Evaluation Of Cast Index In Predicting The Outcome Of Pediatric Forearm Fractures

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Abstract

Background: Pediatric forearm fractures of radius ulna account for 40% of all pediatric fracture. Closed reduction followed by application of well molded plaster cast is the standard treatment for these fractures, which can be complicated by re-displacement inside the cast, which further needs re-manipulation or surgery. We assessed the rate if re-displacement in paediatric forearm fractures treated by cast by calculating the cast index.

Material & Methods: 30 patients with fractures of both radius ulna were treated with close reduction and cast application and Cast Index was calculated in immediate post reduction and subsequent radiographs at 2, 4 and 6 weeks. These were evaluated for re-displacement and their relation with cast index.

Results: The mean CI was found to be 0.858. Three patients had re-displacement which required re-manipulation, the mean CI in these re-displacement group was 0.92. Mean CI was found to be higher in proximal third fractures however it did not correspond to increased incidence of re-displacement.

Conclusion: Our study provides sufficient association of cast index in predicting the outcome of pediatric forearm fractures. Higher CI in proximal third fracture didn't correspond to increased incidence of re-displacement.

Keywords: Forearm fracture, Cast index, Re-displacement

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Introduction

Paediatric forearm fractures are amongst the most common injuries encountered in childhood which makeup 40% of all pediatric fractures [1]. Amongst fractures of forearm i.e. radius-ulna fractures, fractures occur in distal third in 60%, 20% occurs in middle third, 14% in distal physis and approximately 4% in proximal third of radius ulna [2].

Closed reduction followed by application of well molded plaster cast is the standard treatment for pediatric forearm fractures, whereas operative treatment is reserved for unstable fractures, failure to achieve closed acceptable reduction and open fractures or those associated with compartment syndrome [3-5]. Loss of fracture reduction, re-displacement or late displacement is the most common complication of manipulated forearm fractures & cast application, which also may need surgery [6-9]. The cast index (CI) is a simple and quick method of predicting the re-displacement after cast application in radius ulna fractures in paediatric patients, particularly distal radius fractures [10]. Ideal cast index is 0.7 or less for distal radius ulna fractures for reduced risk of re-displacement,

whereas a cast index of 0.8-0.84 is associated with significant risk of subsequent re-displacement [2,3,9]. Hence we conducted this study to predict the re-displacement in forearm fractures at all levels by calculating of cast index.

Material and Methods

The study was a prospective series conducted at our center in 30 cases of paediatric fracture forearm by calculating the cast index and correlating it with re-displacement rate. The study was approved by the institutional ethical committee and written informed consent from the guardian was taken before including them in the study.

All children between 2 – 12 years of age with close fracture of both radius ulna were included in study. Patients less than 2 years or more than 12 years, single bone forearm, open, pathological, segmental or intra-articular fractures were excluded from study.

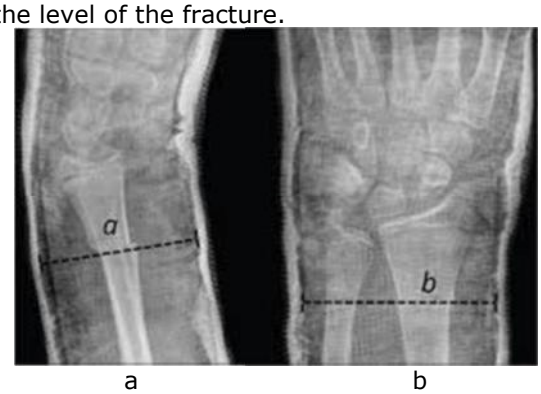
All case included in the study, were given initial symptomatic treatment with slab, Ice fomentation and limb elevation for 3 to 5 days for decreasing the swelling. When swelling subsided, under supine position under short general anaesthesia, the fracture was manipulated and closed reduced to anatomical position under image intensifier guidance. Once proper acceptable reduction was achieved, an above elbow plaster of paris cast was applied after sufficient uniform padding with elbow flexed to 90^0 with forearm in supination for proximal third fracture and mid prone position for all other fractures (table 1) [1].

Table 1 . Acceptable criteria for forearm fractures

Age (years)	Saggital plane (in degree)	Frontal plane (in degree)
4-9	**20**	**15**
9-11	**15**	**5**
11-13	**10**	**0**
>13	**5**	**0**

After the plaster had dried up, true antero-posterior and true lateral radiograph were taken and cast index was calculated using software 'IMAGEJ'. Cast index is calculated by measuring the internal anterio-posterior (AP) diameter of the cast (excluding padding) at the level of the fracture taken on lateral view and dividing it by the internal medio-lateral diameter of the cast (excluding padding) taken on AP view (fig 1). Both measurements are made on the first proper radiograph taken after closed reduction [10].

Fig 1. Calculation of cast index by measuring internal anterio-posterior (AP) diameter on true lateral view (a) and internal medio-lateral diameter on true AP view (b) of the cast (excluding padding) at the level of the fracture.



a b

Post reduction all patients were advised light finger grip and finger extension exercises along with analgesics. Patients were followed up regularly at 2, 4 and 6 weeks after cast application and radiographs were obtained in true antero posterior and true lateral views at each visit and were assessed for re-displacement as well as cast index was calculated. Patients showing re-displacement were re-manipulated under image intensifier guidance and still not having satisfactory reduction were considered for intramedullary nailing. Cast removal was done at 6 weeks when radiological callus bridging three cortexes was seen. Functional outcomes such as final range of motion were not studied.

