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Original Article

Does intramedullary K-wire buried under the skin justify the treatment for both-bone forearm fracture in children? : A descriptive analytical study

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ABSTRACT

Introduction: Surgical treatment including intramedullary K wire fixation is desirable for unstable pediatric both bone fracture to avoid angulation, rotational deformity and refracture ensuring optimal functional outcomes. However, it is debatable to leave free end of K wire exposed or to bury underneath the skin. The aim of the study is to assess the functional outcomes and complications after intramedullary K wire buried under the skin for pediatric both bone fracture.

Method: This is a prospective analytical study performed from 15 August 2021 to 15 February 2023. This study included unstable closed diaphyseal forearm facture in children aged between 5 and 13 years treated with intramedullary K wires which were buried inside the skin. Study variables included demographical profiles, fracture pattern, time for surgical intervention, Modified Flynn et al criteria, time to unite the fracture and any associated complications).

Results: Mean age of the patient in our study was 8.70±2.17 years. Average time required to unite the fracture was 3.15±0.62 months. Thirty-Four (97.2%) patients had excellent outcomes; one (2.8%) patient had good functional outcomes based on Modified Flynn et al criteria. Nine (25.7%) patients had bursa formation at proximal aspect of ulnar K wire while one patient (2.8%) had superficial infection at olecranon site.

Conclusion: Intramedullary K wire for pediatric diaphyseal both bone fractures is excellent surgical technique. Even though controversy exist between exposed K wires and those buried underneath the skin, buried K wires have reasonable advantages and less side effects in terms of infection and overall functional outcomes.

Keywords: Both bone; Bury; Forearm fracture; Functional outcomes; Intramedullary K wire

INTRODUCTION

Conservative treatment has numerous complications including malunion, rotational deformity and refractures for unstable pediatric both bone fractures[1,2]. Out of various surgical techniques like elastic stable nailing, titanium nailing, plating and Kirschner wire (K wire), intramedullary K wire is easy to apply during surgery, easy to remove after bony union, cost effective, can be passed through physis safely and used for distal third radius fracture without angulation[3,4,5].

The perceived advantages of burying K wire underneath the skin are low infection rate, patient's comfort, early mobilization and low refracture rate [6,7,8]. There are numerous articles in favor of keeping free end of K wire exposed [9,10,11]. The main advantage is easy removal of K wire even in outpatient department without giving the anesthesia.

The aim of this study is to assess the functional outcomes, associated complications and cost effectiveness of intramedullary K wire buried under the skin for displaced pediatric both bone fractures.

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METHODS

This is a prospective analytical study performed in Devdaha Medical college and Research Institute, Bhaluhi, Rupandehi and Mercy City Hospital, Butwal from 15 August 2021 to 15 February 2023. Written consent was taken from the relatives of all patients before enrolling into the study. This study included unstable closed diaphyseal forearm facture in children aged from 5 to 13 years treated with intramedullary K wire which were buried inside the skin. Criteria for unstable both bone fractures were mentioned in table 1.

Table 1 showing the criteria for unstable both bone fractures

Age of patient (years)	Angle (degree)	Malrotation (degree)	Bayonet apposition
0 to 10	>15	>45	> 1cm
≥10	>10	>30	0
Approaching skeletal maturity (<2 years growth remaining)	0	0	0

Regarding the sample size calculation, convenient sampling method was used which is inclusion of all unstable pediatric both bone fractures willing to do surgery in our hospital. Stable both bone fractures, open fractures, pathological fractures, comminuted fractures, those associated with other polytrauma fractures, Monteggia and Galeazzi fractures were excluded from the study.

Patients were thoroughly evaluated by any one of the authors before doing the surgery. Besides performing the detailed primary and secondary survey, local examination of the forearm was performed in order to inspect swelling, open fracture, compartment syndrome and distal neurovascular status of forearm. After thorough preoperative assessment, parents or sometimes closed relatives were fully informed regarding the possible outcome of surgery including the potential side effects. Basic blood examination was performed, and patients were evaluated by anesthesiologist before shifting to operation theatre.

