidence when indicated (depending on the type of operation), surgical antibiotic prophylaxis should be administered prior to the surgical incision
SHEA/IDSA 2014	1 Administer only when indicated 1 Administer within 1 hour of incision to maximize tissue concentration
CDC (unpublished draft) 2014	Yes. 1b Administer a preoperative antimicrobial agent only when indicated, i.e. based on published clinical practice guidelines and timed to establish a bacterial concentration of the agent in the serum and tissues when the incision is made

(continued)

Institution	Surgical antibiotic prophylaxis
National Institute for Health and Care Excellence 2008/2013	Yes Antibiotic prophylaxis should not be used routinely for clean non-prosthetic uncomplicated surgery. When antibiotic prophylaxis is needed, a single dose of antibiotic intravenously on starting anaesthesia should be considered. However, prophylaxis should be given earlier for operations in which a tourniquet is used.
Royal College of Surgeons in Ireland 2012	Yes. 1a Single dose only unless otherwise indicated. Give an additional dose of antibiotic if the surgical procedure is prolonged or there is major intraoperative blood loss (>1.5 L in adults or 25 mL/kg in children). Ensure that the antibiotic is given at induction (within 60 minutes before incision)

Key question

What is the role of AMP in laparoscopic abdominal surgeries?

Evidence

Laparoscopic cholecystectomy: The AMP may not be required for patients with low risk undergoing elective surgeries. Experience with more than 10,000 patients studied through RCTs, meta-analysis and systematic reviews suggests that low risk elective laparoscopic cholecystectomy does not require AMP.[4–9] On the other hand, Liang *et al*. also conducted a systematic review and meta-analysis to study the effects of AMP in low-risk patients undergoing laparoscopic cholecystectomy.[10] Their study (5207 patients) concluded that antibiotic prophylaxis is safe and effective in reducing SSIs and global infections during hospitalization or after discharge. There was a shorter postoperative length of hospital stay even in low-risk patients undergoing elective laparoscopic cholecystectomy.

Another study indicates that use of a single dose of AMA prophylaxis may not have a statistically significant result. This study included 5 RCTs which gave 3 to 10 doses as AMP, which is against the definition of an AMP.[10] The following factors are considered as high risk for laparoscopic cholecystectomy[10]

- previous biliary surgery
- age >60 years
- presence of diabetes mellitus
- acute colic within 30 days before laparoscopic cholecystectomy
- jaundice
- acute cholecystitis

- cholangitis
- bile spillage

Laparoscopic bariatric surgery: obesity is an important risk factor for SSIs in bariatric and non-bariatric surgeries.[11,12] The SSI rate in obese patients can be as high as 15%.[13,14] Hence, all patients undergoing bariatric surgery must receive AMP.[1]

Laparoscopic gynaecology surgeries excluding hysterectomy: a recent review of the literature found the SSI rate following gynaecological laparoscopy ranging from 0 to 5.5%.[15] Kocak *et al*. randomized 450 patients, one group (200 patients) were given a single dose of first generation cephalosporin while the other group (250 patients) did not receive any antibiotics. Indications for surgery included infertility, endometriosis, tubal ligation and chronic pelvic pain. They did not find any significant differences between the two groups with respect to SSIs.[16] Litta *et al*. conducted an RCT and randomized 300 patients undergoing laparoscopy into a cefazolin and a placebo group, with 150 patients in each group. They found no significant differences in complications of infections and febrile morbidity.[17]

STATEMENT AND RECOMMENDATION

Statement

Grade A (RCTs and meta-analysis present) – AMP must be based on risk stratification of patients.

Recommendations

- Based on risk factors, high-risk patients who are undergoing elective surgeries must be given antibiotic prophylaxis.
- For low-risk patients, AMP is not recommended and there is a need to clearly identify this group.
- All patients (low or high risk) undergoing emergency surgeries and bariatric surgery must be given AMP.

Key question

Which antimicrobial agents should be considered for prophylaxis in laparoscopic abdominal surgeries?

Evidence

The selection of appropriate prophylactic antibiotic regimens requires consideration of the expected microbial flora at the surgical site, patient-specific factors such as allergy and exposure to resistant bacteria, institution-specific factors such as local antibiograms and availability of antibiotic formulary and drugs.[11]

Cefazolin has a half-life of two hours, giving protection for longer surgeries. It has anti-staphylococcal activity and is the preferred agent in gastrointestinal surgeries in high-risk patients (i.e. obesity). Besides, it is a low-cost drug.[11] Fischer *et al*. conducted a systematic review and meta-analysis comprising 3 RCTs (136 patients) and 4 observational studies comprising 2700 cases and showed that cefazolin is recommended for AMP in bariatric surgery.[18] Liang *et al*. also conducted a meta-analysis of RCTs and observed that cefazolin was the preferred choice for AMP in laparoscopic cholecystectomy.[10]

Published in 2013, clinical practice guidelines for AMP were developed jointly by the American Society of Health-System Pharmacists (ASHP), the Infectious Diseases Society of America (IDSA), the Surgical Infection Society (SIS), and the Society for Healthcare Epidemiology of America (SHEA).[1]

Based on the identified risk factors, their recommendations for AMP in laparoscopic procedures are given below:

Type of procedure	**Antibiotics recommended**	**Redosing interval**	**Alternate antibiotics in case of B lactam allergies**	**Redosing interval**	**Category of evidence**
None or low-risk elective procedures	None		None		A
Elective, high-risk	Cefazolin, Ceftriaxone* Fluoroquinolones, Ampicillin-sulbactam*	4 hours NA 2 hours	Clindamycin or vancomycin + aminoglycoside or '*aztreonam or fluoroquinolone' '**Metronidazole + aminoglycoside' or fluoroquinolone*	6 hours NA 4 hours NA NA	A

* Due to increasing resistance of Gram-negative bacilli (*E.coli, Klebsiella spp, Enterobacter spp*. etc.) in India to ceftriaxone, fluoroquinolones and ampicillin–sulbactam, susceptibility profiles of the local population should be reviewed before use

** Add anaerobic cover for surgeries below the duodenum[11]

STATEMENT AND RECOMMENDATION

Statement

Grade A (RCTs present) – First generation cephalosporins must be considered as the antimicrobial agent of choice.

Recommendations

- Intravenous first-generation cephalosporin such as cefazolin is considered as the antibiotic of choice for AMP.
- In case of allergy to betalactam agents, clindamycin/vancomycin with aminoglycosides may be used.
- Add anaerobic cover, e.g. metronidazole for surgeries below the duodenum.

Key question

What should be the timing of initial dose?

Evidence

Drug considerations include bactericidal activity, pharmacokinetic and pharmacodynamic parameters to ensure the adequate delivery of antibiotics in relation to surgical incision and the maintenance of optimal drug levels throughout the procedure.[11]

Successful prophylaxis requires the delivery of the antimicrobial to the operative site before contamination occurs. This provides serum and tissue concentrations exceeding the MIC for the probable organisms associated with the procedure, at the time of incision, and for the duration of the procedure.[19,20] In a multicentre Dutch study of 1922 patients undergoing total hip arthroplasty, the lowest SSI rate was seen in patients who received the antimicrobial during the 30 minutes before incision.[21] The highest risk for infection was found in patients who received prophylaxis after the incision. A prospective evaluation of 1708 surgical patients receiving AMP found that preoperative administration of antimicrobials within 2 hours before surgical incision decreased the risk of SSI to 0.59%, compared with 3.8% when administered 2–24 hours before surgical incision.[22]

STATEMENT AND RECOMMENDATION

Statement

Grade A (RCTs present) – The first dose should be given within 60 minutes before surgical incision.

Recommendations

- It is recommended that the administration of the first dose of antimicrobial agent should be within 60 minutes prior to surgical incision (golden first hour).
- If vancomycin and fluoroquinolones need to be administered, they should be given within 120 minutes before surgical incision because of the prolonged infusion times required for these drugs (long half-lives).

Key question

When should the antimicrobial agent be redosed?

Evidence

Intraoperative redosing is needed to ensure adequate serum and tissue concentrations of the antimicrobial agent during the procedure,[1,11] especially if the duration of the procedure exceeds two half-lives of the drug and when blood loss exceeds >1500 ml.[23–27] Edmiston *et al*. examined patients undergoing open or laparoscopic RYGB who received cefazolin 2 g intravenously 30–60 minutes before incision.[28] They reported decreasing concentrations of cefazolin in the serum, skin, adipose tissue and omental tissue with increasing BMI. Overall, therapeutic cefazolin tissue concentrations were achieved in only 48.1%, 28.6% and 10.2% of the BMI categories of 40–50, 50–60 and 60 or higher, respectively. Before the second dose (cefazolin 2 g delivered in the third hour of operation), serum concentrations were above the cefazolin breakpoint of 32 µg/ml in 41.1%, 18.2% and 0% of patients in the three BMI groups, respectively. Redosing may not be warranted in patients in whom the half-life of the antimicrobial agent is prolonged (e.g. patients with renal insufficiency or renal failure).[27] The redosing interval should be measured from the time of administration of the preoperative dose, not from the beginning of the procedure.

STATEMENT AND RECOMMENDATION

Statement

Grade A (RCTs present) – The second dose of the antimicrobial agent should be administered at 3 hours.

Recommendations

- One dose is recommended as AMP for surgeries.
- A second dose should be administered at 3 hours if the surgery extends longer.

Key question

What should be the dose of cefazolin?

Evidence

Antimicrobial-specific factors include dosage, half-life, frequency of administration and the degree of protein binding. Furthermore, the effectiveness of the antibiotic is also influenced by the MICs of pathogens targeted.[1] The standard dose of cefazolin is 1 g IV for surgical prophylaxis. Studies have shown that in obese patients there is an increased risk of SSI because the desired concentration of antibiotic is not achieved at the time of surgical incision.[1,10] Pharmacodynamic modelling also suggested that obesity decreased the probability of attaining the desired time above the MIC for the drug, suggesting the need for higher doses.[29] Studies have shown that the drug clearance (C1) and the volume of distribution (Vd) for cephalosporins was directly proportional to body weight causing increased clearance in the obese.[30,31] This finding supports increasing the dose of cephalosporins when used as surgical prophylaxis in the obese. Mann *et al*. observed that the Vd and C1 of cefamandole increased in obese patients undergoing Roux-en-Y gastrojejunostomy when compared with historical non-obese controls.[32] When the dose was doubled, improved therapeutic tissue concentrations were attained. In an RCT, Forse *et al*. observed that in obese patients undergoing vertical banded gastroplasty, serum and adipose cefazolin concentrations at the time of incision and closure were similar between obese patients who received a 2 g prophylactic dose versus non-obese patients who were given a 1 g prophylactic dose.[33] Furthermore, in this study, obese patients who received a 2 g prophylactic dose of cefazolin were found to have decreased postoperative infections compared with obese patients who received 1 g cefazolin (16.5 vs 5.6% for 1 g and 2 g of prophylactic cefazolin, respectively; p=0.03).[32] Thus, weight-based dosing seems appropriate for adult abdominal laparoscopic surgeries.

Dosage of AMP

These recommendations are based on the presumption that all the standard sterilization and infection control procedures are being followed.

STATEMENT AND RECOMMENDATION

Statement

Grade A (RCTs present) – Weight-based dosing should be used.

Recommendation

The antimicrobial prophylactic dose should be weight-based (i.e. cefazolin <120 kg=2 g; >120 kg=3 g).

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3

Sterilization and Infection Control of Laparoscopic Equipment and Instruments

DEFINITIONS

- **Sterilization** describes a process that destroys or eliminates all forms of microbial life and is carried out in healthcare facilities by physical or chemical methods. Steam under pressure, dry heat, EtO gas, hydrogen peroxide gas plasma, and liquid chemicals are the principal sterilizing agents.
- **Disinfection** describes a process that eliminates many or all pathogenic microorganisms, except bacterial spores, on inanimate objects. Commercial literature refer to 'disinfection' as 'sterilization' and items as 'partially sterile'.
- **Decontamination** – removal of all pathogenic micro-organisms from object to make them safe to handle/use/discard.

DISINFECTANTS

- **High-level disinfectants** will kill all micro-organisms except large numbers of bacterial spores.
- **Intermediate-level disinfectants** cidal for mycobacteria, vegetative bacteria, most viruses, and most fungi but do not necessarily kill bacterial spores.
- **Low-level disinfectants** can kill most vegetative bacteria, some fungi, and some viruses in a practical period of time (<10 minutes).
- **Germicides** can kill microorganisms, particularly pathogenic organisms ('germs').
- **Antiseptics** are germicides applied to living tissue and skin.
- **Disinfectants** are antimicrobials applied only to inanimate objects.

TYPES OF INSTRUMENTS

- **Critical** – objects that enter normally sterile tissue or the vascular system or through which blood flows should be sterile.
- **Semi-critical** – objects that touch mucous membranes or skin that is not intact require a disinfection process (high-level disinfection [HLD]) which kills all microorganisms but high numbers of bacterial spores.
- **Non-critical** – objects that touch only intact skin require low-level disinfection (or non-germicidal detergent).

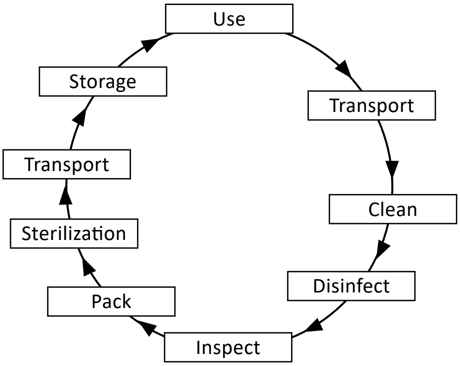
CRITICAL ITEMS

- Critical items confer a high risk for infection if they are contaminated with any microorganism.
- Thus, objects that enter sterile tissue or the vascular system must be sterile because any microbial contamination could transmit disease. This category includes **surgical instruments**, cardiac and urinary catheters, implants and ultrasound probes used in sterile body cavities.
- Most items in this category should be purchased as sterile or be **sterilized** with steam if possible. Heat-sensitive objects can be treated with EtO, hydrogen peroxide gas plasma; or if other methods are unsuitable, by liquid chemical sterilants.
- **Liquid chemical sterilants** reliably produce sterility only if cleaning precedes treatment and if proper guidelines are followed regarding concentration, contact time, temperature and pH.

SEMI-CRITICAL ITEMS – LAPAROSCOPES

- Laparoscopes entering sterile tissue ideally should be sterilized between operations.
- Meticulous cleaning must precede any high-level disinfection or sterilization process.
- Newer models of these instruments can withstand steam sterilization, which for critical items would be preferable to high-level disinfection.
- Although sterilization is preferred, no reports have been published of outbreaks resulting from high-level disinfection of these scopes when they are properly cleaned and disinfected at high levels.
- Laparoscopes entering sterile tissue ideally should be sterilized between operations.

DECONTAMINATION



Laparoscopic instruments

Complex in design and delicate in construction

Blood and tissue enter into the channels

Problems

- Lodging of bioburden in the crevices
- Gentlest methods need to be used for cleaning and sterilization

CLEANING PATH

On table – wipe/keep in water bowls

Running water – decrease the organic load

(+ve pressure due to CO_2 drives blood and debris into channels)

Dismantle and clean the channels

Dip in detergent and enzyme solution

Clean the channel, joints and serrations
Brush (preferably nylon)/water jet

Ultrasound cleaner

Drying

SUBSTANCES HARMFUL FOR INSTRUMENTS

- Saline
- Bleaching powder
- Iodine-based preparations
- Abrasive cleaners – vim powder, etc.
- Laundry detergents
- Surgeon's hand scrub
- Soap

Disinfection – Removes and/or kills the pathogenic microorganisms (Spores not killed)

Low Intermediate High

Low

- Reduces overall number of vegetative microorganism
- Does not destroy TB bacilli spores
- Application – OT table, floor, etc.

Intermediate

- Kills TB bacilli, most virus, and fungi but only some spores
- Application – OPD, where breach of skin/mucosa is not there.

High

- Kills most forms of microbial life including TB bacilli and most of the spores
- Application – scopes, delicate instruments, etc. in minor surgical procedures.

METHODS OF DISINFECTION

- Low temperature steam – 73 °C × 20 min
- Boiling water – 100 °C × 5 min
- Formaldehyde – air-tight chamber
- Glutaraldehyde 2% – effective against most bacteria, virus including hepatitis B&C/HIV

- Cidex solution (2.4% alkaline glutaraldehyde) provides high-level disinfection in 20–45 minutes
- Ortho-phthalaldehyde 0.55% (OPA) 12 minutes soak time at room temperature.

Chemical Disinfectants

Gluteraldehyde

- Destroys microorganisms by alkylation of amino acids
- Efficient bactericidal, fungicidal and virucidal activity but slow mycobactericital activity (>40 minutes)
- Once activated shelf-life – 14 days
- Contact time
  – High-level disinfection 20–90 minutes
  – Sterilization 6–10 hours

Paracetic acid

- Denatures protein and destroys cell membrane
- 30 minutes cycle
- Byproducts are non-toxic (acetic acid, water, oxygen)
- Maximum reuse period is 14 days.
- Effective in the presence of organic matter and at low temperatures
- Has an additional tuberculocidal activity

Ortho-phthalaldehyde (OPA)

- 0.55% 1,2-benzenedicarboxaldehyde

Mode of action
- interacts with amino acids, proteins and microorganisms
- superior mycobactericidal activity as compared to that of glutaraldehyde

Advantages
- More stable
- OPA was effective over a 14-day use cycle
- Less irritable to eyes

Disadvantage
- Stains proteins gray (including unprotected skin)

Soak time – 12 minutes

Hydrogen peroxide

- Bactericidal, virucidal, sporicidal and fungicidal properties

Mode of action

- Hydroxyl free radicals that can attack membrane lipids, DNA and other essential cell components.
- Accelerated hydrogen peroxide (0.5%) – kills viruses in 1 minute and mycobacteria and fungi in 5 minutes.

Perasafe

- 0.08% peracetic acid plus 1.0% hydrogen peroxide

Mode of action

Denatures protein and destroys cell membrane

Advantage

Effectively inactivates mycobacteria resistant to glutaraldehyde

Soak time – 10 minutes

SAFE USE OF CHEMICAL DISINFECTANT

- Check efficacy before use
- Use sterilized stainless steel tray for cidex
- Avoid using plastic tray for cidex
- Thoroughly clean and dry the instruments before putting in cidex (water on instrument changes the pH of cidex)
- Allow cidex to drip back into the tray
- Use gloved hands to pick up the instruments
- Lifter should not touch the tray wall (unsterile!)
- Rinse instruments thoroughly in sterile water (at least 3 times)
- Sterilize the sterile water tray.

Dry all the instruments before use

STERILIZATION

Techniques

Steam

- 121 °C × 15 minutes at 15 psi

Low temperature steam

- (73 °C) + formaldehyde
- Heat sensitive instruments
- Not very popular

Hot air

- Inefficient – good only for grease/ointment, oil, etc.

Ethylene trioxide (ETO)

- Heat sensitive instruments (make sure no soiled instrument)

Paracetic acid

- Denatures protein
- Destroys cell membrane
- 50–56 °C × 12 minutes
- Kills spores

Gama-irradiation – for industrial use

Moist heat (autoclave)

- Moist heat under pressure
- Routinely 121 °C for 15–30 minutes
- Flash autoclave 132 °C
  - 3 minutes non-porous items
  - 10 minutes porous items
  - 4 minutes for non-porous items
  - 4 minutes for porous items
- Quick penetration in material
- Unaffected by presence of organic matter
- For linens, metallic instruments, glass, fluids, plastics

Dry sterilization

- Same advantages as that of wet
- Temperature range 121 °C to 171 °C
- Disadvantage – cycle time is longer
  - 16 hours at 121 °C, 1 hour at 171 °C
  - load capacity is smaller

MONITORING

- Bowie – Davies tape
- Biological indicators
  - Bacillus stearothermophilus spores → for steam autoclaves
  - Bacillus subtilis spores → for dry heat sterilizers

Ethylene oxide

- Useful for a variety of medical devices, e.g. plastic, rubber, endoscope, instruments, fluids, etc.
- Disadvantages:
  – carcinogenic and mutagenic
  – chronic and acute toxicity syndromes
  – standard ETO cycle → 285 minutes + aeration time – 8 to 24 hours
  – occupational hazard to workers and environment
  – necessary aeration period of 8 to 24 hours
- Monitoring → with B subtilis spores

Low temperature steam with gaseous formaldehyde

- An alternative to ETO
- But formaldehyde itself is toxic and carcinogenic
- Combination of gaseous formaldehyde saturated steam at 65 °C

Suitable for heat-labile material, e.g. moss plastics, non-flexible endoscopes and equipment

- Monitoring → by spores
- B. Subtilis
- B. Stearothermophilies

Gas plasma sterilization

- For temperature and moisture-sensitive materials
- Mechanism

H_2O_2 vapours + strong electric field applied

H_2O_2 in plasma state

↓

Hydroxyl and Hydro-peroxy free radicles

↓

Disrupts cell membranes, enzymes and nucleic acids

↓

Cell death

↓

Electric field turned off

↓

Activated compounds recombine to form $H_2O + O_2$

Advantages

- No toxic byproducts
- Cycle time 55 to 75 minutes
- No aeration period → instruments immediately ready for use

Disadvantages

- Not for linens, powders and liquids
- Approved for use on
  - stainless steel devices with lumen >3 mm diameter and length <40 cm
  - metal and plastic instruments with lumen >6 mm diameter and length <31 cm
- Cycle turns off if there is slightest moisture
- Expensive – both equipment and running

FACTORS THAT EFFECT THE EFFICACY OF STERILIZATION AND DISINFECTION

- Prior cleaning of the object
- Organic and inorganic load present
- Type and level of microbial contamination
- Concentration of and exposure time to the germicide
- Physical nature of the object
- Presence of biofilms
- Temperature and pH of the disinfection process
- Relative humidity of the sterilization process (e.g. ethylene oxide)
- Duration of exposure

FORMALIN CHAMBER – THE BANE OF LAPAROSCOPY

- Size used: 9″ × 9″ × 20″
- Tablets: 4, 6, 8, 10, 12, 14
- Minimum exposure time: 24 hours

No Standardization

- How much leak?
- Chamber – How many times opened in 24 hours?

- How many tablets?
- Exposure – How many minutes?
- Temperature
- Do not shove instruments in a chamber and hop from one hospital to another.

RECOMMENDATIONS

- Formaldehyde-alcohol has been deleted as a recommended chemical sterilant or high-level disinfectant
- 3% phenolics and iodophors have been deleted as high-level disinfectants
- Isopropyl alcohol and ethyl alcohol have been excluded as high-level disinfectants.
- New chemical sterilants have been added, including hydrogen peroxide and peracetic acid.
- Exposure time required to achieve high-level disinfection has been changed from 10–30 minutes to 12 minutes or more depending on the Food and Drug Administration (FDA)-cleared claim on labels and the scientific literature
- Heat-tolerant endoscopes and accessories
  – steam sterilization is the first choice
- Heat-sensitive endoscopes and accessories
  – ETO/gas plasma/low temperature steam + formaldehyde
- Insufficient instruments/time to sterilize
  – immersion in 2% glutaraldehyde
  – at least 25 minutes
  – >25 minutes if mycobacterial infection suspected
  – at least 4 hours required to kill spores

REUSE OF DISPOSABLE LAPAROSCOPIC INSTRUMENTS – NO CONSENSUS

- Reusing disposable laparoscopic instruments did not change the operative and postoperative outcomes or the infection rate.[1]
- None of the patients had infection at the wound site or intra-abdominally.[2]
- Disposable laparoscopic instruments with a relatively complex structure are not effective and may result in nosocomial disease transmission.[3]

NOSOCOMIAL TUBERCULAR INFECTION

Several studies have shown that nosocomial tubercular infection is a totally avoidable infection.[4–7]

CONCLUSIONS

- Thorough cleaning is an important primary step
- It is essential to follow rigid protocols for instrument cleaning and sterilization.
- Only well-established methods of sterilization/high-level disinfection should be used.
- Some current practices should be abolished.
  – formalin chambers
  – reuse of disposable instruments
- It is necessary to establish stringent regulations for manufacturers of instruments.

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4

Use of Energy Sources in Laparoscopic Surgery

ELECTROSURGERY IN LAPAROSCOPY

A basic understanding of electrophysics is essential for surgeons to safely apply electrosurgical technology for patient care and avoid complications.[1] Electrosurgery is one of the most commonly used energy systems in laparoscopic surgery.[2] The risk of complications is directly linked to the surgeon's fundamental knowledge of instruments, surgical technique, biophysics, relevant anatomy, and safe technical equipment. When principles are appropriately applied, electrosurgery is safe and effective. Electrothermal injury may result from direct application, failure of insulation, direct coupling, and capacitive coupling.[3]

Electrocautery is NOT Electrosurgery

The terms electrocautery and electrosurgery are frequently used interchangeably; however, these terms define two distinctly different modalities.

Electrocautery is the use of electricity to heat an object which is then used to burn a specific site, for example a hot wire.

Electrosurgery refers to cutting and coagulation of tissue using high frequency electrical current.[4]

BASIC PRINCIPLES OF ELECTROSURGERY

Energy is the product of current and voltage.

Power at a given point is measured in watts (W). It corresponds to the rate of work being performed.

Current (I) is what flows in a wire or conductor like water flowing down a river. Current flows from negative to positive on the surface of a conductor. Current is measured in amperes (A).

Voltage (V) is the difference in electrical potential between two points in a circuit. It makes the current flow through a circuit and is measured in volts (V).

Resistance determines how much current will flow through a component. A very high resistance allows a small amount of current to flow. A very low resistance allows a large amount of current to flow. Resistance is measured in ohms.

Ohm's law states that voltage, i.e. $V = I \times R$

The function of cutting/coagulation is neither that of voltage nor of the current but depends on power in watts.

Power $(P) = V \times I$ (watts). The number reflected on the electrosurgical unit is the wattage. Energy = P × Time

Types of electrosurgery

- Monopolar
- Bipolar

In monopolar electrodes, radiofrequency currents flow from the generator through the active electrode, into target tissue, through the patient, into the dispersive electrode, and then return to the generator.[5] If the return electrode is properly placed, the desired electrosurgical effect takes place only at the active electrode, not at the dispersive electrode.

In bipolar electrodes, both arms of the circuit are delivered to the surgical instrument, and no return electrode plate is required to be placed on the patient.[6] The flow of current is restricted between these two poles. The poles are in close proximity to each other, so lower voltages are used to achieve the effect on the tissue.

Most modern bipolar units employ the cutting waveform, because it is a lower voltage waveform, allowing homeostasis to be established without unnecessary charring.[7] Bipolar electrosurgery has a limited area of thermal spread compared with that of monopolar electrosurgery.[8,9]

Technically both monopolar and bipolar energies are 'bipolar' as there is always an active electrode and a passive electrode.

WAVEFORM

A pure cutting waveform (current mode) is a continuous, unmodulated, undamped waveform.

A coagulation waveform is an interrupted, modulated and damped current with an initial high waveform that quickly dissipates.[6,10]

The coagulation mode produces an interrupted waveform with a duty cycle that is ‘on’ about 6% of the time, i.e. 6% on, 94% off. Blended modes are variations of the ‘cutting’ current. As the duty cycle (amount of time the current is on) diminishes, the voltage must correspondingly increase, provided the power remains constant. The percentage duty cycle can vary, e.g. 80% on, 20% off; 66% on, 34% off; and 50% on, 50% off, and so on. The term ‘blended’ does not refer to a blend of currents, but rather to a blend of surgical effects.

The blended mode permits the surgeon to cut and coagulate at the same time. With cooling periods, cell wall explosion and vaporization are accompanied by slow dehydration of cellular fluid and protein.

WHY DO PATIENTS DON’T GET SHOCK

The reason a patient does not get electrical neurological or muscular stimulation is not because the patient is anaesthesized. It has been seen that neuromuscular stimulation ceases with high frequency currents of more than 100 kHz which is known as radiofrequency current.

One of the principal difference between the cutting and coagulation modes for monopolar diathermy is the difference in voltage and current. Coagulation has high voltage and low ampereage and cutting has high ampereage and low voltage. Blended modes are in between.

TISSUE EFFECTS

- Cutting
- Fulguration
- Desiccation

When a radiofrequency (500 Hz to 3 MHz) alternating current is applied across the cell, these cations and anions rapidly oscillate within the cytoplasm and elevate the temperature within the cell. If the intracellular temperature reaches 70 °C to 80 °C, protein denaturation occurs, initiating the process of ‘white coagulation’ or electrocoagulation.

If the temperature rises quickly to 90 °C, the cells lose water content (dehydration), but preserve architecture in the process which is termed as desiccation.[11] Electrosurgical desiccation can occur using either the cutting or coagulating current modes on the generator.

Table 1. Comparison of the three tissue effects

Tissue effect	Surgical effect	Current waveform	Contact with tissue	Characteristics
Vaporization	Cutting	Continuous (cut)	No contact	Low-voltage sparks, moderate smoke
Fulguration	Haemostasis of small vessels (<1 mm)	Interrupted (coagulation)	No contact	High-voltage sparks, significant smoke and charring
Desiccation	Haemostasis of small vessels (<1 mm)	Continuous (cut) or Interrupted (coagulation)	Contact	Similar action to bipolar electrosurgery, pronounced lateral thermal spread

When the temperature quickly reaches 100 °C and beyond, the intercellular water boils. Subsequently, the formation of steam and intracellular expansion results in explosive vaporization of the cell. The cutting effect (vaporization) is usually produced using a pointed or thin loop-shaped electrode held near to, but not in contact with, the tissue. This concentrates the current at its tip. The current then arcs to the tissue, rapidly elevating the local intracellular temperature and causing vaporization.[11]

Finally, if the cellular temperature reaches 200 °C or more, the process of carbonization (fulguration) occurs. The fulguration effect is a process in which the tissue is superficially carbonized through high-voltage electrosurgical arching,[11] i.e. holding the electrode a short distance away from the tissue, the electric current is delivered by way of sparks 'jumping' across the air space and contacting the tissue. The most common surgical indication for fulguration is rapid control of bleeding across a wide area, such as oozing capillary beds.

To avoid charring, it is better to keep the electrode moving during the procedure. For example, a monopolar electrode with coagulation current and near-contact technique can fulgurate tissue; a bipolar electrode with cutting current and the two-blade contact technique can desiccate tissue.[1,12,13]

STATEMENT AND RECOMMENDATION

Statement

Cutting current must be used for cutting and coagulation in laparoscopic surgery.

Recommendation

Grade A

Low voltage cutting current in monopolar electrosurgery or bipolar electrosurgery, which also uses low voltage cutting current, is the preferred mode for contact coagulation in laparoscopic surgery.

MAS SAFETY CONSIDERATIONS

When electrosurgery is used in the context of minimal access surgery (MAS), it raises a new set of safety concerns. Some of these are:

- Direct coupling
- Insulation failure
- Capacitive coupling

Electrosurgical injury

Injury from inadvertent energy transfer has a reported incidence of 1 to 5 recognized injuries per 1000 cases.

Electrosurgical injury occurs when the electrosurgical unit is accidentally activated while the active electrode is in close proximity to another metal instrument and current from the active electrode flows through the adjacent instrument through the pathway of least resistance, and potentially damages adjacent structures or organs not within the visual field that are in direct contact with the secondary instrument.[14]

STATEMENT AND RECOMMENDATION

Statement

All instruments should be kept under direct vision as far as possible while using energy.

Level of evidence to avoid direct coupling

It can be prevented with visualization of the electrode in contact with the target tissue and avoiding contact with any other conductive instrument before activating the electrode (LoE 3).[1]

Recommendation

Grade C

All laparoscopic instruments should be directly visualized to avoid direct coupling injuries using high voltage coagulation current.

Insulation failure

- Insulation failure is the main cause of laparoscopic electrosurgical injuries and distal third of laparoscopic instruments being the most common site of insulation failure.
- Eighteen percent of insulation defects are located in the section of the instrument most likely to create a catastrophic electrosurgical injury.

Level of evidence in bipolar electrosurgery

- Bipolar electrosurgery has a more limited area of thermal spread (maximal lateral thermal spread within 5 mm), so the depth of damage to the serosal layer is limited. Therefore, it is better to use the bipolar than monopolar method.[5,7,9]
- Disadvantages of bipolar electrosurgery include the increased time needed for coagulation due to a low power setting, charring, and tissue adherence with incidental tearing of adjacent blood vessels.[5,7,9] **(LoE 2)**

Level of evidence in bipolar electrosurgery between cutting and coagulation current

- Effect of voltage and modulation on seal quality using bipolar electrosurgery between cutting and coagulation current studied by Soderstrom concluded that low voltage continuous current causes coagulation in full thickness of tissues. High voltage modulated coagulation current causes incomplete coaptive coagulation. There is superficial coagulation, the deeper layers are insulated from the coagulation effect, the caramelized superficial layer sticks to the instrument and can tear, causing further bleeding.[5] **(LoE 1)**

Originally described as 'Zone 2' by Voyles and Tucker, the location along the instrument, which is outside the view of the monitor but distal to the protective cannula, carries the highest risk for creating an injury that even the most attentive surgeon is unable to detect.[14]

STATEMENT AND RECOMMENDATION

Statement

Cutting current should be preferred to avoid damage to insulation.

Level of evidence in insulation failure

- Excessive use of reusable instruments, particularly with repetitive passage through trocars, and frequent mechanized sterilization are the leading causes of insulation failure.
- By lowering the concentration of the current used, preferably cutting current, and use of an active electrode monitoring system, the risk of accidental burns can be reduced (LoE 2c).[13]

Recommendations

Grade B

- Disposable instruments have a lower incidence of insulation failure compared with reusable instruments.
- Cutting current is preferred.
- Prolonged activation of an electrosurgical instrument should be avoided.

Capacitive coupling

Capacitive coupling is electrical current that is established in tissue or in metal instruments running parallel to but not directly in contact with the active electrode. This occurs when electric current is transferred from one conductor (the active electrode) through intact insulation and into adjacent conductive materials (e.g. bowel) without direct contact.[1]

STATEMENT AND RECOMMENDATION

Statements

- Hybrid cannulas must not be used.
- Use of all-metal cannulas reduces capacitive coupling.

Level of evidence to prevent capacitive coupling

- Hybrid cannulas (plastic collar) convert metal trocar into a high energy capacitor.
- Ironically, the use of metal trocars can actually reduce this risk by allowing the stored energy from a capacitor to dissipate over the large surface area of the patient's skin.
- The use of an active electrode monitoring system and limiting the amount of time that a high voltage setting is used can also eliminate concerns about capacitive coupling (LoE 2c).

Recommendation

Grade B

Metallic trocars should be preferred over plastic trocars while using coagulative current to prevent capacitive coupling.

ADVANCED BIPOLAR ELECTROSURGERY

Advanced bipolar electrosurgery includes:

- LigaSure
- EnSeal

In advanced bipolar electrosurgery, the tissue impedance is monitored with continuous adjustment of the generated voltage and current to maintain the lowest possible power setting to achieve the desired tissue effect.[15]

Bipolar vessel sealing devices – LigaSure (VALLEYLAB)

- Delivers high current (4 A), low voltage (180 V) along with pressure from the jaws to tissue
- Can seal vessels up to 7 mm in size
- Energy of system monitors is expended while denaturing the collagen and elastin within the vessels walls.

- During the cooling phase, cross-linking occurs again and creates a new seal.
- Computer algorithm adjusts the current and voltage based on real-time measures of tissue impedance – constant delivery of wattage over a broad range of tissue types
- Lateral spread 2 mm
- Can withstand 3 times SBP[16]

Bipolar vessel sealing devices – enseal (SURGRx)

- It uses a bipolar electrode to concentrate energy on tissue within the plastic jaws of the instrument and it claims to offer improved efficacy by using a temperature sensitive matrix (nanopolar thermostats) embedded within the jaws of the device that controls the energy delivered to the electrode–tissue interface.
- The instrument can seal vessels between 1 and 7 mm.[17]

Bipolar vessel sealing devices – plasmakintetic (GYRUS)

- Plasmakinetic generates low voltage, high current in pulses and is based on vapour pulse coagulation.
- Pulse-off periods of vapour pulse coagulation allow tissue to cool and moisture to return to the targeted area, thereby greatly reducing hot spots and formation of a coagulum. This technology also results in evenly coagulated target tissue, minimal thermal spread, less sticking, and enhanced haemostasis.[17]

Ultrasonic energy

The harmonic scalpel is an ultrasonic surgical instrument for cutting and coagulating tissue, operating at a frequency of 55.5 kHz/s.

- No electrosurgical current is generated.
- The combination of mechanical energy and the heat that is generated causes denaturation of protein and formation of a coagulum that seals small blood vessels.
- The device has demonstrated the ability to coagulate blood vessels up to 5 mm in diameter with less heat, charring and thermal injury to surrounding tissues.[18]

Low power [CUSA]

- Vibrates at 23.5–25 kHz

- Longitudinal displacement of 200–360 μm
- Cavitation occurs in tissues with high water content
- Little coagulation because of cooling by saline irrigation and little tissue contact
- Collagen-rich tissue spared

High power [HARMONIC ACE]

- Vibrates at 55.5 kHz
- Longitudinal displacement of 80–200 μm (at the tip)
- Local temperature increases to 80 °C
- Denatures proteins by vibration and creates a sticky coagulum that seals vessels.
- Can seal vessels up to 5 mm (FDA approval 3 mm)

Advantages of ultrasonic energy

- No charring of tissues – planes maintained
- Absence of coagulated tissue sticking to active element
- No heat sink effect as is seen in electrosurgery in case of blood vessels
- Much lower temperatures (80 °C versus 400 °C in electrosurgery)
- Can be used as a blunt dissector

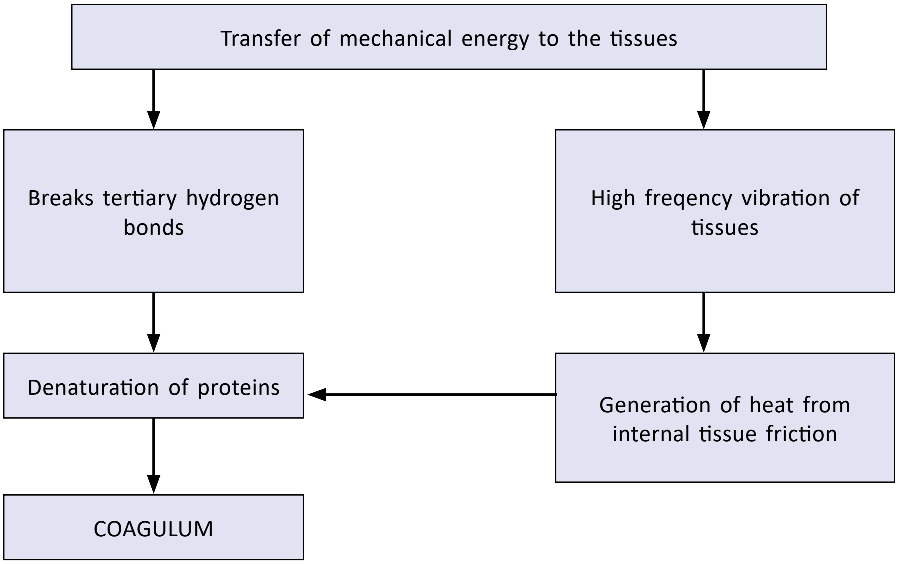

Fig. 1. Mechanism of ultrasonic energy in forming a coagulum

- Less coagulation time; less or no smoke
- No electric current

Comparison of four energy-based vascular sealing and cutting instruments

- The four systems are: Harmonic ACE®, LigaSure® and EnSeal® vessel fusion system. The diameters of the vessels, speed and adequacy of the cutting and sealing process, and bursting pressures were compared.[19]
- The bursting pressures with EnSeal™ were significantly higher than that with all the other instruments. Harmonic ACE™ was the fastest sealing instrument and LigaSure was the slowest. EnSeal and LigaSure created less radial thermal damage to the adventitial collagen of the vessels (LoE 2b, Grade B).

Head-to-head studies

- Harold *et al.*[19]
  - Ligated vessel burst pressure compared for ultrasonic/LigaSure/ titanium clips/plastic clips
  - LigaSure > US burst pressure for 4–7 mm
  - Clips produced highest burst pressure
  - LigaSure was as good as clips for 4–5 mm
  - Thermal spread energy sources ~2 mm
- Hruby *et al.*[20]
  - Harmonic Ace (up to 5 mm), LigaSure (up to 7 mm)
  - Consistent reproducible force
  - Harmonic ACE is two times faster.

Comparison between LigaSure and harmonic

- The LigaSure vessel sealing device is superior over Harmonic Scalpel. It depends on the surgeon preference to deliver the best surgical outcomes in terms of bloodless surgery and safer experience (LoE 2b).
- Estimated blood loss was significantly less in the bipolar vessel sealer when compared with the harmonic scalpel. The bipolar vessel sealer is a reliable and safe tool for reducing intraoperative blood loss in patients undergoing total laparoscopic hysterectomy.[21,22]

STATEMENT AND RECOMMENDATION

Statement

Bipolar sealing devices should be used for achieving better vessel sealing up to 7 mm.

Recommendations

Grade B

- Bipolar sealing devices are better for sealing vessels than ultrasonic shears, which cause less lateral thermal damage compared to harmonic devices.
- An ultrasonic device is faster and has more maneuverability than bipolar sealing devices.

EMERGING TECNOLOGY THUNDERBEAT®

Thunderbeat® is the integration of both bipolar and ultrasonic energies delivered simultaneously from a single versatile instrument. With benefits of each individual energy, the ability to rapidly cut tissue with ultrasonic energy, and the ability to create reliable vessel seals with bipolar energy.[23]

- Fastest in the cutting speed, thereby reducing the operation time
- Reliable 7 mm vessel sealing
- Precise dissection with a fine Jaw design
- Bipolar energy is always available for haemostasis without cutting
- Minimal thermal spread
- Fewer instrument exchanges
- Reduced generation of mist helps in maintaining visibility.

STATEMENT AND RECOMMENDATION

Statement

Combined ultrasonic and bipolar technology may be used for optimum sealing of vessels.

Recommendation

Grade B

Combined use of ultrasonic energy and bipolar electrosurgery using a low voltage cutting mode provides rapid cutting and reliable sealing of vessels up to 7 mm.

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5

Equipment and Instruments

Safe performance of laparoscopic surgery depends on availability of quality equipment and instruments. Over the years as technology has advanced, newer and more sophisticated instruments have become available to surgeons. This chapter gives the recommendations based on current evidence for selection and use of various equipment and instruments used in laparoscopic surgery. Certain limitations should however be kept in mind. These are (i) there are only a few areas in which evidence-based literature is available; (ii) the choice of equipment and instruments usually depends on the preference of the surgeon, financial constraints and local availability; and (iii) introduction of new equipment with ever-changing technology. In the absence of good quality evidence the recommendations are based on expert opinion.

The following equipment and instruments are considered:

1. *Optics:* Laparoscope, endocamera, display monitor, light source, light cable
2. Insufflator
3. *Instruments:* Veress needle, trocars, hand instruments, retractors, needle holder
4. Mini-laparoscopic instruments
5. Laparoscopic stapling devices

LAPAROSCOPE

Most laparoscopes are based on the Hopkins rod-lens system design and are available in diameters ranging from 2 mm to 10 mm, viewing angles of 0°, 30° and 45° and standard as well as longer lengths. The chip-on-the-stick laparoscopes carrying a charged couple device (CCD) at the tip are not in common use.

Key question

Which laparoscope – a 0° or a 30° – is preferred for laparoscopic surgery?

Evidence

There is no good-quality evidence to guide the choice of a laparoscope.

STATEMENT AND RECOMMENDATION

Statement

The choice of one type of laparoscope over the other has not been studied in the literature. Hence the recommendations in this area are governed by convention and expert opinion (LoE 5).

Recommendations

Grade D

- A 0° laparoscope may be used in situations where an end-on vision is required, e.g. during abdominal entry using an optical access trocar or initial dissection for a totally extra peritoneal (TEP).
- A 30° laparoscope provides access to deeper spaces and tends to be more versatile and hence may be preferred over its 0° counterpart for most laparoscopic procedures.
- A 45° laparoscope may be useful in bariatric surgery.

Key question

What length of laparoscope is generally preferred?

Evidence

There is no good-quality evidence to guide the length of a laparoscope.

STATEMENT AND RECOMMENDATION

Statement

The choice of length of the laparoscope has not been studied in the literature. Hence the recommendation in this area is governed by convention and expert opinion (LoE 5).

(continued)

STATEMENT AND RECOMMENDATION

Recommendation

Grade D

For most surgeries, a 31 cm laparoscope is chosen, whereas for bariatric procedures a longer (42 cm) laparoscope is preferred.

Key question

When is a 5 mm laparoscope preferred?

Evidence

There is no good-quality evidence to guide the choice between a 10 mm and 5 mm laparoscope.

STATEMENT AND RECOMMENDATION

Statement

The choice of size of the laparoscope has not been studied in the literature. Hence the recommendation in this area is governed by convention and expert opinion (LoE 5).

Recommendation

Grade D

A 5 mm laparoscope may be preferred over a 10 mm one in conjunction with an optical access trocar at the Palmer's point. It may also be possible to use a 5 mm laparoscope for carrying out procedures, provided it is coupled with a high-definition (HD) endocamera.

ENDOCAMERA

The endocamera systems have evolved over the years from single-chip to three-chip to HD to 4K exactly and 3D systems. A newer endocamera system utilizes the near-infrared imaging along with indocyanine green (ICG) dye.

Key question

Is a true HD system better than a standard three-chip endocamera system?

Evidence

Hagiike *et al.*[1] analysed the use of the previous two systems by 53 participants in laboratory settings and in actual surgery. All participants subjectively evaluated the HD system as being superior to the standard-definition (SD) system and the time taken for knot-tying was significantly less in the HD system.

STATEMENT AND RECOMMENDATION

Statement

A true HD endocamera, by virtue of producing an image of better resolution, appears to be superior to the three-chip camera with a standard monitor (SD system) (LoE 3).

Recommendation

Grade C

An HD endocamera is preferred over an SD endocamera.

Key question

Does a 3D endocamera system carry an advantage over a 2D system?

