*Review Article*

# LAPAROSCOPIC SURGERY

Lt Col KJ PHILIPOSE, VSM*, Brig B SINHA+

ABSTRACT

The speed of adoption and popularity of laparoscopic cholecystectomy is without precedence in modern surgical history. This has resulted in therapeutic and diagnostic laparoscopy being attempted in almost every field of surgery to substitute open surgical procedures. The list is endless. It will take time to evaluate the safety and advantages of many of these procedures as reports of controlled studies and long term follow up results are awaited. While certain procedures like gall bladder surgery and appendicectomy will establish their many fold advantages over open surgery, many other procedures like repair of hernias, radical resection of bowel for malignancy etc may fail to do so once the initial enthusiasm wanes away. Any way the concept of minimally invasive surgery is going to be a dominant factor in the surgery of this decade and one should prepare to face this fascinating challenge. Further developments in laparoscopic instruments, optical system and video imaging techniques will add to the progress and safety of laparoscopic surgical procedures in the days ahead.

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## Introduction

Gynaecologists have been using laparoscopy for evaluating pelvic pathology and performing minor procedure like tube ligation for many years. However, most general surgeons did not recognise its value till the successful performance of laparoscopic cholecystectomy by Phylip Mouret (1987) and Francois Dubois and Jacques Perisant (1988) [1,2]. The subsequent enthusiasm and world wide acceptance of this procedure with its advantages of minimal patients discomfort, short hospital stay and excellent cosmetic results has revolutionised the management of cholelithiasis. The success of laparoscopic cholecystectomy has stimulated interest in minimally invasive surgery and various centres are performing other surgical procedures like appendicectomy, splenectomy, nephrectomy, hernia repair, vagotomy, fundoplication, Heller's oesophagomyotomy, Ramstedt's pyloromyotomy, small and large bowel resection and anterior resection. The initial reports are encouraging though it will require more time to evaluate the final acceptability and safety of many of these procedures.

## History of Laparoscopic Surgery

Georg Kelling was the first to examine the abdominal cavity of dogs with an endoscope. The first major series of laparoscopies in man is attributed to HC Jocobaeus (1911). He devised methods to examine the abdominal and thoracic cavities and used the term 'Laparo thoracoskopie'. He reported laparoscopic diagnosis of tuberculosis, cirrhosis, malignancy and syphilis. WE Stone (1924) from Topeka Kansas reported his experience using a nasopharyngoscope and used the term peritoneoscopy. Steiner (1924) performed this procedure using cystoscope, trocar and oxygen insufflation and used the term abdominoscopy. In 1925 Nadeau and Kampmeir have written about the absorption of air pneumoperitoneum in dogs. Prof Kalk, a hepatologist is

* Reader, Department of Surgery, Armed Forces Medical College, Pune 411 040. + Commandant, Artificial Limb Centre, Pune 411 040.

credited with a number of major innovations including a 135 degree lens system and the dual trocar technique which laid the foundation for the later efforts in therapeutic laparoscopy. A landmark paper published by John C Ruddock in 1937 gives one of the earliest reports of laparoscopic biopsies. ET Anderson (1937) discussed a method to perform laparoscopic tube ligation [3].

Although an automatic pneumoperitoneum needle for safe puncture and insufflation was developed by Gotze as early as 1918, the modern spring loaded needle developed by Janos Veress in 1938 with its modified versions is the most commonly used device for creating pneumoperitoneum. Kurt Semm in the 1960s developed instrumentation for controlled automatic insufflation. He also developed a number of endoscopic instruments and laid the basis for endoscopic abdominal surgery [3].

Despite the technical advances enabling safe laparoscopic procedures, general surgeons failed to take advantage of the experience of their counterparts in gynaecology and incorporate laparoscopy into general surgery [3]. Acceptance of laparoscopy into general surgery awaited the development in the 1980s of the computer chip television camera and video laparoscopy. The user friendly instruments for therapeutic laparoscopy have revolutionised the management of biliary tract lesions and have made possible the management of many more organ system disorders. The American Hospital Association estimates that 80% of abdominal operations can be converted to minimally invasive surgery by 2000 AD.

**Laparoscopic Instrumentation and Video imaging :**

Essential instruments for laparoscopic surgery are listed in Table 1.

Diagnostic laparoscopy can be performed with a low or high laparoflator. Operative laparoscopy requires the use of a high flow auto regulated insufflator capable of delivering atleast 4 L of $CO_2$ per minute to maintain adequate pneumoperitoneum.

TABLE 1
**Essential instruments for laparoscopic surgery**

A. Light source, telescope, video camera system beam splitter, monitor, video recorder and printer.

B. Abdominal puncture instruments, laparoflator, instruments for grasping, dissecting, retraction, for division and coagulation, for occlusion and ligation, for irrigation and suction, stapling devices.

