Technique

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Laparoscopic extraperitoneal inguinal hernia repair

A safe approach based on the understanding of rectus sheath anatomy

N. Katkhouda,[1] G. M. R. Campos,[1] E. Mavor,[1] A. Trussler,[1] M. Khalil,[1] R. Stoppa[2]

[1] Department of Surgery, University of Southern California School of Medicine, 1510 San Pablo Street, #514, Los Angeles, CA 90033, USA
[2] Department of Surgery, Centre Hospitalier Universitaire, Amiens, France

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Abstract. We have devised a reproducible approach to the preperitoneal space for laparoscopic repair of inguinal hernias that is based on an understanding of the abdominal wall anatomy. Laparoscopic totally extraperitoneal herniorrhaphy was performed on 99 hernias in 90 patients at the Los Angeles County–University of Southern California Medical Center, using a standardized approach to the preperitoneal space. Operative times, morbidity, and recurrence rates were recorded prospectively. The median operative time was 37 min (range, 28–60) for unilateral hernias and 46 min (range, 35–73) for bilateral hernias. There were no conversions to open repair, and there was only one conversion to a laparoscopic transabdominal approach. Complications were limited to urinary retention in two patients, pneumoscrotum in one patient, and postoperative pain requiring a large dose of analgesics in one patient. All patients were discharged within 23 h. There were no recurrences or neuralgias on follow-up at 2 years. A standardized approach to the preperitoneal space based on a thorough understanding of the abdominal wall anatomy is essential to a satisfactory outcome in hernia repair.

Key words: Inguinal hernia — Laparoscopic surgery — Totally extraperitoneal hernioplasty — Rectus sheath anatomy

Inguinal hernia repair is one of the most common surgical procedures in the United States, with an estimated 700,000 cases performed annually [5]. Laparoscopic treatment of inguinal hernias is an approach that shares such known advantages of other laparoscopic procedures as a less painful recovery and a quicker return to normal activity [7].

Numerous techniques have been described since the first application of laparoscopy to the management of hernias [2–4, 6, 8–10, 13, 16, 17]. Two techniques have emerged as the mainstays of laparoscopic hernia repair—the transabdominal preperitoneal repair (TAPP) and the totally extraperitoneal (TEP) repair. In the TAPP repair, the peritoneal cavity is entered, the peritoneum is dissected from the myopectineal orifice, a mesh prosthesis is secured, and the peritoneal defect is closed [2]. This technique has been criticized for exposing intraabdominal organs to potential complications, including small bowel injury and obstruction. On the other hand, the TEP repair maintains peritoneal integrity, theoretically eliminating these risks while allowing direct visualization of the groin anatomy, which is critical for a successful repair.

The TEP hernioplasty follows the basic principles of the open preperitoneal giant mesh repair, as first described by Stoppa in 1975 for the repair of bilateral hernias [14]. Stoppa approached the preperitoneal space through the midline to secure a single large prosthesis. Widespread acceptance of the laparoscopic approach has been limited by technical difficulty in gaining access to and insufflating the preperitoneal space *pneumopreperitoneum* despite the availability of recently developed devices such as balloon dissectors, and unfamiliarity with rectus sheath and preperitoneal anatomic structures. Moreover, hemorrhagic complications have been reported as a result of inadvertent injury to the inferior epigastric vessels after the insertion of the umbilical port or during dissection of the preperitoneal space [8, 12, 15].

This article presents a simple, safe, and reproducible technique to dissect the preperitoneal space and create the pneumopreperitoneum that is based on an understanding of the rectus sheath anatomy and its relationship to the transversalis fascia and peritoneum.

Patients and methods

Patients

Between July 1996 and May 1997, 90 patients with 99 hernias underwent laparoscopic totally extraperitoneal herniorrhaphy (TEP) at the Los Ange-

Correspondence to: N. Katkhouda

Table 1. Demographics and types of hernia

Patients/hernias treated	90/99
Age (yr)	48 (17–72)
M:F	85:5
Unilateral hernias	81 patients (90%)
Bilateral hernias	9 patients (10%)
Hernia type	
Direct	54 (55%)
Indirect	31 (31%)
Pantaloon	3 (3%)
Femoral	2 (2%)
Recurrent	9 (9%)

les County–University of Southern California Medical Center. All procedures were completed laparoscopically and performed by residents and fellows under the supervision of attending surgeons. Patient demographics and types of hernia are summarized in Table 1. Patients with large inguinoscrotal hernias or severe liver or cardiopulmonary disease were not included. Informed consent was obtained in all cases. To assess the impact of the method on operative time, we compared this group of patients to a cohort of 181 patients who underwent a TEP repair before implementing the new technique. To limit the effect of the learning curve, data concerning the last 90 patients of the latter group were included.

