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Complications of Laparoscopic Cholecystectomy

[1]Rooh-ul-Muqim, [2]Qutab-e-Alam Jan, [3]Mohammad Zarin, [4]Mehmud Aurangzaib, [5]Aziz Wazir

[1]Assistant Professor of Surgery, Surgical—D-Unit, KTH Peshawar
[2]Senior Registrar, Surgical—A-Unit , KTH Peshawar
[3]Senior Registrar, Surgical—D-Unit, KTH Peshawar,
[4]Associate Professor, Surgical—D-Unit, KTH Peshawar
[5]Professor Incharge, Surgical—D-Unit, KTH Peshawar

Correspondence: Rooh-ul-Muqim
Assistant Professor Surgery, Surgical—D-Unit, Khyber Teaching Hospital, KTH Peshawar
House # 185, St. No. S, Sector J-2, Phase II, Hayatabad Peshawar

Abstract

Objective: To evaluate the complications of laparoscopic cholecystectomy in symptomatic and asymptomatic cholecysto-lithiasis.

Design and duration: Prospective study from 1st June 2005 to 30th June 2007.

Setting: Surgical "D" Unit, Khyber Teaching Hospital, Peshawar.

Patients: All patients with cholecystolithiasis who had laparoscopic cholecystectomy.

Methodology: All patients with gallstone disease both symptomatic and asymptomatic, of both sexes and any age were evaluated by history, examination and investigations and the data collected on a proforma. Patients with chronic liver disease or those deferred by the anesthetist were excluded from the study. All patients underwent laparoscopic cholecystotomy, outcome and complications were analyzed.

Result: 351 patients underwent laparoscopic cholecystectomy in the study period. 314 (89.46%) were females and 37 (10.54%) were males. Common age group was between 21-40 years (56.41%), bleeding was the commonest complication, occurring from trocar site in 35 (9.97%), vascular injury in Callot's triangle in 57 (16.23%) and liver bed in 39 (11.11%) cases. Spilled gallstones occurred in 37 (10.54%), biliary leak in 14 (3.98%) including CBD injury in 2 cases. Port site infection was seen in 17 (4.84%), while bowel injury was seen in only one (0.28%) cases. Conversion to open surgery was in 11 (3.13%) cases. Late complications CBD stricture and Port hernia were seen in 5 (1.42%) and 3(0.85%) cases respectively. Mortality was only 2 (0.56%).

Conclusion: LC is a safe and effective procedure in almost all patients with cholelithiasis. Proper preoperative work up, knowledge of possible complications and adequate training makes this operation a safe procedure with favorable result and lesser complications.

Keywords: Laparoscopic cholecystectomy, complications, outcome, gallstones.

INTRODUCTION

Laparoscopic cholecystectomy (LC) has replaced open surgery in the treatment of cholecystolithiasis. It is now considered the first option and has become the "gold standard" in treating benign gallbladder disease.[1,2] The risk of intraoperative injury during laparoscopic cholecystectomy is higher than in open cholecystectomy.[3,4] It has been anticipated that this will diminish with increasing surgeon experience in the use of LC.[3] In USA approximately one million patients are newly diagnosed annually with gall disease and approximately 600,000 operations are performed a year more than 75% of them by laparoscopy.[5] Laparoscopic cholecystectomy offers the patients the advantages of minimal invasive surgery. However with the widespread acceptance of LC the spectrum of complications in gallstone surgery has changed. The intraoperative complications of LC like bowel and vascular injury (trocar site), biliary leak and bile duct injuries decrease with the passage of time, because of increased experience of the surgeons, popularity of the procedure and introduction of new instruments.

This study presents a 2-years experience of laparoscopic cholecystectomy with the aim to evaluate the complications of laparoscopic cholecystectomy in cholecystolithiasis, both symptomatic and asymptomatic.

MATERIAL AND METHODS

This prospective study was carried out in surgical-D-Unit of Khyber Teaching Hospital Peshawar from 1st June 2005 to 30th June 2007. Data was collected on a proforma designed to include demographic information, history, examination findings, investigations, operation technique and procedure, complications and their management as well as follow up. All patients undergoing laparoscopic cholecystectomy were included while patients deferred by the anesthetist or

undergoing open surgery were excluded from the study. Preoperative prophylactic antibiotics were given to all patients. Mainly three port entry procedure was adopted while the classical 4-port approach was also done in a few cases. One port was made just below the umbilicus for the telescope and camera. The other port wad made in the epigastrium 4 cm below the xiphisternum for dissection in the callot's triangle. The third port was along the right mid-clavicular line at the level of umbilicus for holding the gallbladder. In some cases where the gallbladder was long and the fundus was obscuring the dissection field another port was formed for holding the fundus of the gallbladder. Drain was put through the right sided port where ooze was suspected in dissection area or in difficult cases. The average operation time was 40 minutes. Three doses of injectable antibiotics were given till the next morning. Patients were mobilized on the same evening while they were discharged home the next morning or the second day with advice for follow up visit after 2 weeks to assess the patient for complication.

RESULT

A total of 351 patients had laparoscopic cholecystectomy during the study period. Majority (56.4%) of the cases were aged between 21-40 years, 33.33% were in 41 -60 age while 25 patients were below 20 years and 11 patients had age more than 60 years as shown in Table 1. 89.46% were females. Table 2 shows the investigation. Routine preoperative investigation were done in all cases, liver function tests (LFTs) were performed in 21 cases who looked jaundiced. Serum amylase was done in 11 cases. Ultrasonography was done in all cases while CT scan was done in 17 cases due to a doubtful mass in the epigastrium. ERCP (endoscopic retrograde cholangiopancreatography) in 13 patients who had clinical jaundice or had deranged LFTs. Also MRCP (Magnetic resonance cholangiopancreatography) was done postoperatively in 4 cases which reported a partial injury of the common bile duct in one case while in another case there was complete resection of the common bile duct (CBD).

TABLE 1: Age and sex of patients (n = 351)

Characteristic	*No. of Patients*	*% age*
Age		
< 20 years	25	7.12
21-40 Years	198	56.4%
41-60 years	117	33.33%
> 60 Years	11	3.14%
Sex		
Male	37	10.54
Female	314	89.49

TABLE 2: Investigations (n = 351)

Investigations	*No of Patients*	*%*
Live function tests	21	5.98
Serum amylase	31	8.83
Ultrasonography	351	100
CT scan	17	4.84
ERCP	13	3.70
MRCP	4	1.13

Gallbladder was sent for histopathology in all cases, 203 patients reported for follow up with biopsy report. 171 cases were reported as chronic cholecystitis, 27 as acute cholecystitis and 5 were reported as adenocarcinoma of gallbladder as shown in Table 3.

TABLE 3: Biopsy report (n = 351)

Histopathology	*No. of cases*	*%*
Bladder sent for histopathology	351	
Report available	203	57.83
• Chronic Cholecystitis	171	48.71
• Acute Cholecystitis	27	7.69
• Adenocarcinoma	5	1.42

Bleeding during the procedure was the commonest complication as shown in Table 4. Bleeding from trocar site occurred in 35 (9.97%) cases, from vascular injury in the callot's triangle in 57 (16.23%) and from liver bed in 39 (11.11%) cases. Spilled gallstones was the second common complication occurred in 37 (10.54%) cases where maximum number of stones were recovered during the procedure. Port site infection in 17 (4.84%) cases while patients with biliary leak were 14 (3.98%) and in 12 patients it stopped spontaneously on 5th day while 2 patients needed intervention, with T-tube and Roux-en Y hepaticojejunostomy. Bowel injury occurred only in one (0.28%) patient and was unfortunately not recognized during the procedure and the patient required exploration on the 3rd day. Three patients developed basal pneumonia postoperatively. Common bile duct (CBD) stricture was reported in 5(1.42%) cases latter on during follow-up. Port site hernia was also a late complication and occurred in 3 (0.85%) cases. 11 (3.13%) cases out of 351 were converted to open cases due to adherent gallbladder in 3 cases, 3 due to distorted anatomy and 5 due to bleeding during procedure which was uncontrolled with conventional methods.

Mortality was low in our study with only 2 cases (0.56%), and both were females with high-risk for surgery and anesthesia. 203 patients reported for follow-up after 2 weeks while 148 were lost to follow-up.

TABLE 4: Complications (n = 351)

Complications	*No. of cases*	*%*
Bleeding trocar site	35	9.97%
Vascular injury	57	16.23%
Liver Bed	39	11.11%
Spilled gallstones	37	10.54%
Biliary leak	14	3.98%
Bowel injury	1	0.28%
Port site infection	17	4.84%
CBD stricture	5	1.42%
Port hernia	3	0.85%
Conversion to open surgery	11	3.13%
Pneumonia	3	0.85%
Mortality	2	0.56%

DISCUSSION

Laparoscopic cholecystectomy has virtually replaced conventional open cholecystectomy as the gold standard for symptomatic cholelithiasis and chronic cholecystitis.[6,7] In acute cholecystitis the reports are scanty and conflicting.[7]

The application of laparoscopic technique for cholecystectomy is expanding very rapidly and now performed in almost all major cities and tertiary level hospitals in our country. The laparoscopic approach brings numerous advantages at the expense of higher complication rate especially in training facilities.[6]

This study was specially aimed to focus on the different preoperative and other complications of LC. In our study majority (59.4%) of the patients were in the age group 21-40 years while 25(7.12%) were less than 20 years of age mainly children with hemolytic anemia referred by pediatrician for elective cholecystectomy. 89.4% were females. However in a study of LC in acute cholecystitis the mean age was 43.7 years with a female to male ratio of 4.5:1.[7] In another study of 281 cases of LC there were 140 men and 141 women with a mean age of 56.9 years (range 23-89 years).[8] Curro et al, recommend elective early LC in children with chronic hemolytic anemia and asymptomatic cholelithiasis in order to prevent the potential complications of cholecystitis and choledocholithiasis which lead to major risks, discomfort and longer hospital stay.[9]

We used the three port approach for LC in 311 (88.6%) of our cases while classical 4-port approach was also used in the remaining difficult cases. However recently a two port needlescopic cholecystectomy using all 3 mm miniaturized instruments is considered feasible and may further improve the surgical outcomes in terms of pain and cosmosis.[10] In our cases we used the veress needle for creating pneumoperitoneum, while in one of the studies on LC, direct trocar insertion without pneumoperitoneum was shown to be safe, efficient, rapid and easily learned alternative technique, reducing the number of procedure related complications.[11] The reported incidence of injuries from trocars or veress needle is up to 0.2%.[5]

Bile duct injury is a severe and potentially life threatening complication of LC and several studies report 0.5% to 1.4% incidence bile duct injuries.[12] Cystic duct leak is an infrequent but potentially serious complication of LC and can be reduced by using locking clips instead of simple clips.[13] In our series bile duct injury was minimum and biliary leak occurred in only 14 (3.98%) cases. In 12 cases the leak stopped after the 5th day of operation without any intervention while in 2 cases of common bile duct CBD injury, T tube was placed after ERCP in one cases while in the other laparotomy with Roux-en-Y hepatico-jejunostomy was performed.

Vascular injury was encountered commonly in our series. There were 35 (9.97%) cases of trocar site bleeding, of these 26 cases were controlled with pressure alone while 9 cases required port site exploration and ligation of vessels. Vascular injury in the callots triangle during dissection occurred in 57(16.23%) cases and in 52 cases bleeding was controlled with clip application while 5 cases were converted to open cholecystectomy. Liver bed bleeding was controlled with diathermy while drain was put in few cases small ooze. Only few data are available on the real incidence of bleeding complication from the liver however in a meta-analysis by Shea, 163 patients out of 15,596 suffered vascular injury required conversion with a rate of 8%.[5] Concomitant vascular injuries during LC increase the overall morbidity.[14]

Spillage of gallstones into the peritoneal cavity during LC occurs frequently due to gallbladder perforation and may be associated with complications, and every effort should be made to remove spilled gallstones but conversion is not mandatory.[15-17] Incidence is estimated between 10% and 30%.[5] Abscess and fistula formation in the abdominal wall after stone spillage has been reported.[16] In a retrospective study from Switzerland, only 1.4% of patients with spillage of gallstones during LC developed serious postoperative complications.[5] In our study gallstone spillage occurred in 37(10.4%) cases and maximum number were retrieved during the procedure, and no postoperative complications due to spilled gallstones was recorded.

Port site infection occurred in 17(4.84%) cases and were treated with antibiotics daily dressings and debridements. Significant reduction in the postoperative infection is one of the main benefits of minimally invasive surgery as the rates of surgical site infection is 2% versus 8% in open surgery.[18] In another study it is reported as 1.4% in laparoscopic surgeries versus 14.8% in open cases.[19]

Bowel injuries incidence in LC is 0.07-0.7% and most probably occur during the insertion of the trocars, seldom during

dissection or adhesiolysis and they often remain undetected during operations.[5] There was only one (0.28%) case of bowel injury in our study and it was recognized postoperatively when the patient developed abdominal distension, rigidity and had a toxic look. She was initially treated conservatively but laparotomy was performed on the 3rd day, where a perforation in ileum with edematous gut covered with slough was found. So resection of affected segment with end to end anastomosis was performed. Intestinal ischemia and small bowel evisceration after LC have also been reported.[20,21] Bowel injury can be prevented by trocar placement under direct vision and inspection of abdomen before withdrawing laparoscope.[5]

In our study LC was converted to open surgery in 11(3.13%) patients. In 3 cases the gallbladder was adherent, 5 cases of vascular injury during LC where bleeding could not be controlled with routine methods, and in 3 cases with disturbed anatomy, Tayab M et al, in their study identified two preoperative risk factors for conversion, ultrasonographic signs of inflammation and age more than 60 years.[22] Al Salamah, has reported disturbed anatomy in the region of callot's triangle as the most common cause of conversion observed in 41.5% of converted cases while male gender, age over 65 years, high leukocytes count, gallbladder wall thickness more than 4 mm on USG were observed as the most significant determinants for conversion to open procedure.[7] A conversion rate of 1.88% has been reported in a series of 1220 patients from a single center.[23]

Bile duct injury during LC is a dreaded complication and may lead to post LC benign biliary strictures after few months, increasing the morbidity and mortality related to the procedure.[24] Late postoperative strictures are usually the result of biliary reconstruction for injuries after cholecystectomy or excessive use of electrocautery near CBD.[25] CBD stricture occurred in 5(1.42%) of our cases. ERCP was done in these cases, in 2 cases surgical repair with Roux-en-Y Hepaticojejunostomy was done with good results. Three cases were lost to follow up, probably went to higher center for treatment.

Other minor complications in our study were Port–site hernia in 3 cases, 1 at epigastric site and 2 at umbilical port site. Repair was done at an interval of 4-6 months. Holes greater than 5 mm diameter should be closed at facial level and also removal of gallbladder from epigastric hole is important to prevent enlargement of umbilical port.[21]

Mortality was fortunately low in our series with only 2 cases (0.56%). Both were females and high risk patients with multiple organ disease. One of them developed cardiac arrest during anesthesia on the table and the other expired on the 1st postoperative's day in the ICU. Others have reported a morbidity of 2.9% with no mortality.[7]

Three of our patients developed basal pneumonia and were treated with antibiotics and chest physiotherapy. Average hospital stay was 2 days in our study while it has been reported as 2.29 days including the prolonged stay in complicated cases in a study from a single center by Vagenas K et al.[23] Inspite of the above mentioned complications the overall outcome was satisfactory, with better patient acceptance of the procedure.

CONCLUSIONS

LC is one of the most frequently performed laparoscopic operations. It has a low rate of mortality and morbidity. LC is a safe and effective procedure in almost all patients presenting with cholelithiasis. Most of the complications are due to lack of experience or knowledge of typical error.

A rational selection of patients and proper preoperative work up as well as knowledge of possible complications, a low threshold for conversion, in combination with adequate training makes this operation a safe procedure with favorable results.

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Case Report Related to Laparoscopic Cholecystectomy

Anup Hazra, Richard Siderits, Archan Hazra, Janusz Godyn

Department of Pathology and Laboratory Medicine, UMDNJ-RWJ Medical School and RWJ University Hospital at Hamilton Hamilton, NJ 08690, USA

Correspondence: Anup Hazra
Associate Professor of Pathology and Laboratory Medicine, RWJ Medical School
Vice Chairman and Director of Laboratories, Department of Pathology and Laboratory Medicine
RWJ University Hospital at Hamilton, 1 Hamilton Health Place, Hamilton, NJ 08690
609-584-6569 (p), 609-584-6439 (f), ahazra@rwjuhh.edu, hazraan@yahoo.com

INTRODUCTION

Post laparoscopic cholecystectomy bile spillage, presented clinically as acute appendicitis, mimicking intraoperatively peritoneal carcinomatosis.

Laparoscopic cholecystectomy is a highly popular, minimally invasive surgery, which outweighs the standard "open" surgery for gallbladder operation. However, there are some short-term and long-term complications as a result of intraoperative spillage of bile and gallstones during laparoscopic cholecystectomy. We present this interesting case of a patient who presented with symptoms of acute appendicitis ten years after the laparoscopic cholecystectomy due to the inflammatory response to the bile deposits inside the pelvic peritoneum, which upon diagnostic laparoscopy, mimicked peritoneal carcinomatosis.

REPORT OF A CASE

The patient was a 30-year-old female who was admitted to the emergency room with intermittent sharp and dull pain to her right lower quadrant for the past two days. Patient denied any nausea, vomiting, diarrhea, constipation or temperature. She was in complete normal health prior to this episode. Her past medical and surgical history included hypothyroidism, known allergies to penicillin, and laparoscopic cholecystectomy ten years before. She denied alcohol, tobacco or drug abuse.

Physical examination revealed normal bowel sounds, positive peritoneal signs and guarding. However, Rovsing's sign was absent. Laboratory examination showed mild leukocytosis with slight increase of neutrophils. Computed tomography (CT) of abdomen and pelvis showed mild intra and extra hepatic biliary dilatation. Magnetic resonance imaging (MRI) of abdomen showed no evidence of choledocholithiasis. Preliminary impression was to rule out acute appendicitis, ectopic pregnancy or urinary tract infection.

MATERIALS AND METHODS

The urinalysis shows no pathologic findings and urine cultures were negative. The patient was admitted for diagnostic laparoscopy and probable laparoscopic appendectomy. During the procedure, the surgeon noted multiple small yellow nodules studded on the omentum, serosa of the appendix, and pelvic peritoneum. Proximal segment of the vermiform appendix (Fig. 1) was slightly dilated. These yellow nodules clinically raised the suspicion of peritoneal carcinomatosis. Fallopian tubes and ovaries were unremarkable. Appendectomy was performed and omental biopsy included some of these nodules.

