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Research Article

Luxatio Erecta (Inferior Glenohumeral Joint Dislocation) with Growth Plate Fracture of Proximal Humerus: Case Report of Surgical Treatment in an Adolescent Patient

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Abstract

Fractures involving the growth cartilage of the proximal humerus are uncommon in pediatric traumatology, accounting for only about 5% of all pediatric fractures.

The most widely used classification systems in this field are those specifically designed for the pediatric population: the Salter-Harris classification and the Neer and Horwitz classification. This type of trauma is usually not associated with other joint injuries; therefore, a variety of treatment approaches are adopted for its management.

Even rarer are glenohumeral fracture-dislocations in this patient population, and consequently, there are few clinical studies or reports available in the current literature.

We present the case of A and B, a 13-year-old right-handed male, who sustained thoraco- abdominal and right upper limb trauma following a bicycle fall at approximately 30 km/h. The patient was admitted to the Emergency Department of our hospital with an inferior glenohumeral dislocation (Luxatio Erecta). A CT scan performed after the reduction of the dislocation revealed a displaced fracture of the proximal right humerus involving the articular cartilage. Due to the type of fracture, an emergency Closed Reduction and Internal Fixation (CRIF) using Kirschner wires was performed. Clinical and radiographic follow-up at 1,3,6 and 12 months showed good bone healing and functional recovery of the limb.

The current literature remains divided regarding the optimal treatment for these injuries. While there is consensus favoring conservative treatment in patients under 5 years of age, the recommendations for older pediatric patients are less clear. Furthermore, there are few descriptions of the surgical techniques used for reduction and fixation in such cases.

The objective of this report is to provide a detailed description of the diagnostic and therapeutic process, to compare it with the available literature, and done a valid reference for the management of similar injuries.

Introduction

Proximal humeral growth plate fractures are uncommon injuries in pediatric traumatology, accounting for approximately 5% of all pediatric fractures [1].

The Salter-Harris classification (Figure 1) is the most widely employed system for describing these injuries, as it delineates both the type and the extent of the fracture line [2]. Among the various subtypes, type II fractures are the most frequently observed, characterized by involvement of the growth plate with extension into the proximal metaphyseal-epiphyseal region.

Another classification used to describe these fractures is the Neer and Horwitz classification [3], which describes the degree of displacement through 4 degrees:

- grade I, no displacement or displacement <5 mm
- grade II, displacement up to 1/3 of the shaft's width
- grade III, displacement between 1/3 and 2/3
- grade IV, displacement greater than 2/3 of the shaft's width.

In most cases, this type of injury is not associated with subsequent joint complications. Consequently, several management approaches can be considered. Conservative treatment remains a valid therapeutic option, particularly in cases where fracture stability is acceptable, and displacement is minimal [4,5].

This approach is most frequently adopted in patients under five years of age [6]. Alternative treatment strategies, especially in older pediatric patients or in cases presenting with greater displacement, include reduction and fixation using Kirschner wires, elastic intramedullary nails, external fixation devices, or, in rare cases, plate and screw osteosynthesis [7].

It is crucial to take into account the biological characteristics of

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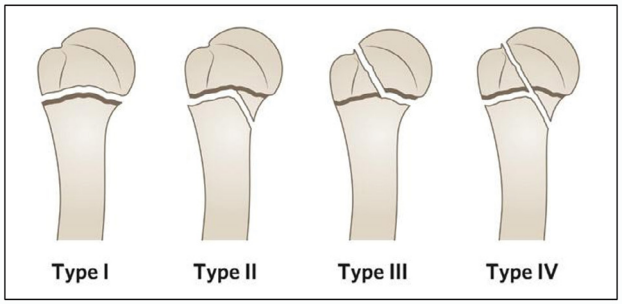


Figure 1: Salter-Harris classification for growth plate fractures.

the affected region and to avoid additional "second-hit" trauma to the growth plate resulting from the placement of invasive fixation devices. For these reasons, the literature indicates that the use of elastic intramedullary nails or Kirschner wires represents the most adopted management approach [8].

Few studies in the literature address the management of more complex cases, in particular, only a limited number of publications focus on fractures associated with joint dislocations.

Such conditions not only require more urgent clinical intervention but also entail greater treatment complexity and, in many instances, necessitate a surgical approach.

The aim of this case report is to evaluate, considering current evidence in the literature, the management of a complex clinical scenario involving a proximal humeral fracture in a peri- adolescent pediatric patient associated with an erect glenohumeral dislocation.

Our intent is to provide insights that may assist in the clinical management of similar cases.

