ORIGINAL ARTICLE

Casting Index Predicting Outcome of Paediatric Forearm Fractures

Anil Gupta, Suhail Malhotra, Kanav Padha, Hilal Ahmed

Abstract

Many pediatric forearm fractures can be treated in plaster following closed reduction. The cast index of >0.8 correlates with increased risk of redisplacement. We hypothesize that an acceptable CI is more difficult to achieve and does not predict outcome in fractures of the proximal forearm. Seventy nine cases of pediatric forearm fractures initially treated by manipulation alone over a year were included in this study. The CI was calculated from the post manipulation radiographs. All fractures were divided as either proximal or distal half forearm based on the location of the radius fracture. Subsequent radiographs were reviewed to assess re-displacement and reoperation. The mean CI was 0.77. Remanipulation was required in five cases (6%), all distal half fractures - mean CI 0.79. CI was higher in proximal half forearm fractures (0.83 vs. 0.76, P = 0.006), nonetheless these fractures did not re-displace more than distal fractures.

Key Words

Cast Index, Closed Reduction, Forearm Fracture, Paediatric, Redisplacement

Introduction

Forearm fractures are among the most common childhood fractures after clavicular fractures. Distal radius fractures are among the most common limb fractures in childhood accounting for about 30% of limb injuries (1) while proximal forearm fractures account for about 16-24% of all paediatric forearm fractures (2). The common age group is >5 years with direct trauma to limb being the most common cause. The incidence of these fractures peaks at the time of puberty in both the sexes (3,4). Closed forearm fractures in children are treated with manipulation and immobilisation in a well fitting cast and mostly achieve a satisfactory outcome in a majority of the patients. Fixation is reserved for unstable fractures, failed reductions and complicated cases eg open fractures and compartment syndrome. Distal radius fractures heal satisfactorily and mild to moderate displacement is acceptable as the remodelling potential is great but same can't be said for children over 9 years of age where this potential decreases (4). Redisplacement rates of as high as 25% are there and some recommend fixation of high risk forearm fractures (3,5).

Studies have shown that most important factor in the re displacement of these fractures is the initial displacement of these fractures (3,6,7). Other factors are resolution of oedema in cast, inadequate reduction, poor casting,oblique fractures etc (8).

An important modifiable factor to reduce fracture re displacement is quality of casting which can be measured by casting indices. The first and the simplest one was defined by Chess *et al* (9). It's calculated by measuring the internal AP diameter of the cast at the level of fracture and dividing it by the internal lateral diameter of the cast (both diameters exclude the padding width). An ideal CI ratio was defined as 0.7 but latest studies conclude that a CI of > 0.8-0.84 carries a significant risk of re displacement signifying a poorly moulded cast (10,11).

Due to the greater amount of tissue pressure in proximal forearm as compared to distal forearm an ideal CI of 0.8 is more difficult to achieve following closed reductions. These fractures are more circular than elliptical in axial section than distal forearm and hence the difficulty in moulding a cast.

From the Department of Orthopedics, Govt. Medical College Jammu- J&K India

Correspondence to : Dr Anil Gupta, Associate Professor, Deptt of Orthopedics, Govt. Medical Colloge, Jammu -J&K- India

Materials and Methods

All patients were under the age of 16 years and underwent closed reductions with subsequent casting . The fractures included fractures of the radius (with or without ulna) . The patient data was collected over a period of 6 months. All fractures were examined radiographically before and after reduction. The casting material was plaster of Paris and casts with an above elbow extension were put on with the elbow flexed to 90 degrees and forearm in neutral position. A uniform layer of padding was put on with a 50% overlap and the POP bandages of 4 inches and 6 inches diameter were used with 33% overlap. All the cases were treated in the emergency department of our hospital. All patients were followed up in 1 week time and subsequently followed up every 2 weeks. The CI was calculated using the computerised systems available for the DICOM system on the digital images procured. The fracture fragment lengths too were calculated using the same system. The CI was calculated by orthopaedic trainees and radiology trainees separately and then compared to detect any interobserver error. The original radiographs were then analysed again by the orthopaedic trainee at end of 6 months to detect any intra observer error or bias.

