



Application of the novel enhanced transabdominal preperitoneal (ETAP) technique for laparoscopic suprapubic incisional hernia repair

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Abstract

Suprapubic incisional hernia is a special type of incisional hernia, the optimal choice of surgery for which remains controversial. Inspired by advantages of laparoscopic incisional hernia repair and inguinal hernia repair, we developed a novel laparoscopic surgery procedure for suprapubic incisional hernia repair: the enhanced transabdominal preperitoneal (ETAP) technique. To create a peritoneal flap, the peritoneum was dissected from 2 cm above the abdominal wall defect to 2 cm below the pubic arch, then the hernia defect was closed with a full-thickness transabdominal suture. Following the position of mesh to cover the defect with an 5-cm overlap on all sides, the peritoneal flap was closed with continuous suture. In this study, a total of 57 patients with suprapubic incisional hernia underwent laparoscopic ETAP. The mean hernia size was 61.5 cm², the average mesh size was 173.6 cm², the mean operating time was 90 min, the mean blood loss was 34 cc, and the average hospital stay was 2.6 days. In the follow-up period, which ranged from 12 to 45 months, the overall incidence of complications was 17.86%. Six patients developed seroma without herniation, six patients suffered from obvious postoperative pain, and four patients experienced urinary retention. All complications resolved without treatment. No recurrence was observed. In conclusion, the laparoscopic ETAP technique contributes to reduced rates of suprapubic incisional hernia repair and mesh-induced complications.

Keywords Suprapubic hernia · Laparoscopic repair · Transabdominal preperitoneal

Introduction

Incisional hernia affects approximately 20% of patients with a history of laparotomy and remains one of the major common and disappointing complications in this group of patients [1]. Furthermore, this type of hernia recurs in 63% of these patients after primary repair [2]. Suprapubic hernia is a term that describes a special type of incisional hernia in which a ventral incisional hernia occurs less than 3 cm above the pubic arch in the midline [3]. Suprapubic hernia usually occurs due to the low mid-line, Maylard, Pfannenstiel or Cherney incisions, which are used in gynecological, rectal and prostatic surgeries [3–6]. The incidence of

suprapubic hernia is low, and the exact incidence has not been reported thus far. Due to the low incidence, limited experience remains the main obstacle regarding the selection of surgical methods and successful treatment [6]. Thus, there is an urgent need for a further study.

The key to a successful repair depends on a comprehensive and detailed understanding of the anatomic structure near the suprapubic hernia. The urinary bladder, bony, neural and vascular structures are located near this type of hernia [7], which makes it difficult to dissect and hence makes the repair a formidable operation. Also, inadequate dissection may prevent the hernia defect from being fully sutured and may make it difficult to achieve sufficient mesh coverage. In addition, the insertion of the abdominal oblique aponeurosis, rectus abdominus musculature and rectus sheath into the symphysis pubis [8] makes up a relatively weak area—the musculotendinous area—and increases the possibility of hernia formation. Furthermore, the reality of difficult fixation of mesh to pubic bones elevates the risk of recurrence of suprapubic hernia [9]. Nowadays, controversy still exists regarding the optimal repair of this special type of

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hernia. With the rapid development of laparoscope technology, traditional open surgery approaches are less frequently applied in hernia repair. However, mesh-induced complications, such as intestinal adhesion, intestinal obstruction, enterocutaneous fistula and mesh erosion into the abdominal viscera [10], can occur in repairs using the intraperitoneal onlay mesh (IPOM) or transabdominal partial extraperitoneal (TAPE) techniques, even though a special coating is applied to cover the mesh. This adhesion and erosion can cause a surgical nightmare. Taken together, laparoscopic repair of the suprapubic hernia requires imperative improvements.

In this study, we draw lessons from previous experience and present a novel laparoscopic technique for suprapubic hernia repair: the enhanced transabdominal preperitoneal (ETAP) technique. The closure of the hernia sac with a full-thickness transabdominal suture and the completely preperitoneal placement of a self-gripping mesh contribute to reduced rates of recurrence and mesh-induced complications.

