



RESEARCH ARTICLE

OUT COMES OF CLOSURE VERSUS NON CLOSURE OF VENTRAL HERNIAL DEFECT DURING
LAPAROSCOPIC HERNIOPLASTY

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ABSTRACT

Hernia is a protrusion of abdominal viscera through a defect in abdominal wall. Successful repair of abdominal hernias requires thorough knowledge of anatomy of anterior abdominal wall and all its layers. Ventral abdominal hernia includes all the hernias occurring through the anterior abdominal wall excluding groin hernias (incisional hernia, epigastrichernia, paraumbilical hernia) (Stoppa, 1989; Ahmed *et al.*, 1995).

Key words:

Incisional hernia, Epigastrichernia,
Paraumbilical hernia.

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INTRODUCTION

Ventral hernias are defects of the anterior abdominal wall can be classified into congenital (epigastric, umbilical, and Spigelian) and acquired (incisional). Incisional hernia is a frequent complication of laparotomies with overall incidence between 2 and 13% (Lomanto *et al.*, 2006; Santora, 1993). According to European Hernia Society (EHS), ventral hernias are divided in two groups: Primary, there are many factors involved in its origin and secondary or Incisional: it appears subsequent to a previous surgical incision in the abdominal wall. Both groups have been further subdivided, by location and size. Primary hernias are classified by size and location and incisional hernias are classified by the size (length and width), location, and rate of recurrence (Muysoms, 2009). Hernia repair continues to be one of the most common surgical operation done by general surgeons. With the advent of laparoscopy, minimally invasive techniques have been used in the abdominal wall reconstructions to reduce postoperative morbidity and wound complications. In fact, over the last decade, laparoscopic repair has been utilized for repairs of many ventral hernia defects due to its efficacy and safety (Heniford *et al.*, 2003; Sajid *et al.*, 2009).

With Comparison to open repairs, laparoscopic ventral hernia repair (LVHR) has been shown to result in reduced wound infection, seroma formation, quicker recovery of bowel function, shorter hospital stay, and better cosmesis (Lomanto *et al.*, 2006; Bencini *et al.*, 2003). In addition, appropriately performed laparoscopic repair has also been associated with low recurrence rates (Heniford *et al.*, 2003; Ramshaw *et al.*, 1999; Novitsky *et al.*, 2006). Not surprisingly, LVHR has been proposed as the gold standard for many ventral hernia repairs (Novitsky *et al.*, 2006; Agarwal *et al.*, 2009). During the past 10 years, laparoscopic repair of ventral hernia has become increasingly established in clinical practice and aimed to be an acceptable and successful technique (Gut *et al.*, 2004; Moulhas *et al.*, 2009). Ventral hernia is one of abdominal wall hernias which is classified into incisional, umbilical, parastomal, epigastric & spigelian (Mensching, 1996). Several procedures have been used for hernia repair. During the last few decades, the open surgical approach has been the standard technique for hernia repair. First it was done by sutures alone, which has several complications such as putting excessive strain on the surrounding tissue through which the sutures are passed and also has high recurrence rate (Stylopoulos, 2005). In order to provide better results and to decrease these complications, an alternative technique was developed in which there is a piece of plastic like mesh or screen material is applied. But also this new technique was associated with high rate of morbidity and recurrence (Stylopoulos, 2005). Lastly, a number of factors

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have led to development of new method of repair called laparoscopic hernia repair. This technique is an extension of the traditional mesh repair techniques, in which the same procedure can be done with relatively several small incisions. This allows repairing the the hernia and placing the mesh with minimal injury to the surface of the abdomen (Stylopoulos, 2005). Also in laparoscopic ventral hernia repair, occult hernia defects were found to be a common finding. The inspection during laparoscopy takes advantage of detecting occult hernia defects precisely, which result in an excellent outcome of laparoscopic ventral hernia repair (Indani *et al.*, 2009). Although laparoscopic ventral hernia repair has decreased complications compared to open techniques, it also has additional complication of port site hernia to its follow up criteria. Recently single port access technique is applied to decrease these complications in spite of two port repair technique (Moulhas *et al.*, 2009). Laparoscopic ventral hernia repair (LVHR) was introduced in 1993. In this technique the mesh was placed over the defect without closing it. This "tension-free" repair was shown to be a safe and feasible alternative to open ventral hernia repair with mesh (LeBlanc, 1993).

Clinical picture

The patient with ventral hernia commonly presents with unremarkable clinical symptoms. Most patients give a history of a swelling or bulge that, elicited by physical activity such as exercise or coughing, and disappearing after stopping the activity or lying down. Examination is performed in both the standing and lying position, Fig (1).

