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A Comparative Study Between Open and Laparoscopic Herniotomy in Pediatric Age Group

Running Title: Pediatric Herniotomy Comparative Study

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Abstract: ***Background: Inguinal hernia is a highly prevalent surgical condition in children, traditionally managed by open herniotomy. With advances in minimally invasive techniques, laparoscopic herniotomy has gained prominence. This study aims to compare the outcomes of these two approaches to guide clinical decision - making for pediatric patients. Objectives: To compare operative time, incidence of intraoperative and postoperative complications, length of hospital stay, and patient/guardian satisfaction between open and laparoscopic herniotomy in children aged 1 month to 12 years. Methodology: This prospective, observational, and comparative study was conducted at the Department of General Surgery, Index Medical College, Indore. Pediatric patients scheduled for elective inguinal herniotomy were enrolled and allocated to either the open or laparoscopic group. Data collected included surgery duration, intraoperative and postoperative complications, and hospital stay. Patient/guardian satisfaction was assessed post - procedure. Ethical approval was obtained from the Institutional Ethics Committee (Ref. No.: IMCHRC/IEC/2023/52, dated 19.08.2023), and written informed consent was secured. Statistical analysis involved descriptive statistics (means, percentages, counts) due to the observational nature of the study, without formal inferential tests for statistical significance between groups. Results: Sixty pediatric patients (30 in each group) were included. The average operative time was 26 minutes for open herniotomy and 27 minutes for laparoscopic herniotomy. No intraoperative complications were observed in either group. Postoperative complications were rare, with 3 cases of wound infection in the open group and 1 wound infection and 1 pleural effusion in the laparoscopic group. The majority of patients (76%) were discharged within 1 day, with similar average hospital stays for both techniques (open: ~1.7 days; laparoscopic: ~1.4 days). Overall patient/guardian satisfaction was high (Open: 96.7%, Laparoscopic: 93.3%), with dissatisfaction linked to complications. Conclusion: Both open and laparoscopic herniotomy are safe and effective for inguinal hernia repair in children, showing comparable rates of postoperative complications, hospital stay, and high patient/guardian satisfaction. Laparoscopic herniotomy had a slightly longer operative time. The choice of technique should be individualized, considering factors such as surgeon experience, patient characteristics, and available resources.***

Keywords: Pediatric, Herniotomy, Open surgery, Laparoscopic surgery, Inguinal hernia, Complications, Operative time, Hospital stay, Patient satisfaction

1. Introduction

Inguinal hernia is one of the most common surgical conditions in the pediatric population, primarily resulting from the incomplete closure of the processus vaginalis during fetal development, which creates a potential pathway for abdominal contents to protrude. Clinical diagnosis is typically made by parents observing a noticeable bulge in the groin area, or by older children directly reporting it [6]. Physical examination usually reveals a thicker cord on the affected side, and gentle pressure often makes the hernia more apparent. Prompt surgical intervention is crucial to prevent severe complications, such as incarceration or strangulation, which can lead to intestinal obstruction, peritonitis, or systemic toxicity [8].

Historically, open herniotomy has been the conventional and widely practiced method for repairing inguinal hernias in children due to its established efficacy and direct access to the hernia sac [8]. However, recent advancements in minimally invasive techniques have led to the increasing popularity of laparoscopic herniotomy, which offers potential benefits such as smaller incisions and enhanced visualization, particularly the ability to inspect the contralateral side [4, 9, 10].

Despite the widespread use of both techniques, a definitive consensus on the optimal surgical approach for pediatric inguinal hernia repair remains elusive. Previous meta - analyses and systematic reviews have compared these approaches, often reporting varied outcomes regarding operative time, pain, complications, and recurrence rates [1, 2, 3]. Some studies indicate that laparoscopic hernia surgery may lead to faster recovery and less postoperative pain, with recurrence rates comparable to open repair [4, 5]. However, other data suggest that laparoscopic operations might carry a slightly higher risk of certain complications, such as testicular problems or wound infections, especially in boys [21, 22].

