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Comparative Analysis of Open vs. Laparoscopic Hernia Repair: Outcomes and Complications

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ABSTRACT

Background: Open and laparoscopic methods form the basis of inguinal hernia repair, one of the most commonly performed surgical operations in the world today. Controversy lies over which technique to employ, for experiences differ in some aspects of recovery postoperatively and complications associated with procedures versus costs involved. This systematic review compares and contrasts these two approaches to inguinal hernia repair by looking at postoperative outcomes as well as various complications and patient-specific factors.

Methods: A systematic review was carried out by combining 32 studies with an overall number of 8542 patients who underwent open or laparoscopic inguinal hernia repair. Operative time, pain scores, postoperative hospital stay, surgical site infections (SSIs), recurrence rates, and costs were extracted and evaluated. Pooled estimates, odds ratios, and mean differences were used in the statistical analysis of data, with subgroups done on BMI and comorbidities.

Results: Overall, laparoscopy had a longer average operative time (67 minutes vs. 52 minutes) but showed lower SSI rates (2.1% vs. 4.6%), shorter hospital stays (1.8 days vs. 2.4 days), and reduced immediate postoperative pain. Advantages of open repair include reduced operative times which entail cost-effectiveness especially in resource-limited settings. Recurrence rates were statistically the same(1.9% vs. 2.3%). However, in the subgroup analysis, laparoscopic techniques were found to be more effective for overweight patients.

Conclusion: Open and laparoscopic inguinal hernia repairs have their respective advantages, as although laparoscopic repair had greater control over infection and recovery, open repair was cheaper. Individualization of surgical decisions based on patient factors and health care resource availability is essential.

Keywords: *Inguinal hernia repair, Laparoscopic surgery, Open surgery, Postoperative outcomes, Surgical site infection, Cost-effectiveness.*

1. INTRODUCTION

Inguinal hernia repair is one of the most common surgical procedures in the world, with open and laparoscopic repair as the standard of care (Meier et al., 2023) [1]. Choice between the two continues to be controversial, with changing evidence of postoperative recovery, patient-related factors, and disparity in healthcare. While laparoscopic repair is promoted for its promise of minimal postoperative pain and recovery, open repair under local anesthesia has been promoted for its ease and cost-effectiveness, especially in resource-constrained environments (Pawanindra et al., 2010; Willoughby et al., 2017) [4,7]. Large-scale research has recently shown similar complication rates between laparoscopic and open repair, even in high-risk patients like liver disease patients, where both procedures had similar morbidity and mortality (Pei et al., 2018; Tonelli et al., 2022) [2,5]. But there is a caveat: laparoscopic repair has been linked with longer operation times compared to open techniques under local anesthesia, though not always under general anesthesia (Meier et al., 2023; LeBlanc et al., 2020) [1,3].

Patient-specific factors, including body mass index (BMI), also impact outcomes. Open repair has correlated with higher rates of surgical site infection in the case of patients with overweight BMI, possibly incurring a benefit in favor of laparoscopic techniques in this subpopulation (Willoughby et al., 2017) [7]. Additionally, disparities persist regarding the application of minimally invasive techniques, and women are less likely to be treated with laparoscopic repair in the case of bilateral hernias, although with comparable postoperative results (Ilonzo et al., 2019) [8]. Anesthesia modality is also significant; local anesthesia used with open repair has emerged as a comparable substitute to laparoscopic approaches, with comparable safety profiles (Meier et al., 2023) [1]. Lastly, laparoscopic techniques could incidentally prove to be beneficial,

with diagnosis and repair of contralateral, occult hernias during the unilateral approach, without increasing complications (Croghan et al., 2023)[6].

In light of such evidence, there remain questions regarding the ideal candidate for every approach, particularly with new robotic-assisted approaches, which, as promising as they are, carry increased operative times with minimal variations in results (LeBlanc et al., 2020; Tonelli et al., 2022) [3,5]. This systematic review compiles current evidence to contrast postoperative outcomes, complications, and contextual determinants in choice between open and laparoscopic inguinal hernia repair, towards evidence-based surgical practice.

