Original article

Short term outcome of treatment with percutaneous cross Kirschner wires in paediatric distal humeral metaphyseal diaphyseal junction fractures

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ABSTRACT

Background: Fractures at the distal metaphyseal diaphyseal junction (MDJ) of humerus in children are less frequently found in literature and controversy exists regarding treatment. Main objectives of the study were to review our experience with these injuries, their treatment with cross Kirschner wires and functional outcome.

Patients and methods: Retrospective review of medical record revealed 16 children of either gender or side presenting in the Department of Orthopedics, Unit-I at Mayo Hospital, Lahore with closed distal MDJ fractures from Aug 2019 to July 2020. These patients were surgically treated with closed reduction and fixation with cross Kirschner wires under fluoroscopy. Time taken for radiological union, complications and functional outcome of the treatment was evaluated.

Results: The mean age at the time of injury was 9.00 ± 1.93 years and mean duration was 2.81 ± 2.29 days. There were 11 (68.8%) males and 5 (31.3%) females having right-sided predominance (75%). Most common mechanism involved was fall (87.5%). Fracture pattern was 43.8% transverse and 56.3 % oblique. Mean Operative time was 55.94 ± 5.23 minutes. Radiological union was observed in mean duration of 6.74± 0.70 weeks. There were no post-operative complications in 56% children. However 25% had pin loosening as a result of pin tract infection, heterotrophic ossification was seen in 12.5% and ulnar nerve palsy in one child. Functional Outcome was evaluated using Flynn's criteria with excellent results in 37.5% children, good in 25%, and fair result in 25% children and 12.5% had poor functional outcome.

Conclusion: Paediatric distal humeral metaphyseal diaphyseal junction fractures are different from traditional supracondylar fractures that can be successfully treated with close reduction and cross Kirschner wires fixation with excellent to good outcome according to Flynn's criteria.

Keywords: Pediatric, Distal Humeral Fractures, Kirschner Wire Fixation, Functional Outcome

INTRODUCTION

Paediatric distal humerus metaphyseal-diaphyseal junction (MDJ) region fractures are complex injuries that offer challenges to pediatric orthopedic surgeon.[1,2,3] These fractures representing 1.5% (16/1100) of all humeral fractures are rare injuries that occur just proximal to the olecranon fossa and distal to the junction of the metaphyseal brim and humeral diaphysis.[1] Fractures in this region are unstable because of extensive damage to the periosteum and rotation of the metaphysis causing varus deformity.[4,5,6] To effectively manage distal humerus MDJ fractures, special attention must be paid to the characteristics of the fracture lines. Two sub types have been described in literature depending upon the fracture line: an oblique pattern with a lateral spike in the distal fragment and a transverse pattern (Figure 1).[6,7,8,9] In the literature, this subset has not been distinguished previously from supracondylar fractures and are treated along the same lines as supracondylar fractures.[10,11]

Treatment is aimed to restore bone healing as well as managing fracture related complications such as loss of reduction with a reported incidence of as high as 18%.[1,2,3,5] Closed Reduction and percutaneous pinning have been the treatment of choice.[2,6,12,13] Evidence regarding close percutaneous Kirschner wire fixation shows variable results probably because of higher location of the fracture line and thin cortical bone of the proximal fragment for the pin purchase.[4,5,6,8] Other techniques that have been used to treat these fractures include Lateral External Fixators and Elastic Stable Intramedullary nails (ESIN).[1,8] However, these

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techniques have varying outcome. and still lack literature support.[12,13] With limited data available and no local study to the best of authors' knowledge in the indexed literature, main objective of this study was to describe single unit experience of a tertiary care referral center with these injuries focusing on their treatment with cross Kirschner wires, post-operative complications and functional outcome using Flynn's Criteria. The use of Flynn's criteria is a widely accepted method for assessing the results of distal humeral fractures.[14] This will help us to better understand these fractures so that distinction could be made from supracondylar fracture.

PATIENTS AND METHODS

After institutional approval, a retrospective review of record of 16 children of either gender or side presenting in the Department of Orthopedics Unit-I at Mayo Hospital, Lahore from August 2019 till July 2020 was evaluated. Children with close distal humeral metaphyseal diaphyseal junction fractures and intact distal neurovascular status were included. Exclusion Criteria included delayed presentation after two weeks of injury, intra-articular fracture pattern, failure to reduce fracture closely, open fractures or vascular injury, pathological fracture and compartment syndrome that could have affected the functional outcome. Demographic details (age, sex, mechanism of trauma, duration and side involved) were recorded. Radiographs were obtained in anteroposterior and lateral views to identify fracture pattern.

