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Editorial

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The COVID-19 pandemic impacts us all. As a result, many researchers will have difficulty meeting the timelines associated with our peer review process during standard times.

In this issue of WJOLS, we have many exciting articles which you will like. There is an interesting article on day care laparoscopic cholecystectomy (LC). Day care LC is feasible, safe, and equally effective if performed in a selected group of patients after establishing strict patient selection criteria. High-risk patients present a challenge to safe surgical practice in a day care, particularly during the early postoperative period. Criteria for patient selection are crucial for the development of safe day care surgery.

There is an original article in this issue on laparoscopic vs. open drainage of complex pyogenic liver abscess. Conventional open liver abscess drainage has some advantages over laparoscopic drainage in operation time, postoperative recovery, and length of hospital stay.

Treatment of diaphragmatic hernia can be performed by laparotomy or thoracotomy or both. Riolfi performed the first successful repair of diaphragmatic hernia in 1886. In this issue, there is a case report on laparoscopic diaphragmatic repair.

Laparoscopic surgery during a pandemic comes with multiple threats for the surgical team. When used during laparoscopic procedures, it will effectively and efficiently remove smoke from the peritoneal cavity. So, the surgeon can have enhanced visualization of the surgical site safety from COVID-19 and improved air quality in the.

Therefore, I request the whole surgical team should wear personal protection equipment including:

- Use of laparoscopic smoke evacuation system
- Medical protective mask (N95)
- Surgical shield uniform
- Disposable medical protective uniform
- Full-face respiratory protective devices, and
- Powered air-purifying respirator

At last, I would like to say that you take time for yourself during this pandemic, slow down and breathe in the freshness. Find moments that belong only to you and may your spirit savor them. Be blessed with all that makes you happy and healthy today and every day!

RK Mishra
Editor-in-Chief
Chairman
World Laparoscopy Hospital
Gurugram, Haryana, India

ORIGINAL ARTICLE

Role of Indocyanine Green in Laparoscopic Cholecystectomy

George C Obonna[1], Martin C Obonna[2], Rajneesh K Mishra[3]

Abstract

Background: The most feared complication during laparoscopic cholecystectomy (LC) is bile duct injury. Real-time intraoperative imaging using indocyanine green (ICG) reduces the risk of bile duct injury by improving visualization of the biliary tree during laparoscopy. This effect will also shorten operative time and hence reduce the dangers of prolonged operation time. It also subserves the diagnostic value in its use in the liver function test.

Aim: This study was aimed to elucidate the role of ICG as an investigative tool that aids the operative procedure of laparoscopic cholecystectomy.

Materials and methods: The analysis of case series of ICG laparoscopic cholecystectomy in our hospital—the World Laparoscopic Hospital, Gurgaon, India.

Results: In all the cases, fluorescent cholangiography using intravenous injection of ICG has become the optimal tool to confirm the biliary tract anatomy during LC because it has potential advantages over radiographic cholangiography in that it does not require irradiation or dissection of the triangle of Calot. This early visualization of the cystic duct and additional imaging of the common bile duct (CBD) may increase safety in LC and offers an alternative to the intraoperative cholangiogram in patients with increased risk of CBD injury.

Conclusion: Laparoscopic cholecystectomy with real-time ICG fluorescence cholangiography enables a better visualization and identification of the biliary tree and therefore should be considered as a means of increasing the safety of LC.

Keywords: Acute cholecystitis, Indocyanine green cholangiography, Laparoscopic cholecystectomy.

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Introduction

Laparoscopic cholecystectomy (LC) is the gold standard in the removal of the diseased gallbladder. Bile duct injury is rare with an incidence of 0.3–0.7%,[1] but it can lead to serious consequences. Surgery for gallbladder disease tends to be difficult for even experienced doctors and has a high risk of complications.

Intraoperative fluorescent imaging with indocyanine green (ICG) has been employed for confirming the potency of vascular reconstruction surgery, liver transplantation,[2] anastomosis of the gastrointestinal tract (GIT),[3] brain aneurysms,[4] identification of sentinel lymph mode navigation,[5] and hepatocellular carcinoma detection.[6] Recently, an intraoperative cholangiography technique in LC involving the excretion of fluorescent ICG in the bile after intravenous injection has been used to determine the bile duct anatomy.[7–9]

Currently, some detailed reports[10,11] have been published on LC using intraoperative ICG cholangiography and suggested its safety and feasibility. In this study, we evaluated the process of intraoperative ICG cholangiography including LC for gallbladder disease.

Indocyanine green is a medical dye that subserves wide application especially in its use in biliary surgery. Its fluorescent properties under near-infrared light have been used in the intraoperative characterization of the biliary tree to ensure safe surgery during LC. It is a tricarbocyanine dye having a molecular weight of 751 Da.

Materials and Methods

Based on the procedures of ICG, LC was performed at the World Laparoscopy Hospital, India.

Results

Results show that there was positive and successful intraoperative identification of the extrahepatic bile ducts. This reduced the likelihood of causing an injury to the bile ducts. This is, however, unlike the conventional imaging, whose results are usually not very successful. It has been noted that the intraoperative misidentification of the bile ducts anatomy is usually the main cause of bile duct injury.

Discussion

Indocyanine green is also known as the florescent dye. This dye has been used since 1956. Aurogreen trade mark is injected intravenously 45 minutes before surgery. It is actually the one that helps light the path for better and real-time identification of the biliary anatomy during LC. There is a florescent imaging system that is usually used together with a laparoscope. The system must have a lightning system that provides light for both infrared and xenon rays. Figure 1 shows the package of ICG. Figure 2 demonstrated

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Fig. 1: Showing a preparation of indocyanine green

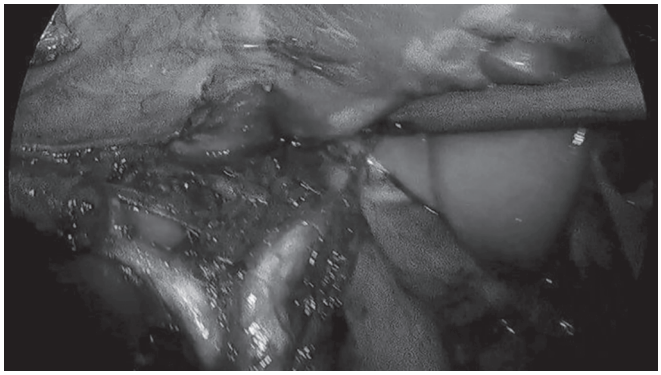

Fig 3: Fluorescent mapping showing cystic, right and left hepatic duct

the highlight near infrared cholangiography and also as shown in Figure 3 is the road map of enhanced fluorescent imaging at LC.

Indocyanine green acts as an imaging agent, which is sterile, water soluble, and has a peak spectral absorption averaging at 805 nm in blood pressure or simply the blood.

It does not undergo enterohepatic recirculation. It only stays in the bile for about 8 minutes after injection. The removal of ICG depends on several factors, including the blood flow of the liver, biliary excretion, and parenchymal cellular function. It is contraindicated in those having iodine toxicity. Sometimes, florescence may not be detected 45 minutes after the injection of ICG. Therefore, when this happens, the second dose of 2.5 µg of ICG can be administered. Also a second injection of ICG can be given if there is anything regarding perfusion that cannot be clearly understood during the surgery. Apart from its role to analyze the extrahepatic biliary anatomy better, thus reducing the incidence of bile duct injury, it also plays a role in identifying the anatomic structure in a quick manner, thereby reducing the time used in performing the procedure of cholangiography and hence also shortening the entire duration of surgery.

There is also no need to bring onboard additional equipment and manpower, especially the radiological personnel for an X-ray.

The technique of ICG also plays a role as a teaching tool for practitioners who are able to identify the relevant extrahepatic

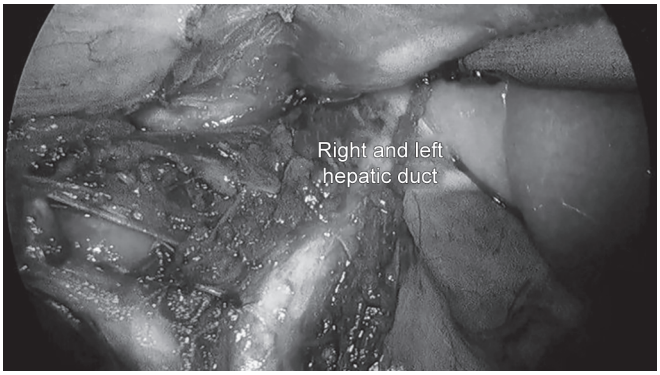

Fig. 2: Fluorescent mapping showing common bile duct and cystic duct

structures in almost every patient. This makes them experienced with the procedure that makes it easier for them to perform future procedure.

It does not require X-ray, thus no one is exposed to radiation. The ICG that is used is usually safe and does not cause any adverse reaction in patients. It is also cost-effective.

Conclusion

Real-time near-infrared fluorescence cholangiography offers better technology that can help with the identification of the vital biliary anatomy.

It helps to reduce the risk of bile duct injury by providing clear vision of the vital extrahepatic structure. The reduced risk helps to avoid complications that can arise from the injury of the bile duct, which sometimes can be fatal to a patient.

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ORIGINAL ARTICLE

Laparoscopic Cholecystectomy and Common Bile Duct Exploration Using Choledochotomy and Primary Closure Following Failed Endoscopic Retrograde Cholangiopancreatography: A Multicentric Comparative Study Using Three-port vs Multiport

Mauricio Pedraza-Ciro[1], Luis F Cabrera[2], Daniel A Gomez[3], Andres C Mendoza-Zuchini[4], Jean A Pulido[5], Maria C Jiménez[6], Ricardo A Villarreal[7], Sebastian Sanchez-Ussa[8]

Abstract

Background: Laparoscopic surgery has changed many ways in which we as surgeons manage patients, offering better results, quicker recovery, and fewer complications using minimally invasive techniques, especially in common bile duct (CBD) surgery. Not only can laparoscopic techniques be applied to programed surgery but also emergencies and those following failed endoscopic retrograde cholangiopancreatography (ERCP).

Objectives and aims: Describe and compare clinical and surgical results of the laparoscopic CBD exploration with primary closure using a 3-port vs multiport approach.

Materials and methods: We present a multicentric comparative study of 197 consecutive patients who underwent a laparoscopic gallbladder removal along with CBD exploration with primary closure following failed (ERCP to extract CBD stones; 104 patients were managed by three-port vs 93 multiport laparoscopic surgery in five centers of Bogotá, Colombia, between 2013 and 2017 with follow-up of 1 year.

Results: A total of 197 patients were taken to laparoscopic gallbladder removal along with CBD exploration with primary closure, 104 patients via three-port technique and 93 patients via multiport. All (100%) the patients had previously failed ERCP. The average surgical time on the three-port approach was 106 minutes vs 123 minutes on multiport. Only in the multiport technique we had an average conversion of 2%. Mean hospital stay of 2.5 days, less for the three-port approach vs multiport in 5–7 days. There was a need of reintervention in 1% of the patients who underwent three-port exploration.

Conclusion: Postoperative pain, use of an additional port, complication rates, operation time, and cost of the three-port technique were similar to those of the conventional approach. Large randomized controlled trials are needed to examine the true benefits of the three-port technique.

Keywords: Common bile duct stones, Laparoscopic cholecystectomy, Laparoscopic common bile duct exploration.

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Introduction

Laparoscopic cholecystectomy (LC) is seen as a gateway to minimally invasive surgery since the first operation was performed in 1987 and reported in 1996.[1] After this stimulating event, various modifications of LC have been developed year by year, including three-port, two-port, and single-port LC.[2] In the era of laparoscopic surgery, the treatment of benign common bile duct (CBD) diseases remains a topic of interest due to its surgical complexity.[3–5] Most CBD interventions are done with open surgery or endoscopically secondary to gallstone obstruction. With advances in surgical technique and instrumentation, CBD exploration using laparoscopy has emerged as an attractive alternative offering a safe and cost-effective option for CBD surgery[6–9] even in the emergency setting and following failed endoscopic treatment.[10,11] This series describes this three-port surgical technique for CBD exploration and primary closure as an alternative to conventional laparoscopy techniques for this surgery.

Materials and Methods

We performed a multicentric retrospective, descriptive, and comparative study of laparoscopic common bile duct exploration

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(LCBDE) by choledochotomy and primary duct closure using the three-port technique vs the conventional laparoscopic approach (CLA) between January 2013 and December 2017 in five centers of Bogota, Colombia. There were 197 consecutive patients with failed endoscopic retrograde cholangiopancreatography (ERCP) in gallbladder and CBD stones. The choice of the use of three ports or the conventional technique was decided by the surgeon based on their expertise, skills, and intraoperative findings. Data from 104 patients with failed ERCP who underwent novel three-port approach were compared with 93 patients of the conventional multiport laparoscopic approach. The evaluated variables were demographic, clinical, intraoperative, and postoperative outcomes (Table 1).

Data were retrospectively collected and entered in the Excel database. These included demographic information, patient medical history (with particular attention to any biliary pathology), symptoms and form of presentation, age, sex, obstructive jaundice, American Society of Anesthesiologists (ASA) physical status classification system (ASAPS), surgery time, bleeding, bile leaks, complications, number of CBD stones removed, use of the T tube, conversion rates to laparotomy, oral feeding time, intensive care unit (ICU) admission, hospital stay time, the need for reintervention, postoperative strictures, stone recurrence, and mortality.

Follow-up data included hospital readmissions, diagnosis of residual stones, or new CBD procedures. Patient follow-up was carried out in the outpatient clinic for the first year, after which all data available in the patient medical records were reviewed; visits to the emergency or gastroenterology departments or any procedure for biliary disorders were investigated.

All patients had preoperative hepatobiliary ultrasound as first diagnosis image, then underwent to magnetic resonance cholangiopancreatography (MRCP) to confirm the diagnosis; Patients who had a CBD stone confirmation and failed ERCP were deemed candidates for a surgical CBD stone removal.

Patient consent for laparoscopic surgery and research was obtained before the procedure was started. The study protocol was approved by our institution's ethics committee. The protocol was implemented in accordance with provisions of the Declaration of Helsinki and Good Clinical Practice guidelines. Two of the surgical centers, where the three-port technique was used, had hepatobiliary surgeons with more than 5-year experience on laparoscopic surgery; in the other three centers, the management was performed by laparoscopic general surgeons. This material was presented at SAGES meeting, Baltimore, 2019 (Abstract id 94039).

Table 1: Comparative sociodemographic variables, between three-port and conventional laparoscopic approach (CLA)

Variables	*Three-port (n = 104)*	*CLA = 93*
Sociodemographic characteristics		
Age (years) (min–max)	47 (47–91)	52 (52–59)
Sex		
Male (%)	72	66
Female (%)	28	34
Patients with comorbidities (%)	32	27
Obese patients (*n*)		
BMI > 30	17	6
ASAPS		
I (%)	35	59
II (%)	48	31
III (%)	17	10
Obstructive jaundice (%)	86	98
Bile duct caliber (mm)	11 (10–13)	13 (10–15)

Indications

Inclusion Criteria

Our series involves patients over 18 years of age with CBD stones taken to cholecystectomy, choledochotomy, and CBD primary closure by the laparoscopic technique following failed ERCP.

Exclusion Criteria

Patients with CBD diameter <6 mm, acute cholangitis, severe acute biliary pancreatitis, previous history of cholecystectomy, CBD malignancy, severe adhesive bowel syndrome due to prior open procedures, and those unwilling or unfit to undergo laparoscopic surgery were excluded.

Surgical Technique

Patient Preparation

All the patients were prepared for LC and CBD exploration using choledochotomy and primary closure just as they would be for an open operation. Patients and their families were informed of the surgical risks, the possible need for additional trocars, conversion to open surgery, and mortality.

Equipment and Room Set-up

Under general anesthesia, the patient was placed in the supine position with both arms tucked along their sides and pneumatic stocking, also with the legs spread wide open. The patients were securely strapped to the surgical bed to facilitate maximum tilting and lateral rotation of the surgical table. All patients received prophylactic antibiotics according to the latest clinical practice WHO guidelines for prevention of surgical site infection (SSI). All of the procedures were performed in the French position, the first surgical assistant stood at the surgeon's right and the second assistant to the left. The scrub nurse stood to the right of the first surgical assistant.

Laparoscopic Cholecystectomy and CBD Exploration Using Choledochotomy and Primary Closure by Three-port Technique

Under general anesthesia, an open Hasson's technique was made for the placement of a 12-mm umbilical port and creation of pneumoperitoneum applying a 14 mm Hg intra-abdominal pressure to allow the insertion of a 30° laparoscope. Two additional ports were placed under direct vision, a 5-mm port in the right flank and a 12-mm port in the left paramedial area (Fig. 1).

Using a single Prolene 2-0 (Ethicon, Inc., Cincinnati, OH, USA) suture, the gallbladder was elevated from the fundus and held against the abdominal wall in the right upper quadrant in order to expose Calot's triangle (Fig. 2). Using a laparoscopic dissector and hook, the triangle of Calot was dissected revealing the critical view. Once the porta hepatis and the inferior hepatic surface were exposed, dissection of the common hepatic and CBD was performed taking care not to devascularize the CBD.

A vertical anterior 10–20 mm choledochotomy was performed. The CBD stones were directly extracted using a laparoscopic dissector followed by proximal and distal bile duct lavage with a Nelaton tube size 16–20 fr. and 20–50 cc of normal saline solution until clear fluid returned (Fig. 3). The last step of the proximal and

distal CBD exploration was done using a Fogarty catheter size 6–8 fr. (Figs 4 and 5).

Primary CBD closure was done using laparoscopic simple interrupted PDS 4-0 (Ethicon, Inc., Cincinnati, OH, USA) sutures. Intraoperative cholangiography through the cystic duct stump was performed to evaluate residual CBD stones (Fig. 6).

The gallbladder portion of the surgery was completed by clipping the cystic artery and duct using titanium clips—3× total clips for each structure. Laparoscopic cholecystectomy was performed using a cystic-fundus technique with a hook. The fundus-abdominal wall suture is cut and using an endo-catch the gallbladder was extracted through the left paramedial port site. The abdominal cavity was drained and checked for bleeding; an active peritoneal drain was placed in the CBD zone. Trocars were extracted under direct vision, pneumoperitoneum was evacuated, and the abdominal wall was closed using simple interrupted PDS 0 (Ethicon, Inc., Cincinnati, OH, USA) sutures and the skin was sutured using Prolene 3-0 (Ethicon, Inc., Cincinnati, OH, USA).

Postoperative Care

The patient ambulated the same day of the procedure and tolerated oral food intake. The abdominal drain was removed at postoperative day 2, and the patient was discharged during the following day among their hemodynamic status improve.

Discharge and Follow-up

Patients were discharged once the peritoneal drain was removed. Follow-up assessment using ultrasound and the liver function test was carried out for 3–24 months after discharge in the outpatient clinic if the patient had jaundice or abdominal pain. If either studies revealed abnormalities for possible residual stones, MRCP or ERCP was carried out to investigate further biliary compromise.

Statistical Analysis

The analysis of data was performed using Microsoft Excel databases and analyzed using the SPSS1 (Statistical Package for the Social Sciences) 22.0 version. Variables continuous were treated by means (range). Variables were summarized using median, minimum, maximum values, and percentages.

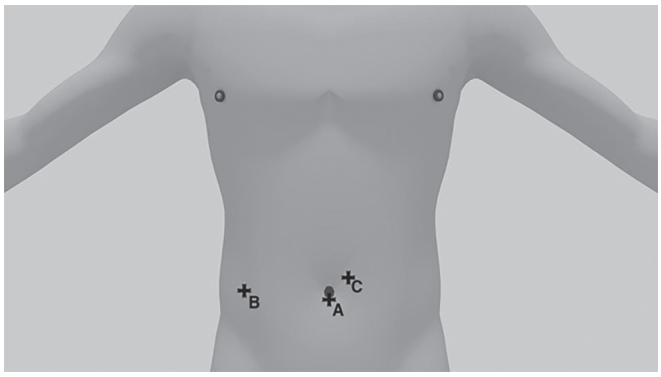

Fig. 1: Trocars position

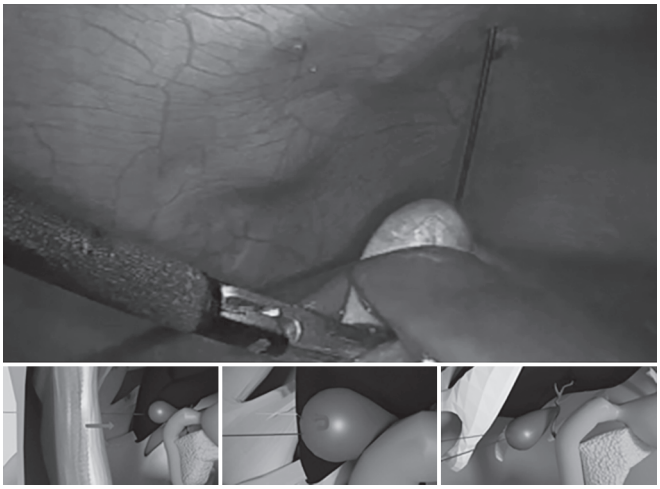

Fig. 2: Gallbladder suspension for exposed Calot's triangle

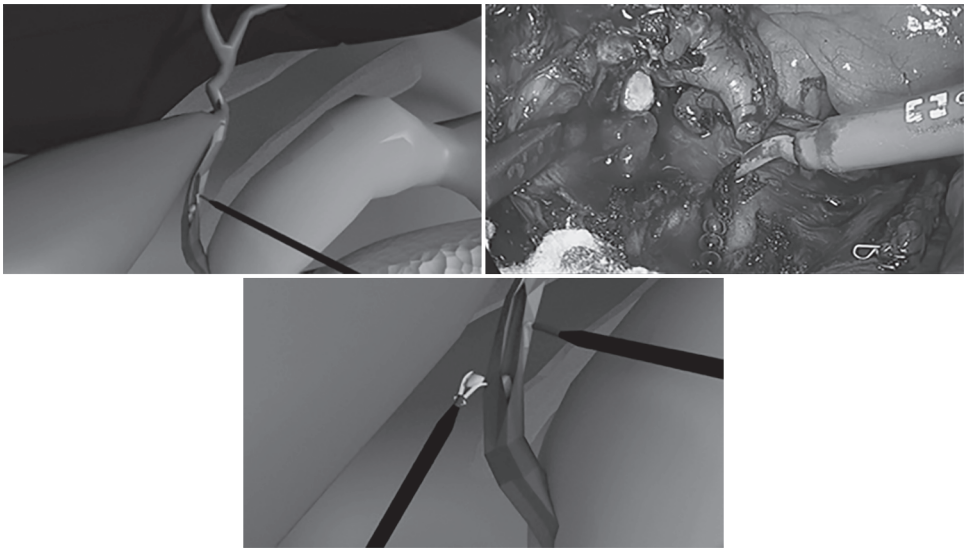

Fig. 3: Choledochotomy

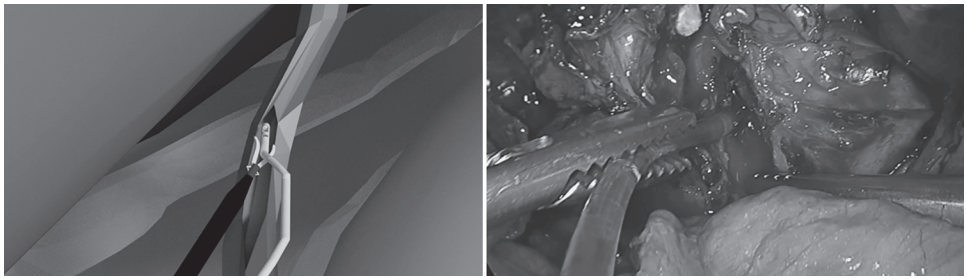

Fig. 4: Distal bile duct lavage with a Nelaton tube

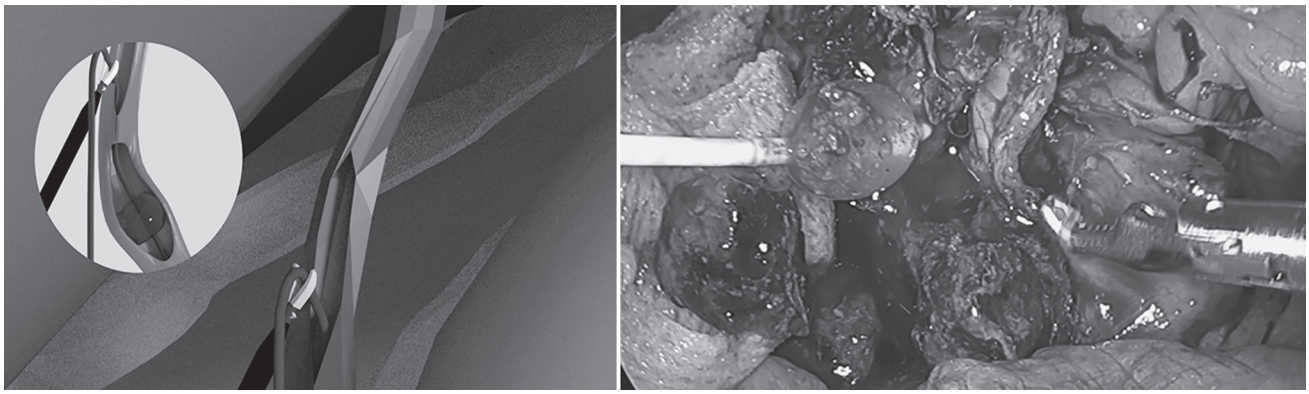

Fig. 5: The common bile duct exploration using a Fogarty catheter

Results

Patient Characteristics

There were 104 patients taken to three-port vs 93 CLA who underwent to CBD exploration with primary closure and cholecystectomy following failed ERCP for CBD stones. The distribution of the matching variables in two groups is shown in Table 1.

