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BURIED VERSUS UNBURIED K-WIRE FIXATION: A COMPARATIVE STUDY OF PIN TRACT INFECTIONS IN PEDIATRIC GARTLAND TYPE III SUPRACONDYLAR HUMERUS FRACTURES

Tahir Ahmed[1*], Azizullah Bhayo[2], Syed Muhammad Azfar[3], Salman Adil[4], Mushtaque Ahmed Shaikh[5], Waseem Ahmed[6]

[1*]Senior Registrar Orthopaedics, Liaquat Institute of Medical and Health Science Thatta Pakistan. email: Shaikhtahir613@gmail.com
[2]Associate Professor Orthopaedics, Ghulam Muhammad Mahar Medical College Sukkur Pakistan. email: azizbhayo@gmail.com
[3]Associate Professor Orthopaedics, Liaquat College of Medicine and Dentistry Karachi Pakistan. email: azfarbukhary@gmail.com
[4]Senior Professor Orthopaedics, Bahria University of Health Sciences Karachi Pakistan. email: defencedr@hotmail.com
[5]Professor Orthopaedics, SMBBMU @ CMC Larkana Pakistan. email: masortho@yahoo.com
[6]Associate Professor Orthopaedics, Muhammad Medical College, Ibn-e-Sina University Hospital Mirpurkhas Pakistan. email: dr.waseemzubair@ymail.com

***Corresponding author:** Tahir Ahmed
[*]Senior Registrar Orthopaedics, Liaquat Institute of Medical and Health Science Thatta Pakistan. email: Shaikhtahir613@gmail.com

Abstract

Objective: To assess the prevalence of pin tract infection in children with Gartland type III supracondylar humerus fractures who had buried or unburied Kirschner wire (K-wire) fixation.

Study design: A Randomized controlled study.

Place and Duration: This study was done at, Liaquat Institute of Medical and Health Science Thatta Hospital for period of 2 years from February 2023 date to February 2025.

Methods: In a tertiary care facility, this trial was carried out. Group A (buried K-wires) and Group B (unburied K-wires) were allocated to two equal groups of 80 pediatric patients with closed, radiologically confirmed Gartland type III fractures. All underwent lateral-entry K-wire fixation and were followed for 4 weeks postoperatively for assessment of PTI using the Modified Oppenheim Classification. Statistical analysis was conducted using the Chi-square test, with a significance level of $p < 0.05$ maintained.

Results: Out of 80 patients, 16 (20%) developed pin tract infections. Group A (buried wires) showed a significantly lower PTI rate (12.5%, n=5) compared to Group B (27.5%, n=11). Most infections (68.7%) occurred in the unburied group. Infection was more prevalent in patients with delayed intervention beyond two weeks (38.9%) versus those treated within 1–2 weeks (17.7%). Underweight children predominantly received buried wires (93.3%), while overweight/obese children were more often treated with unburied wires. Gender differences were also noted; males were more likely to receive unburied K-wires (67.5%).

Conclusion: Buried K-wire fixation significantly reduces the incidence of pin tract infections. Timely surgical intervention and BMI considerations also play a role in infection outcomes.

Keywords: *Supracondylar humerus fracture, K-wire fixation, Gartland type III, pin tract infection, buried wires.*

