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REVIEW ARTICLE

Current Status of Minimal Access Surgery (MAS) in the Field of Maternal-Fetal Medicine

HL Chauke

Maternal and Fetal Medicine (Specialist/Lecturer), Department of Obstetrics and Gynecology, Kalafong Hospital and University of Pretoria, South Africa, Member, International Society of Ultrasound in Obstetrics and Gynecology (ISUOG), World Association of Laparoscopic Surgeons (WALS)

Correspondence: HL Chauke, Maternal and Fetal Medicine (Specialist/Lecturer), Department of Obstetrics and Gynecology Kalafong Hospital and University of Pretoria, South Africa, e-mail: chaukehl@telkomsa.net

Abstract

Minimal access surgery has had resounding impact in the practice of surgery. The advantages include less scarring, quick recovery and return to work. It is not surprising that this field has received attention in the practice of fetal surgery as clinicians were faced with considerable complications inherent in open surgical procedures. The field has evolved, skills refined and technology improved, allowing management of selected fetal conditions through minimal access into the uterine cavity and the fetus. There is however, challenges that needs to be addressed. Open surgery cannot be relegated to history books at this stage and the two approaches have specific indications and are complementary.

Keywords: Laparoscopy in pregnancy, MAS in fetal medicine, maternal fetal medicine and laparoscopy.

INTRODUCTION

Advances in medical imaging have led to an improvement in prenatal diagnosis of congenital anomalies. This has been made possible through the incorporation of new ultrasound technologies, use of doppler and real time imaging. These have resulted in improvement in resolution and quality of ultrasound images. Concurrent use l Magnetic Resonance Imaging (MRI) in fetal imaging has resulted in better definition of pathology and diagnosis in situation where ultrasound imaging turns to be inconclusive.[1] Together with the accolades gained by medical science in the understanding of the pathophysiological basis of diseases, clinicians have never been better equipped in making accurate diagnosis and better positioned in counselling their patients regarding prognosis and options available for the fetal condition in question, as is the case now.

Sir William Albert Liley is regarded as the 'father of fetal medicine'. His successful intrauterine transfusion of fetus affected by Rhesus disease in New Zealand, in 1963, opened a multitude of possibilities and opportunities for fetal medicine specialists.[2,3] This has been followed by different developments, animal studies and refining of skills. The Fetal treatment center at the University of California, San Francisco (UCSF), under the leadership of Michael Harrison (a pediatric surgeon by training), has been at the forefront of this development.[4] This center has been in limelight for performing fetal open fetal surgery and later inversion of minimal fetal approach dubbed 'FETENDO' (use of small

instruments and manipulating them inside the uterine cavity was viewed as similar to playing video games, hence the name). Other groups like the children's hospital of Philadelphia (CHOP), and the fetal center at Leuven, etc joined suite.[2] There are now few specialized centers in different countries dedicated to this cause. The end result has been research and refinement of skills as new knowledge is acquired.[4-6] The observation that postnatal therapy was not the answer to all fetuses, has led to the emergence of fetal surgery over the last 30 years. The vision has been an attempt to salvage the few fetuses with conditions that are known to result in stillbirth if left untreated, arrest the pathophysiological process or reverse fetal damage that is not amenable to postnatal correction. Currently three approaches are available for intrauterine management of fetal conditions, open approach via hysterotomy or minimal access using endoscopy or Fetal Image Guided Surgery (FIGS).[6] The latter approach is what is generally referred to as percutaneous approach. This procedure uses needles to access the fetus under ultrasound guidance. Fetal surgery has undergone evolution from the first successful intrauterine transfusion in New Zealand, hysterotomy for vascular access and intrauterine transfusion (Puerto Rico, 1964), diagnostic fetoscopy (Yale, 1974), Laser ablation of placental vessels (Milwaukee, London,1995) right to the use of amniotic collagen plug (Leuven, 2007) and sclerotherapy for congenital cystic adenomatous malformation (CCAM) performed in Venezuela in 2007. A comprehensive review of these milestones is well articulated in the article by Jancelewicz and Harrison.[2]

The critical point determining success for fetal surgery is a multidisciplinary approach. This itself has led to the current advances in management as each discipline constantly strive to excel in their field with audit as the key factors in reaching new frontiers. The International Fetal Medicine and Surgery Society, has endorsed a consensus statement aimed at guiding the practice of fetal surgery (Table 1).[7]

With the practice of open surgery considerable fetal and maternal morbidity were encountered. This has been the driving force behind the birth of minimal access techniques as clinicians tried to balance the benefit and side effect of intervention. Major drawback of open access was has been preterm labor, preterm rupture of membrane and chorioamnionitis, although there has been notable success.

Minimal access surgery is a well-established surgical approach, often regarded as the preferred method if not gold standard for some form of surgical treatment such as in some general surgical conditions and the elderly.[8,9] Advantages of this technique have been described elsewhere for different kinds of surgical setting.[8,9] The question arises as to the status of minimal access surgery in the current management of fetal conditions given its established role in other forms of surgery. The above question has prompted this literature review.

AIM

The aim of this article was to review the role of minimal access surgery in the management of fetal conditions as published in the literature.

MATERIALS AND METHODS

Literature search was performed using Highwire, Medscape, Medline and google scholar. Keywords used for the search were as follows:

Fetal surgery, Fetoscopy, Minimal access surgery.

Articles were considered in terms of the year of publication, relevance to the topic, publishing/research institution

Table 1: Prerequisites for fetal surgery

1. There should be accurate diagnosis, exclusion of associated anomalies and proper staging of the condition.
2. The natural history and prognosis for the given condition should have been established.
3. Absence of effective postnatal treatment.
4. Animal studies performed *in utero* have demonstrated feasibility and effectiveness of the proposed therapy.
5. The intervention should take place in specialized setting, with multidisciplinary involvement. These centers should have strict protocols and institutional ethics committee approval with informed consent for the affected parents.

Adapted from Deprest et al[7], 2006

and number of cases where an original research was undertaken. Older articles were considered where the author felt that they carried information that was indispensable for the completion of this review.

RESULTS

The findings of the literature search are discussed under different subheadings below.

Ethical Consideration

Intrauterine surgical procedures are fraught with ethical dilemmas. The experimental nature of the procedures and the maternal-fetal conflicts are issues that need consideration. Surgery in the fetus is effectively surgery on the mother who is always an innocent bystander with no direct benefit as far as her well-being is concerned. Risks of anesthesia and surgery to both mother and fetus should be addressed and the woman counselled appropriately to obtain informed consent. The concept of the fetal patient and the boundaries that define this status is often blurred. However, once the woman confer patient status to her unborn baby, the beneficence-based obligations of the clinician to the fetal patient should be weighed against autonomy considerations for the pregnant mother.[10] Possible outcomes and effect on pregnancy, alternative form of treatment and effect of the proposed intervention on her future should be discussed and recommendation from the International Society of Fetal Medicine and Surgery (Table 1), adhered to.

A multidisciplinary team of experts came together at the National Institutes of Health (NHI) in the year 2000 with further recommendations.[11] The principle of redistribution of resources is another ethical issue that need a review on its own when it comes to fetal surgery. Some may argue against the use of limited resources in a world burdened with vast and potentially preventable conditions, for procedures that are best regarded as experimental with questionable long-term effects to the recipients (fetuses). Long-term data is needed to assess the effect that these procedures will have during adulthood to the index patient.

Technical Aspects

Instruments used in fetal endoscopic surgery are purpose-designed. This has come as a result of cooperation between companies and clinicians. Entry into amniotic cavity is by diamond-cut needle within sheath. This has been designed to minimize rupture of membrane and is expandable. Troncars are miniaturised and endoscopes are usually 18 cm in length, 1.2 to 3.5 mm in size.[5] Thirty telescopes offer

maximum visibility in the amniotic cavity but zero degrees are available. Flexible cannulas and telescopes using fiberoptic technology are also available for placental operations.[5]

Carbon dioxide is the gas used for adults endoscopy as it makes visualization easy, is well-absorbed and does not support combustion. This has been shown to result in fetal acidosis and placental insufficiency, when used in fetal surgery.[12,13] Because ultrasound is needed to aid in troncar insertion and fetal monitoring, sonographic images would be compromised by use of carbon dioxide.[5] A fluid exchange medium is often used.

Clinical Application

There are number of fetal conditions that minimal access surgery has been utilized successfully.

Twin to Twin Transfusion Syndrome (TTTS)

This is a complex condition occurring in 10 to 20% of monochorionic pregnancy.[5,14] The pathological basis for this condition is often unpaired vascular anastomoses between the twins. One twin, the donor, suffers from intrauterine growth restriction due to chronic vascular insufficiency and the other become fluid overloaded. There are various staging systems that are used in the management of TTTS, for example; Quintero, Cincinnati, Children's Hospital of Philadelphia (CHOP) and the Cardiovascular Profile Scoring system.[15] Mortality has been reported to be around 80% if untreated.[15]

Treatment options available include, amnioreduction, microseptostomy, fetoscopic laser photocoagulation, photoscopic cord coagulation. A randomized controlled trial comparing laser versus serial amnioreduction concluded that laser was superior to serial amnioreduction in the management of this condition before 26 weeks.[16] The study composed of 72 women for the laser group and 70 women for the amnioreduction group, reported higher likelihood of survival, lower incidence of periventricular leukomalcia and more less neurological complications at 6 months of age in favor of laser treatment. Other studies have reported similar findings.[17,18] The procedure is depicted in Figure 1.

Another option is fetoscopic reduction through cord occlusion/coagulation for the recipient twin with advanced cardiomyopathy and no chance of survival.[19] Advantages of these procedures are that they can be done under local/regional anesthesia or a combination thereof and the patient can be discharged the same day.

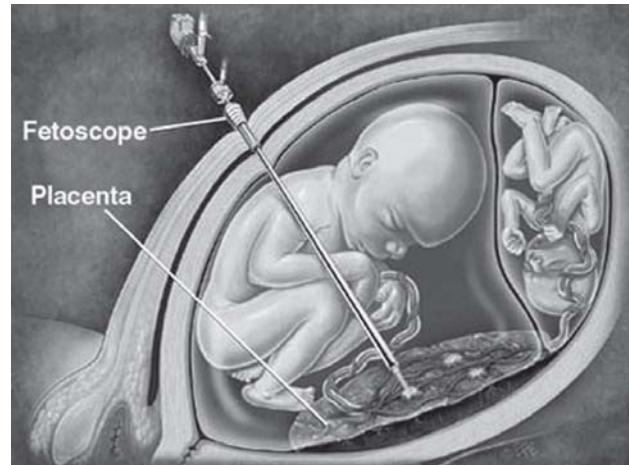Long-term outcome of laser treatment has been studied. In a study of 189 children who underwent intrauterine photo-

Fig. 1: Laser treatment of twin-to-twin transfusion syndrome (From Lambretti,[20] 2009)

coagulation with laser, Banet et al, reported normal development in 78% at 22 months, 11% minor neurological deficit (minor neurological abnormalities, e.g. mildly delayed motor development) while 11% had major neurological sequel such cerebral palsy.[21] These findings were similar to the one reported in the eurofetus (major abnormalities in 13%).[22] In his study, no difference was noted between the amnioreduction and laser-treated group. This underscores the inherent effect of the underlying condition as well as gestational age in treatment outcome not necessarily the form of treatment.[14] Laser, seem to be the best choice in the treatment of severe TTTS.

Congenital Diaphragmatic Hernia (CDH)

This condition affects 1:2400 livebirths.[23] The underlying problem is an anatomical defect in the diaphragm leading to herniation of abdominal organs into the thorax. This results in lung compression, lung hypoplasia, hydrops and fetal demise. The condition ranges from mild to severe. Initial open approach to correct the defect was faced with serious technical challenges.[24,25] Negative prognostic factors for this condition that predict outcome is the presence/absence of liver herniation (liver up/liver down) and the lung-head ratio (LHR).[25,26]

Due to the discouraging results of open surgery, endoscopic fetal surgery evolved. Initial strategies using trancheal clips gave some hope, but clips resulted in laryngeal nerve damage and were difficult to remove.[27] The subsequent use of balloon and EXIT (Ex Utero Intrapartum Treatment) procedure retained the success of the procedure and overcame the problems with the clips.[28] Further research is ongoing.[23] This form of treatment seem to hold hope for the future.

Twin Reversed Arterial Perfusion (TRAP)

This is a rare condition (1:35000 livebirth)[5] characterized by perfusion imbalance as a results of vascular connection between an acardiac achephalic twin and a normal fetus.[29] Blood is pumped by the normal fetus to the 'monster'. Mortality, if untreated is between 50 and 75%.[5,29] Several therapeutic strategies including use of potassium chloride, amnioreduction, extracorporeal knot ligation of the cord, laser, monopolar and bipolar coagulation as well as ultrasonic transaction has been tried.[5,29-31] Although the numbers are not big and difficult to make comparison, laser, bipolar and ultrasonic transaction seems to be promising.

Fetal Tumors

Two common tumors that has been studied are the Sacroccocygeal teratoma (SCT) and congenital cystic adenomatoid of the lung (CCAM).[5] The problems with these tumors is that they may cause compression or lead to high-output cardia failure resulting in fetal death. Open surgery has been used to successfully excise the tumors but limited by complications. Percutaneous approach using radio-frequency ablation (RFA) for treatment of SCT has been reported but was associated with uncontrolled burns to adjacent tissues.[32,33] Open approach seem to offer better results for thoracic lesions and SCT when both are complicated by hydrops.[29]

Obstructive Uropathy

Urinary tract abnormalities constitute 50% of prenatal diagnosed fetal anomalies.[34] The major problem is obstruction leading to renal damage and lung hypoplasia secondary to oligohdramnios. Percutaneous vesicoamniotic shunts have been used with complication rate of 25% due to shunt displacement.[5] Other tried procedures include *in utero* percutaneous cystoscopy and ablation of posterior urethral valve.[35] Long-term results will clarify the value of these procedures.

Other Procedures

Minimal access surgery has been used for the release of amniotic band syndrome with the use of fetoscope. These bands are associated with limb constrictions and amputations as well as postural deformities. Other area that has received attention is the repair of cleft palate endoscopically with minimal or no scarring. Attempt to repair myelomeningocoele endoscopically has been described using carbon dioxide (amniotic fluid removed) and maternal skin craft as the patch material.[36] The results of open surgery for this procedure is yet to be challenged.[37] There is work reported in animals on fetoscopic management of aortic and pulmonary stenosis.

OVERALL COMPLICATIONS

While major complications of open surgery have been reduced by minimal invasive approach, preterm labor and PPROM remain challenge (Table 2).

Table 2: Maternal morbidity and mortality for 178 interventions at University of California, San Francisco with postoperative continuing pregnancy, divided into operative subgroups

	Open hysterotomy	Endoscopy FETENDO/Laparatomy and FETENDO	Percutaneous FIGS/Laparatomy and FIGS	All interventions
Patients with postoperative continuing pregnancy	79	68	31	178
Gestational age at surgery (wks)	25.1	24.5	21.1	24.2
Range (wks) delivery (wks)	17.6-30.4	17.9-32.1	17.0-26.6	17.0-32.1
Gestational age at delivery (wks)	30.1	30.4	32.7	30.7
Range (wks) Interval surgery to delivery (wks)	21.6-36.7 4.9	19.6-39.3 6.0	21.7-40.4 11.6	19.6-40.4 6.5
Range (wks)	0-16	0-19	0.3-21.4	0-21.4
Pulmonary edema	22/79 (27.8%)	17/68 (25.0%)	0/31 (0.0%)	39/178 (21.9%)
Bleeding requiring blood transfusion	11/87 (12.6%)	2/69 (2.9%)	0/31 (0.0%)	13/187 (7.0%)
PTL leading to delivery	26/79 (32.9%)	18/68 (26.5%)	4/31 (12.9%)	48/178 (27.0%)
PPROM	41/79 (51.9%)	30/68 (44.1%)	8/31 (25.8%)	79/178 (44.4%)
Chorioamnionitis	7/79 (8.9%)	1/68 (1.5%)	0/31 (0.0%)	8/178 (4.5%)

Table from Wu and Ball,[38] 2009.

CONCLUSION

Minimal Access Surgery (MAS) has had an impact in the practice of fetal medicine and surgery. It has specific indications and cannot replace open procedures but rather regarded complementary. As the field evolves, new insight gained fetal pathologies, skills, techniques and technology improve, one can only speculate that with time, this field will become more refined and this will translate to better outcomes for the fetal patients.

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Laparoscopic Reversal of Hartmann's Procedure

[1]K Kilic, [2]K Ulker

[1]Medical Faculty, Department of General Surgery, Kafkas University, Kars, Turkey
[2]Medical Faculty, Department of Obstetrics and Gynecology, Kafkas University, Kars, Turkey

Correspondence: K Kilic, Medical Faculty, Department of General Surgery, Kafkas University, Tip Fakultesi Genel Cerrahi ABD 36200, Kars, Turkey, Phone: 90-505745-68-30, e-mail: kilic8@hotmail.com

Abstract

Objective: To assess the outcomes of laparoscopic and open reversal of Hartmann's procedure.

Methods: Studies of laparoscopic reversal of Hartmann's procedure with comparison of open approache are searched from medical literature and outcomes of the approaches made.

Results: Laparoscopic reversal of Hartmann's procedure with the advantages of smaller incisions, decreased postoperative pain, shorter recovery time, and early return to normal activity may reduce morbidity rates. And laparoscopic approach has a clear advantage over open approach for mobilization of the splenic flexure by avoiding an upper abdominal incision and its potentially increased respiratory complications when mobilization is mandotary. The most commonly reported reason for conversion to laparotomy was the failure to identify the rectal stump and conversion rate is between 4 to 22%. There are only two studies directly comparing laparoscopic and open reversal approaches, up-to-date.