Case Presentation

The present case report concerns a 13-year-old right-handed male (AB) who sustained thoraco-abdominal and right upper limb trauma following a high-energy bicycle accident. The patient presented to the Emergency Department of our hospital with a triage code indicating non-immediate urgency, due to suspected right glenohumeral dislocation and possible visceral injury.

At the initial assessment in the Shock Room, the patient appeared alert, oriented, cooperative, and in evident distress. The right upper limb was observed to be fixed in abduction, irreducible, consistent with a probable inferior glenohumeral dislocation ("erecta"). No neurovascular deficits were detected, and there were no signs of open fracture or skin compromise.

A preliminary FAST (Focused Assessment with Sonography for Trauma) examination was negative for visceral injuries, and vital signs were within normal limits. Consequently, procedural sedation with midazolam was administered to allow closed reduction and facilitate subsequent CT scan.

The reductive maneuver was performed without difficulty, successfully restoring the anatomical alignment of the glenohumeral joint. CT scan revealed no visceral organ damage but demonstrated a displaced fracture of the proximal humeral region, classified as Salter-Harris type II, Neer and Horwitz classification Grade IV. Given the degree of displacement and the patient's age, urgent surgical intervention was indicated (Figure 2).

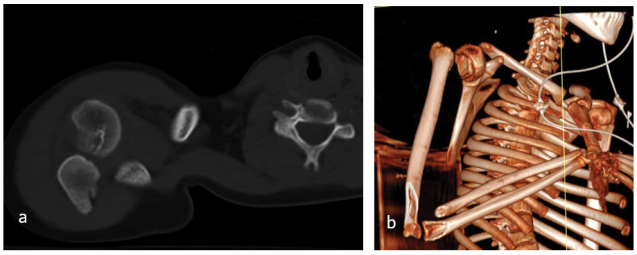


Figure 2: Fracture CT scan; a) axial view b) 3D reconstruction.

Surgical Technique

The size of the articular humeral fragment and the fracture line indicated Closed Reduction and Internal Fixation (CRIF) using Kirschner wires.

The patient was taken to the operating room on an emergency basis. Procedure was performed under general anesthesia with the patient in "beach chair" position. The right upper limb was suspended to facilitate reduction maneuvers, and the fluoroscopic image intensifier was positioned at the patient's head. An immobilization device was placed at the level of the right hemithorax to prevent body movement during traction.

Under image intensification reduction was achieved by applying progressive longitudinal traction along the limb, abducting it to approximately 80°, and performing lateralizing traction on the humeral diaphysis and traction in a posteroanterior direction to correct the displacement. Once an acceptable reduction was confirmed, stabilization was performed using an initial 2 mm Kirschner wire inserted from the lateral cortex of the humeral diaphysis and directed medially toward the central and inferior portion of humeral head.

The introduction of the K-wires from the lateral aspect had to account for the deltoid insertion and the course of the radial nerve. Therefore, a safe zone was considered, with the wires being placed at least 1.5 cm proximal to the deltoid insertion.

The trajectory of the K-wires also had to respect the physiological retroversion of the humeral head, which had been adequately restored during the preceding reduction maneuvers.

Care was taken to avoid wire placement beyond the articular surface of the humeral head. Furthermore, given the necessity to cross the growth plate, multiple checks under image intensification were performed to confirm correct advancement and positioning of the K-wires. Subsequently, a second parallel 2 mm K-wire was introduced. Given the fracture pattern and its instability, we opted to place an additional 2 mm K-wire in an antero-inferior position. A final retrograde K-wire inserted from the humeral head toward the medial humeral diaphysis (Figure 3). At the end of the procedure, under image intensification, the shoulder was mobilized throughout the full range of motion to assess the stability of the fixation. A Gilchrist-type bandage was made to be maintained in the post-operative period.

Follow-up

The patient underwent serial dressings every 7 days without any clinical signs of infection. The first clinical and radiographic follow-up was performed at 30 days. Clinically, initial signs of deltoid muscle hypotrophy were observed, with limited Range of Motion (ROM) due to recent immobilization, a VAS (Visual Analog Scale) score of

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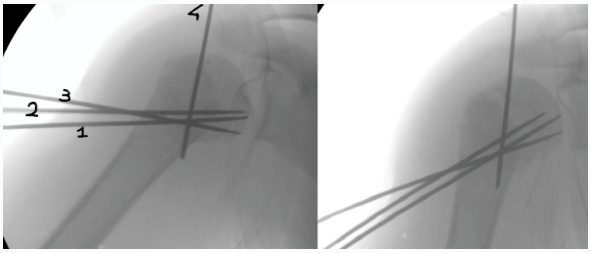


Figure 3: Intraoperative images obtained using a fluoroscopic image intensifier. The order in which K's threads were inserted is also in the graphics.

