Original Article

Management of Pediatric Displaced Distal Metaphyseal Forearm Fracture: Comparison between Cast Immobilization and Percutaneous Kirschner Wire Fixation.

SHRESTHA D, DHOJU D, PARAJULI N, DHAKAL G, SHRESTHA R.

Department of Orthopaedics Dhulikhel Hospital, Kathmandu University Hospital, Dhulikhel, Nepal

ABSTRACT

BACKGROUND: Distal metaphyseal forearm fracture is one of the common injuries in children. Closed reduction and above elbow cast is the standard method of treatment but reported to be associated with redisplacement rate of 7-25%. Closed reduction and fixation with percutaneous Kirschner wire is an alternative treatment option to prevent redisplacement.

METHODS: Thirty five children (group I) of age between 6 to 13 yrs with displaced (more than 50% of cortical diameter) or angulated (more than 20°) distal metaphyseal forearm fracture managed with closed reduction and above elbow cast were compared with 21 children (group II) managed with closed reduction and percutaneous crossed Kirschner fixation. Clinical outcomes and complications were compared in both groups after 12 weeks of follow up.

RESULTS: Preoperative variables in both the groups were comparable. Mean loss of elbow flexion and extension (12° vs. 4°, p =0.08), wrist dorsflexion and palmerflexion (27° vs. 14°, p=0.12) and forearm supination and pronation (27° vs. 15°, p= 0.143) were more in group I but were statistically not significant. Complications rate (28.4% vs. 19.04%, p= 0.04) was higher in group I (such as fracture redisplacement and swelling) than in group II (pin tract infection).

CONCLUSIONS: Grossly displaced or angulated distal metaphyseal forearm both bone fracture in children treated with either closed reduction and above elbow cast or closed reduction with crossed Kirschner wire fixation have no statistically significant clinical outcomes in terms of loss of movement of elbow, wrist and forearm but complication rate is higher in cast group. Percutaneous Kirschner wire fixation prevents redisplacement.

KEY WORDS: *forearm; fracture, metaphysis; percutaneous fixation*

INTRODUCTION

Distal forearm bone fractures comprise 75% of all forearm fracture in children and are mostly treated with closed reduction and cast application but recently the trends are changing towards primarily closed reduction and percutaneous Kirschner wire (K wire) fixation to prevent redisplacement of the fracture in the cast.[1-5] The reported incidence of displacement of metaphyseal fracture of distal radius in cast varies from 7% to 25% with various studies.[3,6] Poor casting technique, presence of associated fracture or plastic deformity of ulna, initially grossly displaced and angulated fracture of radius and increased residual angulations and displacement after reduction are considered to be the factors responsible for displacement after closed reduction and cast application.[1,7-9] Some degree of residual angulations and displacement are accepted because of extremely well remodeling capacity of fracture in children but displacement requiring remanipulation not only have poor results but also creates significant parental distress.[10]

Many authors recommend use of percutaneous K wires for fracture fixation in initially grossly displaced and angulated fracture with associated ulna fracture but these studies have either included all types of distal radius fracture including epiphyseal injury and isolated radius fracture or used single K wire or are retrospective studies.[2, 11, 12]

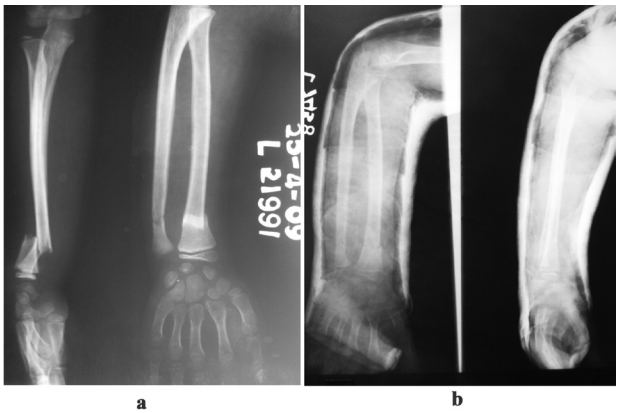
The present prospective cohort study compares clinical outcomes in children with grossly displaced and angulated distal both bone metaphyseal fractures treated with either

closed reduction and long arm cast or closed reduction with percutaneous crossed K wire fixation.

