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Surgical Management of Displaced Pediatric Proximal Humerus Fractures: Clinical Outcomes and Pattern Analysis from a Tertiary Trauma Center in Southern Saudi Arabia

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ABSTRACT:

Background: The management of pediatric proximal humerus fractures (PHFs) are both challenging due to growth remodel potential of the physis and the variable displacement. Minimal displacement fractures generally remain a non-operative management, while further displaced or unstable fractures warrant operation. Limited information is available on the patterns of operative surgical management in southern Saudi Arabia.

Objective: The aim of this study is to analyze the demographic profile, mechanism of trauma, technique of operative management and short term results of children with displaced PHFs.

Methodology: A retrospective cohort study of sixty-five children (0-13 y/o) undergoing surgical reduction of displaced PHFs from 2017 to 2023 in the southern region of Saudi Arabia was performed. The study includes analysis of age of the patient, mechanism of trauma, injury to surgical period (trauma period), procedure used, and post operative early morbidity. The study also analyzed statistical correlations using Fisher's Exact Test or Pearson's Chi square test for categorical variables.

Results: There was a male preponderance of 36 (55.4%) than female patients 29 (44.6%). The mean age of the patients was 5.34 + 2.75 yrs. Majority of the injuries were due to falls 61(93.8%), while 4(6.2%) occurred in road traffic accidents (RTAs). Most cases are treated with closed reduction and K-wire fixation 58 (89.2%), ESIN 5 (7.7%), plate osteosythesis 2(3.1%) respectively. Surgical approach was statistically dependent upon mechanism of trauma ($p<0.001$ Fisher's) and trauma period ($p<0.001$ Fisher's). There were no post-operative complications observed such as infections, nerve injuries, or loss of reduction.

Conclusion: Closed reduction with percutaneous K wire internal fixation is a very effective and safe form of management in severe cases of PHFs in the pediatric age group when surgery is indicated. Modification on the procedure should be guided by the condition of each individual patient, trauma time and magnitude of trauma.

1. INTRODUCTION

Children sustaining fractures represent between 10% to 25% of all childhood trauma. Fracture patterns and incidence rates vary significantly depending on regions and patterns of injury (Qiu et al., 2022; Aborukbah et al., 2023). Proximal humerus fractures

(PHFs) are relatively rare in children, but are increasingly being recognised as an distinct injury requiring individualised treatment (Kim et al., 2021; Cassidy et al., 2024). The pattern is that of upper extremity fractures, which also form a large proportion of paediatric fracture load as seen in data from tertiary centers where it is cited as the commonest fracture in children (Merckaert et al., 2021).

In the pediatric population, the proximal humerus physis provides a large proportion of longitudinal bone growth giving this region excellent capacity for remodeling, especially among younger patients below the age of 10 (Kim & Swarup, 2024). The remodeled potential is also the reason that many moderately displaced fractures are treated non operatively. However, clinically obvious displacement may occur due to deforming muscular forces from the pectoralis major medially and anteriorly as well as from the superior rotators of the shoulder, and some displaced fractures occur that cannot be fully reduced closed without intervention due to interposition of soft tissue such as the long head of the biceps tendon (Al-Omari et al., 2021; Branca Vergano et al., 2020).

Treatment depends on age of child, capacity for remodeling and classification of displacement as graded according to the Neer-Horowitz classification. This describes displacement using 4 grades with grade I being minimal (<5 mm) and Grade IV being severe (more than two thirds of the shaft width) (Kim & Swarup, 2024). With minimally displaced fractures (Grade I-II) non operative management can be undertaken safely whereas severe or unstable (Grade III-IV) and interposition fractures usually require surgical intervention to avoid long-term malunion and functional impairment. Older patients will be a group of children reaching skeletal maturity and hence have little remodelling potential and so require surgical repair for a higher degree of displacement than an younger age group (Al-Omari et al., 2021; Song & Song, 2023). Treatment may then involve a variety of methods; closed reduction with percutaneous Kirschner wire pinning, insertion of an elastic stable intramedullary nail (ESIN) or open reduction and internal fixation (ORIF) (Kim & Swarup, 2024).