Evidence

Several studies have compared the 3D systems with the 2D systems in laboratory settings. Folaranmi *et al.*[2] assessed the time taken by five experts and five novices to perform a validated laparoscopic task on a box simulator using 2D and 3D images. In both the experts and novices, the time taken to complete the task was significantly lower when they used the 3D system. In fact, the use of 3D system was able to improve a novice's performance to the extent that it was not statistically different from that of an expert using a 2D system. Cicione *et al.*[3] assessed the performance of 18 surgeons without previous laparoscopic experience in performance of pyeloplasty and partial nephrectomy in a porcine model using 2D and 3D systems. On a 5-point global rating system, surgeons using a 3D system scored higher than those using a 2D system. However, headache (18.1%), nausea (18.1%) and visual disturbance (18.1%) were common issues reported by surgeons who used the 3D system.

STATEMENT AND RECOMMENDATION

Statement

A 3D endocamera improves the task efficiency as compared to a 2D endocamera and may decrease the time for performance of complex procedures (LoE 3).

Recommendation

Grade C

Whenever available, a 3D endocamera may be preferred over a 2D endocamera.

Key question

Does the near-infrared imaging camera system provide adequate visualization of the biliary tree during laparoscopic cholecystectomy (LC)?

Evidence

Vlek *et al.*[4] recently reported a systematic review evaluating the potential of the near-infrared imaging technique with ICG to identify the biliary tree during LC. Although the biliary tree can be visualized adequately using this near-infrared cholangiography, the authors pointed out that further research is required for optimization and standardization of the technique.

STATEMENT AND RECOMMENDATION

Statement

Use of a near-infrared imaging system with ICG allows visualization of the biliary tree similar to that obtained by intraoperative cholangiography (IOC) (LoE 3).

Recommendation

Grade C

Whenever available, use of a near-infrared imaging system with ICG may be used for visualization of the biliary tree during LC.

DISPLAY MONITOR

The older cathode ray tube (CRT) monitors are today more or less replaced by the LCD and LED monitors. The resolutions of the modern display monitors are standard HD (1280 × 720), full HD (1920 × 1080), 4K (3840 × 2160).

Key question

What characteristics are desirable in choosing a display monitor for laparoscopic surgery?

Evidence

There is no good-quality evidence in the surgical literature to guide the choice of a display monitor.

STATEMENT AND RECOMMENDATION

Statement

It is essential to choose a laparoscope, endocamera and display monitor that complement one another in terms of the resolution and other features so that the best possible image is obtained (LoE 5).

Recommendation

Grade D

LED monitors may be preferred over the LCD monitors as they provide a superior image, consume less electricity and are more durable.

Key question

What should be the aspect ratio of a display monitor used for laparoscopic surgery?

Evidence

Display monitors with an aspect ratio of 16:9 provide an image with a more natural, panoramic view. Also, this type of monitor with a wider peripheral field of vision allows the instruments entering the operative field to be spotted early.[5]

STATEMENT AND RECOMMENDATION

Statement

A display monitor of appropriate size and an aspect ratio of 16:9 may enhance the safety of surgery (LoE 3).

Recommendation

Grade C

It may be preferable to have an aspect ratio of 16:9 in display monitors for use in laparoscopic surgery.

LIGHT SOURCE

The common light sources used for laparoscopic surgery are halogen, xenon and LED.

Key question

How do the various light sources compare with each other?

Evidence

There is no good-quality evidence to compare the various types of light sources in laparoscopic surgery.

STATEMENT AND RECOMMENDATION

Statements

- The halogen light source is cheaper and its bulb lasts longer as compared to the xenon light source.
- A xenon light source may be desirable as compared to a halogen one as the light provided is more natural.
- The LED light source produces less heat and light that is comparable in intensity and colour temperature to the xenon light source (LoE 5).

(continued)

STATEMENT AND RECOMMENDATION

Recommendation

Grade D

The choice of a light source may be based on factors such as the type of endocamera with which it will be coupled, the diameter of the light cable (thinner cables transmit less light) and cost.

LIGHT CABLE

In the light cables, the light is conducted around a curved glass on the principle of total internal reflection. Two types of light cables available are the fibreoptic cables and the fluid crystal gel cables.

Key question

Which type of light cable is preferred in laparoscopic surgery and why?

Evidence

There is no evidence to compare the types of light cables used in laparoscopic surgery.

STATEMENT AND RECOMMENDATION

Statement

Although the gel cables carry more light, the fibreoptic cables are more flexible and produce less heat (LoE 5).

Recommendation

Grade D

Fibreoptic cables may be preferred over the gel cables due to their easier availability and ease of handling.

Key question

What diameter and length of light cable is preferred?

Evidence

There is no evidence to compare the thickness of light cables used in laparoscopic surgery.

STATEMENT AND RECOMMENDATION

Statement

Wider fiberoptic cables carry more light (LoE 5).

Recommendation

Grade D

A wide diameter (4.5 to 5 mm) and long (more than 2 metre) light cable should be used for laparoscopic surgery.

INSUFFLATOR AND INSUFFLATION GASES

The insufflator uses controlled pressure insufflation of the peritoneal cavity to achieve the workspace necessary for laparoscopic surgery.

Key question

What features should a modern insufflator have for use in laparoscopic surgery?

Evidence

There is no robust evidence available to compare the various types of insufflators.

STATEMENT AND RECOMMENDATION

Statement

An insufflator should have visual indicators for preset and actual pressures as well as preset and actual flow rates, which indicate the amount of gas available in the cylinder. The maximum flow rate should be more than 10 L per minute (LoE 5).

Recommendation

Grade D

The choice of insufflator should be guided by the types and complexity of surgeries to be undertaken.

Key question

Which is the most preferred gas for laparoscopic surgery?

Evidence

A Cochrane review identified trials that compared various gases used in laparoscopic surgery.[6] The authors concluded that the quality of evidence was very low. The effects of nitrous oxide and helium pneumoperitoneum compared with carbon dioxide pneumoperitoneum were uncertain. The reviewers felt that the safety of nitrous oxide, helium and room air pneumoperitoneum was yet to be established.

STATEMENT AND RECOMMENDATION

Statement

Carbon dioxide is the gas that is commonly used in laparoscopic surgery due to its easy availability and well-understood physiological effects (LoE 2).

Recommendation

Grade C

Carbon dioxide is the preferred gas for laparoscopic surgery.

Key question

Does the use of heated or humidified gas carry any benefits?

Evidence

Two meta-analyses that analysed the results of several randomized trials have shown that heated, humidified gas leads to a very small reduction in the core body temperature. However, this does not account for clinical improvement in patient outcomes.[7,8]

STATEMENT AND RECOMMENDATION

Statement

The use of heated or humidified gas in laparoscopic surgery does not alter patient outcomes (LoE 1).

Recommendation

Grade A

The use of heated gas, with or without humidification, has no added benefits.

VERESS NEEDLE

Veress needle is used to create pneumoperitoneum and is available in disposable and metallic reusable varieties.

Key question

What safety checks are recommended before the use of a Veress needle?

Evidence

There is no high-quality evidence in this area and the recommendations are derived from convention and expert opinion.

STATEMENT AND RECOMMENDATION

Statement

Safety checks prior to and during the use of a veress needle are an important part of the safety drill undertaken during laparoscopic surgery (LoE 5).

(continued)

STATEMENT AND RECOMMENDATION

Recommendations

Grade D

The following pre-use safety checks are recommended:[9]

- Check the patency by flushing the needle,
- Occlude the tip and push the fluid under moderate pressure to check for leaks, and
- Push the blunt tip against a solid flat surface to ensure that the blunt tip retracts easily and springs forward rapidly and smoothly.

The following intra-use checks are required to confirm the positioning of the needle tip in the intra-peritoneal space before commencing insufflation:

- Aspirate to exclude blood, bowel contents or urine entering the barrel of the syringe,
- Instil 5 ml of saline and confirm its free flow into the abdominal cavity without resistance,
- Re-aspirate to confirm that no saline returns into the syringe, and
- Do the 'hanging drop test' to confirm that a drop of fluid placed in the hub of the needle falls rapidly into the abdominal cavity.

TROCARS

The term 'trocar' refers not to the entire assembly but actually the stylet that is introduced through the tube or cannula. The trocars are generally of metallic/reusable or plastic/disposable variety and are available in various diameters (12 mm, 10 mm, 5 mm, 3 mm, etc.) The optical access trocars have a transparent channel that houses a laparoscope during the insertion of the trocar through the layers of the abdominal wall.

Key question

Which type of tip – conical or pyramidal – is preferred for the trocars?

Evidence

Bohm *et al.*, in an animal study, compared the entry force needed to perforate the abdominal wall, the removal force necessary and the size of the defect in the abdominal wall using conical and pyramidal tip trocars.[10] They found that the pyramidal trocars caused a larger defect than the conical ones.

STATEMENT AND RECOMMENDATION

Statement

Metallic trocars with a conical tip require a higher force of penetration but leave a smaller defect as compared to the pyramidal tip trocars (LoE 5).

Recommendation

Grade D

Conical-tipped trocars may be preferred over the pyramidal-tipped ones.

Key question

Which trocars are associated with the lowest incidence of complications?

Evidence

A detailed Cochrane review which compared the safety aspects associated with the use of different types of trocars found no difference in the incidence of major complications such as vascular or visceral injury when comparing different trocar types with one another.[11]

STATEMENT AND RECOMMENDATION

Statement

The type of trocar used has no bearing on the incidence of major complications (LoE 2).

Recommendation

Grade B

It is the attention to detail in the use of the trocar that determines their safety and therefore it is necessary for the surgeons to familiarize themselves with the features of a particular trocar and its safe use.

HAND INSTRUMENTS

Laparoscopic hand instruments vary in diameter, but the ones measuring 5 mm or 10 mm are most commonly used in adult laparoscopy. Similarly, lengths of the instruments vary from 18 cm to 45 cm and the ones 36 cm in length are used in adults. Reusable laparoscopic instruments can be dismantled to allow thorough cleaning and sterilization. These commonly comprise (i) a handle, (ii) an outer tube and (iii) an insert with a tip. The handles may be of a pistol-grip or coaxial variety.

Key question

How can a surgeon choose the hand instruments?

Evidence

There is no evidence to compare the various aspects of design of hand instruments.

STATEMENT AND RECOMMENDATION

Statement

It is not possible to provide firm guidance as to the superiority of any particular type of handle design or length of hand instruments (LoE 5).

Recommendation

Grade D

The choice of instruments is often subjective and surgeons should choose instruments based on their own comfort and familiarity with a particular design.

RETRACTORS

Laparoscopic retractors are commonly required in upper abdominal/hiatal surgeries to retract the liver. Most of these retractors are fixed to table-mounted rigid or flexible systems so as to provide uninterrupted and sustained retraction for the duration of the procedure. The liver retractors are of three types: (i) Nathanson hook retractor – which is introduced through a skin incision and supports the entire liver, (ii) fan-shaped retractors and (iii) articulating retractors – which are introduced via a 5 mm trocar and activated to one of the predetermined shapes (circular, triangular, hook or angled).

Key question

Which retractor is preferred for retraction of the liver?

Evidence

There is no evidence to compare the various laparoscopic liver retractors.

STATEMENT AND RECOMMENDATION

Statement

A suitable method of liver retraction should be used whenever required (LoE 5).

Recommendation

Grade D

As the Nathanson retractor appears to be less traumatic than the other types of retractors, it may be preferred for retraction of the liver.

NEEDLE HOLDERS

Intracorporeal tissue approximation is a prerequisite in almost all advanced laparoscopic surgical procedures and the needle holder or needle driver is an integral part of this process.

Key question

What are the features of an ideal needle holder?

Evidence

van Veelen *et al*. sought to form new design guidelines for an ergonomic needle holder based on a review of the literature, measurements of the handle-shaft angle in the operating room (OR) and anthropometric data.[12]

STATEMENT AND RECOMMENDATION

Statements

The ideal needle holder should fulfil the following criteria:[12]

- Operability with one hand of the surgeon,
- Handle of the needle holder has to support right- and left-handed suturing,
- There should be an angle of 40° to 50° between the handle and the shaft of the instrument,
- The handle should not open by more than 41 mm, and
- The instrument handle should be at least 10 mm wide (LoE 5).

Recommendation

Grade D

A coaxial needle holder with straight or curved and serrated tips that is best suited for an individual surgeon's grip may be chosen.

Key question

Are the self-righting needle holders preferred over the regular needle holders?

Evidence

There are no data to compare the self-righting with the standard laparoscopic needle holders. There appear to be two major drawbacks with the self-righting needle holders which enable the needle to be held upright as soon as it is picked up. One, the raised edges are sharp and frequently damage or cut through the thread. Secondly, the needle will always be perpendicular to the long axis of the needle holder, which may not always be desirable.

STATEMENT AND RECOMMENDATION

Statement

The self-righting needle holder probably does not provide any advantage over the standard needle holder (LoE 5).

Recommendation

Grade D

Routine use of a self-righting needle holder is not recommended.

Key question

How do the automated suturing devices compare with the standard needle holders?

Evidence

There is some data to show that these devices can reduce the suturing time as well as decrease the learning curve for beginners.[13] However, this comes at an increased cost. In complex procedures such as bariatric surgery, there may be a benefit to using the automated suturing devices as they allow the surgeon to carry out most manoeuvres with a single hand.

STATEMENTS AND RECOMMENDATION

Statement

Automated suturing devices may reduce the suturing time and learning curve for the beginners (LoE 5).

Recommendation

Grade D

The automated suturing devices may be of benefit in complex laparoscopic procedures.

MINI LAPAROSCOPIC INSTRUMENTS

Traditional laparoscopy requires the placement of 5–12 mm incisions with the use of a 10 mm laparoscope. Mini-laparoscopy is defined by the use of a 5 mm laparoscope and other ports smaller than 5 mm, usually 2–3 mm. It is also known by other names such as 'mini-laparoscopic surgery', 'needlescopic surgery' or 'reduced trocar size' surgery.

Key question

Are mini laparoscopic procedures superior to traditional laparoscopic operation?

Evidence

There is no conclusive evidence of mini laparoscopy being superior to traditional laparoscopic surgery.[14–16]

STATEMENT AND RECOMMENDATION

Statement

Mini-laparoscopic surgery offers no advantage over traditional laparoscopic surgery (LoE 4).

Recommendation

Grade C

Routine use of mini-laparoscopic instruments is not beneficial.

LAPAROSCOPIC STAPLING DEVICES

These are increasingly being utilized for both gastrointestinal anastomoses as well as control of vascular structures.

Key question

What are the precautions to be followed while using stapling devices during laparoscopic procedures?

Evidence

There is no evidence related to the use of staplers in the surgical literature.

STATEMENT AND RECOMMENDATION

Statements

- It is necessary to carefully evaluate the tissue thickness before firing the stapler. Staplers should be fired only on well-vascularized tissue.
- Before firing a stapler on major vessels, adequate proximal and distal control should be obtained.
- The choice of staple height varies from organ to organ depending on its thickness.
- A stapler of appropriate height is chosen by studying the product description, keeping in mind that the staple height varies for different manufacturers (LoE 5).[17]

Recommendation

Grade D

The surgeons should thoroughly familiarize themselves with the use of a particular type of laparoscopic stapling device and follow all the safeguards in its use.

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6

Access and Ergonomics

PERITONEAL ACCESS

Any minimal access surgical procedure in the abdominal cavity requires the creation and maintenance of a working space and this is provided by pneumoperitoneum.

Safe and correctly positioned access into the peritoneal cavity is the most preliminary yet crucial step in minimal access surgery. Technical errors and patient-related problems at this first step account for nearly 30% of all complications in minimal access surgery.

Access methods for primary port

Three techniques are popularly practised.

1. Closed technique or Veress needle technique of insertion followed by insufflation; followed by trocar insertion
2. Open technique or Hasson's technique of entry followed by insufflation
3. Optical trocar insertion with or without prior insufflation

Several other techniques are described but the above techniques would suffice in the safe and effective performance of minimal access surgery.

Establishment of pneumoperitoneum

Veress needle technique

The Veress needle consists of a 14-gauge needle of 70–120 mm length with a spring-loaded, blunt obturator that projects just beyond the bevel of the needle. The spring enables the obturator to be pushed back when in contact with a firm structure like sheath; and allows the sharp edge of the needle to pierce through. It springs back and obliterates the sharp edge of the needle when the needle bores through into the peritoneal cavity or comes in contact with softer structures such as the bowel. This helps in preventing inadvertent injury to the latter.

The Veress needle used in conjunction with an electronic insufflator and a suitable trocar enables the establishment of access and maintenance of pneumoperitoneum.

The electronic insufflator must have digital display gauges of the following parameters:

1. Pressure at the tip of the Veress or trocar, i.e. intra-abdominal pressure
2. Flow rate of the gas in litre/min
3. Volume of gas used since the start of the procedure

Carbon dioxide has been universally recommended as the standard gas to be used for insufflation (Grade A).

The first trocar that is inserted after pneumoperitoneum is established is most often of 11 mm diameter to accommodate a 10 mm telescope, which provides best illumination and image quality. However, recent refinements in optics and endovision camera technology allow for a good image with smaller telescopes and use of smaller trocars (7, 5 and 3 mm) and corresponding scopes is increasingly common for the advantage of reduced abdominal wall trauma.

Procedure to establish pneumoperitoneum using the Veress needle

Before the start of the procedure the three components of Veress, insufflator and trocar should be checked for proper function.

Veress needle check

- Flush with sterile normal saline to check patency
- Push obturator against a firm surface and ensure that it retracts and springs back on release

Trocar check

- Sharpness of trocar tip
- Stop cock for free flow
- Valve mechanism

Insufflator checklist

- Check cylinder gas volume and extra cylinder
- Switch on insufflator connect tubing → start gas flow @1 L/min then increase flow rate to the maximum. Check free flow of gas; the intra-abdominal pressure reading should read zero.
- Next occlude the flow. Alarm should sound and the indicator after intra-abdominal pressure should momentarily jump to higher than the set pressure; the gas flow rate should stop and the indicator should fall to 0 L/min.

Confirmation of the Veress needle tip being in the free peritoneal cavity: 'Pneumoperitoneum drill'

1. Aspiration with syringe shows no aspirate (watch out for blood, urine, faecal or bilious aspirate)
2. 2–5 ml normal saline injected through the needle flows freely
3. No return fluid upon re-aspiration after injection of saline as in step 2
4. A drop of saline is placed on the hub of the needle, it gets sucked in during respiration

Umbilical/Periumbilical Veress needle insertion

This is the standard, accepted technique and is employed when:

1. Intra-abdominal adhesions are not expected in the area.
2. There is no scar of previous surgery near the area.
3. No previous history of abdominal infection or sepsis such as tuberculosis, which is not uncommon in India.

The preferred site of insertion is in the midline at the lower border of the umbilical ring or just supra-umbilical.

First trocar entry

The stab incision taken earlier should be of optimum length so that excessive skin friction does not result during the entry.

The patient is maintained in the 15° Trendelenburg position and the trocar is inserted towards the pelvis at an angle of 80° to the anterior abdominal wall keeping in the midline.

Recommendations: Veress needle

1. Unless contraindicated, the standard accepted site for placement of the Veress needle is the umbilical area, in the midline, with or without stabilization of the anterior abdominal wall (LoE 1a, Grade A).
2. In patients with or suspected to have peri-umbilical adhesions, surgical

Left upper quadrant (LUQ)/Palmer's point entry

Palmer's point: Left hypogastrium 3 cm inferior to left subcostal margin in the mid-clavicular line.

Indications

1. Surgical scar at or near the umbilicus
2. Previous history of abdominal tuberculosis

Prerequisites

1. Hepato-splenomegaly is ruled out.
2. Stomach is decompressed.

scars, alternative sites for veress needle insertion should be explored or the open technique should be followed (Grade A).

3. Left upper quadrant (LUQ, Palmer's point) should be considered in patients with suspected or known peri-umbilical adhesions; in presence of umbilical hernia; and in case of three failed insufflation attempts at the umbilicus (LoE 2a, Grade A).
4. The various confirmation tests to confirm the placement of the Veress needle may be misguiding. However, side-to-side waggling of the needle is to be avoided for fear of converting a puncture wound into a larger injury (Grade B).
5. The elevation of the anterior abdominal wall at the time of insertion of the Veress needle or placement of primary trocar does not rule out the risk of visceral or vascular injury (LoE 2a, Grade C).
6. The adequacy of gas insufflated should be determined by intra-abdominal pressure of 10–15 mmHg as indicated on the insufflator panel; and not by a pre-determined volume of the gas (LoE 2a, Grade A).
7. *Choice of gas:* The standard recommended gas for creation and maintenance of pneumoperitoneum during minimal access surgery carbon dioxide (CO_2) (Grade A). Use of atmospheric air is not advised due to an increased risk of air embolism (especially during prolonged surgeries) and fear of explosion due to presence of oxygen. Nitrous oxide is unsuitable as it gets absorbed and interferes with the plane of general anaesthesia.
8. Gastric decompression is advisable prior to the insertion of the Veress needle as well as trocar. This helps in avoiding colonic perforation. The distended stomach tends to push the transverse colon caudally nearer the point of entry at the umbilicus (LoE 1a, Grade B).

OPEN LAPAROSCOPIC ENTRY OR HASSON TECHNIQUE

This technique of laparoscopic access was described by Hasson in 1971 using a specially modified trocar often referred to a Hasson's or Blunt-tipped trocar.

Procedure for open access

Choosing the site:

1. In non-scarred abdomen – the access may be established either trans-umbilical, infra- or supra-umbilical; or as per the location of the target organ in any abdominal quadrant (Grade A).

2. In case of pre-existing surgical scars, it is recommended to choose a quadrant farthest away from the scar (Grade A).

Recommendations: Hasson's/open access technique

- The open entry technique may be utilized as an alternative to the Veress needle technique, especially in scarred abdomen or when Veress needle insertion has failed (LoE 2b, Grade B).
- Although many surgeons prefer the open technique of access; there is no evidence that the open entry technique is superior or inferior to the other access techniques (LoE 3, Grade C).

VISUAL ENTRY SYSTEMS

These specially designed trocars were first introduced in 1994. They were popularized on the concept of providing visual cues to the surgeon so as to enhance patient safety during insertion. The commonly available systems are:

1. Endopath Optiview® Optical trocar manufactured by the Ethicon division of Johnson and Johnson
2. VersaOne® and Visiport® manufactured by Medtronics
3. EndoTIP® manufactured by Karl Storz

Recommendations: Visual entry trocars

1. The visual entry cannula system was initially touted to be superior to traditional techniques due to visual cues ensuring safer access. In practice no superiority to other techniques has been demonstrated (Grade C).
2. The visual entry trocars were said to ensure a minimal size of the entry wound and reduction of force necessary for trocar entry; however, they do have a risk of visceral and vascular injury (Grade C).

ACCESS TECHNIQUES IN SPECIAL SITUATIONS

A. Laparoscopic access in pregnancy: Guidelines and Recommendations

It is recommended that surgery in the course of pregnancy should be confined to emergency life-saving situations. Certain conditions such as acute cholecystitis or acute appendicitis not responding to medical therapy often need intervention.

1. *Pre-procedure obstetrician consultation*: Evaluation of maternal and foetal health is advisable (Grade C).
2. *Timing of surgery:* Surgery should be performed as far as possible in the second trimester (Grade C) unless warranted due to a life-threatening condition.
3. *Method of access:* The open technique is preferred (Grade C) over the Veress needle technique.
4. Pneumoperitoneum pressures should be kept to a minimum, just sufficient to provide a working space (Grade C). Studies suggest foetal acidosis and decreased inferior vena cava blood flow with higher pressures.
5. Laparoscopy may have advantages when compared to open surgery (Grade C).
6. Small case studies have shown a lower incidence of foetal loss, lower analgesic requirements and lower postoperative maternal respiratory depression (Grade C).

B. Laparoscopic access in obese patients: Guidelines and Recommendations

1. In an obese patient, incision prior to insertion of the Veress needle should be trans-umbilical since it is the thinnest part of the abdominal wall; with peritoneum in close proximity with minimal pre-peritoneal fat; even in presence of obesity (LoE 1b, Grade A).
2. The patient should be in the supine position and not in Trendelenburg's position and the direction of the Veress needle entry should be perpendicular to the abdominal wall to avoid chances of its entry into the pre-peritoneal plane (LoE 1b, Grade B).
3. Once the Veress needle is intra-peritoneal, a higher pressure may be required 15–18 mmHg. A higher intra-abdominal pressure is needed to lift a heavy abdominal wall in case of the morbidly obese patient (LoE 1b, Grade A).

Frequency of complications with Veress needle technique and salvage options

At first attempt 0.8% to 16.3%; at second attempt 16.31% to 37.5%; at third attempt 44.4% to 64%; and at more than three attempts 84.6% to 100%. Therefore, after three failed attempts with the Veress needle, the Hasson's/open technique of access is recommended (Grade A).

IMPORTANT RECOMMENDATIONS FOR ACCESS

1. Whichever be the access technique used by the surgeon, utmost care and caution should be exercised at this crucial step (Grade A).
2. The procedure for creation of pneumoperitoneum and abdominal access carries the potential dangers of peritoneal as well as retroperitoneal visceral and vascular injury. The risk is greater in very thin, obese and patients with previous abdominal surgery (Grade B).
3. Introduction of the initial trocar by the open technique is faster as compared to the Veress needle insufflation followed by trocar (Grade A).
4. Although randomized control studies found the open access technique to be faster than the closed technique (Veress+trocar), the expert committee is unable to recommend one over the other (Grade B) due to case-specific bias.
5. Visual entry trocars have several users in India but inadequate data does not allow this committee to recommend them to be inferior or superior to closed or open access techniques since they do carry equal risk of vascular and visceral injury (Grade B).
6. The technique used for access should be adapted to the individual case and open access should be used in cases of previous abdominal surgery (Grade C).
7. Despite several RCTs, guidelines and Cochrane reviews, no technique can be regarded as better than the other (Grade C).
8. The minimal access surgeon should acquaint himself/herself with both the Veress needle as well as the open access techniques (Grade A).

ERGONOMICS IN MINIMAL ACCESS SURGERY

The word 'Ergonomic' originates from the Greek word ergon (labour) and nomog (natural law), which reveal knowledge concerning the law of human labour. It is the study of optimal designs to ensure appropriate psychological and physical interactions among the worker, product and environment. The ground reality of minimal access surgery is that the patient is greatly benefited but the surgeon is highly inconvenienced. The latter is prone to several work-related injuries such as chronic shoulder pain, neck pain, prolapsed inter-vertebral disc, etc. The surgeon faces physical, mental and psychological pressure to complete the procedure by the minimal access technique.

Optimum physical comfort for the operating surgeon rests on the following seven factors

1. Operation table height
2. Monitor location and height
3. Arrangement of activation foot pedals of various devices
4. Choice of hand instruments and comfort for the surgeon
5. Angle at which instruments reach the target organ
6. Arrangement of equipment, connecting cables and tubes
7. Team and assistant coordination with operating surgeon

Operation table height

Proper height adjustment is required so that the angle between the upper and lower arm is between 90–120 while operating.

1. Instruments should be at or below elbow height. This may require lowering the operating table after induction of anaesthesia.
2. If the operating table cannot be lowered suitably, the use of wide platforms is recommended. These should be wide enough not only to accommodate the surgeon and assistant but also the foot-activated pedals of all energy devices and other essential equipment.

Monitor

The optimum location and height are critical factors for maximal operating comfort. These are commonly ignored in most operation theatres.

STATEMENT AND RECOMMENDATION

Statement

Misalignment of eye–hand–monitor axis accounts for a major portion of ergonomic problems faced by the surgeon. Monitor height and position have a direct bearing on neck strain to the surgeon (LoE 1b).

Recommendations

- Directly in front of the surgeon or 15°–40° below eye-level gaze-down, avoid oblique view (Grade A).
- Ceiling-mounted monitors are helpful.

If not available, the monitor may be placed on a separate trolley so that point 1 is adhered to (Grade D).

Foot pedals

The surgeon is often burdened with operating several foot-switches of various devices such as electro-cautery, ultrasonic shears, suction-irrigation pump, image capture device, etc.

Recommendations

- Proper alignment and a standardized placement protocol is required so that the surgeon need not repeatedly look down and away from the operating field to locate the correct pedal.
- Pedals should be at the same level as the surgeon's foot especially if a platform is used.
- Pedals with built-in foot rest are desirable.

Hand instruments

- Various grips are available. Axial and pistol grips are the most popular.
- Choice of handle is as per the surgeon's comfort.

Recommendations for choosing instruments

1. Operating surgeon should ensure the avoidance of excessive wrist flexion and ulnar deviation (Grade A).
2. While selecting the instrument ensure:
   - the forefinger reaches the shaft-rotating knob (Grade D).
   - the handle grip avoids strain on pressure points.
   - permits fine manipulation.
   - it allows the application of force where needed.
   - it provides a reasonable amount of tactile feedback.
   - it is equipped with a sturdy insulation; especially those instruments that are used with energy devices such as electro-cautery.

Port geometry

The concepts of triangulation and sectorization should be followed (Grade A).

Triangulation: Telescope (optical) port should be located at 18–20 cm from the target organ and the accessory ports should be located over the arc of a circle (the radius of which equals distance between optical port to target organ) on either side of the optical port.

Sectorization: Telescope port is on one side with ports to left or right, for example in laparoscopic appendectomy. This is also referred to as the ipsilateral port geometry.

Manipulation and azimuth angles

Effective and efficient surgical manipulation can take place only when the instruments are oriented in the optimum direction. The latter is determined by the angle of the instrument in the vertical and horizontal planes.

- Manipulation angle – angle at which the working instruments meet in the horizontal plane
- Azimuth angle – angle of instrument in the vertical plane

Recommendation

Efficient surgical manipulation is achieved with the manipulation angle of 45°–75° with equal azimuth angles (Grade A).

Recommendations for knotting and suturing

1. *Type of telescope:* 30° or 45° (Grade A)
2. *Needle holders and driver:* Type and choice based on the surgeon's comfort level
3. Self-righting needle holders do not add any advantage (Grade D) to ease of suturing.
4. Manipulation angle of 60° with equal azimuth angles (Grade A)

Arrangement of equipment, connecting cables and tubes

- Avoid clutter
- Colour coding is encouraged
- Imaging equipment such as C arm/sonography machine, energy sources and cables to be individually taped and secured
- Anaesthetic tubes and IV access lines etc. should not get entangled with those in the operative field

Team and assistant coordination with each other and operating surgeon

- Preoperative checklist complete layout (including surgical team, assistants location of monitor, camera cart and energy devices)
- Preoperative equipment check
- Preoperative briefing of the procedure and each team member's role
- Possible need of additional equipment/instruments to be planned for

Operation-theatre (OT) environment

- Air-conditioning is desirable.

- Overhead lights should be strategically positioned with adjustable intensity; as they may cause glare and interfere with visual display monitors.
- Noise levels should be minimal to ensure proper communication between the team members.
- Only essential equipment and instruments to be kept to decrease clutter.

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Access and pneumoperitoneum

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7

Bariatric Surgery

Bariatric surgery evolved as a treatment option for morbid obesity – a disease of severe corpulence affecting the post-war western world. Over the decades it has spread to nearly every part of the world, creating a pandemic of unprecedented proportions. Obesity today may be defined as a non-communicable lifestyle disease of excess fat, associated with severe comorbid conditions, increasing morbidity and mortality in the affected patient population. The condition threatens to undermine all potential healthcare benefits accrued through millennia of scientific progress. There is no organ system which is not adversely affected by obesity. The disease is associated with at least 25 severe comorbid conditions such as diabetes, hypertension, coronary artery disease, obstructive sleep apnoea, osteoarthritis, chronic obstructive airway disease, osteoarthritis and even certain malignancies.[1]

Bariatric surgery is currently the most effective therapy for treating morbid obesity. The minimal invasive technique increased the acceptability of this therapy, which saw a considerable increase in the number of bariatric surgical procedures being performed worldwide. The practice of bariatric surgery in India began at the turn of the century. Dr S. Dhorepatil was the first bariatric surgeon in India who performed the vertical banded gastroplasty (VBG). Long-term results of surgical treatment of obesity have proved it to be superior to conservative measures of losing weight and not only in achieving prolonged weight loss, but also amelioration of associated metabolic disorders.[2–4] The Indian surgical community became aware of the growing problem of obesity in the country and a dedicated society of committed bariatric surgeons came into existence in 2002. Bariatric surgery has since grown into a highly specialized surgical branch, with several centres of excellence across the country. In today's era of consistent patient care, it is time to establish standardized technical guidelines for the practising and novice bariatric surgeon. This will help improve the standard of care being provided to this patient population.

Bariatric surgery has evolved along the two surgical principles of restriction and/or malabsorption. Procedures described and being performed the world over are either restrictive, malabsorptive or a combination of the two. What follows is an attempt to provide evidence-based technical guidelines for three of the common bariatric surgical procedures being performed in India, namely

- The laparoscopic Roux-en-Y gastric bypass (LRYGB) – a predominantly restrictive procedure with minimal malabsorption.
- The laparoscopic sleeve gastrectomy (LSG) – a restrictive procedure.
- The laparoscopic minigastric-one anastomosis gastric bypass (LMGB-OAGB) – a malabsorptive procedure.

Indications

- The National Institutes of Health (NIH) 1992 guidelines recommended bariatric surgery for patients aged 18–65 years and BMI >40 kg/m^2 or BMI 35 kg/m^2 with two severe obesity-related comorbidities.[5]
- Asian guidelines are now accepted by most bariatric societies with modification of indications for weight loss surgery at BMI of 37.5 kg/m^2 or 32.5 kg/m^2 with at least two obesity-related comorbidities.[6]
- As per the latest International Diabetes Federation (IDF) and American Diabetes Association (ADA) guidelines in patients of BMI 30–34.9 kg/m^2 with uncontrolled type 2 diabetes on best medical therapy, metabolic surgery may be considered a viable treatment option. The same limit may be modified based on patients' ethnicity and in Asians and other high-risk ethnic groups it may be lowered by 2.5 kg/m^2.[7]

Contraindications

- Serious uncontrolled psychiatric diseases such as major depression and psychotic disorders,
- Active alcohol and/or drug dependence,
- Short life expectancy due to a terminal disease
- Patients with inability to self-care and without family or social support[8]

Patient positioning and operation theatre layout

- The laparoscopic approach to gastric bypass was first described by Alan Wittgrove in 1994.[9] The technique described a lithotomy posture, with the surgeon standing between the legs of the patient. Higa *et al.*

described a supine position with the operating surgeon standing on the patient's right.[10] Currently, both positions are accepted and being practised depending on the surgeon's preference. The camera assistant stands on the left and the first assistant on the right of the operating surgeon. A single monitor at the head end or two monitors above the right and left shoulder of the patient may be used. The scrub nurse stands on the side of the first assistant (Fig.1).

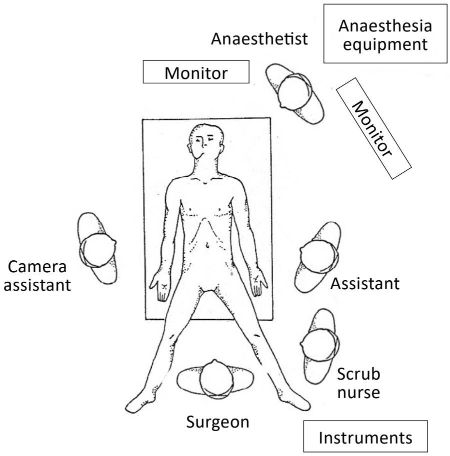

Fig. 1. Patient position

Port placement[11–14]

- The position and number of ports described vary from five to eight. The position of port placement also varies, however a rough estimate applies a distance of 18–20 cm from the xyphoid in an arc from the right to the left hypochindrium (Fig. 2).
- The access is either using the Veress needle at the Palmer's point or supra umbilical, or an optiview port.

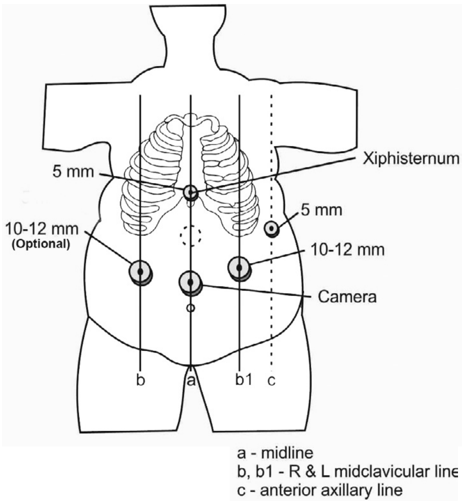

Fig. 2. Port placement

GASTRIC POUCH

Key question

Does the size, volume and orientation of gastric pouch have an effect on weight loss and maintenance?

Evidence

The size of pouch described by Alan Wittgrove, used a 15 cc balloon for calibration and was oriented along the lesser curvature.[9] The first attempt at standardization of gastric pouch was by consensus using a questionnaire circulated to all members of ASBS (American Society of Bariatric Surgery) (LoE 5).[15] Nevertheless, a general consensus on a small gastric pouch measuring 25–30 cc was reached. Subsequently, studies evaluating technical factors affecting weight loss have all suggested a small pouch size to contribute to good weight loss. A prospective cohort study (LoE 2b) comprising 320 patients found an inverse relation of pouch size to percent excess weight loss (%EWL) at 6 and 12 months. Male gender and a high BMI were factors which correlated positively with the pouch size in the same study.[16] A prospective comparative study (LoE 3) evaluating patients maintaining good weight loss (group A–175) with patients demonstrating weight regain (group B–205) at 4.7 years and 6.9 years, respectively, found higher anatomical abnormalities of a dilated pouch and stoma size in patients with weight regain (group B 71.2% vs group A 36.6%). A higher preoperative BMI, longer duration since primary surgery and stoma size independently predicted weight regain in this study.[17] Daniel Riccioppo *et al.* in a recent publication (LoE 4) collated pouch volume and gastric emptying rate with late weight loss maintenance and food tolerance. They found small gastric pouch (volume ≤40 ml) with 75% emptying in the first hour collated positively with long-term weight loss and food tolerance.[18]

However, another study comprising 59 patients (LoE 3), in which the size of the pouch was measured radiologically and evaluated independently by three experts (two surgeons and one radiologist), found no significant difference in size of pouch and weight loss.[19] The average size of pouch was taken as 1.5 times the diameter of the small bowel distal to the gastrojejunostomy. None of the gastric pouches were found to be larger than 3 times the average pouch size. Yet another study by Philippe Topart *et al.*[20] showed similar outcomes with weight loss independent of the pouch size. A total of 107 patients (81%) had a complete follow-up of 35.7±5.8 months and showed a similar pattern of weight loss between average and dilated pouch sizes. The pouch was considered to be dilated if >50 ml in volume. Similar observations were made in the Scandinavian obesity surgery registry comprising 14,168 patients where the size of pouch was estimated by the length of the staple line and had a mean of 145+28 mm.[21] There was no difference observed in weight loss with respect to pouch volume at one year. Again suffice to say that even the size of an enlarged pouch varies by few millilitres from an average pouch, therefore the procedure is best served by a small pouch.

STATEMENT AND RECOMMENDATION

Statements

- The Roux-en-Y gastric bypass is primarily a restrictive procedure. The restriction is provided by decreasing the size of the gastric pouch.
- Most studies mention an average pouch size of 25–30 cc.

Recommendation

Grade A

Although the size of an enlarged pouch varies by only a few millimeters from an average pouch, it is recommended that the procedure is best served by a 25–30 cc pouch.

LIMB LENGTHS

Key question

What is the ideal length of the biliopancreatic limb (BPL) and alimentary limb (AL)?

Evidence

The gastric bypass evolved primarily as a restrictive procedure with the bypass mandated to establish bowel continuity. The roux limb was subsequently added to address the problem of biliary reflux. The standard LRYGB described by Wittgrove,[9] comprised a 10–12 cm long BPL and a 75 cm long AL. The length of the two bowel limbs have undergone numerous alterations in an attempt to define an optimal length for achieving maximal benefit in weight loss and resolution of associated comorbid conditions with minimal adverse sequelae of nutritional deficiencies. Unfortunately, to date there is no consensus on the optimal length of the two limbs. Studies on varying limb lengths include several randomized trials and systematic reviews. The variations studied include alteration in length of BPL/AL (LoE 2,3)[22–28] in a standard or proximal gastric bypass (STDGB), with total bypassed small bowel length from less than 130 cm (short limb), to more than 200 cm (long limb). There was no advantage found by increasing the length of bypassed small bowel in terms of weight loss, however a higher and faster improvement in metabolic conditions has been noted (LoE 2),[29] additionally increasing the length of bypassed small bowel to more than 200 cm resulted in higher micronutrient deficiencies. However, decreasing the length of bypassed bowel to less than 130 cm results in poorer weight loss outcomes as compared to the standard gastric bypass.[22,24,25] There is also a variant based on a fixed length of the common limb – the distal gastric bypass (DGB), wherein the length of the common limb is kept between 50 cm and 200 cm. An LoE 1 study[30] and several LoE 2–3 studies[31–36] have reported none to minimal advantage of weight loss with DGB over STDGB, but with an increased incidence of nutritional deficiencies and morbidity. Most of the information on DGB comes from revision surgeries done in patients failing to lose weight or regaining lost weight.[34,37] A common channel length of 50 cm has been shown to be associated with severe protein calorie malnutrition, hepatic failure and mortality. We still lack better designed studies to distinguish the importance and relevance of each small bowel limb, which may help standardize the appropriate length suitable for a given patient.

STATEMENT AND RECOMMENDATION

Statements

- There is no consensus on an ideal length of the biliopancreatic and alimentary limb (BPL/AL).
- Having longer BPL gives better metabolic and weight loss results but has higher incidence of protein malnutrition and even mortality.
- A DGB with longer AL provided no advantage of weight loss over STDGB.
- A DGB showed slight advantage over STDGB for improving metabolic risk factors at the cost of higher nutritional deficiencies.
- Studies on optimal length of common channel are needed for determining better weight loss benefits.

Recommendations

Grade A

- Optimum results achieved with a combined BPL and AL length between 130 and 200 cm.
- At least 130 cm of jejunum should be bypassed to achieve maximum benefits.
- Bypassing more than 200 cm of small bowel does not improve weight loss predictably and significantly, but shows a more rapid and better metabolic response.

GASTROJEJUNOSTOMY

Key question

What is the best method of performing the gastrojejunostomy (GJ)?

Evidence

Three methods are described for performing the gastrojejunal anastomosis – hand-sewn (HSA), linear-stapled (LSA), and circular-stapled (CSA). There are proponents for every method, with no study eliciting a clear superiority of one technique over the other. An online survey[38] of the American Society for Metabolic and Bariatric Surgery (ASMBS) members on technique of gastric bypass showed the percentage of CSA, LSA and HSA as 43%, 41% and 21%, respectively for the GJ technique. Another clinical study involving the Michigan Bariatric Surgery Collaborative[39] showed that 66% of surgeons preferred CSA, 18% HSA and 16% LSA. No difference was observed in the leak rate, however CSA had a significantly higher postoperative haemorrhage and infection rate as compared to HSA and LSA. A comparative study by Bendewald *et al.*[40] showed no difference between the three techniques in leak rates, strictures (4.3%–6.1%) and marginal ulcers. They concluded all three techniques to be safe, with none emerging as superior to the others.

A cohort study from the Scandinavian obesity registry (LoE 2) compared CSA with LSA and found CSA to be associated with a longer operative time, higher leak rate, postoperative haemorrhage, port site infection, stenosis and marginal ulcers. A comparative study by Lee *et al.*[41] (LoE 3) comparing all three techniques of GJ anastomosis found no difference in weight loss and incidence of stricture between the three methods at 3, 6, 12, and 24 months. A meta-analysis by Jhiang *et al.*[42] compared HSA with mechanical GJ anastomosis and found no difference in the outcomes except for a higher postoperative bleeding and wound infections with circular staplers.

The LSA approach exhibited a slight advantage in the incidence of fewer strictures compared to CSA and HSA. The higher incidence of strictures with CSA have been reported using the 21 mm stapler.[41,43] Nguyen[44] reported an incidence of 26.8% vs 8.8% strictures for 21 mm and 25 mm with CSA. Gonzalez[45] also reported strictures as significantly more common with CSA (30.7%) than HSA (3.5%) or LSA (0%). The 21 mm CSA has a 12 mm internal diameter, whereas a 25 mm CSA results in a 16 mm diameter stoma. A narrow diameter anastomosis is more likely to develop a stenosis. Among the technical factors that can contribute to increased stricture formation are type of stapler used (circular vs linear), stapler size, hand-sewing, and surgeon experience. Other possible mechanisms include ischaemia, non-ischaemic excessive scar formation, recurrent marginal ulceration and tension or malposition. The higher incidence of wound infection reported with CSA (9%–21%) was predictably due to bowel content contamination of the abdominal port by the circular stapler. The use of a sterile cover as contact barrier between the stapler shaft and abdominal port has resulted in significant decrease in wound infection rates to levels similar to those seen with HSA and LSA (0.4%–3%).[40,45,46]

The limiting factor for the popularity of HSA is the technical expertise required. In mechanical anastomosis the circular approach provides standardization of anastomosis size, but is expensive, whereas the linear approach has the advantage of being technically simpler than hand-sewn, with lowest incidence of stricture formation.[46]

STATEMENT AND RECOMMENDATION

Statements

- All three techniques of GJ anastomosis – CSA, LSA, HSA – have similar outcomes in weight loss and complications. HSA requires higher technical expertise. CSA gives a standardized anastomosis and LSA has least morbidity.
- The internal diameter of the stoma should be >12 mm to decrease chances of stenosis.

Recommendation

Grade B

The surgeon may choose to perform the type of anastomosis they have trained in and are most comfortable doing.

JEJUNOJENUNOSTOMY

Key question

Tri-stapled/single-stapled + hand-sewn/bi-stapled – which is the best?

