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Case report

Distal radius nonunion after epiphyseal plate fracture in a 15 years old young rider

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Summary. *Background and aim of the work:* Radius and ulna fractures are the most common long bone fractures in children and adolescents. The majority of these injuries involve the distal metaphyseal portion of the radius associated or not to physeal plate injuries. Because of the high remodelling potential of the distal radius in growing children most injuries heal without complication after closed reduction and immobilization in a long arm cast. Nonunions of closed distal radius fracture are an extremely rare occurrence especially in paediatric population. *Methods:* In this report, we describe a rare case of distal radius fracture nonunion in a 15-years old male rider treated conservatively with cast immobilization. Eight months later he underwent surgical closed reduction and fixation with kirschner wire and cannulated screw. *Results:* Follow-up at 2 years showed satisfying radiological and functional outcomes. The patient ultimately returned to ride 3 months following surgery. *Conclusions:* Nonunion is rarely seen in distal radius fractures in healthy children and adolescents, and there are few studies in the literature. Treatment of the nonunion must be individualized and the results are not entirely predictable. (www.actabiomedica.it)

Key words: non-union, distal radius, physeal plate, paediatric, adolescence

Introduction

The distal part of the forearm is the most common area to sustain a fracture in the paediatric population (1-3). Among all forearm fractures, the distal radius and ulna are most commonly affected.(4,5). Several recent studies suggest that the frequency of paediatric distal radius fractures is rising, likely due to epidemiologic trends toward diminished bone density, increased body mass indices, higher-risk activities, and younger age at the time of initial sports participation (6,7). The mechanism of injury is generally a fall on the outstretched hand and it influences fracture type and degree of displacement (5).

Signs and symptoms of these kind of fractures are pain, swelling, and deformity of the distal forearm that depend on the degree of fracture displacement.

Plain radiographs are essential in order to diagnose the lesion and to assess its classification and degree of displacement. Standard anteroposterior (AP) and lateral (LL) views usually are sufficient. CT and MRI are rarely necessary and they are reserved for evaluation of suspected or misdiagnosed intra-articular fractures or associated carpal injuries and are very useful for pre-operative planning.

Fractures of the distal forearm typically occur during skeletal development. Due to the greater forces borne and imparted to the radius, as well as the increased porosity of the distal radial metaphysis, distal radial fractures are more common than distal ulnar fractures. Physeal plate injuries of this anatomic portion are also commonly seen (8).

The Salter–Harris system is the basis for classification of physeal plate fractures (9) and in the radius type II lesions are the majority (10).

Management is highly influenced by the remodelling potential of the distal radius in growing children. Generally, these injuries are successfully treated with

nonoperative treatment. Surgery is recommended in patients with neurovascular compromise, severely displaced injuries and unstable fractures failing initial nonoperative care.

Loss of reduction and malunion are common occurrence after insufficient closed reduction and cast immobilization (11-16) but most injuries generally heal without complication after this treatment. Nonunion of closed distal radius fracture is an extremely rare occurrence and there are few studies among children and adolescent in the literature.

Case report

G.M. (15 years-old male biker) fell during a race with outstretched hand. After the fall he had pain and couldn't move the right wrist which was swollen. The patient was visited at another emergency room and conventional radiographs at right wrist were done: he reported a Salter Harris type II distal radius fracture and ulnar styloid fracture with physeal plate injury. The fractures were treated with cast immobilization for 4 weeks. After removal of cast the patient started physical rehabilitation and passive and active mobilization but he kept feeling pain and he had persistent functional limitation at the wrist. Eight months after the fall he came to our attention with pain and marked reduction of strength and movement of the wrist. An important limitation of wrist's flexion/extension and reduction of ulnar/radial deviation were observed and the patient was unable to ride. Therefore, an X-ray and CT study were performed (figures 1, 2) and nonunion of distal radius physeal plate was documented. He was operated 5 days later under plexus anaesthesia and antibiotic prophylaxis with first generation cefazolin was administered. The lesion was approached through a volar incision centred over distal radius. There was evidence of fibrous tissue interposed between radial styloid and distal radius so a cleaning of nonunion site was performed until bone fragments bleeding. Fracture was reduced with special instruments under fluoroscopy control (figure 3A and B). After bridging the gap with cancellous bone graft taken from proximal radius osteosynthesis and compression was performed with one 3 mm cannulated screw Asnis (Stryker, Mahwah, NJ, USA) and one K-wire to prevent rotations (figures 3C and 4A and B). The surgery lasted 80 minutes (tourniquet has been maintained for 60 minutes) and the patient was discharged the following day. The wrist joint was initially immobilized with plaster cast for 1 month. After the cast and k-wire has been removed, the patient started rehabilitation program with active and passive mobilizations and progressive strengthening and resistive exercises. Radiographic control performed 2 months from treatment showed bone consolidation and healing of the injury (figure 5A and B). The patient was satisfied and returned to motor race at

