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Buried vs. Unburied K-Wire Fixation: Impact on Pin Tract Infection in Pediatric Gartland Type III Supracondylar Humerus Fractures

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ABSTRACT

Background: Pin tract infections are a common complication of Kirschner wire (K-wire) fixation in the management of Gartland Type III supracondylar humerus fractures in children. Whether buried or unburied K-wires result in lower infection rates remains a subject of debate.

Objective: To compare the infection rates of buried versus unburied K-wire fixation in pediatric patients with Gartland Type III supracondylar humerus fractures.

Material and Methods: This randomized controlled trial was conducted in the **Nishtar Medical University Multan**, from September 2023 to August, 2024. A total of 200 patients aged 4–12 years were equally divided into two groups: Group A (Buried K-Wires) and Group B (Unburied K-Wires). Patients were followed for signs of pin tract infection, and data were analyzed using Pearson's Chi-Square test.

Results: The mean age was 8.04 ± 2.58 years, and the mean duration of fixation was 4.93 ± 0.79 weeks. Pin tract infections were significantly lower in Group A, with 11 (11.0%) cases, compared to 27 (27.0%) in Group B (**p = 0.004**). Infection rates were notably higher in the unburied group among males (**p = 0.016**) and when the duration of fixation exceeded four weeks (**p = 0.004**). Although differences in infection rates across age groups were not statistically significant, a consistent trend of higher infections in the unburied group was observed.

Conclusion: Buried K-wire fixation is safer and more effective in reducing pin tract infections, particularly in males and with extended fixation durations, supporting its use as the preferred technique

Keywords: Gartland Type III fractures, Kirschner wires, buried K-wires, unburied K-wires, pin tract infections, pediatric orthopedic surgery..

1. INTRODUCTION:

The most common elbow fractures in the pediatric population are supracondylar humerus fractures, as shown by Gartland Type III fractures being among the most difficult due to their displacement and instability [1, 2]. Management of these fractures usually consists of closed reduction and percutaneous Kirschner wire (Kwire) fixation. However, a substantial controversy continues to take place regarding either removing or leaving the K-wires exposed, in which removing the K-wires results in a lower infection rate and other complications compared to leaving the K-wires exposed [3]. Comparative rates of pin tract infection of buried and nonburied K wire fixation are an important feature in deciding which fixation technique to use for its resolution.

Several clinical considerations have aroused controversy regarding the appropriate technique of K-wire fixation. It is presumed K-wires placed subcutaneously are buried and in so doing minimize the risks of infection by covering pin tracts from contamination from the outside [4]. However, the need for a secondary surgical procedure to remove buried wires is also associated with concerns regarding increased healthcare costs such as longer hospital stays, another anesthesia exposure, and a longer hospital stay [5]. On the contrary, exposed K-wires come with less invasive method of removal without an additional surgery; however, they may increase chances of superficial pin tract infections [6, 7].

Although generally treatable, pin tract infections can become significant complications leading to osteomyelitis requiring effective treatment strategies [8]. For that reason, the choice to bury K wires or leave them exposed must take into account the risk of infection on one scale, and convenience and economics on the other. The debate has recently been examined in relation to rate of infection and other clinical outcomes for the two techniques. For example, Sahoo et al. found a much higher infection rate in exposed rather than buried K wires [9], though other studies have shown that careful pin tract care may prevent infection regardless of wire placement [10].

Stable supracondylar fractures typically heal without intervention, but their high degree of instability makes supracondylar Gartland Type III fractures particularly challenging, requiring rigid fixation to maintain adequate alignment and healing [11]. Pediatric patients are particularly vulnerable to the complications of nerve injury, stiffness, and residual deformity, demanding that optimal surgical techniques designed to minimize risks be developed. While associated with increased procedural complexity and patient burden, there is evidence that buried K wires may confer an advantage in both infection control, especially in settings with limited access to rigorous postoperative care [12].

The aim of this article is to give a detailed comparison of the incidence of infection between buried and exposed K wire fixation methods in managing children with Gartland Type III supracondylar humerus fractures. This study aims to inform clinicians by synthesizing recent evidence for choosing intrusive treatments that are evidence based and utilize resources available, uniquely informed by the needs of the patient

2. MATERIAL AND METHODS

This study was conducted at the **Nishtar Medical University Multan**, from September 2023 to August, 2024. This was a randomized controlled trial (RCT) designed to evaluate the rate of pin tract infections in children with Gartland Type III supracondylar fractures of the humerus treated with either buried or unburied Kirschner wires (K-wires). The calculated sample size was 200 patients, with 100 patients allocated to each group. The sample size calculation was based on the infection rates reported by Inam et al., with 12.9% infection in the buried group and 29% in the unburied group, at a significance level (α) of 5% and a power of 80% [13].