It involves the assessment of the symmetry of the anterior abdominal wall as well as the search for possible protrusions or retractions during cough or compression. As part of palpation, the hernia protrusion is examined in regard to anatomical relationship to the anterior abdominal wall. Occasionally, palpation may reveal multiple incisional hernias within a scar with fascial bridges in-between.



Fig. 1. Epigastric hernia

Sonography is a helpful diagnostic aid, particularly in small in non palpable hernias, or in obese patients, as it is non-invasive, time and cost-saving, readily repeatable, and practically risk-free.

Besides location and size, ultrasono-graphy allows the determination of hernial content, as well as excluding

important differential diagnoses such as lymphoma or hematoma. Important sonographic criteria for identifying hernias are: detection of a fascial gap (rectus diastase is as differential diagnosis), visualization of hernia content. Computerized tomography or magnetic resonance imaging are methods for complicated hernias or large abdominal wall defects and enable the visualization of internal hernia sac structures and the entire abdominal well as well as their relationship to intrabdominalorgans, Fig (2) .

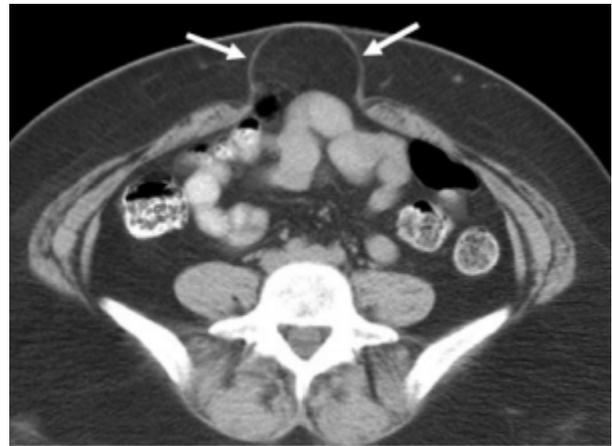


Fig. 2. CT abdomen showed ventral hernia

PATIENT AND METHODS

This study has been conducted in Aswan University Hospitals over a 12 month period between Aug 2016 and Aug 2017 on 30 consecutive patients underwent laparoscopic ventral hernia repair with mesh. These patients were divided: group A Fifteen patients did not have defect closure (non-closure group) and group B Fifteen patients with hernia defect closure and mesh reinforcement (closure group). The clinical diagnosis of ventral hernia was based on symptoms and signs elicited during clinical examination. All patients presented to us in the outpatient clinic. Non of the patients presented with an emergency of the hernia. Preoperative preparation for our laparoscopic hernial repair procedure is straightforward and focus on evaluation for fitness for surgery and an aesthesia and elimination of any evident underlying cause for hernia. Patients arrive at the hospital on the morning of surgery, after fasting from midnight. Immediately prior to surgery, patients receive prophylactic antibiotics. Upon admission, patients were fully examined, routinely investigated and prepared for laparoscopic ventral hernia repair with mesh. All patients were subjected to the following routine investigations: CBC (complete blood count), FBS (fasting blood sugar), Liver functions test, Kidney functions test, Coagulation profile, ECG for patients above 40 years of age and Chest X-ray for patients with chest complaints. The following data were collected for each patient: age, sex, body mass index (BMI), previous hernia repairs, American Society of Anesthesiologists (ASA) classification, size and location of the fascia defect, operative time, estimated blood loss, co-morbidities, length of hospital stay, complications, conversion rate, recurrences and follow-up. Patients age were included in the study from 26 to 55 years presenting with small and medium sized ventral hernias. Patients were capable of understanding and giving signed consent for laparoscopic treatment of ventral hernia.

Nocriteria were decided for selecting our patients to undergo the laparoscopic technique. On the other hand certain criteria

were decided to exclude particular patients from being operated upon laparoscopically, such as : Cardiopulmonary diseases (for fear of the effect of CO₂pneumo peritoneum and general anaesthesia, Large hernias, Recurrent hernias, Incisional hernias, complicated ventral hernia like incarcerated, obstructed, strangulated, infected and irreducible hernias, Severe liver disease .Two patients were complaining of asthmatic bronchitis but it was controlled by medical treatment preoperatively. On per-rectal examination revealed benign enlargement of prostate for one patient and managed urologically by medical treatment.

Preoperative preparation

Abdominal wall hair was shaved one hour before the operation ,patients were asked to void urine just before the operation, prophylactic antibiotic one gram of first generation cephalosporine was given one hour before the operation, and routine 8 hours preoperative fasting. Laparoscopic ventral hernia repair is usually performed under general anesthesia with muscle relaxation.