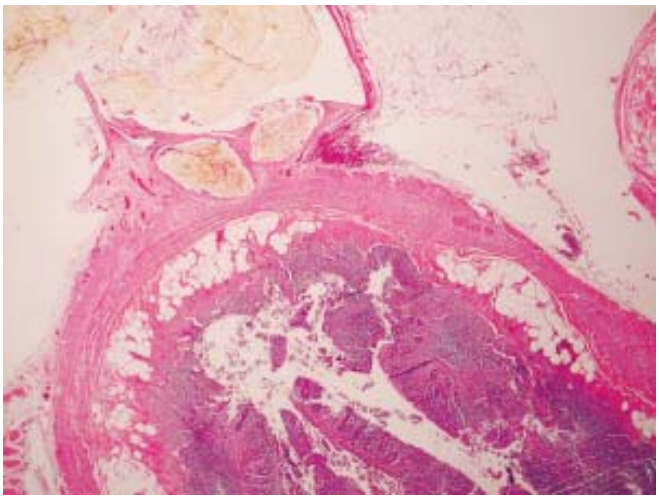

Fig. 1: Vermiform appendix with serosal implants (2X, H and E Stain)

PATHOLOGIC FINDINGS

1. Nodules with nonpolarizing yellow bile pigment material/ precipitate and cholesterol crystals associated with foreign body (Figs 2 to 4) type chronic granulomatous inflammation on serosa of appendix and omentum. No evidence of carcinoma.
2. Mild periappendicitis. The lumen is slightly distended with hemorrhagic fluid.

COMMENT

A review of the history of minimal access surgery by Dr RK Mishra[1] goes back to 1585. Laparoscopic surgery was originally popular amongst gynecologists and orthopedic surgeons. The first scientifically documented laparoscopic cholecystectomy was performed by Erich Muhe in Germany in 1985.[1] Eddie Joe Reddick and Olsen popularized this procedure in the United States in 1989.[1]

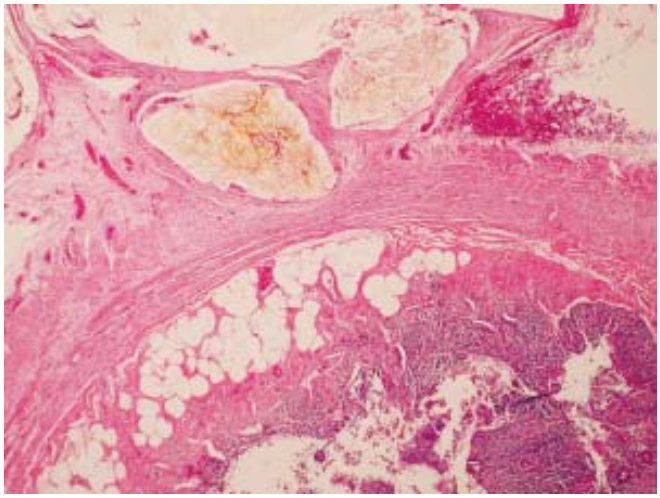

Fig. 2: Loculated bile cysts (4X, H and E Stain)

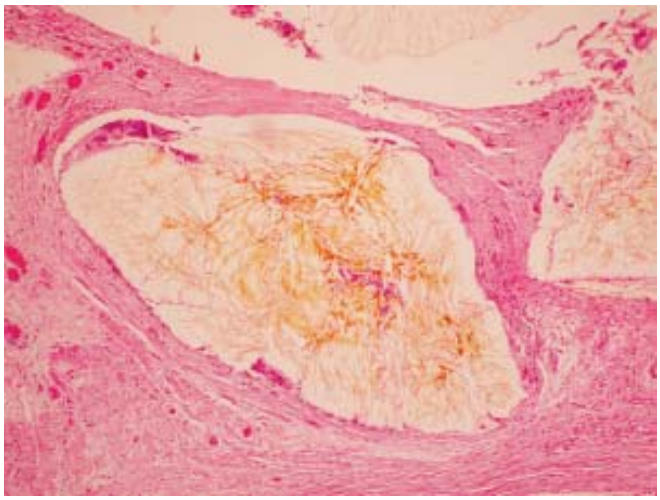

Fig. 3: Bile cysts with fibrous adhesions and periappendicitis (10X, H and E Stain)

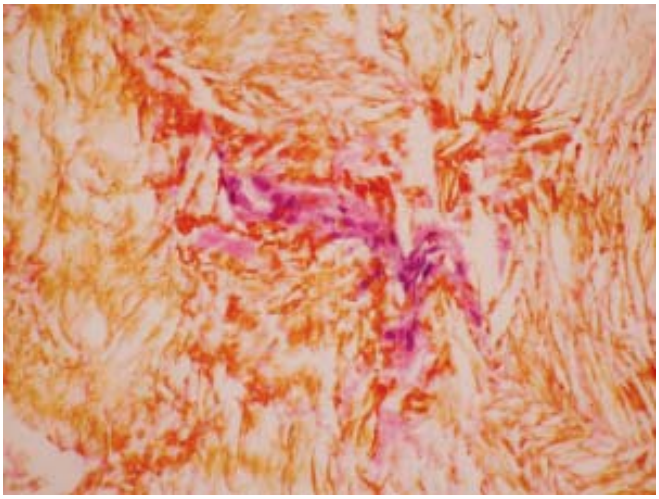

Fig. 4: Foreign body reaction associated with bile pigment (40X, H and E Stain)

There are both short and long-term complications of this minimally invasive procedure, especially in laparoscopic cholecystectomy from the spillage of bile and gallstones inside the peritoneal cavity. Minor intraoperative perforation of the gallbladder occurs in approximately 29% cases. Immediate complications include localized bile collection in the gallbladder fossa, which can be treated by endoscopic retrograde cholangiopancreatography (ERCP) with biliary stenting.[2] Some complication resulted in inflammation and intra-abdominal abscess[3] or, retroperitoneal abscess formation, mimicking gluteal abscess.[4] Attempts should be made to irrigate the field of operation to remove the spilled bile and gallstone to avoid future complications. Other complications include granulomatous peritonitis, mimicking pelvic endometriosis.[5] Sometimes, early complications can be manifested by postoperative pain and pyrexia, identified and corrected.

But, some long-term complications are fascinating to both surgeons and pathologists, which may arise even several years after the operation. Careful taking of history is important to correlate the complications of past laparoscopic procedure with the present illness. Intestinal adhesions and obstruction from chronic serositis or abnormal radiographic presentation of the nodules mimicking tumor are not uncommon. A prospectively maintained database of 1528 patients showed complications in 12% of gallstone spillage patients.[6] To avoid psychological trauma to the patient related to misdiagnosing cancer or performing unnecessary laparotomy, the surgeons should follow on those patients postoperatively. Ultrasound or CT is the most sensitive means for tracing spilled gallstones or abscesses. Cholelithoptysis is a rare complication, including chest discomfort and pleural effusion.[7] Some unusual late

presentations of spilled gallstones and bile include abdominal wall sinus,[8] acute appendicitis,[9] and spontaneous erosion through the back,[10] Sometimes, chronic pain and jaundice can be seen from the retained stones.[11] Bile and stones should be completely removed from the peritoneal cavity, to prevent late complications and unwanted laparotomy.

In conclusion, every effort should be made to make this simple procedure valuable to the patient, clinicians themselves, and long-term cost effective for the health care by removing thoroughly the bile and the gallstones from the peritoneal cavity.

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Laparoscopic Management of Undescended Testis

[1]Sarvepalli Sudhakar, [2]Balachandran Premkumar

[1]General Surgery-registrar, [2]Consultant General and Laparoscopic Surgeon, Apollo Hospitals, Chennai

Abstract: A 28-year-old male was identified to have a right sided undescended testis, on his master health check-up. Ultrasound examination identified the testis to be in the inguinal canal near the deep ring. The patient was counseled of the consequences of undescended testis in the adult and after obtaining his fully informed consent he underwent a laparoscopic right orchidectomy and mesh repair.

This article highlights the consequences of undescended testis, the various modalities of investigation, treatment and also emphasizes on the role of laparoscopy in its management.

Keywords: Undescended testis, cryptorchidism, orchidectomy, laparoscopy.

CASE REPORT

A young software engineer attended the master health check-up as his pre-employment requirement. His clinical examination found the absence of the right testicle. He was not aware that he had a problem, and mentioned that his condition was present from birth. He was completely evaluated and his left testicle was found to be normal. An ultrasound examination confirmed an empty right scrotum with presence of the right testicle with 'altered echotexture' in the right inguinal canal near the deep ring (Fig. 1).

The patient was counseled and informed consent for surgery was obtained. He underwent a laparoscopic right orchidectomy and mesh repair. During surgery his right iliac nodes were found to be enlarged which were removed and sent for histopathological examination.

His postoperative period was uneventful and he was discharged on the first postoperative day. His sutures were removed on the tenth postoperative day.

The histopathological findings of the testis were consistent with cryptorchid testis, while the lymph nodes showed only reactive changes.

The patient was advised to carry on routine activities and have an abdominal ultrasound once a year as follow-up.

OPERATIVE STEPS

Under general anesthesia, the patient was placed in the supine position. The theatre set-up was as shown in the Figure 2.

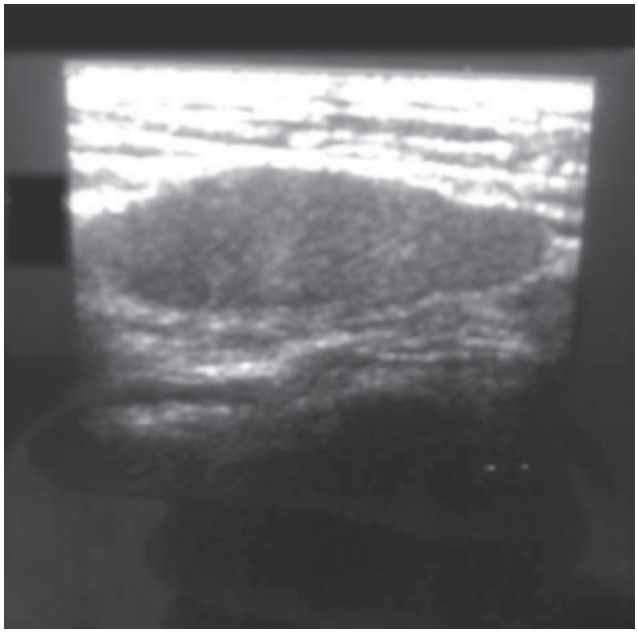

Fig. 1: Ultrasound showing testis in right inguinal canal

The trocars were placed as follows:

- 10 mm—umbilical–camera port.
- 5 mm—right lumbar–right hand working.
- 5 mm—left lumbar–left hand working.

On entry into the peritoneal cavity a thorough inspection of all the viscera was done. The peritoneum over the right inguinal region was dissected and the spermatic cord was identified entering into the deep ring. Traction was applied to the cord and the testis was delivered into the peritoneal cavity. The cord was ligated and the testis was cut and extracted through an extended umbilical port. A few enlarged lymph nodes were found along the right iliac vessels which were removed and sent for histopathology. As the right inguinal canal was empty a mesh repair using prolene mesh was done and anchored with tackers. The peritoneum was closed over the mesh using tackers. Pneumoperitoneum was reduced and the ports were closed with 1' Vicryl; and 3'0 Monocryl.

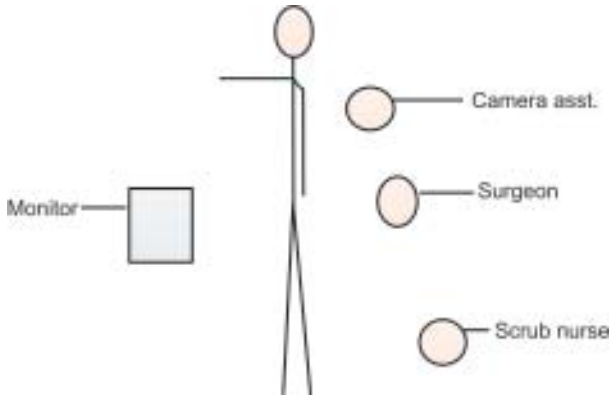

Fig. 2: Setup in the operation theatre

DISCUSSION

Most undescended testicles are present at birth. True undescended testicles rarely descend spontaneously after three months of age. Through surgical examination, about one half of nonpalpable testes are found to be intra-abdominal, while the rest represent absent (vanishing) or atrophic testes. The vanishing testicle is thought to be caused by intrauterine testicular torsion.[11]

Underlying reasons for cryptorchidism, such as Prader-Willi, Kallmann's or Laurence-Moon-Biedl syndromes should be looked for in these patients. The genitalia should be examined for evidence of hypospadias or ambiguity. Concurrence of hypospadias and undescended testis is commonly associated with states of intersexuality,[9] especially mixed gonadal dysgenesis and true hermaphroditism.[10]

Treatment for the undescended testis is recommended as early as six months of age and should be completed before age two.[1] Orchidopexy should be done either as a single or multi staged procedure, and the testis should be brought down into the scrotum. In adults orchidopexy and scrotal placement of the testis gives cosmetic satisfaction to the patient and also maintains steroid hormonogenesis. However, the patient should be counseled on the importance of repeated self examination as the incidence of malignancy in these testicles is higher. If one testis is normal and functioning well the option of orchidectomy can be given to the patient to avoid the problem of these examinations.

CLASSIFICATION OF UNDESCENDED TESTIS

1. True undescended testicles (including intra-abdominal, peeping at the internal ring and canalicular testes), which exist along the normal path of descent and have a normally inserted gubernaculum.
2. Ectopic testicles, which have an abnormal gubernacular insertion.
3. Retractile testicles, which are not truly undescended.

CONSEQUENCES OF UNDESCENDED TESTIS

Testicular neoplasm, subfertility, testicular torsion and inguinal hernia are the known and documented consequences. Of the neoplasms, testicular germ cell cancers are usually seen. The incidence among men with an undescended testicle is approximately one in 1,000 to one in 2,500.[7]

Such individuals are found to have lower sperm counts, poorer quality sperm and lower fertility rates than men whose testicles descended normally. The likelihood of subfertility increases with bilateral involvement and increasing age at the time of orchiopexy.

The incidence of testicular torsion is thought to be higher in undescended testes than in normal scrotal testes. Torsion of an undescended testicle often occurs with the development of a testicular tumor, presumably caused by increased weight and distortion of the normal dimensions of the organ. Torsion of an intra-abdominal testicle may present as an acute abdomen.[10]

Most true cases of undescended testicles are associated with a patent processus vaginalis. A man with an untreated, undescended testicle and an occult inguinal hernia may present at any time with symptoms and complications typical of any inguinal hernia.[7]

HORMONAL THERAPY

Human chorionic gonadotropin (HCG) is used and is administered intramuscularly. However, the likelihood of success is greatest in the most distal true undescended testicles. In theory, an ectopic testis should not respond to hormone therapy because it is physically prevented from descending. A high undescended testis is unlikely to descend completely; if it does, it will probably ascend after the hormone stimulation is withdrawn. Some side effects of hCG administration can be disturbing for parents. These include enlargement of the penis, pubic hair growth, increased testicular size and aggressive behavior during administration. Studies suggest that gonadotropin-releasing hormone (GnRH) is more effective than HCG in achieving testicular descent.[8]

ROLE OF LAPAROSCOPY

It is diagnostic and potentially therapeutic.[3] Initially, it is important to determine whether a testis exists. If the absence of a testis is surgically confirmed by identifying blind-ending testicular vessels, the surgery should be terminated. Sometimes, the testicular vessels are traced to an abdominal, inguinal or scrotal testicular remnant, which is then removed. In about one half of cases, an intra-abdominal testis is found which is either brought to the scrotum or removed.[12]

After performing a diagnostic laparoscopy, the inguinal rings are examined, and the status of the processus vaginalis (patent or non-patent), wolffian structures and testicular vessels can be easily identified.[2] The presence of blind-ending spermatic

vessels confirms an absent testis, allowing termination of the procedure without a groin incision. If vessels and vas deferens exit the internal ring, the groin can be explored. If an intra-abdominal testis is identified, the physician can then choose the best surgical approach.[12]

Laparoscopy is the modality of choice for cryptorchid children.[13] In majority of adult patients cryptorchid testis is intra-abdominal either at the deep ring or high intra-abdominally. Laparoscopy obviates the need of unnecessary inguinal exploration and disrupting normal inguinal canal mechanism. If attenuated testicular vessels are noted entering inguinal canal, then inguinal exploration is indicated. However, in cases of blind ending vas, when there is no inguinal hernia, laparoscopy can be safely used with the deep ring occluding mesh plug.[4]

CONCLUSION

Laparoscopy remains the modality of choice in the diagnosis and surgical management of adult cryptorchidism.[12] Its minimal invasiveness combined with excellent imaging obviates the need for costly investigations like MRI and CT scan and prevents unnecessary inguinal exploration and laparotomy.[5, 6]

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Laparoscopic versus Open Appendectomy for the Treatment of Acute Appendicitis

RK Mishra, GB Hanna, A Cuschieri

Surgical skills Unit: Department of Surgery and Molecular oncology, Ninewells Hospital and Medical School, University of Dundee

Abstract: Open appendectomy is the 'gold standard' for the treatment of acute appendicitis. Laparoscopic appendectomy though widely practiced has not gained universal approval. Although it is a generally safe operation, postoperative complications occur in few patients. Laparoscopic appendectomy was first described in 1983. Reports of early studies were equivocal with few studies evaluating analgesic requirements and the length of hospital stay. This study was aimed to compare laparoscopic with open appendectomy and ascertain the therapeutic benefit, if any, in the overall management of acute appendicitis.

Keywords: Laparoscopic appendectomy, Appendectomy, Appendicitis, Laparoscopic vs open appendectomy.

INTRODUCTION

Appendicitis was first recognized as a disease entity in the sixteenth century and was called perityphlitis. McBurney described the clinical findings in 1889. Minimal access surgery has been proved to be a useful surgical technique. New standards have been established for various indications. Patient comfort is a greater consideration in the 21st century. The acquisition of recent technology and skills now affords a better choice of the mode of surgery. This document reviews the recent advances in treatment technique applicable to laparoscopic appendectomy, examines the literature, and suggests guidelines for laparoscopic intervention in patients with acute appendicitis.

AIMS

The aim of this study was to compare the effectiveness and safety of laparoscopic and conventional "open" appendectomy in the treatment of acute appendicitis. The following parameters were evaluated for both laparoscopic and open procedures.

1. Method of patient selection
2. Operative technique
3. Operating time
4. Intraoperative and postoperative complications
5. Postoperative pain and amount of narcotic used
6. Time until resumption of diet
7. Postoperative morbidity
8. Hospital stay
9. Cost effectiveness and
10. Quality of life analyses.

MATERIALS AND METHODS

A literature search was performed using Medline and the search engine Google. The following search terms were used: "laparoscopic appendectomy", "appendicitis", and "appendicectomy". 3400 citations found in total. Selected papers were screened for further references. Criteria for selection of literature were the number of cases (excluded if less than 20), methods of analysis (statistical or nonstatistical), operative procedure (only universally accepted procedures were selected) and the Institution where the study was done (Specialized institution for laparoscopic surgery).

CONTENT

Evolution of Laparoscopic Appendicectomy

Laparoscopic appendectomy is being done at a time when laparoscopic cholecystectomy has shown definite benefits over the open technique. In the young female the cause of lower abdominal pain is often gynecological. Gynecologists perform diagnostic laparoscopy frequently. Semm, a German gynecologist, performed the first laparoscopic appendectomy in 1983.