Children aged 4–12 years who were diagnosed with Gartland Type III supracondylar fractures of the humerus and managed surgically with closed reduction and K-wire fixation were included in the study. Exclusion criteria included open fractures or fractures associated with neurovascular compromise, systemic infections at the time of presentation, underlying immunodeficiency or other chronic illnesses, and patients lost to follow-up.

Patients were randomly allocated to one of two groups using a computer-generated randomization sequence. In Group A (Buried K-Wires), the K-wires were cut and buried beneath the skin, while in Group B (Unburied K-Wires), the K-wires were left exposed above the skin. All surgeries were performed by consultant orthopedic surgeons using standardized techniques. After closed reduction under general anesthesia, two or three K-wires were used for fixation depending on the fracture configuration. For Group A, the skin was sutured over the cut ends of the wires, while for Group B, the wires were left exposed and bent to prevent migration.

Both groups received similar post-operative care, including application of an above-elbow splint for immobilization, instructions for regular cleaning of the pin site in Group B, and standardized antibiotic prophylaxis with a single pre-operative dose and continuation for 48 hours post-operatively. Follow-up visits were conducted at 2, 4, and 6 weeks post-surgery.

The primary outcome was the presence or absence of pin tract infection, assessed at each follow-up visit. Pin tract infection was diagnosed based on clinical signs, including redness, swelling, tenderness, purulent discharge, or fever. Demographic data (age, gender) and clinical details (duration of fixation, presence of infection) were recorded. The infection rate was compared between the two groups using the chi-square test. A p-value <0.05 was considered statistically significant. Statistical analysis was performed using SPSS version 26.

3. RESULTS

The study included a total of 200 patients, evenly distributed between Group A (Buried K-Wires) and Group B (Unburied K-Wires), with 100 patients in each group. The mean age of participants in Group A was 8.24 ± 2.51 years, while in Group B, it was 7.85 ± 2.64 years, resulting in an overall mean age of 8.04 ± 2.58 years. The mean duration of fixation in Group A was 4.95 ± 0.82 weeks, and in Group B, it was 4.91 ± 0.77 weeks, with an overall mean of 4.93 ± 0.79 weeks.

Pin tract infections occurred in 11 (11.0%) patients in the buried K-wire group and 27 (27.0%) patients in the unburied K-

wire group. This difference was statistically significant (p = 0.004, Pearson Chi-Square), suggesting that buried K-wire fixation is associated with a significantly lower risk of infection. (Table 1)

Infection rates were analyzed across three age categories. Among children aged 4-7 years, infections occurred in 10.3% (4/39) of the buried group compared to 22.0% (11/50) of the unburied group, though the difference was not statistically significant (p = 0.142). In the 8-9 years age group, infection rates were 8.3% (2/24) in the buried group and 31.6% (6/19) in the unburied group (p = 0.052), showing a trend toward higher infection risk in the unburied group. Among children aged 10-12 years, infection rates were highest in the unburied group at 32.3% (10/31) compared to 13.5% (5/37) in the buried group (p = 0.063). While the differences were not statistically significant, a consistent trend of higher infection rates was observed in the unburied group across all age categories.

A gender-based analysis revealed significantly higher infection rates among males in the unburied group (27.6% (16/58)) compared to the buried group (10.2% (6/59)), with a statistically significant difference (p = 0.016). Among females, infection rates were 12.2% (5/41) in the buried group and 26.2% (11/42) in the unburied group, though this difference was not statistically significant (p = 0.106). These findings indicate that male patients in the unburied group were at a particularly higher risk of infection compared to their counterparts in the buried group.

Infection rates were also analyzed based on the duration after surgery, categorized as ≤4 weeks and >4 weeks. In the ≤4 weeks group, infections occurred in 16.7% (6/36) of the buried group compared to 26.5% (9/34) of the unburied group (p = 0.318), showing no significant difference. In the >4 weeks group, infection rates were significantly higher in the unburied group at 27.3% (18/66) compared to 7.8% (5/64) in the buried group (p = 0.004). These results highlight the increased infection risk associated with unburied K-wires over longer post-surgical durations. (Table 2)

Table 1: Comparison of Pin Tract Infection Rates between Buried and Unburied Kirschner Wires

Group	No (n%)	Yes (n%)	Total (n%)	p-value
A (Buried K-Wires)	89 (89.0%)	11 (11.0%)	100 (100%)	0.004
A (Unburied K-Wires)	73 (73.0%)	27 (27.0%)	100 (100%)	

Table 2: Infection Rates by Age, Gender, and Duration after Surgery between Buried and Unburied Kirschner Wires

