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Comparison of Infection Rate in Buried vs. Exposed Ends of K-wire Used in Fixation of Pediatric Supracondylar Humerus Fracture

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ABSTRACT

Objectives: This study aims to compare the rate of pin site infection in pediatric supracondylar fracture fixation in exposed vs. buried K-wire tips. **Methodology:** This prospective study was conducted at Orthopedic and spine unit MTI-HMC, Peshawar from January 2023 to December 2023. This study included 50 pediatric patients that were treated with closed reduction and percutaneous pinning for displaced supracondylar humerus fracture. Patients were followed from fist post-operative till removal of K-wire at 03 weeks for any pin site infection. Data was then recorded, analyzed and presented in percentages. **Results:** Patient with Expose K-wires end were assigned group 1 while buried K-wire ends group was assigned as group 2. 07(14.9%) out of 47 patients in Group 1 developed superficial infection. while 06(14.3%) out of 42 patients in group 2 developed superficial infection. K-wires in group 1 were removed in outpatient department without sedation while K-wires in group 2 were removed Operation Theater under sedation. Infection in both groups was managed with oral antibiotics. **Conclusion:** Infection at pin sites in exposed K-wire ends group was slightly more as compared to buried K-wires end group but they were managed easily with oral antibiotics. Removal of K-wires in buried K-wire ends group required second surgery. Thus, leaving K-wire ends outside skin after fixation of displaced supracondylar humerus fracture is more convenient and cost-effective technique for patient, family and hospital.

INTRODUCTION

Pediatric trauma secondary to falls is a common scenario in the emergency department. Pediatric supracondylar humerus fracture is most common fracture around elbow (01, 03, 04, 06, 07, 09, 10, 14, 16, 17, and 19) comprising around 60-70% (01, 02, 05, 09, 14, and 18) and contributing to 30% of all pediatric limb fractures in below 07 years pediatric population (02, 11). Pediatric Supracondylar humerus fractures are reported with an incidence of 177.3 per 100000(04). Upper limb fractures are more common as compared to lower limb fractures because of the fragile nature of upper limb bone in the pediatric group (01).

Around 70 % of pediatric supracondylar humerus fractures result from falls from height on outstretched hands (02, 11, 13, 20) or direct blows to elbows in early ages (11), but as the child grows, sports and cycling-related injuries predominate (03). 90% of cases of pediatric supracondylar humerus fracture occur in the age group from 05-07 years (01, 04, 05, 12, 14, 16, 18 and 24). Left side is more common than right side (12, 18).

Clinical presentation of these fractures is swelling, pain and limited painful range of motion of the involved elbow (16). The Distal Neurovascular status of the involved limb should be keenly observed for any injury during the trauma episode and later on for compartment syndrome (04, 12). Nerve injuries may occur in association of supracondylar humerus fracture in up to 11.3 % of cases (16).Anterior interosseus is the most commonly injured nerve, which is often a neuropraxia (11, 12, 15).

An anteroposterior (AP) and lateral view X-rays views of the elbow should be performed in case of pain and tenderness after a trauma (04, 07, 12), and the Baumann angle should be calculated to check for acceptability. Besides the Baumann angle anterior humeral line passing relative to capitellum on lateral elbow x-ray (04, 16) and posterior fat pad sign are other parameters that are considered for diagnosis and management of pediatric supracondylar humerus fracture. A positive fat pad sign is suggestive of fracture, even in case of the absence of radiological fracture lines (04, 07). Radiologically 97-98% of these cases are of extension type (05, 11) while 3% account for flexion type (03, 04, 07 and 11). Extension type supracondylar fractures are classified by Gartland according to displacement of distal fragment (01, 04, 16, 17

and 22). Types I are un-displaced with only fracture line seen, that may also be non-visible sometimes and only the fat pad sign gives a clue of the injury. Majority of the supracondylar humerus fracture are of this type (22). Type II Gartland fracture refers to posterior angulation of the distal fragment with posterior cortex intact (16, 17). The anterior humeral line passes posterior to the capitellum. In type III Gartland fracture only the posterior periosteal hinge remains intact (16, 17). Type IV is highly unstable supracondylar humerus fracture with loss of all hinges (17).

