Isolated Diaphyseal Fractures of the Radius in Skeletally Immature Patients

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Abstract Diaphyseal radius fractures without associated ulna fracture or radioulnar dislocation (isolated fracture of the radius) are recognized in adults but are rarely described in skeletally immature patients. A search of our database (1974–2002) identified 17 pediatric patients that had an isolated fracture of the radius. Among the 13 patients with at least 1 year follow-up, ten were treated with manipulative reduction and immobilization in an above elbow cast and three had initial operative treatment with plate and screw fixation. These 13 patients were evaluated for an average of 18 months (range, 12 to 45 months) after injury using the system of Price and colleagues. The incidence of isolated diaphyseal radius fractures in skeletally immature patients was 0.56 per year in our database and represented 27% of the 63 patients with a diaphyseal forearm fracture. All 13 patients, with at least 1 year follow-up, regained full elbow flexion and extension and full forearm rotation. According to the classification system of Price, all 13 patients (100%) had an excellent result. As in adults, isolated radius fractures seem to occur in children more frequently than previously appreciated. Treatment of isolated radius fractures in skeletally immature patients has a low complication rate, and excellent functional outcomes are the rule.

Keywords Radius fracture · Skeletally immature · Diaphyseal

Introduction

Fractures of the forearm are common orthopedic injuries in children [6, 19, 21, 35] accounting for 30% to 50% of all pediatric fractures [2, 15, 18, 38]. About 18% of all forearm fractures occur in the shaft of the radius and the ulna [1, 4, 9], and these diaphyseal fractures can be divided into three categories: plastic deformation, greenstick, and complete diaphyseal fractures. In the forearm, either both bones or one bone and one radioulnar joint (Monteggia and Galeazzi lesions) are typically injured, and isolated fractures are relatively uncommon [36]. Therefore, single-bone fractures should always raise suspicion regarding additional injury to the proximal or distal radioulnar joint [24, 25, 30].

In adults, the concept of an isolated ulna fracture (the so-called “nightstick” fracture) is well-accepted, but the concept of an isolated radius fracture is traditionally less well-accepted, and textbooks usually describe Galeazzi fractures alone [5, 16, 32] or mention isolated radius fractures, but there is a caution that most will have an associated injury to either the proximal or distal radioulnar joint [12, 23, 33]. More recently, however, several papers have described that diaphyseal radius fractures without associated radioulnar dislocation occur more frequently than previously recognized and appear to be more common than Galeazzi lesions [31, 33].

Most reports of diaphyseal forearm fractures in children address treatment techniques of fractures of both the radius and ulna. To our knowledge, there have been no reports of isolated diaphyseal radius fractures in children specifically, although a few patients with isolated radius fractures have

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been included in larger series of diaphyseal forearm fractures in general [17, 20, 22, 28, 29, 34, 39–42]. A few papers state that isolated dislocations of the DRUJ and Galeazzi fractures are unusual in children [3, 13, 24, 37] and the diagnosis can therefore be overlooked [8, 37].

This investigation describes the treatment and subsequent outcome of diaphyseal fractures of the radius without associated injury to the ulna or radioulnar joints (isolated radius fractures) in 17 skeletally immature patients.

Materials and Methods

All fractures at our institution were entered into a database organized according to the AO Comprehensive Classification of Fractures [26] between 1974 and 2002. A search of this database identified 17 consecutive skeletally immature patients that had a treatment of a Type 22-A2 diaphyseal fracture of the radius according to the AO comprehensive classification of fractures [26]. This represented 27% of the 63 skeletally immature patients with a diaphyseal forearm fracture in the database. The incidence of isolated radius fractures in skeletally immature patients was 0.56 at our institution during the study period. Patients were treated by an attending general orthopedic surgeon or a general trauma surgeon experienced in AO principles and techniques of internal fixation [26].

Using a protocol approved by our ethics committee, we reviewed the medical records of these 17 patients. We report the results of treatment in 13 patients that had at least 12 months follow-up available in the medical record.

Clinical outcome was graded with a scale used by Price et al. [27], which is based on the rating scales of Daruwalla [7] and Grace [11]. Patients were rated as excellent if there were no complaints with strenuous physical activity and less than 10° loss of forearm rotation. A result was considered good if there were only mild complaints with strenuous physical activity or an 11° to 30° loss of forearm rotation or both. A result was considered fair if there were mild subjective complaints during daily activities or a 31° to –90° loss of forearm rotation or both. All other results were considered poor.

