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Original Research Article

Predicting contralateral hernia after unilateral inguinal hernia repair in children: a 5-year cohort from Bahrain

Maryam H. Mahdi[1]*, Hasan Marhoon[1], Hussain Alaradi[2], Zainab Zaid[3], Fayza Haider[1]

[1]Department of Paediatric Surgery, Governmental Hospital, Manama, Kingdom of Bahrain
[2]Department of Surgery, Governmental Hospital, Manama, Kingdom of Bahrain
[3]Governmental Hospital, Manama, Kingdom of Bahrain

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***Correspondence:**
Dr. Maryam H. Mahdi,
E-mail: dr.maryam.h.mahdi@gmail.com

ABSTRACT

Background: Inguinal hernias are common in pediatric surgery, with unilateral presentations being most frequent. The development of a metachronous contralateral inguinal hernia (MCIH) after unilateral repair remains a concern, with reported incidence ranging from 5% to 30%. The decision to perform contralateral exploration remains controversial.
Methods: We retrospectively reviewed 202 children (aged 0–14 years) who underwent open unilateral inguinal hernia repair at Salmaniya Medical Complex, Bahrain, between 2019 and 2024. Data were retrieved from operative logs and electronic records. Reoperation for recurrence or contralateral hernia development was documented. Risk factors including prematurity, hernia side, hernia sac size, and comorbidities were assessed for association with recurrence or MCIH using chi-square tests.
Results: Of the 202 patients, 75.7% were male and 24.3% female. Preterm infants (<37 weeks) represented 15.8%. Right-sided hernias were more common (60.9%), left side (39.1%). Large hernia sacs were noted in 61.9% of cases. Overall reoperation rate was 8.9% (18/202), with MCIH accounting for 94.4% of cases. Only one patient had a same-side recurrence. No risk factors showed statistically significant association with recurrence or MCIH ($p>0.3$). For example, reoperation was required in 3.1% of preterm versus 10% of full-term infants ($p=0.317$).
Conclusions: In this cohort, ~9% required reoperation, almost exclusively for MCIH. No traditional risk factors significantly predicted recurrence or contralateral hernia development. These findings suggest that routine contralateral exploration may not be necessary for all patients. Individualized decision-making is recommended, and further studies are needed to identify patients at higher risk for MCIH.

Keywords: Inguinal hernia, Pediatric surgery, Metachronous contralateral inguinal hernia, Recurrence, Contralateral exploration, Surgical complications

INTRODUCTION

Inguinal hernia repair is one of the most common pediatric surgical procedures. The incidence of inguinal hernias in children is approximately 0.8% to 5% and it is higher in premature infants (up to 30%).[1,2] An inguinal hernia results from a patent processus vaginalis, allowing abdominal contents to protrude through the inguinal canal. Normally, the processus vaginalis obliterates around birth; failure to close can lead to an indirect hernia. Unilateral hernias account for the majority (~80%) of cases, with the right side affected more often than the left. Prompt surgical repair is advised after diagnosis due to the risk of incarceration, which is reported at 3–30% in the first six months of life (especially high in preterm infants).[3] A well-documented phenomenon after unilateral repair is the occurrence of a metachronous contralateral inguinal hernia (MCIH). Reported incidence of MCIH ranges from roughly 5–15% in most pediatric series, but it can exceed 20–30% in certain high-risk groups such as infants under

6 months.[4,5] Notably, infants and younger children have a higher likelihood of a contralateral patent processus vaginalis, which underlies these later hernias. Recurrence of the hernia on the same side after repair is comparatively uncommon, with pediatric recurrence rates on the order of 0.5–3% in large cohorts.[4,6] Both MCIH and recurrence impose the need for a second operation, subjecting the child to additional anesthesia and surgical risk.

Whether to perform a prophylactic exploration of the contralateral groin during an initial unilateral hernia repair has been a subject of debate for decades. Advocates of routine contralateral exploration point to the non-negligible incidence of MCIH and the goal of avoiding a second anesthesia and emergent incarceration events. However, prophylactic exploration means many children undergo an unnecessary procedure, with its own risks of complications. Documented risks of bilateral exploration include added operative time, infection (reported in ~0.6–1% of cases), hematoma formation (~0.1%), injury to the spermatic cord structures (including testicular atrophy in ~0.3% of term infants, potentially higher in preterms) and even a small chance of inducing an ipsilateral recurrence (0.4–1%).[7,8] Furthermore, there are anesthetic considerations: emerging evidence links repeated or prolonged exposure to general anesthesia in early childhood with possible adverse neurodevelopmental effects.[7] In fact, the U.S. Food and Drug Administration issued warnings about elective surgeries requiring anesthesia in children under 3 years of age, advising caution with repeated anesthetic exposures. These concerns underscore that any additional procedure should have clear justification.

Given the lack of consensus, many centers have shifted toward a selective approach for contralateral exploration – reserving it for cases with identified risk factors (such as young infants, girls, or a very large internal ring) or using diagnostic laparoscopy to guide the decision.[9] However, criteria for selection vary, and some surgeons still practice routine exploration in infants or certain patient populations. Our study was conducted in this context to provide local evidence from Bahrain. We evaluated a five-year cohort of pediatric patients with unilateral inguinal hernias to determine the incidence of recurrence and contralateral hernia development (MCIH) after open repair. We also analyzed whether patient factors like prematurity, the side of initial hernia, the size of the hernia sac, or the presence of comorbid conditions were associated with higher risk of recurrence or MCIH. We aimed to use these data to inform the management strategy in our region and contribute to the broader discussion on when contralateral exploration is warranted in children.