Laparoscopic cholecystectomy is now the gold standard for cholelithiasis and has virtually replaced open cholecystectomy. However, is this the case for acute appendicitis? The role of laparoscopic appendectomy has not yet been clearly defined. Laparoscopic surgery continues to evolve at such a rapid pace that it is now time to examine the latest developments with regard to acute appendicitis. Numerous factors need to be considered in deciding the ideal, and most appropriate surgical technique for acute appendicitis.

Diagnosis of Acute Appendicitis and Laparoscopic Appendectomy

The diagnosis of acute appendicitis is mainly clinical. Several methods have been suggested to diminish the diagnostic error that occurs if diagnosis is based solely on the clinical picture of suspected appendicitis. The symptoms of appendicitis can initially be difficult to differentiate from gastroenteritis. Early symptoms may include vague bloating, indigestion and mild pain which generally is perceived as being in the area of the umbilicus.

As the infection worsens, the pain becomes more prominent in the right lower quadrant. There is usually nausea, vomiting and loss of appetite. The pain is generally constant and progressive. There may be *diarrhea,* fever, and chills. These symptoms progress over several hours to several days. However, many patients may not report the sequence of symptoms outlined above. Therefore, an accurate diagnosis of appendicitis can often be challenging. Many other conditions can mimic appendicitis such as *gastroenteritis,* kidney stones, urinary infections, ulcerative colitis and Crohn's disease. In women, problems such as *ovarian cysts* and pelvic infections can mimic appendicitis. In fact appendicitis is a disease which can mimic most of the causes of abdominal pain as well as some chest pathology.

Despite new X-ray techniques, CT scans and ultrasounds, the diagnosis of appendicitis can be challenging. So far the most accurate non-invasive method of diagnosis is ultrasonography but this is not totally reliable. The history and physical examination will generally lead to the correct diagnosis. According to one prospective non-randomized study laparoscopy may prevent unnecessary appendectomy in 24% of patients. Laparoscopy reveals a misdiagnosis rate of 8% in males and 41% in females of reproductive age group.[54,55] Laparoscopic appendectomy gives a better evaluation of the peritoneal cavity than that obtained by the standard gridiron exposure. The procedure allows rapid and thorough inspection of the para-colic gutters and the pelvic cavity that is not possible with the open gridiron approach. The laparoscopic approach for patient with suspected appendicitis improves the diagnostic accuracy and is therefore recommended.[70]

There is also debate on whether a normal looking appendix be removed at the time of laparoscopy or not? The major criticism against leaving the appendix in place is that mucosal inflammation might be overlooked because only serosa can be inspected. Walker, et al reported that 3.2% of the intraoperatively normal appearing appendices demonstrated acute inflammation after pathological examination.[51] Mucosal inflammation obviously can never be determined if the appendix is left in place. The majority of surgeons state that normal looking appendix should not be removed.[52] Previously there was doubt on the color reliability of the image of inflamed appendix on the monitor, but after the advent of the three chip camera the sensitivity of laparoscopic diagnosis of appendix is 92%.[53]

Laparoscopic Appendectomy Women vs Men

Most surgeons agree on the use of laparoscopy when a patient is a young female with vague lower abdominal pain and its progress to appendectomy. There are innumerable reports showing that laparoscopy improves diagnosis and reduces unnecessary appendectomies in fertile women.[29,30,41,50,63,65,70]

The diagnostic problem of suspected appendicitis is not limited to fertile women. It is also a problem of premenopausal women. One study was done in Dublin on 100 premenopausal women who were admitted with abdominal pain. After final assessment, patients were placed in following diagnostic categories; gynecological (30%); renal (9%); acute appendicitis (23%); nonspecific abdominal pain (29%) and miscellaneous (9%).

The mean duration of hospital stay for patient with non specific abdominal pain was 67 days and one third of these patients, underwent appendectomy for normal appendix.[75] Abdominal pain in premenopausal women is often psychosomatic and the laparoscopic intervention may be considered in these women with nonspecific pain abdomen to prevent removal of a normal appendix.

Even though laparoscopic appendectomy has been claimed to reduce postoperative pain, length of hospitalization, analgesic doses and surgery associated complication, many surgeons do not advocate this procedure on men because they do not find any superiority of laparoscopy over the open procedure.[20,28,31,36] Cox et al conducted a prospective randomized comparison of open versus laparoscopic appendectomy exclusively in men and they reported that laparoscopic appendectomy in men has significant advantages in terms of more rapid recovery.[60]

Appendectomy in Pediatric Patients

Although laparoscopic appendectomy is gaining popularity, open appendectomy has remained popular with surgeons caring for children. The reasons for this include the increased skill level necessary for pediatric laparoscopic procedures, concerns over increased operating times and costs, and fears that the laparoscopic approach to appendicitis is somehow associated with an increased complication rate.

There is a group of surgeons who are advocating laparoscopic appendectomy in all cases of appendicitis in pediatric patients. In one prospective nonrandomized trial 500 appendectomies were studied, 362 children underwent open procedure and 138 underwent laparoscopic appendectomy. There was no mortality in either group. Major complications were 3% in open group but no major complications were seen in

the laparoscopic group. Minor complications were 20% in open and 13% in laparoscopic appendectomy.[76]

Paya et al published a prospective study of 75 children with perforated appendicitis. Ten underwent laparoscopic appendectomy and the remainder underwent open operation. There were no postoperative abscesses in the laparoscopic group but 2 (3.1%) of 65 patients who had open appendectomies developed postoperative intra-abdominal abscesses.[38]

In a prospective series of children aged 4-12 years, reported from Cairo, 48 underwent open appendectomy and 34 laparoscopic operation, over a 6 month period. Wound complications were fewer, cosmetic appearance better, and time to return to normal activities quicker (7 cf 12 days) in the laparoscopic group.[59] Lintula H, et al studied the effect of laparoscopic appendectomy in children between 4-15 yr of age and demonstrated that laparoscopic appendectomy was not associated with any increase risk of intraoperative or long-term complications.[32]

Appendectomy in Pregnancy

Is laparoscopic appendectomy safe in pregnancy? There has been increased interest in using laparoscopic procedures during pregnancy. A prospective study was done to evaluate the safety and outcome of pregnancy after both open and laparoscopic procedures. 11 pregnant women underwent laparoscopic appendectomy and 11 underwent open appendectomy. Their gestation age ranged from 7 to 34 weeks. The following parameters were analyzed:

- Obstetric and gynecologic risk factors
- Length of procedure
- Perioperative complications
- Length of stay and outcome of pregnancy.

The study showed that laparoscopic appendectomy is safe in all trimesters of pregnancy. There was no significant difference in the length of operation. (60 vs 46 min). There was no fetal loss or other adverse outcome of pregnancy after laparoscopic appendectomy. The development of the infant was normal in both the group of patients.[33]

While these reports indicate that laparoscopy can be safely performed during pregnancy, some surgeons are suggesting that whenever possible, operative intervention should be deferred until the second trimester when fetal risk is lowest.[68] Pneumoperitoneum enhances lower-extremity venous stasis, which already present in gravid patient. Pregnancy also induces a hypercoagulable state, so pneumatic compression devices must be utilized in pregnant women at the time of appendectomy to prevent thromboembolism.

Appendectomy of Obese Patients

In the obese patient laparoscopic appendectomy has shown advantage over the open procedure in a faster postoperative recovery. A group of 106 patients with a body mass index (BMI) > 26.4, representing the upper quintile of 500 prospectively randomized patients, were included in the study. They were randomized to undergo either laparoscopic or open appendectomy. Following parameters were evaluated:

- Operating and anesthesia times
- Postoperative pain
- Complications
- Hospital stay
- Functional index (1 week postoperatively)
- Sick leave, and
- Time to full recovery.

The prolonged hospital stay and sick leave noted in overweight patients undergoing open appendectomy was abolished when overweight patients were treated with laparoscopic appendectomy. Laparoscopic procedures are however more prolonged in the obese than in the normally nourished.[13,57] There is opinion of some surgeons that laparoscopy is beneficial in obese females and those presenting with appendiceal abscess, who are treated by intravenous antibiotics and percutaneous drainage followed by interval appendectomy. But in their opinion laparoscopic appendectomy is not indicated in all patients presenting with periappendicular abscess.[57]

Postoperative Pain

It is proved that laparoscopic procedures cause less post-operative pain than their conventional counterparts. In this study none of the literature reviewed found more pain after laparoscopic procedure. The postoperative narcotic use is less after laparoscopic appendectomy. In one study done by Ortega et al; linear analogue pain scores were recorded in 135 patients blinded to the procedure of operation by special dressing and pain score was very less in laparoscopic group compared to open. Another interesting observation has been the patient's perception of pain after appendectomy. Those who underwent laparoscopic appendectomy were more vocal of pain although it was of a lower intensity. However, after 48 hours they had a better sense of well-being and showed earlier postoperative food intake, ambulation and return to work and sport. This could have arisen from the expectation that laparoscopic procedures are painless or a lower level of endorphins released or the peritoneal injury from the pneumoperitoneum.

Postoperative Recovery after Appendectomy

It has been shown that those patients who underwent successful laparoscopic appendectomy have a better postoperative recovery. The reduced trauma to the abdominal wall is a very significant factor in postsurgical discomfort. The better mobility of the abdominal musculature and the earlier ambulation, reduce

the risk of the early postoperative complications of pneumonia and embolism.

A prospective randomized multi centre study was performed to compare the outcome of laparoscopic and open appendicectomy in patients with suspected acute appendicitis by Hellberg A et al. Patients having laparoscopic appendectomy recovered more quickly than their open counterpart, but interestingly there was no significant difference in sick leave than after laparoscopic operation.[19] An insignificant reduction in sick leave after laparoscopic appendectomy may be due to unawareness of general practitioners about recovery time difference between both the procedures, or patient expectation in terms of time off work.

Laparoscopic Appendectomy and Wound Infection

The risk of wound infection is less in laparoscopic appendectomy compared to the open procedure. A meta-analysis of randomized controlled trials has been reported with outcomes of 2877 patients included in 28 trials. Overall complication rates were comparable, but wound infections were definitely reduced after laparoscopy (2.3% to 6.1%).[17] Rohr et al reported higher wound infection rates after laparoscopic appendectomy, but most of the literature supports the view that wound infection is less common after a laparoscopic procedure. It should be cautioned that the definition of wound infection varies between studies.

Laparoscopic Appendectomy and Intra-abdominal Abscess

Some studies have shown a significantly increased incidence of postoperative intra-abdominal abscess with perforated appendicitis after laparoscopic appendectomy.[9,11,27,45,15,47]

More reports show that there is no increased incidence of intra-abdominal abscess formation after laparoscopic appendectomy. Barkhausen S et al conducted one trial, in which 930 patients were analyzed retrospectively. Conventional appendectomy was performed in 330 patients; laparoscopic in 554 others. The analysis shows that the incidence of intra-abdominal abscess formation rate was same in both groups.[8]

In Los Angeles, 2497 appendectomies were reviewed retrospectively. Indications for these procedures included acute appendicitis 57%, gangrenous appendicitis 12%, and perforated appendicitis in 31%. There was no difference in the rate of intra-abdominal abscess formation between the groups undergoing open and laparoscopic appendectomies for acute and gangrenous appendicitis. For perforated appendicitis, however, there was significantly higher rate of abscess formation following laparoscopic appendectomy compared to open appendectomy (9.0% vs 2.6%, P = 0.015%).[69]

Laparoscopic Appendectomy in Complicated Appendicitis

Due to the risk of intra-abdominal abscess formation there is a strong controversy among surgeons regarding the use of the laparoscopic procedure in complicated appendicitis (gangrenous or perforated).

There are several reports which state that if gangrene or perforation is found at the time of laparoscopic appendectomy than the procedure should be converted. Frazee and Bohannon published a retrospective analysis of 15 patients with gangrenous appendicitis and 19 patients with perforated appendicitis who underwent laparoscopic appendectomy. They found a 7% rate of postoperative intra-abdominal abscess in the gangrenous group and a 26% rate of postoperative intra-abdominal abscess in the perforated group.[15]

A prospective randomized study by Bonnani et al. found that among adult patients, 2 of 66 (3.03%) patients undergoing open appendectomy for complicated (gangrenous or perforated) appendicitis developed postoperative pelvic abscesses. Three of 11 patients (27%), developed postoperative pelvic abscesses following laparoscopic appendectomy for complicated appendicitis, and 1 patient developed a postoperative hepatic abscess.[9]

Tang et al found a postoperative intra-abdominal abscess rate of 11% for perforated appendicitis treated laparoscopically compared with a rate of 3% treated by the open method.[47]

In contrast, there is a group of laparoscopic surgeons, who are now gaining confidence in handling complicated cases of appendicitis. Johnson, after a retrospective trial of 112 patients, advocates that most cases of acute appendicitis with suspected perforation could be managed laparoscopically. There is a large group of surgeons who believe that laparoscopic appendectomy is safe in all form of appendicitis, even in perforated appendicitis.[8,23,24,40,66,67] Some believe that even if the patient presents with fresh lower abdominal early peritonitis or even if there is chance of fresh abscess formation, laparoscopic appendectomy is not only justifiable but also even recommended as the procedure of choice.[48] In generalized peritonitis laparoscopic is not advocated.

Operating Time and Laparoscopic Appendectomy

In almost all the literature the operating time of laparoscopic appendectomy was found to be more than that of open appendectomy. The difference in mean operating time ranged from 8.3 to 29 minute. The operating time of laparoscopic appendectomy also depends on the experience of the surgeon and the competence of their team.[10]

In considering operating time, the exact identification of the timing of the start of the procedure and its conclusion vary. In

general the time should be calculated from the insertion of first trocar to the end of skin suturing. Cox, et al defined operating time as the time from incision to wound closure.[60] Tate et al calculated the time as use of anesthesia to the administration of a reversal agent.[71] Generally all laparoscopic procedures are more time consuming for the following reasons.

- Inherent nature of slow manoeuvre of laparoscopic techniques
- Time taken by careful slow insufflation
- Routine diagnostic laparoscopy before starting any laparoscopic procedure.

A meta-analysis of randomized controlled trial has been reported with outcomes for 2877 patients. The mean operating time was 16 minutes longer for laparoscopic appendectomy.

A prospective randomized trial comparing laparoscopic appendectomy with open appendectomy was conducted in 158 patients by Hansen et al. They reported that despite of longer operating time, (63 versus 40 minutes) the advantages of laparoscopy (such as fewer wound infection and earlier return to normal activity) make it a worthwhile alternative for patients with a clinical diagnosis of acute appendicitis.[61,60]

Kazemier et al in their report of a randomized clinical trial of 201 patients found that laparoscopic appendectomy is superior to open surgery regarding postoperative pain and postoperative complications, recovery time and financial.[66]

Long-term Complications and Laparoscopic Appendectomy

Adhesion formation is now one of the most common causes of intestinal obstruction. The role of adhesion in the development of chronic abdominal pain, although less certain, cannot be ignored.[1] Reduced adhesion formation is a substantive long term advantage of laparoscopic appendectomy.

A study reported an adhesion rate of 80% after open appendectomy compared to 10% after laparoscopic appendectomy, when patients were laparoscoped three months after surgery.[1] It has been shown that the tissue trauma of the incision increases the total inflammatory response, thereby inhibiting fibrinolysis and promoting fibroblast migration and collagen formation.

These results strongly suggest that laparoscopic surgical techniques lead to fewer intra-abdominal adhesions by reducing tissue trauma, which in turn reduces circulating inflammatory mediators.[56]

LAPAROSCOPIC APPENDECTOMY IN SOME DISEASED CONDITIONS

There are some diseases where laparoscopic appendectomy has found clear benefit over open appendectomy.

Cirrhosis

The immunity of the cirrhotic patient is compromised and there is more chance of wound infection with the open procedure. Patients with cirrhosis have shown a faster recovery when treated by laparoscopic procedure, for acute appendicitis.[48] These patients were benefited by this less traumatic method of surgery.

Sickle Cell Disease

There is also a report that laparoscopic appendectomy has clear benefit over open inpatients with sickle disease. Patients with acute appendicitis will certainly require surgery that may be associated with high morbidity and mortality as a result of perioperative and postoperative complications, mainly vaso-occlusive crises (VOC). The introduction of minimally access surgery is believed to be associated with minimal risks to the patients due to its numerous advantages over conventional methods.[5] The morbidity associated with surgery in sickle cell patients can be further reduced by the use of preoperative exchange transfusion and adequate maintenance of hydration in the patient with sickle cell disease.

LAPAROSCOPY AND IMMUNITY

All surgery and anesthesia can cause depression of cell-mediated immunity in the postoperative period, including reduction in the number of circulating lymphocytes, impairment of natural killer cell cytotoxicity, depression of T cell proliferation, and diminished neutrophil function. Animal and clinical studies have shown that laparoscopic surgery impairs a patient's immune state less than open surgery. Cell-mediated immunity is less impaired after laparoscopic operation than after open. Interleukin 6 levels were less in a study on newborn infants undergoing laparoscopic procedures when compared to open.[55]

LAPAROSCOPY AND RISK OF ANESTHESIA

The general anesthesia and the pneumoperitoneum required as part of the laparoscopic procedure does increase risk in certain patient groups. Most surgeons would not recommend laparoscopic appendicectomy in;

- Patients with cardiac diseases and COPD
  - — Should not be considered a good candidate for laparoscopic appendectomy.
- In patients who have had previous lower abdominal surgery
  - — Laparoscopic appendectomy may also be more difficult.
- The elderly
  - — May also be at increased risk for complications with general anesthesia combined with pneumoperitoneum.

- Those with lowered cardiopulmonary reserve
  - With regard to the consequences of the pneumoperitoneum and a longer operative time.

COST EFFECTIVENESS OF LAPAROSCOPIC APPENDECTOMY

Debate still exists about the cost comparison between laparoscopic and open surgery. Most surgeons have the opinion that laparoscopic appendectomy is cost effective. It may be more expensive for the hospital but it offers diagnostic accuracy, and among employed patients, offers cost savings to society as a result of faster return to work.[2,14,18,64]

Heikkinen TJ, et al reported a randomized study for cost effectiveness of laparoscopic appendectomy, the hospital cost for laparoscopic appendectomy was higher, but it offers significant cost savings from the rapid convalescence. Return to normal life and work was faster in the laparoscopic group (14 versus 26.5 days).[18] The Hospital costs of laparoscopic appendectomy were higher but the total costs were lower, such that a saving of $1481 was realized by laparoscopic appendectomy.[2]

LAPAROSCOPIC APPENDECTOMY AND SURGICAL EXPERIENCE

The outcome of any laparoscopic procedure greatly depends on the experience of the surgeon. In a study of two groups, conducted at Los Angeles, general surgical services operated on 413 patients, and 232 cases underwent the same procedure by trained specialized laparoscopic surgeons.

General surgical services	285 acute	61 gangrenous	67 perforated
Laparoscopic surgeons	126 acute	46 gangrenous	60 perforated

10 abscesses occurred postoperatively (2.4%) in the group of patients whose operation was done by general surgical services, and only one case of intra-abdominal abscess (0.025%) were reported in the group of patients whose operation were performed by a standardized laparoscopic method, using skilled dissection, careful use of retrieval bag, proper ligation of stump and thorough peritoneal toilet). This study may be taken to indicate that complications such as intra-abdominal abscess following laparoscopic appendectomy for perforated appendices can be reduced significantly by training.