Non-closure group (group A)

All patient is placed in the supine position under general anesthesia with both arms tucked. If the hernia is in the midline, the surgeon can stand on either side of the patient, with the monitor directly opposite. If the hernia extends significantly to one side, initial trocar placement is done in the other side. Initially, the assistant stands on the same side as the surgeon, however, he may later have to change to the opposite side to help with dissection and stapling. A second monitor on the opposite side of the table is useful. After adequate general anesthesia was obtained, the abdomen was prepped and draped in the usual sterile manner. Pneumoperitoneum was established by veressneedle when possible or an open Hasson technique, or an optical trocar allowing view of the abdominal wall layers during penetration. The position of the trocars varied depending on the size, site and number of existing hernia defects. In general, two 5-mm and one 12-mm trocars were placed along the left lateral abdomen as shown in Fig.(3).



Fig. 3. Port placement

The whole anterior abdominal wall must be completely free from any adhesions, especially when there are multiple

incisions and the hernia contents reduced. One main advantage of the laparoscopic technique is the possibility of defining not only the clinically obvious fascial gap but also the beginning dehiscence of the original incision more or less adjacent to the primary defect. Limited adhesiolysis means losing this advantage. Adhesions near the bowel should be lysed with scissors without any energy source to prevent thermal injury Fig. (4).

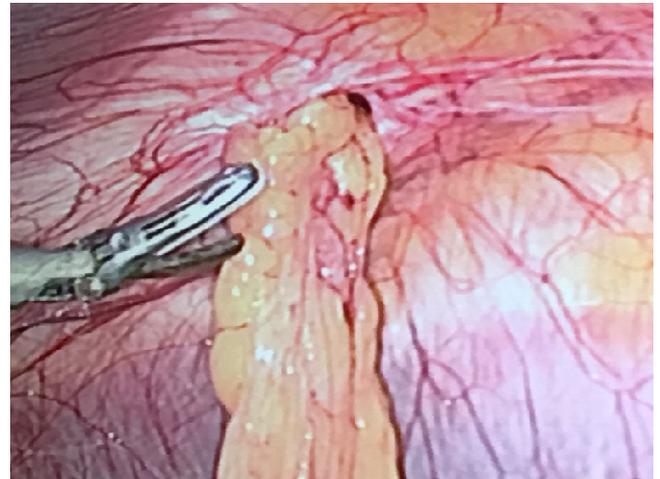


Fig. 4. Dissection of the omentum from the anterior abdominal wall

Only adhesions between the greater omentum and the abdominal wall may be severed with electrocautery or an ultrasonic scalpel. Regions covered with fatty tissue such as the flacciform ligament need to be cleared in order to provide secure fixation of the mesh and not to miss any fascial defects. The peritoneal sac is left in situ. After completion of the dissection, the hernia defect was measured, and a mesh chosen to overlap all margins of the defect by at least 3–5 cm. The periphery of the hernia defect is evaluated by direct vision and palpation and is marked on the abdominal wall skin with a marker. The carbon dioxide should be released prior to measurement, to show the true size of the hernia defect. The craniocaudal and lateral measurements are taken to define the size of the mesh. The surgeon should add 5 cm to these measurements in both directions, which provides a 3-cm overlap of the aponeurotic edges of the hernia by the mesh. After selection of the appropriate-sized mesh, 4 stay sutures were placed at four corners of the mesh and retrieved individually with a suture passer to provide fascial fixation of the mesh. The suture sites are numbered with a marker to allow easier orientation of the prosthetic mesh in the abdominal cavity Fig. (5). The tailored mesh is rolled tightly and inserted in the peritoneal cavity through the 12 mm trocar Fig. (6). It is unrolled inside the abdomen and spread under the defect. Two-mm skin incisions are made in the marked points on the abdominal wall. By Endoclose (Autosuture) inserted through each skin incision into the peritoneal cavity, the 2 ends of each suture are grasped and drawn outside through the skin incision by separate passages and at different angles. The suture ends are tied down extra corporeally and buried subcutaneously. The tacks are Placed at the margins of the mesh at 1-cm intervals. The suture anchorage at 4-cm to 5-cm intervals around the perimeter of the mesh to minimize the risk for mesh migration (Fig ,7 ,8).



Fig. 5. Rolling the mesh with to introduced to abdominal cavity



Fig. 8. Fixation of mesh with tucker



Fig. 6. Passing the rolled mesh through the lateral 12mm port



Fig. 7. Fixation of mesh with tucker

The trocars were removed under direct vision. In several cases, the 12-mm trocar was placed through the skin at the defect for mesh introduction. These sites were covered by mesh and, therefore, were not routinely closed. The fascia for any exposed 12-mm port site was routinely closed with 0-Vicryl suture; skin incisions were closed in subcuticular fashion.