METHODS

Study design and setting

This study was a retrospective cohort analysis of pediatric patients who underwent open unilateral inguinal hernia repair at Salmaniya Medical Complex, the main tertiary care hospital in Bahrain. We reviewed cases from January 2019 through February 2024. The hospital's pediatric surgery department manages all pediatric hernia referrals in the region, providing a representative sample of the local pediatric population.

Inclusion criteria

Children aged 0 to 14 years who presented with a unilateral inguinal hernia (either right or left side) between 2019 and Feb 2024, patients who underwent a primary unilateral inguinal hernia repair during that period, and patients who had any subsequent surgery at our institution for either a recurrence on the same side or a contralateral inguinal hernia during the follow-up period were included.

Exclusion criteria

Children who initially presented with bilateral inguinal hernias (those cases are managed as bilateral repairs and thus not unilateral presentations), children who underwent bilateral inguinal hernia repair (either simultaneously or staged) as their primary procedure, and cases where a contralateral patent processus vaginalis was intentionally ligated at the time of the primary repair (for example, if a contralateral hydrocele or open canal was found and addressed), were excluded to avoid confounding the outcome.

Data collection

We identified eligible cases using the operating theater registry and pediatric surgery logs. A total of 438 inguinal hernia operations were performed in the 5-year period; after applying exclusion criteria (e.g., 62 bilateral cases, plus cases with concurrent PPV ligation), we isolated 376 unilateral repairs.

From these, a random sample of 202 cases was chosen for detailed review (to ensure manageability of data extraction). Using the hospital's electronic medical record system (ISEHA), we collected data on patient demographics (age at surgery, sex, gestational age for prematurity), hernia characteristics (side and any intra-operative notes on sac size or contents), and the presence of chronic medical conditions (e.g., respiratory, cardiac, hematologic, or chromosomal disorders). Operative reports were reviewed to note if the hernia sac was described as "large" or "small" (subjectively noted by the surgeon), and any unusual findings.

Follow-up information was obtained from outpatient clinic notes and emergency visit records up to the end of the study period (February 2024) to identify any episodes of recurrence or contralateral hernia development. For patients who did require reoperation, we recorded the timing of the recurrence or contralateral hernia (in weeks, months, or years after the initial repair).

Outcomes and definitions

The primary outcome was the occurrence of a second inguinal hernia surgery on the same patient, either for a true recurrence on the originally repaired side or for a new hernia on the contralateral side. We define "recurrence" as a hernia reappearing at the site of the initial repair (due to failure or weakness of the repair), and "MCIH" as a hernia manifesting on the opposite side after an initial unilateral repair. For each case with a second surgery, we noted whether it was a recurrence or contralateral hernia, and the time interval from the first surgery to the detection of the second hernia. Secondary outcomes included the prevalence of any complications in the initial surgery (e.g., wound infection, orchitis) as noted in records, and the distribution of various risk factors in the cohort.

Statistical analysis

Categorical data (such as presence versus absence of recurrence, or prematurity status) were summarized as frequencies and percentages. Continuous data like age were summarized by median and range since the age distribution was expected to be skewed toward infants and young children. To test associations between potential risk factors and the primary outcome (recurrence or MCIH), we used chi-square tests or Fisher's exact test as appropriate (given the relatively small number of outcome events). Specifically, we compared reoperation rates between: preterm versus full-term children, initial hernia side (left versus right), and hernia sac size categories (large versus small, excluding unknowns). A p value <0.05 was considered statistically significant. We also calculated a 95% confidence interval for the proportion of patients requiring reoperation to provide an estimate of the incidence of second hernias in our population. Data analysis was performed using Microsoft Excel and statistical package for the social sciences (SPSS) 25.0.

RESULTS

Patient characteristics

A total of 202 children met the inclusion criteria. The cohort was predominantly male (approximately 76%), reflecting the known higher incidence of inguinal hernia in boys. The gender distribution is illustrated in Figure 1. The patients' ages ranged from neonates to 14 years; about one-third (33.7%) were infants under 6 months old at the time of repair, 9.9% were 6–12 months, and the remaining ~56% were over one-year-old (a considerable proportion of cases presenting after infancy). The median age at surgery was 1.5 years. Regarding birth history, 32 patients (15.8%) were born prematurely (defined as gestational age <37 weeks) while the majority (84.2%) were full-term infants. Figure 2 shows the breakdown of full-term vs preterm cases in the study population. There was no notable difference in gender ratio or age distribution between preterm and full-term groups.

Gender distribution of the cohort. A large majority of the children (approximately 3 out of 4) were male, which is consistent with the higher incidence of inguinal hernia in boys. Only about one-quarter of the patients were female. This male predominance aligns with expectations for pediatric hernia cases (Figure 1).