MATERIALS AND METHODS

One hundred and thirty one children of aged 6 to 13 years with distal radius fracture were managed in Dhulikhel Hospital in between July 2007 to June 2009. Among them 63 were distal radius metaphyseal fracture with displacement more than half the diameter of the bone (grade III or IV) or angulations more than 20° and associated with ulna fracture. Isolated fracture of radius, minimally displaced (grade I: no translation and grade II: translation less than half the diameter of bone) or angulated (<20°), compound fractures, radiological suspicion of epiphyseal involvement, bilateral forearm fracture or ipsilateral upper extremity fracture were excluded from the study.

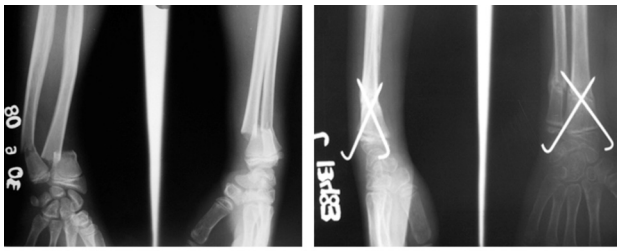
Among 63 children, 41 children (group I) were managed with closed reduction and above elbow cast with standard technique with fluoroscopy guidance under general anesthesia by attending orthopedic surgeon. (Fig. 1a,1b) The acceptable criteria for reduction was fracture apposition more than 80% in both plane and angulations in sagittal plane less than 15°for children below 10 years of age and less than 10° for children more than 10 years of age.



a b

Fig Pre (1a) and post (1b) reduction with closed reduction and above elbow cast application

Twenty two children (group II) underwent closed reduction and percutaneous crossed K wire fixation with fluoroscopy guidance under general anesthesia. First K wire was passed through radial styloid process or just above the physis across the fracture dorso-medially and second K wire through Lister's tubercle towards volar and radial side. (Fig. 2a,2b) Both K wires purchased opposite cortex. Optimal care was taken not to entrap extensor tendons and radial cutaneous nerve. The tip of the K wires bent outside the skin. When closed reduction was not possible, pin leverage technique was used for reduction.[13] Light weight forearm brace was applied post operatively for four weeks.



a b

Fig Pre reduction (2a) with closed reduction and cross k wire fixation. (2b) 4 weeks follow up.

Children were discharged on second day of the procedure and followed up on 1st and 2nd week for radiological evaluation of fracture displacement and pin tract infection and on 4th week for removal of K wires on out patient basis for group II and on 5th week for removal of cast in group I. Choice of further immobilization with forearm slab or brace was dependent upon radiological sign of fracture healing. Active mobilization of fingers, wrist, forearm and elbow was started immediately after removal of K wires or cast. Fracture displaced with apposition less than half the diameter of bone and angulations in sagittal plane more than 15° in children below 10 years of age and more than 10° in children more than 10 years of age detected in first two weeks of follow up were considered as redisplacement and subjected for remanipulation. Functional outcome in terms of loss of extension and flexion of elbow and wrist and supination and pronation of forearm were recorded and compared with contralateral side on 12 week. Six patients in group I and 1 patient in group II who could not be followed up for at least for 12 weeks were excluded from final analysis.

Statistical analysis was performed by using SPSS (Chicago, Illinois) version 11 software for Window. Non parametric test, as appropriate for data, were used for comparison of pre operative and outcome variables. A p value <0.05 was regarded as significant.

RESULTS

Pre operative variables were comparable as shown in table 1. All fractures were managed with closed reduction followed by cast (group I) or percutaneous K wire fixation (group II) within 24 hours of hospital admission but injury-treatment interval varied between six hours to five days. All fractures united in three months follow up. The mean follow up period in group I was 13.4 weeks and 15 weeks in group II.