C. Electrosurgical unit.

D. Laser equipment.

E. $CO_2$ gas source.

F. General surgical equipment and arrangements for laparotomy in case conversion is required.

The development of high intensity Xenon light source has been instrumental in the development of laparoscopic surgery [4]. Good illumination is of utmost importance in video imaging. The $30^0$ oblique forward viewing 10 mm laparoscope is advocated by most laparoscopic surgeons. Flexible laparoscopes are also being developed to visualise areas of abdomen that are currently inaccessible. Several types of trocars both disposable and non disposable are available. Maximum care is required during passage of the first trocar to prevent injury as the subsequent ones can be introduced under laparoscopic vision.

Hemostasis in laparoscopic surgery is usually obtained with the use of some type of thermal cautery or application of clips, ligatures or sutures. Monopolar electrocautery is widely used for coagulation as well as dissection. It can be delivered through a variety of probes, spatulas, hooks, forceps, scalpels and scissors. Bipolar cautery is safer but its use in sharp dissection is limited. Several types of lasers have been used including $CO_2$, Argon, Nd YAG and KTP/532. In general lasers are superior to monopolar electrocautery for sharp dissection but inferior for coagulation [4]. Laser also needs high investment, safety precautions and more expertise in handling.

There has been great interest in laparoscopic stapling devices. The laparoscopic GIA staplers can be used for appendicectomies and bowel resections. The intra abdominal stapler has been used in hernia repairs

and gastric surgery. A large variety of laparoscopic graspers and scissors both in reusable and disposable forms are available. Different forms of organ retractors, suction irrigators, tissue morcellators and specimen retrieval bags are also in use. With the widespread acceptance of laparoscopic surgical procedures tremendous research activity is taking place throughout the world for development of more and more effective and user friendly instruments and the coming years may see many revolutionary innovations.

The most significant development which has made the success of laparoscopic surgery in recent years is the video laparoscopic camera. This enables all the members of the team to view the operative field simultaneously, permitting better co-ordination of movements, there are many areas of video imaging under active investigation. Several triple chip cameras are available with each chip being devoted to one colour of the spectrum. They give better resolution and colour but are less durable and highly expensive [4]. There is scope for development of three dimensional laparoscope and three dimensional imaging will be a necessary component in robotic systems.

## Technical Differences between Laparoscopic and Open Surgery

In laparoscopy there is a lack of direct manual contact with the tissue. One's sense of feel is restricted to that which is transmitted through a 30 cm long instrument. The surgeon is not viewing the laparoscopic field with direct binocular vision. The image is transmitted to a 2D video screen and the laparoscope magnifies the image as much as 16 times its normal size. The magnification accentuates one's natural tremor and the 2D view eliminates the true perception of depth. With practice a certain amount of video - eye - hand co-ordination is cultivated.

Another fundamental difference between laparoscopic and open surgery is that there is restricted instrument mobility with the former. The laparoscopic sheeths are mobile only to the limited degree of elasticity of the abdominal wall. When passing a needle through tissue the surgeon is confined by the trocar placement to a single arc of rotation perpendicular to the axis of the instrument. Therefore proper placement of trocar and cannulae are important. Laparoscopic suturing technology is currently in its infancy and considerable advances are expected over the coming months and years with respect to sutures, needles, needle holders and bowel occlusion clamps [5].

The guiding commandments of laparoscopic surgery are (a) The laparoscopic surgeon must be an experienced general surgeon with some experience in laparoscopy. (b) Patience and adherence to deliberate operative approach. (c) Systematic careful delineation and separation of structures until the anatomy is clearly revealed.

## Limitations of Laparoscopic Surgery

Establishment of laparoscopic surgery unit involves costly and high technology modern equipments which are constantly under revision and upgrading. It needs a specially trained team with skills different from that of open surgery. It cannot be used in all cases and even in the most expert hands there is a percentage of cases that will be converted to open surgery. The operation time in majority of cases is more compared to open surgery. The complication rate is also higher. Some of the general complications are listed in Table 2. Long term effects of many of these procedures cannot be predicted and will require long follow up of these cases.