Previous abdominal surgery history was obtained in patients in both groups. The majority of operations were Caesarean section. Gynecologic operations (hysterectomy, myomectomy, and oophorectomy) and appendectomies followed in the descending order. No upper abdominal operations were seen in both groups.

After all the data were collected, we compared operation time, conversion rates, length of hospital stay, and postoperative complications between two groups. Difference of postoperative results between two groups was shown in Table 2.

There were no preoperative conversion to open surgery in both groups and no laparoscopic salvage (conversion to four-port or more) needed.

Outcome Definitions and Follow-up

Operative time was defined as the interval between the initial skin incision and skin closure. Postoperative hospital stay was defined as the number of days spent in the hospital postoperatively. In-hospital mortality and morbidity were defined as the number of deaths or complications that occurred in hospital. About 2% of patients had postoperative bile leaks treated with ERCP and plastic stent. About 1% of patients had a recidivated CBD stone at 24 months following the procedure and were taken to a new CBD exploration using conventional laparoscopy. There were no mortalities, hospital stay averaged 3 days, and 2% patients required ICU admission for 2–3 days; as a result of the decompensation of their comorbidities, the follow-up time was in a range of 6 months to 5 years and no late complications were documented as stricture (Table 3).

Discussion

To our knowledge, this is the first comparative series of patients taken to a three-port laparoscopic vs multiport CBD exploration, primary closure, and cholecystectomy for CBD stones following failed ERCP. Our goal was to perform a single intervention with less trauma to patients with similar results to traditional laparoscopic approaches reported in the literature avoiding two separate interventions increasing risks to patients.[12–14] The ERCP still offers the best initial approach to CBD stone treatment; however, in cases when extraction is not possible, a single intervention in expert hands may decrease risks and hospital stay to patients.[4] When deemed necessary, a hepatobiliary resonance image was ordered. This series shows a success rate above 99.04%, above those reported by Gigot et al. (74%), one of the first series of laparoscopic CBD surgery.[15] Recent reports show similar success rates such as Salama et al. (95%), highlighting the safety of advanced laparoscopic app roaches.[9,10,16–18]

Our mean CBD diameter was 11 mm, comparable to a study by Chander et al.[19] where the average diameter was 11.7 mm and Topal et al.[18] where the average diameter was 11.5 mm, but Wani et al.[20] and Khan et al.[21] studies showed the mean CBD diameter of 15 mm. Conversion was not needed, similar to no conversions in Bandyopadhyay et al.[22] study to 4% in others.[23,24] The reasons for conversion in their studies were learning curve, dense adhesions, bleeding, technical difficulties, impacted stones, and so on. We started feeding like the study by Bandyopadhyay et al.[22] were started orally on the day of surgery and were ambulatory next day with a mean hospital stay similar of 6.76 $\pm$ 1.33 days ranging from 5 to 11 days.

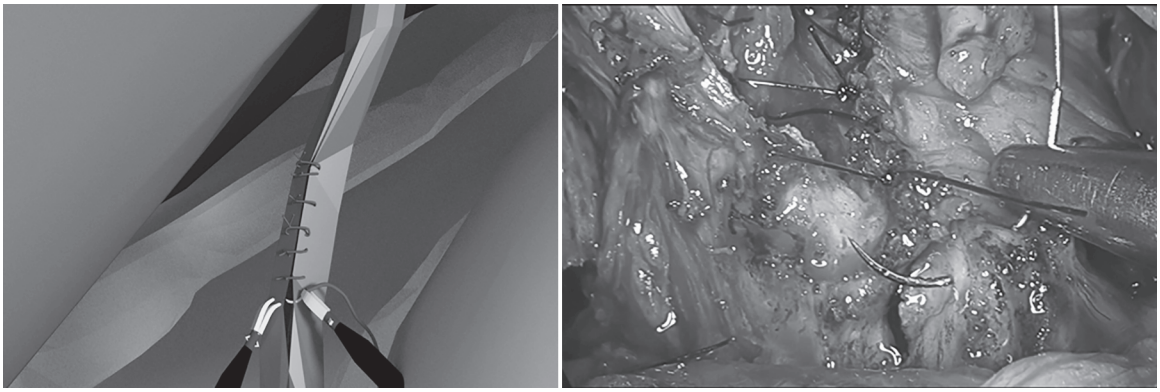

Fig. 6: Primary closure of common bile duct

Table 2: Comparative surgical characteristics, between three-port and conventional laparoscopic approach (CLA)

Surgical characteristics		
Variables	*Three-port (n = 104)*	*CLA = 93*
Surgical time (minutes)	106 (100–130)	123 (115–142)
Number of CBD stones removed	2.8 (2–4)	3 (2–5)
Operative bleeding (mL)	50	50
Conversion to open procedure (%)	0	2

Table 3: Comparative outcomes and complications, between three-port vs conventional laparoscopic approach (CLA)

Variables	*Three-port, n = 104*	*CLA = 93*
Outcomes and complications		
T tube (%)	0	0
Reintervention (%)	0	0
SSI (%)		
Superficial SSI	0	1.5
Bile leak (*n*)	1	3
Need for CBD reexploration (*n*)	1	0
Non per os (days)	1	1
ICU (days)	1–2	1–2
Hospital stay (days)	2–5	5–7
Mortality	0	0
Postoperative strictures	0	0
Stone recurrence (%)	2	2
Maximum follow-up (year)	1	1

SSI, surgical site infection; CBD, common bile duct

Among novelties in this series, we highlight the use of a single procedure to explore the CBD, primary closure avoiding the traditional use of a T tube and cholecystectomy with a three-port technique with similar results to traditional laparoscopic techniques without any variations in intraoperative bleeding or complications. Podda and colleagues reported a meta-analysis including 1,770 patients describing the advantages and superiority of primary CBD closure vs T tube[25,26] and other authors like Platt et al. reported no differences using a laparoscopic approach in elderly patients in comparison to younger patients following choledochotomy and primary closure like in our study.[27] Additionally, a single surgery offers clear advantages to patients allowing for a quicker return to daily activities, fewer days in the hospital, less costs, and fewer complications.[28] Bile duct leak remains a significant topic and although surgeon experience and CBD diameter directly influence this risk, age is not a risk factor and, in our series, just one patient presented bile leak similar to Zhou et al.[29]

Another advantage of laparoscopic CBD exploration is the preservation of the Oddi´sphincter and avoiding complications secondary to endoscopic manipulation such as stenosis and future stone formation.[25] Although there are no significant differences using a three-port approach vs traditional laparoscopy for this procedure, it seems to be a safe and effective method with similar results and less trauma to patients and esthetically superior. It is important to highlight that adding another port or converting to open surgery should not be considered a surgical failure.[30–32] Success rates with three-port LC reaches 90% in most series; in this series success rate was 100%, allowing a more rapid return to daily activities averaging 1–2 days or fewer days in the hospital.[33] This single three-port laparoscopic approach shows results similar to those involving traditional ERCP followed by laparoscopic gallbladder removal done using two separate procedures. The choice of approach depends on patient status, surgeon experience, and equipment availability.[34,35]

Limitations

The main limitation of this study is that it is an observational retrospective study without randomization.

Conclusion

A laparoscopic three-port approach to LCBDE surgery is a high complex minimally invasive surgery that in expert hands can be a safe and cost-effective alternative for CBD stones; nevertheless, a conventional approach seems to have same results. Both types of approach could be "reproducible" and depends on the ergonomic and decision of the surgeons, their expertise, skills, and intraoperative findings. Success rates match those of endoscopy, other laparoscopic techniques, and open surgery with less trauma to the patient and fewer complications.

Compliance with Ethics Guidelines

Daniel Gomez, Luis F Cabrera, Ricardo Villarreal, Mauricio Pedraza, Jean Pulido, Sebastián Sánchez, Cristina Jimenez, and Andres Mendoza have no conflicts of interest or financial ties to disclose.

This article has the ethical approval by all the institutional review boards and ethics committees.

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ORIGINAL ARTICLE

Laparoscopic vs Open Drainage of Complex Pyogenic Liver Abscess

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Abstract

Complex pyogenic liver abscess (CPLA) is a rare fatal disease if untreated. Complex pyogenic liver abscess is a multilocular abscess more than 5 cm in diameter. Pyogenic liver abscess (PLA) is mainly treated by percutaneous aspiration or drainage under antibiotic cover. Surgical drainage is indicated if interventional radiology fails, if ruptured, or if associated with biliary or intra-abdominal pathology. Laparoscopic drainage is a promising management option.

Aim: To evaluate the safety and efficacy of laparoscopic drainage as a management of complex pyogenic liver abscesses in comparison to open surgical drainage.

Materials and methods: Combined retrospective and prospective comparative study of 48 patients having complex PLA who were admitted to NHTMRI and managed by either laparoscopic drainage or open surgical drainage from January 2012 to January 2020 as regards results, complications, perioperative morbidity, mortality, and possible recurrence. Twenty-six patients were managed by open drainage, and 22 patients by laparoscopic drainage. Culture sensitivity of pus was done for all patients. Patients having small, solitary, and unilocular PLA that responded to antibiotic treatment or/and percutaneous drainage were excluded. All patients were subjected to full clinical assessment, laboratory investigations, ultrasonography, computed tomography, or magnetic resonance images for the abdomen and pelvis.

Results: Forty-eight patients having complex PLA with a median age of 54.5 years were managed by either laparoscopic drainage (22 patients) or open surgical drainage (26 patients). The operation time and hospital stay were less, and oral feeding was started earlier in laparoscopic group. Wound infection was higher in open drainage group. Abscess recurrence occurred once in laparoscopic group and once in open surgery group, and both were successfully treated with percutaneous drainage. One laparoscopic operation was converted to open.

Conclusion: Both laparoscopic and open surgical drainage of PLA are safe and effective. Laparoscopic drainage has less operative time, morbidity, and hospital stay; however, open drainage is considered the management of choice for patients with severe sepsis or failed percutaneous drainage.

Keywords: Laparoscopy, Open drainage, Pyogenic liver abscess.

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Introduction

Complex pyogenic liver abscess (CPLA) is a rare potentially fatal condition if untreated. Complex pyogenic liver abscess is an abscess that is multilocular and more than 5 cm in diameter. Pyogenic liver abscess (PLA) is mainly treated by percutaneous aspiration or drainage under antibiotic cover. Surgical drainage is indicated if interventional radiology fails, if ruptured, or if associated with biliary or intra-abdominal pathology. In CPLA, percutaneous drainage may help to optimize clinical condition before surgery.[1,2] Laparoscopic drainage is a promising surgical option.[3]

Large pyogenic multilocular abscesses usually need drainage, in addition to antibiotics for effective management.[1] Antibiotics alone does not work because of large bacterial load, antibiotics inactivation, and ineffective medium for bacterial elimination. Effective drainage shortens the antibiotic therapy duration. The methods include percutaneous needle aspiration (PNA), percutaneous catheter drainage (PCD), open surgical drainage (OSD), and laparoscopic drainage (LD).[4]

Patients with small, solitary, and unilocular abscesses are best managed with percutaneous aspiration plus antibiotics, especially the young healthy patients. Debilitated patients, elderly, diabetic patients, and patients with multiple or CPLA have a higher failure rate with percutaneous aspiration.[5]

Aim

To evaluate the safety and efficacy of laparoscopic drainage as a management of complex pyogenic liver abscesses in comparison to open surgical drainage.

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Materials and Methods

Combined retrospective and prospective comparative study was conducted in NHTMRI from January 2012 to January 2020 on 48 patients (20 males and 28 females) with a median age of 54.5 years (ranges between 34 years and 65 years) having complex liver abscesses managed by either laparoscopic drainage or open surgical drainage. The comparison is as regards results,

complications, perioperative morbidity, mortality, and possible recurrence. Twenty-two patients were managed by laparoscopic drainage and 26 patients by open surgical drainage.

All patients were subjected to full clinical assessment, laboratory investigations (CBC, FBS, PP, HbA1C, creatinine, liver enzymes, albumin and bilirubin levels, PT, PC, and INR), and at least one or two radiological investigations (ultrasonography, computed tomography, or magnetic resonance images for the abdomen and pelvis). Abdominal ultrasonography was done in all patients and computed tomography was done in 22 patients with well-defined low-attenuation lesion that is having enhancing peripheral rim with single multiloculated cystic appearance, and MRI was done in 2 patients with imaging feature of multiloculated cystic lesion of low T1 and high T2 signal with enhancing peripheral rim, liver abscess confirmed at right lobe of liver in 34 patients and at left lobe in 14 patients. Four patients had more than one abscess cavity. The cavity measured between 8 cm and 23 cm in diameter. Eighteen patients had diabetes mellitus (DM). Of the 48 patients, 9 had failed percutaneous drainage. Culture sensitivity of pus was done for all patients.

Written consent form was filled by every patient after detailed explanation of the surgery and possible complications.

Patient Inclusion Criteria

Patient having complex pyogenic liver abscess of more than 5 cm in diameter, multilocular that is not responding to percutaneous drainage, and/or antibiotics.

Patient Exclusion Criteria

Patients having small, solitary, and unilocular pyogenic liver abscess that responded to antibiotic treatment and/or percutaneous drainage were excluded.

Imaging

Imaging plays an important role in the diagnosis of liver abscess, and the main role of imaging is to detect early disease and confirm diagnosis.[6]

Ultrasound and CT have high sensitivities for diagnosis of pyogenic liver abscess reaching to 97%. By ultrasound small abscesses less than 2 cm, appear as hypoechoic lesions or ill-defined areas of distorted parenchymal echogenicity within liver, large abscesses appears as hypoechoic or hyperechoic masses according to the presence of internal debris. Pyogenic abscess sometimes appears as solid lesion.[7]

The ability to differentiate an abscess from a neoplasm at nonenhanced ultrasound is limited compared with CT or MR imaging. However, if solid neoplasm starts to form necrosis, it could be differentiated from abscess by ultrasound.[8]

By contrast enhanced CT, pyogenic liver abscess appears as well-defined, low attenuation mass with an enhancing outer layer. It can appear as a single nonloculated cystic collection, multiloculated cystic mass, solid mass, or multifocal solid lesions.[9]

The characteristic imaging findings of abscess by contrast enhanced CT are called (double target sign) that is seen as central low attenuation cystic area surrounded by a high-density inner ring and a low-density outer ring. The inner layer shows early contrast enhancement with continuous enhancement at delayed phases. The outer layer appears of hypoattenuating with no enhancement in the early post contrast images then enhances in delayed phase.[6]

Another imaging findings called (cluster sign) that is seen with multiple small hypoattenuation abscesses aggregate and coalesce into one single large abscess cavity. Gas within lesions may be seen, either in the form of bubbles or appears as air-fluid leveling, which is a diagnostic sign for an abscess.[10]

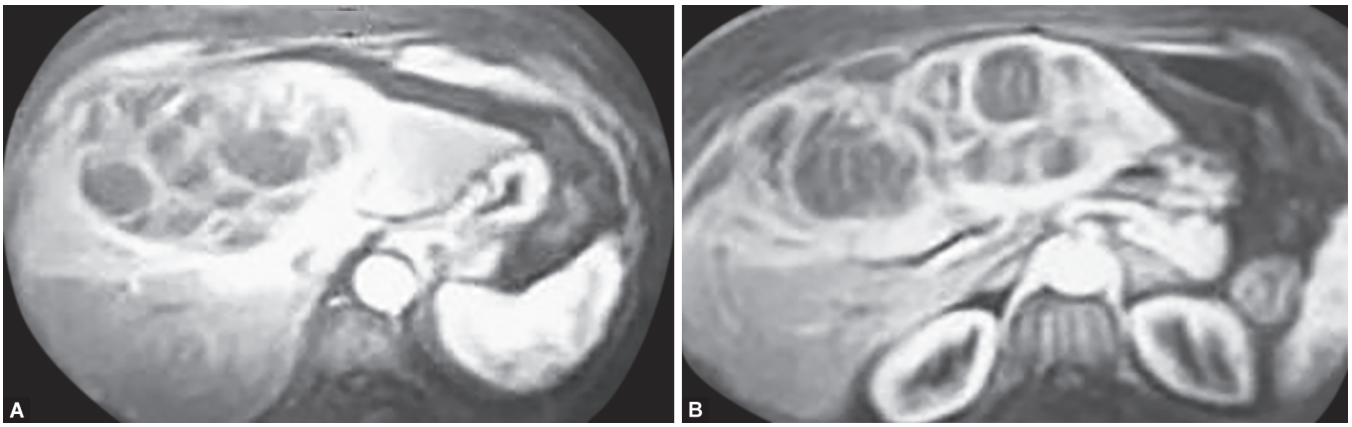
At MR imaging, abscesses seen as central low T1 signal and high T2 signal intensity, but internal signal intensity may vary depending on the protein content. Pyogenic liver abscess appears by dynamic MRI contrast enhancement the same as in contrast enhanced CT, with early enhancement of the inner layers and internal septa and delayed enhancement of the peripheral layer[6] (Fig. 1).

Some abscesses seen surrounded with edema signal, i.e., appears as bright T2 signal intensity with restricted diffusion-weighted images and low signal intensity on ADC maps (Fig. 2).[11]

Operative Techniques

Laparoscopic Drainage

Under general anesthesia, initially pneumoperitoneum was created, then a 10 mm trochar was introduced, and laparoscope was inserted. Diagnostic laparoscopy was performed and then two 5 mm ports were introduced according to the location of the abscess. A 10 mm port was introduced for laparoscopic intraoperative ultrasound. The adhesions between the liver and bowel as well as the anterior abdominal wall were freed and the area where abscess present was exposed. Laparoscopic intraoperative ultrasound was done to detect the exact site and extent of the liver abscess, then deroofing of the abscess was done, and aspiration of the pus by the suction catheter and samples for pus culture was taken. The cavity



Figs 1A and B: (A) MRI dynamic contrast enhancement study showing large bilobar multiloculated pyogenic liver abscesses with early enhancement of the inner layer with internal septal enhancement; (B) Delayed enhancement of the peripheral layer

was irrigated by normal saline, and proper hemostasis was secured. Finally, an abdominal drain was placed in the abscess cavity and another one in the pelvis (Fig. 3).

Open Surgery

A right subcostal incision or a midline abdominal incision was made according to abscess location. Intraoperative ultrasound was done to detect the exact site and extent of the liver abscess then de roofing of the abscess to drain pus and remove the fibrous septa. Hemostasis was secured and latex drainage tube was left (Fig. 2).

Operative and clinical data including operation time, intraoperative blood loss, postoperative complication rate, length of postoperative hospital stay, and rate of abscess recurrence were compared between the two groups.

Regular follow-up was done weekly for the first month after discharge then every 2 months for about one year. Clinical examination and abdominal ultrasound were done every visit.

Study Design

Combined retrospective and prospective study of all complex liver abscesses admitted to NHTMRI from January 2012 to January 2020 and comparison between laparoscopic and open surgical drainage as regards safety, efficacy, hospital stay, perioperative morbidity, mortality, and recurrence.

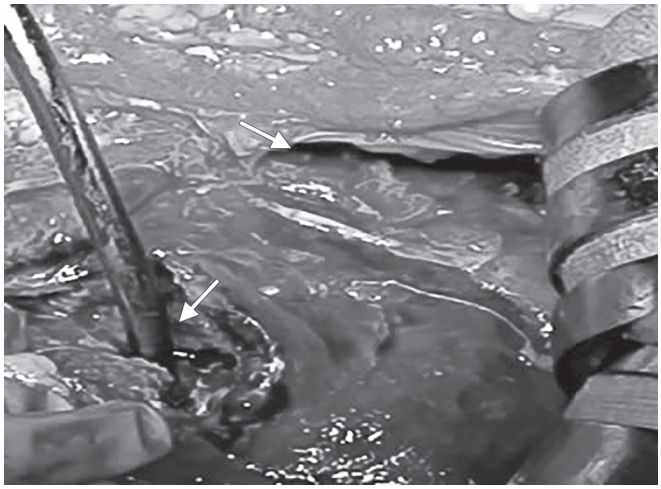


Fig. 2: Open surgical drainage of bilobar multiloculated pyogenic abscesses

Results

Forty-eight patients (20 males and 28 females) with a median age of 54.5 years (ranges between 34 years and 65 years) were included in this study. The clinical and laboratory data of patients with CPLA at presentation are shown in Table 1.

All patient were diagnosed by one or two imaging modalities (ultrasonography, CT, or MRI) and all were successfully treated either by laparoscopic drainage or open surgery confirmed by at least one image modality, CT or MRI examination (Figs 4 and 5).

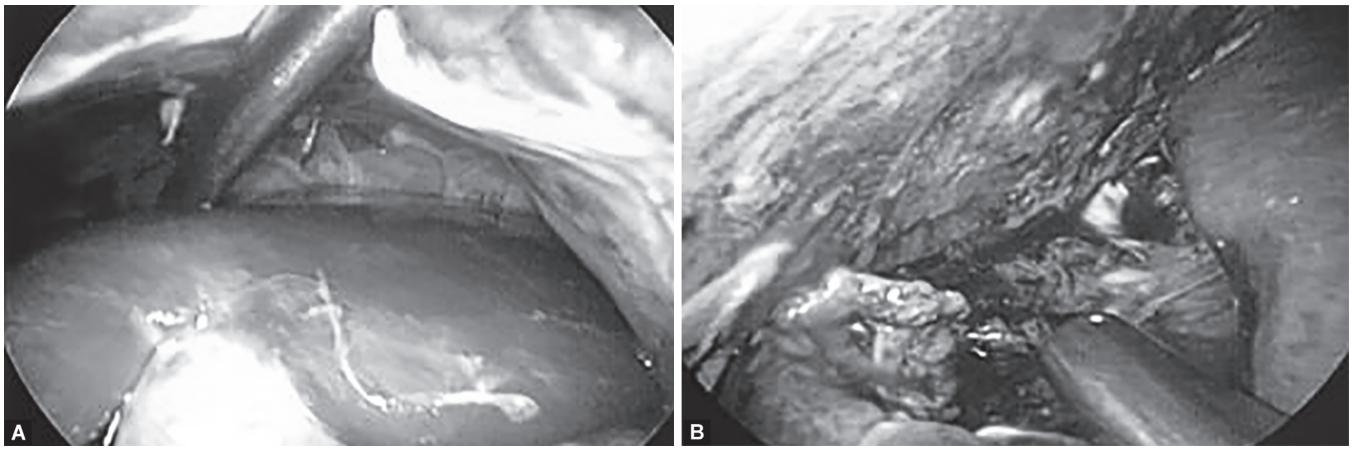
All patients received broad spectrum antibiotics. Nine patients had preoperative failed trial of percutaneous drainage. Twenty-six patients were managed by open surgical drainage and 22 patients by laparoscopic drainage. The operation time and hospital stay were less and oral feeding was started earlier in laparoscopic drainage group. Wound infection was higher in open drainage group. Abscess recurrence occurred once in laparoscopic group and once in open surgery group and both were successfully treated with percutaneous drainage. One laparoscopic operation was converted into open surgical drainage due to unsatisfactory laparoscopic drainage. Results are shown in Table 2.

In pus-culture study of the 48 patients, only 38 cases (79%) had positive microbial reports while 21% had reports with no growth.

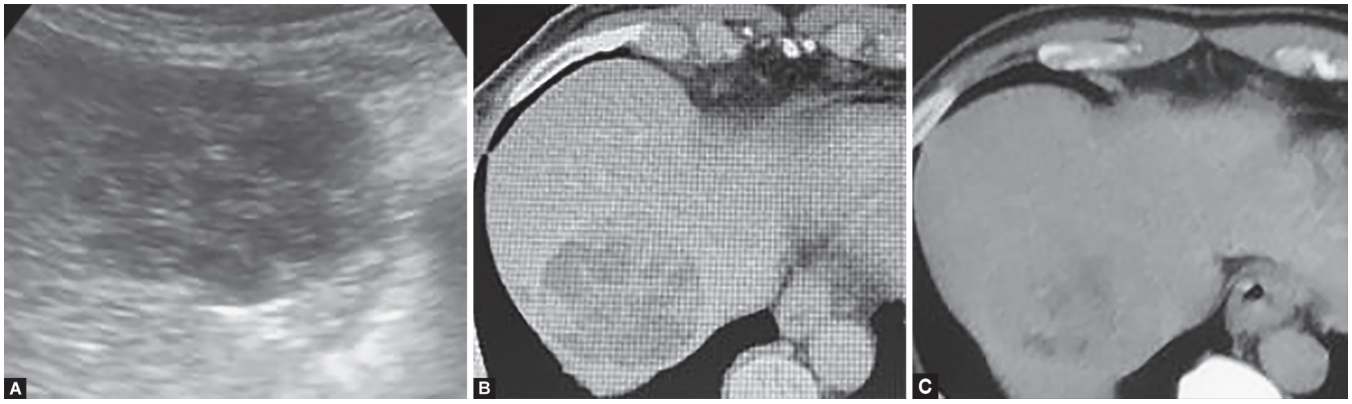
Table 1: Clinical and laboratory data of patients with complex pyogenic liver abscess at presentation

Variables	*LD group (n = 22)*	*OSD group (n = 26)*
Abdominal pain	21	25
Fever/rigors	21	26
Vomiting	11	12
Jaundice	5	6
Abdominal tenderness	19	23
Severe sepsis	1	8
Leukocytosis (>11,000/mL)	22	26
Elevated AST/ALT	12	15
Serum albumin (<3.5 g/dL)	7	9
Total bilirubin (>2 mg/dL)	6	9
Serum creatinine (>1.4 mg/dL)	1	8

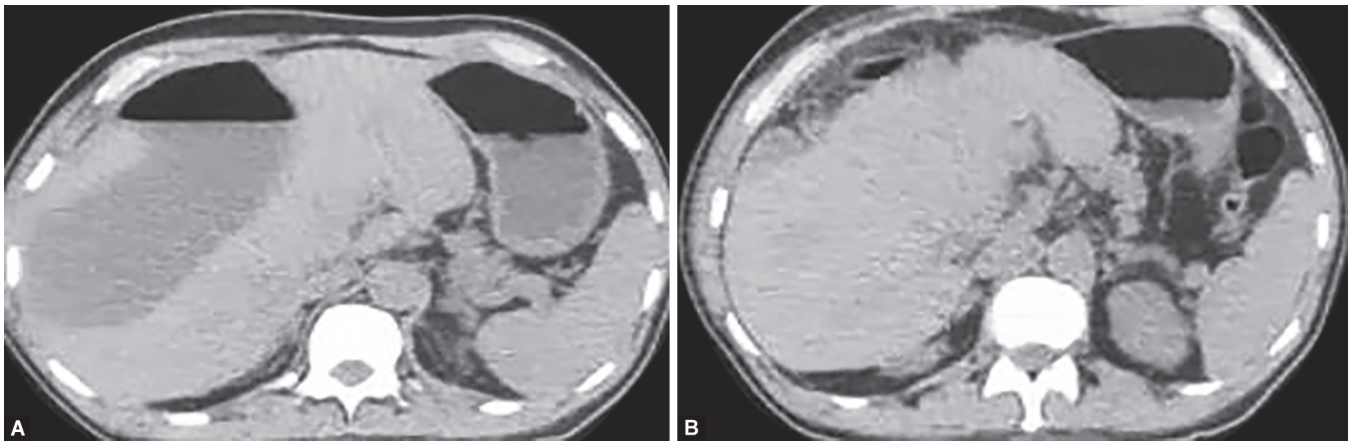
LD, laparoscopic drainage; OSD, open surgical drainage



Figs 3A and B: Laparoscopic drainage of liver abscesses



Figs 4A to C: (A) Ultrasonography of a case of right lobe pyogenic liver abscess of heterogeneous echogenic mass lesion before surgical interference; (B) CT of the same case showing low attenuation mass with internal septa and debris; (C) CT done one week after surgery with nearly total resolution of the abscess



Figs 5A and B: (A) CT scan of a case before laparoscopic drainage showing large right lobe single nonloculated abscess at segment VIII with fluid leveling; (B) CT after laparoscopic drainage showing significance resolution of the lesion

The most common organisms identified were *Escherichia coli* 25% and *Klebsiella pneumoniae* 16%, followed by anaerobics (12.5%), Streptococcus spp (10.4%), and polymicrobial (15%).