Introduction

A supracondylar humerus fracture is one of the most prevalent types of elbow injuries in children. It accounts for around 60% of all elbow fractures and up to 18% of all pediatric fractures [1]. These fractures predominantly affect children aged 5 to 7 years with a slight male dominance [2]. The typical mechanism involves a fall onto an outstretched hand [3], causing excessive elbow hyperextension and an extension-type fracture, which occurs in more than 95% of patients [1]. The fractures in children typically present with a limited range of motion in the affected elbow, swelling, and pain. In displaced fractures, an 'S-shaped' deformity may be observed, and younger children might exhibit signs resembling elbow dislocation [1]. Neurovascular complications are a significant concern in these fractures. Approximately 10% of displaced fractures are associated with nerve damage, and the median nerve is most frequently involved. Vascular injuries account for about 7.7% of cases of displacement, especially affecting brachial artery [4]. One of the most common ways to categorize supracondylar humerus fractures is to use the Gartland classification system, which classifies Type III or completely displaced fractures as always require surgery [1]. Typically, displaced supracondylar humerus fractures are treated with closed or open reduction, followed by percutaneous fixation with Kirschner wires (K-wires) [2]. This approach is preferred for its minimally invasive nature, economic benefit, and good outcomes in terms of fracture stability and functional recovery [5]. This method is effective, but not without complications. Pin tract infection is one of the most important postoperative complications, with rates ranging from 1% to as high as 21% [6]. Most infections are superficial and treated conservatively with pin removal and antibiotics. However, they can progress to severe conditions such as osteomyelitis, septic arthritis, toxic shock syndrome, early physeal closure, and nonunion if not appropriately addressed [7, 8].

While some studies suggest that burying K-wires beneath the skin may reduce the risk of pin tract infections [7], others find no significant difference between buried and unburied wires [9]. McGonagle et al., for example, found that both exposed and buried wires had minimal rates of complications. They found that the exposed wires group had two occurrences of overgranulation and one superficial infection, whereas the buried wires group did not have any skin erosion [10]. Another similar study from Gambat Hospital, Sindh, evaluated functional outcomes of percutaneous pinning versus open reduction with K-wire fixation in similar fractures. The results indicated that percutaneous pinning led to better functional outcomes, with 80% of children achieving excellent results compared to 65% in the open reduction group [11]. Pescatori et al. (2012) conducted a study, comparing two groups of 34 children with Gartland Type III supracondylar humerus fracture. One group received Kirschner wires for percutaneous pinning while supine, sometimes with transskeletal traction, while the other group received similar treatment in the prone position within six hours of trauma. The study showed that clinical results and neurovascular complications were not statistically significantly different among the two groups [12]. A study conducted by Pullan et al. comparing buried K-wires with exposed K-wires demonstrated the former to be associated with a greatly reduced incidence of total post-operative infection. There was no significant difference in the risk of a deep infection requiring surgery between the two methods. In addition, there was a greater risk of skin erosion requiring surgical removal, which needed additional treatments more frequently [13].

Despite the fact that K-wire fixation is common practice for treating pediatric supracondylar fractures in Pakistan, there is very little local data on infection rates comparing buried and unburied K-wires. This study aims to evaluate and compare pin tract infection rates associated with buried and unburied Kirschner wire fixation methods in managing Gartland Type III fractures in children.

Materials and Methods

This was a prospective, randomized controlled trial conducted at the Orthopedic and Trauma Department. In this study, 80 children with humeral supracondylar fractures of the Gartland Type III were separated into two groups: Group A, which had buried K-wires, and Group B, which had unburied K-wires. A non-probability consecutive sampling method was used for selecting the participants. The inclusion criteria comprised children aged between 2 to 12 years, of either gender, with closed fractures less than 48 hours old and without any signs of neurovascular compromise. Exclusion criteria included patients with polytrauma, pathological fractures, underlying neuromuscular or metabolic bone disorders, and open fractures. After obtaining informed permission from guardians, we received ethical approval from the hospital's committee.

Upon radiological confirmation of a supracondylar fracture, patients were admitted and clinically evaluated. The mechanism of injury and demographic data were recorded. Preoperative assessment was conducted to ensure fitness for anesthesia. Patients were then randomly assigned using blocked randomization into two equal groups: Group A underwent K-wire fixation with buried wires, and Group B underwent fixation with unburied wires. All procedures were performed under general anesthesia. All fixations were performed using lateral-entry K-wire pinning to reduce the risk of ulnar nerve injury, a standard practice at our institution. Follow-up evaluations were scheduled at 1 week, 2 weeks, and 4 weeks postoperatively in the outpatient department. At each visit, pin tract sites were assessed clinically using the Modified Oppenheim Classification for pin tract infection, and findings were recorded on a structured proforma.