Evidence

Resection anastomosis of the small bowel has been performed for centuries. Stapled anastomosis were first introduced by Humer Hutl, known as the father of surgical stapler.[48] Their popularity increased in the 1970s with development of light-weight single patient use stapling devices.[49] The jejuno-jejunal anastomosis (JJA) in LRYGB is routinely performed using staplers. The different techniques described include the tri-stapled anastomosis (TSA), the bi-stapled anastomosis (BSA), the single-stapled + hand-sewn anastomosis (SSHSA) and the HSA. An internet survey of practising bariatric surgeons in America in 2008 revealed the percentage of those using SSHSA, BSA, TSA, and HSA to be 53%, 36%, 13%, and 1%, respectively for the jejunojejunostomy technique.[38]

There is not much literature on JJA per se, the level of evidence constitutes mainly case reports and observational studies (LoE 3,4). Adverse events such as bowel obstruction have been reported most commonly due to technical errors especially with the bi-stapled technique, which is now almost obsolete.[50,51] Other causes of obstruction include a kinking at the enteroenterostomy site especially when performed end-to-side and can be prevented by using the anti-obstruction Brolin stitch.[52] Yet another rare but serious cause of obstruction at the JJ site is intussusception.[53,54] The importance of this condition lies in the sometimes serious and even fatal outcome if unrecognized. Two studies from the same surgical group (Madan AK, Frantzides CT, *et al.*) have elaborated on the ease, standardization and safety of the TSA.[55,56] The SSHSA enjoys maximum popularity due to cost-effectiveness and safety.

STATEMENT AND RECOMMENDATION

Statement

TSA and SSHSA both are safe and easily replicated. BSA has higher chances of narrowing the JJ and is best avoided.

Recommendation

Grade B

The surgeon may choose to perform either TSA or SSHSA based on their training and comfort.

CLOSURE OF MESENTERIC DEFECTS

Key question

Should all iatrogenic mesenteric defects be closed?

Evidence

The Roux-en-Y configuration creates potential defects between small bowel loops mesentery and small bowel mesentery and mesocolon. These defects are potential sites for small bowel loops to herniate through, resulting in bowel obstruction and ischaemia. The incidence of internal hernias is high following LRYGB (1.5%–11%) (LoE 2,3).[57–60] The ante colic ante gastric approach has fewer internal hernias.[61,62,63] Closure of the mesenteric defects leads to significant decrease in the incidence of internal hernias (LoE 1,2).[64,65] If undiagnosed, the condition may result in severe morbidity and even mortality.[65] There is a proposed classification – AMSTERDAM Classification for helping in the management algorithm of internal hernias.[67] The evidence in literature is sufficient to acknowledge that internal hernias are a relatively common and serious complication of LRYGB. Closure of mesenteric defects decreases but does not completely eliminate the risk of internal hernias.[68,69] A post LRYGB patient presenting with persistent vague abdominal pain must be referred to a bariatric surgeon and a low threshold for surgical intervention be maintained.

STATEMENT AND RECOMMENDATION

Statement

Mesenteric defects are potential sites for internal hernias. Closure of mesenteric defects significantly brings down the incidence of internal hernias.

Recommendation

Grade A

All mesenteric defects should be closed if possible.

SURGICAL SURPRISES/VARIED INTRAOPERATIVE SCENARIOS: VENTRAL HERNIAS IN BARIATRIC PATIENTS

Key question

When should the ventral hernia in a bariatric patient be repaired?

Evidence

Often morbidly obese patients may have a concomitant ventral hernia at the time of bariatric surgery. Very often the hernia may be diagnosed intraoperatively.[70] There is a dilemma as to when is the best time to repair these hernias? The repair may be before, simultaneously or after the bariatric procedure. Ventral hernia repair in a patient with high BMI has a high morbidity (25.9%) and recurrence (18.5%).[71] Eid *et al*. in a retrospective study of 85 patients, reported a recurrence rate of 22% with simultaneous primary suture repair, no recurrence with biological mesh repair (the group comprised only 12 patients, 3 of whom developed cellulitis and 4 had seromas); however, with a short follow-up of 13 months.

Fourteen deferred patients reported small bowel obstruction in 37.5%.[72] In contrast Newcomb *et al*. report a 100% recurrence in all patients with simultaneous repair of both suture and mesh and recommend an approach of deferring the repair to after weight loss for an improved outcome.[73] However, 22 of their patients underwent an open gastric bypass and therefore the relevance of this paper to current practice is questionable.

Chan *et al*. report on 45 patients undergoing bariatric procedures (36 underwent LRYGB/LSG and 9 had gastric bands placed) with concurrent mesh repair. On a median follow-up of 13 months they report a low rate of infection 5.6% with resectional procedures.[74] An observational study on 54 patients undergoing concurrent mesh repair with bariatric surgery (majority were LSG 48) by Raziel *et al*. report a favourable outcome in terms of mesh infection and recurrence.[75] A similar study by Praveen Raj *et al*. also reports on 36 patients (11 with LRYGB) undergoing their bariatric procedure with a concurrent mesh repair. On a mean follow-up of 18 months for LRYGB and 11 months for LSG, there was no mesh infection or recurrence reported. A study by Cozacov *et al*. on intraperitoneal fluid cultures in patients undergoing LRYGB (26 patients) or LSG (51 patients) showed a positive culture in specimens obtained at the end of the procedure in 4 of the 26 patients undergoing LRYGB.[76] They concluded a concurrent ventral hernia mesh repair in patients undergoing LSG as safe and feasible. There are no large well-designed studies to clearly define the treatment algorithm in morbidly obese patients for bariatric surgery with ventral hernias.

STATEMENT AND RECOMMENDATION

Statement

Ventral hernias in morbidly obese patients present a challenging situation for the surgeon.

Recommendation

Grade B

Symptomatic ventral hernias may be considered for simultaneous repair in patients undergoing low-infection risk bariatric surgery.

KEY POINTS

1. The gastric pouch should be small, sized at 25–30 cm^3.
2. The gastrojejunostomy is fashioned in the technique best known to the operating surgeon. The common techniques are – circular-stapled, linear-stapled + hand-sewn and hand-sewn.
3. The length of the biliopancreatic limb and alimentary limb combined should not exceed 200 cm.
4. The jejunojeunostomy may be made using the tri-stapled or single-stapled + hand-sewn technique. The bi-stapled technique is best avoided.
5. All mesenteric defects should be closed.
6. Simultaneous ventral hernia repair with bariatric surgery may be considered in selected patients and selected bariatric procedures.

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8

Laparoscopic Cholecystectomy

Laparoscopic cholecystectomy is one of the most commonly performed general surgical procedures worldwide. When Eric Muhe performed the first laparoscopic cholecystectomy in Germany in 1985,[1] surgeons were reluctant to accept it. Shorter hospital stay, faster recovery, less pain and better cosmesis collectively made laparoscopic cholecystectomy rapidly popular among patients and surgeons without randomized trials.

Although laparoscopic cholecystectomy is a safe procedure if done properly, it has been reported to be associated with various complications in 2%–18% of patients,[2–4] with bile duct injury being the most catastrophic. Although the reported incidence of bile duct injury has come down from 0.6% in the early 1990s[2] to 0.22% in the last decade,[5] the actual incidence may be higher because of under reporting. Biliary injury can lead to devastating complications such as biliary cirrhosis, which may lead to need for liver transplantation and even mortality.

INDICATIONS

The indications for cholecystectomy can be broadly classified into absolute and relative indications. The absolute indications are those where laparoscopic cholecystectomy is highly recommended and relative indications are those where there continues to be an ambiguity of evidence.

1. Symptomatic cholelithiasis

The most common indication for laparoscopic cholecystectomy is symptomatic gallstones. Patients typically have single or multiple episodes of biliary colic. Patients with symptomatic gallstone disease will require an elective cholecystectomy earlier than later and there is no role of conservative management or observation only in such patients.

Indications of laparoscopic cholecystectomy
Absolute indications (*Grade A/B recommendations*) • Symptomatic cholelithiasis • Acute calculous cholecystitis • Acute acalculous cholecystitis • Biliary pancreatitis • Gallbladder polyp >1 cm or symptomatic
Relative indications (*Grade C/D recommendations*) • Mirizzi's syndrome • Asymptomatic gallbladder polyp >3 mm to 1 cm • Asymptomatic gallstones – Paediatric age group – Congenital haemolytic anaemia – Porcelain gallbladder – Post-transplant

This is the most established indication for laparoscopic cholecystectomy and no evidence is required.

2. Acute calculous cholecystitis

Laparoscopic cholecystectomy is the gold standard for treatment of patients with acute calculous cholecystitis. The timing of surgery – early, delayed or late – has been a matter of considerable debate.

There have been many randomized trials and meta-analyses on the timing of laparoscopic cholecystectomy in acute calculous cholecystitis.[6–9]

The incidence of complications in laparoscopic cholecystectomy has been variously reported in these studies and it is higher than that in patients not having acute calculous cholecystitis. There is a consensus in that laparoscopic cholecystectomy should be done either in the first 24 to 72 hours (up to 5–7 days according to some studies) of acute onset of symptoms. Although there is evidence (LoE 1) showing no difference in conversion or bile duct injury in early or delayed cholecystectomy, it is generally accepted that laparoscopic cholecystectomy during acute cholecystitis is technically difficult and early cholecystectomy should be done only by surgeons and centres where such surgery is routinely done. Laparoscopic cholecystectomy should not be done after the first week of acute onset of symptoms because severe inflammation sets in and it will be difficult to do the cholecystectomy. The rule of thumb is to either do laparoscopic cholecystectomy in the first 24–72 hours or wait till 6 weeks for a better and safe outcome.

Laparoscopic cholecystectomy in acute calculous cholecystitis

STATEMENT AND RECOMMENDATION

Statements

- There is no significant difference in the incidence of bile duct injury, serious complications and conversion rates between early and delayed laparoscopic cholecystectomy in acute cholecystitis (LoE 1).
- Laparoscopic cholecystectomy is associated with faster recovery and shorter hospital stay compared to open cholecystectomy (LoE 1).
- Laparoscopic cholecystectomy in acute cholecystitis has less surgical trauma, less immunosupression and a shorter hospital stay (LoE 2).

Recommendations

Grade A

- Early laparoscopic cholecytectomy (24–72 hours) in acute cholecystitis may be done safely.
- Laparoscopic cholecystectomy is the preferred option in comparison to open cholecystectomy.

Grade B

Early laparoscopic cholecystectomy in acute cholecystitis should be done by experienced laparoscopic surgeons.

3. Acute acalculous cholecystitis

Acalculous cholecystitis accounts for 5%–10% of all cases of acute cholecystitis.[10] It usually occurs in patients with major illness such as sepsis, trauma, burns, immunosuppression and prolonged starvation. The two prevailing treatment options for acute acalculous cholecystitis are cholecystostomy (drainage of the gallbladder) and/or cholecystectomy. Cholecystectomy generally is considered the definitive therapy if it can be performed. However, there is debate as to its optimal timing. Some propose cholecystostomy as the sole treatment. Others affirm that cholecystostomy is only a bridge to safer cholecystectomy or only a trial therapy to see if choecystitis resolves. Ginat and Saad[11] reviewed the topic of cholecystostomy in detail with an excellent discussion of the pros and cons and the complications. Cholecystostomy is generally plausible, rapid and safe. It can be performed transperitoneally or transhepatically under ultrasound or computerized tomography (CT) guidance by surgeons or by interventional radiologist. Maturation of the cholecystostomy tract occurs in about 3 weeks. If cholecystectomy is needed, cholecystostomy may provide time to optimize the patient's condition for surgery. Thus, there seems to be a tendency to favour cholecystostomy before cholecystectomy, unless strong evidence of an ischaemic gallbladder exists, where drainage alone would not be sufficient.

Laparoscopic cholecystectomy in acute acalculous cholecystitis

STATEMENT AND RECOMMENDATION

Statements

- When acute acalculous cholecystitis is suspected, percutaneous cholecystostomy should be performed immediately in selected morbid patients because some patients may improve with this alone (LoE 1).
- Laparoscopic cholecystectomy is indicated in acute acalculous cholecystitis when cholecystostomy fails to alleviate the sepsis, e.g. ischaemic gallbladder (LoE 2).
- Laparoscopic cholecystectomy may be indicated as definitive treatment of acute acalculous cholecystitis (LoE 2).

Recommendation

Grade A

The first line of management of acute acalculous cholecystitis should be percutaneous choleystostomy in selected morbid patients, preferably image-guided.

4. Gallstone pancreatitis

Worldwide, gallstone pancreatitis is the most common cause of acute pancreatitis. This is either due to presence of gallbladder stones, common bile duct stones or microlithiasis. The treatment of these patients requires, in addition to management of pancreatitis, removal of the gallbladder to prevent further occurrences. The timing of performing the laparoscopic cholecystectomy is controversial. The traditional teaching was to perform interval cholecystectomy after 6 weeks of acute pancreatitis. However, it has been shown in the literature that interval cholecystectomy is associated with a higher risk of recurrent biliary events and readmission.[12–14] Recent trials have shown that laparoscopic cholecystectomy can be safely done in the same hospital admission in case of mild biliary pancreatitis. There is no difference in operative complications, conversion rate (7%) and mortality (0%) between cholecystectomy in the same admission and interval cholecystectomy.

Laparoscopic cholecystectomy in biliary pancreatitis

STATEMENT AND RECOMMENDATION

Statements

- There is no significant difference in operative complications, conversion rate, and mortality between same admission and interval cholecystectomy (after 6 weeks) (LoE 1).
- Cholecystectomy during index admission for mild biliary pancreatitis is safe but selection bias may be there (LoE 1).
- Interval cholecystectomy after mild biliary pancreatitis is associated with a high risk of readmission for recurrent biliary events (LoE 1).

Recommendations

Grade A

Laparoscopic cholecystectomy is recommended in index admission in cases of mild acutebiliary pancreatitis.

Grade B

In patients with severe pancreatitis laparoscopic cholecystectomy may be done once the condition of the patient stabilizes.

5. Gallbladder polyp

Laparoscopic cholecystectomy is the treatment of choice for symptomatic polyps and polyps more than 1 cm in size. Asymptomatic polyps less than 1 cm may be observed.[15] In the recent literature there has been a trend towards more aggressive treatment for asymptomatic gallbladder polyps.

Chou *et al*. have followed up 1204 patients with gallbladder polyp for at least 2 years and found an increased risk of malignancy in polyps more than 3 mm in size, and recommended laparoscopic cholecystectomy as a diagnostic tool to rule out malignancy.[16] In a systematic review of 5482 patients with gallbladder polyps, the factors associated with increased risk of malignancy were size more than 6 mm, single or symptomatic polyp, age more than 60 years, Indian ethnicity and associated gallstones or cholecystitis.[17]

Laparoscopic cholecystectomy in gallbladder polyp

STATEMENT AND RECOMMENDATION

Statements

- Surgery is not recommended for patients with asymptomatic gallbladder polyp <10 mm (LoE 2).
- Asymptomatic gallbladder polyp <10 mm in size should be observed at regular intervals (LoE 2).
- Laparoscopic cholecystectomy offers pain relief in >90% of gallbladder polyps associated with pain (LoE 3).
- Risk factors of malignancy (LoE 3)
  - Polyp >6 mm
  - Single polyp
  - Symptomatic polyp
  - Age >60 years
  - Indian ethnicity
  - Associated gallstones
  - Associated cholecystitis

Recommendations

Grade C

- Symptomatic gallbladder polyp requires laparoscopic cholecystectomy.
- Patients with gallbladder polyp >10 mm should undergo laparoscopic cholecystectomy.
- Patients with asymptomatic gallblader polyp <10 mm should be observed and evaluated at regular intervals.
- Patients with asymptomatic gallbladder polyp 6–10 mm in size may be offered laparoscopic cholecystectomy.

6. Mirizzi's syndrome

Mirizzi's syndrome is an uncommon cause of surgical obstructive jaundice caused by impaction of stone in the neck of the gallbladder leading to either external compression of common hepatic duct or fistulization. It has been classified into four types with type 1 having only external compression without fistula formation. Although recent literature has shown that laparoscopic cholecystectomy may be done safely in type 1 and selective cases of type 2 Mirizzi's syndrome,[18,19] it is technically challenging and should be undertaken by experienced surgeons only. Open cholecystectomy is a safer option for surgeons who are not doing such cases regularly.

Laparoscopic cholecystectomy in Mirizzi's syndrome

STATEMENT AND RECOMMENDATION

Statement

With right skills and equipment, laparoscopic cholecystectomy can be performed in type I and II of Mirizzi's syndrome (LoE 4).

Recommendation

Grade C

Laparoscopic cholecystectomy can be safely performed in type I and selective cases of type II by experienced laparoscopic surgeons.

7. Asymptomatic gallstones

Asymptomatic cholelithiasis exists when gallstones are detected in the absence of gallstone-related symptoms, such as history of biliary pain or gallstone related complications such as acute cholecystitis, cholangitis or pancreatitis. Ten percent of these patients will develop symptoms during the first 5 years after diagnosis and 20% by 20 years.[20] After 20 years, approximately two-thirds of patients will remain symptom free. These rates are in sharp contrast with those in symptomatic cholelithiasis, where the annual rates of developing complications and biliary pain are 1.2% and 50%, respectively.

Treatment options for asymptomatic cholelithiasis include expectant management (observation alone) and cholecystectomy (laparoscopic), which can be performed either selectively (for selected subgroups of patients with asymptomatic cholelithiasis), routinely (for all patients with asymptomatic cholelithiasis) or concomitantly during another intra-abdominal operation for an unrelated pathologic condition (e.g. cancer of the colon). Routine laparoscopic choecystectomy is not indicated for all persons with asymptomatic gallstones. There exist specific situations where prophylactic cholecystectomy is performed. Prophylactic laparoscopic cholecystectomy has also been recommended in asymptomatic gallstone disease in view of the high incidence of gallbladder cancer in India especially northern India. The decision to operate in asymptomatic gallstone disease should be individualized based on life expectancy of the patient, American Society of Anaesthesiologists (ASA) grade, regional incidence of gallbladder cancer, patient's choice, etc.

Laparoscopic cholecystectomy in asymptomatic gallstones

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic cholecystectomy is not indicated routinely for asymptomatic gallstones (LoE 4).

Recommendations

Grade C

- Prophylactic laparoscopic cholecystectomy for asymptomatic gallstones is not recommended routinely.
- Laparoscopic cholecystectomy can be performed in selected subgroups of patients with asymptomatic cholelithiasis who are at greater risk for the development of symptoms or complications.

(i) Paediatric age group

The prevalence of cholelithiasis in children is variable, with a global rate of 1.9% in different communities. These children have mostly asymptomatic cholelithiasis, incidentally diagnosed during abdominal sonography. Laparoscopic cholecystectomy may be performed in paediatric patients with asymptomatic gallstones in view of long life expectancy and probability of becoming symptomatic later.

Laparoscopic cholecystectomy in pediatric age group

STATEMENT AND RECOMMENDATION

Statement

Children with asymptomatic gallstones are likely to develop symptoms later due to long life expectancy (LoE 3).

Recommendation

Grade D

Laparoscopic cholecystectomy may be done in children with asymptomatic gallstone disease.

(ii) Congenital haemolytic anaemia

Patients suffering from chronic haemolytic syndromes such as sickle cell disease (SCD) are at risk for gallstone development at a young age, as a result of repeated haemolytic crises. Pigment gallstones are reported in 58% of patients with homozygous SCD and in 17% of patients with heterozygous types of haemoglobinopathies.[21] Two-thirds of them are likely to develop symptoms. Biliary complications of gallstone disease and vaso-occlusive crisis both present with similar manifestations (nausea, abdominal pain, fever, leukocytosis and cholestatic jaundice) and therefore differential diagnosis may be difficult. Also, the onset of gallstones at a young age in SCD raises the lifetime risk of biliary complications, and therefore, prophylactic cholecystectomy for asymptomatic gallstones in patients with SCD is advisable.

Laparoscopic cholecystectomy in congenital haemolytic anaemia

STATEMENT AND RECOMMENDATION

Statements

- Chronic haemolytic syndromes like SCD are at increased risk for gallstone development at a young age (LoE 3).
- Onset of gallstones at a young age raises the lifetime risk of biliary complications (LoE 3).

Recommendation

Grade C

Cholecystectomy for asymptomatic cholelithiasis is advisable in haemolytic disorders.

(iii) Porcelain gallbladder

According to older literature porcelain gallbladder is associated with gallbladder cancer in more than 60% of cases. Recent studies have shown an association of 0%–15% only.[22] Interestingly, Stephen *et al.* found that the incidence of cancer depends on the pattern of calcification, with selective mucosal calcification being associated with a greater risk compared to diffuse intramural calcification. The two entities can be differentiated on high resolution ultrasound. However, considering the high prevalence of gallbladder cancer in India, non-availability of high resolution ultrasound in most centres and difficulty in following up patients due to poor compliance, it might be prudent to perform cholecystectomy if porcelain gallbladder is detected on ultrasound.

Laparoscopic cholecystectomy in porcelain gallbladder

STATEMENT AND RECOMMENDATION

Statements

- Porcelain gallbladder is associated with increased incidence of gallbladder cancer (LoE 4).
- Selective mucosal calcification is associated with greater risk than diffuse intramural calcification and the two can be differentiated on high resolution ultrasound (LoE 4).

(continued)

Laparoscopic cholecystectomy in porcelain gallbladder

STATEMENT AND RECOMMENDATION

Recommendation

Grade C

Laparoscopic cholecystectomy should be performed in presence of porcelain gallbladder especially with selective mucosal calcifications.

(iv) Solid organ transplantation

Prophylactic cholecystectomy should be strongly considered for patients with asymptomatic gallstones waiting to undergo solid organ transplantation. Prophylactic cholecystectomy can be performed either during the pretransplant period or, when appropriate, at the time of transplantation. The theoretical basis for this recommendation is that these patients are more likely to become symptomatic, especially in the first two years after transplantation. Moreover, because of immunosuppression, diagnosis of complications of cholelithiasis may be more difficult; these complications are associated with increased morbidity and mortality. Finally, cyclosporine and tacrolimus (FK 506), used as immunosuppressive agents, are prolithogenic because of decreased bile salt export pump function.

Patients undergoing cardiac transplant are at increased risk of developing gallstones. The 2.2% mortality after cholecystectomy in these patients is considerably higher than the general population, especially in patients undergoing urgent or emergent open cholecystectomy for complicated gallstone disease.[23] Therefore, prophylactic cholecystectomy is recommended in cardiac transplant patients with asymptomatic gallstones, to prevent the development of complicated gallstone disease.

In contrast, the risk of death due to acute cholecystitis in patients who have had kidney, pancreas or lung transplant is less than the risk of mortality from prophylactic cholecystectomy. Kao *et al*. have recommended expectant management for these patients.[24] However, prophylactic laparoscopic cholecystectomy is recommended in these patients also, when they have a stable organ function after transplant. Laparoscopic cholecystectomy in these patients should be done in a centre with expertise in management of transplant patients.

Laparoscopic cholecystectomy in solid organ transplantation

STATEMENT AND RECOMMENDATION

Statements

- Cardiac transplantation carries a higher mortality with expectant management of gallstone disease (LoE 4).
- Pancreas/renal transplantation carries similar mortality with expectant management and prophylactic cholecystectomy (LoE 4).

Recommendations

Grade C

- Prophylactic laparoscopic cholecystectomy is recommended in cardiac transplant recipients.
- Expectant management is preferred in kidney, pancreas and/or pulmonary transplant recipients.

(v) Biliary sludge

Cholecystectomy may be done in asymptomatic individuals with microcalculi or biliary sludge as up to 24% of these patients may develop pancreatobiliary complications, including cholecystitis, choledocholithiasis and pancreatitis.[25,26]

Laparoscopic cholecystectomy in biliary sludge

STATEMENT AND RECOMMENDATION

Statements

- Association between acute pancreatitis and gallbladder sludge is proven (LoE 5).
- Microcalculi are more likely to migrate into the common bile duct than larger stones, especially if gallbladder motility is preserved (LoE 5).

Recommendation

Grade D

Prophylactic laparoscopic cholecystectomy is recommended in patients with gallbladder microcalculi/sludge.

(vi) Diabetes mellitus

Prophylactic cholecystectomy has been recommended for diabetic patients with silent gallstones. This approach has been based on the belief that diabetic patients belong to the high-risk group for the development of complications of gallstone disease (such as infected bile, gangrenous changes and perforation of the gallbladder), that are more severe than in the general population. Earlier reports found that the risk of acute cholecystitis and subsequent perioperative morbidity and mortality was significantly higher in diabetic compared to non-diabetic patients. Therefore, in the past surgeons were urged to consider diabetic patients as a high-risk group and prophylactic cholecystectomy was recommended. Recent evidence, however, has shown that the natural history of gallstones in diabetics is generally more benign than thought in the past, with a low risk of major complications.

The cumulative percentages of initially asymptomatic non-insulin-dependent diabetic patients who presented with symptoms and complications were small (14.9% and 4.2%, respectively).[27] Also, diabetes as an independent risk factor for the formation of gallstones has been questioned and the prevalence of gallstones was found to be similar among diabetic patients (14.4%) and control subjects (12.5%), in a case–control analysis.[28] Moreover, the rates of operative morbidity and mortality for biliary surgery in diabetics currently are comparable, with rates in non-diabetics once other comorbidities such as cardiovascular and renal disease are taken into consideration. Therefore, there is no clear benefit to prophylactic cholecystectomy in diabetic patients with asymptomatic gallstones, because surgery does not appear to increase either the duration or quality of life, but may in fact reduce it. Consequently, diabetic patients should be managed expectantly with the same criteria as the general population.

Laparoscopic cholecystectomy in diabetes mellitus

STATEMENT AND RECOMMENDATION

Statement

The cumulative symptoms and complications of gallstones were found to be similar among diabetic and non-diabetic patients (LoE 3).

Recommendations

Grade C

Prophylactic cholecystectomy does not confer any clear benefit in diabetic patients with asymptomatic gallstones.

Grade D

Prophylactic cholecystectomy may be performed in diabetic patients at a higher risk of complications.

LAPAROSCOPIC CHOLECYSTECTOMY IN SPECIAL SITUATIONS

Pregnancy

The most common non-obstetrical surgical emergencies in pregnancy are acute appendicitis and acute cholecystitis.[29] Laparoscopic cholecystectomy can be performed safely during any trimester of pregnancy with minimal morbidity to the foetus and mother. Delaying surgery until after parturition, has, in fact, been shown to increase complications for both mother and foetus.[30] Laparoscopic cholecystectomy has been found to be associated with fewer maternal, foetal and surgical complications compared to open cholecystectomy.[31]

Pneumoperitoneum may be created by either open or closed technique, by adjusting the site of access according to the fundal height and elevating the abdominal wall during insertion.[32] Ultrasound-guided access may further increase safety.

Laparoscopic cholecystectomy in pregnancy

STATEMENT AND RECOMMENDATION

Statements

- Non-operative management (NOM) of symptomatic gallstones in gravid patients results in recurrent symptoms in 92%, 64% and 44% in 1st, 2nd and 3rd trimester, respectively (LoE 3).
- More than 50% of patients need hospitalization and 23% of these patients develop acute cholecystitis or gallstone pancreatitis (LoE 3).
- Gallstone pancreatitis results in fetal loss in 10%–60% of pregnant mothers (LoE 3).
- Laparoscopy can be performed safely during any trimester of pregnancy with minimal morbidity to the fetus and mother (LoE 2).

Recommendations

Grade B

- Laparoscopic cholecystectomy is recommended in the pregnant patient with symptomatic gallstones.
- Laparoscopic cholecystectomy can be safely performed in any trimester.
- Early elective laparoscopic cholecystectomy is encouraged.

Patients on anticoagulants

There is little published data regarding laparoscopic cholecystectomy in the setting of systemic anticoagulation, but there are at least two recently published studies of patients taking warfarin for long-term systemic anticoagulation. In both, patients had their warfarin discontinued and were bridged to surgery with low molecular weight heparin as inpatients, and laparoscopic cholecystectomy was performed after their international normalized ratio (INR) was 1.5 or less. In one study of 44 anticoagulated patients, postoperative bleeding was significantly more common in the oral anticoagulation group (25%) versus the control group (1.5%), and in the majority of cases, bleeding in the oral anticoagulation group was serious, requiring blood transfusion or reoperation with a concomitantly longer hospital stay, with standard laboratory tests not predicting postoperative haemorrhage.[33] The other study with 33 anticoagulated patients reported no bleeding complications.[34] Based on similar rates of bleeding from other studies of laparoscopic procedures reviewed by the authors, caution in chronically anticoagulated patients is warranted, particularly in those requiring bridging with low molecular weight heparin.

Warfarin should be stopped 5 days prior to surgery and bridging anticoagulation started with unfractionated or low molecular weight heparin. Patients may be taken for surgery if INR is <1.5. Intra-operatively, pneumatic compression device should be used for deep vein thrombosis prophylaxis. Meticulous dissection should be done to avoid bleeding. Prophylactic drain placement may be done. Postoperatively, early mobilization should be encouraged and in the absence of bleeding complications, both warfarin and heparin started when deemed safe by the operating surgeon. Heparin should be continued till the desired INR level is reached.

Laparoscopic cholecystectomy in anticoagulation

STATEMENT AND RECOMMENDATION

Statement

Caution in chronically anticoagulated patients is warranted even after cessation of pharmacotherapy, particularly in those bridged with low molecular weight heparin (LoE 3).

Recommendation

Grade B

Laparoscopic cholecystectomy may be done safely in patients on anticoagulant therapy after cessation of therapy for appropriate time.

Immunocompromised patients

The literature is somewhat divided as far as outcome of laparoscopic cholecystectomy in HIV/AIDS patients is concerned. Leiva *et al.*[35] in a retrospective review of 101 AIDS patients with symptomatic cholecystitis, have found an improved quality of life after cholecystectomy. In this report, 56 patients had open cholecystectomy and 45 laparoscopic. Perioperative mortality was 4% and morbidity was <5% in both laparoscopic and open groups. Ricci *et al.*[36] in a review of 53 patients with AIDS, found 34% morbidity and 2% mortality after laparoscopic or open cholecystectomy.

Conversion rate was 14% in the laparoscopic group. Type of approach and CD4 count (greater or <50 cells/cmm) did not affect morbidity or mortality.

Carroll *et al.*[37] have reported laparoscopic cholecystectomy on 18 HIV infected patients, 12 of whom had AIDS. Five of the 6 patients (83%) without AIDS had improvement of symptoms postoperatively and there was 1 minor complication (17%). In contrast, only 1 of the 12 patients with AIDS had improvement of symptoms and 8 (66%) had complications, including 4 deaths (33%) within 30 days of surgery. The authors have suggested an algorithm for AIDS patients with suspected acute cholecystitis. These patients should undergo a DISIDA scan; if normal, surgery can be avoided. If the gallbladder is not visualized at 4 hours, a delayed scan at 24 hours should be done. If delayed scan is not available, a 4-hour scan should be done after infusion of cholecystokinin. If the gallbladder is not visualized even on a delayed scan, endoscopic retrograde cholangiopancreatography (ERCP) should be done to check for cystic duct patency. If the cystic duct is found to be obstructed, laparoscopic cholecystectomy should be done.

Liver cirrhosis

Cirrhosis places patients at an increased risk for gallstone formation. Since the NIH consensus conference on gallstones and laparoscopic cholecystectomy in 1992 suggested that patients with cirrhosis are 'not usually candidates for laparoscopic cholecystectomy', studies continue to be published supporting the safety of the approach in patients with Child–Pugh (CP) A or B cirrhosis (including downgrading from C after appropriate treatment)[38] with almost no data using the model for end-stage liver disease (MELD) score to compare patients. The scarce published data on CP-C patients is in favour of non-operative management such as percutaneous cholecystostomy and suggests that laparoscopic cholecystectomy should be avoided.[39] Recent studies generally agree that laparoscopic cholecystectomy in selected cirrhotics has a relatively low conversion rate (0%–11%), complication rate (9.5%–21%) and risk of dying (0%–6.3%), with worsening liver failure, presence of ascites and coagulopathy predicting poorer outcomes.[38–43] A recent prospective randomized trial found laparoscopic cholecystectomy was safer than open cholecystectomy in cirrhotics.[44] Some authors have suggested laparoscopic subtotal cholecystectomy as an alternative to laparoscopic cholecystectomy.[45] Most authors caution that bleeding is the most frequent and worrisome complication suggesting that coagulopathy and thrombocytopenia be corrected preoperatively and that dilated pericholecystic and abdominal wall veins or recanalized umbilical veins be treated with care.

Laparoscopic cholecystectomy in liver cirrhosis

STATEMENT AND RECOMMENDATION

Statements

Child Pugh A and B

- Lower incidence of postoperative complications following laparoscopic cholecystectomy (LoE 1a)
- Lower incidence of infectious complications in laparoscopic cholecystectomy (LoE 1a)
- Shorter hospital stay in laparoscopic cholecystectomy (LoE 1a)
- No difference in postoperative hepatic insufficiency between laparoscopic and open cholecystectomy (LoE 1a)

Child–Pugh C

- Laparoscopic cholecystectomy in cirrhotics is associated with higher complications than in non-cirrhotic patients (LoE 4).
- Postoperative complications are related primarily to Child–Pugh grade, being maximum in patients of Child–Pugh C (LoE 4).

Recommendations

Grade A

Laparoscopic cholecystectomy is preferred over open cholecystectomy for patients with Child–Pugh A and B.

Grade C

- Laparoscopic cholecystectomy should not be attempted in Child–Pugh C patients.
- Cholecystostomy is preferred in Child–Pugh C patients.

CONTRAINDICATIONS OF LAPAROSCOPIC CHOLECYSTECTOMY

At present the only absolute contraindications for laparoscopic cholecystectomy are uncontrolled bleeding disorder and patients unfit

CONTRAINDICATIONS OF LAPAROSCOPIC CHOLECYSTECTOMY	
Absolute contraindications Uncontrolled bleeding disorder Unfit for general anaesthesia	**Relative contraindications** Portal hypertension Child–Pugh C cirrhosis Multiple previous laparotomies

for general anaesthesia. However, depending on the expertise of the surgeon, some conditions may be considered as relative contraindications like portal hypertension, multiple previous laparotomies, Mirizzi's syndrome. Although laparoscopic cholecystectomy is recommended in Child–Pugh A/B cirrhosis patients, Child–Pugh C cirrhosis is a relative contraindication due to high risk of liver failure and haemorrhage.[46,47] Image guided percutaneous cholecystostomy is the treatment of choice in this sub-group of patients.

Preoperative work-up and case selection

All patients planned for a laparoscopic cholecystectomy should have a detailed history and clinical examination. The history should include the nature of pain, number of episodes of biliary colic and last episode. One should ask for features suggestive of acute cholecystitis (pain lasting more than 6 hours, fever, tenderness in right upper quadrant), cholangitis (fever, jaundice) and pancreatitis. Any past history of abdominal surgery or hospitalization should be noted. Relevant detailed history regarding the comorbidities including diabetes, hypertension, ischaemic heart disease, chronic obstructive pulmonary disease should be asked for. A note should be made of all the drugs the patient is taking specially any antiplatelets or oral anticoagulants. Females should have a thorough obstetric and menstrual history taken and a note should be made of the last menstrual period and if indicated, a urinary pregnancy test should be performed. All documents available with the patient should be thoroughly reviewed.

The clinical examination includes a good general physical examination. One must look for jaundice. On abdominal examination one should look for right upper quadrant tenderness, palpable gallbladder, hepatomegaly, splenomegaly and signs of portal hypertension, which predict a difficult cholecystectomy. Special consideration should be given to previous surgical scars. Peritoneal access should be planned accordingly.

All patients should have a haemogram, liver function test and ultrasound abdomen. Raised bilirubin, liver enzymes or alkaline phosphatase (ALP) should prompt further investigation. Features to look for in ultrasound include number and size of stones, wall thickness of the gallbladder, whether it is distended or contracted, presence of any polyp or mass, diameter of common bile duct (CBD) and intrahepatic biliary dilatation. Magnetic resonance cholangiopancreatography (MRCP) should be done when there is suspicion of stones in the CBD (raised serum ALP, increased diameter of CBD on ultrasound, history of biliary pancreatitis). Contrast-enhanced computerized tomography (CECT) should be done when ultrasound reveals any polyp, asymmetric or irregular wall thickening, or there is suspicion of gallbladder perforation or portal hypertension. Fine needle aspiration cytology (FNAC) should be done if imaging reveals a gallbladder polyp or mass. Rarely, a hepatobiliary iminodiacetic acid (HIDA) scan is required for confirmation of diagnosis of acute acalculous cholecystitis or biliary dyskinesia.

Comorbidities such as diabetes mellitus, hypertension, hypo- or hyperthyroidism, bronchial asthma or chronic obstructive pulmonary disease must be evaluated by appropriate investigations and optimized before elective laparoscopic cholecystectomy. Optimization of cardio-respiratory status should be done, whenever indicated. Pulmonary function test must be done in patients with chronic obstructive pulmonary disease. Clearance for surgery should be obtained from concerned specialties. If the patient is a known smoker he/she should be advised to stop smoking for at least 4–6 weeks before the procedure.

All antiplatelet drugs should be withheld at least for 7 days prior to surgery. If the patient is on aspirin it should be stopped at least 5 days prior to surgery. Patients on warfarin should be put on bridge therapy and switched over to low molecular weight or unfractionated heparin (UH) at least 4–5 days prior to the planned procedure. Low molecular weight heparin (LMWH) and UH need to be stopped at least 12 hours and 6 hours before the scheduled procedure, respectively.

Diabetic status needs to be monitored and oral hypoglycaemic agents like metformin may need to be stopped 48 hours prior to anaesthesia and operation.

A detailed informed consent should be taken and the patient should be explained about the surgical procedure and its possible complications. The consent should always include the possibility of conversion to open procedure for all patients. This goes a long way in preventing litigations.

Instruments

A 10 mm, 30° telescope is preferred. Although modern 5 mm high definition telescopes provide reasonably good image, beginners may be more comfortable using a 10 mm telescope. A good imaging system is not just necessary but essential. Inadequacies of the vision system add to fatigue and frustration, especially during difficult cases.

A standard 4 port laparoscopic cholecystectomy requires two 10 mm and two 5 mm ports. Before scrubbing surgeons should ensure availability of extra ports. In obese patients or patients with severe adhesions, a fifth port may become handy to retract the liver or release adhesions. Hand instruments include graspers, Maryland scissors, suction cannula, clip applicator, diathermy hook and spatula and gallbladder extractor. If a difficult cholecystectomy is anticipated, it is advisable to arrange needle holder, endostaplers and energy devices like Harmonic. Endobag should be used for retrieval in case of empyema gallbladder, polyp or suspected neoplasm.

INSTRUMENTS

Imaging System
10 mm, 30° telescope
Video recorder

Ports – 10 mm, 5 mm
Maryland dissector
Graspers
Scissors
Diathermy hook/spatula
Suction cannula
Clip applicator
Gallbladder extractor
Endobag

Needle holder
Endostapler
Energy devices

Preoperative preparation

Laparoscopic cholecystectomy should be done under general anaesthesia. Before induction, it is ascertained that the patient's urinary bladder is empty and patient should be asked to void before coming to the theatre. After induction an orogastric tube is placed to decompress the stomach. Prophylactic intravenous antibiotic, usually a first or second generation cephalosporin or fluoroquinolone, is given at the time of induction. A second dose of antibiotic given after 12 hours has been found to have better effect than a single dose in elective cases.[48] There is no evidence to support further use of antibiotics in the postoperative period except in immunocompromised patients such as those on immunosuppression, uncontrolled diabetes, post-transplant. However, patients with acute cholecystitis would require a longer course of antibiotics in view of sepsis.

Prophylactic antibiotics in elective laparoscopic cholecystectomy

STATEMENT AND RECOMMENDATION

Statements

- Two doses of antibiotics are better than a single dose (LoE 1a).
- There is no advantage of giving more than two doses (LoE 1a).

Recommendation

Grade A

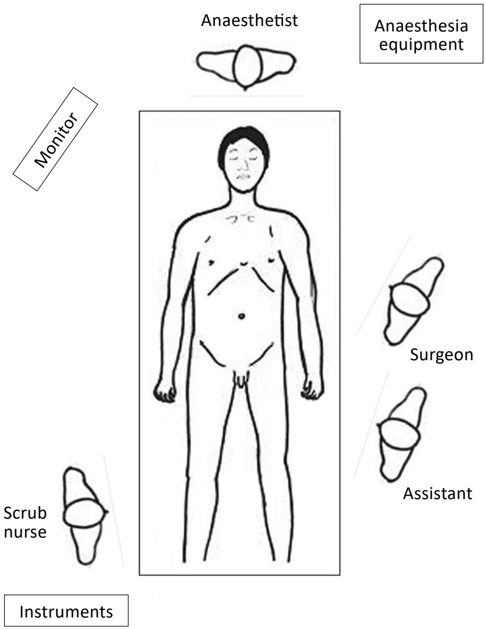
Two doses of prophylactic antibiotics should be given to all patients undergoing elective laparoscopic cholecystectomy; first, at the time of induction and second, 6–12 hours after surgery.

Techniques of laparoscopic cholecystectomy

There are various techniques for laparoscopic cholecystectomy, viz.

1. Standard four-port laparoscopic cholecystectomy
2. Three-port laparoscopic cholecystectomy
3. Single-incision laparoscopic cholecystectomy
4. NOTES cholecystectomy (transvaginal/transgastric)

However, only the standard four-port cholecystectomy is presently the standard of care, which is described below.



Patient position and operating room setup

The procedure is carried out with the patient lying supine, with a 30° head up and 30° right up. The surgeon usually stands on the left of the patient (American position). Some surgeons may prefer to stand between the patient's legs, with the patient positioned in low lithotomy (French position). No significant difference in ergonomics has been found between the two positions.[49]

In the American position the camera assistant stands to the surgeon's left. Another assistant stands on the patient's right and retracts the fundus of the gallbladder cranially, towards the patient's right shoulder. The scrub nurse stands on the patient's left beside the camera assistant. The monitor is kept on the patient's right side. A second monitor on the patient's left is preferable, for the assistant surgeon, scrub nurse and anaesthesia team.

Surgeon position laparoscopic cholecystectomy

STATEMENT AND RECOMMENDATION

Statement

American and French position are similar in terms of ergonomics (LoE 2).

Recommendation

Grade B

Either American or French position may be adopted depending upon the surgeon's preference.

Operative steps

Pneumoperitoneum is created with the patient lying supine just above the umblicus, using either open (Hasson's) or closed (Veress needle) technique, depending on the surgeon's preference. A recent meta-analysis of 46 randomized controlled trials (RCTs) studying a total of 7389 individuals comparing a variety of open and closed access techniques found no difference in complication rates. Therefore, decisions regarding choice of technique are left to the surgeon and should be based on individual training, skill and case assessment.[50] In case of presence of midline scar it is preferable to use alternate entry point such as the Palmer's point.[51] This is about a fingers breadth below the left subcostal margin in the midclavicular line. It has the least amount of adhesions and the abdominal wall is thinner here. However, one must ensure that the stomach is decompressed and there is no splenomegaly before using the Palmer's point. Direct trocar insertion without pneumoperitoneum creation should not be done.

Creation of pneumoperitoneum

STATEMENT AND RECOMMENDATION

Statements

- There is no difference in incidence of vascular or bowel injury between open and closed techniques of pneumoperitoneum creation (LoE 1a).
- Palmer's point in the left upper quadrant is the preferred site in case of previous surgery (LoE 2a).

Recommendations

Grade A

Either open or closed technique can be used for creation of pneumoperitoneum according to the surgeon's preference.

Grade B

Palmer's point in the left upper quadrant should be used for Veress needle insertion in patients with suspected or known periumbilical adhesions (previous laparotomy) and in patients with umbilical hernia.

Pneumoperitoneum is then created using CO_2 initially at a rate of 1 L/min up to a pressure of 4–6 mmHg, and then at 3–6 L/min. End-tidal carbon dioxide ($etCO_2$) monitoring is essential during the creation of pneumoperitoneum. An unusually high pressure at the onset indicates either the Veress is not in the peritoneal cavity or abutting a viscera or omentum. An intra-abdominal pressure of 12–14 mmHg is maintained. Though laparoscopic cholecystectomy can also be performed at lower pressures (<12 mmHg), there is no evidence of benefit of low pressure pneumoperitoneum in low anaesthetic risk patients.[52]

Intra-abdominal pressures

STATEMENT AND RECOMMENDATION

Statement

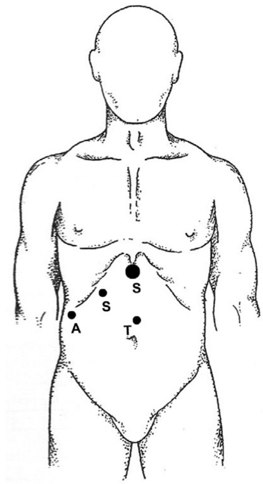
There is no difference between standard and low pressure pneumoperitoneum in low anaesthetic risk patients (LoE 1a).

Recommendation

Grade B

There is no evidence to support routine use of low pressure in low anaesthetic risk patients.

The first port is a 5–10 mm port, inserted just above, below or through the umbilicus. A 10 mm 30° telescope is used. Diagnostic laparoscopy is carried out without changing the position of the patient and iatrogenic injury to any structure, especially omentum and small bowel, ruled out. Pelvic inspection may reveal unsuspected pathology. Liver and both sides of falciform ligament are inspected. If the stomach is found to be distended nasogastric or orogastric tube decompression is done.



Initial inspection

STATEMENT AND RECOMMENDATION

Statements

- An initial inspection should be done after first trocar insertion without changing the position of the patient (LoE 4).
- Thorough examination should be done to rule out any trocar/Veress-related injury (LoE 4).

Recommendation

Grade C

An initial inspection is mandatory after insertion of the first trocar.

Once the first port is inserted, a 15°–30° head up and right up tilt is made and remaining ports inserted under vision. A 10–12 mm epigastric port is inserted just to the right of the falciform ligament two finger breadths below the xiphoid process. Two 5 mm subcostal ports are then placed in the right mid-clavicular line and anterior axillary line, following the baseball diamond or triangulation concept. All these ports are placed under vision and directed towards the gall bladder fossa. However, one should not hesitate to put an extra (fifth) port for retraction of liver, heavy omentum, duodenum or the falciform ligament or for suction (in case of bleeding).