## Diagnostic Laparoscopy

Laparoscopy is useful in the diagnosis of a wide range of disorders. It can be used to evaluate hepatobiliary disorders, abdominal masses, abdominal pain both acute and chronic, PUO, trauma, malignancy and so on [6-8]. Adhesions and bands if seen can be divided under direct vision. Laparoscopic biopsies are superior to percutaneous blind biopsies in that the surgeon can visualise the diseased area and sample appropriate tissue. Emergency diagnostic laparoscopy in

TABLE 2
Complications of laparoscopy

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| Hollow viscus perforation |
| Solid viscus injury |
| Blood vessel injury - haemorrhage |
| Biliary leakage |
| Subcutaneous emphysema, pneumopthorax, pneumomediastinum |
| Gas embolism |
| Cardiorespiratory embarresment due to elevation of diaphragm, compression of inferior vena cava. |
| Flash burn during electrocoagulation, photography and laser burns |
| Explosion with diathermy |
| $CO_2$ absorptions with rise in the arterial $CO_2$ |
| Cardiac arrhythmias and cardiac arrest |
| Danger of transmission of diseases like serum hepatitis and AIDS |

abdominal trauma is extremely accurate compared to four quadrant tap, peritoneal lavage etc. It can be done in the emergency room under local anaesthesia with sedation as long as only low pressures are used (8-10 mmHg) [6]. However if there is an injury to diaphragm, pneumothorax can cause respiratory distress and so utmost care should be taken to avoid or manage this complication. The diagnostic laparoscope 4 mm in diameter is only slightly larger than the diagnostic peritoneal lavage needle and more information is gained by the surgeon. Laparoscopy can be of immense help in the staging of lymphoma and second look procedures in the management of malignant diseases [7].

### Laparoscopic Cholecystectomy

First performed in 1987, the speed of adoption and popularity of this procedure the world over is without precedent in modern surgical history despite the relative lack of information concerning its long term consequences. Today, this is the procedure of choice for the treatment of gall stones in most of the developed countries. Its relative contraindications have thinned down and is done in all types of cases except probably in pregnancy [2,9]. It has a conversion rate of 4-9% and has minimal complication rate. It has proved its superiority over the open and minilap cholecystectomies and is certain to retain its popularity.

Stones in the CBD pose a difficult problem and need more expertise and special equipments. The usual approach is through the cystic duct with or without balloon dilatation. Stones are retrieved through choledoscope or basket. Larger stones can be broken to pieces using laser or electrohydraulic lithotripsy. Smaller fragments can be flushed down to duodenum after balloon dilatation of sphincter of Oddi or endoscopic spincterotomy. Attempts are being made to do laparoscopic direct exploration of CBD when the transcystic approach fails. A dilated duct can be cleared anteriorly and opened using microscissors. Then biliary fogarty catheters are passed superiorly and inferiorly to remove stones. The main problem arises when it comes to closure of the CBD around a T-tube which is within the skills of only a few talented laparoscopic surgeons [10]. Various workers have reported success rates upto 90% in dealing with the CBD stones laparoscopically and endoscopically.

### Laparoscopic Appendicectomy

Although laparoscopic appendicectomy was reported 4 years before lap cholecystectomy, it has not had such a meteoric rise and is practised routinely only in a few centres. This is probably due to the fact that most surgeons can perform open appendicectomy through a small cosmetic incision with minimal complications and a short hospital stay. It is also seen that lap appendicectomy may not have easy access. Against these shortcomings lap appendicectomy has the advantage of excellent exposure of the appendix regardless of its position. With full access to the abdomen and pelvis, pathological conditions in other organs could be searched when the appendix is not actually inflamed. This can save many unnecessary appendicectomies [11].

### Laparoscopic Herniorrhaphy

There are three techniques of performing hernia repair using laparoscope. Trans-

abdominal preperitoneal repair (TAPP) involves entering peritoneal cavity and then coming to the pre-peritoneal space through an incision on the peritoneum above the hernial defect and securing a synthetic mesh over the area. The second method of intraperitoneal onlay mesh (IPOM) envisages placement of a mesh directly onto the peritoneum over the defect and fixing it with stapling device. This involves minimal dissection. However complications attendant to the placement of a prosthesis in contact with intra-abdominal organs is a matter of concern. Laparoscopic extraperitoneal (LEP) repair is the third method which strictly speaking is not a laparoscopic repair as the peritoneal cavity is not entered. Hernial sacs can be closed by clips or suture obliteration.

Lap hernia repair can gain popularity only if it can show its advantages over the conventional repair which in many centres is performed under LA as day care. Most lap herniorrhaphy techniques expose the patients to the inherent risks of laparoscopic penetration of the abdomen and the long term possibility of adhesions to the site of breach of peritoneum [12].