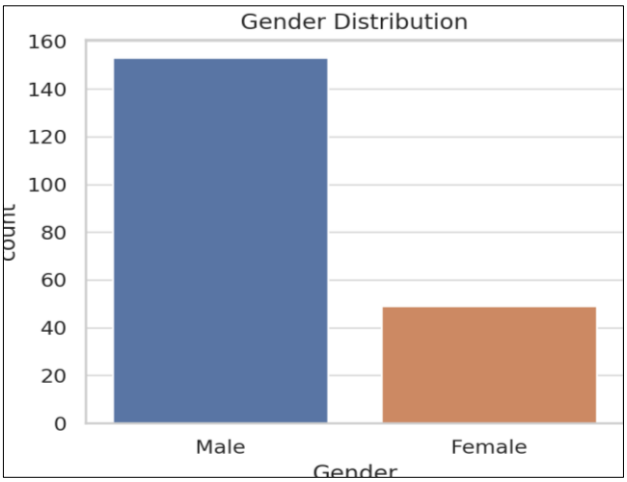

Figure 1: Gender distribution.

Prematurity distribution in the study cohort. Only about 16% of patients were born preterm, whereas the remaining 84% were full-term infants. Prematurity is a known risk factor for inguinal hernia development, but in our cohort preterm infants constituted a minority of cases (reflecting the general population proportions) (Figure 2).

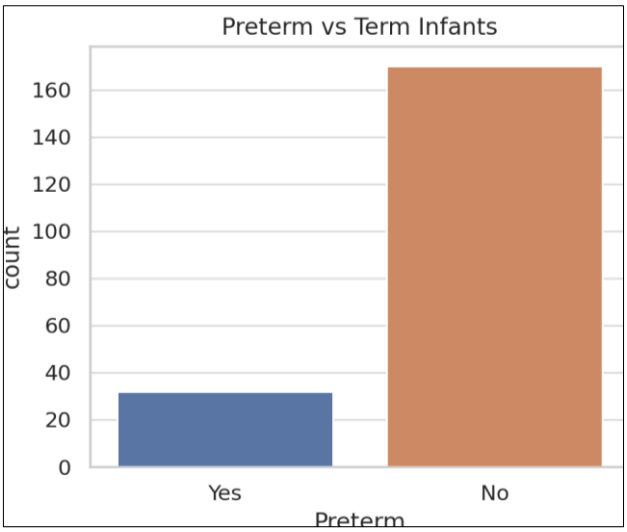

Figure 2: Prematurity distribution.

The majority of children (60.9%) had their hernia on the right side, with 39.1% on the left side. This right-side predominance is consistent with some pediatric series and may relate to later closure of the right processus vaginalis. However, left-sided hernias were also common. We did not routinely explore the contralateral side at the index operation in any case as per our institutional practice.

Figure 3 illustrates the laterality of the primary hernia repairs in the cohort.

Hernia side distribution among the 202 unilateral cases. Just under two-thirds (≈61%) of the children presented with a right-sided inguinal hernia, whereas about 39% had a left-sided hernia. This finding of right-side predominance is in line with clinical observations that right processus vaginalis closure lags behind the left side in many infants (Figure 3).

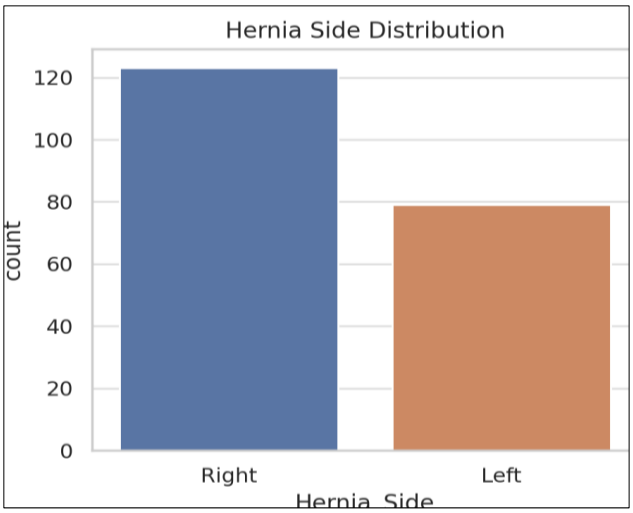

Figure 3: Hernia side distribution.

According to the operative records, surgeons qualitatively described the hernia sac size in many cases. In 125 cases (61.9%), the sac was noted to be "large" (often implying it extended well into the scrotum or thickened edematous sac wall), whereas in 26 cases (12.9%) it was described as "small" (a narrow sac or only a Bubonocele). However, in 51 cases (25.2%), the operative note did not clearly document the sac size (this typically occurred in earlier records or emergency cases). Excluding those with unknown sac size, about 82.8% of the documented cases had large sacs and 17.2% had small sacs. Figure 4 shows the distribution of sac sizes for the cases where this information was available. Notably, this suggests that most patients had a sizable hernia sac at surgery, but the absence of documentation in one-quarter of cases indicates some inconsistency in recording this detail.

Hernia sac size distribution (for cases with documented size). After excluding cases with no clear documentation of sac size, the vast majority of hernias (≈83%) were intra-operatively assessed as having a large sac, while ≈17% were classified as a small sac. (In raw numbers, 125 large versus 26 small sacs were noted.) The considerable number of "large sac" cases might reflect a referral bias (with more noticeable hernias getting referred), but it may also include surgeon subjectivity. It should be noted that in ~25% of cases, the operative notes did not specify sac size, representing a limitation in our data capture (Figure 4).