Operative technique

Patient was positioned supine on theatre table with arm rest on affected side and fluoroscopy machine on opposite side. Above elbow tourniquet was applied followed by primary scrubbing with Savlon and ten percent Betadine. After doing draping and painting, fracture was tried to reduce by giving traction and counter traction. Depending on surgeon comfort, either radius or ulna was fixed first. In our case we usually fixed radius first followed by the ulna. Regarding the size of K wire, we used either 1.5mm, 1.8 mm or 2mm depending on age of the patient and size of intramedullary canal. For radius fixation, tip of K wire with the help of power drill was put on the wrist distal to the center of distal radius. K wire was passed through the skin and penetrated through center of distal radius both AP and Lateral view checking frequently with fluoroscopy machine. Once the K wire was inserted inside the intramedullary canal of radius, it was further advanced till the fracture site while maintaining the constant traction. In case the fracture was not reduced perfectly by giving the traction, anteroposterior and mediolateral manipulation of fracture was performed in order to get the fracture reduced. In most of the time, we were able to reduce the fracture by this method. In case the fracture was not reduced with three unsuccessful attempts of closed reduction, small nick was given over the skin of fracture site through which a small artery forceps was inserted to manipulate the fracture with Kapanji technique. If fracture was not still reduced with all these techniques, small incision was given over the fracture site. Fracture was reduced with the help of bone holding forceps and K wire was advanced till the opposite end of radius.

Regarding the ulna fixation, K wire was put in center of tip of olecranon both AP and Lateral view and followed the same procedure as performed for radius. When we encounter the bone of large intramedullary canal, two K wires were inserted inside the medullary canal to get stable fracture fixation. Regarding the burial of K wire, it was bent up to 90 degree and K wire was severed as close as possible from bone to adequately buried the free end within the skin without giving the incision. In case of ulnar K wire, it was bent as near as possible from the bone and rotated 180 degrees before cutting the wire to get adequate burial inside the skin. Sometimes, to avoid impingement of K wire in ulna, after cutting of wire, small nick was given 2 cm proximal to insertion of K wire on elbow. Now skin was retracted distally to feel the bent end of K wire which was rotated 180 degrees with the help of plier and further impacted towards the bone to get rid of impingement which is the commonest complications in this surgery. After surgery, dressing was done with gauge bandage separately at wrist and elbow without application of posterior slab and forearm was rested in arm pouch sling.

Post-operative care and follow up

Next day operated limb was inspected for any abnormal swelling, neurovascular status and any signs of compartment syndrome. Patient was encouraged to do finger and elbow mobilization as much as possible depending on the tolerance of pain. However, arm pouch sling was suggested to apply till 3 weeks continuously and further three weeks intermittently. Patients were followed up in OPD after one week, three-week, six week and then every month till fracture union. X-ray was performed at every visit excluding the first visit, at that time clinical evaluation was performed to exclude features of compartment syndrome.

Statistical analysis

All the collected data were first filled in Microsoft Excel and then imported to SPSS (version 20) software. Qualitative data were expressed in percentage while quantitative data were expressed in mean ± standard deviation.

RESULTS

Average age of the patient in our study was 8.70±2.17 years (range 5 to 13 years). Twenty-two (62.9%) patients were male while 13 (37.1%) patients were female. There were fractures on left side in 20 (57.1%) cases while 15 (42.9%) fractures were occurred on right side. Regarding mechanism of injury of fractures, majority of fractures 12 (34.3%) occurred while playing outdoor activities, 10 (28.6%) fractures occurred because of self-injury sustained while playing indoor activities, 8 (22.8%) patients sustained fracture due to fall from height while 5 (14.3%) patients sustained fracture because of Road Traffic Accident (RTA). Twenty-three (65.7%) fractures were in middle third of bone while fractures from distal and proximal third were 6 (17.1%) each. Regarding pattern of fracture short oblique and transverse fractures were 17 (48.6%) each while comminuted fracture was only one (2.8%). Total time required for completion of surgical procedure was 21.28±4.99 minutes. Thirty-Four (97.2%) patients had excellent outcomes, one (2.8%) patient had good outcomes while none of the patients had fair and poor functional outcomes based on Modified Flynn et al criteria (Modified by Templeton and Graham). [Table 2]. Average time to unite the fracture was 3.15±0.62 months (2.5 to 4.5 months). Average time of removal of K wire in our study was 3.77±0.84 months. Nine 9 (25.7%) patients had bursa formation at proximal aspect of ulnar K wire while one patient (2.8%) had superficial infection at olecranon site. [Figure 1 and 2].

