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Comparison of outcomes in buried versus exposed Kirschner wire for treatment of paediatric supracondylar humerus fracture

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ABSTRACT

Introduction: The treatment options for paediatric supracondylar distal humerus fractures include close reduction and above elbow slab application, close reduction and percutaneous K-wire fixation, and open reduction and internal fixation using K-wire. For displaced supracondylar fracture closed reduction and percutaneous K-wire fixation, under C-arm guidance, is the current gold standard treatment option. Leaving the K-wire exposed or buried under the skin is decided as per the discretion and convenience of the operating surgeon.

Objectives: The objective of this study is to evaluate and compare the outcomes of buried and exposed K-wire for treatment of paediatric supracondylar humerus fractures.

Methodology: This study is a prospective, comparative, observational study conducted among the paediatric patients visiting Birat medical college teaching hospital OPD/ emergency department with supracondylar humerus fracture. The sample size was calculated to be 90 (45 in each group) on the basis of convenience sampling and samples were collected using systematic random sampling technique. After data collection, all reports are entered in a predetermined Performa and analysed using SPSS version 21.

Results: The overall complications rate was 20%. In the exposed K-wire group, 6 patients (13.33%) had surgical site infection at 4 weeks. Among them, 5 patients (11.11%) had superficial infection and 1 patient (2.22%) had deep infection. In the buried K wire group, only 2 patients (4.44%) had skin perforation and superficial infection. None of the patients had deep infection. There were 2 patients (4.4%) with hyper granulation tissue formation in exposed K wire group which were associated with superficial infection. There were 8 patients (17.8%) with skin irritation/ K wire prominence but without K wire perforation in the buried K wire group which was statistically significant (p value 0.006).

Conclusion: There is no significant difference between the exposed K wire group and buried K wire group.

INTRODUCTION

Supracondylar humerus fracture is one of the most common fractures in paediatric age groups.[1] Closed reduction and percutaneous Kirschner wire fixation, under C-arm guidance, is the current gold standard treatment option for displaced paediatric supracondylar humerus fractures.[2,3]

The treatment options described for these type of fractures are closed reduction and

the use of a splint,[4] closed reduction and percutaneous pinning,[5,6] and open reduction with internal fixation.[7] As closed reduction with percutaneous K wire fixation has reduced the chances of malunion significantly with minimal morbidity, it is advocated as the method of choice.[8] But, there is no clear consensus on whether to leave the K wires buried beneath the skin or leave them exposed over the skin. Till date, this is carried out as per the discretion and convenience of operating surgeons.[9]

Literature are not sparse that establish the rate of infection more with the exposed k wire as compared with the buried ones.[10-12] Also, the less frequent surgical site dressing and non-urgency to remove K wire are added advantages to the patients with the buried k wires. However, the patients with buried K wire are certain to need second surgery for Kirchner wire removal and thus might have to go through general anaesthesia once again.[13,14]

In spite of these controversies, there are very few published studies comparing the outcomes of the exposed and the buried k wire in paediatric supracondylar distal humerus fracture and mainly from western population Also, most of these studies are retrospective. Thus, we envisaged this study to evaluate and compare the outcomes of buried and exposed Kirchner wire for treatment of paediatric supracondylar humerus fractures.

METHODOLOGY

This study is a prospective, comparative, observational study conducted among the paediatric patients visiting orthopaedics out-patient department (OPD)/ emergency at Birat medical college teaching hospital with supracondylar humerus fracture. This study was conducted after ethical clearance from Institutional Review Committee (IRC) at Birat medical college teaching hospital (ref no. IRC-PA-280/2023) from mid-February 2023 till the sample size was achieved. The convenience sample size was calculated to be 90 (45 in each group) i.e. average number of patients visiting orthopaedics OPD/Emergency at Birat medical college teaching hospital with paediatric supracondylar fracture over 3 years. Samples are collected using systematic random sampling techniques. The inclusion and exclusion criteria are as follows:

Inclusion Criteria:

1. Age below 15yrs
2. Radiological evidence of skeletal immaturity
3. Closed fracture
4. Gartland II and III fractures

Exclusion Criteria:

1. Previous history of supracondylar humerus fracture in same limb
2. Other associated fracture in the same limb
3. Supracondylar fractures with white pulseless hand
4. Open fracture
5. Pre operative Local Infection (at the operation site)
6. Lost to follow up
7. Refusal to participate in the study
8. congenital deformities in the upper limb

For classification of supracondylar fracture, Gartland classification was used. Type I is undisplaced supracondylar fracture, type II is displaced with an intact posterior cortex, type III is displaced in two or three planes and type IV is unstable type of supracondylar fracture during reduction in the operation theatre.