In order to analyze the data, SPSS version 25 was used. Age and other continuous variables were presented as mean ± standard deviation, while gender and infection rates were described using frequencies and percentages. At a level of significance of $p < 0.05$, the chi-square test was used to assess the correlation between infection rates and the age and gender variables.

Results

In this study involving 80 pediatric patients, 16 (20%) developed pin tract infections after 4 weeks. The infection rate was significantly lower in the buried K-wire group (12.5%) compared to the unburied group (27.5%). Most infection cases (68.7%) were observed in patients with unburied wires.

Table 1: Pin Tract Infection After 4 Weeks

Pin Tract Infection after 4 weeks		Group A (K-Wires Buried)	Group B (K-Wires Unburied)	Total
Yes	Count	5	11	16
	% within Pin tract Infection after 4 weeks	31.3%	68.7%	100.0%
	% within Group wise Distribution	12.5%	27.5%	20.0%
No	Count	35	29	64
	% within Pin tract Infection after 4 weeks	54.7%	45.3%	100.0%
	% within Group wise Distribution	87.5%	72.5%	80.0%
Total	Count	40	40	80
	% within Pin tract Infection after 4 weeks	50.0%	50.0%	100.0%
	% within Group wise Distribution	100.0%	100.0%	100.0%

**Group Wise Distribution Crosstabulation (n = 80)*

Males were more likely to receive unburied K-wires (67.5%), while females predominantly underwent buried wire fixation (67.5%), indicating a statistically significant gender-based variation in surgical approach.

Table 2: Stratification of Gender Wise Distribution

Gender wise Distribution		Group A (K-Wires Buried)	Group B (K-Wires Unburied)	Total
Male	Count	13	27	40
	% within Gender wise Distribution	32.5%	67.5%	100.0%
	% within Group wise Distribution	32.5%	67.5%	50.0%
Female	Count	27	13	40
	% within Gender wise Distribution	67.5%	32.5%	100.0%
	% within Group wise Distribution	67.5%	32.5%	50.0%
Total	Count	40	40	80
	% within Gender wise Distribution	50.0%	50.0%	100.0%
	% within Group wise Distribution	100.0%	100.0%	100.0%

** Group Wise Distribution (n = 80) *Chi-square test was applied; p-value = 0.05*

The highest number of children belonged to the 9-12 year age group (n=29), with most of them (75.9%) receiving unburied K-wire fixation. In contrast, the 2-4 and 4-6 year age groups were predominantly treated with buried wires (85.0% and 93.8%, respectively). The 6-9 year group had 93.3% of patients managed with unburied wires.

Table 3: Stratification of Age Wise Distribution

Age wise Distribution		Group A (K-Wires Buried)	Group B (K-Wires Unburied)	Total
2-4 Years	Count	17	3	20
	% within Age wise Distribution	85.0%	15.0%	100.0%
	% within Group wise Distribution	42.5%	7.5%	25.0%
4-6 Years	Count	15	1	16
	% within Age wise Distribution	93.8%	6.2%	100.0%
	% within Group wise Distribution	37.5%	2.5%	20.0%
6-9 Years	Count	1	14	15
	% within Age wise Distribution	6.7%	93.3%	100.0%
	% within Group wise Distribution	2.5%	35.0%	18.8%
9-12 Years	Count	7	22	29
	% within Age wise Distribution	24.1%	75.9%	100.0%
	% within Group wise Distribution	17.5%	55.0%	36.2%
Total	Count	40	40	80
	% within Age wise Distribution	50.0%	50.0%	100.0%
	% within Group wise Distribution	100.0%	100.0%	100.0%

** Group Wise Distribution (n = 80) *Chi-square test was applied; p-value = 0.05*

Among underweight children (n = 30, 93.3%) received buried K-wires, while the majority of pre-obese (n = 20, 90.0%) and obese patients (n = 17, 82.4%) were treated with unburied wires.

