

ORIGINAL ARTICLE

Impact of delaying pediatric inguinal hernia repair during COVID-19 pandemic: a multicenter prospective study

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ABSTRACT

Background: Delayed management of pediatric inguinal hernias can lead to serious complications. We sought to determine the effects of delayed elective surgery on uncomplicated inguinal hernias in children and parents' emotional perspectives and anxiety levels during the coronavirus disease 2019 (COVID-19) pandemic.

Methods: This multicenter prospective cohort study included all pediatric patients ≤ 14 years of age with inguinal hernia who were initially scheduled for surgery but were postponed during the national lockdown between March and September 2020. The incidence of all hernia-related complications while awaiting surgery was analyzed. We also surveyed the patients' parents regarding their perspectives, anxiety, and the impact of delayed surgery on their children's well-being.

Results: Forty-eight patients were included in the study. Primary inguinal hernias were noted in 45 (93.8%) patients. Half of the patients had one or more hernia-related emergency room (ER) visits, 18 (37.5%) had one or more hernia incarcerations, and 13 (27.1%) needed emergency hernia repairs. The median waiting time for patients requiring emergency surgery was 65 days. The cumulative hazard of complications increased as the surgical intervention was delayed. Composite complications (defined as any hernia-related ER visit, incarceration, or emergency surgical repair) occurred within a median duration of 167 days. Many parents were concerned about their child's problems and were worried about exposure to the COVID-19 virus if operated on during the pandemic.

Conclusion: Hernia-related complications were high because elective inguinal hernia repair was delayed during the COVID-19 lockdown. To minimize these complications, surgical repair should be carefully timed, particularly during a pandemic.

Keywords: Inguinal hernia, COVID-19, Pandemic, Children.

Introduction

The capacity to deliver timely and safe surgical care has been significantly affected by the coronavirus disease 2019 (COVID-19) pandemic, due to the restrictions that were put in place to prevent virus transmission and reduce direct patient contact. Surprisingly, the number of patients seeking emergency surgical care, including those with incarcerated hernias, has decreased in several healthcare institutions during the peak of the pandemic [1–3].

Pediatric inguinal hernias are benign but can have serious complications if incarcerated, obstructed, or strangulated. Pediatric inguinal hernia incarceration rates vary from 3%

to 12% [4,5]. During the pandemic, a sizable decline in inguinal hernia emergency surgical repairs was reported worldwide [6–9].

During the COVID-19 pandemic, the Pediatric Urology Guidelines Panel of the European Association

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of Urologists strongly suggested delaying pediatric urological surgical treatments, including inguinal hernia repair, for the previously mentioned reasons [10]. According to Hu et al. [11] cancellation of elective surgery during the COVID-19 pandemic was not associated with inguinal hernia-related complications. However, we believe that the time to surgery (median, 31 days) in their study may be too short for complications to occur in the delayed group. To prioritize surgical care during the pandemic, experts recommend urgent evaluation and surgery for symptomatic pediatric inguinal hernias, and delayed care for asymptomatic patients [12]. Despite these recommendations, there remains a significant gap in the literature regarding the clinical and psychological impacts of system-wide, prolonged surgical postponements. Furthermore, relying on single-center observations limits generalizability, highlighting the distinct need for a multicenter study to mitigate institutional bias and accurately capture the true risks associated with extended delays. Therefore, in this multicenter study, we sought to determine the effect of delaying elective surgery during the COVID-19 pandemic on uncomplicated inguinal hernia in children, and to determine the parents' emotional perspectives, anxiety levels, and the impact of delaying the procedure on their child's well-being.

Methods

Study design and setting

After Institutional Review Board (IRB) approval, we conducted a multicenter prospective cohort study from three high-volume, tertiary care hospitals in Riyadh, Saudi Arabia, between March 1st and September 30th 2020. The study was designed and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines [13]. Hospitals included were King Saud University Medical City, King Fahad Medical City, and King Saud Medical City.

Study population

All pediatric patients ≤ 14 years of age diagnosed with inguinal hernia who were scheduled for surgery but postponed due to the COVID-19 pandemic lockdown were included. Patients older than 14 years of age or those who refused to participate in the study were excluded.

Sample size and recruitment

Because this study was conducted during the unprecedented onset of the COVID-19 pandemic, a formal sample size calculation based on expected outcomes was not feasible. Instead, we relied on consecutive sampling of all eligible patients whose surgeries were delayed during the lockdown phase. The patients were identified from hospital databases and patient files.

Data collection

Data were collected by trained surgical residents using a standardized electronic case report form. The phone calls

were made weekly until surgery was performed for each patient.