Port placement

STATEMENT AND RECOMMENDATION

Statements

- Additional ports at epigastrium, mid-clavicular line and anterior axillary line below costal margin (LoE 3).
- All secondary ports to be placed under vision (LoE 3).
- Additional ports, as required, should be placed (LoE 3).

Recommendations

Grade C

- A 10–12 mm epigastric port and two 5 mm subcostal ports are placed in the right mid-clavicular line and anterior axillary line.
- All three ports should be placed under vision.
- Additional ports, as required, may be used.

The second assistant then retracts the fundus of the gallbladder upwards towards the right shoulder of the patient using a blunt grasper through the anterior axillary line port. One must then retract the duodenum down to expose the hepato-duodenal ligament. In a thin built patient, the bluish CBD may be seen (visual cholangiography). Whenever possible an attempt should be made to see the CBD before proceeding with any dissection. If the stomach appears distended at this point the anaesthetist should be asked to decompress stomach through the orogastric tube. The surgeon then grasps the neck of the gall bladder through the midclavicular line port. A gentle downward and outward traction is given on the neck of the gallbladder so as to open the Calot's triangle and place the cystic duct perpendicular to the CBD rather than in line with the CBD.

The dissection is started by opening the peritoneum on the posterior surface of Calot's followed by the peritoneum on the anterior surface. One will encounter the cystic lymph node of Lund, which is an important anatomical landmark and invariably overlies the cystic artery. During the entire dissection one should stay as close as possible to the gall bladder with minimal use of electrocautery. Too much traction on the gallbladder neck should be avoided to prevent tenting of the CBD. One must then make an attempt to visualize Strasberg's critical view of safety (CVS), which includes dissection (i) to completely expose and delineate the hepatocystic triangle, (ii) to identify a single duct and a single artery entering the gallbladder and (iii) to completely separate the lower part of the gallbladder off the liver bed.[53] There are no randomized trials to prove the usefulness of this technique. However, it is recommended to delineate the CVS whenever possible.[54] It is mandatory to be sure of what the structures are before clipping or dividing. One must always think of CBD and be really sure. At this point one can take a small time out and take the opinion of the assistants before clipping or dividing any structures.

Critical view of safety

STATEMENT AND RECOMMENDATION

Statement

There has been a decrease in self-reported bile duct injury during laparoscopic cholecystectomy with the use of *critical view of safety* (LoE 4).

Recommendation

Grade B

Delineation of CVS should always be attempted, if possible.

Hepatic artery pulsations are a good guide in case of any doubt. The hepatic artery pulsation is usually not seen as it is to the left of the CBD. If the hepatic artery pulsations are seen next to the retracted GB, it should raise suspicion that the CBD has got pulled with the gallbladder. Another important landmark is the Sulcus of Rouviere, which is a landmark for the right portal pedicle and is seen in almost

THINK OF THE CBD ALL THE TIME

Do not be in a hurry to clip or divide any structure until the status of the CBD is known with absolute certainty

80% cases.[55] One must always stay anterior to this sulcus to avoid injury to the CBD and right portal pedicle.[56]

Rouviere's sulcus

STATEMENT AND RECOMMENDATION

Statements

- Identification of Rouviere's sulcus as a fixed extra-biliary point ventral to the right portal pedicle is recommended (LoE 4).
- Dissection ventral to this allows a triangle of safe dissection (LoE 4).
- Ensures no unexpected anatomy and confirms the correct anatomical position before any significant structure is divided (LoE 4).

Recommendation

Grade C

Dissection should always be done ventral to Rouviere's sulcus.

One must visualize the widening of cystic duct into the gallbladder (CD-GB junction), which is more important than identifying the CD-CBD junction. Once the cystic duct and cystic artery have been identified they can be either clipped or ligated and then divided. Sometimes, instead of a single cystic artery, anterior and posterior branches of the main artery may be seen to enter the gallbladder, which have to be clipped separately. Variations in the anatomy of the cystic artery and cystic duct are frequent,[57,58] and the surgeon must be aware of these variations.

Cystic artery

STATEMENT AND RECOMMENDATION

Statements

- Clipping and ultrasonic shears are equally effective (LoE 1b).
- Ligation in difficult situation (LoE 1b).
- No monopolar cautery to be used (LoE 1b).

(continued)

Cystic artery

STATEMENT AND RECOMMENDATION

Recommendations

Grade B

- Clips should be used for ligation of cystic artery routinely.
- Difficult situation suture ligation.
- Monopolar diathermy should be avoided.

Once the cystic duct and artery are divided, the gallbladder is dissected off the cystic plate. This dissection should be done in the right plane to avoid perforating the gallbladder or causing bleeding from the liver.However, it is better to err on the gallbladder side, as dissecting into the liver parenchyma can cause severe bleeding which may be difficult to control. Dissection can be done either with monopolar cautery or ultrasonic shears. The use of ultrasonic shear causes less bleeding but adds to the cost of the procedure.[59] Ultrasonic shear may be advantageous in some cases, where the gallbladder is densely adhered to the liver.

Dissection from gallbladder fossa

STATEMENT AND RECOMMENDATION

Statements

- Ultrasonic shears cause less bleeding than monopolar diathermy during dissection of gallbladder from the liver bed (LoE 1b).
- However, one must weigh the benefit against an increased cost (LoE 1b).

Recommendation

Grade B

Monopolar or bipolar diathermy for routine use is recommended.

The gallbladder is usually extracted through the epigastric port. Some surgeons prefer extraction from the umbilical port. Though there is no evidence supporting it, epigastric delivery is preferred as, if spillage of stones or bileoccurs, there is a higher chance of stones getting spilled into the pelvis and getting lost when extraction is done through the umbilical port.

While use of drains after laparoscopic biliary tract surgery is at the discretion of the operating surgeon, recent studies including an RCT and meta-analysis of 12 RCTs have found no advantage of use of drain in uncomplicated cholecystectomy.[60,61] Thus, routine drain placement is not recommended after an uneventful laparoscopic cholecystectomy. However, in difficult cholecystectomies, a subhepatic drain may be placed. Before closing the ports, one should have a final look at the cystic duct and artery stumps and the liver bed and rule out any bleeding or bile leak. Secondary ports should be removed under vision and port sites checked for any bleeding.

Routine drain placement

STATEMENT AND RECOMMENDATION

Statements

- There is no evidence in favour of routine use of drain after laparoscopic cholecystectomy (LoE 1a).
- In difficult cholecystectomies, a subhepatic drain may be placed at the discretion of the surgeon (LoE 4).

Recommendations

Grade A

There is no evidence to advocate the routine use of drain after an uncomplicated laparoscopic cholecystectomy.

Grade B

Drain may be used in elective cholecystectomy at the discretion of the operating surgeon.

Postoperative care

Patients undergoing laparoscopic cholecystectomy should have no or minimal pain and should be up and about few hours after surgery. They should look well, have normal appetite, be haemodynamically stable and have a soft and settled abdomen in the postoperative period. Selected patients with minimal or no systemic illness and within easy reach of the hospital may be discharged on the same day.[62] We prefer to keep the patient in hospital overnight and discharge them on the next morning. Patients are expected to return to work within 7–14 days, depending on the nature of work.

Laparoscopic cholecystectomy in difficult situations

Not all laparoscopic cholecystectomies are straightforward. One may encounter difficulties more often than not. There are some preoperative predictors of difficult cholecystectomy.[63,64] These include:

1. Elderly, male, obese
2. Long duration of symptoms
3. History of acute cholecystitis
4. History of jaundice, cholangitis, acute pancreatitis
5. Porcelain (calcified) gallbladder
6. CBD stones, Mirizzi's syndrome
7. Cirrhosis, portal hypertension
8. Previous endoscopic/upper abdominal surgery, tube cholecystostomy

One needs to be well prepared, have an additional help, extra ports, energy devices and should have a lower threshold for conversion.One can proceed with a laparoscopic approach only if expertise and experience to handle such difficult situations are there. If using a 0° telescope, it should be changed to 30° as it gives a wider field of vision. If the hepatic artery pulsations are seen without any other tissue between the gallbladder and the hepatic artery, it should raise a suspicion that CBD has got pulled with the gallbladder and the structure being considered as the cystic duct for ligation/clipping is actually a narrow CBD and not the cystic duct. Abandoning the procedure by swallowing one's pride might be the best option in a difficult situation. Even if it is decided to proceed with laparoscopic cholecystectomy, there should be a low threshold for conversion to open surgery (laparotomy).

Laparoscopic cholecystectomy in difficult situations

STATEMENT AND RECOMMENDATION

Statement

If the hepatic artery pulsations are seen without any other tissue between the gallbladder and the hepatic artery, it should raise a suspicion that CBD has got pulled with the gallbladder.

Recommendations

Grade C

- Change to a 30° telescope if using 0° telescope.
- To proceed with laparoscopic cholecystectomy only if expertise and experience to handle such difficult situations are there.
- Even if it is decided to proceed with laparoscopic cholecystectomy, there should be a low threshold for open conversion (laparotomy).
- Retreat if not experienced or if there is an unexpected difficult scenario.

In situations where the CVS cannot be defined due to dense adhesions around the Calot's triangle, following options are available.

1. Intraoperative cholangiogram
2. Laparoscopic ultrasound
3. Fundus first approach[65]
4. Subtotal/partial cholecystectomy[66]
5. Open conversion[67]

Intraoperative cholangiogram (IOC)

STATEMENT AND RECOMMENDATION

Statement

There is no evidence to support or abandon IOC in preventing bile duct injury (LoE 1a).

Recommendation

Grade A

IOC is not recommended for routine use. It may be used in difficult anatomy.

Laparoscopic ultrasound (LUS)

STATEMENT AND RECOMMENDATION

Statements

- LUS may be used as an additional intraoperative modality to clearly identify the bile duct and to obviate bile duct injury (LoE 4).
- Laparoscopic US may be helpful in claryfying bile duct anatomy (LoE 5).

Recommendation

Grade C

LUS may be used to delineate bile duct in difficult anatomy.

Fundus first approach

STATEMENT AND RECOMMENDATION

Statements

- Fundus first approach may be attempted in unsafe Calot's triangle (LoE 4).
- It is associated with low conversion and low bile duct injury rates (LoE 4).

Recommendation

Grade C

Fundus first cholecystectomy may be considered as a safe alternative in frozen/difficult Calot's triangle.

Conversion to open

STATEMENT AND RECOMMENDATION

Statements

- Significant increase in complication rates were observed in laparoscopically completed group compared to converted cholecystectomy group (LoE 4).
- A lower incidence of open conversion was observed among patients who had complex biliary injuries or vascular injuries (LoE 4).

(conitnued)

Conversion to open

STATEMENT AND RECOMMENDATION

Recommendations

Grade C

- Chances of conversion and risk of bile duct injury are higher in difficult situations.
- Less experienced surgeons should refer such cases to more experienced surgeons.
- When faced during cholecystectomy, call for help of another surgeon for a second opinion before ligating/dividing any structure
- Retreat if anatomy is not clear and refer the patient to a higher centre.

Laparoscopic partial cholecystectomy (LPC)

STATEMENT AND RECOMMENDATION

Statements

- Mean time of operation more in conversion cholecystectomy (CC) than in laparoscopic partial cholecystectomy (LoE 3).
- Rate of surgical drain usage more in CC group patients than in LPC group (LoE 3).
- Median hospital stay more in CC group (3 days) than in LPC group (1 day) (LoE 3).

Recommendation

Grade B

Laparoscopic partial cholecystectomy is safe and effective in avoiding major bile duct injury in difficult cholecystectomy and thus, may be preferred over conversion.

COMPLICATIONS

Bleeding during laparoscopic cholecystectomy

Bleeding could be access related or during dissection and is usually detected on table. The incidence of vascular injury in closed technique of pneumoperitoneum is 0.008%.[50] Access-related bleeding is commonly from the abdominal wall vessels and can be managed with tamponade or sutures. There are reports of major vessel injury (aorta/inferior vena cava) during access; immediate midline laparotomy is needed for control of such haemorrhage. Bleeding during Calot's dissection could be from the cystic artery, right hepatic artery, portal vein or its collaterals in patients with portal hypertension. It can be from aberrant vessels and may be associated with biliary injury.

The surgeon should not panic, and should not try to catch the bleeder or use cautery blindly, as that can lead to biliary injury. Firm pressure with a gauze should be applied for 5 minutes. During this time the anaesthetist should be informed and help from an expert sought, if possible. Instruments, clips, sutures, local haemostats are also arranged. After 5 minutes the gauze is removed. If bleeding stops dissection is continued. If it persists and the source can be identified, haemostasis is secured using clips or suture. Bleeding from cystic artery may be controlled with bipolar cautery or harmonic also. Bleeding from right hepatic artery may be controlled with clips or suture, but it has to be ensured that there is no associated biliary injury.

Bleeding can also occur from the gallbladder bed while dissecting the gallbladder off the liver. These are usually minor bleeds; however, 10% to 15% of patients have a large branch of the middle hepatic vein adherent to the GB bed. Such bleeding is common in cirrhosis and portal hypertension. In cirrhotics harmonic is superior to conventional monopolar diathermy in terms of blood loss (LoE 2). If the gallbladder is in situ, pressure may be applied with the gallbladder itself. Otherwise, a gauze should be inserted and used for tamponade. Most bleeding would reduce with pressure for 5 minutes and one can continue the procedure. If bleeding persists, pressure is applied for another 5 minutes. If it still continues or the patient becomes haemodynamically unstable, it could be from a hepatic vein tributary. Conversion should be done and hemostasis secured with sutures.

Bleeding may also manifest in the immediate postoperative period as abdominal wall or retroperitoneal haematoma or intraperitoneal bleeding or present even later as haemobilia.

Bile and stone spillage

Spillage can be prevented by careful dissection and identification of correct tissue planes. A turgid gallbladder, e.g. in mucocele or empyema, should be decompressed. Retrieval bags may be used during gallbladder extraction, especially in gangrenous cholecystitis (LoE 4).

Spillage of infected bile can lead to intra-abdominal abscess and systemic infection. Dissemination of gallbladder cancer due to bile spillage has also been reported. If there is bile spillage, it should be immediately sucked. Subhepatic and suprahepatic areas should be lavaged thoroughly with normal saline (LoE 4). No extra antibiotics are required unless there is empyema. If stones are spilled, every attempt must be made to retrieve them. Retained stones, particularly large pigmented or mixed stones, have been found to cause severe complications like parietal and intra-abdominal abscess and fistula. Reports of intestinal obstruction and migration to lungs or urinary tract are also found in the literature. Open conversion is usually not necessary; patience is all that is required to avoid these complications. If one or more stones cannot be retrieved, it must be documented and the patient informed, so that complications, if any, can be detected early.

Stone spillage

STATEMENT AND RECOMMENDATION

Statement

Retained gallstones can cause various postoperative problems including extra-abdominal complications (LoE 2).

Recommendations

Grade B

- In case of perforation of gallbladder during laparoscopic cholecystectomy, spilled gallstones should be collected to prevent complications.
- Open conversion is not necessary.

Bile duct injury

The most feared complication of laparoscopic cholecystectomy is bile duct injury (BDI). Even after three decades since its inception, the rate of bile duct injury is still higher in laparoscopic cholecystectomy compared to open, although the incidence is gradually decreasing.

Intraoperative detection and management

BDI may be suspected on table if there is bile leak from the porta or hepatoduodenal ligament. The source can be gallbladder, cystic duct, common hepatic or bile duct, subvesical duct, accessory or aberrant duct. Various investigations have been described to improve on table detection of biliary injury, like intraoperative cholangiogram,[68] ultrasound, fluorescent cholangiography.[69] However, since these are not used frequently, most surgeons find it difficult to interpret the findings. More often than not, these investigations just increase the operative time and cost, and turn out to be a futile exercise.

Gallbladder bile is thick, viscid and greenish; if certain, one can apply a clip and proceed. Hepatic bile is watery and golden yellow in colour; presence of hepatic bile raises a strong suspicion for BDI, which could be Strasberg type A, C or D. If the bile leak is from a small duct (<2 mm) in the GB fossa, it may be clipped or ligated.If hepatic bile is found anywhere else or from a larger duct, one should either call an expert or abandon the procedure, place subhepatic drain and refer to a higher centre.

BDI should also be suspected if the cystic duct stump retracts down to the duodenum soon after division, or there is a third tubular structure in Calot's triangle after division of cystic duct and artery, or there is an abnormal mucosal patch attached to cystic duct stump. In all of these situations, immediate repair may be done if an expert is available; otherwise the procedure should be abandoned, drain placed and the patient referred to a hepatobiliary centre. Any further dissection may convert it to a higher injury and make it more difficult to repair, and hence, conversion to open is not recommended.

Cannulation of the duct at the site of injury should not be attempted as that can also increase the extent of injury. Primary repair by the operating surgeon has a failure rate ranging from 60% to 90%. Thus, if an expert hepatobiliary surgeon is not available, the procedure should be abandoned, drain placed, patient and relatives counselled and referred to a hepatobiliary centre.

Intraoperative detection and management of BDI

STATEMENT AND RECOMMENDATION

Statements

- In suspected BDI conversion will not help if facilities for primary repair are not available (LoE 3).
- BDI may be worsened by further dissection, whether laparoscopically or by open technique (LoE 3).
- Attempt to cannulate the duct at the site of injury may extend the injury further (LoE 3).
- Drains placed near the site of injury may be sufficient to control the leak (LoE 3).
- Primary repair by the operating surgeon has a failure rate of 60% to 90% (LoE 3).
- Unsatisfactory primary repair decreases the chance of success of subsequent repair (LoE 3).

Recommendations

Grade C

- In suspected BDI either call an expert hepatobiliary surgeon for intraoperative assessment and management, or abandon the procedure, place drains and refer the patient to a specialized centre early.
- Fluorescein cholangiography may be used as a substitute of intraoperative cholangiogram for detection of BDI.

Postoperative detection and management

More commonly, however, BDI manifests in the postoperative period. A high index of suspicion is required. If the patient looks unwell, has more than usual pain, is not sitting up, or has tachycardia or tachypnea, or the abdomen is not settled, the patient should not be discharged.

Depending on the degree of suspicion of bile leak, we recommend a policy of early re-laparoscopy. The epigastric and umbilical ports should be opened; if there is drainage of bile, diagnostic laparoscopy should be done. In the absence of any bile drainage, a litre of normal saline should be instilled through the epigastric port and the return fluid checked for bile stain. On laparoscopy, a thorough lavage should be done and a subhepatic drain placed. If the bile leak is from the cystic duct stump or a duct of Luschka or sectoral duct, a clip or suture is applied. We believe that this approach minimizes the risk of biliary peritonitis and sepsis and helps in creating a controlled external biliary fistula in a minimal invasive manner. Re-laparoscopy should not be delayed waiting for various investigations.

If the patient has a drain *in situ* and there is bile in the drain postoperatively, patient should not be discharged. An ultrasound should be done and any collection should be drained by percutaneous catheter placement or laparoscopic or open drain placement, depending on the expertise available. Drain output should be monitored; if persisting or increasing, patient should be referred to a higher centre. If output shows a decreasing trend, MRCP may be done to detect the source of leak. Leak from the cystic duct stump may be managed by ERCP and stenting.

If the patient develops jaundice without any external biliary fistula, MRCP should be done to rule out stones or stricture. CBD stones can be removed by ERCP and stenting. Stricture should be managed by hepaticojejunostomy by an expert.

Thus, the basic principle of management of biliary injury is to control sepsis by converting it to a controlled biliary fistula and stenting of the bile duct. Delayed repair after 6 weeks by an expert hepatobiliary surgeon and management in high volume centre give the best results.

Postoperative detection and management of BDI

STATEMENT AND RECOMMENDATION

Statements

- Elective repair has better results than immediate repair in terms of stricture formation (LoE 3).
- Repair by a specialist surgeon has better results in terms of stricture formation (LoE 3).

Recommendations

Grade C

- Management of bile duct injury should be done in a specialist centre.
- Delayed repair of bile duct injury after 4–6 weeks by a specialist surgeon is recommended.

Other complications

Access related

These include complications related to pneumoperitoneum like hypercapnia and air embolism, and visceral and vascular injury.

Bowel injury

If detected intraoperatively, immediate laparoscopic or open repair should be done and antibiotics continued in the postoperative period. Delayed detection may necessitate a formal laparotomy, lavage and stoma creation.

Retained/recurrent stone

Stones in the CBD detected within 2 years of laparoscopic cholecystectomy are considered as retained stones, while those detected after 2 years are called recurrent stones. Retained stones may cause cystic duct stump blow out in the immediate postoperative period. A proper patient work up may avoid this complication. It is a life-threatening emergency and has to be managed with laparoscopy or laparotomy, thorough lavage and drain placement. Bile duct stones are retrieved by endoscopic papillotomy.

Lost stones

Spillage and loss of stones should be documented. Stones may present as parietal or intra-abdominal abscess after years, the management of which is in the line of any abscess.

Port-site infection

Port infection is not common. Early postoperative infection is usually due to Staphylococcus and can be managed with antibiotics and drainage. A rare but nagging complication is an infection with non-tuberculous mycobacteria (NTM), which usually presents 3–4 weeks after surgery, as a vesicular swelling at the port site, which ruptures with continued serous discharge. The aetiology is often a breach in asepsis, usually contaminated water supply in the operating room. Treatment is with long term antibiotics against NTM such as clarithromycin and ciprofloxacin.

Follow-up

All patients undergoing laparoscopic cholecystectomy should be followed up after discharge for any complication. Histopathology report should be checked for incidental finding of gallbladder cancer, which may warrant a completion radical cholecystectomy depending on the stage.

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9

CBD Exploration

The first cholecystectomy was performed by Langenbuch in 1882 and the first common bile duct (CBD) exploration was done by Thorton in 1889. The first ERCP with endoscopic sphincterotomy was done in 1974 by Kawai. With the advent of laparoscopy, the whole approach towards CBD stone management changed. Laparoscopic CBD exploration was started by Hunter in the year 1992.

CBD stones occur concomitantly with GB stones in 8%–20% of patients. More common in the advanced age (around 25% of the elderly patients have calculi in the CBD at the time of cholecystectomy). Some of the most dreaded complications are:

- Jaundice/cholangitis/pancreatitis
- 70%–80% of patients with mild biliary pancreatitis – spontaneous passage of stone

There are two types of CBD stones: (i) primary, which arise de novo in CBD (rare); (ii) secondary, which migrate from GB (common).

Early management of CBD stones is of utmost importance as only 5%–12% of CBD stones are asymptomatic and may give rise to life-threatening complications such as acute cholangitis and acute biliary pancreatitis.[1]

During the era of open cholecystectomy, the management of CBD stones was straightforward, but with the advent of laparoscopic and endoscopic techniques, the treatment of CBD stones has changed dramatically and has become controversial.

LAPAROSCOPIC CBD EXPLORATION: INDICATIONS AND CONTRAINDICATIONS

Indications[2]

- Preoperatively diagnosed CBD stone by imaging study
- Stones which could not be extracted by ERCP

- Postoperative retained stone not extracted by ERCP
  (LoE 1a, Grade A)

Contraindications[2]

- Frozen Calot's for which exploration would be difficult
- Patient unstable/unfit for anaesthesia
- Lack of equipment/infrastructure required for the procedure
- Acute pancreatitis
- Cholangitis
- Peritonitis
- Lack of surgeon's expertise
  (LoE 1a, Grade A)

Various options for CBD stone management[3]

The various treatment options for CBD stone are:

- Endoscopic sphincterotomy with stone extraction followed by laparoscopic cholecystectomy.
- Simultaneous endoscopic stone extraction with laparoscopic cholecystectomy.
- Laparoscopic CBD exploration
  i. Laparoscopic trans-cystic CBD exploration
  ii. Laparoscopic choledochotomy
- Open CBD exploration
- Endoscopic sphincterotomy in post-cholecystectomy patients
  (LoE 1b, Grade B)

STATEMENT AND RECOMMENDATION

Statement

Various options are available for the management of CBD stones. The choice depends upon the surgeon's expertise and various patient-related factors.

Recommendation

Grade B

An experienced and skilful surgeon should opt for the laparoscopic approach because of its advantages.

No consensus exists regarding the ideal management of GB + CBD stones. The options depend upon

- the timing of diagnosis of stone in CBD → preoperative, intraoperative or postoperative
- the general condition of the patient → low-risk, high-risk

Diagnosed preoperatively

The most popular approach nowadays is ERCP with stone extraction with stenting (if indicated), followed by laparoscopic cholecystectomy. However, with the gaining expertise in laparoscopic procedures, single-stage laparoscopic CBD exploration is emerging as a primary and cost-effective treatment modality with less morbidity in low-risk patients (LoE 2b, Grade B).[2]

Endoscopic sphincterotomy followed by laparoscopic cholecystectomy

This is the most popular approach these days. Endoscopic stone extraction and sphincterotomy followed by stenting (if required) is performed initially and the patient is operated for laparoscopic cholecystectomy within 72 hours of endoscopic sphincterotomy. This leads to significantly less recurrent biliary events as compared with delayed laparoscopic cholecystectomy (6–8 weeks). There is no difference in conversion rate, operation time or surgical complications. Same day ERCP and laparoscopic cholecystectomy are not recommended as this may cause uncertainty in the early diagnosis of complications and consequently delay management leading to increased morbidity. The disadvantage of ERCP over laparoscopic CBD exploration is the injury to sphincter of Oddi and its loss of function which leads to biliary reflux in the lower end of CBD (LoE 2b, Grade B).[2]

Simultaneous endoscopic sphincterotomy and laparoscopic cholecystectomy

The use of intraoperative ERCP is effective but is associated with logistical and technical difficulties. It requires additional equipment and personal availability in the OT during the procedure. Moreover, the patient's position may be suboptimal for the endoscopist to perform endoscopy, identify the papilla and cannulate it.

In elderly and unfit patients, ERCP and stone extraction is the initial and probably the definitive treatment.

It is also the initial treatment in patients presenting with jaundice, cholangitis or severe pancreatitis.

Lap cholecystectomy is undertaken once the condition of the patient has improved. Biliary stenting is advocated for patients with large dilated CBD, multiple impacted stones or stone not completely removed by ERCP (LoE 2b, Grade C).[2]

STATEMENT AND RECOMMENDATION

Statement

Preoperative ERCP and CBD clearance followed by laparoscopic cholecystectomy within 72 hours is the best modality at present.

Recommendation

Grade B

Due to less complications, the combined approach of endoscopic CBD clearance followed by laparoscopic cholecystectomy should be the choice in eligible patients.

Stones discovered intraoperatively

The available options are:

- Combined laparoscopic treatment (CBD exploration + cholecystectomy)
- Conversion to open CBD
- Post-cholecystectomy ERCP

If the surgeon is experienced enough, trans-cystic total laparoscopic clearance shows the highest success rate of stones removal in two-thirds of cases. For patients in whom laparoscopic trans-cystic CBD exploration has failed, laparoscopic choledochotomy and stone extraction may be performed.

In patients in whom it is not possible to clear the duct by the above approach, a delayed postoperative endoscopic sphincterotomy should be the preferred option in most cases. It is generally undertaken in the same admission and the success rates of stone removal vary from 55% to 80%.

The drawback is the requirement of a third procedure if ERCP fails.

The alternative is delayed treatment where the surgeon can insert a biliary stent through the cystic duct into CBD and through the sphincter of Oddi. This procedure ensures access to the CBD for postoperative endoscopic sphincterotomy.

Finally, as per the surgeon's skill and expertise, she/he can opt for an open CBD exploration followed by drainage procedures such as T-tube drainage or choledochoenterostomy.

LAPAROSCOPIC CBD EXPLORATION

Indications

- Large single (>6–8 mm) or multiple stones.
- Stone proximal to cystic duct–CBD junction
- Failure of endoscopic sphincterotomy extraction for large/occluding stones
- Surgeon's skill and expertise

Contraindications

- <6 mm CBD – postoperative stricture formation is high
- Small stones (<3 mm) – 98% pass without problem
- Grossly dilated CBD >2.5 cm – indicates some form of distal CBD obstruction (LoE 1b, Grade C).[3]

STATEMENT AND RECOMMENDATION

Statement

The laparoscopic approach for CBD clearance is gaining momentum due to lower morbidity, shorter hospital stay and early mobilization.

Recommendation

Grade C

Expert surgeons can go for the laparoscopic approach if there are no contraindications.

APPROACHES FOR LAPAROSCOPIC TRANS-CYSTIC CBD EXPLORATION

Required Skill – Endoscopy[2]

Indications

- Stones (number) – <8
- CBD diameter – <9 mm
- Stones location – distal to cystic duct
- Stones size (mm) – any size

Contraindications

- Friable cystic duct
- Intrahepatic stones

Advantages

- Shorter stay, quick, no T-tube

Disadvantages

- equipment, new skills
  (LoE 2b, Grade B)

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic trans-cystic CBD exploration should be done if the number of stones is <8, CBD diameter is <9 mm and stones located distal to cystic duct insertion.

Recommendation

Grade B

Cases with friable cystic duct and intrahepatic stones should not be managed by this approach.

LAPAROSCOPIC CHOLEDOCHOTOMY

Required skill check – Lap suturing[2]

Indications

- Stones (number) – any number
- CBD diameter – >8 mm
- Stones location – entire duct
- Stones size (mm) – any size

Contraindication

- Small diameter CBD

Advantage

- T-tube for port access

Disadvantages

- Lap suturing
- T-tube (LoE 2b, Grade B)

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic choledochotomy should be done if CBD diameter is >8 mm with no restrictions about the size, number and location of stones.

Recommendation

Grade B

Cases with CBD diameter <8 mm should not be managed by this approach.

STANDARDIZED SURGICAL STEPS

Patient positioning and operation theatre layout[3]

- Place the patient in the supine position with both upper extremities tucked at the patient's side.
- Reverse Trendelenburg position and rotation to a slight left lateral position are helpful in displaying the porta hepatis.

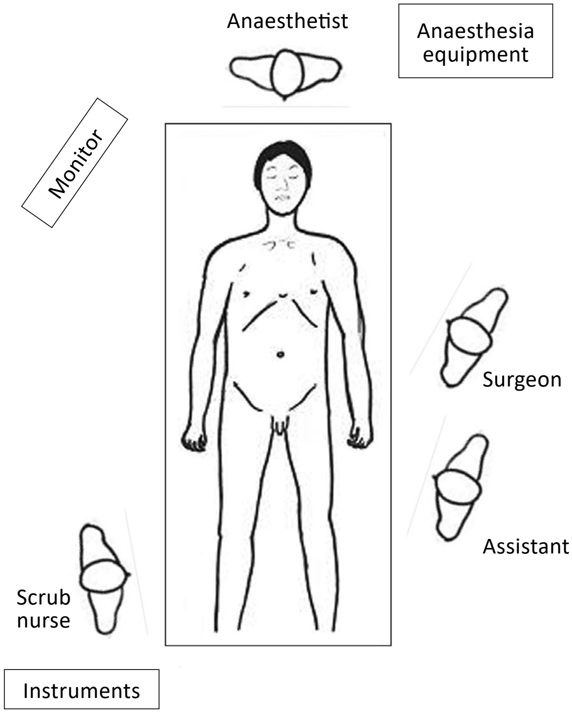

Fig. 1. Patient positioning in OT

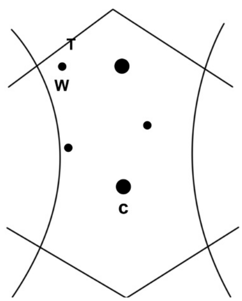

Fig. 2. Port placement

- The schematic diagram of OT setup is shown in Fig. 1 (LoE 5, Grade D).

Port placement[3]

Five ports are required for CBD exploration:

- 10 mm umbilical optical port
- 10 mm epigastric port
- 5 mm RHC and RIF ports
- 5 mm port at the level of umbilicus in the right pararectal position
- 5 mm subxiphoid port (LoE 5, Grade D)

STATEMENT AND RECOMMENDATION

Statement

Ports for laparoscopic CBD are similar to laparoscopic cholecystectomy with additional ports as per the surgeon's preference.

Recommendation

Grade D

We recommend two additional ports – one at pararectal position and the other at subxiphoid (for choledochoscope).

- Initial assessment of abdominal cavity
- Assessment of liver
  - Cirrhotic
  - Fatty
  - Portal hypertension
- Fundal retraction
- Posterior dissection
- Calot's dissection
- Cystic artery ligation and division
- Confirmation of CBD calculus – Lap ultrasonography (USG)
- Cystic duct ligation but not division
- Do not open the CBD without confirming the calculus[3] (LoE 3, Grade B)

Methods of CBD clearance

- Irrigation – by 10 Fr plastic canula introduced through choledochotomy
- Simple pick up with graspers – stones visible through choledochotomy can be picked up
- Using a paediatric nephroscope – introduced percutaneously through a small incision at subxiphoid, introduced through choledochotomy and stones are picked through nephroscopic grasping forceps
- Dormia and balloon – introduced through choledochotomy/cystic duct under C-arm guidance, stones are entraped in dormia/sweeped up
- Desjardine – can be introduced through the epigastric port into choledochotomy and large stones can be picked up from lower end of CBD

- Peroperative lithotripsy – useful in breaking large impacted calculus (LoE 3, Grade B)[3]

STATEMENT AND RECOMMENDATION

Statement

Various options such as irrigation, nephroscopy and lithotripsy are available for CBD clearance.

Recommendation

Grade D

We recommend the use of nephroscope for CBD clearance if amenable.

Confirmation of clearance[4]

- Completion choledochoscopy
- Post-exploratory cholangiogram (LoE 4, Grade C)

After CBD Clearance[4]

- T-tube
- Primary closure with antegrade stenting
- Trans-cystic C-tube
- Primary closure without drainage
- Preoperative naso-biliary drainage
- Preoperative PTC stenting
- Bilio-enteric anastomosis
  - Choledocho-duodenostomy
  - Choledocho-jejunostomy (LoE 4, Grade C)

STATEMENT AND RECOMMENDATION

Statement

T-tube, primary closure with/without stenting, bilio-enteric anastomosis are various options for CBD closure after stone removal.

Recommendation

Grade C

We recommend primary closure over a stent.

INTRAOPERATIVE PITFALLS

Predictors of difficult surgery

- Thin and short patient
- Morbidly obese patient
- Multiple surgeries
  - Gastric surgery/resection anastomosis/peritonitis/abdominal tuberculosis/improperly placed stomas
  - Large ventral hernias
- History of repeated cholecystitis
- Shrunken/thick-walled (>6 mm) GB with pericholecystic fluid
- Cirrhotic liver with portal hypertension
- Persistently raised serum glutamic pyruvic transaminase (SGPT)

Laparoscopic approach – pitfalls

- Thick-walled CBD
  - Problem in confirmation
  - Problem in choledochotomy
  - Cystic duct low insertion and adhesion with CBD
  - Eccentrically placed choledochotomy
  - Malfunctioning dormia
- Impacted stones in the ampulla

Complications[3]

- Biliary leak (2% to 3%)
- Haemoperitoneum
- Subdiaphragmatic collection (1%–1.4%)
- Bilioma (2.1%–3.6%)
- Stone over stent
- Pancreatitis
- Left over stone (2%–8%)
- Conversion (1%–4.5%)
  (LoE 3, Grade B)

Stones discovered postoperatively

These patients are best managed by endoscopic clearance. It has a failure rate of up to 10%. In these situations, the treatment options are either laparoscopic or open exploration depending on the surgical expertise and resources at disposal (LoE 2b, Grade C).[2]

STATEMENT AND RECOMMENDATION

Statements

- Management depends upon the surgeon's expertise and equipment availability.
- ERCP followed by lap cholecystectomy within 72 hours is the most commonly practised method.

Recommendations

- Current recommendations are for laparoscopic cholecystectomy with lap CBD exploration.
- Postoperatively detected stones are best managed by ERCP.

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10

Laparoscopic Appendectomy

INTRODUCTION[1–5]

Appendicectomy as a treatment for acute appendicitis was first described by Charles Mcburney in 1889 before the New York Surgical Society. It remained the procedure of choice for nearly a century before gynaecologist Semm reported laparoscopic appendectomy in 1983 for a non-inflamed appendix. In 1987, Schreiber reported a laparoscopy-assisted appendectomy for the treatment of acute appendicitis. It is a very common procedure and is performed in most of the surgical centres including two- and three-tier cities in India. Many of these centres do not have the facility for laparoscopy and therefore a large number of appendicectomies are likely to performed by the open method. We do not have exact data from India to establish the percentage of laparoscopic appendicectomy; therefore, we will base our guidelines on the available literature in India and the established guidelines from abroad.

Laparoscopic appendicectomy (LA) is a popular and well-established procedure. The results of many randomized studies show that LA should be the first choice where facilities and expertise are available. Laparoscopy has the advantages of (LoE 1, Grade A):

- Less pain
- Minimum wound infections
- Reduced hospital stay
- Early return to work
- Reduced cost

Acute appendicitis is one of the most common surgical abdominal emergencies. More than 250,000 appendectomies are performed each year in the USA. We do not have data from India, but considering our population it is likely to be much higher than that in the USA. The overall lifetime risk of developing acute appendicitis is 8.6% for males and 6.7% for females. The rate of appendicectomy is around 10 per

10,000 cases per year in the USA. This condition is most commonly seen in patients aged between early teens and late forties. There is a slight male-to-female predominance (1.3:1). Overall reported mortality is 0.2%–0.8%. Morbidity and mortality are related to the presenting stage of disease and are higher in cases of perforation.

INDICATIONS[4–8]

- Laparoscopic appendectomy is a safe and effective method for treating uncomplicated appendicitis and may be used as an alternative to standard open appendectomy (OA) (LoE 1, Grade A).
- Laparoscopy offers clear advantages and should be preferred in obese patients, elderly patients and patients with comorbidities. Population-based studies have shown lower rates of complications and mortality, especially in the elderly (2.4% vs 0.5%) for OA vs LA in patients above 65 years of age. Recent database studies on more than 250,000 patients aged >65 years reveal improved clinical outcomes for LA compared with OA in terms of reduced length of stay (LoS), overall costs, morbidity and mortality (LoE 2, Grade B).
- Laparoscopy is feasible and safe in young male patients, though no clear advantages can be demonstrated in this population (LoE 2, Grade B).
- Laparoscopic approach for fertile women with presumed appendicitis should be preferred. With improved visualization of the entire abdomen, laparoscopy for the treatment of appendicitis improves the diagnostic accuracy and can identify the definitive pathology more often than the open approach (LoE 1, Grade A).
- LA may be performed safely in pregnant patients with suspicion of appendicitis. It can be performed safely in any trimester and is considered by many to be the standard of care for gravid patients with suspected appendicitis (LoE 2, Grade B).
- A systematic review by Markar *et al.* including more than 100,000 appendectomies in children found that LA in uncomplicated acute appendicitis is associated with a reduced hospital stay though it has similar postoperative morbidity when compared with OA. In cases of complicated acute appendicitis, LA had decreased overall morbidity, reduced wound infections, less length of hospital stay and postoperative bowel obstruction though the risk of intra-abdominal abscess increased (LoE 1, Grade A).

- In experienced hands, laparoscopy is more beneficial and cost-effective than open surgery for complicated appendicitis (LoE 3, Grade B).

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic appendectomy should be the preferred procedure where facilities and expertise are available.

Recommendations

Grade A

- Uncomplicated appendicitis
- Fertile women
- Children

Grade B

- Young male patients
- Obese patients, patients with comorbidities, elderly patients
- Pregnancy
- Complicated appendicitis

CONTRAINDICATIONS[9–13]

Absolute contraindications for LA are as follows:

- Haemodynamic instability
- Lack of surgical expertise

Relative contraindications mentioned below will depend on the expertise of the surgeon:

- Severe abdominal distention that causes operative view obstruction or complicates abdominal entry and bowel manipulation
- Generalized peritonitis
- Phlegmon

Conservative treatment with antibiotics followed by interval appendectomy has been proposed in patients who do not have generalized peritonitis. This approach has been reported to carry significantly fewer complications, wound infections, abdominal/pelvic abscesses, ileus/bowel obstructions, and reoperations while not increasing hospitalization or length of antibiotic use.

Other contraindications are:

- Multiple previous surgical procedures
- Severe pulmonary disease
- Uncorrected coagulopathy
- Cirrhosis and portal hypertension

PATIENT POSITION[14]

- LA should be performed under general anaesthesia. The ideal position for the anaesthesiologist is the head end of the patient.
- Insertion of naso/orogastric tube is at the anaesthetist's discretion and if there is peritonitis.
- Patient should be ideally made to urinate before surgery to keep the bladder empty or can be catheterized under anaesthesia and removed immediately.
- The preferred position for the patient is supine (patient lying on his back) with head down (Trendelenburg position) at the right side of the table elevated up to make a sloping angle of 10°–15° towards the surgeon. This manoeuvre will help to bring the appendix more in view and displace the small gut towards the left side and upper abdomen (Fig. 1).
- To prevent the patient from slipping during steep positioning strapping, anti-skid devices such as pads, foam, bean bag, sand bag under the patient and on sides can also be used.
- The arms should be tucked with padding, sleighs or sheet tuck to avoid dislodgement, ulnar nerve injury and burn injury to hands.
- The ideal position for the

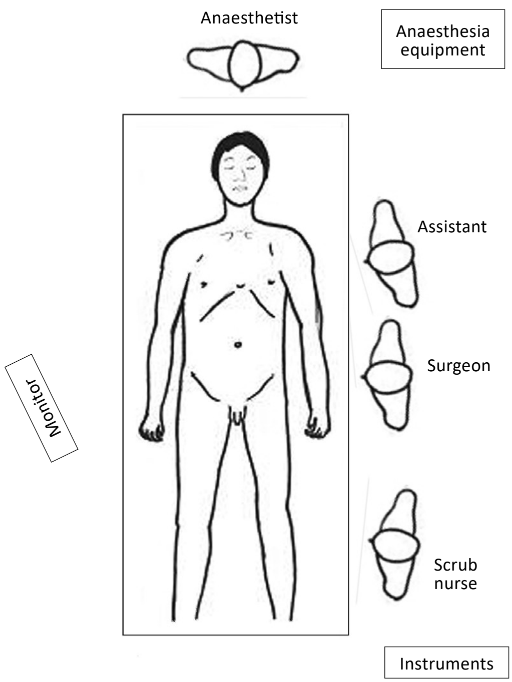

Fig. 1. Patient position

operating surgeon and the assistant is to be on the left side of the patient.
- The ideal position of monitor is on the right side of the patient. The monitor should be straight ahead in line with the forearm–instrument motor axis. Avoid axial rotation of the spine. The monitor should be positioned 15° below the surgeon eye level to avoid neck extension.

PROCEDURE[4,5,15–21]

Port placement

To gain access into the peritoneal cavity, the open/closed method using a Veress needle with a periumbilical incision or an incision through the umbilicus can be performed. A 10 mm cannula (primary cannula) is inserted and carbon dioxide is insufflated to a maximum pressure of 15 mmHg to achieve pneumoperitoneum. A 30°, 5 mm or 10 mm diameter laparoscope is inserted and the abdomin is laparoscopically explored. Two ports (secondary cannulas) are placed under direct vision. The lower (suprapubic) midline (5 mm or 10 mm) port is inserted just above the pubic symphysis with caution not to injure the bladder. The third 5 mm port is in the right lower quadrant at the lateral edge of the rectus muscle, lateral to the inferior epigastric vessel, equidistant from the other two ports (directly over the dissection area). This port placement allows the

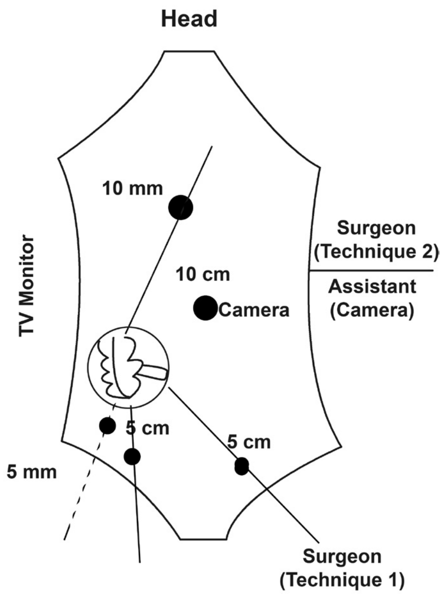

Fig. 2a. Port placement

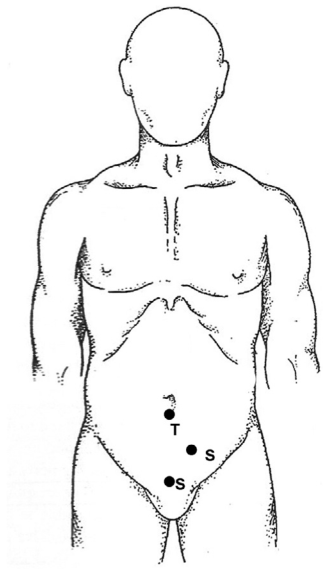

Fig. 2b. Port placement

surgeon to operate in a comfortable position. A third secondary port (5 mm or 10 mm) is occasionally needed in the case of difficult dissection, placed either at the upper right quadrant or the left lower quadrant as shown in Fig. 2a or as a cosmetic alternative in Fig. 2b.

Identification and mobilization of the appendix and mesoappendix

- There is very little Level 1 evidence to compare specific techniques, however some Level 2 and 3 evidence suggests that developing a consistent method decreases costs and OR time and minimizes complications.
- The patient is placed in the mild Trendelenburg slightly left lateral decubitus position to allow the intestines to slide out of the pelvis. A thorough diagnostic laparoscopy is performed including all four quadrants of the abdominal cavity to confirm the diagnosis, to assess other pathologies, and to rule out purulent peritonitis or abscesses.
- Identify the appendix – The omentum adherent to the inflamed appendix can be gently retracted away with the graspers to expose the tip of the appendix. The cecum is identified to determine the site of confluence of the three teniae; this is the place where the base of the appendix is located. Gentle medial retraction of the cecum on the teniae coli allows to bring the appendix into view. With elevation of the appendix, the mesoappendix is usually easily identified. If the tip of the appendix is not visualized, then the ileocecal junction is located as a guide to the appendiceal base, which is 2 cm lateral and inferior. As the cecum is raised, the base can be readily identified even if the tip is not.
- In the case of a retrocecal appendix or a phlegmon, the cecum may have to be mobilized by incising the lateral peritoneal reflections to the cecum and lower ascending colon. After the mesoappendix has been secured, the base of the appendix is dissected to allow for clear visualization of its muscular circumference at the base and its attachment to the cecum to allow for accurate placement of the laparoscopic endoloop/sutures/rarely stapler (especially in India). The inflammatory adhesions are freed by either blunt or sharp dissection using laparoscopic scissors or ultrasonic dissector aiming to free the appendix. If the appendix is inflamed and cannot be grasped, it is usually possible to provide exposure by grasping the mesoappendix.

