



Salter-Harris Type 2 Fracture of Proximal Humerus Successfully Treated with K-Wire Fixation: A Case Report

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Abstract

In pediatric patients, proximal humeral physeal fractures are uncommon injuries compared with distal physeal fractures. Usually, the growth plate is the most vulnerable site of fracture in the proximal humerus.

We describe a case of proximal humerus Salter-Harris (S-H) type II physeal fracture in a ten-year-old girl, successfully treated by a minimal trans-deltoid access and fixation with Kirschner (K-wires), under image guidance. She had satisfactory functional outcome 4 months after surgery with painless near total range of motion.

Treatment is based on patient age, fracture displacement and remodeling capacity. Nonoperative management is successful in younger patients or in less displaced fractures, while operative management is mostly considered in older patients with more displaced fractures. The majority of pediatric shoulder trauma will result in a good outcome.

Keywords: Physeal fracture; Proximal humerus; Salter-Harris type II; K-wires fixation; Pediatric trauma; Pediatric fractures

Abbreviations

K-wires: Kirschner wires; S-H: Salter-Harris fracture classification

Introduction

Proximal humeral fractures in children are relatively uncommon, comprise approximately 2% of all pediatric fractures and 4% to 7% involves the epiphysis [1-5].

The fractures are either metaphyseal, which occur mostly in children 5 to 12 years of age, or epi-physeal separations [6,7].

They are usually caused by sport injuries, motor vehicle accidents, or birth trauma, while the usual mechanism of injury is hyperextension combined with external rotation of the shoulder [1].

Diagnosis is based on plain radiographs and fractures are classified according to their severity and anatomic location.

Fractures involving the growth plate are evaluated with the Salter-Harris (S-H) fracture classification [8,9].

Most proximal humerus fractures in children occur with the involvement of the physis and most commonly are S-H type II injuries. S-H type I fractures are more common in younger children, whereas type III and IV fractures are rare [3,9].

According to the age-related remodeling potential, grade of displacement and functional demands, a case-specific decision has to be made between conservative and operative treatment. No evidence-based algorithm could lead the choice, at the present [1,10].

Here, we report a case of proximal humerus S-H type II physeal fracture, successfully treated with minimal trans-deltoid access and percutaneous pinning with k-wire fixation.

Case Presentation

A ten-year-old girl, reached our emergency ward due to a fall from a jumping mat. She was jumping up and down, when a windstorm has raised the jumping mat causing her fall to the ground.

The patient complained of right shoulder pain with loss of motion, she was conscious and

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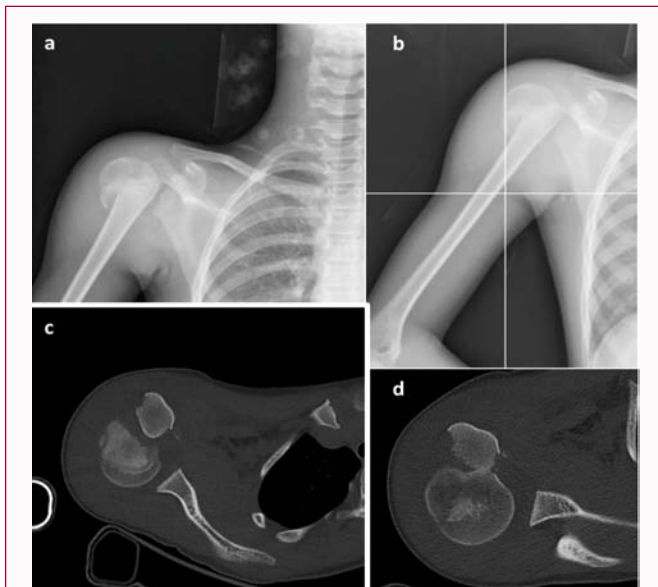


Figure 1: a, b) antero-posterior radiograph representative for clear diagnosis of S-H type II fracture; c, d) imaging appearance at axial CT scan of proximal humerus fracture.



Figure 3: Radiograph at 20 days follow-up.



Figure 4: Radiograph at 45 days follow-up. a) with k-wires, signs of reparative callus b) radiography after removal of the k-wires.



