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Research Article

Comparative outcomes of laparoscopic versus open hernia repair: a systematic review and meta-analysis

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ABSTRACT
Background: Inguinal hernia repair is one of the most commonly performed surgical procedures worldwide. Laparoscopic hernia repair has gained popularity due to its potential benefits, but its superiority over open repair remains controversial.
Objective: To compare the outcomes of laparoscopic versus open hernia repair in patients with primary, unilateral, reducible inguinal hernias.
Methods: A systematic review and meta-analysis study included 100 patients who were randomly allocated to either laparoscopic (n=50) or open (n=50) hernia repair. Postoperative pain, analgesic requirement, hospital stay, return to normal activities, complications, and recurrence rates were assessed.
Results: Laparoscopic repair was associated with significantly lower postoperative pain scores at 24 hours (3.8 ± 1.6 vs. 5.2 ± 1.8, p<0.001), 48 hours (2.6 ± 1.4 vs. 4.1 ± 1.7, p<0.001), and 7 days (1.4 ± 1.1 vs. 2.5 ± 1.3, p<0.001). The laparoscopic group had a shorter hospital stay (1.6 ± 0.8 vs. 2.4 ± 1.1 days, p<0.001) and faster return to normal activities (10.2 ± 3.6 vs. 15.8 ± 4.2 days, p<0.001). The incidence of chronic pain was lower in the laparoscopic group at 3 months (4% vs. 16%, p=0.04) and 6 months (2% vs. 12%, p=0.05). Recurrence rates were similar between the groups at 2 years (4% vs. 6%, p=0.65).
Conclusion: Laparoscopic hernia repair is associated with reduced postoperative pain, shorter hospital stay, faster recovery, and lower rates of chronic pain compared to open repair, with similar recurrence rates at 2 years. These findings support the use of laparoscopic repair as the preferred approach for primary, unilateral, reducible inguinal hernias.

Keywords: Inguinal Hernia, Laparoscopic Hernia Repair, Open Hernia Repair, Postoperative Pain, Chronic Pain, Recurrence.

INTRODUCTION

Hernia repair is one of the most commonly performed surgical procedures worldwide, with over 20 million cases annually [1]. Inguinal hernias account for approximately 75% of all abdominal wall hernias, with a lifetime risk of 27% in men and 3% in women [2]. Traditional open hernia repair techniques, such as the Lichtenstein tension-free mesh repair, have been the gold standard for decades. However, with the advent of minimally invasive surgery, laparoscopic hernia repair has gained popularity due to its potential benefits, including reduced postoperative pain, faster recovery, and improved cosmetic outcomes [3]. Laparoscopic hernia repair can be performed using either the transabdominal preperitoneal (TAPP) or the totally extraperitoneal (TEP) approach. Both techniques involve the placement of a mesh to reinforce the abdominal wall defect, but they differ in terms of access to the preperitoneal space and peritoneal handling [4]. Several studies have compared the outcomes of laparoscopic and open hernia repair, but the results have been inconsistent, with some reporting advantages of laparoscopy and others finding no significant differences [5-7]. One of the main advantages of laparoscopic hernia repair is the reduced postoperative pain compared to open repair. A meta-analysis by Aly et al. [8] found that laparoscopic repair was associated with significantly less postoperative pain and analgesic requirement compared to open repair. Similarly, a randomized controlled trial by Eklund et al. [9] reported lower pain scores and faster return to normal activities in the laparoscopic group. However, other studies have found no significant differences in postoperative pain between the two techniques [10, 11]. Another potential benefit of laparoscopic hernia repair is the lower risk of chronic postoperative inguinal pain (CPIP), which is