Table 1: Pre operative variables in between group I and group II

Variables	Group I (N=35)	Group II (N=21)	P values
Sex			
Male	26	17	
Female	9	4	0.863
Mean age (Yrs ± SD)			
Male	9.2 ±1.3	10.2±1.6	0.751
Female	9.8± 1.4	9.2±1.6	
Dominant hand			
Right	32	21	0.32
Left	3	0	
Displacement			
Grade III	23	12	0.766
Grade IV	12	9	
Mode of injury			
Fall related injury	12	8	
Road traffic accident	9	8	0..801
Sports related	5	4	
Physical assault	1	0	
Others	8	1	
Injury-hospital interval			
< 24 hours	14	9	0.481
> 24 hours	21	12	

At final follow up, there was increased loss of flexion and extension of elbow and wrist as well as pronation and supination of forearm in group I as compare to group II but non of them were statistically significant. (Table 2)

Table 2: Mean loss of range of movement (degrees) on 12 weeks of follow up

Variables	Group I (N=35)	Group II (N=21)	P values
Loss of elbow movement			
Flexion	8°	2°	0.08
Extension	4°	2°	
Loss of wrist movement			
Dorsiflexion	15°	8°	0.12
Palmerflexion	12°	6°	
Loss of forearm movement			
Supination	20°	10°	0.143
Pronation	7°	5°	

In group I, six children (17.14%) had fracture displacement in cast and among them, three were noticed on 1st week of follow up and underwent remanipulation and above elbow cast application; two children presented late (6weeks) with radiological signs of union and hence planned for further management later on and another patient asked for referral for second opinion. Others complications were swelling requiring splitting of cast in four children. Among these 10 children in group I, seven patients had injury hospital interval more than 24 hours and six had completely displaced fracture.

In group II, there were four pin tract related complications. Two presented with serous discharge and two with purulent discharge. They came late for follow up and had poor compliance for pin tract dressing. Both of them had also sprouting infected granuloma at pin insertion site which was excised after removal of K wires under general anesthesia. All children improved with oral antibiotics and routine care of wound or pin tract.

DISCUSSION

Despite being one of the common injury, the management options for distal metaphyseal radius and ulna fracture

in children is controversial. In a randomized controlled trial, McLauchlan GJ et al found that percutaneous K wire fixation is safe and reliable way of maintaining fracture alignment for completely displace distal radius fracture in children.[9] Similar findings are reported by Choi KY et al, Mostafa MF et al, Mani GV et al and Lemput VM et al.[4,12,14,15] Percutaneous K wire fixation in severely displaced fracture is recommended by Zanzam MM et al even if perfect closed reduction has been achieved where as Monga P et al and Proctor MT et al suggest K wire fixation only when anatomical reduction could not be achieved.[1,3,16] Another randomized controlled trail by Milller BS et al , concludes that potentially unstable radius fracture may be effectively treated with either closed reduction and cast immobilization alone or closed reduction with percutaneous pin fixation because they found no significant difference in fracture angulations between two groups in subsequent follow up.[17] The present study compared the loss of movement of elbow, forearm and wrist instead of fracture angulations because clinical outcomes in terms of movement loss are more important than radiological evaluation of fracture angulations. Though there are slightly increased loss of flexion and extension of elbow and wrist and supination and pronation of forearm in children treated with closed reduction and cast application than in K wire fixation group, statistically they are insignificant. Mean loss of elbow flexion and extension (12° vs. 4°, p =0.08), wrist dorsflexion and palmerflexion (27° vs. 14°, p=0.12) and forearm supination and pronation (27° vs. 15°, p= 0.143) were statistically not significant between group I and II.