Collected data included demographic characteristics, age, date of diagnosis, and details of emergency room (ER) visits and surgeries.

Outcome measures

Primary outcomes

Hernia-related ER visits, incarcerations requiring reduction, emergency surgical repair. "Composite complications (yes/no)" was defined as the occurrence of any one of the following: hernia-related ER visit, incarceration requiring manual reduction, or the need for emergency surgical repair.

Secondary outcomes

Parental anxiety and child well-being during the period of surgical delay. A questionnaire was developed by the researchers to assess parental emotional perspectives and child well-being while waiting for surgery.

Parental survey

Parental anxiety and perceptions regarding the surgical delay were evaluated using a targeted, 3-item questionnaire developed by the surgical team. Because this study was conducted during the unprecedented onset of the COVID-19 pandemic, a pre-validated psychometric tool specific to this clinical scenario was not available; therefore, the survey was designed pragmatically to capture immediate parental concerns. The questionnaire comprised two 3-point ordinal scale questions assessing the severity of general anxiety and fear of hospital-acquired COVID-19 exposure, alongside one multiple-choice question (with an open-ended "other" option) to identify the primary source of worry, specifically comparing the fear of hernia complications against the fear of pandemic exposure. To ensure parental comprehension and maximize participation, the survey was administered verbally via structured telephone interviews. The overall response rate for the questionnaire was 100%.

Statistical analysis

Data were analyzed using the Statistical Package for Social Science (SPSS) version 26.0 (IBM SPSS, Armonk, New York, USA). Results are expressed as numbers and percentages for categorical variables and as mean and standard deviation or as the median, range, and interquartile range (IQR) for continuous variables after checking for normality of distribution using the Shapiro-Wilk test. Associations were tested using the chi-squared test or Fisher's exact test. The Mann-Whitney U test was used to determine significant differences in the median age, age at diagnosis, duration until surgery, and time until complications occur. Statistical significance was set at $p < 0.05$. Kaplan-Meier survival estimates for time-to-occurrence of composite complications were performed using Social Science (SPSS) version 26.0 (IBM SPSS, Armonk, New York, USA) [14]. Complete baseline and

follow-up data were available for all enrolled patients; therefore, no statistical handling or imputation for missing data was required, and no patients were lost to follow-up prior to the study endpoint.

Ethical approval

The study protocol was reviewed and approved by the Institutional Review Board (IRB No. 25/1057). All study procedures were conducted in accordance with the ethical standards of the institutional and national research committees. Informed consent was obtained from the parents or legal guardians of all participating children prior to their inclusion in the study.

Results

Forty-eight patients were included in the study, of whom 41 (85.5%) were males. The median age at diagnosis was 463.4 days (range: 30-1,460), and the median gestational age (GA) was 34.4 weeks (range: 22-40). Twenty-one (43.7%) patients were ≤ 1 year of age. Table 1 shows the baseline characteristics of the 48 patients.

Unilateral hernias occurred in 36 patients (75%). The most common symptom was a painless bulge in 19 patients (39.6%), followed by pain reported by the parents in 18 patients (37.5%). Seventeen patients (35.4%) had other congenital anomalies. Primary (not recurrent) inguinal hernia was noted in 45 patients (93.8%), and three (6.3%) had recurrent hernias. Diagnosis of inguinal hernia was confirmed in the outpatient clinics in all patients.

Table 2 presents the outcomes for the entire cohort. Half ($n = 24$) of the patients had one or more ER visits due

to hernia-related complaints, and 18 (37.5%) had one or more incarcerations that required reduction. Thirteen (27.1%) patients required emergency hernia repair. The median time for incarceration events requiring reduction or emergency repair was 65 days (IQR: 0-518 days). When categorized by age (≤ 1 year versus >1 year), right inguinal hernia was significantly more common in older patients, whereas bilateral inguinal hernia was common among younger patients ($p = 0.042$). No significant differences in complications were noted between the age groups (Table 3).

Half of the patients ($n = 24$) experienced composite complications (defined as hernia-related ER visits, incarceration, or emergency surgical repair). When compared with patients without complications, there were no significant differences between the groups with regard to age, sex, weight, or prematurity status (Table 4).

The cumulative hazard for the occurrence of composite complications increased as the surgical intervention was delayed. Time-to-event analysis showed that 14 out of 24 patients (58.3%) who had composite complications had the outcome as early as 1 month, and 18 of these 24 (75%) had the outcome within 2 months. Time-to-event analysis showed the outcome to occur at a median of 167 days from diagnosis (approximately 5 1/2 months) with a 95% CI of 110-226 days (Figure 1).

