Immobilisation of forearm fractures in children

EXTENDED VERSUS FLEXED ELBOW

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Redisplacement of unstable forearm fractures in plaster is common and may be the result of a number of factors. Little attention has been paid to the influence of immobilisation with the elbow extended *versus* flexed. We prospectively treated 111 consecutive children from two centres with closed forearm fractures by closed reduction and casting with the elbow either extended (60) in China or flexed (51) in Israel. We compared the outcome of the two groups. There was no statistically significant difference in the distribution of the age of the patients, the site of fracture or the amount of angulation and displacement between the groups. During the first two weeks after reduction, redisplacement occurred in no child immobilised with the elbow extended and nine of 51 children (17.6%) immobilised with the elbow flexed. Immobilisation of unstable forearm fractures with the elbow extended appears to be a safe and effective method of maintaining reduction.

Fracture of a forearm bone is the most common type of fracture in children. Displaced or angulated fractures frequently require reduction and immobilisation in an above-elbow plaster cast. Redisplacement is common and may result from a number of factors.¹⁻³

Little attention has been paid to the effect on fracture stability after closed reduction of immobilisation with the elbow flexed or extended.^{4,6} Recommendations for immobilisation have been based on theory, experience and tradition.¹ This prospective study was designed to compare the outcome of forearm fractures immobilised with the elbow extended or flexed.

Patients and Methods

Between March 2002 and May 2003, we studied 111 children with closed fractures of the radius, ulna or both who underwent closed reduction in two centres. We excluded children with open fractures, fracture-dislocations, and growth plate fractures.

The patients were divided into two groups. We treated 60 consecutive children (44 boys and 16 girls), with a mean age of seven years (3 to 12) by immobilisation with the elbow extended at Shanghai Children's Medical Center in China. We treated 51 consecutive children (44 boys and seven girls), with a mean age of eight years (3 to 12) by immobilisation with the elbow flexed at Schneider Children's Medical Center in Israel (Table I).

In the extended-elbow group, 36 fractures were on the right side and 24 on the left; 25% involved the radius, 8% the ulna, and 67% both. Of the fractures, three (5%) were located in the proximal third of the bone, 25 (41%) in the midshaft (mean age 5.5 years (3 to 12)), and 32 (54%) at the distal end (mean age 8.8 years (3 to 12)). In the flexed-elbow group, 29 fractures were on the right side and 22 on the left; 11 (22%) involved the radius, one (2%) the ulna, and 39 (76%) both. There was one (2%) in the proximal third of the bone, 27 (53%) in the midshaft (mean age 7.4 years (3 to 12)), and 23 (45%) at the distal end (mean age 8.7 years (3 to 12)) (Table I).

In the extended-elbow group, there were 21 (35%) greenstick fractures with an angulation of more than 15° and 39 (65%) complete fractures with displacement. In the flexed-elbow group, there were 20 (39%) greenstick fractures with an angulation of more than 15° and 31 (61%) complete fractures with displacement (Table I).

Management. Diagnostic anteroposterior (AP) and lateral radiographs were taken in all patients. In both groups, reduction was performed according to previously published methods.^{3,5}

In the extended-elbow group, reduction was performed in the emergency room in 43 patients under sedation. Reduction was confirmed radiographically, and if the findings were not satisfactory, the procedure repeated

Table I. Details and management of the two groups

	Extended-elbow (n = 60)	Flexed-elbow (n = 51)	p value
Age in yrs (range)	7 (3 to 12)	8 (3 to 12)	0.115
Gender			
Boys (%)	44 (73)	44 (86)	0.1099
Girls (%)	16 (27)	7 (14)	
Side of fracture			
Right (%)	36 (60)	29 (57)	0.8470*
Left (%)	24 (40)	22 (43)	
Bone involved			
Radius (%)	15 (25)	11 (22)	0.275†
Ulna (%)	5 (8)	1 (2)	
Both (%)	40 (67)	39 (76)	
Site of fracture			
Proximal end (%)	3 (5)	1 (2)	0.400†
Midshaft (%)	25 (41)	27 (53)	
Distal end (%)	32 (54)	23 (45)	
Type of fracture			
Greenstick (%)	21 (35)	20 (39)	0.6958*
Complete (%)	39 (65)	31 (61)	

* Fisher's exact test

† chi-squared test

under general anaesthesia with the aid of an image intensifier. We treated 17 children in the extended-elbow group from the start under general anaesthesia.

In 22 children in the flexed-elbow group, reduction was performed in the emergency room under local anaesthesia using an intrahaematoma injection of lidocaine 1% and confirmed by radiographic examination. If the reduction was unsatisfactory, it was repeated under general anaesthesia. The remaining 29 children were treated from the start under general anaesthesia with the aid of an image intensifier.

An above-elbow plaster cast was applied over cast padding, with the elbow in extension or flexion and with the forearm in the most stable position of rotation. AP and lateral radiographs were taken one and two weeks after reduction. If there was no further displacement, the cast was removed at four to six weeks, and a radiograph taken to confirm healing. Clinical examination was repeated three months after removal of the cast to assess movement of the elbow and forearm.