Closure group

It was similar to the technique described above for nonclosure. The only difference was that we performed a primary approximation of the fascial edges of the hernia defect with polyester sutures prior to mesh placement using one of three techniques. (1) The hernia defect was closed percutaneously using a suture-passer (2) Intracorporeal defect closure was performed using a needle and standard laparoscopic needle drivers or (3) an Endo Stitch™ suturing device (Fig.9). Several interrupted Figure of eight sutures were placed, and then, tied with a knot pusher. After closing the defect primarily, an appropriately sized mesh was tailored to overlap all margins of the defect by 3–5 cm. Patients were examined postoperatively at 1 week, 3 months, 1 year, and thereafter as clinically indicated. Complete current follow-up was achieved in 30 patients (15 patients of non-closure group and 15 of closure group). Follow-up was achieved by reviewing medical records of clinic visits, and a structured phone interview performed by two reviewers. All patients with a minimum of 7-day follow-up were included in the analysis for follow-up results.

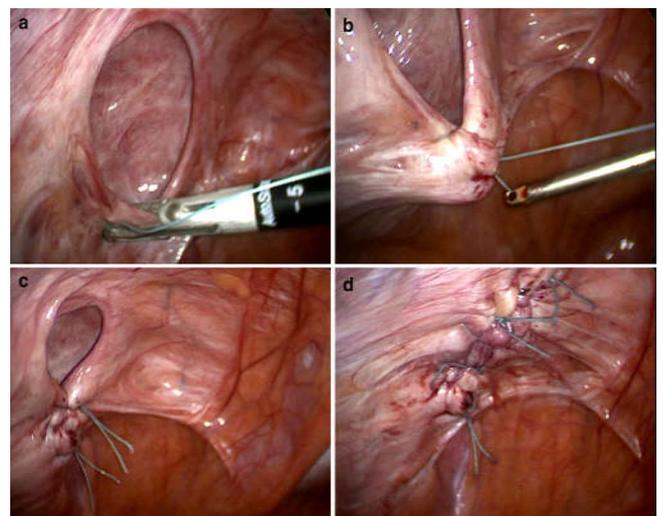


Figure 9. a. Intracorporeal defect closure using Endostitch suturing device. b. Intracorporeal defect closure using Endostitch suturing device. c. Intracorporeal defect closure using Endostitch suturing device. d. Intracorporeal defect closure using Endostitch suturing device

RESULTS

Between AUG 2016 and AUG 2017, 30 patients presented with ventral hernias. All cases were approached laparoscopic ally. We classified the patients into two different groups: Group A non-closure and Group B closure.

Table 1. Patient characteristics

	Group A		Group B	
Number	15		15	
Male	5	33.3%	2	13.3%
Female	10	66.7%	13	86.7%
Mean Age	30		35	
BMI	30		35	
ASA	2.3		2.24	

Patient characteristics

In the non-closure group (group A) there were 15 patients 5 males (33.3%) and 10 females (66.7%) Fig. (10,11). Mean age was 30 years (range 26–50). The average BMI was 30 (range 20–52). The average ASA was 2.3 (range 1–4).

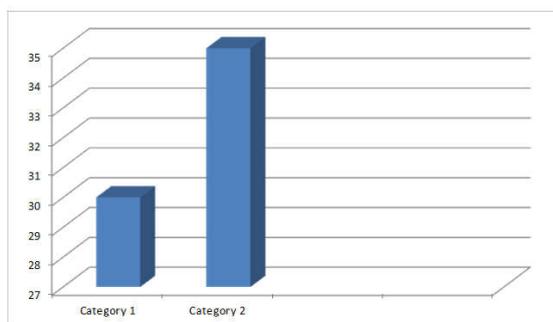
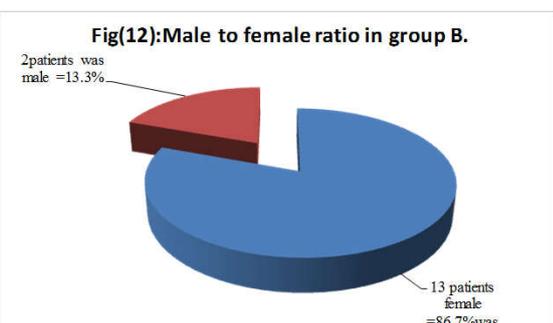
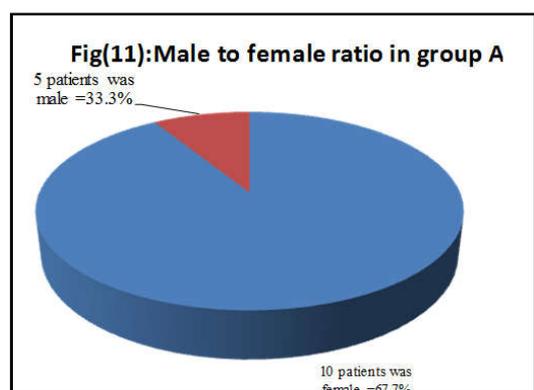


Fig. 10. The mean age for both group A and B

In the closure group (group B) there were 15 patients 2 males (13.3%) and 13 females (86.7%). Mean age was 35 years (range 27–55). The average BMI was 32 (range 21–71). The average ASA was 2.24 (range 1–4).Table (1),(Fig11,12).



