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Mesh Fixation Methods in Groin Hernia Surgery

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Abstract

No unanimous consent has been reached by surgeons in terms of a method for mesh fixation in laparoscopic and open surgery for inguinal hernia repair. Many different methods of fixation are available, and the choice of which one to use is still based on surgeons' preferences. At present, tissue glues, sutures, and laparoscopic tacks are the most common fixating methods. In open technique, sutures have been the method of choice for their reduced costs and surgeons' habits. Nevertheless, tissue glues have been demonstrated to be effective and safe. Similarly, tacks can be considered the most common means of fixation in laparoscopic hernia repair, but they are connected to a higher risk of complication and morbidity. In this chapter, we present these types of mesh fixation, their characteristics and potential risks, and advantages of their use.

Keywords: inguinal hernia, mesh, fixation, fixation techniques, fibrin glue, cyanoacrylic glue, tacks, suture

1. Introduction

Inguinal hernia repair is one of the most common procedures in surgical practice. In the surgical repair of groin hernia, prosthetic meshes and their fixation have been subject to debate. In the last decades, synthetic meshes have become crucial in surgical treatment of inguinal hernia. Once positioned, meshes are designed to be integrated in local tissue by a fibrotic reaction that gradually incorporates them. Therefore, a good fixation is essential to secure the mesh in its correct position, while the integration process occurs.

The introduction of synthetic meshes and their proper fixation has reduced recurrence rates to below 5%. As a consequence, the most frequent postoperative morbidities have become mesh migration, chronic pain, infection, and seroma [1, 2]. In surgical practice the main challenge in mesh fixation consists in finding a good balance between the strength of fixation, in order to avoid recurrence and the risk of tissue trauma and nerve entrapment, leading to chronic pain.

At present, various fixation techniques and materials have been developed, but no unanimous consent has been reached on the “best” method of fixation. The choice is still based on surgeon's preferences and experience, and much still depends on local habits and personal beliefs.

2. Mesh fixation

2.1 Fixation methods

The primary function of a fixation device is to keep the mesh in place until tissue ingrowth is completed. The interaction between mesh and tissue depends on the type of mesh; however, complete integration is usually achieved within 2–3 weeks after surgery. It is important to underline that shear strength is reached for 74% during the first 2 weeks. Until then, therefore, proper fixation is essential. Different types of fixation medium can be used in inguinal hernia surgery, the main ones being tissue glues, staples and tacks, and sutures.

2.1.1 Tissue glues

Tissue adhesives have been introduced in medical practice during the 1960s. Since then, they have been used in numerous procedures like skin closure, suture reinforcement, arteriovenous embolization, endoscopic treatment of ulcers and varices, and fixation of meshes in abdominal wall defect repair.

Two types of tissue adhesive for mesh fixation are available in surgical practice:

2.1.1.1 Fibrin glues (*Tisseel®*, *Tissucol®*, and *Evicel®*)

It is made of four components: human purified fibrinogen, bovine atropine solution, human thrombin, and calcium chloride. Alongside its hemostatic action, the fibrinogen component gives the product tensile strength and adhesive properties. It also promotes fibroblast proliferation [3]. These are mixed at the time of fixation to duplicate the terminal coagulation reaction and generate polymerized fibrin [4]. Once applied to the mesh, 3 min may be required to complete the reaction [5].

2.1.1.2 Cyanoacrylic tissue glues (*Histoacryl®*, *Glubran®*, and *Glubran-2®*)

These glues are synthetic (n-butyl-cyanoacrylate) or hybrid tissue sealants. They are known for strong and rapid adhesive properties. Cyanoacrylic glues ensure high-degree and strong bonding to biologic tissues when compared with other adhesives. When they get in contact with blood or water contained in the tissue, they form a very tight cover, binding to the surface within 5–6 s [6]. Glubran-2 is the most recently produced tissue adhesive. Its peculiarity is a longer radical chain with a lower temperature of polymerization compared to Histoacryl®, which results in lower toxicity and fewer inflammatory reactions [7].

