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Modern Hernia Repair: Advances in Laparoscopic Techniques, Mesh Innovations, and Postoperative Outcomes

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Abstract

Aim:
To assess the clinical results of contemporary hernia repair, with a focus on mesh advancements, laparoscopic methods, and recovery following surgery.

Methodology:
Patient records pertaining to laparoscopic mesh-reinforced inguinal, ventral, and incisional hernia repairs from January 2015 to December 2024 were examined in this retrospective study. We looked at intraoperative parameters, mesh types, surgical methods, demographic factors, and postoperative results. Patients who had emergency surgery, incomplete medical records, or a follow-up of less than a year were not included.

Results:
There were 184 patients in all, and the most prevalent kind (61.4%) was an inguinal hernia. Lightweight polypropylene mesh was most commonly used (62.5%), and TAPP was the most common technique (54.9%). The average hospital stay was 2.3 days, and the average operating time was 78.4 minutes. At follow-up, quality of life significantly improved, but postoperative complications occurred in 14.1% of cases, chronic pain in 7.6%, and recurrence in 3.8%.

Conclusion:
Modern mesh technologies for laparoscopic hernia repair are safe, effective, and linked to lower rates of complications and recurrence as well as better patient recovery and quality of life.

Keywords: Laparoscopic hernia repair, mesh innovations, postoperative outcomes, recurrence, quality of life

Background

The widespread use of laparoscopic procedures and ongoing advancements in mesh technology have significantly changed the landscape of modern hernia repair. Smaller incisions, less postoperative pain, shorter hospital stays, and a quicker return to normal activities are just a few of the well-established benefits that laparoscopic repair offers over traditional open techniques. Many patients and surgeons now favour minimally invasive repair because of these advantages, especially when early recovery and lower morbidity are top concerns. Mesh design advancements have changed clinical practice in tandem with these surgical innovations. Complications like nerve damage, haematomas, and persistent pain are frequently linked to traditional fixation techniques that use sutures or tacks. Newer meshes, especially self-fixating and self-gripping types, have been created to solve these problems. By adhering to tissue without the use of extra fixation tools, these designs hope to lessen fixation-related issues and enhance patient comfort. The effectiveness of these innovative meshes has been strongly supported by randomised controlled trials. Laparoscopic inguinal hernia repair using self-fixated meshes produced excellent safety profiles and aided in a speedy recovery following surgery, as shown by Thölix et al. (1). Building on these results, Thölix et al. (2) confirmed the long-term reliability of self-fixated meshes by reporting positive one-year results in open hernia repair. In a similar vein, Denham et al. (3) examined self-fixating versus non-fixating meshes in laparoscopic repair and found that self-fixation shortened operating times without sacrificing recurrence rates. Pierides et al. (4) demonstrated that self-fixating meshes simplified the surgical procedure while producing results that were comparable to sutured fixation in open repair. Guerron et al. (5) further illustrated the viability of employing self-fixating meshes for laparoscopic single-site repair, thereby enhancing their adaptability in minimally invasive techniques. Additionally, Verhagen et al. (6) verified that self-gripping meshes

produced results comparable to those of conventional polypropylene meshes, with the added advantage of completely removing the need for sutures. When taken as a whole, these studies demonstrate how mesh innovations enhance safety and efficiency by complementing laparoscopic techniques. Self-fixating and self-gripping meshes are a significant development in contemporary hernia repair because they shorten operating times, minimise fixation-related complications, and promote long-lasting, long-term results.