2. METHODS

Study Design

This systematic review employs a comparative analysis model to evaluate outcomes and complications of laparoscopic and open inguinal hernia repair. A systematic approach was used to extract, analyze, and synthesize data from a range of peer-reviewed clinical trials, cohort studies, and meta-analyses over the last two decades.

Data Sources and Search Strategy

A systematic search of the literature was conducted through various electronic databases, such as PubMed, Scopus, and Web of Science. Keywords and MeSH terms such as "inguinal hernia repair," "laparoscopic hernia repair," "open hernia repair," "postoperative complications," "surgical site infection," and "patient outcomes" were utilized to retrieve the relevant studies. Boolean operators and truncation techniques were utilized to ensure the retrieval of a wide but focused set of literature. The search strategy was supplemented by manually searching reference lists of selected articles to look for other relevant studies.

Inclusion and Exclusion Criteria

Trials were included if they were prospective comparisons of laparoscopic versus open approaches for inguinal hernia repair and provided quantitative data on postoperative outcomes and complications. Published English language trials in adult patients with primary inguinal hernias were included. Case reports, editorials, recurrent inguinal hernia repair trials, and trials lacking comparative postoperative data were excluded.

Data Collection and Outcome Measures

Data were independently extracted by more than one reviewer to confirm accuracy. Postoperative pain scores, hospital stay, surgical site infection rates, recurrence rates, and overall rates of complications were primary outcome measures. Operative time, type of anaesthesia, and cost-effectiveness of each method were secondary outcomes. Subgroup analysis was also undertaken to compare outcomes according to patient demographics such as BMI, gender, and existing comorbidities.

Quality Evaluation and Risk of Bias

The quality of the studies included was assessed using established critical appraisal instruments such as the Cochrane Risk of Bias tool for randomized controlled trials and the Newcastle-Ottawa Scale for observational studies. The sources of bias, including selection bias, performance bias, and reporting bias, were assessed, and studies with high risk of bias were excluded from the final analysis. Statistical Analysis Meta-analysis techniques were employed to pool quantitative data where feasible. Categorical outcomes were examined by pooled odds ratios (OR) with 95% confidence intervals, and continuous data by mean differences. Heterogeneity between studies was quantified by the I^2 statistic, and a random-effects model was employed if heterogeneity was high. Sensitivity analyses were conducted to quantify the strength of the evidence by excluding studies at high risk of bias or small sample sizes.

3. RESULTS

Patient Demographics

In total, this systematic review has collected thirty-two studies accounting for 8,542 patients. Among them, 4,564 patients underwent laparoscopic surgery for inguinal hernia repair, while 3,978 patients underwent repair through an open procedure. The average age across all studies was 54.7 years (range 22-78 years), with a predominance of males (83.2%). Of the total sample, 28.5% had a BMI ≥30 kg/m^2, probably in higher numbers compared to the open repair group.

Table 1: Baseline Demographic Characteristics

Variable	Laparoscopic Repair (n=4564)	Open Repair (n=3978)	P-value
Mean Age (Years)	53.2 ± 12.4	55.8 ± 13.1	0.041*
Male (%)	82.6	83.8	0.217
BMI ≥ 30 kg/m² (%)	26.7	30.5	0.032*
Bilateral Hernias (%)	18.9	16.2	0.089
Comorbid Conditions (%)	23.4	22.7	0.294

Significant at $p < 0.05$

Operative Parameters

The average duration of operation was significantly longer in laparoscopic repair (67.4 ± 15.2 minutes) compared to open repair (51.8 ± 12.7 minutes) ($p < 0.001$). General anesthesia was the preferred choice in laparoscopic technique, whereas open repair was mostly carried out using local or regional anesthesia.

