Chapter 4
Basic Concepts in Laparoscopic Hernia Repair

Juan Antonio Martín Cartes, Juan Marín Morales, and Juan Manuel Suárez Grau

Abstract Laparoscopic surgery is the gold standard in multiple surgical fields. In abdominal wall surgery, it is becoming more frequently used, changing rapidly as one generation of surgeons who performed laparotomy incisions is replaced by another that tends towards the laparoscopic approach. One of the key steps is becoming more familiar with the laparoscopic technique, its instruments, and the basic principles of this procedure. Skills are very important as is knowledge about sectorization, triangulation, ergonomics, and the equipment needed to perform this type of surgery (optical, grasper, trocars, etc.).

Keywords Laparoscopy • Hernia • Hernioplasty • Mesh • Optic • Grasper • Trocar • Triangulation • Sectorization • Ergonomics

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Introduction

Although laparoscopy has a long history among general surgeons, it was used only as a diagnostic tool, usually in patients with recurrent abdominal pain of unknown cause. In the early 1970s, some gynecologists realized that the laparoscope could be used therapeutically. Therapeutic laparoscopy, now named minimally invasive surgery, began in the 1980s with the first laparoscopic cholecystectomy. After that, the range of laparoscopic procedures quickly expanded.

Basic Instruments in Laparoscopic Hernia Repair

Videoendoscopic, Light, and Insufflated System

- One or two monitors to obtain a perfect view of the intervention. The main surgeon and the instrumentist should see the intervention adequately with articulated monitors, which can change position according to the evolution of the surgical procedure.
- A system which creates and controls a correct pneumoperitoneum: pneumoflator (Fig. 4.1).
- A system that emits a light source. A fiber-optic light bundle. Illumination is provided by a high intensity but "cold" broadband light source.

Fig. 4.1 Pneumoflator

Fig. 4.2 Energy sources: LigaSure™ (*top*) (Courtesy of Covidien, Dublin, Ireland), UltraCision Harmonic (*center*) (Courtesy of Ethicon Endo-Surgery, Blue Ash, OH, USA), and Thunderbeat (*bottom*) (Courtesy of Olympus, Center Valley, PA, USA)

Energy Sources (Fig. 4.2)

- Electrosurgery to perform a cauterization of the structures. It could be by monopolar or bipolar electrode. Today, the best advance in electrosurgery is the LigaSure™ system (Covidien, Dublin, Ireland); it incorporates a microcomputer that allows correct vessel ligation according to the thickness of the structures.
- Ultrasonic energy (UltraCision Harmonic, Ethicon Endo-Surgery, Blue Ash, OH, USA): This makes a correct dissection by cavitation of the structures. It is able to perform a vessel ligation ultrasonically.

Fig. 4.3 Trocars (5 mm) and BTT trocar (Hasson)

Today, there are instruments that combine these two types of energies: Thunderbeat (Olympus, Center Valley, PA, USA), integration of ultrasonic and advanced bipolar energies delivered through a single multifunctional instrument, allowing a surgeon to simultaneously seal and cut vessels up to and including 7 mm in size with minimal thermal spread.

Trocars and Laparoscopic Dissecting and Grasping Instruments

Trocars (Fig. 4.3)

In ventral hernia repair, the most frequently used trocars are two 5 mm trocars and one 10–12 mm trocar. When the mesh is very large, it could be useful to have a 15 mm trocar.

In inguinal hernia repair, we use two 5 mm trocars and one 10–12 mm trocar. There are many variations, according to the two main types of surgeries:

- TAPP: 2 5 mm trocars and one 10 mm trocar, generally. But we can exchange the 10 mm trocar for a 5 mm trocar (optic) if we use a lightweight mesh, as it is able to handle a 5 mm trocar. We sometimes use a 3 mm trocar on the left side (for the nondominant hand) instead of the 5 mm trocar.