Parent's survey

There were 22 (45.8%) parents who were very to extremely anxious about their child's problem, and the same number were very worried about the potential exposure to COVID-19 during surgery. However, 20 parents (41.7%) were worried that a delay in surgery would worsen their child's problems (Table 5).

All included patients were followed up weekly via phone calls by the surgical team. After the initial lockdown

Table 1. Demographic characteristics of all patients ($n=48$).

Characteristics	<i>n</i> (%) or median (range)
Gender, (%)	
Male	41 (85.4%)
Female	7 (14.6%)
Gestational age (weeks)	34.4 (22-40)
Birth weight (grams)	2800.0 (600-4,000) (IQR 1,800-3,000)
Age at diagnosis (days)	463.4 (30-1,460)
Weight at diagnosis (kg)	9.4 (3.0-23.0)
Laterality (%)	
Right	24 (50.0%)
Left	12 (25.0%)
Bilateral	12 (25.0%)
Associated anomalies	
None	31 (64.6%)
Associated anomalies:	17 (35.4%)
Cardiac	5 (10.4%)
Others	12 (25%)
Inguinal hernia	
Primary	45 (93.8%)
Recurrent	3 (6.3%)
Symptoms / complaints	
Painless bulge	19 (39.6%)
Pain	18 (37.5%)
Cries a lot	5 (10.4%)
Vomiting	5 (10.4%)
Constipation	4 (8.3%)
Others	3 (6.3%)

Table 2. Outcomes of patients ($n = 48$).

Outcomes	<i>n</i> (%) or mean (SD)
Number of hernia-related ER visits	
0	24 (50.0%)
1	15 (31.3%)
2	6 (12.5%)
>2	3 (6.3%)
Number of hernia-related ER visits (mean $\pm$ SD)	1.7 $\pm$ 0.9
Number of incarcerations that required reduction	
0	30 (62.5%)
1	15 (31.3%)
2	1 (2.1%)
>2	2 (4.2%)
Number of incarcerations that required reduction (mean $\pm$ SD)	1.3 $\pm$ 0.9
Need for emergency repair	
Yes	13 (27.1%)
No	35 (72.9%)
Time from diagnosis to incarceration or emergency surgery (median, range)	65 (0-518 days)

Table 3. Comparison of clinical presentation and complications by age groups (≤ 1 year versus > 1 year old).

Variables	≤ 1 year n = 21	> 1 year n = 27	p values
Gender			
Male	18 (85.7%)	23 (85.2%)	0.644
Female	3 (14.3%)	4 (14.8%)	
Laterality			
Right	9 (42.69%)	15 (55.6%)	0.042
Left	3 (14.3%)	9 (33.3%)	
Bilateral	9 (42.9%)	3 (11.1%)	
Recurrence			
Primary	19 (90.5%)	26 (96.3%)	0.405
Recurrent	2 (9.5%)	1 (3.7%)	
Symptoms			
Painless bulge	10 (47.6%)	9 (33.3%)	0.380
Pain	7 (33.3%)	11 (40.7%)	0.765
Cries a lot	4 (19.0%)	1 (3.7%)	0.153
Vomiting	2 (9.5%)	3 (11.1%)	0.858
Constipation	1 (4.8%)	3 (11.1%)	0.621
Others	0	3 (11.1%)	0.373
Complications/ Events			
ER visits	11 (52.4%)	13 (48.1%)	0.771
Incarcerations	9 (42.9%)	9 (33.3%)	0.558
Emergency surgery	7 (33.3%)	6 (22.2%)	0.516
Composite complications (any of the above)	11 (52.4%)	13 (48.1%)	0.771
Time from diagnosis to incarceration or emergency surgery (days)	Median: 44.50 IQR: 376	Median: 65.00 IQR: 100	0.442

IQR, interquartile range.

was lifted, elective surgeries were resumed, and all non-operated cases were followed up and operated on electively. There was no loss of follow-up.

Discussion

During the COVID-19 pandemic, many healthcare institutions have provided limited surgical care for elective cases [15,16]. Timing is essential for pediatric inguinal hernias because, as surgery is delayed, hernia complications are likely to occur [17,18]. In this study, we examined the impact of postponing elective surgery during the lockdown for children with an uncomplicated and reducible inguinal hernia, focusing on the parental perspective, specifically their concerns, and the effects of the delay on the child's overall well-being.