Conclusion: Laparoscopic reversal of Hartmann's procedure for restoration of intestinal continuity can be performed with low morbidity and a short hospital stay.

Keywords: Reversal of Hartmann's procedure, laparoscopy, open, laparotomy, outcomes, complications.

INTRODUCTION

After the description of Hartmann's procedure in 1923, by Henri Albert Hartmann for the treatment of proximal rectal cancer, Hartmann's procedure has been commonly used for conditions like distal large bowel obstruction, complicated diverticulitis and colonic injuries that may be difficult and unsafe for repair (ischemic and inflammatory colitis, traumatic perforation of the colon,volvulus and anastomotic leaks).[1] Following the inital surgery of Hartmann's procedure, after the recovery of the patient, reversal of the procedure for bowel continuity maintanence is indicated. Reversal procedure is a major abdominal surgery and has risks of mortality and morbidity.[2,3]

After the expansion of Minimal Access Surgery (MAS) techniques for colorectal surgery, with clear advantages of low morbidity, less postoperative pain, shorter hospital stay, and an earlier return to normal life; articles about other procedures such as reversal of Hartmann's procedure were published.[4,5] Although the successive studies support the improved outcomes of the laparoscopic Hartmann's reversal, when compared with other laparoscopic surgeries this procedure's improvement is beeing lagged.

Purpose of this review is to compare the outcomes of laparoscopic and laparotomic Hartmann's reversal procedure to enlighten the surgeons while selecting the approach.

METHODS

Recent medical literature for the complications of laparoscopic reversal of Hartmann's procedure was searched. Data were collected by using the online search engines like Pubmed, Highwire, Google and Google Scholar. In the search we included the prospective, retrospective studies and review articles. All the procedures that began laparoscopically, even then converted, were included in the study. Patients' age at reversal, gender, anesthesiologic risk, initial operation indication, comorbidities, operative time, complications, postoperative bowel movements and hospital stay time were the concerns. Previous articles and their results were compared at the base of these parameters.

SURGICAL TECHNIQUE

In the study of M Khaikinin et al in 2006,[6] all patients underwent preoperative mechanical bowel preparation, and a Fleet enema Fleet, Lynchburg, Virginia, USA was administered to empty the rectal stump. In addition, perioperative broad spectrum parenteral antibiotics and subcutaneous low-molecular- weight heparin were routinely used. No ureteric catheters were used in this study. A Jackson-Pratt drain was placed through the lower abdominal trocar site. The patients were placed in a modified lithotomy position with the legs only slightly flexed. Two video monitors were placed on the left side of the patient. The surgeon and first assistant stood on the right side of the

patient, with the second assistant standing on the left. The initial port insertion was performed by one of two techniques depending upon the surgeons' preference. The first technique involved mobilization of the colostomy site through a peristomal incision, with the anvil of a circular stapling device inserted into the lumen. For the left colon, the anvil was placed into the abdominal cavity, and the colostomy site was used as the port site for the establishment of pneumoperitoneum. The fascia at the colostomy site was closed using two continuous 0 Prolene sutures, and the Hasson cannula was placed between these sutures, creating an airtight port site. The second approach involved placement of a Hasson trocar into the right lateral abdomen, away from the previous incision. This approach allowed dissection of adhesions before mobilization of the colostomy from the abdominal wall. Two to three additional ports were then inserted under direct vision. A 12 mm port was placed in the lower right iliac fossa, and a 5 mm port was inserted into the right upper quadrant. The colostomy site was closed primarily. The skin wound was closed using a skin stapler without suturing of the subcutaneous tissues. Intra-abdominal adhesions were dissected free by sharp dissection. The descending colon and the splenic flexure were routinely mobilized to ensure a tension-free colorectal anastomosis. In patients with diverticular disease, any residual distal sigmoid colon was resected to the level of the rectosigmoid junction using a laparoscopic linear stapler. The steep Trendelenburg position with a tilt to the right was useful for keeping the small bowel out of the pelvis. Identification of the rectal stump and its mobilization might be facilitated by the transanally inserted circular stapler or Hegar dilator. The transanal end-to-end anastomosis was performed using a circular stapling device. In this study, all surgeries were performed by six experienced attending surgeons, each of whom had performed more than 20 laparoscopic colorectal procedures and extensive noncolorectal laparoscopic procedures. Hand-assisted laparoscopic surgery was not used for Hartmann's reversal.

In the study of H Mazeh et al,[7] they placed pneumatic compression boots in all cases, and gave intravenous antibiotics approximately 30 minutes preoperatively. A urinary catheter was routinely inserted and patients were placed in either split-legged or modified lithotomy position. Video monitors were placed on the left side of the patient, with the surgeon and assistant standing on the right. Initial port insertion was accomplished by the open Hasson technique in the right lateral abdomen. Two to three additional ports were used in the upper abdomen and right lower quadrant as needed. Lysis of adhesions was done to allow mobilization of the colostomy and identification of the rectal stump. This was carried out using scissors, monopolar diathermy, or ultrasonic activated devices according to surgeon's preference. When necessary to identify the rectal stump, a dilator, stapling device or sigmoidoscope was inserted into the rectum. The colostomy was freed from the abdominal wall and the anvil of a circular stapling device was inserted into the lumen. The colostomy was then delivered into the abdomen, and either a 12 mm trocar placed at this site or fascial closure performed. Mobilization of the left colon, splenic flexure, and resection of proximal sigmoid or left colon were done as needed. A transanal, end-to-end anastomosis was performed using a circular stapling device. Anastomotic integrity was confirmed by using insufflations of air and colored saline. Hand-assisted technique was not used in any case.

RESULTS

Kohler et al in their study[8] had 18 patients for laparoscopic reversal of Hartmann's procedure. They had to convert in two cases (11%). They found the median operative time of 114 (65 to 180) minutes. Only three patients had immediate postoperative wound infections. Their patients had first evacuation 3.3 (3 to 5) days after procedure, and complete oral nutrition was started 3.6 (3 to 5) days after operation. Hospiatal stay was 7.5 (5 to 12) days. Duration of postoperative hospital stay was 7.5 (5 to 12) days. Clinically significant anastomotic stricture which needed endoscopic dilatation was seen only in one patient.

Holland JC et al[9] published their experience of laparoscopic reversal of Hartmann's procedure. They had succes of reversal in 3 of 4 cases.

Michael J Rosen et al.[10] analysed the results of twenty-two laparoscopic reversal of Hartmann's procedure (all but one with left colon colectomies, the reminder right colectomy). They had a sucess rate of 91% (20 cases) with laparoscopic approach. There were 2 conversions to open (9%) secondary to dense adhesions around the rectal stump. The mean time to closure of the colostomy and the mean operative time were 168 days (range 69 to 385 days) 158 minutes (range 84 to 356 minutes), respectively. Blood loss was estimated as averaged 114 ml (range 30 to 250 ml). Hospital stay was 4.2 days (range 2 to 6 days). 3.5 (range 2 to 5 days) days after the operation bowel function returned. Three patients (14%) developed postoperative wound infections. Anastomotic leaks and amortality were not seen. A small hernia at a colostomy site was the only long-term complication in a mean 14.7 months follow-up.

M Khaikin et al,[6] studied 27 patients underwent laparoscopic reversal of the Hartmann's procedure. 17 (63%) of their patients with a mean age of 58.1(23 to 88) years were males and 10 (37%) with a mean age of 62.9 (17 to 80) years were females. There were 2,13 and 12 patients classified for anesthesia risk as ASA 1, 2, 3 respectively. 81.5% (22 cases) of the initial surgery was for benign indications (19 perforated diverculitis, 1 iatrogenic sigmoid perforation, 1 sigmoidal gun shot wound and 1 colon sigmoid volvulus) and 18.5% (5 cases) for obstructing sigmoid carcinoma. Reversal procedures were done 3 to 10 months after the initial operation. They used the colostomy site as the initial port in 21 patients and used Hasson technique in the 6 remaining cases.Their median operative time and median follow-up period were 226 (83 to 329) minutes and 8.5 (2 to 14) months, respectively. Laparoscopical complition success rate was 85.2% (23 cases). Extensive adhesions in three patients and rectal perforation during transanal insertion of the circular stapler in one patient caused canversion. Complications of entorotomy during adhesiolysis and incomplete stapled anastomosis in two patients were repared succesfully laparoscopically. The median bowel movement and the median hospital stay were 4 (1 to 7) days and 6 (3 to 20) days respectively. In 9 (33%) patients, postoperative complications occured. 5 colostomy-site infection, 2 acute upper gastrointestinal bleeding, 2 intra-abdominal bleeding, 1 pseudomembranous colitis and 1 small bowel obstruction were seen. Three patients had more than one complication. One patient with extensive adhesiolysis underwent reoperation on postoperative day 2 for intra-abdominal bleeding. No anastomotic leaks, ureteral injuries, or intra-abdominal abscesses were recorded,and there was no operative mortality. In one patient late complication of the anastomotic stricture 3 months after surgery, successfully dilated endoscopically was observed.

In 2007, Faure JP et al[11] compared the 14 cases of laparoscopic reversal of Hartmann's procedure with 20 cases of open reversal of Hartmann's procedure. They found a conversion rate of 14. 28%. Operating time was shorter for the laparoscopic group 143 (90 to 240) *vs* 180 (90 to 350) minutes. Hospital stay length was shorter for the laparoscopic group 9.5 (4 to 18) *vs* 11 (6 to 39) days. Use of patient-controlled analgesia was not significantly shorter in the laparoscopic group 3 (0 to 4) *vs* 3.5 (0 to 8) times. Morbidities observed in the laparoscopy group include a parietal abscess and an anastomotic stenosis without surgical treatment. The open group had 6 complications of 1 anastomotic leak and 5 incisional hernias.

Carus T Et al[12] in their study succeded to perform 28 of 34 reversal of Hartmann's procedure laparoscopically.

Results were as follows: A short operative time (69 minutes), a conversion rate of 17.9%, wound complications in 10.7% and an anastomosic leak in 1 patient (3.6%). On average the patients were discharged after 8.6 (6 to 17) postoperative days.

Chouillard E et al[13] compared 44 patients who had laparoscopic Hartmann's reversal with the 44 patients who had open Hartmann's reversal. Conversion rate in this was 9.1%. Operative incidents were comparable in both groups. Operative duration was not significantly shorter in open group (195 minute in laparoscopic versus 160 minutes in open group). Mortality rate was 2.2 % and 0% in laparoscopic group and open group, respectively. Overall morbidity rate was 11.4 % and 28.6 % in laparoscopic and open group, respectively (P < 0.05). The mean length of hospital stay was significantly shorter in laparoscopic group (4.8 days when compared to open group 6.8 days), respectively. An efficiency analysis was performed and demonstrated that laparoscopic reversal did not generate a significant additional cost.

Haggi Mazeh et al[7] selected 41 open case of reversal of Hartmann's procedure with the best matched criteria of the 41 laparoscopic reversal cases to compare the outcomes. Diveticulutis was the most common initial operation indication in both groups. Perforation, volvulus (four patients), anastomotic leak (three patients), obstructing colorectal carcinoma, ischemic colitis (three patients), Fournier's gangrene (two patients), trauma (two patients), and rectovaginal fistula (one patient) were the other indications. Convertion rate was 19.5% (8 patients) in laparoscopic group due to dense adhesions or failure to identify the rectal stump. In three of these cases a stapling device that was inserted into the rectum failed to assist in identification of the rectum. In the other five cases dense adhesions were the reason for conversion. There were significant differences in operative time [193.1 (89 to 460) minutes *vs* 209.2 (57 to 335) minutes], blood loss [166.6 (50 to 900) ml *vs* 326.6 (50 to 950) ml], time to bowel movement [4.2 (2 to 5) days *vs* 5.3 (3 to 17) days], time to solid diet [4.6 (2 to 9) days *vs* 5.8 (2 to 10) days] and length of hospital stay [6.5 (3 to 16) days to 8.1 (4 to 22) days], in respective to the first values laparoscopic and second values open group. Postoperative morbidity was 37.8%, most commonly surgical site infection and ileus. Reoperation for two patients was needed in the open group: One for debridement of a deep surgical site infection, and another who developed an incarcerated inguinal hernia on postoperative day 3. Two other patients in this group were admitted to the surgical intensive care unit (SICU) posto-

peratively. One of these patients had severe pulmonary comorbidities and required short postoperative mechanical ventilation. The second patient was admitted to SICU for observation for 24 hours due to the surgeon's request because of the patient's age and comorbidities. Three (7.3%) major complications occurred in the open group (deep vein thrombosis and reoperations) and one (2.4%) major complication occurred in the laparoscopy group (enterocutaneous fistula). The overall complication rate in the laparoscopy group was significantly lower than in the open group (26.8% *vs* 47.8%). There were no anastomotic leaks, uretral injuries or intra-abdominal abscesses in this series, and there were no mortalities. Findings at both the index and the reversal procedures were analyzed to compare differences between the laparoscopic completed and converted groups. No statistically significant difference was found when these criteria were compared between the two groups.

DISCUSSION

Despite its obvious advantage for intestinal continuity, reversal of Hartmann's colostomy is a major abdominal surgery with prolonged recovery. In open reversal morbidity of 4 to 43% was reported, with a wound infection rate of 5 to 24%, and anastomotic dehiscence seen in up to 12%.[14-16] And the mortality rate was reported to differ from 0 to 4%.[17] Because of these risks 40 to 60% of patients refuses reversal. Laparoscopic reversal with the advantages of smaller incisions, decreased postoperative pain, shorter recovery time, and early return to normal activity may reduce morbidity rates. And laparoscopic approach has a clear advantage over open approach for mobilization of the splenic flexure by avoiding an upper abdominal incision and its potentially increased respiratory complications when mobilization is mandatory.[18,19] In laparoscopic approach clear view of the sigmoid and descending colon is possible avoiding the unnecessary dissection. After the description of Gorey et al. and Anderson et al of laparoscopically assisted Hartmann's reversal,[4,5] case reports and small series of laparoscopic reversal have followed. But consensus about the preferred surgical technique is lacking. For safe access to the peritoneum, some suggests insertion of the initial port in the colostomy site once it is reduced into the abdomen. But Hasson technique at the right side or in the upper midline left to the rectus sheath was reported in most studies. The most commonly reported reason for conversion to laparotomy was the failure to identify the rectal stump.[6,7,10] When we searched the medical literature we found a conversion rate between 4 to 22%. But there are only two studies directly comparing laparoscopic and open reversal approaches, up-to-date.[7,10] In both study the groups were similar in the demographic

and clinical data, along with distinct advantage for laparoscopic group having shorter time to bowel function and hospitalization. Both studies demonstrated lower morbidity rates in laparoscopy group. Mazeh et al analyzed laparoscopy group patients that were converted to laparotomy. And they found that these patients had a higher surgical site infection rate than those that were not converted, suggesting that surgical site infection was not solely related to the colostomy site, but also associated with a long midline incision which is avoided in laparoscopy group. And establishment of scheduled and specified training programs of laparoscopic approach in clinic practices and residency programs, gaining of the surgeons the familiarity of various laparoscopic instruments and their operating principles (bipolar, monopolar coagulation, different energy sources, camera, light source, insufflators and hand instruments), laparoscopic ergonomy, anatomy and various operative techniques will aid in lowering the complication rates.

CONCLUSION

Laparoscopic reversal of Hartmann's procedure for restoration of intestinal continuity can be performed with low morbidity and a short hospital stay. The need for conversion to open surgery is not depended the patients' previous surgeries but the presence of dense adhesions and inability to mark the rectal stump. But more and large serious of randomized, prospective studies are needed to clarify the outcomes of laparoscopic and open approaches of reversal of the Hartmann's procedure. Surgical teams adequately and skillfully trained will open the doors of surgery with minimal (may be non) complications.

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Incisional Hernias after Laparoscopic Surgery

Mathews John

Department of General Surgery, Lifeline Hospital, Adoor, Pathanamthitta, Kerala, India

Correspondence: Mathews John, Department of General Surgery, Lifeline Hospital, Adoor, Pathanamthitta, Kerala, India
Phone: + 91-9663054330, e-mail: monoies@gmail.com

Abstract

Objective: To review about incisional hernia following laparoscopic abdominal surgery and the relationship between the pathogenesis and clinical features and manifestation of trocar site hernias.

Methods: We searched for this subject on Medline and Google search by combining all these words like "trocar," "port," "hernia, and "laparoscopy."

Results: We were not able to find a common factor that analyzed the factors related to trocar site hernia by multivariate analysis. Therefore, we could not indicate the only independent risk factor. However, we have referred to many reports that have logically indicated pathogenesis. The literature what we have gone through frequently point out that the main pathogenesis is not host factors but rather technical ones; besides, most accurate reason is that a large trocar size, leaving the fascial defect open, and stretching the port site were closely related to the occurrence of trocar site hernias.

Conclusion: The highlight of this review article is that the drain sites can possibly be one of the sources for bowel complications. We recommend closure of all 10 mm ports. If an intraperitoneal drain is necessary, it should be placed through a 5 mm port only.

Keywords: Laparoscopy, incisional hernia, small bowel obstruction.

INTRODUCTION

In 1987, Mouret performed the first laparoscopic cholecystectomy changing surgical practice and it was mentioned by Rosen and Ponsky.[1] Then the laparoscopic abdominal surgery increased and was common by the 1990s.[2] The adoption of this new technique resulted new, specific operative complications. Incisional hernias at the site of entry of a trocar is a serious complication in laparoscopy,[3] as most trocar site hernias require further surgery.[4]

Fear[5] reported first a trocar site hernia in his large series on abdominal laparoscopy in gynecological diagnosis. Many authors have recognized still this as the first report on trocar site hernias.[2,6-8] Maio and Ruchman[9] then reported on the trocar site hernia associated with small-bowel obstruction occurring immediately after laparoscopic cholecystectomy; this being the first report on trocar site hernias in digestive surgery. In the published reports there is enormously wide variation in the clinical aspects of trocar site hernias; so nowadays we became more concerned about the meaning of the medical term "trocar site hernia," as it is not clearly defined.