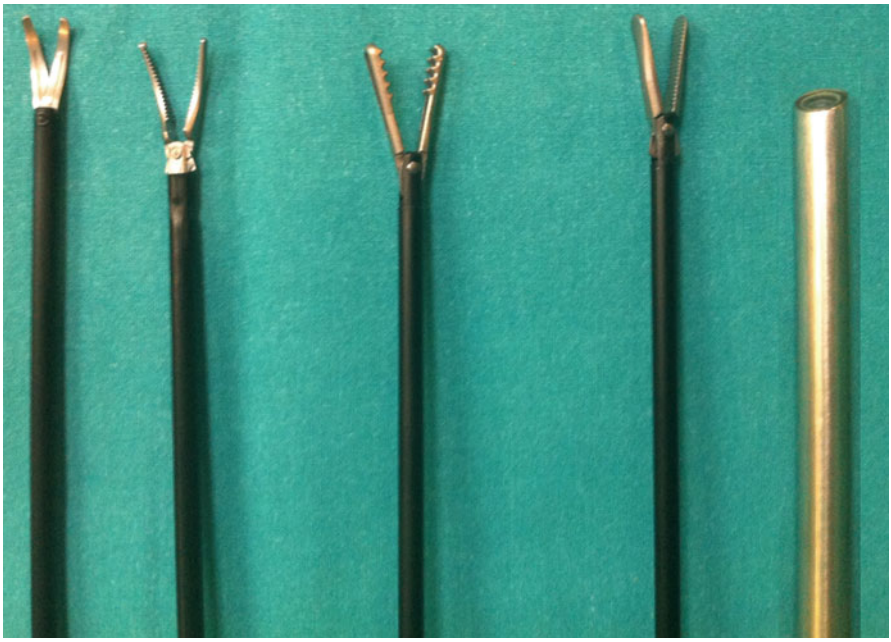

Fig. 4.4 Different styles of graspers, shears, dissectors, and 30° optic in laparoscopy

- TEP: 2 5 mm trocars and two special trocars: BTT and PDB.

There is a device that combines the two special trocars into one: spacemaker, which allows the balloon dissection of the preperitoneal space (usually created by the PDB) and fixes the fascia with a miniballoon in order to maintain that newly created preperitoneal cavity (usually performed by the BTT).

Instruments

- Endograspers (Endo Clinch™ and Endo Grasp™, Covidien, Dublin, Ireland), endoshears, and endodissectors are the main instruments in laparoscopic hernia repair. See Fig. 4.4.
- Other instruments such as an endohook, the Endoloop® (Ethicon Endo-Surgery, Blue Ash, OH, USA), or the Endo Stitch™ (Covidien, Dublin, Ireland) could be used according to the characteristics of the hernia surgery. In single-port surgery, we use roticulator instruments such as the roticulator-endodissector.

Optics

- 5 mm optic: With inclined end, to offer 30°, or normal end that offers 0°
- 10 mm optic: 30° or 0°

Fig. 4.5 (**a**, **b**) Basic instruments in laparoscopic hernia repair

- Other optics: 3 mm optic 0° (its use is rare), roticulator optics in robotic and single-port surgery

  See Fig. 4.5 a, b for the basic instruments used in laparoscopic hernia repair.

Role of Triangulation Techniques and Ergonomics in Laparoscopic Surgery

There is no uniform consensus regarding port placement for advanced laparoscopic procedures. The placement of ports is currently dictated by the surgeon's preference based on individual experience. To facilitate smooth instrument manipulation along