Operative Time

Operative time was ranging between (65-110) minutes with a mean time 75 minutes for group B. The operative times were longer for Group B (closure group) than group A (For non closure group the mean operative time was 60 minutes) .The first 10 cases is longer due to early learning (110minutes) but with more experience the operative time is decreased Fig.(13).

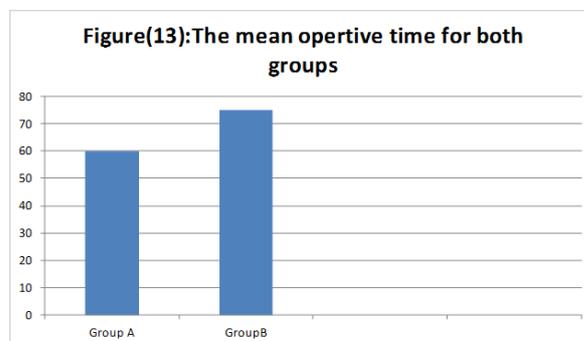
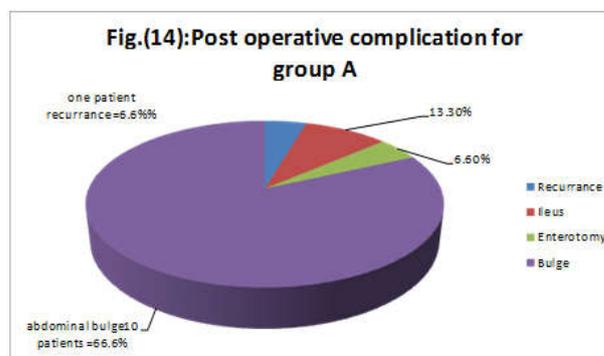


Table 2. Operative and post-operative complications

Complication	Non-closure	Closure
Bowel obstruction	-	-
Seroma	-	1
Recurrence	1	-
Ileus	2	2
Enterotomy	1	-
Respiratory distress	-	1
DVT	-	-
Wound infection	No	No
Bulging	10	No

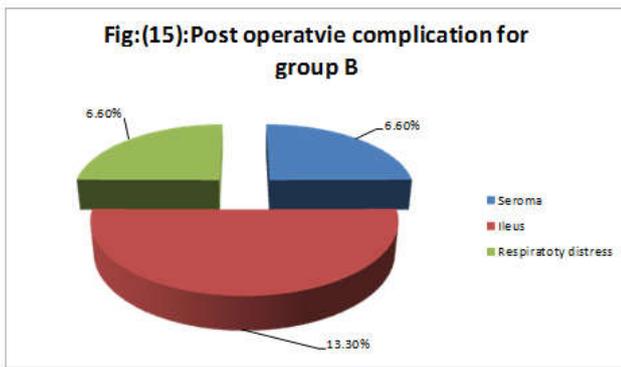
Operative Complications in group A

Accidental injury of small bowel had occurred in one patient by grasper, in spite of it the procedure was completed laparoscopic ally with repair of intestinal injury. One drain was left for this case and removed after 5 days. Recurrence had occurred in one patient (6.6%) may be due to small mesh or in complete fixation of it and appear after 6 months .ileus developed in 2 patients(13.3%)and treated with conservative treatment with IV fluids and NGT and improved later on 24 hours. The bulging appears post operative in 10 patients (66.6%) Fig (14) Table (2).



Operative Complications in group B

Ileus developed in 2 patients (13.3 %) and treated with conservative treatment and treated with conservative treatment with IV fluids and NGT and improved later on 24 hours.



Respiratory distress had occurred in one obese patient (6.6%) and treated with head up, O₂ mask and bronchodilators. Seroma developed in one patients (6.6%) after 3days and treated with U/S guided aspiration. No bulging appears in this group Table (2) (Fig,15).

Post-Operative Hospital Stay

It ranged from 24-48 hours with a mean of 30 hours. One patient stayed in hospital for five days due to intestinal injury. In both groups all patients discharged after two days 1-Oral feeding started after 6 hours post operative for all patients except five patients. 2-Mobilization: 30 patients were fully mobile and doing all activities after being fully conscious. 3-Pain: 20 patients suffer from mild pain (66.6% of the patients) and take single dose of injected analgesic, 5 patients suffer from moderate pain (16.6% of the patients) which response to double dose of injected analgesic, 5 patients suffer from sever pain (16.6% of the patients) but persistant pain, the patients take the non steroidal anti-inflammatory drugs for two weeks and then the pain resolved.