MATERIALS AND METHODS

Data Sources: We searched for this subject on Medline and Google search by combining all these words like "trocar," "port," "hernia", and "laparoscopy."

Data Extraction and Study Selection: We limited the laparoscopic surgeries to cholecystectomy, colon and rectal surgery, fundoplication, and gastric surgery; finding a total of 44 reports on these procedures. Out of these, 19 case reports, 18 original articles and 7 technical notes on "how to do it" were collected. Another 19 additional reports were obtained using the references of those previously obtained study. So a total of 63 reports were reviewed (24 case reports, 27 original articles, 7 technical notes, and 5 review articles).

Data Synthesis: In this review study, we classified trocar site hernia into 3 types. The early-onset type being the first that occurred immediately after the operation, with a small-bowel obstruction, especially the Richter hernia. The late-onset type being the second one that occurred several months after the operation, mostly with local abdominal bulging with no small-bowel obstruction developing and the third one a special type that occurred indicated the protrusion of the intestine and/or omentum.

REVIEW OF LITERATURE

Crist and Gadacz[10] defined trocar site hernia as the development of a hernia at the cannula site, and this same term has been used in many articles over this time; however,

"port site hernia" has also been used by many authors in some other articles in similar situations. Initially, we started searched this topic on Medline combining "trocar," "hernia," and "laparoscopy" and we got 186 reports in English. Second, we combined "port," "hernia," and "laparoscopy" the result was 90 reports in English. We then limited our search in the main operations such as cholecystectomy, colon and rectal surgery, fundoplication (i.e. operation for gastroesophageal reflux disease), and other gastric surgical procedures (e.g. obesity surgery) that are supposed to result in the same operative insult as digestive surgery. Forty-four articles were found on these procedures. Out of the 44 reports, 19 were case reports, 18 were original articles and 7 were technical notes on "how to do it." We found an additional 19 articles using the references of those obtained (except for 3 gynecological articles).[5, 7,11] So total of 63 articles (24 case reports, 27 original articles, 7 technical notes, and 5 review articles). We finally chose trocar site hernia as the best and the relevant medical term as it was the most frequently used and the one that most clearly expressed the condition.

We can classify trocar site hernias into 3 types according to the reported cases that have been analyzed. Early-onset type indicates dehiscence of the anterior fascial plane, posterior fascial plane, and peritoneum. The early-onset type was recognized in many case reports as beginning to develop in the early stages after surgery, often presenting as a small-bowel obstruction. The late-onset type indicates dehiscence of the anterior fascial plane and posterior fascial plane. The hernia sac of late-onset type is the peritoneum. The late-onset type has often been recognized, in many large series, to be related to complications of the trocar insertion. Late-onset type hernias almost always develop in the late stages several months after surgery.

The special type indicates dehiscence of the whole abdominal wall. Protrusion of the intestine and other tissue (e.g. greater omentum) is recognized. The first case, reported by Fear,[5] was of the special type: A loop of the bowel came through a defect as the laparoscope and sheath were withdrawn. Therefore, this first report points us toward expressing a protrusion of the bowel and/or omentum as a "hernia," although in this type there is no hernial sac. Three case reports of the special type have been published since then.[12-14]

Several large series of postoperative complications of laparoscopic cholecystectomy have been reported, where the incidence of trocar site hernia was 1 in 500 cases,[17] 3 in 1983 cases,[18] 1 in 800 cases,[19] 11 in 1300 cases,[20] and 10

in 1453 cases.[21] Callery et al[3] mentioned a very low overall incidence, while Mayol et al[22] stated that all these figures represent only the early results of laparoscopic surgery or gynecologic laparoscopy (i.e. mostly diagnostic laparoscopy); currently all publications have drawn attention to this problem as the number is increasing. Moreover there will be a much higher true incidence and unknown percentage of patients who are asymptomatic might not seek medical examination[6, 8] that is not reported. Coda et al[14] noted that the onset of trocar site hernia is not immediate after surgery rather than early that might elude a surgeon in many surveys unless an extended follow-up procedure has been established. Recently, the incidence of trocar site hernia has been reported as a postoperative complication in gastrointestinal surgery (colorectal surgery for cancer, 0.6%;[23] colectomy for sigmoid diverticulitis, 0.9%;[24] Roux-en-Y gastric bypass, 0.3%[25] and 1.0%;[26] and gastric banding, 0.5%).[27]

From 1995, a large series on digestive surgery on complications of the trocar site in digestive surgery has been published. The incidence of trocar site hernia has been shown to be 0.65% to 2.80%. The studies based on Mayol et al[22] and Nassar et al[28-31] were based on data collected prospectively, and patients have been followed up for several months; therefore, it is supposed that the incidence reported by them (1.50% to 1.80%) is reasonably standard.

DISCUSSION

Diagnosis

We can diagnose the special type of hernia without any modalities. With the early-onset type we are able to locate the site of herniation by computed tomography and surgically reduce and repair the hernia with minimal enlargement of the same trocar puncture wound, thus avoiding a full laparotomy.[41,43,46-48] In many other reports to diagnose early-onset-type hernias a computed tomography was taken[9,16,32,34,38,42,45,50] and were effective in diagnosing them. There were 3 reports of gastrointestinal contrast study which was effective.[33,38,44,49,52,53]

There was an unknown proportion of asymptomatic patients who do not get physically examined,[8] that belonged in late-onset-type hernias although sometimes asymptomatic lumps were found.

Prevention

10 mm fascial defects or larger trocar sites should be closed to prevent hernia formation whenever possible.[4,10,20,34,35,38]

Moreover, Crist and Gadacz[10] mentioned that, in general, 5.5 mm facial defects by trocar sites need not to be closed. However, Sanz-Lopez et al[8] insisted that the general consensus is that trocar site hernias of 5 mm and greater in diameter should be closed at the fascial level, and that defects of any size especially in children should be closed. Some authors have stated their opinion that all 5 mm ports sites routinely might not be necessary to close, but in active manipulation during prolonged procedures, to avoid complications they should be closed.[54,55]

How to properly close a fascial defect is the problem. Matthews et al[15] reported that there were trocar site hernias due to incomplete closure of fascial planes and that the peritoneum should also be closed along with the fascia to obliterate the preperitoneal space, and thus postoperative complication of hernia can be prevented. Velasco et al[51] mentioned that under direct vision only the closure should be done, and it should incorporate all abdominal wall layers to eliminate the peritoneal defect. Callery et al[3] stated that even if to extent the skin incision, all large trocar sites should be closed meticulously. We consider that larger trocar site of 10 mm and above should be closed completely (meaning closure of all layers including the peritoneum) with adequate muscle relaxation. Thus, the lateral trocar should also be closed as there are incidences of trocar site hernia at the lateral port.[56]

Some surgeons recommended a fascial closure device,[16] a spinal cord needle,[57] a suture carrier,[58] a 2 mm trocar,[54] or a Deschamps needle[59] to close the fascia and the peritoneum together. It would be advantageous to try one of these techniques to close all the layers so there won't be any defects. It might be better to use a device like those mentioned earlier if the fascial defect must be closed in a 5 mm trocar site.

Some authors have reported a new type of trocar: as 10 to 12 mm nonbladed trocar sites which is very useful and do not require fascial closure above the arcuate line in nonmidline port sites,[60] so the trocar site hernias frequency could be lowered significantly, from 1.83 to 0.17%, by switching from a sharp cutting device to a cone-shaped trocar tip;[61] and a trocar that expands radially might be useful to prevent hernias. It is supposed that these devices are recognized as useful, but before abandoning fascial closure a randomized large prospective study of digestive surgery is needed.

Many authors have advised to deflate air completely before port removal then fascial closure so as not to draw omentum and intestines into the fascial defect.[2,6,8,32] We

should stick to this rule of deflating intra-abdominal compressed gas before closure.

We believe that closing the fascial defect and peritoneum is the only effective way to prevent trocar site hernias, and that the other methods should be used after improper closure for the worst cases. When active manipulation through a 5 mm port for prolonged time has occurred then to avoid complications the fascial defect should be closed.

TREATMENT

Duron et al[2] investigated 24 cases of reoperated mechanical intestinal obstruction postoperative following laparoscopic surgery that were; 11 (46%) were due to trocar site hernia, 8 (33%) to adhesions, 4 (17%) to gastric bands, and 1 to cecal volvulus. The median interval to reoperation was significantly shorter for trocar site hernias (8 days) than for adhesions (25 days) or gastric bands (22.5 days). To conclude that trocar site hernia will be early onset of small-bowel obstruction. Velasco et al[51] reported that all his patients required surgery to resolve small-bowel obstruction with early post laparoscopic bowel obstruction. They set for decision-making as 14 days after surgery to be the turning point. Moreover, some authors advised that correctly diagnosing Richter hernia will help to lessen any delay in a postlaparoscopic patient with symptoms of small-bowel obstruction.[44, 50] Therefore, further procedures on patients with a small-bowel obstruction is advisable within 2 weeks of laparoscopic surgery. If diagnosis of the obstruction cannot be ruled out, computed tomography will be effective. Nonoperative management (nasogastric suction and other methods) will often end up in waste of time and money, and they will sometimes lead to critical conditions (i.e. strangulation).

CONCLUSION

In this review article, we tried to make a classification of trocar site hernia by studying previous reports and articles published. We think that a more accurate clinical identification is possible from this categorization. These will be useful to prevent complications if the surgeon is able to correlate between the identified types and clinical manifestations before the laparoscopic procedure.

The only surgeon who does not encounter complications is one who is not operating. Complications can happen even in the best of the best hands and it is important that these are recognized on table and addressed immediately. The importance of adequate training and the value of proper

experience are clear. It is a must to train ourselves in the necessary skills of laparoscopy and encourage the development of specially designed fellowships for those performing the most advanced procedures. When there are complications, excellent training and experience should make them bold enough to manage the same by laparoscopy.

Studies have shown wound infection rate is very less when compared to open cases with reduced postoperative pain and recovery period. Drain site related bowel complications, (Abdel-Halim etal) are rare, but its been reported before. Iwase et al reported an incarcerated perforated Richter's hernia through a drain site. Nomura et al reported two cases of bowel perforation due to pressure necrosis due to open silicone drains and when a thorough literature review was done it revealed eight similar cases (six of which where in relation to suction drains). This highlights that drain sites can possibly be one of the source for bowel complications. We recommend closure of all 10 mm ports. If an intraperitoneal drain is necessary, it should be placed through a 5 mm port only.

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Natural Orifice Translumenal Endoscopic Surgery (NOTES) Towards Brighter Future

S Abbas, R Rizvi

Consultant, Minimal Access Surgery, Rizvi Clinic and Research Center, Aligarh, Uttar Pradesh, India

Abstract

In natural orifice translumenal endoscopic surgery (NOTES) intentional puncture of one of the viscera (e.g., stomach, rectum, vagina, and urinary bladder) is made and an endoscope is used to access the abdominal cavity and perform an intra-abdominal operation. Early studies focused on feasibility, including such accomplishments as pure transgastric splenectomy and gastrojejunostomy. Contemporary studies are investigating the infectious and immunologic implications of NOTES and honing the tools and techniques required for complex abdominal operations.

Today NOTES has entered the clinical arena in quite a few cases: The first clinical series of transgastric peritoneoscopy has recently been published; many groups are accumulating patients in studies of NOTES cholecystectomy, either via the transgastric or transvaginal route; and a series of transgastric appendectomies has been well publicized, yet they remains unpublished. Although clinically NOTES is gaining momentum, the field should remain in check while rigorous studies are performed and clinical trials are undertaken. The zeal for NOTES should not take precedence over the welfare of the patient.

Keywords: Endoscopic surgery, translumenal, peritoneoscopy.

Kalloo's publication of transgastric peritoneoscopy in 2004[1] has led to evolution of field of natural orifice translumenal endoscopic surgery (NOTES). In a short time period, NOTES has been shown to be feasible in numerous laboratory animal studies and NOTES-specific instrumentation have already reached the research and development stages. Furthermore, the infectious and immunologic impact of NOTES has, in many cases, shown the equivalence of NOTES to laparoscopy and conventional abdominal surgery. As of now careful clinical trials of NOTES peritoneoscopy and cholecystectomy are being conducted, and as the data accumulate and instrumentation improves, NOTES will play a major role in the future of abdominal surgery.

BASICS

Fundamentally NOTES consist of passage of a flexible endoscope through one of the body's natural orifices, perforation of a viscous, and performance of abdominal surgery using endoscopic visualization. The endoscope may be inserted through the mouth, anus, urethra, or vagina with puncture of the stomach (the esophagus for mediastinal exploration), rectum, urinary bladder, or vagina, respectively. Although details of NOTES procedures vary between centers, most groups usually adhere to the same general principles. For transgastric surgery, a standard gastroscope is passed through the mouth into the stomach, small anterior gastrotomy is made, typically with an endoscopic

needleknife, a wire is passed through the site into the abdominal cavity, and then the tract is enlarged with an endoscopic dilating balloon to accommodate the endoscope. Transvesical and transcolonic operations use similar methods for entering the peritoneal cavity. Once the endoscope is inside the abdominal cavity, a pneumo-peritoneum is generated using endoscopic insufflation and then scope is maneuvered to view the organ of interest. Endoscopic instruments, such as biopsy forceps and polypectomy snares can then be passed through the working channels and used for tissue manipulation. Once the operation is completed, the endoscope is returned to the lumen of the viscus and the viscerotomy is closed.

SHORT COMINGS OF CONTEMPORARY TECHNIQUES

As we can see from the description above, many limitations of current NOTES techniques are evident. Foremost is the fact that a hole is intentionally made in one of the viscera, which ridicules the decades of surgical dogma.

The flexibility of the endoscope causes difficulty in achieving a stable operating field. A deep loop into the pelvis is required to view the right upper quadrant in transgastric approach, and the endoscope might resist this positioning. Because of retroflexion, the endoscopic image might be reversed or inverted, further complicating the operation.

The current shortcomings of adequate instrumentation restricts the ability to perform meticulous dissection in

NOTES. In-line endoscopic tools are also a shortcoming as they have a restricted range of motion and limited degrees of freedom thus hindering the diamond baseball concept of the visual field and instruments, a concept found to be critical in laparoscopy.

As a purposeful viscerotomy is made in NOTES, its secure closure is a must to ensure the safety of the operation. Initial research work managed the viscerotomy without closure or by occlusion using a percutaneous endoscopic gastrostomy (PEG-type gastrostomy tube).[2] Both methods were not successful with high rates of intra-abdominal contamination in the porcine model. Thus, more reliable methods that achieve full-thickness closure of the viscerotomy are currently being evaluated.

ADVANTAGES OF NOTES

Some critics are apprehensive with NOTES, because of its differences with conventional surgical teaching. As of now, advances are being made in limiting some of the current shortcomings of NOTES. However, there may be some benefits of natural orifice surgery that make its pursuit rewarding.

The immunologic impacts of NOTES are favorable for the patient. A recent study from Case Western Reserve University showed lower levels of tumor necrosis factor-α (TNF-α) after NOTES peritoneoscopy compared to laparotomy and laparoscopic abdominal exploration.[3]

NOTES may lead to a lesser degree of impairment of the peritoneal immune system and possibly even improved oncologic and infectious outcomes.

Natural orifice surgery may decrease postoperative abdominal adhesion formation, like laparoscopy, the minimal access nature of NOTES might decrease the stimuli for adhesions formation and, subsequently, reduce the incidence of postoperative adhesive bowel obstruction.

NOTES can be performed without the need for general anesthesia under conscious sedation as no skin incision is made, therefore NOTES could be performed in the intensive care unit or endoscopy suite, rather than an operating room.

The NOTES team and its equipment are more portable as single endoscopy tower houses all of the necessary equipment.

Furthermore, in NOTES, procedures are performed without sterile instruments, only with scopes subjected to high-level disinfection. This makes NOTES more applicable to compromised environments, such as battlefields and especially in developing countries, where sterilization equipment is not readily available.

Finally, last but not the least the esthetic benefits of NOTES the concept of "no-scar" abdominal operations. This has captivated the public at large and is feasible with pure NOTES cases, although esthetics should not be the only driving force behind NOTES.

NOSCAR (NATURAL ORIFICE SURGERY CONSORTIUM FOR ASSESSMENT AND RESEARCH)

In a collaborative effort, members of the American Society for Gastrointestinal Endoscopy and the Society of American Gastrointestinal Endoscopic Surgeons joined to form NOSCAR. The purpose of this organization is to regulate the progress of NOTES and ensure the safety of clinical applications.

A NOSCAR publication which delineates the guidelines for laboratory and clinical natural orifice surgery has been deemed the "White Paper".[4] In the White Paper, the authors outlined the current shortcomings of NOTES techniques and some of the potential solutions. A call for rigorous scientific research was made before clinical employment of NOTES. Cooperation between the fields of gastro-enterology and surgery was mandated, ensuring the communication of research findings and the multidisciplinary make-up of NOTES teams.

Recently, NOSCAR has launched a comprehensive NOTES database. All patients throughout the world who are enrolled in NOTES trials will be entered into the database.

ACHIEVEMENTS TO DATE

The publication by Kalloo led to the organization of the Apollo group. Shortly after the publication of transgastric perito-neoscopy, the Apollo group published reports on transgastric tubal ligation,[5] gastrojejunostomy,[6] and splenectomy[7] in a porcine model.