This prospective observational study aims to systematically evaluate and compare the effectiveness and outcomes of open versus laparoscopic herniotomy in a cohort of pediatric patients at Index Medical College Hospital, Indore. Specifically, we assessed and compared operative time, incidence of intraoperative and postoperative complications, length of hospital stay, and patient/guardian satisfaction. By providing evidence - based insights derived from our local experience, this research seeks to contribute to the existing body of knowledge and inform clinical decision - making for improving care and outcomes in children undergoing inguinal herniotomy.

2. Materials and Methods

Study Design and Ethical Approval

This was a prospective, observational, and comparative study conducted at the Department of General Surgery, Index Medical College, Indore, designed to assess the effectiveness and outcomes of open versus laparoscopic herniotomy in pediatric patients. The study received ethical approval from the Institutional Ethics Committee of Index Medical College, Indore (Ref. No.: IMCHRC/IEC/2023/52, dated 19.08.2023). All procedures were carried out in compliance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from the parents or guardians of all participating pediatric patients after a thorough explanation of the study's objectives, procedures, potential risks, and benefits. Patient confidentiality and well - being were maintained throughout the study.

Study Population

The study population comprised pediatric patients aged 1 month to 12 years diagnosed with an inguinal hernia and scheduled for elective herniotomy.

Inclusion Criteria:

- Patients with a clinical diagnosis of inguinal hernia.
- Patients aged between 1 month and 12 years.
- Patients without serious comorbidities (e. g., severe respiratory, cardiac, or other significant medical conditions).
- Patients whose parents or guardians provided written informed consent.

Exclusion Criteria:

- Patients whose parents or guardians did not provide informed consent.
- Patients with a history of previous inguinal surgery.
- Patients with a history of complications following general anesthesia.
- Patients undergoing emergency surgery for incarcerated or strangulated hernias.

Interventions

Patients were allocated into one of two surgical groups:

1) **Open Herniotomy Group:** Patients underwent conventional open surgical repair.
2) **Laparoscopic Herniotomy Group:** Patients underwent minimally invasive laparoscopic repair.

Preoperative evaluations for both groups included an abdominal ultrasound (USG) with comments on the inguinoscrotal region, complete blood count, liver and kidney function tests, and a comprehensive preoperative anesthesia assessment.

Outcome Measures

Primary Outcomes:

1) **Operative Time:** Measured as the duration from skin incision to wound closure (in minutes).
2) **Length of Hospital Stay:** The period from hospital admission to discharge (in days).
3) **Complications:** Incidence of any intraoperative complications (e. g., bleeding, vascular/visceral injury) or postoperative complications (e. g., wound infection, recurrence, nerve injury, pleural effusion, testicular complications).
4) **Patient/Guardian Satisfaction:** Assessed post - procedure (categorized as Satisfied or Not Satisfied).

Secondary Outcomes:

1) **Aesthetic Outcome:** Scar appearance evaluated at a 6 - week follow - up using a Visual Analog Scale (VAS).
2) **Time to Return to Normal Activity:** Duration until the child resumed usual activities (e. g., attending school).
3) **Cost Analysis:** Comparison of overall treatment expenses, including hospitalization, anesthesia, and equipment.

Statistical Analysis

Due to the observational nature of this comparative study and the primary data presented in the thesis, statistical analysis was descriptive. Data were summarized using means, counts, and percentages. No formal inferential statistical tests (such as t - tests or chi - square tests) were performed to compare the differences between the open and laparoscopic groups for statistical significance. All data presentation is based on the master chart provided in the original thesis document.

3. Results

A total of 60 pediatric patients were included in this study, equally divided with 30 cases (50%) in the Open Herniotomy group and 30 cases (50%) in the Laparoscopic Herniotomy group. The patient age range was 1 month to 12 years, with a predominance of male patients, consistent with the epidemiology of pediatric inguinal hernias [7]. The most common hernia type treated was Right Indirect Inguinal Hernia (71.66%), followed by Left Indirect Inguinal Hernia (26.67%). The distribution of hernia types across both surgical approaches is detailed in Table 1.

