The outcome of Radial Neck Fracture Treated with Closed/ Open Reduction and Retrograde Kirschner Wires Fixation in the Paediatric Age Group

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ABSTRACT

Background

Radial neck fractures in children are rare injuries, representing 1 to 5% of all elbow pediatric fractures. Most of them are non-displaced or slightly displaced and treated conservatively. Severely displaced or angulated radial neck fractures (Judet type III and IV fractures or O'Brien type III radial neck fractures) requires surgical treatment.

Objective

To study the clinical and radiological outcomes of fractures following closed or open reduction and percutaneous intramedullary stabilization of the displaced radial neck fracture in children.

Method

There were 24 children with displaced radial neck fracture Judet type II, III and IV fractures O'Brien type II, III who underwent closed reduction and retrograde intramedullary stabilization with Kirschner wires. Functional outcomes were evaluated based on of Mayo Elbow Performance Score.

Result

The mean age of patients was 8.42 ± 1.82 years with boys 15(62.5%) and girls 9(37.5%) in number. An excellent result was seen in 5(20.8%) cases and good results in 15(62.5%) cases according to the Mayo elbow performance score. Analyzing a passive and active range of motion, 5 had excellent results, 15 had good results and 4 had fair results compared to the normal side. Radiological evaluation showed fracture healing in excellent or good alignment according to Ursei radiological evaluation classification.

Conclusion

Closed reduction and retrograde intramedullary Kirschner wires stabilization for the displaced radial neck fracture provide excellent clinical and radiological results with few complications.

KEY WORDS

Kirschner wires fixation, Paediatric elbow, Radial neck fracture

INTRODUCTION

Radial neck fractures occur in 5-10% of all traumatic injuries of the elbow in the paediatric age group and 1% of all paediatric fractures.[1,2] Undisplaced radial neck fractures are treated conservatively. The outcome of these fractures is good. However, displaced radial neck fractures have fair to poor outcomes even with operative management. In most of these cases, there may be stiffness and a permanent loss of motion.[3-5]

The ossification center of the proximal radial epiphysis appears at the age of 4-6 years. The epiphysis closes at the age of 14 to 17 years. Fractures through the articular surface of the radial head are rare in children. The epiphysis with a metaphyseal chunk of the radial neck is the most common site of fracture.[1]

Several surgical methods for treating radial neck fractures have been described, but the majority of them had poor and unsatisfactory outcomes.[5] In our study, displaced radial neck fractures were treated with closed or open reduction methods and fixed with retrograde K-wire from the distal part of the radius. The clinical and radiological outcomes after treatment were analyzed.

METHODS

A prospective study was conducted in the Department of Orthopaedics Manipal Teaching Hospital, Pokhara Nepal. The study period was from July 2020 to November 2021 for 17 months. There were 24 patients with radial neck fractures who were treated with closed reduction or open reduction and retrograde K-wire fixation.

Inclusion criteria

• All paediatric radial neck fractures that are displaced or angulated (Judet types II, III, and IV fractures or O'Brien types II and III radial neck fractures).[6,7]

• Fracture within 2 weeks of injury

• Patient's parents who gave written consent

Exclusion criteria

• Open fracture

• Comminuted fracture

All the cases were admitted to the hospital. Pre anesthesia checkup was done. The surgery was done under general anesthesia. Cefuroxime (50 mg/kg per dose) was administered intravenously one hour before surgery. Under aseptic conditions, closed reduction was done by pulling the elbow into an extended position. Distal traction was applied while the forearm was supinated and in the varus position. Direct lateral pressure was applied over the radial head to reduce the displaced radial head. Once the best position of the radial neck was obtained, fixation was done under image guidance. In some cases, percutaneous K-wires were used to assist in reduction. The blunt end of large K-wire was used as a lever arm through the fracture from the lateral side to reduce the fracture. In those cases in which closed reduction failed, open reduction was done. A radiocapitellar arthrotomy (Kocher approach) was used for radial neck fracture reduction. forearm was kept in pronated position to avoid posterior interosseous nerve palsy. Following reduction, a retrograde K-wire was inserted from the distal end of the radius to secure the radial neck and, posterior slab was applied. Patients treated with closed reduction were discharged the next day, and patients who were treated with open reduction were discharged on the third postoperative day after dressing. Stitches were removed after 14 days. Patients were advised to follow up after 6 weeks for the removal of the slab and K-wire. They were advised to perform exercises for elbow range of motion, pronation, and supination of the forearm, and strengthening exercises of the arm and forearm. The final assessment was done at the three months follow-up.