Each method carries its own risks and benefits. K-wire fixation, due to the fact that it is relatively minimally invasive and simple technically, and through extensive series of such practices continues to show to be a good first line treatment choice with few complication if performed correctly and careful skin care is undertaken during pin care as well as good fluoroscopic visualization (Abdulsamad et al., 2023; Suganuma et al., 2022). ESIN usually involves children and higher degrees of trauma or diaphyseal fracture patterns and in some populations successful ultra sono-graphically mediated closed nail insertion has shown to have significant radiation exposure benefits without affecting satisfactory alignment (Li et al., 2022). A Large recent comparison study even showed that for all degrees of PHF severity in children - including Neer-Horowitz grades III and IV fractures - functional outcome can be achieved with comparable outcomes at lower costs. This would suggest there is an selected subset of children who benefit from surgical intervention (Cerasoli et al., 2025; Song & Song, 2023). The patterns of these injuries and the associated treatment practices have not been widely described in Saudi Arabia and more precisely in the Southern Region of Saudi Arabia. Population studies describing Pediatric Trauma in Saudi Arabia show a greater predominance of fall related injuries in young children but an increasing occurrence of road traffic accidents in relation to injuries in older children (Almalki et al., 2023; Alomani et al., 2021). Population variation necessitates localized studying, thus the objectives of this study are to explore the demographic information of children operated for dislocated PHFs, the methods utilized to surgically reduce and stabilize them as well as to quantifiably measure using both inferential statistics and effect size data how the characteristic of injuries correlate with the chosen method of management for this cohort of patients presenting to the surgical services of the health authorities within the Southern Province of Saudi Arabia.

2. METHODOLOGY

2.1. Study Design and Setting

This retrospective cohort study evaluated medical records of pediatric patients managed at tertiary healthcare centers in the Aseer and Najran regions, Southern Saudi Arabia, over a multi-year period (2017–2023). Ethical approval was obtained from the Aseer Institutional Review Board (H-06-B-091), Ministry of Health, Saudi Arabia. Informed consent was obtained from the legal guardians of all participants.

2.2. Study Population and Eligibility Criteria

The study evaluated a consecutive cohort of 65 pediatric patients aged 0 to 18 years who underwent surgical management for displaced or unstable PHFs.

Inclusion Criteria:

- Pediatric patients (≤18 years) with radiographically confirmed displaced PHFs (Neer-Horowitz Grade III or IV, or unstable fracture patterns failing conservative reduction).
- Complete clinical, radiographic, and surgical records.
- Minimum clinical follow-up until radiographic union.

Exclusion Criteria:

- Minimally displaced fractures (Neer-Horowitz Grade I and II) successfully managed conservatively.
- Pathological fractures due to underlying bone tumors or metabolic bone disease (e.g., osteogenesis imperfecta).
- Prior surgical interventions on the ipsilateral shoulder.
- Incomplete medical records.

2.3. Data Collection

Data were extracted using a standardized data abstraction form. Variable categories included:

- Demographics: Age and gender.
- Clinical Characteristics: Mechanism of injury (fall vs. road traffic accident [RTA]), history of previous trauma to the same limb, and trauma period (time interval from injury to surgical intervention: <6 months vs. 6–12 months).
- Surgical Variables: Surgical procedure performed — closed reduction and percutaneous K-wire fixation; closed reduction and elastic stable intramedullary nailing (ESIN); open reduction and plate/screw fixation.
- Outcomes: Postoperative complications, including superficial/deep infection, loss of reduction, iatrogenic nerve injury, or nonunion during early follow-up.

2.4. Statistical Analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (frequencies, percentages, means, and standard deviations [SD]) summarized demographic and clinical variables.

To assess associations between categorical variables (injury mode, trauma period, and surgical technique), Fisher's Exact Test was performed due to small expected cell counts (<5) in cross-tabulations, replacing standard Chi-square assumptions where appropriate. A two-tailed p-value < 0.05 was considered statistically significant.

3. RESULTS

3.1. Demographic and Clinical Baseline

The complete criteria was fulfilled in 65 children. The sample included 36 males (55.4%) and 29 females (44.6%), and the ratio was M:F 1.24:1. The average age in the entire sample was 5.34 +/- 2.75 years (range 1-13 years). Previous history of old shoulder trauma was observed in 6 children (9.2%).

