



## Case-controlled Study

## Is the open approach superior to the laparoscopic hernia repair in children? A retrospective comparative study

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## ABSTRACT

**Background:** For many years now, inguinal hernia repair in children has been done either by the open approach or laparoscopically with laparoscopy having the edge in terms of cosmesis and postoperative pain. However, recent studies have called for a return of the open approach as it had a comparable result to laparoscopy with lesser cost. This study aims to compare the outcomes of the two approaches at our institution.

**Methods:** This is a retrospective analysis of the prospectively collected data of all patients aged between 6 months and 13 years who underwent open or laparoscopic inguinal hernia repair in the period between January 2017 and July 2019 at our institution.

**Results:** 155 patients were included in the study. 100 (64.5%) underwent open inguinal repair while 55 (35.5%) were done laparoscopically. There was no significant difference in the postoperative complications between the open and laparoscopic groups ( $P = 0.66$ ). The overall mean operative time for the laparoscopic group and the open group is ( $45.7 \pm 15.2$ ,  $45.5 \pm 15.4$  min,  $P = 0.83$ ) respectively. However, a subgroup analysis showed a statistical difference in the operative time in bilateral hernias favoring the laparoscopic approach, ( $44 \pm 13.2$ ,  $63.2 \pm 26.4$  min respectively,  $P = 0.049$ ). Laparoscopy was also associated with shorter times to full recovery compared to the open group (4.7 days, 7.5 days,  $P = 0.013$ ). Surprisingly, there was no difference in the cosmetic outcome between the two groups which is contrary to the published literature.

**Conclusions:** Laparoscopic inguinal hernia repair in children is a feasible and reproducible procedure. It permits the evaluation of the contralateral groin without further incisions. In our study, laparoscopy was superior in terms of operative time in bilateral hernias and the time to recovery. Finally, an added benefit to laparoscopy is that it offers more training opportunities for fellows and residents to improve their laparoscopic skills.

### 1. Introduction

Inguinal hernias are one of the most common surgical conditions in the pediatric age group [1]. Historically, Open repair has been the standard of care in the pediatric population due to its high success rate and relative simplicity. However, the recent advances and safety records of laparoscopic surgery have increased its adoption among pediatric surgeons around the world.

The unmatched superior visibility of laparoscopic surgery which allows bilateral exploration of the inguinal canal using the same small trocar incisions and with no further incisions is one of the major

advantages of laparoscopy. Additionally, the lower risk of cord damage, decreased postoperative pain, faster recovery, and better cosmesis played a major role in convincing parents of children with inguinal hernias to accept the approach more and more [2,3]. Not only that but adopting the laparoscopic approach is especially important in teaching hospitals, like our institution, since it offers more opportunities for general surgery residents and fellows to improve their laparoscopic skills and it sets them up for more complex laparoscopic procedures in the future. On the other hand, one of the drawbacks of laparoscopy is the increased cost and complexity of laparoscopic systems which have led some researchers to call for a revert to the open approach since some

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recent studies have shown comparable outcomes compared to the laparoscopic approaches.

In our center, we started offering laparoscopic inguinal hernia repair for children who are 6 months or older in January 2017. During the study period, laparoscopic hernia repair was the 2nd most commonly performed laparoscopic procedure after laparoscopic appendectomy. Additionally, of all hernias repaired in our center, 35% were done laparoscopically. All laparoscopic repairs were done using an intra-corporeal suture to close the patent processus vaginalis at the level of the internal ring without excising the hernia sac [4].

The study aims to compare the outcomes of the open and laparoscopic inguinal hernia repairs in the pediatric population at the Pediatric Surgery Center at the Jordan University Hospital to those of other centers around the world.

## 2. Patients and methods

This is a retrospective analysis of the surgical records of all children aged between 6 months and 13 years who underwent open or laparoscopic inguinal hernia repair at the Jordan University Hospital in the period between January 2017 and July 2019. The study was approved by the local ethical committee and registered in the Institute for Clinical and Translational Research registry (NCT04815135) [5].

All surgeries were performed either by a pediatric surgery consultant, a pediatric surgery fellow, or general surgery residents under direct supervision. Open repair was done by dissecting the hernia sac off of the spermatic cord followed by high ligation without excising the hernia sac. The procedure was offered to all children of all ages. However, laparoscopic repairs were offered for children who were 6 months or older only. All the laparoscopic repairs included in this study were done using intra-corporeal suturing of the patent processus vaginalis at the level of the internal ring. The hernia sac was not excised in the laparoscopic group also.