Division of the mesoappendix and appendix

Division of the mesoappendix – Several methods are used for dividing the mesoappendix and appendix. Depending upon how the appendix presents, it may be simplest to divide the mesentery first, which provides the assurance that the dissection of the appendix is carried all the way to the base. The meso appendicular fat is incised with bipolar diathermy or an ultrasonic dissector, starting at the middle of the free edge and working towards the base of the appendix. After mobilizing the appendicular artery through clearance of the surrounding fat, the artery is divided using bipolar diathermy, extracorporeal or intracorporeal tying, ligaclips, ultrasonic dissector and rarely a stapler.

There are no clinical differences in outcomes, LoS and rates of complications between the different techniques described for mesentery dissection (monopolar electrocoagulation, bipolar energy, metal clips, endoloops, ligasure, ultrasonic dissector, etc.) (LoE 3, Grade B).

Antoniou *et al.*[22] published a meta-analysis from eligible 43 RCTs with a collective data from >5000 patients. Suture ligation seemed to be the most effective treatment strategy in terms of both organ/space infection and superficial operative site infection (LoE 1, Grade A).

The use of a ligature or mechanical device to close the appendix stump did not make any clinically significant difference in the rate of overall complications for both adults and children (LoE 1, Grade A).

A surgeon must consider two key points when deciding how to close the appendix stump, namely, patient safety and health economic costs. The appendix is then cut with scissors, leaving a 6 mm stump above the lower loop. There are no advantages of stump inversion over simple ligation, either in open or laparoscopic surgery (LoE 2, Grade B).

Remove the specimen and irrigation

The appendix is removed through the 10 mm suprapubic/umbilical cannula using claw forceps. An extremely bulky or contaminated appendix may be placed in a specimen bag to facilitate removal. The abdominal cavity is carefully inspected for safe completion of the procedure. Any identified pus is suctioned out under direct vision and washed using small amounts of saline and repeated suction in order to avoid diffuse spreading of the infected matter into the remaining abdominal cavity, without forgetting to suck out as much as possible of the lavage fluid. Peritoneal irrigation does not have any advantages over suction alone in complicated appendicitis (LoE 2, Grade B).

Routine drainage has not proven its utility, with the exception of generalized peritonitis, and seems to cause more complications, increasing LoS and recovery time. Meta-analyses by Cheng *et al.*[20] included five trials involving 453 patients with complicated appendicitis who were randomized to the drainage group and the no drainage group after emergency open appendectomies; they found no significant differences between the two groups in the rates of intra-peritoneal abscess or wound infection. The hospital stay was longer in the drainage group than in the no drainage group. In adult patients, therefore drainage should be done after appendectomy for perforated appendicitis and abscess should be used with caution, given the absence of good evidence from the literature (LoE 2, Grade B).

Drains are not recommended in complicated appendicitis in children (LoE 3, Grade B).

The secondary ports are removed under vision to detect any bleeding from the abdominal wall or epigastric vessels.

STATEMENT AND RECOMMENDATION

Statements

- Methods of ligating the mesoappendix and base of the appendix
- Utility of peritoneal irrigation and placement of drain in complicated appendicitis

Recommendations

Grade A

Use of a ligature or mechanical device to close the appendix stump did not make any clinically significant difference in the rate of overall complications for both adults and children.

Grade B

- No clinical differences in outcomes; LoS and rates of complications were observed between the different techniques described for mesentery dissection.
- Peritoneal irrigation does not have any advantages over suction alone in complicated appendicitis.
- Routine drainage has not proven its utility, with the exception of generalized peritonitis.

Wound closure

All (10 mm or 12 mm) ports are closed by transfacial sutures using the cobler needle/suture passer. The wounds are cleaned with antiseptic solution, and the skin closed with staplers.

Conversion to open

A surgeon will occasionally have to convert an LA into an open procedure for several reasons, which include the inability to gain exposure, fear of intestinal injury, inability to recognize the base of the appendix, extensive adhesions and uncontrolled bleeding.

INRAOPERATIVE SURGICAL SURPRISES[4,5,23–29]

Perforated appendicitis

LA may be performed safely in patients with perforated appendicitis (LoE 2, Grade B). It is the preferred approach (LoE 3, Grade C).

Phlegmonous appendicitis/appendicular abscess

In the systematic review and meta-analysis by Andersson *et al.*[30] including 61 studies, non-surgical treatment of appendicular abscess or phlegmon has been reported to succeed in over 90% of patients, with an overall risk of recurrence of 7.4% and 19.7% of cases of abscess percutaneous drainage. Non-operative management is a reasonable first-line treatment for appendicitis with phlegmon or abscess (LoE 1, Grade A).

LA as the first-line approach is a feasible and safe alternative to non-operative management with or without percutaneous drain only in the presence of specific laparoscopic experience and advanced skills. Operative management of acute appendicitis with phlegmon or abscess is a safe alternative to non-operative management in experienced hands (LoE 2, Grade B).

Treatment of normal appendix on laparoscopy for appendicitis

If no other pathology is identified, the decision to remove the appendix should be considered but based on the individual clinical scenario (LoE 3, Grade A).

Macroscopically, normal appendices may have abnormal histopathology. Several studies have shown a 19% to 40% rate of pathologically abnormal appendix in the setting of no visual abnormalities. Cases of postoperative symptoms requiring re-operation for appendectomy have been described in patients whose normal appendix was left in place at the time of the original procedure.

The incidence of unexpected findings in appendectomy specimens is low but the intraoperative diagnosis alone is insufficient for identifying unexpected disease. From the current available evidence, routine histopathology is necessary (LoE 2, Grade B).

Obesity

LA is safe and effective in obese patients. Some advantages of the laparoscopic approach over the open approach may be in access to the appendix, visualization and decrease in wound complications. A meta-analysis of prospective and retrospective comparative series shows the superiority of LA over OA in the obese (body mass index, BMI >30) patients. Dasari *et al.*[28] reported the same encouraging results in a recent systematic review. In the morbidly obese, longer trocars and instruments may be needed (LoE 2, Grade B).

ALTERNATIVE TECHNIQUES[31,32]

Needlescopic laparoscopic appendectomy

Needlescopic instruments are defined as those of 3 mm or less in diameter, which create an even smaller trocar wound and thereby less tissue trauma. This is a feasible procedure but only in experienced hands and in selected patients, especially young girls. It is less invasive and cosmetically superior to the conventional LA.

Single-incision laparoscopic appendectomy

Three-port laparoscopic appendectomy (TPLA) has been shown superior to open appendectomy for acute appendicitis; alternatively, single-incision laparoscopic appendectomy (SILA) is gaining popularity. A total of 8 RCTs comparing SILA (n=616) with TPLA (n=618) were published from 2010 to 2013. SILA had a longer operative time, needed more extra trocars during operation and could return to full activities earlier; however, these differences were not clinically significant. All other parameters were comparable. These results show that SILA is basically as feasible, effective and safe as TPLA when dealing with uncomplicated acute appendicitis (LoE 1, Grade A).

Teoh *et al.*[33] found a higher degree of re-interventions in cases of complicated appendicitis treated by SSALA (single-site access laparoscopic appendectomy). Therefore, they concluded that SSALA does not have any advantages over conventional LA, since the cosmetic effect is minimal, and triangulation is lacking, which is key, especially in complicated appendicitis (LoE 3, Grade B).

Transgastric appendectomy

With the development of the concept of natural orifice transluminal endoscopic surgery (NOTES), an increasing number of reports are appearing on trans-gastric appendectomy. However, this method of appendectomy is extremely difficult in cases of generalized peritonitis, with accompanying severe inflammation, and the existence of adhesion. Therefore, this procedure is not popular and is rarely practised.

STATEMENT AND RECOMMENDATION

Statement

Single-incision laparoscopic appendectomy is as safe as three-port laparoscopic appendectomy.

Recommendations

Grade A

Safe and effective in uncomplicated appendicitis, especially young girls.

Grade B

A single-incision leads to more re-interventions in complicated appendicitis and therefore offers no advantage.

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11

Inguinal Hernia Repair

Inguinal hernia surgery is one of the most common surgeries performed by general surgeons worldwide. Minimal invasive techniques have been used since the 1980s to repair groin hernias. Today laparoendoscopic and lichtenstein repair are the best evaluated surgical techniques. Even though the Laparoendoscopic techniques have been used routinely over the past two decades, there is still a wide variation in techniques practised with varied results. Therefore, it is important to issue guidelines and recommendations.

The two common techniques of totally extra peritoneal (TEP) and transabdominal preperitoneal (TAPP) repair are evaluated and discussed.

INDICATIONS OF TEP / TAPP

- Primary unilateral inguinal hernia in men
- Primary unilateral inguinal hernia in women
- Primary bilateral inguinal hernia in men and women
- Primary scrotal inguinal hernia
- Primary inguinal hernia after previous pelvic and lower abdominal surgery (radical prostatectomy, cystectomy, vascular surgery)
- Recurrent inguinal hernia after anterior repair
- Incarcerated inguinal hernia

Key question

Should laparoendoscopic repair be used for primary unilateral hernia in men?

Evidence

LoE 1b

Recommendation

Grade A

When the surgeon has sufficient experience, TEP/TAPP is comparable to open mesh repair with respect to operative time, complications and recurrence. Acute and chronic groin pain is less but direct costs are higher.[1–14]

Key question

Is laparoendoscopic repair a preferred technique for primary unilateral hernia in women?

Evidence

LoE 2c

Recommendation

Grade D

The existence of femoral hernia should be excluded in all cases of groin hernia and hence the preperitoneal approach should be considered. TAPP has the advantage of viewing the incarcerated intestinal contents. TEP should be combined with diagnostic laparoscopy.[15]

Key question

What is the preferred technique for bilateral groin hernias in men and women?

Evidence

LoE 2b

Recommendation

Grade B

Guidelines of the European Hernia Society had concluded the superiority of laparoendoscopic repairs in bilateral hernias with a moderate level of evidence. No high-level research has changed that position, hence the same recommendation was also followed by the HerniaSurge guidelines.[16–18]

Key question

Can laparoendoscopic repair be performed for primary scrotal inguinal hernia?

Evidence

LoE 3

Recommendation

Grade C

> Scrotal hernia is classified as being a complex condition. For scrotal hernia, only highly experienced endoscopic hernia surgeons should opt for a laparoendoscopic technique. TAPP may be preferred.[19–21]

Key question

Is there any role of laparoscopic repair for incarcerated inguinal hernia?

Evidence

LoE 5

Recommendation

Grade D

> In the presence of an incarcerated inguinal hernia, a diagnostic laparoscopy should be performed.[22–24]
>
> - It is mandatory to assess the viability of hernia contents before any repair.
> - The anterior approach is preferred.

Key question

Is the MIS approach recommended for patients with primary inguinal hernia and previous pelvic operative scars?

Evidence

LoE 5

Recommendation

Grade D

> Only very experienced endoscopic hernia surgeons should opt for the MIS approach. TAPP may be preferred.[25]

Key question

What is the procedure of choice for a failed anterior groin hernia repair?

Evidence

LoE 1b

Recommendation

Grade B

> Endoscopic repair after a failed anterior repair has optimal outcomes with decreased incidence of chronic pain and early return to work. In expert hands the recurrence rates are less than 2%.[26–29]

Key question

What is better for the patient – TEP or TAPP?

Evidence

- LoE 2a – Potentially serious complications are rare after both TAPP and TEP
- LoE 3 – TAPP and TEP show a noticeable learning curve
- LoE 4 – TEP is more suited for regional anaesthesia
- LoE 4 – TAPP is preferred in incarcerated hernias
- LoE 5 – Unsuspected hernias on the contralateral side are easier to detect with TAPP

Recommendation

Grade B

Both techniques are treatment options with comparable short- and long-term results.

Grade D

For patients who have contraindication to GA, TEP may be the preferred option.[30–35]

Key question

What is an optimal patient position and theatre layout for TEP?

Evidence

LoE 5 – There are no studies to compare various layouts of OT and position of surgeons.

Recommendation

Grade D

As a general consensus, the patient stays supine, arms tucked by the side, the surgeon stands on the opposite side of hernia. The monitor is positioned at the foot end of the patient.[33,36]

Key question

What is the safest technique to access preperitoneal space?

Evidence

LoE 4

Recommendation

Grade D

Direct open access is a simple and reproducible technique for accessing the preperitoneal space.[37,38]

Key question

What are the ideal sites for ports during TEP?

Evidence

LoE 4

Recommendation

Grade C

> A 10 mm subumblical port is constant. The two 5 mm working ports can be in the midline with the advantage of accessing both sides with ease. Midline ports also have lesser chances of inferior epigastric vessel injuries and have the advantages of a two-hand dissection from the beginning. Alternatively, the second 5 mm port can be placed laterally close to the anterior superior iliac supine to aid triangulation.[37,39–42]

Key question

Is balloon dissection necessary to create a preperitoneal space?

Evidence

LoE 1b

Recommendation

Grade A

> - The use of a dissection balloon in TEP reduces the conversion rate and may be especially beneficial early in the learning curve.
> - Anatomical delineation of inguinal area and dissection in the extraperitoneal space in TEP repair was equally satisfactory in both the balloon dissection and the telescope dissection group.[25,37,43,44]

Key question

What is the extent of dissection in TEP repair?

Evidence

LoE 3

Recommendation

Grade B

- The dissection should extend superiorly up to the subumbilical area, inferiorly to the space of Retzius, inferolaterally to the psoas muscle and Bogros space until the anterior superior iliac spine (ASIS) is reached, and medially beyond the midline.
- The landmarks to be visualized are the pubic bone, Cooper's ligament, inferior epigastric vessels, spermatic cord, the myopectineal orifice boundaries, and the fascia over the psoas muscle.
- Extensive preperitoneal dissection with complete exposure of the myopectineal orifice of Fruchaud is critical to the success of the laparoscopic inguinal hernia repair.
- Posteriorly, the peritoneum is reflected to the point at which the vas turns medially.[32]
- Complete parietalization of the vas deferens and the testicular vessels needs to be performed.
- Complete dissection of the whole pelvic floor (anatomical) should be done for flat placement of the mesh to cover the entire myopectineal orifice and prevent its folding.[33,45,46]

Key question

How can we reduce the incidence of seroma formation?

Evidence

LoE 2b

Recommendation

Grade B

- Seroma formation seems to be more common after the repair of a direct hernia.
- In large direct hernias, inversion and fixation of the extended fascia transversalis to Cooper's ligament may reduce the frequency of occurrence of sero-haematoma.[25,47]

Key question

How do we manage a complete indirect hernia sac?

Evidence

LoE 4

Recommendation

Grade C

- Complete dissection of large indirect sacs may carry the risk of injury to the cord structures or may disturb blood circulation to the testis.
- A large indirect sac may be ligated proximally and divided distally.[33,37,39]

Key question

What is the optimal mesh size for a unilateral TEP?

Evidence

LoE 2a

Recommendation

Grade A

- Minimum size of 15 cm × 13 cm
- Partial folding of the mesh for ease of introduction and placement
- The mesh should always cross the midline
- The mesh should cover the whole myopectineal orifice.[42,48–51]

Key question

Is mesh fixation necessary during TEP repair?

Evidence

LoE 1b

- Fixation and non-fixation of the mesh are associated with equally low recurrence rates in both TAPP and TEP; however, in most studies the hernia opening was small (<3 cm) or not measured.
- Staple fixation is associated with a higher risk of acute and chronic pain compared with non-fixation.
- Fixation is more expensive than non-fixation.
- Fibrin glue is associated with less acute and chronic pain than stapling.

Recommendation

Grade A

> If TEP technique is used, non-fixation can be considered in all types of inguinal hernia except large direct hernias (M III, EHS classification).[52,53]

Key question

Should seroma be treated?

Evidence

- LoE 1 – Patients who receive anticoagulants are prone to afterbleed.
- LoE 1 – The risk of seroma formation is higher for endoscopic techniques than for open repairs.[54]
- LoE 3 – Most seromas disappear spontaneously within 6–8 weeks. Infection after aspiration of seromas is described.[44]
- LoE 5 – Perioperative drainage to prevent seromas is contradictory.[55,56]

Recommendation

Grade B

> Most seromas are self-limiting and do not warrant aspiration. They usually disappear in 6–8 weeks.[54–56]

Key question

What is optimal patient positioning and OT layout during TAPP?

Evidence

- LoE 5 – There are no comparative studies to compare various positions and theater layouts.

Recommendation

Grade A

> The patient is kept in the supine position. The operating surgeon and the camera assistant stay on the opposite side of the hernia. The monitor is at the foot end of the patient.[57,58]

Key question

What is an ideal port positioning for better ergonomics in TAPP?

Evidence

LoE 3

Recommendation

Grade B

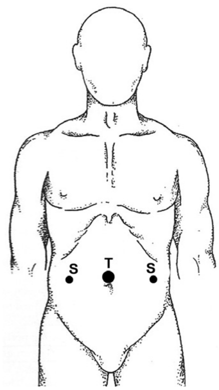

Fig. 1

> Three trocars are usually placed at the umbilical level (optic and two working ports); all working ports are inserted under vision (Fig. 1).[57–60]

Key question

What is the treatment strategy for contralateral occult inguinal hernia?

Evidence

LoE 2b

- The true incidence is unknown.
- In TAPP exploration, occult hernias are observed in 13%–22% of cases.

- TAPP enables rapid evaluation of the contralateral groin.
- 28% of incidental hernias will progress to symptomatic hernia in 15 months.

Recommendation

Grade B

> Must take consent for simultaneous contralateral repair if occult hernia is found.[61–66]

Key question

What is the site and extent of peritoneal incision in TAPP?

Evidence

LoE 3

Recommendation

Grade C

> Incision extends from anterior supliliac spine to medial umbilical ligament, 3–4 cm above the level of deep inguinal ring. Landmarks and extent of dissection stay the same as TEP.[57–60]

Key question

What is the optimal mesh size in TAPP?

Evidence

LoE 2a

Recommendation

Grade A

> A minimum mesh size of 10 cm × 15 cm is a must. A smaller mesh is a risk factor for recurrence.[67,68]

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12

Laparoscopic Ventral Hernia Repair (LVHR)

Laparoscopic ventral hernia repair (LVHR) has gained popularity in recent years, yet there is controversy about the optimal approach to ventral hernia repair. Guidelines for clinical practice are intended to indicate preferred approaches to medical problems as established by experts in the field.

Key question

How comparable are incisional and ventral hernias in terms of operative techniques and outcomes?

Evidence

The techniques and outcomes cannot be considered comparable using the current methods of analysis (LoE 4). This is due to many complex ever-changing variables, as well as, relationships between variables, which are not controllable. Due to the increasing pace of change and the complexity of ventral/incisional hernia patients and techniques, the use of traditional human subjects in clinical research, evidence-based methods and guidelines in healthcare should be considered a starting point, rather than a goal (LoE 4).[1]

STATEMENT AND RECOMMENDATION

Statements

- The level of complexity and variability for patients with ventral/incisional hernia and techniques for repair is high.
- The degree of complexity is growing higher at an increasing rate of change.[2]

(continued)

STATEMENT AND RECOMMENDATION

Recommendation

Grade C

The application of principles of complex adaptive systems science, particularly real-world clinical quality improvement methods, will be required to improve the value of care (quality outcome measures, satisfaction, patient experience, costs, etc.) for the patient with a ventral/incisional hernia.

Key question

Is the routine application of CT and magnetic resonance imaging (MRI) recommended for the diagnosis of ventral/incisional hernias prior to LVHR?

Evidence

In some cases, especially post-traumatic hernias, obese patients, large hernias with loss of domain or special rare entities such as lumbar hernias, a CT scan or MRI can be helpful (LoE 5).[3] In special cases such as post-traumatic hernias, special, rare entities like lumbar hernias or Spiegelian hernias and also in connection with obesity, a CT scan or MRI may be considered (LoE 4).[4] The CT scan is the method of choice for the postoperative differential diagnosis of relapses, seroma, bulging or the condition of remaining hernias. An ultrasound investigation can be helpful in the detection of seromas, but cannot offer as many anatomical details as the CT scan (LoE 4).[5]

STATEMENT AND RECOMMENDATION

Statement

There is insufficient evidence for the routine use of CT/MRI.

Recommendation

Grade B

The CT scan is the method of choice for the postoperative differential diagnosis of relapses, seroma, bulging or the condition of remaining hernias.

Key question

Are the indications for treatment dependent on the size of defect or hernia sac, hernia type, symptoms and age?

Evidence

The size of defect predicts the rate of recurrence: the larger the defect, the higher the recurrence (LoE 2).

STATEMENT AND RECOMMENDATION

Statement

The width of defect is a predictive factor for postoperative complications.

Recommendation

Grade D

Laparoscopic repair should be done for ventral hernias with defect size up to 10 cm. Symptomatic ventral hernias including incisional hernias should be treated surgically. Laparoscopic repair should be used for ventral hernia repair even in the advanced age.[6]

Key question

Is open suture repair dependent on the defect size?

Evidence

A 2005 retrospective study on comparison of mesh and suture repair shows recurrence rates for mesh in 0% vs. 11.5% for suture repair. The infection rate for mesh repair was 0% vs. 11.5% for suture repair (LoE 3).[7] Mesh repair has a higher incidence of seroma and SSI (LoE 2).

STATEMENT AND RECOMMENDATION

Statement

All hernias must be repaired using a mesh.

Recommendation

Grade A

Hernias <2 cm may be repaired with suture repair. The mesh repair has a higher incidence of seroma and SSI.

Key question

What are the limitations of laparoscopic intraperitoneal onlay mesh (IPOM) repair in terms of the defect size or body habitus?[8–11]

Evidence

Laparoscopic repair for ventral hernias of large defects is feasible (LoE 3). Laparoscopic ventral hernia repair is feasible in large defects of 10 –15 cm.

STATEMENT AND RECOMMENDATION

Statement

Intraperitoneal placement of a prosthesis specifically produced for laparoscopic ventral hernia repair is safe (LoE 4).

Recommendation

Grade B

Recurrence rates are higher for defects larger than 10 cm.

Key question

What is the guidance for obese patients with ventral/incisional hernias?

Evidence

Obesity is a risk factor for occurrence of incisional hernias. It leads to a higher perioperative complication rate and a higher recurrence rate after open repair. Multifactorial reasons for this include delayed wound healing, impaired pulmonary function and higher intra-abdominal pressure (LoE 5).[12,13] Laparoscopic repair is recommended for morbidly obese patients with BMI >35 kg/m^2 (LoE 2). Higher recurrence rates are observed in BMI >35 kg/m^2. Complication rates for patients with BMI ≥40 undergoing LVHR are higher than those with BMI <40 kg/m^2 (LoE 3). Recurrence rates increase with BMI >30 kg/m^2. Patients should be informed that LVHR is feasible in obese patients and that complications and wound infections are less likely for LVHR compared to open procedures in obese patients.

STATEMENT AND RECOMMENDATION

Statement

Higher recurrence rates are observed in patients with BMI >35 kg/m^2.

Recommendation

Grade A

Laparoscopic repair is recommended for morbidly obese patients. Patients with BMI >30 kg/m^2 have significantly larger defects and higher recurrence rates, especially those with defects larger than 8–10 cm.

Key question

Recurrence after open surgery: Is re-do better laparoscopically?

Evidence

Laparoscopic repair is better than open repair after recurrence from open repair (LoE 4). A possible advantage of laparoscopic reoperation is the identification of previously undiscovered recurring hernias, which can be taken care of immediately during laparoscopic repair (LoE 4). Also, with sufficient expertise, laparoscopic reoperation could also be carried out following multiple preliminary operations with reasonable certainty and moderate recurrence rates.[14]

STATEMENT AND RECOMMENDATION

Statement

A possible advantage of laparoscopic reoperation is the identification of previously undiscovered recurring hernias, which can be taken care of immediately during laparoscopic repair.

Recommendation

Grade C

Laparoscopic repair is better than open repair after recurrence from open repair.

Key question

What is the evidence for antibiotic and thromboembolic prophylaxis in laparoscopic ventral/incisional hernia surgery?[15,16]

Evidence

Antibiotic prophylaxis is recommended and should be given in accordance with standard guidelines. There are no special recommendations for ventral hernia repair (LoE 4).

STATEMENT AND RECOMMENDATION

Statement

It should be given in accordance with standard guidelines for risk factors for DVT. There are no special recommendations for ventral hernia repair.

Recommendation

Grade B

Antibiotic prophylaxis is recommended.

Key question

What is the guidance positioning of the trocars and creating the capnopneumoperitoneum?[17,18]

Evidence

Primary access for capnoperitoneum should be at least 10 cm away from the scar/hernia site and preferably at the Palmer's point (LoE 2).

STATEMENT AND RECOMMENDATION

Statement

Visually guided trocars do not decrease the incidence of complications.

Recommendations

Grade B

Visually guided trocars do not decrease the incidence of complications.

Grade D

Additional trocars to be placed as per triangulation while maintaining adequate distance to account for the mesh size.

Key question

What are the port types, positions and number in laparoscopic ventral/incisional hernia repair?

Evidence

Epigastric hernias can be approached with lower abdominal ports. Suprapubic/lower abdominal hernias can be approached via epigastric and tworts on either side. Lateral hernias can be approached through contralateral ports.

STATEMENT AND RECOMMENDATION

Recommendation

Grade D

Midline defects should be approached from lateral ports, at least three in numbers.[19,20]

Key question

What are the principles of adhesiolysis?[21,22]

Evidence

Energy sources are to be avoided and cold dissection is to be done. Enterotomy should be repaired immediately after identification and not left for the later part.

> **STATEMENT AND RECOMMENDATION**
>
> **Statement**
>
> Adhesiolysis should be limited to the abdominal wall and area of hernia.
>
> **Recommendation**
>
> **Grade C**
>
> Sharp dissection is recommended.

Key question

What is the importance of defining hernial defect margins and gauging size of the hernia preoperatively and intraoperatively?

> **STATEMENT AND RECOMMENDATION**
>
> **Statement**
>
> Accurate measurement of defect is necessary to determine mesh overlap and prevent recurrence.
>
> **Recommendation**
>
> **Grade B**
>
> Intra-corporeal measurement is more accurate than extracorporeal measurement. Pneumoperitoneum should be reduced to 6–8 mmHg.

Key question

What should be used: Bridging or augmentation?

Evidence

In larger hernias 'bridging repair' may lead to a functional problem. The recti muscles detached from its origin at linea alba not only lose the efficiency of their contraction, but compromise the function of the oblique muscles as well. The balance between the anterior and posterior trunk muscles is disturbed.[23,24]

STATEMENT AND RECOMMENDATION

Statement

'Bridging repair' should be avoided in all hernias except for defects <2 cm. Laparoscopic closure of the fascial defect is technically feasible, yet evidence of any superiority over the standard procedure is lacking.

Recommendation

Grade C

Additional component separation methods are recommended for defects >8 cm, which cannot be closed.

Key question

Reconstruction of the linea alba – yes or no? Is it necessary to close the defect before IPOM?

Evidence

Closure of hernia defect should be undertaken at the surgeon's discretion, as theoretical advantages exist but have not been proven definitely.[25]

Key question

How much overlap is necessary?

Evidence

In case of larger defects and/or obesity, larger overlap is recommended (LoE 4).

STATEMENT AND RECOMMENDATION

Statements

- A minimum of 5 cm of overlap is recommended.
- Proper mesh overlap is a key determinant in hernia recurrence following laparoscopic ventral and incisional hernia repair.

Recommendation

Grade C

In case of larger defects and/or obesity, larger overlap is recommended.[18,26]

Key question

What is the best type of fixation? Are permanent sutures needed?

STATEMENT AND RECOMMENDATION

Statement

A thorough mesh fixation guards against recurrence.

Recommendation

Grade C

Tacks and suture fixation should be done to prevent recurrence.[27]

Key question

What is the type of fixation in suprapubic and subxiphoidal hernias?[28,29]

STATEMENT AND RECOMMENDATION

Statements

- In the laparoscopic and open approaches, it is common to perform a retropubic dissection for sufficient and safe overlap of the mesh.
- Without dissection, the recurrence rate seems to be significantly higher.[29]

Recommendation

Grade C

The retropubic space should be dissected. Both Cooper's ligaments should be exposed/dissected. The mesh should be fixed to Cooper's ligaments.

Evidence – Subxiphoid hernias

No tack fixation should be done caudal to the xiphoid and costal margins.

STATEMENT AND RECOMMENDATION

Statement

The subxiphoid space should be dissected 5 cm above the xiphoid process. The falciform ligament should be taken down.

Recommendation

Penetrating fixation should not be used above the costal margins.

Key question

What is the correct method for mesh insertion?

Evidence

To avoid contact with the skin, the mesh could be inserted with the help of a plastic sleeve.

STATEMENT AND RECOMMENDATION

Statements

- Mesh insertion through a 10 mm or 12 mm port is possible in the majority of laparoscopic incisional/ventral hernia repairs of varying sizes.[19]
- Mesh insertion through a 2–3 cm skin incision at the centre of the defect directly (inside a plastic sleeve) or through a 15 mm port may be a viable alternative for larger defects requiring larger meshes (>30 cm).[30]

Recommendation

Grade C

Skin contact with the mesh should be avoided.

Key question

How to manage bowel injury during laparoscopic ventral/incisional hernia repair?

Evidence

Bowel injury can be classified in one of the three categories. Immediately recognized injuries tend to result from initial port entry or from bowel manipulation and adhesiolysis.[31] It is advisable to gain access to the abdominal cavity via an open technique, far from the hernia or scar. Sharp dissection should always be used in areas of dense adhesions, particularly when the presence of the bowel is suspected. Again, the use of energy sources near the bowel may be a source of delayed injuries with considerably increased morbidity and mortality.[32]

STATEMENT AND RECOMMENDATION

Statements

- The extent of bowel injury and contamination dictate the type of repair.
- Bowel injury does not always require conversion to open repair.
- LVHR can be delayed for patients with high risk factors for developing mesh infection.

Recommendation

Grade C

LVHR may be performed immediately with minimal spillage in the event of bowel injury but this option requires experience.

Key question

Unrecognized enterotomy?[31]

STATEMENT AND RECOMMENDATION

Statements

- Reoperation will be necessary.
- Repair/resection both are appropriate.

Recommendation

Grade C

Mesh explantation with primary repair of hernia.

Key question

What are the risk factors for infection in laparoscopic incisional/ventral hernia repair?

Evidence

Preoperative transfusion may increase the risk of surgical-site infection (SSI). Laparoscopic operations lead to a lower incidence of SSI than open operations because the total length of the incisions is shorter, reducing the risk of bacteria entering the subcutaneous space.[33]

In elderly patients, chronic obstructive pulmonary disease (COPD) and low preoperative serum albumin are independent predictors of wound infections; coronary artery disease (CAD), COPD, low preoperative serum albumin, and steroid use are independent predictors of a longer hospital stay.[34,35]

Patients who undergo ventral hernia repair with simultaneous bowel resection show a higher incidence of infectious and non-infectious complications with mesh use.[35] The incidence of wound infection is lower in laparoscopic hernia repair than in open repair due to the decreased extent of tissue dissection.[36] Patients given a prophylactic antibiotic have a lower incidence of SSI. SSIs could be due to steroid use, smoking, old age, and underlying disorders such as obesity, diabetes, malnutrition, and remote-site infection.[37] The source of SSI is skin flora or bacterial contamination from a viscous. The use of the mesh does not increase the incidence of SSI, although the consequences of the mesh infection may be severe.[34,38] A prolonged preoperative hospital stay and preoperative nares colonization with *Staphylococcus aureus* increase the risk of SSI.[35] The presence of drainage and its duration increase the incidence of SSI. If an indication for drainage exists, it should be as short as possible.[39] The duration of the operation time is the only significant risk factor associated with infection of mesh graft after incisional hernia repair.[40] Patient's age, the American Society of Anesthesiology (ASA) score, smoking, duration of surgery and an emergency setting of the operation are associated with the development of synthetic mesh infection.[37,40] Complications are significantly associated with larger hernias, previous herniorrhaphy, longer operating times and extended hospital stays.[39]

STATEMENT AND RECOMMENDATION

Statements

- If the mesh is placed subcutaneously, SSI is more common than if it is placed in a subaponeurotic premuscular, pre-aponeurotic retromuscular, or preperitoneal space. If infection is present, repair by tension-free non-absorbable prosthetic implants is not recommended.
- Mesh, wherever possible, should not be brought in contact with skin to avoid contamination by skin flora. Polyester meshes are associated with the highest incidence of infection, fistualization and recurrence.

Recommendation

Grade A

Known risk factors for SSI must be treated before operation to the extent possible.

Key question

What is the incidence of mesh infection?

Evidence

The rate of mesh infection after laparoscopic ventral and incisional hernia repair is low (1%).[40] The mesh does not need to be removed in all cases of wound infection after laparoscopic ventral and incisional hernia repair.[39] Infected expanded polytetrafluoroethylene (ePTFE) meshes require removal significantly more often than PP-based meshes.[41] Case reports in the literature indicate that salvage of infected meshes after laparoscopic ventral and incisional hernia repair is possible.[40,41] An infected ePTFE mesh after laparoscopic ventral and incisional hernia repair should be removed. Preservation of an infected composite mesh after laparoscopic ventral and incisional hernia can be attempted by either interventional or conservative treatment using percutaneous drainage, drain irrigation with gentamycin, and intravenous antibiotics. If conservative treatment fails or is not justified for any reason, the established options for treatment of mesh infections after open repair should be used. Because only after the options for individual cases are reported, a decision must be made in accordance with the findings for the individual patient.[42]

STATEMENT AND RECOMMENDATION

Statements

- Conservative management of mesh infection after laparoscopic ventral and incisional hernia repair can be attempted by percutaneous drainage, drain irrigation with gentamycin 80 mg in 20 ml of saline 3 times a day, and intravenous antibiotics.[42]
- When conservative treatment of a mesh infection after laparoscopic ventral and incisional hernia repair fails, all the same options as for mesh infection after open repair need to be considered depending on the individual circumstances of the patient.

Recommendation

Grade D

Mesh removal and primary skin closure, with repair of the defect repeated after 6–9 months.

Key question

Postoperative seroma: What are the risk factors, prevention and best treatment?[32]

Evidence

Patients should be informed on the possibility of both asymptomatic and symptomatic seroma formation. Laparoscopic and open repairs are compared (trials with opposing results). Non-reducible hernia is a risk factor. Seroma may be more common with IPOM than with TAPP LVHR. The incidence increases with the number of prior abdominal incisions. The hospital centre (within the VA system) is an independent predictor of seroma. Cauterizing of the hernia sac may lead to less seroma formation. Placement of a quilting stitch does not affect seroma formation. Double-crown stapling does not decrease seroma formation. No specific mesh type is related to seroma formation. Compression dressing for 1 week reduces the occurrence of seroma. The majority of seromas resolve spontaneously. Aspiration is often effective and repeated aspiration may lead to mesh infection. An abdominal binder does not reduce seroma formation (unpublished RCT data). The length of abdominal binder use does not affect seroma formation. The majority of seromas should be expected to resolve spontaneously. Patients should be informed about the risk of infection if a seroma is repeatedly aspirated.

STATEMENT AND RECOMMENDATION

Statements

- Seroma can be detected by ultrasound in up to 100% of patients.
- Seroma formation peaks at about postoperative day 7.
- Seroma resolution is almost complete at 90 days.
- Up to 30% of patients who experience development of seroma become symptomatic.

Recommendation

Most seromas resolve spontaneously. No active intervention is required.

Key question

Postoperative bulging?

STATEMENT AND RECOMMENDATION

Statements

- Abdominal bulging is a specific problem associated with laparoscopic repair of large incisional hernias.[43]
- In 1.6%–17.4% of patients, bulging is observed after laparoscopic ventral/incisional hernia repair.
- Symptomatic bulging is rare.[44]

Recommendation

Grade B

Symptomatic bulging, although not a recurrence, is an important negative outcome of LVHR. Closure of hernia defect eliminates postoperative seroma and consequently bulging.

Key question

Chronic pain: What are the risk factors, prevention and treatment?

Evidence

Age, gender, preoperative pain, psychosocial factors, cognitive distortion. Local anaesthetic at suture sites during surgery considerably decreases acute early pain. Pain pump placement makes no difference in acute or chronic pain. Tissue glue results in 'low levels of postoperative pain'. The visual analogue scale (VAS) shows no difference between absorbable and permanent fixation sutures at 3 months, but quality-of-life (QoL) differences (physical activity) are experienced. Pain is not correlated with the number of tacks. No consistent difference between PP and other LW meshes is shown by pain scores. Absorbable fixation tacks are associated with few cases of chronic pain at 1 year. Trans-fascial sutures with tacks do not result in higher pain scores than tacks only. Permanent suture fixation at 2–3 cm intervals results in a higher number of patients with pain 6 months postoperatively compared with tacks-only fixation. Pain frequency after permanent suture fixation at 6 months is similar to that for tacks-only fixation. A permanent corner suture plus double-crown tacks result in higher VAS scores than permanent sutures only in hernias with a defect size <5 cm.

Patients should be informed that LVHR may lead to prolonged pain. Surgeons should strive to limit acute pain as a risk factor for chronic pain. Surgeons should use intraoperative suture-site injection of local anaesthetic. The evidence is inconclusive whether the type of suture, tacks, glue or mesh alter the incidence of chronic pain. The lidocaine patch does not significantly reduce postoperative acute or chronic pain. Local injection after surgery at suture sites can resolve pain. Multimodality pain treatment can resolve chronic pain. Injection of local anesthetic at suture sites can be considered in the treatment of chronic pain. Removal of suture, tacks, or mesh can be considered in the treatment of chronic localized pain.

STATEMENT AND RECOMMENDATION

Statement

LVHR results in chronic pain for 2%–4% of patients.[45] Recurrence is associated with chronic pain (open and laparoscopic). Non-midline LVHR is more often associated with chronic pain. The LVHR technique may lead to residual pain in up to 26% of patients. Acute postoperative pain (non-procedure-specific) is experienced.

Recommendations

Grade B

Patients should be informed that LVHR may lead to prolonged pain.

Grade C

Removal of suture, tacks or mesh can be considered in the treatment of chronic pain.

Key question

Recurrence after laparoscopic ventral/incisional hernia repair: What are the risk factors, mechanism and prevention?[32,46]

Evidence

The existing literature does not document the superiority of any one mesh fixation technique in relation to recurrence. The risk factors for recurrence include patient status, underlying disease and perioperative factors (i.e. surgical techniques, postoperative complications, deep abscesses, and early reoperations). Smokers with previous failed repair attempts have a higher risk of recurrence. Postoperative mesh infection requiring removal of the mesh is a predictor of recurrence. Higher incidence of seroma formation and recurrence are reported in cases managed with a dual mesh. Repetition of a previously inadequate technique for recurrent hernia usually fails. The mechanism for recurrence of ventral hernia described in the literature in decreasing order of frequency are infection, lateral detachment of the mesh, inadequate mesh fixation, inadequate mesh, inadequate overlap, missed hernias, raised intra-abdominal pressure and trauma. Recurrence can be caused by improperly placed trans-fascial sutures, extra large bites of the mesh causing excessive tension and, ultimately, a hole in the mesh. Recurrence can happen at defects at trans-fascial suture sites of previous laparoscopic ventral hernia mesh repair. A mesh repair should be used in all eligible patients with a hernia defect larger than 2 cm. For suprapubic hernias, the entire preperitoneal space should be dissected; a mesh overlap of at least 5 cm should be achieved; and fixation of the lower margin of the mesh under direct vision to Cooper's ligaments should be performed. Sufficient overlap of the mesh from the hernia margin and dual methods of fixation should be used.

STATEMENT AND RECOMMENDATION

Statements

- Size of hernia (≥10 cm), body mass index (BMI) (≥30 kg/m^2), history of previous open repair or failed hernia repair, and perioperative complications including SSI are risk factors for recurrence of hernia irrespective of the technique.
- Mesh shift may be a precursor to recurrence of hernia. The mesh tends to shift away from the operative side, leading to recurrence. Recurrence may be a two-step process, beginning first with intraoperative mesh shift followed by additional factors (e.g. mesh contraction) that may accentuate the shift and lead to recurrence.

Recommendation

Grade D

Risk factors predisposing to recurrence after laparoscopic ventral or incisional hernia repair should be eliminated before surgery as far as possible. Insufficient incision scar coverage with mesh, SSIs and gastrointestinal complications should be avoided.

Key question

Is laparoscopic preperitoneal ventral and incisional hernia repair possible?

Evidence

Laparoscopic trans-peritoneal and total extraperitoneal pre-peritoneal/sublay repair are surgical options for the treatment of small- and medium-sized ventral and incisional hernias (EHS classification W1 and W2).[47] Both techniques allow the implantation of large standard synthetic prostheses. These procedures are technically demanding and have longer operating times than open pre-peritoneal/sublay repair and laparoscopic IPOM repair but do not require barrier meshes. Especially in the lower abdomen, laparoscopic trans-peritoneal or extraperitoneal preperitoneal abdominal wall hernia repair can be considered if the required expertise is available.

STATEMENT AND RECOMMENDATION

Statements

- Laparoscopic pre-peritoneal repair combines the advantages of open preperitoneal repair and laparoscopic IPOM technique: small incisions and extraperitoneal mesh position.
- Laparoscopic trans-peritoneal and total extraperitoneal preperitoneal/ sublay repair are surgical options for the cure of small- and medium-sized ventral and incisional hernias (EHS classification W1 and W2) if expertise is available.

Recommendation

Grade D

The classical TEP technique is the laparoscopic procedure closest to an ideal method for inguinal hernia repair, but the technique has several drawbacks such as limited space for dissection and mesh placement, restricted port placement, a low tolerance of accidental pneumoperitoneum and difficulty in teaching and learning the technique.

Key question

What is the role of endoscopic component separation (ECS) in the treatment of large abdominal wall hernias?

Evidence

The ECS is feasible with low morbidity. The ECS can be combined with lap IPOM, open IPOM, open sublay and open onlay technique in complex hernias.[48] Abdominal wall release after ECS is less extensive than after open component separation (OCS). The question whether the lateral compartment should be augmented with the mesh remains unresolved.[49]

STATEMENT AND RECOMMENDATION

Statement

There are fewer wound infections and wound healing problems after ECS compared to OCS.

Recommendation

Grade C

In large and very large ventral and incisional hernias, the ECS can be considered in combination with open or laparoscopic mesh techniques if the surgeon is experienced.

Key question

What is laparoscopic parastomal hernia repair?

Evidence

Laparoscopic parastomal hernia repair is a valid alternative to open repair because its rate of recurrence appears to be lower than that of the open approach.[50] Operative times for parastomal hernia repair are longer than that for LVHR because the technique is more difficult, especially because of a more difficult process of adhesiolysis. Intraoperative complications during laparoscopic repair of parastomal hernias are more frequent than during standard LVHR. A high percentage of parastomal hernias are associated with an additional midline incisional hernia, which makes the surgical procedure more complex. The rates of both recurrence and morbidity are higher after laparoscopic parastomal hernia repair than after LVHR.[51] Results of laparoscopic repair of parastomal hernias could not be compared to the general results of LVHR because the rates of recurrence and morbidity are higher. Laparoscopic repair of parastomal hernias is a more complex technique because a concomitant midline hernia present in a high percentage of patients must also be repaired. Laparoscopic repair of parastomal hernias using a pure expanded polytetrafluoroethylene (ePTFE) mesh is associated with better results than the keyhole technique.[52] The laparoscopic modified Sugarbaker technique or the sandwich technique results in fewer recurrences than the keyhole technique. The results of the three main laparoscopic techniques used to repair parastomal hernias (Sugarbaker, keyhole and sandwich) are similar.[53] Laparoscopic repair of parastomal hernia using the modified Sugarbaker technique should be recommended when a pure ePTFE mesh is used. Although the keyhole technique has a lower recurrence rate compared to the Sugarbaker technique, this could be related to the type of mesh because the series not using a pure ePTFE mesh shows similar recurrence rates as the Sugarbaker technique with this type of mesh.[54,55] None of the techniques described in the literature – Sugarbaker, keyhole or sandwich – is superior. Although there is only one series with the sandwich technique (using two meshes), this technique can be considered a safe alternative to the keyhole or Sugarbaker techniques. The same laparoscopic technique can be performed for a hernia occurring with a colostomy, ileostomy or urostomy, or due to an ileal conduit.[55]

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic repair of parastomal hernias can be performed safely and the rate of recurrences after laparoscopic repair of parastomal hernias is lower than that for the open approach.[49]

Recommendation

Grade B

Laparoscopic repair of parastomal hernia should be considered a safe alternative to the open approach.

Grade C

A laparoscopic approach for parastomal hernias should be considered a difficult technique with longer operating time, more intraoperative complications and more difficult adhesiolysis than the standard LVHR.

Key question

Wht is the comparison of open vs. laparoscopic hernia repair for operating room (OR) time, bowel lesion, seroma and wound infection?

Evidence

- The open and laparoscopic techniques do not differ.

- Some studies show longer and others shorter OR time for the laparoscopic technique. The results are inconclusive.[56]
- The laparoscopic approach carries a higher risk of bowel injury.
- The results are mixed, showing no significant difference between the open and laparoscopic techniques.[56]
- The laparoscopic approach has a significantly lower risk for wound infections.

STATEMENT AND RECOMMENDATION

Statement

The laparoscopic approach carries a higher risk of bowel injury. The results are mixed, showing no significant difference between the open and laparoscopic techniques.[56]

Recommendation

Grade A

Laparoscopic repair is preferred because of a significantly reduced risk of SSI.

Key question

What is the comparison of hospital stay, return to activity, cost, quality of life, pain and recurrence after laparoscopic and open ventral and incisional hernia repair?