Surgical anatomy

The rectus sheath is a fascial envelope surrounding the rectus abdominis muscle that is formed by the aponeuroses of the external oblique, internal oblique, and transversus abdominis muscles [11]. The anterior rectus sheath is continuous from the costal margin to the symphysis pubis, while the posterior sheath is defined at its most inferior extent by the arcuate line of Douglas. Superior to the arcuate line, the anterior and posterior rectus sheaths fuse at the linea alba to completely envelop the rectus abdominis muscle. Inferior to the arcuate line, where the posterior sheath is absent, the following structures are encountered in sequence after the muscle: the transversalis fascia (anterior and posterior lamina), the preperitoneal connective tissue (the true preperitoneal space), the preperitoneal fascia, the preperitoneal fat, and the peritoneum.

Although the position of the arcuate line is somewhat variable, it has been shown in autopsy studies to occur within the superior one-third of the distance from the umbilicus to the symphysis pubis in 96% of the population. The median distance was 48 mm below the umbilicus (range, 16–95 mm) in a study involving the dissection of 112 arcuate lines from 56 cadavers (Fig. 1) [11]. We performed five cadaveric dissections, confirming this finding in all instances.

The preperitoneal space is formed mainly by loose areolar tissue and, a variable but small amount of fat, and it is crossed by a few small vessels. One of its significant characteristics is that it lacks tensile strength, thus allowing for an easy insufflation.

Injuries to the inferior epigastric vessels can occur during dissection of the preperitoneal space. In the groin, these vessels course within the preperitoneal space after arising from the iliac vessels. They pierce the posterior lamina of the transversalis fascia along the posterior surface of the rectus muscle and reach the posterior sheath of the rectus muscle at the level of the arcuate line, where they penetrate the posterior surface of the rectus muscle.

The exposure obtained by entering the preperitoneal space at the level of the arcuate line after breaking through the transversalis fascia allows direct visualization of the inferior epigastric vessels, thereby avoiding their inadvertent injury.

Technique

In preparation for the procedure, the patient is placed under general anesthesia and a Foley catheter is inserted. We use a three-trocar approach for the TEP repair. A 10-mm skin incision is made on the inferior edge of the umbilicus. This site will ultimately be used for the insertion of the video laparoscope. With the aid of two S-shaped retractors, the edges of this opening are translated to one side (right), and the incision is carried down

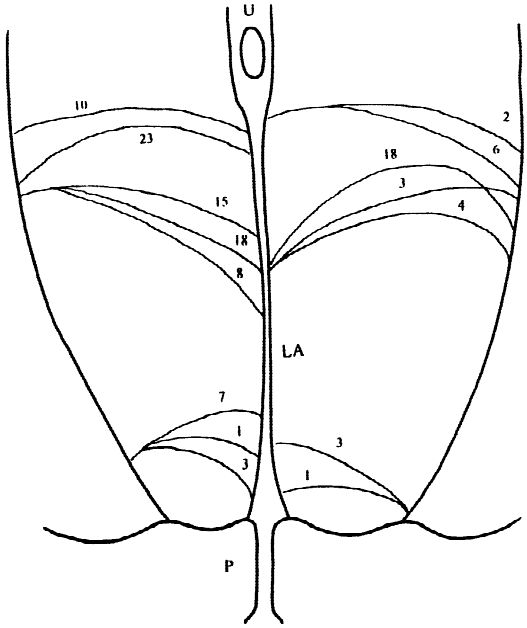


Fig. 1. Incidence and positions of 112 arcuate lines from 56 cadavers. Numbers indicate the incidence of lines in the positions shown relative to the umbilicus and the pubic symphysis. U, umbilicus; LA, linea alba; P, pubic symphysis. (Reprinted with permission from J Anat, Cambridge Univ. Press, Ref. 11.)