Currently, the most widely accepted treatment option is the application of a above elbow cast for type-I extension-type fractures (01 ,03, 04, 08, 10, 16, 17 and 22). Type II, Type III, and Type IV pediatric supracondylar humerus fractures are treated with closed reduction and percutaneous K-wire fixation (02, 03, 04, 09, 10, 16, 17, 18, and 19). Open reduction and K-wire fixation is reserved for irreducible fractures (06, 11, 16 and 17). Two or lateral pins and cross pin configuration is used for fixation which has no statistical impact on stability of fracture fixation (13, 14, 17). Kirschner (K) wires fixation is widely used in managing pediatric limb fracture (07). Complication associated with K-wire fixations includes infection, pin migration, loss of reduction and neurovascular injuries (23). Some studies has reported a rate of 2.3% surgical site infection after close reduction and pinning(24), but in other study Infection rate of as high as 3.6%-77% has been reported (18, 19). Pin site infection may need only oral antibiotics for management or may need removal of pins and debridement (25). No consensus is present whether K-wires should be left outside skin for easy removal or should be buried for fear of skin pathogens migrating to bone and joint along pin tract(07) as leaving K-wire end exposed may facilitate bacterial colonization into wound and bone (04, 25).

The objective of this study is to find the rate of pin site infection in pediatric supracondylar fracture fixation in exposed vs. buried K-wire tips.

Statistical Analysis

The data was analyzed with the help of SPSS 25 for statistical analysis. P Vale of <0.05 was considered significant. Descriptive statistics were performed using mean (±standard deviation), median and range values for continuous data and percentage values for discrete data. Chi-square test was used for finding any association.

METHODOLOGY

This was a prospective study on pediatric patients operated for closed supracondylar humerus fracture at orthopedic and spine Unit MTI-Hayatabad Medical Complex, Peshawar from January 2023 to December 2023. All the pediatric patients with Gartland type 2,3 and 4 supracondylar fracture presented to the orthopedic unit were included in the study so no sampling size calculation was used(26). The average age of the patients was 5.3 years, ranging from 2.5 years to 13 years. 46 out of 89 patients were male children, while 43 were female. The left-side elbow was involved in 56 cases, and 33 patients had right supracondylar humerus fracture. Syndromic patients, patients with metabolic diseases, and patients with open supracondylar fracture were excluded from the study. The study spanned over 01 year from 1st Jan 2024 to 31st Dec 2024. Closed reduction and percutaneous pinning with smooth pins were done in all cases. Leaving the K-wire ends outside or burying them was the surgeon's choice. In 42 patients, k-wires were buried, while in 47 patients, k-wire ends were left exposed. After k-wire fixation, puncture wounds and k-wire ends were covered with sterile dressing, and backslab was applied in 45–90-degree elbow flexion to the affected extremity. K-wires were removed after 03 weeks (15) on the average with a maximum on 26th post-op days, and range of motion started. Wound examination was done at the time of K-wire removal and result recorded for either infected K-wire end or no infection present. Infection labeling was done with clinical examination. Any pus discharge from k-wire ends or k-wire loosing with skin excoriation or discharge was considered as infection. K-wires with exposed ends were removed as day cases without sedation, while buried k-wires were removed in the operation theater under sedation. In the case of pin site infection, all cases were managed by oral antibiotics. Debridement was not needed in any case.

RESULTS

All the patients were called to follow-up at 03 weeks for backslab and k-wire removal. Assessment of wound was done in the same setting. The result showed 07 (14.9%) out of 47 with exposed k-wire group developed pin site infection in the form of superficial infection. On the other hand, 06 (14.3%) out of 42 patients in the k-wire buried group developed puncture wound discharge and excoriation of skin overlying the k-wire ends. The chi-square test was applied which came up with *p*-value of is 0.935. since the p-value is >0.05 the association of infection with k-wire ends is not significant. Left side was involved in 63 percent as compared to right side involved in 37 %. All the infections were dealt with daily dressing and oral 1st generation cephalosporin. No fever was associated with these symptoms, and labs were normal. None of the case required early removal of K-wires. Immediate physiotherapy was started after K-wires removal and the check x-rays. All the buried k-wires were removed under sedation in the operating theater, while all the exposed k-wires were removed as day cases in the outpatient department.

Table 1

Frequency Distribution of Data

Variables			Infection Developed		Total
			NO	YES	
K-wire ends	Buried Ends	Count	36	6	42
		% within k-wire ends	85.70%	14.30%	100%
		% of Total	40.40%	6.70%	47.20%
	Exposed Ends	Count	40	7	47
		% within k-wire ends	85.10%	14.90%	100%
		% of Total	44.90%	7.90%	52.80%
Total		Count	76	13	89
		% of Total	85.40%	14.60%	100%

Table 2

Chi-Square Tests

Variables	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.007a	1	0.935		
Continuity Correction	0.000	1	1.000		
Likelihood Ratio	0.007	1	0.935		
Fisher's Exact Test				1.000	0.588
N of Valid Cases	89				