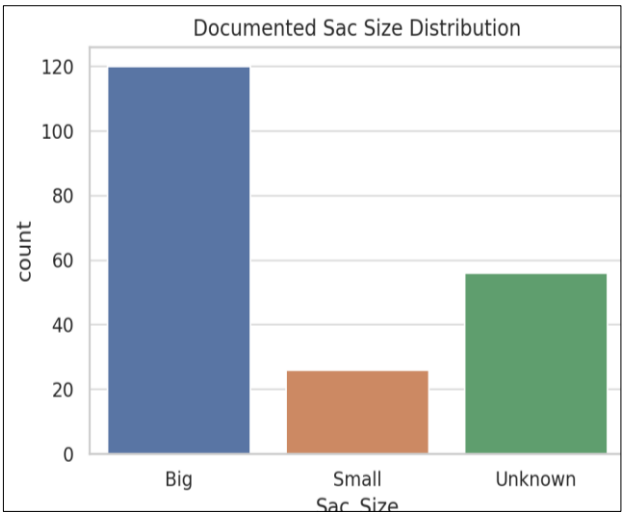

Figure 4: Sac size distribution.

We also reviewed the presence of chronic medical conditions among the patients, as such conditions (e.g., connective tissue disorders, chronic lung disease, or ventriculoperitoneal shunts) can influence hernia outcomes. In our cohort, 17.8% of children (36 out of 202) had at least one chronic comorbidity or congenital condition documented. The most common were hematologic disorders (mainly sickle-cell trait or G6PD deficiency) in about 6% of patients, followed by cardiac anomalies (5%) and respiratory system issues (4%). A few patients (≈1.5%) had chromosomal syndromes. However, when comparing outcomes, we did not find any particular disease category to be significantly associated with hernia recurrence or contralateral hernia development. Children with and without comorbid conditions had similar rates of requiring a second hernia surgery (around 9% in both groups), indicating no clear link in this sample.

Incidence of recurrence and contralateral hernia

During the follow-up period (minimum 1 year, up to 4 years' post-surgery), a total of 18 children out of 202 required a reoperation for inguinal hernia, yielding an overall reoperation incidence of 8.9%. The 95% confidence interval for this proportion is 5.7% to 14.1%, meaning our data are consistent with roughly 1 in 10 children experiencing either a recurrence or a contralateral hernia after an initially unilateral repair. Importantly, the vast majority of these second operations were for metachronous contralateral hernias, not same-side recurrences. Specifically, 17 of the 18 (94.4%) were contralateral hernias, while only 1 case (5.6%) was a true recurrence on the originally repaired side. In other words, among the entire cohort of 202 repairs, the risk of developing a hernia on the opposite side was about 8.4%, whereas the risk of the repaired hernia recurring was about 0.5%.

The single recurrence case occurred in a 3-month-old male infant who had a large right inguinal hernia repaired for

incarceration irreducible hernia; he re-presented with a recurrent right hernia 3 weeks post-operatively (this was classified as an early recurrence due likely to technical failure of the initial repair). He underwent a successful redo herniotomy. The other 17 cases all developed new hernias on the opposite side of their initial repair (metachronous hernias). The timing of these contralateral hernias varied: notably, a significant subset appeared very soon after the initial surgery. In 6 children (33.3% of the reop cases), the contralateral hernia was detected within 2–4 weeks after the first repair – essentially in the first month. In 3 cases (16.7%), the contralateral hernia occurred between 1–6 months post-op, and in 4 cases (22.2%) it occurred at 6–12 months. The remaining 5 cases (27.8%) presented more than one year after the initial surgery, with the longest interval being just under 3 years. This distribution indicates that one-third of metachronous hernias manifested very early, suggesting they were likely already present as an undetected patent processus vaginalis at the time of the first surgery (rather than a new process that developed later). The others mostly occurred within two years, aligning with literature that most MCIH will appear within 2–3 years post-repair. Table 1 summarizes the site and timing of the reoperations in our series).

Occurrence of second hernias among the 202 unilateral cases. Most second hernias were contralateral, with about one-third appearing within the first month after surgery.

Table 1: Occurrence of second inguinal hernias (recurrence versus contralateral) and timing.

Outcome	Number of cases (n=18)	Percentage
Site of second hernia		
Contralateral side (MCIH)	17	94.4
Same side (recurrence)	1	5.6
Timing of second hernia		
Within 2–4 weeks	6	33.3
1–6 months	3	16.7
6–12 months	4	22.2
>1 year	5	27.8

As shown, contralateral hernias far outnumbered recurrences, and a substantial fraction occurred very early after the primary repair. No cases of incarceration of the contralateral hernia were noted – all were electively repaired when identified. Additionally, none of the contralateral hernias occurred in the immediate postoperative hospitalization; they were identified at follow-up visits or by parents noticing a new groin swelling.