Discussion

Before the 1970s, the mortality rate of PLA was high (more than 50%). With the development of imaging, surgical techniques, and effective broad-spectrum antibiotics, the mortality rate is markedly reduced.[12,13] Complex pyogenic liver abscesses usually require surgical drainage either open surgical drainage (OSD) or laparoscopic drainage (LD) under cover of broad-spectrum antibiotics for effective management.[4]

This study conducted in NHTMRI which is a tertiary center specialized for liver surgery from January 2012 to January 2020. During this period, only 48 patients fulfilled criteria of complex liver abscess (more than 5 cm in diameter, multilocular). All patients received systemic antibiotics. Nine patients had preoperative failed trial of percutaneous drainage. Twenty-six patients were managed by open surgical drainage and 22 patients by laparoscopic drainage.

Eighteen patients (37.5%) in the current study had DM which is comparable to study done by Li et al. in 2018 on 246 PLA patients with 90 (36.6%) of them had diabetes and higher than the study of Serraino et al. in which 25 patients of 109 (23%) had DM.[14]

Table 2: Results of laparoscopic drainage group and open surgical drainage group

Variables	*LD group (n = 22)*	*OSD group (n = 26)*
Operative time (median and range), minutes	86 (75–125) minutes	105 (95–140) minutes
Hospital stay (median and range), days	5 (4–7) day	8 (6–11) day
Comorbidity (18/48 diabetics: patients *n* and %)	12/22 (54.5%)	6/26 (23%)
Postoperative wound infection (*n* and %)	0 (0%)	2/26 (7.7%)
Perioperative mortality	0 (0%)	0 (0%)
Failed preoperative percutaneous drainage (9/48 patients)	2/22 (9%)	7/26 (27%)
Abscess recurrence	1/22 (4.5%)	1/26 (3.8%)

LD, laparoscopic drainage; OSD, open surgical drainage

In our study, the four patients that had more than one abscess cavity were diabetic and the two patients who had recurrence were also diabetic.

Preoperative ultrasound, CT, MRI, and intraoperative laparoscopic ultrasound help to identify abscess localization, liquefaction, cavity size, pus volume, multiloculation, septa, and abscess number. Abdominal ultrasonography was done in all patients and was diagnostic alone in 24 (50%) of cases; however, CT was required in 22 patients and MRI in 2 patients to confirm the diagnosis. This is comparable to Serraino et al. study in which ultrasound was diagnostic in 42.4%, CT scan in 51.1%, and MRI in 3.3% of their cases.[14]

Seventy-nine percentage of our patients in this study had positive culture reports while 21% had reports with no growth. The most common organisms identified were *Escherichia coli* 25% and *Klebsiella pneumoniae* 16%. This is comparable to results of Malik et al., Serraino et al., and different from Liu et al. who found that 25 positive results of 66 cases (37.9%), with *Klebsiella pneumoniae* detected in 15 cases (60.0%) as the most common pathogen.[14–16]

The operative time and hospital stay were less and oral feeding was started earlier in laparoscopic drainage group. This is comparable to Tu et al. study as regards hospital stay and oral feeding but not for operation time as Tu and his colleagues had longer LS time perhaps because they managed the biliary pathology at the same time.[17]

In the current study, there were no perioperative mortality which is comparable to Tu et al. study and in contrary to the study done by Malik et al., in which mortality occurred in 19 of 169 patients with pyogenic liver abscesses and it was higher in the nonsurgical drainage group (7 out of 42 patients 16.6%) than the surgically drained group (12 out of 127 patients 9.4%).[15,17] As regards the recurrence rate, it occurred in two cases (4.2%), one case in laparoscopic group 1/22 (4.5%) and one case in open group 1/26 (3.8%) and both were successfully treated with percutaneous drainage.

Conclusion

Both laparoscopic and open surgical drainage of PLA are safe and effective. Laparoscopic drainage has less operative time, morbidity, and hospital stay; however, open drainage is considered the management of choice for patients with critical condition or with failed percutaneous drainage. When laparoscopic drainage is unsatisfactory conversion to open surgical drainage is recommended.

Disclosure

Informed written consent was obtained from the patients.

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ORIGINAL ARTICLE

Hindrance to Day Care Laparoscopic Cholecystectomy in India

Bhaviya Bhargavan Nair Sarala[1], Abhimanyu Kar[2], Supriyo Ghatak[3], Sumit Gulati[4], Vishnu K Bhartia[5], Pradeep K Nemani[6]

Abstract

Background: Laparoscopic cholecystectomy is considered "gold standard" for the treatment of gallstone disease. In spite of the increasing number of laparoscopic cholecystectomies being performed as day care surgery in the West, the surgeons of developing countries are reluctant to adopt this trend probably due to the inadequate resources and infrastructure which they consider a hindrance for safe discharge. Our study aims to assess the feasibility of day care laparoscopic cholecystectomies.

Materials and methods: This is a prospective observational study. All patients undergoing laparoscopic cholecystectomy were assessed postoperatively for dischargeability using post-anesthetic discharge scoring system (PADSS). We assessed the factors delaying the early discharge of laparoscopic cholecystectomy patients in terms of patient factors, intraoperative factors, postoperative factors, social factors, and logistic factors.

Results: Of the total 88 patients, 57 (64.7%) were dischargeable at 6 hours and 78 (88.6%) were dischargeable at 24 hours. Factors found to affect dischargeability of patients at 6 hours were acute cholecystitis and increased duration of surgery. Difficulty of surgery and the use of drain had significant association with nondischargeability at 24 hours. Eighteen patients were fit for discharge by PADSS criteria but not discharged at 24 hours. Factors, which delayed the discharge of these patients, were continuation of intravenous antibiotics, delay in processing insurance, patients' unwillingness for early discharge, presence of drain, and surgeon's perceived fear of complications.

Conclusion: Sixty-five percent of all laparoscopic cholecystectomies can be performed as day care procedure safely. Patients with acute cholecystitis and patients requiring an operative time more than 104 minutes should be observed for 24 hours.

Keywords: Cholecystectomy, Day care surgery, Feasibility, Gallstone, Laparoscopic surgery, Safety.

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Introduction

Laparoscopic cholecystectomy is considered the "gold standard" for the surgical treatment of gallstone disease.[1] Earlier with open cholecystectomies, patients used to stay in the hospital for up to 6 days.[2] The introduction of laparoscopic cholecystectomy drastically shortened the hospital stay of cholecystectomy patients from 2–3 days.[3] In the Western world, laparoscopic cholecystectomies are being performed as a day care surgery further reducing the stay of patients in hospital to less than a day.

Outpatient surgery, also known as ambulatory surgery, same-day surgery, day case, or day surgery, is surgery that does not require an overnight hospital stay. The potential for day care surgery has increased over the last few decades which can be attributed to the advances in surgical technologies and in the field of anesthesiology. Day care surgery allows a person to return home on the same day of the operation is performed and eliminates inpatient hospital admission, thereby reduces cost.

Day care laparoscopic cholecystectomy (DCLC) has already been widely accepted in Western countries and there are many studies on the safety and feasibility of DCLCs. However, these studies are from developed countries where there is advanced system for ambulatory surgeries. Because of differences in the quality of health care delivery, Western guidelines for day care surgery cannot be universally applied to developing countries.

In most part of eastern India, we still follow the traditional practice of discharging the laparoscopic cholecystectomy patients the next day or one day after the surgery probably due to lack of the literature regarding the safety of DCLCs from smaller centers in developing countries where the primary healthcare delivery and infrastructure is poor. For the effective implementation of DCLCs, first we require wide acceptance of overnight or 24 hour discharging units followed by gradual upgradation to day care centers. Further studies on the safety and efficacy of early discharge in laparoscopic cholecystectomies from smaller centers in India might give the surgeons the ever lacking confidence in DCLC.

In our institution, the traditional practice is to discharge the patients almost 48 hours after laparoscopic cholecystectomy. We wanted to find out whether it was safe and feasible to discharge these patients as day care (6 hours) or early (24 hours) in a center like ours where there is no dedicated unit for ambulatory surgery. In this prospective observational study, we aim to identify the patients suitable for DCLC, factors affecting the dischargeability at 6 and 24 hours, as well as to find out the factors delaying the discharge of LC patients more than 24 hours. As day care was not a traditional practice and we were apprehensive on the safety of discharging the LC patients as a day care, we did not discharge

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the patients as day care but continued to monitor all the patients till 24 hours to see whether any patients dischargeable at 6 hours developed any complication during their stay which would have led to a readmission if at all they were discharged as day care.

Materials and Methods

This is a prospective observational study conducted in the Department of General surgery at The Calcutta Medical Research Institute, Kolkata, over a period of 6 months. All consecutive patients, both male and female diagnosed with symptomatic gallstone disease undergoing laparoscopic cholecystectomy in the Department of General Surgery at The Calcutta Medical Research Institute, who gave consent for being a part of the study were included. Patients undergoing other combined procedures with laparoscopic cholecystectomy and pregnant patients undergoing laparoscopic cholecystectomy were excluded.

All patients who underwent laparoscopic cholecystectomy were evaluated preoperatively by a detailed history and the patient factors such as age, sex, BMI, comorbid conditions, past history of surgeries, and ASA score were noted.

Standard four-port laparoscopic cholecystectomy was performed in all the patients by the consultant surgeon. If the gallbladder were not taken out through the umbilical port, the patient was excluded from the study. Standard institutional protocol for postoperative analgesia was followed for all patients.

Several scoring systems have been developed for discharge after ambulatory anesthesia, one of the most widely used being the post-anesthesia discharge scoring system (PADSS), introduced by Chung and colleagues in 1995.[4] We assessed patients at 6 hours and 24 hours postoperatively using PADSS. Maximal score was 10. Patients scoring 9 or 10 were fit for discharge (Table 1).

Table 1: Post-anesthesia discharge scoring system[4]

Vital signs: Vital signs must be stable and consistent with age and preoperative baseline	
BP and pulse within 20% of preoperative baseline	2
BP and pulse 20–40% of preoperative baseline	1
BP and pulse 40% of preoperative baseline	0
Activity level: Patient must be able to ambulate at preoperative level	
Steady gait, no dizziness, or meets preoperative level	2
Requires assistance	1
Unable to ambulate	0
Nausea and vomiting: The patient should have minimal nausea and vomiting before discharge	
Minimal: Successfully treated with PO medication	2
Moderate: Successfully treated with IM medication	1
Severe: Continues after repeated treatment	0
Pain: The patient should have minimal or no pain before discharge. The level of pain that the patient has should be acceptable to the patient. Pain should be controllable by oral analgesics. The location, type, and intensity of pain should be consistent with anticipated postoperative discomfort	
Acceptability	
Yes	2
No	1
Surgical bleeding: Postoperative bleeding should be consistent with expected blood loss for the procedure	
Minimal: Does not require dressing change	2
Moderate: Up to two dressing changes required	1
Severe: More than three dressing changes required	0
Maximum score = 10, score ≥9 is fit for discharge	

At 6 hours, the patients were assessed for their readiness for discharge. All the patients continued to be monitored till 24 hours, any complication during this time was noted, and they were again assessed at 24 hours for their readiness for discharge. If the patient met the criteria for discharge at 24 hours, he/she was discharged and if not discharged the reasons for delayed discharge were noted.

The statistical software SPSS version 20 has been used for the analysis. All categorical variables were analyzed using Fischer exact test and all continuous variables with Mann–Whitney test. An alpha level of 5% has been taken, i.e., if any *p* value is less than 0.05, it has been considered as significant. A multivariate logistic regression was performed including all variables with *p* value <0.05 to predict the factors affecting discharge at 6 hours.

Result and Analysis

A total of 94 patients underwent laparoscopic cholecystectomy for symptomatic gallstone disease during the period of 6 months. Six patients were excluded from the study, one patient due to conversion to open cholecystectomy and five patients as the gallbladder was removed from the epigastric port due to technical difficulties. A total of 88 patients were included in the study.

Fifty-seven (64.7%) patients were dischargeable at 6 hours. At 24 hours, 21 more patients were dischargeable making a total of 78 (88.6%) patients dischargeable at 24 hours. Of the total 78 patients dischargeable at 24 hours, 18 (23.08%) patients were not discharged due to various factors such as social factors, logistic factors, presence of drain, patient preference, and as surgeon anticipated complications. None of the patients who were dischargeable at 6 hours developed any complication during their period of stay in the hospital and continued to remain dischargeable at 24 hours.

Of all the variables analyzed, age, acute cholecystitis, diabetes mellitus (DM), hypertension (HTN), The American Society of Anesthesiologists (ASA) physical status classification system score, difficulty, use of drain, and duration of surgery were found to have significant association with dischargeability of the patients at 6 hours (Table 2). After logistic regression, only acute cholecystitis and duration of surgery had a significant association. From the ROC curve in our study, operating times more than 104 minutes can be considered as a predictive factor for failure of DCLC.

Of all the factors accessed, difficulty of surgery and use of drain were found to have significant association with dischargeability of the patients at 24 hours (Table 3). As these factors were interdependent, we did not perform a regression analysis.

Of the total 88 patients analyzed, 78 (88.6%) patients dischargeable at 24 hours of which 60 patients were discharged at 24 hours. Rest of the 18 patients who were dischargeable were not discharged because of various factors such as continuation of IV antibiotics (1), logistic insurance (6), patient factor (1), presence of drain (8), social factors such as patient living at a far distance (1), and surgeon anticipating complication (1) (Fig. 1).

Discussion

The aim of our study was to detect the dischargeability of the laparoscopic cholecystectomy patients at 6 hours and 24 hours and to determine the factors affecting discharge. As day care laparoscopic cholecystectomy is not a routine practice

Table 2: Factors affecting the dischargeability of patients at 6 hours

Factors	*p value*	*p value after logistic regression*	*Odds ratio (95% CI)*	*Significance using logistic regression*
Age	0.007	0.901	0.997 (0.947–1.049)	Not significant
Acute cholecystitis	0.004	0.059	0.074 (0.005–1.103)	Significant
DM	0.001	0.455	0.456 (0.058–3.578)	Not significant
HTN	0.005	0.317	0.387 (0.060–2.485)	Not significant
Duration of surgery	0.001	0.023	0.976 (0.955–0.997)	Significant
ASA	0.001	0.971	1.037 (0.153–7.022)	Not significant
Difficulty	<0.001	0.140	0.442 (0.149–1.306)	Not significant
Use of drain	<0.001	0.214	0.270 (0.034–2.129)	Not significant

DM, diabetes mellitus; HTN, hypertension; ASA, The American Society of Anesthesiologists (ASA) physical status classification system

Table 3: Factors affecting the dischargeability of patients at 24 hours

Factors	*p value*	*Significance*
Difficulty	0.008	Significant
Use of drain	0.005	Significant

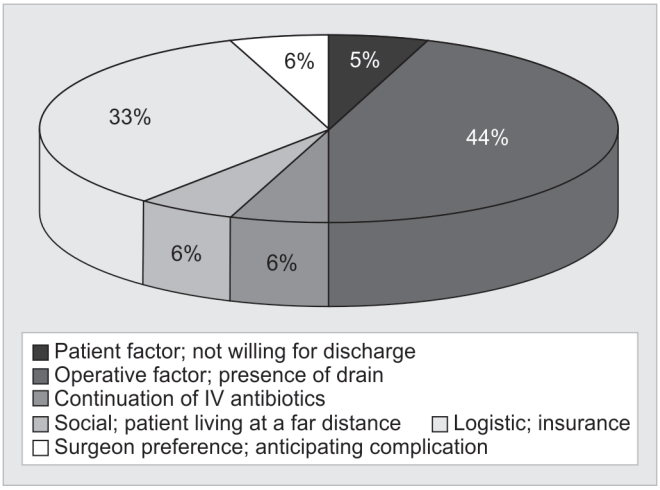

Fig. 1: Factors delaying discharge at 24 hours

at our institution, all the patients were assessed at 6 hours for dischargeability and then followed up till 24 hours till their discharge to see if they developed any complications which could have been a reason for readmission if at all these patients were discharged at 6 hours as day care. None of the patients who were dischargeable at 6 hours developed any complication during their period of stay in the hospital and continued to remain dischargeable at 24 hours.

Of the total 88 patients analyzed, 57 (64.7%) patients were dischargeable at 6 hours and 78 (88.6%) patients dischargeable at 24 hours. This means that 65% of all the laparoscopic cholecystectomies can be performed as DCLCs.

We found age (*p* value—0.007), acute cholecystitis (0.004), diabetes mellitus (*p* value—0.001), hypertension (*p* value—0.005), ASA score (*p* value—0.001), duration of surgery (0.001), difficulty of surgery (*p* value < 0.001), and use of drain (*p* value < 0.001) to have significant association with dischargeability at 6 hours. After logistic regression analysis, only duration of surgery and acute cholecystitis were found to have a significant association (Table 2).

Previous studies stated age as a factor for failed discharge of DCLCs.[5,6] In the study by Lledó et al. (*n* = 410), they found age of patient over 65 years [*p* = 0.021; odds ratio (OR) = 2.225; 95% confidence interval (CI), 1.130–4.381] as a predictive factor for overnight admission or failed discharge.[5] In another study by Psaila et al., age over 50 years was one of the factors which adversely affected the same-day discharge.[6] Contrary to these finding, a study on DCLCs in elderly showed that ambulatory LCs are safe in elderly patients (>65 years).[7] In our study, age was not a significant factor associated with dischargeability at 6 hours, after regression analysis. This is an indicator that even in elderly patients who have no other comorbidities, DCLCs might be safe.

In the study by Chauhan et al. although ASA grade III and IV were excluded, four of their day care cases required admission due to reasons like hypertension, COPD, and diabetes.[8] They were of the opinion that these are dynamic diseases and likely to change between the interval between initial preanesthetic assessment and final surgery. In our study, although independently ASA score, diabetes, and hypertension had a significant association, and these variables did not show significant association after regression analysis. This might be due the interdependency of the variables such as age, hypertension, diabetes, and ASA score. A good initial preanesthetic evaluation and stringent patient selection for DCLCs should be followed to avoid potentially dangerous outcomes and decrease the number of cancellations of day care surgeries.

In our study, 53 (60.23%) patients had easy surgery, 25 (28.41%) patients had moderately difficult, and 10 (11.36%) patients had very difficult surgery. Difficulty of surgery independently had a significant association with dischargeability 6 hours. The lack of the significant association after regression analysis may be due to its association with duration of surgery. Lledó et al. in their study had similar findings and identified "dissection difficulty" as one of the predictive factors related to overnight stay in DCLCs.[9]

Use of drain had a significant association with dischargeability at 6 hours in the initial analysis. This might be attributed to the increased pain experienced and the difficulty to ambulate in the patients with drain *in situ*. After regression analysis, the association was found to be not significant. This lack of significance after regression analysis might be due to the association between difficulty of surgery and usage of drain. We had used drain almost routinely for all the difficult cases. The nondischargeability in patients with drain might be mainly due to the difficulty of the surgery rather than the presence of drain.

The mean operative time in our study was 97.39 minutes (SD = 38.03). In our study, duration of surgery was a statistically significant independent factor associated with dischargeability at 6 hours. One of the studies had showed operation duration superior to 60 minutes to be a predictive factor to overnight admission.[5] From

the ROC curve in our study, operating times more than 104 minutes can be considered as a predictive factor for failure of DCLC.

Acute cholecystitis had a significant association with dischargeability at 6 hours with a *p* value of 0.004. Patients with acute cholecystitis might not be ideal candidate for day care surgeries and can be considered as exclusion criteria in selection of patients for DCLCs.

Of all the factors accessed, difficulty of surgery and use of drain were found to have significant association with dischargeability of the patients at 24 hours. Sherigar et al. in their study showed 3.4% readmission after discharge in the first phase due to wound related problems and surgical complication (cystic artery pseudoaneurysm) and 3.5% readmission in the second phase which was also due to wound related problems and surgical complication (CBD injury).[10] These findings are consistent with our results showing that the main causes for the patients being nondischargeable even at 24 hours are difficult surgeries and surgical complications.

Of the total 88 patients, 60 patients were discharged at 24 hours, 10 patients were not dischargeable, and 18 patients were not discharged due to various factors such as social factors, logistic factors, presence of drain, patient preference, surgeon anticipated complications, and surgical complications. This is similar to the results of several other previous published studies.[9–18] Although several[9,10,12,13,17–20] had shown postoperative emesis as one of the major causes for nondischargeability, none of our patients had postoperative nausea and vomiting leading to nondischargeability. Eighteen patients who were dischargeable were not discharged because of various factors such as continuation of IV antibiotics (1), logistic insurance (4), patient factor due to patients unwillingness for discharge (1), presence of drain (7), social factors such as patient living at a far distance (1), surgeon anticipating complication (1), and surgical complication (1).

The main drawback of this study is that although we have seen for the dischargeability of the patients at 6 hours, we have not really discharged the patients. In our study, none of the patients who were dischargeable at 6 hours developed any complications during their stay at the hospital which would mean if at all these patients were discharged, these patients might not have required readmission. But this might be attributed to the good inpatient care provided at the hospital, and if these patients were discharged at 6 hours in real situation, they might have required readmissions.

Conclusion

Of the total 88 patients analyzed, 57 (64.7%) patients were dischargeable at 6 hours. We can conclude that 65% of all the laparoscopic cholecystectomies can be performed as DCLCs if stringent selection criteria are followed. From our study, we can conclude that it will be safe to go for day care laparoscopic cholecystectomies in majority of patients except those with acute cholecystitis. Patients requiring an operative time more than 104 minutes should be observed for 24 hours.

88.6% patients were dischargeable at 24 hours. Surgeon should anticipate a delayed discharge in patients who had a difficult surgery or when drain was used. All the patients who underwent laparoscopic cholecystectomies without these two factors were dischargeable by 24 hours. Even in patients where drain is used should be considered for early discharge if the PADSS criteria are met and the drain can be removed at a later date on OPD basis.

In our study, 13 patients of the 59 patients who were dischargeable at 24 hours were not discharged because of various factors such as continuation of IV antibiotics (1), logistic factor (insurance) (4), patient factor (1), presence of drain (5), social factor such as patient living at a far distance (1), and as surgeon anticipated complications (1).

Appropriate antibiotic usage, surgeon and patient awareness about the treatment protocols, and streamlining hospital processes can mitigate some of these factors delaying discharge. This will have a significant impact in cutting off the hospital costs as well as in preventing hospital-acquired infections.

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RESEARCH ARTICLE

Mini Two-port Laparoscopic Appendicectomy with Novel Knotting Technique

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Abstract

Background: In pursuit of minimizing surgical trauma and achieving better esthetics by reducing the size and number of ports, this mini two-port technique was devised to offer an easier and safe alternative in comparison to conventional three-port technique. An easy and cost-effective mini two-port appendicectomy is made possible with a unique intracorporeal surgical knotting through a single 5-mm port with a single instrument, thus reducing number and size of ports and with a better cosmetic result.

Materials and methods: Total 200 patients underwent laparoscopic appendicectomy out of which, mini two-port appendicectomy (TPA) with novel knotting technique could be successfully performed on 168 patients (84%) and remaining 32 patients (16%) required conventional three-port technique (CLA). None of the cases were converted to open.

Results: Patient undergoing two-port laparoscopic appendicectomy had shorter operative time with better cosmetic result with no incidence of port-site hernia. There was no difficulty in adhesiolysis and intraoperative bleeding control. Infection rate was 0.59% and 3.12% for TPA and CLA, respectively. Incidence of intraoperative bleeding and intraoperative rupture of appendix was less in TPA (1.19% and 0%) as compared to CLA (6.25% and 3.125%). Mean hospital stay was less in TPA (1.7 days) compared to CLA (2.1 days).

Conclusion: This mini two-port technique with novel knotting technique is easy to learn and helps to overcome the challenges and limitations faced during two laparoscopic appendicectomies; however conversion to conventional approach in complicated cases is still advisable. It is safe and effective intermediate option from conventional three-port to SILS/NOTES/Endo GIA staplers.

