

Original Research Article

A prospective study of management of distal end of radius fracture in children

Pratik Gohil, Deepak Jain*, Saijyot Raut, Parimal Malviya, Alfven Vieira, Tushar Agrawal

Department of Orthopaedics, MGM Institute of Health Sciences, Navi Mumbai, Maharashtra, India

Received: 16 April 2020

Revised: 14 May 2020

Accepted: 28 May 2020

*Correspondence:

Dr. Deepak Jain,

E-mail: deepaksjain1993@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Distal end radius (DER) fractures represents one of the common fractures in the paediatric age group. Most of this injury are managed by closed reduction and casting. We investigated the degree to which the clinical and radiographic follow-ups reveal complications that lead to a change in management of the un-manipulated distal radius fractures in children less than 14 years of age. We determined the frequency and type of complications registered during treatment, and assessed the stability of the different fracture types.

Methods: Study includes examination of 30 patients with closed DER fractures who were admitted in tertiary care centre between August 2016 to April 2018.

Results: Closed reduction and casting was modality of treatment in 40%, casting was done in 33.3% and closed reduction and k wire were done in 26.7%. In patients with closed reduction and k wire slab was given. Gartland and Werley's scoring system was used and found that 60% patients have 0 score, 30% have 1 score, 6.7% have 2 score and 3.3% have 3 score. 29 patients had excellent result and 1 patient had fair result.

Conclusions: In this study of management of DER fracture in children with different modality of treatment, we noted that if it is an undisplaced fracture, can be managed with casting. If it is displaced fracture and reduction is achieved then closed reduction and casting can be done. If displacement is more than 50% of bone diameter then closed reduction and k wire can be done.

Keywords: DER, Paediatric, Closed reduction

INTRODUCTION

Forearm fractures accounts for one of the commonest fractures in the children, and the distal radius being the commonest site affected accounting for 25-27% of these fractures. The most common site for fracture in forearm is metaphyseal region followed by diaphysis and least common site is epiphysis fracture.¹

Eighty-one percent occur in kids who are older than five years, with a peak incidence of distal forearm fractures occurring between ages 12-14 in boys and 10-12 in girls. The standard mechanism of injury is a direct fall

in or around the house.¹ Traditionally, most of the fractures have been treated by a decent closed anatomical reduction and immobilisation in a cast. Conservative methods still play a major role in treatment and 85% of these fractures achieved satisfactory results with these methods.²

Fracture healing is fast, and also the fractures have an excellent capacity to spontaneously correct residual axial deformities throughout the growing years; nevertheless, even though several studies have shown that complete remodelling does not always occur, this is especially very true in children who are older than 8 to 10 years of age. Maintaining acceptable reduction isn't always possible

and re-displacement or re-angulation during cast treatment might occur; this is the foremost commonly reported complication in pediatric forearm fractures. Very high rates of unacceptable degrees of displacement after the initial fracture reduction have been reported. Some recent reports have indicated associate inflated trend for the routine use of percutaneous K-wire fixation for the initial treatment of high-risk fractures.³

Distal radius fractures are the foremost common fracture in childhood, and also the incidence is rising. Most minimally displaced fractures are usually treated without manipulation, and immobilized between three and six weeks. Displaced fractures are typically manipulated before immobilization. The rate of long-term complications in childhood distal radius fractures is comparatively low. Despite this, clinical and radiographic follow-up examinations are performed.

In childhood, the periosteal sleeve is generally thick and protects the cortex. The bone is softer and more pliable than the bone in adults.⁴ This accounts for the range of different fracture varieties that's is unambiguously seen in childhood particularly the buckle (torus), the classical greenstick fracture, the complete fractures (adult type), and the fractures involving the growth plate. Additionally, the plasticity of the children's long bones can lead to bowing of the radius. Several authors consider buckle fractures to be stable, however one study reported seven percent subsequent displacement among buckle fracture.⁴ Greenstick fractures are less stable. The periosteal hinge has been considered important in the stability of fractures. Complete fractures are therefore considered extremely unstable. Physeal fractures can may result in growth disturbances and are often monitored closely. Follow-up radiographs are undertaken to identify fractures that have become displaced and need manipulation with or without k wire fixation.⁴

We investigated the degree to which the clinical and radiographic follow-ups reveal complications that lead to a change in management of the un-manipulated distal radius fractures in children less than 14 years of age. We determined the frequency and type of complications registered during treatment, and assessed the stability of the different fracture types.