Self-help and writing ability were assessed during immobilisation to compare the extended and flexed positions of the elbow. After two weeks of cast immobilisation, the children were asked to eat with a spoon or chopsticks, take off a shirt, and write a three-word sentence unaided. Cast fit was assessed by examination of the radiograph after reduction.

The data were recorded on a Microsoft Excel file (Microsoft Corp, Redmond, Washington) and submitted for independent statistical analysis with the Fisher's exact test and chi-squared test.

Results

There were no significant differences between the groups in mean age ($p = 0.115$), gender distribution ($p = 0.1099$),

involved hand ($p = 0.8470$), and involved bone ($p = 0.275$) (Table I). In the extended-elbow group, 21 (35%) of the children presented with greenstick fractures $> 15^\circ$ of angulation and 39 (65%) with complete, displaced fractures. The corresponding incidence in the flexed-elbow group was 20 (39%) and 31 (61%); neither of these differences was statistically significant ($p = 0.6958$). The distribution of the site of fracture was also similar in the two groups ($p = 0.400$) (Table I).

No redisplacement occurred in the extended-elbow group, and all healed uneventfully.

During the first two weeks after reduction, nine patients (17.6%) in the flexed-elbow group presented with redisplacement of the fracture, defined as an angulation of $> 15^\circ$ on the follow-up radiograph. Three had redisplacement in the midshaft (age 5, 6, 12 years) and six at the distal end (mean age 8.3 years (6 to 12)). Six of these patients had complete fractures of the radius and ulna (three midshaft, three distal end), two had complete fractures of the radius (distal), and one had a greenstick fracture of the radius and ulna (distal). All the patients whose fractures redisplaced showed minimal displacement with or without angulation of up to 5° on the immediate radiograph after reduction. Treatment consisted of repeat reduction under general anaesthesia. The mean time between fracture and remanipulation was 11 days. All fractures were still mobile at this stage. In all cases, healing with good alignment was obtained.

There was no cast slippage in either group. Radiographs of the redisplaced fractures showed adequate cast fit.

In the first three months after removal of the plaster cast a full range of elbow movement and forearm rotation was regained in both groups. All children required help with activities of daily living during cast immobilisation, regardless of whether the elbow was extended or flexed.

Discussion

In this study immobilisation of forearm fractures with the elbow extended produced better results than with the elbow flexed. Similar results were published in three previous studies of forearm fractures treated by immobilisation with the elbow extended;⁴⁻⁶ redisplacement was noted in only one patient. By contrast, Waters³ reported a 30% redisplacement rate after reduction and immobilisation of distal forearm fractures with the elbow flexed.

Several factors may contribute to the stability of the fracture after reduction such as age, bone involved, the site of the fracture and the initial angulation and displacement. All of these were similar in the two groups in our study. The role of age remains controversial.^{2,3} Waters³ claimed that the risk of loss of reduction increased with age, whereas Haddad and Williams² found no discernible relationship between redisplacement and age. In this study, the mean age of those with redisplacement of the fracture was the same as for the whole group with distal forearm fractures, whether immobilised with the elbow extended or flexed.

Furthermore, two of the three children whose midshaft fractures redisplaced were aged five and six years, which is close to the mean age of the children who presented with a midshaft fracture in the extended-elbow group, in which no redisplacement occurred. These findings suggest that age difference between the groups did not contribute to the different rates of redisplacement.

Boyer et al¹ claimed that in children with distal-third forearm fractures, the position of immobilisation did not significantly affect the residual angulation at the time of union. In this study, the most stable position of reduction of the forearm (neutral, supine, prone) was determined by the attending resident. Although application of the cast may lead to redisplacement, in both our centres, fracture reduction and plaster application were performed by experienced residents. Radiographs of the redisplaced fracture showed that the casts had been satisfactorily applied.

A nonanatomical alignment on the initial post-reduction radiograph is also a high risk factor for redisplacement.² In this series, the post-reduction radiographs showed only minimal residual displacement with < 5° angulation in all children with redisplaced fractures. This degree of displacement is acceptable and warrants only weekly radiographic follow-up during the first few weeks, as was done in this study.⁷

Some authors claim that immobilisation of the elbow in extension may cause stiffness, whereas others have found no such association.⁴⁻⁶ In the present study, all patients regained a full range of elbow movement within three months of removal of the cast.

The application of a plaster cast with the elbow extended is easy and, in our opinion provides better mechanical immobilisation of the fracture, thereby avoiding redisplacement.

Walker and Rang⁶ suggested that despite the advantages of maintaining unstable fractures in plaster casts with the elbow extended, this position is awkward for patients, and therefore advised the use of the flexion position. However, Shaer et al,⁵ found that children quickly adapt to the extended position. In this series, immobilisation with either an extended or flexed elbow interfered with daily activities and children in both groups required help with eating and dressing, and none could write a sentence easily.

We conclude that immobilisation of forearm fractures with the elbow extended is a safe and effective method for maintaining reduction.

Supplementary Material

A further opinion by Miss Deborah Eastwood is available with the electronic version of this article on our website at www.jbjs.org.uk

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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