All children underwent surgery under general anesthesia. Close reduction attempt was done under image intensifier with traction applied to the involved limb in 10-15º flexion at elbow. Rotation was then addressed afterwards and with gradual flexion of elbow along with downward push of the humeral shaft with the help of fingers, reduction was achieved. Care was taken with the help of assistant at this moment to hold the humeral shaft while the wires were placed. If fracture was not reduced, repeat maneuver was done to obtain close reduction. These patients were excluded from the study for open reduction. For those in whom closed reduction was achieved, images were obtained in Jones and lateral view and Kirschner wires of size 2.0 mm were inserted from the medial and lateral condyles so as to engage the proximal fracture segment through cortices. (Figure 2, a, b, c)

All surgeries were done by consultant trained for at least one year after fellowship in paediatric orthopaedics. Distal neurovascular status was checked and a back slab was applied with elbow in flexion at 90º and forearm in supination. Operative time was noted from the files of patient. Postoperative radiographs were evaluated. Children were then discharged and followed up in outpatient department at 4th week for clinical examination and radiographs to see presence of callous formation and Kirschner wire placement. With Kirschner wires in place, passive elbow flexion was advised at 4th week. Kirschner wires were removed at radiological union (6 to 8 weeks) and time to union was noted. (Figure 2 d, e) Active range of physiotherapy was advised after wire removal. Clinical Outcome was evaluated by measuring the loss of carrying angle and any motion loss around elbow (Figure 2 f, g). Patients were then graded as excellent, good, fair and poor using Flynn's criteria.

Data was analyzed through SPSS version 25. Fischer exact test was used to compare complications and clinical outcome between fracture pattern and surgical duration with complications.

RESULTS

Out of 16 patients who met the inclusion criteria, there were 11 (68.8%) males and 5 (31.3%) females. Mean age of the children at presentation was 9.00 ± 1.93 years (range 6 to 14 years). Most common mechanism involved was fall in 14 (87.5%) children followed by road traffic accident in 2 (12.5%) children. All patients presented with mean duration of 2.81 ± 2.29 days (0 to 8 days) since injury. Right sided injury was seen in 12 (75%) of children while 4 (25%) of children had involvement of the left side. Regarding fracture pattern, 9 (56.3%) were of oblique type and 7 (43.8%) were classified as transverse type. Mean Operative time was 55.94 ± 5.23 minutes. Radiological union was observed in the mean duration of 6.74 ± 0.70 weeks (6

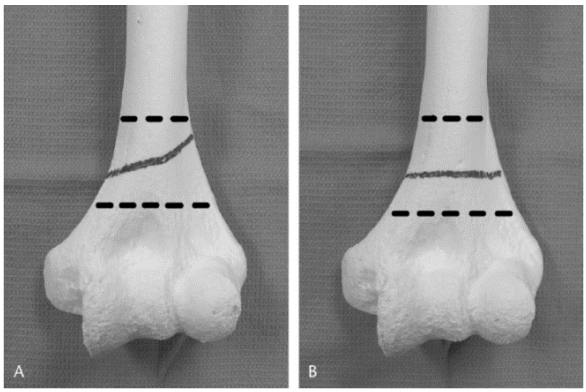

Figure 1: A, bone model showing oblique fracture line. Dotted lines showing the metaphyseal-diaphyseal area. B, transverse fracture pattern.[6,11]

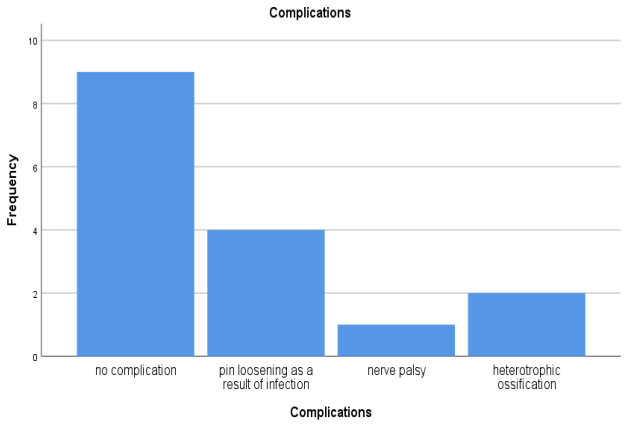

Figure 2: Complications after fixation with cross Kirschner Wires.

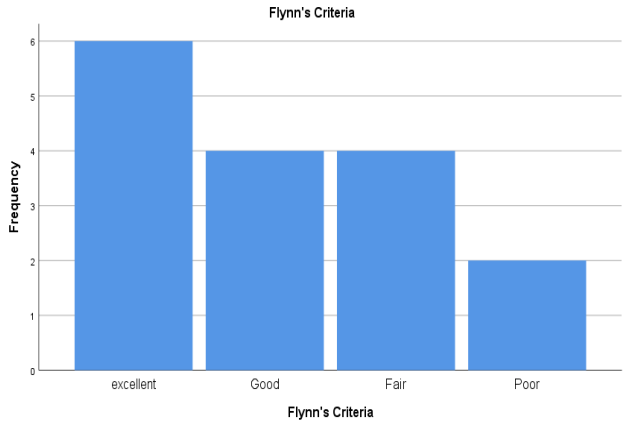

Figure 3: Rating according to Flynn's Criteria.