METHODS

The study includes examination of 30 patients, 6 to 14 years of age with closed distal end of radius fracture who were admitted in MGM Medical College and Hospital Kamothe between August 2016 to April 2018 who were treated with plaster cast or surgical intervention.

Inclusion criteria

Patients of age 6 to 14 years, fresh distal end of radius fracture, closed fracture, and compound fracture were included.

Exclusion criteria

Patients with old untreated fractures, bilateral distal end radius fracture, and pathological fracture were excluded.

Patients were treated with cast immobilization alone or closed reduction and casting or with K wire fixation. Closed reduction and casting were done under short GA and closed reduction and k wire fixation were done in GA.

Acceptable remodelling capability in sagittal plane below ten year is ten to twenty-five degree and above ten year is 5 to 20 degree. In frontal plane 10 degree or less is acceptable. Considering this in mind reduction were accepted after closed and casting or closed reduction and k wire.

For all patients with acute undisplaced distal end radius fracture after confirming with X-ray above elbow slab were given for three days on OPD basis for swelling to get subside. After three days slab is converted to above elbow cast with casting index in mind and X-ray were repeated after casting and casting index were calculated.

For all patients with displaced distal end radius fracture were admitted and after taking clearance from anaesthesia department patient were taken for OT for closed reduction and casting or closed reduction with k wire depending on acceptable reduction (if there is more than 50% translation compared to diameter of radius then fracture is was fixed with k wire). For all patients undergoing closed reduction and casting were given above elbow cast and X-ray were done after procedure. SPSS 24 version is the statistical tool used to analyses the data in this study.

RESULTS

Majority of patients (60%) are above 10 years of age followed by 40% in age group between 6-10 years. The mean age in patients was 11±2.12 years.

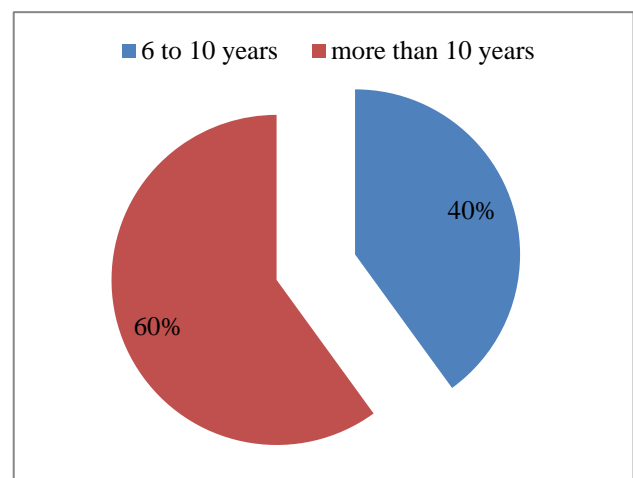


Figure 1: Distribution patients according to age.

There was male preponderance 83.3% in the study while female patients constituted 16.7% of the study group.

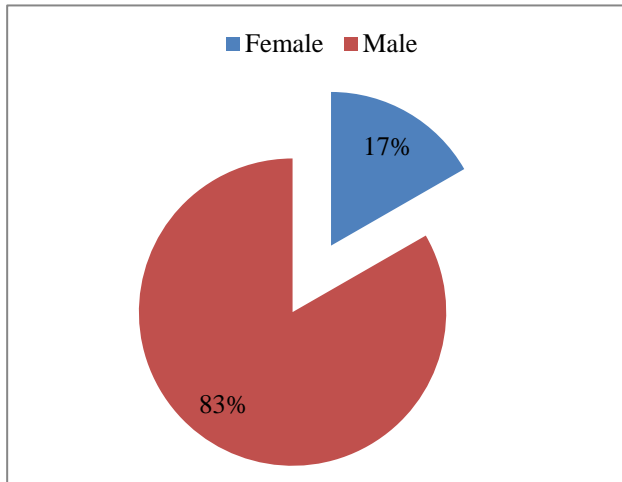


Figure 2: Distribution of patients according to gender.

In the study, there is left sided predominance compared to the right side (60% vs 40%).