Keywords: Appendicitis, Laparoscopic appendicectomy, Novel knotting technique, Two-port laparoscopic appendicectomy.

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Introduction

Acute appendicitis is common gastrointestinal condition in emergency surgical practice. It affects group of people irrespective of age, nationality, and religion. The incidence of acute appendicitis is probably lower in Asian and African countries accounting to the intake of high fiber diet by their inhabitants. Dietary fiber helps decrease the viscosity of feces, decrease bowel transit time, and reduce the formation of fecolith, one of the common causes of appendiceal lumen obstruction.

In an age group of 21–30 years, highest incidence is seen in male compared to female, where the highest incidence was observed in the age group of 11–20 years. Incidence remains same for both sexes after the age of 30 years.

The diagnosis is done by clinical signs and symptoms, Mantrels score, ultrasonography, computerized tomography. Computerized tomography being the investigation of choice. The treatment of modality for appendicitis is appendicectomy. Laparoscopy is a new gold standard for treatment of acute and chronic appendicitis. Conventional appendicectomy is by 3-port technique. But in pursuit of minimizing surgical trauma and achieving better cosmetic results without compromising on basic principal of appendicectomy, this mini two-port technique is described, wherein limitations and challenges of intracorporeal knotting faced during two-port technique by using single 5-mm port are overcome by our novel knotting technique, thus to make mini two-port technique feasible. This technique can be considered as safe, cosmetic, and cost-effective intermediate option between three-port technique and Stapler, SILS, NOTES appendicectomy.

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Materials and Methods

A total of 200 prospective nonrandomized patients were subjected to begin with two-port laparoscopic appendicectomy over the period of 3 years from 2014 to 2016 for appendicitis after written, informed, and valid consent. Ethical clearance was not obtained since it was a study involving variation in knotting technique. Of these, in 168 patients, mini two-port appendicectomy (TPA) was feasible, and in remaining 32 patients, conventional laparoscopic appendicectomy (CLA) had to be done due to severe inflammation, adhesions, and specimen that cannot be retrieved through 5-mm

port. Young cosmesis oriented patients with acute appendicitis without lump or perforation, recurrent appendicitis having symptoms due to fecolith, and incidental finding of inflamed appendix in diagnostic laparoscopy. Preileal, subceacal, and pelvic position of appendix were preferred.

Operative Technique

Under general anesthesia, patient is placed in Trendelenburg position with laparoscopy trolley on patient's right and surgeon on patient's left side. Laparoscopic access into the abdomen was obtained via Hasson's technique through the umbilicus with 5-mm port, and the procedure was started by creating pneumoperitoneum through umbilical port with insufflation pressures being maintained between 10 and 12 mm Hg. A 5-mm 30° scope is introduced through the 5-mm umbilical port. Under direct vision, a 5-mm trocar was inserted through a suprapubic incision made below the pubic hairline (Fig. 1). A 2-0 polypropylene suture is threaded and reversed through an 18-gauge epidural needle to create a loop at the tip. This needle loop retractor is then inserted in the right iliac fossa (Fig. 1) at the position of appendix as defined by laparoscopy. Dissection of mesoappendix up to the base of the mesoappendix is done using bipolar energy device (Fig. 1).

In Case of Dense Adhesions and When Tip of Appendix is Not Visualized

In difficult appendix with adhesions and when the tip of the appendix is not visualized, a double loop retraction, one with additional subserosal appendix stitch with 2-0 polyglactin suture passed through abdominal wall is taken on most visible portion of appendix which aides in retraction and dissection of the appendix, and when tip becomes visible, a second 2-0 polypropylene loop retraction as described above is used (Fig. 1) to hitch up the appendix and aid in the process of adhesiolysis (Fig. 1). After adequate mobilization, first polyglactin suture is later removed and then the tip of appendix is then repositioned within 2-0 polypropylene loop. Mesoappendix is divided with bipolar energy device till base is visible (Fig. 1). A segment of 2-0 polyglactin suture held on tip of needle holder together is introduced through the 5-mm suprapubic port so as to encircle the base of the appendix. After encircling the base and creating a loop, tip of the 2-0 polyglactin suture is again held with needle holder in the right hand of surgeon and with outer end of 2-0 polyglactin suture held in surgeon's left hand, and single instrument surgical knot analogs to the open technique is performed (Fig. 2), wherein internal end of the suture is held with needle holder in the right hand and the long end of 2-0 polyglactin suture is held externally by the left hand. Another knot is placed at the distal location in the similar fashion and appendix is divided and delivered through either of 5-mm port after completely withdrawing specimen within the cannula of 5-mm port to prevent port-site contamination.

In a Case of Grossly Inflamed Appendix/Edematous Cecum

In an instance of the edematous cecum and grossly inflamed appendix, base of the appendix is transfixed (Fig. 3) with entire length of 2-0 polyglactin suture introduced through a percutaneous puncture in right iliac fossa, needle is cut and retrieved through right iliac fossa, and opposite long end of suture is pulled out through 5-mm port alongside of the needle holder. Knot analogous to the open surgical knot is placed as described above, and then second surgical intracorporeal knot is placed distally. Appendix is divided between two knots and retrieved. None of the operated cases were converted to conventional 3-port or open appendicectomy.

Results

A total of 200 patients were operated of which 168 underwent TPA and 32 underwent CLA. Comparison of the two group's operative time was 24 minutes and 42 minutes for TPA and CLA, respectively.

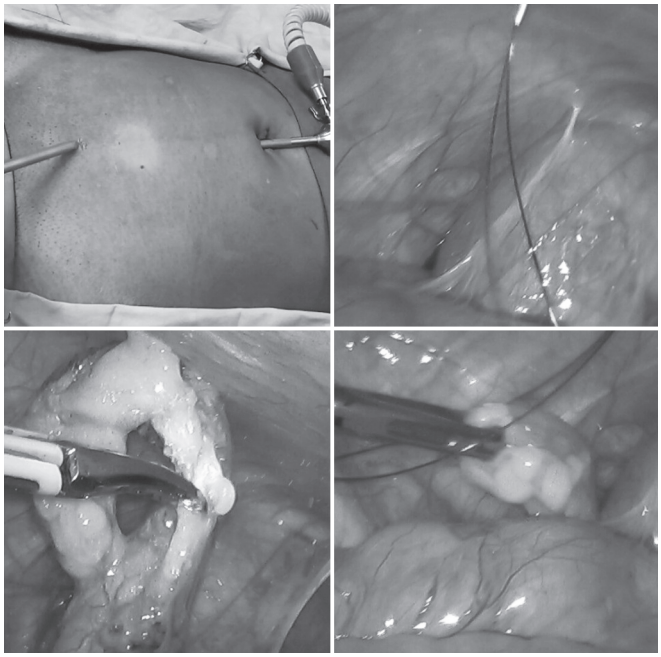

Fig. 1: Two 5-mm port placement, polypropylene loop retraction of appendix, and dissection of mesoappendix with bipolar device up to base of appendix

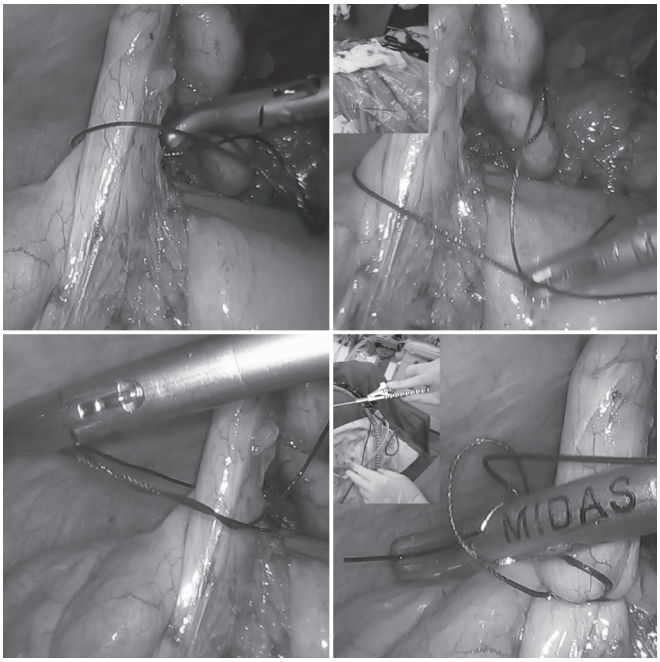

Fig. 2: 2-0 Polyglactin held with needle holder is passed through 5-mm port; suture is encircled around the base to form loop, and surgical knot tied

Better cosmesis achieved in TPA as scar was hidden in umbilicus and pubic hairline producing scarless appearance (Fig. 4) and scar was visible at umbilicus and left iliac fossa in CLA. Infection rate was 0.59% and 3.125% for TPA and CLA, respectively. Incidence of intraoperative bleeding and intraoperative rupture of appendix was less in TPA (1.19% and 0%, respectively) as compared to CLA (6.25% and 3.125%, respectively). Mean hospital stay was less in TPA (1.7 days) compared to CLA (2.1 days). No major intraoperative complications were observed (Table 1).

Discussion

The incidence of appendicitis gradually rises from birth,[1] peaks in the late 10 years, and gradually declines in the geriatric years.[2] It is most prevalent in young belonging to the age group of 10–19 years.[3] In recent years, the number of cases in patients aged 30–69 years has increased to 6.3%.[4] However, cosmesis has been an utmost importance lately among all the age groups.

Clinical presentation of 30% to 45% patients suspected of appendicitis is frequently unspecified and despite common occurrence leads to many difficulties in diagnosis. Diagnosis of acute appendicitis includes clinical examination, laboratory tests, diagnostic scoring systems, and imaging modalities like ultrasonography and computerized tomography. CT demonstrates a sensitivity and specificity of 83%–100%.[5] Scoring systems link clinical examination and laboratory tests by certain quantification of symptoms, signs, and laboratory parameters.[6]

The first successful appendicectomy was performed in by Claudius Amyand in 1735. Laparoscopic appendicectomy was first performed by the German gynecologist Kurt Semm in 1980,[7] which became a new gold standard in surgical treatment of appendicitis.[8] Surgical advancement in the management of acute appendicitis has evolved in great extent in the last 120 years, from McBurney's simple large incision and its modification to minimally invasive LA, to barely noticeable incisions after single-incision laparoscopic surgery (SILS).[9]

The safest treatment in all stages of the inflamed appendix is appendicectomy.[10] Open appendicectomy always results in a disfiguring scar over the abdomen. Cosmetic outcome is important to consider as the disease affects mainly the young people.[11,12] Apart from cosmesis, Larson et al.[13] has established numerous reasons why a laparoscopic procedure stands superior to the conventional open appendicectomy which includes better visualization and magnification, exploration of all surrounding viscera, better handling in obese patients, minimal tissue trauma, and reduced the incidence of surgical-site infection.[14,15]

The conventional three-port laparoscopic appendicectomy includes 10-mm camera port at the umbilicus and 2 working 5-mm

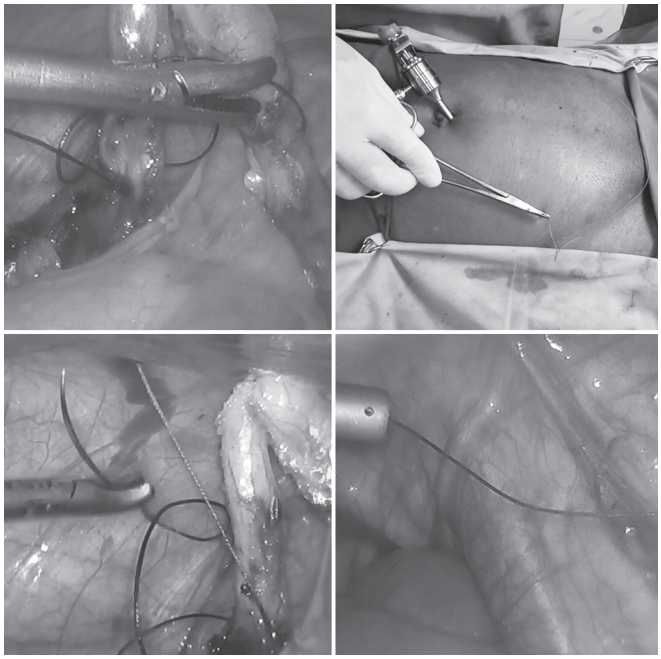

Fig. 3: Trans-fixation of base of appendix by percutaneous introduction of polyglactin suture, needle retrieved, and long end of suture pulled out through port and knotting done

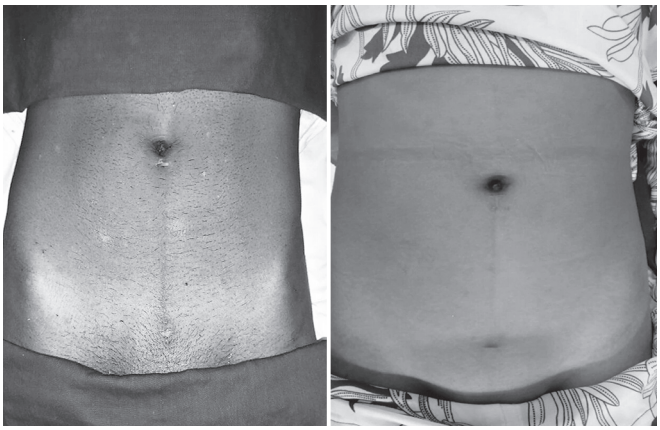

Fig. 4: Postoperative scar in male and female patients

Table 1: Showing results of two-port appendicectomy vs conventional laparoscopic appendicectomy

S. no	*Parameters*	*Mini two-port technique of appendicectomy (n = 168)*	*Conventional three-port appendicectomy (n = 32)*
1	Operative time (minutes)	24	42
2	Cosmesis	Two 5-mm port scars hidden in umbilicus and pubic hairline producing "scarless" appearance	One 10 mm and two 5 mm. Scar visible at umbilicus and lt. iliac fossa
3	Wound infection	1 (0.59%)	1 (3.125%)
4	Hospital stay (mean days)	1.7	2.1
5	Intraoperative rupture of appendix	0	1 (3.125%)
6	Intraoperative bleeding	2 (1.19%)	2 (6.25%)
7	Adhesiolysis	50	12

ports in suprapubic region and left iliac fossa. Laparoscopy gives great advantage to both patient and surgeon and also the efforts to reduce the resultant trauma and to increase better cosmetic results by decreasing the size and number of cuts created for the ports. Mini-laparoscopy poses as an option to achieve this by using portals located as usual but with using instruments of smaller diameter.[15,16] Our technique of mini two-port appendicectomy gives the advantages of the both decreased number and size of the scar as compared to the CLA (Fig. 4).

The TPA technique with loop polypropylene retraction provides a good result even with extensive inflammation, enables stable manipulation, and gives better counter traction than conventional forceps used in three-port technique. The site for placement of the needle loop is decided on the basis of the position of the appendix on laparoscopic visualization of the appendix, also considering ergonomic viewpoint. The umbilical and suprapubic port sites are hidden by natural camouflages, and the left Iliac fossa (LIF) port is the only visible external sign of surgery in the CLA. The two-port technique avoids even this marker of abdominal invasion,[17] and 5-mm umbilical port further reduces the scar size.

As per Khan and Al-Bassam,[18] studies suggest that the two-port appendicectomy compared to three port was quicker to perform with less postoperative analgesia requirement with an added advantage of smaller incision and a better cosmetic result. There are many studies that have used this surgical technique[19] but with use of commercially endoloop, knot pusher.

Our intracorporeal two-port laparoscopic appendicectomy with indigenously completely intracorporeal novel knotting technique is an appealing alternative for the treatment of acute appendicitis because of its decreased invasiveness and improved cosmesis. The use of an intra-abdominal sling technique by using needle retraction suture counterpoises for the lack of the retraction port in the left iliac fossa and eliminates any skin scarring at that site. The use of novel knotting technique helps reduce the size of the working port as 12-mm ports are used in case of stapler-assisted ligation of base of appendix.

In epochs where surgeons are focusing on transluminal approaches to access the abdominal cavity, laparoscopy is favored for its extended advantages of enhanced exposure, ergonomics, instrument diversity, economically sound, and overall patient safety.[7] TPA is a hybrid technique combines the advantages of laparoscopy, which consists of aspects like improved visualization and better abdominal exploration, and traditional techniques of open surgery.[7]

Nevertheless, despite these advantages, efforts to further decrease the abdominal incision and scar has led into expansion of natural orifice transluminal endoscopic surgery (NOTES). Even though NOTES is virtually scarless as the intra-abdominal entry points are hidden. There are several drawbacks, such as, lack of instruments availability, intraluminal invasion of the hollow organs, and failed sutures, which fails the idea of cost benefit analysis.[20,21]

Single-incision laparoscopic surgery applies a single multiluminal port, or multiple monoluminal ports, through a single skin incision. Although this technique has been embraced by surgeons worldwide, instruments and procedure are under fundamental stage of investigation.[22] List of disadvantages include lack of triangulation and ease of maneuverability due to clashing of instruments as it uses single umbilical port for all the working instruments and requirements of specialized instruments. As per Donmez et al.,[23] in SILS port procedure, a 2.5-cm incision is required, which may result increased infection risk, port-site hernia, postoperative pain, and subsequently a large visible scar which is avoided in 2-port technique. SILS also demands requirements of specialized instruments leading higher operation cost.[24–27]

The only limitation of TPA with as described by Kiran et al.[28] is the presence of dense adhesions and long appendix, but here a double retraction technique described in our study can overcome this shortcoming. Our study also describes the technique pragmatic in cases of edematous cecum and grossly inflamed appendix, which further circumvents the likelihoods of conversion to CLA or open appendicectomy. The suture used polyglactin 2-0 in ligating the base of the appendix in our technique is easily available and cost-effective in contrast to the endoloop or Endo GI stapler. The two-port technique further reducing the financial burden and can be used in rural and peripheral areas with limited resources.[29,30] This novel suturing technique is easy to learn (reproducible) and apply (replicable), with short learning cure. The overall procedure can be performed by trained laparoscopic surgeon, whereas SILS and NOTES demand expertise and also have a steep learning curve.[5]

In pursuit of minimizing surgical trauma and achieving better esthetics by reducing the size and number of ports, this mini two-port technique is devised to offer an easier and safe alternative in comparison to conventional three-port technique. This led to the invention of laparoscopic surgical knot which can be tied with a single instrument through a single port and single hand which can also be used to ligate cystic duct, renal vessels, splenic vessels, or any other tubular structure without need for additional port.

Conclusion

This mini two-port technique with novel knotting technique is easy to learn and helps to overcome the challenges and limitations faced during two laparoscopic appendicectomies; however, conversion to conventional approach in complicated cases is still advisable. It is safe and effective intermediate option from conventional three port to SILS/NOTES/Endo GIA staplers.

Statement of Authorship and Conflict of Interest

All authors listed below have participated sufficiently in the work to take public responsibility for appropriate portions of the content.

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RESEARCH ARTICLE

Open vs Laparoscopic Inguinal Hernia Repair: Influences of Patient Age and BMI on Analgesic Requirements and Hospital Stay Duration

Derek K Mwagiru[1], Theresa A Larkin[2]

Abstract

Aim: Comparisons between open vs laparoscopic surgical methods for inguinal hernia repair have yielded inconsistent results with respect to patients' pain levels and analgesic requirements post-surgery. This study compared open vs laparoscopic inguinal hernia repair in terms of types and quantity of analgesics administered during the postoperative recovery period and the hospital stay, including the influences of patient characteristics such as age, BMI, and previous inguinal hernia repair.

Materials and methods: This was a cross-sectional study of retrospective analysis of data pertaining to inguinal hernia repairs in a rural hospital in Australia.

Results: Among 63 patients (60 males), 62% had undergone open and 38% laparoscopic surgery for inguinal hernia repair. Type and dose of analgesic medications given during both the postoperative recovery period and the hospital ward stay and the duration of the hospital stay were not significantly different between open and laparoscopic groups. However, there were significant influences of BMI, with significantly more overweight and obese patients requiring a combination of opioids with nonsteroidal anti-inflammatory drug (NSAID) or paracetamol during the hospital stay, and with obese patients having the longest hospital stay, followed by overweight patients. Patients who had open surgery were significantly older and less likely to have had a previous inguinal hernia repair than those who had laparoscopic surgery, and there was a significant correlation between age and duration of hospital stay.

Conclusion: Patient characteristics of age, BMI, and previous inguinal hernia repair are confounding factors when comparing analgesic requirements and hospital stay duration after open vs laparoscopic inguinal hernia repair.

Keywords: Analgesic, BMI, Inguinal hernia, Laparoscopic.

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Introduction

Inguinal hernias are one of the most common abdominal pathologies requiring surgery,[1] with the lifetime risks of developing an inguinal hernia estimated to be 27% for men and 3% for women.[2] An indirect inguinal hernia passes through the inguinal canal, while a direct inguinal hernia protrudes through the abdominal wall in the area of Hesselbach's triangle.[3,4] Both types of hernias can arise due to either congenital or acquired weakness of the abdominal wall and/or inguinal canal structures.

Current methods of inguinal hernia repair include either an open or a laparoscopic surgical approach, with the overall success based primarily on the fewest complications and the earliest return to normal activities.[5] Open hernia repairs involve an incision through the skin, fascia, and muscle of the abdominal wall to expose and reduce the hernia.[6] In contrast, the laparoscopic method is minimally invasive and does not require the division of muscle.[7] Despite laparoscopic surgery being technically more complex, which necessitates a longer duration of general anesthesia,[7,8] it is usually associated with a shorter recovery time compared with open surgery.[9–12]

Recently, there has been increased focus on postoperative and chronic pain as measures of surgical success.[10] Several studies have reported chronic pain rates of up to 20% after inguinal hernia repair.[13–17] Of significance is that in addition to postoperative pain itself being a measure of surgery recovery, untreated postoperative pain is a risk factor for chronic pain.[13] Assessment of postoperative pain after inguinal hernia repair using visual analog scores (VAS) is inconclusive;[5,12,18] however, as a subjective measure of pain this is limited. Other studies have compared analgesic consumption following inguinal hernia repair and reported this was lower after laparoscopic than open surgery, during the first day[5,10,11,14,19] and the first 7 days after surgery;[12,20,21] or not different between the two surgical modes.[22] However, most of these studies only assessed patients' intake of diclofenac and paracetamol, and did not consider any of the opioid-based analgesic medications administered during the immediate postoperative period or the hospital ward stay.

Patient characteristics can also influence analgesic medication intake. There are several predictors of chronic pain including younger age, higher BMI, and being discharged on the day of surgery rather than staying overnight;[15,23] however, the associations between these variables and postoperative pain have not been

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reported with respect to inguinal hernia repair. In particular, while obesity affects drug volume distribution and modifies anesthetic requirements during surgery,[24] little research has examined the influence of BMI on postoperative analgesic use. Considering that increased body weight is an independent risk factor for developing an inguinal hernia, this is an important factor to assess in this context.

A comprehensive examination of postoperative analgesia consumption after open vs laparoscopic inguinal hernia repair in Australia is lacking. The current study aims to compare open vs laparoscopic surgical methods for inguinal hernia repairs in terms of the types and quantity of analgesia administered during the immediate postoperative recovery period (up to 1 hour post-surgery) and for the duration of the patient's hospital ward stay. In addition, patient characteristics of sex, age, weight, BMI, type of inguinal hernia, and previous inguinal hernia repair were included in analyzes for further comparison between open and laparoscopic groups, and associations between subgroups.

Materials and Methods

The project was undertaken after approval by the Human Research Ethics Committee of the University of Wollongong (LNR/16/WGONG/253). Patient data were obtained from Griffith Base Hospital, a 114-bed regional hospital in New South Wales, Australia, for all patients aged at least 18 years who had undergone an inguinal hernia repair during 2016–2017, using the hospital database (SurgiNet). All records were deidentified and only anonymous data were analyzed. Data collected included sex, age, weight, BMI, type of inguinal hernia (direct or indirect), whether there had been a previous inguinal hernia repair, the surgical repair method (open or laparoscopic), and duration of hospital stay. Details pertaining to analgesic medications given during recovery and while on the hospital ward were obtained from the respective medication charts. The type(s) of medication and dosage (concentration and frequency) were recorded, and total dose after surgery was calculated: (i) during recovery and (ii) during the hospital stay. To compare between doses of different opioid medications, an equivalent morphine dose was calculated, where 1 mg morphine = 1 mg oxycodone = 10 µg fentanyl.

Data were analyzed using IBM SPSS Statistics 21. Results are reported as means with standard deviations. Data between groups (open vs laparoscopic surgery) were compared using Student's unpaired *t* tests. Patients' BMIs were classified[25] as healthy (BMI = 18.5–24.9 kg/m^2), overweight (BMI = 25–30 kg/m^2), or obese (BMI > 30 kg/m^2). The distributions of previous hernia, hernia type, and type of analgesia medication (for the recovery and hospital stay periods) were compared between surgery modes and BMI categories using Chi-square tests. One-way ANOVA was used to compare analgesic doses per BMI category.

Results

Demographic and Anthropometric Data

Data from a total of 63 patients (60 males and 3 females) were included in the study. Demographic and anthropometric data are presented in Table 1. The majority of patients, including all three females, had undergone open surgery. There was a distinct difference in surgical mode for those younger vs older than 50 years of age: 76% of patients aged between 20 years and 49 years had undergone laparoscopic surgery while 81% of those aged between 50 years and 88 years had open surgery.