Evidence

The time until return to activity does not differ significantly between laparoscopic and open repairs. Laparoscopic incisional hernia repair is associated with a faster return to work than open repair. Suture fixation is associated with a faster return to work after laparoscopic repair than after tacks fixation.[57] Return to activity after laparoscopic incisional and ventral hernia repair does not differ significantly between suture and tacks fixation. The time for return to work is significantly longer for smokers and patients with demands of hard physical work.[57] Suture fixation is recommended over tacks plus suture fixation because of early return to full activity. Because of the earlier return to work, laparoscopic incisional and ventral hernia repair is preferred to open repair. The cost of surgery is higher for the laparoscopic procedure, but a shorter hospital stay may make laparoscopic surgery more cost-effective. Suture fixation is a cost-effective alternative to tacks fixation for small- and medium-sized defects in anatomically accessible areas. The quality-of-life (QoL) does not differ between open and laparoscopic repairs of incisional and ventral hernia. Use of absorbable sutures with tacks leads to better QoL than tacks with non-absorbable sutures or tacks only. The QoL does not differ between suture and tacks fixation in laparoscopic repair of incisional and ventral hernia. Laparoscopic repair leads to significant improvement in the QoL compared with open repair. LVHR leads to a significant improvement in the QoL experienced by the patient. Patient satisfaction is higher after LVHR than after open repair. Patients are satisfied cosmetically after suture fixation. Laparoscopic repair is recommended because it gives a QoL comparable with that of open repair. The incidence of pain, both acute and chronic, does not differ significantly between open repair and LVHR.[58] In laparoscopic repair, the incidence of early postoperative pain and chronic pain is less with suture fixation than with tacks fixation. Chronic pain in LVHR is not significantly associated with preoperative pain. Pain does not differ between heavy-weight PP mesh and light-weight barrier-coated meshes. Chronic postoperative pain is more common after LVHR in recurrent cases than in primary cases. Fixation with both tacks and transfixation suture results in more pain. Pain after LVHR is mostly at the suture site. Defect closure may lead to chronic pain. Sutures cause ischaemic injuries to the anterior abdominal wall musculature or the neurovascular bundle, resulting in pain. Nerve entrapment by tacks is another possible explanation for the postoperative pain. The pain scores associated with open repair and LVHR are similar. Suture fixation alone for small- and medium-sized defects may result in less pain and can be recommended.[59]

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic incisional and ventral hernia repair (LIVHR) significantly reduces the hospital stay compared with open repair. Hospital stays are comparable after suture fixation and tacks fixation. The hospital stay is significantly shorter after LIVHR than after open repair for patients with hernias >15 cm. The hospital stay is shorter after LIVHR for primary ventral hernia than after incisional hernia.

Recommendation

Grade D

Suture fixation in laparoscopic incisional hernia repair is recommended. Laparoscopic incisional hernia repair can be recommended as a cost-effective option.

Key question

Do we have an ideal mesh in terms of prevention of adhesions? Are coated meshes really necessary? Are there data to support the manufacturers' claims of superiority? Is a permanent or absorbable barrier preferred?

Evidence

LIVHR can be performed with the use of ePTFE, polyvinylidene fluoride or polyvinylidenedifluoride (PVDF) or composite meshes and is appropriate for use within the abdominal cavity.

The results of experimental studies on large animals with LVHR and comparison of meshes show advantages of light-weight PP meshes vs heavy-weight meshes, ePTFE and composite meshes vs pure PP meshes, composite meshes vs ePTFE meshes and composite meshes vs non-composite meshes.[60,61] After laparoscopic incisional hernia repair, adhesions will develop in at least two-thirds of patients. Adhesions cannot be completely prevented by any of the materials used as intraperitoneal onlay meshes (IPOM), and consequently adhesions must be expected in most patients.

Materials for use within the abdominal cavity can be made of ePTFE, PVDF, polyester or PP which needs an additional barrier to prevent any direct contact with the intestine (composite meshes). Unprotected porous PP and polyester meshes, which are placed in direct contact to the bowel, induce a higher risk for bowel erosion and/or bowel resection at subsequent surgery.

A low recurrence rate can be achieved if adequate technique is applied with all available materials.[62] Film-like materials tend to show encapsulation and sometimes extensive shrinkage and require a method of permanent fixation.

Enterocutaneous fistulas after LVHR are rare events, particularly with ePTFE.

Experimental studies in animals showed contradictory results and are not strictly comparable.

Tissue integration of the various devices with different design characteristics differ and require different fixation techniques.

There is no ideal mesh, but every mesh has to be considered as a compromise with regard to strength, elasticity, tissue in-growth and cellular response, with its specific advantages and disadvantages.

Most devices demonstrate a lack of stretchability, so that folding or wrinkling of the fixed mesh after release of the pneumoperitoneum may be unavoidable.[63]

For LIVHR, only materials approved for use in the abdominal cavity (PTFE, PVDF and composite meshes) should be used. Meshes lacking approval for use within the abdominal cavity should not be used.

It is difficult to eradicate bacteria from ePTFE, and therefore it should be removed (explanted) in the presence of severe contamination. The final choice of mesh should be based on the surgeon's preference while awaiting further data from RCTs. Based on present knowledge, plain PP (without a protective layer) cannot be recommended for intra-abdominal use.

Fixation has to consider the specific flexibility and tissue integration of the device. Quality control of outcome requires a long follow-up and should use registries with standardized sets of variables with an open-ended option for surveillance.

STATEMENT AND RECOMMENDATION

Statements

- After laparoscopic incisional hernia repair, adhesions will develop in at least two-thirds of patients. Adhesions cannot be completely prevented by any of the materials used as IPOM, and consequently adhesions must be expected in most patients.[60]
- Materials for use within the abdominal cavity can be made of ePTFE, PVDF, polyester or PP which need an additional barrier to prevent any direct contact with the intestine (composite meshes). Unprotected porous PP and polyester meshes, which are placed in direct contact to the bowel, induce a higher risk for bowel erosion and/or bowel resection at subsequent surgery.[60]

Recommendation

Grade D

The final choice of mesh should be based on the surgeon's preference while awaiting further data from RCTs. Based on present knowledge, plain PP (without a protective layer) cannot be recommended for intra-abdominal use. Fixation has to consider the specific flexibility and tissue integration of the device. Quality control of outcome requires a long follow-up and should use registries with standardized sets of variables with an open-ended option for surveillance.[64]

Key question

What is the role of biological meshes in LIVHR? Are they advantageous in infected abdominal wall?

Evidence

The use of non-cross-linked biological meshes for elective laparoscopic bridging repair of incisional and ventral hernias shows a high recurrence rate. Recurrence rate in elective laparoscopic repair of incisional and ventral hernias using a cross-linked acellular porcine dermal collagen implant is not significantly higher compared to synthetic composite mesh. Biological meshes are not impervious to infection.[63,64] LIVHR with non-cross-linked biological meshes in an infected or potentially contaminated surgical field may be a viable option if the hernia defect is closed primarily. Elective LIVHR with cross-linked biological meshes can be considered a reasonable surgical option.[65]

STATEMENT AND RECOMMENDATION

Statement

LIVHR in an infected or potentially contaminated surgical field can be performed with non-cross-linked biological meshes but the defect should be closed with suture(s).

Recommendation

Grade D

Elective LIVHR should not be performed with the use of non-cross-linked biological mesh with a bridging technique. Caution is advised in the use of biological meshes in a contaminated field.

Key question

What happens to synthetic mesh after it is inserted into the body?

STATEMENT AND RECOMMENDATION

Statement

It appears that a permanent synthetic (plastic) mesh used for hernia repair is not inert when placed in the patient's body. This biological interaction is complex and the effects can be variable.

Recommendation

Grade D

Because there is no way to predict the biological interaction of each patient to each available hernia mesh, the patient should be informed of potential interactions and complications. The complexity and variability of biological interaction would also argue against the standardization of a mesh within a hospital or outpatient surgery centre, allowing surgeons and patients to have options between a variety of mesh choices.[53]

Key question

Open abdominal surgery and stoma surgery: What are the indications for prophylactic mesh implantation and risk reduction strategies?

Evidence

Measures to lower the incidence of incisional hernia include technical surgical considerations and placement of a prophylactic mesh at primary surgery. LoE 1 – Prophylactic mesh placement in primary stoma formation reduces the rate of parastomal hernia without increasing morbidity, although this evidence is based on small patient populations.[66]

LoE 2 – The incidence of incisional hernia is same after previous midline or transverse abdominal incisions.[67]

LoE 1 – Fascia closure with a continuous suture technique using slowly resorbable suture material significantly reduces the incidence of incisional hernia after elective median laparotomy.[66]

STATEMENT AND RECOMMENDATION

Statements

- The incidence of incisional hernia after laparotomy has been reported to be up to 20% and up to 48% after abdominal stoma formation.
- Connective tissue disorders (patients with abdominal aortic aneurysm) and morbid obesity are the two most important risk factors in patients for development of incisional hernia.
- The other risk factors for patients are neoplastic pathology, age over 70 years, respiratory failure, malnutrition and smoking.[66]

Recommendation

Prophylactic mesh placement reduces the rate of incisional hernia in risk groups with morbid obesity or aortic aneurysm.

Key question

From robotic surgery to natural orifice transluminal endoscopic surgery (NOTES) and single-port surgery: Do these have any role in ventral/ incisional hernia repair?

Evidence

Robotic Surgery[68]

- If a surgical manipulator computer-controlled device can improve performance and outcome, patients will benefit, especially in a procedure where the learning curve is steep, such as hernia repair.
- A study showed that the robot-assisted LVHR using intracorporeal suturing allowed for stable suture fixation under direct visualization and eliminated the need for tackers. Other studies also confirmed the benefits of the da Vinci system for intracorporeal suturing in humans.[69]
- The use of robotics in ventral hernia repair is still very limited because of the large expense associated with the technique. Further research is needed to show the superiority of the technique in recurrence rate or postoperative pain, so as to justify the use of such expensive procedures.
- Patients who had robotic ventral hernia repair did not have significant improvement compared with the LVHR group in either short-term outcomes or opiate medication used.[70]

Single-port surgery

Through a small incision (1.5–2.5 cm), the single-port device can be inserted, which can then allow access of multiple sites for the laparoscope and instruments to carry out the surgery. It appears that the cosmetic advantage offered by single-port endolaparoscopic surgery makes this approach an attractive option for patients who desire an additional benefit of cosmesis.[71] Further clinical studies involving large series of patients are needed to confirm the benefits and advantages of single-port endolaparoscopic surgery over standard procedures. A few case reports on inguinal and ventral hernia repair have shown promising results.

STATEMENT AND RECOMMENDATION

Statements

- The concept of performing surgery inside the abdominal cavity by accessing it through a natural orifice (mouth, vagina or other) represents another potential innovation. The actual benefits of NOTES, however, have yet to be proven because most research in this exciting new field is focused on small trials involving animal models.
- Single-port access ventral hernia repair seems to be a safe and feasible alternative option to conventional laparoscopy in selected cases, but further RCTs are needed.[72]

Recommendation

NOTES

Grade C

Some human experience has been gained, but the technique is currently considered experimental; it has received much criticism and skepticism amidst enthusiasm.

Key question

What are lumbar and unusual hernias?[73–80]

Evidence

Subxiphoid and subcostal incisional hernias

Three different authors have described 21 laparoscopic procedures with recurrence rates ranging from 10% to 33%. Their results are likely to be related to the learning curve of the techniques. An important technical point is the need to dissect the falciform ligament up to the hepatic veins providing a generous retroxiphoid overlap beyond the edge of the hernia defect. Endoscopic tackers can be used around the edges to fix the prosthesis avoiding the area beyond the costal chondral margin. In other series, the placement of additional full-thickness or intraperitoneal abdominal wall stitches allowed additional strength to mesh fixation.

Suprapubic incisional hernias

All the authors underline the importance of preperitoneal surgical dissection by developing a peritoneal flap with direct visualization of the pubic bone, Cooper's ligaments and the inferior epigastric and iliac vessels to obtain sufficient mesh overlap in an area with limited space. The meshes are most frequently fixated to the periosteum of the posterior pubis and Cooper's ligaments bilaterally and then to the aponeurosis in a double-crown fashion. The inferior margin of the mesh should extend below the pubic arch by at least 2 cm to enable secure fixation to Cooper's ligaments bilaterally.

STATEMENT AND RECOMMENDATION

Statements

- Previous surgery usually produces abdominal wall musculature denervation causing disruption of normal anatomy and large bulging defects that occupy most of the lumbar region.
- Laparoscopic repair is a safe and effective procedure in the management of incisional hernia of the abdominal borders with potentially better short-terms results and less recurrence rate than open repair in selected cases.
- Careful standardization of mesh fixation technique is mandatory and must be tailored for each specific hernia site.

Recommendation

NOTES

Grade B

The procedure of choice should be laparoscopic except for large hernias because the recurrence rate is higher than in open repair. Laparoscopic lumbar defect repair usually requires a combination of both transabdominal stitches and metallic tacks and is always described as technically challenging.

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13

Management of Benign Oesophageal Disorders

GERD[1,2]

- GERD (gastro-oesophageal reflux disease) is defined according to the Montreal consensus as 'a condition which develops when the reflux of stomach contents causes troublesome symptoms and/or complications.'
- Symptoms are considered 'troublesome' if they adversely affect an individual's well-being.
- Diagnosis of GERD can be confirmed if at least one of the following conditions exists:
  a. Mucosal break seen on endoscopy in a patient with typical symptoms
  b. Barrett's oesophagus on biopsy
  c. Peptic stricture in the absence of malignancy, or positive pH-metry.

Indications for surgery[3]

- Failed medical management
- The patient opts for surgery despite successful medical management
- Extra-oesophageal manifestations
- Complications of GERD
- Standardization of antireflux surgery technique highly desirable
- Expert supervision during early experience
- Reoperative antireflux surgery should be performed in a high-volume centre.

LAP vs. OPEN[4]

Laparoscopic fundoplication should be preferred over its open alternative as it is associated with superior early outcomes and no significant differences in late outcomes.

Type of fundoplication[5]

- Partial fundoplication is associated with less postoperative dysphagia, fewer reoperations, and similar patient satisfaction and effectiveness in controlling GERD compared with total fundoplication up to five years after surgery (LoE 1).
- It should also be noted that a body of literature suggests that anterior partial fundoplication may be less effective in the long term (LoE 2) and retrospective data suggest that partial fundoplication may not be as effective as total in the long run (LoE 3).
- Paucity of long-term follow-up data comparing the effectiveness of the procedures makes it hard to recommend one type of fundoplication over the other.

Divison of short gastric vessels[6–10]

- When the fundus can be wrapped around the oesophagus without significant tension, no division of the short gastrics seems necessary (LoE 1).
- Division should be undertaken when a tension-free fundoplication cannot be accomplished (LoE 2).

Crural closure[11]

Crural closure should be strongly considered during fundoplication when the hiatal opening is large and mesh reinforcement may be beneficial in decreasing the incidence of wrap herniation (LoE 2).

Antireflux surgery in morbidly obese[12]

Due to concerns of higher failure rates in the morbidly obese and inability of fundoplication to address the underlying problem (obesity) and its associated comorbidities, gastric bypass should be the procedure of choice when treating GERD in this patient group (LoE 2).

Predictors of success[13]

- Fundoplication in patients showing poor response to preoperative proton-pump inhibitor (PPI) treatment (LoE 3).
- Age should not be considered a contraindication in otherwise acceptable operative candidates (LoE 3).
- Care should be taken to minimize early postoperative severe gagging, belching and vomiting (LoE 3).

- A partial wrap should be considered in patients with a preoperative diagnosis of major depression (LoE 3).

Revisional surgery

Laparoscopic reoperative antireflux surgery is feasible, safe and effective but has higher complication rates compared with primary repair and should be undertaken only by experienced surgeons using an approach similar to primary fundoplication (LoE 2).

HIATUS HERNIA

Diagnosis

- Hiatal hernia can be diagnosed by various modalities (plain chest radiographs, ECG, contrast studies, CT, manometry).
- Only those investigations which will alter the clinical management of the patient should be performed (LoE 3).

Indications for surgery

- Repair of a type I hernia in the absence of reflux disease is not necessary (LoE 3).
- All symptomatic para-oesophageal hiatal hernias should be repaired, particularly those with acute obstructive symptoms or which have undergone volvulus (LoE 4).[14–17]
- Acute gastric volvulus requires reduction of the stomach with limited resection if needed (LoE 4).
- Routine elective repair of completely asymptomatic para-oesophageal hernias may not always be indicated. Consideration for surgery should include the patient's age and comorbidities (LoE 3).[18–20]

Repair of hiatal hernia during bariatric operations

- During operations for Roux-en-Y gastric bypass, sleeve gastrectomy and the placement of adjustable gastric bands, all detected hiatal hernias should be repaired (LoE 3).[21,22]

Technical considerations

- Hiatal hernias can be effectively repaired by a transabdominal or transthoracic approach (LoE 4).
- The morbidity due to a laparoscopic approach is markedly less than that of an open approach (LoE 2).

- Laparoscopic hiatal hernia repair is the preferred approach for the majority of hiatal hernias (LoE 4).[23]
- The use of mesh for reinforcement of large hiatal hernia repairs leads to decreased short-term recurrence rates (LoE 4).
- A fundoplication must be performed during repair of a sliding type hiatal hernia and para-oesophageal hernia repair (LoE 2).
- In the absence of achalasia, tailoring of the fundoplication to preoperative manometric data may not be necessary (LoE 2).
- A necessary step of hiatal hernia repair is to return the gastro-oesophageal junction to an infradiaphragmatic position (LoE 3).
- Gastropexy may safely be used in addition to hiatal repair (LoE 4).[24]

Postoperative management

- Postoperative nausea and vomiting should be treated aggressively to minimize poor outcomes (LoE 2).
- Routine postoperative contrast studies are not necessary in asymptomatic patients (LoE 3).[25–28]

Revisional surgery

Revisional surgery can be safely undertaken laparoscopically by experienced surgeons (LoE 3).[13]

Barrett's oesophagus and antireflux surgery

- Detection of Barrett's oesophagus with adenocarcinoma involving the submucosa or deeper excludes the patient from antireflux surgery and demands comprehensive stage-specific therapy (LoE 1).
- High grade intraepithelial neoplasia (HGIN) and intramucosal carcinoma (IMC) can be effectively treated with endoscopic therapy including photodynamic therapy (PDT), endoscopic mucosal resection (EMR), radiofrquency ablation (RFA), alone or in combination (LoE 2).
- Antireflux surgery can be performed after achieving complete histological eradication of the lesion with endoscopic therapy (LoE 3).
- Antireflux surgery may be performed in a patient with non-neoplastic intramucosal (IM), indefinite for dysplasia (IND) and low-grade intraepithelial neoplasia (LGIN); with or without endoscopic therapy to eradicate the Barrett's tissue.
- Antireflux surgery does not alter the need for continued surveillance endoscopy in patients with Barrett's oesophagus. Patients who have undergone endoscopic ablative therapy and antireflux surgery should

continue surveillance endoscopy according to their baseline grade of Barrett's (LoE 1).[29]

Achlasia cardia

- *Diagnostic workup:* Barium oesophagram, an upper endoscopy and oesophageal manometry (+++, strong).
- *Use of pharmacotherapy:* Very limited role, can be used in early stages of the disease, temporarily prior to more definitive treatments, or for patients who fail or are not candidates for other treatment modalities (LoE 4).[30]
- *Use of botulinum toxin:* Effectiveness limited especially in the long term. Should be reserved for patients considered poor candidates for other more effective treatment options (LoE 4).
- *Endoscopic dilatation:* Among non-operative treatment techniques, most effective for dysphagia relief but also associated with the highest risk of complications, it should be considered in selected patients who refuse surgery or are poor operative candidates (LoE 4).[31]
- *Use of oesophageal stents:* Not recommended (LoE 2).
- *Surgical treatment:* Safety and effectiveness of laparoscopic myotomy is well established (LoE 4).
- Recurrent symptoms in a small minority in the long term often associated with postoperative reflux.[32]
- *Effect of prior endoscopic treatments on myotomy outcomes:* Prior endoscopic treatment for achalasia may be associated with higher myotomy morbidity, but the literature is inconclusive. A careful approach by an experienced team is advisable (LoE 2).[33]
- *Surgery versus other treatment modalities:* Laparoscopic myotomy with partial fundoplication superior to other treatment modalities; should be considered the procedure of choice (LoE 4).
- *Type of surgical approach:* Transabdominal superior to transthoracic approach due to improved postoperative reflux control by the addition of an antireflux procedure (LoE 3).
- *Role of fundoplication:* Patients who undergo a myotomy should also have a fundoplication to prevent postoperative reflux and minimize treatment failures (LoE 3).[34]
- The optimal type of fundoplication is debated (posterior vs. anterior) but partial fundoplication should be favoured over total fundoplication as it is associated with decreased dysphagia rates and similar reflux control (LoE 2).[35]

Length of myotomy

- The recommended length of the myotomy has ranged between 4 and 8 cm on the oesophagus and 0.5 to 2 cm on the stomach.
- Symptomatic improvement and lower oesophageal resting pressures have been found to be similar (mean, 10–12 mmHg) when the myotomy is within this range.
- *Recommendation:* The length of the oesophageal myotomy should be at least 4 cm on the oesophagus and 0.5–2 cm on the stomach.[35,36]

Choice of suture for crural repair

- The oesophagogastric junction is retracted anteriorly and to the left, to expose the hiatus. We approximate the hiatus with 1-0 prolene (interrupted sutures) by intracorporeal suturing. In certain situations, the left crus is spread out as a sheet over the aorta, hence care must be taken while taking sutures on the left crus. The first stitch is placed close to the median arcuate ligament. In a wide hiatus, 3 or 4 stitches (1 cm apart) may be needed for adequate narrowing of the hiatus with non-absorbable 1-0 sutures.
- Crural closure should be strongly considered during fundoplication when the hiatal opening is large and mesh reinforcement may be beneficial in decreasing the incidence of wrap herniation (LoE 2).[37]
- *Treatment options after failed myotomy:* Repeat myotomy may be superior to endoscopic treatment and should be undertaken by experienced surgeons (LoE 2).
- Oesophagectomy should be considered in appropriately selected patients after myotomy failure (LoE 1).[38]

Role of intraoperative manometry and endoscopy

Intraoperative manometry and endoscopy add to the precision of the myotomy and are extremely helpful, especially during early surgical experience with myotomy. An intraoperative mean pressure of 15.1 mmHg was associated with a higher postoperative dysphagia compared with a pressure of 6.2 mmHg. Many studies have shown that patients with intraoperative manometry suffered a lower incidence of residual dysphagia postoperatively than patients without it (0% vs. 21.5%).[39]

Peroral endoscopic myotomy (POEM) in achalasia

- Patients with type III achalasia require a long myotomy in the oesophageal body that cannot be performed with a laparoscopic approach but can easily be performed through the per oral approach. A recent multicentre study showed excellent outcomes with clinical improvement in 93% of patients during a mean follow-up of 234 days.

- Patients with end-stage achalasia, laparoscopic heller myotomy (LHM) has traditionally been avoided in these patients because it is unlikely to prevent the need for esophagectomy and would cause scarring and adhesions around the hiatus that might make subsequent oesophagectomy more challenging.[40]
- Patients who have previously been treated with Heller myotomy, botox, or balloon dilation are candidates for POEM. It has been shown to be effective in patients who have previously undergone endoscopic treatments and LHM.
- POEM seems to be extremely safe in experienced hands of highly skilled pioneers and early adopters.
- Three retrospective cohort studies from the USA have compared LHM and POEM.
- Overall, these studies found that POEM was equivalent or superior to LHM in all areas assessed.
- Studies have shown that centres need to perform a minimum of 20–40 POEM procedures to achieve competence, and about 60 to achieve mastery of this technically challenging procedure.[41,42]

Peptic stricture

- Stricture dilatation is the initial means of relieving dysphagia. Dysphagia resolves when the stricture can be dilated to 14 mm (46 Fr) (three types of dilators are commonly used).
- Mercury-filled rubber bougie are generally employed for strictures no smaller than 4 mm.
- Wire-guided dilators (Savary-Gilliard) pass over a guidewire are designed for use with fluoroscopy, and are better for narrow, tortuous strictures.
- Polyethylene balloon dilators are generally used through the endoscope and are also good for narrow, tortuous strictures. In theory, they are better than wire-guided dilators since they exert no longitudinal shearing force on the oesophagus, but this has not been substantiated.[43]

Surgery

Surgery is more effective than medical therapy for healing oesophagitis Traditional indications for surgery in patients with peptic stricture include:

a. inability to dilate the stricture
b. frequent recurrence of dysphagia
c. oesophagitis refractory to medical therapy
d. extra-oesophageal manifestations such as aspiration pneumonia
e. consideration of cost and long-term side-effects of medical therapy in young patients
f. Typically, surgery has been the last option; however, with the introduction of minimal invasive techniques this reservation is being challenged. Laparoscopic Nissen fundoplication is associated with much less patient discomfort and faster recovery than open surgery.
g. For dilatable strictures, the healing of oesophagitis is promoted with a standard antireflux procedure. The most common antireflux procedures are partial (Toupet, Belsey) or complete (Nissen) fundoplications. Of these, the Nissen fundoplication is the most popular.
h. In a randomized trial comparing medical to surgical therapy for complicated GER, surgical therapy was more effective in improving symptoms of oesophagitis and associated with higher patient satisfaction.[44,45]

Epiphrenic diverticula

- Epiphrenic diverticula should be repaired surgically when symptomatic.
- Given their frequent association with achalasia, oesophageal manometry should be done to confirm the diagnosis of achalasia when they are identified.
- A myotomy at the opposite side of the diverticulum that goes beyond the distal extent of the diverticulum should be performed when achalasia is present.
- Concomitant diverticulectomy may be indicated based on the size of the diverticulum.
- When the diverticula are not resected, endoscopic surveillance is advised.
- The optimal approach for their treatment needs further study, and surgeons should be aware of the relatively high incidence of postoperative leaks (LoE 1).[46]

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14

Role of Diagnostic Laparoscopy in Abdominal Disorders

Diagnostic laparoscopy enables the direct inspection of large surface areas of intra-abdominal organs and facilitates obtaining biopsy specimens, cultures and aspiration. Laparoscopic ultrasound can be used to evaluate deep organ parts that are not amenable to inspection. However, the technology and techniques of laparoscopy are getting refined by the day leading to micro-specialization and hybrid interventional and surgical specialists. However, a standalone role of diagnostic and staging work with laparoscopy is diminishing.

The steps of staging and diagnostic laparoscopy are often the initial steps of definitive therapy.

The following areas have witnessed strong evidence-based publications:

1. Congenital disorders
2. Benign disorders
3. Abdominal trauma
4. Abdominal emergencies
5. Laparoscopy in pregnancy
6. Intra-abdominal malignancy

Given the complexity of the healthcare environment, these guidelines are intended to be flexible, as the surgeon must always choose the approach best suited to the patient and variables in existence at the time of the decision.

BENIGN GI DISORDERS

Abdominal trauma

Abdominal trauma is a cause for trepidation for the managing physician as sudden deterioration is a definite possibility. Hence prediction for the need for definitive surgery and validation of the pathway is essential.

In blunt trauma:[1]

- Moderate ongoing bleeding, with increase of intraperitoneal fluid volume >200 ml/h but <500 ml/h in serial ultrasound examinations
- Impossibility to exclude hollow organ injuries
- Bladder injury grade III (American Association for the Surgery of Trauma [AAST])
- Spleen injury grade II to III (AAST)

In penetrating trauma:[1]

- Multiple (>3) wounds of anterior abdominal wall without clinical and instrumental evidences of abdominal organ injury
- Penetrating thoracoabdominal trauma
- Impossibility to inspect a wound canal along its length (e.g. stab wounds in lumbar or gluteal regions)

Failure of non-operative management (NOM) is an indication for laparoscopy either in blunt or in penetrating abdominal trauma.[2]

STATEMENT AND RECOMMENDATION

Recommendations

- Diagnostic laparoscopy may be considered as a tool to evaluate diaphragmatic lacerations and peritoneal penetration (LoE 3).
- Diagnostic laparoscopy plays a crucial role in examination of abdominal trauma patients with equivocal results of non-invasive investigations (LoE 3).

Contraindications

- Laparoscopy is contraindicated in haemodynamically unstable patients,[3] in patients with peritonitis, or in patients with ongoing bleeding, when expected rate of bleeding is >500 ml/h (LoE 2).
- Laparoscopy is also not advisable in patients with severe traumatic brain injury as intracerebral pressure is known to increase with raised intra-abdominal pressure, which has potential to cause further brain damage (LoE 5).

OBSCURE GI BLEED

The management of conditions causing obscure GI bleeding has been revolutionized with the advent of laparoscopic techniques.[4] The serosal surface and mesentery of the entire small bowel can be inspected directly by laparoscopy. Mucosal lesions causing GI bleed not visible on the serosal surface can be detected by combining laparoscopy with perioperative small intestine enteroscopy, small bowel finger exploration carried out through minilaparatomy and intra-operative endoscopy or laparoscopic ultrasonography.[5]

ABDOMINAL EMERGENCIES IN PREGNANCY

Approximately 1 in 500 women will require non-obstetrical abdominal surgery during pregnancy. The common non-obstetrical surgical emergencies complicating pregnancy are acute appendicitis and cholecystitis. Other conditions that may require surgical intervention during pregnancy include ovarian – cysts, masses or torsion, symptomatic cholelithiasis, adrenal tumours, splenic disorders, symptomatic hernias, complications of inflammatory bowel diseases, and other rare conditions.

Initially laparoscopy was contraindicated during pregnancy due to concerns for uterine injury from trocar placement and fetal malperfusion due to pneumoperitoneum. Increased experience has now made laparoscopy the preferred mode of surgical access in the gravid patient.

Diagnostic laparoscopy

Early correct diagnosis of abdominal conditions during pregnancy optimizes maternal and fetal outcomes.[6] When available resources are insufficient in making a definite diagnosis, or imaging is inconclusive, diagnostic laparoscopy may be considered. The risks of delayed diagnosis should be weighed against the risk of possible negative laparoscopy.

STATEMENT AND RECOMMENDATION

Recommendations

- In the absence of access to imaging modalities, laparoscopy may be used selectively in the workup and treatment of acute abdominal processes in pregnancy (LoE 3).
- Laparoscopic treatment of acute abdominal disease offers similar benefits to pregnant and non-pregnant patients compared to laparotomy (LoE 2).

Imaging is preferred over diagnostic laparoscopy for the workup of abdominal processes during pregnancy. When imaging is unavailable or inconclusive, using laparoscopy as a diagnostic tool may be considered.

Laparoscopy should be used judiciously, as there may be an increased risk of preterm labour and fetal demise after negative laparoscopy for presumed appendicitis. The risks and benefits of diagnostic laparoscopy for other conditions during pregnancy have not been well documented and require further study.

Preoperative decision-making

Once the decision to operate has been made, the surgical approach (laparotomy versus laparoscopy) should be determined based on the skills of the surgeon and the availability of appropriate staff and equipment. Benefits of laparoscopy during pregnancy appear similar to those in non-pregnant patients including less postoperative pain, less postoperative ileus, decreased length of hospital stays and faster return to work.[7]

Other advantages of laparoscopy in the pregnant patient include decreased fetal respiratory depression due to diminished postoperative narcotic requirements, lower risk of wound complications, diminished postoperative maternal hypoventilation and decreased risk of thromboembolic events. The improved visualization in laparoscopy may reduce the risk of uterine irritability by decreasing the need for uterine manipulation.

Laparoscopy and trimester of pregnancy

Laparoscopy can be safely performed during any trimester of pregnancy when operation is indicated (LoE 2).

Traditionally, the recommendation for non-emergent procedures during pregnancy has been to avoid surgery during the first and third trimesters to minimize the risk of spontaneous abortion and preterm labour, respectively. This has led some authors to suggest delaying surgery until the second trimester and that the gestational age limit for successful completion of laparoscopic surgery during pregnancy should be 26–28 weeks. These recommendations are not supported by good quality evidence; recent literature has shown that pregnant patients may undergo laparoscopic surgery safely during any trimester without an increased risk to the mother or fetus.

CONGENITAL DISORDERS

Cryptorchidism

Benefits of laparoscopy have been well established in the management of cryptorchidism in select situations (Grade B).[8]

Over 70% of cryptorchid testes are palpable by physical examination and need no imaging. In the remaining 30% cases with a non-palpable testis, the challenge is to confirm absence or presence of the testis. A radiological test cannot demonstrate with accuracy the absence of a testis. Therefore, a surgical exploration, such as diagnostic laparoscopy (or open exploration), must be performed on all non-palpable unilateral and most bilateral cryptorchid patients.

Prepubertal boys with non-palpable testes, should be re-examined under anaesthesia to assess for presence of testes.[9] If the testis is palpable, open orchidopexy should be undertaken. However, if the testis is non-palpable, surgical exploration and if indicated abdominal orchidopexy should be performed (Grade B). Studies evaluating laparoscopy for determining the location of the testicle have reported findings similar to that of open exploration.

Laparoscopic exploration

All guidelines recommend laparoscopic exploration for non-palpable undescended testis (UDT). Diagnostic laparoscopy is the current gold standard with high sensitivity and specificity for identification of non-palpable testes and with the possibility for use in treatment subsequently. However, the Canadian Urological Association[10] recommends that when ipsilateral scrotal nubbin and contralateral compensatory testicular hypertrophy are detected, scrotal incision can be used before inguinal or laparoscopic exploration to remove scrotal nubbin while confirming the diagnosis.

ABDOMINAL INFECTIONS

What are the indications for laparoscopy?

Laparoscopic surgery for perforation of hollow viscus is replacing conventional laparotomies.[11] Ulcer perforation, diverticular perforation and traumatic perforations are the most common surgeries being performed.[12]

Perforated peptic ulcer

Laparoscopy should probably not be used for the treatment of peritonitis due to perforated peptic ulcer in a patient presenting more than one of the following risk factors: state of shock on admission, ASA score III–IV and presence of symptoms for >24 hours (LoE 2).

Rationale: The Boey score attributes one point to the following risk factors: shock on admission, ASA score III–IV, symptoms present for >24 hours. In a meta-analysis combining 56 publications and 2784 patients, the authors concluded that laparoscopy was a safe procedure in patients with a Boey score of 0 or 1, whereas laparoscopy is contraindicated in patients with a Boey score of 2 or 3 due to the very high morbidity and mortality.

Diverticular disease

All guidelines recommend laparoscopy for elective surgery. It is the only aspect of diverticular disease which is based on high-quality evidence.[13,14] The Polish Society of Gastroenterology (PSG)/Polish Society of Surgery (PSS) limits laparoscopy in complicated cases to highly experienced centres (Concordance 9/9). In case of emergency, five guidelines recommend laparoscopic approach, two consider it for selected patients; the PSG/PSS limits laparoscopy for Hinchey III to highly experienced centres, whereas for Hinchey IV, laparotomy is recommended. Evidence for laparoscopy in case of emergency is poor.

Laparoscopy should not be performed in the case of purulent peritonitis due to diverticulosis (Hinchey IV) or generalized peritonitis (Grade A).[14]

Rationale: No randomized prospective study has compared laparoscopy and laparotomy in perforated sigmoid diverticulitis. Eleven studies comprising a total of 276 cases of Hinchey II (pelvic abscess <4 cm away from the colon) and Hinchey III peritonitis (purulent) treated by laparoscopic lavage and drainage reported a morbidity rate of 10.5%. Laparoscopy is not recommended in purulent peritonitis (Hinchey IV) due to a 7-day reoperation rate of 37%.[15]

ABDOMINAL TUBERCULOSIS

Guideline

Tuberculosis (NG33) National Institute for Health and Care Excellence (NICE) 2016

The NG33 NICE 2016 guideline has established the role of diagnostic laparoscopy in the diagnosis of abdominal tuberculosis. The advantage of laparoscopy is being able to access the appropriate fluid and tissues, essential for the diagnosis and to assess the resistance pattern.

It should be noted that appropriate sterilization methods are to be implemented in the cleaning of access and laparoscopic instruments especially when used for abdominal infections.

INTESTINAL OBSTRUCTION

Laparoscopy in intestinal obstruction has a diagnostic accuracy of >98%; it can simultaneously be therapeutic.

In a hypotensive patient or a patient in shock, laparoscopy should be avoided or approached with extreme caution.[16]

Patients with a high clinical suspicion of intestinal gangrene/diffuse peritonitis should be approached with caution. In this situation, laparoscopy serves primarily a diagnostic function.

Several studies have been published on the safety and efficacy of laparoscopic adhesiolysis. It has been concluded that success depends greatly on the level of expertise of the operating surgeon and patient selection. The broad range in selection criteria makes it difficult to compare the studies. The efficacy of laparoscopy ranges from 40% to 91% with conversion rates from 6.7% to 43%. Complications range from 3% to 18%, an unrecognized enterotomy, the most feared one.

STATEMENT AND RECOMMENDATION

Recommendation

Laparoscopic management of acute small bowel obstruction is feasible and safe in experienced hands with significant advantages for the patient (LoE 3).

COLOUTERINE FISTULA

Diagnostic hysteroscopy enables rapid diagnosis of the colouterine fistula.[17] Diagnostic hysteroscopy is the first-choice diagnostic tool for investigation of any abnormal vaginal discharge such as blood or stool because it enables direct vision and biopsy of the lesions of the lower genital tract quickly and at low cost.

ABDOMINAL TUBERCULOSIS				
Suspected site of disease	**Possible imaging techniques***	**Specimen**	**Routine test**	**Additional tests on primary specimen (if it would alter management)**
Gastrointestinal	Ultrasound CT Laparoscopy	Biopsy of omentum Biopsy of bowel Biopsy of liver	Microscopy Culture Histology	–
		Ascitic fluid	Microscopy Culture Cytology	Adenocine deaminase assay
Genitourinary	Ultrasound Intravenous urography Laparoscopy	Early morning urine	Culture	–
		Biopsy from site of disease, such as endometrial curettings or renal biopsy	Microscopy Culture Histology	–
* Taking into account, for example, the exact site of suspected disease and the availability of the test at the time of assessment				

In terms of surgical management, besides primary resection of the colon, there is some debate about en bloc hysterectomy versus uterine preservation. Current obstetric/gynaecology and older open surgery literature advocates en bloc hysterectomy, whereas a recent laparoscopic report favours uterine preservation.

IATROGENIC COLONOSCOPIC PERFORATION (ICP)

Treatment of ICP

- Is explorative laparoscopy indicated in all patients with ICP?
- What are the indications for conversion from laparoscopy to open surgery in patients with surgical ICP?

Surgery is indicated as the first treatment in patients with ongoing sepsis, signs of diffuse peritonitis, large perforations, and failure of conservative management and in the presence of certain concomitant pathologies, such as unresected polyps with high suspicion of being a carcinoma.

The perioperative morbidity and mortality related to surgery for ICP are considerable, with rates of 21%–44% and 7%–25%, respectively. Particularly frail patients, such as older patients and patients with low preoperative blood pressure, can have higher risks of mortality associated with colorectal perforation. Thus, appropriate patient selection and surgical procedures are crucial in limiting the morbidity and mortality related to surgery for ICP.

In general, intraoperative findings determine the best technique to apply according to different scenarios. Surgical procedures for the management of ICP include colorraphy, wedge resection, colostomy by exteriorization of the perforation and colonic resection with or without primary anastomosis or stoma.

The decision regarding the type of surgical procedure depends on[18]

- the size, location, and aetiology of the ICP;
- the viability of the surrounding colon and mesocolon;
- the degree of and time from the development of peritonitis;
- the patient's general status and the presence of comorbidities;
- the quality of the colonic preparation; and
- the presence of residual lesions not resected during the colonoscopy procedure.

Explorative laparoscopy is a minimal invasive technique, useful for performing both diagnostic and potentially therapeutic procedures. Its timely application may prevent ongoing inflammation and injury that would necessitate more invasive measures, such as open laparotomy and/or colonic diversion.[19]

Diagnostic laparoscopy can identify the perforation, its size and specific location. It can help define the potential cause of perforation (e.g. perforation caused by the shaft of the endoscope, cautery, presence of mesenteric hematomas, emphysema or effusions), thus guiding the choice of treatment.

An early diagnosis and timely management, ensures reduced morbidity and length of stay and faster postoperative recovery. In endoscopic lesions not mandating surgical resection, small tears and a healthy and well perfused colon, a laparoscopic primary repair can be safely performed.

For both diagnostic and therapeutic purposes, the potential exists for definitive surgical procedures, including suturing the defect, wedge resection and segmental resection with or without anastomosis and/or stoma, in presence of adequate surgical expertise.[20]

BENIGN GYNAECOLOGICAL DISORDERS

Endometriosis

Endometriosis is a chronic inflammatory disease, defined by the presence of ectopic endometrial tissue.[21] This disease can be asymptomatic or associated with symptoms such as dysmenorrhea, chronic pelvic pain, dyspareunia, infertility, as well as cyclic urinary and intestinal symptoms according to the location of the disease. The most common location of endometriosis is the pelvis, but distant endometriosis tissue can also be found. Diagnostic laparoscopy with histopathological confirmation is considered the gold standard for the diagnosis of endometriosis.

However, non-invasive diagnosis with methods such as transvaginal ultrasound (TVUS) with or without bowel preparation and magnetic resonance imaging (MRI) have been gaining a greater role in the diagnosis of endometriosis outside of surgery.

Endometriosis is classified as superficial (or peritoneal), ovarian (endometrioma) and deep (defined as infiltrating lesions >5 mm in depth). The clinical presentations of each of the disease types vary between patients and treatment recommendations are generally based on symptoms and fertility status. The understanding of endometriosis has changed significantly in recent years with the growing body of evidence on the role of preoperative imaging, efficacy of medical therapy, perioperative outcomes of different surgical approaches and their impact on ovarian reserve.

The treatment guidelines, divided according to the types of endometriosis and clinical presentation of pain and infertility are summarized.[22]

Superficial endometriosis – Pain

Many international societies agree that the gold standard for the diagnosis of endometriosis is laparoscopy with histological confirmation. So far none of the society guidelines mention the role of imaging in the preoperative diagnosis of the superficial disease. Both laparotomy and laparoscopy are effective, with the latter modality being associated with less postoperative pain, shorter hospital stay and better cosmetic outcome. In superficial endometriosis identified at laparoscopy, surgical resection is preferred because it provides additional histological confirmation even though ablation of lesions has been shown to improve symptoms in 62% to 80% of cases after 6 months of treatment.

In asymptomatic women with infertility, laparoscopy should not be performed only to rule out or diagnose endometriosis.[23] The likelihood of finding endometriosis is increased in the presence of pain or abnormal physical examination findings. The Society of Obstetricians and Gynaecologists of Canada (SOGC) recommends that surgery should be indicated in these patients to improve both fertility outcomes and to relieve pain.

Pelvic pain

The recommendation of diagnostic laparoscopy for every woman presenting with pelvic pain would involve a large number of diagnostic laparoscopies. In the absence of a definite endometriotic ovarian cyst on ultrasound, which would require surgical removal, patients with pelvic pain could first be given a trial of medical treatment such as progesterone derivatives, oral contraceptive pills, gonadotropin-releasing hormone (GnRH) analogues, or non-steroidal anti-inflammatory drugs (NSAIDs). In the case of a good response, the laparoscopy would not be necessarily required, saving immediate healthcare costs. The choice of medical or surgical treatment can be offered to the patient after balancing the risks and benefits of both options, and carefully discussing before favouring the surgical route. In the case of a definite endometriotic cyst or mass on imaging, the first-line therapy is clearly a surgical one.

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15

Minimal Invasive Adrenal Surgery

Laparoscopic adrenalectomy is now an established procedure for benign adrenal disease and selective malignant conditions. Starting with trans-abdominal approach, multiple approaches to reduce pain, hospital stay, morbidity have been described. These guidelines have been evolved in a question–answer format.

We did a PubMed search and analysed all relevant references on laparoscopic adrenalectomy, minimal invasive adrenalectomy, retroperitoneal adrenalectomy and published guidelines on this topic by various Societies such as SAGES, Polish, Italain, American Association of Endocrinologists, Endocrine Surgeons and European. The study included 335 articles – 16 meta-analyses, 3 RCTs, 2 multicentre studies, 151 systematic reviews, 149 review articles, 10 review analysis and 6 guidelines.

Key question

What is the role of laparoscopic adrenalectomy and what are the indications?

Evidence

Since the first description of laparoscopic adrenalectomy in the early 1990s, laparoscopic adrenalectomy has been reported widely from various centres. Laparoscopic adrenalectomy is considered the 'gold standard' for most benign adrenal neoplasms.[1,2]

A recent meta-analysis by Heger *et al*. evaluated 26 studies comparing open with minimal invasive adrenalectomy and concluded that minimal invasive adrenalectomy is safe and should be preferred over open adrenalectomy due to shorter length of stay (LoS), lower blood loss, and equivalent complication rates (LoE 1a).[3]

In patients with adrenal-mediated hypertension, viz. hyperaldosteronism and pheochromocytoma, retrospective cohort studies have revealed better outcomes in terms of pharmacological recovery, quality of life and cost effectiveness (LoE 3).[4,5] Other reported indications for adrenalectomy are Cushing syndrome (pituitary or adrenal), adrenocorticotropic hormone (ACTH) independent macro-nodular adrenal hyperplasia and primary pigmented nodular adrenocortical disease (PPNAD), adrenal haemorrhage, androgen-secreting tumours, and incidentaloma including myelolipoma, ganglioneuromas.[6,7]

The role of minimal invasive surgery in incidentaloma, adreno-cortical carcinoma (ACC), adrenal metastasis (AM) and adrenal cysts are dealt with separately.

STATEMENT AND RECOMMENDATION

Recommendations

Grade A

- Laparoscopic adrenalectomy should be offered as the therapeutic option of choice for all benign adrenal tumours (LoE 3).
- Minimal invasive adrenalectomy has become the standard of care for most adrenal masses (LoE 3).

Key question

What is adrenal incidentaloma (AI) and how is it managed?