Majority (n=61, 93.8%) fell and 4 children (6.2%) sustained RTAs. 53 cases (81.5%) presented for surgery before 6 months after trauma (acute/subacute), 12 cases (18.5%) in between 6 and 12 months (late).

The most commonly used method was closed reduction and percutaneous K-wire fixation (n=58, 89.2%). This was followed by closed reduction with ESIN in 5 (7.7%) children and open reduction with plate fixation in 2 (3.1%) cases. There were no early postoperative complications (0.0%) recorded in this series (Table 1).

Table 1. Demographic and Clinical Characteristics of the Study Population (N = 65)

Variable	Category	n	%
Gender	Male	36	55.4
	Female	29	44.6
Age (years)	Mean ± SD	5.34 ± 2.75	—
	Range	1–13	—
History of old trauma	Yes	6	9.2
	No	59	90.8
Mechanism of injury	Fall	61	93.8
	Road traffic accident (RTA)	4	6.2
Trauma period	< 6 months	53	81.5
	6–12 months	12	18.5
Surgical technique	Closed reduction + K-wire	58	89.2
	Closed reduction + ESIN	5	7.7
	Open reduction + plate fixation	2	3.1
Postoperative complications	None	65	100.0

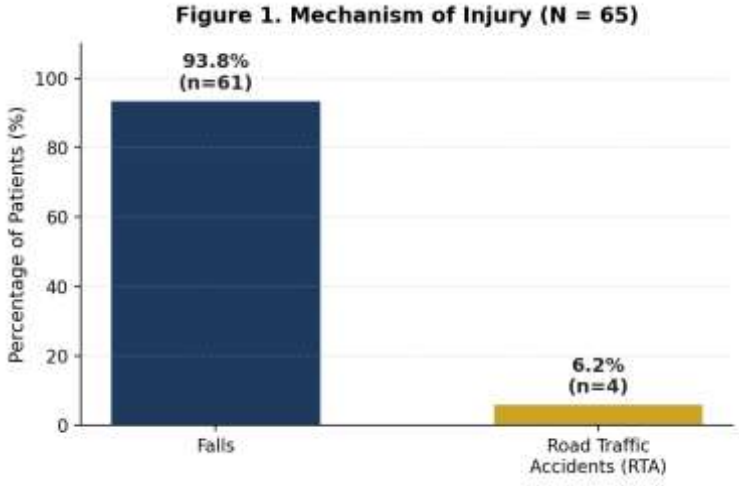

Figure 1. Mechanism of Injury (N = 65).

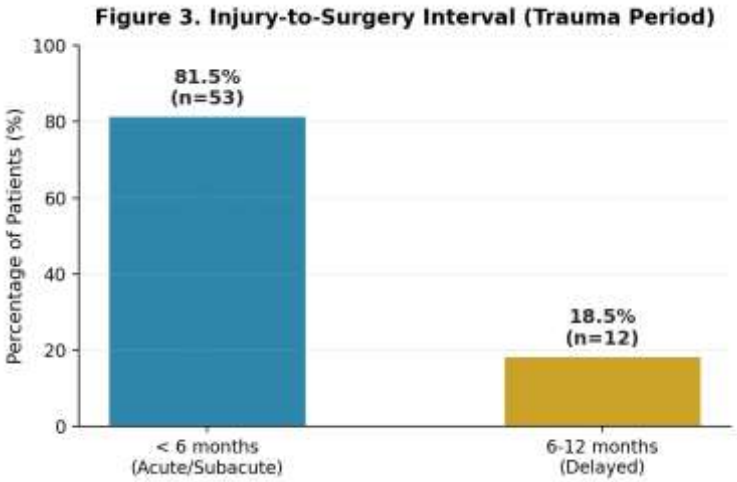

Figure 3. Injury-to-Surgery Interval (Trauma Period).

