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Editorial

The World Journal of Laparoscopic Surgery (WJOLS) is slowly creating new milestones and now it is the most popular peer-reviewed academic journal of minimal access surgery that aims to guide clinical practice and improves laparoscopic skills of surgeons and gynecologists. Now, WJOLS has already entered in its sixth year and there is dramatically increased acceptance of this journal from all over the world.

Due to huge demand and long waiting list of authors to get their article published in this journal, we have started giving priority to manuscripts that are supported by major national and international foundations and those that are of great basic and clinical significance.

WJOLS is official publication of World Association of Laparoscopic Surgeons (WALS) and, today, WALS has become the most prominent and highly respected professional group for the minimal access surgical specialty in India, and has a high profile in other parts of the world. The objectives of the association are to promote laparoscopic surgery in theory and practice, and attempt to establish uniform training requirements for the specialty and encourage these worldwide.

In this issue of WJOLS, there are many interesting articles, including latest technique of performing Gastric Plication surgery. In this issue, few interesting HD laparoscopic videos are included in DVD as Laparoscopic Surgery for Endometriosis, Laparoscopic Fundoplication Surgery, Diagnostic Laparoscopy and Tubal Patency Test, Laparoscopic Management of Dermoid Cyst, Tension-free Vaginal Tape Obturator for Stress Urinary Incontinence and Laparoscopic Appendicectomy.

I hope this issue will be very useful for surgeons and gynecologists. Your feedback will be highly appreciated. I think it is very important to have a feedback loop from our readers, where you are constantly giving advice about what is lacking and how we could do it better. The single best piece of advice is criticism, what we need from the readers. That is how we improve.

With Regards

RK Mishra
Editor-in-Chief

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ORIGINAL ARTICLE

Laparoscopy: A Procedure no less than Laparotomy for Lymph Node Dissection in Total Gastrectomy for Gastric Carcinoma

T Anil Kumar, Manoj Gowda, Manash Ranjan Sahoo

ABSTRACT

Aim: To show that laparoscopic lymph node dissection and harvesting is equal to laparotomic lymph node dissection in patients undergoing total gastrectomy for gastric carcinoma.

Materials and methods: Retrospective data was collected from 36 patients who underwent total gastrectomy for carcinoma stomach. Fifteen patients underwent open total gastrectomy (OG) and other 21 laparoscopic assisted total gastrectomy (LAG) over a period of 4 years from March 2009 to June 2012. In the laparoscopic group, dissection of lymph nodes and division of ligaments and omentum was done laparoscopically using harmonic scalpel. Both groups were compared for operative blood loss, operative time, blood transfusion, morbidity, mortality, the number of harvested lymph nodes (HLNs) with emphasis on harvested lymph nodes.

Results: There were no significant differences in morbidity or mortality in both groups. Tumor free margins were obtained in all cases. Compared with OG group, the LAG group had significantly less blood loss, but a longer operation time. The mean harvested lymph nodes (HLN's) is 24.7 in LAG group as compared 23.3 in OG group.

Conclusion: Laparoscopic dissection and harvested lymph nodes is equivalent to OG with no other significant differences except for decreased blood loss and increased operative time. Thus, this procedure can achieve the same result as OG.

Keywords: Open gastrectomy, Laparoscopic-assisted gastrectomy, Gastric cancer, Harvested lymph nodes.

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INTRODUCTION

While laparoscopic approaches are used for many abdominal procedures and allow for faster recovery of bowel function, better immunologic response and overall accelerated recovery for the patient, the use of laparoscopy for cancer surgery is still a matter of debate. For patients with cancer, questions remain about the immunologic implications of laparoscopic surgery, the adequacy and standardization of laparoscopic techniques, the risk for disease recurrence, and the impact on survival. The safety and efficacy of laparoscopic surgery for colorectal cancer has certainly been established, but the same rigorous approach to other cancers has yet to be reported. Gastric cancer is the fourth most common cancer and the second leading cause of cancer-related deaths worldwide.[1,2] In the Far East countries such as China,[3] Korea[4] and Japan,[5] gastric cancer is the most prevalent malignancy, and the leading cause of cancer-related deaths. Since the first report of laparoscopic gastrectomy in 1992,[6] laparoscopy-assisted gastrectomy (LAG) has been carried out not only in distal gastrectomy, but also in proximal gastrectomy and total gastrectomy.[7-9] Several randomized control trials (RCTs) have shown that LAG can be performed in early gastric cancer (EGC).[10-15] Radical surgical resection of the stomach and regional lymph nodes dissection is still the mainstream of the treatment of AGC. However, LAG for the treatment of advanced gastric cancer (AGC) has remained controversial, mainly due to a lack of evidence from large-scale studies demonstrating that laparoscopic D2 dissection, the standard lymphadenectomy for AGC, is equivalent to open surgery. Recently, some studies have evaluated the outcome of D2 lymph node dissection in LAG and open surgery for gastric cancer.[16-19] In this study, we evaluated operative blood loss, operative time, blood transfusion, morbidity, mortality, the number of harvested lymph nodes (HLNs) with emphasis on HLNs between LAG and OG.

MATERIALS AND METHODS

Retrospective data was collected from 36 patients who underwent total gastrectomy for carcinoma stomach over a period of 4 years from March 2009 to June 2012 in the Department of Surgery SCB Medical College, Cuttack, India. The exclusion criteria included: (1) invasion of adjacent structures; (2) distant metastases; and (3) associated comorbid conditions making unfit to undergo surgery. Routine blood examination, chest X-ray, contrast-enhanced computed tomographic scan of the abdomen and pelvis and endoscopy were performed before operation. Biopsy revealed adenocarcinoma in all cases. The study population thus included 20 cases that successfully underwent radical gastrectomy with D2 dissection. Twenty-one cases underwent LAG and other 15 OG. Mean period of follow-up was 8 months.

OPERATIVE PROCEDURE

Laparoscopy-assisted total gastrectomy with D2 dissection: This procedure was performed for gastric cancer involving more than two-third of the stomach. Under five port approach (Fig. 1) the greater omentum was first dissected, using the harmonic scalpel along the border of the transverse colon. The right gastroepiploic vessel was clipped and cut at its origin with the harmonic; lymph nodes alongside of it were removed. The duodenal tunnel was made and duodenum was divided 2 cm distal to prepyloric vein using linear cutting stapler (Fig. 2). Then the left gastroepiploic vessel was cut, allowing lymph nodes alongside it to be removed. Then the gastropancreatic fold was exposed. Along with the gastroduodenal artery, the common hepatic artery could be skeletonized easily. The right gastric artery was divided and cut at its origin, from the proper hepatic artery to complete dissection of lymph nodes alongside of it. Then the lymph nodes located along the celiac trunk and the left gastric artery was removed. The left gastric artery was cut from the celiac trunk using clips. Then the splenic artery was skeletonized from its origin to the end in order to remove lymph nodes. After returning the stomach and the greater omentum to normal position, the lesser omentum could be resected close to the liver edge (Fig. 3) to the esophagogastric junction, with dissection of lymph nodes. Lastly lymph nodes along the hepatic artery were dissected. After standard D2 dissection was completed, an upper midline incision (about 10 cm) was made. The gastrectomy was performed using knife at the esophagogastric junction (Fig. 4) and esophagojejunostomy was done using circular stapler (Figs 5 and 6) (Ethicon make) and jejunojejunostomy was done to complete Roux-en-y anastomosis.

In open gastrectomy (OG) upper midline incision about 20 cm was given and the procedure is same as LAG.

Postoperatively patients were on Ryle's tube for minimum of 5 days. Oral liquids were started from 6th postoperative day. During surgery, operative time, blood loss, and the amount of blood transfusion were recorded. Postoperative complications, categorized as surgical and nonsurgical complications were observed. Mortality was defined as any death that occurred during hospital stay. The depth of tumor invasion, tumor size, margins, the number of HLNs, and positive lymph nodes were determined by pathological analysis.

RESULTS

There were no significant differences in morbidity or mortality in both groups. Tumor free margins were obtained in all cases. Compared with OG group, the LAG group had significantly less blood loss, but a longer operation time. Since, we were interested in the number of lymph node harvested, the mean HLN's were 24.7 in LAG group as compared 23.3 in OG group.

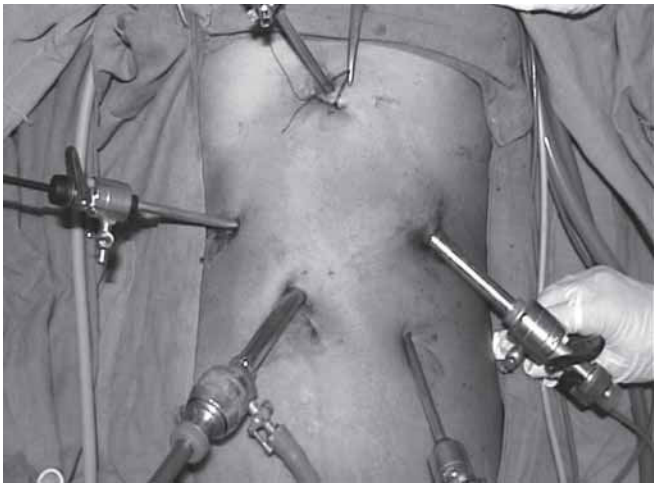

Fig. 1: Port positions in laparoscopic gastrectomy

Fig. 2: Division of pylorus distal to prepyloric vein using linear cutter stapler

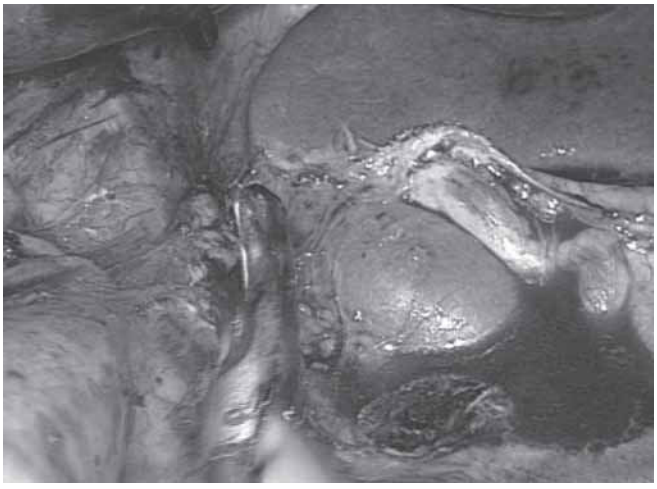

Fig. 3: Division of lesser omentum close to liver edge

Fig. 4: Gastrectomy performed using knife at the esophago-gastric junction

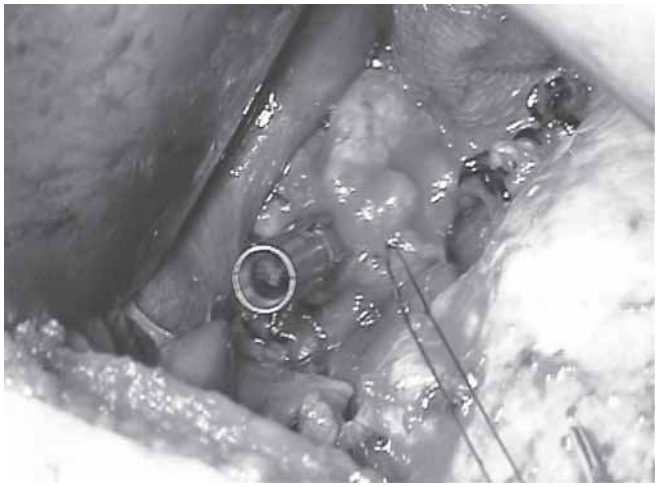

Fig. 5: Anvil placed into the esophagus

Fig. 6: Docking of anvil into circular stapler

DISCUSSION

For the treatment of AGC, surgical procedures include gastrectomy and lymphadenectomy. However, the extent of lymph node dissection has remained controversial worldwide.[19] In Eastern Asian countries such as Japan, China, and Korea, D2 dissection has been the standard operation.[20] However, in Western countries, D2 dissection is thought to be accompanied by significant mortality and morbidity, with no survival advantage.[21-23] Hartgrink et al[22] reported the results of a Dutch gastric cancer group trial in 2004, which included 711 patients who underwent randomly assigned treatment with curative intent (380 in D1 and 331 in D2). Both the postoperative morbidity (25 *vs* 43%, $p < 0.001$) and mortality (4 *vs* 10%, $p = 0.004$) were significantly higher in patients who underwent D2 dissection, while there was no difference in the 11-year overall survival (30 *vs* 35%, $p = 0.53$) between the two groups. Those results were similar to that of the Medical Research Council Gastric Cancer Surgical Trial. [22] However, the conclusions drawn from those two famous RCTs were questioned by Eastern investigators. The main concern was that 80 centers participated in the Dutch gastric cancer group trial, so the mean number of patients who underwent D2 dissection in each center was less than 5. Thus, the discommenders considered it very difficult to perform safe and standard D2 dissections in each center. Unexpectedly, in the 15-year follow-up from the Dutch gastric cancer group trial, published in 2010,[24] the gastric cancer-related death rate of the D2 group was significantly lower than that of the D1 group (37 *vs* 48%, $p = 0.01$), local recurrence was 12% in the D2 group *vs* 22% in D1, and regional recurrence was 13% in D2 *vs* 19% in D1. Thus, the authors recommended D2 dissection as the standard surgical approach for resectable gastric cancer. Currently, more and more evidences have proved D2 dissection as a feasible and safe procedure with survival advantages as compared with the D1 dissection,[25-27] and D2 dissection has been gradually accepted by Western investigators. In the 2010 National Comprehensive Cancer Network guidelines, the panel recommended that gastric cancer surgery should remove D2 lymph nodes with the goal of examining 15 or more lymph nodes. Although, D2 dissection is performed in AGC as a standard procedure, more and more investigators have emphasized the need for D2 dissection in EGC because of preoperative understaging.[28,29] In gastric cancer, laparoscopic surgery has not yet been validated, and thus, was only performed in a limited number of patients with EGC in six small-scale RCTs;[10-13,15] this was due to the difficulties in systematic lymph node dissection, especially in the standard D2 dissection. The number of HLNs is regarded as an important short-term oncological outcome of laparoscopic D2 dissection. Several recent retrospective studies have shown that laparoscopic D2 dissection is both a safe and oncologically feasible procedure, with a similar number of HLNs compared with open dissection.[16-19,28] Du

et al[16] evaluated 82 patients with AGC who underwent laparoscopy-assisted total gastrectomy with D2 dissection compared with 94 patients who received open surgery; a similar number of HLNs was obtained in both groups (34.2 ± 13.5 *vs* 36.4 ± 19.1, p = 0.331). In our hospital we are doing D2 dissection for all cases of gastric cancer. In this study we want to highlight that laparoscopic D2 gastrectomy provides same result as that of open surgery even in terms of HCNs as there is very much debate now over this issue which is also an important prognostic factor.

CONCLUSION

Laparoscopic dissection and harvested lymph nodes is equivalent to OG with no other significant differences except for decreased blood loss and increased operative time. Thus, this procedure can achieve the same result as OG. However, large-scale RCTs with a longer follow-up period should be carried out in future studies to prove that LAG with D2 dissection is a good alternative to OG in selected patients.

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ORIGINAL ARTICLE

Laparoscopic Management of Perforated Peptic Ulcer in Early and Late Presentation: A Comparative Study

T Anil Kumar, Manoj Gowda, Manash Ranjan Sahoo

ABSTRACT

Aim: To compare results of laparoscopic treatment of perforated peptic ulcer (PPU) in early and late presentation.

Materials and methods: Fifty-eight patients of age ranging from 18 to 55 years underwent laparoscopic closure of PPU over a period of 4 years between 2008 and 2011 of which 43 were male, 15 were female. In our study we took early presentation as 3 days and late presentation as 3 to 7 days (time taken for seeking treatment from the onset of symptoms). Thirty-seven presented early whereas other 21 presented late. All patients were compared for variables like operating time, intraoperative complications, risk of anesthesia, rate of conversion to open surgery, postoperative pain and the opiate analgesic requirements, postoperative morbidity and mortality, hospital stay.

Results: Mean operating time for patients with early presentation was 60 *vs* 90 minutes for delayed presentation. Conversion rate was 0 in early presentation 47.6% (10 cases) in late presentation. Thorough abdominal toileting was possible in all cases of early presentation. In late presentation it was possible only in 6 out of 11 cases after excluding conversion rate because of intestinal matting. No patients had any anesthesia problem in early presentation but 3 out of 11 cases had delayed recovery from anesthesia requiring treatment in intensive care unit. Post-operatively Opioid analgesia was required for mean of 3 days in early presentation *vs* mean of 4 days in late presentation. Nasogastric tube was removed on 3rd day in early presentation *vs* 4th day in late presentation which coincided with return of bowel sounds. Port site infection was seen in 5 out of 37 cases in early presentation and 2 out of 11 in late presentation. Intraperitoneal localized abscess was seen in 2 out of 11 cases in delayed presentation and none in early presentation which was then managed by aspiration. Mean hospital stay was 5 days in early presentation and 7 days in late presentation.

Conclusion: Laparoscopic treatment of PPU is safe, feasible done with ease in patients presenting less than 3 days and also in some cases of late presentation, with anesthetic complication, postoperative complications and conversion rate increasing with delayed presentation.

Keywords: Laparoscopic, Perforated duodenal ulcer, Early presentation, Delayed presentation, Opioid analgesia.

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INTRODUCTION

Laparoscopic treatment of perforated duodenal ulcer was first reported in 1990.[1,2] Perforated peptic ulcer (PPU) is a condition in which laparoscopic repair is an attractive option. Not only is it possible to identify the site and pathology of the perforation, but the procedure also allows closure of the perforation and peritoneal lavage, just like in open repair but without a large upper abdominal incision.[3,4]

In the past 2 decades, there has been a change in the pattern of perforated peptic ulcer disease in affecting old and infirm patients, with a high association with nonsteroidal anti-inflammatory agents.[5-12] They seldom require any definitive procedure, which is associated with increased rates of perioperative death and complications.[13] *Helicobacter pylori* is now the recognized culprit of the majority of patients with duodenal and gastric ulcers, and posteradication ulcer recurrence is uncommon.[14-16] Acid-reduction procedures are not required for this group of patients. As a result, simple closure of the perforation with an omental patch has become the favored management approach in many institutions. It is technically straightforward and reliable and is also the preferred approach for high-risk patients.[17-23] In this study we compare results of laparoscopic treatment of PPU in early and late presentation.

MATERIALS AND METHODS

Not all patients are suitable for laparoscopic repair, and it is important to preselect patients who are good candidates for laparoscopic surgery.[3] Boey's classification appears to be a helpful tool in decision-making.[24,25] The Boey score is a count of risk factors, which are: shock on admission, American Society of Anesthesiologists (ASA) grade III and V, and duration of symptoms.[26] The maximum score is 3, which indicates high surgical risk. Laparoscopic repair is reported only to be safe with Boey score 0 and 1.[27,28] Elderly patients more than 70 years, cardiac pathology, chronic respiratory insufficiency, obesity, severe cirrhosis, severe coagulopathy, delayed presentation more than 7 days, patients requiring continuous vasopressor infusion to maintain blood pressure were excluded. Intraoperative exclusion criteria for the laparoscopic repair are: a nonjuxtapyloric gastric ulcer, an ulcer greater than 2 cm in diameter, concomitant hemorrhage, inability to tolerate pneumoperitoneum. After excluding patients from above criteria 58 patients of age ranging from 18 to 55 years underwent laparoscopic closure of PPU over a period of 4 years between 2008 and 2011 of which 43 were male,

15 were female. In our study we took early presentation as 3 days and late presentation as 3 to 7 days (time taken for seeking treatment from the onset of symptoms). Thirty-seven presented early whereas other 21 presented late. All patients were compared for variables like operating time, intraoperative complications, risk of anesthesia, rate of conversion to open surgery, postoperative pain and the opiate analgesic requirements, postoperative morbidity and mortality, hospital stay. Postoperative follow-up was done at 1, 6 months, 1 year and yearly thereafter.

After initial resuscitation and investigation revealing gas under diaphragm in straight X-ray of abdomen, patients were posted for surgery.

SURGICAL TECHNIQUE

After general anesthesia the patients were positioned in reverse Trendelenburg's position, modified Fowler position with the thighs slightly flexed at the hip joints. The operating surgeon stood between the patient's legs. The camera surgeon stood on the patient's right side and the assistant surgeon on the left side. The camera port (10 mm) was placed in the umbilicus. The right hand working port (10 mm) was placed medial to the left midclavicular line, just above the level of the umbilicus. The left-hand working port (5 mm) was placed in the right midclavicular line, above the level of the umbilicus. A 5 mm port was placed in the epigastrium to retract the quadrate lobe of the liver. After identifying perforation (Fig. 1) the perforation was closed with interrupted sutures of 2-0 polyglactin. Three interrupted sutures were placed and kept without tying (Figs 2 and 3). An omental flap raised with intact blood supply was placed over the perforation, and the sutures were tied over the omental flap (Fig. 4), completely sealing the perforation. Thorough peritoneal lavage was then given with 4 to 6L of saline irrigation and aspiration mainly was in supra- and subhepatic regions, the left subdiaphragmatic space, pelvic cavity and interloop collections. After lavage, all the fluid was aspirated and a tube drain was kept in the subhepatic space and pelvis in all cases.

RESULTS

Comparison of results between early and delayed presentation are tabulated in Table 1.

Thorough abdominal toileting could not be done because of intestinal matting. Port site infection was managed conservatively with dressing. Intraperitoneal localized abscess was aspirated under ultrasound guidance.

DISCUSSION

In 2002, Lagoo et al added the sixth decision for a surgeon to be made regarding PPU to the existing five therapeutic decisions proposed by Feliciano in 1992.[24] The first decisions were about the need for surgical or conservative treatment, to use omentoplasty or not, the condition of the patient to undergo surgery, and which medication should be given. The sixth decision was: 'Are we going to perform

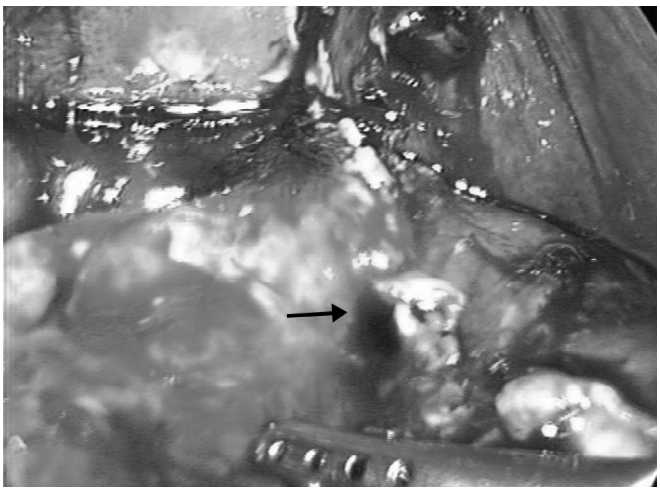

Fig. 1: Arrow pointing the perforation

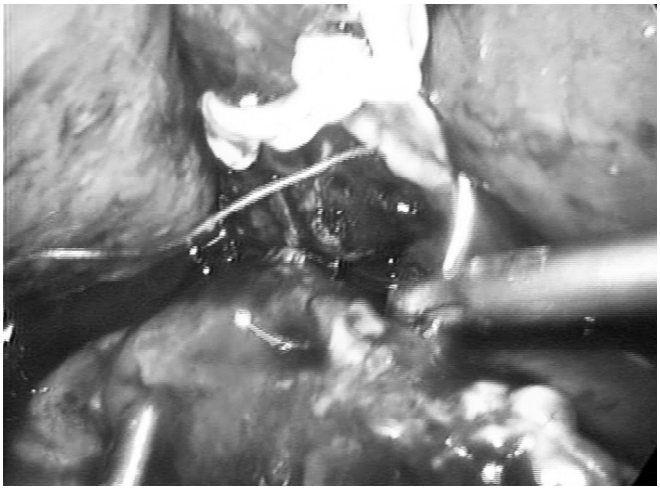

Fig. 2: Taking a bite through perforation using polyglactin suture

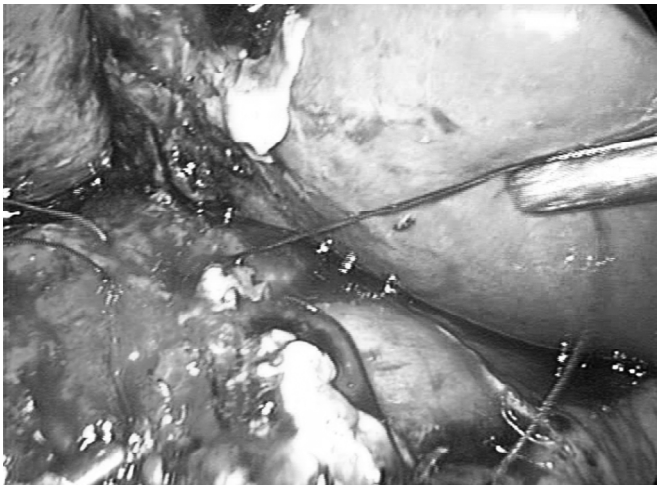

Fig. 3: Interrupted sutures are placed

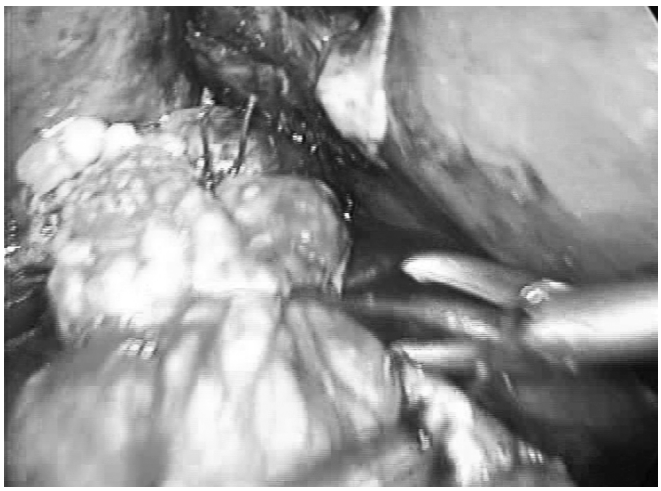

Fig. 4: Sutures are tied over omental flap

this procedure laparoscopically or open?' Is there really a sixth decision to be made, or are there enough proven benefits of laparoscopic correction that this should not be a question anymore? Management of peptic ulcer perforation is controversial.[29,30] Laparoscopic surgical treatment is attractive due to a lower morbidity rate associated with it than with conventional surgery.[31] A recent review[32] compared laparoscopic *vs* open peptic perforation surgery; laparoscopic repair was associated with lesser postoperative analgesic use, decreased hospital stay, lower wound infection rate, and lower mortality rate; open repair was associated with reduced operating time and suture-site leakage. A variety of laparoscopic techniques,[33-40] including a combined laparoscopic-endoscopic method,[41] have been described. We prefer intracorporeal suturing against extracorporeal knotting because the latter is likely to cut through the friable edge of the perforation. Laparoscopic perforation closure can be performed effectively with viable Graham's patch omentoplasty as in conventional surgery.

