Laparoscopic Transabdominal Preperitoneal Repair of Ventral Hernia: A Step Towards Physiological Repair

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Abstract The laparoscopic ventral hernia repair with preperitoneal placement of mesh minimizes the complications related to the intraperitoneal position of mesh and fixating devices. It allows safe use of conventional and less expensive polypropylene mesh. The prospectively collected data of 68 patients who underwent laparoscopic transabdominal preperitoneal mesh hernioplasty, for different types of ventral hernias between January 2005 and December 2009 was retrospectively reviewed. The study included 68 patients, 16 males and 52 females with a mean age 51.1 ± 11.1 years (range 23–74 years). Most of the hernias (67.6%) were in the midline position. The mean size of the defect was 30.8 ± 24.4 cm² (range, 4–144 cm²) and the mean mesh size was 237.8 ± 66.8 cm² (range, 144–484 cm²). The mean operating time was 96.7 ± 16.7 min (range 70–150 min). All repairs were done with polypropylene mesh. The mean postoperative hospital stay was 1.5 ± 0.6 days (range, 1–4 days). Nineteen patients (27.9%) suffered from postoperative complications. Four patients (5.8%) were detected to have seroma formation. There were two recurrences (2.9%). The mean follow up was 22.7 ± 13.4 months (range, 6–48 months). The laparoscopic preperitoneal ventral hernia repair with polypropylene mesh is cheaper and has acceptable postoperative outcomes. Peritoneal coverage of the mesh not only acts as a barrier between mesh and bowel and thereby prevents adhesions, it also provides an additional security of fixation. This is a safe and feasible option of ventral hernia repair in expert hands.

However, for proper validation of these conclusions a long term prospective clinical trial is required.

Keywords Laparoscopy · Preperitoneal · Ventral hernia · Polypropylene

Introduction

“Hernia repair remains a challenge” – this is an old statement made by Bilioth 150 years ago. Since then, tremendous advances have taken place in the field of hernia surgery. Several methods of ventral hernia repair have been practised from conventional suture repair to open tension-free mesh repair methods, but with suboptimal results. Recurrence rates, after conventional suture repair, range from 24% to 54% [1–4], whereas tension-free repair mechanism with prosthetic mesh has lowered the recurrence rate up to 10%–24% [2, 3]. Extensive dissection of soft tissue is required for mesh placement and is also associated with high rate of wound-related complications (18%–27%) [5]. These drawbacks are reduced by minimal invasive approach which causes minimum trauma to the abdominal wall and lowers the recurrence rate to 2–5% [4]. Laparoscopic repair is based on techniques of open preperitoneal repair by Stoppa [6] and Rives [7]. In 1993, LeBlanc and Booth [8] first described laparoscopic incisional hernia repair with placement of intra-abdominal mesh posterior to the abdominal wall followed by suture fixation. However, laparoscopic intraperitoneal placement of prosthetic mesh is associated with adhesion formation, bowel obstruction and enterocutaneous fistula. These complications are more common with polypropylene mesh and are statistically significant when compared with expanded polytetrafluoroethylene (ePTFE) [4, 9] or barrier

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meshes [10]. Using a barrier mesh, instead of polypropylene mesh, lowers these risks, but increases the cost of the procedure considerably. Preperitoneal retromuscular positioning of polypropylene mesh results in negligible adhesion formation because the peritoneum acts as a natural barrier between the bowel and the mesh resulting in low postoperative complications [11]. It is also far less expensive than the barrier mesh.

Laparoscopic preperitoneal mesh implantation usually follows the current principle of hernia surgery, and is based on the sound physiological principle of diffusing the total intra-abdominal pressure on each square inch of the implanted mesh [12]. It ensures immediate firm fixation of the mesh to the abdominal wall with the intra-abdominal pressure exerted via the peritoneal envelop [13]. The tissue ingrowth is expected to be more extensive than the mesh in the intra-abdominal position. These advantages have an effect on the major surgical outcomes in laparoscopic preperitoneal ventral hernia repair [14].

We present our experience of laparoscopic preperitoneal ventral hernia repair with polypropylene mesh and discuss the feasibility, technical aspects, complications and the outcomes.