Materials and methods

A retrospective study of 57 patients who underwent suprapubic incisional hernia from January 2013 to January 2018, who underwent laparoscopic ETAP in the department of gastrointestinal surgery of Henan Province People's Hospital, was conducted. Incisional hernia located less than 3 cm above the pubic arch in the midline was classified as suprapubic hernia. The clinical data, including patient demographics, number of previous repairs, number of previous abdominal operations, number of hernias, defect diameter, mesh size, complications and recurrence were retrospectively reviewed. The patients were followed up every 3 months.

All operations were conducted by one surgeon at our hospital. The patients were escorted to the gastrointestinal surgery floor, and were discharged as soon as they were able to tolerate a general diet and gain adequate pain control. In the follow-up examinations, postoperative pain, seroma, scar-related sequelae and recurrence were evaluated. Abdominal CT was advised for patients with suspected recurrence. Written informed consent was obtained from all subjects before their enrolment in the study. The project was approved by the Ethics Committee of Henan Province People's Hospital.

Surgical technique

All patients were placed in the dorsal position under general anesthesia. Pneumoperitoneum was established by the introduction of a Veress needle at the midpoint of the left costal arch. The first port was placed to the left of the median

epigastrium, then the laparoscope was inserted for exploration of the abdominal cavity. Another two ports were placed in the lateral abdominal wall, far from the hernia defect, to provide a good view, assess the defect and perform intestinal adhesiolysis. When the enterolysis was performed, it is reasonable to avoid intestinal damage and preserve the peritoneal integrity as much as possible. The hernia sac was exposed, and the sizes of abdominal wall defect and the distance from the inferior margin of the hernia to the pubic arch were measured with a thin plastic metric ruler inside the abdominal cavity (Fig. 1a). In cases in which the distance above the pubic arch was less than 3 cm, laparoscopic ETAP repair was performed. A horizontal peritoneal incision approximately 2 cm above the defect was made with cautery scissors to create a peritoneal flap. The peritoneum was dissected both by blunt and sharp dissection. In this process, we continually assessed the skin plane and peritoneum to prevent damaging the peritoneum and going through the skin. The bladder was bluntly moved to 2 cm underneath the inferior edge of the pubic arch after instillation of approximately 250 ml of saline. The flap was extended bilaterally to the lateral umbilical folds and down to more than 2 cm below the inferior edge of the pubic arch (Fig. 1b). At the end of dissection, the pubic symphysis, Cooper's ligaments and iliac vessels were exposed directly. Special attention should be paid to the pubis and Cooper's ligament because of their close vicinity to neurovascular structures. A 2-mm incision was made in the midline of the hernia sac, and the hernia sac was repaired with full-thickness transdermal sutures by pre-tied 1–0 prolene suture thread (Fig. 1c). We then reduced the pneumoperitoneum pressure, tied up the suture and closed the defect (Fig. 1d). A self-gripping mesh (TEM1515G, Medtronic, USA) was introduced through a 10-mm port and spread inside the abdomen. The peritoneal flap was confirmed to create enough space to cover the defect for the mesh, the lower edge of which was inserted 2 cm below the inferior edge of the pubic arch. The self-gripping mesh was held up against the anterior abdominal wall by the pneumoperitoneum pressure (Fig. 1e). The titanium helical tacks were used to reinforce the mesh every 1 cm with the double-crown technique. Finally, the peritoneal flap was closed with V-loc sutures (Fig. 1f). All patients were required to apply a compression bandage for 3–6 months.