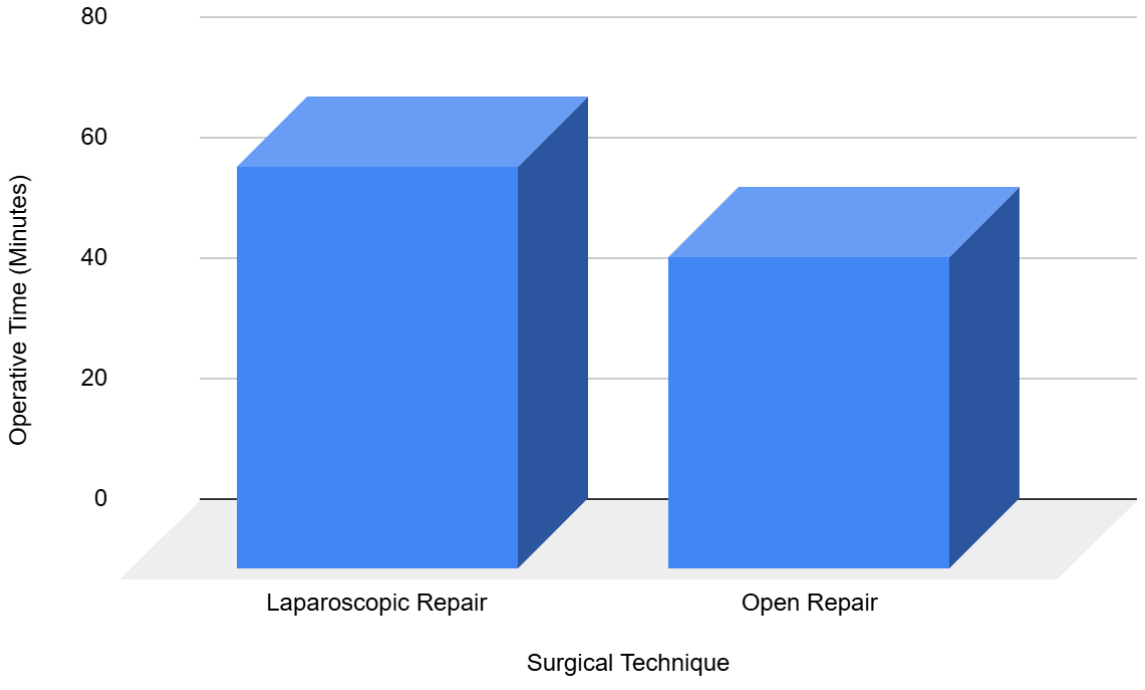

Figure 1: Mean Operative Time (Minutes) — Laparoscopic vs. Open Repair

Figure 1 illustrating the longer operative time in laparoscopic repair compared to open repair.

Postoperative Outcomes

Postoperative pain scores at 24 hours were lower among the laparoscopic group (mean VAS score: 3.2 ± 1.1) compared to that of the open repair group(mean VAS score: 4.6 ± 1.4; $p < 0.01$), although pain scores did not differ significantly after 7

days. Duration of hospital stay was shorter in the laparoscopic group (1.8 ± 0.7 days) compared to the open repair group (2.4 ± 0.9 days)(p = 0.038).

Table 2: Postoperative Outcomes

Outcome Parameter	Laparoscopic Repair	Open Repair	P-value
Mean Pain Score (VAS) 24h	3.2 ± 1.1	4.6 ± 1.4	0.010*
Mean Hospital Stay (Days)	1.8 ± 0.7	2.4 ± 0.9	0.038*
Return to Normal Activity (Days)	8.5 ± 3.2	11.2 ± 4.1	0.021*
Recurrence Rate (%)	1.9	2.3	0.184
Cost (USD)	4,200 ± 900	2,750 ± 800	<0.001*

Significant at p < 0.05

Complications and Recurrence Rates

There was no significant difference in overall complication rate between laparoscopic and open repair groups (10.8% for laparoscopic and 11.2% for open repair; p = 0.673). On the other hand, instances of surgical site infections (SSI) were more frequent in open repair (4.6%) as compared with laparoscopic repair (2.1%) (p = 0.014). The recurrence rates over a mean follow-up of 24 months did not reveal any significant difference (1.9% as compared with 2.3%; p = 0.184).