In this study, half of the patients developed complications, including hernia-related ER visits, hernia incarceration, and the need for emergency surgical repair. This observation is higher than the previously reported risk of incarceration, which varies between 3% and 13% [19,20]. The optimal timing of inguinal hernia repair in children remains controversial, with recommendations ranging from 7 to 14 days to avoid the increasing risk of hernia incarceration [4,19–24]. In contrast, Bawazir et al. [25] observed that early surgery in the neonatal period may result in increased postoperative complications, including apnea, admission to the pediatric intensive care unit, hernia recurrence, and testicular atrophy [25]. These findings were recently confirmed by the

Table 4. Comparing patients who had hernia-related complications versus those who had no complications.

Variables	No complications n = 24	With complications n = 24	p values
Gender			
Male	19 (79.2%)	22 (91.7%)	0.416
Female	5 (20.8%)	2 (8.3%)	
Current age (months): median	16	18	0.907
Gestational age (weeks): median	37.0	38.0	0.136
Birth weight (grams): median	2,950.0 IQR: 1,050	2,700.0 IQR: 1,200	0.797
Age at diagnosis (months): median	7.5	4	0.601
Weight at diagnosis (grams)	Median: 9,500.0 IQR: 8,000	Median: 10,000 IQR: 6,000	0.959
Laterality			
Right	14 (58.3%)	10 (41.7%)	0.183
Left	3 (12.5%)	9 (37.5%)	
Bilateral	7 (29.2%)	5 (20.8%)	
Symptoms			
Painless bulge	10 (41.7%)	15 (37.5%)	0.500
Pain	6 (25.0%)	12 (50.0%)	0.068
Cries a lot	1 (4.2%)	4 (16.7%)	0.174
Vomiting	0	5 (20.8%)	0.025
Constipation	0	4 (16.7%)	0.055
Others	0	3 (12.6%)	0.500

IQR, interquartile range.

Hernia in Premies (HIP) trial, supporting delaying inguinal hernia repair until after initial discharge from the neonatal intensive care unit to avoid serious adverse events [26]. In addition to being linked to greater rates of incarceration, longer surgical wait times are linked to more frequent visits to the emergency room and parental frustration [22]. According to a 2008 survey by Chen et al. [4] the average wait times for hernia repair in Canadian and American hospitals were 99 and 27 days, respectively [22].

Worldwide, hospitals have reacted to COVID-19 by reducing non-emergent healthcare visits to preserve personal protective equipment, optimize resource utilization, and minimize the spread of the virus [27–29]. Interestingly, this pause in elective surgical cases was not associated with short-term adverse outcomes [30]. Hu et al. [11] showed that delaying pediatric inguinal hernia repair during the pandemic did not appear to increase the likelihood of incarceration or emergency department visits [13]. In contrast, our findings showed high rates of hernia-related complications because elective repair was postponed during the lockdown period. During the study period, 50% of the patients made at least one visit to the ER because of hernia-related complaints. More than 50% of patients with hernias who visited the ER were born prematurely at a GA of less than 36 weeks; 37.5% of the cohort had one or more incarcerations, and 27.1% needed emergency hernia repair. Our findings revealed that if surgical intervention is postponed, the cumulative risk of complications increases well beyond pre-pandemic complication rates [4,11,19,24,25]. Within 2 months of diagnosis, 75% of our patients