Results

A total of 30 cases of both bone forearm fracture with mean age 7.06 year (range 2 to 12 year) were included. 17 were male and 13 were female. Mean follow period in study was 7.2 weeks (6 to 12 week). The fracture was seen at proximal, middle and distal third forearm in seen in 6, 15 and 9 cases respectively. The mean cast index of all the cases was 0.858 (range 0.65 to 1.004). The mean cast index in proximal, middle and distal forearm was 0.92, 0.86 and 0.80 respectively. Re-displacement was seen in only 3(10%)

cases with cast index of 0.75, 0.97 and 1.004 and the mean cast index in these re-displacement cases was 0.908 (range 0.75 to 1.004) (fig 2). This re-displacement was seen in one case of distal forearm fracture and two cases were in middle forearm fracture (table 2). The change in cast index at 2, 4 and 6 weeks was not significantly different. Nonunion was seen in only in one case, which was treated surgical with intramedullary nailing, the mean cast index in this case was 1.002

Fig 2. A three year child with both bone forearm fracture pre reduction x rays lateral (a) & AP (b) view, showing cast index of 0.97 after reduction in immediate post reduction in lateral (c) & AP (d) view. Lateral (e) and AP (f) x rays in 4 week follow show displacement, which was treated by intramedullary nails (g & h).

Table 2. Mean cast index at proximal, middle and distal third forearm level

Site of Fracture	No. of Cases	Cast Index	Re-displacement	Non Union
Proximal third	6 (20%)	0.92 (0.82-1.004)	-	1
Middle third	15 (50%)	0.86 (0.7-1.0)	2	-
Distal third	9 (30%)	0.806 (0.65-0.91)	1	-

Discussion

Paediatric forearm fractures are one the common childhood injuries. 80% of these fractures occur in children > 5 years of age with usual mode of injury being direct trauma to upper limb or by fall. The incidence peaks at 9–12 years in girls and 12–15 years in boys [2].

Standard treatment of these fractures is close reduction, manipulation and attaining acceptable reduction followed by application of well molded above elbow cast to maintain the alignment [1-3]. When acceptable reduction cannot be achieved and maintained by closed means operative management is required [4,6-9]. Although anatomical reduction is desirable for all fractures, some degree of angulation is acceptable in these fractures largely due to inherent ability of pediatric bone to remodel (table 1) [1].

Maintenance of reduction requires application of a well molded plaster cast with a thin uniform padding so as to achieve 3 point fixation. Even after this re-displacement remains the most common complication after cast application, which may require further manipulation or surgery. Cast index is simple and easily reproducible predictor of re-displacement in cast for forearm fractures that may further require re-manipulation calculated by just measuring internal diameter of the cast in true lateral radiograph divided by internal diameter of cast in true anterio-posterior radiograph taken in immediate post reduction x-ray [2,3].

We studied 30 paediatric patients of both bone forearm fractures from age 2 to 12 years with mean age of 7.06 years, who were treated with closed reduction and above elbow cast, and were assessed for rate of re-displacement and correlated it with cast index. The mean cast index in our study was 0.859 (range 0.65 to 1.004). The mean cast index for proximal, middle and lower third levels was 0.92, 0.86 and 0.80 respectively. This higher cast index in proximal third fracture, like other studies is due to increased muscular cover seen in proximal forearm and difficult to achieve an elliptical cast molding as compared to distal third [3].

Owing to the increased muscular cover in proximal and middle third forearm, use of cast

index as a predictor of outcome is favored for distal forearm fractures only, but we tried to include all levels of fractures of both bone forearm (proximal, middle or distal) for prediction of re-displacement rate. The reported rate of displacement is 7%-25% [3]. Re-displacement in our series was seen in only 3 (10%) cases with cast index of 0.75, 0.97 and 1.004 and the mean cast index in these re-displacement group was 0.908 (range 0.75 to 1.004). Re-displacement was in one case of distal forearm fracture and two cases were of middle forearm fracture. This showed that the re-displacement rate is not associated with the level of fractures, but is directly proportional to cast index i.e. higher the cast index higher is the chance of re-displacement. The cut-off level of cast index as given by Sheikh et al was 0.77 for re-displacement and 0.92 for second procedure by Debnath et al, whereas in our study this level was 0.85 [2,3]. The probable reason for this difference may be difference in padding material used by us compared to their study. Further our study is limited by lesser number of patients.

Ali Turgut et al associated cast index of less than 0.775 with tight cast syndrome and cast index more than 0.875 with loss of reduction. They recommended a cast index between 0.775 and 0.875 to prevent both tight cast syndrome as well as loss of reduction [11]. However in our study no patient complained of tight cast even with cast index of less than 0.775.

Conclusion

Cast index can help in predicting the outcome of pediatric forearm fractures and the chance of re-displacement, higher cast index is associated with higher chance of re-displacement in cast. The higher mean cast index proximal third fracture, owes to increased muscular in proximal forearm and it doesn't correspond to increased incidence of re-displacement.

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