4, and no peripheral neurovascular deficits. The self-administered questionnaire DASH Score (Arm, Shoulder and Hand Disability) was found to have a score of 45. The CONSTANT-MURLEY (CM) score was 55. Strength assessment using Manual Muscle Testing (MMT) was 3.

In radiographic control, early reparative phenomena were observed at the fracture site, with no evidence of displacement for this reason, the K-wires were removed, and radiographic evaluation was repeated (Figure 4).

At the subsequent follow-up, approximately 2 months after injury, clinical examination revealed persistent deltoid hypotrophy and improving joint ROM (flexion-extension: 30°-0°-110°; abduction-adduction: 40°-0°-120°; internal-external rotation: 50°-0°-60°). The DASH score was 35 points. Strength assessment using Manual Muscle Testing (MMT) was 4. C-M score was 70.

A moderate-to-severe atrophy of the deltoid muscle was observed; therefore, an electromyographic examination was requested to assess potential nerve deficits. The patient reported that he had not yet started the physiotherapy program. Radiographs showed a normal progression of fracture healing (Figure 5).

The electromyography, performed after 15 days, report showed no evidence of nerve deficits. The patient reported having started the rehabilitation program 80 days after the traumatic event.

At the 6-month follow-up, a marked improvement in joint ROM was observed which was found to be within the physiological range and comparable to the contralateral side. The DASH score was 18 points, C-M score was 88, MMT was 5, without strength deficit. The X-rays showed no abnormalities, only physiological healing processes.

A further clinical evaluation was performed 12 months after the trauma, at the conclusion of the physiotherapy program. At this time, shoulder function and muscle strength were fully restored, but deltoid muscle hypotrophy was still present (Figure 6). The patient reported that they had not yet resumed sports activities due to fear of sustaining a new injury. Instructions were given for a return to sports to strengthen the deltoid muscle. The DASH score was 7 and C-M was 98. The Manual Muscle Testing (MMT) was 5.

Radiographic follow-up showed excellent bone healing (Figure 7). For this reason, it was decided to discontinue further follow-up (Table 1).

Discussion

The low incidence of fractures of this type results in limited descriptions of similar cases in the literature and, consequently, unclear scientific evidence. An even rarer occurrence is the association

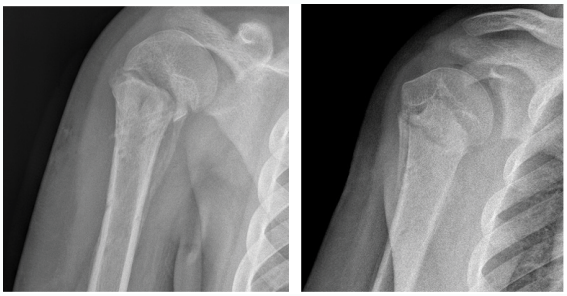


Figure 4: First radiographic evaluation at one month post-injury.

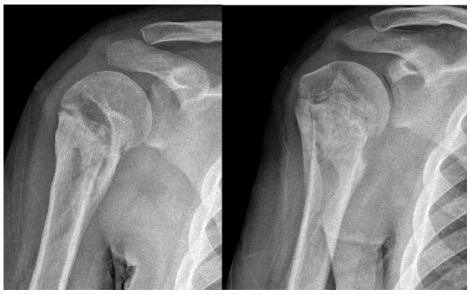


Figure 5: Radiographic evaluation at two months post-injury.



Figure 6: Clinical evaluation at the end of the follow-up. Note the hypotrophy of the right deltoid muscle. The joint ROM is like the contralateral shoulder.

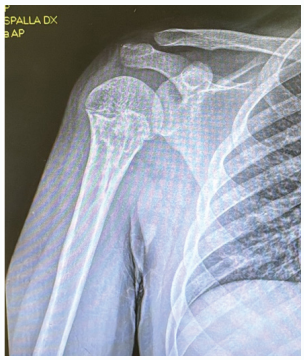


Figure 7: Last radiographic check with confirmation of a valid fracture healing outcome.

between physeal fractures and inferior glenohumeral dislocations of the "erecta" type.

The prognosis for Salter-Harris type I, II, III, and IV fractures is generally favorable, particularly when managed according to proper timing and indications. Indeed, as described by Cassidy RH as early as 1958 [9], management of these fractures on the day of the traumatic

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Table 1: Summary table of clinical assessments and scores used.