DISCUSSION

Laparoscopic appendectomy has gained lot of attention around the world. However, the role of laparoscopy for appendectomy, one of the commonest indications, remains controversial. Several controlled trials have been conducted, some are in favor of laparoscopy, others not. The goal of this review was to ascertain that if the laparoscopic appendectomy is superior to conventional, and if so what are the benefits and how it could it be instituted more widely. There is also diversity in the quality of the randomized controlled trials. The main variable in these trials are following parameters:

- Number of patients in trial
- Withdrawal of cases
- Exclusion of cases
- Blinding
- Intention to treat analysis
- Publication biases
- Local practice variation
- Prophylaxis antibiotic used
- Follow-up failure.

Without proper attention to the detail of all the parameters it is very difficult to draw a conclusion. It has been found among the surgeons that; there is a hidden competition between laparoscopic surgeons and the surgeons who are still doing conventional surgery, and this competition influences the result of study. One should always think of laparoscopic surgery and open as being complimentary to each other.

A successful outcome requires greater skills from the operator. The result of many comparative studies have shown that outcome of laparoscopic appendectomy was influenced by the experience and technique of the operator. Minimal access surgery requires different skills and technological knowledge. With a clear diagnosis of complicated appendicitis, the skill and experience of the surgeon should be considered for the selection of operating method. Surgeons should perform the procedure with which they are more comfortable.

RELATIVE RISK FACTORS OF LAPAROSCOPIC APPENDECTOMY

Missed Diagnosis

There is report also of Mucinous cystadenoma of the cecum missed at laparoscopic appendectomy.[49] Less than 1% of all patients with suspected acute appendicitis are found to have an associated malignant process. During conventional appendectomy through a laparotomy incision, the caecum and the appendix are easily palpated, and an obvious mass can be detected and properly managed at the time of appendectomy. The inability to palpate any mass is an inherent problem of laparoscopic surgery.

Bleeding

From the mesoappendix, omental vessels or retroperitoneum. Bleeding is usually recognized intraoperatively via adequate exposure, lighting, and suction. It is recognized postoperatively by tachycardia, hypotension, decreased urine output, anemia, or other evidence of hemorrhagic shock.

Visceral Injury

Risk of accidental burns is higher with monopolar system because electricity seeks the path of least resistance, which may be adjacent bowel. In a bipolar system since the current does not have to travel through the patient, there is little chance of injury to remote viscera. In laparoscopic appendectomy only bipolar current should be used. Laparoscopists should also routinely explore the rest of the abdomen.

Wound Infection

It is recognized by erythema, fluctuation and purulent drainage from port sites. The absence of wound infections after laparoscopic appendectomy can be attributed to the practice of placing the appendix in a sterile bag or into the trocar sleeve prior to removal from the abdomen. The regular use of retrieval bag is a very good practice for preventing infection of the wound.

Incomplete Appendectomy

If surgeon is not experienced, the stump of the appendix may be to long. There is a report of intra-abdominal abscess formation due to retained faecolith after laparoscopic appendectomy. It is strongly advised that the surgeons performing laparoscopic appendectomy should remove faecolith if found, and the stump of appendix should not big enough to contain any thing.[11] Incomplete appendectomy is a result of ligation of the appendix too far from the base. It may lead to recurrent appendicitis, which presents with symptoms and signs of appendicitis even after laparoscopic appendectomy.

Some surgeons prefer stapling of the appendiceal stump for laparoscopic appendectomy for the treatment of all forms of appendicitis.[34] But most of the surgeons now agree that ligation of the appendectomy stump is the best approach. There is report of slippage of clip, residual appendicitis followed by abscess formation after using clip for appendiceal stump.[74] The ligation should be preformed by using endoloop, an intra-corporeal surgeon's knot, or done extra corporeally using a Meltzer's knot or Tayside knot. The security of the knot is essential. It is influenced by the proper port location and experience of the surgeon.[4]

Leakage of Purulent Exudates from Appendix at the time of Operation

Usually seen intraoperatively while dissecting appendix. Copious irrigation and suction followed by continued antibiotics can prevent this complication until patient is afebrile with a normal white blood cell count. Use a retrieval bag. to prevent the spillage of infected material from the appendiceal lumen.

Intra-abdominal Abscess

This postoperative morbidity is recognized by prolonged ileus, sluggish recovery, rising leukocytosis, spiking fevers, tachycardia, and rarely a palpable mass. After confirmation of the intra-abdominal abscess drainage of pus followed by antibiotic therapy is essential. Sometime laparotomy may be required.

Hernia

Trocar site hernia as visible or palpable bulge is sometime encountered. Possible occult hernia manifested by pain or symptoms of bowel obstruction.

Laparoscopic appendectomy is now safe in experienced hands. In experienced hands, satisfactory peritoneal toilet can be performed even in the presence of Peri-appendiceal pus and regional peritonitis. Laparoscopic appendectomy is not advocated when the patient has generalized peritonitis.

Indications for the surgical treatment of appendicitis:

Laparoscopic appendectomy	*Open appendectomy*
Female of reproductive age group	Complicated appendicitis
Female of premenopausal group	COPD or cardiac disease
Suspected appendicitis	Generalized peritonitis
High working class	Previous lower abdominal surgery
Obese patients	Hypercoagulable sates
Disease conditions like cirrhosis of liver and sickle cell disease	Stump appendicitis after previous Incomplete appendectomy
Immune-compromised patients	

Future Prospects of Laparoscopic Appendectomy

In the future, remote handling technology will overcome some of the manipulative restriction of current instruments. There is no doubt that 20 years from now some surgeons will be operating exclusively via a computer interface controlling a master–slave manipulator. But the future of any new technology depends upon applications and training.[3]

CONCLUSION

Laparoscopic appendectomy is equally safe, and can provide less postoperative morbidity in experienced hands, as open appendectomy. Most cases of acute appendicitis can be treated laparoscopically. Laparoscopic appendectomy is a useful method for reducing hospital stay, complications and return to normal activity. With better training in minimal access surgery now available, the time has arrived for it to take its place in the surgeon's repertoire.

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Comparison of Drugs and Intravenous Crystalloid in Reduction of Postoperative Nausea and Vomiting after Laparoscopic Surgery

Alaa H Ali

Department of Anesthesiology, Medical city, Iraq, Baghdad

Abstract

Background: Nausea and vomiting are frequent after general anesthesia ,the most important causes of morbidity after anesthesia and surgery are postoperative nausea and vomiting.

Methods: A comparative analysis of published articles was done to determine the relative efficacy and safety of ondansetron, droperidol, metoclopramide, dexamethasone, and intravenous crystalloid fluid for the prevention of postoperative nausea and vomiting. I performed a literature search of English references using both the MEDLINE database and a manual search. Double-blinded, randomized, controlled trials comparing the effect of these agents in reduction or prevention of postoperative nausea and vomiting.

Results: A total of 60 studies were identified, of which 6 were excluded for methodological concerns. For each comparison of drugs, ondansetron ($P < 0.001$), droperidol ($P < 0.001$) were more effective than metoclopramide in preventing vomiting. We conclude that ondansetron and droperidol are more effective than metoclopramide in reducing postoperative nausea and vomiting. The incidence of vomiting was reduced in the intravenous administration of crystalloid 30 mg/kg in healthy adults ($P = 0.001$) and for dexamethasone is ($P < 0.03$).

Conclusion: In summary, both ondansetron and droperidol were more effective than metoclopramide, intravenous crystalloid fluid and dexamethasone in preventing postoperative vomiting.

Keywords: Laparoscopy postoperative nausea and vomiting, droperidol, metoclopramide, ondansetron, IV crystalloid.

INTRODUCTION

Postoperative nausea and vomiting (PONV) remains one of the most common postoperative complications and is experienced by up to 70% of patients (Hofer and colleagues).[1] It is a limiting factor in the early discharge of ambulatory surgery patients and is a leading cause of unanticipated hospital admission.[2,3] There is still controversy concerning the best approach to managing postoperative nausea and vomiting (PONV).[4] PONV can lead to increased recovery room time, expanded nursing care, and potential hospital admission—all factors that may increase total health care costs. Patients report that avoidance of PONV is of greater concern than avoidance of postoperative pain.[5] The optimal approach to PONV management remains unclear to many clinicians. Guidelines for prevention and treatment of PONV based on data from systematic reviews of randomized trials have been published.[6,7] Patients incur a fluid deficit by mandatory preoperative fasting. Guided intravenous fluid therapy improves outcomes in major surgery.[8,9] It has been suggested that relative hypovolemia may be a factor in such adverse outcomes after surgery and that preoperative administration of intravenous fluids reduces their incidence.[10] Gan and colleagues showed an earlier return to bowel function, decreased length of hospital stay and a reduction in PONV by using esophageal Doppler with goal-directed therapy aimed at maintaining stroke volume.[11] While they studied a major surgery group with expected blood loss in excess of 500 ml, their work supports our hypothesis that reduced bowel mucosal perfusion may be a factor in PONV. I, therefore performed a meta-analysis of published, randomized, controlled trials of prophylactic antiemetic therapy to determine the relative efficacy and safety of ondansetron, metoclopramide, droperidol, intravenous crystalloid fluid and dexamethasone for preventing PONV.

METHODS

An initial list of published studies was obtained by searching the MEDLINE database from (1996 to 2007) using the terms (MeSH as well as text search) "prevention," "postoperative complications," "nausea and vomiting" separately for "ondansetron," "droperidol," "metoclopramide, dexamethasone, and intravenous crystalloid fluid." The list was expanded by a manual search of table of contents in English anesthesiology journals and reference lists from all articles, review articles, correspondence, and abstracts related to PONV. Only English-language references were included.

Articles that met the following criteria were included in the meta-analysis:

1. The study was a double-blinded, randomized, controlled trial;
2. Patients underwent general anesthesia for laparoscopy;
3. Vomiting, nausea, or the use of rescue antiemetic therapy were identified as outcomes;
4. Antiemetic therapy was administered prophylactically, not just in the treatment of PONV;
5. At least two drugs (metoclopramide 10 mg, droperidol 20 microgram, ondansetron 2 mg, dexamethasone 2 mg IV crystalloid fluid 10 ml/kg and 30 ml/kg) were compared.

The meta-analyses were designed to determine the relative efficacy of ondansetron, droperidol, metoclopramide, dexamethasone and IV crystalloid fluid compared with each other in reducing the odds of PONV. Separate meta-analyses were performed for the different drug combinations. All patients from the included studies were categorized as having postoperative vomiting or nausea or using rescue antiemetic medication under each two-drug comparison. In some studies, counts were calculated from percentages identified in tables or figures. Studies with different drug doses within the therapeutic range. In the study where the patients received crystalloid fluid (JJ magner)[12] divided the patient into two group the CSL-10 group ($n = 70$) received compound sodium lactate (CSL) 10 ml kg–1; the CSL-30 group ($n = 70$) received CSL 30 ml kg–1. CSL contains sodium 131 mmol litre–1, potassium 5 mmol litre–1, calcium 2 mmol litre–1, chloride 111 mmol litre–1 and lactate 29 mmol litre–1. To maintain patient and investigator blinding, intravenous fluid administration was initiated in the preoperative area.

RESULT

The details of the articles involving a total of 676 patients included in the meta-analyses. The meta-analysis comparing the efficacy of ondansetron versus metoclopramide included 175 patients (Tables 1 and 2).[12] Droperidol versus metoclopramide analysis included (Table 2).[13] The ondansetron

TABLE 1: Demographic and clinical characteristic of patient population (N = 175)

Group (n)	*Age (yr)*	*Body weight (kg)*	*History of motion sickness*	*History of PONV*
Ondansetron (58)	34 + 10	58 + 11	18	NPAE = 16 PAEP = 24 NPAE = 18
Metoclopramide (57)	36 + 10	56 + 8	19	NPAE = 13 PAEP = 26 PAENP = 18
Placebo (60)	35 + 12	56 + 10	21	NPAE = 26 PAENP = 17

Age and body weight data are presented as mean = No. History of motion sickness and PONV data as presented as the number of patient. PONV = postoperative nausea and vomiting. NPAE = no previous anesthetic experience, PAEP = previous anesthetic experience with PONV, PANP = previous anesthetic experience without PONV.

TABLE 2: Odds ratio (95% confidence interval of one hour efficacy of antiemetic regimen in 175 patients)

Variables	*Odds ratio*		
	Nonadjusted	*Adjusted*	*P value**
Age (SD 10.8 yr)	0/85 (0.62-1.15)	1.02 (0.66-1.57)	0.927
Body weight (SD 9.6 kg)	0.78 (0.57-1.06)	0.67 (0.43-1.06)	0.080)
Motion sickness (present versus absent)	1.19 (0.61-2.32)	1.85 (0.75-4.56)	0.175
Past history			
PAEP versus NPAE	0.51 (0.24-1.11)	0.51 (0.18-1.49)	
PAENP versus NPAE	1.35 (0.55-3.27)	1.31 (0.38-4.55)	0.151
Duration (SD 32.5 min)	0.76 (0.56-1.03)	1.07 (0.60-1.93)	0.812
Fentanyl (SD 159 µg)	0.56 (0.41-0.78)	0.33 (0.17-0.62)	< 0.001
Treatment			
Ondansetron versus metoclopramide	6.73 (2.13-2.14)	17.8 (3.97-79.7)	
Placebo versus metoclopramide	0.27 (0.1300.58)	0.18 (0.07-0.45)	< 0.001

Odds ratio were derived from a logistic regression model. Odds ratios for continuous variables were computed on the basis of an increase in the values of 1 SD. NPAE = no previous anesthetic experience, PAEP = previous anesthetic experience with postoperative nausea and vomiting, PAENP = previous anesthetic experience without postoperative nausea and vomiting. *P = values were computed controlling for all other variables.

TABLE 3: Postoperative nausea and vomiting

	Comparison of drug 1st versus drug 2nd		
	Ondansetron versus metoclopramide	*Ondansetron versus droperiodol*	*Droperiodol versus* metoclopramide
Nausea	10	13	15
No of studies	907/1697 (53)	1587/2743 (58)	473/1021 (46)
Nausea/no of patients (%)			
Incidence nausea (5)			
Drug 1	48	57	41
Drug 2	59	58	52
Pooled OR (95% CI)	0.70 (0.45, 1.10)	0.99 (0.66, 1.47)	0.66 (0.48, 0.90)
P	0.125	> 0.9	0.008
Vomiting			
No of studies	17	22	20
Vomiting/no. of patients (%)	955/2272 (42)	1435/3750 (38)	412/1374 (30)
Incidence vomiting (%)			
Drug 1	35	34	26
Drug 2	50	42	34
Pooled OR (95% CI)	0.43 (0.31, 0.61)	0.70 (0.52, 0.94)	0.68 (0.54, 0.85)
P	< 0.001	0.018	< 0.001

OR = odds ratio, *Drugs 1—the first drug in each comparison, Drug 2—the second drug in each comparison.

versus droperidol (Table 3)[14] and the difference between them in 1st day (Fig. 1).

This prospective, randomized, double-blind clinical investigation has shown a beneficial effect of rapid infusion of 30 ml kg–1 compared with 10 ml kg–1 of crystalloid solution in reducing the incidence of PONV after gynecologic laparoscopy in ASA 1 female patients. However, there were no significant differences in the subjective symptoms of dizziness, thirst or opioid consumption at any time. Sore throat was transiently increased in the CSL-30 group on emergence from anesthesia (Table 4).

TABLE 4: Subject characteristics

	Ondansetron (n = 80)	*Droperidol (n = 78)*
Age (yr)	33 (18-49)	32 (19-50)
Weight (kg)	70 (43-128)	68 (46-110)
Operative time (min)	25 (7-75)	28 (5-106)
Anesthesia time (min)	52 (28-105)	53 (28-152)
Type of surgery		
Tubal ligation	52	56
Diagnostic lap	17	12
Pelviscopy	11	10
Time in PACU (min)	128 (75-268)	118 (42-220)
Fentanyl dose (μg)	206 (0-550)	178 (0-575)

Values are mean (range). There were no significant differences between groups.
Lap = Laparoscopy, PACU = postanesthesia care unit.

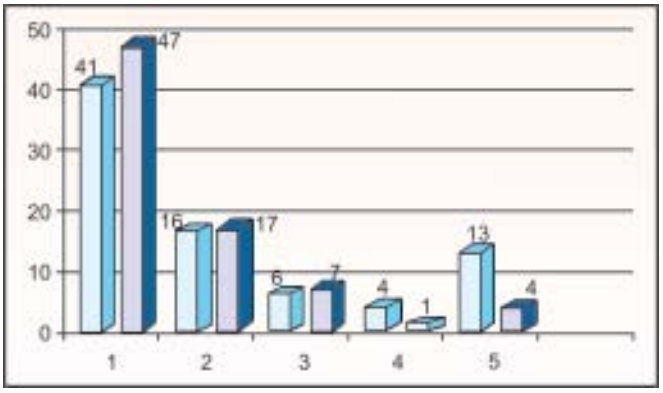

Fig. 1: Distribution for nausea and vomiting postoperatively in 1st 24 h light bars = ondesteron, dark bars = droperidol, p = 0.115 for the comparisons in the study for the patient receiving crystalloid fluid. In the first 48 h after anesthesia, the incidence of vomiting was lower in the CSL-30 group than in the CSL-10 group (8.6% vs 25.7%, P = 0.01). Antiemetic use was less in the CSL-30 group at 0.5 h (2.9% vs 14.3%, P = 0.04). The incidence of severe nausea was significantly reduced in the treatment group at awakening (2.9% vs 15.7%, P = 0.02), 2 h (0.0% vs 8.6%, P = 0.04) and cumulatively (5.7% vs 27.1%, P = 0.001)[12]

The result for dexamethasone in comparison with metaclopramide as in Tables 5 to 7.[15] Patients in group I reported a lower incidence of PONV and requested less rescue antiemetics than those in group III during the first four postoperative hours ($P < 0.01$). Patients in group I reported a lower incidence of PONV than those in groups II ($P < 0.05$) and III ($P < 0.01$) during the 24 hr postoperative period. Groups II and III did not differ

TABLE 5: Postoperative nausea and vomiting cumulative refers to number of patient affected or treated, not number of episodes CSL = compound sodium lactate

	CSL 10 ml kg⁻1	*CSL 30 ml kg⁻1*	*P-value*
Vomiting			
Preoperative	0 (0.0)	0 (0.0)	0.886
0.5 h	9 (12.9)	2 (2.9)	0.06
2 h	7 (10.0)	1 (1.4)	0.07
24 h	6 (8.6)	3 (4.4)	0.52
48 h	1(1.5)	1 (1.5)	0.49
Cumulative	18 (25.7)	6 (8.6)	0.01
Nausea: severe only			
Preoperative	0 (0.0)	0 (0.0)	0.886
0.5 h	11 (15.7)	2 (2.9)	0.02
2 h	6 (8.6)	0 (0.0)	0.04
24 h	5 (7.1)	2 (2.9)	0.46
48 h	0 (0.0)	1 (1.5)	0.99
Cumulative	19 (27.1)	4 (5.7)	0.001
Nausea: severe with antiemetic given			
Preoperative	0 (0.0)	0 (0.0)	0.886
0.5 h	10 (14.3)	2 (2.9)	0.04
2 h	6 (8.6)	0 (0.0)	0.04
24 h	3 (4.5)	1 (1.4)	0.58
48 h	0 (0.0)	1 (1.5)	0.99
Cumulative	16 (22.3)	4 (5.7)	0.008
Nausea: total			
Preoperative	0 (0.0)	0 (0.0)	0.886
0.5 h	17 (24.3)	19 (27.1)	0.85
2 h	11 (15.7)	8 (11.4)	0.62
24 h	8 (11.4)	3 (4.4)	0.23
48 h	3 (4.3)	2 (3.0)	0.97
Cumulative	26 (37.1)	26 (37.1)	0.86
Antiemetic use			
Preoperative	0 (0.0)	0 (0.0)	0.886
0.5 h	10 (14.3)	2 (2.9)	0.035
2 h	7 (10.0)	2 (2.9)	0.168
24 h	3 (4.29)	1 (1.47)	0.63
48 h	0 (0)	1 (1.5)	0.98
Cumulative	16 (22.9)	8 (11.9)	0.146

from each other in the incidence of PONV and the proportion of patients who requested rescue antiemetics.

