Ulnar plating for the treatment of unstable fractures of the forearm in children

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Different methods of internal fixation are used to treat unstable forearm fractures in children. Results of single bone fixation are comparable to those with both bone fixations with a lesser morbidity.

Eighteen skeletally immature patients with unstable forearm fractures were treated by ulnar plating. There were 13 boys (72.3%) and five girls. The mean age was 10.7 years at the time of injury. Three children (16.6%) had open fractures. The follow-up ranged from 14 to 46 months (mean 27.7 months).

All fractures healed in an average time of 11.4 weeks. Seventeen patients had either excellent or good functional results. Three patients had a loss of ≤ 15° of pronation and another patient had a loss of 25° of pronation and ≤ 15° of supination. One patient had an early superficial infection resolved with antibiotics. No child complained of any limitation in activities of daily living and all could participate in strenuous activities.

We conclude that ulnar plating is a good management policy for unstable forearm fracture in children with a satisfactory functional outcome, less morbidity and fewer complications.

Keywords : forearm fracture ; children ; ulnar plating.

INTRODUCTION

In young children with forearm fractures, significant residual displacement or angulation and a lesser amount of malrotation predictably remodel owing to the remodeling capabilities of the immature bone (*4,6,9,13*). In children older than 8 years, residual deformity often fails to remodel and may contribute to loss of motion and a poor functional outcome (*1,4,6,10,16,18,25*). When acceptable closed reduction cannot be obtained or maintained, surgical intervention may be necessary (*29*).

Open reduction and stabilization of unstable pediatric forearm fractures with either plates or intramedullary devices remains controversial because of potential associated complications (*29*).

There is a paucity of literature regarding the complications and disability of open reduction and internal fixation of forearm fractures in children (*29*). Operative methods of stabilization in children include percutaneous pins and plaster (*28*), intramedullary nailing (*20,27*) and compression plates (*11,23*).

Reported results of either single or both bone fixations with different methods were encouraging (*3, 12,19*).

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We report our results with single bone plating of unstable diaphyseal fractures of both bones of the forearm in skeletally immature patients.

PATIENTS AND METHODS

We report 18 unstable diaphyseal forearm fractures in 18 skeletally immature patients. All were complete fractures. The radial fractures were located in the mid-shaft in 10, in the proximal third in 6 and in the distal third in two patients, whereas the ulnar fractures were located in the mid-shaft in 14 and in the proximal third in 4 patients. There were 13 boys (72.3%) and 5 girls with the right forearm involved in 12 patients (66.7%). The mean age at time of injury was 10.7 years (range, 8 to 14 years). Fifteen fractures were closed and three were open ; two of the open fractures were grade one according to Gustilo and Anderson (14) and their wounds overlayed the ulna alone. The third open fracture was grade two. The identified mechanism of injury is shown in table I.

Initially all patients with closed fractures had closed reduction under general anaesthesia. If an acceptable reduction could not be obtained or maintained, open reduction was performed. Open fractures were considered unstable and were treated by immediate surgical debridement and fixation.

Reduction was considered unacceptable when there was an angular deformity of the radius or ulna of > 10 degrees or > 50% translation at the fracture site plus angulation.

All patients had the ulnar fracture stabilized through a dorsal approach by use of an AO small fragment set and a 3.5 mm dynamic compression plate following the principles of the AO group. An above-elbow plaster cast was applied for 6 weeks after which the patient was referred to physiotherapy.

At follow-up, patients were evaluated for range of motion of wrist, elbow and forearm using a goniometer

as described by Roberts (25). Forearm pronation / supination was isolated from radiocarpal rotation and measured in relation to the uninvolved arm.

The status of wound healing and neurovascular integrity was assessed. Subjective assessment included : residual pain and functional disabilities related to weakness or stiffness. Functional results were graded according to the criteria proposed by Daruwalla and Price *et al* (8, 24) with the modification of Bhaskar and Roberts (3).

Standard radiographs were evaluated for alignment ; angulation was measured on radiographs using the greatest deformity seen on the AP and lateral views (2).

Children were followed-up until they reached either the clinical end point of a healed fracture with full normal function or stable clinical function that neither improved nor worsened with subsequent growth.

RESULTS

All patients have been reexamined and followed up to the clinical end point. The mean follow-up was 27.7 months (ranging between 14 and 46 months). The mean tourniquet time for fixation was 38 minutes (range, 30 to 55 minutes). Fracture healing was assessed radiologically and clinically. All fractures healed. Neither nonunions nor malunions were reported. The average time to union was 11.4 weeks (range, 8 to16 weeks).

At the end of follow-up, range of motion showed no significant loss in elbow and wrist movement. Pronation was affected more than supination, the mean value of pronation was 81.4° compared with a mean of 93.6° for the uninvolved arm, whereas the mean value of supination was 95.2° compared with a mean of 100° for the uninvolved arm.

Three patients had a loss of ≤15° of pronation (fig 1) and another patient had a loss of 25° of pronation and ≤15° of supination (grade two open fracture of both forearm bones).

The mean radiographic angulation was 5.8° (0° to 13°) in the AP view and 3° (0° to 7°) in the lateral view.

One patient (grade two open fracture both forearm bones) developed a postoperative superficial infection resolving with antibiotics, later he complained of an unsightly scar of more than 5 mm wide after plate removal.