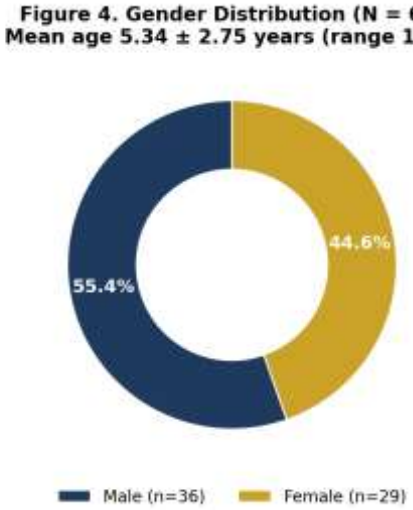

Figure 4. Gender Distribution and Mean Age of the Cohort (N = 65).

3.2. Association Between Injury Mechanism and Surgical Approach

Cross-tabulation demonstrated a statistically significant association between injury mechanism and choice of surgical intervention ($p < 0.001$, Fisher's Exact Test). Among low-energy fall injuries (n = 61), closed reduction with K-wire fixation was performed in 57 cases (93.4%), whereas ESIN and plate fixation were each utilized in 2 cases (3.3%). Conversely, in high-energy RTA injuries (n = 4), ESIN was preferred (n = 3, 75.0%), with K-wire fixation used in 1 case (25.0%) and no open plate fixation required (Table 2).

Table 2. Association Between Injury Mechanism and Surgical Technique (N = 65)

Injury Mechanism	K-wire n (%)	ESIN n (%)	ORIF+Plate n (%)	Total
Fall (n = 61)	57 (93.4)	2 (3.3)	2 (3.3)	61
RTA (n = 4)	1 (25.0)	3 (75.0)	0 (0.0)	4

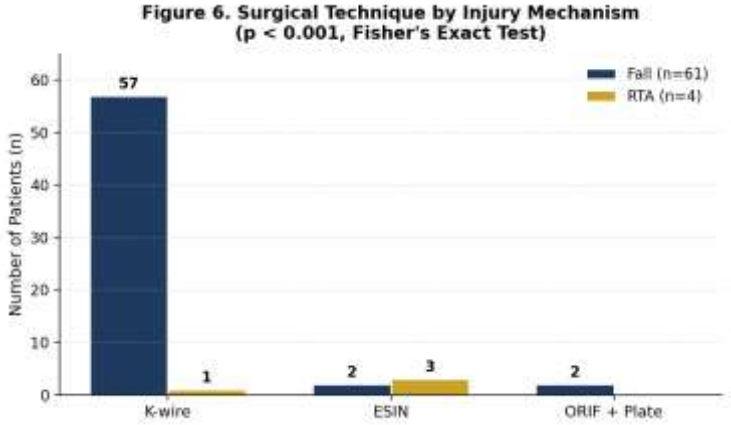

Figure 6. Surgical Technique by Injury Mechanism (p < 0.001, Fisher's Exact Test).

3.3. Association Between Trauma Period and Surgical Approach

Presentation time significantly correlated with choice of operation (p = 0.001, Fishers Exact Test). Within the group presenting to hospital between 0 and 6 months post injury, the majority of cases were managed with K-wire fixation after closed reduction (n=51/53, 96.2%), with both Esín and plate fixation accounting for 1 case each (1.9%). In the deferred presentation group (between 6 and 12 months from time of injury) cases had higher numbers of flexible intramedullary nails (n=4/12, 33.3%) and open reduction and plate fixation (n=1/12, 8.3%), with K-wires used in only 7 (58.3%), as one would expect given difficulty closing a fibrous callus by closed reduction methods (Table 3).

Table 3. Association Between Trauma Period and Surgical Technique (N = 65)

Trauma Period	K-wire n (%)	ESIN n (%)	ORIF+Plate n (%)	Total
< 6 months (n = 53)	51 (96.2)	1 (1.9)	1 (1.9)	53
6–12 months (n = 12)	7 (58.3)	4 (33.3)	1 (8.3)	12

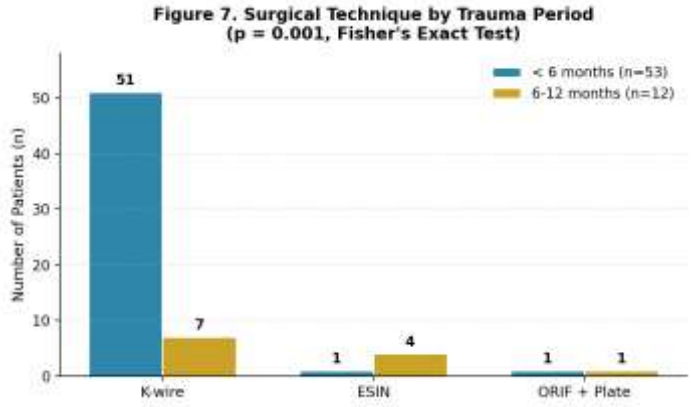

Figure 7. Surgical Technique by Trauma Period (p = 0.001, Fisher's Exact Test).