Data collection includes age, gender, duration of surgery, presence of a patent contralateral processus vaginalis, length of stay, time to recovery, post-operative complication, readmission rate, recurrence rate, and the overall cost. A parental phone interview was conducted to complete data collection and assess the patient's and the family's satisfaction and cosmetic outcomes.

Data were analyzed using Microsoft Excel® and SPSS 24.0 (SPSS Inc., Chicago, IL). Discrete variables are reported as numbers and percentages. Continuous variables are reported as means and standard deviations. A two-tailed P value of <0.05 was considered statistically significant. We used the student's *t*-test to compare continuous variables and the chi-squared test to compare categorical variables.

The work has been reported in line with the STROCSS criteria [6].

## 3. Results

One hundred and fifty-five 155 patients underwent inguinal hernia repair in the study period and were included in the analysis. 100 (64.5%) children underwent open repair, while the remaining 55 (35.5%) had a laparoscopic repair. None of the laparoscopic cases were converted to open repairs in our study.

The Patients' demographics are shown in Table 1. There was no

**Table 1**  
Demographic data.

	Open (n = 100)	Laparoscopic (n = 55)	p-value
Age (months) mean(range)	49.9 (7–152)	63.3 (7–154)	NS*
Gender (males) n(%)	80 (80%)	39 (70.9%)	0.18*
Side of repair n(%)	89 (89%)	45 (81.8%)	0.211^
Unilateral	11 (18.9%)	10 (18%)	
Bilateral			

\*Not Significant. ^ Chi-square test was performed.

significant difference in the age of patients who underwent open inguinal hernia repair compared to the patients who received laparoscopic inguinal hernia repair. ( $p < 0.16$ ).

There was no significant difference in gender distribution between the open and laparoscopic groups ( $P = 0.18$ ) as shown in Table 1.

The overall mean operative time was similar between the two groups,  $45.5 \pm 15.4$ ,  $45.7 \pm 15.1$  min respectively ( $P = 0.83$ ). However, a subgroup analysis showed a statistical difference in the operative time in bilateral hernias in favor of the laparoscopic group over the open group,  $63.2 \pm 25.1$ ,  $44 \pm 12.6$  min respectively,  $P = 0.049$ . Table 2.

Patients who underwent laparoscopic repair needed 3 days less on average to reach full recovery after surgery compared to those in the open group, ( $4.7 \pm 4.8$  days,  $7.5 \pm 8.2$  days,  $P = 0.013$ ).

During the study period, our hospital guidelines mandated 6–12 h of observation after any laparoscopic surgery performed on children, which were revised recently, and full recovery is now considered as the discharge criteria in those patients. However, the mandated observation period partially explains the significantly longer length of stay in the laparoscopic group ( $P = 0.001$ ).

During an average of 13 months of follow-up, 5 (5%) cases in the open cohort had recurrences while no recurrences were reported in the laparoscopic group. There was no significant difference in postoperative complications ( $P = 0.66$ ) as detailed in Table 2.

Cost analysis showed a significant difference in favor of the open repair which is one of the drawbacks of the laparoscopic approach ( $p > 0.001$ ). Surprisingly, there was no significant difference in the cosmetic outcomes between the 2 groups.

## 4. Discussion

In the past decade, minimally invasive approaches have been adopted in the pediatric population for the treatment of a wide range of pediatric surgical conditions. This is greatly shown in the management of pediatric inguinal hernias with various techniques being described three decades ago. However, one of the main concerns of pediatric surgeons is the fear of an increased recurrence rate although multiple studies in the literature have shown that recurrences after laparoscopy is

**Table 2**  
Open vs laparoscopic groups.

	Open (n = 100)	Laparoscopic (n = 55)	P value
OR duration (min) mean $\pm$ SD	$45.5 \pm 15.4$	$45.7 \pm 15.1$	0.83
Unilateral	$43.2 \pm 11.9$	$46.1 \pm 15.5$	0.284
Bilateral	$63.2 \pm 25.1$	$44 \pm 12.6$	0.049
LOS (hours)	42 (42%)	0 (0%)	0.001^
Less than 6	19 (19%)	14 (25%)	
6–12	12 (12%)	16 (28.6%)	
12–24	19 (19%)	23 (41.1%)	
24–48	8 (8%)	2 (3.6%)	
More than 48			
Postoperative complications	1	1	0.66
Seroma	1	1	
Hematoma	2	1	
SSI	1	2	
Refractory pain	2	0	
Scar formation			
Recurrence rate	1	0	
Immediate	2	0	
Within 30 days	2	0	
More than 30 days			
Cost (JOD) mean $\pm$ SD	$534.3 \pm 220.16$	$888.9 \pm 203.4$	>0.001
Cosmesis <sup>a</sup> mean	4.93	4.95	0.70
Recovery Hours	$7.5 \pm 8.2$	$4.7 \pm 4.8$	0.013

LOS; length of stay.