Table I. — Mechanism of injury

Mechanism of injury	No.	%
Fall on the outstretched arm	7	38.9
Sports injury	6	33.3
Run over accident	3	16.7
Motor car accident	1	5.6
Fall from height	1	5.6

Fig. 1. — 11-year-old boy with ulnar plating. Plate removed with complete remodeling at end of follow-up (38 months). Good functional result.

Fig. 2. — 13-year-old boy with ulnar plating, plate removed with complete remodeling at end of follow-up (30 months). Excellent functional result.

The functional results were graded as fair in one patient, good in four and excellent in thirteen (table II). No child complained of any limitation in activities of daily living and all could participate in strenuous activities (fig 2).

At end of follow-up 11 patients had their plate removed as a routine procedure. No case of refracture after plate removal was reported.

DISCUSSION

Diaphyseal fractures of the forearm bones are the third most common fractures in the child's upper extremity (*22*). The current standard of care for the vast majority of these fractures in children is closed reduction and casting (*12*). Remodeling capabilities of fractured forearm bones in children

Table II. — Functional results according to the criteria of Daruwalla (8)

Outcome	Symptoms	Loss of forearm rotation	No.	%
Excellent	No complaint with strenuous physical activities	< 15°	13	72.2
Good	Mild complaint with strenuous physical activities	15 to 30°	4	22.2
Fair	Mild complaint with daily activities	30 to 90°	1	5.6
Poor	All other results		0	0

are often unpredictable (29). However, the amount of angulation or rotational deformity or both that can be accepted with closed treatment of forearm fractures remains controversial. Most consider an angular deformity of > 10°, rotational deformity of > 40° and complete displacement unacceptable (4,13,18,24).

For fractures involving the distal third of the forearm, Hughtson (16) stated that angular deformities of 30°-40° in patients younger than 10 years would adequately remodel, whereas, Cooper (5) thought that ≤ 20° would adequately remodel. Fuller and McCullough (13) advised accepting ≤ 20° of angulation in children younger than 14 years for distal fractures. Daruwalla (8) concluded that angular deformities of ≥ 10° in the midshaft or proximal forearm would not remodel. Matthew et al (21) reported that an angulation of < 10° caused no loss of rotation. Open fractures are unstable by their nature and early stabilization facilitates soft tissues management and healing (29).

Nielsen and Simonsen (23) disregarded the age when making their treatment decisions because children younger than 10 years of age can also fail to correct large deformities. So, treatment of forearm fractures is generally age-dependent and must be individualized.

The failure rate for closed management of paediatric both bone forearm fractures could range from 1.5% to 31% (18,20,27,28). Indications for operative intervention in paediatric forearm fractures include : open fractures, unstable fractures, irreducible fractures, inability to maintain reduction in a cast and pathologic fractures (4,13, 15,16,18,24,27).

All children in this series, regardless of age or deformity were treated with at least one attempt to closed reduction. The decision to employ internal fixation was made when adequate alignment could not be obtained or maintained.

The types of operative stabilization advocated for these fractures include plating, intramedullary elastic nailing and intramedullary K-wire fixation. Each type of fixation has its merits and disadvantages. Apart from the choice of stabilization technique, the second important decision in the operative management of paediatric forearm fractures is the number of bones to be stabilized. There have been several reports on the excellent outcome of managing diaphyseal fractures of both forearm bones by single bone fixation (3,12,19,30).

Plating both forearm bones allows a perfect anatomical reduction and assures maintenance of both angular and rotational alignment. Unfortunately, it is the most invasive technique to stabilize a fractured forearm in a child, with increased morbidity and risk of complications.

Cullen et al (7) reported 18 complications in 10 of the 20 patients included in their study using intramedullary nailing for paediatric forearm fractures, though they reported excellent results in 17 and good in two patients. These complications included hardware migration, infection, loss of reduction, reoperation, synostosis, significant reduction of range of motion, muscle entrapment and delayed union. This may reflect the fact that intramedullary nailing had a high morbidity rate although the final functional results were excellent.

Fernandez et al (11) concluded that both plate and intramedullary fixation will provide

worthwhile functional results in treatment of unstable forearm fracture in children.

Bhaskar and Roberts (*3*), in their comparative study reported complications in 40% in patients who were treated by plating of both bones compared with no complication in those patients who had ulnar plating only. Biomechanical data have been published which suggest that ulnar plating alone can provide adequate stability when both forearm bones are fractured (*17*). Ulnar fixation alone restores the length of the forearm and provides a stable strut for manipulation of the radial fracture (*3*). Also, we think that the unfixed reduced radius receives a good blood supply from the encircling muscle envelop which enhances union.

The operative time for plating the ulna was nearly half the time needed for plating both bones. The mean healing time in this study was 11.4 weeks which is comparable to the healing time in several studies using different methods of fixation (*3,11,12,19,22,27,29*).

We had one patient with loss of more than 30° of forearm rotation, fortunately he had no subjective symptoms with strenuous activity and compensated very well. All of our patients continued to participate in all types of physical activities.

We conclude that ulnar plating is a good management policy for unstable forearm fracture in children with a satisfactory functional outcome, less morbidity and fewer complications.

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