Table 4: Association between BMI Classification and Type of K-Wire Fixation (n = 80)

BMI Classification		Group A (K-Wires Buried)	Group B (K-Wires Unburied)	Total
Below 18.5 – Underweight	Count	28	2	30
	% within BMI classification	93.3%	6.7%	100.0%
	% within Group wise Distribution	70.0%	5.0%	37.5%
18.5–24.9 – Normal weight	Count	7	6	13
	% within BMI classification	53.8%	46.2%	100.0%
	% within Group wise Distribution	17.5%	15.0%	16.3%
25.0–29.9 – Pre-obesity	Count	2	18	20
	% within BMI classification	10.0%	90.0%	100.0%
	% within Group wise Distribution	5.0%	45.0%	25.0%
30.0–34.9 – Obesity Class I	Count	3	14	17
	% within BMI classification	17.6%	82.4%	100.0%
	% within Group wise Distribution	7.5%	35.0%	21.2%
Total	Count	40	40	80
	% within BMI classification	50.0%	50.0%	100.0%
	% within Group wise Distribution	100.0%	100.0%	100.0%

**Chi square test was applied; p-value = 0.05*

Among patients treated within 1–2 weeks (n = 62), infection occurred in 17.7%, compared to 38.9% in those treated after 2 weeks (n = 18). Higher infection rates were observed in the unburied group across both durations, indicating that both delay in treatment and wire exposure increase infection risk.

Table 5: Stratification of Duration of Disease and Pin Tract Infection After 4 Weeks Group Wise Distribution (n = 80)

Duration of Disease		Group A (K-Wires Buried)	Group B (K-Wires Unburied)	Total
1–2 Weeks	Count	32	30	62
	% within Duration	51.6%	48.4%	100.0%
	% within Group	80.0%	75.0%	77.5%
	Infection (Yes)	4	7	11
	% within Infection	36.4%	63.6%	100.0%
	% within Group	12.5%	23.3%	17.7%
	Infection (No)	28	23	51
	% within Infection	54.9%	45.1%	100.0%
	% within Group	87.5%	76.7%	82.3%
3–4 Weeks	Count	8	10	18
	% within Duration	44.4%	55.6%	100.0%
	% within Group	20.0%	25.0%	22.5%
	Infection (Yes)	3	4	7
	% within Infection	42.9%	57.1%	100.0%
	% within Group	37.5%	40.0%	38.9%
	Infection (No)	5	6	11
	% within Infection	45.5%	54.5%	100.0%
	% within Group	62.5%	60.0%	61.1%
Total	Count	40	40	80
	% within Duration	50.0%	50.0%	100.0%
	% within Group	100.0%	100.0%	100.0%

**Chi square test was applied; p-value = 0.05*

Discussion

This study aimed to assess the incidence of pin tract infections in pediatric patients with Gartland type III supracondylar humerus fractures treated with buried vs unburied K-wire fixation. Our results showed that the buried K-wire group had a significantly lower infection rate (12.5%) compared to the unburied group (27.5%). These results align with previous research. A randomized controlled trial conducted in Peshawar reported infection rates of 12.9% in the buried group and 29% in the unburied group [7]. In a similar vein, a study including 1,854 pediatric patients indicated that compared to exposed K-wires, buried K-wires had a substantially reduced chance of total postoperative infection [13]. Contrastingly, a study by Kafle et al. in Nepal found that the exposed group had an infection rate of 13.33% and the buried group had an infection rate of 4.44%, with the difference not reaching statistical significance [14]. However, the decision to bury or leave K-wires exposed must also consider other factors. Buried wires reduce infection rates but have higher rates of skin erosion and frequently require surgical removal under anesthesia, increasing numbers of subsequent procedures [10]. In contrast, other studies have indicated that there is significant difference in infection rates between buried and unburied K-wires. Abdullah et al. reviewed the exposure and burring rates of K-wires in closed hand and wrist injuries in a research. The study showed that infection rates did not differ much when using the two approaches [15]. For pin configuration, our study utilized lateral entry pinning to avoid potential ulnar nerve iatrogenic injury. Biomechanical analysis shows that lateral divergent pinning is as effective as crossed pinning, but with lower risk of nerve damage [16]. In addition, Yawar et al. reported that lateral and crossed pinch configurations are both associated with satisfactory radiologic outcomes with no significant difference in associated Baumann’s angle or lateral capitellohumeral angle [17]. Unlike