Recently, members of the Apollo group collaborated in the performance of per oral transgastric ventral hernia repairs in a porcine model. These publications were significant as it proved that complex operations were feasible using NOTES techniques and the animals survived without undue complications.

Many studies followed and performed animal feasibility studies. Transgastric appendectomy,[8] cholecystectomy,[9] and oopherectomy[10] were performed. The transcolonic[9] approach was used to perform cholecystectomy, and the transvaginal approach has been used in laboratory animals to perform nephrectomy.[11] Combined transrectal and

transgastric approaches allowed performance of complex small bowel resections with intracorporeal formation of anastomoses.[12] Much of the initial studies focused on the feasibility of NOTES. It is now believed that although complex and plagued with restrictions, practically any abdominal operation could be performed using the available natural orifice techniques.

Reliable closure of the viscerotomy is the corner stone in avoiding intra-abdominal sepsis. As mentioned above, leaving the viscerotomy open and PEG tube occlusion of the gastrotomy were shown to be inadequate in the porcine model. Endoclips for closure have also been used with some success,[13] however clips only provide mucosal approximation. Numerous devices have been used to attempt full thickness closure. One such instrument is the NDO Plicator which was initially developed for the endoscopic management of gastroesophageal reflux disease. It is a 15 mm instrument whose jaws place a full-thickness permanent suture with polytetrafluoroethylene bolsters. Closure of full-thickness gastrotomies has been shown to be reliable with the NDO Plicator.[14,15] Bursting pressures of the porcine stomach after closure exceed 90 mm Hg and a water-tight closure is achieved, as evidenced by fluoroscopic contrast studies. Survival studies in porcine models have shown minimal rates of intra-abdominal infections after transgastric peritoneoscopy and closure with the NDO Plicator.

Another method of gastrotomy closure is using a commercially available over tube and suturing device.[16] The over tube is steerable, torque-stable, fixable, and accommodates a slim endoscope and a suturing device. The suturing device consists of a grasper that locks at 45 degrees angle to the instrument shaft. A needle and suture passes through the device and can be bolstered with polyester tissue anchors. In the porcine stomach, robust, full-thickness sutures and fine tissue manipulation was achievable using this platform.

The self-approximating translumenal access technique (STAT)[17,18] has been developed by the Penn State group that might obviate the need for full thickness closure. An incision is first made in the gastric mucosa, and then a submucosal tunnel is developed of at least 5 cm length using a dissecting balloon. After tunneling away from the mucosal defect, the muscularis and serosa are punctured, and the abdomen is entered. After the operation, the scope is withdrawn and only the mucosa is closed. In a porcine model, this technique has yielded favorable results.

Sumiyama have published transgastric cholecystectomies in laboratory animals using an offset gastrostomy, similar to STAT. A submucosal tunnel was created using high pressure carbon dioxide followed by puncture of the remaining gastric wall. The endoscope was advanced through the tunnel into the peritoneal cavity and a cholecystectomy was performed. The submucosal tunnel was crafted cephalad to position the endoscope for operating in the right upper quadrant. At the end of the operation, the mucosal entry point was closed with clips or tissue anchors.

The Ohio State group has closed gastrotomies in animal studies with a bio absorbable plug, as in inguinal hernia repair.[19,20] This eliminated the need for complex tissue manipulation and provided watertight closure with minimal chances of infectious complications. This technique might simplify the process of viscerotomy closure.

The pneumoperitoneum in NOTES is commonly created using endoscopic insufflators and as in laparoscopy, the intra-abdominal pressure requires continuous monitoring otherwise unchecked insufflation might lead to abdominal compartment syndrome. A recent study have shown that pressure transducers fitted to the end of a gastroscope or passed through a working channel can detect intra-abdominal pressure with a high accuracy.[21] Such devices could be easily incorporated into NOTES operating endoscopes. Alternative means to monitor intra-abdominal pressure include passage of a transabdominal Verees needle for the same.

Adequate retraction is a must to safely perform complex abdominal operations, such as cholecystectomy but with endoscopic instruments, appropriate retraction has been difficult to achieve. Keeping this in mind a group from the University of Texas-Southwestern has developed an ingenious method using intra-abdominal magnets to provide retraction during operations.[22,23] In their technique, an external magnet is paired to its intra-abdominal counterpart. The organ of interest is attached with a metal device, such as a clip, and paired to the magnet. Tissue manipulation is performed by moving the external magnet to achieve the desired retraction. To provide a stable surgical field for natural orifice surgery, new endoscopes are under development. Swanstrom[24] and others[16] are using endoscopes that allow the surgeon to operate with both hands, without the need of one hand being used for stabilizing the endoscope. Others[25] are using commercially available multi bending endoscopes with dual instrumentation channels to provide better stability and maneuverability at the same time.

The NOTES endoscope of the future will have the ability to maintain a fixed position and its multi working channels would be angled in such a way as to make a diamond baseball concept with the operating field.

Some groups have overcome these obstacles of diamond baseball concept and retraction by inserting more than one

endoscopes into the abdomen. A group from the University of California-San Diego has performed complex small bowel resections by inserting endoscopes and staplers through both stomach and rectum.[12,26] Although these procedures were done under laparoscopic supervision, but the same dual scope technique might be applied to pure NOTES cases.

Recently, NOTES sigmoid colectomy has been performed in human cadavers without a flexible endoscope. Swanstrom used transanal endoscopic microsurgery techniques to perform a radical sigmoid colectomy.[27] with high ligation of the vessels and generous lymphadenectomy.

There are only few reports in the literature of human transluminal cholecystectomy, all of them using the transvaginal route.

CLINICAL NOTES

Although one can suggest that natural orifice surgery has been practiced for years as translumenal drainage of pancreatic pseudocysts[28] and transgastric pancreatic debridement[29] are considered standard procedures for many advanced endoscopists. Culdoscopy, a procedure in which a laparoscope is inserted into the abdomen through the vagina, is commonly used in the management of infertility and tubal ligation. Some even might even suggest that percutaneous endoscopic gastrostomy, first described in 1979,[30] was the first endoscopic procedure that purposely breached the gastric lumen and supplanted a standard operation, thus qualifying as NOTES.

The first reported case of actual natural orifice surgery was performed nearly a decade ago by a surgeon in the United States. A hybrid of laparoscopic/endoscopic cholecystectomy was undertaken. Needlescopic instruments were used and laparoscopic cholecystectomy was done using standard techniques, however, for the retrieval of gallbladder anterior gastrotomy was made and the specimen was placed into the stomach and removed by mouth with the endoscope. The gastrotomy was then closed using intracorporeal suturing techniques.

After this first unpublished hybrid case, natural orifice techniques were largely ignored until Kalloo's 2004 publication. After the successes of the Apollo group with laboratory notes, a group in India performed a series of transgastric appendectomies and transgastric tubal ligations. Although unpublished, the videos have been widely circulated. The Columbia group in New York City performed a hybrid cholecystectomy with extraction of the specimen through the vagina.[31,32] Dissection and retraction were performed with both the laparoscopic and endoscopic

instruments. The patient, reportedly recovered well after this procedure without complications. Many series of hybrid cholecystectomy, using a variety of techniques, have been publicized at international surgery and gastroenterology meetings.

The Ohio State group performed the first institutional review board-approved series of hybrid transgastric peritoneoscopy.[33] NOTES peritoneoscopy was performed in all patients with suspected adenocarcinoma of head of the pancreas. An initial diagnostic laparoscopy was performed followed by the creation of an anterior gastrotomy and transgastric peritoneoscopy under laparoscopic supervision. In most of the cases, NOTES abdominal exploration was found to be equivalent to laparoscopy in detecting peritoneal metastases. There were no complications directly related to the transgastric procedure. Thus the authors concluded that transgastric peritoneoscopy in humans is feasible and safe.

The first case of pure NOTES published from the United States was conducted at case Western Reserve University, Cleveland.[34] A PEG tube placed for nutritional support was dislodged three days after its initial placement and as the stomach had not yet adhered to the anterior gastric wall, therefore there was a free communication between the gastric lumen and the abdomen. The abdominal exploration and irrigation was done, and the gastrostomy tube was restored using pure NOTES techniques. To retrieve the PEG without laparotomy or laparoscopy, a gastroscope was advanced into the stomach, the prior gastrotomy site was dilated with a balloon and the endoscope advanced into the abdominal cavity. Some soilage was identified, which was cleansed using the endoscopic irrigation channel. The original abdominal incision was used to pass a wire into the peritoneal cavity, and the PEG was retrieved using the pull technique. After the "PEG Rescue" the patient recovery was uneventful.

The first true translumenal cholecystectomy was reported by Marescaux and colleagues from Strasbourg, France.[35] The transvaginal route was used to access the abdomen in a 30-year-old woman with symptomatic cholelithiasis. A 2 mm needle port was used for insufflation and monitoring of intra-abdominal pressure. The cholecystectomy was performed without the aid of a laparoscope using only NOTES techniques. The patient's recovery was uneventful.

NOTES: WHOSE DOMAIN IS IT ANYWAY?

The question arises as to whether surgeons or gastro-enterologists will be the primary operators of NOTES.[36,37]

After all, abdominal operations are typically under the purview of the general surgeon, but gastroenterologists are usually expert in flexible endoscopy. In all likelihood, minimal access surgeons and a small subset of advanced gastrointestinal endoscopists will be the NOTES surgeons of the future.

The NOTES surgeon should be expert in flexible endoscopy, abdominal anatomy, and surgical techniques. He or she should be capable of managing the pre- and postoperative care of the patients and, in particular, should be capable of handling complications from the procedure itself. It is also practical and of paramount importance that NOTES surgeons should be able to perform an operation laparoscopically and conventionally, as conversion to one of these modalities is a possibility in any NOTES procedure. These qualifications cross the boundaries of most gastrointestinal endoscopy teaching programs; hence, a new training model should be adopted. A gastrointestinal surgeon wishing to practice NOTES should pursue fellowship training in advanced endoscopy while gastroenterologist should complete a year of advanced interventional endoscopy and possibly an additional year dedicated to Surgery. Trainees from both the fields of surgery and gastroenterology should dedicate a substantial amount of time to laboratory endeavors, as this is where skills can be safely polished before clinical application. Training for a future in NOTES surgery will be different for surgeons and gastroenterologists. A gastrointestinal surgeon will likely focus on the technical aspects of flexible endoscopy, and a gastroenterologist might need familiarization with gross abdominal anatomy and laparoscopy. Neither surgeons nor gastroenterologists should consider NOTES an infringement on their territory or the demise of traditional surgery or endoscopy.

A BRIGHT FUTURE

Although today we are not far from but still we are not on the brink of widespread pure clinical NOTES. There are many potential applications of NOTES that will likely manifest in the near future. Given the portability of NOTES equipment and the requirement for only conscious sedation, NOTES is ideally suited for the intensive care units. There are two potential scenarios that have been described are applicable to ICU NOTES: diaphragm pacing and peritoneoscopic examination for ischemic bowel.

Diaphragm pacing has been shown to be effective modality in promoting ventilator weaning in ICU patients.[38] The procedure is commonly performed laparoscopically in the operating room with insertion of pacing wires into both

hemi diaphragms and externalization of the wires. The same procedure of insertion could be performed through a gastrotomy using NOTES which might obviate the need to transport a critically ill patient to the operating room.

Another scenario applicable to NOTES is the question of necrotic small bowel in cases of potential mesenteric ischemia in ICU patients.[39] These types of patients are usually critically ill and cannot taken to the computed tomography (CT) scanner without risks. The presence of ischemic small bowel might be confirmed with transgastric peritoneoscopy and should a short segment of ischemic small bowel be visualized, the patient could be wheeled to the operating room. Extensive small bowel necrosis not compatible with life might not be suitable for an operation, and the costs associated with a nontherapeutic laparotomy would be spared.

The minimal requirements of instruments and only the need for disinfection, rather than sterilization, make NOTES appropriate for developing regions of the world. NOTES could be performed without the infrastructure requirements of an operating theater and sterilization unit. The light source, video processor, and monitor could be easily transported from one place to another to best serve populations in need. NOTES might be the means to bring surgical care to underserved people even in the remotest of places.

The transportable nature of NOTES might make it amenable for battlefield abdominal exploration. A frontline facility could be arranged to explore the abdomen after serious abdominal trauma, If required hemostasis might be achieved with topical hemostatics or endoscopically placed packing. Once stabilized, the patient could then be transported to a higher center for definitive management.

Another possible derivative of NOTES is single port laparoscopy. For example a cholecystectomy might be performed through a single 10 mm umbilical port. A flexible laparoscope could be maneuvered into position and locked into place and special triangulating instruments with multiple degrees of freedom could then be used for the dissection. Specimen removal would then occur through the single umbilical port.

CRITIQUES

It is more than tempting to be swept up in the euphoria for NOTES, but hard data supporting the clinical applications of NOTES need to be accumulated before widespread use. NOSCAR put forward the questions regarding the safety and utility of NOTES in the White Paper, and some of the answers are manifesting.

The infectious implications of transvisceral surgery may not be as critical as originally presumed. Certainly, bacteria will gain access to the abdominal cavity, but the peritoneum is efficient at clearing the microbes. After all, the bariatric surgeon is not overly worried about the gastrotomy contaminating the peritoneal cavity during construction of the proximal anastomosis. However, a temporary open gastrotomy is not harmful, but peritoneal soilage from a leaking closure may be devastating. Therefore, a substantial amount of effort should be devoted to assuring a reliable method of viscerotomy closure.

Other studies have also shown optimism regarding NOTES, as evidence is accumulating that the immune impact of NOTES is equivalent to laparoscopy. Some groups are developing ingenious methods of intra-abdominal access, retraction and dissection. Novel methods of transgastric access might simplify the issue of reliable closure. In aggregate, these data might be a further evidence that there is a role for NOTES in gastrointestinal surgery.

CONCLUSION

At present, this is generally true that routine NOTES cholecystectomies or appendectomies (i.e. those not under the aegis of an approved clinical trial) should probably not be performed until laboratory and technical advances materialize. Contrarily, there are likely a limited number of applications that are well-suited to the current application of NOTES, e.g. PEG rescue is a simple procedure that relies on available equipment and could have a role in patients with early dislodgement of a PEG tube. NOTES do not signal the demise of traditional gastrointestinal surgery or laparoscopy. It is plainly evident that further advances are required before NOTES can be considered for widespread application.

Current endoscopic instruments are not yet appropriate for total NOTES, but they allow operations using a hybrid approach. Tools that help in retraction, exposure and dissection needs to be developed. An over tube with multiple channels or a multiple channel endoscope with deflecting channels that give good retraction and dissection is likely to be of paramount value.

Above all, regard for patient safety must prevail. Only those with vast laboratory experience with NOTES should contemplate clinical NOTES procedures. Initially, only patients enrolled in clinical trials should undergo NOTES. To conclude NOTES is a precious raw diamond which needs to be further cut and polished.

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REVIEW ARTICLE

Laparoscopy in Colorectal Malignancies: Current Concepts

Kaundinya Kiran Bharatam

Surgical Registrar, Global Hospitals, Hyderabad, Andhra Pradesh, India

Correspondence: Kaundinya Kiran Bharatam, Surgical Registrar, Global Hospitals, Hyderabad, Andhra Pradesh, India
e-mail: kaundinyakiran@gmail.com

Abstract

Laparoscopic surgery has widely spread in the treatment of colorectal cancer. For colorectal cancers, many randomized controlled trials regarding short-term outcome demonstrate that laparoscopic surgery is feasible, safe and has many benefits including reduction in a perioperative mortality. In terms of long-term outcome, four randomized controlled trials insist that there are no differences in both laparoscopic and open surgeries proving oncologic safety and that the long-term outcome is at least not inferior to open resection. However, there are still more important issues including long-term oncological outcome for advanced colon cancer, costeffectiveness and the impact on quality of life of patients.

Keywords: Colorectal malignancies, laparoscopy in colorectal malignancies, cancer sigmoid colon, rectal cancer.

INTRODUCTION

After the acceptance of laparoscopy as the gold standard management for cholelithiasis, more and more thoughts are now being directed towards the use of laparoscopy in colorectal cancer surgery. Advantages of laparoscopic surgery like less postoperative pain, shorter hospital stay, decreased incidence of paralytic ileus, improved cosmesis, less intraoperative blood loss, decreased use of narcotics, and fewer postoperative wound complications have been the driving force of this consideration.[1-3] But concerns remain regarding potential violation of principles of oncologic surgery, technical aspects of performing the procedure, adequate staging capability, and existing learning curves.[4,5] Port-site recurrences were the major setback in the use of laparoscopy for colorectal malignancies. Hence investigators embarked on conducting multicentric randomized controlled trials to compare the effect of laparoscopic colorectal surgery and open surgery for colorectal malignancy in terms of recurrence and survival.

MATERIALS AND METHODS

A literature search was performed using Medline and search engine Google. The following search terms were used "laparoscopy" and "colorectal malignancies". More than 1500 citations were found. Selected papers were screened for further references. Criteria for selection was year of study, number of cases, methods of analysis, and institutions where studies were conducted.

VARIOUS OPERATIVE TECHNIQUES AVAILABLE

The learning curve for laparoscopic colorectal cancer surgery is estimated to be 35 to 50 procedures. As mentioned the 3 minimally invasive techniques used to resect the colon/rectum are:

- Laparoscopic colorectal surgery, in which the mesentry and the bowel are mobilized and transected laparoscopically. The anastomosis of the colon/rectum is done intracorporeally or extracorporeally. The specimen is removed from the abdomen via a small extraction incision, often the same incision through which the anastomosis may be performed or via the perineal wound created in perineal dissection of the rectal mobilization.
- Laparoscopic-assisted colorectal surgery is executed with full laparoscopic mobilization of the colon and rectum followed by externalization of the bowel through a small incision. The resection and the anastomosis is done extracorporeally.
- Hand-assisted laparoscopic colorectal surgery is a hybrid that shares techniques of laparoscopic and open surgery, a hand port is used to aid in the retraction, mobilization, and dissection of the bowel. The actual resection and anastomosis of the colon can be performed as in a

laparoscopic colectomy or laparoscopic assisted colectomy. Once the rectum is delivered through the perineal wound, one of the ports is used on left side to fashion an end colostomy.