At present, there is no evidence in medical literature as to which glue may be considered better in mesh fixation during inguinal hernia repair. Nevertheless, it must be remarked that using glue for mesh fixation increases the costs of hernioplasty, if compared with sutures.

2.1.2 Tacks

Tack fixation has been performed since the introduction of laparoscopic inguinal and ventral hernia repair between the late 1980s and the early 1990s. In current practice, three types of tacks are commonly used, divided into two categories: absorbable and nonabsorbable.

2.1.2.1 Helical titanium tacks (ProTack®)

It is a laparoscopic device, which places a helical coil into the fascia and muscle of the anterior abdominal wall. The tack itself has a helical shape, measures 4 mm in length and 3 mm in width, and penetrates approximately 3–4 mm into these tissues. To be placed correctly, tacks must be placed 1–1.5 cm apart, along the periphery of the mesh [8].

2.1.2.2 Helical nontitanium tacks (PermaFix®)

These tacks are made of polyacetal, a molded, polymer-based material. It is a permanent hollow tack with an atraumatic tip, 6.7 mm long [9].

2.1.2.3 Absorbable tacks (AbsorbaTack®, PermaSorb®, and SorbaFix®)

These tacks are made of polymers or copolymers (poly(D,L)-lactide or glycolide-co-L-lactide). They measure between 6.4 and 6.7 mm and adsorb in 12–16 months [9].

Overall, tacks provide an excellent fixation strength, and they are also easy to apply. Nevertheless, their use is associated with significant morbidity. The penetration of the abdominal wall, in fact, may cause nerve and vessel entrapment. Also, tacks are themselves foreign bodies introduced in the abdomen, so they may cause inflammatory reactions. As a result, a significant number of patients suffer from pain and develop adhesion in the postoperative period. Moreover, cases of migration of titanium tacks have been described. At present, absorbable tacks are connected to lower inflammation rates, adhesion formation, and migration so the use of titanium tacks is no longer advisable.

2.1.3 Sutures

Sutures commonly used in hernia repair are divided into two: absorbable and nonabsorbable, each characterized by a different degree of tension generated and a different time of strength loss due to degradation.

2.1.3.1 Absorbable sutures (poliglecaprone (Monocryl®), polyglactin (Vicryl®), polyglycolic acid (Dexon®), polyglyconate (Maxon®), and polydioxanone (PDS®))

Their loss of strength has been classified and varies from a minimum of 1 week (Monocryl®) to a maximum of 4–5 weeks (PDS®).

2.1.3.2 Nonabsorbable sutures (polypropylene (Prolene®) and polyamide (Nylon®))

These sutures are designed to retain most of their strength indefinitely.

International medical literature offers evidence that both absorbable and nonabsorbable sutures seem to provide enough strength and tension to prevent recurrence. International randomized trials do not seem to highlight significant difference between the two types of sutures in terms of postoperative complications.

Nevertheless, nonabsorbable suture seems to be connected to a higher incidence of postoperative pain due to entrapment of a nerve by suture or mesh [10].

2.2 Mesh fixation and surgical techniques

As mentioned above, several mesh fixation methods exist, including tacks, staples, self-fixing, fibrin sealants, synthetic glues, and sutures. Which method to choose to secure a mesh during surgical hernia repair depends on many factors such as personal beliefs, local habits and “dogmas,” type of the hernia, and size of the defect but, most of all, on surgical technique.

Two approaches to repair inguinal hernia are common practice in surgery: the open approach, usually the Lichtenstein technique, and the laparoscopic approach, meaning both preperitoneal and extraperitoneal repair.

2.2.1 Open technique

Groin hernioplasty is the most common operation in general surgery. Due to its lower costs, shorter operating times, and reduced complication risks, the open Lichtenstein technique is performed more frequently. Lichtenstein hernia repair, in fact, is simple, safe, and easy to learn, with very good results in terms of morbidity and a very low recurrence rate.