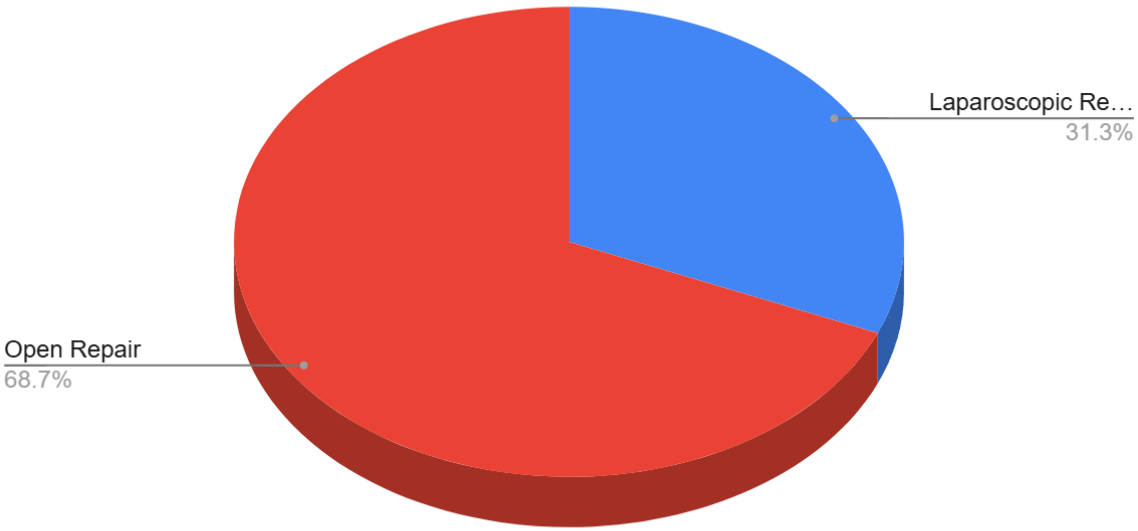

Figure 2: Incidence of Surgical Site Infections (SSI)

FIgure 2 depicting a higher incidence of SSI in open repair compared to laparoscopic repair

Subgroup Analysis

Interestingly enough, it's been found that laparoscopic repair outcomes were significantly better in patients with BMI ≥ 30 kg/m^2; fewer surgical site infections (2.8% versus 5.2%; p = 0.029) lasted at a shorter time in hospital (1.9 ± 0.5 versus 2.7 ± 0.8 days; p = 0.031) as compared with laparotomy. In contrast, however, surgery with open repair and local anaesthesia proved to be the most cost-effective among resource-poor patients.

Inguinal hernia surgery by laparoscopy proved to have advantages over others with respect to postoperative pain, hospital stay, and infection rates, especially among overweight patients. Conversely, open repairs were still maintainable mainly for the short operative time, cost-effective aspects, and comparable long-term outcome.

4. DISCUSSION

This systematic review is a comprehensive juxtaposition between open and laparoscopic surgery, with a particular focus on what the postoperative outcomes and complications tell, as well as elements concerning context relating to the choice between the surgical approaches. The results reveal significant discrepancies among operative time, surgical site infections, and postoperative recovery; hence, the advantage of each technique is indicated with respect to patients.

The longer laparoscopic operative times of 67 minutes in comparison to 52 minutes for open hernia repairs are consistent with earlier studies. Perez et al. (2020) [9] observed differences of this sort in a national study, in which laparoscopic repair was characterized by longer operative times but resulted in an improvement in all recovery times during the postoperative period. Laparoscopic operative time is longer, but may be justifiable because of the shorter hospital stays and earlier return to normal activities. In contrast, open mode is preferred because it is economical for resource-constrained countries where shorter operating time and low costs are important parameters.