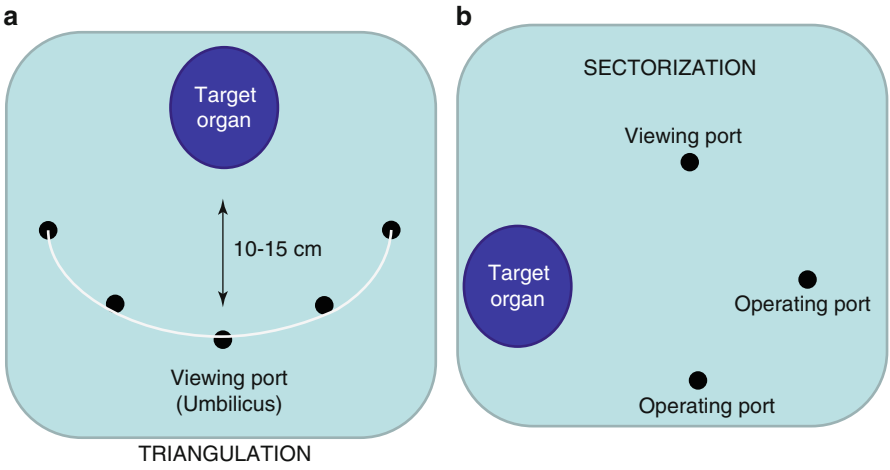

Fig. 4.6 (**a**, **b**) Triangulation (**a**) and sectorization (**b**) in laparoscopy

with adequate visualization during laparoscopy, trocars usually are placed in triangular fashion. This is termed triangulation. See Fig. 4.6a.

The target organ should be 15–20 cm from the central port used for placing the optical trocar [1]. Generally, the two remaining trocars are placed in the same 15–20 cm arc at 5–7 cm on either side of the optical trocar [2]. This allows the instrument to work at 60°–90° angles with the target tissue and to avoid problems of long handles due to port placement that is too distant or too close; it also avoids the problem of abdominal wall interference. If necessary, two more retracting ports can be placed in the same arc but more laterally so that instruments do not clash.

When the optical trocar is placed as one of the lateral port trocars, it is called sectorization. See Fig. 4.6b. Sectoring of instruments should be avoided by beginners since it requires a greater degree of understanding of laparoscopic views and significantly different one-eye coordination.

More specifically, there are ergonomic issues that are unique to laparoscopic hernia repair, such as the strain of working against the camera (mirror-image effect) and the complex movements required to repair hernia defects from underneath the anterior abdominal wall during ventral hernioplasty. The attention to the current operative environment and the selection of appropriate available instrumentation may improve operative efficiency and protect the health of the surgeon.

The etiology of the ergonomic problem in laparoscopy is multifactorial. Consideration should be given to instrumentation, image quality, the positioning of the patient, the surgical staff, and the equipment. Within the current ergonomic constraints of laparoscopy, changes can and should be made to increase the comfort of the surgeon and reduce muscular fatigue. Instrumentation should be selected not only for function but also for ease of use and proper individual surgical fit.

The operating table should be positioned so that the instrument handles are at the surgeon's elbow level [3]. Similarly, the video monitor should be positioned at or

slightly above eye level. Suspended mobile monitors may facilitate this adjustment. The monitor should be in alignment with the operative target and the surgeon. Foot pedals that control energy sources should be placed within a small radius from the surgeon's feet to avoid stiffening and straining to maintain balance. Patient position is also crucial. The patient should be positioned to allow gravity to assist with operative exposure, reducing the exertion needed from the surgeon and assistants for retraction.

The patient's arms should be tucked during ventral herniorrhaphy to provide freedom of movement by the surgeon and assistants around the operating table. Attention to these details in positioning and operative setup should greatly improve operative efficiency.

Incisional Ventral Hernia

It was in 1991 that the first laparoscopic approach in the repair of incisional hernia was reported. Since that time, there has been a steady acceptance of this procedure because of the improvement in the recovery of the patient, the decreased rates in wound complications and mesh infections, and the notable decline in the recurrence rate compared with that of the open technique. In general, all the significant steps of the two different approaches are similar. The laparoscopic approach may be more suitable for straightforward hernias, with open repair reserved for the more complex hernias. Laparoscopic ventral hernia repair appears to be an acceptable alternative that can be offered by surgeons proficient in advanced laparoscopic techniques [4]. See Fig. 4.7.

Inguinal Hernia

With respect to inguinal hernia, we want to point out that since Bassini in the late nineteenth century, there was no area of surgery more controversial than the surgical repair of groin hernias. The search for the best way to repair this condition has produced a vast number of solutions. In the early 1990s, laparoscopic approach for inguinal hernia repair was introduced; as a result, the transabdominal preperitoneal approach (TAPP) and the totally extraperitoneal (TEP) became widely accepted. See Fig. 4.8.