Another major issue in distal metaphyseal pediatric forearm fracture treated with closed reduction and cast application is redisplcaemnet and various risk factors are attributed for this complication. Gibbon CL et al consider isolated radius fracture is more prone to redipsplacement where as Schnieder J et al and Bohm ER et al consider associated ulna fracture is a risk factor for redisplacement.[8,9,18] The cast indexes, type of anesthesia, surgeon's experience are few among the risk factors considered responsible for redisplacement but consensus are lacking.[14,17] The initial displacement and post reduction residual translation were found to be a statistically significant risk factor for redisplacement by various authors.[1,3,7] The present study excluded all isolated radius fractures; all reduction was performed by attending orthopedic surgeons under general anesthesia so that clinical outcomes can be compared with least confounding factors possible. Since age of the children does not significantly influence the risk of redisplacemnt and criteria of adequate reduction or loss of reduction which has been adjusted for remaining growth potential according to age(below and above 10 yrs) is similar for both group I and II, outcome measurement was not analyzed in different age group in the present study.[9,16]

Redisplacement requiring remanipulation are associated with poor outcome.[19, 20] But due to lack of uniform criteria for defining redisplacement in literature, reported incidence varies from 7% to 25%. In the present study, redisplacement was defined when fracture loss more than 50% cortical contact or sagittaly angulated (more than 15° for children less than 10 years and more than 10° children more than 10 years). With these criteria, six children (17.14%) had redisplacement in the cast which is comparable to 14.04% as reported by Monga P et al.[1] Among these six children, five children presented after 24 hours of injury (2-5 days after injury) and had dorsally displaced fracture which is similar to finding reported by Schneider J et al.[9]

In the present study, complication rate (28.5%) is higher in the cast group (including both fracture displacement and swelling requiring splitting the cast) as compare to 19.04% in K wire fixation group (pin tract infection) which is statistically significant (p=0.04). Similar results have been reported by Miller BS et al.[17] But we did not encounter radial cutaneous nerve injury or entrapment of extensor tendons. Making a small stab incision and blunt dissection with hemostat up to bone is recommended before inserting the K wires. Pin tract related complications like loosening, migration or infection are usual complications of percutaneous technique of fracture fixation. We ensured double cortical purchase of both K wires in all cases except in two cases where one of the wires was passed intramedullary. Bending the K wire and leaving outside skin not only prevents migration but also allow removal on out patient basis under mild sedation if required. Superficial infection usually resolves with repeated pin tract dressing and oral antibiotics but deep infection need

incision and drainage and wound care. Non compliance for follow up because of various reasons is not uncommon in our practice. Two patients in the preset study who presented late because of difficulty in transportation had infected sprouting granuloma at K wire insertion site which resolved after excision without long term effect.

Another important concern is risk of growth plate injury by K wire insertion. Though various techniques have been reported to avoid growth plate while inserting K wire, it has been found that there is no long term squeal as a result of trans-epiphyseal smooth K wire insertion.[17, 21, 22]

CONCLUSION

Grossly displaced or angulated distal metaphyseal forearm both bone fracture in children treated with either closed reduction and above elbow cast or closed reduction with crossed K wire fixation have no statistically significant clinical outcomes in terms of loss of movement of elbow, wrist and forearm. However, loss of movement and complication rate is higher in cast group and per cutaneous K wire fixation can prevent redisplacement. Randomized controlled trial with larger sample size is required to confirm our findings.

