Original Clinical Article

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No incidence of glenohumeral joint dislocation in a review of 220 paediatric proximal humerus fractures

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Abstract

Purpose Proximal humerus fractures in adults are approached with a high suspicion for potential associated glenohumeral dislocation. Axillary views of the shoulder can be painful and possibly even lead to dynamic angulation of the proximal humerus fracture. The incidence of associated glenohumeral dislocation in the paediatric population is unclear and it would be useful to determine whether children with proximal humerus fracture require specific axillary view imaging to rule out dislocation.

Methods We retrospectively reviewed 220 proximal humerus fractures in 218 total children. Imaging and follow-up clinic notes were reviewed for potential glenohumeral dislocation.

Results Average patient age was 9.8 years SD 3.8 with 55% of the patients male and a wide variety of mechanisms of injury. None of the 220 fractures evaluated showed radiographic evidence of a shoulder dislocation, and all 218 children had a follow-up appointment at least 21 days after the injury without any clinical concern of a missed shoulder dislocation.

Conclusion No paediatric patients presenting with proximal humerus fractures had a corresponding glenohumeral joint dislocation in our relatively large series. We recommend obtaining this additional imaging only in cases with higher energy mechanisms, if there is suspicion of subluxation or dislocation on anteroposterior and scapular-Y views or if there is clinical concern.

Level of Evidence Level III Diagnostic

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Keywords: glenohumeral dislocation; paediatric; proximal humerus; fracture; injury

Introduction

Proximal humerus fractures account for approximately 2.2% of all paediatric fractures.[1] Glenohumeral dislocation in the context of a proximal humerus fracture is an uncommon but well-documented condition in the adult population.[2–4] A number of individual case reports confirm that fracture-dislocations of the shoulder can also occur in children.[5–9] In the adult population, it is common practice to obtain an axillary view in addition to the true anteroposterior and scapular-Y views in any patient with a proximal humerus fracture as a glenohumeral dislocation may not be obvious without such axillary view radiographs.[10] Given the potential for paediatric fracture-dislocations, there are similar recommendations to obtain an axillary view radiograph when a paediatric patient presents with a proximal humerus fracture.[11,12]

We are unaware of any previous study that has examined the incidence of glenohumeral dislocation in paediatric proximal humerus fractures. While the consequences of missing a shoulder dislocation are severe, obtaining an axillary view radiograph in a child with a proximal humerus fracture can be painful. In addition, this manouevre may cause the fracture to dynamically angulate further, potentially leading to additional imaging and reduction attempts (Fig. 1). An understanding of the incidence of paediatric fracture-dislocations could help guide a clinician to best balance thoroughness of evaluation with patient comfort and cost. To clarify this issue, we designed a retrospective chart review study to evaluate the prevalence of glenohumeral dislocations in children with proximal humerus fractures.

Materials and methods

A retrospective chart review study was approved by our Institutional Review Board on 21 March 2017 (IRB #03-17-11). The inclusion criteria included patients with proximal