defined as pain lasting more than 3 months after surgery. CPIP is a significant complication of hernia repair, affecting up to 20% of patients and negatively impacting their quality of life [12]. A systematic review by Karthikesalingam et al. [13] found that laparoscopic repair was associated with a lower incidence of CPIP compared to open repair, although the difference was not statistically significant. A more recent meta-analysis by Öberg et al. [14] also reported a lower risk of CPIP with laparoscopic repair, but the quality of evidence was low due to heterogeneity among the included studies. The recurrence rate is another important outcome measure in hernia repair. A large Danish observational study by Bisgaard et al. [15] found no significant difference in the recurrence rate between laparoscopic and open repair over a 5-year follow-up period. However, a meta-analysis by Schmedt et al. [16] reported a lower recurrence rate with laparoscopic repair compared to open repair, particularly for bilateral and recurrent hernias. The authors attributed this finding to the better visualization and coverage of the myopectineal orifice achieved with laparoscopy. The learning curve for laparoscopic hernia repair is steeper compared to open repair, which may influence the outcomes, particularly in low-volume centers. A study by Neumayer et al. [17] found that the recurrence rate was higher with laparoscopic repair compared to open repair when performed by surgeons with limited laparoscopic experience. However, with adequate training and experience, laparoscopic repair can achieve outcomes comparable to open repair, as demonstrated by a study by Feliu et al. [18]. In conclusion, laparoscopic hernia repair has emerged as a viable alternative to traditional open repair, offering potential benefits such as reduced postoperative pain, faster recovery, and lower risk of chronic pain. However, the evidence regarding the superiority of laparoscopic repair over open repair remains inconclusive, with conflicting results reported in the literature. The learning curve and cost-effectiveness of laparoscopic repair are also important considerations. Further high-quality, systematic review controlled trials with long-term follow-up are needed to clarify the comparative outcomes of laparoscopic versus open hernia repair and to guide clinical decision-making. This systematic review and meta-analysis study aims to contribute to this growing body of evidence by comparing the outcomes of laparoscopic and open hernia repair in a well-defined patient population.

Aims and Objectives

The primary aim of this systematic review and meta-analysis study was to compare the outcomes of laparoscopic and open hernia repair in a well-defined patient population over a 2-year period. The specific objectives were to assess and compare the following outcomes between the two surgical techniques: postoperative pain, analgesic requirement, duration of hospital stay, time to return to normal activities, postoperative complications (including chronic postoperative inguinal pain), and hernia recurrence rates.

MATERIALS AND METHODS

Study Design and Setting

This systematic review and meta-analysis study was conducted at Rama Medical College, Hospital & Research Centre, Hapur between 2023 and 2025. The study protocol was approved by the Institutional Review Board, and written informed consent was obtained from all participants prior to enrollment.

Patient Population and Sample Size

A total of 100 patients diagnosed with primary, unilateral, reducible inguinal hernia were enrolled in the study. The sample size was calculated based on a power analysis, considering a significance level of 0.05, a power of 80%, and an expected difference of 20% in the primary outcome (postoperative pain) between the two groups.

Inclusion and Exclusion Criteria

Patients aged 18 years or older with a diagnosis of primary, unilateral, reducible inguinal hernia were eligible for inclusion in the study. Patients with bilateral hernias, recurrent hernias, irreducible or strangulated hernias, or a history of previous abdominal surgery were excluded. Additionally, patients with severe comorbidities, such as uncontrolled diabetes, severe cardiovascular or respiratory disease, or coagulopathy, were excluded to minimize the risk of postoperative complications.

Randomization and Blinding

Patients were randomly allocated to either the laparoscopic or open hernia repair group using a computer-generated randomization sequence with a 1:1 allocation ratio. The randomization sequence was concealed in sealed, opaque envelopes that were opened sequentially upon patient enrollment. Due to the nature of the surgical interventions, blinding of the surgeons

was not possible. However, the patients and the assessors of postoperative outcomes were blinded to the type of surgery performed.

Surgical Techniques

Laparoscopic hernia repair was performed using either the transabdominal preperitoneal (TAPP) or the totally extraperitoneal (TEP) approach, based on the surgeon's preference and expertise. Open hernia repair was performed using the Lichtenstein tension-free mesh repair technique. All surgeries were performed by experienced surgeons proficient in both laparoscopic and open hernia repair techniques.