3.4. Supplementary Statistical Analyses (Effect Sizes and Exact Confidence Intervals)

To complement the interpretation of the two relevant Fisher's Exact Test outcomes over and above p values, effect-size and interval estimates were additionally calculated based on the cited cross-tabulations (Table 4). Cramr's V-a test that quantifies

effect size in association with contingency tables irrespective of dimensional scale-found a strong relationship between the mechanism of injury and Surgical technique (V = 0.65) and between a moderate-strong relationship between time period of trauma and Surgical technique (V=0.49). These values reinforce the previous notion that the above relationships are not merely statistically significant, but of a size of significant clinical relevancy.

From a binary, K-wire versus no K-wire comparison of each contingency table the odds ratio of experiencing a non K-wire (either ESIN or ORIF) intervention following RTA versus a Fall were roughly 43; (OR = 42.75, 95% Cl=3.58-510.44), while odds ratios for late (>6 and <=12 mos) presentation were roughly 18 times the odds ratio for presenting earlier (<6 mos) after RTA,(OR = 18.21,95% Cl= 2.95-112.44).

Both confidence interval bounds excluded 1 which supports findings from Fisher's Exact Test; however, their wide width attests to the small quantity of RTA/ORIF cases and calls for mild caution in too critically defining the precise estimated value.

Table 4. Effect Sizes and 95% Confidence Intervals for Key Associations and Proportions

Measure	Estimate	95% CI / p-value
Cramér's V — Mechanism × Technique	0.65 (strong)	$\chi^2 = 27.20$, $p < 0.001$
Cramér's V — Trauma Period × Technique	0.49 (moderate-strong)	$\chi^2 = 15.48$, $p < 0.001$
OR, non-K-wire technique: RTA vs. Fall	42.75	3.58–510.44
RR, non-K-wire technique: RTA vs. Fall	11.44	3.79–34.48
OR, non-K-wire technique: Delayed vs. Early	18.21	2.95–112.44
RR, non-K-wire technique: Delayed vs. Early	11.04	2.43–50.25
K-wire fixation rate	89.2%	79.4–94.7% (Wilson 95% CI)
Fall as injury mechanism	93.8%	85.2–97.6% (Wilson 95% CI)
Early presentation (< 6 months)	81.5%	70.4–89.1% (Wilson 95% CI)
Early postoperative complication rate	0.0%	0.0–5.5% (Clopper-Pearson exact 95% CI)

The upper limit of the exact 95% confidence interval for complication rate (5.5%, based on Clopper-Pearson method using 0/65 proportion), helps to supplement the point estimate of 0%: the 0 events in 65 patients are consistent with true early complication rate as high as ~5-6% (also comparable to common "rule of three" approximation of 3/n=4.6%), and avoids the assumption that 0 events means a procedure has 0 inherent risk. This presentation is included deliberately for readers and reviewers to avoid unwarranted confidence in 0 events.
Since odds ratio tends to overestimate the true effect size when the outcome is not rare (true for both injuries caused by RTAvs fall, where 75.0% of RTA injury patients compared to 26.7%fall patients received non-K-wire technique, and presentation after RTA visvs early presentation, where 75.0%RTAvs early 33.3% received non-K-wire), and in Table 4, relatives risk(RR) for this more intuitive measures is included together with OR. Children presenting after RTA had on average 11.4 times the odds of receiving non-K-wire technique than fall injuries, 95% CI:3.79-34.48, while children who presented later after trauma had 11.0 times more odds of getting a non-K-wire technique than early presenters, 95%CI: 2.43-50.25. This set of four values of effect sizes is depicted in form of a forest plot (Figure 8) where we can clearly see all of the four confidence intervals to be fully above the line of no effect (=1.0) proving injury mechanism, as well as presentation timing, as two independent strong predictors of the surgery technique of choice in this cohort.