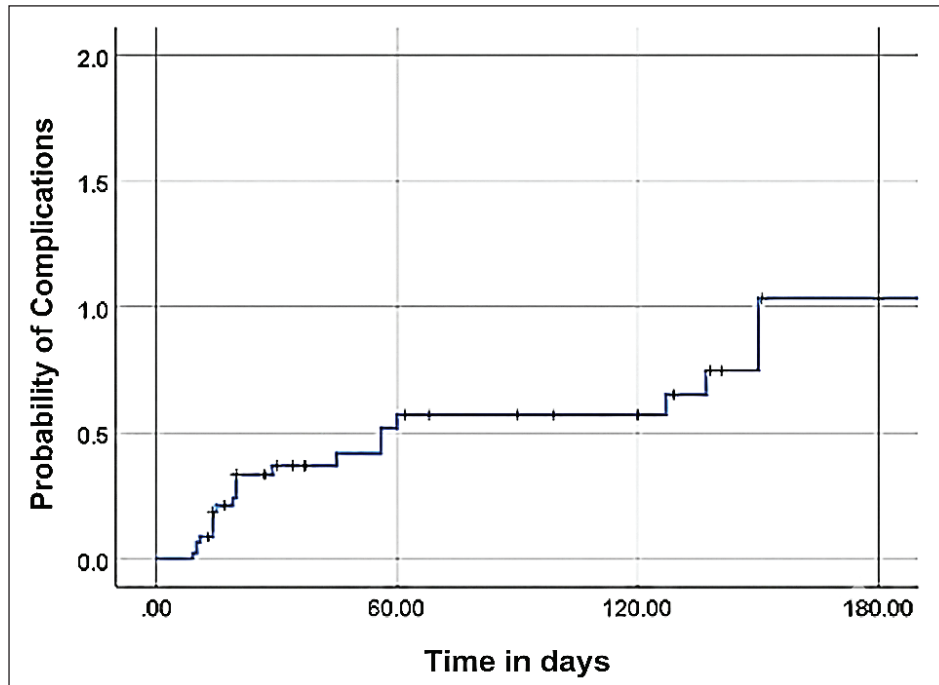


Figure 1. Cumulative hazard using the Kaplan-Meier Survival curve for the duration of postponement of surgery to the occurrence of composite hernia-related complications.

developed composite complications. This increase in hernia-related complications relative to the pre-pandemic rates is yet to be investigated, but perhaps it is due to the nature of the lockdown period, which resulted in the closure of clinics and all elective clinical encounters, limiting the counselling of patients about their disease and reasons to seek emergency care.

Our time-to-event analysis showed that almost 60% of our patients had hernia incarceration or need for emergency surgery at a median age of 65 days, with no significant effect of age or prematurity. This suggests that early interventions should be targeted to minimize the occurrence of complications. This observation is consistent with previous studies that attempted to investigate the ideal time for surgery [4,19–24].

Another important issue is parental anxiety and stress during times of limited access to non-emergent healthcare. Parents of children awaiting various operations experience anxiety and stress, and many were unable to perform their usual activities [19,24]. This is heightened by the long waiting time during the COVID-19 lockdown period and the concern that their children might be exposed to COVID-19 if brought to the hospital or undergo surgery. These observations highlight the importance of good communication with parents of children awaiting surgery during stressful times. According to our study, 45.9% of parents were extremely concerned that delaying the procedure might increase the likelihood of hernia-related complications.

The difficulties encountered during the COVID-19 pandemic have provided insights into the value of efficient protocol-based management. Our findings highlight the importance of risk assessment for conditions that were previously thought to require elective surgical treatment

Table 5. Parents' perspective survey results.

Questions	n (%)
Level of parent's anxiety	
Not anxious	6 (12.5%)
Minimal to mild anxiousness	20 (41.7%)
Very to extremely anxious	22 (45.8%)
Level of worry about potential exposure of the child to the COVID-19 virus during surgery	
Not worried	10 (20.8%)
Minimal to moderate worry	16 (12.5%)
Very to extremely worried	22 (45.8%)
Reasons for parents' anxiety, worry, and distress	
Worried that delaying surgery will worsen the child's condition	20 (41.7%)
Concerned that surgery during the pandemic will affect their child's health	8 (16.7%)

when access to healthcare is limited. Common pediatric surgical conditions such as inguinal hernia require prompt referral to a surgeon for evaluation and timely surgical repair and at the same time addressing the concerns of the parents and providing adequate education to minimize anxiety, frustration, and unnecessary ER visits.

The findings of this study should be carefully considered in the context of these limitations. First, the relatively small sample size, despite the inclusion of three referral hospitals, might have underpowered our study. We believe that the main reason for the low number of patients was the nature of the lockdown and the cessation of all clinics, referrals, and elective encounters. Therefore, most of our patients were diagnosed before the lockdown period and had already been seen in pediatric surgery clinics. Another possible reason for these low numbers

is parental concerns about exposure to COVID-19 when seeking medical care. Second, there is an inherent risk of information bias related to the accuracy of medical records documented during emergency room visits.

Conclusion

Inguinal hernia-related complications, including incarceration and the need for emergency surgery, were associated with delayed elective hernia repair during the COVID-19 lockdown. These rates are higher than the pre-pandemic rates, indicating the significant impact of delayed elective surgeries. Surgeons and health managers should carefully address this seemingly low-risk condition when prioritizing surgical care when healthcare is under pressure.

List of Abbreviations

ER	Emergency Room
GA	Gestational Age
IQR	Interquartile Range
IRB	Institutional Review Board
SPSS	Statistical Package for Social Science

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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Consent to participate

Written informed consent was obtained from all the participants.

Ethical approval

The study was approved by the Institutional Review Board (IRB) at King Saud University, Riyadh (Approval No. 25/1057).

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Supplementary content (If any) is available online.

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