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REVIEW ARTICLE

Mesh fixation techniques in laparoscopic hernia repair: A current evidence-based review

Laparoskopik fıtık onarımında mesh sabitleme teknikleri: Güncel kanıta dayalı bir derleme

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Abstract

This evidence-based review analyzes mesh fixation techniques in laparoscopic inguinal hernia repair, highlighting a significant shift from traditional penetrating methods, like tacks and sutures, to atraumatic alternatives such as tissue adhesives and non-fixation approaches. The primary driver for this change is the goal of minimizing chronic postoperative pain, a significant complication associated with traumatic fixation, while maintaining low hernia recurrence rates. For small to medium-sized hernias (<3-4 cm), numerous studies show that non-fixation, particularly in Totally Extraperitoneal (TEP) repair, and the use of adhesives do not increase recurrence but significantly reduce chronic pain, operative time, and costs. However, for large medial hernias, fixation is still recommended to prevent mesh migration and recurrence, with tissue adhesives presenting a safer alternative to tacks. The review concludes that the ideal fixation strategy is a "tailor-made" decision, balancing hernia characteristics, surgical technique, and patient factors to optimize outcomes, with emerging technologies like robotics and next-generation meshes promising even less painful solutions in the future.

Keywords: Laparoscopic inguinal hernia repair, mesh fixation, chronic pain, atraumatic fixation, recurrence.

Özet

Bu kanıta dayalı derleme, laparoskopik inguinal herni onarımındaki mesh tespit (fiksasyon) tekniklerini analiz etmekte ve zımba (tack) ve dikiş gibi geleneksel penetran (delici) yöntemlerden, doku yapıştırıcıları ve fiksasyonsuz yaklaşımlar gibi atravmatik alternatiflere doğru olan önemli kaymayı vurgulamaktadır. Bu değişimin arkasındaki temel neden, düşük fıtık nüks oranlarını korurken travmatik fiksasyonla ilişkili önemli bir komplikasyon olan kronik postoperatif ağrıyı en aza indirme hedefidir. Küçük ve orta büyüklükteki fıtıklar (<3-4 cm) için çok sayıda çalışma, özellikle Total Ekstraperitoneal (TEP) onarımda fiksasyon yapılmamasının ve yapıştırıcı kullanılmasının nüks oranlarını artırmadığını, ancak kronik ağrıyı, ameliyat süresini ve maliyetleri önemli ölçüde azalttığını göstermektedir. Bununla birlikte, büyük medial fıtıklarda mesh kaymasını ve nüksü önlemek için fiksasyon hâlâ önerilmekte olup, doku yapıştırıcıları zımbalara göre daha güvenli bir alternatif sunmaktadır. Derleme, ideal fiksasyon stratejisinin, sonuçları optimize etmek için fıtığın özelliklerini, cerrahi tekniği ve hasta faktörlerini dengeleyen "kişiye özel" bir karar olduğu sonucuna varmaktadır. Robotik cerrahi ve yeni nesil meshler gibi gelişmekte olan teknolojiler ise gelecekte daha da ağrısız çözümler vadetmektedir.

Anahtar Kelimeler: Laparoskopik inguinal herni onarımı, mesh fiksasyonu, kronik ağrı, atravmatik fiksasyon, nüks.

INTRODUCTION

Inguinal hernia repair is one of the most frequently performed procedures in general surgery (1). Minimal-access laparoscopic methods have become the standard of care, particularly for bilateral and recurrent hernias, due to advantages such as reduced postoperative pain, faster recovery, and an earlier return to normal activities (2). The most significant development in hernia surgery has been the widespread use of synthetic mesh based on the "tension-free repair" principle (3). The use of mesh has historically led to a significant decrease in recurrence rates. In laparoscopic repair, the primary function of the mesh is to broadly cover the hernia defect, thereby distributing intra-abdominal pressure and serving as a scaffold for tissue integration (4). The purpose of mesh fixation is to prevent mesh migration, thus minimizing the risk of recurrence (5). However, traumatic fixation methods such as tacks or sutures are a leading cause of chronic postoperative inguinal pain (inguinodynia), which can severely impact a patient's quality of life by causing nerve damage (2).