Table 1: Hernia Type Distribution by Surgical Approach (N=60)

Type of Hernia	Open Herniotomy (N=30)	Laparoscopic Herniotomy (N=30)	Overall (N=60)
Right Indirect Inguinal Hernia	19	21	40
Left Indirect Inguinal Hernia	8	8	16
Right Direct Inguinal Hernia	2	0	2
Left Direct Inguinal Hernia	0	1	1
Right Femoral Hernia	1	0	1
Bilateral Indirect Inguinal Hernia	1	0	1

Note: Percentages derived from the overall count: Right Indirect (66.7%), Left Indirect (26.7%), Right Direct (3.3%), Left Direct (1.7%), Right Femoral (1.7%), Bilateral Indirect (1.7%).

Operative Time: The average operative time for open herniotomy was approximately 26 minutes. For laparoscopic herniotomy, the average operative time was approximately 27 minutes, indicating a marginally longer duration for the minimally invasive approach.

Intraoperative Complications: No intraoperative complications were reported in either the open or laparoscopic herniotomy groups.

Postoperative Complications: Overall, 5 cases (8.3%) experienced postoperative complications (3 in the open group, 2 in the laparoscopic group). As detailed in Table 2:

- In the Open Herniotomy group, wound infection occurred in 3 cases.
- In the Laparoscopic Herniotomy group, wound infection was noted in 1 case, and 1 case of pleural effusion was observed.

Table 2: Postoperative Complications by Surgical Approach (N=60)

Complication	Open Herniotomy (N=30)	Laparoscopic Herniotomy (N=30)	Total (N=60)
Intraoperative Complications	0	0	0
Postoperative Wound Infection	3	1	4
Postoperative Pleural Effusion	0	1	1
Total Cases With Postoperative Complications	3	2	5

Length of Hospital Stay: The majority of patients in both groups experienced short hospital stays. Most patients (46 cases, 76%) were discharged within 1 day. Longer stays were less common: 7 cases (11.6%) stayed for 2 days, 3 cases (5%) for 3 days, 3 cases (5%) for 4 days, and 1 case (1.6%) for 7 days (the pleural effusion case in the laparoscopic group). Both approaches demonstrated comparable average hospital stays, with longer durations primarily associated with the occurrence of complications.

Patient/Guardian Satisfaction: High levels of satisfaction were reported in both surgical groups. In the Open Herniotomy group, 29 out of 30 patients/guardians (96.7%) expressed satisfaction. In the Laparoscopic Herniotomy group, 28 out of 30 (93.3%) expressed satisfaction. Dissatisfaction was primarily observed in cases that experienced postoperative complications.

4. Discussion

This prospective observational study evaluated the comparative outcomes of open and laparoscopic herniotomy in 60 pediatric patients. Our findings indicate that while laparoscopic herniotomy generally involved a slightly longer operative duration, both surgical approaches demonstrated comparable safety profiles with no intraoperative complications. Furthermore, the incidence of postoperative complications, length of hospital stay, and overall patient/guardian satisfaction levels were similar between the two groups.

The observation of a marginally longer operative time for laparoscopic herniotomy in our cohort aligns with some previous comparative studies [1, 5, 13]. This extended duration can be attributed to the additional initial steps inherent in laparoscopic procedures, such as establishing pneumoperitoneum and precise trocar placement, which may demand a learning curve and advanced surgical skills [4]. Despite this, the complete absence of intraoperative complications in both groups strongly underscores the overall safety of these procedures when performed by experienced surgeons in a controlled setting, suggesting that both methods are viable options for pediatric inguinal hernia repair.

Regarding postoperative outcomes, the comparable rates of wound infection and short hospital stays observed in our study suggest that both techniques facilitate similar recovery times and enable early discharge, which is reassuring for both clinicians and parents. While open herniotomy showed slightly more wound infections (3 cases vs.1 case in laparoscopic), this difference was minimal in our small sample and not formally compared for statistical significance. The occurrence of a single case of pleural effusion in the laparoscopic group, a rare but recognized complication associated with insufflation, highlights the specific risk profile of this minimally invasive approach [35].

A significant potential advantage of laparoscopic herniotomy, consistent with existing literature, is the direct visualization and potential repair of a contralateral patent processus vaginalis (CPPV) [28]. While our study's primary data did not explicitly quantify the incidence or repair of CPPV, this benefit is a recognized factor in potentially reducing future contralateral hernia risks, particularly in predisposed patients. This is a point where the benefits of laparoscopic techniques can become more apparent over a longer follow - up period.