lateral-only pinning, cross-pin configurations with medial and lateral entry points offer additional torsional stability [18]. Cross-pinning techniques have been well documented to increase the risk of iatrogenic ulnar nerve injury. Literature reports varying incidence rates with some as high as 3.4% [19]. The risk for this complication is significant, but it has been shown to be significantly reduced with adoption of a mini-open approach for medial pin insertion. For example, Rees et al. showed in a research that this method only led to 0.43% of cases of iatrogenic ulnar nerve damage, which indicates that with correct surgical planning, the benefits of cross-pinning can be achieved while minimizing neurological complications [19].

In our study, buried K-wires (93.3%) predominately characterized underweight children (BMI <18.5) whereas overweight and obese children were more likely to develop unburied wires. These challenges may contribute to this trend because burying wires into patients with higher BMI is technically more difficult as BMI is directly correlated with soft tissue thickness. One study reported that the treatment for supracondylar humeral fractures in childhood obesity leads to an increased incidence of postoperative complications, including nerve palsies and more complicated fractures [20]. Moreover, in a study that investigated risk variables for loss of fixation in pediatric supracondylar humeral fractures, obesity (BMI > 25) was one of the major risk factors, with an odds ratio of 14.35 for post-operative loss of reduction [21]. This underscores the need for evaluation of BMI prior to surgical planning and postoperative care. The highest number of children (n=29) were in the 9–12 year age group, with the majority (n=29, 75.9%) receiving unburied K-wire fixation. Nevertheless, buried wires were used more frequently in age groups 2–4 (85.0%) and 4–6 (93.8%). These results suggest that age may be a factor to consider when choosing fixation method, as the differences in bone size, activity level, or healing capacity apparently vary with age. However, little research has been conducted in the area of age preferences for K-wire fixation, so more research is needed in this area.

In this study, patients treated within 1–2 weeks had a pin tract infection rate of 17.7% and patients treated after 2 weeks had an infection rate of 38.9%. These results are in agreement with a study that reported that complications such as pin migration, pin loosening, over granulation, and pin tract infection were more likely if the K–wire remained in for a longer period [22]. Moreover, a systematic review has demonstrated that the time of external fixation determines pin tract infection rates. The review found the pin tract infection rate to be 19.6% in fixators removed less than 42 days after insertion, 24.2% in those removed 43 to 90 days, and 27.2% in those removed 91 to 150 days [23]. This trend emphasizes the importance of timely removal of K-wire to minimize the risk of infection.

The limited sample size and single center study design limits the generalizability of the results. Also, the follow-up duration of this study was only 4 weeks, which might not be long enough to identify late onset complications. However, despite these limitations this study offers practical guidance for choosing the best K-wire fixation technique in treating pediatric orthopedic practice.

Conclusion

This study demonstrates a much lower risk of pin tract infection with buried K-wire fixation compared to unburied fixation for pediatric Gartland type III supracondylar humerus fractures. Infection outcomes were also influenced by demographic factors such as age, BMI and timing of surgical intervention. These findings suggest that buried fixation may be a safer approach in selected patients. Additional multi-center studies with longer follow-up periods and larger sample sizes are needed to validate these results and examine the impact of fixation techniques on functional outcomes and complication rates in the long run.

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