The clinical and radiological outcomes of all patients were evaluated at 6 weeks and 3 months. Clinical evaluation was done using the Mayo Elbow Performance Score (MEPS).[8] (Table 1) The radial angle was measured by drawing a line parallel to the superior articular surface of the radial head and another line perpendicular to the articular surface. The third line is drawn through the radial shaft. These two lines formed the angle that was measured to assess the radial neck angle. The radial angle was measured immediately after surgery and again 6 weeks later, just before the removal of the K-wires, to observe how the reduction had changed.

Table 1. Mayo elbow performance score (MEPS)

Variable	Definition	Number of points
Pain (max - 45 points)	None	45
	Mild	30
	Moderate	15
	Severe	0
Range of motion (max - 20 points)	Arc > 100˚	20
	Arc 50-100˚	15
	Arc < 50˚	5
Stability (max 10 points)	Stable	10
	Moderately unstable	5
	Grossly unstable	0
Function (max 25 points)	Able to comb hair	5
	Able to feed on self	5
	Able to perform personal hygiene tasks	5
	Able to put on shirt	5
	Able to put on shoes	5

The total score ranges from 5 to 100 points, with higher scores indicating better function.

Excellent: Score between 90 and 100;

Good: Between 75 and 89;

Fair: Between 60 and 74;

Poor: Less than 60 points

Postoperatively, radiological evaluation was done in accordance with the Ursei classification.[9] The reduction was considered excellent when it healed in the anatomical position; good when the radial neck angle is less than 20˚, medium when the angle is between 20˚ to 40˚ and poor with an angle of more than 40˚.[8,9]

The Mayo Elbow Performance Score was used to assess the functional outcome following surgery (MEPS).[8] Flexion and extension of the elbow, pronation, and supination of the forearm, and the angle of the extended elbows were measured by a goniometer. The uninjured elbows served as controls. The last follow-up radiographs included standard anteroposterior and lateral projections of the injured elbow. All measurements were performed by a single author to minimize error.

The MEPS is one of the most commonly used elbow rating systems. The radiocapitellar joint is a secondary elbow stabilizer. The radial head provides approximately 30% of valgus stability.[1,8,9] The joint's stability was graded as stable, mildly unstable, or unstable. The functional score is determined based on the patient's ability to perform normal activities of daily living. The total score ranges from 5 to 100 points, with higher scores indicating better function and low scores indicating poor functional outcomes.[8] Possible complications such as avascular necrosis, nonunion, proximal synostosis, heterotopic ossification, infection, and premature epiphyseal closure were documented.

RESULTS

The study included a total of 24 patients who presented with radial neck fractures. The demographic profiles of the patients are shown in table 2.

Table 2. Demographic profiles of the patients.

Parameters	Numbers or Means	Range
Age	8.42 ± 1.82 years	6 – 13 years
Sex		
Male	15 (62.5%)	
Female	9 (37.5%)	
Time duration from trauma to surgery (days)	2.13 ± 0.80 days	1 – 4 days
Duration of surgery	62.50 ± 14.82 minutes	30 – 80 minutes

Based on Judet's classification, there were 6 (25%) Type II fractures, 10 (41.7%) Type III fractures, and 8 (33.3%) Type IV fractures. In 21 patients, the fracture was reduced by closed methods, and 3 patients required an open reduction.

All patients' fractures had healed within six weeks. The result of surgery based upon Mayo's criteria is as follows: (Table 3)

Table 3. Outcome of patients on basis of MEPS

Radial head fracture	Excellent 90-100	Good 75-89	Fair 60-74	Poor <60	Total
2	4	1	0	1	6
3	1	7	1	1	10
4	0	7	1	0	8
Total	5 (20.8)	15 (62.5)	2 (8.3)	2 (8.3)	24

On radiological evaluation, 19 cases healed in excellent alignment and 5 cases healed in good alignment. The difference between the radial neck angle at 6 weeks and the angle immediately after reduction are 3.21 ± 2.52, which is not statistically significant (Table 4).

Table 4. Comparison of radial neck angle

	Mean	Std. Deviation	95% Confidence Interval of the Difference		Sig.
			Lower	Upper	
Change in angle at 6 weeks - radial neck angle after surgery	3.208	2.519	2.145	4.272	.000

No patients developed avascular necrosis, radioulnar synostosis, periarticular ossification, or nerve damage. A superficial infection at the pin entry site was present in two cases; this infection was treated with oral antibiotics and resolved after the pin was removed.