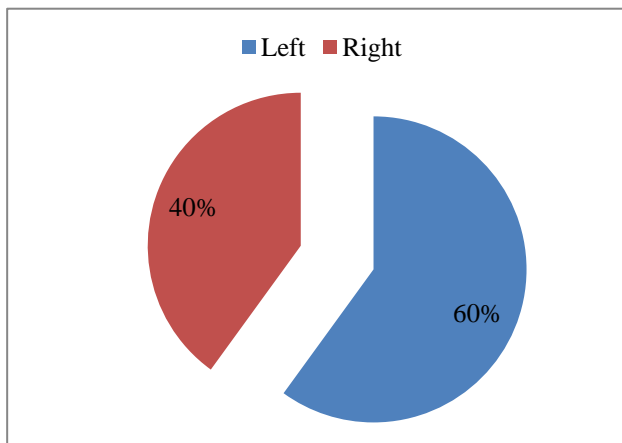


Figure 3: Distribution of patients according to laterality of fracture.

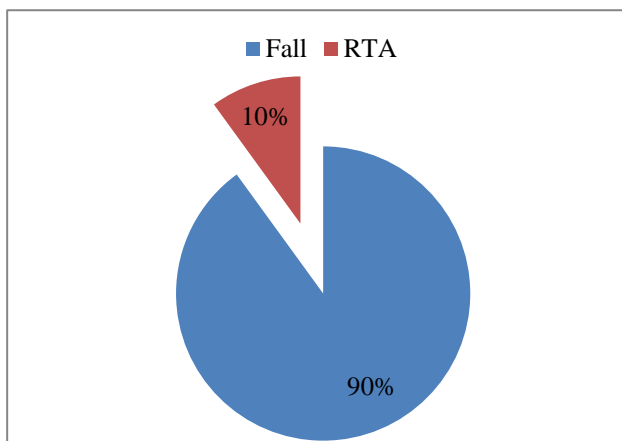


Figure 4: Distribution of patients according to mode of injury.

Fall on outstretched hand was observed to be the main cause of fracture 90% compared to RTA 10%.

Closed reduction and casting were modality of treatment in 40%, casting was done in 33.3% and closed reduction and k wire were done in 26.7%.

Table 1: Distribution of patients according to treatment given.

Treatment given	No of patients	%
Cast	10	33.3
Closed reduction and k wire	8	26.7
Closed reduction casting	12	40.0
Total	30	100.0

In patients with closed reduction and k wire slab was given. Patient with closed reduction and casting and in patient with only casting index range from 0.73-0.8.

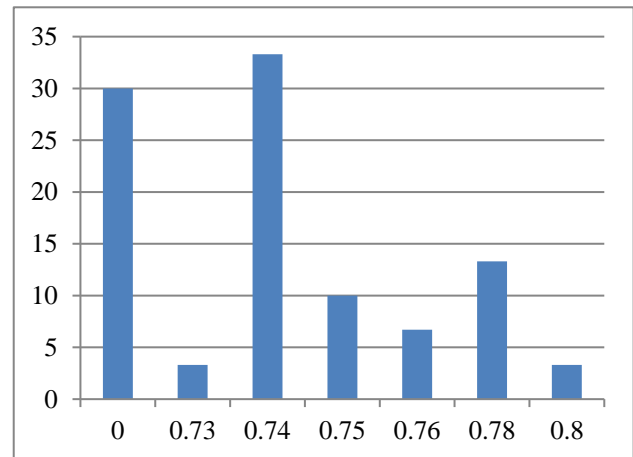


Figure 5: Distribution of patients according to casting index.

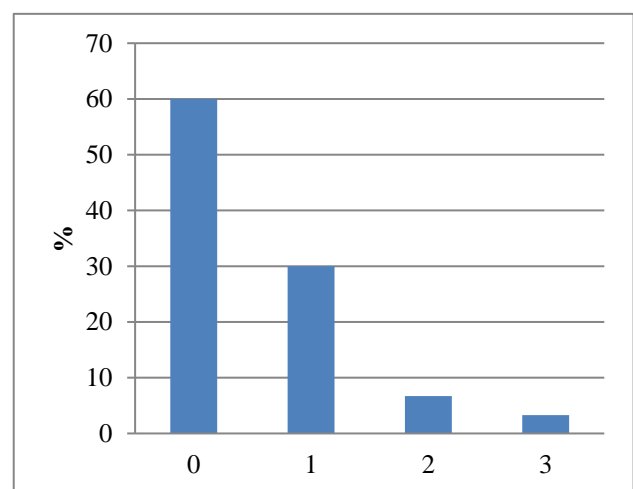


Figure 6: Distribution of patients according to Gartland and Werelys score.