Follow up (Month)	VAS	ROM	DASH score	CONSTANT-MURLEY score
1	5	extension-flexion: 20°-0°-60°; abduction-adduction: 90°-0°-30°; internal-external rotation: 30°-0°-40°	45	55
2	3	extension-flexion: 30°-0°-110°; abduction-adduction: 110°-0°-40°; internal-external rotation: 50°-0°-60°	35	70
6	2	extension-flexion: 45°-0°-180°; abduction-adduction: 180°-0°-45°; internal-external rotation: 90°-0°-90°	18	88
12	0	extension-flexion: 45°-0°-180°; abduction-adduction: 180°-0°-45°; internal-external rotation: 90°-0°-90°	7	98

event facilitates reduction maneuvers and requires less invasive manipulation.

Conservative treatment should always be considered, especially in patients under five years of age or in cases of minimally displaced or non-displaced fractures. Kim, et al. [10] report favorable outcomes with conservative management, as this bone segment demonstrates considerable tolerance to displacement. However, outcomes may include upper limb length discrepancies, varus deformities, and joint subluxations due to reduced muscular tonicity or prolonged immobilization, particularly in older patients.

In patients over twelve years of age, the capacity for spontaneous correction of angular deformities is reduced, thereby increasing the relevance of surgical intervention. According to the literature, as reported by Bohler [5], an axial displacement of up to 60° is considered acceptable in patients younger than twelve years. Beyond this age, the tolerable displacement decreases to 30° of axial deviation. This threshold further decreases to 20°, irrespective of age, for valgus deviations.

In the clinical case described the decision to perform a closed reduction and Kirschner wire fixation was dictated by the need to achieve satisfactory fracture reduction and stability while minimizing violation of the growth plate. The displacement was not suitable for conservative management, and there was also an indication for urgent surgical intervention to facilitate reduction maneuvers, avoid excessively aggressive manipulation, and reduce the risk-albeit very low in the pediatric population-of avascular necrosis [11].

In the review by Verdano, et al. [4], six cases of proximal humeral Salter-Harris type II fractures were treated with Closed Reduction and Internal Fixation (CRIF) using Kirschner wires, achieving satisfactory outcomes at two-year follow-up. The use of Kirschner wires provides a construct with good stability while posing minimal procedural risks, particularly those related to pin tract infection or growth plate injury.

The choice of fixation method should primarily consider the patient's age and the growth potential of the physis [12]. Of course, surgical intervention carries potential risks, such as the use of overly invasive fixation methods on the growth plates, infection of the surgical site or implanted devices, or neurovascular complications [13].

Nevertheless, even more invasive procedures, such as plate-and-screw fixation, have demonstrated an acceptable safety profile and satisfactory functional outcomes. In some cases, soft tissue interposition prevents closed reduction. The study by Oenning, et al. [14] reports on 18 patients with proximal humeral fractures, with a mean age of 12.1 years and open growth plates, treated with plate-and-screw fixation *via* a deltopectoral approach. No growth plate-related complications were observed despite the more invasive procedure.

The literature also describes complications related to muscular tonicity, particularly of the deltoid, in cases of suboptimal fracture healing [15]. This muscle is affected both by immobilization and the surgical insult from percutaneous procedures. Therefore, in addition to appropriate surgical technique, early restoration of movement and subsequent return to sports are of fundamental importance. As described by Li, et al. [16], an early rehabilitative approach is also crucial in pediatric patients to preserve proper muscle tone and trophism.

Conclusions

Although only a few cases are reported in the literature, surgical fixation of proximal humeral fractures in pediatric patients appears to be a safe option and may even be necessary in cases such as ours, which was complicated by a joint dislocation and a highly unstable fracture pattern. Therefore, we can conclude that patient age, fracture pattern, timing, and, most importantly, the choice of fixation method is crucial for the management of these injuries. However, data analyzed from the literature indicate that closed reduction and internal fixation with Kirschner wires (CRIF) demonstrates good reliability and safety. Surgical fixation also offers the advantage of enabling a faster recovery of joint mobility. In fact, for this type of injury, it is essential to initiate an early physiotherapy and rehabilitation program to maintain proper muscle tone and trophism. Delay in this regard, as occurred in our case, increases the risk of muscle hypotrophy.

Moreover, it is necessary to educate both the patient and their parents about the importance of returning to athletic activity as soon as bone healing is adequate to tolerate the stress.

Despite these encouraging findings, an increase in both the dissemination and production of publications on these injuries is desirable to generate stronger evidence and broader clinical experience.

We hope that sharing our experience, described in detail particularly with regard to the surgical technique, may be useful for daily clinical practice.

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