Materials and Methods

A single surgical team, led by the second author, performed laparoscopic preperitoneal mesh placement for 68 patients with different types of ventral hernias, between January 2005 and December 2009, at the Department of Minimal Access and Bariatric Surgery, ILS Hospital, Kolkata India. For each patient, demographic, preoperative, and postoperative data were prospectively maintained on a Microsoft office Excel file. The authors retrospectively reviewed these data, and the outcomes were recorded.

Surgical Technique

All operations were performed under general anaesthesia. Patients were placed in a supine position. The arm on the side of surgeon was tucked by the side of the patients and the other arm kept free for intravenous access. A single dose of third-generation cephalosporin was administered at the time of induction of anaesthesia. The patients were catheterised after the anaesthesia was induced. Pneumoperitoneum was established with a veress needle placed in a virgin area at least 10 cm from the defect margin, mostly in the left hypochondrium. A 5-mm port was placed at that site and a 5-mm 30° telescope was used for initial visualisation of the peritoneal cavity. Subsequent ports, one 10 mm and another 5 mm were placed under vision, following the principle of triangulation. The 10-mm port was positioned in between the two 5-mm ports and it

subsequently acted as the optical port. The positions of the surgeon, assistant, scrub nurse and the monitor were according to the location of the hernia defects (Fig. 1).

All abdominal wall adhesions were divided with ultracision scalpel and the contents of the hernial sac were reduced. A curvilinear incision was made over the peritoneum at least 5 cm away from the margin of the fascial defect. For midline periumbilical defects, true preperitoneal dissection involves a substantial risk of perforation of the peritoneum. Hence, in the case of these defects, the incision was deepened up to the retrorectus level, and a retromuscular plane anterior to the posterior rectus sheath was developed (Fig. 2). Below the arcuate line, the peritoneum is thick and fat-laden, so creating a preperitoneal space is easy.

The sac was carefully freed from adhesions by sharp dissection at the fascial defect margin. Once this was done, it was easy to pull the remaining portion of the sac from the superficial subcutaneous fascia. When complete reduction of the sac was not possible, an incision was made over the neck of the hernia, leaving a circular opening in the peritoneum that was subsequently closed by an intra-corporeal polyglactin suture.

The peritoneal dissection was carried out till 5 cm beyond the margin of the hernial defect, except for the suprapubic hernia where dissection was extended down up to the pubic bone exposing bilateral Cooper's ligaments. An appropriate-sized polypropylene mesh was chosen, allowing at least 5-cm overlap on all sides. The mesh was folded exactly into half and a stay-suture was made in the centre of the mesh so as to make it coincide with the centre of the hernial defect. The mesh was rolled along its long axis and introduced through the 10-mm port with a pair of grasping forceps. It was unrolled in the preperitoneal space

Fig. 1 Port position and OT set-up. **a.** Port position for lower midline incisional hernia, **b.** Port position for periumbilical hernia. U–Umbilicus, S–Surgeon, M–Monitor, D–Defect, O–10-mm optical port, RW–5-mm right hand working port, LW–5-mm left hand working port

Fig. 2 Completion of retromuscular plane dissection

and fixed onto the abdominal wall with helical tacks (Protack; Autosuture, Tyco Health care, United States Surgical, Norwalk, CT, USA) as well as with the intracorporeal 2–0 polypropylene sutures. For suprapubic hernia, the lower margin of the mesh was fixed with the posterior pubis and Cooper's ligament bilaterally. For subcostal defects, the upper margin of the mesh was fixed to the intercostal ligaments by intracorporeal sutures. Transfascial sutures were not done. Reperitonealisation was done by continuous intracorporeal suturing of the peritoneal flaps with 2–0 polyglactin suture (Fig. 3). A pressure dressing was applied over the operated area and left on for 5 days.

Oral intake of food began on postoperative day 1. Patients were followed up after 1 week, 1 month, 3 months, 6 months, 1 year, 2 years, 3 years and 4 years of operation. Follow-up of all the patients was also attempted through a telephonic conversation during the course of data compilation.