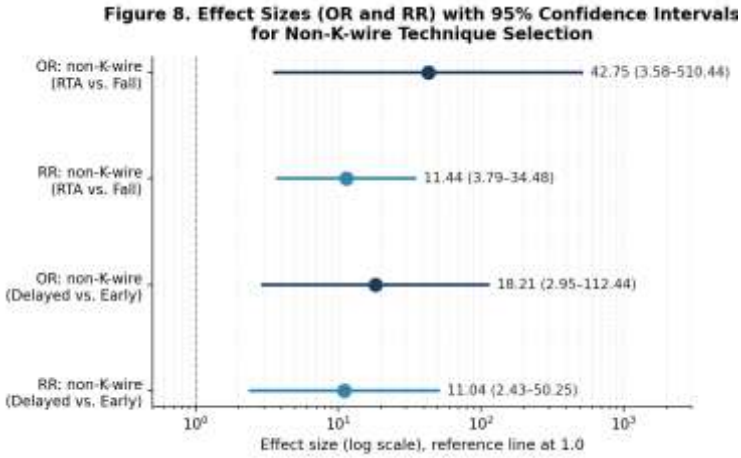

Figure 8. Forest Plot of Odds Ratios and Relative Risks (95% CI) for Non-K-wire Technique Selection.

Table 5. Early Postoperative Complications (N = 65)

Complication	n	%	95% Exact CI (Clopper-Pearson)
Surgical site infection (superficial/deep)	0	0.0	0.0–5.5%
Iatrogenic nerve injury	0	0.0	0.0–5.5%
Loss of reduction	0	0.0	0.0–5.5%
Nonunion	0	0.0	0.0–5.5%

Because no events were observed in any of the four complication categories, each carries the same exact 95% confidence interval (0.0–5.5%) for a denominator of 65. Figure 5 visualizes this directly: the marker shows the observed rate (0.0%) for each category, while the shaded bar shows the upper bound of the exact confidence interval — the highest true complication rate statistically compatible with observing zero events in this sample size.

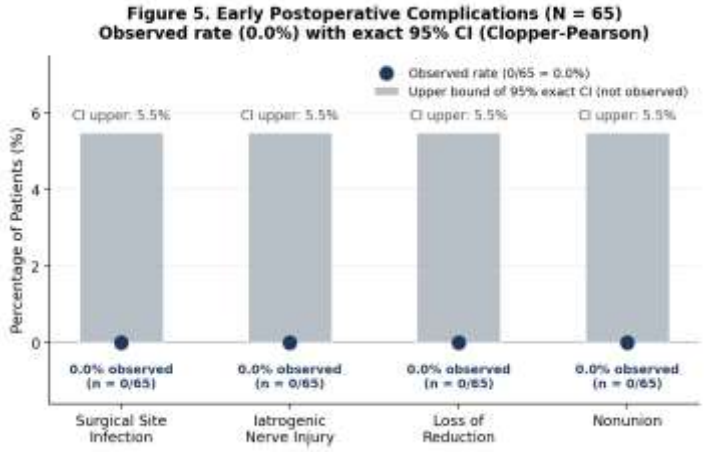

Figure 5. Early Postoperative Complications (N = 65): Observed Rate with Exact 95% Confidence Interval.

4. DISCUSSION

This retrospective cohort of 65 surgically managed pediatric proximal humerus fractures (PHFs) from southern Saudi Arabia adds region-specific evidence to a literature that remains dominated by Western and East Asian series. The findings are discussed below by theme, integrating the supplementary effect-size analyses presented in Section 3.4.