Both the TAPP and the TEP approaches use the basic principle of placing a piece of mesh in the preperitoneal space as described by Stoppa. The optimal repair has been assessed by random controlled trials (RCT) and population-based studies.

With TAPP, the surgeon goes into the peritoneal cavity and places a mesh through a peritoneal incision over possible hernia sites. TEP is different in that the peritoneal cavity is not entered and mesh is used to seal the hernia from outside the peritoneum (the thin membrane covering the organs in the abdomen). This approach is

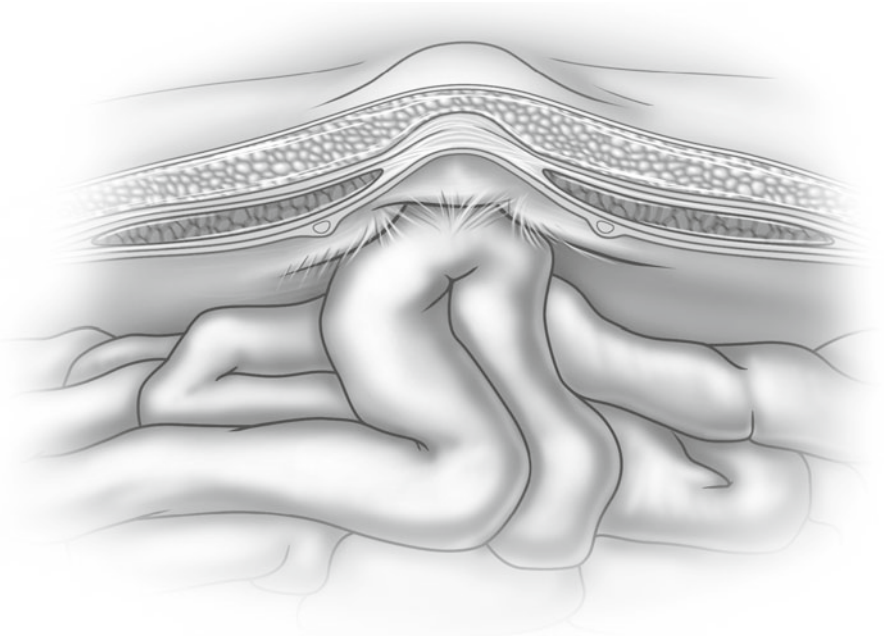

Fig. 4.7 Ventral hernia

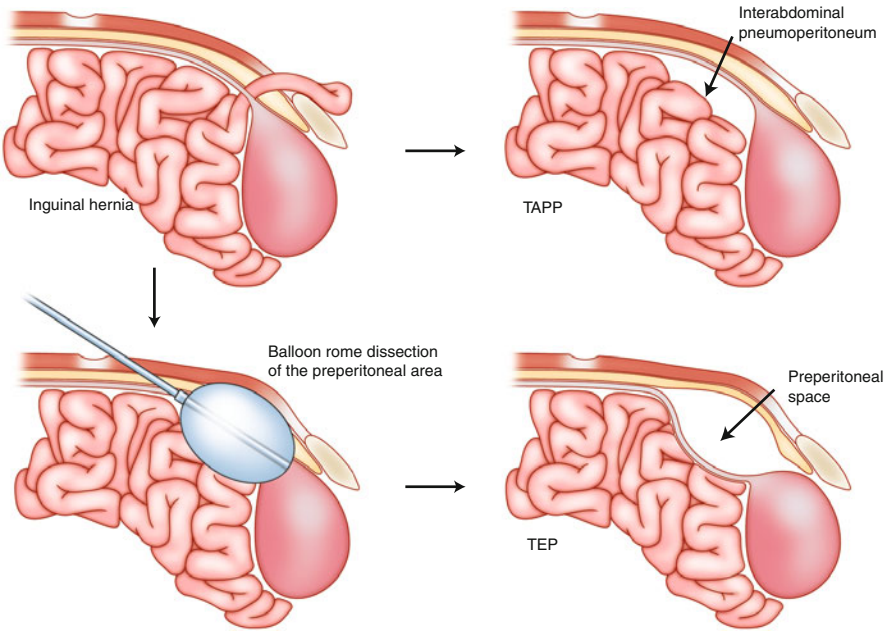

Fig. 4.8 Techniques in laparoscopic inguinal hernia repair

considered to be more difficult than TAPP but may have fewer complications. In both these repairs, the mesh is in direct contact with the fascia of the transversalis muscle in the preperitoneal space, allowing tissue ingrowth which leads to the fixation of the mesh. The surgeon's skill should determine the method used. There is no "best" form of hernia repair: it should be tailored to the nature of hernia, patient characteristics, and the preference of the surgeon and the patient

The advantages and disadvantages of TEP are the following: dissection is easy, anatomical landmarks are difficult to find, peritoneal tear may lead to conversion, and less of a chance of bowel injuries and intraperitoneal adhesions.

The pros and cons of TAPP are the following: anatomical landmarks are easily found, wide dissection is more challenging, the peritoneum can be divided and eventually closed, and it minimizes the risk of peritoneal adhesions.

Based on what we have learned from evidence and practice, the selective use of laparoscopic repair of inguinal hernias depends on the balance of costs, benefits, and risks. Laparoscopic repair is associated with less acute pain and faster recovery. Furthermore, available data suggest less chronic long-term pain after laparoscopic repair. In female