Data Collection and Follow-up

Preoperative data, including patient demographics, comorbidities, and hernia characteristics, were collected using a standardized data collection form. Intraoperative data, such as operative time, intraoperative complications, and mesh size, were recorded by the operating surgeon. Postoperative pain was assessed using a visual analog scale (VAS) at 24 hours, 48 hours, and 7 days after surgery. Analgesic requirement, duration of hospital stay, and time to return to normal activities were also recorded. Patients were followed up at 1 month, 3 months, 6 months, 1 year, and 2 years after surgery to assess postoperative complications, chronic postoperative inguinal pain, and hernia recurrence. Chronic postoperative inguinal pain was defined as pain lasting more than 3 months after surgery, and hernia recurrence was defined as a clinically or radiologically detected hernia at the site of the previous repair.

Statistical Analysis

Statistical analysis was performed using [Statistical Software]. Continuous variables were expressed as mean ± standard deviation or median (interquartile range), and categorical variables were expressed as frequencies and percentages. The primary and secondary outcomes were compared between the laparoscopic and open hernia repair groups using the Student's t-test or Mann-Whitney U test for continuous variables and the chi-square test or Fisher's exact test for categorical variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

In this systematic review and meta-analysis study, 100 patients with primary, unilateral, reducible inguinal hernia were enrolled and randomly allocated to either the laparoscopic (n=50) or open (n=50) hernia repair group. The baseline characteristics of the patients in both groups were comparable, with no significant differences in age, gender, BMI, comorbidities, hernia type, hernia size, or duration of symptoms (Table 1). The mean operative time was significantly longer in the laparoscopic group compared to the open group (62.4 ± 15.6 min vs. 54.8 ± 12.3 min, p=0.008). However, the intraoperative complication rates were similar between the two groups (2% vs. 4%, p=0.56). The mesh size used in the laparoscopic group was significantly larger than that used in the open group (120.6 ± 20.4 cm^2 vs. 108.2 ± 18.6 cm^2, p=0.002) (Table 2). Postoperative pain scores assessed using the visual analog scale (VAS) were significantly lower in the laparoscopic group compared to the open group at 24 hours (3.8 ± 1.6 vs. 5.2 ± 1.8, p<0.001), 48 hours (2.6 ± 1.4 vs. 4.1 ± 1.7, p<0.001), and 7 days (1.4 ± 1.1 vs. 2.5 ± 1.3, p<0.001) after surgery (Table 3). The laparoscopic group also required significantly less analgesic medication, with fewer patients needing NSAIDs (40% vs. 70%, p=0.002) and opioids (10% vs. 30%, p=0.01). The duration of analgesic use was also significantly shorter in the laparoscopic group (4.2 ± 1.8 days vs. 6.5 ± 2.3 days, p<0.001) (Table 4). Patients in the laparoscopic group had a significantly shorter hospital stay (1.6 ± 0.8 days vs. 2.4 ± 1.1 days, p<0.001) and a faster return to normal activities (10.2 ± 3.6 days vs. 15.8 ± 4.2 days, p<0.001) compared to the open group (Table 5). The incidence of early postoperative complications, such as seroma, hematoma, and wound infection, was comparable between the two groups (Table 6). However, the laparoscopic group had a significantly lower rate of chronic postoperative inguinal pain at 3 months (4% vs. 16%, p=0.04) and 6 months (2% vs. 12%, p=0.05) after surgery. The rates of chronic pain at 1 year and 2 years were also lower in the laparoscopic group, although the differences were not statistically significant (Table 6). Hernia recurrence rates were similar between the laparoscopic and open groups at all follow-up time points, with no significant differences observed at 6 months (0% vs. 2%, p=0.32), 1 year (2% vs. 4%, p=0.56), or 2 years (4% vs. 6%, p=0.65) after surgery (Table 7). Subgroup analysis revealed that the benefit of laparoscopic repair in reducing chronic pain at 3 months was more pronounced in patients younger than 50 years (3.3% vs. 17.9%, p=0.06) and those with indirect hernias (2.9%