Figure 2: Postoperative antero-posterior radiograph of the right shoulder with k-wires, showing healed fracture with restoration of anatomy.

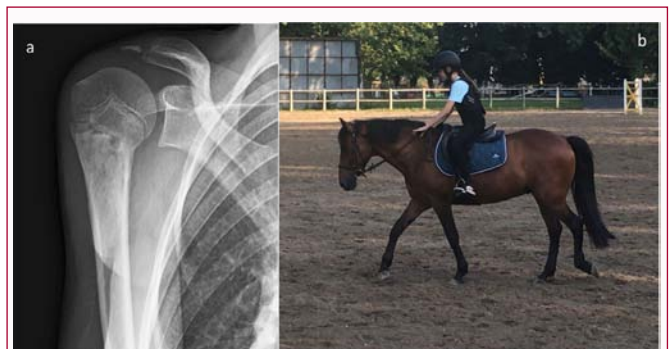


Figure 5: Four months follow-up. a) at 4 months follow-up, anteroposterior radiographs of the right shoulder showing partial obliteration of the physis with no sign of avascular necrosis. b) the girl had resumed riding.

oriented. A physical examination identified tenderness on her right shoulder, with a slight swelling and limitation of movement. No noticeable neurological or vascular problem, such as tingling sensation or Tinel sign below the shoulder joint, were observed. The radial artery pulsation could be well palpable around the wrist. Anteroposterior radiographs (Figure 1a, 1b) and TC-scan revealed a Salter-Harris type II proximal humerus injuries (Figure 1c, 1d).

There were associated conservative fractures of left sacral wing, both ischiopubic branches with diastasis of pubic symphysis and a cervical curve inversion at C4-C5.

After the pre-operative preparations had been completed, the patient was taken to the operating room. Considering the age and the grade of displacement, a decision for percutaneous reduction and fixation with Kirschner wires was taken. In supine position, fluoroscopy guided, closed and percutaneous reduction under general anesthesia and interscalene block, was not successful due to the angulation of fracture stumps; open surgery was therefore necessary. Minimal trans-deltoid access was performed, reduced the fracture and fixed with three K-wires of 1.8 mm (Figure 2).

In post-operative time was placed a shoulder abduction tutor

The patient was postoperatively followed-up for 4 weeks in abduction tutor. Fracture union was identified on the radiographs taken at the end of the postoperative 3rd week and 5th week. At the 20-day X-rays check were visible osteo-repairs sign, with indication to starting commuter movements of the right shoulder (Figure 3). At the 45-days clinical check (Figure 4a) were removed the k-wires (Figure 4b), with indication to the gradual weaning from shoulder tutor during daytime. The night wearing was preserved for the following 15 days. The patient was commenced on an exercise program in order to increase the range of motion of her shoulder joint. After an exercise program of 2 weeks, the range of motion of the patient's joint was almost fully restored. In the postoperative 12th week, it was observed that the range of motion of her joint was comparable to her healthy side. Agonistic activity and weight lifting were not recommended for



Figure 6: Twelve months clinical follow-up.

the following 3 months. At the 3-month clinical check the right side shows partial obliteration of the physis with no signs of avascular necrosis (Figure 5a), the ROM of shoulder has been restored, allowing her to resume riding (Figure 5b).

At 12 months, the patient showed a complete restoration of the function and full range of motion with neither pain, nor Disabilities of the Arm, Shoulder, and Hand (DASH) score of 1.7/100 (Figure 6).

Discussion

Proximal humerus fractures in children comprise approximately 2% of all pediatric fractures, and between 4% to 7% of all epiphyseal fractures [1,5,8,11].

They are usually caused by sport injuries, motor vehicle accidents, or birth trauma, while the usual mechanism of injury is hyperextension combined with external rotation of the shoulder in high-energy trauma [8].

The diagnosis of these fractures is typically done recurring to radiography. So overall, indications for a CT scan for proximal humerus fractures in children are limited, due to the risk of ionizing radiation on the developing body. In cases with difficulty obtaining orthogonal radiography or in complex fracture pattern or dislocation, CT may be indicated [3].