Risk factor analysis

We examined whether certain baseline factors were more frequently associated with the children who needed reoperations. First, considering prematurity: out of 32 preterm infants in the cohort, only 1 (3.1%) developed a contralateral hernia (and none had a recurrence). In contrast, among the 170 children born full-term, 17 (10.0%) experienced a contralateral hernia or recurrence. Although the rate was higher in full-term children in absolute terms, this difference was not statistically significant (χ^2 test, p=0.317). Figure 5 compares the reoperation rates between preterm and full-term groups. The finding suggests that, within our sample, being born premature did not confer an increased risk of MCIH or recurrence – if anything, the observed rate was lower, though we caution that the numbers of events are small. This result is somewhat counterintuitive, as some prior studies have reported prematurity as a risk factor for bilateral hernias due to the higher incidence of patent processus vaginalis in premature infants. In our cohort, the low incidence in preterms may be due to the limited sample of preemies or possibly a shorter follow-up for some who were infants at study end.

Reoperation (contralateral hernia or recurrence) rates in preterm versus full-term children. The orange bar (preterm) shows a 3.1% reoperation rate (1 out of 32 preterm infants), while the green bar (full-term) shows about a 10% reoperation rate (17 out of 170 full-term children). This difference was not statistically significant (p=0.317). Interestingly, in our data preterm infants did not exhibit a higher risk of developing a metachronous hernia compared to full-term infants, contrary to expectations. However, the number of preterm infants was relatively small, and most second hernias occurred in older, full-term children.

Next, we assessed the side of the initial hernia as a potential risk factor. Of the 79 children who had a left-sided hernia repair initially, 7 eventually needed a second operation (1 recurrence on the left, 6 new right-side hernias). This is an 8.9% rate (7/79). For the 123 children with an initial right-sided hernia, 11 required a reoperation (0 recurrences, 11 new left-side hernias), which is an 8.9% rate as well. The rates were virtually identical, and as expected the association was not significant (p=1.0). In summary, we found no evidence that the laterality of the first hernia influenced the chance of a contralateral hernia – a child with a left hernia was just as likely (≈9%) to later get a right hernia as vice versa. This aligns with larger studies that have generally found laterality is not a strong independent predictor when analyzed in multivariate context, though some reports have noted a slight predominance of contralateral occurrence after left-sided repairs. Our data suggest symmetry in risk (we did not create a separate figure for this since the rates were the same on both sides).

Finally, regarding hernia sac size at the initial repair: excluding cases with unknown sac documentation, we compared outcomes in those with a “large” sac versus “small” sac. Among 125 children with a large sac, 9 developed a contralateral hernia (7.2%). Among 26 with a small sac, 2 developed a contralateral hernia (7.7%).

Additionally, in the unknown sac group (51 cases), 7 had a contralateral hernia (13.7%). Statistically, there was no significant difference between large and small sac groups (p=0.407 for large vs small). The somewhat higher percentage in the "unknown" category likely does not imply a true higher risk, but rather reflects the fact that those cases were less clearly documented; it's possible some of those had large sacs but were not recorded. Thus, we found no clear correlation between the size of the hernia sac at surgery and the likelihood of a contralateral hernia later. This is notable because one might hypothesize that a very large hernia (indicating a wide processus vaginalis) could predict an open processus on the opposite side. Our results did not show such a trend, though our ability to detect it was limited by the data quality and sample size.

No other factors (such as the presence of a urological problem: undescended testis, hypospadias or family history of hernia) showed any obvious pattern with the outcomes in our review, although these were not formally tested. There were also no significant differences in the follow-up duration between those who had second hernias and those who did not – many second hernias occurred early, as noted, and others who did not have one were followed just as long in many cases.

Follow-up

The follow-up duration varied: approximately 47% of patients had follow-up for less than 2 years (some infants and toddlers were lost to follow-up after a year or so if asymptomatic), 27% had about 2 years of follow-up, and ~26% had more than 2 years (including some up to 4 years). We recognize that some children with shorter follow-up might still develop a contralateral hernia after our study cutoff. However, since literature suggests most MCIH appear within 2–3 years, our follow-up should capture the majority of clinically relevant outcomes. No cases of testicular atrophy or chronic pain were noted on follow-up; in particular, the single recurrence case did not have any gonadal compromise. We educated all families at discharge about the risk of a hernia on the opposite side and advised them to return if any swelling is noticed, which likely contributed to early detection in several instances.

In summary, our results indicate that about one in eleven children will develop a contralateral hernia within a few years after a unilateral repair, whereas true recurrences are very rare. We did not identify specific clinical predictors for those who developed contralateral hernias – in our cohort, that outcome appeared somewhat idiosyncratic, striking across different ages, both genders, and both preterm and full-term, regardless of initial hernia side or sac size. This unpredictability highlights the central dilemma: many children will never develop a contralateral hernia, while a minority will. The following section discusses these findings in context and implications for surgical decision-making.

DISCUSSION

Our study found an 8.4% rate of metachronous contralateral inguinal hernia (MCIH), which aligns with rates reported in previous literature.[10] A 2015 meta-analysis by Ron et al found an MCIH rate between 4% and 8%, consistent with our findings.[5]

We observed no significant difference in MCIH development between left-sided and right-sided initial hernias (both 8.9%), contradicting studies such as Wenk et al, which noted higher contralateral hernia rates after left-sided repairs.[11]

Prematurity was not significantly associated with MCIH in our cohort (3.1% versus 10.0% in full-term), differing from findings by Esposito et al, who reported higher bilateral hernia rates among preterm infants.[8]

Regarding hernia sac size, our study found no significant association between sac size and the likelihood of contralateral hernia (7.2% in large sacs versus 7.7% in small sacs), challenging assumptions that a larger sac indicates a more patent processus vaginalis.