From the result we can see that the Prophylactic intravenous dexamethasone 5 mg significantly reduces the incidence of PONV in women undergoing ambulatory laparoscopic tubal ligation. At this dose, dexamethasone is more effective than metoclopramide 10 mg or placebo.[16]

DISCUSSION

The clinical benefits of routine antiemetic prophylaxis for high-risk surgical patients have been well documented in the anesthesia literature.[4,20-25] These benefits were not limited to cost savings for treatment of emetic episodes but also included improved patient satisfaction compared with simply treating presenting symptoms.[22,23] Although multimodal antiemetic regimens involving up to three antiemetic drugs are justified in patients at high risk of developing PONV,[20] the possibility of adverse drug interactions increases as a function of the number of drugs administered. In this meta-analysis, I demonstrated that the prophylactic administration of ondansetron and droperidol was more effective than that of metoclopramide, dexamethasone and intravenous crystalloid in preventing postoperative nausea and vomiting. The droperidol is less cost than ondasetron and the intravenous crystalloid have same effect in decreasing the postoperative nausea and vomiting, so we can use droperidol and crystalloid for prophylactic antiemetic effect. The results were sometimes variable, and most studies individually lacked the power to detect differences in efficacy among the different drugs. In such settings, the use of a meta-analysis has been advocated to provide greater power to detect differences among the drugs and to obtain a more precise estimate of effect size.[17,18] The results of the meta-analyses in the present study are strengthened by the remarkable consistency of the large number of individual studies for most drug comparisons. A meta-analysis merits more confidence when the individual ORs for each study are predominately on the same side of the no difference line, an OR of 1.0.[19] This consistency of results occurred with both the ondansetron versus metoclopramide and the droperidol versus ondansetron analyses. This meta-analysis suggests that the usual clinical doses of either ondansetron or droperidol, rather than metoclopramide, dexamethasone, and intravenous crystalloid fluid should be administered for the greatest antiemetic efficacy. Droperidol and ondansetron were similarly effective in preventing PONV in adults.

CONCLUSION

All methods were associated with low incidence of postoperative nausea and vomiting. I conclude that

TABLE 6: Patients characteristics

	Dexamethasone (Group I)	Metoclopramide (Group II)	Saline (Group III)
No.	39	38	38
Age (yr)	32 (27–35)	34 (31–36)	35 (30–37)
Weight (kg)	54 (42–72)	56 (46–75)	56 (45–76)
Height (cm)	158 (145–172)	157 (138–170)	156 (139–173)
		Interval since last menstrual period (days)	
0–8	12	11	11
9–16	7	9	10
16–28	11	12	9
>28	9	6	8
Duration of anesthesia (min)			
65 (45–78)	68 (49–78)	64 (51–76)	
Duration of surgery (min)	41 (32–63)	45 (38–65)	42 (38–64)

Values given as numbers or median (range).

TABLE 7: Incidence of nausea and vomiting after laparoscopic tubal ligation

	Dexamethasone (Group I)	Metoclopramide (Group II)	Saline (Group III)
No.	39	38	38
		In the PACU (0-4 hr postoperatively)	
- Nausea	6 (15)	8 (21)	12 (32)
- Vomiting	3 (8)	6 (16)	10 (26)
- Total	9 (23)	14 (37)	22 (58)
- Rescue antiemetic	4 (10)	10 (26)	16 (42)
		After discharge (4-24 hr postoperatively)	
- Nausea	4 (10)	6 (15)	8 (21)
- Vomiting	1 (3)	4 (11)	3 (8)
- Total	5 (13)	10 (26)	11 (29)
		From 0-24 hr postoperatively	
- Nausea	8 (21)	12 (32)	13 (34)
- Vomiting	3 (8)	8 (21)	11 (29)
- Total	11 (28)*	20 (53)	24 (63)
Successful protection	28 (72)*	18 (47)	14 (37)

Values are numbers of patients (%). PACU = postanesthetic care unit. Successful protection was defined as no nausea, no vomiting and no antiemetic medication.*$P < 0.05$ when compared with group II; $P < 0.01$ when compared with group III using 3×22 test followed by 2×22 test.

ondansetron, droperidol were more effective than the anther in laparoscopy. Equivalents effectiveness for ondansetron, droperidol, and significant cost saving may be obtained by using droperidol prophylactically for laparoscopic surgery.

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Pregnancy Outcomes Following Laparoscopic Myomectomy

Hanom Husni Syam
Obstetrician and Gynecologist Specialist, Diploma in Minimal Access Surgery (Laparoscopy)
Member World Association of Laparoscopic Surgeon (WALS), Department of Obstetric and Gynecology
Trisakti University Jakarta, Teratai Fertility (IVF) Clinic Gading Pluit Hospital Jakarta

Abstract

Background: The laparoscopic approach to myomectomy has raised questions about the risk of uterine rupture in patients who become pregnant following surgery. It has been suggested that the rupture outside labor in pregnancies following laparoscopic myomectomy can be due to the difficulty of suturing or to the presence of a hematoma or to the wide use of radiofrequencies.

Aim: To assess the outcome of pregnancy following laparoscopic myomectomy.

Methods: A literature search performed using engine Google, High wire press, Springer link, and Yahoo. Selected papers screened for other related reports.

Results: There were no incidents of uterine scar rupture in any of these studies.

Conclusions: Uterine rupture during pregnancies following laparoscopic myomectomy is rare. This review article did not confirm the hypothesis that laparoscopic myomectomy is associated with an increased risk for uterine dehiscence during pregnancy.

Keywords: Laparoscopic myomectomy, pregnancy, and uterine rupture

INTRODUCTION

Nowadays, laparoscopic myomectomy has become the elective procedure in selected patients. Laparoscopy effectively shortens the hospital stay and avoids the major risk of the classical route, i.e. adhesion formation. Laparoscopic myomectomy (LM) is a recently introduced technique that enables intramural and subserous myomas < 9 cm in size and few in number to be managed by surgery. The rate of complications in the short-term is low, provided that the surgeons are suitably trained (Dubuisson et al, 1996). Compared with myomectomy by laparotomy, LM offers reduced postoperative pain, a shorter hospital stay, and quicker return to normal activity (Mais et al, 1996). When pregnancy is desired, the technique appears particularly advantageous in that it could reduce the risk of postoperative adhesions compared with laparotomy (Bulletti et al, 1996). In selected cases, laparoscopic myomectomy has been reported to be an effective technique that is associated with a low rate of patient morbidity (Dubuisson et al, 1996). Because myomectomy is often performed to preserve the uterus for future pregnancy, maintaining the integrity of the uterine wall is of utmost importance (Dubuisson et al, 1995).

It is found that there is an increasing concern over the incidence of uterine rupture in pregnant women with a history of an earlier laparoscopic myomectomy. The fact that uterine rupture has been reported remote from term and following myomectomies performed for subserous and even pedunculated myomas (Dubuisson et al, 2000) are especially worrying. Uterine rupture has also been reported to occur without signs of fetal distress. Most cases of uterine rupture have been described as isolated case reports, and several case series have had no or very low rates of this complication (Dubuisson et al, 2000; Seinera et al, 2000).

OPERATIVE TECHNIQUES

The difficulties in the operation, as with myomectomy by laparotomy, are the risk of peroperative hemorrhage and the prevention of postoperative adhesions. Use of the laparoscopic route for the myomectomy also raises certain particular problems connected with this approach: bloodless enucleation of the myomata is absolutely essential and a perfect suture must be achieved to obtain a good quality scar. There are several principles to use of the LM technique (Dubuisson et al, 2000).

The principles of microsurgery must be applied to LM: avoidance of intraperitoneal contamination; use of fine and atraumatic instruments; gentle and atraumatic manipulation of the uterus without grasping the pelvic organs (except the myoma itself).

When performed LM, each myoma must be excised via its own hysterotomy: it cannot use the same technique as myomectomy by laparotomy that is, removing all the myomata present on the uterus via an anterior sagittal hysterotomy.

Dissection must take place in every case along the cleavage plane separating the myoma from the adjacent myometrium. This cleavage plane is bounded by a pseudo-capsule made up

of compressed muscular fibres and diverted uterine vessels. This allows healthy adjacent myometrium to be preserved and damage avoided to the peri-myomatous vessels which are often distended due to compression by the myoma and could be the origin of considerable hemorrhage.

Electrocoagulation must be used as sparingly as possible to achieve hemostasis of the edges after myomectomy. Certain cases of uterine rupture during pregnancy reported after LM and after myolysis suggest that the use of electrocoagulation may induce necrosis of the myometrium resulting in a postoperative fistula.

Suture of the hysterotomy must always respect a certain number of principles. Indeed any technical deficiency when carrying it out may result in uterine rupture during a subsequent pregnancy. Apart from pedunculated myomata, the myomectomy sites must always be sutured. In the experience of certain teams at the beginning, when no suture was carried out, the resulting scars were fine or dehiscent. The uterine suture does not necessarily have to use several planes, despite the recommendation of certain authors. The suture must always take up the full depth of the edges of the hysterotomy and result in total contact over the whole of the myomectomy defect in order to avoid secondary constitution of a hematoma deep inside the myometrium (Figs 1 and 2). This kind of hematoma can cause weakness in the scar tissues and the constitution of a secondary fistula. When the uterine cavity has been opened or when the myomectomy defect is deep, it is necessary to make a suture in two planes. It is possible to make this type of suture in several planes by laparoscopy. However, if this proves difficult there should be no hesitation in using laparoscopic assisted myomectomy (LAM) to complete it successfully. This procedure is an intermediate procedure between laparotomy and LM: laparoscopy is used to help myoma(ta) exposure; to begin or achieve enucleation; the uterine suture is then carried out by mini-laparotomy in a traditional fashion.

Myomectomy was performed with a standard technique using three suprapubic ports. The uterus was always cannulated to allow the correct exposure of myomas. For pedunculated myomas, the pedicle was secured using a pre-tied or extracorporeally-tied loop and coagulated and transected with bipolar forceps and scissors. To decrease vascularization and blood loss, starting in 1997 Rossetti et al, injected myomas with diluted (1: 100) ornithine vasopressin. For subserous and intramural myomas, they carried out the serosal incision vertically over the convex surface of the myoma using a monopolar hook. After exposure of the myoma pseudocapsule, grasping forceps were positioned to apply traction to the myoma and expose the cleavage plane. Enucleation was carried out by traction on the fibroid and by division with a unipolar hook or mechanical cleavage. Hemostasis during dissection was achieved by bipolar coagulation. Suturing was usually done along one or two layers depending on the depth of incision

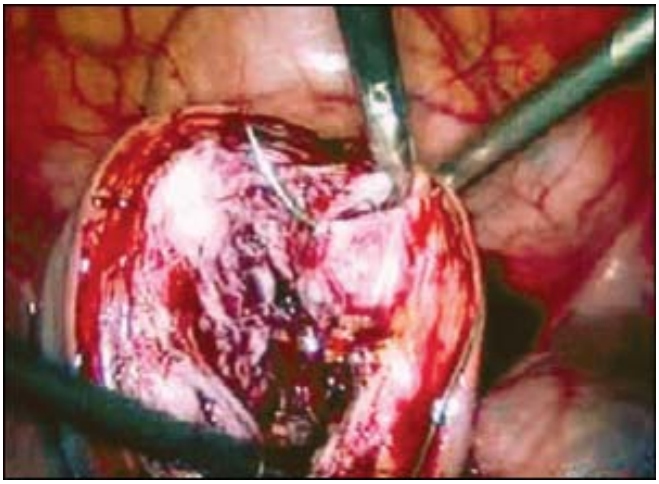

Fig. 1: Suturing the cut edges after myomectomy

Fig. 2: After closure of myometrium

with interrupted, simple or more frequently cross-stitches tied intracorporeally using 1 or 0 Polyglactin sutures.

MATERIAL AND METHODS

A literature search was performed using Highwire press, Pubmed, the search engine Google and Online Springer facility available at Laparoscopy Hospital, New Delhi. The following search terms were used: "Laparoscopic myomectomy, Pregnancy, Uterine rupture and Pregnancy outcomes". Selected papers were screened for further references. Criteria for selection of literature were the number of cases (excluded if less than 20), methods of analysis statistical or non-statistical, operative procedure only universally accepted procedures were selected and the institution where the study was done (Specialized institution for laparoscopic myomectomy were given more preference).

RESULTS

Kucera E et al (2006), in their report analyzed 69 patients after LM. The conception rate after LM was 56.5%. They didn't observe any increased incidence of fetomaternal morbidity or severe pregnancy and labor related complications. There was no uterine rupture after LM in their group. The cesarean section was rate 44.8%. LM in infertile patient is one of the most common surgical procedures. The appropriate surgical management of uterine scar is mandatory. Skilled reproductive surgeon must perform this operation. The pregnancy following LM is at high-risk with increased caesarean section rate.

Paul PG, et al (2006), reported that uterine rupture during pregnancies following laparoscopic myomectomy is rare following single-layer myometrial closure. Of the 217 women followed up, 115 had pregnancies subsequent to a laparoscopic myomectomy. Of 141 pregnancies, there were 87 cesarean sections, 19 vaginal deliveries, 29 abortions and 6 ectopic pregnancies. There were no incidents of uterine scar rupture in any of these pregnancies.

Goldberg J et al (2006), showed that although most pregnancies following uterine artery embolization have good outcomes, myomectomy should be recommended as the treatment of choice over uterine artery embolization in most patients desiring future fertility. Pregnancy rates following myomectomy, both via laparoscopy and laparotomy, are in the 50-60% range, with most having good outcomes. Both myomectomy and uterine artery embolization are safe and effective fibroid treatments, which should be discussed with appropriate candidates. Pregnancy complications, most importantly preterm delivery, spontaneous abortion, abnormal placentation and postpartum hemorrhage, are increased following uterine artery embolization compared to myomectomy.

Seracchioli R et al (2006), reported that of the 514 women followed up, 158 pregnancies were achieved. There were 43 (27.2%) spontaneous abortions, 4 (2.6%) ectopic pregnancies, and 1 (0.6%) therapeutic abortion. Only 27 patients (25.5%) had vaginal deliveries, whereas 79 (74.5%) underwent cesarean section. No instances of uterine rupture were recorded. Their preliminary results confirmed that LM, performed by an expert surgeon, could restore reproductive capacity, allowing patients to have a successful pregnancy.

Campo S et al (2003), analyzed that myomectomy significantly improves pregnancy outcome in patients with subserous or intramural fibroids, probably removing a plausible cause of altered uterine contractility or blood supply. Out of 128 patients submitted to myomectomy, we considered eligible for this study only the 41 patients wishing to conceive after surgery and who did not present any plausible infertility factor, apart from the removed myomas. Their results suggest that the main determinants of pregnancy rate after surgery are patient age, diameter and intramural localization of the myomas and type of surgery.

Soriano D et al (2003), found that of 106 infertile women with uterine leiomyoma, of whom 88 women underwent laparoscopic myomectomy and 18 laparoconversion. No difference in the pregnancy rate was noted between the laparoscopic and laparoconversion groups (48 and 56%, respectively). There was no difference between the two groups as regards the rates of pregnancy-related complications and vaginal delivery. No uterine rupture occurred. They concluded that laparoscopic myomectomy is feasible and safe, and should be considered for infertile women with uterine fibroids. Fertility and pregnancy outcomes following laparoscopic myomectomy are comparable with those following myomectomy after laparoconversion.

Landi S et al (2003), described that of 72 women were pregnant at least once after laparoscopic myomectomy. Four women conceived twice and four are pregnant as of this writing. One multiple pregnancy occurred. Twelve pregnancies resulted in first-trimester miscarriage, one in an ectopic pregnancy, one in a blighted ovum, and one in a hydatiform mole. One patient underwent elective first-trimester termination of pregnancy. Thirty-one women had vaginal delivery at term and 26 were delivered by cesarean section. No case of uterine rupture or dehiscence occurred.

Stringer NH et al (2001), found that laparoscopic suturing of the endometrial cavity in three layers does not prevent future pregnancies, and pregnancies can progress to term and in some cases be delivered vaginally without dehiscence.

Dubuisson JB et al (2000), found that ninety-eight patients became pregnant at least once after LM, giving a total of 145 pregnancies. Among the 100 patients who had delivery, there were three cases of spontaneous uterine rupture. Because only one of these uterine ruptures occurred on the LM scar, the risk of uterine rupture was 1.0% (95% CI 0.0-5.5%). Seventy-two patients (72.0%) had trials of labor. Of these, 58 (80.6%) were delivered vaginally. There was no uterine rupture during the trials of labor. Spontaneous uterine rupture seems to be rare after LM. When performing LM, particular care must be given to the uterine closure.

Seinera et al (2000), described that the pregnancy outcome of 54 patients submitted to laparoscopic myomectomy at their institution and prospectively followed during subsequent pregnancies. A total of 202 patients underwent laparoscopic myomectomy. A total of 65 pregnancies occurred in 54 patients who became pregnant following surgery. No cases of uterine rupture occurred. A cesarean section was performed in 45 cases. In terms of the safety of laparoscopic myomectomy in patients who become pregnant following surgery, their results were encouraging. They suggested that further studies are needed to provide reliable data on the risk factors and the true incidence of uterine rupture.

Nezhat CH et al (1999), analyzed that of the 115 women, there were 42 pregnancies in 31 patients. Two women were lost to follow-up. Of the remaining 40 pregnancies, six ended with

vaginal delivery at term. Cesareans were performed in 22 cases, including 21 at term and one at 26 weeks gestation. Two pregnancies were associated with a normal delivery, but the mode of delivery is unknown. Eight resulted in first trimester pregnancy loss, one was an ectopic pregnancy, and one patient underwent elective termination. Spontaneous uterine rupture was not noted during pregnancy or at term in any of the cases. Our series did not confirm the hypothesis that laparoscopic myomectomy is associated with an increased risk for uterine dehiscence during pregnancy.