Both sutures (absorbable and nonabsorbable) and glues (fibrin and cyanoacrylic) can be used to seal the mesh to the abdominal wall.

According to standard operating technique, once the mesh is placed and adjusted, the upper edge is kept in place with two or three sutures, one to the rectus sheath and the others to the internal oblique aponeurosis. Also the lower lateral edges of each of the two tails of the mesh are fixed to the inguinal ligament, leaving enough space for the passage of the spermatic cord.

The use of tissue adhesive to secure the mesh has become an internationally accepted practice in the last few decades. In the sutureless technique, the mesh is fixated by using fibrin or cyanoacrylic glue, whose components get mixed during the operation. Once activated, the glue is poured beneath the mesh, covering the whole Hesselbach's triangle. The mesh is placed above the glue and pressed against the inguinal floor for about 2 min [11].

Suture mesh fixation in inguinal hernia repair represents the main source of complications, possibly leading to inflammation and surgical site infection (SSI), hematoma, nerve entrapment, and chronic pain.

A 2014 systematic review including 12 articles by Sanders et al. [12] found an infection rate between 0 and 3.5%, and no significant difference in terms of SSIs incidence was detected between the groups. Anyway, there is no study specifying the depth of infection, whether it was deep or superficial. This could lead to improper conclusions, being a deep infection more related to the presence of the mesh.

Pain is a very important outcome after surgical repair of groin hernia. Pain is defined as acute, when it occurs in the first week after the operation, and chronic, when it lasts beyond 3 months after surgery. Two RCTs, recently published in medical literature, have demonstrated a significant lower incidence of acute pain after using fibrin sealant ($p < 0.001$) [13] and cyanoacrylic glue ($p < 0.003$) [14] compared to suture fixation.

A recent meta-analysis, including 13 RCTs comparing glue versus suture mesh fixation in Lichtenstein inguinal hernia repair [15, 16], showed a lower incidence of early acute pain ($p = 0.03$) and hematoma in the glue fixation group. On the other hand, chronic pain is one of the main issues after hernioplasty, and sutureless

techniques were introduced in surgery in an attempt to reduce its incidence, without affecting recurrence rates. According to the international guidelines for groin hernia management, the incidence of chronic pain ranges from 0 to 36.3% [17]. In particular, 14.7% is for sutures, 7.6% for cyanoacrylic glues, and 3.7% for fibrin glues. Three international RCTs suggest that the use of fibrin or cyanoacrylic glue can reduce pain if compared to suture [10, 12]. In particular, the TIMELI international trial demonstrated that fibrin glue was connected to the reduction of chronic symptoms like numbness and discomfort after 1 year.

Among the possible complications, recurrence is possibly the one that concerns surgeons the most. According to Sanders et al.'s review, recurrence rate is 1.3%. There was no significant difference between fixation methods in any of the RCTs, although long-term recurrence rates have not been determined and large hernias often have been excluded.

Concluding, in open inguinal hernia repair, no differences in recurrence or surgical site infection between different mesh fixation methods have been reported in literature, while sutureless fixation may reduce the onset of acute and chronic pain. Therefore, according to HerniaSurge Group consensus, glue fixation in the Lichtenstein technique can be performed in direct or indirect hernias less than 3 cm large (MII or LII types, EHS classification).

2.2.2 Laparoscopic technique

At present, the two most common laparoscopic techniques for hernia repair are the transabdominal preperitoneal repair (TAPP) and the total extraperitoneal repair (TEP). Both techniques involve the placement of a mesh in the preperitoneal space that must cover all potential hernia sites. The mesh in the preperitoneal space is subject to intra-abdominal forces and may be easily displaced before fibrosis seals it to the inguinal canal. In particular, the medial edge of the mesh is most susceptible to displacement, leading to inevitable recurrence if the medial part of the inguinal canal gets exposed. This underlines the importance of fixation [18]. Tacks, glues, and sutures can all be used to fixate the mesh.