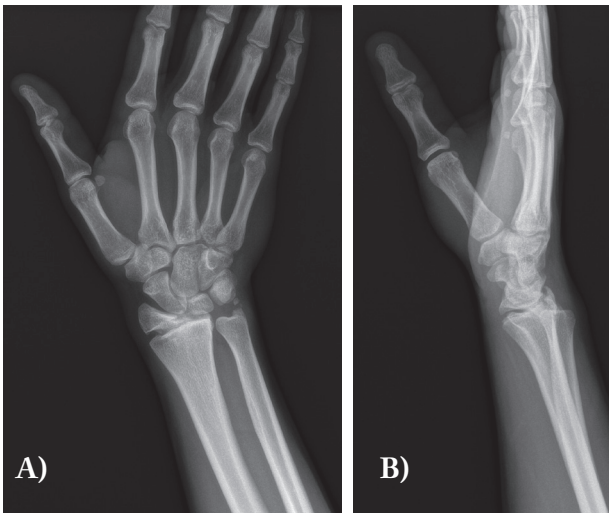

Figure 1. Preoperative X-rays (8 month after fall); AP (A) and LL views (B)

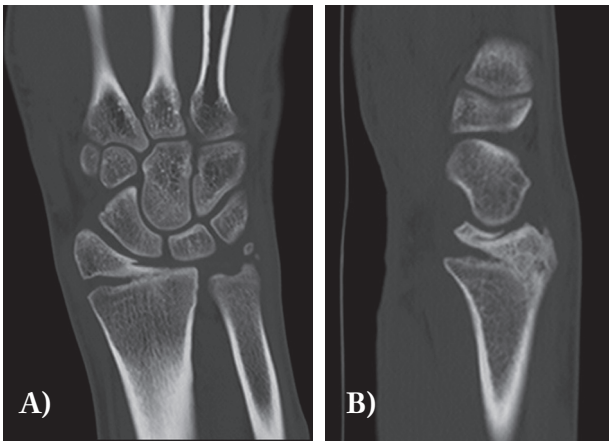

Figure 2. Preoperative CT study with physeal plate nonunion of distal radius; AP (A) and LL views (B)

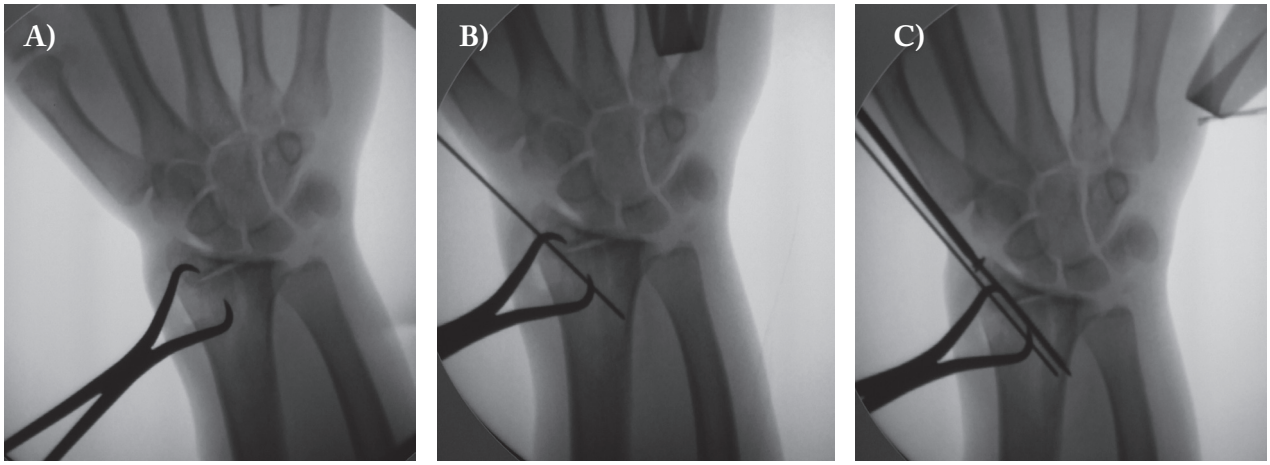

Figure 3. Intraoperative fluoroscopic controls: reduction of fracture (A); transitory stabilization with K-wire (B); definitive fixation with k-wire and compression screw (C)