CO_2 insufflation of the peritoneal cavity in the presence of peritonitis has been shown in rat models to cause an increase in bacterial translocation[42,43] from the peritoneal cavity to the bloodstream. Although, laparoscopic intervention would have been thought to be unsafe, such is not the case, and several studies have documented that laparoscopic surgery is to be safe even in the presence of peritonitis.[44,45]

The most common reason for conversion was the size of perforation, but by using an omental patch this might not necessarily have to be a reason anymore to convert. From literature it was already known that other common reasons for conversion include failure to locate the perforation.[46] Shock at admission was associated with a significant higher conversion rate (50 *vs* 8%).[24] In our study reason for conversion were dense adhesions which increased with increase in time for presentation, and unable to locate site of perforation which occurred mostly in patients presented after 5 days.

Overall there seems to be significant proof of the benefits of laparoscopic repair, but it is technical demanding surgery which needs a surgeon experienced with laparoscopy.[24,46] CO_2 insufflation of the peritoneal cavity in the presence of peritonitis has been shown in rat models to cause an increase in bacterial translocation.[24] This led to the assumption that laparoscopic surgery might be dangerous in patients with prolonged peritonitis. Vaidya et al performed laparoscopic repair in patients with symptoms of PPU for more than 24 hours and concluded that it was safe even in patients with prolonged peritonitis, which has been confirmed by others.[24,44,47,48] In our study laparoscopic repair could be done with ease in patients presenting less than 3 days, also it could be done in patients presenting after 3 days with increasing difficulty, morbidity complications like localized peritoneal abscess, port site infection and with increase conversion rates.

CONCLUSION

Laparoscopic treatment of PPU is safe, feasible, done with ease in patients presenting less than 3 days and also in some cases of late presentation, with anesthetic complication, postoperative complications, conversion rate, duration of hospital stay with increasing morbidity increasing with delayed presentation.

Table 1: Comparison of results between early and delayed presentation. Thorough abdominal toileting could not be done because of intestinal matting. Port site infection was managed conservatively with dressing. Intraperitoneal localized abscess was aspirated under ultrasound guidance

Variables	*Early presentation*	*Delayed presentation*
Mean operating time	60 minutes	90 minutes
Conversion rate	0 out of 37 cases (0%)	10 out of 21 (47.6%)
Thorough abdominal toileting	0 out of 37 cases (0%)	6 out of 11 (54.5%)
Delayed recovery from anesthesia	0 out of 37 cases (0%)	3 out of 11 case (27.3%)
Postoperative opioid analgesia	Mean 3 days	Mean 4 days
Nasogastric tube removal	3rd day	4th day
Port site infection	5 out of 37 cases (13.5%)	2 out of 11 cases (18.2%)
Intraperitoneal localized abscess	0 out of 37 cases (0%)	2 out of 11 cases (18.2%)
Duration of hospital stay	Mean 5 days	Mean 7 days

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ORIGINAL ARTICLE

Laparoscopic Orchidopexy without Division of Spermatic Vessels using a Neoinguinal Canal Approach: A Single Center Experience

Ved Bhaskar, Manash Ranjan Sahoo

ABSTRACT

Introduction: About 1 to 2% of boys at age of 1 year have an undescended testis (UDT); almost 20% of UDT are nonpalpable. Several surgical procedures have been described but there are no formal guidelines for the management of boys with nonpalpable testis. We report our experience with laparoscopic orchiopexy performed without dividing the spermatic vessels in this case series over a period of 4 years stating that the Fowler-Stephens technique is no longer indicated for the treatment of the intra-abdominal testis.

Materials and methods: Over a period of 7 years from 2005 to 2012, we carried out diagnostic laparoscopy on 50 nonpalpable intra-abdominal testis in 45 boys followed by laparoscopic orchiopexy without sectioning the spermatic vessels even in cases where testis was higher up (30 cases). The technique consisted in sectioning the gubernaculum, opening the peritoneum laterally to the spermatic vessels, and mobilizing the testicular vessels and the vas deferens in a retroperitoneal position for 8 to 10 cm. The testis was then brought down into the scrotum through a neo-inguinal ring created just lateral to medial umbilical ligament.

Results: Out of 45 cases with 50 undescended testis, 30 testes were abdominal, away from the internal ring out of which we were able to bring 28 testis in the scrotum without dividing the spermatic vessels, using a neo-inguinal ring. The other two patients had to undergo orchidectomy because of atretic testis. In the remaining 20 cases, the testis was at the inguinal ring or close to it and mobilized easily through the neo-inguinal ring to scrotum. The mean follow-up period has been 14 months (6 months to 2 years) and all the testes were found to be in scrotum with no atrophy.

Conclusion: On the basis of our experience, we believe that laparoscopic orchiopexy without division of the spermatic vessels should be the treatment of choice in the management of nonpalpable testes because it does not compromise the normal testicular vascularization. Creation of neo-inguinal canal lateral to the medial umbilical ligament has the advantage of gaining more length on the vessels and vas to bring the testis to scrotum and hence Fowler-Stephens procedure is no longer routinely indicated in management of high abdominal testis.

Keywords: Neo-inguinal ring, Laparoscopic orchidopexy, Undescended testis, Subdartos pouch.

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INTRODUCTION

Cryptorchidism is a common urological problem with 1 to 2% of boys at age of 1 year having an undescended testis (UDT); this disorder is unilateral in about 90% of individuals and bilateral in about 10%. Almost 20% of undescended testes are nonpalpable.[1] Important potential long standing effect of cryptorchidism include infertility and testicular cancer.

The importance of a descended testis has been known since ancient times, but the mechanism of descent remained obscure until 1786 when Hunter dissected the human fetus and found the intra-abdominal testis connected to the inguinal-abdominal wall by a ligament called gubernaculum testis because it appeared to guide the testis to the scrotum.[2] Numerous factors interact to effect normal testicular development and descent including endocrine, paracrine, growth and mechanical factors. Any abnormality in this process can result in an undescended testis, which carries fertility and malignancy implications. Infact recent studies even show a relation of genitofemoral nerve to descent of testis in mice models.[3]

UDT is defined as a testis that cannot be manipulated to the bottom of the scrotum without undue tension on the spermatic cord. There is variability in nomenclature relating to UDT but the clearest classification is palpable and nonpalpable testis.[4]

UDT are usually evaluated and managed by imaging methods and surgery, respectively.[1] Management of the nonpalpable testis is a diagnostic and therapeutic challenge. The diagnostic difficulty involves determining if such a testis is present and, if so, its location and further management. Laparoscopy was first used in 1976 to locate UDT.[5]

Treatment of the patient with abdominal testis is controversial. Difficulty in mobilization, as well as significant complications including atrophy, have led to a multitude of approaches to this dilemma.[6] This scenario is not new, and all pediatric surgeons are familiar with the numerous procedures available to treat these patients, including staged orchidopexy, transperitoneal or retroperitoneal orchidopexy via an extended inguinal or Pfannenstiel incision, Fowler-Stephens orchidopexy in 1 or 2 stages, microvascular transplantation and laparoscopic

vessel clipping followed several months later by extended inguinal or transabdominal orchidopexy.[7] In our current series, laparoscopic management of these testes yielded success in 48 of the 48 cases (100%). Orchidectomy was done for the remaining two patients as they had atrophied testes and they belonged to postpubertal age group.

In our series, technique consisted in sectioning the gubernaculum (when present), opening the peritoneum laterally to the spermatic vessels, and mobilizing the testicular vessels and the vas deferens in a retroperitoneal position for 8 to 10 cm. In our technique the vas avoided going around the inferior epigastric vessels, thereby gaining at least 2 to 3 cm of extra length. This route gives a direct approach to the scrotum. So by using this neo-inguinal canal route we could mobilize all the testes to scrotum. The greater degree of success with the laparoscopic procedure may be because of the magnification used which may have led to better preservation of small collateral vasculature.

MATERIALS AND METHODS

This procedure was carried out in Department of General Surgery, SCB Medical College, Cuttack over a period of 7 years from 2005 to 2012 using laparoscopic approach and patients were followed up regularly. Then a retrospective analysis after collection of all the data from medical records was done. One important point to be noted here is that the main author being a general surgeon usually got cases which were of somewhat higher age group as compared to most other studies which are conducted in pediatric surgery departments. Most of the cases were postpubertal males in whom testis was nonfunctional. They had mainly come for psychological and cosmetic reasons.

A risk bond for surgery and a formal consent for orchidectomy were taken in all cases. The bladder was emptied using a urethral catheter. Diagnostic laparoscopy was then performed through an optic port introduced through 11 mm supraumbilical incision. The entire abdomen was inspected and various anatomical landmarks identified. The peritoneal cavity was insufflated with carbon dioxide to a maximum pressure of 12 mm Hg. If an intra-abdominal or 'peeping' testis was found, two accessory working trocars 6 mm were placed at the level of umbilicus in the midclavicular line on either side of the abdomen under direct vision.

With gentle traction on the testis, using the harmonic scalpel the most distal gubernacular attachment was divided (Fig. 1). The peritoneum overlying the spermatic vessels is then incised. This incision frees the testicular vessels from the posterior peritoneal attachments and provides the additional length for proper mobilization of the testis into the scrotum. Dissection was continued cranially as far as necessary to gain enough length of the spermatic vessels to allow tension free orchiopexy (Fig. 2). Then the peritoneum superior to the vas deferens was incised to gain additional vasal length. Periodically the testis was moved toward the contralateral internal ring as an average estimate of whether sufficient length had been attained to move it to the scrotum (Fig. 3).

A neo-ring was then created just lateral to the medial umbilical ligament. The endodissector was driven out of the scrotal incision, guided by an index finger invaginating the scrotum (Fig. 4). A small scrotal incision was made and a dartos pouch developed. A Kelly's forceps was introduced from the scrotal incision through this new ring into the abdomen (Fig. 5), and grasped the testis, ensuring that only the gubernacular tissue was held (Fig. 6). It is inadvisable to grab the vas or the advential tissues around the epididymis, as this can crush the delicate blood supply (Fig. 7). The neo-ring was narrowed using one or two

Fig. 1: Beginning of testicular mobilization

Fig. 2: Mobilization continued

intracorporeal suturing (Fig. 8). The testis was brought out into the scrotum and the length checked by deflating the abdomen (Fig. 9). Releasing the pneumoperitoneum gives additional length that at times would obviate vessel ligation. Once the testis was freely lying in the newly created subdartos pouch, scrotal incision was closed with catgut

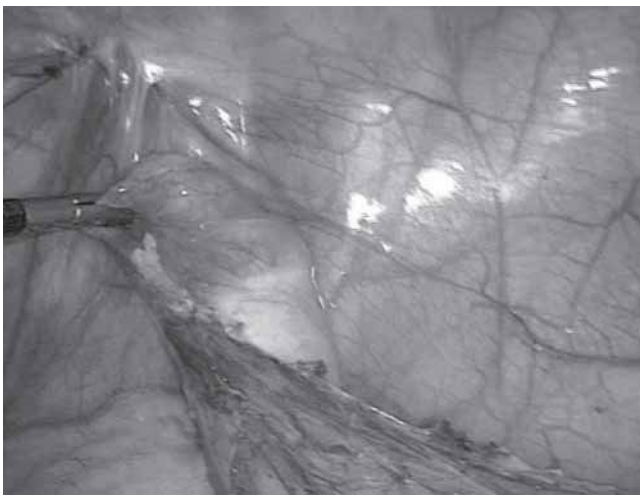

Fig. 3: Adequacy of mobilization being checked by pulling the testis to the opposite ring

Fig. 6: Testis grasped and taken out through the new ring. The internal ring can be seen laterally

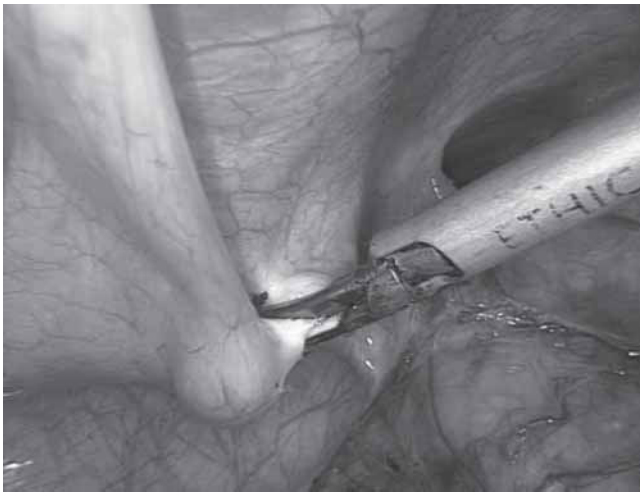

Fig. 4: Endodissector was driven out of the scrotal incision

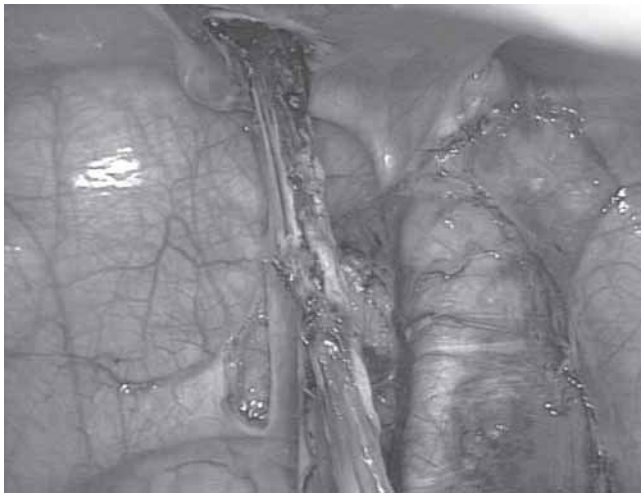

Fig. 7: Testis is entirely out through the new ring

Fig. 5: Kelly's forceps was introduced from the scrotal incision through this new ring into the abdomen

Fig. 8: The neo-ring narrowed using one or two intracorporeal suturing

(Fig. 10), and abdominal skin incision was closed with ethibond so that the patient need not come back for stitch removal. In bilateral cases, one side was dealt first followed by surgery for the other side 6 months later. Postoperatively they were started with oral feed on the next day and Doppler assessment of the gonadal vessels done to ensure good vascularity to the testis before the patient was discharged. Patients were followed up after 6 months and 1 year.

RESULTS

A total of 50 nonpalpable testes in 45 patients were taken up for diagnostic laparoscopy and and the initial inspection revealed 24 testes on right side, 16 on left and 5 cases were bilateral. There were 20 testes which were in or around the internal ring while 30 were intra-abdominal with 8 testes lying proximal to iliac vessels. Two out of this 8 were atrophic and were found in postpubertal boys. Mean age of patients was 14.5 years (8-24 years). Mean operative time was 78 mintues (52-90 min). Surgery was considered successful if the testis was in scrotum without any atrophy after a period of minimum 6 months from surgery.

We could mobilize all the 48 testes to the bottom of scrotum in the subdartos pouch through the neo-inguinal ring by the above mentioned techniques and placed them securely without any tension. We did not require any spermatic vessel ligation or a two-stage operation even for testes which were located higher up, thus excluding any theoretical risk of testicular atrophy although there were difficulty mobilizing them. But with meticulous dissection higher up in the retroperitoneum and using the new route to scrotum which at least gives 2 to 3 cm extra by not going around the inferior epigastric and the inguinal canal we were successful in mobilizing even difficult cases. On two occasions we performed an orchidectomy where we found the testis to be atrophied.

We did not have any complications intraoperatively and patients were discharged next day. They were followed-up regularly. After 6 months of follow-up we did not find any retraction of testis or any atrophy. All the testis were well placed inside the scrotum and of normal size and shape.

DISCUSSION

The availability of a wide variety of therapeutic strategies to treat intra-abdominal test indicates that the ideal technique to manage this type of pathology has not yet been found. The operations available are extended groin approach,[8] preperitoneal exploration,[9] two-stage or one-stage Fowler-Stephen method,[10,11] microvascular transplantation[12] and laparoscopic orchiopexy.[13] Orchiopexy by high division of testicular vessels may carry a high incidence (10%) of testicular atrophy.[14] The experience with microvascular autotransplantation is less and the procedure is lengthy.[12] In recent years laparoscopic orchiopexy without division of spermatic vessels has been taken up by many centers.[15-18] The main advantages of laparoscopic orchiopexy without division of spermatic vessels are that testicular vessels are well-preserved and mobilized for a longer length and that it is a minimally invasive procedure.

Scrotal testis resides in a specialized low-temperature environment with the pampiniform plexus, scrotal pigmentation, absence of subcutaneous fat. Low temperature is regulated by temperature-sensitive muscles–cremaster and dartos. All these ensure decreased temperature of the gonad. The scrotal testis in the human is maintained at 33ºC compared with 34ºC to 35ºC noted in the inguinal region and 37ºC intra-abdominally.[19] The physiology of the testis is well-adapted to this lower temperature; therefore, in the undescended testis where the ambient temperature is increased the testis undergoes progressive alteration.[20] Germ

Fig. 9: Testis was brought out into the scrotum

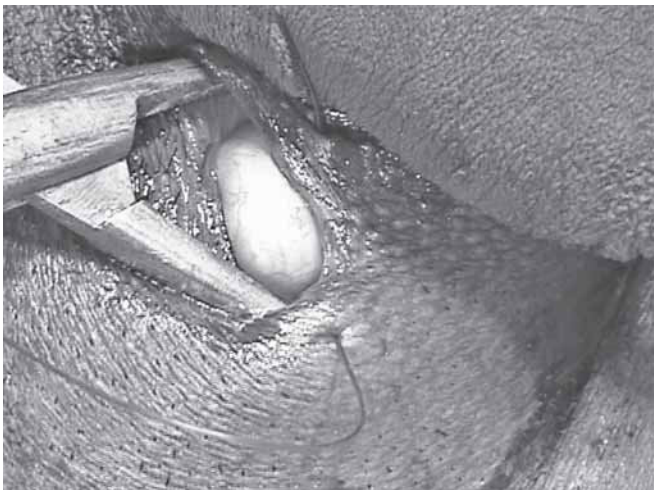

Fig. 10: Testis freely lying in the newly created subdartos pouch. Scrotal incision closed with catgut

cell deficiency in cryptorchidism was previously regarded as congenital.[21] It has been observed that the histology of the testis is initially normal and becomes progressively abnormal with age.

More detailed studies showed impaired Leydig cells development in undescended testes in the first 2 to 6 months, whereas the Sertoli and germ cells appeared normal.[22] By the end of the second year of life, nearly 40% of undescended testes had completely lost their germ cells. They concluded that germ cell deficiency in undescended testis is secondary.[22] In previous generations, it was believed that the undescended testis suffered no adverse changes until after puberty and surgical intervention was not necessary until 12 to 15 years of age.[23] The evidence that germ cell maturation is already abnormal after 6 months of age has led clinicians to appreciate that not only is postnatal degeneration is important issue but also that early intervention may prevent it.

Paternity rates are not deficient in unilateral cryptorchidism; but with bilateral cryptorchidism, fertility is significantly impaired.[24] Data attempting to correlate fertility rates with timing of surgery are not yet available because there are no long-term studies of children undergoing orchiopexy in the first year of life. The risk of developing testicular cancer is 5 to 60 times greater for men with cryptorchidism.[25] The increased risk may be due to an underlying genetic and hormonal etiology that causes both cryptorchidism and testicular cancer.[25] The association of orchiopexy with decrease in cancer risk has not been demonstrated prospectively.[26] Nevertheless, orchiopexy facilitates testicular examination and early cancer detection. Treatment of undescended testes improves fertility and endocrine function, reduces the risk of torsion and trauma, facilitates examination of testis and creates a normal-appearing scrotum.

The undescended testis is unlikely to descend after age of 9 to 12 month of age. For some years, orchiopexy has been recommended in the second year of life, but now orchiopexy is recommended at 6 months of age. This is because the first sign of damage to the testes are identified at about 6 months of age.[27] The mainstay of therapy for the palpable undescended testes is surgical orchiopexy with creation of a subdartos pouch.

CONCLUSION

On the basis of our experience, we believe that orchidopexy without division of the spermatic vessels should be the treatment of choice even for the cases of high intra-abdominal testis because this procedure does not affect normal testicular vascularization and eliminates any theoretical risk of devascularization and later atrophy of the testes so intimately related to Fowler-Stephens technique. And specially with the use of laparoscopy where extensive retroperitoneal dissection can be carried out under magnification and using the neo-inguinal ring we can easily mobilize all the testes to the scrotum without the need of division of spermatic vessels. Although the number of patients in our series is relatively small, our excellent success rate makes this procedure good alternative to the routine Fowler-Stephens procedure in patients with an abdominal testis.

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ORIGINAL ARTICLE

Laparoscopic *vs* Open Total Mesorectal Excision for Rectal Cancer: A Clinical Comparative Study in a Government Sector Hospital

Manash Ranjan Sahoo, T Anil Kumar, Sunil Jaiswal

ABSTRACT

Aims and objectives: To assess feasibility, advantages, oncological safety, cost-effectiveness and short-term results of laparoscopic *vs* open total mesorectal excision (TME) for rectal cancer in a government sector hospital.

Patients and methods: This comparative nonrandomized retrospective study analyzes the data of 70 patients with rectal cancer treated with low anterior resection (LAR) or abdomino-perineal resection (APR) from May 2007 to June 2012. Of these 40 patients underwent laparoscopic TME and 30 underwent open TME. Both the groups were comparable.

Results: Laparoscopic surgery took longer to perform (200 *vs* 150 min), but was accompanied by less blood loss (200 *vs* 800 ml) and fewer postoperative complications. Enteric function recovered sooner after laparoscopy than open surgery.Hospital stay was shorter for patients who underwent a laparoscopic surgery (7 *vs* 10 days). The mean number of harvested lymph nodes was greater in the laparoscopic group than in the open group (12 ± 3 *vs* 9 ± 2). Mean follow-up time was 30 months (range: 28-32 months). No local recurrence was found.

Conclusion: This study shows that laparoscopic TME for rectal cancer is a safe and feasible technique with some short-term benefits over open TME.

Keywords: Total mesorectal excision, Low anterior resection, Abdominoperineal resection.