In our study, Gartland and Warley’s scoring system was used to assess the outcome of patients. 60% patients have 0 score, 30% have 1 score, 6.7% have 2 score and 3.3% have 3 score. 29 patients have excellent result and 1 patient have fair result.

In our study, maximum number of patients 86.7% have union at 4 weeks, 10% of patients have union at 6 weeks, 3.3% of patient have union at 4.3 weeks.

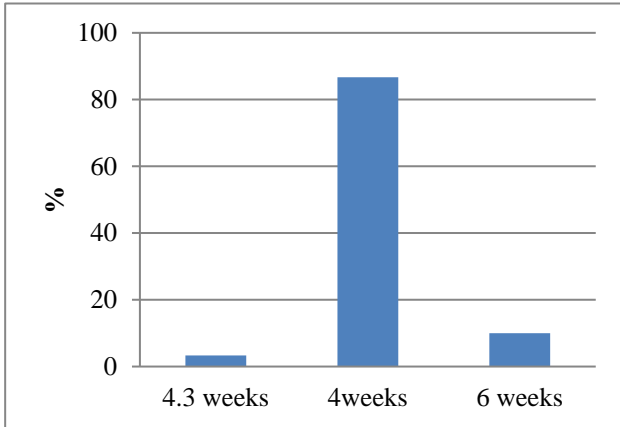


Figure 7: Distribution of patients according to time of union.

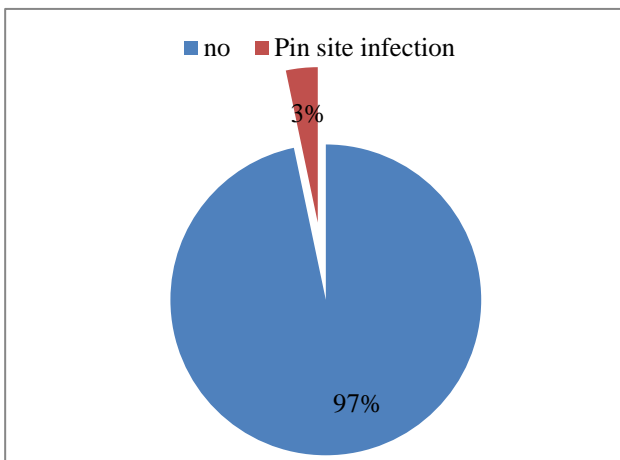


Figure 8: Complications.

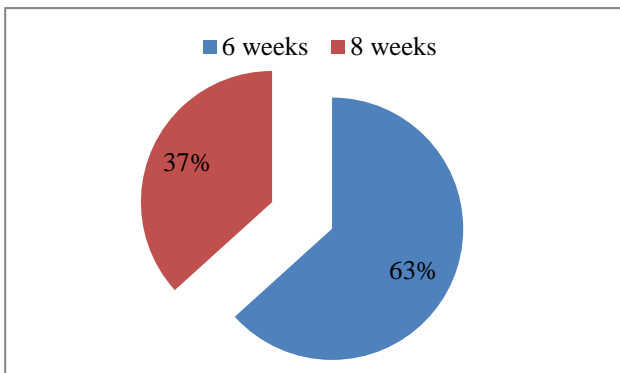


Figure 9: Range of motion.

In this study, we found only one patient of closed reduction and k wire who got infected at pin tract site which was treated with local antibiotic and daily pin tract dressing.

In this study majority of patient 63.3% achieved full range of motion by 6 weeks followed by 36.7% patients achieved full range of motion by 8 weeks.

DISCUSSION

The goal of pediatric distal end radius fracture care is to achieve bony union within acceptable radiographic parameters to optimize long term function and avoid late complication. Management is influenced tremendously by the remodelling potential of distal radius in growing children. In general, remodelling potential is dependent upon the amount of skeletal growth remaining, proximity of the injury to the physis, and relationship of the deformity to plane of adjacent joint motion.