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This situation has reshaped the definition of success in hernia surgery. In the last decade, preventing chronic pain and maximizing patient quality of life have become primary goals, alongside low recurrence rates (2). This paradigm shift has led surgeons to explore atraumatic alternatives such as tissue adhesives and non-fixation approaches. The purpose of this review is to synthesize the literature of the last decade and compare penetrating, non-penetrating, and fixation-free mesh fixation techniques used in laparoscopic inguinal hernia repair, considering the delicate balance between recurrence rates and chronic pain.

Laparoscopic Repair Techniques and Their Effects on Fixation Strategy

There are two primary approaches to laparoscopic inguinal hernia repair: Transabdominal Preperitoneal (TAPP) and Totally Extraperitoneal (TEP) (1). Both techniques are based on the principle of placing a large mesh in the preperitoneal space to cover the hernia defects (4).

TAPP (Transabdominal Preperitoneal) Repair: This method involves entering the abdominal cavity, incising the peritoneum, and accessing the preperitoneal space to place the mesh. It offers a large working space and clear anatomical orientation. However, there is a theoretically higher risk of organ injury due to entry into the peritoneal cavity (2).

TEP (Totally Extraperitoneal) Repair: This procedure is performed entirely outside the peritoneal space. Since the peritoneal integrity is maintained, the theoretical risk of intra-abdominal organ injury and adhesions is minimized. However, the learning curve is steeper, and the working space is more limited (6).

The impact of these two approaches on fixation strategies differs. TAPP enables surgeons to reach directly at this region through an incision within the abdominal wall, increasing their familiarity with anatomical orientation generally, whereas TEP avoids accessing the peritoneal cavity, lowering the risk of intra-abdominal complications (7). Therefore, guidelines from bodies like the European Hernia Society (EHS) recommend a non-fixation approach as standard in TEP repair (2). In the TAPP technique, however, because the peritoneum is incised and repaired, this natural pressure effect is less reliable, and surgeons may be more inclined to fixate the mesh, especially in large hernias.

In laparoscopic bilateral inguinal hernia repair, the choice of mesh fixation technique critically balances recurrence risk against postoperative morbidity. Meta-analyses consistently demonstrate that fibrin glue fixation significantly reduces both acute and chronic postoperative pain and hematoma formation compared to tacker-based mechanical fixation, without increasing hernia recurrence rates (8). Self-fixating (self-gripping) meshes have also emerged as a viable alternative, offering equivalent fixation strength and enabling faster recovery and similar recurrence outcomes when compared with conventional self-adhesive meshes. Consequently, non-penetrating fixation methods—glue or self-fixating meshes—are often favored in contemporary minimally invasive bilateral repairs to improve patient comfort without compromising long-term success (9).

Mesh Fixation Methods: Advantages and Disadvantages

Mesh fixation methods can be classified based on their mechanism of tissue penetration as penetrating (mechanical), non-penetrating (atraumatic), and fixation-free (5).

Penetrating (Mechanical) Fixation: Tacks and Sutures

These methods secure the mesh by piercing or suturing it to the tissue. They provide strong fixation but carry the potential for tissue trauma and nerve damage.

- Tacks: Made of metallic (permanent) or absorbable (biodegradable) materials. Although they are quick and practical, permanent metallic tacks in particular carry risks such as chronic pain, permanent foreign body reaction, and imaging artifacts (10). While absorbable tacks aim to reduce these risks, there is evidence that the absorption process itself can be a source of inflammatory reaction and pain (10).
- Sutures: This is one of the strongest fixation methods, but it is time-consuming and has the highest risk of causing severe chronic pain due to nerve entrapment along the suture line (10).

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Non-Penetrating (Atraumatic) Fixation: Adhesives and Self-Fixating Meshes

These methods work on the principle of adhesion without piercing the tissue and aim to reduce the risk of chronic pain.

- Tissue Adhesives (Glues): Can be fibrin-based (biological) or cyanoacrylate-based (synthetic). Numerous studies have shown that adhesives significantly reduce the risk of chronic pain compared to tacks (11). Fibrin glues are fully biocompatible, whereas cyanoacrylate adhesives offer more practical, cheaper, and stronger adhesion (12).
- Self-Fixating Meshes: Their surfaces are coated with micro-hooks (e.g., ProGrip™) or an adhesive gel (e.g., Adhesix™). They eliminate the need for an additional fixation device, thereby shortening the operative time and avoiding fixation-related complications (5). Their main disadvantage is their high cost.