Notably, 33% of MCIH cases occurred within the first month post-repair, indicating the probable preexistence of an occult processus vaginalis, as suggested by Grosfeld et al.[4] This timing suggests that early contralateral hernia presentations may be anticipated and managed electively.

Given the lack of definitive predictive factors, our findings support the selective exploration approach advocated in multiple reviews including those by Kokorowski et al and Staerkle et al, who emphasized that routine contralateral exploration doubles surgical risk without sufficient benefit.[12,13]

Furthermore, none of our MCIH cases presented with incarceration, suggesting that a watchful waiting approach remains safe and appropriate if caregivers are educated and follow-up is ensured.

In summary, while our findings are broadly consistent with international literature, they offer important regional data. They underscore the absence of reliable clinical predictors for MCIH and validate the practice of individualized contralateral exploration based on intraoperative findings or patient-specific risk factors.

Notably, we observed that one-third of contralateral hernias occurred in the first month after the initial surgery. This underscores that many children likely had an asymptomatic patent processus vaginalis on the opposite side at the time of the first operation. It was simply not clinically evident then, but became apparent shortly after. This early occurrence pattern is consistent with the idea that if a contralateral hernia is going to develop, a good portion will do so soon, as also noted by others. Conversely, if a child remains hernia-free in the

contralateral groin for a couple of years' post-repair, the likelihood of ever developing MCIH diminishes significantly. Our study's follow-up design captured these early cases well.

A central question is whether any factors can predict which children will get a contralateral hernia – a "high-risk" subset who might benefit from upfront contralateral exploration. We hypothesized that preterm infants, those with left-sided hernias, or those with very large hernia sacs might be at higher risk, based on suggestions in prior studies.[6,11,14] However, our analysis did not find statistically significant differences: preterm status did not confer higher risk (in fact our preterm group had a lower observed rate), left versus right made no difference, and sac size was not predictive. The lack of association could be due to our sample size (only 18 total events to compare across groups), meaning we may have been underpowered to detect modest differences. It could also be that these factors truly are not strong discriminators on their own. For example, while Wenk et al found that initial left-sided hernias carried higher odds of contralateral occurrence (8.5% versus ~4–6% for right), our numbers (8.9% versus 8.9%) didn't show that trend – possibly due to random variation or a difference in population characteristics.[15] Our finding on prematurity is intriguing; some prior data suggest bilateral hernias are more common in preemies, but we did not see MCIH more frequently in those who were preterm. This might be because extremely premature infants with bilateral hernias tend to present and get operated as bilateral cases (and thus were excluded), whereas our included "preterm" infants were mostly moderate preemies with unilateral disease. It's also possible that careful clinical examination (and perhaps the routine use of contralateral exploration in some of our tiniest infants by surgeon's judgment) prevented some MCIH in that group. In summary, our results emphasize that it is difficult to prospectively identify which child will develop a contralateral hernia – a conclusion echoed by other authors who have tried risk-scoring systems. Some international studies developed a scoring system including factors like age, side, and weight; they found initial left side and a high score predicted contralateral hernia.[16] Such tools are promising but need external validation. In our cohort, no simple factor stood out strongly.

Our findings carry clinical implications for pediatric surgeons in Bahrain and similar settings. Given that we did not identify a subgroup with dramatically higher risk, a policy of routine contralateral exploration in all unilateral cases would mean a lot of unnecessary surgeries. Roughly 90% of our patients did not develop a contralateral hernia in the follow-up period. Exploratory surgery on all of them would have incurred needless additional operative time and exposure. Meanwhile, the ~9% who did develop MCIH were later brought back for repair; these second surgeries were uneventful elective procedures in our series, with no emergency incarcerations or major complications recorded. This supports the strategy of watchful waiting for contralateral hernia rather than prophylactic exploration, especially in settings where follow-up is reliable and parents can be educated to detect a hernia early. It is worth noting that none of the MCIH in our study presented as strangulated or urgent cases – they were all recognized early and repaired electively. This may not always be the case (incarceration of MCIH has been reported, particularly in infants), but our experience suggests it is a manageable risk with proper counseling.

When considering the risks of contralateral exploration, one must recall that adding a contralateral herniotomy can slightly increase operative risk and anesthesia time. Although pediatric hernia surgery is safe, additional dissection on the contralateral side carries a small risk of complications such as infection (~1%), bleeding, or injury to vas deferens or gonadal vessels. The incidence of testicular atrophy after standard hernia repair is very low (well under 1% in full-term infants), but it is reported to be higher in premature infants if bilateral exploration is done (possibly up to a few percent).[17] In our series, by not exploring contralaterals routinely, we avoided exposing ~184 children to an unnecessary contralateral dissection, and we observed no cases of atrophy or major complication in the 202 index repairs. On the flip side, 17 children did require a second anesthetic for MCIH repair. Modern anesthesia for infants and children is quite safe, but concerns remain about potential neurocognitive effects of multiple exposures in early life. The FDA caution from 2016 advises minimizing elective procedures under age 3 that are not necessary. Our findings suggest that unnecessary exploration can be avoided in most cases without a large increase in risk, provided that parents and providers remain vigilant for contralateral hernias.