Figure 4: Preoperative radiograph of a 10-year-old male child presenting one week after injury (a), close reduction and cross kirschner wire fixation was done (b)(c), Radiograph at 6th week showing union (d)(e) and no loss of carrying angle and no loss of elbow flexion showing excellent result according to Flynn's Criteria in our case(f)(g).

to 8 weeks). There were no postoperative complications in nine (56.3%) patients However 4 (25%) had pin loosening as a result of pin insertion site infection and were managed with oral. antibiotics and back slab application with elbow in 90^0 flexion till radiological union. There was 1 patient (6.3%) of radial nerve injury that was noted after surgery but it was resolved at last follow up. Heterotrophic ossification was seen in 2 (12.5%) patients and both had limited range of elbow flexion (Figure 2). Functional Outcome was evaluated according to rating of Flynn's criteria at 6th month follow up. Six (37.5%) children had excellent results, 4 (25%) had good four (25%) had fair and 2 (12.5%) had poor functional outcome. Both had heterotrophic ossification (Figure 3).

DISCUSSION

This series reports distal humeral metaphyseal diaphyseal junction fractures, not previously well described in the international and local literature.

These fractures occur just proximal to the olecranon fossa.[6] Management of distal humerus MDJ fractures can be very challenging not only because of the unique anatomy of the distal humerus but mainly because of the higher location, different characteristics of the fracture lines and increased rate of conversion from close to open reduction.[4,6,11-13] Cvitanich and Hoffman reported 16 MDJ fractures in children over four-year period from 1997 to 2000.[12] Mean age at presentation was 4.8 years. Fayssoux and coworkers described 14 children having mean age at presentation of 4.9 years.[6] Kumar and colleagues studied 6 children with mean age of 5.8 years.[13] Mean age in study by Lorenza Marengo et al.[1] was 9.7 years. The mean age in current study was 9.00 ± 1.93 (6-14 years), no child below 6 years presented in this study that's why mean age is different compared to previous studies.[6,12,13] This age group is the reason that 2.0 mm Kirschner wires was used in all of cases to provide stability at the fracture site in this study and this is evident through literature.[1,2,4] This study found most of the MDJ fractures as oblique type as most of them presented after history of fall in playground area. While transverse type was found mainly in those children having history of road traffic accident. This mechanism is consistent with previous reports.[3,5] Previous researchers described percutaneous pinning as the best form of treatment for these fractures and recommended immobilization for 4 weeks.[12,13] Fayssoux and colleagues treated all children with close reduction and Kirschner wire fixation and emphasized close post-operative follow-up for excellent outcome.[6] They removed Kirschner wires at a mean duration of 3.78±0.24 weeks. Others also followed the same protocol for hardware removal after 3rd week and encountered re-fracture in one patient.[1,12] In present study, Passive elbow motion exercises were advised after 4 weeks to gain early range of motion, Kirschner wires were removed when there was evidence of radiological union (6.74 ± 0.70 weeks). Active range of exercises was started afterwards. This rehabilitation protocol described in literature along with Kirschner wires removal as per radiological union explains more children in this series to have excellent to good outcome according to Flynn's criteria and is recommended to be followed.[6,12] Kumar and co-authers treated transverse fractures with close reduction percutaneous pinning and managed two cases of oblique fractures with conservative treatment, but both these oblique fracture children were of less than 3 years.[13] However, present study included all children above 6 years showed that Kirschner wire fixation offers same results in both fracture types (transverse as well as oblique) in terms of functional outcome and acceptable complications. In one study the mean operative time was 66 minutes.[6] In current study operative time was 56 minutes and had no impact with the duration of radiological union. However with longer operative duration the complication incidence does increase as evident in our series and also reported in the literature as well.[1,5,6,11,13] Elastic Stable Intramedullary Nails (ESIN) results in stable reduction, good rotational control, and faster mobilization have been investigated in metaphyseal-diaphyseal junction fractures using Me´taizeau's technique.[12] However, this technique offer challenges for the surgeons because of unique anatomy of distal humerus, antegrade insertion can result in radial nerve palsy, reoperation for hardware removal and weaker against translational and torsional forces in oblique fractures.[11] Using Kirschner wires of size 2.0 mm retrograde technique, we found it was easy and safe to perform that fix both columns and provide greatest stability in varus, external and internal rotation also evident in a previous study.[11] One biomechanical study with composite bone models found Kirschner wires to be superior to both ESIN and EF in the transverse and oblique fracture models with both 2-crossed and 3-crossed Kirschner wires having same stability. [11]

Small sample size and short follow-up remain limitations of present study and longer follow-up to delineate more functional result and complications is recommended.

CONCLUSION

Paediatric distal humeral metaphyseal diaphyseal junction fractures are unique group of fractures which can be successfully treated with close reduction, 2.0 mm cross Kirschner wires, early passive range of motion at 4th week and strict post-operative follow-up protocols. Technique seems acceptable for these fractures and excellent to good outcome according to can be achieved.

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