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INTRODUCTION

Since its introduction in 1982, the total mesorectal excision (TME) concept by Heald et al[1] has become the gold standard in surgical treatment of rectal cancer.[2,3] It includes the standard excision of the total mesorectum, through the avascular 'holy plane', removing potential micrometastases enclosed in the mesorectum. At present, TME in combination with preoperative radiation therapy offers the lowest local recurrence rate (5%) and the highest 5-year survival rate (80%) in patients with mid- and low-rectal cancer.[4,5]

There are however problems with open TME surgery, mainly pertaining to difficulties in pelvic dissection, often leading to functional urogenital problems–especially in male patients– and possibly a less radical resection. Moreover, the increased use of coloanal anastomosis has also increased the need for better visualization during pelvic dissection. The laparoscopic approach to rectal cancer may be an attractive alternative for open TME because it offers better visualization, more delicate instrumentation and better tissue handling. This in turn, may lead to an adequate dissection up to the pelvic floor in combination with a better preservation of the hypogastric plexus and erigent nerves, possibly resulting in an improved functional and oncological outcome.

Several recently published randomized studies have shown short-term benefits of the laparoscopic approach to colon cancer over the open approach, without compromising oncological outcome.[6-9] Hence, we performed a study to compare laparoscopic TME with open TME in terms of perioperative and short-term outcomes in patients with rectal cancer in government sector hospital SCB Medical College, Cuttack.

PATIENTS AND METHODS

Seventy patients undergoing low anterior resection and abdominoperineal resections for rectal carcinoma between May 2007 and June 2012 at SCB Medical College and Hospital (Cuttack, Orissa, India) were entered into a database. Of these 40 patients underwent laparoscopic resection and 30 conventional open resection.

Exclusion criteria were:

1. Presence of distant metastasis
2. Locally advanced disease with invasion into adjacent pelvic organs
3. Acute bowel obstruction or perforation from cancer
4. Severe medical illness.

All patients received the same pretreatment workup, including an ultrasound, colonoscopy with biopsies, chest X-ray and carcinoembryonic antigen (CEA) level for dissemination status. CECT abdomen was routinely done to rule out metastatic disease and to look for evidence of local infiltration, gauge the size of tumor and regional lymph node involvement.

All patients received mechanical bowel preparation day before the operation. Systematic prophylactic antibiotics were given intravenously at the time of induction.

OPERATIVE TECHNIQUE

Patient was placed in head down Lloyd-Davies Trendelenburg position with surgeon and camera assistant on patient's right side. Five ports were routinely used with subumbilical port used for 30º angled telescope. No deviation from basic principles of open oncologic colorectal surgery was permitted and performed as follows: laparoscopic abdominal exploration, preliminary identification, ligation and transection of IMA (Fig. 1) and IMV with clips, mobilization of left hemicolon and splenic flexure, identification of ureters and hypogastric nerves bilaterally, rectal mobilization (for higher lesion mesorectal tissue down to 5 cm below tumor routinely excised and TME in tumors of middle and distal third) and intracorporeal transection of rectum below growth with an endoluminal stapler (Fig. 2) in case of restorative resection. Abdomen opened by Pfannenstiel incision (maximum 5 cm length) and resection of tumor bearing bowel completed extra-corporeally. Anvil of circular stapler inserted into proximal bowel, gut put back in peritoneal cavity, pneumoperitoneum re-established and intracorporeal anastomosis done with circular stapler passed per anally (Figs 3 and 4). For LAR, temporary diverting covering loop ileostomy is used (Fig. 5).

In patients with APR, pelvic dissection done as far distally as possible abdomen opened by extension of port in left lower quadrant, descending colon transected extracorporeally and end colostomy created. Conventional perineal dissection and delivery of specimen through perineal wound. Perineal drains routinely used. Throughout the surgery meticulous hemostasis was maintained to prevent light absorption by hemoglobin which reduces picture quality.

RESULTS

The patients characteristics in laparoscopic or open resection group are summarized in Table 1. The two groups were comparable in terms of age, sex, American Society of Anesthesia score (ASA score), pathologic stage and type of resection.

The mean operating time was significantly longer in LAP resection group than in open resection group. The amount of operative blood loss was lower in LAP resection group

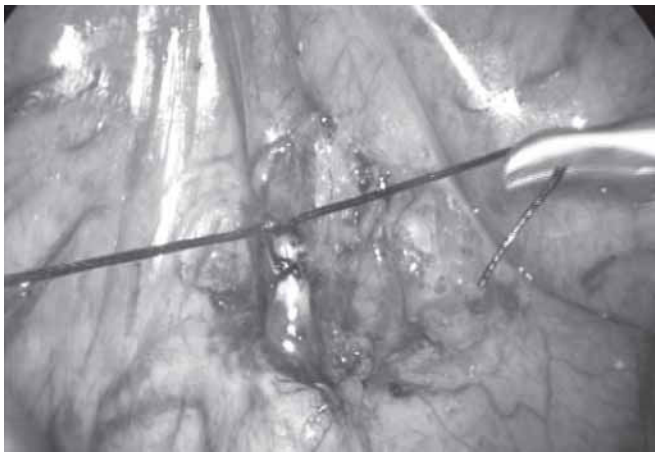

Fig. 1: Ligation of inferior mesenteric artery

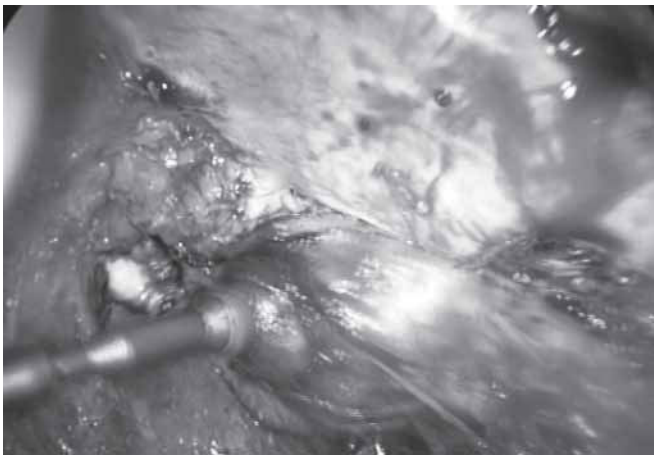

Fig. 3: Introduction of circular stapler per anally

Fig. 2: Resection of rectum keeping tumor-free margin using Endo Gia stapler

Fig. 4: Completed coloanal anastomosis

Fig. 5: Covering loop ileostomy

than in conventional surgery group (Table 2). Five patients needed conversion to open surgery in laparoscopic resection group, two because of advanced disease and the other three because of dense adhesions.

Postoperative complications were more frequent in the open resection group than in LAP resection group. The passage of flatus occurred earlier in laparoscopic resection group, and oral intake could be started earlier in the LAP resection group. Mean postoperative stay was shorter in LAP resection group than in open resection group.

To assess the adequacy of oncological resection, several parameters were examined from pathology reports. Evaluation of the resected specimens is summarized in Table 3. The mean number of lymph nodes removed in LAP or open resection group was 12 ± 3 and 9 ± 2, respectively. No significant difference was found between the 2 groups. The average lengths of removed specimens with the two surgical procedures were also comparable. Tumor distances from the closest margin were similar too for the two procedures, and were adequate from an oncological standpoint of view. Histological examination revealed that proximal and distal margins were free of tumor in all surgical specimens in both groups. The complications in the two groups are shown in Table 4.

Table 1: Patients characteristics in laparoscopic or open resection group

	LAP resection group (40)	*Open resection group (30)*
1. Age (yrs)	52 ± 8	54 ± 7
2. Male:Female	17:23	14:16
3. ASA score	2	2
4. Preoperative CEA	3.4	4.2
5. Location of tumor		
• Lower rectum	8	6
• Upper rectum	14	10
• Mid rectum	18	14
6. Grade of differentiation		
• Well	14	10
• Moderately	20	12
• Poor	6	8

Table 2: Intra- and postoperative results

	LAP resection group (40)	*Open resection group (30)*
1. Mean operative time (mins)	200	150
2. Mean blood loss (ml)	200	800
3. Diverting ileostomy	30	15
4. Conversion	5	–
5. Mean length of hospital stay (days)	7	10
6. Mean oral intake (days)	3	5

Table 3: Histopathological evaluation of the resected specimens

	LAP resection group (40)	*Open resection group (30)*
1. Lymph nodes harvested	12 ± 3	9 ± 2
2. Resected bowel (cm)		
LAR	21	26
APR	27.5	32
3. Distal resection margin (cm)	3.7	3.5

Table 4: The complications of the two groups

	LAP resection group (40)	*Open resection group (30)*
1. Ureter injury	1	1
2. Rectum perforation	0	1
3. Wound infection	1	6
4. Perineum infection	1	6
5. Anastomotic leak	1	2
6. Paralytic ileus	0	5
7. Urinary retention	1	3
8. Recurrence		
– Port site	0	–
– Local	1	3
– Distant	2	3

DISCUSSION

Laparoscopic techniques have been attempted and applied to wide range of colorectal disease since, first published study of laparoscopic colectomy in 1991 by Jacobs et al.[10] After almost 20 years of clinical application, use of laparoscopy for treatment of colorectal cancer is still controversial because long-term outcome in malignancy is of overwhelming importance compared with potential benefits obtained in the early postoperative course and advantages in cosmesis.[11] There were serious concerns about potential inadequacy of resection, possible staging inaccuracies or possibility that use of pneumoperitoneum altered the patterns of tumor dissemination.[7] Many questions have arisen concerning the oncological safety of this approach, following reports on port site metastases.[12-14] In nonrandomized comparative studies, laparoscopic and open

excision of rectal cancer was found to be equivalent in achieving distal and radial negative margins. Adequacy of radial resection can also be measured by ability to achieve high ligation, specimen characteristics and lymph node yield which in many recent studies have shown to be comparable in open and laparoscopic group.[15] Port site recurrences were as infrequent as incisional metastases in these studies, making it very likely that port site metastases in earlier reports were due to technical failure rather than to inherent problems with laparoscopy.

Three factors have stimulated the development of laparoscopic surgery for rectal cancer. Firstly, the technical difficulty of rectal dissections in a narrow pelvis, especially in male patients. Secondly, the inherent benefit of improved fine instruments and the improved visualization provided by the laparoscopic camera during pelvic dissection. Thirdly, the possibility to better dissect the rectum up to the pelvic floor in order to perform a coloanal anastomosis, avoiding an abdominoperineal resection, in selected patients with very low rectal cancer.

Laparoscopic colorectal surgery invariably takes longer time than a corresponding open procedure. This was true at the beginning of the learning curve, but many surgeons would disagree with this with the current level of expertize. Our study also confirmed the low rate of postoperative complications after minimally invasive procedures. Postoperative ileus, urinary retention, and wound infections occurred less frequently than that in the open resection group. These advantages have also been confirmed by many authors.[9,16] Comorbidity does not appear to be a major obstacle for laparoscopic technique and even elderly patients with comorbidities may be benefited with reduced postoperative morbidity. With magnified view and improved visualization of deep pelvic structures under laparoscope, postoperative genitourinary dysfunction after rectal cancer surgery, which is of paramount importance from patient's perspective, can be minimized.

Repeated evidences have indicated that a laparoscopic approach in colorectal cancer has several advantages including a shorter hospital stay, less pain, a better appearance and decreased postoperative analgesia requirements. In fact, laparoscopic surgery has been found to be associated with significantly decreased intraoperative blood loss and postoperative complications as well.[6,17] Furthermore, theoretic advantages of less physiologic trauma and immunologic suppression have recently received more attention in the literatures.[16,18] A less intensive inflammatory response has also been demonstrated after laparoscopic surgery compared with conventional open surgery.

For low rectal lesions laparoscopy-assisted abdominoperineal resection also allowed earlier postoperative recovery, with an equivalent tumor clearance, morbidity, mortality, disease-free interval and duration of survival.[21]

One final consideration that has to be made regarding laparoscopic surgery is cost effectiveness. Indeed, laparoscopic procedure itself is more expensive than conventional techniques because of the use of single use trocars and endoluminal staplers. However, when one takes into account ICU stay and overall hospital stay laparoscopic procedure is significantly superior, bringing considerable savings to the budget.

The difficulty in operating, resecting, anastomosing in pelvic cavity has led nowadays robotic surgeries to overtake conventional laparoscopic surgery.

To date, all reported comparative nonrandomized studies and randomized studies have shown no difference in recurrence and survival rates with laparoscopic *vs* open colorectal resection, and a lower overall morbidity with laparoscopic procedure.[19] Wise selection of appropriate cases should guide the novice in advanced laparoscopic surgery. With development of improved techniques and more experience, operating time can gradually be reduced with improved outcomes.

CONCLUSION

Our results suggest that laparoscopic resection for rectal cancer can be performed safely and without compromising oncological principles. There are definitely improved short-term outcomes with laparoscopic surgery.

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ORIGINAL ARTICLE

Ethical Issues and Training in Laparoscopic Surgery

Hana Alhomoud

ABSTRACT

Teaching operative laparoscopic skills by taking into account the basic principles of medical ethics in a recognized teaching hospital like the World Laparoscopic Hospital in India under the supervision of experienced laparoscopic surgeons is of paramount importance to surgical training.

Keywords: Ethics, Laparoscopy, World laparoscopic hospital.

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INTRODUCTION

Ethics, also known as moral philosophy, is a branch of philosophy that involves systematizing, defending and recommending concepts of right and wrong conduct. It comes from the Greek word ethos, which means 'character'.[1]

Each generation of surgeons inherits the moral and ethical foundations from the preceding generation and must practice the art and science of surgery based on these principles. While the foundations remain unchanged, the applications become more complex and the decisions more difficult as advancing technology provides greater opportunities to save lives and relieve pain and suffering. Until the past 50 years, the technology did not exist to treat many diseases, surgery was relatively straightforward, and all a surgeon's effort was directed at stopping the advance of a disease or correcting a congenital defect. Sometimes social issues related to advanced surgical technology, such as implementing an unproven technology or itinerant surgery, would arise. With each of the new dilemmas, the foundations have continued to suffice, although the solutions have become more complex. More importantly, the ethical dilemmas have dramatically increased in scope; rather than revolving only around an individual patient or the conduct of medical practice, the impact of technologies have driven the ethical implications to the new dimensions of global health, population imperatives, and impact of the evolution of the human species *per se*.[2]

Since, laparoscopic was first introduced in surgical practice, there has been a progressive increase in the number of its potential applications in surgical specialties, including both complex oncologic extirpation surgeries and meticulous reconstructive techniques. This situation is bringing new and promising changes to surgical practice, but correct performance of these procedures require previous training to acquire sufficient manual dexterity so that avoidable harm is not caused to patients who are operated on with these techniques.[3]

Specifically, laparoscopic training can be carried out using different modalities, such as the pelvitrainer, performance of laparoscopy in experimental animals or cadavers, or using virtual reality simulators in specially equipped centers.

World laparoscopic hospital (WLH) in India which is a well-recognized training laparoscopic center under the supervision of an experienced laparoscopic surgeon Professor Mishra. In the WLH you can find all the modalities of laparoscopic training. Professor Mishra ensures that the trainee receives all the basic training in laparoscopy. Trainee spends a period of basic training in experimental animals, pigs. In this phase, the trainee can become familiarized with the routes of surgical approach and placements of the trocars, and begin to acquire the necessary skills to perform endoscopic dissection and tissue suturing. Thus it seems that the greater the skill acquired through experimental surgery, the shorter the time required to transfer this skill to surgical practice in humans, with the subsequent technical assistance of experienced laparoscopic surgeons.

With these premises for training, it is attempted to preserve the principal of beneficence, which, according to Gracia,[4] is the ethical principle that obliges one not only to cause harm, but to do good.

WLH ensures that the trainee will learn the basic principal of medical ethics (beneficence, nonmaleficence, autonomy and justice).[5] During the training program in WLH a qualified laparoscopic surgeons will guide the trainees how to assess the effectiveness and safety of a new laparoscopic surgical device before using it. Because human dignity is the priority in WLH, Professor Mishra obliges himself to teach the trainees how to obtain informed consent from patients in a manner that is comprehensible and in accordance with the language, customs and culture of the patient. Informing in this way of the advantages of laparoscopy as well as its limitations and the possibility of conversion to open surgery.

It can be concluded that correct training in laparoscopy in a well-recognized center like the WLH in India will

provide the trainees with a proper training program where they will be competent in using the laparoscopic surgical devices and new technology as well as knowing the basic medical ethics.

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ORIGINAL ARTICLE

Laparoscopic Cholecystectomy: What is Appropriate Position of Epigastric Port?

Sarbjit Singh, Shubham Lavania

ABSTRACT

Laparoscopic cholecystectomy is a very commonly performed procedure. Position of epigastric port is prefered by some surgeons from left side of the falciform ligament, whereas others prefer from right side of ligament. In this study we have compared the ergonomics and results of two approaches by conducting the procedure upon 100 patients. The advantages and disadvantages of each technique are discussed in this report.

Keywords: Epigastric port, Laparoscopic cholecystectomy Port position.

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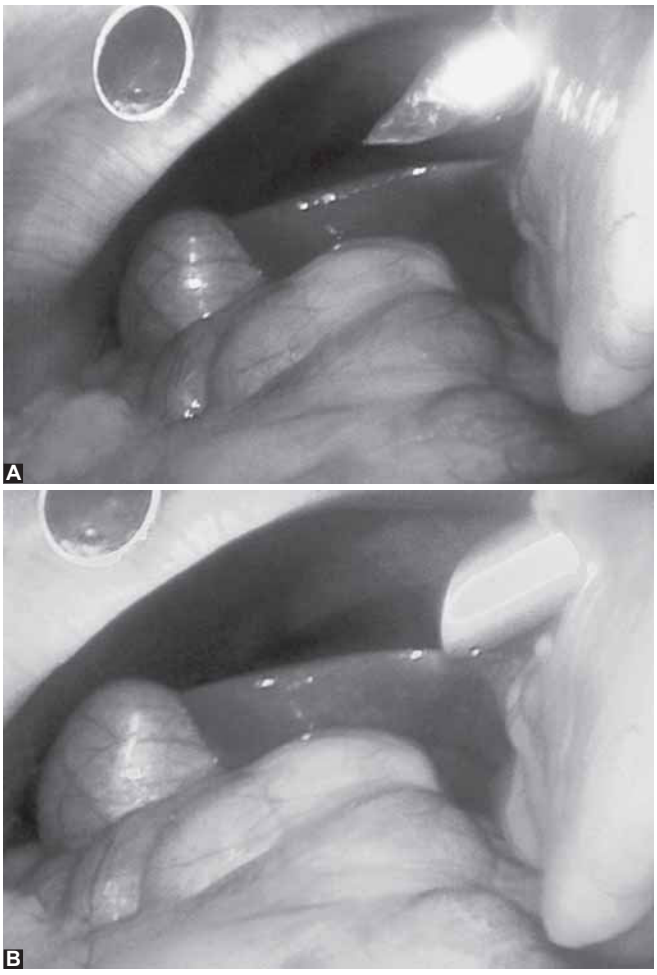
INTRODUCTION

Laparoscopic cholecystectomy has become the gold standard technique in treatment for gallbladder disease. This is essentially a safe procedure with low complications, morbidity and mortality rate.[1,2] In the first decade after the advent of laparoscopic surgery both the surgeon and patient had a lot of inconvenience due to higher complication rate in patients and greater physical strain experienced by surgeons. Later on it was realized that the inconvenience can be avoided in many patients by better understanding of principles of ergonomics. One of the important is the proper port position in relation to the target organ of dissection. Although there is no controversy about the position of umbilical, right subcostal (midclavicular) and right anterior axillary ports in laparoscopic cholecystectomy,[19] but there is no uniform consensus about the position of epigastric port. Conventionally epigastric port is inserted to the right of falciform ligament.[18,20] In literature, position to the left of ligament is also mentioned.[17] Present study compares the ergonomics and results of left and right position of epigastric port in relation to falciform ligament in laparoscopic cholecystectomy.

PATIENTS AND METHODS

The study was conducted upon 100 patients of laparoscopic cholecystectomy from August, 2011 to January, 2013 at our institute. Fifty patients were randomized to study group and 50 patients to conventional group. Patients having acute cholecystitis, cardiorespiratory problems, coagulation disorders, suspected malignancy, previous abdominal surgery and pregnancy were excluded from study. A 10 mm port was introduced through infraumbilical crease and pneumoperitoneum was created by open method. A 30 telescope was used in both the groups. Epigastric port in study group, was inserted (under telescopic vision) to the left of falciform ligament after making skin incision just below the xiphoid. After entering the abdomen falciform ligament was pierced from left to right (Figs 1A and B) and port was positioned toward gallbladder. In conventional group, after making skin incision just below the xiphoid, abdomen was entered on right side of falciform ligament (Fig. 2). Position of right midclavicular port and right anterior axillary ports was same in both the groups.



Figs 1A and B: Insertion of epigastric trocar to the left side of falciform ligament

Intraoperative and postoperative results of two groups were compared in terms of time taken for insertion of ports and completion of procedure, subjective ease of dissection, freedom of instrument movement, difficulty in extraction of gallbladder, bile and gallstone spills, intraoperative hemorrhage, conversion rate, injury to biliary tree and organs, hospital stay and port site hernia.

RESULTS

Average time taken for insertion of epigastric trocar was 10 seconds in study group and 7 seconds in conventional group. However, average time taken for completion of procedure was less in study group as compared to conventional group (40 *vs* 55 minutes). In study group freedom of instrument manipulation and precision of movements (Fig. 3) was more as compared to that in conventional group. Intraoperative hemorrhage due to cystic artery bleed occurred in 5 (10%) cases in conventional group. Out of these 2 (4%) cases were converted to open procedure. Perforation of gallbladder due to excessive traction on fundus and Hartmann pouch occurred in 3 (6%) cases in conventional group leading to bile spillage. None of these two complications occurred in study group. Difficulty in extraction of gallbladder (Figs 5A and B) was experienced in 18 (36%) cases in study group and 11 (22%) cases of conventional group. This was due to impaction of gallbladder due to large size of stones. In such cases extraction of gallbladder was facilitated by extension of fascial incision and dilatation of tract. Gallstone spillage occurred in falciform ligament in 5 (10 %) case of study group. Average hospital stay was 2.5 days in both the groups. There was no complication like bile duct injury, visceral organ injury and complaint of trocar site hernia in either of the two groups.