Dubuisson JB et al (1996), reported that the overall rate of intrauterine pregnancy, after laparoscopic myomectomy, was 33.3% (seven patients). Out of the seven pregnancies, four were spontaneous and began within 1 year of the operation. The other three were achieved after *in vitro* fertilization in patients with associated infertility factors. In the four patients who gave birth by cesarean section, no adhesions were found on the myomectomy scar. From these preliminary results, laparoscopic surgery for myomas seems to offer comparable results with those obtained by laparotomy. No uterine rupture was observed.

Ribeiro SC et al (1999), laparoscopic myomectomy can be offered to patients who want to have children and who refuse to undergo an abdominal myomectomy. Patient selection as well as meticulous surgical technique is the key factors in achieving a successful outcome.

Daraï E et al (1997), reported that of 19 pregnancies were obtained in 17 patients after laparoscopic myomectomy (38.6%): eight vaginal deliveries, three cesarean sections, four miscarriages, two abortions, one ectopic pregnancy and one therapeutic abortion. No uterine rupture was noted. Pelvic adhesions were found in the four patients who underwent second-look procedure. Their preliminary results indicate that laparoscopic myomectomy is a useful technique.

DISCUSSION

Myomectomy is a challenging procedure because it involves the reconstruction of an organ that can undergo remarkable structural changes, as it does in pregnancy. The literature documents normal reproductive performance of uteri after laparotomic myomectomy (Li et al, 1999). Paul et al (2006), found that the frequencies of early pregnancy losses and preterm deliveries in their series were within normal limits, though that for ectopic pregnancies was higher (4.3%). This is consistent with the higher incidence of ectopic pregnancies in patients with infertility (Pisarska and Carson, 1999). Nezhat et al (1999) found that in their series, the observed frequency of miscarriages, ectopic pregnancies and preterm deliveries was within normal limits. The present 19% miscarriage rate matches the 19% reported after myomectomy at laparotomy (Buttram and Reiter, 1981).

Most studies have reported an increased incidence of cesarean section (Hurst et al, 2005). This is not unexpected in the presence of a scarred uterus. In addition, most patients have a history of infertility and are in the older age groups. This though does not make myomectomy a mandatory indication for elective cesarean sections, high vaginal delivery rates have been achieved in studies by Dubuisson et al, (2000). Recommendations for a waiting period before attempting pregnancy to ensure adequate wound healing though recommended have been questioned (Landi et al, 2003), and are not backed by good evidence. Paul et al (2006), showed that the majority of their patients conceived in the first year after surgery (82.6%) and a significant number in the first six months (55.6%). Nezhat et al (1999), described that the increased incidence of cesareans is not surprising, since this is the recommended method of delivery for women in whom the uterine wall has been deeply penetrated. All of the patients who delivered vaginally had pedunculated or subserosal myomas.

Pregnancies following any surgical procedure involving the uterus have an increased risk of rupture or dehiscence during pregnancy and labor. Such risks in relation to cesarean sections have been well quantified. This has helped in improved management of post-cesarean pregnancies before and during labor. The same cannot be applied in cases of women with a previous history of myomectomy, whether open or laparoscopic, because of the absence of good quality studies. One possible cause of uterine rupture after laparoscopic myomectomy is the wide use of electrosurgery that may result in poor vascularization and tissue necrosis with an adverse effect on scar strength (Nezhat et al, 1996). Electrosurgery was used to remove the myoma and obtain hemostasis in five out of the six reported uterine ruptures. In one case the uterus ruptured at 26 weeks following laparoscopic myolysis of a 3 cm intramural myoma (Arcangeli and Pasquarette, 1997). Myolysis is an endoscopic technique in which the tumor is coagulated with the help of bipolar probes inserted into the myoma. In the reported case there was no suture of the uterine wound.

Although many studies did not show any cases of uterine rupture, the occurrences mentioned above should serve as a warning. Considering that the procedure of laparoscopic myomectomy is rather new, it may not be efficacious for patients who desire future pregnancy, especially when performed by the novice endoscopic surgeon. In any case, laparoscopic myomectomy should be performed cautiously. Excess thermal damage should be avoided and adequate uterine repair must be assured using multiple layer suturing techniques. Both thermal damage and hematoma formation have been blamed as causes for suboptimal healing and rupture during a future pregnancy (Dubuisson et al, 2000; Landi et al, 2003). Thermal damage has been especially blamed in cases where subserous myomas were removed (Nkemayim et al, 2000). Correct reapproximation is not dependent on the number of layers of sutures but on the

technique of full thickness, evenly spaced suture placement, thus avoiding hematoma formation. Overaggressive control of bleeders using electrosurgical techniques should be avoided. Increasing the numbers or layers of sutures without adhering to the above principles may in fact compromise healing by causing tissue ischemia. Paul et al, 2006, found that uterine rupture following laparoscopic myomectomy is rare following single-layer myometrial closure. This data though reassuring are not conclusive, and there is a need for a randomized study to compare single-layer and multilayer suturing techniques.

CONCLUSIONS

LM enables surgical treatment of subserous and intramural myomata of average size (< 9 cm) and a few in number. When the surgeons are sufficiently experienced this technique does not involve a greater risk of operative complications. LM might reduce the risk of postoperative adhesions compared with laparotomy, which is a considerable advantage in a context of surgery for infertility. At present there is not enough evidence to say whether the hysterotomy scars after LM are as strong as those obtained after laparotomy. The risk of uterine rupture after LM seems low, however, and should not constitute a counter-indication for this operation if pregnancy is desired, provided that the myomectomy is truly justified. If good quality uterine scar is to be obtained, the surgeons need to be very experienced in laparoscopic surgery and to pay particular care when suturing the uterus. Obstetricians dealing with antenatal patients with a history of a myomectomy before should be aware of possible complications and should consider management of such patients as in cases of post-cesarean pregnancies.

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Laparoscopic versus Open Repair of Inguinal Hernia

Snehal Fegade

Satod, Taluka-Yawal, Dist Jalgaon: Pin: 42530; Maharashtra

Abstract

Background: Despite a large number of clinical studies in recent years no consensus has been achieved on the surgical technique of inguinal hernia repair for various reasons. "Experts" believe that their own preferred open methods have the lowest possible recurrence and complication rates. They tend to attribute any negative results, as shown by a number of regional quality studies, to other surgeons' poor skill rather than to the technique itself. This review article aimed to compare laparoscopic versus open Laparoscopic hernia repair.

Keywords: Laparoscopic inguinal hernia repair, Hernioplasty, Inguinal hernia, Laparoscopic vs open inguinal hernia repair.

INTRODUCTION

Repair of inguinal hernia is one of the commonest surgical procedures worldwide. Irrespective of country, race or socioeconomic status hernia constitutes a major health-care drain.

There are three important landmarks in the history of repair of inguinal hernia.

1. Tissue repair Eduardo Bassini 1888
2. Onlay mesh Irving Lichtenstein 1984 (tension-free) repair
3. Laparoscopic Ger, Shultz, hernia repair Corbitt, etc. 1990.

AIMS

The aim of this study was to compare the effectiveness and safety of laparoscopic and conventional open repair in the treatment of inguinal hernia.

The following parameters were evaluated for both laparoscopic and open procedures.

- Method of patient selection
- Operative technique
- Operating time
- Intraoperative and postoperative complications
- Postoperative pain and amount of narcotics used
- Postoperative recovery
- Recurrence
- Bilateral assessment and treatment
- Cost effectiveness
- Learning curve.

MATERIALS AND METHODS

A literature review was performed using Springer link, BMJ, Journal of MAS and major general search engines like Google, MSN, and Yahoo, etc. The following search terms were used: Laparoscopic inguinal hernia repair, Hernioplasty and Laparoscopic vs open inguinal hernia repair. 1,600 citations found in total selected papers were screened for further references. Criteria for selection of literature were the number of cases (excluded if less than 20), methods of analysis (statistical or non statistical), operative procedure (only universally accepted procedures were selected) and the institution where the study was done (Specialized institution for laparoscopic inguinal hernia repair were given more preference).

METHOD OF PATIENT SELECTION

Anesthetic Consideration

The general anesthesia and the pneumoperitoneum required as part of the laparoscopic procedure do increase the risk in certain groups of patients. However, procedures requiring only extra peritoneal insufflation of gas, like total extraperitoneal hernia repair (TEP), may be successfully conducted under regional anesthesia.[1]

Most surgeons would not recommend laparoscopic hernia repair in those with pre-existing disease conditions. Patients with cardiac diseases and COPD should not be considered as a good candidate for laparoscopy. The laparoscopic hernia repair may also be more difficult in patients who have had previous lower abdominal surgery. The elderly may also be at increased risk for complications with general anesthesia combined with pneumoperitoneum.

VARIOUS OPERATIVE TECHNIQUES AVAILABLE

Presently various modalities of treatment are available for repair of inguinal hernia.

Open Suture Repair of Inguinal Hernia

Following methods of suture repair of inguinal hernia is practiced:

- Bassini's repair
- Halsted repair
- Tanner (relaxing incision to reduce suture line tension)
- McVay repair
- Shouldice's repair

Open Mesh Repair of Inguinal Hernia

Materials from native tissues like strips of external oblique aponeurosis, fascia lata grafts from thigh and even skin from the edges of the incision to metal and silk were tried in hernia repair.

The concept of hernia repair underwent evolution with the introduction of monofilament knitted polyethylene plastic mesh. PPM remains most popular both in open and laparoscopic surgery. However, Dacron a machine knitted polyester polymer was the first popular nonmetallic mesh. In 1976, Gore developed the expanded PTFE or e-PTFE. Recently some of the prosthetic biomaterials have been combined together to form various composite mesh in an attempt to minimize the undesirable side effects. Composix® meshes (polypropylene with a thin coat of e-PTFE on one side). Vypro® mesh {light, large pore multifilament mesh composed of 50% polyglactin 910 (absorbable) and 50% polypropylene}. Ingrowths of fibrous tissue and collagen provide strength to the repair.[2]

Significantly less pain on exercise after 6 months and fewer patients reported the feeling of a foreign body after repair with use of lightweight composite mesh.

Cumberland and Scales criteria for an ideal prosthetic mesh: it should be chemically inert, noncarcinogenic, capable of resisting mechanical strain and resist bursting by the maximum forces created by the intra-abdominal pressure, easy to handle and fabricate as per requirement, allow tissue ingrowth within it resulting in normal pattern of tissue healing and repair without inciting adhesion formation if placed intra-abdominally. The tissue fluids should not physically modify it or incite inflammatory, foreign body or allergic reaction and it should resist infection. It must conform easily to the abdominal/inguinal wall and be seen-through for accurate placement over the defect. Finally; it should not be too costly.

A perfect prosthesis in addition to above should be impregnated with antibiotic material to resist infection, allow fibrous tissue ingrowths on one side for proper fixation and anti-adhesive properties on the other to avoid adhesions to the abdominal viscera and finally should respond like autologous tissue *in vivo*.

Tension-free Repair of Inguinal Hernia

Tension free repair requires a mesh. Placement is either by open anterior, open posterior approach or by laparoscopic means.

a. Giant prosthetic reinforcement of the visceral sac (GPRVS), Reni Stoppa
b. Lichtenstein onlay patch repair
c. Patch and plug repair
d. Kugel patch
e. The PROLENE® polypropylene hernia system

Laparoscopic Hernia Repair

Ger in 1982 attempted minimal access groin hernia repair by closing the opening of an indirect inguinal hernial sac using Michel clips. Bogojavlensky in 1989 modified the technique by intra-corporeal suture of the deep ring after plugging a PPM into the sac. Toy and Smoot in 1991 described a technique of intraperitoneal onlay mesh (IPOM) placement, where an intra-abdominal piece of polypropylene or e-PTFE was stapled over the myopectineal orifice without dissection of the peritoneum.

The present day techniques of laparoscopic hernia repair evolved from Stoppa's concept of pre-peritoneal reinforcement of fascia transversalis over the myopectineal orifice with its multiple openings by a prosthetic mesh. In the early 1990's Arregui and Doin described the transabdominal pre-peritoneal repair (TAPP), where the abdominal cavity is first entered, peritoneum over the posterior wall of the inguinal canal is incised to enter into the avascular preperitoneal plane which is adequately dissected to place a large (15 × 10 cm) mesh over the hernial orifices. After fixation of the mesh, the peritoneum is carefully sutured or stapled. TAPP approach has the advantage of identifying missed additional direct or femoral hernia during the first operation itself.

Around the same time Phillips and McKernan described the totally extraperitoneal (TEP) technique of endoscopic hernioplasty where the peritoneal cavity is not breached and the entire dissection is performed bluntly in the extraperitoneal space with a balloon device or the tip of the laparoscope itself. An advanced knowledge of the posterior anatomy of the inguinal region is imperative. Once the dissection is complete, a 15 × 10 cm mesh is stapled in place over the myopectineal orifice. It appears to be the most common endoscopic repair today.

In both these repairs, the mesh is in direct contact with the fascia of the transversalis muscle in the pre-peritoneal space, allows tissue ingrowths leading to the fixation of the mesh (as opposed to being in contact to the peritoneum as in IPOM repair where it is prone to migrate).

Relative Contraindication for Laparoscopic Approach

A. Obesity with BMI >30
B. Significant chest disease
C. Patient on anticoagulants
D. Adhesions
E. Massive hernias

F. Pregnancy
G. Unfit for GA

Inguinal Hernia Repair in Pediatric Patients

Small children gain little benefit from laparoscopic hernia repair as inguinal skin crease incision used in the herniotomy is one of best incisions as far as cosmesis is concerned. It is hardly visible after a few months. Also, it is covered in the underwear. Compared to this three stab incisions, however small, are in the visible area.[3]

Inguinal Hernia Repair in Obese Patients

Operations in patients with BMI above 27 may be difficult for less experienced surgeons, particularly when trying to encircle an indirect sac. Patients with BMI of above 30 should be encouraged to loose weight or should even be turned down for the laparoscopic approach. They are incidentally more likely to develop recurrence after an open hernia repair. It is also easy for the laparoscopic surgeon to become disoriented when the patient is very obese.

Inguinal Hernia Repair in Recurrence

Generally, the short-term recurrence rate of laparoscopic inguinal hernia repair is reported to be less than 5%. In both the open and laparoscopic repair procedures, the aim is to cover the whole inguino-femoral area by a preperitoneal prosthetic mesh, and recurrences should not occur. When they do occur, recurrences must be regarded as technical failures. Recurrences after laparoscopic repair most often result from using too small a mesh, or not using staples to fix the mesh. Most recurrences after laparoscopic hernia repair occurred medially, and the technique was adjusted. The mesh is now placed at least until the midline, and occasionally hernia staples are used when an adequate overlap (2 cm) cannot be achieved medially. The totally extraperitoneal technique is now used more often, allowing for better visual control in the medial part of the operating field.

OPERATING TIME

Operating times of surgical techniques varies between surgeons and also vary considerably between centers. It reduces with experience[5] and comparison between laparoscopic and open surgery is subject to bias due to pre-existing familiarity with open techniques. It is less important to the patient than a successful operation; the time taken to perform the surgery can have cost implications.[6] The operative time to perform unilateral primary inguinal repair has frequently been reported as longer for laparoscopic compared to open repair, however the mean difference in 36 of 37 randomized trials is 14.81 minutes.[7] These differences disappear in bilateral and recurrent hernia repairs.

POSTOPERATIVE PAIN AND AMOUNT OF NARCOTICS USED

The open tension-free mesh repair is found to cause less postoperative pain than open non-mesh repairs. However most randomized trials assessing postoperative pain between open tension-free repairs and laparoscopic repairs report less pain in the laparoscopic groups. In many cases this also results in less analgesia being consumed by the patient.[8-11]

COMPLICATION RATES

Complications in endoscopic inguinal hernia surgery are more dangerous and more frequent than those of open surgery, especially in inexperienced hands and hence are best avoided. It is possible to avoid most of these complications if one follows a set of well-defined steps and principles of endoscopic inguinal hernia surgery.[4,12]

Complications of laparoscopic repair of inguinal hernia can be divided into:

- Intraoperative
- Postoperative

Intraoperative Complications and Precaution to Avoid these Complications

During Creation of Preperitoneal Space

This is the most important step for beginners.

- A wide linea alba may result in breaching the peritoneum; in such a situation, it is best to close the rectus and incise the sheath more laterally
- Improper placement of balloon trocar causing dissection of muscle fibers
- Entry into peritoneum causing pneumoperitoneum
- Rupture of balloon in preperitoneal space
- The Hassan's trocar must snugly fit into the incision to avoid CO_2 leak

To avoid these, one must ensure that the balloon is made properly and the correct space is entered by retracting the rectus muscle laterally to visualize the posterior rectus sheath. Also the balloon trocar is inserted gently, parallel to the abdominal wall, to avoid puncturing the peritoneum. The balloon must be inflated slowly with saline to ensure smooth and even distension and prevent its rupture.

Precautions during Port Placement

The trocars should be short and threaded in proportion to less workspace and to ensure a snug fit respectively. The skin incisions should be just adequate to grip the trocar and prevent its slipping. The patient should empty their bladder before surgery as the suprapubic trocar could injure a filled bladder.

The pressure in the preperitoneal space must be such as to offer sufficient resistance during trocar insertion to avoid puncturing the peritoneum.

Correct Identification of the Anatomical Landmarks

The next most important and crucial step in any hernia surgery is the correct identification of anatomical landmarks. This is difficult for beginners as the anatomy is different from that seen in open surgery. The first most important step is to identify the pubic bone. Once this is seen, the rest of the landmarks are traced keeping this as reference point. One is advised to keep away from the triangle of doom, which contains the iliac vessels and to avoid placing tacks in the triangle of pain laterally.

Bladder Injuries

Bladder injury most commonly occurs during port placement, dissecting a large direct sac or in a sliding hernia. It is mandatory to empty the bladder prior to an inguinal hernia repair to avoid a trocar injury. It is advisable that beginners catheterize the bladder during the initial part of their learning curve. The diagnosis is evident when one sees urine in the extraperitoneal space. Repair is done with vicryl in two layers and a urinary catheter inserted for 7-10 days.[4]

Bowel Injuries

Bowel injury is rare during hernia surgery. It can occur when reducing large hernias, inadvertent opening of peritoneum causing the bowel to come into the field of surgery and in reduction of sliding hernias. Injury is best avoided in such circumstances by opening the hernial sac as close as possible to the deep ring. The initial studies showed a higher incidence, especially with TAPP, but it decreased over time.[4]

Vascular Injury

This is one of the commonest injuries occurring in hernia repair and often a reason for conversion. The various sites where it can occur is rectus muscle vessel injury during trocar insertion; inferior epigastric vessel injury; bleeding from venous plexus on the pubic symphysis; aberrant obturator vein injury; testicular vessel injury; and the most disastrous of all, iliac vessels, which requires an emergency conversion to control the bleeding and the immediate services of a vascular surgeon to repair the same. Most of the other bleeding can be controlled with cautery or clips. Careful dissection and adherence to the principles of surgery will help in avoiding most of these injuries.[4]

Injury to vas Deferens

Injury occurs while dissecting the hernia sac from the cord structures. The injury causes an eventual fibrotic narrowing of the vas. A complete transaction of the vas needs to be repaired in a young patient. An injury to the vas is best avoided and this may be done by identifying before dividing any structure near the deep ring or floor of the extraperitoneal space. Also the separation of cord structures from the hernial sac must be gentle and direct; grasping of vas deferens with forceps must be avoided.