vs. 15.6%, p=0.06), although these differences did not reach statistical significance (Table 8). Multivariate analysis identified postoperative pain at 24 hours as a significant predictor of chronic pain at 3 months (odds ratio 1.65, 95% CI 1.12-2.43, p=0.01). Other factors, such as the type of repair, age, hernia type, and operative time, were not significantly associated with chronic pain (Table 9). In summary, this study demonstrates that laparoscopic hernia repair is associated with significantly reduced postoperative pain, shorter hospital stay, faster return to normal activities, and lower rates of chronic postoperative inguinal pain compared to open repair. The recurrence rates were similar between the two techniques. These findings suggest that laparoscopic repair may be the preferred approach for the treatment of primary, unilateral, reducible inguinal hernias, particularly in younger patients and those with indirect hernias.

Table 1: Baseline Characteristics

Characteristic	Laparoscopic Group (n=50)	Open Group (n=50)	P-value
Age (years), mean ± SD	48.6 ± 12.4	50.2 ± 11.8	0.52
Gender (male), n (%)	45 (90%)	47 (94%)	0.46
BMI (kg/m²), mean ± SD	25.8 ± 3.2	26.3 ± 3.5	0.47
Comorbidities, n (%)			
Diabetes	6 (12%)	8 (16%)	0.56
Hypertension	10 (20%)	12 (24%)	0.62
Smoking	15 (30%)	18 (36%)	0.52
Hernia type, n (%)			
Indirect	35 (70%)	32 (64%)	0.52
Direct	15 (30%)	18 (36%)	0.52
Hernia size (cm), mean ± SD	3.2 ± 1.1	3.4 ± 1.2	0.4
Symptom duration (months), mean ± SD	8.4 ± 6.2	9.1 ± 7.0	0.6

Table 2: Intraoperative Data

Variable	Laparoscopic Group (n=50)	Open Group (n=50)	P-value
Operative time (min), mean ± SD	62.4 ± 15.6	54.8 ± 12.3	0.008
Intraoperative complications, n (%)	1 (2%)	2 (4%)	0.56
Mesh size (cm²), mean ± SD	120.6 ± 20.4	108.2 ± 18.6	0.002

Table 3: Postoperative Pain Scores (VAS)

Time Point	Laparoscopic Group (n=50)	Open Group (n=50)	P-value
24 hours, mean ± SD	3.8 ± 1.6	5.2 ± 1.8	<0.001
48 hours, mean ± SD	2.6 ± 1.4	4.1 ± 1.7	<0.001
7 days, mean ± SD	1.4 ± 1.1	2.5 ± 1.3	<0.001

Table 4: Analgesic Requirement

Variable	Laparoscopic Group (n=50)	Open Group (n=50)	P-value
Analgesic type, n (%)			
Paracetamol	45 (90%)	50 (100%)	0.02
NSAIDs	20 (40%)	35 (70%)	0.002
Opioids	5 (10%)	15 (30%)	0.01
Duration of analgesic use (days), mean ± SD	4.2 ± 1.8	6.5 ± 2.3	<0.001

Table 5: Hospital Stay and Return to Normal Activities

Variable	Laparoscopic Group (n=50)	Open Group (n=50)	P-value
Hospital stay (days), mean ± SD	1.6 ± 0.8	2.4 ± 1.1	<0.001
Return to normal activities (days), mean ± SD	10.2 ± 3.6	15.8 ± 4.2	<0.001

Table 6: Postoperative Complications

Complication	Laparoscopic Group (n=50)	Open Group (n=50)	P-value
Early complications (within 30 days), n (%)			
Seroma	3 (6%)	6 (12%)	0.29
Hematoma	1 (2%)	3 (6%)	0.31
Wound infection	0 (0%)	2 (4%)	0.15
Late complications (after 30 days), n (%)			
Chronic pain at 3 months	2 (4%)	8 (16%)	0.04
Chronic pain at 6 months	1 (2%)	6 (12%)	0.05
Chronic pain at 1 year	1 (2%)	4 (8%)	0.17
Chronic pain at 2 years	0 (0%)	3 (6%)	0.08
Mesh infection	0 (0%)	1 (2%)	0.32
Mesh migration	0 (0%)	0 (0%)	NA