DISCUSSION

It was for the first time in the history of laparoscopic surgery when, Kelling introduced a visualizing scope in the peritoneum of a dog in 1901.[5] It took another 8 decades for a perfect laparoscopic technique to develop, when for the first time, Mouret[6] performed a successful laparoscopic cholecystectomy in 1987. Laparoscopic surgery provides less pain for the patient but is more demanding for the surgeon.[3] Neck pain and spondylosis has been observed to be recurring complaint among surgeons in high volume centers in first decade after the advent of minimal access surgery.[7] Other physical constraints reported are cervical spondylitis, shoulder pain, backache, hand finger joint pain, tenosynovitis and stress exhaustion.[8,9] Surgical procedures are mentally and physically demanding and stress during surgery may compromise patient safety.[4] Ergonomic integration and suitable operating room environment are necessary to improve efficacy, safety and comfort for the operating team. The term ergonomics is derived from Greek words ergon meaning work and nomos meaning arrangement. Ergonomics is the scientific study of the people at work.[3]

Fig. 2: Trocar inserted to the right of falciform ligament

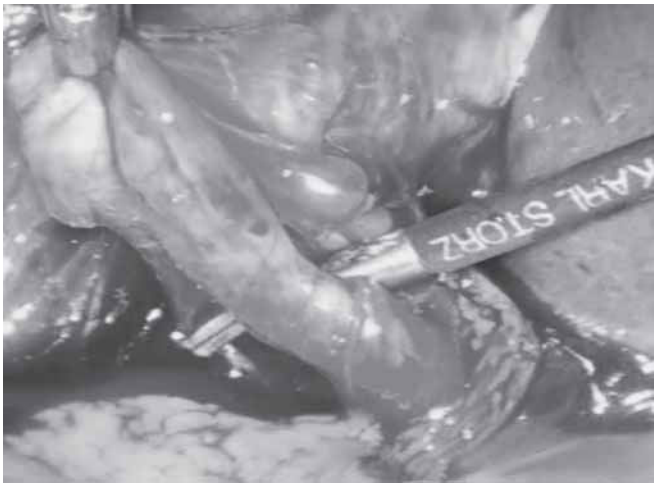


Fig. 3: Freedom of instrument manipulation in study group

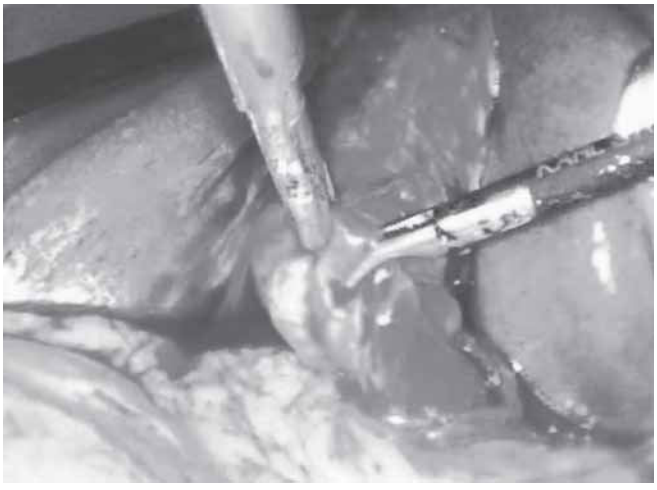
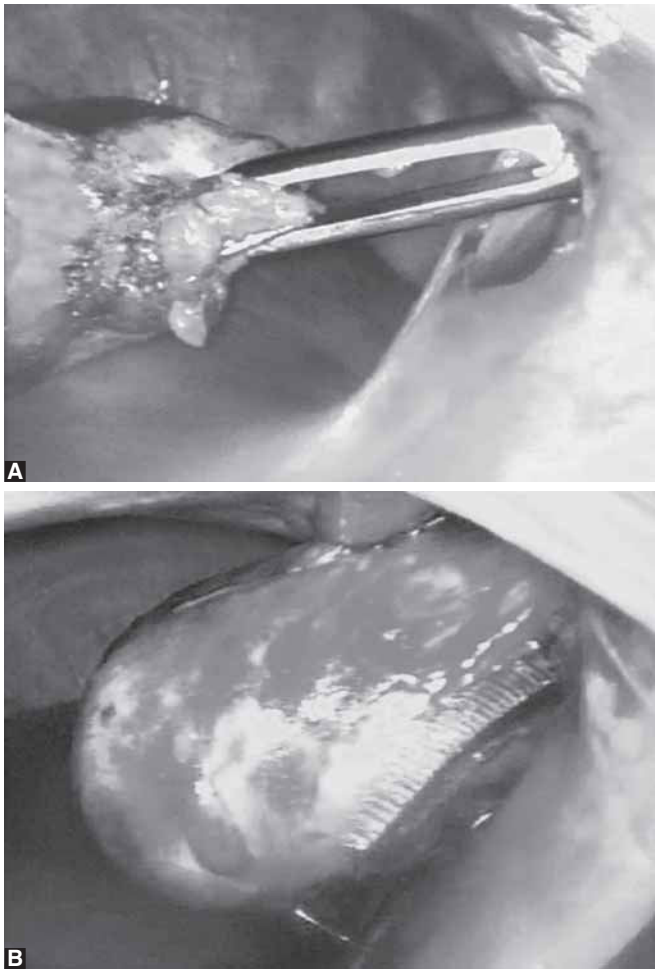


Fig. 4: Working angle in study group

There is no uniform consensus about the epigastric trocar placement in laparoscopic cholecystectomy. In literature of laparoscopic cholecystectomy some authors recommend the placement of epigastric trocar from left side of falciform ligament whereas others recommend from the right side of ligament.[17,18,20] To facilitate smooth instrument manipulation along with adequate visualization during laparoscopic surgery, usually trocars are placed in triangular fashion. The target organ should be 15 to 20 cm from the center port used for optical trocar. The two remaining ports are placed in the same 15 to 20 cm arch at 5 to 7 cm on either side of optical trocar. This allows the instruments to work at 60 to 90° angle.[10] For the best task efficiency manipulation angle from 45 to 75°, with equal azimuth angle is recommended.[11]

In our study average duration of operation was less in study group than in conventional group. It was also less than that (i.e. 43.4 minutes) experienced by Hasbahceci et al in their study.[12] Average hospital stay in both the groups was same (2.5 days) and was comparable to other studies.[13] By putting epigastric trocar on left side of falciform ligament, we could get a better manipulation angle (Fig. 4). There was greater freedom of instrument manipulation and comparative ease of dissection in study group, which resulted in comparative short duration of operation and fewer complications than conventional group and other studies.[14] A common problem of difficult extraction of stone-filled gallbladder as experienced by Lange et al and Bordelon et al in their study[15,16] was encountered in both the groups. This could be overcome by extension of facial incision.



Figs 5A and B: Difficult extraction of gallbladder

CONCLUSION

In laparoscopic cholecystectomy, epigastric port when inserted to the left of falciform ligament gives better ergonomics than from right of ligament. This position gives greater freedom and precision for instrument movements making the procedure efficient, easier and safe. Difficulty in extraction of stone-filled gallbladder can be overcomed by extension of fascial incision.

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ORIGINAL ARTICLE

Retrospective Review of Laparoscopic Adrenalectomy: An Experience at King Fahad Medical City, Riyadh

Bandar N Alharthi, Syed Zahid Zadie, Javeria Iqbal

ABSTRACT

Background: Laparoscopic adrenalectomy is considered the standard surgical approach for adrenal tumors and is replacing the open technique in the majority of centers. The aim of the present study was to review the authors experience with laparoscopic adrenalectomy.

Materials and methods: A retrospective review of laparoscopic adrenalectomies performed by an endocrine surgeon over a period of 4 years at King Fahad Medical City was conducted perioperative and postoperative records were studied.

Results: Total of 10 patients underwent laparoscopic adrenalectomy. Mean operative time was 3 hours and 30 minutes; length of hospital stay was significantly low. Complications were few, with one patient developing a port site hernia.

Conclusion: Laparoscopic adrenalectomy can be performed safely and has the advantages of minimally invasive surgery. With experience the technical aspects show marked improvement as there is a learning curve.

Keywords: Adrenal tumors, Adrenalectomy, Laparoscopy.

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INTRODUCTION

Adrenal tumors represent a wide spectrum of pathologies ranging from benign adenoma to adrenocortical carcinoma. Indications for adrenalectomy include hormone secretion and/or perceived risk of malignancy (i.e. tumor size, radiographic features, local invasion, lymph node involvement or distant metastasis).[1-3]

The introduction of laparoscopic cholecystectomy in 1988 ushered in a new surgical era.[4] The potential benefits of minimally invasive operations include shorter hospital stay, minimal morbidity, rapid postoperative recovery and an early return to preoperative activities.[5]

The surgical approach to the adrenal gland requires a large flank incision leading to increased morbidity. Adrenal surgery was revolutionized by the introduction of laparoscopy.[6]

The adrenal glands are ideal for a laparoscopic approach as they are small and have a low incidence of malignancy.[7-9] Laparoscopic adrenalectomy has become the standard technique for the surgical removal of the adrenal glands at many centers worldwide.[10]

The present study was undertaken with the objective of assessing the effectiveness of laparoscopic adrenalectomy in terms of operative time, complications and length of hospital stay.

MATERIALS AND METHODS

The present study was conducted at King Fahad Medical City, Riyadh over a period of 4 years from June 2008 till June 2012.

A retrospective review was made and included 10 patients who underwent complete transperitoneal laparoscopic unilateral adrenalectomy. A formal approval was taken from the Ethical Review Board.

The following data was analyzed: age and gender; tumor characteristics like site, size, functional status, operative time and blood loss, complications, pathology and length of hospital stay.

Operative Technique

The laparoscopic adrenalectomy was performed by trans-peritoneal approach. The patient is placed on the operative table in the lateral decubitus position with the table extended to facilitate exposure. In our study access to the peritoneal cavity was obtained by the open technique in the first three cases and by the closed technique using Veress needle in the rest of the cases. The abdomen is insufflated with carbon dioxide to a pressure of 15 mm Hg. A 10 to 12 mm trocar is placed into the abdominal cavity and the laparoscopic camera inserted. The underlying viscus is examined for any evidence of injury. Three additional 10 to 12 mm trocars are placed, one each in the midclavicular line approximately two finger breaths below the costal margin, in the anterior axillary line at a similar level to the camera port, and in the posterior axillary line. This posterior-most port has to be inserted after the hepatic or splenic flexure has been reflected from the abdominal wall. The approach to the right adrenal gland is performed by completely dividing the triangular ligament of the right lobe of the liver up to the suprahepatic vena cava. The peritoneum is further separated inferiorly and the liver retracted to facilitate the exposure of the inferior vena cava. The adrenal gland dissection begins from the medial margin and gradually proceeds toward the lateral margin. The adrenal vein entering the vena cava is identified early in the course of dissection and is doubly ligated with

metal clips and divided. The dissection proceeds superiorly, with the fatty tissue containing small vessels between the adrenal gland and the lateral aspect of the inferior vena cava being divided carefully. The posterior and inferior musculature of the diaphragm can be seen at this point. The dissection proceeds inferiorly until the inferior medial aspect of the gland is well identified and freed from Gerota's fascia. This is facilitated by the liberal use of clips to divide numerous small vessels in the retroperitoneal tissue. The posterior, medial, and superior aspects of the adrenal are dissected more easily from the undersurface of the diaphragm and retroperitoneal tissues. The adrenal gland is removed in a endoscopic bag through the lateral most port site. The retroperitoneal space is examined for any evidence of bleeding. This dissection is facilitated by using a 30-degree viewing laparoscope. The left adrenal gland is approached by a similar transperitoneal procedure in the lateral decubitus position, but here additionally only two more ports are placed. After the splenic flexure has been incised and the colon reflected inferiorly, the spleen is mobilized by dividing the peritoneum posterior to the spleen completely and by dividing the phrenolienal ligament. The weight of the spleen causes it to fall forward, facilitating the exposure so that the spleen does not need to be retracted by instruments. Dissection of the tissue surrounding the posterior surface of the tail of the pancreas helps define the anterior border of the left adrenal gland. The dissection continues in the posterior and inferior fibrofatty tissue between the adrenal and kidney and proceeds anteriorly in an attempt to locate the left adrenal vein. When this is identified, it is doubly clipped and divided. The fibrofatty tissue on the superior, posterior, and medial aspects of the adrenal gland is divided using electrocautery and metal clips and the adrenal is removed.

Data were collected in a retrospective fashion in all patients by review of the medical records, including the anesthesia record, pathology report, and operative note. The operative time was defined as the time of the initial skin incision to completion of skin closure, estimated blood loss was obtained from the anesthesia record, and length of stay was defined by the number of days in the hospital after the operative procedure.

RESULTS

Laparoscopic adrenalectomy was performed in 10 patients over a period of 4 years. The youngest patients in our study was 23 years old, while the eldest was 64 years.

There was a female preponderance, with 8 females as compared to 2 males. Out of the 10 tumors, 6 were found to be functional. Tumors were located on the left side in 6 patients and on the right side in 4 patients.

The size of the tumor ranged from 1.5 × 1.5 × 1.2 cm to the largest being 10.5 × 8 × 5 cm. In our study the histo-pathological examination of the specimen's revealed 5 cases of adrenal adenomas. Two patients had pheochromocytomas and 1 patient had an adrenal teratoma. 2 patients were diagnosed to have adrenal lipomas as listed in the Table 1.

The mean operative time for laparoscopic adrenalectomies was 3 hours and 45 minutes. Blood loss ranged from 50 to 500 ml. None of the patients required blood transfusion. Complications were seen in 3 patients, 2 patients developed chest infection and 1 developed a port site hernia. No other complications were encountered.

The hospital stay ranged from 1 to 5 days with a mean of 2.5 days. Postoperative narcotic requirement was significantly low in our study.

DISCUSSION

Classically, adrenalectomy for a benign disease has been performed by a retroperitoneal posterior or transperitoneal anterior approach. Gagner et al in 1992 described a method for removal of benign adrenal tumors through a laparoscopic approach.[10]

The age, gender distribution, functional status, of the tumor, tumor characteristics like site and size were consistent

Table 1: Demographics and clinical characteristics of patients

Patient	Age (yrs)	Gender	Site	Size (cm)	Operative time (mins)	Blood loss (ml)	Pathology	Hospital stay	Complications
1	29	Female	Left	3 × 2.5 × 1	210	500	Pheochromocytoma	5	Nil
2	23	Male	Left	10.5 × 8 × 5	180	250	Adrenal adenoma	2	Nil
3	46	Female	Right	8.5 × 5 × 2	150	100	Lipoma	2	Nil
4	25	Female	Left	1.5 × 1.5 × 1.2	155	50	Adrenal adenoma	1	Nil
5	60	Female	Left	5 × 3 × 2.5	300	250	Pheochromocytoma	3	Chest infection
6	62	Female	Left	4 × 2 × 1	225	500	Adrenal adenoma	5	Chest infection
7	56	Female	Right	9 × 7.5 × 2.5	275	400	Lipoma	2	Port site hernia
8	29	Female	Right	7 × 6.7 × 3	220	100	Mature cystic teratoma	1	Nil
9	43	Female	Right	2.3 × 1.2 × 1.2	200	100	Adrenal adenoma	3	Nil
10	64	Male	Left	8 × 5 × 2	180	50	Adrenal adenoma	1	Nil

with other studies. Jacob et al found results which are comparable to our study.[11]

The operative time required for laparoscopic adrenalectomy diminished progressively with repeated experience. Marked improvement was seen gradually in the technical aspects of the adrenalectomy indicating a learning curve. Similar reports were published by Prinz.[12]

The advantages of total transperitoneal laparoscopic adrenalectomy are better visualization of anatomy, easy accessibility and a better exposure. Similar advantages were identified by AlOtaibi.[13]

In our study the feasibility of the laparoscopic approach in terms of safety, outcome, efficacy and complications was similar to other well-established studies.[14-17] A major complication in our study was a port site hernia in one patient. Laparoscopic adrenalectomy was performed in two patients of pheochromocytoma, five patients had adrenal adenomas. Recent studies have suggested that the ability to diagnose, localize, preoperative blockade and control of the intraoperative hemodynamics of the pheochromocytomas have reached a level where laparoscopic approach can be considered safe.[18]

In our study there was a significant reduction in the need for parenteral pain medication, a more rapid resumption of regular diet and a significant decrease in length of postoperative stay. These results confirm and enhance other studies.[19,20]

CONCLUSION

Laparoscopic adrenalectomy can be performed safely and efficiently and confers the benefits of minimally invasive surgery. Significant advantages of the laparoscopic approach are better patient satisfaction, decreased length of hospital stay and early return to normal activity.

Laparoscopic approach can be employed in most patients with adrenal pathology. Laparoscopic adrenalectomy requires the knowledge and experience of an open adrenalectomy and extensive laparoscopic experience.

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ORIGINAL ARTICLE

Our Experience of Open Technique of Creating Pneumoperitoneum through Umbilical Cicatrix from a Remote Health Facility at Nepal

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ABSTRACT

Background: Two methods have been used for peritoneal access to create pnemoperitoneum–the open and the closed technique. We are describing here an open technique of creating pneumoperitoneum through the umbilical cicatrix. We have been using this technique routinely in view of its safety, rapidity and technical ease.

Materials and methods: This method was used in 156 patients serially to create pneumoperitoneum. Patients were followed at 10 days, 3 months and 1 year interval.

Results: The time range was 22 to 540 seconds. The mean time taken was 85 seconds. More than 70% of the patients (n = 110) fell in the range of 22 to 80 seconds where as 36 were in the range of 80 to 100 seconds. Ten patients had the range of 100 to 540 seconds. There were no incidences of vessel or viscus injury even in reoperative cases. There were no cases of any major bleeding or hematoma. Two cases had wound infection which subsided with antibiotic and wound drainage. Out of 42 patients who have completed 3 months follow-up and 11 patients who have completed 1 year follow-up, none showed any port site hernia.

Conclusion: The open technique of creating pneumoperitoneum through the umbilical cicatrix is a safe and rapid technique.

Keywords: Open, Pneumoperitoneum, Laparoscopy, Umbilicus.

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INTRODUCTION

Open and the closed technique have been used by laparoscopic surgeons for peritoneal access to create pneumoperitoneum. We are describing here an open technique of creating pneumoperitoneum through the umbilical cicatrix. We have been using this technique routinely in view of its safety, rapidity and technical ease.

MATERIALS AND METHODS

In this technique, the umbilicus is caught with the help of two towel clips and traction is applied in an upward direction (Fig. 1). In this position palpation of the umbilicus is done to feel for its junction with the linea alba. Once the junction is identified, a skin crease incision is taken either in the subumbilical or supraumbilical position depending on the operation contemplated. After careful hemostasis, the incision is deepened till the portion of the umbilical tube joining the linea alba is exposed and suitable retraction is applied to maintain this position and field of vision. With a no. 15 blade a small incision of around 5 mm is taken on the junction (Fig. 2). Care should be taken at this stage to complete this step under vision without introducing the blade too much inside. A blunt tipped hemostat is gently introduced through the incision (Fig. 3). A gushing noise can be heard at this juncture due to air entry inside the peritoneal cavity. This will widen the peritoneal space and

Fig. 1: Usual identification of the junction between umbilicus and anterior rectus sheath is very important

Fig. 2: The incision is placed on the junction of umbilicus and anterior rectus sheath

take the abdominal wall further away from the abdominal viscera. The stab wound should not be widened further as it is easy to maintain good air seal around a small wound. If the hemostat is going inside the peritoneal cavity without any undue resistance peritoneal access is almost certain. However, if the incision is too much away from the umbilical tube and sheath junction, a separate posterior sheath may be encountered. In this situation, one option is to dissect and incise the posterior sheath as well. Other option is to start fresh at the junction closing the former wound. The first port is then introduced directing toward the right shoulder while maintaining gentle upward traction on the anterior abdominal wall either by towel clips or manually (preferred) (Fig. 4). Once the peritoneal access and working ports have been introduced, careful laparoscopic survey of the port and underlying structures is carried out to rule out any inadvertent tissue injury. At the completion of the operation, the umbilical wound is routinely were closed in 2 layers–one for the sheath and other for the skin. In case of reopertaive abdomen, a digital exploration might have to be performed prior to introduction of the hemostat. This widens the stab wound and creates air leak. One or two sutures beside the stab wound will help to reduce the wound size and prevent any major air leak afterwards.

This method was used in 156 patients serially to create pneumoperitoneum between 2008 and 2010 at our institute. Patients were followed at 10 days, 3 months and 1 year interval. The operating time, i.e. the time from skin incision to insertion of the first port was noted in all cases. Out of 156 patients, 90 were females and 66 were males patient. The age range was 16 to 74 years. 16 cases had reoperative abdomen. Majority of the patients (n = 115) had BMI range of 26 to 29 where as only 10 cases had BMI of 30 to 32. Twenty-six cases had BMI of 21 to 25. Various other parameters were also studied like bleeding, infection, visceral/vessel injury, incidence of failed trocar insertion and extraperitoneal insufflations. Although, port site hernia is one of the study parameters, it will require long-term follow-up to document its exact incidence.

RESULTS

The time range was 22 to 540 seconds. The mean time taken was 85 seconds. More than 70% of the patients (n = 110) fell in the range of 22 to 80 seconds where as 36 were in the range of 80 to 100 seconds. Ten patients had the range of 100 to 540 seconds. There were no incidences of vessel or viscus injury even in reoperative cases. There were no cases of any major bleeding or hematoma. Two cases had wound infection which subsided with antibiotic and wound drainage. Out of 42 patients who have completed 3 months follow-up and 11 patients who have completed 1 year follow-up, none showed any port site hernia.

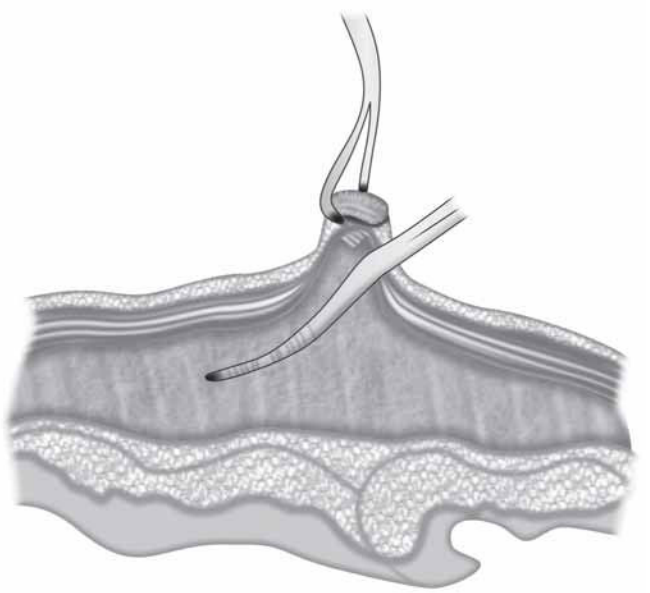

Fig. 3: Gently introduce a hemostat

Fig. 4: Maintaining an upward traction on the anterior abdominal wall either on the umbilicus with the towel clips or manually with hand grip (preferred), the first part is introduced

DISCUSSION

The open and closed technique exists in the armamentarium of the laparoscopic surgeons to create pneumoperitoneum. Although the European Association for Endoscopic Surgery (EAES) could not provide a conclusive guideline regarding use of either technique, they agree that major vascular injuries most often occur with the Veress needle approach. The reason for ambiguity in recommendation is inadequate sample size to find a difference in serious complications. Further, the meta-analysis by Merlin et al has demonstrated the safety of the open technique over the closed technique.[1]

Several randomized control trials have already uncovered some of the additional advantages of open

technique namely reduced incidences of failed trocar entry and extraperitoneal insufflations.[2]

Traditional Hasson's technique, although safe especially in case of reoperative abdomen with adhesions, is time consuming.[3] Secondly it is associated with frequent leaks. In contrast, open technique by direct trocar entry is faster than the closed counterpart.[4]

The time taken for creating pneumoperitoneum using our technique is only 85 seconds which is in sharp contrast with the average time taken for creating pneumoperitoneum using Veress needle technique 214 to 300 seconds.[5-7] Moberg et al who have been using an almost similar technique since 1998 in 4,400 patients have reported their mean operating time to be 93 seconds.[8] Although our mean operating time is 85 seconds, in more than 70% of the patients (n = 110) the time taken fell in the range of 42 to 80 seconds with a mean of 78 seconds. More time was required for the obese patients, increasing the overall mean operating time to 85 seconds.

The lack of any major vessel or viscus injury in this small group is encouraging and supports the safety of this technique, although it will require a lot more cases to elucidate its safety and long-term results. A distinct advantage of this technique is its application in case of reoperative abdomen where the incision can be widened to insert a finger to do digital palpation of any structure adhered to the incision and to do adhesionolysis, if required.

As mentioned previously, we had two incidences of extra-peritoneal insufflations. This was due to port insertion at a place away from the junction of the umbilicus and the linea alba where the peritoneum tends to remain as a separate layer. Hence, the port enters into the extraperitoneal space leading to extraperitoneal insufflation. Choosing the correct site of insertion avoids this problem.

Especially for the beginners starting laparoscopy, the closed technique of creating pneumoperitoneum requires some amount of adaptation of motor skills to learn the technique of blind first port insertion where as in open technique the first port is always under visual and tactile guidance. Secondly, the air entry before the port insertion makes sufficient space for safe port entry. The controlled environment of open access technique under vision gives additional confidence to a biginner.

The open technique of creating pneumoperitoneum through the umbilical cicatrix is a safe and rapid technique.

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REVIEW ARTICLE

The Impact of Obesity on Laparoscopic Colorectal Resection

Hana Alhomoud

ABSTRACT

Purpose: A review article to assess the impact of obesity on laparoscopic colorectal resection.

Materials and methods: Relevant papers were searched using Medline, Embase, the Cochrane Central Register of Controlled Trials Clinical Trial. Government, National Research Register, by using the search terms 'laparoscopic colorectal surgery, obese, laparoscopy'.

Conclusion: Laparoscopic colorectal resection are feasible in obese patients. However, increased rates of conversion to laparotomy should be anticipated with increased length of hospitalization when compared to nonobese patients.

Keywords: Colorectal surgery, Laparoscopic colectomy, Obesity.

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INTRODUCTION

Obesity is defined as excessive enlargement of the body's total quantity of fat or excessive accumulation of body fat.[1] The rates of obesity are very high at present in Western countries. The rate has also increased gradually in Asian countries. However, the percentage of obese people in Asian population is lower than those in western populations.[2] Obesity relates to various diseases and maybe associated with increased risk of cancers.[3,4] In general surgery, it has been considered one of the risk factors.[5] In laparoscopic surgery, it has been considered that obesity may reduce technical feasibility, prolongation operative time and increasing operative blood loss and has been regarded as a relative contraindication factor for laparoscopic surgery.[6-8] Recently, with the improvement of laparoscopic technique and instruments, laparoscopic surgery has been proposed as a promising approach for obese patients. However, the outcome of laparoscopic colectomy in obese patients is controversial. Some investigators have suggested that laparoscopic colectomy for diverticular disease and colorectal cancer can be performed safely in obese patients.[9,10] While others have reported high rates of conversions and complications than in nonobese patients.[6,11]

The aim of this review article is to assess the impact of obesity on laparoscopic colorectal resection.