The Cast Index was calculated as a ratio of internal cast AP diameter and lateral diameter excluding the padding as described by Chess et al. Both measurements were taken at the level of the radius fracture site. This is a validated index and the ideal CI was taken as 0.8 or less. All fractures were subsequently categorised as proximal or distal by dividing the length of the distal radial fragment with that of entire radius. The resultant values ranged from 0(distal) to 1(proximal) . The fractures with a ratio of < 0.5 were grouped as distal and those with ratio of >0.5 were grouped as proximal. The measurements were made from proximal radio-ulnar joint proximally to wrist joint distally.

The data was analysed using Microsoft Excel. The variable was fracture position and outcome was CI and re manipulation due to re displacement. t - tests and Chi-square tests were used.

Results

79 cases (47 males and 32 females) between ages 2 to 16 were included. 15 were excluded due to incomplete follow up. The mean CI was 0.77 . The mean fracture position was 0.25 , that is, the distal radial fragment was just over a quarter of the total bone length . 6 cases in total were re manipulated . Mean follow up time was every 2 weeks and mean time to Union was 11 weeks. The inter and intra observer bias was very less and CI could be reproduced reliably. In the re displacement cases the displacement reoccurred at 2-3 weeks after re manipulation . No significant variations were found once the fractures were grouped age wise with the only difference being that the older children tend to have more distal fractures. On summarising the results with fractures grouped in proximal or distal halves of the forearm, it was found that patients with proximal forearm fractures tend to lie in an older age bracket and had concurrent ulna fracture. However the fact that there was a proximal ulna fracture did not mean it would re displace . There was no significant difference in re angulation of fractures, other fracture characteristics or patient demographics.

Discussion

A risk of closed reduction is re displacement post reduction. Closed reduction with K-wire fixation is reserved for cases with high risk of redisplacement post reduction at our hospital. Both K wires and elastic nails are accepted forms of treatment here. The position of the elbow in supination, mid pronation and pronation were

Table 1. Showing the Fracture Detail of Study Population

	Fracture position (distal forearm)	**Fracture position (proximal forearm)**
Numbers.	66.	13
Male/female.	41/25.	6/7
Mean age(Yrs).	6.	9
Initial displacement.	20.	24
Mean CI.	0.76.	0.83
Ulna fracture	25.	12
Re operation.	6.	0

Table 2. Showing Dimensions and Statistical Correlation

Initial CI. (ortho).	**Initial CI. (Radio).**	**Re measurement (At 6 M ; ortho)**
0.62.	0.63.	0.63.
0.69.	0.69.	0.69.
0.78.	0.77.	0.81.
1.00.	1.00	0.98
0.89.	0.85.	0.84
0.83.	0.78.	0.79
0.83.	0.8.	0.83
0.58.	0.57.	0.59
0.66.	0.71.	0.69
0.78.	0.77.	0.75
Mean error (SD%).	2.76.	3.09
Correlation value	0.978.	0.979

thought to be important for stabilising the reduced fracture in the past for proximal,mid and distal forearm fractures respectively but recent research contradicts any such theory and hence the position of neutral position was used throughout the study (12,13). Significant risk factors for loss of reduction can be divided into fracture related ,surgeon related and patient related8. The most important ones being initial displacement of fracture,near anatomical reduction and closed fitting cast. Many studies have shown an increased risk of redisplacement in combined fractures of both radius and ulna (13). The most important factors for adequate fracture reduction and casting are thin uniform padding and good moulding technique to achieve a proper three point fixation (14). A previous study too found out that the knowledge about st indices and hence the knowledge of redisplacement helped the surgeons perform a better reduction and predict failure rates (15). Clearly, these indices need to be used in association with patient and fracture characteristics in clinical assessment.