Pneumoperitoneum

It is a common occurrence in TEP which every surgeon should be prepared to handle. Putting the patient in Trendelenburg position and increasing the insufflation pressures to 15 mmHg helps. If the problem still persists, a Veress needle can be inserted at Palmer's point.[4]

Postoperative Complications

Seroma/Hematoma Formation

It is a common complication after laparoscopic hernia surgery, the incidence being in the range of 5-25%. They are specially seen after large indirect hernia repair. Most resolve spontaneously over 4-6 weeks. A seroma can be avoided by minimizing dissection of the hernia sac from the cord structures, fixing the direct sac to pubic bone and fenestrating the transversalis fascia in a direct hernia. Some surgeons put in a drain if there is excessive bleeding or after extensive dissection.

Urinary Retention

This complication after hernia repair has a reported incidence of 1.3 to 5.8%. It is usually precipitated in elderly patients, especially if symptoms of prostatism are present. These patients are best catheterized prior to surgery and catheter removed the next day morning.

Neuralgias

The incidence of this complication is reported to be between 0.5 and 4.6% depending on the technique of repair. The intraperitoneal onlay mesh method had the highest incidence of neuralgias in one study and was hence abandoned as a form of viable repair. The commonly involved nerves are lateral cutaneous nerve of thigh, genitofemoral nerve and intermediate cutaneous nerve of thigh. They are usually involved by mesh-induced fibrosis or entrapment by a tack. The complication is prevented by avoiding fixing the mesh lateral to the deep inguinal ring in the region of the triangle of pain, safe dissection of a large hernial sac and no dissection of fascia over the psoas.

Testicular Pain and Swelling

It occurs due to excessive dissection of a sac from the cord structures, especially a complete sac. Reported incidence is of

0.9 to 1.5%. Most are transient. Orchitis was found in a small number of patients but did not lead to testicular atrophy.

Mesh Infection and Wound Infection

Wound infection rates are very low. Mesh infection is a very serious complication and care must be taken to maintain strict aseptic precautions during the entire procedure. Any endogenous infection must be treated with an adequate course of antibiotics prior to surgery.

Recurrence

It is the most important endpoint of any hernia surgery. It requires a proper and thorough knowledge of anatomy and a thorough technique of repair to help keep the recurrence in endoscopic repair to a minimum.

Postoperative Recovery

Marked variations are seen in postoperative recovery due to patient motivation, postoperative advice, and definition of "normal activity", existing co-morbidity and local "culture". Nevertheless all trials reporting this as an endpoint of study show a significant improvement in the laparoscopic group, with no real difference between the TAPP and TEP groups. This is estimated to equate to an absolute difference of about 7 days in terms of time off work.[13]

RECURRENCE

Recurrence rates are low with the use of mesh and not significantly different between open or laparoscopic techniques.

Causes of Recurrence in Laparoscopic Inguinal Hernia Repair

What then can cause mesh dislocation or failure? The factors involved are insufficient size, wrong/defective material, incorrect placement, immediate or very early displacement by folding, lifting by a hematoma or urinary retention, missed cord lipomas and herniation through the keyhole (mesh slit) late displacement by insufficient scar tissue ingrowth, mesh protrusion, collagen disease or pronounced shrinkage. Despite the correct and stable mesh position, there is still a limited risk of a late sliding of the retroperitoneal fat under/ in front of the mesh into the enlarged inner ring.[14]

Leibl *et al* in 2000 advised to avoid slitting of the mesh and increase its size to reduce the recurrence rate. Generous dissection of preperitoneal space is required to eliminate potential herniation through the slit or strangulation of the cord structures completely and reduces the risk of genitofemoral neuropathy.

Mesh Size

The mesh size should be adequate to cover the entire myopectineal orifice. The established size in 2006 is 15 cm x 10 cm per unilateral hernia, with minor deviations.

Mesh Material

The mechanical strength of available meshes exceeds the intra-abdominal peak pressures and by far even the lightweight meshes are strong enough for inguinal repair. Aachen group made an important contribution for understanding the interaction of the living tissue with the implanted mesh material. The negative impact of pronounced shrinkage of the traditional heavyweight meshes was recognized as an important factor promoting recurrence. Schumpelick and coauthors have introduced the logical trend of the use of lightweight meshes. The new macroporous compound meshes present both the successful reduction of the overall foreign body amount and the preservation of mesh elasticity after the scar tissue ingrowths, due to very limited shrinkage and reduced bridging effect.

Fixation of the Mesh

In the early years of laparoscopic hernia repairs, a strong fixation seemed to be the most important factor in prevention of recurrence. With growing size of the mesh and true macro porous materials being used, the belief in strength reduced and gave way to the concern of acute/chronic pain possibly caused by fixation. The controversy of fixing or nonfixing the mesh is currently under scrutiny.

Technical Experience

The long learning curve of endoscopic repairs contains the potential risk of technical errors leading to unacceptable rise of recurrence rate. This fact highlights the need for structured well-mentored teaching, a high level of standardization of the procedure and rigorous adherence to the principles of laparoscopic hernia repair. The impact of experience on the recurrence rate was in both extremes well documented.

Collagen Status

Inborn or acquired abnormalities in collagen synthesis are associated with higher incidence of hernia formation and recurrences.

Other Factors

The negative effect on healing in hernia repair is often related with malnutrition, obesity, steroids, type II diabetes, chronic lung disease, jaundice, radiotherapy, chemotherapy oral

anticoagulants, smoking, heavy lifting, malignancy and anemia. Laparoscopic inguinal hernia repair offers excellent results in experienced hands.

BILATERAL ASSESSMENT AND TREATMENT

Up to 30% of patients with a unilateral hernia will subsequently develop a further hernia on the contralateral side. Also, when examined at operation, 10-25% is found to have an occult hernia on the contralateral side. Both laparoscopic approaches allow assessment and treatment of the contralateral side at the same operation without the need for further surgical incisions, very little further dissection and minimal additional postoperative pain.[15] In open surgery a further large incision is required in the opposite groin. This considerably impairs postoperative mobility and increases the likelihood of admission to hospital. Some surgeons advocate routine repair of the contralateral side during laparoscopic repair.

COST EFFECTIVENESS

It is suggested that laparoscopic hernia repair is more expensive to perform than open hernia repair. The primary reason for this relates to the cost of extra equipment used for the laparoscopic repair with secondary costs attributed to perceived increases in operating time for the laparoscopic procedure.[16] From the Indian perspective, various factors come into play when analyzing the cost implications of laparoscopic repair of inguinal hernia. In most hospitals, except the larger corporate ones, the theater time is charged on a per-case basis rather than by the hour. Thus, increase in the operating time, particularly during the learning curve, does not necessarily mean additional expense for the patient. If the surgeon were to adopt cost-containment strategies such as use of reusable laparoscopic instruments (which is more or less the norm in India) as against disposable ones, use of indigenous balloons devices rather than commercially available ones, sparing use of fixation devices and reliance on sutures for fixation of the mesh, the cost of the laparoscopic hernia repair should be comparable to the open repair. It is likely that many surgeons are already practicing these strategies and passing on the benefits of laparoscopic repair to their patients.[17]

LEARNING CURVE

This period represents the developmental and learning curve for the consultant and the senior registrars. There have been some modifications of the technique as difficulties have been recognized. There is steep learning curve for laparoscopic repair. Initially everyone used to fix mesh with staples, but nowadays many surgeons are using sutures for it. As experience increases, our ability to recognize finer structures and to keep within the correct tissue planes, improves. This has been associated with lower minor-complication rates and higher percentage of pain-free recoveries.

DISCUSSION

The Shouldice technique is the 'gold standard' of open non-mesh hernia repair. The 5-year recurrence rate is acceptable, with no difference between TAPP and Shouldice repair. Poor operative performance resulted in a higher recurrence rate. The TAPP operation represents an excellent alternative for primary inguinal hernia repair. Laparoscopic repair compared favorably with Lichtenstein repair for primary indirect and direct hernias, and unilateral and bilateral recurrent hernias, but was inferior for primary bilateral hernias. General anesthesia and higher costs are reasonable compromises for a shorter period of discomfort in patients with a low ASA index and busy job/sport activity.[18]

With open Lichtenstein hernia repair in terms of intraoperative and postoperative complications and short-term recurrence. In fact with extra care, complications can be nearly avoided. The laparoscopic operations caused significantly less pain in the early postoperative period, leading to earlier mobilization and earlier return to work than open mesh repair. This was clearly seen in the manual workers undergoing laparoscopic operation. Furthermore, laparoscopic TEP repair is associated with greater patient satisfaction and better cosmetic results than its open counterpart. On the basis of these early experiences, laparoscopic extraperitoneal hernia repair seems to be as good as, if not superior to, the existing open Lichtenstein repair in terms of postoperative pain, hospital stay, return to work, and cosmesis provided the long-term recurrence rates also are comparable. It is possible to achieve high standards even during the learning phase of the surgeon if there is strict adherence to the protocols. The TEP technique took no longer to perform, and was associated with less postoperative pain, a shorter period of sick leave and a faster recovery, compared with open Lichtenstein hernia repair.[19]

TAPP and TEP repairs were compared and found to give equally good results. TAPP is an easier procedure to learn and is less expensive than TEP repair done with balloon dissectors and their ports; however, the reverse is true if no balloon dissectors and staples are used during TEP repair. TEP repair has a longer learning curve.[1]

Laparoscopic hernia repair may not be more expensive than open repair in terms of direct hospital costs or where a difference exists, this is relatively small. Societal costs due quicker recovery and return to employment show clear advantages for the laparoscopic repair and although not currently evaluated in detail, the reduction in chronic groin pain after laparoscopic repair is likely to lead to savings in both direct hospital costs and societal costs.

At present, the laparoscopic repair of hernias finds its clinical niche in patients with bilateral or recurrent hernias or in patients

with unilateral hernia who desire a minimal period of postoperative disability.[20]

Open hernia repair requires an incision at the point of maximum weakness, dividing of muscle and then suturing to repair the defect. This damage must heal before the wound become comfortable. Type of anesthetic used to affect the repair does not affect the period of discomfort. In a laparoscopic repair no incision is made in the groin. The small wounds which are made heal rapidly and have been shown to cause negligible postoperative pain. Further mesh is placed inside the groin muscle in the preperitoneal layer and this seems a more logical position to prevent peritoneal contents bulging out of a muscle defect than placing a mesh on the outside of the defect. Laparoscopic repair has no surgical weakness postoperatively.

NICE guidelines on laparoscopic hernia repair have been updated in September 2004.

As Per current Guidelines

1. Patient should be given a choice of open and laparoscopic repair of hernia in all suitable cases i.e., even in primary unilateral inguinal hernias.
2. Laparoscopic hernia repair should be performed only by appropriately trained surgeons.
3. Patients should be told about TAPP and TEP repair and their risks so, they choose an appropriate procedure.
4. For repair of recurrent and bilateral inguinal hernia, laparoscopic repair should be considered.
5. When laparoscopic surgery is undertaken for inguinal hernia, the totally extraperitoneal (TEP) procedure should be preferred.

RECOMMENDATION

The important points to be kept in mind during the surgery are:

- After dissecting direct sac, all peritoneal adhesions around the margin of the defect should be meticulously lysed.
- Always search for an indirect sac, even if a direct hernia has been reduced.
- Reflect the peritoneum off the cord completely.
- Place an adequate size mesh to cover the myopectineal orifice completely, preferably the size of 15 × 15 cm.
- The lower margin of the mesh must be comfortably placed - medially in the retropubic space and laterally over the psoas muscle.
- Perform a 2-point fixation of the mesh on the medial aspect over the Cooper's ligament.
- Avoid cutting of the mesh over the cord. This weakens the mesh and provides a potential site for recurrence.
- Ensure adequate hemostasis prior to placing the mesh.
- The most important factor is the adequate training and learning of the right technique.

CONCLUSION AND RECOMMENDATIONS

Laparoscopic hernia repair is safe and provide less postoperative morbidity in experienced hands and definitely has many advantages over open repair. For bilateral and recurrent inguinal hernias laparoscopic approach is recommended. Nowadays for primary inguinal hernia also it is recommended. For sliding hernia also TAPP is the preferred approach.

The final word on hernia will probably never be written. In collecting, assimilating and distilling the wisdom of today we must provide a base from which further advances may be made.[21]

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Role of OT Table Height on the Task Performance of Minimal Access Surgery

Gurvinder Kaur

Western Coalfields Ltd, Coal Estate, Civil Lines, Nagpur 44001

Abstract: The advent of laparoscopic surgery has changed the concept of surgery from prolonged painful to painless, cosmetically satisfying and short stay. In the past few years many instruments have been developed and introduced into the operating room (OR), but there has been ongoing debate about the optical ergonomic posture of the operating surgeon.

One of the main ergonomic problem in our currently available operating room table is that they are designed for the open surgery and are not ideal (suitable) for the laparoscopic surgery. Since laparoscopic surgery requires the use of longer instruments than open surgery, thus changing the relation between the height of the surgeon and the desirable height of the operating room table.

This study aims to understand an ergonomically optimal operating table height required for the particular height of the surgeon from the floor so that they can perform their surgery comfortably.

The operating table height was defined as the upper level of the table from the floor. The study was undertaken keeping all other variables fixed (Elevation angle, Manipulation angle, Azimuth angle, Distance of monitor.) Coaxial alignments were maintained. The only variable was the operating room (OR) table height.

Keywords: Ergonomics, Laparoscopy, Operation Table Height.

Definitions

Elevation angle: It is an angle between the instrument and the body of the patient.

Manipulation angle: It is an angle between the two working instruments.

Azimuth angle: It is an angle between the one side of instrument and the telescope.

Coaxial alignment: The axis joining the eye of the surgeon, target of dissection and the center of monitor.

INTRODUCTION

Ergonomics is the study (or science) of the interaction between human and their working environment in terms of equipment design, work place layout the working environment, safety, productivity and training. Often called the "human factors" in the United States, it is the psychological and physical interaction between the user (e.g. surgeon, assistants or nurse) and their tools.[1]

Since the past fifteen years laparoscopic surgery has become part of the visceral surgery, providing the patient short painless and a quick recovery. In the literature laparoscopic surgery is in many cases associated with ergonomics problems.[2-4] Infact poor ergonomics has always been one of the major drawbacks of endoscopic surgery. In the last decade or so, many new instruments and devices have been developed for the laparoscopic surgery. The handling of these tools has a sizeable impact on the length of the procedure in terms of time and the overall morbidity. The relationship between the surgeon and the tools also determine how much effort is expended by the surgeon.

The fatigue and discomfort of the surgeon's complaints during laparoscopy have led to several studies which investigate the origin of the physical problems.[5-9]

A comparative study of the surgeon's posture during open and laparoscopic surgery[6] showed more upright head and back posture with less body movements during laparoscopic surgery. There were significant musculoskeletal complaints of neck and arms. One study has shown that laparoscopy instruments causes excessive flexion and ulnar deviation of the surgeon's wrist with abduction of arm during manipulation.[7-10] This ergonomic problem results from the combined effect of the fixed point of insertion of the laparoscope through the body wall, a large external arc of the arm movement due to greater length of the instrument and the poorly adjusted operating table height.

The Society of American Gastrointestinal Endoscopic Surgeons (SAGES) realized the importance and established a study group for improving the ergonomics in the operating room.[11-13] DeQuervain pointed out the importance of adjusting of the table for the positioning of the patients in relation to the surgeon for open surgery.[14-15] In laparoscopic surgery the situation differs, since the table cannot be lowered sufficiently for precise and relaxed work. To overcome this problem the surgeon compensates by elevating their arms which is fatiguing.[16]

Guidelines for the height of the work surfaces for standing workers in industry or offices have existed for many years.[17] In medical literature, there has been, however, less focus on the ergonomics problem of operating table height during laparoscopy. Only recently a paper has been published dealing with the ergonomic problem of incorrect operating table height.[18]

This aim of the study was to find out the ergonomically optimal operating table height required for the particular height of the surgeon for laparoscopic surgery in order the surgeon can perform their task comfortably without the extreme upper limb joint movements. The approach of this study can be extended as guidelines for designing of the ergonomically optimal operating table.

MATERIAL AND METHOD

The study was carried out in the Laparoscopic Laboratory of Laparoscopy Hospital, New Delhi. A literature search was also performed using Medline and the search engine Google to find out for any such related article. The following search terms were used "ergonomics, ergonomics in surgery, ergonomics in laparoscopy".

The tests were performed on endo-trainer using the six different table heights for a particular surgeon for task performance. All the other variables were kept fixed or constant (Elevation angle, Manipulation angle, Azimuth angle, Distance of the Monitor). The coaxial alignments were maintained. The only variable studied was the OR Table Height. The neutral zone of joint movements is shown in Table 1.

The ports were introduced keeping in mind the "baseball diamond" concept.[19]

1. The telescope was fixed in between the working instruments.
2. Level 1 lever system was used for the insertion of the instrument through the ports, i.e. half the instrument was inside and half the instrument was kept outside maintaining the Elevation angle of 30 degree.
3. Manipulation angle was fixed to 60 degree.
4. Azimuth angle was fixed to 30 degree.

TABLE 1: Neutral zone of joint movement (VAN VEELEN)

Joint	*Movement*	*Neutral zone (degree)*
Shoulder	Abduction	< 30
	Adduction	< 30
Elbow	Flexion	> 30 < 130
	Extension	0
Wrist	Ulnar abduction	< 15
	Radial abduction	< 15
	Palmer flexion	< 15
	Dorsal flexion	< 15

Fig. 1: Abduction of the shoulder were measured

Fig 2: Flexion of the wrist and elbow were measured

Fig 3: Operating table height

The joint movement and the angles (abduction of the shoulder and flexion of the wrist) of the shoulder elbow and wrist were measured by video recording and snap shots during the task performance (Figs 1 and 2).

The results were evaluated by a questionnaire and snap shots. The optimum operating table height was defined for the

different height of surgeon. The girth of the patient was kept constant during the study as the task was performed on the endo-trainer.

Task

The subject had to perform the task of tying the intracorporeal knot. The operating table height was adjusted to six different height for a particular surgeon. The monitor was placed in front of the surgeon at a height of 170 cm from floor.

Subjects

Consisted of surgeon and laparoscopic trainees. The total numbers of subjects were twenty-five out of which five were females and the rest twenty were. They worked mostly with right hand.

Operation Table Height (Fig. 3)

Six different heights of the operating table was adjusted varying from 65 to 90 cm.

Duration of Each Observation

The duration of each observation was for five minutes for each height of operating room table. For six different heights of the table the total observation duration was of 30 minutes for the task performance with respect to the position of shoulder, elbow and wrist movements.

Video Analysis

The camera was used to record the position of the shoulder, hand arm and wrist joint and videos snaps were taken during the task performance at different operating table height.

Questionnaire

The subjects were asked for the particular level of discomfort of the operating table height during their task performance.