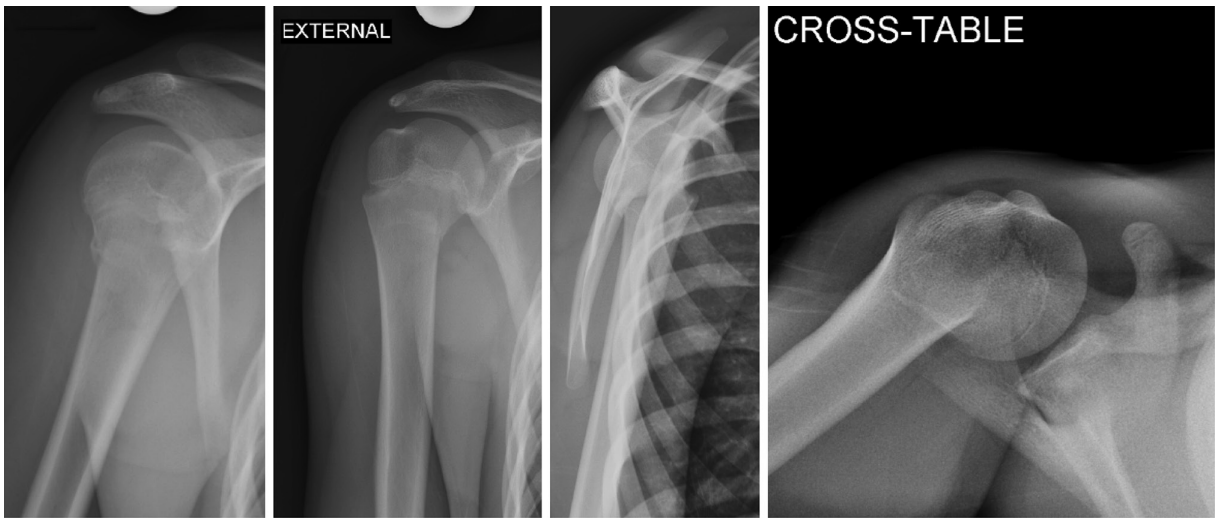

Fig. 1 A 15-year-old male with a right proximal humerus fracture. Internal, external and scapular-Y views show mild angulation. The axillary view confirms that there is no glenohumeral dislocation but there appears to be dynamic angulation with the view that both causes the child pain and raises concern that the fracture may be more angulated enough to justify additional workup and/or treatment.

humerus fracture that were 17 years of age and younger at the time of the injury and that were evaluated for shoulder injury with radiographic views (anteroposterior, internal/external rotation views, scapular-Y view, axillary view) and/or advanced imaging (CT or MRI). The exclusion criteria were patients over the age of 17 years at the time of the injury, patients without a true proximal humerus fracture and patients with pathological fractures. Patients were also excluded if they had less than 21 days of follow-up. A patient search was run for all patients: 1) 17 years and younger; 2) seen between the dates of 01 February 2007 to 01 February 2017; 3) treated in our primary hospital or affiliated orthopaedics clinics, emergency rooms or urgent care centres; and 4) seen for any of the following International Classification of Diseases-9 codes: 812, 812.0, 812.00, 812.01, 812.02, 812.03, 812.09, 812.1, 812.10, 812.11, 812.12, 812.13, 812.19, 812.2, 812.20, 812.21, 812.3, 812.30, 812.31. These codes correlate with open or closed fractures of the upper end of the humerus, shaft or unspecified part of the humerus.

In this study we defined a proximal humerus fracture as an extra-articular fracture near the proximal end of the humerus in which the width of the cortex at the site of the fracture was less than or equal to one-half the width of the cortex at its thickest point in the diaphysis.

We recorded each patient's gender, date of birth, mechanism of injury, date of injury, date of first medical encounter and of each subsequent encounter related to the humerus fracture and imaging modalities and views available at each visit. We also reviewed the written medical records from each visit to determine if there were any clinical indications of unusual pain or long-term complications suggesting an undiagnosed shoulder dislocation. Finally, we reviewed the patient's radiographic imaging to determine presence or absence of glenohumeral dislocation, size of humeral shaft and fracture displacement, angulation and classification (Salter Harris type I, Salter Harris type II,[13] all metaphyseal or other). Displacement, angulation and humeral shaft size were measured in anteroposterior and scapular-Y views, when available. Absolute values were used for all measurements.

Results

A total of 218 children were enrolled in this study with two patients having bilateral proximal humerus fractures, for a total of 220 fractures. The average age was 9.8 years SD 3.8. Demographics are listed in Table 1. Overall, there were a variety of mechanisms of injury, with the majority being from falls (49.1%) or sports injuries (38.1%), most commonly football (Table 2). Most of the fractures were entirely metaphyseal, making up 80.5% of the total number of humerus fractures observed (Table 3). Mean absolute fracture displacement and angulation were 3.5 mm sd 5.8 and 16.8° sd 17.0°, respectively, in the anteroposterior view, and 4.2 mm sd 8.2 and 20.6° sd 18.1°, respectively, in the scapular-Y view (Table 4). The majority of patients had isolated proximal humerus fractures, however, 12 (5.5%) of the patients had additional injuries, with a total of four distal radius fractures, three ulnar shaft fractures, one radius and ulnar shaft fracture, one humerus shaft fracture for an overall segmental pattern, one clavicle shaft fracture, one acromion avulsion fracture,

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Table 1 Gender and ethnicity of the patients

	Patients (n)	Patients (%) (n = 218)
Gender		
Male	121	*55.5*
Female	97	*44.5*
Ethnicity		
Caucasian	145	*66.5*
African American	58	*26.6*
Asian	1	*0.5*
Hispanic	0	*0*
Unknown/Other	14	*6.4*