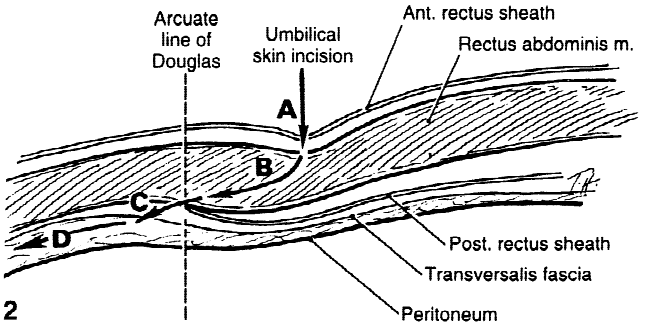
to the anterior rectus sheath. This lateral translation avoids the linea alba. A 10-mm lateral incision on the anterior rectus sheath is performed, exposing the rectus abdominis muscle, and stay sutures are placed in the sheath. The fibers of the rectus muscle are then spread using retractors, allowing the posterior sheath to be visualized. This sheath will be left intact throughout the procedure.

A channel between the rectus muscle and posterior sheath is created with a blunt dissector or the index finger, aiming toward the symphysis pubis. A blunt Hassan trocar with a 0° laparoscope is introduced in the space between the rectus muscle and the posterior rectus sheath. It is aimed beyond the superior one-third of the distance between the umbilicus and the pubic symphysis. This angle allows the tip of the trocar to be positioned inferior to the arcuate line. The blunt trocar is then advanced at a 30° angle off the midline toward the side of the hernia, thus breaking through the posterior lamina of the transversalis fascia and ending in the preperitoneal space (Fig. 2). Gentle side-to-side movements of the trocar are used to dissect the space. Caution must be taken to avoid aiming too posteriorly and injuring the bladder or entering the peritoneal space. A 30° laparoscope should not be used at this point, lest the angled view provided have the same consequence.

Once the trocar has been advanced into the preperitoneal space, the patient is placed in the Trendelenburg position, and the space is insufflated with CO_2 to a pressure of $\leqslant$12 mmHg. A 30° laparoscope replaces the 0° scope. The inferior epigastric vessels are clearly visualized laterally on the posterior surface of the rectus muscle and during their free course within the preperitoneal space.

Lateral dissection of the preperitoneal space is then performed following insertion of a 5-mm trocar on the midline at mid-distance between the symphysis pubis and the umbilicus. This lateral dissection is critical to the successful deployment of the mesh prosthesis. Once the lateral dissection is complete, the last 10-mm trocar is inserted on the ipsilateral side of the repair ~4 cm medial to the anterior-superior iliac spine. For the repair of bilateral hernias, the same three port sites are used, since we have found that the 10-mm trocar inserted on the right side can also be used for the repair of left-sided hernias.

The use of a balloon dissector follows the same principles and simplifies the dissection. The posterior rectus sheath is identified, and the plane of dissection is initiated bluntly. The balloon device is introduced over the 0° laparoscope to the level of, but not beyond, the symphysis pubis. The balloon is inflated, dissecting the preperitoneal space (Fig. 3). One of the advantages of this device is that the preperitoneal space can be visualized through the transparent structure of the balloon.



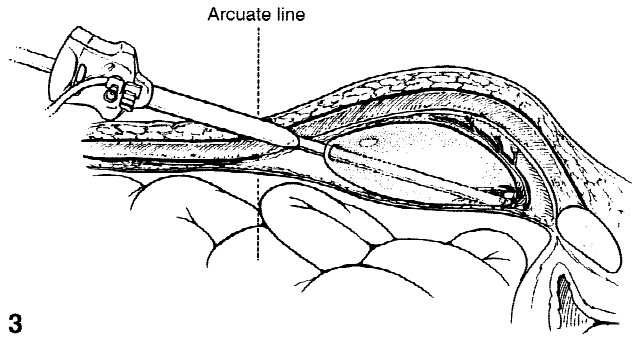


Fig. 2. Key steps for creation of the pneumopreperitoneum. **A** Incision in anterior rectus sheath. **B** Spreading of rectus muscle fibers. **C** Insertion of a blunt trocar in an oblique fashion beyond the arcuate line. **D** Penetration of the preperitoneal space after breaking through the transversalis fascia.

Fig. 3. Balloon dissection of the preperitoneal space.