Arguably, the most popular technique among surgeons is the use of tacks. However, it is known that using tacks and staples to secure the mesh can lead to complications, such as chronic pain. During the mesh fixation, in fact, it is really important not to place any tack or staple below the iliopubic tract, avoiding the triangle of pain. Lateral fixation should also be avoided, to prevent inadvertent damage to the nerves. Also misplaced tacks are described in literature to be responsible for nerve irritation and injury. The alternatives of the use of tacks are tissue glues and sutures.

Sutures usually require expertise and longer operating times. Both absorbable and nonabsorbable sutures may be used to fixate mesh to the abdominal wall. Sutures are usually applied transfascially after reduction of intraperitoneal pressure. Suture type, quantity, and placement vary among surgeons and no "gold standard" technique has been established [19].

Tissue glues have been introduced in laparoscopic hernia repair to reduce morbidity, such as pain and hematoma, thanks to their atraumatic application and their hemostatic properties [20].

Several studies, including meta-analyses and RCTs, comparing complication rates after different fixation methods, have been produced.

Complications after TEP repair, using tacks against glue, have been analyzed in a recent review by Kaul et al. [21]. The authors included in the study four RCTs for a total of 664 procedures. According to their results, no significant difference in terms of SSIs rates could be registered.

Acute pain after TEP was analyzed in a randomized prospective trial by Lau in [22]. The study concluded that, even if glue group consumed significantly less analgesics compared to staple group ($p = 0.034$), no significant difference has been registered in the postoperative pain score in the first week after surgery. On the other hand, Kaul et al.'s review reported a significant difference in terms of chronic pain incidence between the two groups (OR 3.25; 95% CI 1.62–6.49).

As already said, recurrence is a very important outcome when it comes to inguinal hernia repair. According to the two meta-analyses present in literature, there is no evidence of a significant difference in terms of recurrence, after using tissue sealants or tacks to fix the mesh [21, 23].

Similar results can be found in literature about TAPP technique. In a recent meta-analyses by Shah et al. [24], including five randomized controlled trials and five non-RCTs, no significant differences were found in terms of acute pain, SSIs, or recurrence. Nevertheless, patients who underwent TAPP hernia repair, using tissue sealant for mesh fixation, experienced significant less chronic pain ($p = 0.005$). Several RCTs published in the last decade have confirmed these findings [25–27].

Concluding, international RCTs and several meta-analyses have proven tissue glue to be as safe as tacks in terms of recurrence and SSI. In addition, chronic pain was significantly less represented when tissue adhesives were used for the fixation of the mesh. Therefore, according to international guidelines, to minimize the risk of acute postoperative pain, atraumatic fixation techniques (fibrin glue, cyanoacrylate) should be considered.

3. Conclusions

When it comes to mesh fixation, no unanimous consent about technique has ever been reached. Several types of fixation methods exist such as tacks, staples, self-fixing, fibrin sealants, glues, and sutures. The choice of which method to use strongly depends on the type of surgery and the type of defect but also (and often decisively) on surgeons' personal beliefs and local habits. In open technique both sutures and tissue adhesives have been proven equally safe in terms of recurrence and wound infection, but glues are connected to less chronic pain onset. Therefore, glue fixation in the Lichtenstein technique can be performed in MII or LII types (EHS classification) hernias.

Similarly, in the laparoscopic approach, tacks or glues can be used to secure the mesh showing similar recurrence rates. Again, adhesive fixation is connected to less morbidity in terms of chronic pain.

In conclusion, international RCTs and recent meta-analyses have confirmed tissue adhesives to be a valid alternative to traditional sutures and tacks. When it comes to the choice of which fixation procedure to perform in inguinal hernia repair, many authors advise the use of tissue sealants to minimize the risks of chronic pain, justifying the higher costs due to the use of expensive glues.

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Conflict of interest

The authors do not have any conflict of interest.

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