Evidence

An AI is a mass lesion >1 cm in diameter, serendipitously discovered by radiological examination done for some other cause and includes a spectrum of varied adrenal pathologies.[8] A review of the literature reveals that 80% of patients with incidentalomas had non-functioning adenoma, 5% subclinical Cushing syndrome, 5% pheochromocytoma, <5% adrenocortical carcinoma, 2.5% metastatic lesion, 1% aldosteronoma and other rare conditions such as ganglioneuroma, myelolipoma or benign cyst.[9]

The screening protocol for AI includes hormonal evaluation and imaging. The primary goal is to identify with ACC, prevalence of which depends on the size of the tumour (25% of lesions >6 cm turn out to be ACC).[7] A 4 cm cut-off is associated with a sensitivity of 93% and a specificity of 24% in preoperative diagnosis.[10,11] In a cost-effectiveness model, Wang *et al*. randomized patients with 4 cm AI with no suspicion of malignancy to surgery, surveillance or no follow-up. In the base-case analysis, assuming a 2.0% probability of ACC for a 4 cm tumour, they found surgery to be more cost-effective than surveillance (LoE 1b).[12]

Surgical resection is recommended for patients with adrenal masses >4 cm in diameter. However, the clinical scenario, imaging characteristics and patient age frequently guide the management decisions in patients who have AIs that fall on either side of the 4 cm diameter cut-off.[11]

In a randomized prospective study, Toniato *et al*. randomized 45 patients of AI with subclinical Cushing syndrome (SCS) to surgery or conservative treatment. They found that diabetes, hypertension, obesity and hyperlipidaemia improved significantly in operated patients. No changes in bone parameters were seen after surgery in SCS patients with osteoporosis. On the other hand, some worsening of diabetes mellitus, hypertension and hyperlipidaemia was noted in conservatively-managed patients (LoE 1a).[13]

Up to 15% of incidentalomas have bilateral lesions. The protocol for bilateral adrenal incidentalomas (BAIs) remains the same as that for unilateral. In a meta-analysis to find the differences between unilateral and bilateral incidentalomas, Paschou *et al*. found evidence that patients with BAI present a higher prevalence of SCS compared to patients with unilateral AIs (LoE 2a).[14]

For AIs <4 cm with imaging characteristics consistent with a benign adenoma, the American Association of Clinical Endocrinologists (AACE) and the American Association of Endocrine Surgeons (AAES) guidelines recommend follow-up with radiological imaging at 3–6 months and then annually for 1–2 years, and hormonal re-evaluation annually for up to 5 years.[7] The European Society of Endocrinology Clinical Practice Guideline recommends no follow-up radiological or biochemical investigations beyond 12 months if there is no change in the clinical or radiological parameters.[15] Loh *et al*. have tried to evaluate outcomes in non-operated patients of AI in a meta-analysis. The long-term follow-up of 1298 patients was studied and they concluded that malignant change and risk of developing overt disease in non-functioning AI is rare. They recommend a less stringent follow-up in non-functional benign-appearing small incidentalomas.[16]

Thus, we recommend case-based follow-up depending on the clinical, radiological and biochemical findings at initial workup keeping in mind the patient's age and comorbid condition.

STATEMENT AND RECOMMENDATION

Recommendation

Grade A

Surgical treatment should be offered to patients with adrenal incidentaloma of size ≥4 cm. Or, any size where imaging examinations suggest a malignant lesion (oncological recommendation) or with confirmed hormonal activity (endocrinological recommendation) (LoE 1b).

Key question

Is there a role of minimal invasive adrenalectomy in adrenocortical carcinoma (ACC)?

Evidence

The oncological outcomes in ACC depend upon the size of the tumour, lymph node dissection and volume of work at the centre where surgery is performed.[17,18] A poor outcome is likely to result from inadequate surgery, irrespective of whether the approach is open or laparoscopic.[19]

A recent meta-analysis comparing the oncological outcome between open and laparoscopic adrenalectomy concluded that the latter for localized ACC is effective and safe as open adrenalectomy as long as oncological principles are respected and are performed by expert surgeons in high volume centres (LoE 2a).[20] A systematic review showed no difference in the outcome between open and laparoscopic approaches in stage I and II.[17]

If proper negative surgical margins are achieved and there is no lymph nodal involvement, both open adrenalectomy and laparoscopic adrenalectomy have been found to have the same long-term outcomes.[21] For tumours of limited size (<10 cm) without evidence of invasiveness, laparoscopic adrenalectomy does not seem to be oncologically inferior to open surgery when performed in a state-of-the-art manner and when oncological standards (margin-free resection, avoidance of tumour spillage) are respected.[22]

A study of the various meta-analyses of patients undergoing surgery for ACC shows a selection bias in patients undergoing laparoscopic adrenalectomy where size of tumour was smaller. In high-volume centres, more aggressive and open surgery was performed. In low-volume centres, higher local recurrence, distant metastases rates and a shorter time to recurrence were seen.[23,24] Thus, the quality of evidence in most studies is not very high.

In a large database study, postoperative complications have been found to be high after surgery in malignant tumours, whether in open or laparoscopic.[25]

Several studies suggest that open surgery, i.e. en bloc resection of contiguous involved structure and regional lymph nodes have best outcomes (LoE 2c, Grade A).[26,27]

The debate continues over the approach, viz. laparoscopic or open, for ACC. Further data would be required to substantiate and have a strong recommendation in this regard. Since higher recurrences have been recorded in low-volume centres, ACC should be treated in high-volume centres.

STATEMENT AND RECOMMENDATION

Statement

Open adrenalectomy is the treatment of choice in ACC (LoE 2a).

Recommendation

Grade A

The laparoscopic approach may be offered in stage I/II ACC in high-volume centres, provided due adherence to oncological principles is followed.

Key question

Is there a role of minimal invasive adrenalectomy in adrenal metastasis (AM)?

Evidence

The advent of imaging such as high-resolution CT scan and PET scans have resulted in increasing the diagnosis of AM during evaluation or follow-up of primary disease. Apart from the basic functional evaluation to exclude secretary nature of the tumour, it is also essential to assess the stage of primary disease, biological behaviour of the tumour and fitness of patient.

There is evidence to suggest that solitary metastases to the adrenal gland without local invasion can be approached laparoscopically.[28,29] Adrenal biopsy should be performed only if the expected findings are likely to alter the management (LoE 2a).[29] The objective of surgery in dealing with AM is to clear entire adrenal tissue without compromise – off the kidney, inferior vena cava (IVC), diaphragm on the right and tail of the pancreas on the left. Better overall survival can be achieved provided there is margin negative resection and no capsular breach.[30] The dimensions and absence of invasion on imaging, the evolutive status of the disease and the performance status of the patient are key factors for laparoscopic adrenalectomy. Conversion to open is suggested if these criteria cannot be met.[31]

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic adrenalectomy is superior to open adrenalectomy in cases of solitary adrenal metastasis, but complete oncological clearance is mandatory and conversion to open surgery is suggested if oncological clearance cannot be achieved (LoE 2a).

Recommendation

Grade C

Key question

How to manage an adrenal cyst?

Evidence

Laparoscopic treatment of adrenal cysts is reported in case reports. There are no high-level studies for management of adrenal cysts.

Cysts constitute 5.4% to 6.0% of all pathological changes affecting adrenal glands.[32] Adrenal cysts could be pure cysts (endothelial such as lymphangioma, haemorrhagic – also called pseudocysts and epithelial or true cysts), parasitic cysts (e.g. hydatid) and tumour-related cysts (necrosis in pheochromocytoma or ACC, teratoma).[32,33] One-third of the cases are incidental and two-thirds cysts are symptomatic (large size or rapid growth).

Surgical intervention is generally indicated for adrenal cysts when they are functional, symptomatic, parasitic, malignant, enlarging, or ≥5 cm;[32,34] 15% are associated with a range of hormonally active pathological syndromes of the adrenal cortex and medulla.[35,36] In an adrenal haemorrhagic cyst, pheochromocytoma can be considered as a differential diagnosis.[35]

Laparoscopic partial adrenalectomy or a total adrenalectomy can be performed in cases of larger cysts which compromise most of the adrenal gland.[37]

Retroperitoneal laparoscopic decortication may be the preferred treatment option for large benign adrenal cysts.[38]

STATEMENT AND RECOMMENDATION

Statements

- Adrenal cysts >3 cm, hormonally active, rapidly growing and suspected tumour should be operated (LoE 3).
- Pure cysts can be marsupalized or subjected to adrenal-preserving surgery. Adrenalectomy may be required when the cyst totally involves the gland (LoE 3).
- The laparoscopic approach may be undertaken by an experienced surgeon (LoE 3).

Recommendation

Grade D

Key question

What are the various approaches of minimal invasive adrenalectomy?

Evidence

Several approaches of minimal invasive adrenalectomy have been described. The most common approach is lateral transabdominal adrenalectomy (LTA). In recent years, the posterior retroperitoneoscopic adrenalectomy (PRA) has become a common approach in many centres.[39,40] The lesser used approaches are lateral retroperitoneoscopic adrenalectomy (LPA) and anterior transabdominal adrenalectomy (ATA). The advantages of the LTA approach are familiarity of peritoneal cavity to general and laparoscopic surgeons. It offers excellent exposure with greater working space.

The PRA approach gives direct access to the adrenal gland avoiding the intra-abdominal cavity. The advantage of this procedure is that it avoids the need for mobilizing fragile organs such as the liver, pancreas and spleen potentially saving time, surgical trauma and complications. The position facilitates bilateral adrenalectomy. The disadvantages are working in an unfamiliar territory and lack of experience.

The LPA technique is the most commonly used by urosurgeons. It avoids the peritoneal cavity and is advocated in patients with prior abdominal surgery.

ATA is the sub-mesocolic approach for left-sided disease and is the least commonly used technique. The disadvantages are longer operative time and requirement of greater number of ports.

Both LTA and PRA have been compared in the literature. Meta-analyses by Constantinidis *et al.*[41] and Nigris *et al.*[41,42] with respect to operative time, blood loss, hospital stay and complications were comparable while Chen *et al.* favoured PRA.[43]

In a randomized controlled trial (RCT) by Chai *et al.*,[44] 83 patients were randomly assigned to the LTA group or the PRA group. The mean operative time was the primary end-point and was found to be comparable. There were no differences in the secondary outcomes, viz. blood loss, intraoperative haemodynamic stability, postoperative pain, recovery of bowel movement and complication rates between the groups (LoE 1b). However, in an earlier RCT, Barczinsky *et al.* found comparable safety in both approaches but secondary end-points in terms of duration of surgery; blood loss, postoperative pain, earlier recovery, improved cost-effectiveness, and risk of surgical access site herniation were in favour of PRA.[45] This study included 61 patients.[45]

In search of a better technique, Conzo *et al.*[39] analysed the available literature for complications following both techniques and concluded that LTA is a safe and standardized procedure with a shorter learning curve and a similar low morbidity rate, even for tumours >6 cm. Further studies are however needed to objectively evaluate these techniques.

The familiarity of the technique depends upon the experience and training of the surgeon. It is advantageous to know more than one technique to be able to apply it as per individual case demand.[30,46]

According to these studies and SAGES guidelines,[30] in previous abdominal surgery and in bilateral adrenalectomies, PRA may be advantageous and associated with fewer complications. In obese patients (BMI >35 kg/m^2) and large tumours (>6 cm), a lateral transabdominal approach may be better.

STATEMENT AND RECOMMENDATION

Recommendation

Grade D

Laparoscopic transabdominal adrenalectomy and retroperitoneal adrenalectomy are equivalent in most outcomes. Experience of the operating surgeon is of utmost importance in getting a good result (LoE 1b).

Key question

What should be the method and timing for taking the adrenal vein?

Evidence

Wu *et al*. randomized 113 patients of pheochromocytoma into two groups depending upon vein ligation before or after gland dissection.[47] The groups showed no difference in blood pressure fluctuations and plasma catecholamines. The timing of taking the adrenal vein has no impact on intraoperative blood pressure fluctuations and blood loss (LoE 1b). However, most series prefer taking the adrenal vein in the initial part of dissection to avoid haemorrhage.

STATEMENT AND RECOMMENDATION

Statement

Ligation of the adrenal vein before or after dissection of the gland has no significant impact on blood pressure fluctuations (LoE 1b).

Recommendation

Grade D

Key question

When should partial adrenalectomy be performed?

Evidence

For patients requiring bilateral adrenalectomy for conditions such as hereditary pheochromocytoma, cortical sparing adrenalectomy can be performed. This avoids the need for life-long steroid replacement.

The reported amount of adrenal cortical tissue needed to preserve adrenal function is one-third of one gland or 15% of the total adrenal cortical tissue.[48] Cortical tissue to be retained should not be mobilized to avoid devascularization. Tumours should be resected with a 0.5–1 cm margin of normal adrenal tissue. Preservation of the adrenal vein is not essential and depends on the situation. Laparoscopic ultrasound helps in clear differentiation.[49,50]

Long-term outcomes after partial adrenalectomy have shown steroid-free outcomes in up to 91% of patients.[50]

STATEMENT AND RECOMMENDATION

Statement

For patients requiring bilateral adrenalectomy, such as for hereditary pheochromocytoma, laparoscopic cortical sparing surgery may be the procedure of choice (LoE 1b).

Recommendation

Grade C

Key question

What is the role of single-site adrenalectomy?

Evidence

Reports of laparo-endoscopic single-site (LESS) transabdominal as well as retroperitoneal adrenalectomy are available in the literature. Single-port adrenalectomy has shown no significant differences in patient's length of stay or morbidity, small benefit in cosmesis and postoperative pain but longer operative times.[51,52]

Wang *et al*. in their meta-analysis of observational studies (LoE 2a) found LESS-AD to be feasible and safe though with a longer operative time but could not verify other potential advantages (i.e. cosmesis, recovery time, convalescence, port-related complications).[53]

A recent meta-analysis of retrospective studies (LoE 2a) shows shorter length of hospital stay and reduced postoperative pain scores in certain patients but recommend high-quality, double-blind RCTs with longer-term follow-up to confirm and update the findings.[54]

STATEMENT AND RECOMMENDATION

Statement

Laparoendoscopic single-site adrenalectomy is an alternative technique of minimal invasive adrenalectomy. It can be used safely in experienced hands though no additional benefit is yet shown (LoE 2a).

Recommendation

Grade C

Key question

Are there any advantages of robotic adrenalectomy over laparoscopic adrenalectomy?

Evidence

Robotic adrenalectomy is a recent entrant in the field of adrenalectomy. A retrospective comparison between robotic adrenalectomy and laparoscopic adrenalectomy in patients from a high-volume centre by Pineda-Solis *et al.*[55] found robotic adrenalectomy to be as safe and technically feasible as laparoscopic adrenalectomy. There are subjective benefits for the surgeon, such as a three-dimensional operative field, ergonomically comfortable position and elimination of surgeon's tremor. The operating time with robotic adrenalectomy is significantly longer but patient outcomes are similar to those of the laparoscopic technique (LoE 3).

A database study of the national inpatient sample of 1006 patients, published in 2018 (patient population 2009–2012), has found that the rate of robotic adrenalectomy increased annually. The overall benefit for robotic adrenalectomy was found to be small with comparatively higher total cost, which outweighs the benefits (LoE 4).[56]

Morelli *et al.*[57] in their case–control study where 41 patients were subjected to robotic adrenalectomy, found that the operative times were shorter in patients with BMI >30 kg/m^2, tumour size >6 cm and patients with previous abdominal surgery.

A meta-analysis of 13 studies by Agrusa *et al.*[40] found no significant differences between robotic adrenalectomy and laparoscopic adrenalectomy. The significant finding was that the patients in the robotic adrenalectomy group had lower BMI, thus indicating a selection bias (LoE 2a).

A prospective study by Agcaoglu *et al.*,[58] comparing robotic with laparoscopic PRA, concluded that beyond the learning curve for experienced laparoscopic surgeons, robotic PRA shortens the skin-to-skin operative time compared with the laparoscopic approach. The immediate postoperative pain was less severe for patients who undergo robotic PRA (LoE 2b).

Three meta-analyses[59–61] have shown inconsistent operative times and have recommended further RCTs (LoE 2a).

Therefore, there is no standardization for robotic adrenalectomy. There is also a practical limitation of non-availability of the technology for a large number of surgeons.

STATEMENT AND RECOMMENDATION

Statement

Robotic adrenalectomy is safe and feasible in experienced hands. Benefits to the surgeon exist in terms of ergonomic consideration, but patient outcomes may not differ significantly from laparoscopic adrenalectomy. Robotic adrenalectomy may offer advantages in cases of large tumours, morbid obesity and previous abdominal surgery (LoE 3).

Recommendation

Grade D

Key question

Should non-ACC (adreno-cortical carcinoma) large adrenal tumours be dealt with minimal invasive techniques?

Evidence

No particular definition of a large adrenal tumour exists. Most reports suggest 5 cm as the cut-off.[62] Both trans-abdominal and retroperitoneal routes have been used for large adrenal tumours.[63,64] Laparoscopic adrenalectomy is safe and feasible in large masses provided the surgeon has adequate experience and a low threshold for conversion. Tumours >12 cm have greater technical difficulty, longer operating time, increased blood loss, more complications and potential for malignancy with adjacent organ involvement.

A prospective non-randomized study of large pheochromocytoma done by Wang *et al*. found that laparoscopic adrenalectomy could be performed in >6 cm tumours safely and with faster postoperative recovery (LoE 2b).[65]

A large retrospective cohort study of 200 patients (LoE 4) concluded that surgeons skilled in advanced laparoscopy and adrenal surgery can perform laparoscopic adrenalectomy safely in patients with ≥5 cm tumours although operative time may be increased for ≥8 cm tumours.[62]

Chen *et al*.[66] in their observational study comparing retroperitoneal laparoscopic adrenalectomy and trans-abdominal laparoscopic adrenalectomy in 78 patients with tumours >5 cm have found comparable results.

Recent data shows robotic adrenalectomy to be useful in large tumours; it shortens operative time and decreases the rate of conversion to an open procedure. However, this is limited to centres where robotic technology is available and becomes a preferred mode of surgery for that group of surgeons.[59]

STATEMENT AND RECOMMENDATION

Statement

Trans-abdominal laparoscopic adrenalectomy can be offered to patients with large adrenal tumours by surgeons skilled in laparoscopic surgery (LoE 4).

Recommendation

Grade C

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16

Minimal Access Surgery for GI Cancers

The minimal invasive approach for intra-abdominal pathology, fathered by Kurt Semm, who performed the first laparoscopic appendectomy, has revolutionized the surgical therapy for gastrointestinal cancers and gained widespread acceptance after initial reports of successful laparoscopic assisted colectomy reported by Jacobs *et al*. in 1991.[1] The initial apprehensions of port site metastasis, tumour dissemination and low lymph node yield purportedly resulting in an inferior oncological outcome have been gradually allayed over the years after several large retrospective series and prospective trials[2,3] which demonstrated similar oncological outcomes with the advantage of less wound complications, less pain, a shorter length of stay, better cosmesis and palliation (bypass, creation of a diversion stoma, feeding jejunostomy or radiofrequency ablation) via the minimal invasive approach.

Technical advances in the form of NOTES, SILS and robotic surgery have carried laparoscopic surgery to new levels. LoE 1 has established the role of laparoscopy in colorectal surgery.[4] Commendable results have been noted with gastrointestinal stromal tumours (GISTs), oesophageal and pancreatic cancers. Total gastrectomy, pancreaticoduodenectomy and major hepatic resections are now being performed at specialized centres with good results. Newer techniques such as laparoscopic ultrasound (LUS) and NIR (near infrared) fluorescence imaging using ICG (indocyanine green) help in defining the vascularity of tumour and the anastomosis and aid in lymph node mapping further adding to the oncological benefit.

The guidelines and recommendations for the application of minimal access procedures for various cancers of the digestive system have been mentioned in this chapter. These recommendations were laid down by various groups working on specific cancers across the world and published on various platforms. The authors of this chapter evaluated and formulated the guidelines in the Indian context.

STAGING LAPAROSCOPY FOR GASTROINTESTINAL CANCERS

Laparoscopy along with conventional imaging techniques provides comprehensive assessment of the patient. While imaging gives an indirect evidence of underlying disease, laparoscopy by providing a direct view helps in assessment of the extent of the pathology, provides directed biopsy and aids in obtaining a cytological specimen either with peritoneal lavage or fine-needle aspiration techniques. Staging laparoscopy as a part of preoperative assessment is used for carcinoma of the oesophagus, stomach, pancreas and colorectum. Staging laparoscopy is vital in avoiding unwanted laparotomies in cases where imaging studies fail to identify metastatic or unresectable disease, especially in hepatobiliary cancers. Staging laparoscopy has a sensitivity of 66%–100% with a diagnostic accuracy of 87% for the lower oesophageal cancer and 100% for the biliarytract tumours.[5] In a prospective multi-institutional study by National Cancer Institute,[6] ultrasonography, computed tomography (CT), magnetic resonance imaging (MRI) and endoscopic ultrasound failed to identify 25% of metastatic disease identified by laparoscopy. LUS may be included as an adjunct during staging as it helps in identifying small lesions, guiding biopsies and allowing for assessment of tumour–vessel interface. Studies suggest that the application of LUS in cancer staging increases the accuracy by 5%–25%. The role of NIR fluorescence imaging using ICG (indocyanine green) for sentinel lymph node mapping is rapidly evolving.

General indications for staging laparoscopy[7]

Staging laparoscopy is used for preoperative assessment before major surgery. It is useful for documentation of hepatic, nodal or peritoneal involvement. It allows for the assessment of ascitic fluid or the fluid obtained after lavage. Evaluation of borderline resectable tumours after preoperative imaging and response to neoadjuvant or adjuvant therapy can be accomplished effectively.

Operating room (OR) setup

- OR should be equipped for administration of anaesthesia with full resuscitative and energy source support.
- An OT table that allows the patient to be placed in both full Trendelenburg and reverse Trendelenburg positions.

- The patient should be placed supine, prepared from nipple to mid-thigh.
- The surgeon stands on the opposite side of the pathology but may change position if required to access all the quadrants.
- Two video monitors should be available.
- The 10 mm 30° scope is better as it allows better light and view to approach bowel or viscera from different angles for requisite dissection.

Port placement

Laparoscope should be placed through a midline infraumbilical trocar site using a 10-mm trocar sleeve. One or two additional 5-mm trocars can be placed in each upper quadrant depending on the area to be examined.

Principles of evaluation and procedure[8]

The patient is placed in a steep Trendelenburg position and inspection of the pelvic peritoneum is performed for small peritoneal deposits. The patient can then be rotated to the right and left decubitus positions ('air planing' the table) and inspected for ascites. Any ascitic fluid needs to be aspirated and a note is made about the volume and sample sent for cytology. If no ascitic fluid is present, abdominal lavage can be performed with 500 ml of saline to obtain fluid for cytological examination but should be done before manipulation of the primary or metastatic tumour. All the fluid is aspirated and sent for evaluation for malignant cells. Assessment of the primary tumour for local extent, size, fixation and possible extension to contiguous organs is performed. The liver is inspected by placing the patient in the reverse Trendelenburg position, with the left side down and biopsy of any lesions on liver surface is performed. Laparoscopy can also identify the presence of the cirrhotic liver and its severity, which may also be a major contraindication to further resection. The patient is then re-positioned to 10º Trendelenburg position and colonic mesocolon is examined after retracting the omentum toward the left upper quadrant. This is done by elevating the transverse colon, which allows the ligament of Treitz to be identified. The mesocolon is carefully inspected and any suspicious nodules or nodes can be biopsied. Any lesions on the peritoneum or omentum can be biopsied.

Lesser sac can be examined after dividing the gastrocolicomentum and superior pancreatic area is inspected for evidence of local or regional pancreatic cancer. Gastrohepaticomentum can be divided to search for lymph nodes in the region of the subhepatic space and along the lesser curvature of the stomach.

With this technique, one can inspect the lymph nodes in the region of the left gastric and celiac vessels. Metal clips should be placed near positive nodes to facilitate planning of future radiation therapy. In pancreatic cancer, kocherization of the duodenum may be performed to allow biopsies of retroduodenal and other node-bearing areas. Intraoperative LUS may aid in assessment of the tumour. By using frequency probes ranging from 5 to 10 MHz, a high-resolution imaging of the liver, bile ducts, pancreas, abdominal vessels and lymph nodes can be obtained. A feeding jejunostomy tube can be placed for enteral feeding if needed. Before removing the ports, adequate hemostasis is ensured and fascia of ports more than 5 mm closed with an absorbable suture.

MINIMAL ACCESS SURGERY FOR OESOPHAGEAL CANCERS

The incidence of oesophageal cancer has been increasing dramatically over the past three decades with oesophagectomy forming an integral part of the treatment. The complex nature of the surgery and concerns regarding nodal and margin clearance, gastric tube necrosis and anastomotic failure have hindered the rapid adoption of minimal access techniques for this malignancy contrary to other gastrointestinal cancers. Oesophagus, a tubular organ of long length encompassing three compartments of the body, consequently has various surgical approaches with multiple possible patient positioning for the same. Various minimal invasive techniques include laparoscopic transhiatal oesophagectomy, thoracoscopic laparoscopic oesophagectomy (TLE) also known as MIE (total minimal invasive oesophagectomy), hybrid MIE – thoracoscopy and laparotomy or thoracotomy and laparoscopic, VATS-assisted oesophagectomy, video-assisted mediastinoscopic-transhiatal oesophagectomy combined with laparoscopy and robotic-assisted MIE.

The most commonly used techniques include:

- Thoracoscopic oesophagectomy in the prone position
- Total MIE/TLE in the left lateral decubitus position
- VATS-assisted oesophagectomy
- MIE in the semi-prone position
- Robot-assisted MIE

Role of staging laparoscopy

STATEMENT AND RECOMMENDATION

Statement

Minimal invasive staging laparoscopy is indicated in malignancy.

Recommendation

Advantages of minimal invasive surgical staging over conventional techniques are the improved assessment of locoregional disease and enhanced identification of distant metastases (LoE 3, Grade B).[9]

Minimal invasive oesophagectomy – benefits over open technique

STATEMENT AND RECOMMENDATION

Statement

MIE reduces chances of postoperative infections.

Recommendation

Short-term benefits of minimal invasive oesophagectomy for patients with resectable oesophageal cancer have been established in terms of fewer pulmonary infection in the first two weeks or in the hospital setting (LoE 1, Grade A).[10]

Short-term outcomes of minimal invasive oesophagectomy

STATEMENT AND RECOMMENDATION

Statement

MIE offers favourable short-term outcomes.

Recommendation

Minimal invasive oesophagectomy has superiority over open esophagectomy in terms of the occurrence of in-hospital mortality[11] (LoE 3) and a shorter length of stay, fewer pulmonary infections in the MIE group (LoE 1, Grade A).[12]

Non-inferiority of minimal invasive oesophagectomy

STATEMENT AND RECOMMENDATION

Statement

MIE has outcomes similar to open oesophagectomy.

Recommendation

Surgical approach has no significant impact on survival at any stage of disease. There is no statistically significant difference in oncological clearance by resection margins between procedures when compared by disease stage (LoE 3, Grade B).[13]

Thoracoscopic oeosphagectomy in prone position

STATEMENT AND RECOMMENDATION

Statement

Thoracospcopic oesophagectomy offers certain added advantages in prone position.

Recommendations

- Compared to the left lateral decubitus position, the prone position allows better operative exposure and improved surgeon ergonomics, resulting in reduced pulmonary complications, a shorter operation and less blood loss (LoE 3, Grade B).[14]
- MIE in the prone position preserves better oxygenation of patients during the early recovery period, and is associated with less blood loss and a larger number of dissected lymph nodes (LoE 3, Grade B).[15]

MIE in semi-prone position

STATEMENT AND RECOMMENDATION

Statement

Thoracoscopic oesophagectomy offers added advantages in semi-prone position.

Recommendation

MIE in semi-prone position has certain advantages over prone in terms of rapid conversion into classical thoracotomy when needed and better lymph node yield. However, semi-prone MIE has been associated with longer operative time without considerable differences regarding radical resections, postoperative complications and hospital stay (LoE 3, Grade B).[16]

VATS-assisted oesophagectomy

STATEMENT AND RECOMMENDATION

Statement

VATS-assisted oesophagectomy reduces incidence of complications.

Recommendation

The overall incidence of postoperative complications as well as the incidence of pulmonary complications is lower in the patients undergoing VATS-assisted MIE as compared to open oesophagectomy (LoE 3, Grade B).[17]

Extent of lymphadenectomy for oesophageal cancer

STATEMENT AND RECOMMENDATION

Statement

The surgical strategy is decided on the nodal distribution pattern.

(continued)

Extent of lymphadenectomy for oesophageal cancer

STATEMENT AND RECOMMENDATION

Recommendations

- Lymph node status has been found to be an independent predictor of survival (LoE 3, Grade B).[18]
- Meta-analysis has shown that 3-field lymphadenectomy improves overall survival rate but has more complications in terms of recurrent nerve palsy and anastomosis leak (LoE 2, Grade B).[19]
- In squamous cell carcinoma, a 3-field lymph node dissection should be done (LoE 2, Grade B).[19]
- For adenocarcinoma, Siewert I and adenocarcinomas located in the thoracic oesophagus, an extended or total lymphadenectomy (3-field) should be done (LoE 3, Grade B).[20]
- For type II, a 2-field lymphadenectomy should be done (abdominal and mediastinal lymph nodes up to level of carina) (LoE 3, Grade B).[21]
- A transthoracic procedure enables a more extensive lymphadenectomy as compared to transhiatal (LoE 2, Grade B).[22]
- Minimum number of nodes to be resected in T1, T2 and T3 tumours should be 10, 20 and 30 lymph nodes, respectively (LoE 3, Grade B).[23]

Learning curve associated with MIE

STATEMENT AND RECOMMENDATION

Statement

MIE has its own learning curve.

Recommendation

MIE is associated with a steep learning curve with a minimum of 30 cases required (LoE 3, Grade B).[24]

Robotic minimal invasive oesophagectomy

STATEMENT AND RECOMMENDATION

Statement

Robotic MIE offers its own advantages.

Recommendation

Robotic MIE has advantages in better reduction in the incidence of recurrent laryngeal nerve palsy and hoarseness (LoE 3)[25] and lymph node yield (LoE 2, Grade B).[26]

MINIMAL ACCESS SURGERY IN GASTRIC CANCER

Laparoscopic radical gastrectomy with nodal dissection has widely penetrated the East Asian countries where the incidence of gastric cancer is higher than the rest of the world. Laparoscopic distal gastrectomy for stage I disease is regarded as one of the options in the latest Japanese guidelines, however, its applicability to more advanced disease (stage II/III) is still under debate.

While the operative technique of laparoscopic D2 dissection is getting standardized, the necessity and laparoscopic application of total omentectomy, splenic hilar dissection, management of bulky nodes or large primary tumour and need for an oesophageal anastomosis in the chest when indicated and extensive peritoneal lavage can be considered technical limitations.

Further technological innovations including the next generation surgical robots may help overcome these difficulties for the surgeons. Currently, three large-scaled randomized phase 3 clinical trials are ongoing in East Asia and the accrual of patients has already completed. The results and long-term outcomes of these well-designed studies will validate the oncological adequacy of the laparoscopic approach.

Laparoscopic-assisted distal gastrectomy (LADG)

STATEMENT AND RECOMMENDATION

Statement

LADG offers nearly similar benefits as open gastrectomy.

Recommendation

LADG is associated with a similar or lower morbidity and better short-term outcomes compared to open distal gastrectomy. Owing to the literature evidence of oncological adequacy, LADG is indicated for early gastric cancer and is being routinely practised in South Korea and Japan for these early lesions. These results, however, largely represent the Eastern experience and cannot be extrapolated to patients with advanced tumours. Significant limitations exist to draw definitive conclusions for all gastric cancers and for oncological adequacy of laparoscopic D2 lymphadenectomy. The limited number of published randomized controlled trials, the small sample sizes to date and the limited duration of follow up does not make it possible to indicate the use of LADG as a recommended procedure for every gastric cancer (LoE 1b, Grade A).[27]

Laparoscopic-assisted total gastrectomy (LATG)

STATEMENT AND RECOMMENDATION

Statement

LATG is a complex procedure.

Recommendation

The acceptance of laparoscopic-assisted total gastrectomy (LATG) as an alternative to the open approach is limited, essentially due to its technical complexity. There is a particular concern about the complexity involved in reconstruction of the alimentary tract, such as oesophago-jejunal anastomosis and its attending potentially serious complications (LoE 1b, Grade A).[27]

Omentectomy vs bursectomy

STATEMENT AND RECOMMENDATION

Statement

Omentectomy has oncological value in curative treatment of gastric cancer.

Recommendations

- Bursectomy has been conventionally considered an integral part of D2 radical gastrectomy for gastric cancer owing to the concept of oncological adequacy particularly for posterior wall tumours, based on the theoretical rationale of reducing the risk of peritoneal recurrences by removing the peritoneum which might contain micrometastases (LoE 1b, Grade A).[27]
- No survival difference between omentectomy versus bursectomy for T3/T4 tumours has been shown recently, though, bursectomy is not related with increased morbidity or mortality. Bursectomy is not being recommended as a standard procedure for advanced gastric cancer (AGC) in Japan now. Performing a complete bursectomy was considered technically challenging while total omentectomy does not seem impossible for experienced laparoscopic surgeons. Total omentectomy and not bursectomy may become a standard component of the laparoscopic radical operation for AGC (LoE 1b, Grade A).[27]

Splenic hilar dissection for proximal gastric cancer

STATEMENT AND RECOMMENDATION

Statement

Role of splenic hilar dissection for proximal gastric cancer is controversial.

(continued)

Splenic hilar dissection for proximal gastric cancer

STATEMENT AND RECOMMENDATION

Recommendation

There is a growing consensus that complete lymph nodal dissection of the splenic hilum may not be required for most of the proximal AGCs. Laparoscopy may not be a limitation in performing the radical operation for gastric cancer in that sense. With the advances in imaging technology and availability of 3D CT, laparoscopic surgery has the potential to be the appropriate modality in the selective cases where splenic hilar dissection is required, since it can negotiate the issues of the deeper cavity and the complicated anatomy with better visualization and access (LoE 1b, Grade A).[27]

Bulky positive nodes or large primary tumour

STATEMENT AND RECOMMENDATION

Statement

Laparoscopy for bulky positive nodes and large primary tumour is technically complex.

Recommendation

Laparoscopic procedure has a limitation to manage tumours with bulky nodal disease or large primary tumours (type 3 tumours >8 cm or type 4) with concerns of spillage of cancer cells by manipulation with endoscopic instruments. The loss of tactile sensation, crucial for a surgical procedure in such cases, is an important limitation of laparoscopic procedure compared to open surgery in such a situation. Neoadjuvant chemotherapy using newer regimens is under investigation by several prospective clinical studies. Laparoscopic surgery for patients treated with neoadjuvant chemotherapy in advanced gastric cancers may be a technically demanding operation in the presence of unusual tissue fibrosis and oedema (LoE 2, Grade B).[27]

Outcome of laparoscopic procedures for gastric cancer

STATEMENT AND RECOMMENDATION

Statement

Outcomes of laparoscopic procedures for gastric cancer are favourable.

Recommendation

The available data on long-term outcomes comes from retrospective clinical studies that include small- and medium-sized samples from both western and eastern countries. Majority of the studies have reported that laparoscopic surgery is associated with less blood loss, faster recovery of patients, less pain, shorter hospital stay and longer operating time (LoE 1b, Grade A).[27]

Future perspectives

STATEMENT AND RECOMMENDATION

Statement

Future trends in management of gastric cancer by minimal invasive approach are encouraging.

Recommendation

The final results of phase 3 trials are awaited. The outcomes in terms of survival and patterns of recurrences after laparoscopic surgery need to be determined. Surgical techniques are going to get refined with time and the availability of improved imaging, better visualization and improved dexterity with robotic systems are expected to shorten the learning curve and circumvent the existing limitations and make laparoscopy also suitable for advanced gastric cancers requiring surgery (LoE 2, Grade B).[27]

LAPAROSCOPY FOR GASTROINTESTINAL STROMAL TUMOURS (GISTS)

STATEMENT AND RECOMMENDATION

Statement

Primary GIST of stomach can be safely managed laparoscopically.

Recommendation

GISTs are the most common mesenchymal tumours of the gastrointestinal tract and most commonly found in the stomach. Surgical resection of the primary gastric GISTs with complete resection margin has been the forefront of curative treatment. The indications for surgical resection are usually related to symptomatic gastric GISTs at presentation. Primary gastric GISTs resection performed conventionally through an open surgery can now be frequently achieved by minimal invasive surgery with similar oncological outcome (LoE 1b, Grade A).[28]

Statement

Tumour factor in GIST determines the choice of approach.

Recommendations

- Surgeon's selection of the type of surgical techniques such as open, laparoscopic and endoscopic resections depends on the site, size and local invasion of gastric GISTs to the adjacent organ. These factors also dictate the extent of gastric resections in the form of wedge, partial or total gastrectomy. These tumour factors (size and mitotic index), patient factors (older age, male) and surgical factors (incomplete resection margin, tumour rupture or spillage) play an important role in stratifying the malignant potential risk of primary gastric GISTs and their chances of recurrence (LoE 1b, Grade A).[28]
- Prognosis is mainly based on tumour size and histological features rather than wide resection margins which make laparoscopic resection more popular for GIST treatment (LoE 1b, Grade A).[28]
- The laparoscopic approach is safe and feasible for the treatment of gastric GISTs with regards to short and long-term outcome. In selective patients, the laparoscopic approach is preferable over open for its minimal invasive advantages (LoE 1b, Grade A).[28]

LAPAROSCOPY FOR GALLBLADDER CARCINOMA

Gallbladder carcinoma (GBC), though a rare malignancy, has a high incidence in India and is a considerable source of mortality. Natural biology of carcinoma gallbladder is very aggressive and has overall poor outlook with most patients presenting in advanced stages of the disease. The primary concerns, which led to a preliminary nihilistic approach to laparoscopy, included the feasibility of achieving an adequate hepatectomy and lymphadenectomy, the risk of intraoperative peritoneal dissemination, and possible port site recurrences. It has been recently realized that, if correctly performed, it may be an elective approach for primary early cases and a feasible tool for radical re-resection of incidental cases. Guidelines for GBC have been presented by the American Hepato-Pancreato-Biliary Association (AHPBA)-sponsored consensus meeting of expert panellists which are mentioned as follows.[29]

Staging laparoscopy (SL)

STATEMENT AND RECOMMENDATION

Statement

Staging laparoscopy (SL) is beneficial in gallbladder cancer.

Recommendations

- The minimum staging evaluation of patients with suspected or proven GBC includes contrasted cross-sectional imaging and diagnostic laparoscopy.
- Although carcinoma gallbladder is a relatively uncommon disease worldwide, it is a common cancer in North India and is a source of considerable mortality.
- SL helps in detection of radiological occult metastasis avoiding unnecessary non-therapeutic laparotomy.
- SL should be considered prior to laparotomy, particularly in patients with T3 tumours and adverse pathological characteristics (LoE 2, Grade B).
- Routine port site excision is not indicated (LoE 3, Grade B).
- The overall yield of SL in carcinoma gallbladder is 27% with a sensitivity of 64% (LoE 1, Grade A).

(continued)

Staging laparoscopy (SL)

STATEMENT AND RECOMMENDATION

Recommendations

- Overall yield of SL in locally advanced GBC (25%) is significantly higher than in early GBC (10%), the accuracy of SL for unresectable disease (56%), in locally advanced GBC, however, is similar to early GBC tumours (54%). Hence SL has an equally important role in both the groups (LoE 2, Grade A).
- The sensitivity of SL can be further improved by intraoperative US (LoE 1, Grade 1B)[1] and routine intraoperative interaortocaval lymph node biopsy and frozen section (LoE 2, Grade 1B).

Resectional surgery

STATEMENT AND RECOMMENDATION

Statement

Minimal invasive resectional surgery for gallbladder cancer is technically complex with variable stage-wise outcomes.

Recommendations

- The benefits of performing a laparoscopic resection include accomplishing the procedure with similar radicality both in terms of adequate liver resection and locoregional lymphadenectomy with all the benefits of the minimal access approach including less pain, early ambulation, decreased would-related complications and a cosmetic scar. A careful patient selection and proper surgical techniques such as minimal tumour handling, avoidance of bile spillage and the use of a protective bag for specimen extraction, early oncological outcomes comparable to the open procedure can be achieved and the benefits of a minimal invasive procedure can be provided to the patients (LoE 3, Grade 1C).
- Laparoscopic radical cholecystectomy is a technically complex procedure and should be performed only in centres with sufficient experience in advanced laparoscopic hepatobiliary surgery (LoE 4, Grade C).

(continued)

Resectional surgery

STATEMENT AND RECOMMENDATION

Recommendations

- For many years, laparoscopic surgery in GBC patients was considered contraindicated. It has been recently realized that, if correctly performed, it may be an elective approach for primary early cases (pT1a, pT1b, and pT2) and a feasible tool for radical re-resection of incidental cases. Survival rate for GBC patients is strictly related to parietal invasion depth of the tumour. Simple cholecystectomy may be an adequate treatment for earlier stages (pTis and pT1a). Radical cholecystectomy, including hepatic resection with regional lymphadenectomy, is recommended for pT1b and later-stage carcinomas as long as a curative resection can be performed (LoE 1b, Grade A).
- Minimal invasive GBC resections should be limited to early T-stage patients treated by expert surgeons who have demonstrated outcomes using this approach that are oncologically equivalent to those of open surgery (LoE 4, Grade C).
- Adequate lymphadenectomy includes intraoperative assessment of any suspicious regional nodes, evaluation of the aortocaval nodal basin and the recovery of at least six nodes. Patients with confirmed metastases to N2 nodal stations do not benefit from radical resection and should receive systemic and/or palliative treatments (LoE 2, Grade B).
- Patients with incidentally identified T1b, T2 or T3 disease in a cholecystectomy specimen should undergo re-resection with a goal of R0 resection and should include excision of all lymph nodes in the hepatoduodenal ligament (LoE 1b, Grade A).
- Extended lymph node dissection is not routinely indicated. Major hepatectomy and/or bile duct resection is not routinely indicate unless these are required to achieve an R0 margin (LoE 2, Grade B).
- Particularly in areas of high incidence, routine gallbladder specimens should be pathologically assessed and the minimum examination should include the microscopic evaluation of three sections and the cystic duct margin.

(continued)

Resectional surgery

STATEMENT AND RECOMMENDATION

Recommendations

- During the initial analysis, a finding of high-grade dysplasia, hyalinizing cholecystitis and/or neoplastic polyps should prompt the complete sampling of the entire gallbladder specimen to accurately stage any associated invasive malignancy.
- Gallbladder specimens with proven cancer should be extensively sampled and prognostic factors determined, including microscopic depth of tumour invasion, tumour involvement of the cystic duct margin, involvement of Rokitansky–Aschoff sinuses and serosal versus hepatic surface involvement.

LAPAROSCOPIC LIVER RESECTION FOR HEPATOCELLULAR CARCINOMA

Laparoscopic liver resection is now being increasingly performed and has become an accepted modality. There have been two international consensus conferences where experts worked up guidelines to standardize the laparoscopic approach for liver resections and improve its safety. Most resections have been performed for patients with liver metastases. The concurrent presence of liver cirrhosis with hepatocellular carcinoma (HCC) pose a great challenge to clinicians trying to establish a routine use of laparoscopic liver resections for HCC. More than 9000 cases have been published in the form of various case series, reviews and meta-analysis. Many specialized centers of liver cancer management are now entering the exploration and assessment phase.

The first Asia Pacific consensus meeting for HCC was held in conjunction with the 7th Asia-Pacific Primary Liver Cancer Expert Meeting in Hong Kong in order to achieve the goals of defining the role of laparoscopic liver resection in HCC management and developing recommendations and guidelines. In this consensus meeting, the expert panel made 22 recommendations on the position of laparoscopic hepatectomy for HCC. These recommendations consolidate the latest evidence pertaining to HCC treatment and provide detailed guidelines on how to deploy laparoscopic liver resection effectively for this group of patients. Most of the evidence gathered was LoE 3 and 4. Currently, there is no LoE 1 and 2 evidence for laparoscopic resection for HCC and further high-quality research is needed to conclude the growth of laparoscopic liver resection. The consensus recommendations as drawn by this expert group are mentioned underneath.[30]

Evidence on laparoscopic liver resection for HCC

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic liver resection in HCC is beneficial with marginal liver function.

Recommendations

- Laparoscopic minor liver resection for early stage (≤T2) HCC located in segment 2, 3, 4b, 5 or 6 is a safe option in centres with experience (LoE 3, Grade B).
- Laparoscopic minor liver resection in difficult locations – 1, 4a, 7, 8 (difficulty score intermediate grade or above) – should be performed in centres of excellence (LoE 3, Grade B).
- Laparoscopic major hepatectomy (more than three segments) is an operation with high complexity and should be carried out in centres of excellence. Further evidence will support the development of this practice (LoE 3, Grade B).

Patient selection for laparoscopic hepatectomy for HCC

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic liver resection in HCC is beneficial with marginal liver function.

Recommendations

Liver function evaluation

- Selection of patients for laparoscopic liver resection for HCC in terms of liver function should be the same as in open liver resection (LoE 3, Grade B).
- Laparoscopic liver resection for HCC is reported to be better tolerated in patients with marginal liver function (LoE 3, Grade B).

Patient selection for laparoscopic hepatectomy for HCC

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic resection is considered on the basis of tumour size and tumour location.

Recommendations

Tumour size consideration

- Laparoscopic liver resection for HCCs ≤5 cm in favourable locations is a safe procedure incenters with experience (LoE 3, Grade B).
- Laparoscopic liver resection for HCCs >5 cm should only be carried out in centres of excellence (LoE 4, Grade C).
- Laparoscopic liver resection is not usually indicated for HCCs >10 cm. Patients should be carefully selected and the resection should be performed only in centres of excellence (LoE 4, Grade C).

Tumour location, anatomical resection versus non-anatomical resection

STATEMENT AND RECOMMENDATION

Recommendations

- Laparoscopic wedge liver resection for small (<2 cm) peripheral HCCs is the preferable surgical option (LoE 3, Grade B).
- Laparoscopic anatomical liver resection (including monosegmentectomy and subsegmentectomy) is generally recommended for patients with HCC (LoE 3, Grade B).