Table 1: Demographic and anthropometric data for patients who underwent open and laparoscopic surgery methods of inguinal hernia repair. Mean ± standard deviation with range in parentheses

	Open surgery (n = 39; 62%)	*Laparoscopic surgery (n = 24; 38%)*	*Between-group comparison*
Age (years)	66 ± 16 (22–88)	47 ± 16 (20–83)	$p < 0.0001$
Weight (kg)	79 ± 13 (53–110)	84 ± 15 (78–112)	$p = 0.126$
BMI (kg/m^2)	27 ± 3 (18–37)	28 ± 4 (20–37)	$p = 0.274$
Hernia type: direct vs indirect	41% vs 59%	46% vs 54%	$\chi^2 = 0.140$ $p = 0.708$
Previous hernia	21%	58%	$\chi^2 = 9.351$ $p = 0.002$

Hernia Type and Previous Hernia

The majority (64%) of those with a previous hernia underwent laparoscopic surgery, while the majority (76%) of those for whom this was their first hernia repair had open surgery. A significantly higher proportion of patients with a direct hernia compared with an indirect hernia had a previous hernia (68% vs 29%; $\chi^2 = 8.853$, $p = 0.003$). There were no significant effect of any of age, BMI, or weight on having an indirect vs direct hernia.

Hospital Stay Duration and Pain Medications Administered

Duration of hospital stay was not significantly different between the open and laparoscopic surgeries (Table 2); however, there was a significant correlation between age and duration of hospital stay ($R = 0.314$, $p = 0.012$). Medications given during the immediate postoperative period and the hospital stay included paracetamol, nonsteroidal anti-inflammatory drugs (NSAIDs), and opioid medications (morphine or fentanyl). Participants' analgesic medication for each time period was classified as (i) none, (ii) paracetamol and/or NSAID, (iii) opioid medication, and (iv) a combination of opioid medication with either paracetamol or NSAID.

Pain Medication in the Immediate Postoperative Period

During the first hour post-surgery, just over half (57%) of all patients did not receive any analgesia and 43% were given opioid medication (fentanyl 20–200 µg or morphine 2.5–15 mg). There was no significant difference between the open vs laparoscopic surgery groups for medication type ($\chi^2 = 0.140$, $p = 0.708$), or equivalent morphine dose total or per kg body weight (Table 2), or for equivalent morphine dose when only those who received opioid analgesic were considered ($p = 0.64$). There was a trend for an inverse correlation between age and equivalent morphine dose ($R = -0.243$, $p = 0.055$).

Pain Medication during the Hospital Stay

During the hospital stay, the majority (57%) of all patients received a combination of NSAIDs and opioids, 30% received only paracetamol and/or NSAIDs, 5% received only opioids, and 8% did not receive

Table 2: Medication data for patients who underwent open and laparoscopic surgery methods of inguinal hernia repair. Mean ± standard deviation with range in parentheses. Between-group comparisons: Student's unpaired *t* tests

		Open surgery (n = 39)	*Laparoscopic surgery (n = 24)*	*Between-group comparison*
Length of hospital stay (days)		2.2 ± 0.8 (1–5)	2.0 ± 0.8 (1–5)	$p = 0.496$
Medication dose (mg)				
Recovery	Opioid equivalents	3.7 ± 5.9 (0–25)	4.7 ± 6.2 (0–20)	$p = 0.553$
	Opioid equivalents/kg body weight	0.05 ± 0.08 (0–0.35)	0.05 ± 0.07 (0–0.24)	$p = 0.703$
Hospital stay	Opioid equivalents	17.3 ± 17.7 (0–55)	15.2 ± 21.6 (0–75)	$p = 0.675$
	Paracetamol (g)	5.7 ± 3.7 (0–1.6)	4.8 ± 3.9 (0–1.6)	$p = 0.344$
	NSAID	112 ± 275 (0–1200)	209 ± 601 (0–2800)	$p = 0.394$
	Opioid equivalents/kg body weight	0.22 ± 0.23 (0–0.75)	0.19 ± 0.26 (0–0.76)	$p = 0.259$
	Paracetamol (g)/kg body weight	0.07 ± 0.05 (0–0.17)	0.06 ± 0.05 (0–0.24)	$p = 0.583$

any medication. There were no significant difference between surgery groups for medication type ($\chi^2 = 1.993$, $p = 0.574$), for equivalent morphine dose total or per kg body weight (Table 2), or for equivalent morphine dose when only those who received opioid analgesic were included in analysis ($p = 0.88$). There was no correlation between age and equivalent morphine dose ($R = 0.025$, $p = 0.844$).

Influences of BMI

The BMI group (15 healthy weight, 37 overweight, and 11 obese patients) had no significant effect on the distribution of medication type received during the immediate postoperative period ($\chi^2 = 1.508$; $p = 0.471$), but did have a significant influence on category of pain medication required during the hospital stay ($\chi^2 = 12.783$; $p = 0.047$). During this time, the majority of overweight and obese patients (62 and 60%, respectively) but less than half (43%) of healthy patients required a combination of opioids with either NSAID or paracetamol. Among healthy-weight patients, equivalent proportions (21% each) required just opioids or NSAIDs and/or paracetamol, and 14% did not receive any pain medication. In contrast, among overweight and obese patients, none received opioids alone; 33 and 30%, respectively, required only NSAIDs and/or paracetamol; and only 5 and 10%, respectively, did not require any medication. There was no influence of BMI on dose per kg body weight for opioid analgesics received during the immediate postoperative period, or for opioids or paracetamol during the hospital stay ($F_{2,60} = 1.216$, $p = 0.304$; $F_{2,60} = 0.042$, $p = 0.959$; $F_{2,60} = 0.546$, $p = 0.582$, respectively). The BMI also significantly influenced hospital stay duration ($\chi^2 = 20.74$; $p = 0.008$): the majority of healthy patients (72%) stayed 1–2 days, and overweight patients (87%) stayed 2 days, and all obese patients stayed at least 2 days.

Discussion

Just over one-third (38%) of inguinal hernia repairs in the current study were conducted using laparoscopic surgery, which is similar to the overall Australian rate for the 15 years prior, of 43%.[1] Overall, there were no significant differences between patients who underwent open vs laparoscopic surgery for inguinal hernia repair in terms of type and dose of analgesic medications given during the immediate postoperative period or the hospital stay, or the duration of the hospital stay. However, there was an influence of BMI on several measures, with increased BMI associated with requiring a combination of opioids with NSAIDs or paracetamol rather than none of, or any of these alone, and with a longer hospital stay, which is clinically relevant. Patients in the open surgery group were significantly older, which reflects Australian epidemiological data that elderly patients are less likely to undergo laparoscopic surgical repair of groin hernias.[1] Further, age was significantly correlated with hospital stay duration, and almost significantly ($p = 0.055$) inversely correlated with equivalent morphine dose in the postoperative period, so this is a confounding factor. Patients who underwent laparoscopic surgery and patients with a direct hernia were significantly more likely to have had a previous hernia repair. Overall, there was large variation in the total dose of all medications given.

The current finding of no difference in analgesic consumption after open vs laparoscopic surgery during the immediate postoperative period and hospital stay is in contrast with much previous research.[5,10–12,14,20,21] These studies all reported significantly lower pain medication requirements after laparoscopic compared with open surgery for inguinal hernia repair. Notably, in the current study, patients who underwent open surgery were significantly older, and there was an inverse correlation, close to significant, between age and equivalent morphine dose in the postoperative period. This is in line with previous reports that younger age is associated with increased perception of chronic pain,[15,23] but may have masked any between groups difference in analgesic medication administration because of the confounding effects of age and pain. In the case of age-matched groups, analgesic requirements may have been less after laparoscopic vs open surgery, as per the above-mentioned previously reported findings. Interactions between surgery mode and age should be included in comparisons of different surgical methods for more accurate results.

A limitation of previous research examining analgesic doses after inguinal hernia repair is that opioid medications were not included in analyzes. In the current study, the majority of patients (62%) received opioid medication (mean of 16.5 ± 2.4 mg) during their hospital stay. The proportion of patients receiving opioid medication in the current study was higher than, but the dose was similar to, a comparable study that reported 40% of patients took opioid analgesics (most common total intake of 10–20 mg) for up to 1 week post-surgery.[26] Given the widespread opioid tolerance and abuse and the increasing move to avoid opioids for surgical pain, including after inguinal hernia repair,[27] it is crucial that opioid consumption is assessed, particularly when comparing surgical modalities. Further, in the current study there was a significant effect of BMI on the analgesic profile during the hospital stay, with overweight and obese participants more likely to require a combination of opioid and NSAIDs, rather than just NSAIDs or

paracetamol alone, or no analgesia. However, opioid dose per kg body weight did not differ based on the BMI category, contradicting a previous report of 30% less morphine consumption per kg body weight in obese than healthy-weight patients.[28] Given the increased prevalence of intake of opioid(s) in combination with NSAID and/or paracetamol among patients with higher BMI in the current study, and that higher BMI is a predictor of chronic pain post-surgery,[15,23] which has a significant health burden, this is clinically relevant.

Duration of hospital stay did not differ after open vs laparoscopic surgery, which reflects the findings of an earlier study.[20] However, age was a confounding factor, with a significant correlation between age and hospital stay duration. Considering that patients in the open surgery group were significantly older than those in the laparoscopic group, with age-matched groups, open surgery may have been associated with a shorter hospital stay duration. The influence of BMI on hospital stay duration, whereby obese patients stayed an average extra day compared with those with a healthy BMI contradicts a previous study of no significant difference between those with a BMI greater or less than 30 kg/m^2 on hospital stay after incisional hernia repair.[29] The impact of a higher BMI on hospital stay is significant in terms of health economics considering the large costs associated with this.[30]

There were several limitations to the current study. This research included a relatively small sample size ($n = 63$); however, this is similar to previous studies of total patient numbers ranging between 50 and 100.[12,14,20–22] Because of the large variability in patients' analgesic requirements, greater investigation into the influence of patient characteristics in a larger cohort, alongside subjective measures of pain, would provide more information on the determinants of this. Further, a longitudinal study design to assess return to activities of daily living as well as chronic pain and analgesia consumption would provide better data with respect to patient impact and the wider health burden.

Overall, this study demonstrated that patient characteristics of age and BMI influence analgesic consumption during, and duration of, the hospital stay following repair of inguinal hernia, with no main effect of the surgery mode. Further research is warranted with respect to the interactions between patient characteristics and recovery following open and laparoscopic surgical repair modes for inguinal hernia repair, with the ultimate goal being optimal patient recovery.

Clinical Significance

Postoperative analgesic requirements in inguinal hernia repair is significantly impacted by patient factors of age, BMI, and previous inguinal hernia repairs. Patient characteristics need to be considered in future research and assessment of postoperative pain in inguinal hernia surgery.

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REVIEW ARTICLE

Laparoscopic Ventral Hernia Repair with Polypropylene Mesh: A Literature Review

Elmutaz Kanani

Abstract

Background: Laparoscopic ventral hernia repair (LVHR) is currently considered the gold standard. However, the mesh selection is still controversial. The aim of this review is to look for evidence that supports the use of polypropylene mesh (PPM) in the intraperitoneal position in LVHR.

Materials and methods: The literature was searched systematically using Google Scholar and PubMed for controlled studies, prospective descriptive series, and retrospective case series.

Results: A total of 11 studies were retrieved. All the studies were either retrospective or animal experiments. Their outcomes are heterogeneous and they have multiple weaknesses.

Conclusion: The literature clearly lacks data from controlled randomized trials in humans that can give strong evidence. The use of intraperitoneal PPM in LVHR remains an individual surgeon preference decision until well-designed prospective double-blind randomized controlled clinical trials are available.

Keywords: Complication, Laparoscopy, Mesh, Polypropylene, Prolene, Ventral hernia.

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Introduction

In laparoscopic ventral hernia repair (LVHR), there are different techniques practiced like three ports repair, two ports repair, intraperitoneal, and totally extraperitoneal repair. The intraperitoneal technique (IPOM), although simple and successful, faces the dilemma of mesh selection. A large number of variable mesh types are available in the market and each claimed to be superior to others. Likewise, the cost is not uniform as some are very expensive while others are cheaper. Reliable data on mesh safety and efficacy are not available to the clinician.[1] The polypropylene mesh (PPM) is among the cheapest and had stood the test of time in extraperitoneal hernia repair. Its use in intraperitoneal position still remains doubtful due to the possibility of its adhesion to bowel causing serious complications like intestinal obstruction and fistulization. Newly developed meshes proved to reduce the inflammatory response and therefore reduce the adhesion formation.[2] Coatings added to newer meshes aim also to prevent bowel adhesion to the mesh surface. In fact, this also had been scrutinized and some newer meshes were found to cause adhesions in animal experiments.[3] This conflicting information put the surgeon in a difficult situation especially when expensive types of mesh cannot be provided because of financial restrictions. Patient safety should not be simply jeopardized because of financial aspects and this is a major ethical issue.

In this review, we tried to answer the question of is it safe to use intraperitoneal PPM in ventral hernia repair by retrieving the evidence from the published literature about the topic.

Materials and Methods

A systematic literature search using the databases of Google Scholar and PubMed was performed. Eleven articles were retrieved. They were four literature reviews, four case series, and three animal experiments. The articles were then analyzed in terms of year of publication, type of study, details of the study, number of participant subjects, duration of the study and maximum duration of follow-up, method of assessment of complications, and the final recommendations.

Results

A total of eleven articles were retrieved. Three were animal experiments, four are case series, and four are literature reviews. Four studies concluded that PPM is safe however; none of them was a prospective randomized study. On the other hand, four studies gave recommendations against the PPM. The remaining three studies either left the choice of mesh to the surgeon's preference or recommended a barrier between mesh and intestine. The case series have in common limited number of subjects and they vary in follow-up duration as all had short-term follow-up. The assessment methods were also different between the studies. The results of animal experiments cannot be generalized to humans. The literature review recommendations are heterogeneous and nonconclusive. Table 1 summarizes the findings of all these articles.

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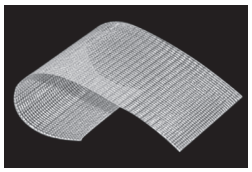
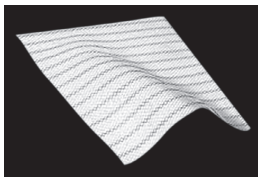
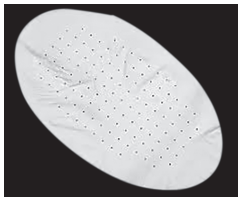
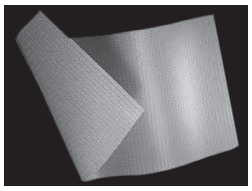
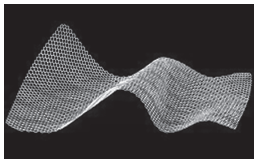
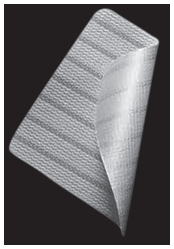
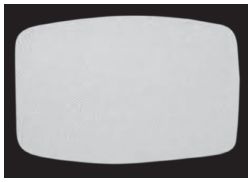
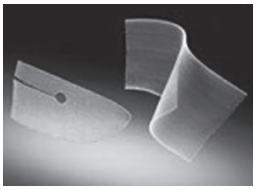
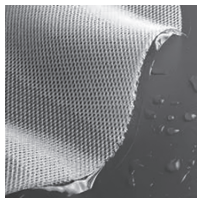
Table 1: Summary of relevant studies

Authors	*Year of publication*	*Type of study*	*Details of study*	*No. of subjects*	*Follow-up time*	*Conclusions*
Zieren et al.[2]	2004	Experimental in pigs	Compared Vypro and prolene mesh		3 months	Both meshes cannot be recommended for intraperitoneal placement in hernia surgery because of their adhesion potential and risk of bowel obstruction.
Bingener et al.[4]	2004	Case series	Polypropylene mesh with interposition of omentum over loops of bowel	30 patients	14 months	PPM with interposition of omentum is not associated with visceral adhesions in the majority of patients.
Burger et al.[3]	2006	Experimental in rats	Compared different types of mesh		30 days	Recommended the use of Parietex composite and Sepramesh for hernia repair in which direct contact with the abdominal viscera cannot be avoided.
Doctor[5]	2006	Literature review	Compared prostheses with and without barrier			Prosthesis with a barrier only should be used for intra-abdominal placement to prevent bowel adhesions.
Eriksen et al.[1]	2007	Literature review				Choice of mesh depends on surgeon's preference and cost till further randomized controlled clinical trials are available.
Jitea et al.[6]	2008	Case series	Polypropylene mesh with omentum interposition between mesh and bowel	21 patients	6–12 months	Intraperitoneal PPM in umbilical hernia repair is a safe, efficient, and rapid method avoiding infection complications in obese cirrhotic patient.
Schreinemacher et al.[7]	2009	Experimental in rats	Compared six mesh types (PPM, Ultrapro, Proceed, Parietex Composite, and c-Qur)		30 days	The absorbable layers of Parietex and C-Qur reduce adhesion formation to intraperitoneal mesh in the short-term, but the effect diminishes and phagocytosis of absorbable coatings may contribute to adhesion formation.
Qadri et al.[8]	2010	Case series		80 patients	28 months	Intraperitoneal use of PPM was not associated with any significant complication.
Yildirim et al.[9]	2010	Case series		25 patients	28 months	The tension-free repair of incisional hernia with PPM in the intraperitoneal position is a safe and easy procedure with acceptable morbidity and no recurrence.
Tran et al.[10]	2012	Experiment in pigs	Compared PPM and DualMesh with and without fibrin sealant		3 months	DualMesh caused fewer omental and visceral adhesions than PPM did. Fibrin sealant eliminated adhesions to DualMesh and prevented adhesions to PPM when applied over the entire surface.
Ramakrishna and Lakshman[11]	2013	Literature review	Intraperitoneal PPM and newer meshes in ventral hernia repair			Complications of intraperitoneal PPM can occur with the newer meshes also. There is no statistically significant difference in the incidence of these complications between these meshes.

Table 2: Some of the common mesh types

Name	*Composition*	*Image*
Prolene	Polypropylene	
Ultrapro	Polypropylene–polyglecaprone composite	
Tutomesh	Bovine pericardium	
Sepramesh	Polypropylene with carboxymethylcellulose–sodium hyaluronate coating	
Timesh	Titanium–polypropylene composite	
Proceed	Polypropylene–polydioxanone composite with oxidized cellulose coating	
C-Qur	Omega-3 fatty acid-coated polypropylene	
Marlex	Crystalline polypropylene and high-density polyethylene (HDPE)	
DualMesh	e-PTFE	
Parietex composite	Polyester with collagen–polyethylene glycol–glycerol coating	

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Discussion

Hernia repair has to be completed by the placement of a mesh except in few situations.[12,13] Which type of mesh is the best for each hernia is a controversial issue. There are different surgeon's opinions as well as a large pool of mesh types to select from. These mesh types differ in composition, coatings, pore size, strength, shrinkage, and methods of fixation. The commonly used mesh types are illustrated in Table 2.

Complications secondary to the presence of mesh do occur and there is no available mesh type without such a risk. In the literature, there are reports of different complications associated with different mesh types.[2,14,15] Among the common complications are adhesions formation leading to bowel obstruction, fistulization, sinus formation, infection, and hernia recurrence. The development of complications is sometimes related to the position of the mesh rather than to its composition. For example, the PPM triggers the formation of adhesions, which is beneficial in the peri-peritoneal position while may be harmful if placed intraperitoneal.[16]

Despite the fact that all the case series analyzed in this review recommended a safe intraperitoneal placement of PPM, none of them qualify as an acceptable level of evidence. They have in common limited number of subjects and they vary in follow-up duration as all had short-term follow-up. The assessment methods were also different between the studies, e.g., Bingener and colleagues used ultrasound scan to examine the presence of intraperitoneal adhesions in their study.[4]

In the animal experiments two studies rejected the use of intraperitoneal PPM while the third one did not give clear recommendation but concluded that even coated meshes reduce the incidence of adhesions only in the short-term. Table 2 illustrates the common types of meshes. The results of animal experiments cannot be generalized directly to humans. Beside that they all lack

long-term follow-up and had included small numbers of subjects. Tran and colleagues studied the use of the fibrin sealant to cover the mesh and reported adhesions prevention after its use.[10] However, the fibrin sealant itself is costly, which takes us back to square one of the financial limitations.

The literature reviews failed to come up with a high-level evidence. In their review, Eriksen and his colleagues could not make out a clear recommendation from the published literature.[1] Later on, Doctor HG in his review rejected the use of intraperitoneal PPM.[5] In the most recent comprehensive literature review by Ramakrishna and Lakshman, no statistically significant difference in the incidence of complications between the PPM and newer meshes was found.[11] The data they gathered were heterogeneous and they could not find a prospective controlled randomized double-blind study comparing intraperitoneal placement of PPM with newer meshes.

Conclusion

The choice of mesh for intraperitoneal placement remains an unsolved issue. Complications had been reported with most of the mesh types. Well-designed prospective randomized controlled double-blind studies are required to generate high-level evidence that can change practice. Until then the mesh selection is a surgeon's decision depending on his/her preference and patient's affordability.

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REVIEW ARTICLE

Laparoscopic Intervention after Ventriculoperitoneal Shunt: A Case Report, Systematic Review, and Recommendations

Morva Tahmasbi Rad[1], Sandra Bogdanyova[2], Lisa M Wilhelm[3], Juergen Konczalla[4], Florian J Raimann[5], Markus Wallwiener[6], Sven Becker[7]

Abstract

Background: In patients presenting pelvic pathology and a placed ventriculoperitoneal (VP) shunt, there is uncertainty regarding the decision whether to use laparoscopy. The aim of the article is to examine the available literature as well as sharing our own experiences operating on a patient with a VP shunt using laparoscopy.

Materials and methods: We searched online libraries (PubMed, EMBASE, and Google Scholar) for all publications published between January 1975 and December 2018 on our topic. We performed a systematic review and shared our experience with laparoscopy in a patient with shunt and ovarian cancer.

Results: The age of the patients ranged from 1 to 79 years. The operations were performed by the departments of general surgery, gynecology, and urology. The time from the shunt operation to laparoscopy ranged from 5 days to 28 years. In different articles, four important points were considered and discussed: the risk of a shunt infection or complication, technical difficulties carrying out laparoscopy in patients with a VP shunt, the necessity of routine monitoring of the intracranial pressure (ICP) intraoperatively, and perioperative strategies to avoid complications.

Conclusion: It seems that a laparoscopic surgery in adults with a VP shunt appears to be a safe option. Based on the results of our case and the review of literature, we consider it necessary to have a neurosurgical consult performed prior to surgery, to have the procedure be carried out by an experienced surgeon, and to avoid complications by implementing recommended precautions.

Keywords: Complication, Laparoscopy, Shunt failure, Ventriculoperitoneal shunt.

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Introduction

The approach to abdominal procedures has transitioned toward less invasive techniques. The reduction in postoperative pain, decreases in wound infection, reduced hospital stay and cosmetic benefits have warranted its widespread use. With its increased use, surgeons are presented with a group of patients whose medical conditions are a challenge when performing laparoscopic surgery. Patients treated with a VP shunt represent such a group.[1]

Shunting is the most common treatment of hydrocephalus. Across all age-groups, the prevalence of hydrocephalus is estimated at 1.0 to 1.5%[2] and about 100,000 shunts are implanted each year in the developed countries.[2,3] Hydrocephalus has different etiologies, including malformations, agenesis, infections, mass lesions (tumors, hematomas, cysts, and abscesses), head trauma, and hemorrhages. A VP shunt is a mechanical device designed to transport the excess cerebrospinal fluid (CSF) from or near the point of obstruction to a reabsorption site and is implanted subcutaneously.[4] The absorption site is usually the abdomen (peritoneum). The valve and reservoir control the fluid withdrawn from the brain. The distal end is a small narrow piece of tubing which leads the excess CSF into the peritoneum (Figs 1 and 2). The unidirectionally designed valve is necessary to prevent the reflux of CSF and intra-abdominal fluid. It allows the fluid to flow only when the pressure inside the skull has exceeded a certain value (usually referred to as the "opening pressure").[3,4]

The ICP (pressure inside the skull), is normally 7 to 15 mm Hg at rest for a mature adult in the supine position. This varies by about 1 mm Hg caused by shifting in the production and absorption of CSF. The CSF pressure is shown to be influenced by abrupt changes in the intrathoracic pressure during coughing or intra-abdominal pressure, for example, Valsalva maneuver or communication with the vascular system (venous and arterial). The ICP at 20 to 25 mm Hg, which is the upper limit of the norm, may require treatment to reduce the ICP. When the ICP exceeds 40 to 50 mm Hg, the cerebral perfusion decreases to a level causing loss of consciousness and leading to infarction or brain dead.

A rise in the ICP is a result of a pressure rise in the vena cava when insufflating the abdomen with CO_2, and this leads to an obstruction of the cerebral veins. Hypercapnia caused by the absorption of

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CO2 through the peritoneal cavity and the effect of insufflation on ventilation can also lead to dilatation of the intracranial arteries and increases the cerebral perfusion.[5–7] In healthy people, the increased cerebral perfusion and ICP are temporary and tend to normalize after 10 minutes.