The high levels of patient/guardian satisfaction observed in both groups further support the general acceptability and effectiveness of these surgical methods. This emphasizes that successful outcomes, low complication rates, and efficient recovery contribute significantly to positive experiences for families, irrespective of the technique chosen. Therefore, the decision between open and laparoscopic herniotomy should be individualized, carefully considering factors such as the surgeon's expertise, the patient's specific medical condition (e. g., bilaterality, age), and the available healthcare resources.

5. Limitations

This study has several limitations that should be acknowledged when interpreting the results:

1) **Single - Center Design and Limited Sample Size:** The study was conducted at a single institution with a relatively small sample size (N=60), which may limit the generalizability of the findings to a broader population or diverse healthcare settings.
2) **Observational Design and Lack of Inferential Statistics:** As a prospective observational study without randomization or formal inferential statistical comparisons between groups, we cannot establish causality or draw conclusions about statistically

significant differences between the two techniques. The results are primarily descriptive.

3) **Short Follow - Up Duration:** The immediate postoperative follow - up period restricts the ability to draw definitive conclusions regarding long - term outcomes, such as recurrence rates or chronic pain, which are critical considerations for pediatric hernia repair [41, 46].
4) **Lack of Detailed Cost - Effectiveness Analysis:** The study did not include a comprehensive economic analysis, which would be valuable for evaluating the overall cost - effectiveness of each surgical method, including equipment, hospital resources, and parental work loss.
5) **Exclusion of Emergency Cases:** This research focused exclusively on elective herniotomy cases. Therefore, the findings may not be directly applicable to patients presenting with incarcerated or strangulated hernias, where the surgical approach and outcomes might differ significantly [51].

6. Future Directions

To enhance surgical decision - making and improve care for pediatric hernias, future research should focus on:

1) Conducting larger, multi - center randomized controlled trials to provide more robust evidence and improve generalizability.
2) Implementing long - term follow - up studies to thoroughly assess recurrence rates, chronic pain, and other late - onset complications.
3) Performing detailed cost - benefit analyses, taking into account all relevant economic implications for patients and healthcare systems.
4) Evaluating the impact of enhanced recovery after surgery (ERAS) protocols in pediatric herniotomy to further optimize recovery and reduce hospital stays [37].
5) Investigating outcomes in emergency situations (incarcerated/strangulated hernias) to determine the efficacy and safety of surgical interventions in these high - risk scenarios.

7. Conclusion

This prospective observational study compared open and laparoscopic herniotomy in 60 pediatric patients. The results indicate that while laparoscopic herniotomy involved a slightly longer operative time, both methods demonstrated comparable rates of postoperative complications, similar lengths of hospital stay, and high levels of patient/guardian satisfaction. Both approaches are proven safe and effective for inguinal hernia repair in children. The optimal choice between laparoscopic and open herniotomy should be a personalized decision, guided by surgeon experience, individual patient needs, and available healthcare resources.

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Conflict of Interest/Competing Interests
The authors declare that they have no competing interests.

Author Contributions
Dr. Shubham Parashar: Conceptualization, Data Collection, Manuscript Writing (Original Draft). **Dr. Mayur Maheshwari:** Supervision, Methodology, Review & Editing of Manuscript.

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Figures and Tables

Table 1: Hernia Type Distribution by Surgical Approach (N=60)

Type of Hernia	Open Herniotomy (N=30)	Laparoscopic Herniotomy (N=30)	Overall (N=60)
Right Indirect Inguinal Hernia	19	21	40
Left Indirect Inguinal Hernia	8	8	16
Right Direct Inguinal Hernia	2	0	2
Left Direct Inguinal Hernia	0	1	1
Right Femoral Hernia	1	0	1
Bilateral Indirect Inguinal Hernia	1	0	1

Table 2: Intraoperative and Postoperative Complications by Surgical Approach (N=60)

Complication	Open Herniotomy (N=30)	Laparoscopic Herniotomy (N=30)	Total (N=60)
Intraoperative Complications	0	0	0
Postoperative Wound Infection	3	1	4
Postoperative Pleural Effusion	0	1	1
Total Cases With Postoperative Complications	3	2	5