Fracture in very young children, close to the distal physis, with preponderantly sagittal plane angulation have greatest remodelling capability. Acceptable sagittal plane angulation of acute distal radial metaphyseal fractures has been reported to be from ten to thirty-five degrees in patients under five year of age. Similarly, in patients under ten years of age, the degree of acceptable angulation has ranged from ten to twenty-five degrees.⁵⁻⁷ For children over ten years of age, acceptable alignment has ranged from five to twenty degrees depending on the skeletal maturity of the patient.

Criteria for what constitutes acceptable frontal plane deformity are lot of uniform. The fracture tends to displace radially with associate apex ulnar angulation. This deformity additionally has remodelling potential however less than sagittal plane deformity.⁸⁻¹⁰ Most authorities agree that ten degrees or less of acute malalignment in the frontal plane should be accepted. Greater magnitudes of coronal plane malalignment may not remodel and may result in limitations of forearm rotation.¹¹⁻¹⁴

In general, twenty to thirty degrees of sagittal plane angulation, ten to fifteen degrees of radioulnar deviation, and complete bayonet apposition with reliably remodel in younger children with growth remaining.^{15,16}

In the present study, keeping in mind above acceptable criteria of angulation modality of treatment were decide. For a similar reason mention above the vast majority of pediatric distal radius fractures could also be successfully treated with nonoperative treatment include torus, displaced physeal or metaphyseal fractures within acceptable parameters of expected skeletal remodelling, displaced fractures with unacceptable alignment amenable to closed reduction and immobilization, and late presenting displaced physeal injuries.

As others, we tend to documented a greater incidence of distal forearm fractures in boys than girls. The gender

differences were small below ten years of age, however fracture rates rose rapidly thenceforth to a peak among girls aged 9-12 years and boys aged 12-15. These results are consistent with those of other researchers, who have found that the peak incidence of distal forearm fractures spans the pubertal growth spurt, that reaches its maximum at around age twelve years in girls and age fourteen years in boys.^{17,18}

The mechanism of injury in distal radius fractures in the pediatric population has been well documented. The main varieties of activities inflicting distal radius fractures in children are fall on hand while sports, car accidents, and playing. Khosla et al. found that from 1999 to 2001, 10% of all pediatric distal radius fractures in Olmsted County occurred while children were using playground equipment. Data from Ryan et al. documented 30% of distal radius fractures resulting from sports related injuries in the 10-14 years age group, whereas sports were accountable for 47% of these fractures in the 15-17 years age group. The foremost common mechanism of injury was fall on hand related, with studies showing around 80% of injuries occurring in this fashion. In our study too majority of the patients had injury by fall on hand while playing.

The management of pediatric distal radius fractures is controversial. The necessity for optimal reduction to allow normal patient function post-injury has recently been questioned. Crawford et al. treated fifty-one children with cast application and mild moulding to correct the angulation only, with no formal reduction, therefore requiring no sedation or anaesthesia. All cases united with full function at 1 year, and that they found this to be nine times cheaper than MUA and k wire fixation.

In different studies, the use of closed reduction and cast immobilisation alone in pediatric distal radius fracture has been related to with high rates of re-displacement which result in re-manipulation under anaesthesia.¹⁹⁻²¹

In contrast to this study in our study we didn't found single case with re-displacement that needed re-manipulation again or k wire fixation owing to casting index and acceptable criteria of angulation according to age of patients, but number of patients is less in our study. Initial

reduction has additionally been found to be essential in preventing re-displacement. Jordan and Westacott found that unless optimum reduction (defined as less 10% residual translation and less 5% of angulation) was obtained, there was a major risk of re-displacement.