DISCUSSION

In the last deced, laparoscopy has become the gold standard procedure in many surgical operation. At the beginning of the 1990 laparoscopic hernia repair was controversial, because many studies reported an early recurrence rate as high as 25% (Wintringer, 2006). But now, after a decade of experience in laparoscopic hernia surgery, this method has gained worldwide acceptance and has become, in many centers, the first choice for hernia repair. In 2004, Franklin *et al.* reported their 11 years experience with laparoscopic ventral hernia repair. Their technique included primary closure of the defect before mesh fixation. Benefits included lower recurrence rate (2.9 %) and less operative and post operative complications (10.1 %) at a mean follow-up of 47.1 months (Franklin *et al.*, 2004). In 2011, some described intracorporeal technique of hernia defect closure using the Endo Stitch TM suturing device (Jorge, 2011). Several benefits have been reported with hernia defect closure. For example, have suggested that by closing the defect, especially large ones, the repair is stronger and more reliable. It has also been suggested that by approximating the fascial edges, a more physiologic restoration of abdominal wall function is achieved. Greater mesh overlap and better cosmesis has also been suggested (Jorge, 2011; Palanivelu *et al.*, 2007). A disadvantage cited with the laparoscopic “tension-free” technique without defect closure is a bulging the mesh bulges through the defect (Schoenmaeckers *et al.*, 2010; Tse *et al.*, 2010). The mesh can also come in contact with the skin, especially in larger defects.

Conversely, when the defect is closed, the mesh is never in contact with the skin because the abdominal wall muscle and fascia provide a physical barrier. This may also help prevent mesh erosion of the skin and subsequent infections (Palanivelu *et al.*, 2007; Agarwal *et al.*, 2008; Chelala *et al.*, 2007). Finally, a lower rate of wound and mesh infection with defect closure (Franklin *et al.*, 2004; Palanivelu *et al.*, 2007; Chelala *et al.*, 2007). Recurrence rate after laparoscopic ventral hernia repair are reported to range from 4.2 to 16.7 % (Pierce *et al.*, 2007; Heniford *et al.*, 2003; LeBlanc, 2005; Clapp *et al.*, 2012). Some Authors reported lower recurrence rates with defect closure from 0 to 2.9 (Franklin *et al.*, 2004; Palanivelu *et al.*, 2007; Agarwal *et al.*, 2008; Chelala *et al.*, 2007). We reported in our study of 15 patients described a laparoscopic sutured closure of the defect with mesh reinforcement and reported no recurrence during a mean follow-up of 12 months. We found in our study a recurrence rate was 6.6% in the non defect closure group. Some Authors have also considered disadvantages of closing the defect. Percutaneous sutures were associated with abdominal discomfort (up to 6 months after surgery), pain and neuralgia (Franklin *et al.*, 2004; Jagad, 2008). The pain may be due to fixation techniques, whether tacks, sutures or a combination, and how many of each all probably play a role.

Mesh fixation can be achieved using suture, tacks or a combination. In a meta-analysis, with tackers fixation associated with shorter operative time and less postoperative pain (Franklin *et al.*, 2004; Franklin *et al.*, 1988).we used a combination of tacks and sutures. At least four corners of the mesh were secured with transfascial sutures and then tacks were applied. In our study , rates of seroma formation about 6.6 % .We found a slightly higher incidence of seroma formation in the closure group due to the inability of the fluid collecting in the sac to drainback into the peritoneal cavity. Similar to Franklin *et al.* who reported rates of 15–20 % for seroma formation, in defect closure .Our results are encouraging and demonstrate the safety and feasibility of hernia defect closure. Operative times have been reported as “prolonged” when using transfascial or intracorporeal suturing. In Franklin’s study average OT of 68 min ⁽²¹⁾. Our operative times were prolonged in closure group with a mean of 60min in the non-closure group and 75 min in closure group.