Ideal extent of resection is defined by the removal of the blood supply and lymphatics at the level of origin of the primary feeding arterial vessel. Furthermore, the lesion should be excised *en bloc* with tumor-free radial margins (R0) to be considered curative.[4,6]

ISSUES REGARDING LAPAROSCOPIC COLORECTAL SURGERY IN MALIGNANCY

a. *Port-site tumor recurrence*: Several theories had been proposed for the possible increase in incidence of wound metastasis associated with laparoscopic surgery including mechanical, metabolic, immunologic and hematogenous routes of tumor implantation.[7] Direct, mechanical contamination from contact between the excised tumor mass and the wound site was initially believed to be a logical etiology; although wound metastasis have occurred at other port sites, suggesting the role of alternative mechanisms.[8] Despite the benefit in decreased systemic cell mediated immune suppression associated with laparoscopy, CO_2 has been shown to result in an acidotic intraperitoneal environment and impaired peritoneal macrophage function contributing to local tumor implantation.[9-11] But still use of wound protectors and specimen extraction bags to prevent direct contamination of incision sites and use of a general cytotoxic substance like povidone-iodine were excellent in preventing port-site incisional tumor implantation after laparoscopy.

b. *Missing hepatic metastatic lesions*: Due to the loss of tactile sensation, concern regarding potential to miss hepatic metastatic lesions did arise. The use of intraoperative laparoscopic ultrasonography to effectively evaluate liver for lesions has eased this issue.

c. Technical expertise in laparoscopic procedure.

SYSTEMIC AND METABOLIC EFFECTS OF MINIMALLY INVASIVE SURGERY

The systemic immune system's physiological response to surgical trauma affects several metabolic pathways, producing a state of immunosupression that varies according to the extent of operative trauma.[12] This was suggested by smaller elevations in serum interleukin (IL-6), tumor necrosis factor and C-reactive protein (CRP) after laparoscopic surgery.[13] Such short-term alterations and their long-term implications on tumor recurrence and patient survival though unknown, yet some effects of open surgery may be more deleterious than when the operation is performed laparoscopically. Wu et al found that in patients with colonic carcinoma, postoperative leukocyte counts and leukocyte subpopulations normalized earlier after laparoscopic colectomy than after open surgery.

PROSPECTIVE RANDOMIZED CONTROLLED TRIALS: LONG-TERM RESULTS AND OUTCOMES

A review of conducted prospective randomized controlled trials revealed the efficacy of laparoscopic colorectal surgery for malignancy. The United Kingdom Medical Research Council Conventional *vs* Laparoscopic Assisted Surgery in Colorectal Cancer (UK MRC CLASICC; clinical trial no ISRCTN 74883561) trial is a randomized clinical study of laparoscopic- assisted *vs* conventional open surgery in patients with colorectal cancer. Approximately 794 patients were randomized (268 open and 526 laparoscopic) between July, 96 and June, 2002.[14]

The 3-year overall survival (OS) for all patients was 67.8 % with 87 deaths in the open arm and 161 deaths in the laparoscopic arm. Overall cause of death was similar in both arms. There was no difference in 3-year OS for patients with either colon or rectal cancer. Overall, there was no evidence of a difference between the two techniques for any stage of disease, though a nonsignificant trend was observed for improved 3-year OS after laparoscopic surgery in patients with Dukes' A rectal cancers. The 3-year disease free survival (DFS) for all patients was 66.8%. There was no difference between the two surgical techniques in 3-year DFS.

The overall local recurrence rate at 3 years was 8.4%. The overall distant recurrence rate at 3 years was 14.9%. Overall there were 10 wound/port-site recurrences within 3 years of randomization. There was one wound/port-site recurrence in the open arm and nine wound/port-site recurrences in the laparoscopic arm. The open wound/port-site recurrence was 0.6% and laparoscopic wound/port-site recurrence was 2.5%. Patients developing wound/port-site recurrences tended to have larger tumors (median diameter 45 mm) compared to patients without wound/port-site recurrence (median diameter 35 mm), more advanced disease (7 of 10 had Dukes' C1 or C2 cancers), or evidence of intra-abdominal recurrence (7 of 10).

The trial confirms and extends previous studies reporting that for any stage 3-year survival and disease free intervals are no worse than in patients undergoing laparoscopic colorectal surgery as compared to open surgery. The DFS, OS, and local recurrences in patients undergoing laparoscopic resection of colorectal cancer are as good with laparoscopic surgery as with open surgery.

Overall, 10 wound or port-site recurrences occurred in 639 patients randomly assigned who had curative colorectal cancer surgery (1.9%). Of these, only one (0.2%) was reported as a true port-site recurrence, with the remainder being retrieval site recurrences. The majority of retrieval site recurrences occurred in patients with larger tumors or more advanced disease, emphasizing the need for adequate wound protection during specimen extraction. Port-site recurrences in the Barcelona and Clinical Outcomes of Surgery Therapy (COST) trials were 0.94% and 0.5% respectively.[15] Previous studies investigating immune dysfunction after laparoscopic surgery have failed to demonstrate any difference in comparision to open surgery.[16]

In long-term observations, the Quality of Life (QOL) after laparoscopic surgery is no worse than conventional open surgery. In a previous subgroup analysis of rectal cancer surgery, a nonsignificant trend for worse sexual function in males was reported after laparoscopic resection.[17] The long-term QOL analysis presented here emphasizes the decline in male sexual function after rectal resection was present in both arms.

Another randomized trial conducted by the clinical outcomes of surgical therapy study group (COST) between August, 94 and August, 2001 of 872 patients was carried out where a total of 428 patients underwent open colectomy and 435 were treated laparoscopically. Operative times were significantly longer in the laparoscopic surgery group than in the open colectomy group (150 *vs* 95 minutes). The extent of resection was similar in both groups; bowel margins were less than 5 cm in 6% of patients in the open colectomy group and 5 % in laparoscopic group. Perioperative recovery was faster in the laparoscopic surgery group than in the open colectomy group, reflected by shorter hospital stay and briefer use of parenteral narcotics and oral analgesics. There were no statistical differences between the groups in the rates of intraoperative complications (2% in the open colectomy group and 4% in the laparoscopic group), 30 day postoperative mortality rates and severity of post-operative complications at discharge at 60 days and rates of readmission or reoperation (< 2% in each group).

After a median follow-up of 4.4 years, 160 patients had a recurrence of tumor (84 in the open colectomy group and 76 in the laparoscopic surgery group) and 186 had died (95 and 91 respectively). The cumulative incidence of recurrence among patients treated with the laparoscopic procedure did not differ significantly from the open group. The overall survival was also very similar in the two groups as was the disease free survival rate. These findings held true for any stage of cancer; there were no significant differences between treatment groups in the time to recurrence, disease free survival or overall survival. Tumor recurred in surgical wounds in 3 patients-2 in laparoscopy and 1 in open group.

Other multi-institutional randomized controlled trials like the Barcelona trial, COST trial, and COLOR trial have level 1 evidence to support the advantages of and refute the disadvantages of laparoscopic curable colon cancer surgery.[18,19]

Although clinical trials establish the safety and feasibility of laparoscopic colectomy in colon cancer, less evidence exists for the same in rectal cancer. Laparotomy and meticulous total mesorectal excision as advocated by Herald et al is currently the accepted standard of care for carcinoma rectum; a technique associated with low recurrence and optimal survival.[20] Laparoscopic surgery in rectal cancers requires to duplicate these oncologic results. Many authors have published significant case-series studies establishing the safety of laparoscopic rectal cancer surgery with >1200 patients. Feliciotti et al prospectively studied laparoscopic assisted and open resections and found both methods to respect oncologic principles with similar long-term outcomes.[21] Prospective studies have revealed that laparoscopic resection compared with open surgery did not worsen survival or disease control in patients with rectosigmoid cancer. 2 recent meta-analysis reviewed the current literature on the laparoscopic resection of rectal cancer.[22,23] Gao et al analyzed 11 studies (1995-2005), which included 285 patients who had undergone laparoscopic resection for rectal cancer. The authors found that laparoscopic surgery was associated with lower morbidity but longer operating time. Wound infection, anastomotic leakage, and mortality were similar in the open and laparoscopic groups. Aziz et al analyzed 20 studies (1993-2004) including 909 patients who had undergone laparoscopic rectal cancer resection and 1162 who had undergone open surgery. Reduction in length of stay and time to first bowel movement and stomal function in patients who underwent laparoscopic surgery was revealed. In the set of abdominoperineal resection, laparoscopic patients

required fewer parenteral analgesics and had reduced rates of postoperative wound infections.

CONCLUSION

Serious concerns about the potential inadequacy of resection, possible staging inaccuracies, tumor cell dissemination demanded prospective randomized comparisons between the open and laparoscopic procedures for colorectal malignancies. Multi-institutional studies provide data in support of safety of laparoscopy with respect to complications, time to recurrence, disease free survival, overall survival, and quality of life. Operative factors like extent of resection–specifically nos of lymph nodes sampled, length of bowel and mesentry resected and bowel margins– did not vary in both the groups. Hence, it may be suggested that it is safe to proceed with laparoscopic colorectal cancer surgery and that plans to conduct comprehensive analysis of the quality of life, cost and cost-effectiveness of laparascopic surgery for colorectal malignancies may be undertaken.[24]

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ORIGINAL ARTICLE

Comparative Study of Postoperative Adhesions by Laparotomy and Laparoscopic Procedures

Rama Hegde

Government Hospital, Sirsi, Karwar, Karnataka, India

Correspondence: Rama Hegde, Government Hospital, Sirsi, Karwar, Karnataka-581403, India, e-mail: ramahegde7@rediff mail.com

Abstract

Background: Abdominal operations result in random and unpredictable adhesion formation. Postoperative adhesion may contribute to recurrent episodes of small bowel obstruction, chronic pain abdomen or both. Laparotomy and laparoscopy are the modes used to treat the adhesion related complications.

Aims and objectives: (1) To study the adhesion related complications and treat the same by means of laparotomy and laparoscopic procedures. (2) To study how the risk of postoperative adhesions can be minimized.

Materials and methods: About 50 cases from March 2007 to February 2009 were studied in Government hospital, Sirsi, Karnataka, India. Patients who underwent some surgical procedures before presenting with adhesions related complications like small bowel obstruction and chronic pain abdomen were considered. Patients who required intervention were treated with surgical procedures. Patients who presented with obstructive features underwent laparotomy and who presented with chronic pain abdomen underwent laparoscopy.

Results: All the 50 patients who were in our study had undergone some conventional surgeries in previous instance. No patient in our study had undergone laparoscopy in previous instance. Appendicectomy (40%), lower segment cesarean section (22%) were the common surgeries which resulted in adhesions. Thirty-four patients in our study presented with obstructive features, underwent laparotomy and adhesiolysis. Sixteen patients in our study underwent laparoscopy for chronic pain abdomen. Both surgeries were safe and resulted in recovery of almost all patients. We could not follow-up most of the patients after 3 months so the outcome of adhesiolysis by both procedures is not known.

Conclusion: (1) Conventional surgeries leads to more adhesion formation than the minimal invasive procedures. (2) Appendicectomy and pelvic surgeries are the common cause of adhesions. (3) Both laparotomy and laparoscopy can be safely used as mode of treatment of adhesion related complications. (4) Operative treatment of acute abdomen by laparoscopy can be recommended.

Keywords: Laparotomy, laparoscopy, postoperative adhesions, adhesiolysis.

INTRODUCTION

Postoperative adhesions remain one of the most common problems which the surgeons have to face in present time. Adhesions are bands of tissues that connect anatomic sites at locations, where there should not be connections. Postoperative surgical adhesions are formed as a result of trauma, infection or injury to tissue. A surgical incision made into abdominal wall in an aseptic injury, yet it may get infected. Over the past two decades there have been many claims made that alternative in mode of access into abdominal cavity or instruments utilized will reduce postoperative adhesions. There is little evidence that development of adhesions in humans is less prevalent following laparoscopic procedures compared to laparotomies. There is high incidence (40 to 60%) of morbid events like small bowel obstruction associated with presence of adhesions. Mortality has been reported to be up to 30%. Adhesions result in large surgical workload and cost to health care systems. Good surgical technique remains an important part of prevention of adhesion. Intra-abdominal adhesions may be prevented by minimizing injury and there is increasing evidence that laparoscopic surgery is an important method of adhesion prevention.

OBJECTIVES

I opted to take this study with following aims and objectives:
1. To study adhesion related complications and to treat the same by means of laparoscopy and laparotomy.
2. To study how the risk of postoperative adhesions can be minimized.
3. To asses clinically the feasibility or limitations of laparoscopy.

MATERIALS AND METHODS

Postoperative adhesions presenting as acute and subacute intestinal obstruction is one of the common condition presenting in surgical department. In this study, I have taken the patients who attended the OPD and emergency department from March 2007 to February 2009.

Patients who presented with pain abdomen, distension, vomiting who previously underwent some abdominal surgical procedure were considered for the study. Patients who recovered after conservative management were not included in study.

The patients with above symptoms are admitted to ward with provisional diagnosis of acute, subacute intestinal obstruction and pain abdomen, assuming postoperative adhesions as a cause. A detailed history, previous surgery and examination were done. The routine investigations were done. RBS, S, blood urea, serum creatinine was also done. Serum electrolytes were done for patient who presented with features of obstruction. Plain X-ray abdomen was done for all cases presenting with features of obstruction. CT scan of abdomen was not done on any patients as diagnosis of obstruction was made out by X-ray. ECG and chest X-ray were done in elderly individuals and individuals with significant clinical findings. Routine ultrasound scanning of abdomen was not done due to want of 24 hours emergency services but they were done during office hours and out side the institution wherever possible.

Immediately after admission along with above procedure resuscitation with IV fluids especially ringer lactate and normal saline infusion started till hydration and urine output becomes normal. For patients with obstructive features nasogastric decompression with Ryles tube carried and antibiotic prophylaxis started. Close observation of all parameters (like pulse rate, blood pressure, abdominal girth, bowel sounds, tenderness and guarding looked for. Patients who recovered from obstructive features by passing bowels, reduction in pain and tenderness were managed conservatively and were excluded from the study. Patients with above signs and symptoms and in patients with clear cut signs and symptoms of intestinal obstruction for long duration were managed with surgical procedures. Patient presenting with features of obstruction were posted for laparotomy and adhesiolysis was done. Patients presenting with long-lasting pain abdomen were chosen for laparoscopic procedure. I attended operative procedures in majority of cases and findings were recorded and photographs were taken. Surgery adopted and criteria for deciding the procedures were noted. The postoperative period was monitored carefully and all parameters were recorded four hourly bases depending upon patient's general condition. Postoperative follow-up after discharging of patients was done in majority of patients up to 3 months. Most of the patients did not come for follow-up after one or two visits. The results are tabulated stressing the following points, age, sex, symptoms, examination finding, previous surgeries, operative procedure adopted and duration of hospital stay.

RESULTS

The study of 50 cases of postoperative adhesions by laparotomy and laparoscopic procedures from March 2007 to February 2009.

Age *vs* Sex Correlation

In our study, Male:Female ratio is 1:1. 28% of the cases that is 14 off the 50 cases were in the age group of 31 to 40 followed by 26% of the cases in age group of 21 to 30.

Sex *vs* Pain Abdomen, Distension and Vomiting

All the 50 cases presented with pain abdomen. Distension of abdomen was present in 20 off the 25 male patients. Among females 13 cases presented with distension of abdomen and absent in 12 cases. This shows distension of abdomen is less common in females than in males in our study. Ten cases presented with vomiting 7 male and 3 female.

Age and Sex *vs* Previous Surgeries and Frequency

Previous appendicectomy was the commonest surgery done constituting 20(40%) of the 50 cases. Among males appendicectomy was the commonest previous surgery followed by cholecystectomy. Among females 11 cases underwent previous cesarean section followed by hysterectomy. Cases which underwent previous appendicectomy and cesarian section are of younger age group. Previous hysterectomy and cholecystectomy belonged to older age group.

Diagnosis

34 cases presented with obstructive features. 14 with acute and 20 with subacute intestinal obstruction. 16 cases presented with chronic pain abdomen.

Sex *vs* Diagnosis Correlation

Acute intestinal obstruction was more common among males (44%). Among females, subacute intestinal obstruction and chronic pain abdomen (44%) was a common presentation.

Diagnosis and Sex *vs* Procedure Correlation; Age *vs* Clinical Presentation; Sex *vs* Diagnosis

Laparoscopy and adhesiolysis was done in 16 cases who presented with pain abdomen, of which 11 were female and 5 male. Laparotomy and adhesiolysis was done in 34 cases that presented with acute and subacute intestinal obstruction of which 20 male and 14 female cases.

Intraoperative Complications

Intraoperative complications—1 case in laparoscopy had the intraoperative complication of bleeding. 7 cases had intraoperative complication in laparotomy—3 enterotomy, 2 bleeding, 1 resection and anostomosis and 1 resection with ileostomy. 41 cases (82%) did not have any intraoperative complications.