In such cases wherever re-displacement may be a high risk, k wire fixation has been recommended as a method to prevent this.²²⁻²⁴ Additionally, three-point moulding of the plaster cast has been shown to have a significant effect on preventing displacement.^{25,26}

In 1995 Choi et al studied that Distal radial fractures are common in children. Recent outcome studies have cast doubt on the success of treatment by closed reduction and application of plaster. The foremost important risk issue for poor outcome is translation of the fracture. If a distal radial fracture is displaced by more than half the diameter of the bone at the fracture site it should be classified as high risk. They performed percutaneous Kirschner-wire pinning on 157 such high-risk distal radial fractures in children under sixteen years of age. The predicted early and late failure rate was reduced from 60% to 14% and only 1.5% of patients had significant limitation of forearm movement of more than 15 degrees in the final assessment at a mean of thirty one months after operation. There have been no cases of early physal closure or deep infection.²⁷⁻²⁹

Use of K wires in pediatric distal radius fractures have been shown to be better than cast immobilization alone.³⁰⁻³² However opinion on when they should be used varies. Proctor et al recommended their use when perfect reduction isn't achieved and Zamzam et al concluded that k wires should be used for all completely displaced radial fractures regardless of reduction.³³⁻³⁵ In our study we tend to determine to place k wire if there's displacement of distal end radius more than the half the diameter of the bone.

Complication rates related to K wire use are extremely variable. Miller et al reported six out of sixteen patients 38% experienced complications such as pin-site infection 13% and pin migration 13%. In a series of 157 patients, Choi et al found pin-site infection recorded in eight patients 5.7% and neuropraxia in two 1.4%.³⁶⁻³⁸

Table 2: Gartland and Werley.³⁹

Variables		0	1	2	3		
Treatment given	Cast	Count	10	0	0	0	10
		%	55.6	0.0	0.0	0.0	33.3
	Closed reduction and k wire	Count	1	5	1	1	8
		%	5.6	55.6	50.0	100.0	26.7
	Closed reduction casting	Count	7	4	1	0	12
		%	38.9	44.4	50.0	0.0	40.0
Total	Count	18	9	2	1	30	
	%	100.0	100.0	100.0	100.0	100.0	

Chi square test, p value - 0.01.

Table 3: Gartland and Werley interpretation.

Score	Result	Number
0 to 2	Excellent	29
3 to 8	Good	1
9 to 20	Fair	0
21 and above	Poor	0

In the current study 1 patient was recorded with superficial pin site infection in second week which were treated with local application of antibiotic and daily pin tract dressing, aside from this there have been no other complication recorded.

CONCLUSION

In this study of management of distal end radius fracture in children with different modality of treatment, we noted that if it is a undisplaced fracture, can be managed with casting. If it is displaced fracture and reduction is achieved, then closed reduction and casting can be done. If displacement is more than 50% of bone diameter then closed reduction and k wire can be done. Limitation of study is small sample size.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

- Hove LM, Brudvik C. Displaced paediatric fractures of the distal radius. Arch Orthop Trauma Surg. 2008;128:55-60.
- Merchan REC. Pediatric fractures of the forearm. Clin Orthop Relat Res. 2005;432:65-72.
- Alemdaroglu KB, Iltar S, Çimen O, Uysal M. Risk factors in re-displacement of distal radial fractures in children. J Bone Joint Surg. 2008;90:1224-30.
- Randsborg PH, Sivertsen EA. Distal radius fractures in children: substantial difference in stability between buckle and greenstick fractures. Acta Orthop. 2009;80(5):585-9.
- Friberg KS. Remodelling after distal forearm fractures in children III, Correction of residual angulation in fractures of the radius. Acta Orthop Scand. 1979;50(6-2):7419.
- 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 Br. 1993;75(5):808.
- 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 Br. 1995;77(5):797-801.
- Randsborg H, Sivertsen EA. Distal radius fractures in children: substantial difference in stability between buckle and greenstick fractures. Acta Orthop. 2009;80(5):585-9.
- Proctor MT, Moore DJ, Paterson JM. Re-displacement after manipulation of distal radial fractures in children. J Bone Joint Surg Br. 1993;75(3):453-4.
- 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 Br. 1993;75(5):808.
- 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 Br. 1995;77(5):797-801.
- Strub WM, Foad SL, Mehlman CT, Crawford AH. Reduction versus remodelling in pediatric distal forearm fractures: a preliminary cost analysis. J Pediatr Orthop B. 2003;12(2):109-15.
- 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;124(3):179-86.
- Zamzam MM, Khoshhal KI. Displaced fracture of the distal radius in children: factors responsible for re displacement after closed reduction. J Bone Joint Surg Br. 2005;87(6):841-3.
- 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(4):4904.
- Hove LM, Brudvik C. Displaced paediatric fractures of the distal radius. Arch Orthop Trauma Surg. 2008;128(1):55-60.
- Randsborg H, Sivertsen EA. Distal radius fractures in children: substantial difference in stability between buckle and greenstick fractures. Acta Orthop. 2009;80(5):585-9.
- Leemput VW, Ridder DK. Distal metaphyseal radius fractures in children: reduction with or without pinning. Acta Orthop Belg. 2009;75(3):306.
- Mazzini JP, Martin JR. Paediatric forearm and distal radius fractures: risk factors and re-displacement role of casting indices. Int Orthop. 2010;34(3):407-12.
- Rijal PR, Shrestha BP, Nepal P, Khanal GP, Karn NK, Singh MP, et al. Randomized controlled trial comparing above- and below elbow plaster casts for distal forearm fractures in children. J Child Orthop. 2010;4(3):233-7.
- Sharma S, Bowe D, Walters SJ, Flowers MJ. Dorsal cortical comminution as a predictor of re-displacement of distal radius fractures in children. Injury. 2011;42(2):173-7.
- Mazzini JP, Beck N, Brewer J, Baldwin K, Sankar W, Flynn J. Distal metaphyseal radius fractures in children following closed reduction and casting: can loss of reduction be predicted. Int Orthop. 2012;36(7):1435-40.