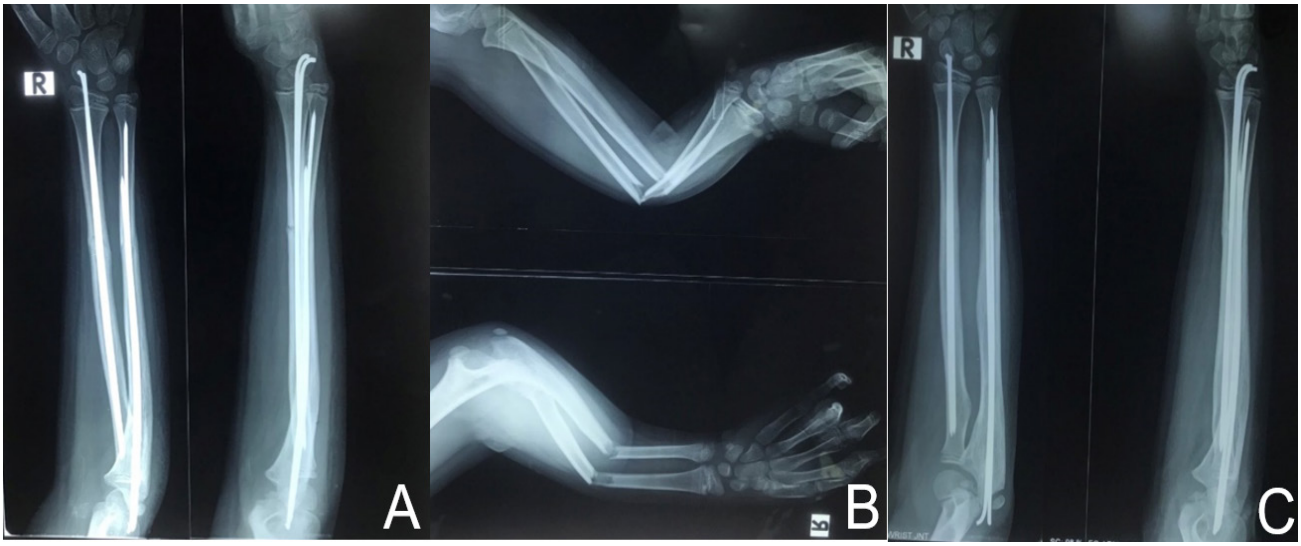

Figure 1 Case 1: Preoperative Xray forearm of 12 years old child AP and Lateral showing both bone fractures (A); Postoperative Xray at 3 months (B); Postoperative Xray at 4 months (C)