DISCUSSION

Postoperative adhesions are one of the common surgical problems all over the world. There is a little evidence that development of adhesions in humans less prevalent following laparoscopic procedures versus open (laparotomy) procedures. Major clinical concerns associated with postoperative adhesion formation are small bowel obstruction, chronic abdominal and pelvic pain, infertility. Open and laparoscopic adhesiolysis is done to treat the patient presenting with adhesion related complications. This study highlights the magnitude of problem of adhesion and treatment of the same by laparoscopic and laparotomy. About 50 patients were treated from March 2007 to Februrary 2009.

Age Incidence

The youngest patient in the study was of 5 years and oldest patient was 85 years old. The mean age was 40.10 years of this 42.92 years for male and 37.32 years for female. The mean difference in the age between male and female is not statistically significant. In this study, 54% of patient belonged to 21 to 40 years of age.

Previous studies by Majewski WD reported the mean age of 38.9 ± 19.9 years.

Parent S et al reported in his study the mean age of 48.2 years. These studies almost correlate with present study.

Sex Incidence

In the present study, there were 25 males and 25 females among 50 cases. The male female ratio is 1:1.

Previous Surgeries

In the present study, all the 50 patients underwent laparotomy for some cause. No cases were available for study that underwent laparoscopy in first instance. This shows that there is a reduction of adhesion formation after laparoscopic surgery compared to open surgery.

Gutt CN et al reported that in all clinical studies most of the experimental studies found a reduction of adhesion formation after laparoscopic surgery compared to open surgery. Schafer M et al reported that laparoscopic surgical procedures with their minimal access to abdominal cavity are associated with fewer postoperative adhesions compared to open surgery, although adhesion formation cannot be entirely prevented. Levrant SG et al reported prior laparotomy, whether through a midline vertical or suprapubic transverse incision, significantly increased the frequency of anterior abdominal wall adhesion and thus adhesions may complicate the placement of the laparoscopic cannula through the umbilicus. Majewsji WD reported laparoscopic treatment of patients with acute abdomen offers an outcome comparable to that achieved with open approach. There were fewer episodes of adhesions ileus in laparoscopic patients. Consequently the operative treatment of acute abdomen patients by laparoscopy can be recommended. In the present study, appendicectomy and cholecystectomy were the leading previous surgeries which led to adhesion formation in males. Cesarian, appendicectomy, hysterectomy were the leading previous surgeries in females. Menzies D, Ellis H31 reported cholecystectomy, appendicectomy, colon surgery and pelvic surgery are associated more with adhesion formation. This study coincides with present study. In present study, all 50 patients presented with pain abdomen. Distension of abdomen was present in 20 males and absent in 5 whereas 13 females presented with distention and absent in 12. Vomiting was present in 10 patients, 7 males and 3 females.

Clinical Presentation

In present study, 34 patients presented with obstructive symptoms. 14 acute and 20 subacute intestinal obstructions. 16 patients presented with chronic pain abdomen which was off more than 6 month duration. Menzies D et al[31] reported small bowel obstruction, chronic abdominal and pelvic pain, infertility are of major clinical concern associated with adhesion. Schafer M et al reported early and late bowel obstruction, chronic abdominal pain and infertility all the main clinical complications and they also increase the socioeconomic costs.

Investigations

In the present study investigations did not have much role to play. Plain X-ray abdomen was taken for all patients presented with acute obstructive symptoms. Ultrasound was advised for patients preventing with chronic pain abdomen to rule out other cause. Other investigations like CT, MRI were not affordable by patients. Routine investigations were done to all patients.

Treatment

In the present study, 34 patients (20-subacute and 14-acute intestinal obstruction) were treated by laparotomy, suspecting adhesion to be the cause. Most of the cases were opened with midline incisions; care was taken not to injure the bowel. Adhesions in most conditions were to the anterior abdominal wall was released, wash was given with isotonic saline and in few patients ringer lactate solution (300 ml) was left in the abdominal cavity. Peritoneum closure was avoided in many patients. In present study 16 patients presented with chronic pain abdomen for more than 6 months. They were subjected to diagnostic laparoscopy. Pneumoperitoneum was created using veress needle in few cases and open Hassan's technique in others. Adhesiolysis was done and in few cases, 300 ml of Ringer lactate left alone in abdominal cavity. No cases were converted to laparotomy. Parent S et al reported laparoscopic treatment of adhesion occlusion is a feasible operation. Sato Y et al reported laparoscopic adhesiolysis is a safe and effective treatment for small bowel obstructions. Conversion to laparotomy should be considered in patients well dense adhesions. However, in our study we subjected the patients to laparotomy suspecting dense adhesions and possible high complication rate. Swank DT et al reported laparoscopic adhesiolysis in patients with chronic pain abdomen seems to be feasible and effective operation with considerable risk.

Duration of Surgery

In present study, the mean time for laparoscopy and adhesiolysis was 53.44 minutes and laparotomy and adhesiolysis was 92.65 minutes.

Intraoperative Complications

In present study, we had 9 complications–8 in laparotomy and 1 in laparoscopy. 3 enterotomies which occurred while release of adhesions which was closed primarily. 4 cases had bleeding–1 in laparoscopy and 3 in laparotomy for which hemostasis was achieved. 1 case had a patch of gangrene which was resected and anastomosed. 1 case had gangrene of whole of ascending colon up to transverse colon which was resected and ileostomy was done. C Wellstein et al reported 15 major intraoperative complication in lap group off 52 patients and 8 intraoperative complications off 62 conventional group (P = 0.156) results of present study is comparable. No major postoperative complications were observed is our study except for prolonged paralytic ileus for few patients.

Duration of Stay

In present study in laparoscopy and adhesiolysis, mean duration of stay was 5.81 days and in laparotomy and adhesiolysis it was 13.53 days. C Wellstein et al reported 11.3 days of hospital stay for laparoscopy group and 18.1 days for laparotomy group. This difference in laparoscopic group in our study might be due to choosing of small bowel obstruction in the group. In present study only chronic pain abdomen cases were chosen. In present study in laparoscopy group, patient were mobilized on mean 2.94 days and laparotomy group 6.97 days.

FOLLOW-UP

Most of the patients in our study did not turn up after 3 months follow-up. So long-term outcome of procedure used for adhesiolysis could not be made out.

CONCLUSION

1. Postoperative adhesions are still a common surgical problem.
2. Mostly occurring in 20 to 40 years age group, the active period of ones life.
3. Pain abdomen vomiting and distension common symptoms.
4. Previous laparotomy is common cause of postoperative adhesions than previous laparoscopy.
5. Second surgery requires more time than the normal and meticulous techniques to avoid complication.
6. Previous appendicectomy is the commonest cause of postoperative adhesion in males. Previous pelvic surgeries commonest among female.
7. Minimally invasive procedures like laparoscopy minimize the adhesion formation.
8. Diagnostic laparoscopy can be used as a mode of treatment for patient with chronic pain abdomen.
9. Laparoscopic adhesiolysis takes less time, less hospital stay and early ambulation.

10. Adhesions can be prevented by using laparoscopy as a means of surgery in first instance.
11. Adhesions can also be presented with meticulous technique and minimal tissue handling.
12. Laparotomy and adhesiolysis can be used for patients with acute intestinal obstruction safely.

SUMMARY

A clinical study of 50 cases of postoperative adhesions by laparotomy and laparoscopy was done during March 2007 to February 2009.

Various etiopathogenies of postoperative adhesions with respect to age and etiology and to monitor the outcome of management like laparoscopic and conventional (open) adhesiolysis.

The mean age of incidence is – 40.10 years. The incidence was more in 31 to 40 years of age group followed by 21 to 30.

Sex Ratio is 1:1 for male and females.

All patients in this study presented with pain abdomen, 33 patients presented with distension of abdomen and 10 patients with vomiting.

Clinically the patients were diagnosed to have acute, subacute intestinal obstruction and chronic pain abdomen. Patient with acute and subacute intestinal obstruction were subjected to plain X-ray abdomen and patient with chronic pain abdomen to ultrasound abdomen.

All the patients in this study underwent surgery. Patients with acute, subacute intestinal obstruction well subjected to laparotomy and patient with chronic pain abdomen to laparoscopy. 34 patients underwent laparotomy and adhesiolysis and 16 patients underwent laparoscopy and adhesiolysis.

Mean time for laparotomy 92.65 minutes Mean time for laparoscopy 53.44 minutes.

Mean duration of stay following laparotomy was 13.53 days and following laparoscopy it was 5.81days.

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ORIGINAL ARTICLE

An Improved Bipolar Cautery with Scissors for Laparoscopic Surgery with Additional Feature

Shelar Sharad Shivdas

Sushrut Maternity and Surgical Nursing Home, Miraroad, Thane, Maharashtra, India

Correspondence: Shelar Sharad Shivdas, Sushrut Maternity and Surgical Nursing Home, Miraroad, Thane, Maharashtra-401107, India, e-mail: sharad_shelar01@yahoo.co.in

Abstract

Background: In laparoscopic surgery, usually a vascular pedicle or a tissue to be cut is first coagulated and later cut by scissors separately. Here the author has created an instrument with dual function of hemostasis as well as cutting without changing the instruments.

Methods: The author has used the described instrument for comparision in 16 laparoscopic appendicectomy and 14 laparoscopic hysterectomy. Here the parameter was time required for only cauterization and subsiquent cutting. Appendix was ligated by Meltzers knot.

Keywords: Laparoscopic bipolar cautery forceps with scissors.

LAPAROSCOPIC APPENDICECTOMY

Bipolar cautery with scissors, 7 cases were performed: 4, 5, 7, 6.5, 4, 6 minutes. Average time required: 5 minutes. Conventional Bipolar cautery forceps and scissors used separately. Nine cases were performed: 14, 10, 12, 14, 11, 16, 13, 24, and 13 minutes. Average time required: 13 minutes.

LAPAROSCOPIC HYSTERECTOMY

Bipolar cautery with scissors, 6 cases were performed: 10, 12, 14, 10, 15, 13 minutes. Average time required: 12 minutes. Conventional Bipolar cautery forceps and scissors used separately 8 cases were performed: 23, 31, 28, 31, 21, 35, 25, 30 minutes. Average time required: 28 minutes.

Thus there was less than 50% of time required with new instrument for the coagulation as well as cutting and indirectly the duration of surgery. In conventional method, the time is wasted in removal and introduction of instrument one by one. A significant amount of CO_2 is leaked through the port. Repeatedly introduction of instruments may create inconvenience to surgeon and occasionally may cause trauma to internal organs.

DESIGN AND FUNCTIONING

In close association with Jyoti Engineering, Vasai, the bipolar cautery forceps with scissors was developed (Fig. 1). The instrument is made up of stainless steel and contains two compartments (Fig. 2).

The main instrument is 10 mm sheath with length of 30 cm while hand operating part is 10 cm. The superior compartment consists of bipolar unit which is fixed type while the inferior compartment consists of scissor which is sliding type. The instrument is passed through 10 mm cannula. The tissue to be cauterized is held between the jaws of bipolar forceps and coagulated. After adequate effect
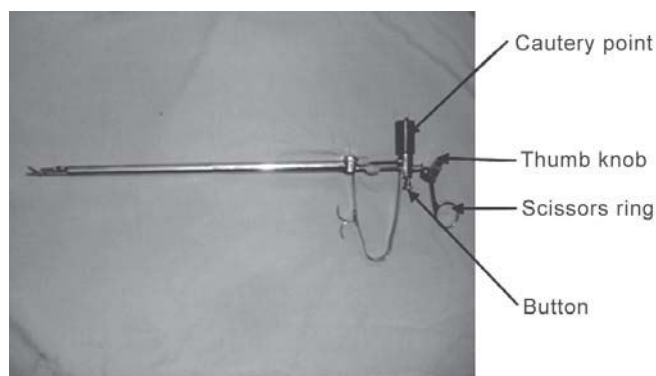

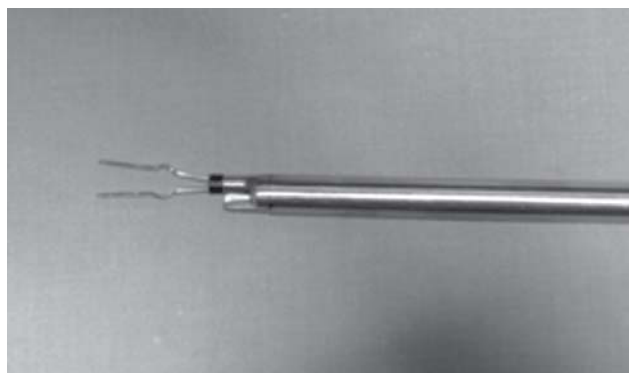**Fig. 1:** Bipolar with scissors instrument
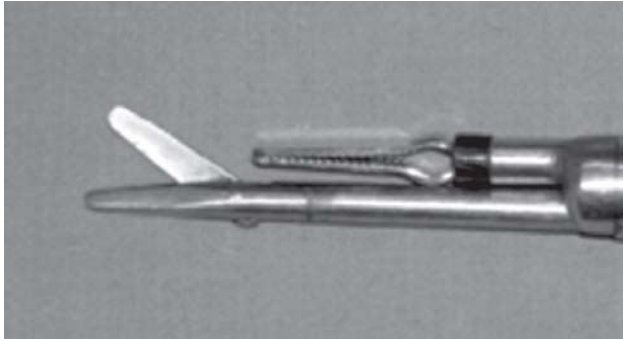

Fig. 2: Bipolar with hidden scissors

Fig. 3: Scissors with hidden bipolar

Fig. 4: Bipolar cautery forceps

the tissue is released. Now keeping the instrument in same position the knob of the scissors is pressed with thumb of same hand thus projecting out the scissors (Fig. 3). The scissor unit will automatically get locked. Now put the thumb of same hand in ring of scissors which will operate the jaws. Once the tissue is cut a button at the backside of the bipolar U arm is pressed, unlocking the unit and the scissors will be retracted inside. Now the instrument is ready for bipolar cauterization (Fig. 4).

DISCUSSION

The instrument can be used with single hand very easily. The surgeon should have proper knowledge of principles of electrosurgical dynamics to achieve maximum effect of coagulation and minimum side effects.[1,7,9] If properly used with irrigation a vessel up to 5 mm can be coagulated.[3,11, 12,14] There are better coagulating systems like harmonic, ligasure[13] available but they are costly and the operating handles have to be changed after 5 to 6 sittings. There are other limitations like Ligasure can not be used as dissector and its cutting of tissue with monopoler current/sliding blade is blind.

It also cannot be used as plain scissors. Harmonic is good dissector, excellent coagulant but it is not useful if a vessel starts bleeding profusely. It can be dangerous if its oscillating jaw which is in lowerside touches underling important structure like vessel, ureter or bowel.[8]

The advantage of the new instrument is that it can be used as a tissue holding without trauma, cutting, coagulation, hemostasis of a bleeder as well as blunt dissection without changing the instrument. If a pedicle is having big vessel one can coagulate it in gradual steps and cutting under vision to confirm complete hemostasis and with out charring of tissue and minimum lateral thermal tissue damage.

The instrument can be used to hold structure like bowel, adnexa for manipulation. The scissors can be used for continuous cutting of peritoneum, avascular bands, adhesion and sharp dissection.

The other advantages of the instrument are, it is cheap and doesent require costly endosurgical unit or ultrasonic device. The instrument can be reused, autoclavable and has minimum maintenance.

The scissors is not damaged by charring and frequent cleaning as in roboscissors, Multifunctional bipolar scissors[5,6] and ligasure where sliding blade becomes blunt. Few pediatric laparoscopic surgeon use[4] single stapler for appendix along with mesoappendix. This method may be risky in case of thick turgid or very thin appendix as stapler pin may not hold the tissue firmly.

CLINICAL USE

A laparoscopic surgeon can use the said instrument for coagulation, cutting and dissection as a single step or in combination as per requirement.

Method of Coagulation

A tissue, vessel or a pedicle to deal with is held between the two jaws of the bipolar forceps. It is cauterized with coagulation current in short period to prevent charring of the tissue. If minimum of current and high voltage is used maximum effect of coagulation is achieved by cogulative necrosis of tissue and fluids. The further heat spread to surrounding tissue can be prevented by irrigation of the electrodes by glycine or weak electrolyte solution. Thus lateral tissue damage is mininmal.

Method of Cutting

Once the tissue is optimally coagulated the tissue is relased and the scissor is protruted by pressing the thumb knob.Now the tissue is cut under vision with presision by the scissors with movement of the ring. One can guarded cutting under vision, as if there is incomplete hemostasis immediately coagulation can be done.

CONCLUSION

The described dual instrument has become very useful in laparoscopic surgery in our hands.The bipolar cautery

forceps with scissors have benift over other forms of bipolar coagulation because goagulated tissue is divided without instrument changing saving the time by almost 50%. The other indirect advantages are as follows:

1. Less manipulation of instrument, thus less stress to surgeon and assistant.[5]
2. Presise and guarded cutting (which it is not in bipolar cautery with sliding or monpolar blade in between the jaws).
3. Less amount of CO_2 utilised as gas is leaked.
4. No sticking of tissue or charring of scissors as in case of roboscissors and in caseof bipolar coagulation multi-functional instrument[5] and its maintenance. No need of frequent cleaning.
5. Cost benift as durable, cheap, less maintenance.
6. Reusable and can be autoclavable.
7. Doesent requires costly ESU/Ultrasonic device
8. Safer than monpolar cautery (No remote injury, direct coupling, insulation failure, capactive coupling and minimum lateral tissue damage.[2,10]

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ORIGINAL ARTICLE

Bile Duct Injury in Laparoscopic Cholecystectomy without On-table Cholangiography

[1]Mohammad Zarin, [2]Mujeeb-Ur-Rehman, [3]Shehzad Akbar, [4]Usra Ahmed, [5]Mansoor Khan
[6]Rooh-Ul-Muqim [7]Aziz Wazir, [8]Muhammad Salman

[1]Assistant Professor, Department of Surgery (Surgical "C" Unit), Khyber Teaching Hospital, Peshawar, Pakistan

[2,5,8]Resident, Department of Surgery (Surgical "C" Unit), Khyber Teaching Hospital, Peshawar, Pakistan

[3]Assistant Professor, Khyber Girls Medical College, Peshawar, Pakistan

[4]House Officer, Khyber Teaching Hospital, Peshawar, Pakistan

[6]Associate Professor, Department of Surgery (Surgical "C" Unit), Khyber Teaching Hospital, Peshawar, Pakistan

[7]Professor, Department of Surgery (Surgical "C" Unit), Khyber Teaching Hospital, Peshawar, Pakistan

Correspondence: Mohammad Zarin, Assistant Professor, Department of Surgery (Surgical "C" Unit), Khyber Teaching Hospital Room No. 86, Old Doctor's Hostel, Peshawar, Pakistan, Phone: 03339414477, e-mail: drmzareen@yahoo.co.uk

Abstract

Objective: To determine the safety of laparoscopic cholecystectomy without On-table cholangiography.