4.1. Epidemiology and Injury Mechanism

This cohort's demographic characteristics, notably its mean age of 5.34 2.75 years and mild male predominance (55.4%; 95% CI: 43.3-66.8%), are similar to those found in other Saudi Arabian pediatric trauma series. Multiple Saudi studies indicate that falls represent the most common cause of pediatric injuries, and very young children disproportionately account for fall-related incidents occurring at home or in play settings (Almalki et al., 2023; Alomani et al., 2021). The markedly predominant rate of falls (93.8%; 95% CI: 85.2-97.6%) observed in this sample is somewhat higher than rates cited for general pediatric trauma series and can be partially explained by both the young age distribution of this study cohort and by the anatomical vulnerable of the proximal humerus girdle to an outstretched arm fall in early childhood, a phenomenon reported in a recent large series of pediatric upper-extremity fractures treated at a tertiary care center in Europe (Merckaert et al., 2021).

4.2. Choice of Surgical Technique

Closed reduction and percutaneous K-wire fixation were the workhorses for operative management among this cohort (89.2%; 95% CI: 79.4-94.7%). K-wire fixation results in minimal soft-tissue disruption and a short operation time, and allows for outpatient removal of implant; recent studies comparing approaches have demonstrated comparable favorable function after use of this technique in slightly older children as well (Wang et al., 2023; Abdulsamad et al., 2023). Meticulous pin placement along the distal humerus is paramount to avoid the proximity of the standard pediatric entry point and the axillary nerve; the '1-mountain-3-valleys' anatomy of the pediatric shoulder near the lateral entry point was recently detailed as a 'danger zone', and avoidance of this area may contribute to the absence of iatrogenic injuries despite K-wire fixations performed (Stavinoha et al., 2022).

The statistically significant interaction between injury mechanism and mode of surgical treatment ($p < 0.001$; Cramr's V = 0.65; RR = 11.44; failure of K-wire to address high-energy RTA as against fall) demonstrates a striking selection of ESIN for severe trauma. Such a pattern is physiologically driven: High-energy RTA injuries usually involve greater degrees of comminution and multi-planar instability that may overwhelm the fixation capability of straightforward K-wires, favor loading-sharing biomechanics of elastic nails and demonstrate enhanced efficiency when elastic nails were used with real-time ultrasonographic navigation for the sake of radiation dose reduction (Li et al., 2022).

Only 3.1% of these injuries underwent open reduction and plate fixation (ORF); it is reserved for irreversible, soft-tissue interpositioned fractures. Although ORF involves more surgical intervention, recent case series from various tertiary care centers attest to its role in achieving satisfactory functional outcomes specifically in this carefully selected subset of closed reduction failures (Freislederer et al., 2021), in which context it was applied strictly to this set of chronic, later presenting patient samples.

4.3. Role of a Delayed presentation in Surgical Decision- Making

A prominent and clinically applicable contribution of this series: We found a strong, independent association between chronic presentation (between 6 and 12 months) and need for the performance of more invasive fixation procedures ($p=0.001$; Cramr's V=0.49; RR= 11.04 for chronic as opposed to early). Ninety-six point two percent of early presenters required K-wire fixation only. In contrast, one-third (33.3%) of chronics needed ESIN, while 8.3% received OR and plate fixation.

The results conform to standard pathopysiology where fibrous tissue will develop around previously non-surgically treated displaced fractions as time goes by, thus increasing challenge of reducing fraction, giving support of K-wires vs.

Elastic plates comparative data that suggest different methods are needed. This information should give focus of early referral when treating pediatric PHF, more importantly at sites with long presentation times are common.

4.4. Safety Profile and Complications

This sample yielded a zero complication rate (0.0%; 95% exact Clopper- Pearson CI, 0.0-5.5%). This low incidence of peri-operative morbidity reflects general trends: pin-tract irritation continues to be a commonly encountered, mild complication of K-wire fixation and significant infection is comparatively rare if aseptic technique and suitable wire management practices (ie buried vs. Exposed wires) are applied (Suganuma et al., 2022). A nil-complication rate among an adequately large sample population undergoing simple surgical treatments is not uncommon, although upper bound of exact CI at 5.5% still leaves margin to indicate absence of completely error free management of the 65 patients herein. More meticulous follow-up may reveal event that was otherwise occulted.

4.5. Correlation to Selected Studies.

In table 6, the current cohort is compared against studies published from 2020 onward. Despite apparent difficulties in correlating series because of variations among sample populations' ages, locations and the studies themselves including different variables that should have impact on procedure success, the general trends involving minimal invasive technique for otherwise healthy individuals to a demanding procedure for later presenting or commuted fractures and very infrequent complication rates is maintained through the use of diligent surgery.