Figure 1. Showing radial neck fracture treated with intramedullary k-wire fixation and final X-ray after removal of k-wire.

DISCUSSION

Radial neck fractures in children are not very frequent but they deserve great attention due to their complications and long-term functional disabilities. It is reported in the literature that the age interval for radial neck fracture in children is between 8 and 12 years, the male-to-female ratio is 1:1, and the right-to-left ratio is equal.[1,2,5] The youngest child in our study was 6 years old, the oldest was 13 years old, and two-thirds of the patients were male.

The study was done to reveal the clinical and radiological outcome of a displaced pediatric radial neck fracture. All cases were treated with retrograde intramedullary K-wire fixation. For patients with an angulation of more than 30°,

a closed reduction was done. When the closed reduction failed, the percutaneous K-wire-assisted reduction was attempted. An open reduction has been applied to fractures that cannot be adequately reduced to an angle of less than 30° using closed or percutaneous methods.

There are several methods for treating a radial neck fracture, including percutaneous pinning, the ESIN technique suggested by Metaizeau et al. and open reduction with or without internal fixation.[9-12] In our study, the reduction was accomplished through closed or percutaneous K-wire-assisted techniques in 21 cases, compared to 3 cases where the reduction was achieved through an open procedure, as the closed technique failed. Retrograde K-wire was used to stabilize all fractures from the distal radius.

Klitscher et al. found that over 85% of radial neck fractures treated with closed reduction and percutaneous fixation had excellent to good outcomes.[13] The study by Tarallo et al. shows excellent to good results in more than 80% of his cases.[14] Metaizeau et al. treated the radial neck fractures using an intramedullary K-wire, which subsequently fixed the fractures and maintained a stable reduction.[10,11] They report 100% excellent results in grade 3 tilts and 74% excellent results in grade 4 tilts. They treated radial neck fractures with closed reduction and percutaneous fixation, which is similar to our study, with 83% excellent to good results according to MEPS criteria.

The closed reduction technique preserves the lateral periosteal and epiphyseal blood supply to the radial head. Intra-medullary internal fixation prevents the displacement of fractures during the healing period. They also provided soft tissue attachment preservation, which improved the vascularity of fracture fragments and helped in early healing.

Most surgeons do not prefer open reduction, which may cause avascular necrosis of the radial head.[14] Most of the studies reported higher rates of avascular necrosis, premature epiphyseal fusion, and heterotopic ossification after open reductions compared to closed reductions.[12,14] In our study, Judet, type IV, and those in need of open reduction had poor results compared to closed reduction methods. Five patients who had a good radiological alignment were older than 10 years. Among them, 3 patients were treated with open reduction and intramedullary K-wire fixation. This is similar to the research by Mattos et al. and Zimmerman et al. in which children older than 10 years with open reduction had poor outcomes in comparison to those with closed reduction.[15,16] Instead of a good reduction of fractures, open reduction results in the worst outcome.[17]

Several studies have shown the procedure of closed reduction and intramedullary pinning of isolated radial neck fractures is a safe technique leading to reliable results in children, which is also seen in our study.[10,11,13] Reduction and osteosynthesis of radial neck fractures by intramedullary K-wires appear to be a simple, safe, and effective treatment.[18] There was no displacement of the fracture fragment stabilized by retrograde K-wire. We applied a posterior slab for additional support in each case, which may have contributed to stable fixation without significant fracture displacement.

Although our study demonstrates excellent to good results, a longer-followed randomized controlled trial may provide additional recommendations for further management.

CONCLUSION

The current study shows that treatment of a radial neck fracture with closed reduction and intramedullary K-wire fixation is a simple, reliable, and effective technique leading to excellent to good clinical results. The minimally invasive technique and internal fixation allowed the fracture to heal without additional complications.