Non-Fixation Approach

The rationale behind this approach is that when a sufficiently wide dissection is performed and a large enough mesh is used to overlap the hernia defect by at least 3-5 cm, the intra-abdominal pressure will be adequate to hold the mesh in place (5). Numerous meta-analyses have proven that in small to medium-sized hernias (<3-4 cm), a non-fixation approach does not increase recurrence rates but significantly reduces operative time, cost, and most importantly, postoperative acute and chronic pain (6).

Evidence-Based Evaluation of Clinical Outcomes

Chronic Pain and Recurrence Rates

The most critical balance in the choice of fixation technique is between chronic pain and recurrence rates.

Chronic Pain: The most consistent finding in the literature is that atraumatic fixation methods (adhesives) and the non-fixation approach statistically significantly reduce the incidence of chronic pain compared to mechanical fixation methods (tacks, sutures) (11). In a study by Öner (2023), the chronic pain rate was 2.2% in the group using cyanoacrylate adhesive, while it was 12.3% in the group using absorbable tacks (p=0.008) (12).

Hernia Recurrence: It is generally accepted that for small and medium-sized hernia defects (<3-4 cm), there is no significant difference in recurrence rates among different fixation methods (tacks, adhesives, non-fixation) (13). This suggests that adequate preperitoneal dissection and the use of an appropriately sized mesh are more critical in preventing mesh migration than fixation itself.

The most important exception to this general consensus is large medial hernias. EHS guidelines strongly recommend fixation for large medial direct hernias, defined as M3 in the EHS classification, to reduce the risk of mesh migration and consequently, recurrence (2).

Safe Fixation and a Personalized Approach

In laparoscopic inguinal hernia repair, it is vital to be aware of two potentially dangerous anatomical triangles during mesh fixation: the Triangle of Doom, which is bordered by the vas deferens medially and the spermatic vessels laterally and contains major vessels such as the external iliac artery and vein, and the Triangle of Pain, which is bordered by the iliopubic tract superiorly and the gonadal vessels medially and contains important nerves including the lateral femoral cutaneous nerve, femoral branch of the genitofemoral nerve, and femoral nerve (4). Applying penetrating fixation in these areas can lead to life-threatening bleeding or severe chronic neuropathic pain. Safe fixation points include the Cooper's ligament medially and the anterior abdominal wall muscles superiorly/laterally (4).

Modern hernia surgery adopts a "tailor-made" treatment philosophy (1). The fixation strategy is central to this personalized approach. The decision to fixate requires a risk-benefit analysis based on factors such as the size and type of the hernia, the surgical technique used (TAPP/TEP), the patient's activity level, and the surgeon's experience.

Future Perspectives

Hernia surgery and mesh technology continue to evolve dynamically.

Robotic Surgery: Robotic platforms, with their 3D

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imaging and superior maneuverability, are making suture fixation, which is technically challenging in conventional laparoscopy, more practical (14). This may allow surgeons to utilize the high fixation strength of sutures without the risk of nerve damage that can be caused by tacks. Current meta-analyses show no significant difference in recurrence and complication rates between robotic TAPP (rTAPP) and laparoscopic TAPP (LTAPP), but rTAPP is associated with longer operative times and higher costs (15).

New Generation Meshes: Biosynthetic and fully absorbable meshes aim to reduce permanent foreign body reactions and the risk of mesh-related chronic pain by serving as a temporary scaffold for the body's own tissue regeneration before being absorbed over time (16). Innovations such as 3D-printed patient-specific meshes and drug-eluting "smart" meshes hold the potential to further reduce or completely eliminate the need for fixation in the future (17).

CONCLUSION

Mesh fixation in laparoscopic inguinal hernia repair is a "balancing act" that requires careful consideration of the trade-off between the risk of recurrence and the risk of chronic pain.

The literature of the last decade shows a clear trend away from penetrating methods towards atraumatic (adhesive) and non-fixation approaches, which have been proven to reduce the risk of chronic pain.

In small and medium-sized hernias, especially in TEP repair, the non-fixation approach offers significant advantages in terms of pain, cost, and operative time without increasing recurrence rates.

In situations where fixation is necessary, such as large medial hernias, tissue adhesives are an effective and safe alternative to tacks, significantly reducing the risk of chronic pain.

The final fixation strategy should be personalized based on evidence-based medicine principles, taking into account the hernia's anatomy, the laparoscopic technique used, the surgeon's experience, and patient factors.

The future of hernia surgery will be built not only on stronger repairs but also on technologies and strategies that offer more painless and comfortable outcomes for patients.

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