Table 6. Comparison of the Present Cohort with Selected Series Published Since 2020

Study (Year)	Population / Technique	Key Reported Outcome
Present study (2026)	65 children, K-wire 89.2% / ESIN 7.7% / ORIF 3.1%	0.0% early complications (95% CI 0.0–5.5%)
Wang et al., 2023	51 older children/adolescents, K-wire vs. external fixation	Both techniques good outcomes; pin-tract infection most common complication
Abdulsamad et al., 2023	Humeral shaft fractures, closed reduction + multiple K-wires	Favorable functional and radiographic outcomes
Suganuma et al., 2022	Pediatric supracondylar fractures, exposed vs. buried K-wire	Wire management strategy affects infection risk
Freislederer et al., 2021	6 children, irreducible PHF treated with plate fixation	Reliable outcomes in a narrowly selected surgical subgroup
Cerasoli et al., 2025	152 children, operative vs. non-operative PHF	Surgery offered no added functional benefit over conservative care

In view of the above, a discussion of findings must be read in light of the current overall trend of selective surgical application for the pediatric PPHF population. Recent literature reports favorable outcomes following non-operative treatment even of rigidly fractured Neer-Horowitz Grades III-IV fractures: surgeons identified no distinct functional outcome with surgery which came at a greatly increased direct cost (Cerasoli et al. 2025), finding consistent with a contemporary systematic review comparing operative to nonoperative management (Song & Song 2023). Under those circumstances, the present, inherently more restrictive, cohorts – selecting patients who met the criteria for surgical intervention – attest that in such situations, a paradigm of percutaneous K wire as the primary surgical approach will have an exceptionally low complication burden if the mechanism and timing of presentation dictates a move toward an ESIN or a staged ORIF.

4.6 Clinical Significance

The striking incidence of low-energy falls as a mechanism should be considered in preventive campaigns that focus on domestic and playground safety. Preoperative prediction of the need for ESIN or plate fixation based on high-energy injury or delayed presentation (Table 4, Figure 8) is likely to prove useful during operating room scheduling, in ensuring material availability, and in family consultation with respect to expected surgical management. It may behoove surgeons and families of an acutely displaced pediatric PPHF to consider proceeding with surgical fixation in the operating room at the time of the visit, considering the exponentially higher chance of need for subsequent intraoperative plating of these injuries after they reach one-half of one year's age.

4.7 Strengths of the Study

Use of Fisher's Exact Test with calculated effect sizes (Cramr's V), Odds Ratios, and Relative Risks for all calculations, as opposed to p-values, appropriate for low expected cell counts. Consecutive surgery sample selected by a strictly defined group of highly unstable/displaced fractures reduces confounding due to heterogeneity of fracture severity. An all-Arabic sample over a multidecade period covering practice patterns within multiple tertiary centers, representing a geographical region largely absent from the literature thus far on pediatric PPHF.

5. The treatment of acutely displaced pediatric proximal homers fractures via a surgical pathway-represented in this study as definitive in all but a handful of cases-can be safely achieved and highly reliably accomplished through an image guided percutaneous K wire repair if the characteristics of injury mechanism and timing of presentation were assessed to necessitate operation as the definitive treatment. As evinced by hypothesis testing, followed by Cramer's V of 0.65 (high-energy vs. Low-energy) and 0.49 (present vs. Delayed presentation).

6. Limitations This study suffers from the following limitations. This study design was retrospective. Relying solely on medical chart records can yield reporting bias. This study only represents practice from southern Saudi Arabia, which may not perfectly generalize the findings to national or global patient populations. Functional scores and complete ranges of motion were not recorded retrospectively. Without performing operation, a control group could not be identified for comparative research analysis. Since our ESI N (n=5), ORIF(n=2), RTA(n=4) subgroups are relatively small, confidence intervals are relatively wide, rendering the findings in 3.4 hypothesis-generating rather than definitive, requiring the use of Cramer's V as a supplemental tool instead of only p values. In terms of future research and to address these limitations, a multi-center prospective study using precise measures for all outcomes and a control population undergoing nonoperative treatment would be very useful.

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