Table 2 Distribution of mechanisms of injury

	Patients (n)	Patients (%) (n = 218)
Falls	107	*49.0*
From couch or higher	66	*30.3*
Down stairs	6	*2.8*
From motorized car, dirtbike or hoverboard	5	*2.3*
Unspecified height	30	*13.8*
Athletic activity	83	*38.1*
Football	25	*11.5*
Baseball	2	*0.9*
Soccer	3	*1.4*
Basketball	4	*1.8*
Gymnastics	4	*1.8*
Horseback riding	5	*2.3*
Ice skating	1	*0.5*
Snowboarding	6	*2.8*
Skateboarding/rollerblading	1	*0.5*
Skiing	4	*1.8*
Dive on grass	1	*0.5*
Wrestling	6	*2.8*
Sledding	2	*0.9*
Trampoline	11	*5.1*
Bicycle/scooter	8	*3.7*
Other	15	*6.9*
Struck by vehicle	7	*3.2*
Direct trauma	1	*0.5*
Seizure	1	*0.5*
Arm restrained behind back while being arrested	2	*0.9*
Birth injury	1	*0.5*
Infant being dressed	1	*0.5*
Motor vehicle accident	2	*0.9*
Unknown (Unspecified)	13	*6.0*

one proximal femur fracture, one metacarpal fracture and one great toe fracture.

Of the 220 paediatric proximal humerus fractures reviewed, radiologic evaluation showed no evidence of shoulder dislocation in any of the patients. On the initial visits, 146 had AP shoulder views, 135 had scapular-Y views, eight had transthoracic views, 25 had axillary views, one had a Grashey view, 100 had AP humerus views, and 101 had lateral humerus views. None of the patients had advanced imaging done on their first visit, and only one had an MRI on a subsequent visit. In addition to review of radiography, physician notes of initial visit and follow-up visits were also reviewed. All patients included in the study had at least one follow-up visit 21 days after the injury or later. Review of all physician notes revealed no mention of persistent pain or significantly limited range of motion to suggest missed dislocation in any of the children.

Table 3 Fracture classifications

	Proximal humerus fractures (n)	Proximal humerus fractures (%) (n = 220)	Average age (SD) (yrs)
Salter Harris I	18	*8.2*	12.2 (3.5)
Salter Harris II	24	*10.9*	11.9 (2.9)
All metaphyseal	177	*80.5*	9.3 (3.6)
Segmental shaft fracture	1	*0.5*	2.0 (0)

Table 4 Average displacement, angulation and humeral shaft sizes

	Anteroposterior view		Scapular-Y view	
	Average (mm)	SD	Average (mm)	SD
Displacement	3.5	5.8	4.2	8.2
Size of humeral shaft	16.3	3.7	17.8	5.5
Angulation	16.8°	17.1°	20.6°	18.1°

Discussion

Although clinical practice may differ from the general guidelines, review of the literature requires a full trauma series (including true anteroposterior, scapular-Y and axillary views) for thorough evaluation of a patient with a shoulder injury.[4,11,12] These recommendations exist because anteroposterior and scapular-Y views are not adequate to rule out shoulder dislocation in adults. While the consequences of missing a shoulder dislocation can be severe, the procedure required to obtain an axillary view in a paediatric patient with a proximal humerus fracture can be painful and cause dynamic angulation of the fracture (Fig. 1). To our knowledge, no previous study has rigorously explored the association between proximal humerus fracture and shoulder dislocation in children.

This study found that dislocation of the glenohumeral joint is exceedingly rare in children with proximal humerus fractures, with none of the 220 humerus fractures showing evidence of a dislocation. Our patient population spanned both genders, some variation of ethnicities and a wide range of age at the time of the injury. Additionally, our patients were involved in many different mechanisms of injury, including high- and low-energy mechanisms. Given these findings, in paediatric proximal humerus fractures we recommend axillary views or advanced imaging to rule out glenohumeral dislocation only when there is a concerning mechanism of injury, particularly a high-energy accident such as a motor vehicle accident or sports injury, or concern for possible subluxation or dislocation on standard radiographic views.