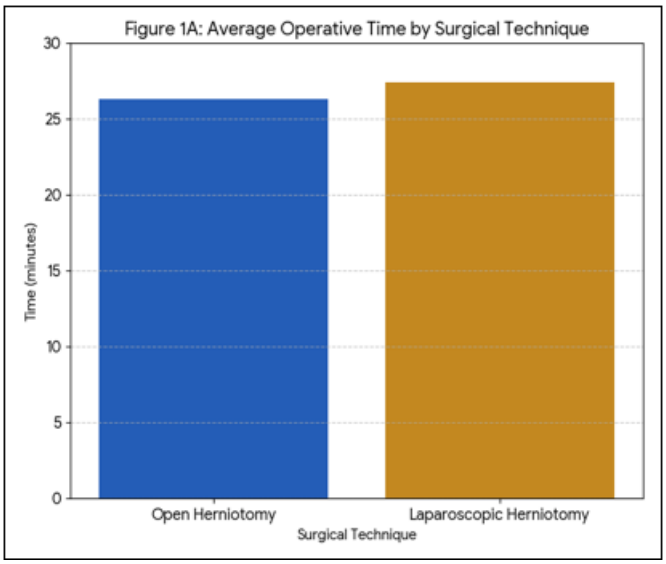
Figure 1A: Average Operative Time by Surgical Technique
Time (minutes)
0
5
10
15
20
25
30
Open Herniotomy
Laparoscopic Herniotomy
Surgical Technique

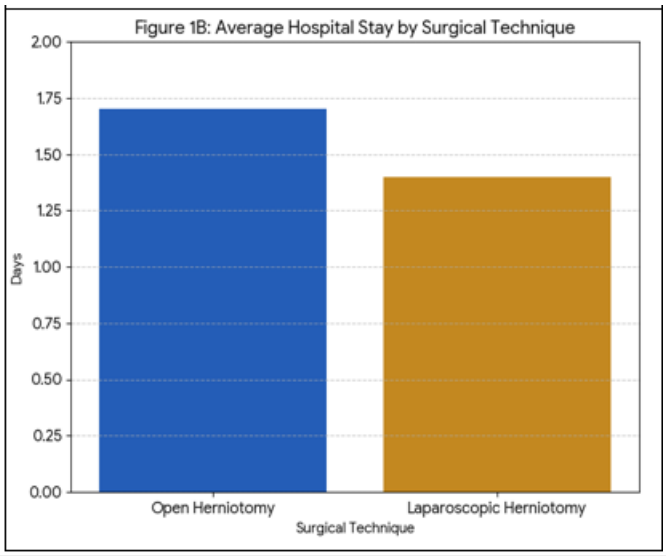
Figure 1B: Average Hospital Stay by Surgical Technique
Days
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Open Herniotomy
Laparoscopic Herniotomy
Surgical Technique