Patients meeting inclusion criteria were shuffled into two groups A and B. First patient was chosen by asking him/her to pull one folded token among the two. Two tokens were prepared beforehand mentioning “Group A” or “Group B” on the inner side. The chosen token was unfolded to reveal whether they belong to group A or B. K wires will be left exposed for group A and buried for group B. Decisions regarding burying or leaving K wire exposed during surgery were made accordingly. The next patient would belong to the next group whichever was excluded for the first patient. Patients meeting inclusion criteria are recruited to two groups in alternating order thereafter.

The surgery was done under general anaesthesia in routine operation theatre on elective surgery basis once the anaesthesiologist finds them fit for surgery.

Following surgery, patients were shifted to post operative ward and kept in observation. Post operative radiographs were obtained on the same day. The next day they were shifted to the orthopaedics ward. Decision to discharge the patients was taken once the patients were visited in daily ward rounds. All the patients were discharged with oral antibiotics (Cefuroxime) and analgesics (NSAIDS; ibuprofen or Aceclofenac) for 5 days in post operative day 1, after 24 hours of observation, irrespective of K wire whether exposed or buried. They were advised for operative limb elevation in arm pouch and active finger movements of the same upper limb. Patients were called up in follow up on OPD basis. Wounds were inspected for any complications like infection, K wire back out, accidental K wire removal, skin irritation/perforation, hyper granulation tissue formation in 3rd postoperative week.

Any purulent/ serosanguineous discharge, slough, erythema/ induration around the surgical site is taken as Infection. Superficial infection is the one involving only skin and subcutaneous tissue. However, deep infection is the one involving tissues deeper layers (fascia, muscles, bones) or joints. Any new exuberant hyper-granulation tissue at the site of K wire insertion is taken as hyper-granulation tissue formation.

All reports were entered in a predetermined Proforma and analysed using SPSS version 21.

RESULTS

Out of 90 participants, 48 (53.3%) were males and 42 were (46.7%) females. The mean age of the participants was 7.1 ± 2.4 years; range 3-13 years.

Mean age in the exposed K wire group was 7.0 ± 2.5 years while that in the buried K wire group was 7.1 ± 2.4 years. Similarly, median age was 7.0 with interquartile range 5.0 – 8.0 in exposed k wire group, while that in buried K wire group was 7.0 with interquartile range 5.0 – 9.0. The gender distribution of participants in both the groups was similar. 53.3% were male and 46.7% were females in both the groups.

On observing the fracture pattern, Gartland III was the most common fracture pattern requiring operative intervention in both groups accounting more than half (55.6%) of the study population, followed by Gartland II (40% in exposed K wire group and 42.2% in buried K wire group) and then Gartland IV (4.4% in exposed K wire group and 2.2% in buried K wire group).

More than 3/4th of the patients had just 2 wires used for the fracture fixation; 34 (75.6%) patients in exposed K wire group and 36 (80%) patients in buried K wire group. Only 11 (24.4%) patients in the exposed K wire group had 3 K wires used and 9 (20%) patients in the buried K wire group had 3 K wires used for fracture fixation. Regarding the K wire configuration in operated patients, most had 2 divergent K wires, 34 (75.6%) in exposed K wire group and 36 (80%) in buried K wire group. In the exposed K wire group few patients, 3 (6.7%) had 3 divergent K wires while 8 (17.8%) had 2 lateral divergent and 1 medial K wire used for fixation of fracture. Similarly, in the buried K wire group 2 (4.4%) patients had all 3 K wires divergent and 7 (15.6%) patients had 2 lateral divergent and 1 medial K wire used for fracture fixation.

Fig: A **Fig: B** **Fig: C**

Fig. 1: Immediate post operative clinical pictures of patient undergoing fracture fixation with 3 divergent exposed K wire (A), 2 divergent exposed K wire (B) and buried K wire (C)

Table 1: Baseline characteristics of study participants across two groups. [n, %]

	Exposed K wire (n=45)	Buried K wire (n=45)	p-value
Age (in years)			
Mean ± SD	7.0 ± 2.5	7.1 ± 2.4	0.766*
Median (IQR)	7.0 (5.0 – 8.0)	7.0 (5.0 – 9.0)	
Gender			
Male	24, 53.3%	24, 53.3%	0.999+
Female	21, 46.7%	21, 46.7%	
Fracture Pattern			

Table 1 continue...