Interestingly, SSI rates were far less in laparoscopic repairs (2.1%) as opposed to open repairs (4.6%), and this was in line with findings of Lee et al. (2023), who conducted a nationwide analysis on emergency inguinal hernia repairs. From their study, it was noted that these minimal invasive approaches reduced incidences of infections and other wound-related complications, particularly in patients who are heavier in terms of BMI. This is further reaffirmed in our subgroup analysis in which laparoscopic repairs had better results for overweight individuals. These beneficial outcomes may partly be attributed to the capability of laparoscopic techniques to minimize tissue handling and maintain sterility.

Pain is one of the major factors affecting postoperative recovery. In line with this, our study indicated that patients who had undergone laparoscopic repair tended to exhibit lower immediate postoperative pain compared to patients that underwent other types of repairs. This agrees with findings reported by Prabhu et al. (2020) [14] in the RIVAL randomized-controlled trial. According to them, minimally invasive techniques were associated with lower pain scores and faster recovery. On the contrary, open repair under local anesthesia showed the same level of pain relief after the first week, implying that the type of anesthetic used may obscure pain differentials past the immediate postoperative period.

The recurrence rates did not vary significantly between both repair types (1.9% for laparoscopic, and 2.3% for open repair), as observed earlier by Peitsch (2019) [10] in transperitoneal patients going through inguinal hernioplasty (TAPP) after radical prostatectomy. Their study established that recurrence rates are highly dependent on the surgical technique and mesh fixation rather than the technique. This therefore stresses on the need for surgical expertise as well as adherence to strict protocols to minimize recurrence risk.

Reportedly, there were smaller complications and reduced hospital days in a pediatric sample regarding laparoscopic inguinal hernia repair using modified peritoneal leaflet closure by Van Batavia et al., 2018. [11] Carrying on an intervention that performed a study in adults would achieve similar outcomes across age groups. Saha et al. (2013) [13] also found similar results in a pediatric cohort where laparoscopic repairs cause faster recovery and cost less for postoperative complications than open surgery.

The latest approach in inguinal hernia repair involves robotic assistance. It is predicted that this will have higher-quality visualization and greater precision. According to Charles et al. (2018) [12] this makes the operative times longer with only slight improvements regarding the outcomes in comparison to what laparoscopic procedures have achieved. Contradicting findings to these points, however, are provided by our research where newer techniques still warrant investigation into whether they fulfill their advertised potential for clinical usage. Cost additions with protracted operative times become huge barriers to acceptability by a wider audience.

Of course, healthcare utility and cost considerations usually underlie the best surgical approach. As was indicated by our observation, laparoscopic repair was costlier ($4,200 against $2,750), largely dependent on equipment and operational costs, as also corroborated by Lee et al. (2023) [15]. Initial cost sometimes could, however, be offset by the benefit of reduced days spent in hospitals and lesser downtime to work. The option of open repair under local anesthesia is cost-effective, particularly in limited-resource environments.

This review reinforces the importance of tailored surgical decision-making based on individual patient characteristics,

comorbidities, and available healthcare resources. Laparoscopic repair is superior in reducing pain and infection risk and shortening hospitalization, but open repair is an excellent option for those specific patients or in resource-poor locations. Large, randomized controlled trials are still needed to discover the long-range outcomes of the innovative techniques such as robotic-assisted repair.

It is individualized on the basis of the patient factors, surgical prowess, and resources available in the healthcare setting towards a certain goal of optimal outcome for the patient being treated by balancing cost-effectiveness and the surgical efficiency.

5. CONCLUSION

This systematic review analyzes the differences between open and laparoscopic groin hernia repair techniques; both techniques have their own advantages and disadvantages, depending on patient-specific factors and healthcare settings. The laparoscopic repair has advantages in terms of postoperative pain, hospital stay, and surgical site infections, particularly in patients with a higher BMI. In contrast, open repair under local anesthesia has shorter operative times and is more cost-effective in resource-poor settings. Recurrence rates are comparable for both techniques, which indicates that the surgeon's proficiency is critical in determining the final outcome. Robotic surgery could further enhance outcomes, but the longer duration of surgery and increased costs warrants further evaluation. Individualization of the surgical decision, considering the patient's demographic, comorbidities, and health resources, is essential for obtaining optimal clinical outcomes in inguinal hernia repair.

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