Results

This study included 68 patients. Forty-six patients (67.6%) had incisional hernia, of which 3 patients had recurrent incisional hernia and 22 (32.3%) patients had primary ventral hernia. The hernia in most cases (67.6%) was in the

Fig. 3 Reperitonealisation by 2–0 polyglactin continuous suture

midline position. There were 16 males and 52 females (M:F ratio 1:3.25) with a mean age of 51.1 ± 11.1 years (range: 23–74 years), mean body mass index of 30.2 ± 3.0 kg/m² (range: 23.5–37 kg/m²) and mean American Society of Anesthesiologists' score of 1.9 ± 0.7 (range: 1–3) (Table 1). Co-morbidities such as chronic obstructive pulmonary disease, diabetes, hypertension, and hypothyroidism were present in 38.2% of the patients. The mean size of the defect was 30.8 ± 24.4 cm² (range: 4–144 cm²) and the mean mesh size was 237.8 ± 66.8 cm² (range: 144–484 cm²). The mean operating time was 96.7 ± 16.7 min (range: 70–150 min). All repairs were done with polypropylene mesh. Of the patients, a 55-year-old female had a 144-cm² defect just above the left iliac crest that had developed after taking a bone graft, and the defect was set right by placing a 484-cm² polypropylene mesh in the preperitoneal space. There were no major intraoperative complications. One of the patients had inferior epigastric vessel injury that was controlled by clip-application. Two patients had small bowel serosal tears that occurred while separating the adherent bowel from the hernial sac and were treated by 3–0 polyglactin intracorporeal sutures. The mean postoperative hospital stay was 1.5 ± 0.6 days (range: 1–4 days) and 27.9% of the patients suffered from postoperative complications. Postoperative pain was assessed with a visual analogue scale; the mean score on postoperative day 1 being 5.1 ± 0.9 (range: 3–7) and on postoperative day 30

Table 1 Patient characteristics

Parameters	Value
Age (yrs.) (Mean±SD)	51.1±11.1
BMI(kg/m ²) (Mean±SD)	30.2±3.0
ASA Score (Mean±SD)	1.9±0.7
I. Incisional hernia	46(67.6%)
Lower midline	20
Upper midline	3
Pfannenstiel incision-	
Lateral defect	3
Medial defect	2
Gridiron incision	4
Kocher's incision	3
Pyelolithotomy incision	2
Umbilical port site hernia	3
Drain site hernia	2
Infraumbilical recurrent incisional	3
Miscellaneous	1
II. Primary ventral hernia	22(32.3%)
Umbilical & paraumbilical	11
Spigelian	6
Epigastric	4
Lumbar	1

being 1.7 ± 0.7 (range: 0–3). Operative details and outcomes are mentioned in Table 2. One patient developed considerable prolonged pain of more than 8-week duration at the site of tack, and the condition was managed with a combination of opioid and nonopioid analgesics without the removal of the tack. Three elderly male patients developed urine-retention conditions after removal of the urinary catheter on postoperative day 1. All patients began their oral intake of food on postoperative day 1, except for two patients who had prolonged ileus lasting for 72–96 h and were managed conservatively. There was no instance of mesh infection. Three patients had port-site infection, which was managed with dressings and antibiotics. Four patients (5.8%) were detected to have seroma formation in the early postoperative period. All patients were managed conservatively and the seroma disappeared within 8–12 weeks. One patient had haematoma formation, anterior to the mesh, detected in the first postoperative week on ultrasound imaging. It was treated with needle aspiration, compression bandage and antibiotics. There were two recurrences (2.9%) which happened between the first and second years of follow-up. Both the recurrences were noticed in a site away from the initial defect. Both the patients opted for the surgery to be performed again, at a different hospital. The mean follow-up duration was 22.7 ± 13.4 months (range: 6–48 months). Of the total patients, 17.6% were lost to follow-up between the first and fourth years.