Results

A total of 57 patients (mean age, 51.0 years [range 34–71 years], mean body mass index [BMI], 30.8 kg/m² [range 22–48 kg/m²]; male, *n* = 21; female, *n* = 36) were included in our study. Most patients were overweight or obese. Previous surgeries are listed in Table 1. None of the patients had a history of multiple previous surgeries. Among

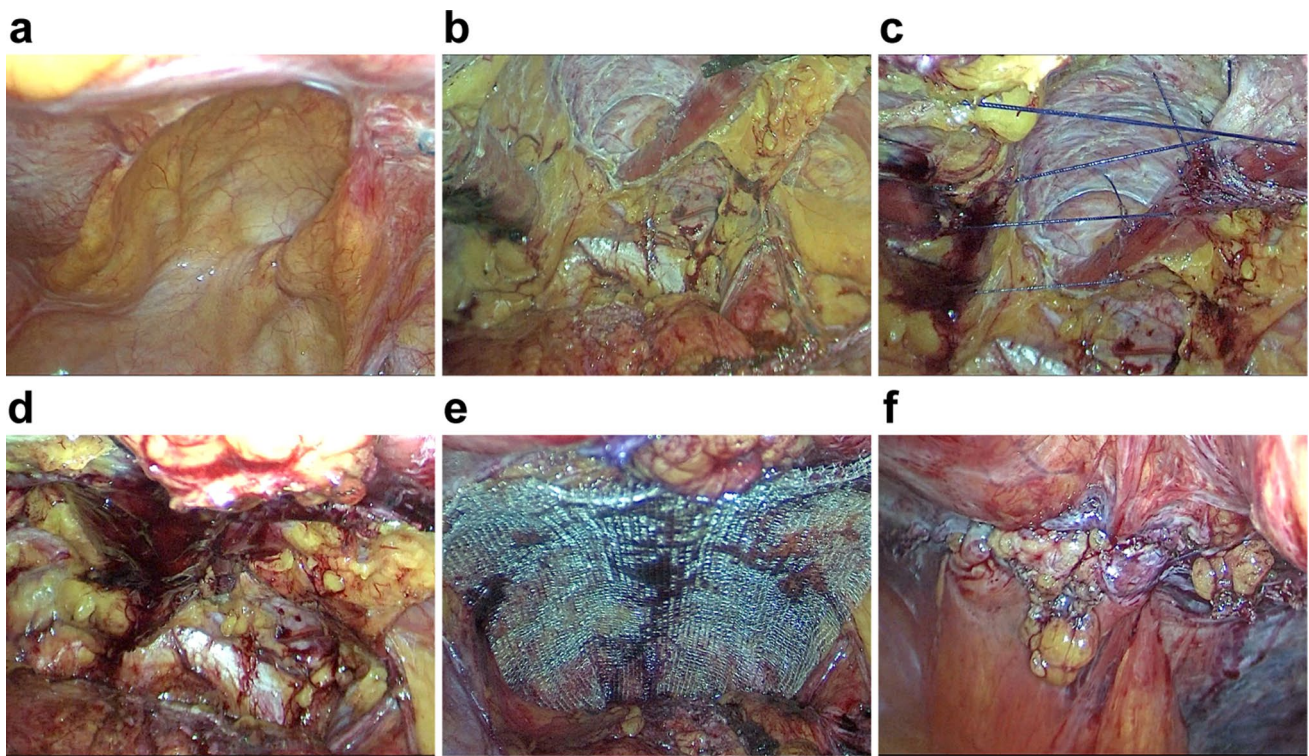


Fig.1 Representative images of the operation. **a** Exposing the hernia sac and measuring the size of the abdominal wall defect and the distance from the inferior margin of hernia to the pubic arch. **b** Dissociating the peritoneal flap. **c** Repairing the hernia sac with full-

thickness transdermal suture. **d** Closing the defect. **e** Placing a self-gripping mesh in the preperitoneal space. **f** Closing the peritoneal flap with continuous suture

Table 1 Categories of previous surgery

Previous surgery	Patients (<i>n</i> =57)
Bowel related	12 (21.05%)
Urological	15 (26.32%)
Gynecological	27 (47.37%)
Pelvic tumor	3 (5.26%)

these patients, 54 patients were treated with the laparoscopic ETAP technique for suprapubic hernia repair; in 3 cases, it was changed to laparoscopic TAPE because the damaged peritoneal flap could not completely cover the mesh, and in 3 cases, indirect inguinal hernia repair was added to the laparoscopic right transabdominal preperitoneal (TAPP) technique. There was no conversion to open laparotomy in these patients.