23. Richards, Robin R. Chronic Disorders of the Forearm. *Current Concepts Review*. 1996;78(6):916-30.
24. Larsen WJ. *Human embryology*. 1 edition. 2001: 281-286.
25. Henry G. *Osteology, forearm muscles in Gray's Anatomy* Edt. Williams, Peter L et al., Norwich, Churchill Livingstone; 1989: 410-415.
26. Worlock P, Stower M. Fracture patterns in Nottingham children. *J Pediatr Orthop*. 1986;6(6):656-60.
27. Bae DS, Waters PM. Pediatric distal radius fractures and triangular fibrocartilage complex injuries. *Hand Clin*. 2006;22(1):43-53.
28. Randsborg PH, Sivertsen EA. Classification of distal radius fractures in children: good inter and intra observer reliability, which improves with clinical experience. *BMC Musculoskelet Disord*. 2012;13:6.
29. Light TR, Ogden DA, Ogden JA. The anatomy of metaphyseal torus fractures. *Clin Orthop Relat Res*. 1984;188:103-11.
30. Peterson HA. Physeal fractures: Part 2. Two previously unclassified types. *J Pediatr Orthop*. 1994;14(4):431-8.
31. Peterson HA. Physeal fractures: Part 3. Classification. *J Pediatr Orthop*. 1994;14(4):439-48.
32. Peterson HA, Madhok R, Benson JT. Physeal fractures: Part 1. Epidemiology in Olmsted County M innesota 1979-1988. *J Pediatr Orthop*. 1994;14(4):423-30.
33. Evans EM. Fractures of the radius and ulna. *J Bone Joint Surg Br*. 1951;33(4):548-61.
34. Kalkwarf HJ, Laor T, Bean JA. Fracture risk in children with a forearm injury is associated with volumetric bone density and cortical area (by peripheral QCT) and areal bone density (by DXA). *Osteoporos Int*. 2011;22(2):607-16.
35. Kennedy RM, Porter FL, Miller JP. Comparison of fentanyl/midazolam with ketamine/midazolam for pediatric orthopedic emergencies. *Pediatrics*. 1998;102(4-1):956-63.
36. Ogden JA, Beall JK, Conlogue GJ. Radiology of postnatal skeletal development IV, Distal radius and ulna. *Skeletal Radiol*. 1981;6(4):255-66.
37. Pountos I, Clegg J, Siddiqui A. Diagnosis and treatment of greenstick and torus fractures of the distal radius in children: a prospective randomised single blind study. *J Child Orthop*. 2010;4(4):321-6.
38. Rettig ME, Raskin KB. Galeazzi fracture-dislocation: a new treatment-oriented classification. *J Hand Surg Am*. 2001;26(2):228-35.
39. Gartland JJ, Werley CW. Evaluation of healed Colles' fracture. *J Bone Joint Surg Am*. 1951;33:895-907.

Cite this article as: Gohil P, Jain D, Raut S, Malviya P, Vieira A, Agrawal T. A prospective study of management of distal end of radius fracture in children. *Int J Res Orthop* 2020;6:803-9.