### Laparoscopic Bowel Resection

Laparoscopic techniques have been devised to resect large intestines and rectum. For the right colon, after the trocars are introduced the lines of resection in the transverse colon and terminal ileum are marked with silk suture. The right colon is grasped and pulled towards the patients midline and the laparoscopic scissors with diathermy are used to mobilise the entire right colon along the white line of Todt. The hepatocolic ligament is divided using cautery and endo clips. The ureter is identified and safeguarded. The mesentery of the right colon and distal ileum is divided with a laparoscopic linear stapling device close to the superior mesenteric artery at the origin of right colic and ileocolic arteries. After complete mobilisation of the bowel it is removed through a 3-4 cm upper midline abdominal incision and a side to side anastomosis between the terminal ileum and transverse colon is performed externally using a GIA stapler. The bowel ends are closed with a TA55 stapler. After the anastomosis is completed, the bowel is dropped back to the abdominal cavity and the midline incision is closed. The abdomen is then reinsufflated and irrigated with saline and all trocars removed. Blood loss is minimal with hardly any wound infection. The average operating time is 2.5-3 hrs [1].

In the left colon also, the procedure is more or less on the same lines, but it is necessary to mobilise the proximal transverse colon and hepatic flexure to reduce tension on the anastomosis. The mobilised bowel is brought out through a 3-4 cm oblique incision made in the left lower quadrant,. Resection and anastomosis done outside and the anastomosed bowel reposited back. Operating time is around 170 minutes. Patients were able to take clear fluids within 24 hours of surgery and could be discharged from hospital on the fourth day.

The procedure of performing the resection anastomosis externally through the additional incision is called facilitated resection. However, there are also reports of colectomies being performed as a completely closed laparoscopic procedure. The resected bowel being collected in a camera bag and taken out through rectum or a widened umbilical port [13].

Anterior resections of the colon have been performed in a fashion similar to left colon resections. An end to end anatomosis is performed with a circular stapler passed through the rectum after purse string sutures have been placed intracorporeally in the proximal and distal bowel. Both purse string sutures are tied over the stapler, the stapler is closed and the anastomosis completed. Similarly successful laparoscopic technique for AP resections and end colostomy have been reported. It is also possible to perform a sigmoid loop colostomy through laparoscope.

Inspite of the advantages claimed there are several points of cautions that need be considered in case of laparoscopic bowel

resections for malignant diseases. The tactile sense of the surgeon is decreased and thus one is not able to feel the enlarged lymph nodes. In addition the no touch technique cannot be performed as major blood vessels are not identified until the colon has been mobilised. Only time will tell whether an adequate cancer clearance operation can be performed through this technique [1]. However, with the use of newly developed laparoscopic staplers, atraumatic graspers and bowel retractors, with greater familiarity with the technique, ones ability to perform these procedures will improve.

## Duodenal Ulcer and Gastro Oesophageal Reflux

In recent years endoscopic modification of certain traditional surgical procedures for duodenal ulcer and gastro oesophageal reflux have been attempted and reported highly successful. The work of Katkhouda and Mouel has focussed on the anterior seromyotomy and posterior truncal vagotomy procedure [14]. The posterior vagus is accessed through the gastro hepatic ligament, dissected free from the posterior aspect of oesophagus, clipped and divided. The anterior lesser curvature seromyotomy begins at the cardia and is extended in a curved fashion 1.5 cm from the lesser curvature to 6 cm short of pylorus. The seromyotomy is then closed either by suturing or by stapling of the muscular layers in an overlapping fashion.

There are also reports of successful performance of truncal vagotomy and pyloroplasty and highly selective vagotomy by laparoscopic technique. The use of angled endoscopes and the magnification provided by laparoscopy aid in the identification and division of small vagal fibres adjacent to oesophagus which explains the lesser recurrence rate. There are also reports of gastric procedures like omentopexy for perforated duodenal ulcer and repair of full thickness gastric injury through laparoscope.

In laparoscopic Nissen fundoplication, reduction of hiatal hernia is performed by downward traction on the stomach and careful cutting of adhesions to the herinal sac. The oesophagus, diaphragmatic crura and vagus nerves are dissected as in open procedure. Crural repair and fundoplication are completed as in open procedure. Facility for intra-corporeal suturing and knotting is essential [14]. Nabona advocates ligamentum teres cardiopexy in which the ligamentum teres is mobilised and used as a sling about the cardio-oesophageal junction. Cuschieri has accomplished this procedure laparoscopically. A simpler procedure is the laparoscopic fixation of an Angelchick antireflux prosthesis at the cardio-oesophageal junction.

## Other Surgical Procedures

The list of therapeutic laparoscopic procedures already attempted or under trial is very long. Shimi, Banting and Cuschieri reported excellent palliation following laparoscopic cholecystojejunostomy in five patients suffering from obstructive jaundice due to advanced carcinoma of pancreas [15]. Splenectomy, nephrectomy, varicocoel surgery and placement of tubes for gastric and jejunal feeding are certain other areas where the use of laparoscope is being attempted. Laparoscopic hysterectomy with morcellation of cervix is an advance over total hysterectomy as it could preserve the pelvic floor while reducing the chance of further development of cancer. The patient suffers less physical strain and pain compared to vaginal hysterectomy.

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