Methodology

To assess the results of contemporary hernia repair, a retrospective clinical study was conducted, paying special attention to laparoscopic procedures, mesh design advancements, and related postoperative outcomes. The study comprised a thorough examination of the Department of General Surgery's patient records from January 2015 to December 2024, a ten-year span. The inclusion criteria included all patients who had had laparoscopic mesh-reinforced hernia repair, including inguinal, ventral, and incisional hernias. The type of hernia, the particular laparoscopic technique used, the mesh type, the fixation method, and intraoperative parameters like operative time and any procedural complications were all documented, along with important patient demographics like age, sex, and comorbidities. The length of hospital stay, postoperative pain as measured by standardised pain scales, complications related to wounds and mesh, recurrence rates, and patient-reported quality of life were all systematically evaluated as postoperative outcomes. During follow-up, radiological imaging and clinical evaluations were utilised to confirm chronic pain or recurrence. To guarantee data reliability, patients with emergency procedures, incomplete documentation, or follow-up times shorter than a year were not included. To protect patient privacy, data collection was anonymised, and the study received institutional review board ethical approval before it started. The collected data was examined to find trends in the results, evaluate the influence of various mesh advancements, and contrast the efficacy of different laparoscopic methods. The focus was on assessing the effectiveness, safety, and long-term viability of contemporary hernia repair techniques. The study sought to offer a thorough grasp of current procedures in laparoscopic hernia repair as well as the clinical ramifications of developing mesh technologies by methodically analysing these parameters.

Results

The study included 184 patients who had laparoscopic hernia repair between January 2015 and December 2024. The patients' average age was 48.6 ± 12.3 years, and their male to female ratio was 2.4:1. Inguinal hernias were repaired the most frequently (61.4%), followed by ventral (25.5%) and incisional (13.1%). The most common technique was laparoscopic transabdominal preperitoneal (TAPP) repair (54.9%), followed by laparoscopic intraperitoneal onlay mesh (IPOM) repair (12.5%) and totally extraperitoneal (TEP) repair (32.6%). Lightweight polypropylene mesh was utilised in most cases (62.5%), followed by composite meshes (25.0%) and biologic meshes (12.5%). The average hospital stay was 2.3 ± 0.9 days, and the average operating time was 78.4 ± 21.6 minutes. Seroma (6.0%) and surgical site infection (3.8%) were the most frequent postoperative complications, occurring in 14.1% of patients. 7.6% of patients reported having chronic pain at the 12-month follow-up. During the follow-up period, recurrence was reported in 3.8% of cases. At six months, patient-reported quality of life scores showed a significant improvement

over baseline. Table 1 shows a comprehensive distribution of surgical techniques, patient characteristics, and results.

Table 1. Clinical characteristics, surgical details, and postoperative outcomes of patients undergoing laparoscopic hernia repair

Parameter	n (%) or Mean ± SD
Total patients	184
Mean age (years)	48.6 ± 12.3
Sex (M:F)	130 (70.6%) : 54 (29.4%)
Hernia type	
– Inguinal	113 (61.4%)
– Ventral	47 (25.5%)
– Incisional	24 (13.1%)
Surgical technique	
– TAPP	101 (54.9%)
– TEP	60 (32.6%)
– IPOM	23 (12.5%)
Mesh type	
– Lightweight polypropylene	115 (62.5%)
– Composite mesh	46 (25.0%)
– Biologic mesh	23 (12.5%)
Operative time (min)	78.4 ± 21.6
Hospital stay (days)	2.3 ± 0.9
Postoperative complications	26 (14.1%)
– Seroma	11 (6.0%)
– Infection	7 (3.8%)
– Hematoma	5 (2.7%)

Parameter	n (%) or Mean ± SD
– Others	3 (1.6%)
Chronic pain (>12 months)	14 (7.6%)
Recurrence	7 (3.8%)
Improved QoL at 6 months	159 (86.4%)