Figure 1

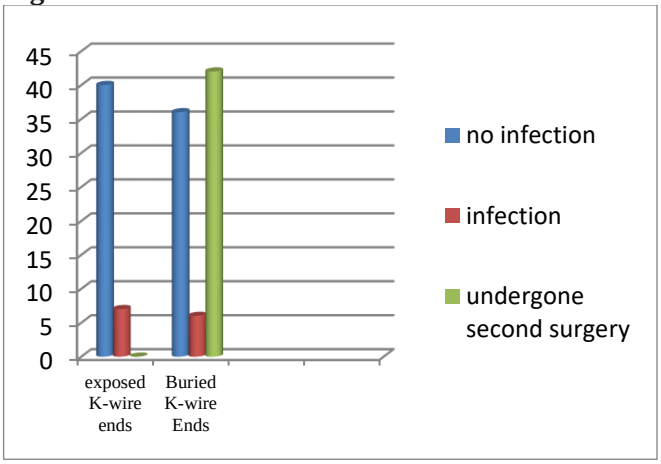

Table 3

Side Affected				
Right	Frequency	Percent	Valid Percent	Cumulative Percent
Left	33	37.1	37.1	37.1
Total	56	62.9	62.9	100.0
	89	100.0	100.0	100.0

DISCUSSION

Consensus exists for the type of treatment of displaced pediatric supracondylar humerus fracture, but keeping the k-wire ends exposed or buried is up to surgeons' preference. Some pediatric orthopedic surgeons advocate leaving k-wires end outside skin to spare the risk of second surgery and anesthesia. On the contrary, others believe leaving the k-wire ends outside exposes the patient to infection development, leading to chronic osteomyelitis. Green classified pin tract infection into minor and major [21]. Moroni et al then extended the classification into 6 grades. Redness or skin excoriation was labeled as grade 1. Grade 2 was when need for antibiotics required. When response to antibiotics was not optimal and needed K-wire removal was graded as 03. Grade 4 had more than one pin involved and required K-wire removal. Grade 5 infection had osteomyelitic changes while Grade 6 infections had osteomyelitis and a sequestrum that required further surgeries [21]. Analyzing the results of this study, there were 03 patients with grade 01 infection in buried K-wires and 01 patient with grade 02 infections. While in exposed K-wire group all of the 05 patients that developed infection had grade 02 infection. Although none of them led to deep infection or chronic osteomyelitis. None of the patients underwent a second surgery for k-wire removal or debridement in exposed K-wire group but in buried K-wire group all patients underwent second surgery for K-wire removal. The infection subsided in 5-7 days with daily sterile dressing and oral antibiotics.

Kao et al. compared two groups of pediatric supracondylar fracture k-wire fixations. One group was of daily care group while the other was non care group in which no daily care was used. Infection was more in daily care group 57.5% as compared to 26.8% [20]. Lu, Di et al study didn't find significant difference in daily care group, every second day care group and weekly care group patients [19]. Although infection was high in both groups but the rate of infection depends on definition of infection, type of implant used and pin site care protocol [19].

A study by Ezeokoli, Ekene U et al on infection in supracondylar humerus fracture fixation by K-wiere fixation demonstrated in fact rate of around 0.53% but labeled infection as purulent discharge, fever and osteomyelitits[03]. They did not consider skin irritation and excoriation as infection. In our study no patient developed fever, purulent discharge or osteomyelitis. That's why our infection rate came out high compared to previous studies.

A meta-analysis on buried vs. exposed k-wire in pediatric humerus lateral condyle elbow fracture fixation by Jack Pullan, Olusegun Ayeko and James Metcalfe also concluded that though infection rate was high in exposed k-wire fixation group, deep infection was comparable in both groups, and even skin erosion was high in buried k-wire group. They found that leaving the k-wire end exposed is cost-effective and more convenient for the patients and their families [07].

Another systemic review by J C R Wormald , C Y Park, D M Eastwood on buried vs. exposed k-wires for pediatric lateral humeral condyle fracture fixation also demonstrated no significant difference in both groups regarding infection. Besides that they also asserted the

opinion that leaving k wire buried carries the disadvantage of secondary surgery [8].

Leaving k-wires outside has the advantage of less burden on the hospital in terms of bed occupancy and finances. Likewise, the removal of k-wire in an outpatient setup is also less traumatic to patient and their family, who don't have to stay for long and keep the patient nil by mouth.

Limitations

Health and hygiene status of the children was not taking into account which has a key impact on post-operative infection risk and healing potential of wound. Another limitation was determining extent of soft tissue at the time injury before undertaking surgical procedure.

CONCLUSION

Besides a relatively increased risk of superficial infection in the exposed k-wire group, this is a cost-effective and more convenient treatment option for supracondylar humerus fracture in the pediatric age group.

Authors' Contribution

1. Muhammad Qasim - Concept & Design, Data Acquisition, Data Analysis
2. Awais Wali - Drafting, Manuscript, correspondence
3. Shafi ul Haq - Data Acquisition, Data Analysis
4. Muhammad Waqar - Concept & Design

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