MATERIALS AND METHODS

A systematic search of the scientific literature was carried out using the Medline, Embase, the Cochrane Central Register of Controlled Trials Clinical Trials, National Research Register, The York (UK) Center for Reviews, American College of Physicians Journal Club, Australian Clinical Trials Registry, relevant online journals and the Internet for years 1983 to 2012 to obtain access to all publications, especially randomized controlled trials (RCTs), systemic reviews, and meta-analysis involving the impact of obesity on laparoscopic colorectal resection. Searches were conducted without language restriction. To avoid duplication of data, articles from the same unit or hospital were basically included only once if data was updated in a later publication. However, if surgical cases did not overlap among reports by even the same institute, these reports were all included. The search terms were: laparoscopic colectomy, obesity, laparoscopy, body mass index (BMI), laparoscopic colorectal surgery, obese. All available publications from the past 20 years, primarily from high-volume surgical centers, were considered.

RESULTS

A total of 33 studies were found,[6,9-25,27-40,43] including three matched case control studies[13,14,18] and one review article.[46] Among those, 17 were 'comparative studies'[6,9,12-25] (the total number patients n = 9231), which focused on the comparison of short-term outcomes in laparoscopic colorectal surgery between obese (the total number of patients n = 1,766) and nonobese (the total number of patients n = 7,465). These studies consisted of three matched case control studies and 14 case control studies. Remaining studies included 15 'noncomparative' ones[6,9,11,26-36] which examined the relation between BMI or body weight and short-term outcomes. Results of these studies showed that obesity often accompanied by pre-existing comorbidities and associated with longer operative times and higher rates of conversion to open procedures mainly because of the problem of exposure and difficulties in dissection. Although some studies showed obesity was associated with increased postoperative morbidity including cardiopulmonary and systemic complications, or ileus leading to longer hospital stay, there was no evidence about the negative impact of obesity on intraoperative blood loss, perioperative mortality, and reoperation rate. Whether obesity is a risk factor for

wound infection after laparoscopic colectomy remains unclear. Though sometimes in obese patients, additional number of ports were necessary to successfully complete the procedure laparoscopically, obesity did not influence the number of dissected lymph nodes in cancer surgery. The postoperative recovery of gastrointestinal function was similar between obese and nonobese patients.

DISCUSSION

There is sufficient evidence that obesity is often accompanied by pre-existing comorbidities,[6,12-14,16,18,24,25] increased operative times, and higher conversion rates mainly due to the problem of exposure and dissection difficulties.[6,9,15,16,18,20,21,24,30,31,33,37,42] Nevertheless, only limited studies[6,13,21,24] show that obesity increases postoperative morbidities including cardiopulmonary,[16,17] systemic complications,[17,24] or ileus,[6,13] which may also lead to longer hospital stay.[6,21]

Remarkably there is almost no evidence about the negative impact of obesity upon intraoperative blood loss, perioperative mortality rate, reoperation rate, and the postoperative recovery of gastrointestinal function in laparoscopic colorectal surgery.

An important drawback of performing laparoscopic surgery on obese patients is the difficulty in obtaining good exposure of the operation field (particularly at the base of the mesentery) associated with increased technical demands leading to longer operative time, increased number of ports, or higher rate of conversion to open procedure. These difficulties may be caused by the need to manipulate bulky mesentery, and maneuvering of instruments in a restricted working area.[6,9,13,36,41] Leroy et al,[10] on the basis of a retrospective analysis of 123 elective laparoscopic left colectomies, showed that obesity does not have an adverse impact on the technical difficulty and postoperative outcomes; surprisingly, hospital stay in obese patients was found to be shorter than in nonobese patients. These findings are important because they contradict the long-held perception that obesity is associated with increased surgical risk and sometimes negative impact on postoperative course. However, Sarli et al[44] pointed out that this message could be misleading and the explanation for the differing results may lie in the differing experience of surgeons. In addition, over the last decade, surgical instruments such as the laparoscope, energy/stapling devices,[41] 3-chip charge-coupled devices,[45] or high-definition television[46] have furthered evolved technologically, and these may also play a role in helping surgeons perform surgeries on obese patients.

One might expect increased postoperative morbidity in obese patients because they often have worse American Society of Anesthesiology (ASA) scores or more pre-existing comorbid illnesses including diabetes, hypertension, cardiovascular disease, and lipid disorder. However, among the eight comparative studies,[6,12-14,16,18,24,25] which showed significantly increased comorbidities in obese patients, only three studies[6,13,25] found increased morbidities. This is an important finding and a possible explanation for this result is that obese patients might have benefited from the laparoscopic approach itself, that is, minimally invasive surgery providing decreased pain, reduced pulmonary dysfunction, and less perioperative stress response.[47-50]

These results of the current review are supported by a large cohort of study (n = 6,336, including 808 obese patients),[51] which reported that the incidence of postoperative complications did not differ between obese and nonobese patients after elective general surgery (15.3 *vs* 16.0%, p = 0.26), although obese patients had more comorbidities. With the exception of the incidence of surgical site infections (4 *vs* 3%, p = 0.03), this finding held true for all types of complications and for patients with severe obesity (BMI > 35 kg/m^2). In the multivariate analysis, open surgery and ASA classification and type of surgery, and not obesity, were found to be independent risk factors for development of postoperative complications, suggesting that the laparoscopic approach reduces overall morbidities in general surgery independent of BMI. Furthermore, laparoscopic colectomy for obese patients has been supported by a case-matched comparative study with open colectomy conducted by Delaney et al[26] analyzing total 94 patients with BMI > 30 kg/m^2 who underwent laparoscopic colectomy. They reported that there were no statistically significant differences in the operative time, complication rate, readmission rate and reoperation rate. The direct costs between laparoscopic and open colectomy in obese patients were similar, with the hospital stay being significantly shorter after laparoscopic colectomy. In addition, although obesity was associated with a high conversion rate, outcomes in the converted cases was comparable to matched open cases. These results suggests that laparoscopic colorectal surgery can be performed safely in obese patients and offers the benefit of earlier postoperative recovery without increasing morbidities or costs compared with traditional open surgery.

In terms of oncological adequacy at resection, most studies[10,13,16,19,22] show that the number of harvested lymph nodes and resection margins are not affected by obesity. However, these studies analyzed only short term outcomes of laparoscopic colorectal surgery for obese patients. Because some previous studies[33,52,53] have shown that conversion to open procedure contributes to a negative impact on survival and disease recurrence in patients with colorectal cancer, it might be theoretically possible that

obesity influences the prognosis of these patients because of its association with an increased conversion rate. However, Singh et al[13] reported similar results about disease-free (91.9 *vs* 92.4%, p = 0.661) and overall survival (p = 0.565) at a median follow-up of 2 years in obese (n = 62) and nonobese (n = 172) patients undergoing laparoscopic colectomy for colorectal cancer. There are no other studies comparing tumor recurrence or long-term prognosis between obese and nonobese patients undergoing laparoscopic colorectal surgery for colorectal cancer.

Body mass index is a commonly used objective measure of body fat, with the global cutoff point for obesity proposed by the World Health Organization being BMI > 30 kg/m^2. Most of the studies[6,9,10,13,15,16,18-20,23,25] reviewed have used this cutoff measure to define obesity. However, the distribution of BMI has been found to differ among various ethnic groups. Moreover, a potential disadvantage of BMI is that the value does not consistently reflect body adipose tissue accumulation. In particular, Asian populations may have greater visceral adiposity, which might cause technical difficulty in laparoscopic operation despite the mean BMI being lower than in non-Asian populations.[2] Therefore, the classification of obesity by using the cutoff value of BMI suggested by the World Health Organization may underestimate the risk profile associated with visceral obesity.[2] Two Japanese groups,[21,24] by using visceral fat area measured by computed tomography as the definition of obesity, showed longer operative times and increased morbidity in visceral 'obese' patients, whereas there was no significant difference when they were classified by BMI. Another study[17] used the waist circumference (>85 cm in male or >90 cm in female) as the definition of obesity and identified significantly increased systematic complications in obese patients. However, because these reports used Japanese BMI classification of obesity (BMI > 25 kg/m^2),[54] their findings do not necessarily undermine the utility of BMI as an obesity criterion, which is easy to calculate. An appropriate definition of obesity should also probably include differences in ethnicity. This aspect also seems to be important to accurately evaluate the risk of obese patients in laparoscopic surgery.

CONCLUSION

Current evidence seems to suggest that laparoscopic colorectal surgery in obese patients is not associated with increased perioperative mortality, higher reoperation rate, or delayed postoperative recovery of gastrointestinal function. In addition, despite obesity often being accompanied by pre-existing comorbidities, very few studies show increased postoperative morbidity with longer hospital stay in obese patients. Although the laparoscopic approach may be associated with longer operative times and higher conversion rates in obese patients than in nonobese patients, it appears to be a safe and feasible option with no evidence for compromise in the treatment of disease.

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REVIEW ARTICLE

Laparoscopic *vs* Open Anterior Resection

Sachin Shashikant Ingle

ABSTRACT

Background: Worldwide about 782,000 people are diagnosed with colorectal cancer each year. Colorectal cancer is the third leading diagnosed cancer in the United States and the second leading cause of cancer-related deaths in Western countries. Surgery is the primary treatment modality in colorectal cancer. The laparoscopic approach to colectomy is slowly gaining acceptance for the management of colorectal pathology. The cost-effectiveness and long-term outcomes with laparoscopic colectomy (LAC) for malignancy are less well accepted. This review article was aimed to compare laparoscopic with open anterior resection and ascertain the therapeutic benefit, if any, in the overall management rectal cancer.

Keywords: Anterior resection, Laparoscopy, Open surgery, Comparison.

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INTRODUCTION

Laparoscopic resection of the colon was first described in 1990. Early reports regarding laparoscopic-assisted colectomy revealed a more rapid recovery from surgery and decreased surgical complications. Yet, wound site recurrence, which reached 21% in some studies, raised significant concerns about this technique.[1] The cost-effectiveness and long-term outcomes with laparoscopic colectomy (LAC) for malignancy are less well-accepted. Smaller incision size leads to improved cosmesis and reduced postoperative pain. The laparoscopic approach is also associated with less postoperative ileus and earlier tolerance of diet. These factors contribute to earlier recovery of the patient with a reduced hospital stay and earlier return to normal activity.[2]

Laparoscopic colorectal surgery can be done in three ways:

- Purely laparoscopic
- Laparoscopic assisted
- Hand-assisted laparoscopic surgery (HALS).

AIMS

The aim of this study was to compare the effectiveness and safety of laparoscopic and conventional 'open' anterior resection (AR) in the treatment of rectal cancer. 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
10. Quality of life analyses
11. Circumferential resection margin and distal cut margin
12. Long-term outcome.

MATERIALS AND METHODS

A literature review was performed using SpringerLink, Journal of MAS and major general search engines like Google, MSN, etc. The following search terms were used: AR, laparoscopy, open surgery, comparison. 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 AR was given more preference).

CONTENT

Choice of Surgical Approach for Rectal Lesion

In the abdominoperineal resection (APR) a double approach is employed, abdominal and perineal, often with two operative teams working simultaneously. The procedure chosen for midrectal carcinoma depends on different variables, the decision often not being made until during the procedure depending on the size of the tumor, localization, invasion, etc. If the lesion can be palpated easily on rectal examination, APR is indicated (this is approximated at 3 to 7 cm from the anal verge). If at the time of the resection the remaining rectum is enough to perform an anastomosis, a low AR could be safely performed. Generally, APR is required for lesions distal to 7 to 8 cm from the anal verge. For lesions above 12 cm, AR perhaps is always done. For lesions between 8 and 12 cm, the procedure may depend on the above-mentioned factors. The approach to the tumor for a low AR is similar to that used in APR, including removal of ischiorectal fat and

sigmoid mesentery and rectal mobilization to the level of the levator ani muscles. The low AR with primary anastomosis below the level of the peritoneal reflection is completed if the distal margin is clear and enough rectal tissue is viable to perform an end-to-end anastomosis safely. However, if the surgeon believes that anastomosis cannot be completed safely, an APR is recommended.

Procedure for Laparoscopic Anterior Resection

Place the patient in steep Trendelenburg position with the right side of the table down. A thorough inspection is required for patients with cancer to exclude any metastatic disease. Place the first three (10-12 mm) trocars in the supraumbilical region and right upper and right lower quadrants, lateral to the rectus muscle. Place a fourth (10-12 mm) trocar in the left upper quadrant lateral to the rectus muscle. This will be exchanged for a 33 mm trocar later. Additional (10-12 mm) trocars may be needed for retraction. After mobilizing the left colon, grasp the sigmoid colon with an endoscopic Babcock clamp and retract it medially to expose the white line of Toldt (Fig. 1). Using either an ultrasonically activated scissors or a cautery scissors, incise the peritoneum to mobilize the sigmoid and left colon to the level of the splenic flexure. Continually, regrasp and manipulate the colon as the dissection progresses medially to expose Gerota's fascia, the ureter, and the sacral promontory. Grasp the rectosigmoid junction using an endoscopic Babcock clamp and retract it anteriorly toward the abdominal wall.

Enter the presacral plane posteriorly with ultrasonic or cautery scissors (Fig. 2). Dissect posteriorly to well below the level of the pathology, using sharp dissection. Intraoperative rigid proctoscopy is often helpful to confirm the exact level of the lesion. Mark the site with clips. Continue the dissection laterally and finally anteriorly to circumferentially free the mesorectum at least 5 cm distal to the distal edge of the tumor.

Serially divide and ligate the mesorectum (at right angles to the rectum) with a series of clips, vascular stapler, or ultrasonically activated scissors. Bare rectum should be demonstrated circumferentially. Perform a total mesorectum excision for tumors in the lower two-thirds of the rectum, to obtain adequate tumor control. Extrude the specimen through the port or in continuity with the port. If the specimen is too large, remove the port and deliver the bowel through an enlarged incision protected by a plastic wound drape. Perform the proximal resection extracorporeally in the conventional fashion. Place a purse string suture and insert the circular stapling anvil into the proximal end of bowel. Secure the purse string suture and replace the bowel into the abdominal cavity. Replace the 33 mm trocar (if it was removed) and re-establish pneumoperitoneum. Grasp the anvil with an anvil-grasping clamp, usually passed through the right upper or lower quadrant trocar sites. Assess the ability of the anvil to reach the planned anastomotic site. Further mobilization and/or vascular division may be needed, and should be performed if necessary. Verify the correct orientation (i.e. no twist) for the proximal bowel. Insert a circular stapler transanally and advance it to the distal staple line. Under direct laparoscopic visual control, extend the spike of the stapler through the distal staple line. Move the laparoscope to the right or left lower quadrant port to best visualize the anvil and stapler head coming together. Once satisfied, close, fire and remove the stapler. Inspect the two donuts for completeness. Test the anastomosis by placing an atraumatic Dennis-type clamp across the bowel proximal to the anastomosis. Use the suction irrigator to fill the pelvis with saline and immerse the anastomosis. Insufflate the rectum with air, using a bulb syringe, proctoscope, or flexible sigmoidoscope, and observe for air bubbles. Irrigate the abdomen, obtain hemostasis, and close the trocar sites. Close the 33 mm port site with interrupted absorbable sutures.[3]

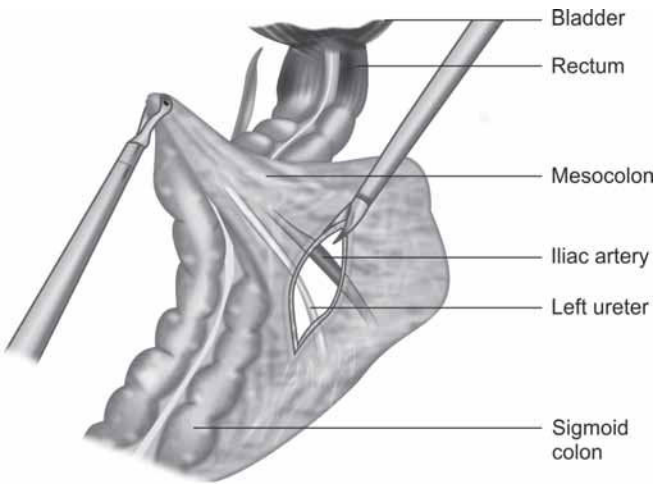

Fig. 1: Medial to lateral dissection taking care of left ureter

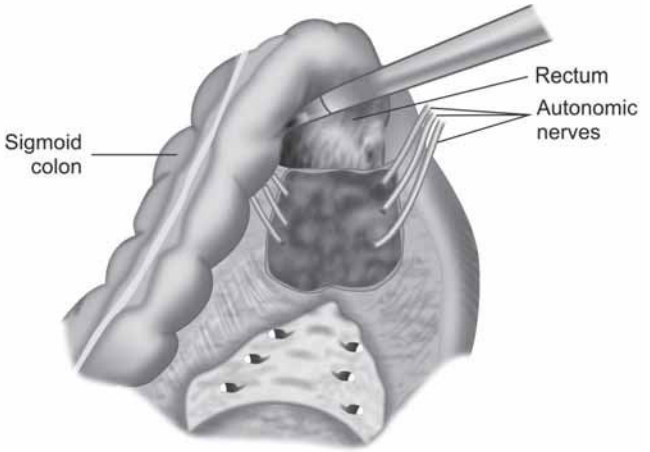

Fig. 2: Complete posterior dissection identifying the autonomic nerves

TOTAL MESORECTAL EXCISION

Total mesorectal excision (TME) in conjunction with a laparoscopic AR or an abdominal perineal resection involves precise sharp dissection and removal of the entire rectal mesentery, including that distal to the tumor, as an intact unit. Unlike conventional blunt dissection, the rectal mesentery is removed sharply under direct visualization emphasizing autonomic nerve preservation, complete hemostasis, and avoidance of violation of the mesorectal envelope. Its rationale is underscored by the hypothesis that the field of rectal cancer spread is limited to this envelope and its total removal encompasses virtually every tumor satellite. The reduction of positive radial margins can be reduced from 25% in conventional surgery to 7% in cases resected by TME. Furthermore, Adam et al showed that patients with positive radial margins were three times more likely to die and 12 times more likely to have local recurrence than patients without radial margin involvement.[4]

BLOOD LOSS AND COLORECTAL SURGERY

According to study conducted by Kiran et al in 147 the open colectomy group required significantly more units of blood ($p = 0.003$) to maintain similar hemoglobin levels after surgery. Estimated blood loss ($p = 0.001$) and the number of patients who received transfusions on the day of surgery ($p = 0.002$), during the first 48 hours after surgery ($p = 0.005$), and during the entire hospital stay ($p = 0.003$) were significantly higher in the open colectomy group.[5] According to Wen-Xi Wu intraoperative blood loss was less in laparoscopic resection group than in open resection group.[6]

IMMUNE RESPONSE AND LAPAROSCOPY

According to Wichman et al 70 prospectively enrolled patients with colorectal diseases were undergoing laparoscopic ($n = 35$) or open ($n = 35$) surgery. Significant differences between study and control patients ($p = 0.05$) were detected regarding circulating interleukin-6 and C-reactive protein levels with a reduced proinflammatory response to surgery in patients after laparoscopic surgery. Furthermore, postoperative natural killer cell counts were significantly higher in patients after laparoscopic surgery. The levels of B lymphocytes and T lymphocytes and helper T-cell counts and cytotoxic (suppressor) T-cell counts did not show significant differences after open or laparoscopic surgery.[7]

COST AND LAPAROSCOPY

According to Chapman et al LAC patients ($n = 150$) were compared with the same number of open colectomy patients. Operating room costs were significantly higher after LAC ($p = 0.0001$), but length of hospital stay was significantly lower ($p = 0.0001$). This resulted in significantly lower total costs ($p = 0.0007$) owing to lower pharmacy ($p = 0.0001$), laboratory ($p = 0.0001$), and ward nursing costs ($p = 0.0004$).[8] According to Hoffman et al the length of the operative procedure, operating room charge, and the total hospital charge were greater for patients undergoing laparoscopic-assisted colectomies and were discharged from the hospital sooner than patients who underwent open colectomies.[9]

OPERATING TIME

According to Mathur et al median operating time for laparoscopic abdominoperineal resection was 296 minutes, initial 7 cases taking an average of 368 minutes, while subsequent 7 cases average operating time was 232.5 minutes. In laparoscopic AR, average duration of surgery was 356 minutes, first 4 cases taking 400 minutes while for last 2 cases, and mean operating time was 300 minutes.[10] According to Wen-Xi Wu the operative time was longer in laparoscopic resection group than in open resection group (189 ± 18 *vs* 146 ± 22 minutes, $p < 0.05$).[6] According to Tsang et al from March 1999 to September 2004, 105 patients underwent laparoscopic TME with colonic J-pouch reconstruction. The mean operating time was 170.4 minutes.[11] According to Chapman et al laparoscopic resection of colorectal malignancy was time-consuming.[8] According to Veenhof et al laparoscopic surgery took longer to perform (250 *vs* 197.5 minutes, $p = 0.01$), but was accompanied by less blood loss (350 *vs* 800 ml, $p = 0.01$).[12]

CONVERSION RATE

Many different types of colectomies were performed successfully and safely for a variety of surgical indications. The conversion rate was 22.5%, which decreased to 15% in the second half of the series.[9]

USE OF NARCOTICS AND ANALGESICS

According to Anne-Marie Boller et al the following four phase III randomized controlled trials have completed accrual and reported early data on recovery benefits for LAC: Barcelona, Clinical Outcomes of Surgical Therapy Study Group (COSTSG), Colon Cancer Laparoscopic or Open Resection (COLOR), and Conventional versus Laparoscopic-Assisted Surgery in Colorectal Cancer (CLASICC). These trials have uniformly and consistently shown a significant reduction in the use of narcotics and oral analgesics.[1] According to Chapman et al laparoscopic resection procedure's advantages revolve around early recovery from surgery and reduced pain.[8] According to Hoffman et al patients who underwent laparoscopic operations had a shorter period of postoperative ileus and less pain, and were discharged from the hospital sooner than patients who underwent open colectomies.[9]

START OF ORAL FEEDS

According to Mathur et al oral feeds started on postoperative day 2.[10] According to Anne-Marie Boller et al for LAC the trials were: Barcelona, COSTSG, COLOR, and CLASICC. These trials have shown a significant reduction in the use of narcotics and oral analgesics and length of hospital stay, as well as a faster return of diet and bowel function, with LAC.[1] According to Wai Lun Law et al laparoscopically operated patients have significantly earlier return of bowel function, earlier resumption of diet, and shorter hospital stay.[13] According to Veenhof et al enteric function recovered sooner after laparoscopy.[12] According to Hoffman et al patients who underwent laparoscopic operations had a shorter period of postoperative ileus and less pain, resumed a regular diet sooner, and were discharged from the hospital sooner than patients who underwent open colectomies.[9]

POSTOPERATIVE MORBIDITY AND MORTALITY

According to Mathur et al, two out of 20 patients have wound infection.[10] According to Wen-Xi Wu et al the overall postoperative morbidity was 5.6% in the LAP resection group and 27.8% in open resection group ($p < 0.05$). No anastomotic leakage was found in both groups.[6] According to Tsang et al six patients underwent reoperation for major complications. Erectile dysfunction occurred in 13.6% of males, while two patients developed incomplete bladder denervation.[11] According to Wai Lun Law et al during period 2, the operative mortality rates of patients with laparoscopic ($n = 401$) and open resection ($n = 255$) were 0.8 and 3.7%, respectively ($p = 0.022$), and the morbidity rates were 21.7 and 15.7%, respectively ($p = 0.068$). The operative mortality rates were 4.4 and 2.6% in periods 1 and 2, respectively ($p = 0.132$). The 3-year overall survivals (OS) for patients with nondisseminated disease were 69.7 and 76.1% for periods 1 and 2, respectively ($p = 0.019$).[13] According to Jin-Tung Liang et al, in patients with a successful nerve-preserving surgery (96.4%, $n = 108$), 104 patients completed the evaluation of urinary function. The median duration for indwelling urine Foley catheter was 3.0 days (range: 1.0-7.0 days). The voiding function after removal of the urine Foley catheter was good (IPSS: 0-7) in 98 (94.2%) patients, fair (IPSS, 8-14) in 5 (4.8%), and poor (IPSS, 15-35) in 1 (1.0%).[14]

HOSPITAL STAY

According to Mathur et al median hospital stay was 11 days.[10] According to Anne-Marie Boller et al for LAC: Barcelona, COSTSG, COLOR, and CLASICC. These trials have shown a significant reduction length of hospital stay, a faster return of diet and bowel function, with LAC.[1] These findings were also supported by Conor P Delaney et al, Wai Lun Law et al, Veenhof et al and George C Hoffman et al in their respective trials.[2,9,12,13]

PORT-SITE METASTASIS

According to Mathur et al, Tsang et al and Eric C Poulin et al in their trials there was no incidence of port metastasis in any patient.[10,11,15]

NUMBER OF LYMPH NODES DISSECTED

According to Wen-Xi Wu et al the mean number of harvested lymph nodes in laparoscopic resection group was comparable to those in open resection group.[6] This is also supported by Hoffman et al.[9] According to George Pechlivanides et al in their trial group A included 39 patients who had an open TME with low AR of the rectum (LARR) and four with APR of the rectum. In group B, there were 34 patients who had a laparoscopic TME (27 with LARR and 7 with APR). The mean number of lymph nodes retrieved in group A specimens was 19.2 (5-45) and in group B 19.2 (8-41) ($p = 0.2$). In group A, 3.9 (1-9) regional, 13.9 (3-34) intermediate and 1.5 (1-3) apical lymph nodes were retrieved. The respective values in group B were 3.7 (3-7), 14.4 (4-33) and 1.3 (1-3). Differences between groups were not significant. Also, the incidence of lymph node involvement by the tumor was not significantly different between groups (group A: 23; group B: 19).[16]

CIRCUMFERENTIAL RESECTION MARGIN AND DISTAL CUT MARGIN

According to Jayne et al higher positivity of the circumferential resection margin was reported after laparoscopic AR, but it did not translate into an increased incidence of local recurrence[17] and according to Tsang et al there was 1 case of microscopic circumferential margin involvement and 1 case of microscopic distal margin involvement.[11]

LONG-TERM OUTCOME

According to Jayne et al 794 patients were recruited (526 laparoscopic and 268 open). Overall, there were no differences in the long-term outcomes. The differences in survival rates were OS of 1.8% (95% CI: 5.2-8.8%; $p = 0.55$), disease free survival (DFS) of 1.4% (95% CI: 9.5-6.7%; $p = 0.70$), local recurrence of 0.8% (95% CI: 5.7-4.2%; $p = 0.76$), and quality of life (QoL) ($P = 0.01$ for all scales).[17] According to Wai Lun Law et al the 3-year OS in those with nondisseminated disease were 74.4 and 78.8% for open and laparoscopic resection, respectively ($p = 0.046$). The operative morality rates were 4.4 and 2.6% in periods

1 and 2, respectively (p = 0.132). The 3-year OS for patients with nondisseminated disease were 69.7 and 76.1% for periods 1 and 2, respectively (p = 0.019).[13] Two trials, Barcelona and COSTSG, have sufficient maturation and follow-up to report recurrence and survival data, and neither has found a survival disadvantage in patients treated with LAC. Results of the Barcelona trial suggest a cancer-related survival advantage in patients treated with LAC, based solely on differences in patients with stage III disease; this is not confirmed by the COSTSG trial.[1] According to Tsang et al actuarial 5-year cancer-specific survival and local recurrence rates were 81.3 and 8.9%, respectively.[11] According to Hoffman et al for patients undergoing laparoscopic-assisted colectomies for primary colorectal malignancy, no adverse patterns of recurrence or decreased survival has been noted at 2-year follow-up when compared with standard open colorectal cancer surgery.[9] According to Poulin et al the median follow-up was 24 months for patients with stage I, II and III disease and 9 months for patients with stage IV disease. Observed 2-year survival rates were 100% stage I, 88.7% stage II, 80.6% stage III, and 28.6% stage IV. Survival rates at 4 years were 100% stage I, 79.5% stage II, 53.7% stage III and 0% stage IV. No trocar site recurrence was observed.[15]

DISCUSSION

Despite the potential advantages to be gained by the patient and the community from laparoscopic colorectal surgery (e.g. reduced postoperative pain, early return of gastrointestinal function, shorter hospital stay, and earlier return to full activity), laparoscopy is slowly gaining acceptance by the surgical community for rectal cancer.