The role of laparoscopic liver resection versus radiofrequency ablation

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic liver resection offers benefits over RFA.

Recommendations

- The effectiveness of laparoscopic liver resection is comparable to that of radiofrequency ablation, with a lower recurrence rate in patients with small HCCs (LoE 3, Grade B).
- Laparoscopic liver resection minimizes the risk of local intrahepatic recurrence, which can result from pre-existing microscopic tumour foci or tumour dissemination by radiofrequency ablation (LoE 3, Grade B).
- Laparoscopic liver resection is favoured in patients with peripheral HCCs in segments 2–6 and/or when a histological assessment is desirable (LoE 4, Grade C).

Learning curve of laparoscopic liver resection for HCC

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic liver resection has a learning curve.

Recommendations

- The difficulty scoring system is useful for evaluation of the operation difficulty of laparoscopic liver resection for HCC (LoE 3, Grade B).
- Laparoscopic liver resection for HCC classified into high and intermediate difficulty should be performed in centres of excellence (LoE 4, Grade C).
- It is necessary to gradually improve skills according to the difficulty level (LoE 4, Grade C).

The use of augmented laparoscopic technology, robots and other adjuncts in hepatectomy, indocyanine green fluorescence and 3D laparoscopy

STATEMENT AND RECOMMENDATION

Statement

Augmented laparoscopic technology may add a value to hepatic resection.

Recommendations

- Indocyanine green fluorescence is a promising technology that may have a value on laparoscopic liver resection for HCC (LoE 4, Grade C).
- 3D laparoscopy is a useful adjunct that may enhance surgeons' performance in laparoscopic liver resection for HCC (LoE 4, Grade C).

Robotic-assisted hepatectomy

STATEMENT AND RECOMMENDATION

Statement

Staging laparoscopy in hilar cholangio carcinama may have a role in detecting liver/peritoneal metastasis.

Recommendations

- The feasibility and safety of robotic minor/major resection for HCC have been demonstrated with trained surgeons and appropriate patient selection (LoE 3, Grade B).
- The robotic approach may have a role in treating HCC in difficult segments and bring about a higher rate of major hepatectomy in some centres (LoE 3, Grade B).
- Comparative studies have not shown any significant differences in the short-term outcomes brought by the laparoscopic approach (LoE 3, Grade B) and evidence is needed to define its long-term oncological outcomes for HCC.

The use of haemostatic agents

STATEMENT AND RECOMMENDATION

Recommendation

Further evidence is required to support the use of haemostatic agents for laparoscopic liver resection for HCC with cirrhosis (LoE 4, Grade C).

LAPAROSCOPIC LIVER RESECTION FOR HILAR CHOLANGIOCARCINOMA

STATEMENT AND RECOMMENDATION

Statement

Laparoscopy is comparable to open surgery for intrahepatic carcinoma.

Recommendation

Staging Laparoscopy

Hilar cholangiocarcinoma is a rare disease with a dismal prognosis. Radical surgery consisting of a combined extrahepatic bile duct and partial liver resection is the only curative treatment. Despite various imaging techniques used for preoperative staging including the latest generation CT or MRI scans, up to half of the patients have locally advanced or metastatic disease at surgical exploration. Staging laparoscopy (SL) prior to exploration may detect small liver metastases or peritoneal metastases that are frequently undetectable on routine CT or MRI scans. Additional SL may therefore prevent unnecessary laparotomy and associated postoperative morbidity. The overall sensitivity of SL to detect unresectability is relatively low (~50%), however, sensitivity for liver and peritoneal metastases is reasonable (77%–80%). As the yield and sensitivity of SL may decrease over years with further improvement of preoperative imaging techniques, the utility of this additional staging modality may further diminish, thereby discouraging its routine use (LoE 3, Grade B).[31]

STATEMENT AND RECOMMENDATION

Recommendation

Resectional Surgery

Laparoscopic resection in patients with intrahepatic carcinoma (ICC) is feasible and safe. Regarding oncological adequacy, as R0 resections, depth of margins and long-term overall and disease-free survival, laparoscopy is comparable to open procedures for ICC. An adequate patient selection is required to obtain optimal results. Use of laparoscopy in perihilar carcinoma (PHC) has not gained popularity. Further studies are still needed to confirm the benefit of this approach over conventional surgery for PHC (LoE 3, Grade B).[31]

LAPAROSCOPIC PANCREATIC SURGERY (LAPS)

First introduced in the mid 1990s, laparoscopic pancreatic surgery (LAPS) developed slowly, presumably due to anatomic complexity of the region and high postoperative morbidity involved. Although initially considered for staging purposes only, increasing experience in laparoscopy enabled the application of LAPS for more advanced procedures. Laparoscopic pancreatic surgery includes laparoscopic distal pancreatectomy (LDP), pancreatoduodenectomy (LPD), enucleation, central pancreatectomy and ultrasound. LAPS is currently in its development and exploration stages. LDP is feasible and safe and is being performed in many centres, while LPD is limited to few centres. An international panel of experts assembled on the basis of their clinical and scientific expertise in laparoscopic and open pancreatic surgery at the European association for endoscopic surgery clinical consensus conference. The recommendations of the EAES Consensus Conference Study Group are mentioned underneath.[32]

Distal pancreatectomy

STATEMENT AND RECOMMENDATION

Statement

LDP is a safer alternative to the open procedure and retains all the benefits of laparoscopy.

(continued)

Distal pancreatectomy

STATEMENT AND RECOMMENDATION

Recommendation

Laparoscopic distal pancreatectomy is a feasible and safe alternative to open approach in the treatment of benign and malignant pancreatic lesions, providing advantages in terms of reduced blood loss and enhanced postoperative recovery resulting in shorter hospital stay (LoE 3, Grade B).

Statement

Lap/open tech of stump closure does not impact formation of pancreatic fistula.

Recommendation

The rate of pancreatic fistula is similar after laparoscopic and open distal pancreatectomy, independent from the technique of pancreatic stump closure (LoE 3, Grade B).

Statement

Spleen preserving LDP has advantage over Warshaw's technique in preventing spleenic infarct in benign lesions.

Recommendations

- Spleen-preserving laparoscopic distal pancreatectomy can be considered in patients with benign tumours (LoE 3, Grade B).
- Spleen-preserving laparoscopic distal pancreatectomy with preservation of splenic vessels seems to be advantageous over the Warshaw's technique in terms of postoperative outcomes, particularly splenic infarction (LoE 3, Grade B).

Statement

Quality of life index is better in LDP compared to open procedure.

Recommendation

Laparoscopic distal pancreatectomy is associated with the significantly better quality of life compared to the open approach (LoE 2b, Grade B).

(continued)

Distal pancreatectomy

STATEMENT AND RECOMMENDATION

Statement

Feasibility and safety of LDP in PNET is well established.

Recommendation

Laparoscopic distal pancreatectomy is feasible and safe in patients with pancreatic neuroendocrine tumours providing satisfactory postoperative and oncological outcomes (LoE 3, Grade B).

Statement

Short-term and long-term oncological outcomes are similar in LDP versus open technique for pancreatic ductal adenocarcinoma.

Recommendation

Laparoscopic distal pancreatectomy is feasible and safe in patients with pancreatic ductal adenocarcinoma, providing favourable outcomes in terms of estimated blood loss and hospital stay when compared with open technique. Short- and long-term oncological outcomes are similar (LoE 3, Grade B).

Statement

Radical pancreatospleenectomy is possible through laparoscopically for the treatment of pancreatic ductal adenocarcinoma.

Recommendation

Laparoscopic radical antegrade modular pancreatosplenectomy is feasible for the treatment of pancreatic ductal adenocarcinoma. Currently, the choice of surgical technique should be left to the surgeon's discretion (LoE 4, Grade C).

(continued)

Distal pancreatectomy

STATEMENT AND RECOMMENDATION

Statement

Extended LDP has surgical outcome similar to standard procedure.

Recommendation

Extended laparoscopic distal pancreatectomy (defined by the International Study Group for Pancreatic Surgery) is associated with surgical outcomes similar to standard procedure. Despite decreased survival compared with the standard procedure, it may still be of use in selected patients with tumours extending beyond the pancreas (LoE 4, Grade C).

Statement

LDP procedure has a steeper learning curve.

Recommendation

A significant reduction in operative time during laparoscopic distal pancreatectomy can be obtained after 10–17 procedures. Other possible indicators for learning curve are conversion rate and intraoperative blood loss (LoE 3, Grade B).

Statement

Cost is comparable for LDP procedure versus open technique.

Recommendation

Laparoscopic distal pancreatectomy is associated with higher operative costs and lower postoperative costs compared with open technique resulting in comparable cost for both procedures (LoE 3, Grade B).

Laparoscopic pancreaticoduodenectomy

STATEMENT AND RECOMMENDATION

Statement

Indications for LDP remain the same as those for the open approach in the hands of experts.

Recommendation

For surgeons who are highly experienced in laparoscopic pancreatoduodenectomy, indications are the same as for open pancreatoduodenectomy (LoE 3, Grade B).

Statement

LPD has many advantages over open except for longer operative time.

Recommendation

LPD seems to be advantageous over open approach in terms of blood loss, rate of delayed gastric emptying and hospital stay, but results in longer operative time. It also provides better quality of life within the first 6 months after surgery (LoE 4, Grade C).

Statement

Short-term oncological outcome and survival are comparable.

Recommendation

Short-term oncological outcomes (harvested lymph nodes/positive resection margins) and survival are comparable between laparoscopic and open pancreatoduodenectomy (LoE 3, Grade B).

Statement

LPD procedure has longer a learning curve.

Recommendation

LPD becomes a standardized procedure after performing 30–60 procedures. Operation time, intraoperative blood loss, conversion, postoperative complication rate and length of hospital stay are the indicators for learning curve assessment (LoE 4, Grade C).

Laparoscopic pancreatic enucleation

STATEMENT AND RECOMMENDATION

Statement

Indications and results of laparoscopic pancreatic enucleation are similar to open.

Recommendations

- Indications for laparoscopic pancreatic enucleation do not differ from those in open surgery (LoE 3, Grade B).
- Although the results of laparoscopic and open enucleation are similar, laparoscopy results in reducing the operative time, blood loss and postoperative pain (LoE 3, Grade B).

Laparoscopic central pancreatectomy

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic central pancreatectomy can be done safely in selected patients.

Recommendation

Laparoscopic central pancreatectomy is feasible and safe in selected patients with small benign and low-grade malignant lesions in the pancreatic neck and proximal body (LoE 3, Grade B).

Laparoscopic vs robotic pancreatic surgery

STATEMENT AND RECOMMENDATION

Statement

Robotic pancreatic surgery has no added advantages over the laparoscopic approach.

Recommendations

- Robotic distal pancreatectomy does not seem to be advantageous over laparoscopic approach in terms of surgical and oncological outcomes (LoE 3, Grade B).
- Robotic pancreatoduodenectomy is a new technology that does not provide any clear benefit over laparoscopic pancreatoduodenectomy. Its role should be estimated in further studies (LoE 3, Grade B).

Intraoperative laparoscopic ultrasound

STATEMENT AND RECOMMENDATION

Statement

Intraoperative LUS has a role in pancreatic surgery.

Recommendation

Compared with preoperative imaging, intraoperative LUS is an efficient tool, essential in the setting of laparoscopic pancreatic surgery (LoE 4, Grade C).

LAPAROSCOPIC SURGERY FOR COLORECTAL CANCER

Colorectal cancer (CRC) is one of the most common malignancies and a leading cause of death worldwide with rectal cancer being the most common site.[33,34] In India, the incidence rates for colorectal cancer are 4.3 and 3.4 per 100,000 in men and women, respectively.[35] The first laparoscopic colonic cancer resection was performed in 1991. For a long time later, laparoscopic colorectal cancer resections especially rectal cancer resections remained a matter of debate and controversy. There were initial concerns regarding potential violation of oncological principles, the effects of carbon dioxide insufflation, atypical patterns of recurrence and the phenomenon of port site tumour recurrence. With large multicentric trials demonstrating that these concerns were unjustified, the laparoscopic approach has become the modality of choice in many centres of the world. It does, however, have a steep learning curve requiring advanced surgical skills and experience.

The guidelines mentioned underneath were written by SAGES and approved by the American Society of Colon and Rectal Surgeons (ASCRS).

- Abdominal, pelvic and chest CT (LoE 1, Grade A).

Staging and tumour localization

STATEMENT AND RECOMMENDATION

Statement

Tumour localization should be done endoscopically either in preoperative period or during intraoperative period.

Recommendations

- Should include an assessment of the completeness of surgical resection designated by residual tumour code R (LoE 1, Grade A).
- Every effort should be made to localize the tumour preoperatively. Small lesions should be marked endoscopically with permanent tattoos before surgery to maximize the surgeon's ability to identify the lesion. Surgeons should be prepared to use colonoscopy intraoperatively if lesion localization is uncertain (LoE 1, Grade A).

Diagnostic evaluation for metastases

STATEMENT AND RECOMMENDATION

Statement

Different radiological modalities are required for diagnostic evaluation and staging of colorectal cancer.

Recommendation

For patients with colon or rectal cancer, the chest, abdomen and pelvis should be evaluated preoperatively with CT scan. In patients with rectal cancer, preoperative locoregional staging with endorectal ultrasound or MRI is also recommended (LoE 1, Grade A).

Preparation for operation

STATEMENT AND RECOMMENDATION

Statement

Mechanical bowel preparation (MBP) helps in intraoperative bowel handling and colonoscopy.

Recommendation

Preoperative MBP should be used to facilitate manipulation of the bowel during the laparoscopic approach and to facilitate intraoperative colonoscopy when needed (LoE 1b, Grade A).

Laparoscopic approach

STATEMENT AND RECOMMENDATION

Statement

Minimal invasive colectomy is safer in the hands of experts.

Recommendation

When expertise is available, a minimal invasive approach to elective colectomy should be preferred (LoE 1, Grade A).

Surgical technique: Colon

STATEMENT AND RECOMMENDATION

Statement

It is safer to perform laparoscopic resection of colonic malignancy following standard oncological principles.

Recommendation

Laparoscopic resection following standard oncological principles: proximal ligation of the primary arterial supply to the segment harbouring the cancer, appropriate proximal and distal margins, and adequate lymphadenectomy should be performed (LoE 1, Grade A).

Surgical technique: Rectum

STATEMENT AND RECOMMENDATION

Statement

Laparoscopic TME can be done safely following standard oncological principles.

Recommendation

Laparoscopic resection for rectal cancer follows standard oncological principles: adequate distal margin, ligation at the origin of the arterial supply for the involved rectal segment and mesorectal excision should be performed (LoE 1, Grade A).

Contiguous organ attachment

STATEMENT AND RECOMMENDATION

Statement

En block resection of locally advanced colorectal malignancy can be approached laparoscopically with low threshold for conversion.

Recommendation

For locally advanced adherent colon and rectal tumours, an *en bloc* resection is recommended. An open approach if a laparoscopic *en bloc* resection cannot be performed adequately should be undertaken (LoE 1b, Grade A).

Extended lymphadenectomy

STATEMENT AND RECOMMENDATION

Statement

Extended lymphadenectomy is not recommended routinely.

Recommendation

Routine extended lymphadenectomy is not recommended (LoE 1b, Grade A).

Obstructing Colon Cancer (right-sided)

STATEMENT AND RECOMMENDATION

Statement

There should be low threshold for conversion in obstructing right colonic cancer when oncological safety is questionable.

Recommendation

Patients with an obstructing right or transverse colon cancer should undergo a right or an extended right colectomy. The open approach is required if the laparoscopic approach will not result in an oncologically sound resection (LoE 2b, Grade B).

Obstructing colon cancer (left-sided)

STATEMENT AND RECOMMENDATION

Statement

Colonic stenting in left-sided constricting colonic cancer increases the chances of single-stage procedure and decreases the rate of end colostomy.

Recommendation

For patients with an obstructing left-sided colon cancer, the procedure should be individualized according to clinical factors. Colonic stenting may increase the likelihood of completing a single-stage procedure and may decrease the likelihood of an end colostomy (LoE 2b, Grade B).

Prevention of wound complications

STATEMENT AND RECOMMENDATION

Statement

Port-site metastasis can be prevented by wound protector.

Recommendation

The use of a wound protector at the extraction site and irrigation of port sites and extraction site incisions may reduce abdominal wall cancer recurrences (LoE 2b, Grade B).

Robotic surgery

STATEMENT AND RECOMMENDATION

Statement

Robotic surgery for colorectal cancer is safe but without any added advantage.

Recommendation

While robotic surgery for colon and rectal cancer appears feasible and safe, in the absence of long-term oncological outcome studies, no clear recommendation can be made (LoE 4, Grade C).

Training and experience

STATEMENT AND RECOMMENDATION

Statement

Colorectal cancer surgery is technically demanding; the surgeon should have sound knowledge and enough experience.

Recommendation

Before they adopt the laparoscopic approach for resection of curable colon and rectal cancer, surgeons must have adequate knowledge, training and experience in laparoscopic techniques and oncological principles (LoE 1a, Grade A).

Preoperative localization

STATEMENT AND RECOMMENDATION

Statement

Smaller lesions should be localized endoscopically.

Recommendation

Every effort should be made to localize the tumour preoperatively before embarking on the laparoscopic colorectal cancer resections. Use of endoscopic tattooing before surgery for smaller lesions and intraoperative colonoscopy for doubtful lesions should be considered.[36–38]

Staging laparoscopy for colorectal cancer

STATEMENT AND RECOMMENDATION

Recommendations

- Though seldom useful in treatment of primary colorectal cancer, staging laparoscopy may be useful in patients with resectable liver metastatic disease from colorectal cancer to rule out extra hepatic metastasis not detected on cross-sectional imaging.
- However, owing to low yield of staging laparoscopy and/or LUS (19%) with overall sensitivity of 59% as shown by a recent meta-analysis, staging laparoscopy is not universally recommended in staging patients with potentially resectable colorectal liver metastasis.[39]

Laparoscopic surgery for carcinoma colon

STATEMENT AND RECOMMENDATION

Statement

Minimal invasive colectomy for colon cancer is preferred by experts in elective setting.

Recommendations

- When expertise is available, a minimal invasive approach to elective colectomy for colon cancer is preferred (LoE 1a, Grade A).
- Several large multi-institutional randomized trials with experienced surgeons have demonstrated equivalent oncological outcomes including overall and recurrence-free survival rates after laparoscopic procedures compared with open surgical resection of localized colon cancer.[40–43]
- Laparoscopic resection should follow standard oncological principles: Proximal ligation of the primary arterial supply to the segment harbouring the cancer, appropriate proximal and distal margins and adequate lymphadenectomy.

(continued)

Laparoscopic surgery for carcinoma colon

STATEMENT AND RECOMMENDATION

Recommendations

Four large, multicentric trials following standardized oncological principles showed no significant difference in proximal and distal margins, number of lymph nodes retrieved between laparoscopy and open groups. They also showed that long-term survival and recurrence were no different for patients treated with open and laparoscopic surgery.[40,42–45]

Laparoscopic surgery for carcinoma rectum

STATEMENT AND RECOMMENDATION

Statement

In expert hand laparoscopic TME has equivalent oncological outcomes to open TME.

Recommendations

- Current evidence indicates that laparoscopic TME can be performed with equivalent oncological outcomes in comparison with open TME when performed by experienced laparoscopic surgeons possessing the necessary technical expertise (LoE 1a, Grade A).[45–50]
- Laparoscopic resection for rectal cancer should be done according to standard oncological principles: Adequate distal margin, ligation at the origin of the arterial supply for the involved rectal segment and total mesorectal excision.

Learning curve

STATEMENT AND RECOMMENDATION

Statement

Steep learning curve for laparoscopic CRC resection mandates advance laparoscopic training and principles.

Recommendations

- The laparoscopic CRC resections have a steep learning curve and a surgeon attempting the laparoscopic resections for colorectal cancers must have adequate training and experience in advanced laparoscopic techniques and principles (LoE 1a, Grade A).
- Some clinical trials mandated a minimum of 20 laparoscopic colon cancer operations for surgeon inclusion into trials,[45] whereas few studies have suggested that at learning curve of at least 50 cases is required to gain adequate training and experience for undertaking laparoscopic colorectal cancer resections.[51,52]

ICG AND NIR IMMUNOFLUORESCENCE IN MINIMAL INVASIVE SURGERY FOR GI CANCERS

Indocyanine green (ICG) is a hydrophilic tricarbocyanine molecule with hydrophobic properties that binds strongly to plasma proteins; predominantly albumin and remains confined to the intravascular space for the majority of its 2–5 minutes half-life, making it an optimal surrogate for blood flow. After intravenous injection, ICG is visualized as green when excited by light in the NIR spectrum with an NIR camera in 30–60 seconds. It has an established safety profile. These unique properties allow this technology to be used in conditions where there is a change in tissue perfusion between the diseased and normal tissue. It has found particular utility in gastrointestinal pathology with regards to sentinel lymph node mapping, endoscopic fluorescent clips for the localization of colonic tumours in laparoscopic surgery, resection of colorectal liver metastases, perfusion angiography, identification of biliary anatomy, identification of peritoneal endometriosis, intraoperative ureteric localization, identifying the transanal TME dissection plane potentially helping to avoid iatrogenic injuries to vital structures. This powerful tool when applied for lymphatic mapping, identification of micrometastatic disease and focused target nodal assessment has the potential to change the operative course and recommendations for adjuvant therapy postoperatively in gastrointestinal malignancies.

ICG in hepatobiliary malignancies

STATEMENT AND RECOMMENDATION

Statement

Intraoperative ICG fluorescence imaging has a definitive role in identification and resection of hepatic tumours.

Recommendation

Intraoperative ICG-fluorescence imaging has a potential role in the identification of hepatic tumours and segmental boundaries and help in safe and accurate completion of laparoscopic hepatectomies with a high sensitivity of 70%–100% (LoE 3, Grade B).[53]

ICG in colorectal liver metastasis

STATEMENT AND RECOMMENDATION

Statement

ICG has an advantage over USG as a navigation tool in colorectal surgery.

Recommendation

ICG-fluorescence imaging is now utilized as a navigation tool for resecting metastatic hepatic tumours in laparoscopic hepatectomy, scoring over the intraoperative USG which cannot identify lesions less than 3 mm in size (LoE 3, Grade B).[54]

ICG in perfusion angiography

STATEMENT AND RECOMMENDATION

Statement

ICG-fluorescence imaging is a more sensitive tool than intraoperative sonography in detecting colorectal liver metastasis.

Recommendations

- Use of ICG is becoming established in assessing both foregut and hindgut anastomotic perfusion with the potential of lowering leak rates by changing the surgical plan.
- In cervical post-oesophagectomy anastomoses with gastric pull-up, it reduces the leak rate (LoE 4, Grade C).[55]
- ICG-fluorescence imaging reduces anastamotic leak rates following colorectal surgery for cancer (LoE 3, Grade B).[56]

Sentinel lymph node identification (colon carcinoma)

STATEMENT AND RECOMMENDATION

Recommendation

Indocyanine green (ICG) NIR fluorescence in sentinel lymph node (SLN) detection in CRC is a technique with a sensitivity and specificity of 70% and 85%, respectively (LoE 3, Grade B).[57]

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Guidelines for Training in Laparoscopic Surgery

INTRODUCTION

Skill acquisition requires adequate and proper training with a focus on patient safety and surgical efficacy. The surgical skill required for performing laparoscopic surgery is far more compared to open surgery and is associated with a steep learning curve. The demand for learning advanced surgical skills in a short, timeframe has been a challenge to the surgical fraternity. This has led to evolution of specific courses on laparoscopic surgical skills. In certain surgical sub-specialities, only advanced procedures need to be performed and hence lack of adequate exposure to basic surgeries pose greater challenges to skills training. Any skills training has to be followed by assessment of skills and granting privileges. These challenges can be met by a properly designed curriculum, presence of experienced faculty and proper infrastructure. With the advent of newer technologies, refinement and development of newer instrumentation and simultaneous development of newer surgical techniques, learning newer skills is a continuing phenomenon throughout the surgical career. With so many different demands, there is a need to design different types of courses on laparoscopic surgical skills. Certification at the end of training requires assessment of surgical skills, which remains an evolving field at present.

There is a dire necessity for creating an educational policy which will include practical guidelines for designing laparoscopic surgical skills programmes that would cater to various groups of surgeons and residents to decipher the right knowledge and skills required for them to perform different laparoscopic surgeries. Residents may need courses on skills outside their curriculum to fulfil these needs (LoE 2c, Grade B).

CURRICULUM

To educate participants in clinical skills, techniques and/or procedures, every skills training course must have a mission statement that defines its objectives. The curriculum needs to be designed for a comprehensive training that includes acquisition of knowledge of instrumentation and equipment, their maintenance, pre-, intra- and postoperative considerations, management of technical difficulties and complications with a focus on surgical safety. Training courses should also define the eligibility criteria for candidates and state the objective and expectation from the particular training course. The skills course must define eligibility for participation. The trainee must have appropriate background knowledge, basic skills and clinical experience relevant to the tasks to be learned. We suggest the use of 'Kern's Six-Step Approach to Curriculum', a well-established model, which is used to design course curricula (LoE 2a, Grade A).

The topics covered in the curriculum should include:

- Patient selection and preoperative preparation
- Indications and contraindications of the procedure
- Operating room (OR) setup, instrumentation and their maintenance
- Intraoperative considerations which include anaesthesia, safety precautions, details of the operative procedure including techniques that need to be used in cases of variation in anatomy and pathology
- Use of various instruments as well as energy sources and trouble shooting
- Postoperative complications and their management

The course curriculum should define the tasks that will be taught. It should also define the skill levels and mention about the progress from one skill level to the next. It should contain a syllabus, with written material, videos and references to further one's knowledge. Pre- and post-testing with an explanation about the right answers is recommended. There should be emphasis on safety, economy and care of instruments.

The duration of the skills course should be based on the type of training course and the level of skill acquisition involved. The curriculum should be designed in such a way that in the duration of the course, the trainee will be able to acquire the level of the skill expected from the course. If possible the trainees should be assessed initially and based on their experience in laparoscopic surgery, the training should be optimized. At the end of the course there should be an objective evaluation of skills.

Training in laparoscopic surgery can be considered at two levels – basic and advanced. With a long learning curve, laparoscopic surgery would require further training with an advanced course preferably after a minimum of 5 years of certified experience.

Training course should ensure learning in the following three domains – cognitive (knowledge), affective (behaviour, communications skills towards the patients) and psychomotor (skill development).

The various types of training courses that are presently being organized are as follows:

- MCh (MAS)
- Fellowship/FNB
- Mini-fellowships
- Basic comprehensive course
- Weekend CME/Hands-on Programmes (2–5 days)

Fellowship and postgraduate courses in minimal access surgery should include lectures, video demonstrations, seminars and symposia, panel discussions, ward rounds and case presentations, journal club, inter-departmental meetings, presentation of papers in conferences and regular meets, publications in important journals, project work, practical training in bench models, assisting live surgeries, performing surgeries under supervision.

The candidate will be given an opportunity to observe (O), assist surgeries (A), perform with assistance (PA) and perform independently (PI) in various cases and the minimum participation of the candidate will be predetermined. Total duration of training is specified. A logbook should be maintained by residents. It is recommended to develop a criteria-based curriculum (LoE 1b, Grade A).

TRAINING METHODS

Training for laparoscopic surgery should entail the following.

Training of skills as task-based exercises

Every surgery is a combination of several tasks that are performed repeatedly. Identifying each of these tasks and teaching them step by step with focus on economy of movements (avoiding non-purposeful actions) would help in perfecting the skill of performing each of these tasks. The task-based exercises should include blunt and sharp dissection, cannulation, diathermy dissection, suturing and knotting skills. Any other skill that is particularly necessary for performing a procedure that the course is designed to teach should also be included.

Training to perform a particular procedure

This includes a sequential step-by-step skills performance of a particular procedure that the course is designed to teach. This should include didactic sessions and video demonstrations. Live operative demonstration of the operative procedure with consideration of variations in anatomy and pathology that may be encountered and addressing troubleshooting issues. Teaching a procedure is possible in a dry lab with harvested organs, wet lab, virtual reality simulators or by assisting live procedures.

Training as a team

Laparoscopic surgery needs to be performed with a lot of coordination between the various team members who include camera-holding assistant and other assisting surgeons along with the operating surgeon. This needs particular mention and the role of each person should be defined and ideally the whole team of the trainee surgeon should have an exposure to the performance of surgical procedures during the training course.

Remote telementoring

With improved communication technology, it is possible to mentor junior surgeons remotely. There has to be proper infrastructure, support and adequate training available at the operation theatre for any eventualities for considering telementoring. All statutory requirements as well as appropriate consent need to be obtained.

The traditional halstead apprenticeship model of surgical training has shifted towards one of proficiency-based training. It is no longer acceptable to attempt a surgical procedure without appropriate training. There is growing opinion regarding the use of several types of training modules to achieve this purpose.

There has to be a course evaluation by the trainees at the end of each course, which forms the basis for assessment and improvement of the course.

TRAINING MODULES

The challenges faced in laparoscopic surgery include altered tactile feedback, different eye–hand coordination, translation of two-dimensional video image to a three-dimensional working area and the fulcrum effect. These skills are difficult to learn in the operating room and face serious safety issues. The training modules that are developed and used for skills training outside the operation theatre are designed to achieve these objectives. These are surrogate for the human body and do not pose health and safety issues.

The modules that are being used for training laparoscopic surgical skills presently include the following.

Bench models – Several types of bench models are used for laparoscopic surgical training:

Inanimate or mechanical simulator is a simple trainer without any electronics and software involved except for a camera. It is low in cost, can only simulate tasks and not the entire procedure. It offers realistic haptic feedback, but assessment of performance and skills is more subjective and there is lack of interactivity.

Computer-based or virtual reality simulators offer both task-based and procedure-based training. These can also be used for training of rare events and uncommon surgeries as well as crisis training such as bleeding from a major blood vessel. Haptic feedback is available in more expensive simulators. Studies have proved that simulator training reduces the risk of errors during first operations apart from reducing operation time and complications. Profficiency-based training, with optimal provision of immediate feedback and on-the-spot instructions, the motivation for deliberate practice and the availability of practising on varying levels of difficulty – all seem to enhance the learning outcomes of simulation. It is much easier to correct mistakes early during the learning process prior to incorrect practices becoming ingrained. Virtual reality training has become one of the mainstays of surgical training outside the operating room (LoE 1b, Grade A).

Augmented reality simulation is a combination of real and virtual reality in one system. It offers haptic feedback. Objective assessment and interactivity is available. Here the same operative instruments are used. The physical task can be combined with demonstration videos and a trainee's performance can be compared. Another approach is tracking of visual pathway of instruments, which can be shown during playback of performance. There is no need for an expert laparoscopic surgeon to be available on the scene for virtual and augmented reality training modules (LoE 2c, Grade C).

Hybrid modules comprise trainers designed to house harvested animal tissues and organs. A circulation pump can be used to make these organs mimic bleeding. There is a real-time haptic feedback and avoidance of statutory requirements to run an animal laboratory.

Animal laboratories have facilities for performing surgeries on animals which give a realistic haptic feedback to create pneumoperitoneum and introduce ports. It is ideal for procedure training and practice teamwork, but requires sacrifice of animals. This has been an ideal scenario for the last few decades for laparoscopic surgical training. Regulations necessitating animals to be euthanized and used for surgical training has now precluded bleeding during surgery. Hence, realistic surgical experience is not achieved. There is also an aversion to use animals by many trainers due to these regulations (LoE 2c, Grade C).

Cadaver simulation gives a better understanding of dissection and helps in improving surgical performance. This is an opportunity to perform surgery in true human anatomy. Though it is a superior bench model, it cannot be widely used as a laparoscopic training model due to lack of availability and high cost. There may be risk of infection (LoE 2c, Grade A).

Teamwork training can be ideally accomplished in animal and cadaver laboratories. It is important to use training modules that can also assess a trainee's skills.

Skills laboratories should have a minimum of four workstations.

Validity of training modules

Validity is defined as the extent to which an assessment instrument measures what it was designed to measure. There are different levels of validity:

- *Face validity,* in which a defined group of subjects are asked to judge the degree of resemblance between the system under study and the real activity.
- *Content validity* examines the level to which the system covers the subject matter of the real activity.
- The degree to which the assessment can discriminate between different ability or experience levels is related to **constructor** *contrast validity*.
- The most powerful evidence is gained through concurrent or **predictive** *validity*, in which performance on the system is compared with outcomes from an established assessment method designed to measure the same skills or attributes.

Validation of training modules and methodologies is required before they are widely accepted for training. Virtual reality simulators have been validated and should be used for training laparoscopic surgical skills.

LEVELS OF SKILLS

Only preliminary work has been done in defining levels of skills and training. The Guidelines for Laparoscopic Surgery written by Professor Tehemton E. Udwadia are as follows:

Level 1 Training

- Initiation of training in basic procedures of laparoscopic surgery.

Prerequisite for progression to level 2 training

- 20 cases at level 1 as an assistant and a further 10 as a main surgeon.
- Level 2 diagnostic laparoscopy in patients with:
  - Previous laparotomy
  - Adhesiolysis
  - Laparoscopic cholecystectomy where there are no prognostic features to predict a difficult dissection
  - Interval appendectomy

Prerequisite for progression beyond level 2 training

- 20 cases at level 2 as an assistant and a further 20 as a main surgeon

Prerequisite for progression beyond level 3 training

- All laparoscopic cholecystectomy
- All laparoscopic appendectomy
- Laparoscopic repair of hernia

Prerequisite for progression beyond level 4 training

(To be placed in the relevant level when feasibility demonstrated)

- Laparoscopic vagotomy and diagnostic seromyotomy
- Fundoplication
- Splenectomy
- Other advanced laparoscopic procedures (LoE 2a, Grade A)

Now that we have progressed to organ transplants and liver resections using laparoscopy, there is an urgent need for a new classification that defines higher levels of competence.

ASSESSMENT OF SKILLS

Surgical competence has two major components – cognitive competence and technical skill in surgery. Assessment tools for measuring cognitive competence are widely available; it is the technical aspect that suffers from poor and subjective assessment strategies.

Some skill assessment tools currently followed are:

- MISTELS (McGill Inanimate System for Training and Evaluation of Laparoscopic Skills)
- OSATS (Objective Structured Assessment of Technical Skills)
  - Measures technical ability by means of specific checklists and a global rating score
- ADEPT (Advanced Dundee Psychomotor Test)
  - Reflects (and assesses) innate psychomotor ability
- One of these or any other tool has to be followed for assessment of laparoscopic surgical skills. It should involve fairness, reliability, validity and alignment with the learning content.
- Assessment of skills should be done objectively by using scoring methods for various tasks periodically or continuously throughout the course and the improvement of skills in each trainee should be assessed to ensure they achieve the goals of the course (LoE 1b, Grade B).

TRAINING CENTRE

Training centres are created in the following categories:

- *Training centres established by private institutions/industry/corporates*
  These are facilities created for conducting short courses of a few days. The courses have to be very specifically defined as per their objectives and should follow strict criteria of selection of candidates. The limitation of these training facilities is the absence of operation theatres and experience of live operative demonstration.
- *Hospitals with dedicated training facilities*
  These are mostly driven by hospitals having a focus on laparoscopic surgery, most of them with a social objective to spread their knowledge and expertise. These are centres which run comprehensive courses in basic or advanced laparoscopic surgery and may have postgraduate residency programmes.
- *Medical colleges/hospital with large volume of minimal access surgery work*

recognized by a regulatory body
These are institutes which have the potential to grow to centres of excellence. They are ideal setups for both undergraduate and postgraduate training. Due to their volumes they can offer vast experience in operation theatres. They have a potential for research and development of newer technologies and procedures.

Some of the requirements for skills training centre are:

- Auditorium/seminar room which can accommodate 75 people, with large screens and a projector system.
- Skills lab with bench training models, preferably with virtual reality simulators.
- Library with relevant books, journals and videos.
- High speed internet for e-learning and web-based programme (LoE 3, Grade C).

REGULATORY BODY

There has to be a regulatory body which recognizes and also periodically offers guidelines for training activities. This could be the national or state medical council, state medical universities, national or state speciality associations. Training facilities should be offered affiliation to these bodies and all courses run by the training centres should be recognized or endorsed by them.

FACULTY

The faculty should have adequate knowledge and experience in laparoscopic surgery and should be recognized as experts.

The course director should have a minimum of 10 years of experience after postgraduation in laparoscopic surgery in both basic and advanced procedures. This should be associated with both clinical and laboratory experience and teaching expertise. There should be an appropriate ratio of faculty to trainees

CERTIFICATION

Certification must ensure competence and adequate laparoscopic skill. Every training course should have either a certificate of attendance, participation or more specifically the skill acquired should be assessed and then certified by either the training institute or by a professional/ scientific organization.

Fellowship or postgraduate courses follow more stringent criteria to certify based on a traditional examination.

To ensure ongoing competence, periodic re-certification should be insisted upon and appropriate privileges should be awarded to surgeons based on their surgical practice and competence to perform specific surgeries.

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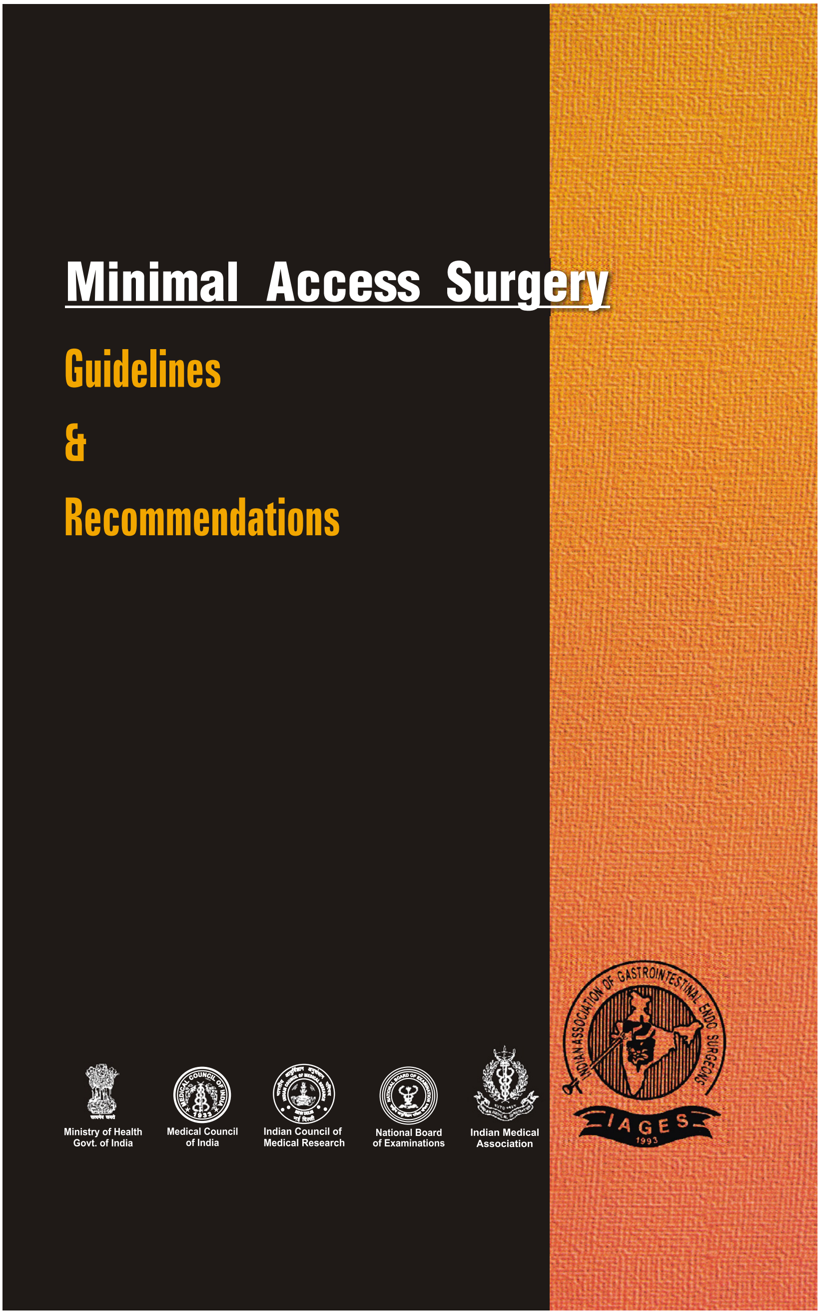
Glimpses of the First Edition



Glimpses of the First Edition

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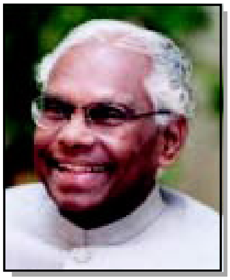

MESSAGE

Application of minimal access surgery has simplified surgical procedures by avoiding many complications and difficulties in the field and extended immense relief and benefits to the patients. It is appropriate that such modern and innovative practices are adopted by following relevant guidelines.

I am glad that an expert committee has been established in the ACADIMA 2000 to formulate guidelines and recommendations on the issue of minimal access surgery for the use of the surgeons, hospitals, nursing homes and allied medical industry. I am confident that such an important step will further facilitate the easy application of minimal access surgery in our country. On this occasion I extend my greetings and good wishes to all those associated with the formulation of these guidelines for the success of the minimal access surgery in our country.

July 9, 2002
New Delhi

(K.R. NARAYANAN)

FOREWORD

It is over a decade since laparoscopic surgery commenced in the Indian subcontinent. Since then it has spread all over the country and is being carried out in large metropolitan institutions as also in small towns. Moreover its spectrum is gradually progressing beyond the traditional laparoscopic cholecystectomy, which will always remain the flagship of laparoscopic surgery. In similar vein the Indian Association of Gastrointestinal Endo-Surgeons was started by a small group from all over the country in Mumbai in April 1993. In the span of just a few years its membership has grown to well over one thousand and its activities multiplied in proportion. It is worth stressing that about 40% of IAGES membership is from small towns. Laparoscopic surgery in a developing country has its own problems as also the thrills and fulfilment and it was felt desirable that the IAGES formulate a set of practice guidelines for laparoscopic surgery in Indian conditions.

Surgeons are, by nature, individualistic and often resist regimentation. We felt there is a need for practice guidelines in laparoscopic surgery to standardize a methodology and rationale for all laparoscopic procedures with the sole aim of improving the quality of care delivered to all our patients. These guidelines are offered as systematically developed statements to assist surgeons in decisions related to the practice and outcome of laparoscopic surgery. These statements are a result of months of work and many hours of intense discussions at several meetings by every member of the Core Group under the very able Chairmanship of the President of IAGES, Dr. Pradeep Chowbey. These guidelines are presented in full appreciation that surgery is always in a state of change and progress and these guidelines will be reviewed, altered, added to on a continuous ongoing basis.

Even a decade after it is being practised in India, in several quarters the rationale of any high-tech surgery is always questioned in a country lacking in primary health care, sanitation and safe water. These criticisms do have significance and relevance. Surgery is a humanitarian science and if it is to remain so it must be our intent and mission to ensure that the cutting edge of surgical progress is made available to all people, in all places, whatever their socio-economic conditions. Only then can we, with real honesty, claim that laparoscopic surgery has fully arrived in India. That this is not currently so is an accepted fact. After thirty years of travel, visiting surgical centres of excellence, as also surgeons in small towns and rural areas throughout India, I have unshakable confidence in the quality and commitment of the Indian surgeon. If any group of surgeons, anywhere, can carry out this stupendous task, I am sure it can only be by Indian surgeons.

These Practical Guidelines and recommendations are hopefully the first step on the long path towards meeting this challenge and achieving what could be one of the greatest success stories in the history of surgery.

Tehemton E. Udwadia
Founder President - IAGES

Glimpses of the First Edition

INTRODUCTION

It gives me great pleasure to present the "Minimal Access Surgery Guidelines and Recommendations."

The surgical fraternity in India has been at the forefront of a revolution with the introduction of Minimal Access Surgery. The ingenuity and innovation of Indian surgeons has ensured that this 'high technology' surgery has today percolated to all corners of our country. It is a glowing tribute to Indian Surgery that Minimal Access Surgery has not only taken firm roots but rapidly prospered inspite of the inherent limitations and tremendous odds stacked against most surgeons. Given the amazing array of instrumentation, equipment and surgical techniques available today, a need for a rational and 'standard' approach in laparoscopy has been felt for many years. It was during ACADIMA 2000, a multispeciality conference held in New Delhi that the thought process crystallized and a decision was taken to introduce a set of recommendatory guidelines for safe practice of Minimal Access Surgery, accredited by the Indian Medical Association (IMA), National Board of Examinations, Medical Council of India, Ministry of Health and Indian Council of Medical Research and endorsed by IAGES.

I accepted this onerous task with a certain degree of trepidation but secure in the firm conviction that I was blessed with the continuous support, best wishes and firm backing of colleagues who would readily share their expertise. Accordingly, a core group of experts was constituted and several brainstorming sessions were held where issues were discussed threadbare. All proceedings / deliberations / presentations were formatted by computers for standardization and also the entire deliberations were audio recorded. Inherent in the nature of formulating guidelines is the necessity to include surgical practice in a very wide scenario and therefore may guidelines / suggestions many appear rather non-specific. Moreover, there are many issues, which remain grey areas on which consensus today remains elusive. These areas have been deliberately omitted.

We are all aware that Surgery is continuously and constantly evolving, current guidelines may not be valid a few years hence. It shall remain our endeavour to constantly update these guidelines in future.

There are bound to be shortcomings in this unique maiden venture and I earnestly solicit any criticism / suggestions for improvement. However, this effort does place our country among the group of countries / surgical associations which have formulated their own guidelines on Minimal Access Surgery.

I remain indebted to our experts who contributed so readily with their time and expertise at great personal inconvenience. I take this opportunity to salute Dr. Tehemton Udwadia, a true pioneer who showed us the way. I am indebted to my mentor, Dr. SK Sama, Chairman, Sir Ganga Ram Hospital and the Minimal Access Surgery team for their untiring efforts in helping this publication take shape. I appreciate Pfizer for their generous contribution, patience and constant support in compiling this edition.

PRADEEP K CHOWBEY
Chairman, Core Group

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