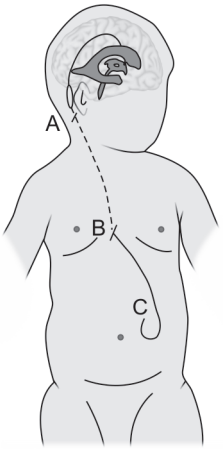


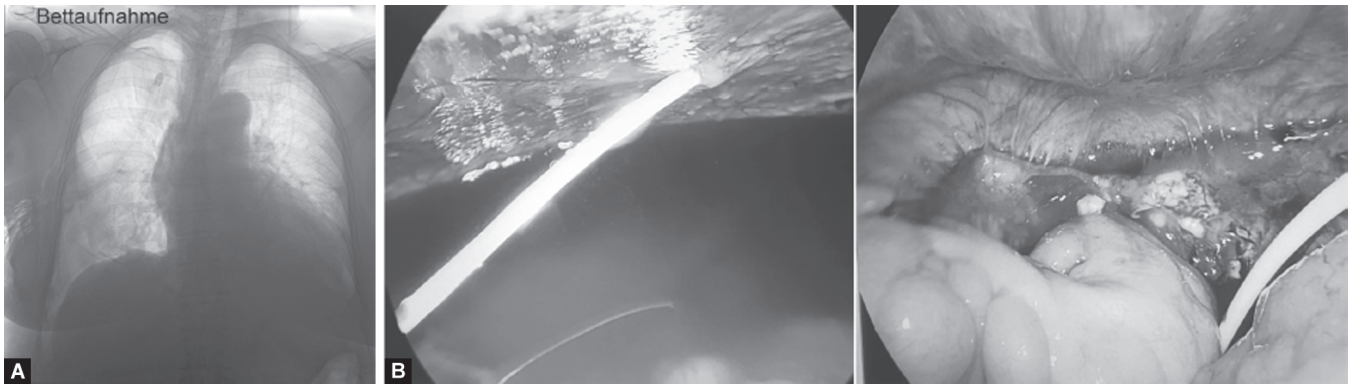
Fig. 1: The shunt has three components: the proximal portion of the shunt which is implanted into the ventricle of the brain, above which the obstruction has occurred; (A) Valve, reservoir, and shunt assistant; (A and B) subcutaneously implanted catheter; (B) The shunt enters the abdomen where it can be externalized or clamped; (B and C) The distal catheter (intraperitoneal part) which leads to the point where the excess CSF will be drained and be absorbed by the body

In patients with a VP (ventriculoperitoneal) shunt, there have been concerns about performing longer laparoscopic pressure. First, the general fear is based on the thought that increasing the pressure of the abdominal cavity could impair the drainage. Second, the carbon dioxide insufflated into the abdomen could get into the ventricular system and third, the acutely elevated ICP and increased intracranial blood volume are caused by the elevated venous pressure or hypercapnia.[8] An acute increase in ICP may result in a dangerous combination of hypertension with bradycardia and subsequently a serious neurological complication as a result of a posterior encephalic herniation (Fig. 3).[1,5–7,9]

On the contrary, the presence of a foreign body, such as a VP shunt, and the possibility of a bacterial inoculum being introduced during the operation presumably increase the chance of developing an infection[10] and adhesions.[11–14] The direct communication between the peritoneal cavity and the ventricular system in patients with VP shunts could also predispose patients to developing meningitis, shunt malformation, mental changes, seizure disorders, and decreased intellectual abilities.[10,13–16]

Patients who have VP shunts represent a special group who require special attention.[17] At the time, they have a near to normal life expectancy and are presume to undergo laparoscopic operations as other patients. We are presenting a case of a patient with ascites, a cardiovascular decompensation, and a VP shunt *in situ*.

Data regarding the intraoperative and postoperative complications or recommendations for patients with VP shunt who undergo laparoscopy are scarce. We present a systematic review of the topic in our article.



Figs 2A and B: Shunt view in (A) X-ray; (B) Laparoscopy

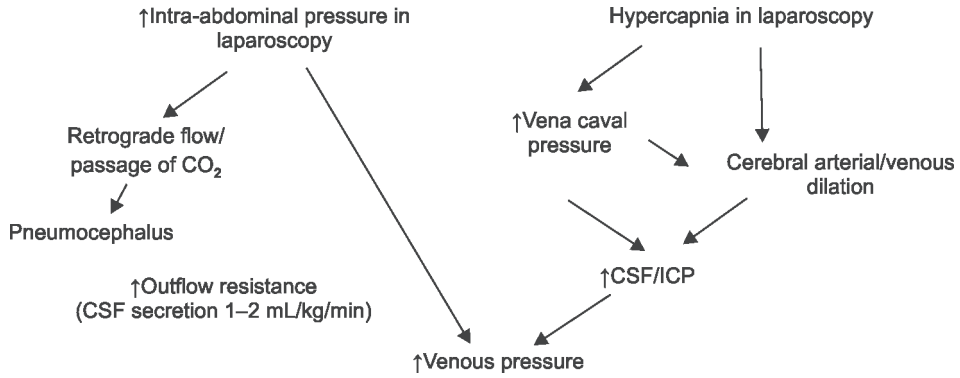


Fig. 3: Ventriculoperitoneal shunt and potential risk of laparoscopy

Case Description

A 74-year-old female had been referred to the department of gynecology with ascites. She came to the hospital 3 weeks prior for dyspnea and tachycardia. She was initially admitted to the cardiology department with increased levels of D-dimer, troponin, and pleural effusion. The medical history of the patient revealed a head trauma followed by an epileptic seizure. In 2004, she had undergone several cranial operations resulting in a VP shunt.

As reported by colleagues from the cardiology department, at the time of admission the patient was conscious, alert, and oriented. She presented with tachycardia (heart rate 144/minute), and the electrocardiography (ECG) showed atrial fibrillation and high blood pressure of 155/95 mm Hg. The laboratory results were normal: white cell count, 8.8 trillion cells/L, hemoglobin 15 g/dL, normal serum electrolytes, and coagulation profile. A blood gas analysis showed the following values: pH: 7.47, pO_2: 70 mm Hg, pCO_2: 29 mm Hg, HCO_3: 23 mmol/L, lactate: 15 mg/dL, and O_2 saturation 96%. Chest X-rays revealed pleural effusion and lung infiltration. An ultrasound was performed, which showed cholecystolithiasis and ascites. A paracentesis of approximately 6 l of ascites was carried out and a sample of the fluid was sent to the pathology. The atrial fibrillation was treated with beta-blockers, and the patient was started on anticoagulation therapy. The transthoracic echocardiogram had presented a mild mitral and tricuspid insufficiency and an ejection fraction of 40%.

The pathology findings showed non-small cell adenocarcinoma and the patient was referred to the department of internal medicine to rule out lung, pancreas, and gastrointestinal malignancies. There were no tumor or suspicion lesions in the endoscopic ultrasound, esophagogastroduodenoscopy, and colonoscopy. The computed tomography (CT) scan of the thorax and abdomen pointed out only suspicious abdominal retroperitoneal lymph nodes, and there were no other relevant findings. The patient was referred to the department of gynecology to rule out gynecological malignancy.

During the examination in our department, she had normal vital parameters. The abdominal examination showed a distended abdomen. No lesions or tumors were found in vaginal examination. The Pap smear was normal. The vaginal ultrasound revealed small ovaries and an endometrium thickness of 8 mm. To rule out a gynecological malignancy, we proceeded with hysteroscopy, dilatation, curettage, and laparoscopy with biopsies.

In the operating room, the patient was placed in a supine position. After the induction of general anesthesia, an orogastric and a Foley catheter were placed with the patient in the low lithotomy position. A 1-cm umbilical incision was carried out, followed by the placement of the Veress needle and insufflation of the abdomen up to 20 mm Hg (high flow technique). After establishing a 20-mm Hg pneumoperitoneum, a 10-mm port and camera were inserted in the abdominal cavity. The peritoneal contents were visualized, confirming no injury or abnormality. The distal VP shunt tube was lying across a small bowel in the left peritoneum and appeared to be intact without signs of abnormalities. The pneumoperitoneum was reduced and maintained at 14 mm Hg. Three liters of ascites were excreted. Because of adhesions in the left part of the pelvis, we could not see the left ovary properly. After removing the adhesions, there appeared to be suspicious lesions on the left fallopian tube and the left ovary. We took several biopsies and removed all of them in an EnDo-Bag. The surgical field was examined and there was no bleeding. No drain was inserted. The patient was administered antibiotics (cefuroxime and metronidazole) intraoperatively as well as postoperatively for 5 days.

In the postoperative phase, the patient presented no complications and was discharged 24 hours after the operation. There were no neurological symptoms. A neurosurgical consultation had taken place, and no intervention was recommended. The patient demonstrated an uneventful recovery. The histopathological results showed papillary serous carcinoma of the fallopian tube. The patient underwent an ovarian cancer typical laparotomy. In the 8-month follow-up, the patient showed no neurological complications.

Materials and Methods

Search Strategy, Study Selection, and Data Extraction

We searched PubMed, EMBASE, and Google Scholar for all publications between January 1975 and December 2018 with the search terms "ventriculoperitoneal shunt," "laparoscopy," "complications," "management," "cerebral monitoring," and "intracranial pressure".

The preliminary search results and article titles have been reviewed. All studies published with an abstract in English which reported at least one case of laparoscopic operation after VP shunts were potentially eligible for inclusion and have been screened to assess whether a full text was possible to acquire. Then all abstracts and full texts for all potentially eligible studies were reviewed and data were extracted. The relevant abstracts have been selected of this initial pool. A reference list of retrieved relevant articles was screened for other studies. Any disagreement during study selection and the data extraction process was resolved by discussion with the senior author (Sv.B). We excluded studies that were written and published in languages other than English or provided insufficient data.

A total of 136 publications were initially identified as eligible using the mentioned search terms. The inclusion criteria were met in 26 publications which came to 19.11%. A systematic review was performed according to Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines (Liberati 2009).[18] Flowchart 1 summarizes the article's search strategy.

Results

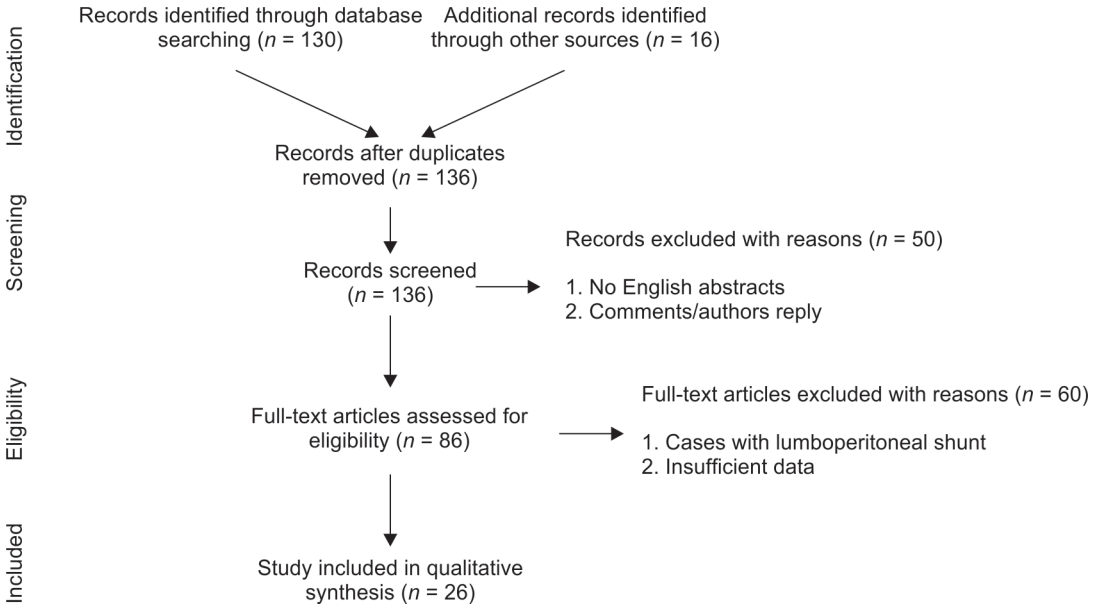
Population of Reported Patients

According to our research, 128 cases of laparoscopic operations after VP shunt were reported between 1992 and 2018 (Table 1). The collected data included the gender and the age of the patients, the kind of laparoscopic intervention, time from the shunt insertion to the laparoscopic operation, the pressure of pneumoperitoneum, manipulation with the VP shunt during the operation, and the complications. In our analysis, we specifically focused on different approaches and managements in patients with VP shunts needing laparoscopic intervention.[1,2,8,10,17,19–39]

The age of the patients ranged from 1 to 79 years. The operations were performed by the departments of general surgery, gynecology, and urology. The time from the shunt operation to laparoscopy ranged from 5 days to 28 years. The year the shunt was manufactured ranged from 1975 to 2013.

In different articles,[1,2,8,10,17,19–37,39,40] four important points are considered and discussed: the risk of a shunt infection or complication, technical difficulties carrying out laparoscopy in patients with a VP shunt, the necessity of routine monitoring of

Flowchart 1: Flowchart of articles during the review process



the ICP intraoperatively, and perioperative strategies to avoid complications.

Reported Cases, Complications, and Technical Difficulties

The pressure used for the pneumoperitoneum was between 8 mm Hg and 50 mm Hg, mostly 12 mm Hg.[1,2,8,10,17,19–37,39,40] The following complications occurred: one case of massive subcutaneous emphysema, 11 cases of conversion to laparotomy due to extensive inflammation, gangrenous situation,[10,20] a large tumor, and adhesions.[21,36] One case of shunt failure directly after the operation,[24] eight cases of postoperative VP shunt removal or revision due to infection,[1,2,8,10] one case of multiple organ failure and death,[20] and one case of pneumocephalus.[36]

Two cases of cancer with the VP shunt were reported, one prostatectomy in prostate cancer,[27] and one colectomy in cecal cancer.[38] In all the cases the traditional laparoscopy was used, except for one where robotic hysterectomy was carried out.[33]

The first reported case of laparoscopic surgery having complications with a VP shunt was described by Schwed et al.[19] They reported a 73-year-old woman who underwent a laparoscopic cholecystectomy 10 days after the insertion of a VP shunt. She suffered subcutaneous emphysema and impaired respiratory condition directly after the procedure. The patient recovered uneventfully with no evidence of postoperative infection.[19]

Collure et al.[20] observed one case of multiple organ failure, of a group of four patients, after a laparoscopic operation. A patient with multimorbidities received a laparoscopic cholecystectomy to reduce the surgical trauma and the long recovery phase that follows an open procedure. The postoperative period for this patient was complicated by lobar pneumonia, which progressed into multiorgan failure and the patient died.[20]

Tobias et al.[21] reported the first gynecological case in 1996. They did a safe diagnostic laparoscopy with a pneumoperitoneum pressure of 15 mm Hg in a patient with a pelvic tumor. The operation was converted to laparotomy due to adhesions and the size of the tumor.[21]

Baskin et al.[24] described the first documented case of laparoscopically induced VP shunt failure in 1998.[24] Postoperatively, the patient's condition was not improving, and he was experiencing intermittent apnea. He had to be re-intubated. An urgent head CT that the patient underwent shortly after experiencing the symptoms demonstrated a ventriculomegaly with no evidence of intracranial hemorrhage or pneumocephalus. The patient was indicated for another surgery. Intraoperatively, an isolated distal shunt obstruction was detected. A gentle irrigation cleared the occlusion. The authors believe that this shunt dysfunction occurred as a result of the peritoneal insufflation.

Allam et al.[10] conducted a chart review of 23 patients from 1994 to 2003 in the USA and reported a 57% rate of conversion to an open procedure, which was attributed to dense adhesion. Two patients required a shunt removal and replacement caused by a postoperative shunt infection. It has been documented that those two patients did not receive prophylactic antibiotics perioperatively. The rest of the patients was administered antibiotics pre-, intra, or postoperatively.

Raskin et al.[36] demonstrated a case of a 24-year-old female who had a VP shunt for more than 20 years, in 2011. She was diagnosed with endometriosis and underwent a laparoscopic bilateral salpingo-oophorectomy with the abdominal pressure of 50 mm Hg. The procedure was converted to an open laparotomy due to significant abdominal adhesions.

Approximately 1 week after the surgery, the patient presented with increased agitation and abdominal distension. A CT of the pelvis revealed an abscess requiring a placement of a pelvic drain and a VP shunt externalization. A head CT prior to the shunt removal showed a pneumocephalus with air to be seen within the shunt valve.[36]

Monitoring of the ICP Intraoperatively/Protecting Techniques

The first monitoring was reported by Collure et al.[20] who documented the ongoing flow of the CSF *in vivo* in VP shunts with the pneumoperitoneum pressure of 10 to 15 mm Hg.[20]

Table 1: An overview of studies reported different laparoscopic operations (general surgery, gynecology, and urology) in patients with VP shunts

Author, year	*Cases sex (F/M)*	*Age (year)*	*Operations*	*Age of VP shunt*	*Pneumoperitoneum pressure (mm Hg)*	*Complications*
Schwed, 1992	1 (F)	73	Cholecystectomy	10 days	15	Massive subcutaneous emphysema
Collure, 1995	4 (1 F/3 M)	39–75	Cholecystectomy	1–20 years	10–15	Multiple organ failure (1 case), 1 conversion to laparotomy
Tobias, 1996	1 (F)	64	Staging laparoscopy	7 years	15	Conversion to laparotomy
Uzzo, 1997	2 (1F/1M)	7 & 8	Bladder autoaugmentation	7 years	12	
Gaskill, 1998	1 (F)	16	Fundoplication	16 years	N/A	
Baskin, 1998	1 (M)	52	Jejunostomy	5 days	15	Shunt dysfunction
Jackman, 2000	18 (12 F/6 M)	13.2 (1–28)	Colostomy	N.A	16 (12–20)	3 shunt revisions
Walker, 2000	10 (N/A)	1–16	Funduplication, cholecystectomy	N/A	10–15	
Kimura, 2002	2 (1 F/1 M)	9–13	Cholecystectomy	N/A	N/A	
Brown, 2004	1 (M)	59	Prostatectomy in prostate cancer	28 years	15	
Ravaoherisoa, 2004	1 (F)	36	Resection of an ovarian cyst	N/A	N/A	
Al-Mufarrej, 2005	1 (F)	34	Cholecystectomy	3 years	13	
Martinez Ramos, 2006	1 (F)	33	Cholecystectomy	N/A	N/A	
Barina, 2007	3		Appendectomy	N/A	N/A	2 shunt removal
Li, 2008	7	47 (2–79)	4 cholecystectomy and 3 gastric bypass surgeries	N/A	N/A	
Fraser, 2009	51	3.5	Fundoplication/ gastrostomy	1.3yr		1 shunt infection and removal
Hammill, 2010	1 (F)	71	Cholecystectomy	10 years	N/A	
Allam, 2011	14	59	Cholecystectomy	N/A	N/A	8 conversions to laparotomy, 2 cases of VP shunt removal
Bush, 2011	1 (F)	34	Robotic hysterectomy	24	12	
Damrah, 2011	1 (M)	64	Cholecystectomy	6	12–15	
Ghomi, 2011	1	21	Hysteropexy	N/A	5–15	
Raskin, 2011	1 (F)	24	Bilateral salpingo-oophorectomy in endometriosis	20 years	50	Pneumocephalus, conversion to laparotomy
Sankpal, 2011	1 (F)	32	Salpingotomy in ectopic pregnancy	10 years	12	
Torigoe, 2013[38]	1 (F)	51	Colectomy in cecal cancer	N/A	8	
Cobianchi, 2014	1 (M)	41	Cholecystectomy	1	12	
Albarrak, 2015	1 (F)	41	Cholecystectomy	3 years	12	
Our case, 2020	1 (F)	74	Biopsies in the cancer of ovary	12	14–20	

In 1997, Uzzo et al.[22] used intraoperative ICP monitoring (introduction of the needle into the shunt reservoir) and saw a sudden increase in ICP by 12 mm Hg to a maximum of 25 mm Hg. This was matched by an increase in the flow rate of the CSF from the shunt, and no adverse neurological effects were observed postoperatively.

Jackman et al.[1] reviewed the intraoperatively documented records of 18 patients with a VP shunt after 19 consecutive laparoscopic operations, looking for signs of increased ICP. They reported no evidence of clinically increased ICP.

In 2004, Ravaoherisoa et al.[28] reported a successful laparoscopic resection of an ovarian cyst and described the use of transcranial Doppler. There was no difference in cerebral blood flow when the patient was placed in the Trendelenburg position with an insufflation pressure of 10 mm Hg. However, there was a decrease

in cerebral blood flow, when the abdominal pressure reached 15 mm Hg, and a rapid improvement was observed when the pressure decreased to 10 mm Hg.

Protecting the shunt from a potential reflux has always been a concern; therefore, several reports have been published addressing methods to temporarily protect the shunt during laparoscopic procedures.

There were several cases without any safety precautions being described,[1,8,17,20–26,32,34,37,39] but some surgeons used the following protecting techniques: clamping of the shunt intra-abdominally,[19,29,38] clamping of the shunt through a skin incision,[23] externalization of the shunt before insufflation[10,27,30] or intraoperatively because of the possibility of a peritonitis,[31] and packing of the shunt with a simple gauze, so that it is further away from the operative field.[10,27] Two cases were reported with patients who were diagnosed with cancer, where clamping[38] and intraoperative shunt externalization were the methods of choice.[27]

Some authors tried other methods to protect the shunts' function. In 2011, Ghomi et al.[35] reported a case of laparoscopic hysteropexy, where the intraperitoneal pressure decreased from 15 to 5 mm Hg every 30 minutes to minimize the changes in the ICP. This strategy was recommended as an option to prevent the possible shunt occlusions and a rise in the ICP.

Discussion

Laparoscopic surgery has become a preferred method of accessing and treating a variety of patients with intraperitoneal pathologies. Given the fact that laparoscopic interventions are now being used in a wider range of patients, surgeons can expect to encounter patients who have undergone placements of VP shunts and who present potential candidates for laparoscopic procedures.

The first VP shunt implantation was performed in 1908.[1] Schwed et al.[19] described the first laparoscopic operation in a patient with a VP shunt in 1992. The observation of a high ICP in animal models raised concerns about the safety of laparoscopy.[41] In 1995, after monitoring the flow of CSF in VP shunts intraoperatively with a pneumoperitoneum pressure of 10 to 15 mm Hg, it was suggested that elective laparoscopic operations in patients with VP shunts can be done safely without the need of clamping or the necessity of any other manipulation with the shunt.[20] Despite some successful reports,[16,17] the first intraoperative ICP monitoring was executed in 1997.[18] It showed a transient increase in the ICP during the laparoscopy and raised some questions whether a routine ICP monitoring should be advised.

To determine the potential for back-pressure failure and to observe the retrograde valve leaks, in 1999 Neale and Falk[42] performed a very interesting experiment. An *in vitro* model was used to test nine forms of VP shunt valves and demonstrated that none of the valves showed any retrograde flow when exposed to pressure up to 350 mm Hg. The disruption in the seal on seven of nine shunts was, however, seen at pressure above 80 mm Hg. That presents a level of pressure that is approximately seven times above the maintained pressure during laparoscopic surgery. These findings were questioning the previous strategies of clamping or externalizing the end of the VP shunt to minimize the risk of a retrograde flow and were suggesting that these manipulations could possibly result in an increase in the ICP due to the blockage of normal CSF flow.

Five different valves simulating a closed system were studied by Matsumoto et al.[43] in Japan in 2010. There was no reflux of the CO_2 for any of the valves with a pressure of less than 25 mm Hg.[8]

The original shunting equipment was quite like a simple catheter. Soon after developing the shunt a no-reflow valve was added. This design was effective and did not change significantly thereafter. The risk of a sudden rise in the ICP was possibly overevaluated.[39]

The only case of pneumocephalus was reported by Raskin et al.[36] He reported that the pressure used during laparoscopy was 50 mm Hg in a patient with a VP shunt that was placed more than 20 years prior to the procedure. The authors of this article were contacted, and it reveals that this pressure was documented from an operation report written by the gynecologist and could not be proved again.

The first reported complication was a respiratory failure caused by extensive subcutaneous emphysema after a laparoscopic surgery in a patient who had a VP shunt placed shortly before the procedure.[15] A severe subcutaneous emphysema developed during the peritoneal insufflations of CO_2 along a VP track created prior to 10 days. This case report implies that a newly placed VP catheter should be viewed as a relative contraindication to laparoscopy. This problem can be avoided by delaying the laparoscopy.

The first case of shunt failure[20] was caused by a distal shunt obstruction due to an air lock or soft tissue impaction that was created during laparoscopic placement of a feeding jejunostomy tube.[27] The patient required an urgent reoperation to clear the distal shunt. This could be avoided by checking the intraperitoneal end of the shunt, so that it does not get twisted or compressed.

There is only one case of robotic surgery (hysterectomy) and it was successful.[33] It is an important case, because the Trendelenburg position in robotic surgery is steeper and there is no possibility of changing the degree of the Trendelenburg position after the docking. In this report, the authors temporarily clamped the shunt and the pressure throughout the operation was held at 12 mm Hg.[32]

Long-lasting laparoscopic operations in VP shunt patients are still being discussed and operations that take longer than 3 hours are not recommended.[39]

An infection of a VP shunt is always an issue. Different studies proved that the shunt infection correlates with the number of exposures of the shunt system to a surgical glove.[10] The specific advantages of laparoscopy in patients with a VP shunt may include less intra-abdominal adhesion formation and limited glove-to-shunt contact. Theoretically these advantages of laparoscopy should decrease the need for shunt revision due to the loss of absorptive peritoneal surface and decrease in the risk of a shunt infection.[1,12] Allam et al.[10] have shown that intra-abdominal operations appear to result in a shunt infection with the rate of 9% within 30 days after the operation. The rate is like the reported findings about infections after a shunt insertion or a shunt revision. It is believed that a rational use of antibiotics can reduce the consequences of a CSF infection and decrease the likelihood of a subsequent infection.[9,10] Burns and Dippe[11] found that 53% of postoperative surgical site infections are not identified until after the patient was discharged from the hospital. Therefore, educating the patients and their families about the signs and symptoms of an altered VP shunt function (like headaches and photophobia) that may result from a postoperative infection is recommended. If the patients can recognize the symptoms of an infection after being discharging from the hospital, it could prevent potential serious complications.[2,11,15] A preexisting VP shunt often causes clinically significant intra-abdominal adhesions, and these can lead to a higher conversion rate.[10,21,36]

In our case, we entered the peritoneum with the pressure of 20 mm Hg. Intraoperatively there were no complications and the patient had no complaints after the operation. Based on our case and the available data, we suggest that laparoscopic operations can be safely performed with only routine anesthetic monitoring in patients with a VP shunt.[39] A careful placement of the trocar should be considered to avoid damaging the shunt and intraoperatively a careful manipulation with the peritoneal portion of the catheter is recommended as well. The literature did not show any benefit to using invasive ICP monitoring mainly because of the high possibility of risks like intracranial hemorrhage. Invasive perioperative ICP monitoring may be an option in very complex cases but generally a direct monitoring of the ICP during laparoscopic surgery does not appear to be necessary. The risk of retrograde failure of the valve system was shown to be minimal, even with an intra-abdominal pressure of 80 mm Hg. Currently there is no evidence that suggests clamping or externalization of the catheter is necessary. Manipulating with the VP shunt could potentially increase the ICP. The shunt material deteriorates with time, therefore the signs of increased ICP must be always considered. We believe that a consult with a neurosurgeon prior to the operation is advisable in order to verify the correct function of the shunt valve. The patient should be made aware of the potential risks associated with the procedure, including shunt obstruction, damage, and infection and should sign a patient's consent.[27,39] The anesthesiologist should always inform the surgeon about the signs of increased ICP such as bradycardia and hypertension.[33]

A pelvic operation, lasting many hours, can affect the surgeons' ability to monitor the shunt, and this could potentially[27] be the reason why any occlusions or back-pressure problems are overseen. In these cases, an intermittent release of the pneumoperitoneum, reduction of the Trendelenburg position, and inspection of the end of the shunt would give a possibility to avoid such complications.