A CT-scan total body was performed in our patient because she had suffered a high-energy trauma involving the cervical spine, humerus, pelvis and her abdomen. In our patient anteroposterior radiographs revealed a proximal humerus fracture involving the physis (S-H type II). CT scan and radiographs showed fractures of left sacral wing, both ischiopubic branches with diastasis of pubic symphysis and a cervical curve inversion at C4-C5.

Fractures involving the growth plate are classified with the S-H fracture classification [11].

In literature isolated physeal separation (Salter-Harris I) is seen in new-born and toddlers, with a second peak of physeal separation seen in the young adolescent thrower. In Children from 5 to 11 years, the majority of fractures involving the proximal humerus are metaphyseal, whereas Salter-Harris type II fractures are predominantly seen in children 11 years and up. Salter-Harris type III and IV injuries are rarely seen and are usually associated with high-energy trauma [3,9,11].

About 80% of the longitudinal growth of the humerus occurs at the proximal humeral physis. This high activity level explains the awful remodeling of proximal humerus fractures in the pediatric population. Younger is the patient, higher the remodeling potential

[1,8].

Bone healing and spontaneous remodeling of proximal humerus fractures in children are usually good and non-operative treatment is preferred.

Surgical fixation has traditionally been recommended in proximal humerus fractures when closed reduction is unsatisfactory due to interposed long head of biceps tendon, deltoid muscle or capsule, and in cases of nerve or artery injuries [12,13].

Percutaneous Kirschner wire pinning is the most usual fixation in children, often combined with closed reduction [8].

In our patient a closed reduction and synthesis with k-wires was attempted, but ineffective making it necessary resort to reduction with small trans deltoid access. The fixation using k-wires for the Salter-Harris type II humerus fracture had satisfactory outcome.

Although the k-wire fixation was successful, routine use in complex fractures cannot be recommended due to the risk of avascular necrosis. In our study as also reported in that of Umesh at al., immobilization was maintained for a longer duration and the patient was closely monitored for avascular necrosis [14]. In our patient the good outcome may be the combination of intact blood supply and periosteum, intact rotator cuff mechanism, patient's young age with healthy bone metabolism and achievement of good reduction with restoration of the articular surface and calcar.

Wang et al. reported epiphyseal devascularization in a 10-year-old boy with fracture-dislocation of the shoulder [15,16], whereas Lee et al. reported avascular necrosis on the humeral head in a 16-year-old boy [17]. In both cases, open reduction was performed [15].

Dobbs at al. in their study described an 8-year-old boy presented after falling off his bicycle and sustaining a Neer grade IV proximal humeral epiphyseal fracture and a 14-year-old boy sustained a Neer grade IV proximal humeral epiphyseal fracture while playing football. They were treated in the operating room with a successful closed reduction followed by percutaneous pinning with two K-wires. Instead, a 15-year-old boy sustained a Neer grade III proximal humeral epiphyseal fracture from a fall on the basketball, attempted closed reduction of the fracture in the operating room failed. The patient underwent an open reduction through a deltopectoral approach and k-wires fixation.

Treatment protocol for severely displaced fractures of the proximal humeral epiphysis was designed to minimize residual fracture deformity and subsequent loss of normal shoulder mechanics. Proximal humeral fractures in children, that require management in the operating room, typically are successfully reduced closed and then percutaneously pinned [12].

In those rare cases in which an acceptable reduction is not obtained closed, an open reduction and internal fixation as in our patient treated with a mini trans-deltoid approach is performed.

Conclusion

Proximal humerus fractures in children commonly occur after a traumatic fall and high-energy trauma. Treatment depends on patient age, fracture displacement and remodeling capacity. Nonoperative management is successful in younger patients or less displaced fractures, instead operative management is usually considered in older patients with more displaced fractures. Restoration of the

articular surface and the calcar is essential for functional outcome. This successful case of k-wire fixation is low cost, readily, available simple strategy may be useful in selective instances.

Percutaneous k-wire pinning is the most usual fixation in children, combined with closed reduction; open reduction by minimal access is important to restore the correct anatomy, whereas the closed reduction was not possible. Although the k-wire fixation was successful, in our case the follow up becomes important to control the risk of avascular necrosis.

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