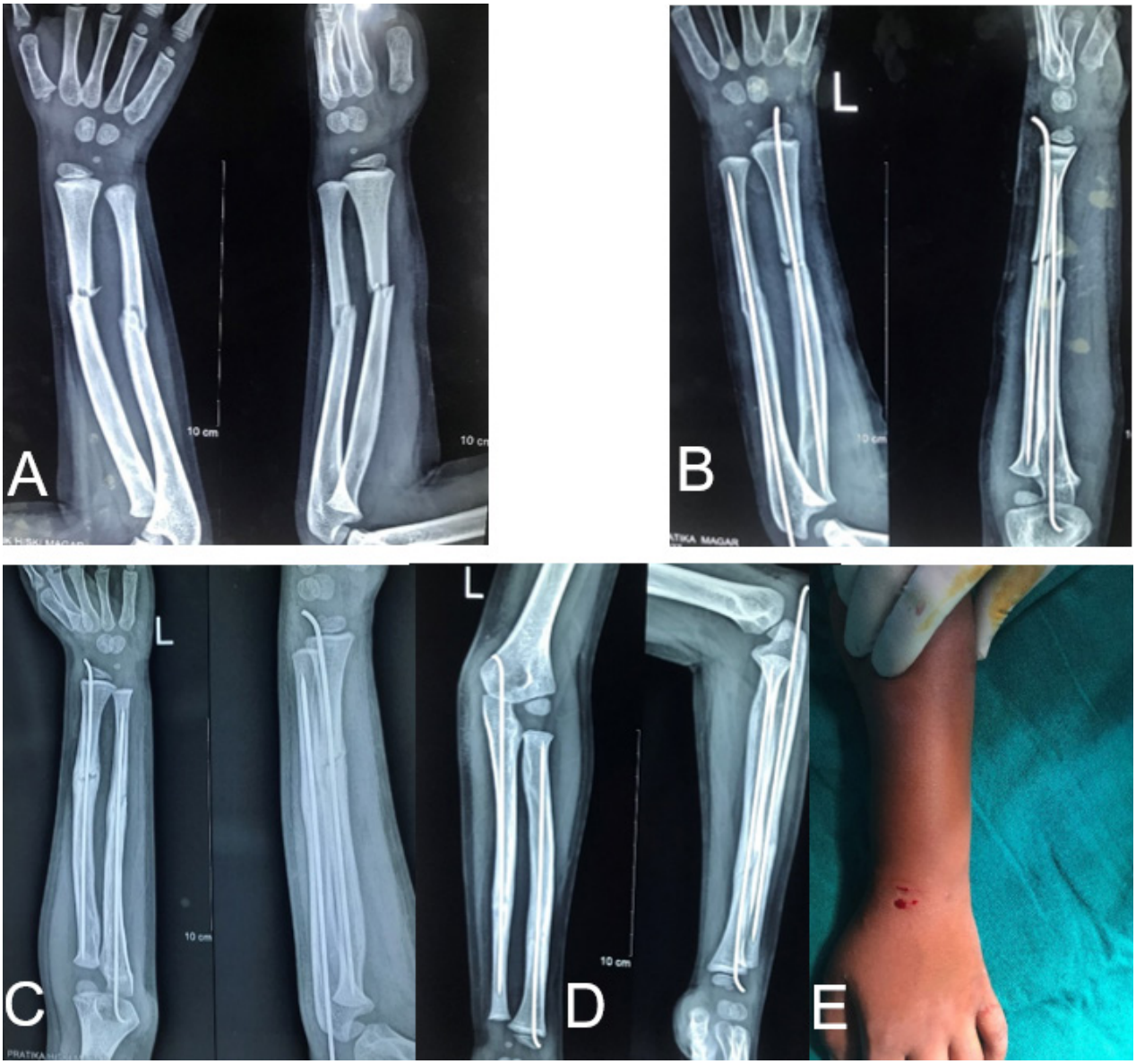

Figure 2 Case 2: Preoperative Xray of 5 years old children AP and presumed Lateral view showing both ulna and radius fractures (A); Postoperative Xray at 3 weeks (B); Xray at 6 weeks (C); Xray at 3 months (D); Punctured wound at wrist after burial of K wire in wrist (E)

Table 2 Showing Modified Flynn et criteria by Templeton and Graham for functional outcomes of both bone forearm fracture (Function is compared to uninjured limb)

Functional Outcomes	Loss of elbow flexion/ extension	Loss of forearm supination/ pronation	Loss of wrist flexion/ extension	Change in carrying angle
Excellent	0 to 5	0 to 15	0 to 15	0 to 5
Good	6 to 10	16 to 30	16 to 30	6nto 10
Fair	11 to 15	31 to 45	31 to 45	11 to 15
Poor	>15	>45	>45	>15

DISCUSSION

Both bone forearm fracture which is also called as diaphyseal forearm fracture is one of the common fractures in pediatric population which comprises 13% of all pediatric fractures and ranks as third most common fracture among these population [12,13,14]. These diaphyseal fractures, if not treated principally, have a great tendency to have residual deformity [15].

Residual malunion and rotational deformity in both bone forearm fracture can lead to severe restriction of supination and pronation movement specially in older children because physis are in the state of near fusion in older children causing decreased potential of bone remodeling[16]. Therefore, anatomical reduction of both ulna and radius fracture and maintenance of radial bow has a great impact on desirable functional outcomes in both bone fractures [16]. Even though first line of treatment for both-bone fracture in children is conservative, there are certain indications where operative treatment is mandatory. Angulation more than 15degree, rotation more than 45degree, bayonet apposition more than 1 cm in children less than 10 years while angulation more than 10degree, rotation more than 30 degree and any length of bayonet apposition in children more than 10 years are indications for surgery [17].