The final steps involve treatment of the hernia sac and its contents with parietalization placement of the mesh prosthesis. We do not fix the prosthesis with staples, since the pressure exerted by the peritoneum and the intraabdominal contents will keep the mesh in place. If staples are used, they should be applied above (anterior to) the iliopubic tract to avoid lateral nerve injuries and at Cooper's ligament. When staples are applied to Cooper's ligament, care must be taken to avoid injuring the corona mortis, the anastomotic pubic venous branches between the inferior epigastric, and the obturator vessels. Inadvertent injury to these branches, along with unnamed pubic veins, can cause substantial bleeding. In general, no more than 3–4 staples are required to fix the mesh.

Statistical analysis

Comparison of operative times was assessed using the Student's *t*-test. Values of $p < 0.05$ were considered significant.

Results

All procedures were completed laparoscopically, and preperitoneal exposure of the working space was optimal in all patients when a balloon dissector was used. The median operating time was 39 min (range, 28–60) for unilateral hernias and 48 min (range, 35–73) for bilateral hernias. As a comparison, OR time for 90 patients (77 unilateral and 13 bilateral hernias) operated on using the TEP repair before implementation of the current standardized technique was 53 min and 67 min, respectively ($p < 0.05$). Those patients were approached through a midline dissection, following the linea alba. Blood loss was minimal in all patients.

One patient with a large indirect sliding hernia was converted to a laparoscopic transabdominal preperitoneal approach (TAPP) after an opening in the peritoneal sac did not allow maintenance of an adequate pneumopreperitoneum.

Postoperative complications occurred in four patients (4.5%). One patient presented with pneumoscrotum; another complained of a pulling sensation and pain requiring larger dose of analgesics. This patient had repair of large bilateral hernias. Two others had urinary retention. No patient returned with hematoma or infection. All 90 patients were discharged within 23 h. One patient with postoperative urinary retention was readmitted for resection of a prostatic adenoma. All patients were seen 10 days after surgery; 90% of them had already returned to regular activities, and none required ongoing analgesia.

Follow-up was obtained in all patients at 1 year and in 76 patients (84.4%) at 2 years. No clinically apparent recurrences were observed. No neurologic complications were noted on follow-up.

Discussion

Although the choice of technique (open or laparoscopic) for primary hernias is still a subject of debate, the utilization of laparoscopy for recurrent or bilateral hernias is gaining acceptance, since it can offer a satisfactory repair avoiding two separate incisions or a dissection in a scarred and weakened inguinal region.

Laparoscopic totally extraperitoneal (TEP) hernia repair seeks to reproduce Stoppa's open procedure endoscopically [14]. It is becoming the laparoscopic procedure of choice in many centers, because it maintains peritoneal integrity, reducing the risk of small bowel adhesions, perforation, and obstruction as reported with the TAPP approach [15]. We have abandoned the TAPP repair because we are convinced of the superiority of the extraperitoneal technique. One exception to the use of the TEP repair would be cases in which it is technically impossible to maintain the pneumopreperitoneum due to an opening of the hernial sac during the extraperitoneal dissection. Large indirect inguinoscrotal hernias can be a laparoscopic challenge when the preperitoneal approach is used. Reduction of the hernia may indeed require opening the sac, which insufflates the peritoneal cavity and collapses the preperitoneal space. This type of hernia is probably best approached with an open or a laparoscopic TAPP repair. All other hernias (small indirect, direct, and femoral) are amenable to the TEP repair.

Universal acceptance of the laparoscopic preperitoneal approach has been hindered by: cost issues, the absence of adequate large prospective randomized trials, and technical difficulties. Liem et al. demonstrated the superior results of the laparoscopic repair over the open anterior approach [7], but they did not limit patients receiving open repairs to the tension-free mesh repair as is widely practiced in the United States. Interestingly, none of the 487 patients included in this prospective randomized trial had any form of fixation of the mesh. On the other hand, in several smaller studies, the outcomes were hampered by the learning curve of the investigators [1, 8].

The technique described here to access the preperitoneal

space has enabled us to institute a uniform approach and teach the procedure safely to surgical residents, since no major morbidity was noted in our study. Operative times have been significantly reduced from the times recorded before implementation of this technique.

In conclusion, a standardized approach to the preperitoneal space based on the understanding of the anatomy of the abdominal wall allows the laparoscopic procedure to be taught safely and in a reproducible fashion. Finally, we believe that the use of this technique will contribute to an improvement of the results in future randomized trials comparing open tension-free mesh repair to laparoscopic preperitoneal hernia repair.

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