Discussion

Over the past 20 years, a major focus of surgical research has been the relative efficacy of open versus laparoscopic hernia repair. Even though both strategies are still frequently used, mounting data indicates significant variations in patient outcomes that inform surgical judgement. In a seminal randomised controlled trial, Neumayer et al. (7) showed that laparoscopic repair offers the benefits of less postoperative pain and a quicker return to regular activities. They did, however, also note a marginally elevated risk of intraoperative complications, specifically harm to surrounding structures, highlighting the challenging learning curve that comes with minimally invasive procedures. Training protocols have been impacted by this discovery, which highlights the significance of surgical proficiency in guaranteeing the security of laparoscopic procedures. On the basis of this, Dedemadi et al. (8) carried out a meta-analysis contrasting open and laparoscopic repair for recurrent hernias. According to their findings, laparoscopy is the recommended treatment for patients with recurrent disease because it clearly has advantages, especially in terms of reduced complication rates and enhanced recovery. In a systematic review, Yang and Deng (9) further supported these findings by stating that, while recurrence rates were similar to those of open repair, laparoscopic repair produced better short-term results, particularly in terms of postoperative pain and mobility. These results imply that early recovery and decreased morbidity are the primary advantages of laparoscopy, while long-term durability remains comparable across methods. Another crucial aspect of primary unilateral hernias was brought to light by Bullen et al. (10) who demonstrated that laparoscopic repair offers patients a balanced benefit by lowering the risk of chronic pain, a significant determinant of quality of life, without compromising recurrence outcomes. Mesh fixation is a key component of contemporary hernia surgery. In their evaluation of various fixation techniques for laparoscopic ventral hernia repair, Ahmed et al. (11) discovered that non-fixation or atraumatic fixation techniques were linked to lower postoperative pain than conventional tacks or sutures. Crucially, recurrence rates were unaffected, suggesting that less invasive fixation techniques can offer similar durability while enhancing patient comfort. By contrasting robotic and laparoscopic ventral hernia repair, Petro et al. (12) expanded this conversation into the field of robotic surgery. According to their randomised trial, robotic repair produced better patient-reported outcomes, especially when it came to postoperative pain, functional recovery, and general satisfaction. Despite the fact that robotic surgery is more expensive, its advantages for quality of life are indisputable. Additional support was offered by Dhanani et al. (13) who reported two-year follow-up results that demonstrated the durability of robotic repair outcomes, thereby reaffirming its potential use in complex cases or in facilities with sophisticated surgical infrastructure. Another crucial factor that affects results is the mesh material selection. In their comparison of synthetic and biologic meshes for complex ventral

hernia repairs, Olavarria et al. (14) showed that synthetic meshes were linked to better long-term results and fewer complications. Given the high expense of biologic meshes, which frequently prevents their routine use, this finding is noteworthy. By comparing patient-reported outcomes in abdominal wall repairs using synthetic versus biosynthetic meshes, Kulkarni et al. (15) contributed to this knowledge by discovering that synthetic materials produced better functional and comfort outcomes. Their results highlight the usefulness and dependability of synthetic meshes in the majority of clinical settings. As the gold standard for long-lasting hernia repair, synthetic meshes routinely outperform biologic meshes in recurrence prevention, according to a systematic review and meta-analysis conducted by Figueiredo et al. (16). Last but not least, Eltair et al. (17) thoroughly examined mesh fixation techniques in laparoscopic groin hernia repair and found that, although the fixation method had no discernible impact on recurrence rates, it did affect early postoperative pain. This implies that non-fixation or atraumatic methods might be better, particularly for patients whose main concern is postoperative pain. When combined, these results show that improvements in mesh technology, fixation techniques, and surgical technique have all contributed to the multifaceted evolution of contemporary hernia repair. Robotic surgery is becoming a viable substitute with better patient-reported results, but laparoscopy has clear benefits in terms of less postoperative pain and a faster recovery. The choice of mesh is still crucial, with synthetic meshes showing better safety and efficacy than biologic or biosynthetic alternatives. In the end, the key to improving hernia repair results is still customising the surgical strategy and mesh selection to each patient's unique characteristics.

Conclusion

When using contemporary mesh innovations, laparoscopic hernia repair showed promising results with low rates of complications and recurrence. Shorter hospital stays, manageable operating times, and enhanced patient-reported quality of life were all benefits of the procedures. These results lend credence to laparoscopic repair as a secure and successful treatment method for incisional, ventral, and inguinal hernias**.**

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