Though it's more difficult to achieve a CI of <0.8 in proximal forearm fractures still this doesn't cause a significant loss of reduction and thus no need for remanipulation. There is more soft tissue proximally and hence a more elliptical cast is difficult to achieve. Although in case of distal fracture a CI of < 0.8 dictated a predictable good result and a CI of > 0.8 predicted a future loss of reduction. A less elliptical forearm cast with a higher CI although may still provide an adequate three point fixation. Proper moulding techniques were applied to both distal and proximal forearm fracture and it is the shape of the proximal forearm that doesn't allow the CI to be achieved although the loss of reduction in this area didn't correlate as well as distal forearm. Inter and intra observer bias and errors were low and suggest that the CI can be used as practical approach to the management of these fractures in day to day casting techniques. It still stands true that low CI were difficult to achieve in proximal forearm yet none had to be re operated .

Conclusion

Cast index remains a useful clinical tool to rapidly assess cast molding following closed reduction of distal forearm fractures and to predict redisplacement of distal forearm fractures as highlighted in multiple previous studies. Its use in proximal half forearm fractures should be discouraged, however, as the shape of the proximal forearm makes it difficult to achieve an acceptable CI of <0.8 despite adequate molding and a higher CI in the proximal forearm does not predict the risk of redisplacement or re-manipulation.

References

1. Cheng JC, Shen WY. Limb fracture pattern in different pediatric age groups: A study of 3,350 children. *J Orthop Trauma* 1993;7:15-22
2. Carson S, Woolridge DP, Colletti J, Kilgore K. Pediatric upper extremity injuries. *Pediatr Clin North Am* 2006;53: 41-67
3. Zamzam MM, Khoshhal KI. Displaced fracture of the distal radius in children: Factors responsible for redisplacement after closed reduction. *J Bone Joint Surg Br* 2005;87:841-3.
4. Hove LM, Brudvik C. Displaced paediatric fractures of the distal radius. *Arch Orthop Trauma Surg* 2008;128:55-60.
5. Garg NK, Ballal MS, Malek IA, Webster RA, Bruce CE. Use of elastic stable intramedullary nailing for treating unstable forearm fractures in children. *J Trauma* 2008;65:109-15.
6. Proctor MT, Moore DJ, Paterson JM. Redisplacement after manipulation of distal radial fractures in children. *J Bone Joint Surg Br* 1993;75:453-4.
7. Alemdarolu KB, Iltar S, Cimen O, *et al*. Risk factors in redisplacement of distal radial fractures in children. *J Bone Joint Surg Am* 2008;90:1224-30.
8. Pretell Mazzini J, Rodriguez Martin J. Paediatric forearm and distal radius fractures: Risk factors and redisplacement - Role of casting indices. *Int Orthop* 2010;34:407-12.
9. Chess DG, Hyndman JC, Leahey JL, *et al*. Short arm plaster cast for distal pediatric forearm fractures. *J Pediatr Orthop* 1994;14:211-3.
10. Bhatia M, Housden PH. Redisplacement of paediatric forearm fractures: Role of plaster moulding and padding. *Injury* 2006;37:259-68.
11. Debnath UK, Guha AR, Das S. Distal forearm fractures in children: Cast index as predictor of re-manipulation. *Indian J Orthop* 2011;45:341-6.
12. Boyer BA, Overton B, Schrader W, Riley P, Fleissner P. Position of immobilization for pediatric forearm fractures. *J Pediatr Orthop* 2002;22:185-7.
13. 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 Am* 2006;88:1-8.
14. Voto SJ, Weiner DS, Leighley B. Redisplacement after closed reduction of forearm fractures in children. *J Pediatr Orthop*1990;10:79-84.
15. Singh S, Bhatia M, Housden P. Cast and padding indices used for clinical decision making in forearm fractures in children. *Acta Orthop*2008;79:386-9.