The mean hernia size was 61.5 cm² (range 7.5–99.0 cm²), and the average mesh size was 173.6 cm² (range 65.0–224.0 cm²). The largest suprapubic hernia was a 9 × 11 cm² defect, which required a mesh of 14 × 16 cm². All repairs were conducted with a self-gripping mesh (TEM1515G, Medtronic, USA). The mean operating time was 90 min (range 60–130 min). As the operator's proficiency in the

Table 2 Complications in ETAP repair of suprapubic hernia

Complications	Patients (<i>n</i> =56)
Seroma in abdominal wall defect area	6 (10.71%)
Obvious postoperative pain in Operative area	6 (10.71%)
Urinary retention	4 (7.14%)
Intestinal adhesion	0
Intestinal obstruction	0
Intestinal fistula	0
Overall complications	10 (17.86%)

technique gradually increased, the operating time significantly decreased. The mean blood loss was 34 cc (range 22–85 cc), and the average hospital stay was 2.6 day (range 1–7 days).

The mean follow-up period was 26 months (range 12–45 months), 16 cases were followed for more than 36 months. The postoperative complications in ETAP repair are listed in Table 2. The overall incidence of complications was 17.86%, and no recurrence was observed in the follow-up. Seroma in the abdominal wall defect area, without herniation, was confirmed by abdominal CT. In all cases, seromas were spontaneously absorbed within 1 month

without any specific treatment. Normally, the postoperative pain in operative area was gradually relieved within 2 weeks without analgesia. For this obvious postoperative pain, the patients were required to apply an abdominal bandage for enhanced compression bandaging for 3–6 months, which relieved obvious postoperative pain. Urinary retention disappeared within 1 month without catheterization. CT images of the same transverse section in one patient before surgery at 3 months after operation, and at 8 months after operation are shown in Fig. 2. Forty-three patients (76.8%) were still on a regular follow-up schedule at the time of writing this report.

Discussion

Suprapubic hernia is a special type of incisional hernia in the hypogastrium. The incidence of incisional hernia in Pfannenstiel incisions was reported to be < 2.1% [11], while that in midline incisions was reported to be up to 46% [12]. Disappointingly, the rate of recurrence after open primary suture repair for incisional hernia was reported to be 63%, while that of suprapubic hernia—in the largest series of cases treated with laparoscopic repair ($n = 36$)—was 5.5% [9]. Consequently, it is imperative to improve the laparoscopic repair of suprapubic hernia.

In 1990, Bendavid first reported the open repair of suprapubic hernia [13]. A polypropylene mesh was inserted into the preperitoneal space and fixed laterally to the Cooper's ligaments and arcuate pubic ligaments. None of the seven patients in the report developed recurrence, infection, or seroma. Traditional open surgery has the advantages of being a simple and low-cost operation; however, the efficacy differs. The first laparoscopic repair of suprapubic hernia was reported by Hirasa in 2001 [14]. A composite mesh was used to cover the defect, and fixed by spiral tacks. In 2005, Carbonell reported the largest series of cases of laparoscopic repair of suprapubic hernia [9]. A piece of

expanded polytetrafluoroethylene (ePTFE) composite mesh was placed in the preperitoneal flap, and the superior and lateral portions of the mesh were fixed to the abdominal wall with sutures by a suture passer and spiral tacks, while the inferior portion was tacked into the pubis and Cooper's ligament literally. The incidence of complications was 16.6% over 21 months of follow-up. However, the placement of composite mesh increases the incidence of mesh-induced complications and cost; thus, it is not popular in underdeveloped areas. At present, there is no consensus on the optimal method of laparoscopic repair for suprapubic hernia. The close proximity of the urinary bladder and bony, neural and vascular structures increases the difficulty of the operation. Combining the advantages of laparoscopic incisional hernia repair and laparoscopic inguinal hernia repair, we innovatively proposed laparoscopic ETAP repair for suprapubic hernia.