There are several techniques for surgical treatment of pediatric both bone fracture which are either intramedullary fixation like elastic stable intramedullary nailing (ESIN), titanium elastic nailing system (TENS), K wires or open reduction and internal fixation with plates and screws [18]. Increased tendency of doing the surgical treatment is to avoid the re-displacement, malunion and refracture so that optimal functional outcomes will be ensured [19].

If pediatric both bone fractures were decided to treat by intramedullary K wire fixation, then next option is to decide whether free end of K wire to leave exposed outside the skin or to bury underneath the skin. The perceived advantages of burying K wire underneath the skin are low prevalence of infection, increased patient's comfort, no need to apply plaster for longer time, early mobilization and decreased tendency of having joint stiffness, ability to keep the K wire for longer time inside the bone to enhance complete healing of bone and reducing the refracture after removal of K wires. Conversely, the main advantage of keeping free end of K wire exposed outside the skin is easy removal of K wire even in outpatient department without giving the anesthesia. However, patients have to come for follow up for inspection of wound due to perceived irritation of skin with free end of K wire [20,21]. Therefore, keeping K wire exposed or buried under the skin is debatable. Even though there are many studies which favor to keep the K wire buried in order to reduce the infection and refracture rate, most of them were retrospective without proper control group [9,22].

In spite of significant development in the field of orthopedics and traumatology, some aspects of management in these kinds of fractures are still unanswerable and heavily depend on the surgeon's personal experience and local practices. One of these unanswered issues is to leave free end of intramedullary K wire exposed or buried.

In our study, average time required to unite the fracture was 3.15±0.62 months (2.5 to 4.5 months). Thirty-Four (97.2%) patients had excellent outcomes, one (2.8%) patient had good outcomes while none of the patients had fair and poor functional outcomes based on Modified Flynn et al criteria (Modified by Templeton and Graham). One patient had superficial infection at proximal end of ulnar K wire, 9 cases had visible and palpable bursa formation at the same site. However, bursa formation at olecranon site does not cause any significant pain and disability for the children even though respective parents of the children are extremely concerned for appearance of swelling and its possible complications in future. They were easily convinced by proper explanation of disappearance of swelling after removal of K wire.

What we have tried to minimize the bursa formation and consequent infection of ulnar bone is to properly bury the K wire in the olecranon region either by cutting the bent K wire as near as possible from ulnar bone and turn 180 degree upward avoiding the sharp end of K wire to impinge the skin or giving the small mini-incision 2 cm proximal to olecranon region after retraction of skin distally and turn the free end of bent K wire 180 degree upwards with the help of plier and further impacted towards the bone so that K wire will not directly under the skin incision. Meanwhile, parents were suggested to take care of their children not to directly put their elbow on the chair or ground while reading or playing games.

Average time of removal of K wires in our study was 3.77±0.84 months. The only disadvantage of buried K wire under the skin is to give anesthesia for the child in order to remove the K wire which will further increase the economic burden to the family, however patients need not to come for regular follow up especially from peripheral region to reduce the cost to some extent and even do not need to apply the plaster after intramedullary K wire fixation buried under the skin. In order to avoid application of plaster, we tried to make fixation stable by putting two intramedullary K wires especially in case of radius when there was large intramedullary canal. If we still feel that fracture fixation was not sufficiently stable enough, above elbow slab was applied for 3 weeks. During whole study period we did not encounter any cases with physeal arrest and bowing of either bone.

Hargreaves et al [8] performed the prospective randomized trial comparing the infection rates of K wires fixed percutaneously and those buried underneath the skin and found that percutaneous K wires had significantly greater incidence of infection rate as compared to their counterparts.

Lakshmanan et al [23] also mentioned that infection rate after percutaneous K wire fixation is higher in range so that K wires should be buried in order to stay in safe limit. However, study of Kelly et al [9] is contradicting to these studies and they had concluded that there was not significant difference in terms of refractures, infections and overall complications rates between the exposed and buried K wires.

LIMITATION OF THE STUDY

This is the prospective descriptive study without having the control group. Therefore, it will be better to perform the comparative study between the exposed and buried K wires treated for pediatric both bone fractures.

CONCLUSION

Intramedullary K wires fixation for unstable pediatric diaphyseal both bone fractures is excellent surgical technique. Even though controversy exist between the exposed K wires and those buried underneath the skin, buried K wires have reasonable advantages and less side effects in terms of infection and overall functional outcomes.

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