Gartland II	18, 40%	19, 42.2%	0.835⁺
Gartland III	25, 55.6%	25, 55.6%	
Gartland IV	2, 4.4%	1, 2.2%	
Configuration of K wires used			
2 Divergent	34, 75.6%	36, 80%	0.851⁺
3 (All Divergent)	3, 6.7%	2, 4.4%	
3 (2 Divergent, 1 Medial)	8, 17.8%	7, 15.6%	

* Mann Whitney U Test; ⁺Chi-square test; Bold signifies statistical significance at p<0.05

In our study, the average time of K wire removal was 3.5 ± 0.6 weeks for exposed k wire group and about a week later, 4.4 ± 0.6 weeks for buried K wire group. Similarly, median was 3.0 (2.0 – 4.0) weeks for exposed K wire group and 4.0 (4.0 – 5.0) weeks for buried K wire group which was statistically significant (p-value <0.001).

Table 2: Operative details of study participants across two groups. [n, %]

	Exposed K wire (n=45)	Buried K wire (n=45)	p-value
Removal of K wire (in weeks)			
Mean ± SD	3.5 ± 0.6	4.4 ± 0.6	<0.001*
Median (IQR)	3.0 (2.0 – 4.0)	4.0 (4.0 – 5.0)	

* Mann Whitney U Test; Bold signifies statistical significance at p<0.05

Patients in exposed K wire group had their K wires removed in outpatient basis. All the patient with buried K wire had to go through second surgery for K wire removal, except for the 2 patients who developed skin perforation secondary to skin irritation with K wire prominence. All of these patients had K wire removal in general anaesthesia as the first case of the day and were discharged on the same day after 6 hours observation in post operative ward.

The overall postoperative complication rate in our study is 20% (17.7% in exposed K wire group and 22.2% in buried K wire group). This included superficial infection, deep infection, hyper granulation tissue formation and skin irritation secondary to K wire prominence without skin perforation. If the skin irritation secondary to hardware prominence without skin perforation were excluded as complications, the complications rate would be as low as 4.44% in the buried k wire group.

Infection rates: Amongst 45 patients of exposed K wire group, a total of 6 patients (13.33%) had surgical site infection at 4 weeks. Among them, 5 patients (11.11%) had superficial infection and 1 patient (2.22%) had deep infection.

In the other group with buried K wire, only 2 patients (4.44%) had skin perforation and superficial infection. None of the patients had a deep infection.

All of these patients healed after K wire removal without any antimicrobial therapy. Any further investigation or intervention were not required in any of these patients in either group, except dressing with betadine antiseptic solution.

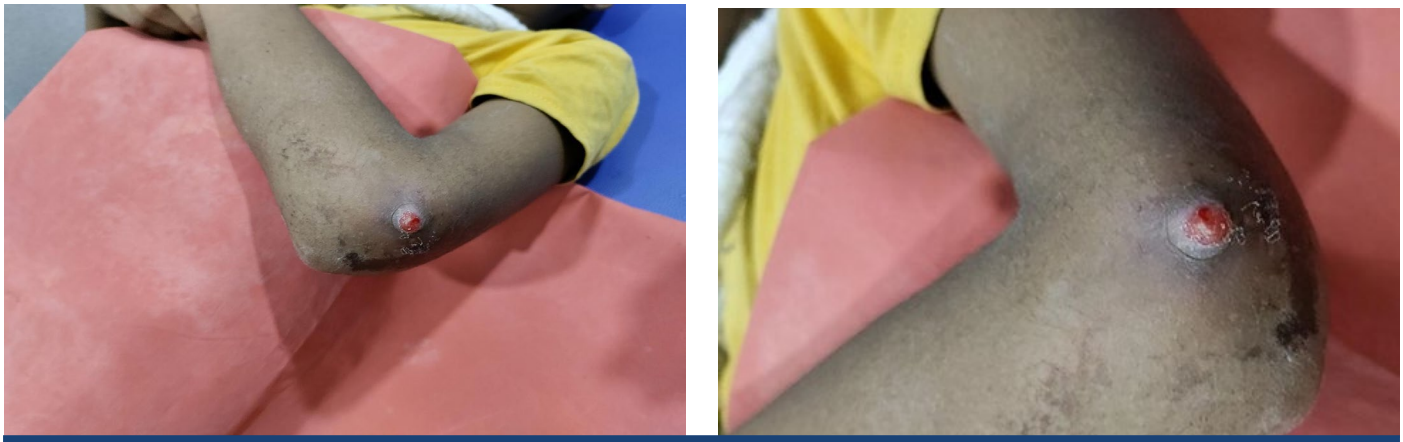

Fig. 2: Superficial infection at 4 weeks after surgery in a patient with exposed K wire (A) and buried K wire (B)

Other complications: There were 2 patients (4.4%) with hyper granulation tissue formation in the exposed K wire group which were associated with superficial infection and none in the buried k wire group. Both of these patients had hyper granulation tissue removal and dressing using betadine antiseptic solution at the time of K wire removal. These patients responded well to this treatment and didn't require any further intervention.