Comparing our study to international ones, the 8.9% contralateral hernia rate we found is within the typical range reported. A meta-analysis by Kokorowski et al found an overall MCIH incidence of ~6% and recommended against routine exploration, noting most occur in infants under 1 year.[12] Another recent meta-analysis by Staerkle et al reported a similar range and concluded that routine exploration doubles operative time and risk with marginal benefit.[13] Our data support these conclusions in the context of a Middle Eastern population – essentially reinforcing that the natural history of pediatric hernias here is comparable to elsewhere. An interesting point is that earlier studies from the Middle East (e.g., a 5-year series from Iran by Askarpour et al) also found low recurrence rates (~1.7%) and recommended individualized decisions for contralateral exploration.[18] Thus, our study adds regional evidence that contributes to the global understanding: the policy of selective rather than routine contralateral exploration is reasonable. We would advocate exploring the contralateral side only in specific circumstances – for instance, in an infant girl (given the difficulty of detecting a contralateral hernia in females and the higher relative risk in left-sided hernias in girls), or perhaps in an infant boy with a very large hernia and a wide internal ring on inspection where suspicion is high.[19] In most other cases, especially in older children, the

risk of MCIH appears too low to justify the additional immediate surgery.

Our study also underscores the importance of proper documentation and long-term follow-up. We struggled with incomplete operative records regarding sac size, which limited analysis. We have since emphasized in our unit the need to document contralateral ring inspection and sac details in operative notes. Additionally, ensuring follow-up at 6 months and 1–2 years post-op (or educating primary care for the same) can catch metachronous hernias early. Early detection means elective repair, which has excellent outcomes, whereas missing a contralateral hernia could lead to an emergency if it incarcerates. Fortunately, pediatric hernias rarely strangulate within the first weeks of appearance if addressed promptly. In our cohort, early follow-up helped identify all contralateral cases before any strangulation occurred.

In summary, our results contribute to the evidence that routine contralateral exploration in children with unilateral inguinal hernias is not generally indicated – given an 8–9% yield, it means over 90% of children would undergo an unnecessary second groin dissection. The safer strategy is to repair the symptomatic side and carefully observe. The approach should be individualized: for example, a very high-risk infant (perhaps extremely low birth weight with a right hernia under 1 month old) might still be considered for a contralateral look under anesthesia on a case-by-case basis, especially if future access to surgery is a concern. However, for the majority, avoiding the additional procedure is preferable. Our practice in Bahrain will continue to be selective, and these data will help us counsel families more concretely – we can inform parents that roughly 1 in 10 might develop a hernia on the other side, and if it happens we will fix it, but in 9 out of 10 cases no second surgery will be needed. This balances transparency with reassurance.

This study evaluated pediatric inguinal hernia outcomes in Bahrain with a focus on the development of contralateral hernias after unilateral repair. Our findings reinforce several points known from the international literature while adding specific data relevant to our region. We confirmed that the incidence of MCIH in children (about 8–9% in our series) is a significant consideration, whereas recurrence of the repaired hernia is exceedingly uncommon (~0.5%). These results align with prior reports where MCIH incidences of 5–15% are documented and recurrence rates are generally under 2%.

Notably, we observed that one-third of contralateral hernias occurred in the first month after the initial surgery. This underscores that many children likely had an asymptomatic patent processus vaginalis on the opposite side at the time of the first operation. It was simply not clinically evident then, but became apparent shortly after. This early occurrence pattern is consistent with the idea that if a contralateral hernia is going to develop, a good portion will do so soon, as also noted by others. Conversely, if a child remains hernia-free in the contralateral groin for a couple of years' post-repair, the likelihood of ever developing MCIH diminishes significantly. Our study's follow-up design captured these early cases well.

A central question is whether any factors can predict which children will get a contralateral hernia – a "high-risk" subset who might benefit from upfront contralateral exploration. We hypothesized that preterm infants, those with left-sided hernias, or those with very large hernia sacs might be at higher risk, based on suggestions in prior studies. However, our analysis did not find statistically significant differences: preterm status did not confer higher risk (in fact our preterm group had a lower observed rate), left versus right made no difference, and sac size was not predictive. The lack of association could be due to our sample size (only 18 total events to compare across groups), meaning we may have been underpowered to detect modest differences. It could also be that these factors truly are not strong discriminators on their own. For example, while Wenk et al found that initial left-sided hernias carried higher odds of contralateral occurrence (8.5% versus ~4–6% for right), our numbers (8.9% versus 8.9%) didn't show that trend – possibly due to random variation or a difference in population characteristics.[15] Our finding on prematurity is intriguing; some prior data suggest bilateral hernias are more common in preemies, but we did not see MCIH more frequently in those who were preterm. This might be because extremely premature infants with bilateral hernias tend to present and get operated as bilateral cases (and thus were excluded), whereas our included "preterm" infants were mostly moderate preemies with unilateral disease. It's also possible that careful clinical examination (and perhaps the routine use of contralateral exploration in some of our tiniest infants by surgeon's judgment) prevented some MCIH in that group. In summary, our results emphasize that it is difficult to prospectively identify which child will develop a contralateral hernia – a conclusion echoed by other authors who have tried risk-scoring systems. A scoring system has been developed including factors like age, side, and weight; they found initial left side and a high score predicted contralateral hernia. Such tools are promising but need external validation.[16,20] In our cohort, no simple factor stood out strongly.