The factors of concern in laparoscopy were:

1. Increased complexity of laparoscopic techniques
2. Duration of surgery and of the learning curve
3. Lack of data from randomized controlled trials
4. Port-site metastases in malignant disease
5. Adequacy of free resection margins and lymph node retrieval, while performing a TME for middle and low rectal cancer.

It has been shown that many nodal metastases in colorectal cancer are found in small lymph nodes of 5 mm in diameter and that a minimum of 12 to 18 lymph nodes must be examined, a very careful search for lymph nodes must be performed.[16] Two recently published meta-analyses show that laparoscopic rectal cancer surgery may accomplish an oncological clearance of similar quality to the open approach. The meta-analysis by Aziz et al including 1,375 patients from 17 studies shows no significant differences in the proportion of patients with positive radial margins and the number of lymph nodes harvested between laparoscopic and open LAR or APR for rectal cancer surgery. Of the six studies reporting on lymph node retrieval included in the meta-analysis by Gao et al, five report no difference in lymph node numbers removed with the specimen between the open and the laparoscopic resection of the rectum.

Postoperative Pain

Regarding postoperative pain numerous randomized controlled trials have demonstrated a significant reduction in pain or analgesic requirements in the immediate postoperative period.

Bokey et al did not find a significant difference in analgesic requirements after laparoscopic when compared with open surgery. Reports on comparative operating times between the two procedures are also equivocal.[2]

Quality of Life

Exact QoL between two groups is difficult to measure because of lack of more sensitive and appropriate instruments. Therefore, based on literature the patient's experienced better QoL with reduced pain in the immediate postoperative period.

Recovery of Bowel Function

Faster recovery of bowel function is another significant advantage seen in the laparoscopic group.

Length of Hospital Stay

Most studies have reported a shorter duration of stay after laparoscopic-assisted colectomy. Others, however, report a similar length of stay for patients undergoing surgery by the two approaches, although this may be related to differing length of stay in different cultural environments and less experience with the technique in some reports.[2]

Cost

Direct costs following the laparoscopic surgery are higher than the open one. However, the diehard supporters of laparoscopic surgery have argued that the total costs to the society may actually be lower considering the improved short-term and potential long-term outcomes associated with the minimally access approach.

Port-site Recurrence

Concerning with port-site recurrence, numerous experimental studies have been published since 1991. They

have analyzed the possible role of pneumoperitoneum and carbon dioxide, the pathophysiology of minimally invasive techniques on tumor response and immunity. In laparoscopic procedure, the tumor was removed through small incisions in the abdominal wall or perineal, and this maneuver may theoretically lead to a risk of tumor contamination. To avoid port-site metastasis, Balli et al described a routine to follow in colorectal cancer resection: fixation of trocars to the abdominal wall, high vascular ligation, isolation of specimens before extraction from the abdominal cavity, and intraperitoneal and trocar site irrigation with a tumoricidal solution. With improved incision protection techniques, the reported port-site recurrence rate dropped rapidly. Zmora reported a pot-site recurrence rate of 1% in a review of 1,737 patients who have undergone laparoscopic colorectal resection for malignancy. Ramos et al reported abdominal wall metastases in only 3 of 208 patients with a minimum follow-up period of 1 year. All recurrences were in patients with Duke's C-stage carcinoma, and 2 of the 3 were found to have diffused peritoneal carcinomatosis at the initial surgery. The port-site metastasis has not been a significant issue in the presence of adequate training and laparoscopic skills.[6]

Long-term Outcomes

The long-term outcomes have been studied considering the following aspects:

- Tumor recurrence
- Disease free survival and
- Overall survival.

Another concern is regarding the accidental tumor spillage during laparoscopic colorectal resections that is caused by grasping and manipulating the bowel in the narrow pelvis. Recently, Franklin et al reported the results of LAC in 50 consecutive patients with stage III colorectal cancer, which was performed at a single hospital. The OS rates at 3 and 5 years were 54.5 and 38.5%, respectively, and the cancer-adjusted survival rates were 60.8 and 49%. For low rectal lesions laparoscopy-assisted APR (28.6% in our series) also allowed earlier postoperative recovery, with an equivalent tumor clearance, morbidity, mortality, disease free interval and duration of survival.[6]

The CLASICC trial has added to the body of evidence that vindicates the use of laparoscopic resection for colon cancer without detriment to long-term oncological outcomes. This study has now extended this conclusion to the use of laparoscopic resection of rectal cancer. Importantly, the higher positivity of circumferential resection margin seen after laparoscopic AR has not resulted in an increased incidence of local recurrence, and supports the continued use of the laparoscopic approach in these patients.[17]

In vast majority of reports, postoperative mortality rates following laparoscopic rectal cancer excision were low—overall mortality rate in the literature is 1.3%.[10]

IMMUNITY

The postoperative immune dysfunction is important for patients undergoing surgery for benign as well as malignant disease because it influences the rate of infectious complications as well as the growth of disseminated tumor cells. Especially in patients with cancer, better preserved postoperative immunity could result in better long-term oncologic results.[7]

CONCLUSION

This literature review shown that with laparoscopic technique, all oncologic principles of rectal cancer surgery could be followed. With regard to morbidity, local disease recurrence and survival figures, laparoscopic surgery is at least comparable with open surgery and it offers distinct advantage in early postoperative period and in terms of cosmesis and with development of improved techniques and more experience, operating time can gradually be reduced. These favorable findings of laparoscopic resection for colorectal malignancy certainly warranted further longer follow-up and results of prospectively randomized studies.

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REVIEW ARTICLE

Robotic Gynecological Surgery: A Clinical Approach

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ABSTRACT

Objective: To provide a review in the available literature in robotic gynecological surgery, focusing on history of robotic surgery, basic setup, advantages and disadvantages of the robotic surgery, uses of surgical robots, the future of the robotic surgery and finally laparoendoscopic single site robotic surgery.

Design: Literature survey.

Conclusion: Although it is not evident that robotic surgery is superior to conventional laparoscopic surgery in surgical outcomes, many studies demonstrate the positive feasibility of robotic assisted laparoscopic surgery in many gynecological fields including cancer. Robotic surgery is considered as a solution for the technical problems of minimal invasive surgery. However, the economic feasibility of robotic surgery still remains as an obstacle which should be overcomed. It is expected with further development of robotic technology that the concept of high cost will be resolved.

Keywords: Single-port laparoscopy, Robotic surgery, Gynecologic surgery.

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INTRODUCTION

Operative laparoscopy developed a lot in the last years and the appearance of minimally invasive surgery (MIS) led to advances in general surgery as well. Operative laparoscopy was initiated in the 1970s, while laser and electric energy technology was integrated into laparoscopic surgery in the early 1980s. Now, laparoscopic surgery has become an essential part of surgical treatment for many diseases including cancers. Compared with laparotomy, laparoscopic approach offers several advantages, such as faster return to normal activity, better cosmetic results and shorter length of hospital stay. The technology and techniques related to laparoscopic surgery are still evolving to the direction of easier and less invasive laparoscopic surgery. So wherever in the body a cavity exists or a cavity can be created, laparoscopy is indicated and probably preferable. The limiting factor is the availability of proper instruments, skill and experience of the surgeon. Despite several advantages of laparoscopic surgery, the disadvantages of conventional laparoscopy limit its use. However, the robotic surgery has been developed to overcome on the current limitations of conventional laparoscopy. The use of robots in surgery has been introduced from about 25 years. The first application of a robot in surgery was in neurosurgery then in orthopedic surgery which used a device to aide in total hip replacements, also in the field of urology, transurethral resection of the prostate can be performed by a robot through guidance from a preoperatively constructed three-dimensional (3D) image.[1] Robotic surgery carries with it the potential to transform laparoscopic surgery by providing instruments with distal ends that is similar to the fine movements of the human hand and it can also provide the surgeon with a high-definition, 3D view of the operative field. As this technology grows and develops, the hope is that further development will allow for more precise and even less invasive surgical options beyond laparoscopy and the current forms of surgical robots.[2] The robotic systems begin to be put to many tests, the surgeons are focusing on the surgical robot not as a mechanical device but as an information system, so robotic system should be fused with other information systems. One example of this type of fusion is image-guided surgery, also called surgical navigation. Robot-assisted surgeons will be able to see real-time, 3D images electronically of the operative field that is displayed on the monitor. In other words, on the screen, human anatomy will be appear translucent, and the surgeon will be able to determine the exact location of a lesion and more readily avoid damaging vital structures such as major vessels. In fact, with preoperative scanner images, surgeons could robotically practice their patients' surgery the night before, and the robot's computer could be programmed not to allow its instruments to penetrate vital organs so avoid intraoperative accidents.[3]

HISTORY OF ROBOTIC SURGERY

The term 'robot' was first introduced to the public in 1921 when the Czech writer Karel Capek described the notion in his play Rossum's Universal Robots. The term 'robot' originated from 'robota,' which means 'work' in the Czech language. For many years, robots have achieved development from simple machines performing the same tasks to a highly sophisticated machine capable of performing very delicate operation. In the surgical field, automated endoscopic system for optimal positioning (AESOP) was the first laparoscopic camera holder by robot. Although AESOP has been used in over 10,000 laparoscopic surgeries, it was only designed to offer greater vision control to the surgeon and to eliminate the need for an assistant who manipulated the endoscope.[4] Computers and technology are increasingly interacting with

surgeons both inside and outside of the operating room. The computer's ability to enhance, modify or transform electronic data is changing patient management before, during and after surgery. However, these technologic advancements are having a great influence on the planning and performance of the surgery. Although robots are still unintelligent machines, great steps have been made in expanding their use. Today robots are used to perform highly specific, highly precise, and dangerous tasks in industry and research which not possible with a human work force. Robotics, however, has been slow entered the field of medicine. The lack of fusion between industrial robotics and medicine, particularly surgery, is ended nowadays. Voice-activated robotic arms routinely produce endoscopic cameras, and complex master slave robotic systems are currently approved, marketed, and used for a variety of procedures.[5] The beginning of surgical robots have entered the field of endoscopic surgery to overcome the capabilities of human surgeons beyond the limits of conventional laparoscopy. The history of robotics in surgery begins with the Puma 560, a robot used in 1985 by Kwoh et al to perform neurosurgical biopsies with greater precision. Three years later, Davies et al performed a transurethral resection of the prostate using the Puma 560. This system eventually lead to the development of Probot, a robot designed specifically for transurethral resection of the prostate. While Probot was being developed, Integrated Surgical Supplies Ltd. of Sacramento, CA, was developing ROBODOC, a robotic system designed to cut the femur in hip replacement surgeries. ROBODOC was the first surgical robot approved by the FDA.[6] Also in the mid-to-late 1980s a group of researchers at the National Air and Space Administration (NASA) Ames became interested in using this information to develop telepresence surgery. This concept of telesurgery became one of the main forces behind the development of surgical robots.[7] While these robots were being developed, general surgeons and endoscopists joined the development team and accept it to overcome the limitations of conventional laparoscopic surgery.

Initial clinical trials using robotics in the operating room have shown the ability of the system to enhance the skill of the surgeon to perform technically delicate suturing and dissection. By enhancing the skill of the surgeon, the robot has aided in the development of microsurgical procedures, such as those used in cardiac and infertility surgery, and their advance into the field of endoscopic surgery. The computer interface helps the surgeon perform the microanastomoses using a minimally invasive approach beside the advantages to the patient of such techniques, including reduced recovery time and better cosmoses.[8]

BASIC SETUP

Today, many robots and robot enhancements are being researched and developed. Schurr et al at Eberhard Karls University's section for MIS have developed a master-slave manipulator system that they call ARTEMIS. This system consists of two robotic arms that are controlled by a surgeon at a control console. Dario et al at the MiTech laboratory of Scuola Superiore Sant'Anna in Italy have developed a prototype miniature robotic system for computer-enhanced colonoscopy. This system provides the same functions as conventional colonoscopy systems but it does an inchworm-like movement using vacuum suction. Because this system allows the endoscopist to teleoperate or directly supervise this endoscope, the surgeons believe that this system is not only suitable but may expand the applications of endoluminal diagnosis and surgery.[9] In 1998, Computer Motion which already had manufactured the AESOP developed the ZEUS surgical robot with a 2D imaging system similar to that of standard laparoscopy. On the other hand, the Da Vinci surgical system was introduced which has four robotic arms and obtained US Food and Drug Administration (FDA) approval in 2001, and become the most common robotic system used in the world. The competition between the ZEUS and the Da Vinci surgical systems ended when Computer Motion was introduce into robotic surgery in 2003.[10]

The Zeus system is composed of a surgeon control console and three table-mounted robotic arms. The right and left robotic arms replicate the arms of the surgeon, and the third arm is an AESOP voice-controlled robotic endoscope for visualization. In the Zeus system, the surgeon is seated comfortably upright with the video monitor and instrument handles positioned to maximize dexterity and allow complete visualization of the surgical field. The system uses both straight shafted endoscopic instruments similar to conventional endoscopic instruments and jointed instruments with articulating end-effectors and 7º of freedom.[11] The Da Vinci robotic system consists of three main components: The robotic cart, the vision cart, and the operating console. Four robotic arms are mounted on the robotic cart which can be placed freely next to the patient. The robotic cart connects to the laparoscopic trocars on the patient's abdomen which connected to the operating console through a cable. The Da Vinci surgical system is equipped with a 3D vision system in which double endoscopes generate two images resulting in the perception of a 3D image. In addition, robotic arms with surgical instruments have three or four joint which reproduce the range of motion and dexterity of the surgeon's hand. The surgeon sits at the surgical console and performs the surgery by manipulating the controller in it. The movement is translated from the

surgeon's fingers to the tip of the surgical instruments. Despite all of these technologic advancements that make the surgeon nearly autonomous, an assistant is still required for all robot-assisted cases. Their responsibility is mainly instrument exchanges, suction and irrigation, suture introduction and retrieval and additional retraction.[12]

ADVANTAGES OF THE ROBOTIC SURGERY

Robotic surgery offers several advantages over laparoscopy: A 3D vision, wristed instrumentation, and comfortable positioning for the surgeon while performing surgical procedures. The only currently available surgical robot employs two magnifying cameras that when used provide 3D vision to the surgeon with an available high-definition vision system. This enhanced visualization gives the gynecologist the ability to identify tissue planes, blood vessels and nerves while performing the surgical procedure, also decreased blood loss has been reported in robotic surgery. The limited degrees of freedom associated with a standard laparoscopic instrument compared with the surgeon hand decrease the dexterity of the surgeon and his ability to perform delicate procedures like difficult dissections, lymph node removal. Wristed instrumentation allows the gynecologic surgeon to obtain the exact instrument angle available at laparotomy. This also eliminates the fulcrum effect that is present with conventional laparoscopy, where surgeons need to move their hand in the opposite direction to the certain location of the distal instrument tip.[13] With robotic surgery the movements are natural and surgeons move their hands in the direction they want the instruments to move. Three degrees are provided by the robotic arms attached to the abdominal wall trocars (insertion, pitch, yaw), and 4º result from the 'wristed' instruments (pitch, yaw, roll and grip). The terms pitch, roll and yaw are the three characteristics that describe the rotations in three dimensions around the robotic instrument. Pitch is the rotation around the lateral or transverse axis. The yaw is rotation about the vertical axis, and the roll is rotation around the longitudinal axis. The improved dexterity and control allow for finer, more delicate, tremor-free manipulation, dissection, removal or reconstruction of tissue.[14] Fatigue and physical discomfort can become limitations during any surgical procedure. During laparoscopy, surgeons are often suffering from difficult technique to complete the surgical procedure because they need to reach over the patient's abdomen to manipulate the hand controls on the laparoscopic instruments. With robotic surgery, the surgeon sits comfortably at the surgical console and manipulates the hand controls and foot pedals. This may serve to reduce fatigue and discomfort during complex surgical procedures.[15]

DISADVANTAGES OF THE ROBOTIC SURGERY

The main disadvantages of robotic surgery applications are the cost, the large size of the robot and console, limited availability within some health systems, lack of tactile feedback, the need to train surgeons, and operating room availability on the use of this technology. The costs associated with robotic surgery include the cost of the unit that can range from 1.4 to 1.6 million dollars and the cost of instrumentation that has limited its uses. Health systems need to perform an investment analysis which gives fixed costs associated with the purchase, high robotic surgical volume is required to improve this calculation. Additional costs that need to be considered include the time and cost of training surgeons and operating room and increased operative time associated with operating room setup as well as the assembly and disassembly of the robotic system during the early phase of the training. There is evidence that with experience in robotic surgery, the operative time can become shorter than with laparoscopy.[16] The bedside assistant may experience difficulty in manipulating laparoscopic instruments through an assistant port because the robotic arms are moving over the patient abdomen at the same time. Although robotic instrument exchange can become more efficient compared with laparoscopy but it still requires attachment of the robotic instruments to the instrument arms before insertion. Another current limitation of robotic surgery is the lack of tactile feedback, so if there are particular structures that the surgeon desires to palpate, they can do by laparoscopy before using the robot or ask the bedside assistant to palpate and confirm the location.[17] Moving the robot to the operating table and attaching the robotic arms to the trocars is often a major disadvantage requiring significant time. With practice and training, this can be performed quickly but in more time that require with laparoscopy. Because the operating table and the robot do not communicate and are not synchronized, once the robotic unit is united, the patient bed cannot be moved in any direction, otherwise, the trocar depth can become incorrectly positioned and abdominal wall as well as visceral trauma could occur. Increased operative time associated with some robotic surgeries which may have associated side effects, including anesthetic complications.[18] Finally the size of both the robotic unit and console become a major consideration. Depending on current operating room size and availability, relocation to a larger operating room may be necessary. Many of these disadvantages could be improved with further development. Table 1 shows the advantages and disadvantages of conventional laparoscopic surgery *vs* robot surgery.

USES OF ROBOTIC SURGERY

Several robotic systems are currently approved by the FDA for specific surgical procedures. The Zeus system and the Da Vinci system have been used in many laparoscopic surgeries, including cholecystectomies, mitral valve repairs, radical prostatectomies, reversal of tubal ligations, in addition to many gastrointestinal surgeries, nephrectomies and kidney transplants. The number and types of surgeries being performed with robots is increasing rapidly as these system accepted by many institutions. Perhaps the most notable use of these systems is in totally endoscopic coronary artery grafting.[19] The amount of data evaluated the robotic surgery is growing rapidly, and the early data are promising. Many studies have evaluated the feasibility of robot-assisted surgery. The studies also found the robot to be most useful in intra-abdominal microsurgery or for manipulations in very small spaces.

Another use for robotic systems is in pediatric laparoscopic surgery. Currently, laparoscopic pediatric surgery is limited by an inability to perform precise anastomoses of 2 to 15 ml. Although laparoscopic techniques may be used to treat infants with intestinal atresia, choledochal cysts, biliary atresia, and esophageal atresia in term and preterm infants, it is not the standard approach because of the technical difficulties.[20] Despite many studies showing the feasibility of robotic surgery, there is still much to be desired. More high quality clinical trials need to be performed and much more experience needs to be obtained before the full potential of these systems can be realized. One of the most important uses of robotic surgery is in gynecological surgery. The surgeon can perform hysterectomy which is the most important procedure in gynecology robotic hysterectomy and is preferable than laparoscopic, vaginal or abdominal hysterectomy. Operative times ranged from 270 to 600 minutes, and blood loss ranged between 50 and 1,500 ml, with an average loss of 300 ml. The average hospital stay was 2 days, with a range of 1 to 3 days.[21]

Robotic surgery is also used in gynecological oncology which is due to a great progression of robotic technology. In 2005, the first feasibility studies in both Europe and the United States were published. The surgeon can mange many malignancies by robotic surgery such as cervical, endometrial and ovarian cancer as well as pelvic lymph nodes removal without port-site metastasis or recurrences which not found with a mean follow-up of 10 months.[22] In reproductive surgery, the robotic surgery is used to evaluate the cases of infertility; robotic myomectomy has many advantages such like as decrease the risk of adhesion and pelvic organ manipulation which affect the fertility. Although the costs and operative times were higher in the robotic myomectomy but the patients had significantly less blood loss and did not require blood transfusions. Another usage of robotic surgery in reproductive surgery is in tubal reanastomosis which perform to treat the tubal blockage due to tubal pathology and this is considered one of microsurgical procedures which can be performed by robotic surgery. Robotic surgery also has a role in urogynecology. Laparoscopic sacrocolpopexy is used as vaginal reconstructive surgery, can be performed by robotic surgery in which the surgeons can perform the presacral dissection laparoscopically, put the mesh, and intracorporeal suturing, which has significant advantages to the robotic approach.[23] Table 2 shows summary of current applications of robotic surgery.