Finally, an antegrade spread of malignant cells from the central nervous system through VP shunts was described,[44–46] suggesting that if a retrograde valve failure occurred, the central nervous system could be inoculated with malignant cells from the pelvis. In our case, our patient showed no signs of metastasis after the follow-up of 8 months.

Conclusion and Recommendations

Laparoscopic surgery in adults with VP shunts utilizing routine anesthetic monitoring appears to be safe. However, it must be carried out in a facility that has optimal possibilities of monitoring the patient. The medications used by the anesthesiologist, pneumoperitoneum, and patient positioning can potentially elevate ICP. The safest way to avoid such complications is to be aware of their existence and to take precautionary measures to minimize their effects.[39] Here are some recommendations from our experience and the reviewed articles:

- A neurosurgical consultation before and after the laparoscopic procedure to verify the proper functioning of the shunt and the valve is necessary.[17]
- The patient should be made aware of the potential risks associated with the procedure, including a shunt obstruction, damage, or infection.[27]
- The only relative contraindication should be if the catheter was recently placed, the risk of developing subcutaneous emphysema is high and to avoid this problem the laparoscopy should be delayed.[39] If the tissue after placing the shunt becomes more fibrotic, then it is necessary to avoid the development of the emphysema. How much time exactly is needed for the tissue to become fibrotic is not known yet.
- It is recommended that the procedure is performed by an experienced laparoscopic surgeon in order to minimize the chance of spillage and contamination.[17]
- The surgeon should be aware of the location of the catheter within the abdominal wall to avoid inadvertent damage to the catheter during the placement of the trocar.
- It is important to ensure that the intraperitoneal portion of the catheter is not twisted or obstructed prior to decompression of the abdomen.
- Longer laparoscopic or robotic surgeries using a steep Trendelenburg position should be carried out with caution.
- An extended course of prophylactic antibiotics is recommended.
- Perioperative invasive ICP monitoring may be an option in very complex cases, but it is associated with some complications.
- To identify an infection in its early stages, a prompt treatment may prevent potential serious complications.[2] Educating the patients and their families about the signs and symptoms of an altered VP shunt function (headaches and photophobia) that may result from a postoperative infection is useful.[2]

Compliance with Ethical Standards

No animal research has been used.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with human participants or animals performed by any of the authors.

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CASE REPORT

Multiple and Bilobed Ovarian Dermoid Cysts: Complications and their Successful Laparoscopic Management

Nayanika Gaur[1], Nitin Shah[2], Manish Jha[3]

Abstract

Background: Ovarian dermoid is one of the commonly occurring ovarian neoplasms in young women but the occurrence of multiple dermoid cysts is comparatively rare.

Case description: This is a case of 24-year-old woman who ignored her first diagnosis and management plan for a 3 × 3 cm dermoid cyst in one of the ovaries and later returned with severe symptoms of abdominal pain and vomiting and with a CT scan diagnosis of bilateral, large (7 × 7 cm) dermoid cysts. She was prepared for laparoscopic bilateral dermoid cyst excision, until the intraoperative scenario, revealing right-sided twisted bilobed dermoid cyst and left-sided twin dermoid cysts changed the original plan. Finally, the patient underwent right-sided ovariotomy with right-sided salpingectomy and left-sided twin dermoid cysts excision.

Conclusion: Laparoscopy is the surgical mode of choice in dermoid presentations. Evaluation of contralateral ovary must be carried out while dealing with dermoid cyst of one ovary.

Clinical significance: Torsion of a large dermoid cyst is not an indication for ovariotomy. However, ischemic dermoid cysts require an on-table judgement for cystectomy or ovariotomy. Laparoscopic management in skilled hands favors cystectomy. Examining contralateral ovary must be a routine while operating on a patient with dermoid cysts in ovary.

Keywords: Diagnostic laparoscopy, Gynecology, Gynec-oncology.

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Introduction

Adnexal masses are commonly encountered and managed by gynecologists. Benign ovarian teratomas or dermoid cysts of the ovary are considered the most common benign ovarian neoplasms in young and middle-aged women and account for 20–25% of all ovarian tumors in this age group. Usually dermoid cysts are unilateral, but in 10–15% cases, bilateral and/or multiple dermoid cysts may be encountered.[1]

The majority of dermoid cysts are asymptomatic and are often discovered incidentally. The symptomatic ones are usually with the complications of preexisting dermoid cysts like torsion, rupture, or rarely malignancy.

With the advances in endoscopic surgery, laparoscopic excision of dermoid cysts has become a gold standard approach.

This case report highlights the occurrence of multiple and bilobed dermoid cysts, associated complications, the surgical dilemma of oophorectomy or cystectomy, and successful laparoscopic management.

Case Description

Case History

A 24-year-old, Para 1, admitted with complaints of severe abdominal pain mainly in right iliac fossa radiating to thighs, associated with complaints of 10–14 episodes of vomiting for one day. No history of fever, bowel/bladder disturbances, weight loss, or menstrual irregularities. No positive family history. Previously, she was diagnosed with a 3 × 3 cm right-sided ovarian dermoid cyst 4 months ago and was advised surgery, which she refused and was lost to follow-up.

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Conflict of interest: None

Examination

Her general condition was fair, and vitals were stable. Per abdomen, a well-defined mass reaching up to umbilicus was felt, and tenderness on transverse mobility was noted. No ascites was felt.

Investigations

Routine and preoperative investigations were within normal limits.

Ca-125: 36.3 U/mL, CEA: 2.30 ng/mL

Ultrasonography

Right and left adnexal cysts of 7 × 7 cm and 6 × 9 cm with mixed echogenicity, with fat and fluid contents and focal hyperechoic lesions were noted. Doppler suggested reduced blood flow in the

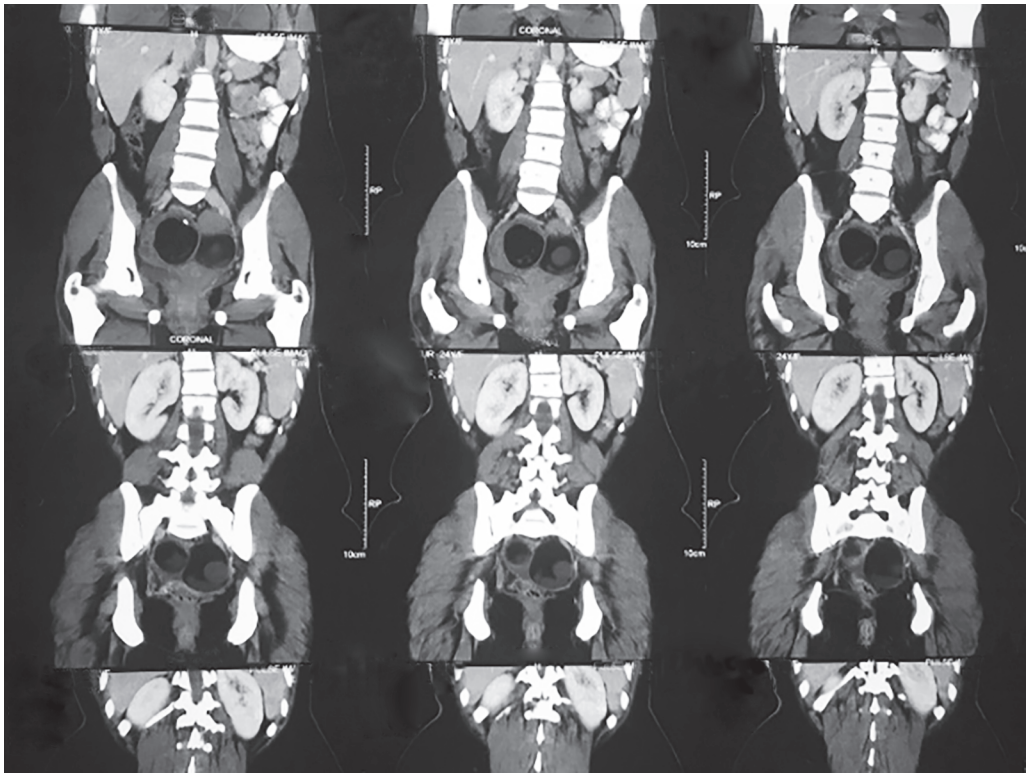

Fig. 1: CT scan showing bilateral adnexal cysts with mixed echogenicity

Fig. 2: Left ovary appearing collapsed after first dermoid cyst removal, posteriorly, second dermoid cyst visible

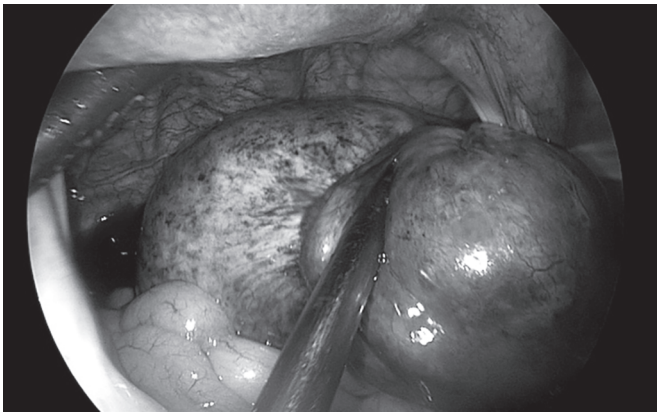

Fig. 3: Right ovary twisted, bilobed dermoid cyst

right adnexa suggestive of torsion. Uterus was normal size. No free fluid in the pelvis was noted.

Multidimensional CT of pelvis with contrast confirmed the ultrasound findings (Fig. 1).

Management Plan

Bilateral laparoscopic cystectomy SOS ovariotomy was planned for this patient under general anesthesia.

Laparoscopic Findings (Figs 2 and 3)

- Bilateral smooth ovarian cysts
- Right cyst bilobed and ischemic, each measuring 4 × 4 cm.
- Right Fallopian tube engorged and twisted along with the bilobed ovarian cyst by 2 turns.
- Left ovary enlarged up to 9 × 9 cm appearing as one big ovarian cyst.
- Left fallopian tube normal.
- No adhesions.
- Intact capsule.

The presence of two dermoid cysts co-inhabiting in left ovary could not be differentiated until the proximal one was removed. Complete cystectomy of both dermoid cysts (4 × 4 cm and 5 × 5 cm respectively) from the left ovary was carried out, and hemostasis was checked in the remaining normal ovarian tissue on the left side.

The dilemma was whether or not to remove the ovary on the right side along with the dermoid cyst. After a considerable discussion, the decision of right-sided ovariotomy with right-sided salpingectomy was taken and proceeded.

Spillage of dermoid contents from the left-sided cystectomy was unavoidable. Rest of the specimens were placed intact in an endo-bag made from urine bag and suctioned out from the 5 mm lower side port now converted into a 10 mm port.

Thorough peritoneal lavage with warm saline was given, and hemostasis was reconfirmed before closure.

Postoperative recovery was uneventful. The patient was discharged on the 3rd postoperative day. She was followed up on postoperative day 7 for suture removal with the histopathological confirmation of bilateral dermoid ovarian cyst.

Discussion

Dermoid cyst is a frequently encountered tumor of ovary, usually unilateral, sometimes bilateral, and rarely more than two in the same patient. There are very few reports on multiple dermoid cysts in a patient. Bournas et al.[2] documented four dermoid cysts within the right ovary and one in the contralateral ovary. Sinha et al.[3] described seven and three dermoid cysts in left and right ovaries, respectively. Our case describes two dermoid cysts in the left ovary and one bilobed dermoid cyst, with torsion in the right ovary.

Before the advent of modern minimally invasive surgical techniques, dermoid cysts produced some morbidity and mortality because of their propensity to undergo torsion leading to ovarian infarction or rupture leading to chemical peritonitis.

The use of laparoscopic technique reduces hospitalization, infection rate, and recovery time along with a cosmetically acceptable scar. One of the theoretical pitfalls of laparoscopy is the assumed high risk of intraoperative cyst rupture leading to spillage and chemical peritonitis.

Kocak et al. described dermoid cyst extraction with spillage in 42.5% cases and none developing chemical peritonitis. Berg et al. reported spillage in 66% cases in their study and no intra- or postoperative complications and no evidence of chemical peritonitis. Considering the literature on spillage rates in excision of dermoid cysts and the incidence of chemical peritonitis, the rate of clinical chemical peritonitis following spillage in laparoscopic dermoid cystectomy is <0.2%.[4]

Spillage can be prevented by the use of an endobag or by giving a thorough peritoneal lavage with warm fluids. It is our routine practice to use the urobag as an endobag for such cases. In fact, it can be argued that cyst contents spillage is easier and more efficiently managed during laparoscopy rather than laparotomy because of better exposure of the pouch of Douglas and the feasibility of extensive peritoneal lavage.

Oophorectomy vs Cystectomy

There are no data in the literature that prove the superiority of one over the other. The decision is primarily based on fertility status and the viability of the remaining tissue. There is a 3–4% risk of torsion in ovarian mature cystic teratomas. An emergency laparoscopic untwisting of adnexa is recommended. Persistent black color of the adnexa after untwisting is not an indication of systematic oophorectomy since functional recovery is possible.[5] In our case, ovariotomy was kept as an alternative considering patient's parity, future need for fertility, and patient's decision over the pathology. During the surgery, we proceeded with cystectomy on the left side and salpingo-oophorectomy on the right side.

Conclusion

Laparoscopy should be considered as a method of choice for mature cystic teratomas of ovary. It should be performed by experienced advanced laparoscopic surgeons.

We conclude that while dealing with dermoid cysts, the surgeon must evaluate the contralateral side also. The cyst wall must be removed to prevent the possibility of recurrence.

The risk of chemical peritonitis due to spillage in such cases is extremely less and can be easily managed with copious peritoneal lavage and with the use of endobag for specimen retrieval.

Clinical Significance

- Torsion of a dermoid cyst is not an absolute indication for ovariotomy.
- Contralateral ovary must be examined while dealing with cases of dermoid cyst as bilateral dermoid cysts are also a possibility.
- Endobag can be made using a simple urobag, which is a very economical method to prevent spillage of dermoid contents.

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CASE REPORT

Laparoscopic Diaphragmatic Repair: A Single-center Experience

Eppa Vimalakar Reddy[1], Gourang Shroff[2], Vemula Bala Reddy[3], Dinesh Reddy Kaipu[4], Raju Musham[5]

Abstract

Background: With the ongoing advances in the field of laparoscopy, more and more of diaphragmatic repairs are being performed laparoscopically. All forms of diaphragmatic pathologies, such as congenital diaphragmatic hernia (CDH) including diaphragmatic eventration, hiatus hernia as well as traumatic diaphragmatic rupture, can be well performed through laparoscopy. Laparoscopic repair along with the advantage of improved vision and accessibility can also avoid large incisions, thereby reducing morbidity and long hospital stay, due to pain and lung complications, with early return to work.

Materials and methods: A total of five cases underwent laparoscopic diaphragmatic repair at our center in 1 year duration. All cases were followed up with immediate postoperative and quarterly chest X-rays.

Results: None required conversion to open. Diaphragm was reconstructed and reinforced with mesh. None had any postoperative complications. Follow-up postoperative chest X-rays were unremarkable.

Conclusion: Laparoscopic diaphragmatic hernia repair is a feasible, acceptable, affordable, superior, and safe alternative to open repair with better short-term postoperative outcomes and a recurrence rate similar to the open approach.

Keywords: Congenital diaphragmatic hernia, Diaphragmatic eventration, Laparoscopy, Mesh repair, Minimal invasive, Traumatic diaphragmatic rupture.

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Introduction

Among the various organs of the torso, diaphragm is a relatively rarely encountered surgical organ. Most common pathologies involving the diaphragm include congenital or acquired diaphragmatic hernias, diaphragmatic eventrations, hiatus hernia, and traumatic diaphragmatic rupture.

The congenital diaphragmatic hernias (CDHs) are usually reported in pediatric age-group with pulmonary complications. Asymptomatic neglected CDH is also in later age-group. In adults, traumatic rupture and eventration are relatively more common. Sudden elevation in the pleuroperitoneal pressure gradient[1] results in traumatic diaphragmatic rupture. Due to protective effect of liver,[2] underdiagnosis on the right side, and weak left hemidiaphragm at embryonic fusion points of pleuroperitoneal canals,[1,3,4] it is more common on the left side. Chronic, undiagnosed, or ignored rupture develops dense adhesions between the abdominal organs, sac, and pleura predisposing to incarceration as well as damage to contents during reduction.[5]

The average age of presentation in adults is 36 years, with a male preponderance (11:2).[6] It is more common on the left side (85%).[7] Most patients present with shortness of breath (SOB) on exertion, atypical chest pain, abdomen pain, or recurrent lung infections. Rarely may present with obstruction. Sometimes may be asymptomatic and incidentally detected or present with a history of blunt trauma. The contrast-enhanced computed tomography (CECT) abdomen is the most acceptable diagnostic tool.

Surgery is indicated for symptomatic[8] as well as asymptomatic patients who are fit for surgery.[9–11] Laparoscopy has superseded open repair as a standard of care.

Controversies in diaphragmatic hernia management include (1) management of hernia sac, (2) to close the defect or not, and (3) the choice of mesh.[12] Although the risk of seroma formation in the remnant sac is present, most surgeons prefer to leave the sac behind, due to the chances of pleural injury. A study of the 30-day postoperative CT scan showed complete disappearance of sac by 30th day.[13] No studies had proven superiority of interruption over continuous sutures or permanent over absorbable sutures.[14] Defects larger than 20 to 30 cm should be reinforced with appropriate mesh.[11,15]

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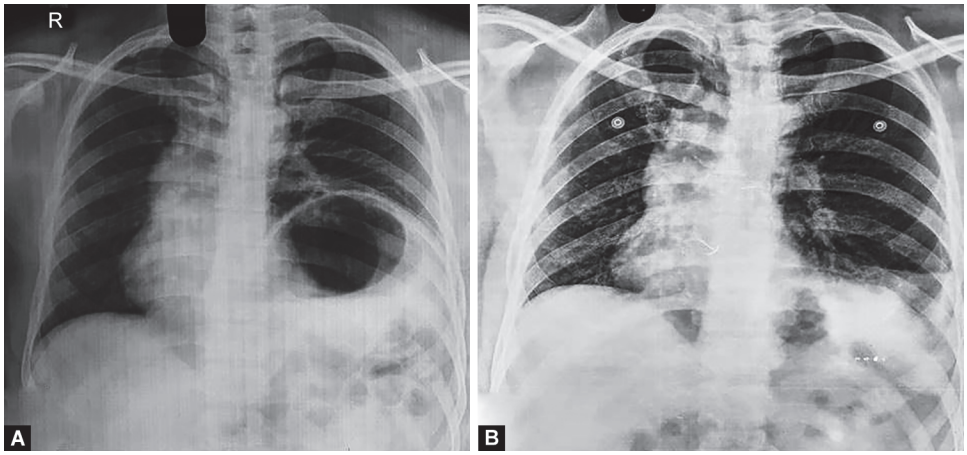
Materials and Methods

A total of five cases underwent laparoscopic diaphragmatic repair at our center in 1 year duration. Two were for left diaphragmatic eventration (Fig. 1), one for right Morgagni, one for left Bochdalek (Fig. 2), and one for left traumatic rupture (Fig. 3).

All cases were evaluated with preoperative chest X-ray and CECT abdomen.

Operative Procedure

Under general anesthesia, with single lung ventilation, patients were kept in supine, leg split position with reverse Trendelenburg



Figs 1A and B: (A) Preoperative; (B) Postoperative chest X-ray of eventration

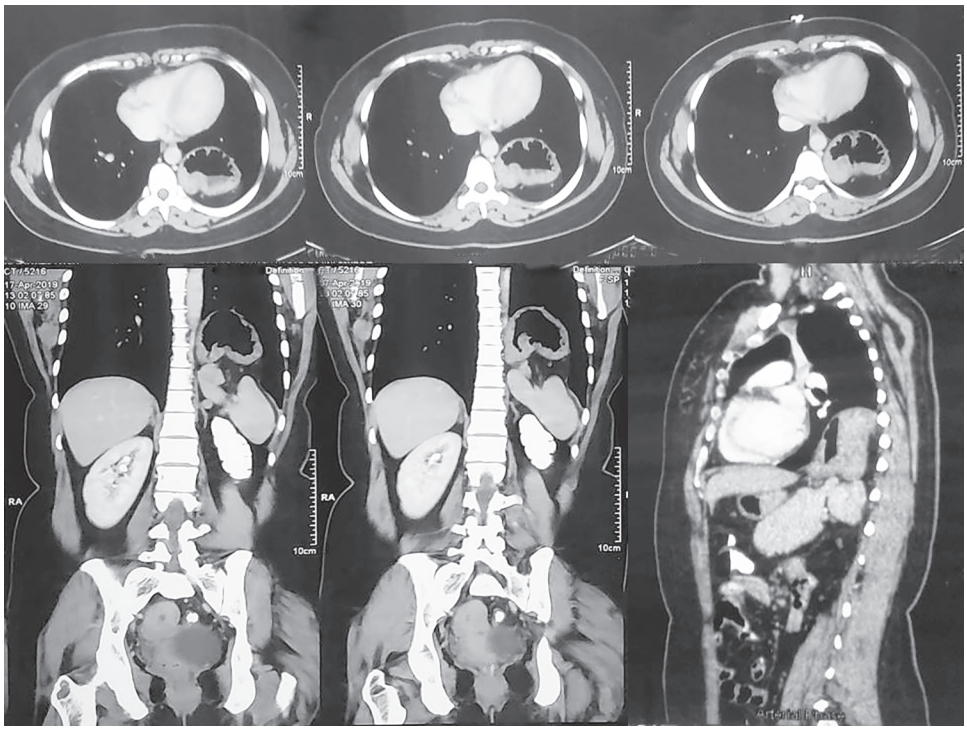


Fig. 2: The CECT abdomen image of Bochdalek hernia

tilt and sand bag under lower chest. Pneumoperitoneum created with Veress needle. Lower intra-abdominal pressure was used (10 mm Hg). A 10-mm umbilical port was used for camera with 30°/45° laparoscope and the remaining 5 mm ports placed as needed (Fig. 4).

For hernias, after reducing the contents, the sac was excised safely (Fig. 5). In the case of eventration, small rent was made in the thinned out diaphragm to create pneumothorax and reduce tension on diaphragm, the redundant thinned out sac was excised. Reconstruction done with barbed polydioxanone sutures (V-Loc) and reinforced with mesh. In the case of traumatic rupture, transmigrated abdominal contents were replaced in the abdominal cavity. Tension-free reconstruction was done with barbed PDS suture with interrupted ethibond sutures. The ICD was placed under vision before the defect closure (Fig. 6).

All cases were followed up with 1 week postoperative and quarterly chest X-rays.

Results

A total of five cases underwent laparoscopic diaphragmatic repair, and their characteristics are tabulated in Table 1.

The average age was 43.4 years (21 to 30 = one, 31 to 40 years = three, 71 to 80 years = one). Three of five cases were males (M:F = 3:2). Four of five cases were on the left side.

All cases presented with the chief complaint of shortness of breath on exertion, one case had a recent history of blunt trauma on the chest. None of the cases had features of obstruction.