Category	Group	No (n%)	Yes (n%)	Total (n%)	p-value
Age Group	**4-7 years**				
	A (Buried K-Wires)	35 (89.7%)	4 (10.3%)	39 (100%)	0.142
	A (Unburied K-Wires)	39 (78.0%)	11 (22.0%)	50 (100%)	
	8-9 years				
	A (Buried K-Wires)	22 (91.7%)	2 (8.3%)	24 (100%)	0.052
	A (Unburied K-Wires)	13 (68.4%)	6 (31.6%)	19 (100%)	
	10-12 years				
	A (Buried K-Wires)	32 (86.5%)	5 (13.5%)	37 (100%)	0.063
	A (Unburied K-Wires)	21 (67.7%)	10 (32.3%)	31 (100%)	
Gender	**Male**				
	A (Buried K-Wires)	53 (89.8%)	6 (10.2%)	59 (100%)	0.016
	A (Unburied K-Wires)	42 (72.4%)	16 (27.6%)	58 (100%)	
	Female				
	A (Buried K-Wires)	36 (87.8%)	5 (12.2%)	41 (100%)	0.106

Category	Group	No (n%)	Yes (n%)	Total (n%)	p-value
	A (Unburied K-Wires)	31 (73.8%)	11 (26.2%)	42 (100%)	
Duration After Surgery	**≤4 weeks**				
	A (Buried K-Wires)	30 (83.3%)	6 (16.7%)	36 (100%)	0.318
	A (Unburied K-Wires)	25 (73.5%)	9 (26.5%)	34 (100%)	
	>4 weeks				
	A (Buried K-Wires)	59 (92.2%)	5 (7.8%)	64 (100%)	0.004
	A (Unburied K-Wires)	48 (72.7%)	18 (27.3%)	66 (100%)	

4. DISCUSSION

The findings of this study align with previous research comparing the rates of pin tract infections in buried and unburied Kirschner wires (K-wires) used in pediatric supracondylar humerus fractures. Our results demonstrate that buried K-wires significantly reduce the risk of infection, especially beyond four weeks post-surgery, with 11.0% infection in the buried group compared to 27.0% in the unburied group ($p = 0.004$). These observations corroborate findings in the literature.

A 12.9% infection rate in the buried group, vs 29.0% in the unburied group was reported by Inam et al. [13]. Our results are consistent with similar findings that buried K-wires reduce infection risks. Additionally, they recommend closed reduction and buried lateral pinning as a reliable and safe technique to support the use of this approach clinically.

Kafle et al. [14] showed significantly higher incidence of superficial infection in the exposed k wire (13.33%) in contrast to buried (4.44%) group. They also observed the complications, like hypergranulation tissue and skin irritation in the exposed group, that seemingly also relate to our findings that unburied wires have higher infection rates. They added, however, that they found no 'overall significant difference between the outcomes', which may be due, in part, to differences in study design and patient characteristics.

Saeed et al. [15] showed a substantial decrease in infection rates with buried wires (2.5%) over non buried wires (20%). The main focus of this paper was the protective influence of wiring after open reduction and fixation, especially in children. Furthermore, the large disparity in infection rates confirms our conclusion that buried K wire fixation is a safer technique than unburied fixation.

Aubret et al [16] studied removal of unburied K-wires prior to complete healing, but found very low infection rates (1.9%) in both buried and unburied groups. In their study, however, their design removed unburied K wires early, limiting exposure duration and infection risk. We present these results as evidence that early removal of unburied K-wires could minimize infection risks and urge caution against delayed removal in Gartland Type III fractures, in that the infection rates appear greater than would be expected in the generally healthy population.

In their cohort study, Saeed et al. [17] also noted significantly decreased infection rate, (2.5%) in buried group from 20% in unburied group. Their findings support buried wires more effectively protecting from complications related to K-wire fixation.

There was no significant difference in the rate of infection between exposed and buried K wires according to Suganuma et al. [18], but there were increased outpatient visits and longer hospitalization in buried group. Although the presence of these factors exacerbates the burden on families, reduced infectious rates seen with all buried wires militate against these logistical concerns.

Percutaneous pinning were compared to open reduction with K – wire fixation by Bhatti et al. [19] who showed minimum complication and excellent functional outcome. While their study did not look at the infection rate, their results were striking and emphasized the benefit of minimally invasive methods, such as buried pinning, in improving outcomes of Gartland type III fractures.Finally, Abdullah et al. [20] conducted a prospective study on wrist and hand fixations and found no significant difference in infection rates between buried and exposed K-wires. However, the anatomical and biomechanical differences between the wrist and humerus, as well as variations in study populations, limit the generalizability of these findings to pediatric supracondylar fractures.

5. CONCLUSION

Buried Kirschner wire fixation significantly reduces the risk of pin tract infections in pediatric patients with Gartland Type III supracondylar humerus fractures compared to unburied fixation, particularly in male patients and in cases where the wires

remain in place for more than four weeks. Although trends of higher infection rates were observed across all age groups in the unburied group, these differences were not statistically significant. The findings highlight the protective role of buried K-wire fixation, offering a safer and more reliable approach to minimizing complications, especially during extended post-surgical durations. This reinforces the clinical recommendation of using buried K-wires as a standard practice in managing such fractures

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