There were 8 patients (17.8%) with skin irritation/ K wire prominence but without K wire perforation in the buried K wire group. This was statistically significant (p value 0.006). This was addressed by K wire removal at the normal stipulated time as other cases.

Fig 3: K wire prominence without skin perforation in a patient of buried K wire group.

In our study we didn't get any iatrogenic ulnar nerve injury, although a total of 5 patients had medial K wire insertion, in both the groups, during percutaneous fixation of paediatric distal humerus supracondylar fracture. We also didn't observe any accidental k wire removal or proximal K wire migration and compartment syndrome. None of the operated cases had loss of reduction requiring revision surgery. This may be attributed to immobilization with above elbow slab till radiological evidence of callus formation was seen in plain digital radiographs in almost all patients.

Table 3: Post operative complication in study participants across two groups. [n, %]

	Exposed K wire (n=45)	Buried K wire (n=45)	p-value
Uneventful	39 (86.7%)	35 (77.8%)	0.270*
Superficial infection	5 (11.1%)	2 (4.4%)	0.434*
Deep infection	1 (2.2%)	0	0.500*
Hyper granulation tissue formation	2 (4.4%)	0	0.494*
Skin irritation / K wire prominence	0	8 (17.8%)	0.006*

* Mann Whitney U Test; Bold signifies statistical significance at p<0.05

DISCUSSIONS

In this study, 6 out of 45 patients (13.33%) had pin-tract infection at 4 weeks in the exposed k wire group. In the other group with buried K wire, only 2 patients (4.44%) had skin perforation and superficial infection. This was in accordance with the study conducted by Taylor J. Ridley et. al in 2017 where they concluded patients with exposed K-wires for fixation of phalangeal, metacarpal, or distal radius fractures were more likely to be treated for a pin-site infection than those with K-wires buried beneath the skin.

We also observed very less deep infection rate in either group as compared to superficial infection rate, 2.22% in exposed k wire group and none in buried K wire group. Similar study conducted by Bashyal et al in 2009 also demonstrated that deep infection rate was very less as compared to the superficial infection rate as in our study. In the same study, the most common complication following supracondylar fracture fixation was proximal migration of K wire necessitating unexpected return to the operating room for pin removal in 1.8% of the patients We did not encounter any such complications necessitating urgent K wire removal. This might be because of the fact that we had our K wire distal end slightly bent before burying into the skin.

In the study conducted by S. Suganuma et al in 2022, they had no any complications like Iatrogenic ulnar nerve injury, compartment syndrome, non-union, proximal migration of K wire These findings were similar as in our study. Ten patients (22.22%) in the buried K wire group in our study had skin irritation; 2 of them (20%) had skin perforation and subsequent superficial infection. These incidences are similar to the study conducted by S Suganuma et.al which also had skin irritation in 30% of the patients and 14% of those patients with skin irritation had skin perforation. As observed in our study, skin irritation secondary to K wire prominence is more in the buried K wire group than in the exposed K wire group, the study conducted by S Suganuma et. Al in 2022 also reports the same. And this is statistically significant in both the studies.

In our study all of the patients with surgical site infection healed after K wire removal without any antimicrobial therapy. Any further investigation or intervention were not required in any of these patients in either group, except dressing with betadine antiseptic solution. However, in the study conducted by S. Suganuma et al in 2022, all infection subsided with oral antibiotics and /or k wire removal

In the study "Close reduction and percutaneous k-wire fixation without image intensifier in supracondylar fracture of humerus in

children" conducted by R. Mohammad et al in 2013 the average postoperative hospital stay was 2.4 days (12-72hrs) However, all the patients were discharged on post operative day 1 in our study, irrespective of K wire whether buried or kept exposed

CONCLUSION

We conclude that exposed K wires or buried K wire does not lead to any clinically significant differences in final outcomes in terms of rate of complications encountered or functional recovery in paediatric distal humerus supracondylar fractures.

RECOMMENDATIONS

While the patients with exposed K wires have their K wires removed on an Outpatient basis, the patients with the buried K wires have to go for second surgery on a daycare basis. This not only adds financial burden to the patient but also adds to the operative case load in a high volume centre. Thus, we prefer leaving the K wire exposed while treating paediatric supracondylar fractures with close reduction and percutaneous K wire fixation.

LIMITATION OF THE STUDY

This study was carried out in a short duration of time with limited samples. It would have been better with longer research duration and bigger sample size.

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CONFLICT OF INTEREST None

FINANCIAL DISCLOSURE None

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