REFERENCES

1. Monga P, Raghupathy A, Courtman NH. Factors affecting remanipulation in paediatric forearm fractures. J of Pediatr Orthop B 2010;19:181–187.
2. McLauchlan GJ, Cowan B, Annan IH, Robb JE. Management of completely displaced metaphyseal fractures of the distal radius in children. A prospective randomised controlled trial. J Bone Joint Surg 2002; 84B:413–417.
3. Proctor MT, Moore DJ, Paterson JM. Redisplacement after manipulation of distal radial fractures in children. J Bone Joint Surg 1993;75B:453-454.
4. Mani GV, Hui PW, Cheng JC. Translation of the radius as a predictor of outcome in distal radial fractures of children. J Bone Joint Surg 1993; 75B:808–811.
5. Abraham A, Handoll HH, Khan T. Interventions for treating wrist fractures in children. Cochrane Database Syst Rev 2008; 4.
6. Voto SJ, Weiner DS, Leighley B. Redisplacement after closed reduction of forearm fractures in children. J Pediatr Orthop 1990;10:79–84.
7. Alemdaroglu KB, Iltar S, Çimen O, Uysal M, Alagöz E, Atlihan D. Risk factors in redisplacement of distal radial fractures in children. J Bone Joint Surg 2008;90A:1224-1230.
8. Gibbons CLMH, Woods DA, Pailthorpe C, Carr AJ, Worlock P. The management of isolated distal radius fractures in children. J Pediatr Orthop 1994;14: 207–210.
9. Schneider J, Staubli G, Kubat S, Altermatt S. Treating displaced distal forearm fractures in children. Eur J Trauma Emerg Surg 2007;33:619–625.
10. Herring JA, editor. Fracture of the forearm. In: Tachdjian's Pediatric Orthopaedics. 4th ed. Vol. 3. Philadelphia: W.B. Saunders; 2008. 2536-2567.
11. LuscombeKL, Chaudhary S, Dwyer JSM, Shanmgam C, Maffuli N. Selective Kirschner wiring for displaced distal radial fractures in children. Acta Orthop Traumatol Turc 2010;44(2):117-123.
12. Leemput WV, Ridder KD. Distal metaphyseal radius fractures in children: reduction with or without pinning. Acta Orthop. Belg 2009; 75:306-309.
13. Waters PM, Bae DS: Fractures of the distal radius and ulna. In: Beaty JH, Kasser JR (editors) Rockwood and Wilkins Fractures in Children. 7th ed. Philadelphia, Lippincott Williams & Wilkins; 2010. 292-346.
14. Choi KY, Chan WS, Lam TP, Cheng JC. Percutaneous Kirschner-wire pinning for severely displaced distal radial fractures in children. A report of 157 cases. J Bone Joint Surg 1995;77B:797-801.
15. Mostafa MF, El-Adl G, Enan A. Percuataneous Kirschner fixation for displaced distal forearm fractures in children. Acta Orthop. Belg 2009;75: 459-466.
16. Zamzam MM, Khoshhal KI. Displaced fracture of the distal radius in children: factors responsible for re-displacement after closed reduction. J Bone Joint Surg 2005; 87B:841–843.
17. Miller BS, Taylor B, Widmann RF, Bae DS, Snyder BD, Waters PM. Cast immobilization versus percutaneous pin fixation of displaced distal radius fractures in children: a prospective, randomized study. J Pediatr Orthop 2005;25:490–494.

18. Bohm ER, Bubbar V, Yong-Hing K, Dzus A. Above and below-the-elbow plaster casts for distal forearm fractures in children. A randomized controlled trial. J Bone Joint Surg 2006;88A:1-8.

19. Zimmermann R, Gschwentner M, Kralinger F, Arora R, Gabl M, Pechlaner S. Long-term results following pediatric distal forearm fractures. Arch Orthop Trauma Surg 2004;24:179–186.

20. Zimmermann R, Gabl M, Angermann P, Lutz M, Reinhart C, Kralinger F, Pechlaner S. Late sequelae of fractures of the distal third of the forearm during the growth period. Handchir Mikrochir Plast Chir 2000;32(4):242-249.

21. Hang Yung PS, Lam CY, Wah Ng BN, Lam TP, Yiu Cheng JC. Percutaneous transphyseal intramedullary Kirschner wire pinning: A safe and effective procedure for treatment of displaced diaphyseal forearm fracture in children. J Pediatr Orthop 2004;24:7–12.

22. Jung HJ, Jung YB, Jang EC, Song KS, Kang KS, Kang SY, Lee JS. Transradioulnar single Kirschner-wire fixation versus conventional Kirschner-wire fixation for unstable fractures of both of the distal forearm bones in children. J Pediatr Orthop 2007;27:867-872.

CORRESPONDENCE:
Dr. Dipak Shrestha
Department of Orthopaedics
Dhulikhel Hospital
Kathmandu University Hospital
Dhulikhel, Nepal
E-mail: dsmsortho@gmail.com