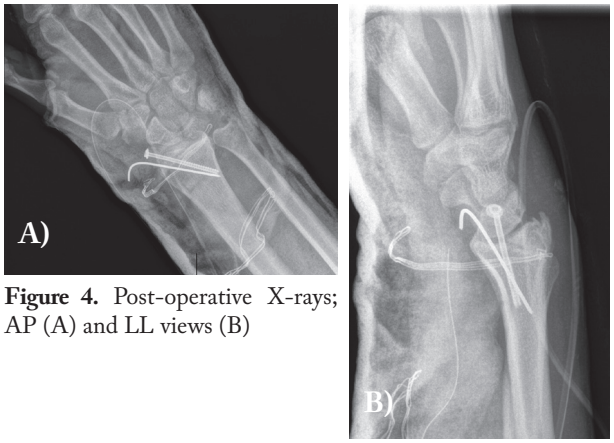

Figure 4. Post-operative X-rays; AP (A) and LL views (B)

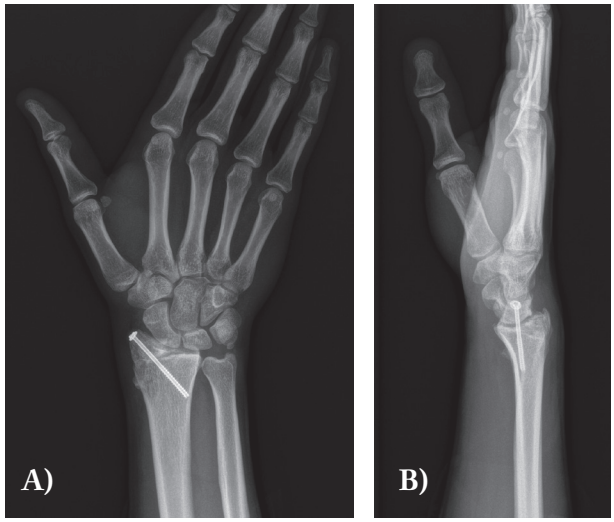

Figure 5. X-rays 2 months after surgery and removal of K-wire; AP (A) and LL views (B)

3 months from surgery. Nowadays, there are no limitations of strength and of range of motion of the right wrist and no pain has been reported (figure 6A and B).

Discussion

Distal radius fractures are the most common orthopaedic injuries that occur in the paediatric and adolescent population. Most of these lesions involves the distal metaphyseal portion of the radius but physeal plates traumas are also commonly seen, with the majority being Salter Harris type I or II fractures (17). The annual incidence of distal radius fractures has increased as a result of earlier participation in sporting activities, increased body mass index, and decreased bone mineral density (1). Distal radius fractures are more frequently sustained after a fall onto an outstretched arm that results in axial compression on the extremity or from direct trauma to the extremity. AP and LL x-ray views of the wrist usually are sufficient to diagnose a distal radius fracture. The management is based on several factors, including patient age, fracture pattern, and the amount of growth remaining. Non-