Mesh placed in four of five cases. The ICD kept in four five cases and removed on the second postoperative day. None required conversion to open. Average operation time was 105 minutes. None

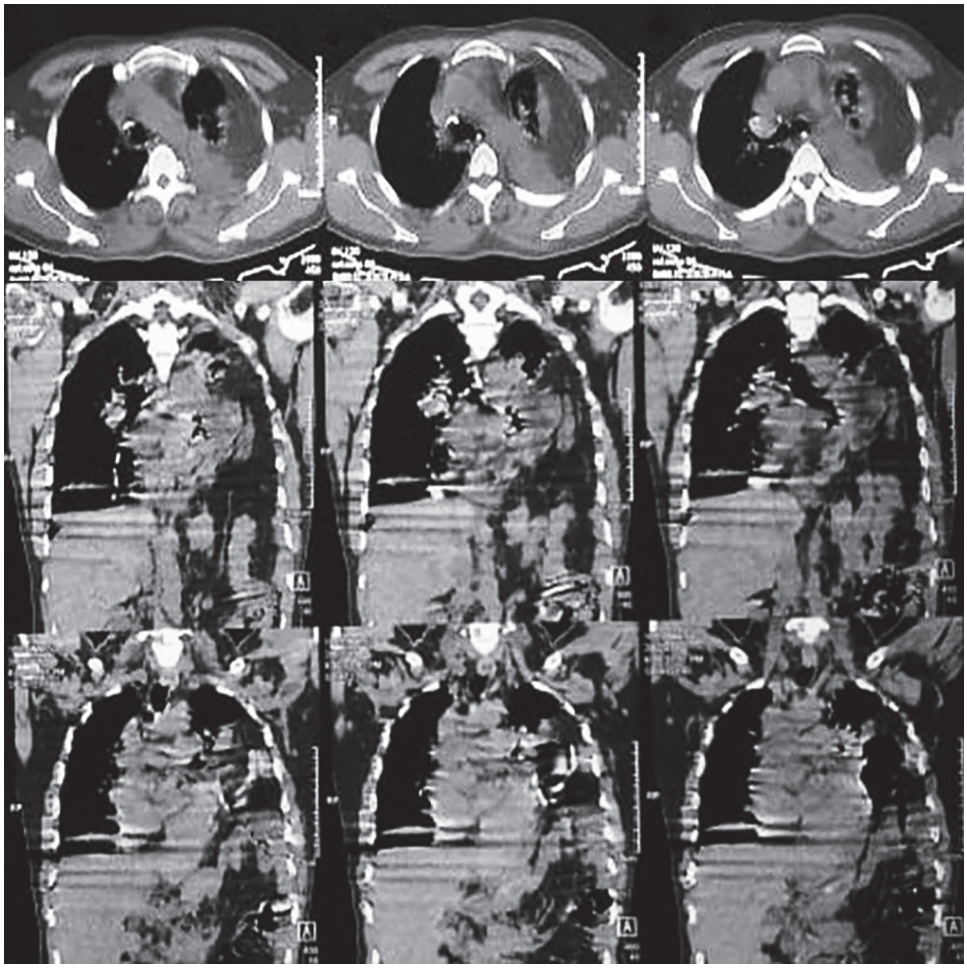


Fig. 3: The CECT abdomen image of diaphragmatic tear

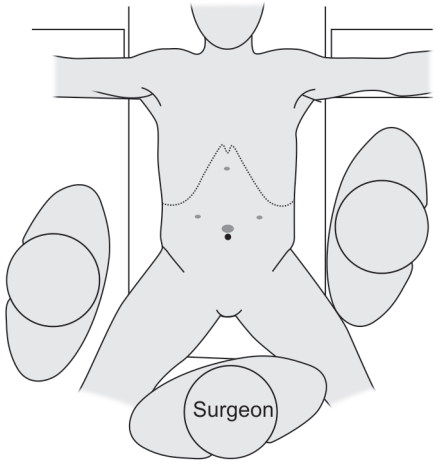


Fig. 4: Patient position and port system

has significant blood loss. The average postoperative pain score was 2.8. Average hospital stay was 3.8 days. None developed any postoperative complications. Follow-up postoperative chest X-rays were unremarkable.

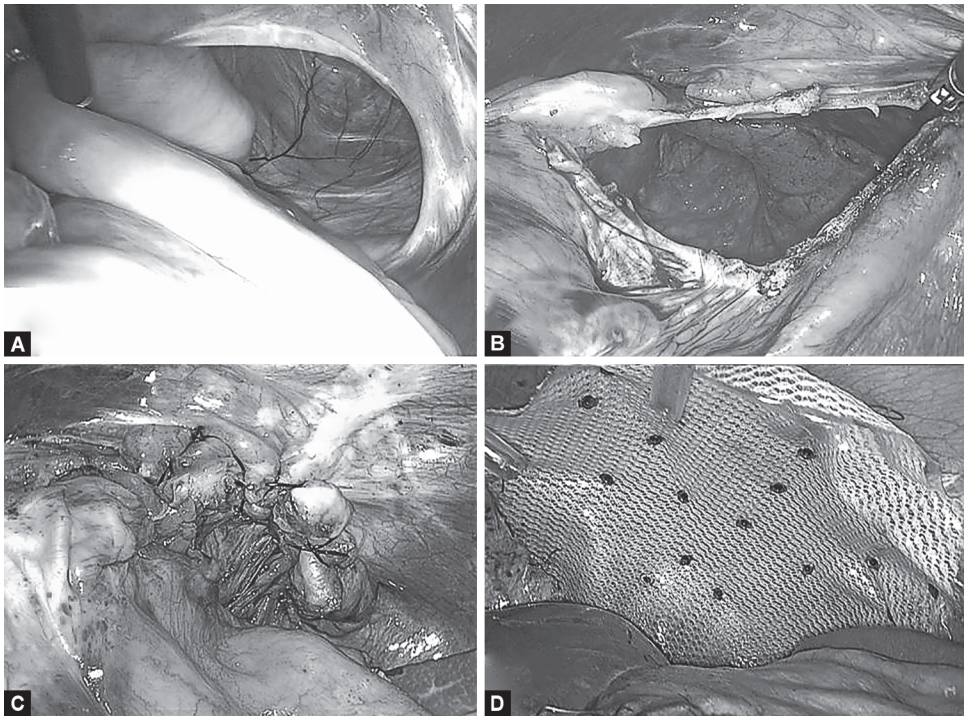
Discussion

Campos and Sipes[16] in 1991 and Kuster et al.[17] in 1992 reported the first laparoscopic diaphragmatic repairs. Ever since then, laparoscopic repair has increasing been accepted as an alternative to open repair.

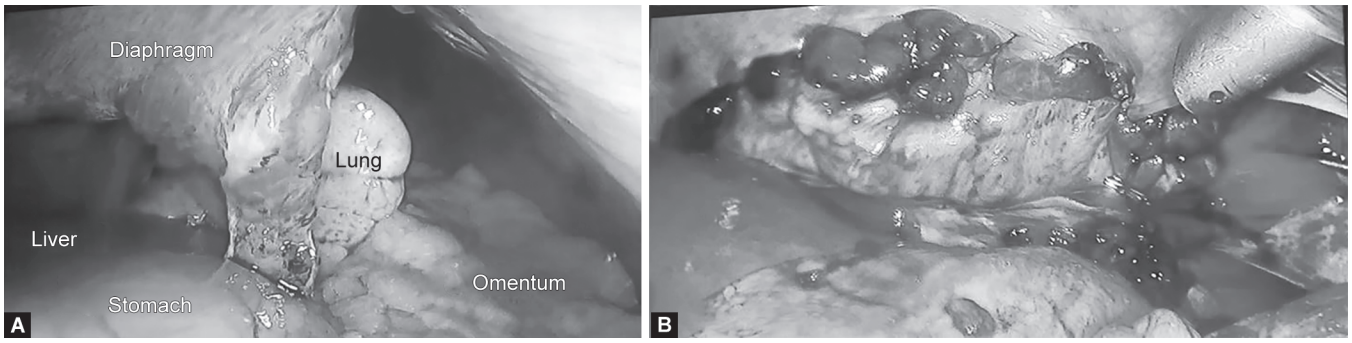
Open repair has disadvantages such as increased postoperative pain, long hospital stay, large incision and wound-related complications, pulmonary complications, and poor cosmesis.[18] Thoracoabdominal or thoracotomy approach showed increased incidence of ventilator requirement and increased incidence of deep venous thrombosis and pulmonary thromboembolism.[19]

Along with enhanced vision and better accessibility, laparoscopy has the advantage of less postoperative pain, faster recovery, shorter hospital stay (4.5 vs 5.9),[19] early return to work, decreased risk of wound complications, reduced morbidity, and good cosmesis. In our study, one patient (20%) had Bochdalek hernia. Palanivelu et al. reported 57%, Saroj et al. reported 30%, and Sharma et al. reported it as 62%. Among the various types of CDH, Bochdalek hernia is the most common type, but in adult population the percentages may be altered, compared to the pediatric group.

All cases (100%) had SOB on exertion as the presenting complaint, none had a history of recurrent pneumonias or any



Figs 5A to D: Intraoperative image of Bochdalek hernia: (A) Defect; (B) Sac dissected; (C) After repair; (D) After mesh placement



Figs 6A and B: Intraoperative image of diaphragmatic tear: (A) Before repair; (B) After repair

Table 1: Patient characteristics and data

	Diagnosis	*Age/sex*	*ICD*	*OT time*	*Postoperative pain score*	*Hospital stay*	*Postoperative complications*
1	Left traumatic diaph. rupture	38/M	+	120 minutes	4	4 days	Nil
2	Left diaph. eventration	39/M	–	105 minutes	3	3 days	Nil
3	Left diaph. eventration	35/M	+	120 minutes	2	3 days	Nil
4	Right Morgagni hernia	76/F	+	90 minutes	3	5 days	Nil
5	Left Bochdalek hernia	29/F	+	90 minutes	2	4 days	Nil
Avg.		43.4 years	4/5	105 minutes	2.8	3.8	Nil

features of obstruction. Sharma et al. reported that 60% cases had SOB and 40% had abdomen pain.

In the current study, average age was 43.4 years. Three of five cases were males. For four of the five cases it was on the right side, consistent with Saroj et al. whose average age was 36 years, M:F = 11:2 and Lt:Rt = 12:1.

All cases were evaluated with CECT abdomen, which is the most accepted imaging modality, particularly when the defect size is small.[20] Approximately 38% of cases is misdiagnosed as pneumothorax, empyema, lung cyst, or pleural effusion, if CT scan is not done.[21,22]

In three of four hernia cases, neck of the hernia was wide and sac could be excised with ease (except in the case of Morgagni hernia, the mesh was placed in four of five cases (except in traumatic rupture), ICD in 4 of 5 cases, consistent with Palanivelu et al.[12] who quoted 85.7% meshplasty and 14 of 21 cases.

Average hospital stay was 3.8 days (3 to 5 days), consistent with Saroj et al.[6] who quoted a hospital stay of 4 days and Phillips et al.[14] quoted 4.5 days.

None of our cases had any postoperative morbidity or recurrence, consistent with Phillips et al.[14] who quoted modest postoperative morbidity and recurrence rates similar to open.

Laparoscopic diaphragmatic hernia repair is increasingly being reported to have better short-term postoperative outcomes[19] and a recurrence rate similar to the open approach.[14]

Conclusion

Laparoscopic diaphragmatic hernia repair is an feasible, acceptable, affordable, superior, and safe alternative to open repair with better short-term postoperative outcomes and a recurrence rate similar to the open approach.

With regard to the controversies in diaphragmatic hernia management, at our center, we (1) excise thinned out diaphragm or hernia sac only when feasible and safe; (2) close the defect, without tension on the diaphragm, with barbed, continuous PDS sutures and interrupted ethibond sutures, wherever appropriate; (3) mesh reinforcement done in all cases of hernia and eventration, unless contraindicated.

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LETTER TO THE EDITOR

Laparoscopy: A See- and -treat Modality for Lower Abdominal Pain in Females

Amina Kuraishy[1], Noor Afshan Sabzposh[2], Afzal Anees[3]

Abstract

Background: In females, lower abdominal pain (LAP) is a common presenting complaint that has a diverse etiology. It can involve reproductive, gastrointestinal, genitourinary, and musculoskeletal systems; therefore, accurate diagnosis is a clinical challenge. Laparoscopy has become the gold standard for the diagnosis and management of LAP.

Aims and objectives: To diagnose the cause of LAP with laparoscopy and to correlate it with clinical examination and ultrasound.

Materials and methods: A prospective study was conducted from December 2012 to January 2015 in JNMCH, Aligarh. Laparoscopy was performed on 84 patients with complaints of LAP (acute, subacute, or chronic). Data were statistically analyzed on the basis of the epidemiology, clinical features, ultrasound findings, and laparoscopic findings. Correlation of clinical, ultrasound, and laparoscopic finding was done.

Results: With laparoscopy, diagnosis was established in 94.1% ($n = 79$) of patients. The most common cause of LAP was pelvic inflammatory disease (PID) present in 20.2% ($n = 17$) of patients followed by endometriosis in 17.9% ($n = 15$), ectopic pregnancy in 15.5% ($n = 13$), ovarian cyst in 15.5% ($n = 13$), genital TB in 7.1% ($n = 6$), etc. Therapeutic laparoscopy was performed in 82.1% ($n = 69$) of women, which included adhesiolysis, cystectomy, cystotomy, salpingectomy, salpingostomy fulguration of endometriotic lesions, ovarian drilling, myomectomy, and salpingo-ophorectomy.

Conclusion: Laparoscopy can be used as the first-line interventional investigation for LAP. Besides diagnosis, it also has a therapeutic role. Therefore, it can be considered as a "see and treat" modality.

Keywords: Adhesiolysis, Laparoscopic, Ultrasound.

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Introduction

In females, lower abdominal pain (LAP) is a very common presenting complaint in both the outpatient and emergency department. It can be acute, subacute, and chronic in nature. Acute LAP is intense and characterized by sudden onset, sharp rise, and short course. To consider a pain as acute pelvic pain, different authors have defined different durations. Some authors have defined it as the pain lasting for less than 7 days[1] while others have defined it as the pain lasting for less than 3 months.[2] The gynecological causes of acute pelvic pain are pelvic inflammatory disease (PID), ectopic pregnancy, adnexal torsion, ruptured ovarian cyst, and adhesions. Subacute pelvic pain is the pain that does not clearly fit either in acute or chronic category and requires consideration of differential diagnosis for both acute and chronic pain. Chronic pelvic pain is defined as intermittent or constant pain in the lower abdomen or the pelvis of at least 6 months' duration, not associated with menstruation, intercourse, or pregnancy. It is severe enough to cause functional disability or may require medical or surgical intervention.[3] The causes of chronic pelvic pain are chronic PID, endometriosis, and adhesions.[4]

The etiology is of LAP is diverse. It can be reproductive, gastrointestinal, genitourinary, or musculoskeletal. Hence, accurate diagnosis of the underlying cause presents a clinical challenge.[3,4] In many cases, the cause of LAP remains obscure despite thorough examination, lab investigations, and noninvasive imaging like ultrasonography (USG), CT, and MRI. Laparoscopy has been increasingly recognized as a key in solving the diagnostic dilemma. Not only that, treatment may also be provided in the same sitting.[5] Therefore, the present study was conducted to assess the role of laparoscopy for diagnosis and management of LAP.

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Conflict of interest: None

Materials and Methods

The prospective study was conducted on 84 patients from December 2012 to January 2015 after getting approval from the ethical committee. Women with complaints of LAP—acute, subacute, and chronic—were included in the study. Patients with abdominal trauma, gynecological malignancy, cardiopulmonary disease, and peritonitis were excluded from the study.

A detailed clinical history was taken regarding site, duration, pain, nature, and radiation of pain; aggravating and relieving factors; and associated complaints like dyspareunia, dysmenorrhea, discharge per vaginam, gastrointestinal, and urological complaints. Menstrual history, obstetric history, and past history were also taken.

All women underwent a thorough general, systemic, and gynecological examination. Routine investigations were carried

out in all the patients, which included complete hemogram, renal function test, random blood sugar, urine examination, and culture sensitivity, if required. Imaging methods included USG of the abdomen and the pelvis, which was performed in all the patients, and X-ray, CT scan, or MRI whenever necessary. Laparoscopy was performed in all the patients under general anesthesia; the Karl Storz laparoscope (10 mm and 5 mm), both straight viewing 0° and oblique viewing 30°, was used.

The methodical inspection of the upper and lower abdomen was done. All the pathological findings were noted, and if required the operative procedure was also done in the same sitting like taking biopsies, performing adhesiolysis, cyst aspiration, cystectomy, salpingectomy, oophorectomy, etc. All the samples were sent for histopathological examination and the final diagnosis was confirmed. In cases where complication occurred or therapeutic laparoscopy was difficult, the laparoscopic procedure was converted into laparotomy. The gathered data were statistically analyzed. Descriptive statistics that included frequency, mean, percentage, and standard deviation were calculated. The McNemar's test was used to test the significance of difference for qualitative variables. The Probability value (p value < 0.05) was considered statistically significant.

Results

The mean age of patients in the study was 28.0 ± 6.4 years (age range 15–60 years). The other characteristics of the patients are as shown in Table 1. We categorized the duration of pain as acute (duration of less than 1 week), which was present in 16.7% ($n = 14$), as subacute (duration of 1 week to 6 months) in 26.2% ($n = 22$), and as chronic (duration of more than 6 months) in 57.1% ($n = 48$) of patients. The maximum duration of pain was 36 months and the minimum duration was 24 hours.

Along with LAP, the associated symptoms were dysmenorrhea in 30.9% ($n = 26$), primary infertility in 22.6% ($n = 19$), dyspareunia in 15.4% ($n = 13$), spotting in 14.3% ($n = 12$), secondary infertility in 9.5% ($n = 8$), white discharge per vaginam in 7.2% ($n = 6$), oligomenorrhea in 7.2% ($n = 6$), and menorrhagia in 5.9% ($n = 5$) of patients. Per vaginal examination revealed tenderness in the fornix 34.5% ($n = 29$), adnexal mass 30.9% ($n = 26$), restricted mobility of the uterus 19.0% ($n = 16$), fullness in the fornix 15.5% ($n = 13$), cervical motion tenderness 15.5% ($n = 13$), retroverted uterus 8.3% ($n = 7$), and bulky uterus 8.3% ($n = 7$).

Transabdominal ultrasound was performed in all the patients. The collection in the pouch of Douglas was found in maximum number of cases 34.5% ($n = 29$), followed by other abnormalities as shown in Table 2. After history, examination, and ultrasound, a provisional diagnosis was established in only 75% ($n = 63$) of patients. In rest of 25% ($n = 21$), the diagnosis was in dilemma. Most common cause was PID in 19.0% ($n = 16$) followed by other causes (Table 3).

All the 84 patients underwent laparoscopy for confirmation. After which diagnosis was established in 94.1% ($n = 79$) of patients. In 5.9% ($n = 5$) of patients, diagnosis of pain could not be established as no pelvic pathology was observed on laparoscopy. The most cause of LAP after laparoscopy was PID present in 20.2% ($n = 17$) of patients (Table 4).

The second most common diagnosis was endometriosis present in 17.9% ($n = 15$) of cases. Ectopic pregnancy was present in 15.5% ($n = 13$) of cases. Ovarian cyst was found in 15.5% ($n = 13$) of cases. About 7.1% ($n = 6$) of females were diagnosed as cases of genital TB. Out of which, one case was of genital TB with fibroid. polycystic ovarian disease (PCOD) was found in 4.8% ($n = 4$) of cases. Intra-abdominal adhesions formed secondary to past history of

Table 1: Characteristics of the patients

	Number	*Percentage*
Marital status		
Married	76	90.5
Unmarried	08	9.5
Parity		
Nulliparous	48	57.1
Multiparous	36	42.9
Past history		
Abdominal surgery	22	26.1
PID	20	23.8
Pulmonary TB	2	2.4
Abdominal TB	1	1.2
Duration of pain		
Acute	14	16.7
Subacute	22	26.2
Chronic	48	57.1

Table 2: Findings on transabdominal ultrasonography

Structure	*Abnormality*	*Number*	*Percentage*
Uterus	Fibroid	3	3.6
	Perforation	1	1.2
	Absent (post-hysterectomy)	1	1.2
	Didelphys with hematometra hematocolpos	1	1.2
Fallopian tubes	Ectopic pregnancy	13	15.5
	Dilated	2	2.4
	Hydrosalpinx	2	2.4
Ovaries	Ovarian cyst	13	15.5
	Ovarian endometriosis	10	11.7
	TO mass	4	4.8
	Polycystic ovaries	4	4.8
Pouch of Douglas	Collection	29	34.5
	Intrauterine contraceptive device	2	2.4

Table 3: Provisional diagnosis on the basis of history, examination, and ultrasound

Diagnosis	*Number*	*Percentage*
Diagnostic dilemma	21	25.0
PID	16	19.0
Ovarian cyst	13	15.5
Ectopic pregnancy	13	15.5
Endometriosis	10	11.9
Polycystic ovarian disease	4	4.7
Fibroid	3	3.6
Misplaced Intrauterine contraceptive device	2	2.4
Cervicitis	1	1.2
Didelphys uterus	1	1.2
Total	84	100

Table 4: Final diagnosis after laparoscopy

Laparoscopic diagnosis	*Number*	*Percentage*
Pelvic inflammatory disease	17	20.2
Endometriosis	15	17.9
Ectopic pregnancy	13	15.5
Ovarian cyst	13	15.5
Genital TB	6	7.1
Diagnostic dilemma	5	5.9
Only adhesions	5	5.9
Polycystic ovarian disease	4	4.8
Fibroid	2	2.4
Misplaced intrauterine contraceptive device with uterine perforation	2	2.4
Uterus didelphys with obstructed hemivagina	1	1.2
Pelvic abscess	1	1.2
Total	84	100

Table 5: Correlation between provisional and laparoscopic diagnosis of lower abdominal pain

		Laparoscopic diagnosis		
		Diagnosed	*Undiagnosed*	*Total*
Provisional diagnosis	Diagnosed	62	1	63
	Undiagnosed	17	4	21
	Total	79	5	84

abdominal surgery without any gynecological problem were found in 5.9% ($n = 5$) of cases. Myoma was found in 2.4% ($n = 2$) of cases. There were two (2.4%) cases of misplaced intrauterine contraceptive device (IUCD) where the IUCDs were found in the Pouch of Douglas (POD). One patient (1.2%) was diagnosed as the didelphys uterus with obstructed hemivagina with hematometra, hematocolpos, and hematosalpinx. There was one (1.2%) case of pelvic abscess where thick pus with adhesion was present.

Correlation was done between the provisional diagnosis, made on the basis of clinical examination and abdominal ultrasound, with the final diagnosis made after laparoscopy and histopathology (Table 5). There were 73.8% ($n = 62$) cases where the cause of LAP was diagnosed both by clinical examination with USG and by laparoscopy. In 20.2% ($n = 17$) of cases, no abnormality was detected on clinical examination and USG; diagnosis was in dilemma. Only after laparoscopy, the cause of LAP was established. There were 7.1% ($n = 6$) cases of genital TB, 5.9% ($n = 5$) cases of endometriosis, 5.9% ($n = 5$) cases of intra-abdominal adhesions, and 1.2% ($n = 1$) cases of PID. There was one case (1.2%) of chronic cervicitis where no abnormality was found on either laparoscopy or ultrasound. It was found on clinical examination. No abnormality was detected in 4.8% ($n = 4$) cases either on clinical examination, USG, or laparoscopy. On applying the McNemar's test, the p value was less than 0.05, which shows laparoscopy is statistically significant for the diagnosis of LAP. So, when history, examination, noninvasive investigations, and laparoscopy are combined the diagnosis rate is increased. Not only that, the patients are treated in the same sitting when the pathology was noted.

Diagnostic as well as therapeutic laparoscopy was performed in 82.1% ($n = 69$) of women. Adhesiolysis was done in 41.7% ($n = 35$), followed by other procedures given in Table 6. In 8.3% ($n = 7$) cases, the laparoscopy was converted into laparotomy and treatment was provided in the same sitting. No major intraoperative, postoperative, or anesthetic complications were encountered.

Table 6: Therapeutic laparoscopy

Laparoscopic treatment	*Number*	*Percentage*
Adhesiolysis	35	41.7
Cystectomy	15	17.9
Fulguration of endometriotic plaques	15	17.9
Cystotomy	8	9.5
Salpingectomy	8	9.5
Salpingostomy	5	5.9
Ovarian drilling	4	4.8
Myomectomy	3	3.6
Intrauterine contraceptive device removed from peritoneal cavity	2	2.4
Salpingo-oophrectomy	1	1.2

Discussion

Lower abdominal pain represents a significant problem in female patients. It is a common problem faced not only by the gynecologists but by all practicing physicians. For the correct diagnosis of lower abdominal pathology, even a battery of investigations may not reveal exact cause of pain. In the present study, on the basis of history, examination, and ultrasound a provisional diagnosis could be reached only in 75% ($n = 63$) of the cases and rest of the 25% ($n = 21$) cases did not revealed any abnormality, which is similar to the study conducted by Morino et al., who diagnosed 73.4% of patients on the basis of basic investigations and abdominal USG.[6]

Although laparoscopy is an invasive modality, it allows the surgeon to survey the entire abdomen through a small puncture, better than any other investigative modalities. It can be considered as the first-line interventional investigation for LAP. In the present study after laparoscopy, pathology was found in 94.1% ($n = 79$) of cases and no abnormality was noted in remaining 5.9% ($n = 5$) of patients. Thus, laparoscopy increases the chances of diagnosing the cause of LAP. This shows that laparoscopy is a very good diagnostic tool for the LAP. Our finding is quite similar to Arya and Gaur, Bareeq and Dayna, Ali et al., and Baria, who also reported pathology on laparoscopy in 90, 98, 93.3 and 90% of cases, respectively.[7–10] Moussa et al., Kang et al., and Morino also found abnormality in nearly same frequency, 78.6, 79.2, and 80%, respectively.[6,11,12]

Besides diagnosis, laparoscopy can also help in the management of both acute, subacute, and chronic LAP. Therapeutic intervention like adhesiolysis, fulguration of endometriotic lesions, cystectomy, and salpingectomy can be done at the same sitting, thus avoiding unnecessary laparotomy. Therefore, it can be considered as a "see and treat" modality. In the present study, therapeutic laparoscopy was performed in 82.1% of woman. Moussa, Arya and Gaur, Bareeq and Dayna, Baria, and Kumar et al. also have performed therapeutic laparoscopy in the same sitting in 64.3, 75.5, 78, 90, and 69% patients, respectively.[7,8,10,12,13]

Sometimes, though no abnormality is detected on laparoscopy, it helps in giving reassurance to the patients and removes the psychological concern, which is associated with chronic pelvic pain. If laparoscopic exploration is not sufficient, the surgeon should not hesitate to convert into laparotomy. In the present study, 8.3%

($n = 7$) cases were converted to the open procedure for therapeutic intervention. Studies like Arya and Gaur, Bareeq and Dayna, and Teamma also converted laparoscopy into therapeutic laparotomy in 13.5, 2, and 6.4% cases, respectively.[7,8,14] The reasons behind the conversion in their studies were early experience, extensive adhesions, bowel resection, and technical fault.

Limitations

Transvaginal ultrasound was not done, which is more sensitive and specific for detecting pelvic pathology. Preoperative and postoperative pain scoring, to assess the resolution of pain, was not done.

Conclusion

Laparoscopy can be considered as a diagnostic and therapeutic tool in acute, subacute, and chronic LAP. It can also be considered as the first-line minimally invasive investigation for undiagnosed LAP.

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