REFERENCES

1. Tachdjian MO. Clinical pediatric orthopedics. Stamford, CT: Appleton & Lange; 1994.
2. Wilkins K. Fractures and dislocations of the elbow region. In: Rockwood CA, Wilkins KE, King RE, editors. Fractures in Children Lippincott. Philadelphia; 1991. p. 728–51.
3. Brandão GF, Soares CB, Teixeira LEM, Boechat L de C. Displaced radial neck fractures in children: Association of the métaizeau and böhler surgical techniques. *J Pediatr Orthop* [Internet]. 2010;30(2):110–4. Available from: http://dx.doi.org/10.1097/ BPO.0b013e3181cf118a
4. Ugutmen E, Ozkan K, Ozkan FU, Eceviz E, Altintas F, Unay K. Reduction and fixation of radius neck fractures in children with intramedullary pin. *J Pediatr Orthop B* [Internet]. 2010;19(4):289–93. Available from: http://dx.doi.org/10.1097/bpb.0b013e32833918a0
5. D'souza S, Vaishya R, Klenerman L. Management of radial neck fractures in children: a retrospective analysis of one hundred patients. *J Pediatr Orthop.* 1993 Mar-Apr;13(2):232-8. PMID: 8459018.
6. Judet J, Judet R, Lefranc J. Fracture du col radial chez l'enfant. *Ann Chir.* 1962;16:1377–85. PMID: 13957959.
7. O'Brien PI. Injuries involving the proximal radial epiphysis. *Clin Orthop Relat Res* [Internet]. 1965;41(1):51–8. Available from: http://dx.doi.org/10.1097/00003086-196500410-00006
8. Bf M An KN, Chao EY. Functional evaluation of the elbow. The elbow and its disorders. Philadelphia: WB Saunders; 1993.
9. Çevik N, Cansabuncu G, Akalın Y, Otuzbir A, Öztürk A, Özkan Y. Functional and radiological results of percutaneous K-wire aided Métaizeau technique in the treatment of displaced radial neck fractures in children. *Acta Orthop Traumatol Turc* [Internet]. 2018;52(6):428–34. Available from: http://dx.doi.org/10.1016/j.aott.2018.07.007
10. Cha SM, Shin HD, Kim KC, Han SC. Percutaneous reduction and leverage fixation using K-wires in paediatric angulated radial neck fractures. *Int Orthop.* 2012 Apr;36(4):803–9. doi: 10.1007/s00264-011-1387-3. Epub 2011 Oct 29. PMID: 22038445; PMCID: PMC3311808.
11. Métaizeau JP. Reduction and osteosynthesis of radial neck fractures in children by centromedullary pinning. Injury. 2005 Feb;36 Suppl 1:A75-7. doi: 10.1016/j.injury.2004.12.016. PMID: 15652940.

12. Tan BHM, Mahadev A. Radial neck fractures in children. *J Orthop Surg* (Hong Kong) [Internet]. 2011;19(2):209–12. Available from: http://dx.doi.org/10.1177/230949901101900216

13. Klitscher D, Richter S, Bodenschatz K, Hückstädt T, Weltzien A, Müller LP, et al. Evaluation of severely displaced radial neck fractures in children treated with elastic stable intramedullary nailing. *J Pediatr Orthop* [Internet]. 2009;29(7):698–703. Available from: http://dx.doi.org/10.1097/BPO.0b013e3181b76895

14. Tarallo L, Mugnai R, Fiacchi F, Capra F, Catani F. Management of displaced radial neck fractures in children: percutaneous pinning vs. elastic stable intramedullary nailing. *J Orthop Traumatol* [Internet]. 2013;14(4):291–7. Available from: http://dx.doi.org/10.1007/s10195-013-0252-0

15. De Mattos CB, Ramski DE, Kushare IV, Angsanuntsukh C, Flynn JM. Radial Neck Fractures in Children and Adolescents: An Examination of Operative and Nonoperative Treatment and Outcomes. *J Pediatr Orthop*. 2016 Jan;36(1):6-12. doi: 10.1097/BPO.0000000000000387. PMID: 25812145.

16. Zimmerman RM, Kalish LA, Hresko MT, Waters PM, Bae DS. Surgical management of pediatric radial neck fractures. *J Bone Joint Surg Am* [Internet]. 2013;95(20):1825–32. Available from: http://dx.doi.org/10.2106/JBJS.L.01130

17. Gutiérrez-de la Iglesia D, Pérez-López LM, Cabrera-González M, Knörr-Giménez J. Surgical techniques for displaced radial neck fractures: Predictive factors of functional results. *J Pediatr Orthop* [Internet]. 2017;37(3):159–65. Available from: http://dx.doi.org/10.1097/BPO.0000000000000617

18. Koca K, Erdem Y, Neyişci Ç, Erşen Ö. Intramedullary elastic nailing of the displaced radial neck fractures in children. *Acta Orthop Traumatol Turc* [Internet]. 2017;51(6):451–4. Available from: http://dx.doi.org/10.1016/j.aott.2017.03.021