^Chi-square test.

<sup>a</sup> According to a scale from 1 to 5, with 5 being the highest satisfaction.

lower than in the open approach [7]. Additionally, the higher cost due to the use of specialized monitors and instruments and the learning curve needed to master the laparoscopic approach were additional factors that held some surgeons back from adopting it, compared to the open technique which is simpler, easier to perform does not require specialized tools [8].

But on the other hand, one of the most important advantages of laparoscopy over the open approach is the ability to visualize and repair contralateral defects without the need for more incisions, which is not possible in open repairs, especially in infants due to the high rate of patent processus vaginalis which is reported to be around 44%–57% in recent studies [9].

In our study, the overall mean operative duration in the laparoscopic group was 45.7 min, while it was 47.8 3 min in the open group ( $P = 0.83$ ). But operative times in bilateral hernia were significantly shorter in the laparoscopic group when compared to the open group ( $P = 0.049$ ). These results were consistent with multiple studies that have shown a decreased operative times using laparoscopy [10,11].

One such study is a systematic review of fifty-three studies published by Esposito et al. [12]. In this systematic review, the operative duration was significantly shorter in the laparoscopic group for bilateral hernias compared to the open group, whereas there was no significant difference in terms of operative time for unilateral inguinal hernia repair. The result of this review in addition to other similar studies published in the literature demonstrates the superiority of laparoscopy in terms of operative duration over the open approach keeping in mind that bilateral repairs are done without further incisions.

A randomized clinical trial conducted at Al-Azhar University Hospitals by Shalaby et al. also showed a marked reduction in the operative time, lower rate of recurrence. In this study, no testicular atrophy or iatrogenic ascent of the testis were reported in addition to the excellent cosmetic results [13].

Another study published in 2017 was a retrospective cohort by Zhu et al. which also reported shorter operative time, better scar appearance, less postoperative complications in the laparoscopic group [11].

The time to recovery was significantly shorter in the laparoscopic group in our study. However, there was no significant difference in the length of stay and the development of postoperative pain between the two groups. This is in contrast to a study performed in Finland which reported increased postoperative pain in the laparoscopic group although the time to recovery was similar between the laparoscopic and open groups [14]. The similar length of stay is mostly related to the lack of laparoscopic facilities in the day-case unit at our institution for pediatric patients, so we were forced to admit all our patients to the surgical wards, unlike open cases which were mostly done in the day-case unit. Additionally, the hospital guidelines during the study period mandated 6–12 h of observation in the inpatient wards before discharge in all children who had laparoscopic surgery.

Cost analysis between the two groups revealed a statistically significant difference in cost favoring the open group which was to be expected with more recent and newer technology. However, the cost will drop significantly over the upcoming years when the competition and adoption rate grows [13,15].

The most important limitations of this study were the retrospective nature and the significant difference in sample size between the open and laparoscopic group which may over/under-estimate the results. Weight and height were not collected in this study but should be taken into consideration with further studies.

Overall, no conclusions can be drawn to decide the superiority of one technique over the other. However, different studies have confirmed the comparable results of both techniques similar to our results [12,16].

## 5. Conclusion

Laparoscopic inguinal hernia repair in children is a safe, reproducible, and feasible procedure. It is associated with shorter operative

duration and faster time to recovery compared to open repair. Finally, based on the results of our study, laparoscopic hernia repair was comparable to the open approach in children older than 6 months who present with inguinal hernia.

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## Author contribution

Raed N Al-Taher developed the main concept and designed the study. Ibrahim A Khrais contributed toward data analysis, literature review and drafted the manuscript. Suhub W Alma'aitah contributed to the editing. Abdulhakim A Al Saiad, Abdullah A Al-aboodi, Osama M Saleh, Nesreen Dwekat, Huthaifa W Alma'aitah, Zean M Bello, contributed toward data collection. Mohammad Z Rashdan supervised and helped edit the manuscript.

## Registration of research studies

Name of the registry: [Clinicaltrials.gov](https://clinicaltrials.gov).

Unique Identifying number or registration ID: NCT05011786.

Hyperlink to your specific registration (must be publicly accessible and will be checked): <https://clinicaltrials.gov/ct2/show/NCT05011786>.

## Guarantor

Ibrahim Khrais.

## Consent

No consent has been obtained for this study as it does not disclose any personal information of the study subjects and in accordance with the IRB guidelines at the Jordan University Hospital.

## Declaration of competing interest

All authors declare no conflict of interest.

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