THE FUTURE OF THE ROBOTIC SURGERY

Robotic surgery is in its infancy. Many disadvantages will be resolved with the time. The surgeons will overcome the obstacles such as malpractice liability, training requirements. Many of current advantages in robotic assisted surgery ensure its continued development and expansion. One

Table 1: Advantages and disadvantages of conventional laparoscopic surgery *vs* robotic surgery

	Conventional laparoscopy	*Robotic surgery*
Advantages	Well-developed technology Affordable and available Proven efficacy	3D visualization Improved dexterity 7° of freedom Elimination of fulcrum effect Elimination of physiologic tremors Ability to scale motions Microanastomosis possible Telesurgery
Disadvantages	Loss of touch sensation Compromised dexterity Limited degrees of motion The fulcrum effect Amplification of physiologic tremors Loss of 3D visualization	Very expensive High startup cost May require extra staff to operate New technology Unproven benefit

Table 2: Summary of current applications of robotic surgery

Orthopedic surgery	*Neurosurgery*	*Gynecology*	*Cardiothoracic surgery*	*Urology*	*General surgery*
• Hip arthroplasty • Knee surgery • Spine surgery	Radiosurgery	Hysterectomies Ovarian resection Tubal reanastomosis	CABG Mitral valve repair	Nephrectomy Prostatectomy Ureter repair	Cholecystectomy Gastric bypass Adrenalectomy Bowel resection Esophagectomy

Table 3: Summary of trials of the operations done by robotic in gynecology

References	*Year*	*Type of study*	*No. of patient*	*Type of operation*	*Duration of the surgery (min)*	*Blood loss (CC)*	*Hospital stay (day)*	*Complications rate (%)*	*Conversion to other method (%)*
Magrina, Kho et al.	2008	Prospective	27	Robot-assisted laparoscopic radical hysterectomy	185	100	1.9	32.5	0
Estape, Lamrou et al.	2009	Prospective	32	Robot-assisted laparoscopic radical hysterectomy	2.4 hours	130	2.6	18.8	0
Maggioni, Minig et al.	2009	Prospective	40	Robot-assisted laparoscopic radical hysterectomy	272	78	3.7	32.5	0
Seamon, Cohn et al.	2009	Retrospective	105	Robot-assisted laparoscopic staging surgery in endometrial cancer	242	99	1	12.9	
Cardenas-Goicoechea J et al.	2010	Retrospective	275	Robotic staging of endometrial cancer	237	109	1.88	0	1
Soto E et al.	2011	Retrospective	124	Robotic hysterectomy	150.8	131.5	2.2	0	0
ElSahwi KS et al.	2012	Retrospective	155	Robotic staging of endometrial cancer	127	119	1.5	1 death	0
Madhuri TK et al.	2012	Prospective	104	Simple and radical hysterectomy	-	155.24	3	0	0
Cardenas-Goicoechea J et al.	2013	Retrospective	432	Robotic staging of endometrial cancer	218	187	1.96	0	0
Nakib G et al.	2013	Retrospective	6	Robotic assisted surgery for adnexal pathologies	117.5	-	-	0	0

exciting possibility is expanding the use of preoperative (computed tomography or magnetic resonance) and intraoperative video image to get better guide to the surgeon in dissection and identifying pathology. The nature of robotic systems also makes the possibility of long distance intraoperative consultation or guidance possible and it may provide new opportunities for teaching and assessment of new surgeons. The Zeus robotic surgical system already made a device called SOCRATES that allows surgeons at remote sites to connect to an operating room and share video and audio, to use a 'telestrator' to highlight anatomy, and to control the AESOP endoscopic camera. Although these systems have greatly improved dexterity, they should be developed with the instrumentation or to be incorporated in the full range of sensory input. More standard mechanical tools and more energy directed tools need to be developed.[24]

LESS ROBOTIC SURGERY

Recently a less invasive alternative to conventional laparoscopy or robotic surgery has been developed which is laparo-endoscopic single-site surgery (LESS), also known as single-port surgery. Single-port laparoscopy (SPL) enhances the cosmetic benefits of MIS while minimizing the potential morbidity associated with multiple incisions. The primary advances in LESS as applied to urologic and gastrointestinal surgery demonstrate that the techniques are feasible provided that both optimal surgical techniques and optimal instrumentation are available.[25] The principle concept of LESS is to place all of the laparoscopic ports through the same incision. Now various devices designed to overcome the technical challenges for LESS have been developed and introduced in endoscopic surgery, those devices include laparoscopic ports designed to apply multiple instruments through a single incision, flexible and long endoscopes and articulating variable length instruments. In addition, the Da Vinci robotic platforms with articulating instruments can be integrated into LESS for many surgical procedures.[26] The first experience with robotic LESS was reported by Haber et al then Kaouk et al who reported the first robotic single-port transumbilical surgery in urology by performing a successful radical prostatectomy and nephrectomy. The ability of the robotic arms to enable more degrees of freedom and triangulation at the surgical site facilitate the surgical success.

The robotic LESS is a novel technique which has developed for performing various endoscopic surgical procedures. The surgeons use advances in minimally invasive techniques and technological innovation, including use of the newest generation of port systems that allow several conventional laparoscopic or robotic instruments to be handled simultaneously through a single operating trocar. Other innovations that facilitated the single-port surgical approach included articulating laparoscopes and instruments and multifunctional 5 mm laparoscopic instruments such as the LigaSure Advance™ which allow tissue fusion, vessel sealing, spot coagulation and endoscissor functions in one instrument.[27] Potential advantages of single-port robotic surgery over conventional multiport laparoscopy include the advantages of the robotic system and also the single-port surgery which give better cosmoses from a hidden umbilical scar and a fewer trocar incisions has been used, a possible decrease in morbidity related to visceral and vascular injury during trocar placement as well as decrease postoperative wound infection, hernia formation and elimination of multiple trocar site closures, 3D visualization, improvement of dexterity are obtained by robotic system. No effect of fulcrum is reported in LESS robotic surgery as well as micro-anastomosis become possible. But LESS robotic surgery has increased the number and size of ports required so the typical robotic surgical procedure should include three 8 mm ports and two 12 mm ports.[28] Triangulation is needed for proper dissection; at same time it provides effective traction and counter traction, it is difficult with SPL and becomes easy with robotic surgery. Instrument crowding is the most important problem in single-port surgery not present with using robot. This is due to the development of streamlined profile camera systems which used instruments of different lengths. Instrument and robotic arms crowding can also be overcomed by using 5 mm not 8 mm robotic trocars and by using a 30º robotic camera down or up depending on the case. This modification enables spacing of the robotic arms as far possible from the camera arm. Several single-port devices are available including the SILS Port Multiple Instrument Access Port, GelPort, Uni-X Single-Port System and ASC R-port laparoscopic access device. The major problem with the various single-port devices is gas leaking and structural integrity in response to the movement of robotic arms. There are also some patient-related limitations because the surgeon used the umbilicus as the entry point, this limit patient who would be appropriate for robotic-assisted single site surgery.[29] Single port laparoscopic Surgery (SPLS) is considered a feasible approach for many endoscopic surgical fields especially in gynecological endoscopic surgery like single-port hysterectomy and adnexectomy. SPLS is also used in the field of gynecologic oncology; SPLS may be applied to adnexal surgery in patients with adnexal tumors, prophylactic oophorectomy in patients with high risk of developing ovarian cancer, and hysterectomy in patients with preinvasive cervical carcinoma. With technical advances in the robotic system more complicated procedures in gynecologic oncology, such as radical hysterectomy and endometrial cancer staging surgery might be conducted with SPLS in the near future.[30] Table 3 shows summary of trials of the operations done by robotic in gynecology.

DISCUSSION

The numerous benefits of MIS are better cosmetic results, reduced operative morbidity, reduced postoperative pain, and shorter length of hospital stay compared with laparotomic surgery. MIS has taken the place of laparotomy and became essential in many surgical fields. However, technical difficulties have prevented the widespread of MIS. Over the last three decades, laparoscopic technologies have developed, and robotic surgery using the Da Vinci system has been introduced. Although it is not evident that robotic surgery is superior to conventional laparoscopic surgery in surgical outcomes, many studies demonstrate the positive feasibility of robot-assisted laparoscopic surgery in many

field including cancer. Robotic surgery is considered as a solution for the technical problems of MIS. However, the economic feasibility of robotic surgery still remains as an obstacle which should be overcomed. It is expected with further development of robotic technology and the Da Vinci robotic platform, the concept of high cost will be resolved. Robotic surgery has many advantages like 3D vision with high-definition vision system; increase the dexterity of the surgeon and his ability to perform delicate operations, and comfortable positioning for the surgeon while performing surgical procedures because the surgeon sits on robotic console away from the patient. However, there are some disadvantages to the robotic surgery like high cost, the large size of the robot set up, and there is no tactile feedback during operation. But with the future, the robotic surgery will be progressing and its disadvantages will be resolved with the time.

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REVIEW ARTICLE

Robotic *vs* Laparoscopic Hysterectomy: Is Robot Superior?

Mokoena Martins Mohosho

ABSTRACT

The objective of this article is to reflect the current stand on robotic *vs* laparoscopic hysterectomy. There are only few recent studies comparing robotic with laparoscopic hysterectomy and most are retrospective. Early studies found prolonged operating times (e.g. 150.8 *vs* 114.4 minutes, p = 0.001) for robotic assisted than laparoscopic hysterectomy,[1,2] but this appears to have been the result of a lack of experience with this new technology; the learning curve to reduce the robotic surgical time had median of 29 cases per surgeon.[10] Subsequent studies reported operative durations which are comparable to conventional total laparoscopic hysterectomy, approximately 2 hours.[13,14] A minority of studies have reported that robotic-assisted is superior to conventional laparoscopic hysterectomy, with reports of shorter operative duration, decreased blood loss, decreased rate of conversion to laparotomy, decreased use of postoperative narcotic analgesia, and shorter hospital stay.[1,2,12]

Materials and methods: This involved the review of related articles to robotic *vs* laparoscopic hysterectomy. The scope of this review covered Medline, UpToDate, PubMed, Highwire press, Da Vinci community, Google search engine.[12,13]

Summary: Recent comparative studies have found that robotic and conventional laparoscopic hysterectomy are essentially equivalent regarding surgical and clinical outcome. Operating times are slightly higher and costs are significantly higher for the robotic hysterectomy.

Keywords: Robotic hysterectomy, Laparoscopic hysterectomy, Hysterectomy, Minimal access surgery, Cost of robotic surgery, Robotic *vs* laparoscopic hysterectomy.

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INTRODUCTION

Despite the presence of multiple nonsurgical alternatives for treating uterine disease, hysterectomy continues to be one of the most commonly performed gynecologic procedures. A minimal access approach to hysterectomy, which has several benefits over the traditional abdominal technique, has already established a modest attraction in gynecologic surgery. However, its practice and adoption is currently still limited. Factors that might explain this slow adoption include the learning curve associated with minimal access surgery, lack of sufficient resident and fellow training, uneven availability of proper equipment, as well as a low level of physician reimbursement.[3,10,15]

Laparoscopic measures in gynecologic surgery have been performed successfully in excess of 20 years now. The 1st total laparoscopic hysterectomy was performed by Reich et al in 1988.[14] Since then, substantial improvements in optic systems and instrumentation have made laparoscopic surgery a lot more accurate, safer and probably easier to learn. As a result of these technical advances during the past two decades, complicated procedures like gynecologic cancer surgery, surgery of deep infiltrating endometriosis or prolapse surgery today can be performed safely by laparoscopy.[7,11,13]

A surgical robot is a computer-controlled device that can be programmed to aid the positioning and manipulation of surgical instruments. Surgical robotics is typically used in laparoscopy rather than open surgical approaches. Since 1980s, surgical robots have been developed to address the limitations of laparoscopy, including two-dimensional visualization, incomplete articulation of instruments and ergonomic limitations.[15]

Features of Robotic Surgery

The most important benefits of robot-assisted over conventional laparoscopy are:[12,13]

- *Superior visualization:* Three-dimensional (3D) *vs* two-dimensional (2D) imaging from the operative field.
- *Mechanical improvements:* A fulcrum effect is created when rigid conventional instruments pass through the incision, thereby ultimately causing inversion of movement from the surgeon's hand for the working end of the instrument. When an instrument is introduced in a trocar, the abdominal wall is the fulcrum. Each time a surgeon's hand moves in one direction, the instrument moves in the opposite direction. If a patient is obese, there is more torque placed on the instrument and the rigid smaller caliber instruments as of laparoscope, may fracture. Robotic instruments are less likely to break, thus, many surgeons prefer robot-assisted laparoscopy in obese patients. This is because all robotic instruments are 8 mm wide and attached to the robotic arms, which often attach to the robotic cannulas (trocars). The force that the abdominal wall places on each instrument is sustained by the trocar and mechanical robotic arm. The robotic laparoscope is 11 mm in diameter and is also introduced through a trocar, which is docked on the robotic scope arm. In contrast, conventional laparoscopy is performed with 3 or 5 mm instruments which are introduced through smaller trocars.

Also, robotic instruments have 7º of freedom, similar to the human arm and hand, while rigid conventional instruments have 4º of freedom. While there are newer flexible laparoscopic needle holders which move around in 7º (e.g. Autonomy Laparo-Angle™), movements with these are not intuitive and their use requires additional training.

- *Stabilization of instruments within surgical field:* In conventional laparoscopy, small movements from the surgeon are amplified (including errors or hand tremor). Robot-assisted surgery minimizes surgeon tremor.
- *Improved ergonomics for the operating surgeon:* The surgeon can be seated with telerobotic systems. This avoidance of long-term standing during surgery could possibly be particularly beneficial to surgeons who are pregnant and have orthopedic limitations.

Limitations of Robotic Surgery

Limitations of robotic technology include:[15]

- Additional surgical training
- Increased costs and operating room time
- Bulkiness of the devices
- Instrumentation limitations (e.g. lack of a robotic suction and irrigation device, size, cost)
- Lack of haptics (tactile feedback)
- Risk of mechanical failure
- Limited number of energy sources (i.e. less than conventional laparoscopy)
- Not designed for abdominal surgery involving more than two quadrants (the device has to be redocked and repositioned to operate in the quadrants it is not facing).

In this article the comparison of robot-assisted hysterectomy to conventional laparoscopic hysterectomy for benign and malignant indications is reviewed with the recent data available.

RESULTS

The main focus of this comparison between these two minimally invasive procedures is on the clinical outcome and the costs.

In earlier studies the robotic hysterectomy was superior to laparoscopic hysterectomy in less conversion rate, less blood loss, shortened hospital stay. However, it was found that operative time was longer and the costs were higher with robotic than laparoscopic hysterectomy.[1-3] The incidence of complication was the same in both procedures. Only in one study the less cost and shorter operative time was found in robotic than laparoscopic hysterectomy.[6] In the study by Thomas et al[3] the robotic hysterectomy was superior with blood loss of 113 *vs* 60.9 ml ($p < 0.0001$); hospital stay of 1.6 *vs* 1.1 days ($p < 0.007$); conversion rate of 9 *vs* 4%, but inferior to conversional hysterectomy with operative time of 92.2 *vs* 78.7 minutes. Both earlier and recent studies show significantly higher cost with robotic than laparoscopic hysterectomy. The study by Frey et al[6] showed higher cost with robotic than laparoscopic hysterectomy with $2995 *vs* with $3735 ($p = 0.003$).

DISCUSSION

This comparison between robotic and laparoscopic hysterectomy is apparently important, as worldwide robotic procedures are gaining more and more interest in gynecological surgery. But there are only few comparative studies on this subject and most are retrospective with a low case load.

Both of them are minimally invasive procedures with the only difference being the use of the robot. Costs are significantly higher for robotic hysterectomy and the difference per case adds up to approximately 2500 USD excluding the cost for investment and amortization.[15] Robotic hysterectomy is easy to learn for the experienced laparoscopic surgeon, but to reach operating times of the conventional laparoscopic hysterectomy, a learning curve of at least 50 cases seems to be needed.[13] Robotic hysterectomy may not offer a benefit for expert laparoscopic surgeons as well as the clinical outcome is most likely not better, but it might be a tool which offers an opportunity to perform a minimally invasive hysterectomy to more surgeons and also to give more patients the advantages of this minimally invasive surgery.

Recent studies show that the clinical outcome seems to be the same for robotic and conventional laparoscopic hysterectomy. Operating times are slightly higher and costs are significantly higher for that robotic procedure.[7,8,10,12,13] A few studies indicated that the robotic hysterectomy carries less risks and can be performed easier in patients with increased BMI than laparoscopic hysterectomy.[5,7] It was also demonstrated in a single study[9] that there are less musculoskeletal strain injuries among surgeons performing robotic procedures than conversional laparoscopic procedures.

It is clear from recent reports that this prolonged operative times and higher cost are the two main drawbacks of robotic hysterectomy against laparoscopic hysterectomy.[4,13,14] The robotic operative time can be improved with training of gynecologic surgeons. Despite these promising results, the proportion of robotic hysterectomies is disappointingly low weighed against laparoscopic hysterectomies worldwide; consequently laparoscopic hysterectomy continues to be the most common minimal access surgical approach in nearly all countries worldwide. This is because of most likely the limited exposure to robotic surgery in several hospitals in which gynecologic surgeons are educated and trained. To overcome this drawback of robotic hysterectomy, intensive training of surgeons is required. To attain training and

competence, a surgeon can create three robotic cases prior to scheduled training in an animal lab at various robotic-training centers so that he or she immediately implements the training and reinforces what he/she learns inside the animate or cadaver lab. The volume of mentored patient procedures resulting in independent practice varies from institution to institution and will be likely individualized based on surgical experience and technical ability. Additionally, many institutions are imposing a certain volume of cases to ensure that they maintain a competent level of skill, although individual differences in acquiring skills make an arbitrary number of completed cases illogical. Further, performance of one type of pelvic surgery does not mean another type of pelvic procedure can be performed safely. Credentialing requirements vary among institutions and many institutions are in the process or have recently established criteria for credentialing surgeons to perform procedures on robotic platforms.

Surgical learning curves depend on two elements of surgical volume: total number of procedures performed and the time interval between procedures. Proficiency in a new procedure includes the procedure itself and also the ability to manage complications. Furthermore, safe surgical practice also is dependent upon continued surgical volume after training, equally as for laparoscopic hysterectomy. Additionally, most experts agree that the surgeon must be competent in performing a procedure via laparoscopy before learning a robotic approach. However, there may come a time in the future that many open surgeries are converted to robotic surgery and therefore, trainees will perform a certain procedure solely with robot-assisted.

Robotic surgical procedures are expensive. The da Vinci® system currently costs over $1.75 million, each instrument attached to the robotic arm costs between $2200 and $3200 and requires replacement after 10 uses. Costs incurred by robotic surgery include capital acquisition, limited use instruments, team training expenses, equipment maintenance, equipment repair, and operating room set-up time. As noted above, robot-assisted cases cost approximately $2000 more per case as opposed to same procedure accomplished by conventional laparoscopic procedure. Inside the era of healthcare reform, this elevated cost will be the greatest detriment to continued implementation of robotic surgery. More prospective research is required to analyze overall costs (direct and indirect) of robot-assisted procedures to medical care systems.[15]

The rapid uptake of robotic hysterectomy is likely to be as result of a variety of factors. First, robotic surgery could be easier to learn than laparoscopy because it is more analogs to traditional open surgery. Second, robotic assistance may accommodate the culmination of extra-technically demanding cases that would otherwise have required laparotomy. Third, robotic surgery has become the topic of extensive marketing not just in surgeons and hospitals, but also to medical consumers.[15] The potential effect on this marketing may be the topic of numerous reports.[16] The improved use of laparoscopic hysterectomy is noted almost solely at hospitals where robotic surgical procedures are not performed[16] and also this may be due to competitive pressures or even an increased awareness and appreciation of minimally invasive surgical options for hysterectomy.

Robotic surgery is of enormous interest for future years and in my opinion will significantly influence minimal access surgical procedures. Robotic surgery is still in its infancy and I believe that further improvements in technology and costs are needed. Furthermore, technical advances such as reducing bulkiness, better suturing techniques and implementation of learning software/simulators and teaching consoles, robotic surgery may help in its endemic use. Multiple issues concerning the use of robotics in gynecology remain. Short-and long-term patient outcomes must be further evaluated with randomized prospective trials. Surgical costs, considering postoperative variables, need critical review.

CONCLUSION

Clinical outcomes for both the robotic and conventional laparoscopic hysterectomy are equivalent. Cost and operative time for the robotic-assisted hysterectomy is higher than that of conventional laparoscopic hysterectomy. As technical evolution has always influenced surgery during the past, I do believe that robotic surgery has enormous technical potential to play a crucial role in the next decade.

However, until randomized controlled studies of comparative effectiveness are conducted to further decisions regarding the diffusion of robotic in conventional laparoscopic hysterectomy, I cannot definitively state the superiority of robotic over conventional hysterectomy.

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REVIEW ARTICLE

Barbed Sutures in Laparoscopic Myomectomy—Realistic Expectations: A Critical Review

Shyjus Puliyathinkal

ABSTRACT

The purpose of this review is to critically analyze the effectiveness of self-retaining barbed sutures in intracorporeal suturing in terms of tissue approximation, intraoperative blood loss, reduction in operative time, duration of hospital stay and postoperative adhesions.

Materials and methods: We analyzed 9 published articles to critically look at the effectiveness of self-retaining barbed suture in laparoscopic myomectomy. A literature research was performed using internet.

Discussion: Barbed suture seems to be a reasonably good option for intracorporeal suturing in laparoscopic myomectomy. The time required for intracorporeal suturing was significantly less with barbed suturing (11.5 min/9.9 min/126s) when compared to the conventional suturing (17.4 min/15.8 min/272.6s). The total operative time required with barbed sutures (118 min/51 min) was found to be significantly reduced in comparison with conventional sutures (162 min/ 58 min). The intraoperative blood loss was found to be significantly reduced in 2 of the 3 studies with the use of barbed sutures. Fall in hemoglobin and duration of hospital stay also seems to be reduced with the self-retaining sutures.

Conclusion: The self-retaining barbed suture seems to be an effective option for intracorporeal suturing in laparoscopic myomectomy with numerous benefits.

Keywords: Laparoscopic myomectomy, Barbed sutures in laparoscopic myomectomy, Self-retaining sutures in laparoscopic myomectomy, Scar integrity with barbed sutures, Complications of laparoscopic myomectomy.

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INTRODUCTION

Fibroid uterus is one of the commonest pathology affecting up to 30% of women in reproductive age group. It can present with a wide spectrum of symptoms including pelvic pain, abnormal uterine bleeding, pressure symptoms, pelvic mass and infertility. The current scenario of delayed marriages and delayed conception after marriage can aggravate the impact of such hormone responsive uterine pathologies. Despite this trend, there is an increasing desire for fertility preservation, thus creating a renewed interest in conservative uterine surgeries in comparison to hysterectomies.

Laparoscopic myomectomy, in its early years (1970's) was meant exclusively for subserous myomas.[1] From the beginning of the 1990s, techniques were developed to tackle the intramural myoma too by the laparoscopic route.[2] Today, laparoscopic myomectomy is on its way to attaining the status of a superior approach for women because of the proven advantages with respect to postoperative pain, shorter hospitalization and convalescence, and for the obvious cosmetic reasons, in comparison to the open approach. However, laparoscopic myomectomy has always been subjected to considerable debate. In particular, for intramural myoma, the technique is reputed to be technically difficult, of longer duration, with more blood loss. The quality of the uterine scar obtained by this technique is also questionable, to withstand a subsequent pregnancy.[3]

The purpose of this review is to critically analyze the effectiveness of self-retaining barbed sutures in intracorporeal suturing in terms of tissue approximation, intraoperative blood loss, reduction in operative time, duration of hospital stay and postoperative adhesions.

Bidirectional barbed suture is a new design that incorporates tiny barbs spaced evenly along the length of the suture cut facing in opposite directions from the midpoint.[5,7] Unlike the smooth-textured traditional suture, the bidirectional barbs on this new product introduce a new paradigm in which wound tension is evenly distributed across the length of the suture line rather than at the knotted end.[8,10] No knots are required with bidirectional barbed suture.[9]

MATERIALS AND METHODS

A literature search was performed using Google, Yahoo, Springerlink and Highwire Press. The following search terms were used: laparoscopic myomectomy, barbed sutures in laparoscopic myomectomy, self-retaining sutures in laparoscopic myomectomy, scar integrity with barbed sutures, complications of laparoscopic myomectomy.

Considering the fact that this suture is a relatively newer entry in this field, 9 of the available published articles were chosen for this review.

The criteria of selection were:

- *Type of operative procedure:* Laparoscopic myomectomy with intracorporeal suturing with barbed sutures or conventional suturing with knotting.
- The institution where the procedure was practiced (preference for those specialized for laparoscopic surgery).

Laparoscopic pelvic myomectomy procedures practiced:

- The uterus was always cannulated to allow the correct exposure of myomas.

- To reduce vascularization and blood loss, the myomas were injected with diluted vasopressin.
- For subserous and intramural myomas, myomectomy was carried out the with a 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 with barbed sutures or conventional vicryl sutures.
- *Removal of myoma:* Larger myoma were removed through posterior colpotomy. Medium and large size fibroid is morcellated using a morcellator or scissors. For infected and suspected carcinoma, tissue retrieval bag should be used.