Level of comfort (from best to worst) was graded:

A. *Comfortable:* When the subject's upper extremities were in neutral zone posture.

B. *Less comfort:* When there was minimum deviation from the above posture (Abduction of shoulder joint and flexion of wrist joint).

C. *Discomfort:* When there was increasing abduction of shoulder joints with increasing flexion of wrist joint to perform the task.

D. *Uncomfort:* When there was complementary increased abduction of shoulder joint with increased flexion of wrist joint to perform the task.

RESULTS

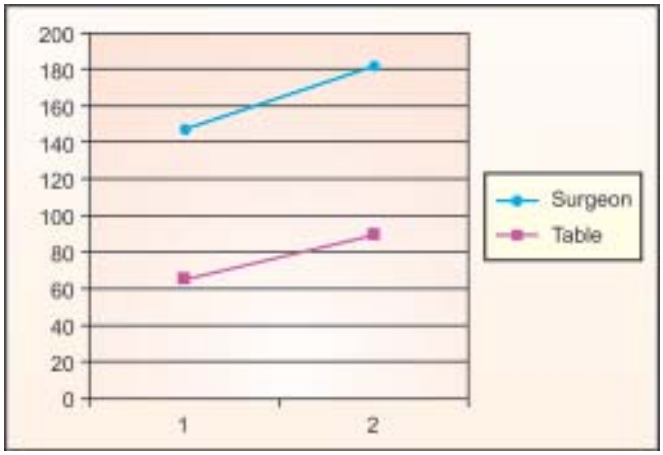
The results of the level of comfort of OR table during task performance with respect of the height of the surgeon is shown in Table 2. The short stature subjects (147 to 151 cm) were comfortable at 65 cm table height while the tall subjects (178 to 182 cm) experienced comfort at 90 cm OR table height.

The maximum subjects were in the height group 165 to 170 cm which is the average height of the Indian masses, were comfortable during their task performance at 80 cm OR table height.

There was a parallel steady rise in trend (Graph 1). As the height of the surgeon increased there was proportionate increase in the vertical height of the OR table.

TABLE 2: Subjects height versus table height (comfort level)

Subject (surgeon height cm)	*Comfort of the level of OR Table height (cm)*
147	65
150	65
151	65
155	70
156	70
160	75
160	75
161	75
163	75
164	75
165	80
165	80
166	80
167	80
167	80
168	80
168	80
170	80
171	85
172	85
173	85
174	85
178	90
180	90
182	90



Graph 1: Relation between surgeon and OR table height (cm)

The results of the video analysis are shown in Table 3. For 155 cm subject height was comfortable at 70 cm in the neutral zone posture showing shoulder joint was abducted at 15 degree and elbow joint showed extension at 125 degree abduction of wrist joint.

At 65 cm OR table height there was less comfort experienced by the subject as the shoulder joint was abducted to zero degree and the elbow joint extended to more than 130 degree (i.e. 150 degree). On further raising the table height to 75 cm there was the same less comfort. The shoulder joint was abducted to 40 degree with extension of the elbow joint to 120 degree to perform the task.

When the OR table height was further raised to 85 cm there was discomfort experienced by the subject since the abduction of shoulder joint had increased further to 45 degree combined with the increasing flexion of wrist joint to perform the task. At

TABLE 3: Subjects Height versus Table Height

OT Table Height (cm)	*Abduction Angle of Shoulder*	*Flexion of Elbow and wrist*	*Observation*
65	 0°	 150°	B = Less comfort minimal deviation from neutral zone posture.
70	 15°	 125°	A = Comfortable-neutral zone posture shoulder joint abducted 15° elbow extended 125° wrist joint extended.
75	 40°	 120°	B = Less comfort minimal deviation from neutral zone posture.

Contd...

Contd...

OT Table Height (cm)	*Abduction Angle of Shoulder*	*Flexion of Elbow and wrist*	*Observation*
80	 45°	 115°	C = Discomfort starting of abduction of shoulder joint, increasing flexion of elbow joint, flexion and ulnar deviation of wrist joint
85	 60°	 105°	C = Discomfort starting of abduction of shoulder joint, increasing flexion of elbow joint, flexion and ulnar deviation of wrist joint
90	 75°	 Angle cannot be calculated from side (awkward position)	D = Uncomfort complementary increased abduction of shoulder joint 75° increased flexion and ulnar deviation of wrist joint

90 cm for the particular surgeon height there was uncomfort felt by surgeon during task performance. This was compensated by the complementary increased abduction of shoulder joint (75 degree) and then elbow joint was straightened, also there was increased flexion and ulnar deviation of wrist joint.

The different grades of comfort level as stated by the surgeon during the task performance at the six different OR table height is shown in (Table 4). The result of the objective evaluation with video analysis co-relate with the subjective assessment of the comfort level of the subjects (questionnaire) working at the particular vertical height of the OR table.

The height of the operating table varies in relation to the surgeon's level of comfort for task performance.

DISCUSSION

The operating room (OR) table height is one of the important factors deciding the ergonomics of the laparoscopic surgery. The height of the table has an effect on the upper joint movements of the shoulders, arms and wrist during laparoscopy. The fixed position of the trocars and the scope in the abdominal wall require the surgeon to move the upper extremities into making longer external arc of movements with long awkward positions manipulating the tissues at different angles inside the abdomen.[3]

This study was carried out to define the ergonomically optimal OR table height which will suit the particular height of the surgeon performing laparoscopic surgery. Unfortunately most of the OR table available in the laparoscopic theater is made for open surgery and it becomes inconvenient to use during laparoscopic surgery. The endo-trainer used during the study represents the manipulation done in the dissection phase of an operation.

The results of study show that subject height in the range of 147 to 151 cm were comfortable at 65 cm OR table height while subjects of 152 to 156 cm expressed their comfort at 70 cm. For 160 to 164 cm surgeon height the comfort level of OR table height was 75 cm. The maximum number of subjects ranged

TABLE 4: Comfort levels as stated by surgeons

Height of subject (cm)	*OR table height (cm) and grade of comfort level*					
	65	70	75	80	85	90
147	A	B	B	C	D	D
150	A	B	B	B	C	D
151	A	B	B	C	C	D
155	B	A	B	C	C	D
156	B	A	B	B	C	D
160	B	B	A	B	C	D
160	B	B	A	B	C	D
161	C	B	A	B	C	D
163	C	B	A	B	C	D
164	C	B	A	B	C	D
165	C	C	B	A	B	C
165	C	C	B	A	B	C
166	C	C	B	A	B	C
167	C	B	B	A	B	C
167	C	C	B	A	B	C
168	C	C	B	A	B	C
168	C	C	B	A	B	C
170	B	B	B	A	B	C
171	C	C	B	B	A	B
172	C	C	B	B	A	B
173	C	C	B	B	A	B
174	C	C	B	B	A	B
178	D	C	C	B	B	A
180	D	C	C	B	B	A
182	D	C	C	B	B	A

from 165 to 170 cm height were comfortable during the task performance at 80 cm OR table height. For 171 to 178 cm subject height the comfortable height was defined at 85 cm. While (180-182 cm height of subjects observed comfort level at 90 cm OR table height. For lower table height many subjects had to tilt on one side and bend forward to compensate the low instrument position. At this height the flexion of the spinal column shows higher discomfort and difficulty though the upper arm muscle is working at low level. Thus, the optimum working height of a surgeon is a compromise between the position of the spinal column and the arm position with the resultant fatigue of the respective antagonist muscle. A higher OR table is also not good because then is increased abduction of shoulder combined with flexion and ulnar deviation of the wrist. This causes fatigue of the wrist joints.

Berguer recently recommended adjusting the operating table so that the height of the prone patient is at the level of the surgeon's upper thigh. The minimum vertical range of the operating table was not specified. Further more the hands should be positioned at the level of the elbow with the forearm in a horizontal position.

Secondly, the video stills taken during the task performance for the joint movements of the upper extremities is a reliable method as the interpretation of the abduction angle of shoulder joint and angle of elbow joint, the flexion and ulnar deviation of wrist joint during the task performance and examined jointly by the two persons and the angles are measured using the set square scale. The result show that at lower OR table height for corresponding height of the surgeon there was less comfort with abduction of shoulder joint (0 degree) and flexion of elbow joint 150 degree.

At higher OR table height in respect to the surgeon height there was discomfort of the upper extremities with the starting of abduction of shoulder joint (> 45 degree) with flexion of elbow joint < 30 degree and ulnar deviation of wrist joint. At still higher OR table height there was uncomfort when the task

could be done with complimentary increased abduction of shoulder joint 75 degree and increased flexion and ulnar deviation of the wrist joint.

The comfortable height of the OR table was from 65 to 90 cm for short and tall stature subjects respectively. For the mean height of the subjects 165 to 170 the comfortable OR table height was 80 cm. These OR table height were considered comfortable for the corresponding subject height because they had more freedom in movement and had less discomfort in the backs shoulder and wrist.

Tendick et al[20] were the first investigators to show the manipulation problems in laparoscopic surgery emphasizing the negative effect on the surgeon's dexterity of the narrow degree of freedom with use of laparoscopic instruments. Patkin and Isabel[21] further reviewed human interface problems in laparoscopic surgery and identified the need for a human engineering (ergonomic) approach to the design of the laparoscopic operating environment. A 1997 survey conducted by the Society of American Gastrointestinal Endoscopic Surgery (SAGES) found an 8-12% incidences of pain or numbness in the upper extremities following laparoscopic surgery.

Although the primary aim of the operation is not the comfort of the surgeon, the data reported by Hanna et al show that inefficient working postures directly affect the working efficiency of the surgeon.

The study shows that OR table height is less than that used for open surgery. The surgeon should adjust his/her OR table height corresponding to his own height according to the table and graph which we have discussed.

After analyzing the ration of surgeon's height with the OR table height we hypothesized that the OR table height should be Surgeon's Height into 0.49.

$$\text{OR Table Height} = \text{Surgeon's Height} \times 0.49$$

CONCLUSION

In this study it was observed laparoscopic OR table height has an effect on the upper joint movements. The laparoscopic OR table height should vary from 65 to 90 cm from the floor. The surgeon should be able to adjust the OR table corresponding to his/her height in order to bring upper joint movements to the minimum position with the resultant less discomfort in the shoulder, back elbow and the wrist.

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The Impact of the Learning Curve in Laparoscopic Surgery

Rehana Jabeen Raja
25, Acacia Drive, Runda, Nairobi, Kenya

Abstract: TP Wright originally introduced the concept of a learning curve in aircraft manufacturing in 1936.[1] He described a basic theory for costing the repetitive production of airplane assemblies. The term was introduced to medicine in the 1980s after the advent of minimal access surgery. It also caught the attention of the public and the legal profession when a surgeon told a public enquiry in Britain that a high death rate was inevitable while surgeons were on a learning curve.[2] Recently it has been labeled as a dangerous curve[3] with a morbidity, mortality and unproven outcomes. Yet there is no standardization of what the term means. In an endeavor to help laparoscopic surgeons towards evidence based practices this commentary will define and describe the learning curve, its drawing followed by a discussion of the factors affecting it, statistical evaluation, effect on randomized controlled trials and clinical implications for both practice and training, the limitations and pitfalls, ethical dilemmas and some thoughts to pave the way ahead.

DEFINITION AND DESCRIPTION

For the Wright learning curve, the underlying hypothesis is that the direct man-hours necessary to complete a unit of production will decrease by a constant percentage each time the production quantity is doubled. In manufacturing, the learning curve applies to the time and cost of production. Can a surgeons learning curve be described on similar lines? A simple definition would be : the time taken and/or the number of procedures an average surgeon needs to be able to perform a procedure independently with a reasonable outcome.[1] But then who is an average surgeon ? Another definition may be that a learning curve is a graphic representation of the relationship between experience with a new procedure or technique and an outcome variable such as operation time, complication rate, hospital stay or mortality.[4] A learning curve may also be operationally defined as an improvement in performance over time. Although learning theorists often disagree about what learning is, they agree that whatever the process is, its effects are clearly cumulative and may therefore be plotted as a curve. By cumulative it is meant that somehow the effects of experience carry over to aid later performance. This property is fundamental to the construction of learning curves. The improvement tends to be most rapid at first and then tails off. Hence there are three main features of a learning curve. First, the initial or starting point defines where the performance of an individual surgeon begins. Secondly, the rate of learning measures how quickly the surgeon will reach a certain level of performance and thirdly the asymptote or expert level measures where the surgeons performance stabilizes.[5] This has implications for the laparoscopic surgeon—it suggests that practice always help improve performance but the most dramatic improvement happens first. Also with sufficient practice surgeons can achieve comparable levels of performance.

THE DRAWING OF LEARNING CURVES

There are a variety of methods of constructing learning curves. They all assume that successive exposures in a learning series may be plotted on the *x*-axis, response characteristics on *y*-axis and the data points distributed in the *xy* plane may be legitimately connected by a curve. This is the Cartesian Method.[6] More recently the Cumulative Sum Method has been applied for the construction of these curves for basic skills in anesthetic procedures—the method consists of relatively simple calculations that can be easily performed on an electronic spreadsheet. Statistical inferences can be made from observed successes and failures. The method also provides both numerical and graphical representation of the learning process.[7]

The multimode learning curve is useful because several factors can be put into one graph.[8] The earlier used method of the performance analysis with its on the spot appraisals at certain time intervals has been replaced by continuous assessment. For continuous data like operation time the Moving average method is useful.[9]

FACTORS AFFECTING LEARNING CURVES

A complex hierarchy of factors are involved here.[5] At the bottom factors like guidelines, protocols and standards for clinical governance agreed upon by the medical fraternity are vital. Next the Institutional policies and cost effectiveness are contributory. Needless to say the surgical team, the case mix and public awareness are relevant. The final level in the hierarchy that can influence individual learning is the characteristics of the surgeon such as attitude, capacity for acquiring new skills and previous experience.[10]

Amongst the latter that is the characteristics of the surgeon the learning curve may depend on the manual dexterity of the individual surgeon and the background knowledge of surgical anatomy. The type of training the surgeon has received is also important[11] as training on inanimate trainers and animal tissue has been shown to facilitate the process of learning. The slope of the curve depends on the nature of the procedure and frequency of procedures performed in specific time period. Many studies suggest that complication rates are inversely proportional to the volume of the surgical workload.[12] However rapidity of learning is not significantly related to the surgeons age, size of practice or hospital setting.[13] Another important factor that affects the learning curve is the supporting surgical team. A recent observational study[14] to investigate the incidence of technical equipment problems during laparoscopic procedures reported that in 87% of procedures one or more incidents with technical equipment or instruments occurred. Hence improvement and standardization of equipment combined with incorporation of check lists to be used before surgery has been recommended.

STATISTICAL EVALUATION OF LEARNING CURVES

Various statistical methods have been reported in the assessment of the learning curve.[15] Commonly data are split into arbitrary groups and the means compared by chi-squared test or ANOVA. Some studies had data displayed graphically with no statistical analysis. Others used univariate analysis of experience versus outcome. Some studies used multivariate analysis techniques such as logistic regression and multiple regression to adjust for confounding factors. A systematic review[16] concluded that the statistical methods used for assessing learning curves have been crude and the reporting of studies poor. Recognizing that better methods may be developed in other non clinical fields where learning curves are present (psychology and manufacturing) a systematic search was made of the non clinical literature[17] to identify novel statistical methods for modeling learning curves. A number of techniques were identified including generalized estimating equations and multilevel models. The main recommendation was that given the hierarchical nature of the learning curve data and the need to adjust for covariant, hierarchical statistical models should be used.

EFFECT OF LEARNING CURVE ON RANDOMIZED CONTROLLED TRIALS

The learning curve can cause difficulties in the interpretation of RCTs by distorting comparisons. The usual approaches to designing trials of new surgical techniques has been either to provide intensive training and supervision or require participating surgeons to perform a fixed number of procedures prior to participation in a trial. Surgeons have been reluctant to randomize until they are proficient in a technique but then once convinced of its worth argue that it is too late to randomize. However the best way to address the problem is to have a statistical description of the learning curve effect within a trial and various methods can then be used. Example Bayesian hierarchical model.[5]

IMPLICATIONS FOR PRACTICE AND TRAINING

In the current era of evidence based medicine enthusiasm for laparoscopic surgery is rapidly gaining momentum. There is an immense amount of literature showing advantages of minimal access surgery and acceptance by the public. The learning curve for many procedures has been documented.[18,19,20] As far as training is concerned, the introduction of laparoscopic techniques in surgery led to many unnecessary complications. This led to the development of skills laboratories involving use of box trainers with either innate or animal tissues but lacks objective assessment of skill acquisition.[21] Virtual reality simulators have the ability to teach psychomotor skills. However it is a training tool and needs to be thoughtfully introduced into the surgical training curriculum.[22] A recent prospective randomized controlled trial[23] showed that virtual simulator combined with inanimate box training leads to better laparoscopic skill acquisition. An interesting finding reported is that in skills training every task should be repeated atleast 30 to 35 times for maximum benefit.[24] The distribution of training over several days has also been shown to be superior to training in one day.[25] Other factors enhancing training are fellowship programmer,[26] or playing video games.[27] One can also obtain feedback for improvement of training program. In one such study the deficiency factors[28] identified were lack of knowledge, lack of synchronized movement of the non dominant hand and easy physical fatigue. Incorporation of intensive, well planned invitro training into the curriculum were made and the programme reassessed.

WHAT ARE THE LIMITATIONS OR PITFALLS ?

"Steep" learning curves are usually used to describe procedures that are difficult to learn – however this is a misnomer as it implies that large gains in proficiency are achieved over a small number of cases. Instead the curve for a procedure that requires a lot of cases to reach proficiency should be described as "flattened".[29]

As long as no valid scoring system concerning the complexity of a surgical intervention exists, the learning curve cannot be used as benchmarks to compare different surgeons or clinics as legitimate instruments to rank surgeons or different hospitals.

Limitations of long learning curves, facilities for training, mistakes of pioneers, surgical techniques not being described in books are some of the limitations described.[30]

There are other limitations due to the nature of laparoscopic surgery like the lack of 3D vision and of tactile sensations,[31] difficult hand eye coordination and long instruments.

ETHICAL DILEMMAS

Many dilemmas exist[32] and many questions will always be with us—who bears the burden of the learning curve ? Are the patients aware of the risks ? Many reports validate the impression that a patient operated upon during the learning curve takes greater risks and incurs more adverse circumstances than the patient operated upon later. The issue of how informed the informed consent should be needs to be addressed. Is the integrity and conscience of a surgeon measurable? Should the forces of marketing be curtailed or regulated?

THE WAY FORWARD

Laparoscopic surgery is here to stay and success in it is determined by how quickly and effectively we learn. However certain measures may be taken to lessen some of the adverse effects of the learning curve and others to help laparoscopic surgeons ease into the specialist. Setting up[32] of minimal standards and credentialing is a must. Current guidelines in many countries are vague and general. The evidence for training is well documented. The message for individual surgeons is to identify their deficiencies, and chart a way forward for their personal graph of progress. Evaluation and monitoring in a systematic scientific manner will benefit the surgeon with a satisfactory learning curve that will ensure that patient welfare is not compromised.

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EUROPE
39 Brush Field Way
Knaphill
Woking
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INDIA
Laparoscopy Hospital
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