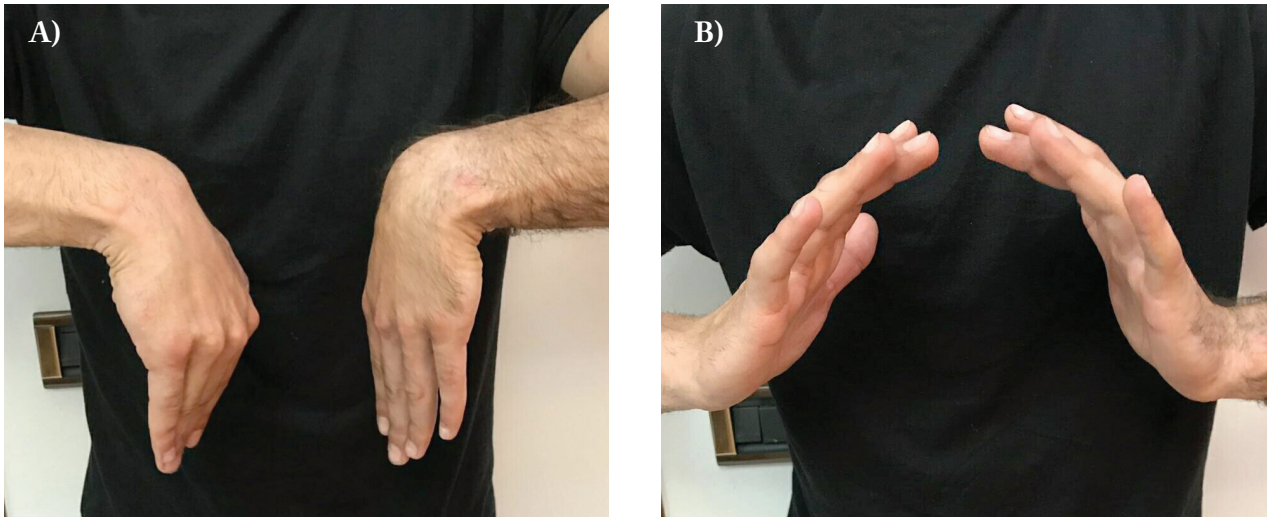

Figure 6. Clinical images 2 months after fixation with good recovery in function

surgical management is the most common treatment option for patients who have distal radius fractures because marked potential for remodelling exists. If substantial angulation or displacement is present, closed reduction manoeuvres with or without percutaneous pinning should be performed (18).

In adults pseudoarthrosis consequent to distal radius fractures is a rare occurrence but reports in the literature are present. Bacorn and Kurtzke (20) found an incidence of nonunion of 0.2%. Watson-Jones (21) reported only one nonunion out of 3199 distal radius fractures.

This type of nonunion can be observed after internal fixation, external fixation, or non-operative treatment (22) and it has been reported that comorbidities medical conditions such as diabetes, peripheral vascular disease, alcoholism, smoking and obesity may increase its risk (23-25)

An ulnar styloid fracture often occur in association with a distal radial fracture but a meta-analysis by Yuan et al. suggest that it doesn't affect the outcomes (26). In the same way Zenke et al. showed that the presence of an ulnar styloid fracture does not affect the outcome of a fracture of the distal radius which is stabilized with a volar locking plate (27).

In children, nonunion has been universally related to a pathologic condition of the bone or vascularity (10). Congenital pseudoarthrosis, neurofibromatosis, osteomyelitis and bone loss should be always suspected in a patient with a nonunion after a benign fracture (19). In paediatric fractures, nonunions have been usually reported in diaphyseal regions (28). Pseudoarthrosis following a closed radial or ulnar fracture is extremely rare and to the best of our knowledge only few reports are cited in literature in paediatric age group (29-35).

Kwa *et al*. in the first ever case reported had described a distal radius nonunion following a closed fracture in an otherwise healthy child (30). This was managed by bone grafting and casting. The factors attributed to nonunion in this report were inadequate immobilization and severe initial displacement. In two other case reports, nonunion in children had been attributed to open surgery (35), soft-tissue or vascular problems (36).

Sivashanmugam et al., focusing on pseudoarthrosis treatment, stressed the great osteogenic potential of the periosteum in children and adolescents. Their case report highlights the possibility of stimulating bony union by distracting the minimally disturbed soft tissue and thick osteogenic periosteal envelope to treat paediatric atrophic nonunion in selected patients (37). In general, in these type of patients excision of the fibrous tissue followed by compression and stabilization are sufficient in order to obtain consolidation.

Debridement of the necrotic bone and either traditional bone grafting, osteoclasis lengthening, vas-

cularised bone grafting, or creation of a single-bone forearm are surgical options and the choice depends on the individual patient (17)

Conclusions

Because of favourable local biological factors, nonunion is rarely seen in distal radius fractures in children and adolescents .

As consequence of the great osteogenic potential of the periosteum in children and adolescents, its treatment usually requires isolated excision of the fibrous tissue and internal fixation.

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