Table 2 Operative details and outcomes

Parameters	Value
I. Operative details	
Fascial defect size (cm ²) (mean±SD)	30.8±24.4
Mesh size (cm ²) (mean±SD)	237.8±66.8
Operating time (mins.) (mean±SD)	96.7±16.7
II. Outcomes	
Intraoperative bleeding	1(1.4%)
Viscus injury (serosal tear)	2(2.9%)
Pneumonia	0
Urinary retention	3(4.4%)
Prolonged ileus	2(2.9%)
Deep vein thrombosis	0
Seroma formation	4(5.8%)
Hematoma formation	1(1.4%)
Port site infection	3(4.4%)
Mesh infection	0
Intraabdominal sepsis	0
Recurrence of hernia	2(2.9%)
Prolonged pain	1(1.4%)
Post op. hospital stay (days) (mean±SD)	1.5±0.6
Follow up (months) (mean±SD)	22.7±13.4

Discussion

Ventral hernia is a frequently encountered complication following open abdominal surgery. The incidence varies between 2% and 20% [15, 16].

Repair of incisional hernia has been a challenging surgical problem for years. Several operative techniques have evolved ranging from conventional direct suture closure and tension-free mesh repair of the defect to recently developed laparoscopic mesh hernioplasty. The operative technique of open suture repair is associated with high incidence of recurrence compared to open tension-free mesh hernioplasty. It has been shown that the latter results in a better long-term outcome [1, 4].

LeBlanc and Booth [8] first described the laparoscopic repair of incisional hernia in 1993. Since then, it has been gaining popularity, as it avoids long incision and extensive dissection for mesh placement.

Currently, laparoscopic repair with prosthetic mesh is rapidly becoming the gold standard for treating ventral hernia, with 4.7% recurrence rate reported by Cobb et al. [17].

Laparoscopically, ventral hernia repair is done by placing the mesh in either the preperitoneal (retromuscular) space or in the intraperitoneal on-lay position. The placement of a large mesh in the preperitoneal space allows an even distribution of forces along the surface area of the mesh, which may account for the strength of repair and the decreased recurrence rates associated with it [5].

In intraperitoneal mesh placement, the direct contact of mesh with the abdominal contents cannot be avoided. The mesh acts like a foreign material to the abdominal contents and incites inflammatory reaction and adhesion formation [18].

Severity of mesh-related complications depends on the position of the mesh in relation to the abdominal wall [19]. Intense inflammatory reaction leading to adhesion formation, chronic pain [20], intestinal obstruction [20, 21], and enterocutaneous fistula [5] have been observed when polypropylene mesh is used as intraperitoneal on-lay for ventral hernia repair. This also makes surgery in the future difficult [22]. However, in the study by Vrijland et al [23], the association between enterocutaneous fistula and intraperitoneal polypropylene mesh placement was not noted.

Halm et al [24] examined the impact of mesh position on the outcomes in 66 patients who underwent ventral hernia repair and also required a subsequent laparotomy. Compared to patients with preperitoneal mesh repair, patients with intraperitoneal mesh repair had higher perioperative complications (76% vs. 29%), more intra-abdominal adhesions (62% vs. 26%), and fistula (5% vs. 0%), and required more bowel resection (20% vs. 0%). It should be noted that 93% of these patients had an unprotected polypropylene mesh placed during their initial ventral hernia repair.

The intra-abdominal use of ePTFE mesh has significantly reduced risk of these complications as it incites a limited inflammation and foreign-body response [25]. However, risk of adhesion and fistula formation is not completely eliminated because recently a case of enterocutaneous fistula formation associated with ePTFE mesh has been reported [9].

Luijendijk et al [3] stated that neither experimental nor clinical studies have provided conclusive information on the efficacy of interposition of polyglactin mesh in preventing adhesion formation and subsequent complications.

Arnaud et al [26] demonstrated that Parietex™ composite mesh (polyester mesh with reabsorbable collagen barrier) had fewer visceral adhesions when compared to an unprotected polyester mesh (18% vs. 77%). In a similar study, Balique et al. [27] reported that Parietex™ resulted in an ultrasonic adhesion-free abdomen in 86% of patients at one year].

In intraperitoneal placement, barrier meshes have a definite advantage over polypropylene meshes as they cause fewer adhesions to underlying viscera and low risk of fistula formation. The major disadvantage is their cost. These expensive meshes for hernia repair are far from the reach of majority of the patients, so a low-cost option in the form of preperitoneal repair with polypropylene mesh is suggested.