patients, laparoscopic repair is the recommended method. Laparoscopic repair is preferred in patients with a previous open repair, while patients with recurrence after laparoscopic repair should undergo open mesh repair. Surgical services should review their current practice and adopt laparoscopic hernia surgery with appropriate training. This procedure at the present time can be indicated in incisional hernia, in bilateral hernia, in reproduced hernia, and in the obese patient (recommendation grade B).

Prosthetic Biomaterial to Repair the Incisional Hernia

Incisional Ventral Hernia

At present, there are several different products that are designed to be used specifically for this procedure [5]. In the vast majority of clinical centers, this procedure is performed entirely in the intraperitoneal position. Because of this, the biomaterial will contact the intestinal contents. The original description of this procedure used an early form of expanded polytetrafluoroethylene (e-PTFE). The use of this biomaterial is preferred in the majority of published series because it is much less prone to the development of adhesions.

Dualmesh® (W.L. Gore & Associates, Newark, DE, USA) products have been hailed as a successful advance; all those products are single components that have a rough surface and a visceral one (parietal and visceral).

The Dualmesh products are impregnated with silver carbonate and chlorhexidine diacetate, which act to inhibit microbial colonization of the device for up to 14 days post-implantation and resist initial biofilm formation. The silver in the product turns it to a brown color so that it can reduce the glare of the prosthesis when used laparoscopically.

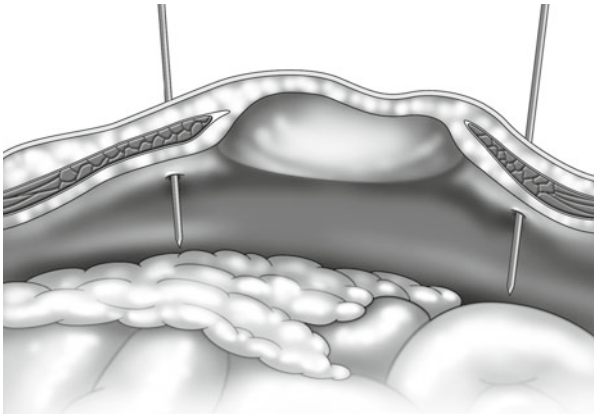

Fig. 4.9 Needles to identify the margins of the hernia

Recently, other, newer biomaterials such as Composix™ and Composix™ EX (both: Davol, Warwick, RI, USA) combine two different products into a two-layer prosthesis. Both have a polypropylene mesh (PPL) attached to a layer of e-PTFE.