DISCUSSION

Time Required for Intracorporeal Suturing (Table 1)

In the study done by Franco Alessandri et al 2010, it was found that the time required to suture the uterine wall defect was significantly lower in group using barbed sutures (11.5 ± 4.1 minutes) than in the group using conventional sutures (17.4 ± 3.8 minutes; $p < 0.001$).[4]

In the other study done on animal model by JI Einarsson et al 2011 myometrial closure was found to be significantly faster using barbed suture (126.5 seconds) when compared to traditional suture (272.6 seconds; $p < 0.001$).[12]

In yet another study done by Roberto Angioli et al 2012 it was found that suturing time was found to be significantly lower in the V-Loc (Barbed suture) than in the control (9.9 ± 4.3 *vs* 15.8 ± 4.7 minutes; $p = 0.0004$) group.[6]

TOTAL DURATION OF SURGERY (TABLE 2)

In the study done by Franco Alessandri et al 2010 it was found that there was no significant difference in the operative time between group using barbed sutures and the group using conventional sutures.[4]

In another study done by JI Einarsson et al 2011, it was found that use of bidirectional barbed suture was found to significantly shorten the mean (SD) duration of surgery [118 (53) minutes *vs* 162 (69) minutes; $p < 0.05$] when compared to conventional suturing.[12]

In a study conducted by JI Einarsson et al 2011 in animal model it was found that the mean total procedure time was 13.3 minutes.[11]

In yet another study done by Roberto Angioli et al 2012 it was found that the mean operative time was shorter in the V-Loc (51 ± 18.1 minutes) than in the control (58 ± 17.8 minutes) group.[6]

INTRAOPERATIVE BLOOD LOSS

In the study done by Franco Alessandri et al 2010 it was found that the intraoperative blood loss was significantly lower in group using barbed sutures than the group using conventional sutures ($p = 0.004$).[4]

In another study done by JI Einarsson et al 2011 it was found that there were no significant differences with respect to the intraoperative blood loss between barbed and conventional sutures.[12]

In yet another study done by Roberto Angioli et al 2012 intraoperative bleeding was found to be significantly lower in the V-Loc group ($p = 0.0076$).[6]

In the study done by JI Einarsson et al 2010 in an animal model found that the mean blood loss was 159 ml.[11]

FALL IN HEMOGLOBIN LEVELS

In a study done by Roberto Angioli et al 2012, drop in hemoglobin was found to be significantly lower in the V-Loc group ($p = 0.0176$).[6]

Table 1: Time needed for intracorporeal suturing

Study	*Barbed sutures*	*Conventional sutures*	*p-value*
Franco Alessandri et al 2010	11.5 ± 4.1 mins	17.4 ± 3.8 mins	<0.001
JI Einarsson et al 2011	126.5 seconds	272.6 seconds	<0.001
Roberto Angioli et al 2012	9.9 ± 4.3 mins	15.8 ± 4.7 mins	= 0.0004

Table 2: Total duration of surgery

Study	*Barbed sutures*	*Conventional sutures*	*p-value*
Franco Alessandri et al 2010			No significance difference
JI Einarsson et al 2011	118 minutes	162 minutes	<0.05
Roberto Angioli et al 2012	51 ± 18.1 mins	58 ± 17.8 mins	NA

None of the other studies specifically looked at a fall in hemoglobin levels between the barbed and conventional suture groups.

DURATION OF HOSPITAL STAY

In a study done by JI Einarsson et al 2011 it was found that the use of barbed sutures reduced the duration of hospital stay [0.58 (0.46) days *vs* 0.97 (0.45) days; $p < 0.05$].[12]

None of the other studies specifically compared the duration of hospital stay between the barbed and conventional suture groups.

POSTOPERATIVE ADHESIONS

In the study done on animal model by JI Einarsson et al. 2011 the mean (SD) adhesion score was not significantly different between the barbed suture group [3.78 (3.92)] *vs* the Vicryl group [3.04 (3.75)].[11]

None of the other studies specifically compared the adhesion scores between the barbed and conventional suture groups.

CONCLUSION

A laparoscopic approach to myomectomy may be safely chosen for patients to be proposed for surgical treatment of subserous and intramural myomata of average size and few in number. The use of barbed sutures appears to significantly reduce the myoma bed suturing time as well as the mean operation time, when compared to the conventional intracorporeal suturing with knotting. Intracorporeal suturing with barbed sutures was also seen to reduce the intraoperative blood loss and fall in hemoglobin levels when compared to the conventional suturing. Myomectomy scars after laparoscopy is a debatable issue but the studies reviewed here seems to present a picture of comparable healing rates and strength when compared to conventional suturing. Further studies with longer follow-up would be needed to present a clearer picture on scar integrity with use of barbed sutures. Most importantly, the use of barbed sutures can help to popularize laparoscopic myomectomy even among those surgeons who have been unable to master laparoscopic knotting skills.

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SURGICAL TECHNIQUE

A Cost-effective Way of Performing Laparoscopic Radical Nephrectomy in a Remote Health Facility in Nepal

Aswini Kumar Misro, Prakash Sapkota, Radhika Misro

ABSTRACT

Laparoscopic radical nephrectomy (LRN) has been established as standard of care for T1 and T2 renal tumors. The aim of this article is to present our way of performing the surgery with an aim to reduce the overall cost of surgery.

Use of new improvised instruments makes surgery easy going. However, this additional comfort comes at a cost which is not always within the reach of common man. In order to give the advantage of minimal access surgery to patients coming to a remote health facility in the hilly areas of Nepal we adopt the following modifications describes in the article.

Keywords: Nephrectomy, Laparoscopy, Cancer, Kidney.

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INTRODUCTION

Laparoscopic radical nephrectomy (LRN) has been established as standard of care for T1 and T2 renal tumors.[1-3] The aim of this article is to present our way of performing the surgery with an aim to reduce the overall cost of surgery.

Use of new improvised laparoscopic instruments and accessories makes surgery easy going. However, this additional comfort comes at a cost which is not always within the reach of a common man. In order to give the advantage of minimal access surgery to patients coming to a remote health facility in the hilly areas of Nepal, we adopt the following modifications describes in the article.

PATIENT POSITION

Patient is placed in 45º lateral position with arms positioned appropriately. Kidney bridge is elevated with the table slightly flexed. Patient is securely strapped to the table. Pressure points including axilla, knees, elbows, and ankles should be padded to prevent neuromuscular injury. Urinary catheter and nasogastric tube is inserted. The sterile preparation and draping is done to whole of the abdomen in the front and back. The team position is shown in Figure 1 with surgeon standing on the contralateral side.

Peritoneal access is achieved by open technique through umbilical cicatrix . The 11 mm first port or optical port is inserted in the umbilicus followed by two 5 mm ports, in epigastric region and the other in anterior axillary line an inch below the costal margin. An 11 mm lateral port is introduced laterally (Fig. 2). One of the purposes of 11 mm in this area is to accommodate the 10 mm clip applicator for the renal pedicles. 10 mm 30º camera is preferable.

OPERATIVE STEPS

Ten steps of LRN:

1. The line of Toldt is incised by harmonic scalpel a centimeter away from the colon, starting from iliac vessel to the hepatic/splenic flexure in vertical dimension and from hepatic flexure till inferior venacava horizontally.
2. The posterior parietal peritonium is gently lifted off the Gerota's facsia by blunt dissection. Ascending colon, hepatic flexure and duodenum is gradually mobilzed till the anterior aspect of the venacava is visible.
3. Ureter and gonadal vessel identified at the pelvic brim. The area medial to the 2 structures cleared to identify the psoas muscle (Figs 3 for step 3 to 9).
4. The ureter is then traced upward and used as roadway to reach hilum. Once the hilum is reached the ureter should be divided keeping a long stalk to aid in retraction when necessary.

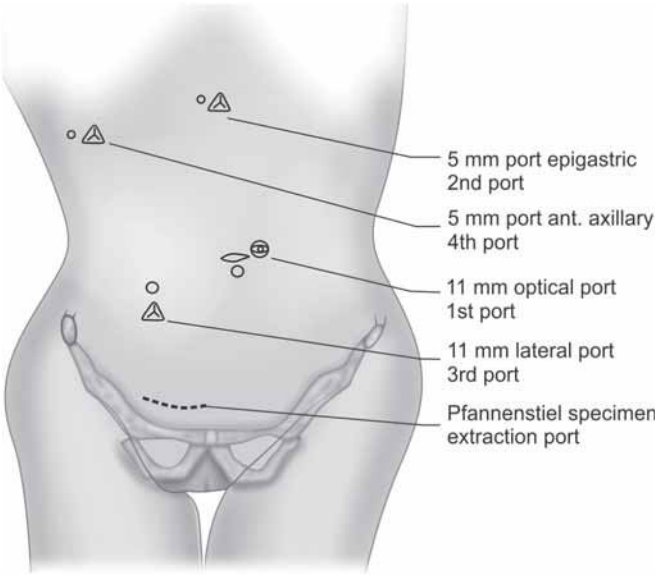

Fig. 1: Port positioning for a right sided nephrectomy

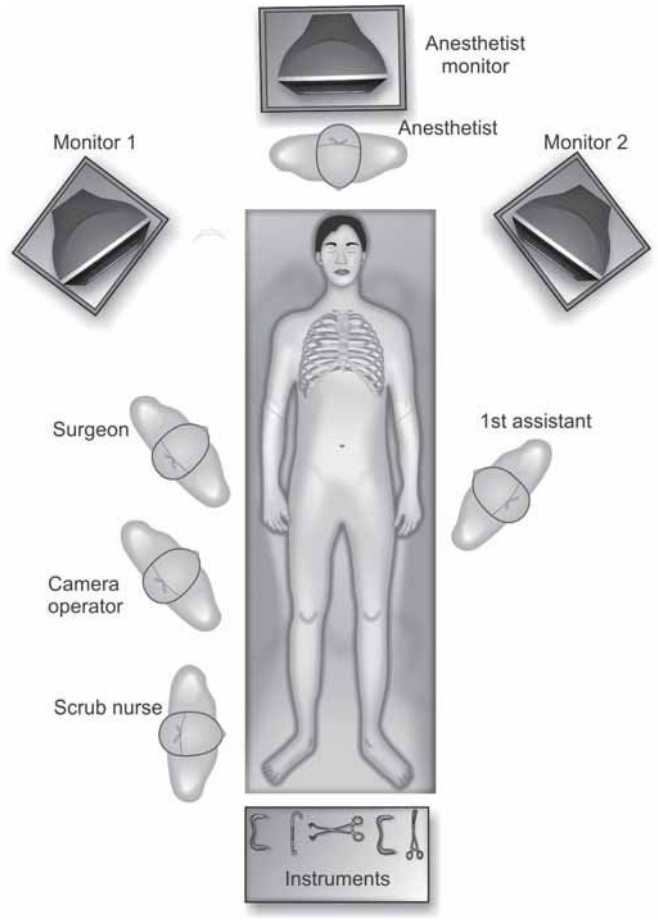

Fig. 2: Team position for a right sided nephrectomy

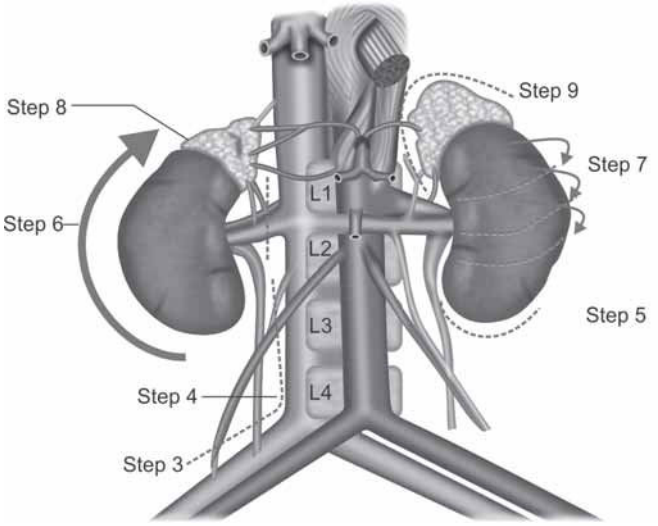

Fig. 3: Steps 3 to 9 of laparoscopic radical nephrectomy

5. Now is time for the posterior dissection. It is started with the lower pole mobilization followed by lateral border and upper pole.
6. With continued dissection, the kidney is flipped over in the anteromedial direction exposing the renal artery.
7. Renal artery is circumferentially mobilized. Two clips are applied to renal artery with a gap of 1 cm. In the mentioned gap a transfixation suture is applied to add to the security of the clips. I usually tie another suture distal to the previous one. This obviates the need for any vascular stapler and there by minimizes the cost of surgery.
8. Same steps are repeated for the renal vein.
9. On the right side, if adrenalectomy is to be performed, dissection is continued upward along the side of venacava till adrenal vein is encountered which is then divided between clips. Afterward the superior border is dissected from the surrounding structure with the help of harmonic scalpel. On the left side the adrenal vein is clipped and cut. Then the rest of the dissection is carried out similar to right side.
10. The specimen is now put inside a retrieval bag. Using a Pfennensteil incision the specimen is retrieved.

On the left side the Toldt line incision and dissection are far more extensive in comparison. The descending colon, pancreas and splenic flexure are mobilized medially severing the splenocolic, phernico-colic and splenorenal ligaments. The spleen is allowed to gravitate medially aiding in the exposure and mobilization.

Fig. 4: Postoperative wound appearance

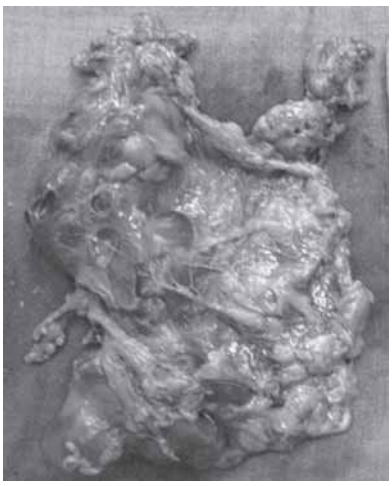

Fig. 5: Laparoscopic radical nephrectomy specimen

The specimen extraction is done with the help of a custom-made extraction bag tailored out of a urinary collection bag. A strong purse string is attached around the opening of the bag to aid in extraction. The extraction bag is introduced through the Pfannenstiel incision with the attached thread being securely caught outside the abdomen. A large wet mop is used on the incision to prevent air leak. Once the specimen is positioned in the bag, gentle traction is applied to the thread which brings the specimen to the extraction wound. Then the bag is then retrieved. The way of constructing the extraction bag is beyond the scope of this article. A drain is inserted if there is any concern about bleeding. Pneumoperitoneum is evacuated and the wounds are closed Figures 4 and 5.

The summary of this technique are:

1. Open technique of pneumoperitoneum even in obese patients.
2. No use of vascular stapler. Instead we would use laparoscopic intracorporeal knotting. A transfixation suture placed between 2 clips ensures complete vessel ligation without any compromise on pedicle security.
3. Use of Pfannenstiel incision of specimen retrieval avoiding any muscle cutting. This contributes to less postoperative pain, improved cosmesis, less chance of incisional hernia, enhanced recovery postoperatively and reduced analgesia requirement.
4. Custom home made extraction bag from urinary catheter bag. This adds to the cost cutting without increasing the complexity of specimen extraction.

POSTOPERATIVE CARE

Patient is allowed on fluid and diet as tolerated. Antibiotics are routinely prescribed. Patient is encouraged to mobilize and is discharged when improvement is satisfactory.

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CASE REPORT

CO_2 Inducer, Indicator ($EtCO_2$) and venting it, is the Healer of Subcutaneous Emphysema

Suman Gupta, Preeti Agrawal, Arunkumar Arumugam

ABSTRACT

Today, surgeons across the world have realized the benefits of laparoscopic approach, for short hospital stay, improved postoperative recovery times. Thus, laparoscopic surgeries are being used with greater frequency in health care system. However, laparoscopy is not without complications like, subcutaneous emphysema, pneumopericardium, pneumothorax, gas embolism, visceral injuries. Since, these complications remain a cause of concern, we need better trained anesthesiologist and laparoscopic surgeons. Regular assessment and monitoring should be done to recognize the complication as early as possible and prompt treatment for positive patient outcome.

Subcutaneous emphysema is defined as the presence of gas within the tissue, beneath the skin. Here, we describe a case report where the patient developed massive subcutaneous emphysema during laparoscopic ovarian cystectomy.

Keywords: Carbon dioxide, Hyperventilation, Laparoscopy, Subcutaneous emphysema, Ovarian cystectomy.

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INTRODUCTION

As budding surgeons are using laparoscopic approach for almost all surgeries with greater frequency, providing anesthesia for laparoscopic surgeries has become a new challenge for anesthesiologist. It has its own advantages and disadvantages. Laparoscopic surgery allows for smaller surgical incisions and minimal invasiveness, while still providing sufficient visualization of peritoneal cavity. Carbon dioxide (CO_2) has proven to be beneficial for insufflations because of its rapid diffusion ability, low cost and decrease flammability compared with alternative gases (air, helium, argon, and N_2O). However, insufflations can cause CO_2 diffusion into subcutaneous tissue to cause subcutaneous emphysema. The incidence of subcutaneous emphysema in laparoscopic surgery is 0.3 to 3%.[1] Various risk factors attributing to it are increased age, multiple surgical ports, high insufflations pressures and prolonged surgical time.[2] Recently, the influence of insufflations pressures and surgical duration has been demonstrated to have the most important impact on the rate of CO_2 absorption.[2]

Laparoscopic approaches in gynecologic procedure are being used since 1937.[3] Here, we report a case where massive subcutaneous emphysema developed in a patient undergoing laparoscopic ovarian cystectomy.

CASE REPORT

A 25-year-old 45 kg woman of American Society of Anesthesiologist (ASA) physical status II was scheduled to undergo a laparoscopic ovarian cystectomy. She had no previous illness. Preoperative laboratory investigations were within normal limits. She was shifted to the operation room (OR) and all standard monitor were applied [noninvasive blood pressure (NIBP), pulse oximetry, electrocardiogram]. Anesthesia was induced uneventfully with sodium thiopentone 5 mg/kg (2.5%), succinylcholine 1.5 mg/kg, fentanyl 2 μg/kg BW intravenously, O_2:N_2O 50% each and 0.5% halothane. Trachea was intubated with Portex 7.5 mm cuffed endotracheal tube and confirmed by bilateral equal breath sounds and capnography showing end tidal carbon dioxide ($EtCO_2$). Neuromuscular blockade was achieved by nondepolarizing muscle relaxant injection atracurium. Adequate minute ventilation was delivered with tidal volume of 8 ml/kg BW and respiratory rate of 14/min. A nasogastric tube was placed after induction of general anesthesia. The Veress needle and trocar were inserted into the peritoneal cavity without difficulty. Patient's hemodynamics was stable initially during the procedure with an $EtCO_2$ of 30 mm Hg. After 15 minutes of CO_2 insufflation there was a steady rise of $EtCO_2$ from 30 to 78 mm Hg, with peak airway pressure rising to 40 mm Hg. The insufflation pressure was reduced from 23 to 12 mm Hg. Hyperventilation was instituted, even then there was no fall in $EtCO_2$. We took the patient on manual ventilation and noticed resistance in the bag and were unable to ventilate the patient despite adequate depth of anesthesia. Patient heart rate rose to 130/min and NIBP to 160/100 mm Hg. While auscultating for the air entry we undraped the patient, which unveiled swelling of face, edematous eyes and crepitus all over the chest, both arms and abdomen as the patient had developed subcutaneous emphysema. Complication was notified to the surgeon and laparoscopic check was made for any rent in

diaphragm which was found intact, the laparoscopic approach was abandoned and converted to conventional incision, which vented out the accumulated CO_2 rapidly. N_2O was stopped and was ventilated with 100% O_2. Arterial blood gas analysis showed pH: 7.26, PCO_2: 90 mm Hg, PO_2: 80 mm Hg, HCO_3: 18 mmol/l. Vitals were monitored. Injection mannitol 0.5 gm/kg IV was given in view of suspecting raised intracranial pressure (ICP) because of hypercarbia. After 15 to 20 minutes the subcutaneous emphysema started subsiding with $EtCO_2$ approaching to near normal level. At the end of surgery, patient was reversed for the residual neuromuscular blockade with injection neostigmine 0.05 mg/kg and glycopyrrolate injection 0.01 mg/kg. Trachea was extubated after the patient was fully awake and maintaining 100% saturation. Patient was shifted to postoperative ward and the postoperative stay of the patient was uneventful.

DISCUSSION

With developing technology, laparoscopic procedures are being frequently used worldwide, because of its minimal invasive nature of surgery, cosmetically better scar, early postoperative recovery. Laparoscopic procedures have a positive overall economic benefit due to the shorter hospital stays necessary for patients, compared with those undergoing open procedures.[4] In spite of all advantages laparoscopic procedures are not without complications. The potential complications include subcutaneous emphysema, pneumopericardium, pneumothorax, gas embolism, visceral injuries.[2] Most commonly used among the gases for insufflation is CO_2, as it is readily available, low cost, a high Ostwald's B/G partition coefficient (0.48), and odourless, inert, nonflammable, rapidly buffered in the body by bicarbonate and excreted via lungs. But this aberrant diffusible property of CO_2 is responsible for various complications. At rest, body cells consume 200 ml/min of O_2 and produce same amount of CO_2.[5] During insufflations as much as 120 L can accumulate in the body during pneumoperitoneum.[1]

Subcutaneous emphysema is an uncommon complication during laparoscopic procedure. It occurs when the insufflations pressure is greater than 12 mm Hg or because of leakage of CO_2 through the trocar site as they pass through the skin and muscle. In our case, the insufflation pressure was found to be 23 mm Hg at the time of diagnosing subcutaneous emphysema. Singh et al demonstrated subcutaneous emphysema to be more common during extraperitoneal *vs* intraperitoneal laparoscopic procedure due to the large CO_2 absorption surface area provided by the large extraperitoneal space.[2]

Reference is made to 4-point scale comparing varying degrees of subcutaneous emphysema.[6]

- 0 = no subcutaneous emphysema
- 1 = mild emphysema with crepitus at trocar insertion sites or in the groin
- 2 = marked emphysema with crepitus extending to the abdomen and thighs
- 3 = massive emphysema extending to the chest or neck and face.

Our patient developed massive subcutaneous emphysema extending to chest, neck and face, resulting in difficulty in ventilating the patient.

Acute rise in $EtCO_2$ and peak airway pressure was the first indicator which signalled the occurrence of subcutaneous emphysema. The resulting hypercarbia increases the cardiac output, arterial blood pressure, ICP and respiratory acidosis.

The management of subcutaneous emphysema during laparoscopic procedure include hyperventilation, abandoning the laparoscopic procedure, discontinuation of N_2O, monitoring the vitals. Certain anesthetic recommendation for the management of patient undergoing laparoscopic procedure has been described.[7]

1. Monitoring of CO_2 insufflation pressure (<12 mm Hg).
2. Routine and frequent examination and palpation of abdominal and chest wall to detect subcutaneous gas accumulation.
3. Use of N_2O with caution.
4. Adjusting the ventilation to an acceptable $EtCO_2$.
5. Ruling out all other causes of subcutaneous emphysema and acute hypercarbia.

CONCLUSION

Laparoscopic surgery represents a new challenge to the anesthesiologist. A thorough concept of pathophysiological changes during laparoscopy, strict monitoring and prompt diagnosis and treatment of complications can result in positive patient outcome.

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Editorial

Hello Friends!

Minimal Access Surgical technology has enabled surgeons to perform disfiguring surgical procedures with few complications, faster recovery time, and only minute scars. Once the da Vinci Robotic Surgery came into market, it was looking like it will replace the laparoscopic surgery in future. US regulators began surveying robotic surgeons recent years about the da Vinci robots and they found a sharp increase in reports of adverse events, including 70 deaths since 2009. Many surgeons, in addition, question the benefits of the da Vinci because randomized trials have shown, it does not cut complications during hysterectomies compared with less-invasive surgical measures.

The da Vinci system is utilized in two thousand hospitals in United States of America, but many lawsuits has been filed. One of the lawsuits against Intuitive indicated surgeons were hastily trained to use the robotic surgical system by the company in order to move more products out the door faster. Intuitive surgical is saying that pressure to cut hospital costs, coupled with slower growth in the health cost procedures using robot surgery are to blame for the decline in use of da Vinci Robot. In my opinion da Vinci Robots are physically incapable of empathy or a warm touch that has always been an integral part of laparoscopic surgical undertakings.

I started doing da Vinci surgery at World Laparoscopy Hospital from 2010 but even in my opinion the new hospital should not be in hurry to buy da Vinci Robot and invest huge amount of money. Though specific minimal access surgical procedures are undeniably more efficient, faster, and less invasive or risky when utilizing the da Vinci, but few in-depth study have been documented. Statistical data comparing traditional laparoscopic surgical methods and da Vinci methods has shown that utilizing robots in the operating room only confers certain procedures an overall advantage.

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