Among all 17 patients in the cohort, there were 14 male and three female patients with an average age of 10 years (range, 1 to 18 years). Eight patients injured the left arm and nine patients injured the right arm. Limb dominance was not recorded. Patients were injured in a fall from a standing height in ten cases (four during sports), three in a bicycle accident, and four in a motor vehicle collision (one as pedestrian). Two patients had injuries of the ipsilateral upper extremity, including a distal humerus fracture and a humeral shaft fracture.

Results

Injury Characteristics

The isolated radius fractures were classified based on radiographs taken immediately after injury and intraoperative findings according to the *Comprehensive Classification of Fractures* [26] as Type A2.1 in 4, Type A2.2 in 11, and Type A2.3 in 2 cases, respectively (Figs. 1 and 2).

Figure 1 **a** Anteroposterior and lateral radiographs of a 10-year-old boy who fell at school and sustained an isolated fracture of the radial diaphysis. **b** Anteroposterior and lateral radiographs demonstrating cast immobilization. **c** Radiographs obtained 6 months after injury show solid healing of the fracture.

Figure 2 **a** Anteroposterior radiograph of a 5-year-old boy who fell at home sustaining an isolated fracture of the distal radial diaphysis. **b** Anteroposterior and lateral radiographs demonstrating treatment with

cast immobilization. **c** Radiographs taken nearly 1 year after injury show solid healing and some remodeling.

Patients with at Least 12 Months Follow-up

Among the 13 patients with at least 12 months follow-up, several different surgeons participated in the care of these patients, and no standard protocols were used. Ten patients were treated with manipulative reduction and immobilization in an above elbow cast under general anesthesia. Three patients had initial operative treatment. Looking back, there were no clear protocols for determining operative or nonoperative treatment and this seems to have been surgeon preference alone. The patients who were treated by splint or cast alone had an average age of 9 years (range, 1 to 16 years), and the operatively treated patients had an average age of 17 years (range, 17 to 18 years). All of the operatively treated patients had open reduction and plate and screw fixation using a 6-hole 3.5-mm dynamic compression plate (DCP), screws in two patients, and a 4-hole 3.5-mm DCP in one patient.

The nine patients, who were treated by splint or cast alone, were immobilized for an average of 44 days (range, 21 to 63 days). The four operatively treated patients started elbow exercises the first day after surgery. For all patients, active-assisted range of motion exercises were initiated at the time the splint or cast was discontinued.

Complications and Additional Surgeries

One patient was felt to have inadequate alignment 2 weeks after manipulation and casting and was treated with open reduction and plate and screw fixation. One cast-treated patient sustained a refracture within 3 months that was treated in a cast.

Final Result

At an average of 18 months (range, 12 to 45 months) after the injury, all 13 patients evaluated at least 1 year after injury had regained full elbow flexion and extension and full forearm rotation. According to the classification system of Price, all 13 patients (100%) had an excellent result.

Discussion

The low incidence of isolated diaphyseal radius fractures in skeletally immature patients (0.56 per year at our institution during the study period) may explain why they are underrepresented in the literature. As in adults, we now recognize that skeletally immature patients can sustain an isolated fracture of the radius without additional fractures or dislocations. These findings should not encourage complacency but should rather increase vigilance regarding potential radioulnar injuries. In the absence of radioulnar injury, an isolated radius fracture may prove more straightforward to treat than a Galeazzi injury and may have a better prognosis.

Cast treatment is effective in most skeletally immature patients with isolated radius fractures, and surgery seemed to be used primarily in older patients and according to surgeon preference at our institution. The role of operative treatment remains unclear, but as with other diaphyseal forearm injuries in the skeletally immature, operative treatment should be more readily considered in patients nearing skeletal maturity. According to the literature, the following guidelines may be reasonable: angulation of up to 20° is acceptable in children less than 8 years old, but no

more than 10° is acceptable in older children with less than 2 years of expected additional growth [7, 10, 14, 27].

Isolated radius fractures seem to occur in adults and children more frequently than previously appreciated. Based on our data, it seems possible for the radius to be fractured without dislocating the radioulnar joints or also fracturing the ulna. This small series shows that treatment of isolated radius fractures in skeletally immature patients has a low complication rate, and excellent functional outcomes are the rule.

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