Parietex™ and Parietene™ (both: Covidien, Dublin, Ireland) combine polyester and polypropylene materials in an attempt to prevent the development of peritoneal adhesions to the prosthesis.

There have been reports of pain and peritoneal adhesions that are quite significant with the use of those materials. Moreover, some authors reported that the use of e-PTFE over PPL does not appear to be protective against adhesions.

Biomaterials based on collagen matrix are the newest used for surgical hernia management. They are based on the noncellular collagen of either the porcine small intestinal submucosa or porcine dermal collagen or human cadaver dermis. Those biomaterials are penetrated and replaced by the native collagen of the patient so that a new fascial area will be created.

Overlapping the prosthesis is a very important aspect of this surgical technique; we have to consider that the prosthesis usually can shrink, so the recommendation is to leave an overlap ring of about 5 cm around it.

In the last few years, more and more prostheses have become commercially available, but the problem of large hernias and peritoneal adhesions is still an issue.

Double-Crown Technique in Ventral Hernia

Once the adhesiolysis process is completed, we proceed to identify the defect and the sac. The hernia defect must be delineated by marking the margins of the hernia (not the sac) on the skin of the patient. We insert an intramuscular needle through the skin and abdominal wall. The tip of the needle is visualized inside the abdominal cavity under laparoscopic vision to detect and trace the hernia defect on the patient's skin. See Fig. 4.9.

An exact measurement of the defect is determined when the abdomen is fully desufflated. The patch is then chosen to provide an overlap of at least 5 cm. Once the mesh is selected, several marks or sutures are traced on the mesh, and similar

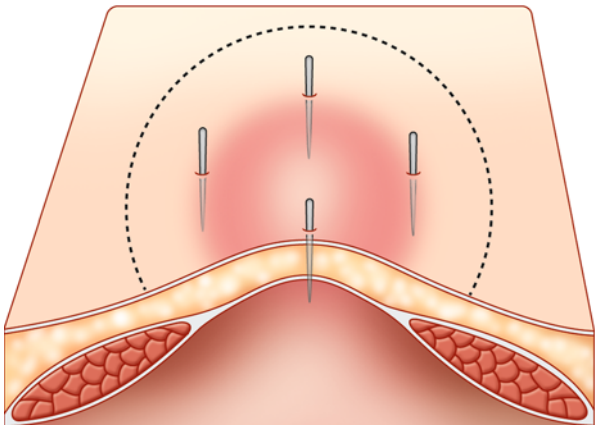

Fig. 4.10 Needles in the margins of the hernia and skin marked with the 5 cm overlap to determine the size of the mesh

marks are traced on the patient's skin in order to facilitate orientation of the prosthesis within the cavity. See Fig. 4.10.

Afterwards, we roll the mesh along its long axis. This will make it easier to perform the maneuvers needed to expand the mesh once attachment has begun. We introduce the mesh through one of the trocars to prevent potential contamination, which may occur if it is inserted through the skin.

After having put the mesh inside the cavity and unrolled it properly, it must be oriented by using the marks previously drawn or the sutures on the mesh. The corresponding area of the abdominal wall where the mesh is to be fixed is located by pushing on the abdominal wall at that site. We usually insert a needle at the level of the circle on the abdomen in order to locate the area where the first tack should be placed. When this tack is placed, we stretch the mesh in the caudal direction and perform the same maneuver, placing the second tack. A variation of the technique consists of hanging the mesh from the four cardinal points with transfascial sutures. Afterwards, we place the outer crown. The transmural sutures are cut and removed before we place the inner crown.

Once the mesh is fixed from the four cardinal points, we extend it adequately, adding an outer crown of tacks that is placed directly on the margin of the mesh.

The tackers are separated from each other by a distance of 1–2 cm, which is adequate to ensure that the intestinal loops do not slip between the tacks resulting in an acute incarceration.

Once the outer crown is finished, we add the inner crown of tacks. A needle can be introduced at this level, so that we can identify the area where the inner crown of tacks should be placed.