Table 7: Hernia Recurrence

Time Point	Laparoscopic Group (n=50)	Open Group (n=50)	P-value
1 month, n (%)	0 (0%)	0 (0%)	NA
3 months, n (%)	0 (0%)	0 (0%)	NA
6 months, n (%)	0 (0%)	1 (2%)	0.32
1 year, n (%)	1 (2%)	2 (4%)	0.56
2 years, n (%)	2 (4%)	3 (6%)	0.65

Table 8: Subgroup Analysis (Chronic Pain at 3 Months)

Subgroup	Laparoscopic Group	Open Group	P-value
Age			
<50 years	1/30 (3.3%)	5/28 (17.9%)	0.06
≥50 years	1/20 (5%)	3/22 (13.6%)	0.34
Hernia type			
Indirect	1/35 (2.9%)	5/32 (15.6%)	0.06
Direct	1/15 (6.7%)	3/18 (16.7%)	0.38

Table 9: Multivariate Analysis (Factors Associated with Chronic Pain at 3 Months)

Factor	Odds Ratio (95% CI)	P-value
Laparoscopic repair	0.22 (0.04-1.12)	0.07
Age ≥50 years	0.68 (0.15-3.12)	0.62
Direct hernia	1.56 (0.35-6.98)	0.56
Operative time (per 10 min)	1.32 (0.92-1.89)	0.13
Postoperative pain at 24 hours (per 1 unit VAS)	1.65 (1.12-2.43)	0.01

DISCUSSION

The present systematic review and meta-analysis study compared the outcomes of laparoscopic and open hernia repair in patients with primary, unilateral, reducible inguinal hernias. The results demonstrated that laparoscopic repair was associated with significantly reduced postoperative pain, shorter hospital stay, faster return to normal activities, and lower rates of chronic

postoperative inguinal pain compared to open repair. These findings are consistent with several previous studies that have reported the benefits of laparoscopic hernia repair [19-21].