Study design: Quasi-experimental study.

Setting and duration: Surgical "D" ward Khyber teaching hospital Peshawar from January 2005 to December 2008.

Methodology: Patients of acute or chronic cholecystitis due to gallstones were included in this study while patients of obstructive jaundice and gallbladder mass were excluded. All patients were operated through laparoscopic cholecystectomy without On-table cholangiography. During procedure, bile duct injury were noted and evidences of bile duct injury were also collected postoperatively during hospitalization and follow-up visits. Data regarding complications in terms of bile duct injury were recorded and analyzed.

Results: A total of 7 (0.92%) bile duct injuries were noted in this series. There were two (0.26%) cases of partial injury to the common hepatic duct out of which 1 was a case of Mirizzi's syndrome. In the second case, a partial injury to the common hepatic duct occurred during an attempt to cauterize the avulse branch of cystic artery. In two (0.26%) patient's partial injury to common bile duct occurred due to tenting of common bile duct. Complete transaction of common bile duct occurred in two (0.26%) cases. In one (0.13%) patient post-operative leakage was found to be due to severed cholecystohepatic duct.

Conclusion: The results clearly show that there is hardly any difference as far as the CBD injury is concerned with or without On-table cholangiography, provided we have a good back-up by a radiologist for pre- and postoperative ultrasound and ERCP.

Keywords: Laparoscopic cholecystectomy (LC), common bile duct (CBD), On-table chalangiogram (OTC), ultrasonography (USG).

INTRODUCTION

The introduction of laparoscopic cholecystectomy has increased bile duct injuries by three to four folds.[1,2] Bile duct injury can lead to bile leakage, peritonitis, stricture formation, cholangitis, jaundice, chronic liver disease and septicemia. These injuries are frequently amenable to delayed recognition and difficult reoperations due to inflammation, infection and malnutrition.[3] A number of techniques have been devised to prevent such injuries and among these On-table cholangiography (OTC) is widely practiced. On-table cholangiography (OTC) was first recommended by Mirizzi[4] in 1931 on the basis of high incidence of common bile duct

stones and thus reducing the incidence of unnecessary CBD exploration from 66% to < 5%.[5] In cholecystectomy, the routine use of OTC is controversial as it is useful to map the anatomy of the biliary tree but on the other hand it increases the operation time, cost and unnecessary CBD exploration due to poor quality images and false-negative and false-positive results. The debate becomes further complicated with the advent of laparoscopic cholecystectomy which demands additional technical skills for OTC.[6] Numerous studies have shown that Laparoscopic cholecystectomy was performed safely with minimal use of OTC.[7,8] While others insist the routine use of OTC during laparoscopic cholecystectomy to minimize the CBD injuries.[9-11]

In our setup, On-table cholangiography is not performed routinely while doing laparoscopic cholecystectomy. It is mainly due to technical difficulty and nonavailability of the equipment in most hospitals. In this study, we report the outcome of a series of patients undergone LC without On-table cholangiography.

PATIENTS AND METHODS

This study was carried out in surgical "D" ward Khyber Teaching Hospital, Peshawar from January 2005 to December 2008. A total of 760 patients were included in this study. Patients of known gallstone disease without clinically and radiological proven complications (obstructive jaundice) were subjected to laparoscopic cholecystectomy. Patients were admitted through outpatient or emergency department. After proper history and examination the gallstone diseases was diagnosed by ultrasonography and CT-scan where needed. Patients with complications like obstructive jaundice or gallbladder mass were excluded from the study. All patients were operated as elective cases with laparoscopic procedure. Three ports laparoscopic cholecystectomy was performed in majority of the cases while four ports technique was adopted in difficult cases. Meticulous concentration was adopted for hepatobiliary anomalies. On-table cholangiography was performed in none of the cases. At the completion of procedure biliary tracts were examined carefully for evidence of evident or potential damage. They were observed for a day or two and then were discharged home. They were advised to attend the follow-up clinics at four to six weeks interval. During postoperative course and follow ups, they were looked for evidence of bile duct injury (peritonitis, biliary leakage through drain or biliary fistula). Thus detected cases of bile duct injury were admitted for further work up. The data were entered into a proforma and was analyzed and results were drawn at the completion of study.

RESULTS

Out of the total 760 cases that underwent laparoscopic cholecystectomy bile duct injury was observed in 7 (0.92%) seven cases (Table 1).

Partial Injury to CHD

There were 2 (0.26%) cases of partial injury to the common bile duct. One case was that of the "Mirizzi syndrome". The opening between the Hartman's pouch and CHD (common hepatic duct) became evident during dissection. Hence immediate laparotomy was done and T-tube placed. In the second case, a small spurt occurred from a vessel running over the CHD during dissection of dense adhesions in Calot's triangle, hence diathermy was used to coagulate the bleeder. Nothing happened during the operation. The patient recovered well and was discharged home. However, the patient returned with biliary peritonitis after one week, ERCP confirmed the leak in CHD. Laparotomy showed a hole at the site where diathermy was used, a T tube was placed.

Partial Injury to CBD

In 2 (0.26%) patients, the partial injury to CBD occurred due to tenting and both these injuries were detected peroperatively. The problem was rectified by conversion to open surgery and insertion of T-tube.

Complete Transaction of CBD

This occurred in 2 (0.26%) patients. In one, who had a very small gallbladder (hardly 2 cm), that was buried in the liver near porta hepatis. Besides the entire gallbladder was occupied by a large stone. Thus CBD was mistaken for cystic duct, clipped and divided. The gallbladder which was densely adherent with the under surface of liver and was separated by blunt and sharp dissection using scissors and diathermy hook, and removed. Drain was placed but next

Table 1: Management of complications

Type of injury	No. (%)	Action taken	Result
Partial injury to CBD	2 (0.26%)	Laparotomy and T-tube	No further complication
Partial injury to CHD	2 (0.26%)	Laparotomy and T-tube insertion	No further complication
Cholecystohepatic duct leak	1 (0.13%)	Drain placed under ultrasound control	Leak continued after two weeks Laparotomy and stitch applied to the duct
Complete transaction of CBD	2 (0.26%)	Hepatojejunostomy/choledochojejunostomy	Complete recovery after four weeks

day it showed 400 cc of bile which increased in amount over the next 48 hours. ERCP confirmed the block in the CBD. Laparotomy and hepatojejunostomy was performed, and the patient ultimately recovered. In second patient, this disaster happened because of a congenital anomaly (absent cystic duct). Conversion and choledochojejunostomy was performed.

Leak from Cholecystohepatic Duct

This was realized in a patient who returned on the 4th postoperative day with abdominal distension and pain. Ultrasound showed a huge collection under the liver and ultrasound guided drain was placed. As the leakage continued (around 1000 ml of bile daily), laparotomy was performed which revealed a cholecystohepatic duct which was ligated. The patient recovered uneventfully.

DISCUSSION

The spectrum of iatrogenic bile duct injuries ranges from clip impingements to complete transection of the common bile duct. We observed almost all of these injuries in our study.

It has been previously suggested that the high rate of biliary injury associated with laparoscopic cholecystectomy is the result of the learning curve.[12,13] However, other authors have reported it an ongoing problem well beyond the learning period.[14,15] In our study, all the cases were performed by experienced laparoscopic surgeons who had already performed more than 100 LC, yet the bile duct injuries occurred in 0.92% of cases which indicates that no surgeon is immune from bile duct injuries during LC. Carroll BJ et al[16] also experienced that most of the injuries occurred from surgeons who were out of the learning curve.

In the current study, technical errors were the primary cause of bile duct injuries. In 4 (57.14%) cases, these injuries were the result of misidentification of the anatomy due to inadequate dissection and undue tension, resulting in the tenting of CBD. While in one case (14.28%), injury occurred due to cauterization. Carroll BJ et[16] observed misidentification of anatomy in 48% cases and cautery injury in 11% of the cases. According to Hunter JG[17] these injuries can be avoided by the use of a 30° angle forward oblique viewing telescope, firm cephalic traction on the fundus and lateral traction on the infundibulum to place the cystic duct perpendicular to the common duct, dissection of the cystic duct where it joins the gallbladder, and routine fluoroscopic cholangiography.

On-table cholangiography (OTC) reduces the chances of bile duct injuries, therefore some authors advocate routine while other selective cholangiography during LC. However, due to lack of facility and expertise we perform LC without OTC. Experience of laparoscopic cholecystectomy in the United States, where OTC is either a routine or selectively performed, showed the incidence of bile duct injury as 0.6%.[18] MacFadyen BV et al[19] observed the incidence of bile duct injury as 0.5%, while Calvete J et al.[20] experienced injury rate of 1.3%. In our study, we found the rate of bile duct injuries as 0.92% which is comparable with incidence of centers where OTC is routinely or selectively performed. Archer SB et al[21] in their study also reported better detection rate of bile duct injuries even without doing OTC.

CONCLUSION

Laparoscopic cholecystectomy can be performed safely without the use of OTC, provided that pre- and/or postoperative ERCP is available and performed when indicated.

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ORIGINAL ARTICLE

Single Port Endolaparoscopic Surgery (SPES) in Double Abdominal Procedures

Michael M Lawenko, Javier Lopez-Gutierrez, Alembert Lee-Ong, Davide Lomanto

Minimally Invasive Surgical Center, Department of Surgery, National University Health System, Singapore

Correspondence: Davide Lomanto, Director, Minimally Invasive Center, Department of Surgery, National University Health System, 5 Lower Kent Ridge Road, Singapore-119074, Phone: +6567722897, Fax: +6567746077, e-mail: surdl@nus.edu.sg

Abstract

Background: Single port endolaparoscopic Surgery (SPES) has gained enthusiasm in the surgical community because of the perceived better postoperative outcome, namely a single incision. We write this prospective observational study to ascertain the feasibility and safety of this technique in patients needing two operations.

Methodology: Three patients who underwent double procedures each. Case 1: Transabdominal preperitoneal hernia repair with gastric wedge resection. Case 2: Cholecystectomy with diaphragmatic hernia repair. Case 3: Oophorectomy with incisional hernia repair. Patient demographics, type of port used, operating time, complications and scar length were collected.

Results: Operating time for the first case was 250, 210 and 105 minutes respectively. Incision length varied from 2 to 3 cm. Addition of a 5 mm port and an intraoperative complication of a laceration of the liver after suturing of the gallbladder fundus was noted in the second case.

Conclusion: SPES is a feasible and safe technique for approaching double procedures. It drastically reduces the number of scars that a double procedure creates and if difficulty arises another port can always be added to ease the operation.

INTRODUCTION

Since the first laparoscopic cholecystectomy[1-3] more than two decades ago, laparoscopic surgery has evolved from basic procedure to most advanced surgical operations. This is a result of the better clinical outcome compared to conventional surgery. The success of many procedures like cholecystectomy, GERD surgery, obesity surgery and more has been driven because of the shorter hospital stay, better cosmesis and less pain, becoming a gold standard approach for many of them. Subsequently, Laparoscopic surgery has also evolved by minimizing the size of the wound with the use of mini-instruments called minilaparoscopic surgery or needlescopic surgery. Several studies showed that procedures with mini-intrumentations were feasible, with lesser postoperative pain and smaller scar compared to standard laparoscopic surgery[4-8] but the worldwide acceptance of this technique was not achieved as expected.

The advent of single port endolaparoscopic surgery (SPES) in the last year seems to address this issue but more clinical studies are needed to prove these endpoints. To our knowledge there is no report yet for single port surgery being done for two abdominal procedures.

We report our experience in using SPES in patients undergoing double procedures with the aim of assessing the feasibility and safety of doing two abdominal operations using a single entry.

MATERIALS AND METHODS

From May to November 2009, three patients underwent double abdominal procedures. Informed consent was taken explaining the possible risk of conversion to conventional laparoscopy. Data regarding patient demographics, type of operation, operating time, complications, postoperative pain score was collected.

Case 1: 56 years old male with a 5 × 4 cm gastrointestinal stromal tumor (GIST) at the posterior gastric wall near the lesser curvature and a right indirect inguinal hernia. The single port device (SILS™, Covidien, Norwalk, USA) was inserted through a 2 cm transumbilical incision. Hernia repair was first done using the transabdominal preperitoneal approach (TAPP). The peritoneal flap was created using articulated instruments (Roticulator™, Covidien, Norwalk, USA) and straight conventional graspers and scissors. A 15 × 10 cm lightweight polyester mesh (Parietene™, Covidien, Norwalk, USA) covered the myopectenial orifice and fixation with nonabsorbable tackers (Protack™, Covidien, Norwalk USA) at the Cooper's ligament. The

peritoneal flap was closed over the mesh with tackers. The GIST tumor was lifted using sutures and wedge resection was performed with linear staplers (Echelon™, Johnson and Johnson, New Jersey, USA) using 4 blue cartridges. Intraoperative endoscopy was performed to assess completion of the resection and to verify the staple line. The specimen was extracted and the umbilical incision was closed with absorbable sutures.

Case 2: 55 years old male with traumatic left diaphragmatic hernia and symptomatic gallstone disease. The single port device (Triport™, Olympus, Tokyo, Japan) was inserted via a 2 cm supraumbilical, incision. Articulated instruments and hook diathermy were used. The gallbladder fundus was retracted using sutures (puppet technique)[6] and the cystic duct and artery were clipped with hemostatic clips (Hemo-Lok™, Weck, N Carolina, USA). The left diaphragmatic hernia was identified and incarcerated omentum was reduced. Repair was done with 2-0 nonabsorbable sutures. An additional 5 mm port in the left subcostal was necessary to achieve the triangulation needed to assist in endosuturing. A 15 × 10 cm polyester composite mesh (Parietex™ Covidien, Norwalk, USA).

Case 3: 77 years old female with a left ovarian cyst and a right incisional hernia from a previous appendectomy. The single port device (SILS™, Covidien, Norwalk, USA), port was inserted in a 2 cm incision in the left lower abdominal quadrant. The uterus was lifted using an intrauterine retractor and left oophorectomy was completed using bipolar scissors. Subsequent adhesiolysis was done and the omentum was freed and reduced into the abdominal cavity. The hernial defect was closed with nonabsorbable transfascial sutures and covered with a 10 × 15 cm antiadhesive mesh (C-Qur™, Atrium Medical, Hudson, USA). Mesh fixation with transfascial sutures and titanium tackers (Protack™, Covidien, Norwalk, USA) was done.

RESULTS

DISCUSSION

Single port endolaparoscopy (SPES) further minimized the invasiveness of the surgical procedure by limiting the trauma from several incisions to a single incision. Different endolaparoscopic procedures using this approach were seen to be feasible and safe,[9-12] there still is no proven advantage of this technique over conventional endolaparoscopy. We believe that decreasing the number of incisions and increasing the number of procedures done will be the great advantage of single port surgery.

We made use of two devices locally available: the SILS™ device (Covidien, Norwalk, USA) and the Triport™ (Olympus, Tokyo, Japan). In 2 cases, the SILS™ device was used. This is an hour glass shaped port made of an elastic polymer that is squeezed to fit a 2 cm incision into the abdominal cavity. It comes with low profile 5 mm and a 12 mm trocars which are inserted into the port. The Triport™ was used in one case. This access device has 3 gelatin coated working ports, namely one 12 mm and two 5 mm ports and an insufflation and gas release port. The adjustable double layer transparent plastic sheath is adjusted to the thickenss of the abdominal wall (up to 10 cm).[13-15]

Comparing the ports, we found that the Triport™ was easier to insert in a 2 cm incision and is versatile on different abdominal wall thickness. The drawback is its more propensity for gas leak around the incision site, the difficulty in inserting instruments through the gelport cap and the friction encountered with instrument movement in and out of the port. This was remedied with a small incision over the gelport caps and lubrication of instrument with lubricating jelly. The SILS™ port on the other hand has a more airtight seal and greater ease of instrument insertion and movement. Its drawback is that is requires a certain effort to insert in a 2 cm incision and it was not suited for abdominal wall thickness greater than 5 cm. Introduction of the 12 mm trocar was very difficult and it made the port expand, affecting the inflow of gas. This was remedied but removing two 5 mm trocars while using the 12 mm trocar.