Inguinal Hernia

Open hernioplasty refers to insertion of a prosthetic mesh (e.g., polypropylene) to cover and support the posterior wall of the inguinal canal. The mesh is cut to size, with two limbs encircling the cord at the deep ring, and is then sutured to

the posterior wall behind the cord. Alternatively, the mesh can be inserted via an extraperitoneal approach and placed deep into the defect in the posterior wall.

Laparoscopic repair is performed under general anesthesia, using either a transperitoneal or extraperitoneal approach [6, 7]. The technique is not appropriate for large or irreductible hernias. The sac is separated from the spermatic cord and excised, and a mesh is inserted to strengthen the posterior wall, with or without a small plug of synthetic material being inserted into the deep ring. Advantages of laparoscopic hernia repair include reduced postoperative pain and earlier return to work. Disadvantages include increased risk of femoral nerve and spermatic cord damage, risk of developing intraperitoneal adhesions with the transperitoneal procedure, and greater cost and duration than the other operation. Initial experience indicates that recurrence rates are similar to those associated with open operations.

Fixation of the Biomaterial

Ventral Hernia

Mesh should be appropriately fixed either with sutures, staplers, or tackers to prevent contraction and/or migration of the mesh. To fix it, we can use absorbable or nonabsorbable tacks or glues.

This is a frequent controversial area referred to in laparoscopic incisional ventral hernia. In the early 1990s, the majority of the published reports employed the use of transfascial sutures that could be associated to different types of metal fixation.

Transfascial stitches, despite having been preferred for a long time, have not demonstrated better results than tackers in reported series that have long-term follow-up.

In our center, we have used tacks in a “double-crown” technique for quite some time without association with transfascial stitches, and we are very satisfied with this technique. We want to emphasize that it is incumbent upon the surgeon to use the method that works best for him/her.

Inguinal Hernia

The debate whether or not to employ fixation is focused on two main issues: does lack of fixation lead to higher recurrence rates and does use of fixation lead to increased rates of chronic pain and neuralgias? Mesh fixation and nonfixation both have similar low recurrence rates in TAPP and TEP. Not fixing the mesh has less or similar incidence of chronic pain.

A secondary issue is related to cost: if fixation is eliminated, the cost of the procedure is reduced. Proponents of mesh fixation are concerned about mesh migration,

rolling, or shrinking, leading to hernia recurrence. Tissue adhesives such as fibrin sealants may be used to fix the mesh.

Complications

Minor postoperative problems occur. More serious complications such as damage to the spermatic cord, nerve or major vascular injuries, bowel obstruction, and bladder injury have been reported with laparoscopic repair. Recurrence of a hernia is a major drawback.

Postoperative Seroma

The appearance of a seroma after undergoing a laparoscopic hernia repair is so common that many surgeons do not consider it a real complication. It should be expected due to the fact that the peritoneal sac is not removed. These can be managed expectantly in most cases [8].

Summary

Laparoscopic incisional ventral hernia repair is a feasible technique, but patient selection is very important. Currently, it requires intraperitoneal prosthetic material as a patch. Hernias up to 2 cm in diameter should not be undertaken with this approach nor should a multirecurrent incisional hernia in a patient having well-known or suspected severe intraperitoneal adhesions. As with other laparoscopic procedures, we need good patient selection, honest knowledge of the surgeon's laparoscopic skills, and the attitude that conversion to open repair is not a failure. Laparoscopic repair of ventral hernias is also an effective modality for recurrent hernias that have been repaired anteriorly (open).

Laparoscopic inguinal hernia repair is clearly indicated for bilateral and/or recurrent inguinal hernias and should be offered to select unilateral primary inguinal hernia patients because the pain and the recurrences, in an expert's hands, are minor.

In patients without previous preperitoneal dissection, the totally extraperitoneal (TEP) approach is the best choice due to avoidance of the peritoneal cavity and the resultant potential for fewer major complications. However, we should not be hesitant to employ the transabdominal preperitoneal (TAPP) repair for TEP difficulties requiring conversion or when previous preperitoneal dissection is present.

A large piece of mesh should be used with adequate fixation to minimize both chronic pain and recurrence.

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