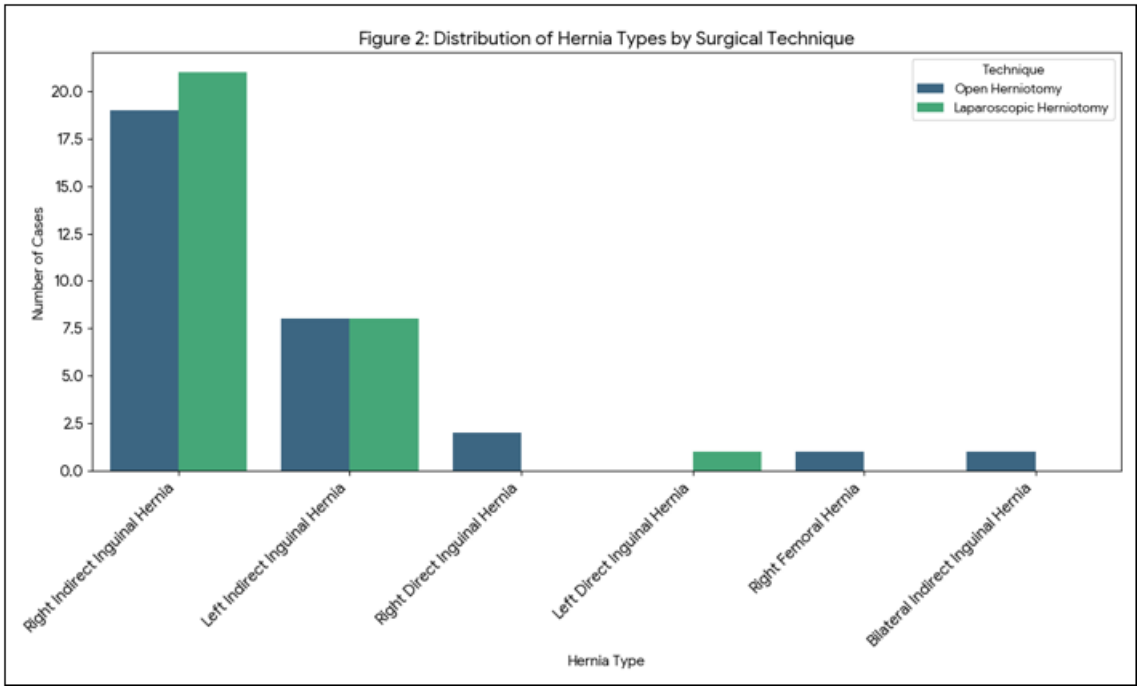
Figure 2: Distribution of Hernia Types by Surgical Technique
Technique
Open Herniotomy
Laparoscopic Herniotomy
Number of Cases
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Right Indirect Inguinal Hernia
Left Indirect Inguinal Hernia
Right Direct Inguinal Hernia
Left Direct Inguinal Hernia
Right Femoral Hernia
Bilateral Indirect Inguinal Hernia
Hernia Type

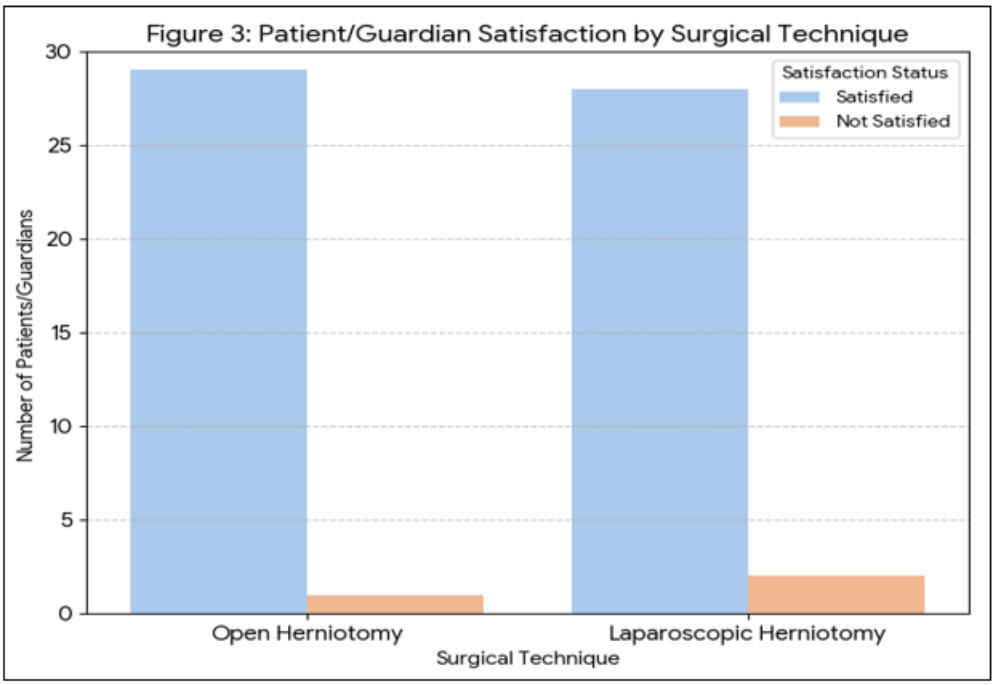
Figure 3: Patient/Guardian Satisfaction by Surgical Technique
Satisfaction Status
Satisfied
Not Satisfied
Number of Patients/Guardians
30
25
20
15
10
5
0
Open Herniotomy
Laparoscopic Herniotomy
Surgical Technique