The existence of paediatric fracture-dislocations of the shoulder has been well described in the literature, particularly in the form of individual case reports.[5–9] The children in these five case reports ranged from 2 to 11 years of age with a mix of high- and low-energy mechanisms of injury: a fall from 1.5 metres,[5] a fall down a 75-foot river embankment,[6] a fall from undisclosed height,[7] a fall from

stroller[8] and a fall from a ladder.[9] There were two each Salter Harris I and II fractures and one metaphyseal fracture, and the humeral head and glenoid were not articulating on the anteroposterior view in four cases, while in the fifth case the humeral head was notably inferiorly positioned with the physis inferior to the level of the inferior glenoid and dislocation confirmed with bilateral anteroposterior views of the humerus,[5–9] overall indicating that axillary imaging was not necessary to diagnose the dislocation.

This study does have important limitations. The literature describes paediatric fracture-dislocations of the shoulder as generally being associated with high-energy injuries.[11] Many of the patient injuries in this study would not qualify as high-energy injuries, thus making it less likely for fracture-dislocation to occur. However, the case reports that we are aware of did include low energy mechanisms, and this study provides useful information for when a child presents with a proximal humerus fracture of a milder mechanism. Given the retrospective nature of our study, the majority of children did not have axillary views or advanced imaging at the time of injury. However, all children had a follow-up at least 21 days after the injury occurred, and we suspect that a missed shoulder dislocation would be relatively obvious on clinical follow-up. In addition, all five case reports of proximal humerus fractures in the literature had clear signs of dislocation on the anteroposterior view with the humeral head visibly dissociated from the glenoid fossa.

In summary, this study has determined the incidence of glenohumeral dislocation in the context of paediatric proximal humerus fracture to be very low. Due to the rarity of fracture-dislocation of the shoulder in children, we hypothesize that an axillary radiograph is not necessary in every case of paediatric proximal humerus fracture as some authors recommend.[4,11,12] Instead, we recommend that a physician be selective in ordering an axillary radiograph in order to decrease exposure to radiation, limit patient discomfort and avoid possible risk of dynamic angulation of the fracture. In cases of a high-energy mechanism or concerning appearance clinically or radiographically in anteroposterior and scapular-Y views, clinicians should still consider axillary views or advanced imaging to rule out potential glenohumeral dislocation.

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COMPLIANCE WITH ETHICAL STANDARDS

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No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

ETHICAL STATEMENT

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed Consent: Not required for this work.

ICMJE CONFLICT OF INTEREST STATEMENT

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REFERENCES

1. **Landin LA.** Epidemiology of children's fractures. *J Pediatr Orthop B* 1997;6:79–83.

2. **Khmelnitskaya E, Lamont LE, Taylor SA, et al.** Evaluation and management of proximal humerus fractures. *Adv Orthop* 2012;2012:861598.

3. **Jo MJ, Gardner MJ.** Proximal humerus fractures. *Curr Rev Musculoskelet Med* 2012;5:192–198.

4. **Malik S, Chiampas G, Leonard H.** Emergent evaluation of injuries to the shoulder, clavicle, and humerus. *Emerg Med Clin North Am* 2010;28:739–763.

5. **Isik M, Subasi M, Cebesoy O, Koca I, Pamukcu U.** Traumatic shoulder fracture-dislocation in a 7-year-old child: a case report. *J Med Case Reports* 2013;7:156.

6. **Obremskey W, Routt ML Jr.** Fracture-dislocation of the shoulder in a child: case report. *J Trauma* 1994;36:137–140.

7. **Nugpok O, Menon J, Satyanarayana P**. Fracture dislocation shoulder in a 3-year-old. *Eur J Orthop Surg Traumatol* 2010;20:333–334.

8. **Winmoon C, Sathira-Angkura V, Kunakornsawat S, Prasartritha T.** Fracture-dislocation of the glenohumeral joint in a 2-year-old child: case report. *J Trauma* 2003;54:372–375.

9. **Jin S, Cai H, Xu Y.** Shoulder dislocation combined with proximal humerus fracture in children: a case report and literature review. *Medicine (Baltimore)* 2017;96:e8977.

10. **Burkhart KJ, Dietz SO, Bastian L, et al.** The treatment of proximal humeral fracture in adults. *Dtsch Arztebl Int* 2013;110:591–597.

11. **Popkin CA, Levine WN, Ahmad CS.** Evaluation and management of pediatric proximal humerus fractures. *J Am Acad Orthop Surg* 2015;23:77–86.

12. **Shrader MW.** Proximal humerus and humeral shaft fractures in children. *Hand Clin* 2007;23:431–435, vi.

13. **Salter RB, Harris WR.** Injuries involving the epiphyseal plate. *J Bone Joint Surg [Am]* 1963;45;587–622.