Our findings carry clinical implications for pediatric surgeons in Bahrain and similar settings. Given that we did not identify a subgroup with dramatically higher risk, a policy of routine contralateral exploration in all unilateral cases would mean a lot of unnecessary surgeries. Roughly 90% of our patients did not develop a contralateral hernia in the follow-up period. Exploratory surgery on all of them would have incurred needless additional operative time and exposure. Meanwhile, the ~9% who did develop MCIH were later brought back for repair; these second surgeries were uneventful elective procedures in our series, with no emergency incarcerations or major complications recorded. This supports the strategy of

watchful waiting for contralateral hernia rather than prophylactic exploration, especially in settings where follow-up is reliable and parents can be educated to detect a hernia early. It is worth noting that none of the MCIH in our study presented as strangulated or urgent cases – they were all recognized early and repaired electively. This may not always be the case (incarceration of MCIH has been reported, particularly in infants), but our experience suggests it is a manageable risk with proper counseling.

When considering the risks of contralateral exploration, one must recall that adding a contralateral herniotomy can slightly increase operative risk and anesthesia time. Although pediatric hernia surgery is safe, additional dissection on the contralateral side carries a small risk of complications such as infection (~1%), bleeding, or injury to vas deferens or gonadal vessels. The incidence of testicular atrophy after standard hernia repair is very low (well under 1% in full-term infants), but it is reported to be higher in premature infants if bilateral exploration is done (possibly up to a few percent). In our series, by not exploring contralaterals routinely, we avoided exposing ~184 children to an unnecessary contralateral dissection, and we observed no cases of atrophy or major complication in the 202 index repairs. On the flip side, 17 children did require a second anesthetic for MCIH repair. Modern anesthesia for infants and children is quite safe, but concerns remain about potential neurocognitive effects of multiple exposures in early life. The FDA caution from 2016 advises minimizing elective procedures under age 3 that are not necessary. Our findings suggest that unnecessary exploration can be avoided in most cases without a large increase in risk, provided that parents and providers remain vigilant for contralateral hernias.

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In summary, our results contribute to the evidence that routine contralateral exploration in children with unilateral inguinal hernias is not generally indicated – given an 8–9% yield, it means over 90% of children would undergo an unnecessary second groin dissection. The safer strategy is to repair the symptomatic side and carefully observe. The approach should be individualized: for example, a very high-risk infant (perhaps extremely low birth weight with a right hernia under 1 month old) might still be considered for a contralateral look under anesthesia on a case-by-case basis, especially if future access to surgery is a concern. However, for the majority, avoiding the additional procedure is preferable. Our practice in Bahrain will continue to be selective, and these data will help us counsel families more concretely – we can inform parents that roughly 1 in 10 might develop a hernia on the other side, and if it happens we will fix it, but in 9 out of 10 cases no second surgery will be needed. This balances transparency with reassurance.

Limitations

This study has several limitations. First, it is a retrospective analysis, which may be affected by documentation bias and inconsistencies in record keeping—particularly regarding the size of the hernia sac, which was undocumented in approximately 25% of cases. Second, the follow-up period varied between patients, and while the minimum follow-up was one year, some cases may still develop metachronous hernias beyond the observation window. Third, due to the study's single-center design and relatively modest sample size, findings may not be fully generalizable to other populations. Additionally, subjective intraoperative assessments (e.g., sac size) were not standardized, potentially affecting the accuracy of comparisons. Finally, the sample size for reoperations was limited (n=18), which reduces statistical power to detect associations with potential risk factors.

CONCLUSION

In this five-year cohort study of pediatric unilateral inguinal hernia repairs in Bahrain, we found that the incidence of MCIH was about 8–9%, whereas true recurrence of the repaired hernia was very rare (~0.5%). We did not identify prematurity, hernia side, or intra-operative sac size as significant risk factors for contralateral hernia development – indicating that these events are not easily predictable based on the common clinical parameters. The vast majority of children who undergo unilateral hernia repair will not develop a contralateral hernia during childhood, and routine contralateral exploration would result in many unnecessary surgeries. Given the low yield and the potential risks, we recommend against routine contralateral exploration in children with a unilateral inguinal hernia, especially in settings where follow-up can be ensured. Instead, a vigilant observational strategy is justified: repair the presenting hernia and educate the caregivers about signs of a hernia on the opposite side. Should a contralateral hernia appear, it can be dealt with electively at that time. This approach minimizes unnecessary anesthesia exposure and surgical risk in the majority of patients, while still ultimately addressing the minority that develop contralateral disease.

Our findings reinforce global best practices and are particularly relevant for pediatric surgical practice in Bahrain and the region. They highlight that our local patient outcomes mirror international trends, and thus international guidelines (which increasingly favor selective exploration) are applicable here. We stress the importance of individualized decision-making – for certain high-risk infants, surgeons may still opt for a contralateral exploration based on clinical judgment. However, population-wide, a policy of routine exploration cannot be universally recommended. Finally, this study underscores a need for further research to better stratify risk (perhaps exploring genetic or anatomical markers of bilateral processus patency). Multicenter collaborations or randomized trials (such as the ongoing HERNIIA trial) will shed more light on cost-effectiveness and long-term outcomes of contralateral exploration versus observation. Until then, our data support the practice of repairing only the symptomatic side in most pediatric inguinal hernia cases.

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