Procedure	Operating time (minutes)	Intraoperative complications	Port used	Additional 5 mm port	Size of incision (cm)	Size of scar (cm)
TAPP + Gastric wedge resection	250	None	SILS™	Nil	2	2.5
Cholecystectomy + Diaphragmatic hernia repair	210	small laceration of the liver	Triport™	1	2	2.5
Oophorectomy + Incisional hernia repair	105	None	SILS™	Nil	2	2.5

In our experience, the most important aspect in performing single port surgery for double procedures is the placement of the port. The port must be situated in a position that provides maximal access to both procedures by providing an optimal view of the surgical working field, maintaining adequate instrument triangulation and give a suitable ergonomic position for the surgeon. The first case was approached through the umbilicus as both the hernia repair and the gastric wedge resection was accessed by a simple change in the surgeon's position. A supraumbilical incision was done for the second case as we wanted our instruments to reach left hemidiaphragm and still maintain adequate access to the gallbladder. For the third case, placing the port in the the left lower quadrant along the midclavicular line provided maintained the triangulation of instruments for manipulating the left ovary at the same time does not compromise the working area for the right lower quadrant incisional hernia.

Choosing which procedure to do first is another factor to take into consideration. In the first and third case, the first procedure was chosen based on the technical ease of the operation as compared with the second procedure. For the second case, cholecystectomy was done first because any spillage of bile that occurred would affect the decision to place a mesh on the diaphragmatic defect.

With regards to the instruments, articulating instruments provided the triangulation needed in terms of retraction. In cholecystectomy, the Roticulator™ grasper was useful in retraction of the Hartmann's pouch of the gallbladder while the fundus was retracted with sutures.[16] Regarding optics, a rigid 5 mm 30º scope (Endoeye™, Olympus, Tokyo, Japan) was our preference because the light cable is situated at the end of the camera head and not on top which eliminates clashing of instruments.

The complication encountered was a small laceration on the liver that was experienced while suturing the fundus of the gallbladder for retraction and was controlled with cauterization. An additional 5 mm port was placed due to the increased triangulation needed to suture the diaphragmatic defect.

CONCLUSION

SPES is a feasible and safe technique for approaching double procedures. It drastically reduces the number of scars that a double procedure creates and if difficulty arises another port can always be added to ease the operation.

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ORIGINAL ARTICLE

Effects of CO_2 Pneumoperitoneum and Enteric Disturbance on β-endorphin in SD Rats

Wu Gang, Cai Duan, Lu Lei, Ma Bao-Jin, Zhang Yan-Ling

Department of General Surgery, Huashan Hospital, Fudan University, Wulumuqi, Shanghai, China

Correspondence: Wu Gang, Department of General Surgery, Huashan Hospital, Fudan University, Wulumuqi, Road No. 12 Shanghai-200040, China, e-mail: wugang66916@yahoo.com.cn

Abstract

Objective: To study the effects of enteric disturbance and CO_2 pneumoperitoneum on serum β-endorphin (β-EP) in SD rats, and discuss their influences on perioperative stress responses.

Methods: 120 SPF-grade male SD rats were anesthetized intraperitoneally and equally randomized to four groups: group A, CO_2 pneumoperitoneum at 1.0 kPa; group B, a 5 cm abdominal incision without enteric disturbance; group C, a 5 cm abdominal incision with enteric disturbance; and group D, control Group. Serum β-EP was measured at 10, 20 and 40 minutes after initiation of surgery.

Results: The serum β-EP concentration of group A was 2.74 ± 0.67 ng/ml, 1.57 ± 0.64 ng/ml and 1.64 ± 0.74 ng/ml at 10, 20 and 40 minutes of CO_2 pneumoperitoneum respectively, which was significantly higher than that of the control group (P < 0.01). The serum β-EP concentration of group B was 2.53 ± 0.86 ng/ml, 1.46 ± 0.11 ng/ml and 1.34 ± 0.14 ng/ml at 10, 20 and 40 minutes after the 5 cm abdominal incision was made, which was very significantly higher than that of the control group (P < 0.01). The serum –EP concentration of group C was 3.77 ± 0.51 ng/ml, 2.99 ± 0.70 ng/ml and 2.67 ± 0.54 ng/ml at 10, 20 and 40 minutes after the 5 cm abdominal incision was made with enteric disturbance. There was a very significant difference in the concentration of serum β-EP at 10, 20 and 40 minutes between Group C and Group B (P < 0.01).

Conclusion: Both enteric disturbance and CO_2 pneumoperitoneum are important stimulating factors inducing stress responses in rats. Enteric disturbance may accentuate the severity of stress responses in laparotomy.

Keywords: β-endorphin, pneumoperitoneum, laparoscopy, stress responses.

INTRODUCTION

Carbon dioxide (CO_2) pneumoperitoneum, abdominal incision and especially enteric disturbance are very important stressful stimuli of abdominal surgery including laparoscopy. Surgery is a stressful stimulus that elicits inflammatory, endocrine and metabolic responses as represented by increased levels of stress hormones, leading to substrate mobilization. These changes together constitute the stress response. The stress response caused by surgery is conditioned by several factors such as anxiety, incision size, enteric disturbance (enteric exposure and drawing), exposure of abdominal organs to air, temperature change, operation duration, pain, hemorrhage, and infection. To obtain excellent exposure in laparotomy, it is necessary to incise the abdomen and pull the intestine. Avoidance of enteric disturbance, less hemorrhage, smaller incisional size and shorter operation duration contribute to lowering stress responses in laparoscopic surgery. Laparoscopic surgery and induction of pneumoperitoneum cause minimal activation of stress hormones, resulting in a lower stress response on the part of the patient, and possibly a shorter recovery time.

Serum β-endorphin (β-EP) and cortisol levels are often elevated in animals and humans under major stress conditions including perioperative procedures. Increased generation of β-EP and cortisol contributes to trauma-related acute phase reaction and hypermetabolic response. Secretion of β-EP and cortisol plays a central role in mediating metabolic responses to stress, and there is a linear correlation between cortisol values and the severity of injury. As β-EP is positively correlated with cortisol, and both hormones are the result of corticotropin-releasing hormone (CRH) activation, increased circulating β-EP seems to be part of the response to stress.

In this experimental study, the effect of enteric disturbance and carbon dioxide (CO_2) pneumoperitoneum on stress response was studied in a rat model. Serum β-EP of SPF-grade male SD rats was measured at different time points after initiation of surgery under the experimental condition of CO_2 pneumoperitoneum at 1.0 kPa, a 5 cm abdominal incision without enteric distrubance, or a 5 cm abdominal incision with enteric disturbance to see whether intestinal disturbance as an important factor increased the degree of stress response, and whether reducing intraoperative traction on the intestine reduced the extent and shortened the duration of perioperative stress response, thus reducing trauma and promoting patient rehabilitation.

MATERIALS AND METHODS

Animal Grouping

SPF-grade SD male rats weighing 190-220 gm (Shanghai Laboratory Animal Center, Chinese Academy of Sciences) were given free access to tap water and pelleted food throughout the course of study. Laboratory temperature was maintained at 23ºC and relative humidity at 48%.

Grouping: 120 rats were equally randomized to four groups before intraperitoneal anesthesia with 1% sodium thiopental (0.5 ml/100 gm). In group A, CO_2 pneumoperitoneum was established by abdominal paracentesis at a stable pressure of 1.0 kPa using a pneumoperitoneum machine (STORZ 26020S); in group B, a 5 cm abdominal incision was made on the upper abdomen of rats without any disturbance on the incision and abdominal organs; in group C, a 5 cm abdominal incision was made on the upper abdomen of rats with pulling the intestine with a retractor using 5N pulling power; and in group D, only intraperitoneal anesthesia was performed without any surgical procedure. Serum β-EP was measured at 10, 20 and 40 min postoperatively in every other 10 rats of each group. Serum β-EP was measured in another 10 rats immediately after i.p. anesthesia as normal level.

Estimation of Serum β-EP Levels

Reagents and equipment included a plasma β-EP Kit (Department of Neurobiology of the Second Military Medical University, Shanghai, China), a pneumoperitoneum machine (STORZ 26020S), a refrigerated centrifuge (DL-8R, Centrifugal Machinery Research Institute, Shanghai), and RIA measuring instrument (SN-695, Shanghai).

2 ml blood samples drawn by cardiac puncture were collected in heparinized Vacutainer tubes containing pre-cooled 0.3 mol/LEDTA-2Na (20 mg/l) and aprotinin (500 U/ml), and centrifuged immediately at 3000 gm for 15 minutes. The plasma was stored at 75°C for estimation of the serum β-EP concentration by using a commercial radioimmunoassay kit.

Statistical Analysis

Significant interactions were decomposed by using simple main effects F tests. The significance was evaluated at a level of 0.05. All statistical analyses were performed with the SPSS statistical software package, version 10.1, by a personal computer.

RESULTS

CO_2 Pneumoperitoneum Increases Serum β-EP. The mean serum β-EP concentration was 0.61 ± 0.35 ng/ml immediately after IP anesthesia in the control group. The plasma β-endorphin concentration increased after the establishment of the CO_2 pneumoperitoneum gradually, and rose to the peak at 10 minutes after continuum of the CO_2 pneumoperitoneum, and then decreased at 20n and 40 minutes gradually. The serum β-EP concentration in group A was 2.74 ± 0.67 ng/ml, 1.57 ± 0.64 ng/ml and 1.64 ± 0.74 ng/ml at 10, 20 and 40 minutes respectively, *vs* 0.61 ng/ml, 0.65 ng/ml and 0.64 ng/ml in the control group ($P < 0.01$).

Incising the Abdomen Increases Plasma β-EP

The serum β-EP concentration increased gradually after the 5 cm incision was made on the abdomen, rose to the peak at 10 minutes, and then decreased at 20 and 40 minutes gradually. The serum β-EP concentration of group A was 2.87 ± 0.47 ng/ml, 1.58 ± 0.61 ng/ml and 1.41 ± 0.79 ng/ml at 10, 20 and 40 minutes, respectively, which was significantly higher than that of the control group ($P < 0.01$).

Enteric Disturbance Accentuates the Severity of Stress Response

In group A, B and C, serum β-EP was significantly increased at 10, 20 and 40 minutes compared with the control ($P < 0.01$). There was no significant difference in plasma β-EP at 10, 20 and 40 minutes between group A and B, but the
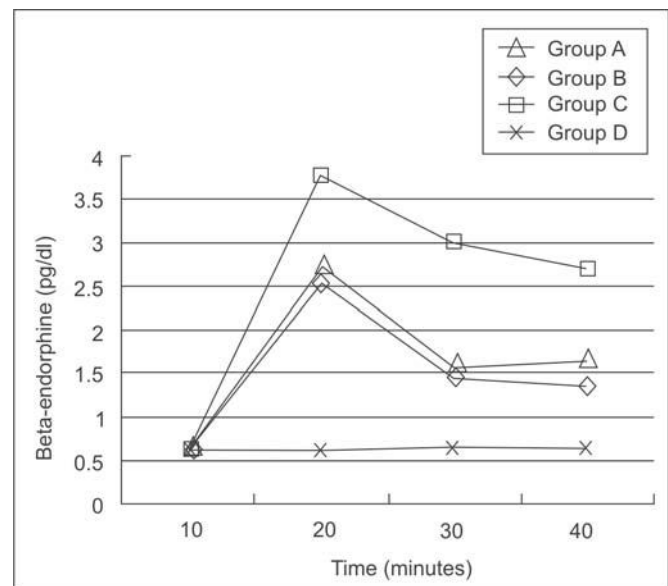

Fig. 1: Serum β-EP was significantly increased at 10, 20 and 40 minutes in group A, B and C as compared with that of the control ($P < 0.01$). There was significant difference in plasma β-EP at 10, 20 and 40 minutes between group B and C ($P < 0.01$), and also between Group A and C ($P < 0.01$), but there was no significant difference between group A and B ($P > 0.05$)

difference between group A and C was significant (P < 0.01). It was 3.77 ± 0.51 ng/ml, 2.99 ± 0.70 ng/ml and 2.67 ± 0.54 ng/ml at 10, 20 and 40 minutes respectively in group C, vs 2.53 ± 0.86 ng/ml, 1.46 ± 0.11 ng/ml and 1.34 ± 0.14 ng/ml in group B (P < 0.01).

DISCUSSION

Over the past few decades, corticotropin-releasing factor (CRF) signaling pathways have been shown to be the main coordinators of endocrine, behavioral and immune responses to stress.[1-4] The central effectors of stress response are the corticotrophin-releasing hormone (CRH) and locus coeruleus-norepinephrine (LC-NE) /sympathetic systems. The CRH system activates stress response and is subject to modulation by cytokines, hormones and neurotransmitters. This stress system is tonically active, but both physical and emotional stressors that exceed a critical threshold increase its activity further. The principal role of glucocorticoids during the stress response is thought to be restraint of the effectors of stress response.[5,6]

β-EP is an opioid peptide representing the C-terminal 31 acid residue fragment of proopiomelanocortin (POMC). The release of β-EP from the pituitary into the cardiovascular compartment under physical or emotional stress has been frequently reported. It is well-established that in the pituitary gland CRH stimulates the release of beta-endorphin via a cAMP-linked mechanism.[7-9] Guillemin et al first reported that β-EP was released from the pituitary into the blood in rats under stress, and that all kinds of stress could stimulate the secretion of serum β-EP, which was controlled by the hypothalamus, mainly by adenohypophysis synthesis, and from POMC and its precursor substances.[10,11] The concentration of serum β-EP increased with stress responses caused by different factors, reached the peak 5 ~ 10 minutes after continuum of the stress factors, and then decreased gradually.

In parallel with an increase in plasma β-EP concentration during stress, an elevation in adrenocorticotropic hormone (ACTH) and cortisol plasma concentrations was observed.[12-14] Stress could stimulate the secretion of serum β-EP, inhibit activity of the sympathetic-adrenal system, regulate the stress intensity, and inhibit secretion of ACTH, glucocorticoid and vasopressin.[15] H. Harbach et al found cortisol as a 'long-term parameter' of the endocrine response to stress.[16-18] In their previous studies, β-endorphin was measured under different stress conditions. In parallel with an increase in β-EP concentrations during stress, an elevation in ACTH and plasma cortisol concentrations was observed. Kho and

colleagues measured a significant increase in β-EP levels during acupuncture and transcutaneous stimulation even before skin incision for abdominal surgery and also before laryngoscopy for intubation had been performed.[19] Elevated serum EP and cortisol levels were observed in animals and humans subjected to major stress. Hamit Okur et al reported that there was a linear correlation between β-EP and cortisol values and the injury severity.[20] Increased β-EP and cortisol generation contributes to the acute phase reaction and hypermetabolic response that accompanies trauma. The secretion of cortisol plays a central role in mediating the metabolic responses to stress. Under perioperative conditions, corticotroph-type POMC derivatives such as ACTH or β-EP immunoreactive material (β-endorphin IRM) have been reported to be released in conditions of preoperative stress, surgical injury, or postoperative pain.[21,22] Study of Marschall, et al indicates that although β-END and ACTH are both produced by the pituitary and derived from a common precursor, the type of stimuli (pre-vs postsurgical stress) seems to differentially affect their plasma levels.[23]

The stress response caused by surgery is conditioned by several factors such as anxiety, incision size, enteric disturbance (enteric exposure and drawing), exposure of abdominal organs to air, temperature change, operation duration, operated organ and operative type, pain, hemorrhage and infection. Avoidance of enteric disturbance, less hemorrhage, smaller incision size and shorter operation duration contribute to lowering stress response of laparoscopic surgery. To obtain excellent exposure in laparotomy, it is necessary to incise the abdomen and pull the intestine. As laparoscopic surgery and induction of pneumoperitoneum cause minimal activation of the stress hormones, they should result in a lower stress response on the part of the patient, and possibly a shorter recovery time. But whether reducing intraoperative pulling of the intestine truly reduced the extent and shortened the duration of perioperative stress response, thus reducing trauma and promoting patient rehabilitation was not conclusive.

The results of this study show that serum β-EP was elevated, and the degree of elevation was related to the severity of injury. Surgery is a stressful stimulus that elicits inflammatory, endocrine and metabolic responses consisting of increased levels of stress hormones, leading to substrate mobilization.[24,25] These changes together constitute the stress response. Laparoscopic surgery causes minimal activation of the stress hormones while laparotomy results in a more obvious response of the stress hormones, probably due to

increased tissue trauma and less enteric disturbance in laparoscopic surgery.[26,27] β-EP levels increased with pain increasing. Since β-EP was positively correlated with cortisol, and both hormones are the result of CRH activation, increased circulating β-EP seemed to be part of the response to pain and/or stress.[28]

Perioperative serum β-EP concentration change of laparoscopic laparoscopic cholecystectomy (LC) and open cholecystectomy (OC) is very important, and the plasma β-EP concentration is in parallel with the extent and duration of trauma.[14] Intestinal disturbance such as intestinal stretch, exposure of abdominal organs to air or temperature change is part of surgical trauma. Without disturbance to the gastrointestinal tract and exposure of abdominal organs to air may be the important mechanism of mini-invasive surgery, such as LC. CO_2 pneumoperitoneum and intestinal disturbance caused the stress response in rats, and induced the central nervous system to stimulate the hypothalamus releasing CRH, which stimulates the pituitary gland to secrete β-EP. β-EP in group A (CO_2 pneumoperitoneum at 1.0 kPa) or Group B (5 cm abdominal incision without enteric disturbance) increased significantly, indicating that these two experimental conditions can cause stress response in rats, though the difference between the two groups was insignificant ($P > 0.05$). There was a very significant difference in plasma β-EP at 10 and 20 minutes and a significant difference at 40 minutes between group C and B, suggesting that intestinal disturbance can increase the extent of the stress response under the experimental conditions. This experimental study also explored the relationship between intestinal disturbance and serum β-EP in rats. Reducing intraoperative traction on the intestine can reduce the extent and shorten the duration of perioperative stress response, thus reducing trauma and promoting patient rehabilitation.[29]

CONCLUSION

Our results suggest that intestinal disturbance as an important factor can increase the degree of stress response, and may therefore be an important mechanism for minimally invasive intervention such as LC without interference from intestinal traction.

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