In our study we confirm primary fascial closure during laparoscopic ventral hernia repair with mesh showed good results. When compared to the standard laparoscopic ventral hernia repair with mesh, primary fascial closure appears to yield lower rates of both hernia recurrence and clinical bulging. It also causes no increase in the SSI rate. Primary fascial closure is recommended for quality hernia repair (Agarwal *et al.*, 2008). Unlike groin hernias where the margins of repair are fixed structures and “tension-free” makes physiologic sense, the ventral abdominal wall exists under constant physiologic tension with mobile margins. Failure to return the abdominal wall to its normal anatomic position risks a nonfunctional abdomen (Franklin *et al.*, 2004). Primary fascia closure restores normal anatomy by reapproximating the abdominal wall under physiologic tension, which may restore its function and prevent bulging. Also, by eliminating the dead space, the incidence of seromas and wound complications may be decreased. Primary fascial closure using laparoscopic ventral hernia repair with mesh may decrease the hernia recurrence rate. Closing the fascial defect allows wider lateral mesh overlap, which may explain this finding

Use of laparoscopic techniques for hernia repair has lowered SSI rates and decreased the length of hospital stay. But many hernia repairs cannot be undertaken laparoscopically because of extensive adhesions, large hernia defects, and the level of contamination. Extracorporeal and intracorporeal closures of a defect have advantages and disadvantages. Extracorporeal suturing allows closure of large defects and complete desufflation of the abdomen while tying the sutures, minimizing tension on the suture line. However, percutaneous closure requires multiple punctures in the skin and may increase the risk of an SSI and suture granuloma. Not all ventral hernias are amenable for fascial closure during laparoscopic repair. Size plays a substantial role. For small defects, particularly Swiss-cheese type defects, fascial closure may not be warranted unless a single defect is large (3 cm wide) (Palanivelu *et al.*, 2007; Chelala *et al.*, 2007; Millennium Research Group, 2009). Closure of defects (6 to 10 cm) wide can be challenging. The largest defect reported being closed was 12 cm wide (Chelala *et al.*, 2007; Millennium Research Group, 2009). Although there is no accepted way to evaluate abdominal compliance and elasticity in the clinical setting, easily distensible abdominal walls are more amenable to primary fascial closure. Our study suggests that primary fascial closure in conjunction with laparoscopic ventral hernia repair appears promising, because it is safe and may provide superior outcomes with decreased recurrence rates, lower rate of seroma formation and bulging. Also, patients appear to be more satisfied with the results and have improved functional status compared to a bridged repair.

Conclusion

Laparoscopic ventral hernia repair with defect closure provides durable repair with low recurrence rate. We found in our study it is safe to close the defect. By avoiding mesh bridging, defect closure results in restoration of a functional and dynamic abdominal wall that may be more physiologic in nature.