In the ETAP technique, a peritoneal flap is raised to create sufficient space, and the hernia sac is then dissected and sutured with full-thickness transdermal suture. A self-gripping mesh is placed to cover the hernia with the inferior margin 2 cm lower than pubic arch, and fixed by spiral tacks. Finally, the peritoneal flap is closed with continuous suture. Thus, the mesh is completely placed in the preperitoneal space, which not only preserves the integrity of the peritoneum, but also avoids direct contact with abdominal viscera. In this study, the incidence of complications was 17.86%, and no mesh-induced complications occurred. No recurrence was observed over a mean follow-up period of 26 months. For 6 cases with obvious postoperative pain, the patients were required to perform enhanced compression bandaging with an abdominal bandage for 3–6 months, and the obvious postoperative pain gets relieved. Since compression bandaging with an abdominal bandage helps to reduce the abdominal wall tension and restricts the abdominal wall activity, which facilitates the fit between the mesh and tissues and reduces the duration of pain, it is easy to see that

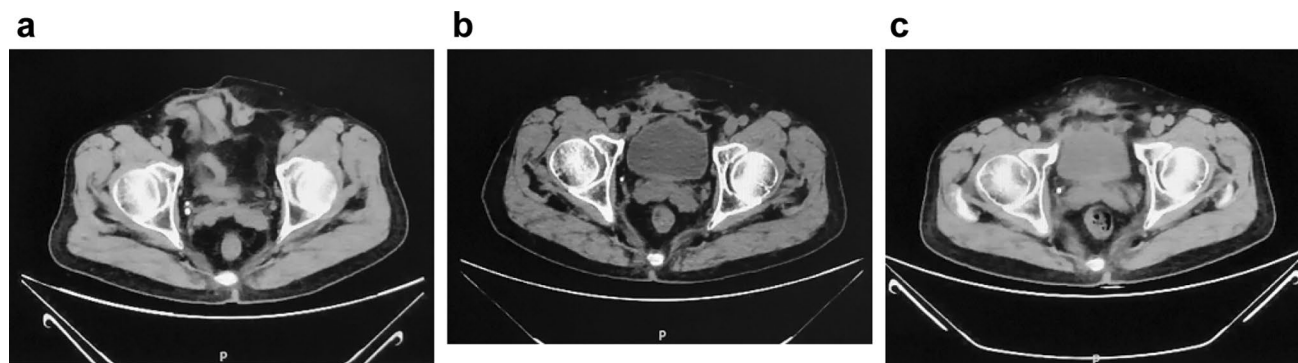


Fig. 2 CT images of the abdominal cross-section of one patient before and after surgery. **a** Before surgery. **b** Three months after surgery. **c** Eight months after surgery

the novel technology is appropriate in laparoscopic repair of suprapubic hernia.

Based on our experience, when performing intestinal adhesiolysis, care should be taken to avoid intestinal damage and preserve the peritoneal integrity. In cases involving severe intestinal adhesion, it would be better to damage the peritoneum than the intestinal tube. Attention should also be paid to preserving peritoneal integrity when raising the peritoneal flap. When the peritoneal defect is too large to cover the mesh, the omentum or mesh with coating can be used to repair the defect. In this study, TAPE repair was used in one case because the damaged peritoneal flap could not completely cover the mesh. No patients developed complications or recurrence in 2 years of follow-up. In addition, raising the peritoneal flap contributes to the evaluation of the sizes and numbers of fascial defects and avoids the risk of a “missed hernia” [15], which may result in recurrence. According to the experience of laparoscopic ventral hernia repairs, it is critical that the mesh overlaps the edge of the defect by 5 cm. Thus, the preperitoneal space that is raised should be of sufficient size. Inadequate exposure of Cooper’s ligament was reported to be an important reason for the high rate of recurrence (50%) in low ventral hernia repair [16]. During the fixation of mesh to the abdominal wall, the inferior margin is difficult to treat due to the limitation imposed by the pubic bones. We concluded that dissecting the peritoneum laterally to Cooper’s ligament and pubic tubercle and down to at least 2 cm below the pubic arch. This area is rich with neural and vascular structures; thus, the taking down of the bladder is useful for identifying the pubic bones and dissecting the peritoneum.