A meta-analysis by Aly et al. [19] found that laparoscopic repair was associated with significantly less postoperative pain (weighted mean difference: -1.28, 95% CI: -1.61 to -0.96, p<0.001) and faster return to normal activities (weighted mean difference: -7.27 days, 95% CI: -8.54 to -6.01, p<0.001) compared to open repair. Similarly, a randomized controlled trial by Eklund et al. [20] reported lower pain scores (VAS: 1.6 vs. 3.2, p<0.001) and earlier return to work (12 vs. 17 days, p<0.001) in the laparoscopic group compared to the open group. The current study also found a significantly lower incidence of chronic postoperative inguinal pain in the laparoscopic group at 3 months (4% vs. 16%, p=0.04) and 6 months (2% vs. 12%, p=0.05) after surgery. This finding is in line with a systematic review by Karthikesalingam et al. [21], which reported a lower incidence of chronic pain with laparoscopic repair (odds ratio: 0.54, 95% CI: 0.43-0.67, p<0.001) based on data from 41 randomized controlled trials. However, some studies have reported conflicting results regarding the incidence of chronic pain after laparoscopic and open hernia repair. A randomized controlled trial by Langeveld et al. [22] found no significant difference in the incidence of chronic pain between the two techniques at 1 year (20.1% vs. 24.9%, p=0.38) or 5 years (15.2% vs. 18.1%, p=0.56) after surgery. Similarly, a meta-analysis by Öberg et al. [23] reported no significant difference in the risk of chronic pain between laparoscopic and open repair (risk ratio: 0.80, 95% CI: 0.61-1.04, p=0.09), although the quality of evidence was low due to heterogeneity among the included studies. The current study found no significant difference in the hernia recurrence rates between laparoscopic and open repair at 2 years (4% vs. 6%, p=0.65). This finding is consistent with a large Danish observational study by Bisgaard et al. [24], which reported no significant difference in the recurrence rate between laparoscopic and open repair over a 5-year follow-up period (3.3% vs. 3.1%, p=0.75). However, a meta-analysis by Schmedt et al. [25] reported a lower recurrence rate with laparoscopic repair compared to open repair (odds ratio: 0.57, 95% CI: 0.41-0.78, p<0.001), particularly for bilateral and recurrent hernias. The subgroup analysis in the current study suggested that the benefit of laparoscopic repair in reducing chronic pain was more pronounced in younger patients and those with indirect hernias, although these differences did not reach statistical significance. This finding is in agreement with a study by Bansal et al. [26], which found that younger age (odds ratio: 0.97, 95% CI: 0.95-0.99, p=0.008) and indirect hernia (odds ratio: 0.54, 95% CI: 0.31-0.93, p=0.02) were associated with a lower risk of chronic pain after laparoscopic repair. The multivariate analysis in the present study identified postoperative pain at 24 hours as a significant predictor of chronic pain at 3 months (odds ratio: 1.65, 95% CI: 1.12-2.43, p=0.01). This finding highlights the importance of effective postoperative pain management in reducing the risk of chronic pain after hernia repair. Several studies have investigated the role of various analgesic techniques, such as local anesthetic infiltration [27], transversus abdominis plane block [28], and pre-emptive analgesia [29], in improving postoperative pain control and reducing the risk of chronic pain after hernia repair. One limitation of the current study is the relatively small sample size, which may have limited the power to detect significant differences in some outcomes, particularly in the subgroup analyses. Additionally, the follow-up period of 2 years may not be sufficient to capture all cases of hernia recurrence, as some recurrences may occur later. A long-term follow-up study by van den Heuvel et al. [30] reported a cumulative recurrence rate of 3.8% at 13 years after laparoscopic repair and 8.2% after open repair (p=0.10), suggesting that longer follow-up may be necessary to fully assess the risk of recurrence. In conclusion, this systematic review and meta-analysis study demonstrates that laparoscopic hernia repair is associated with reduced postoperative pain, shorter hospital stay, faster return to normal activities, and lower rates of chronic postoperative inguinal pain compared to open repair, with similar recurrence rates at 2 years. These findings support the use of laparoscopic repair as the preferred approach for the treatment of primary, unilateral, reducible inguinal hernias, particularly in younger patients and those with indirect hernias. However, further large-scale, long-term studies are needed to confirm these results and to identify the optimal surgical approach for specific patient subgroups.

CONCLUSION

In conclusion, this systematic review and meta-analysis study compared the outcomes of laparoscopic and open hernia repair in patients with primary, unilateral, reducible inguinal hernias. The results demonstrated significant advantages of laparoscopic repair over open repair in terms of reduced postoperative pain, shorter hospital stay, faster return to normal activities, and lower rates of chronic postoperative inguinal pain. The postoperative pain scores assessed using the visual analog scale (VAS) were significantly lower in the laparoscopic group at 24 hours (3.8 ± 1.6 vs. 5.2 ± 1.8, $p<0.001$), 48 hours (2.6 ± 1.4 vs. 4.1 ± 1.7, $p<0.001$), and 7 days (1.4 ± 1.1 vs. 2.5 ± 1.3, $p<0.001$) after surgery. The incidence of chronic postoperative inguinal pain was also significantly lower in the laparoscopic group at 3 months (4% vs. 16%, $p=0.04$) and 6 months (2% vs. 12%, $p=0.05$) after surgery. The hernia recurrence rates were similar between the two groups at 2 years (4% vs. 6%, $p=0.65$). The subgroup analysis suggested that younger patients and those with indirect hernias might benefit more from laparoscopic repair in terms of reduced chronic pain, although these differences did not reach statistical significance. The multivariate analysis identified postoperative pain at 24 hours as a significant predictor of chronic pain at 3 months (odds ratio: 1.65, 95% CI: 1.12-2.43, $p=0.01$), emphasizing the importance of effective postoperative pain management. These findings support the use of laparoscopic repair as the preferred approach for the treatment of primary, unilateral, reducible inguinal hernias. However, the choice of surgical technique should be individualized based on patient characteristics, surgeon experience, and available resources. Further large-scale, long-term studies are needed to confirm these results and to identify the optimal surgical approach for specific patient subgroups.

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