REFERENCES

- Agarwal BB, Agarwal S, Mahajan KC 2008. Laparoscopic ventral hernia repair: innovative anatomical closure, mesh insertion without 10 mm transmyofascial port, and atraumatic mesh fixation: a preliminary experience of a new technique. *Surg Endosc* 23(4):900–905.
- Agarwal BB, Agarwal S, Mahajan KC. 2009. Laparoscopic ventral hernia repair: innovative anatomical closure, mesh insertion without 10-mm transmyofascial port, and atraumatic mesh fixation: a preliminary experience of a new technique. *Surg Endosc*. 23:900–5.
- Ahmed; D. Khan MJ. 1995. Use of mesh in the management of recurrent incisional hernias. *Pak. J. Surgery.*, 11: 101-02.
- Bencini L, Sanchez LJ, Bof fi B, Farsi M, Scatizzi M, Moretti R. 2003. Incisional hernia: repair retrospective comparison of laparoscopic and open techniques. *Surg Endosc.* 17:1546–51.
- Carbajo MA, Martin del Olmo JC, Blanco JI, de la Cuesta C, Toledano M, Martin F, Vaquero C, Inglada L. 1999. Laparoscopic treatment vs. open surgery in the solution of major incisional and abdominal wall hernias with mesh. *Surg Endosc.* 13:250–2.
- Chelala E, Thoma M, Tatete B, Lemye AC, Dessily M, Alle JL. 2007. The suturing concept for laparoscopic mesh fixation in ventral and incisional hernia repair: mid-term analysis of 400 cases. *Surg Endosc.*, 21:391–39528.
- Clapp ML, Hicks SC, Awad SS, Liang MK 2012. Transcutaneous closure of central defects (TCCD) in laparoscopic ventral hernia repairs (LVHR). *World J Surg.*, 37(1):42–51.
- DeMaria EJ, Moss JM, Sugerman HJ 2000. Laparoscopic intraperitoneal polytetrafluoroethylene (PTFE) prosthetic patch repair of ventral hernia: prospective comparison to open prefascial polypropylene mesh repair. *Surg Endosc.*, 14:326–329.
- Franklin M, Dorman J, Glass J, Balli J, Gonzalez J 1998. Laparoscopic ventral hernia repair. *Surg Laparosc Endosc.*, 8(4):294-299.
- Franklin ME, Gonzalez JJ, Glass JL, Manjarrez A 2004. Laparoscopic ventral and incisional hernia repair: 11-year experience. *Hernia* 8:23–27.
- Gut C, Qniu T, Mehrabi A and Buchler W. 2004. Fewer adhesions induced by laparoscopic surgery. *Surg Endosc*; 18:898-906.
- Heniford BT, Park A, Ramshaw BJ *et al.* 2003. Laparoscopic repair of ventral hernias: nine years' experience with 850 consecutive hernias. *Ann Surg* 238:391–399 (discussion 399–400).
- Heniford BT, Park A, Ramshaw BJ, Voeller G. 2003. Laparoscopic repair of ventral hernias: nine years' experience with 850 consecutive hernias. *Ann Surg.*, 238:391–9.
- Indani H, Sasaki H, Yashioka T, Asami S, Kurose Y, Nojima H, Muro M, Yamashita T, Hirata M, Kumano K and Kin H 2009. Laparoscopic ventral hernia repair has an advantage of detecting occult hernia defects. *Surg Endosc*; 23:P454.
- Jagad RB 2008. Laparoscopic ventral hernia repair: a new method for fixation of the mesh with sutures. *Surg Laparosc Endosc Percutan Tech* 18(3):277–279.
- Jorge I, Maciel VH, Lujan H. 2011. New technique for fascial defect approximation during laparoscopic ventral hernia repair with mesh. Abstract-Emerging Technology Session SAGES Annual Meeting.
- LeBlanc KA 2005. Incisional hernia repair: laparoscopic techniques. *World J Surg* 29:1073–1079.
- LeBlanc KA, Booth WV. 1993. Laparoscopic repair of incisional abdominal hernias using expanded polytetrafluoroethylene: preliminary findings. *Surg Laparosc Endosc* 3:39–41
- Lomanto D, Iyer SG, Shabbir A, Cheah WK 2006. Laparoscopic versus open ventral hernia mesh repair: a prospective study. *Surg Endosc* 20:1030–1035
- Lomanto D, Iyer SG, Shabbir A, Cheah WK. 2006. Laparoscopic versus open ventral hernia mesh repair: a prospective study. *Surg Endosc.* 20:1030–5.
- Mensching J and Musielewicz A 1996. Abdominal wall hernias. *Emerg med clin north am* 14(4): 793-56.
- Millennium Research Group 2009. US markets for soft tissue repair. Millennium Research Group, Inc., Toronto.
- Moulhas A, Podalsky E, Curcello P *et al.* 2009. Single port access ventral hernia repair. *Surg Endosc*; 23:S094.
- Muysoms FE, *et al.* 2009. Classification of primary and incisional abdominal wall hernias. *Hernia*. 13(4):407–14.
- Novitsky YW, Cobb WS, Kercher KW, Matthews BD, Sing RF, Heniford BT. 2006. Laparoscopic ventral hernia repair in obese patients: a new standard of care. *Arch Surg.* 141:57–61.
- Olmi S, Scaini GC, Erba L, Croce E. 2007. Laparoscopic versus open incisional hernia repair. *Surg Endosc.*, 21:555–559.

- Palanivelu C, Jani KV, Senthilnathan P *et al.* 2007. Laparoscopic sutured closure with mesh reinforcement of incisional hernias. *Hernia* 11:223–228.
- Pierce RA, Spitler JA, Frisella MM *et al.* 2007. Pooled data analysis of laparoscopic versus open ventral hernia repair: 14 years of patient data accrual. *Surg Endosc* 21:378–386
- Ramshaw BJ, Esartia P, Schwab J, Mason EM, Wilson RA, Duncan TD, Miller J, Lucas GW, Promes J. 1999. Comparison of laparoscopic and open ventral herniorrhaphy. *Am Surg.* 65:827–31. discussion 831–822.
- Sajid MS, Bokhari SA, Mallick AS, Cheek E, Baig MK. 2009. Laparoscopic versus open repair of incisional/ventral hernia: a meta-analysis. *Am J Surg.*, 197:64–724.
- Santora TA, Roslyn JJ 1993. Incisional hernia. *Surg Clin North Am* 73:557–570
- Schoenmaeckers E, Wassenaar EB, Raymakers JT, Rakic S. 2010. Bulging of the mesh after laparoscopic repair of ventral and incisional hernias. *J Society Laparoendosc Surg* 14(4):541–546.
- Stoppa RE. 1989. The treatment of complicated groin and incisional hernias. *World J Surgery.*, 13: 545–54.
- Stylopoulos N and Rattner D 2005. The history of hiatal hernia surgery from bowditch to laparoscopy. *Ann Surg*; 15:185–193.
- Tse GH, Stutchfield BM, Duckworth AD, de Beaux AC, Tulloh B. 2010. Pseudo-recurrence following laparoscopic ventral and incisional hernia repair. *Hernia* 14(6):583–587.
- Wintringer A 2006. Total extraperitoneal hernia repair after radical prostatectomy or previous abdominal surgery, *Surg Endosc* (20) 473–476.