Regarding the management of the hernia sac, it was closed by full-thickness transdermal suture. This reduced the incidence of seroma formation [17] and recurrence. In this study, the incidence of seroma in the abdominal wall defect area was 10.71%. This useful technique was also approved by Palanivelu [6]. However, according to our survey, full-thickness transdermal suture may cause severe postoperative pain.

A self-gripping mesh is completely placed in the preperitoneal space, which causes the mesh to hold onto the abdominal wall under intraabdominal pressure [18]. It is believed that it is possible to reduce the incidence of mesh-induced complications. In this study, no mesh-induced complications occurred and the overall incidence of complications was 17.86%. To determine the appropriate size of mesh, the size of the defect must be measured. A 5 cm (if not, no less than 3 cm) overlap of mesh is recommended for laparoscopic repair [19]; thus, we added 5 cm to the size of the defect when determining the size of the mesh. An adequate mesh overlap distributes intraabdominal pressure over a wider area and allows fibrous growth into the mesh-fascia interface, which helps to reduce the risk of recurrence.

It is well-known that mesh fixation of sufficient strength is a key element in preventing recurrence in patients with hernia [20]. In this study, we identified that fixation of the mesh with spiral tacks every 1 cm was sufficient due to the use of self-gripping mesh. Tacks into Cooper’s ligament and the periosteum of the pubis may lead to pain and osteitis pubis. Additionally, this location is close to the external iliac vessels and urinary bladder; thus, when performing fixation, attention is required to avoid damaging these vulnerable structures. As a novel technique, to guarantee the strength of the repair, we fixed the mesh with helical tacks in the initial exploration period. With constant exploration, we found that it may be not necessary to fix self-gripping mesh with helical tacks. The use helical increases the cost of the procedure and is associated with postoperative pain. However, due to the special structure of the suprapubic hernia, dissociation of 5 cm below hernia sac is not always acquired. In these cases or in cases involving a large hernia, we fixed the mesh to the bilateral Cooper ligaments and pubic nodules with 3–5 helical tacks to enhance the strength of the repair. We believe that the closure of the hernia sac with full-thickness transdermal suture, placement of self-gripping mesh in the preperitoneal space, and fixation using spiral tacks is sufficient to guarantee the strength of repair. In addition, the cost of self-gripping mesh and titanium tacks is cheaper in comparison to the use of a mesh with a special coating. However, more cases and a longer follow-up period may be necessary in a future study.

Conclusions

In summary, the closure of the hernia sac with full-thickness transabdominal suture and fixation with spiral tacks increased the strength of repair and decreased the rate of recurrence, and the complete placement of a self-gripping mesh in the preperitoneal space reduces the incidence of complications. The laparoscopic ETAP technique in suprapubic hernia repair is safe and feasible.

Author contributions H.Z. and C.Z. conceived and designed all experiments and the manuscript. W.Z. and Z.Z. collected and analyzed the data. All authors contributed toward the data analysis, drafting and revising the paper, gave final approval of the version to be published and agree to be accountable for all aspects of the work.

Compliance with ethical standards

Conflict of interest The authors declare no conflicts of interest in association with the present study.

Ethical approval The project was approved by the Ethics Committee of Henan provincial people’s Hospital. Written informed consent was obtained from all subjects before enrollment in the study.

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