In their experimental study, Diaz-Pizarro Graf et al [28] demonstrated that the laparoscopic transabdominal preperitoneal approach to place a polypropylene mesh in a swine model for ventral hernia repair was not only technically feasible but also showed that there was less formation of adhesion with the mesh (88.81% vs. 27.27%, $p=0.032$) and less interloop adhesion formation (81.81 vs. 9.09% $p=0.003$). Macroscopically, these adhesions are less firm when the mesh is placed preperitoneally rather than intraperitoneally ($p=0.001$). They also demonstrated that preperitoneal polypropylene mesh induces fibrous reaction by direct contact with the muscle fibres and enhances the integration of prosthetic material with the adjacent tissue reinforcing the mesh fixation and its strength.

Similarly, Chowbey et al [29] demonstrated that preperitoneal placement of a polypropylene mesh is technically feasible and appears to have an advantage over laparoscopic intraperitoneal mesh placement for incisional hernia in selected patients.

Fixating devices such as spiral tacks or even sutures when placed intraperitoneally are likely to cause adhesions or erosion into the bowel, which cause fistulisation [30, 31]. In this study, spiral tacks and intracorporeal sutures were used to fix the polypropylene mesh to the abdominal wall that along with the mesh were covered by peritoneal flaps at the end of the procedure, and tacks-related complications were not encountered with.

One of the disadvantages of preperitoneal approach is longer operative duration required in dissection and the development of retromuscular plane for mesh placement. There is a slight

possibility of inferior epigastric artery injury during the development of planes, hence, the risk of postoperative haematoma formation is slightly high. In this study, one patient (1.44%) developed haematoma in postoperative period and was treated conservatively. Postoperative haematoma is not observed in many intraperitoneal on-lay mesh placement cases, it has been reported in 1%–15% of patients [32, 33].

Laparoscopic ventral hernia repair has been shown to have fewer postoperative wound complications, shorter hospital stay, minimal postoperative pain, early return of bowel function and faster resumption of normal activities than open ventral hernia repair has shown to have [32, 34].

In the present study, the mean postoperative hospital stay was 1.5 ± 0.6 days and the overall rate of postoperative complication was 27.9%. These findings are supported by other studies of laparoscopic intraperitoneal on-lay mesh repair in which mean hospital stay was between 1.25 and 1.5 days and the rate of postoperative complications was between 14% and 18% [33, 35].

The most frequently reported complication of laparoscopic ventral hernia repair is seroma formation. Most of the seromas develop anterior to the mesh and within the retained hernial sac. The mean incidence of seroma is 11.4%, in a range of 4 to 8 weeks, in the large reported series [4]. In the largest multi-institutional trial, seromas that were clinically apparent more than 8 weeks postoperatively were considered a complication, and they occurred in 2.6% of the patients [36].

In this study, the rate of seroma formation was 5.8% in the early postoperative period and the condition resolved after 8–12 weeks with conservative management. During the dissection of preperitoneal/retromuscular spaces, most of the hernial sacs were either totally dissected down or in case where the sac was tethered to scarred tissue, partial dissection of the sac was performed. A compression bandage was routinely applied at the hernia repair site for at least 5 days. The low incidence of seroma formation was probably due to these two reasons.

In this study, two (2.9%) patients developed hernia again. Similar recurrence rate was reported by Chowbey et al. [29] in their series which included 34 patients who underwent ventral hernia repair with extraperitoneal mesh.

Conclusions

The results of this study show that preperitoneal repair of ventral hernia is feasible and safe when performed by experts. The preperitoneal placement of the mesh not only avoids the direct contact of the prosthesis with viscera, but also provides additional security of fixation and, thus, minimises their complications. It allows safe use of conventional and less expensive polypropylene mesh which has high intrinsic tensile strength and good memory.

This study included a small cohort and had a shorter follow-up, although the recurrence rate and morbidities were low. However, for proper validation of these conclusions a long-term prospective clinical trial is required.

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