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Author	Family Name	**Miller**
	Particle	
	Given Name	**Christopher**
	Suffix	
	Division	Clarendon Wing Radiology Department
	Organization	Leeds Children's Hospital, Leeds Teaching Hospitals NHS Trust, Leeds Children's Hospital at The Leeds General Infirmary
	Address	Leeds LS2 9NS, UK
Author	Family Name	**Grainger**
	Particle	
	Given Name	**Andrew**
	Suffix	
	Division	Department of Radiology
	Organization	Chapel Allerton Hospital, Leeds Teaching Hospitals NHS Trust
	Address	Leeds, UK
Author	Family Name	**Phillips**
	Particle	
	Given Name	**Robert**
	Suffix	
	Division	Department of Paediatric Oncology
	Organization	Leeds Children's Hospital, Leeds Teaching Hospitals NHS Trust
	Address	Leeds, UK
Author	Family Name	**Sabouni**
	Particle	
	Given Name	**Mohamed**
	Suffix	
	Division	Department of Paediatric Orthopaedic Surgery
	Organization	Leeds Children's Hospital, Leeds Teaching Hospitals NHS Trust
	Address	Leeds, UK
	Family Name	**Kraft**

Corresponding Author	Particle	
	Given Name	**Jeannette K.**
	Suffix	
	Division	Clarendon Wing Radiology Department
	Organization	Leeds Children's Hospital, Leeds Teaching Hospitals NHS Trust, Leeds Children's Hospital at The Leeds General Infirmary
	Address	Leeds LS2 9NS, UK
	e-mail	Jeannette.Kraft@nhs.net

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Abstract	A 4-year-old boy presented with swelling over the inferior tip of the scapula and an unclear history. Initial radiographic findings were concerning for an aggressive lesion. This case highlights how a multimodality imaging approach was used to relieve uncertainty by diagnosing a paediatric bowing type fracture of the scapular tip.

Keywords (separated by '-')	Child - Fracture - Magnetic resonance imaging - Radiography - Scapula - Ultrasound
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CASE REPORT

Bowing fracture of the inferior angle of the scapula, a difficult diagnosis

Christopher Miller[1] · Andrew Grainger[2] · Robert Phillips[3] · Mohamed Sabouni[4] · Jeannette K. Kraft[1]

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Abstract A 4-year-old boy presented with swelling over the inferior tip of the scapula and an unclear history. Initial radiographic findings were concerning for an aggressive lesion. This case highlights how a multimodality imaging approach was used to relieve uncertainty by diagnosing a paediatric bowing type fracture of the scapular tip.

Keywords Child · Fracture · Magnetic resonance imaging · Radiography · Scapula · Ultrasound

Introduction

Scapula fractures occur infrequently in children and are usually the result of major trauma with multiple injuries. This is because the scapula is well protected by surrounding musculature. Therefore, fractures usually involve the glenoid, coracoid process and acromion. Fractures of the inferior angle of the scapula are very rare in children with only a few case reports in the literature [1–4]. They usually represent avulsion fractures due to the action of serratus anterior or latissimus dorsi muscles [1].

Case report

A 4-year-old boy presented to the emergency department at an outside institution with swelling over the left scapula noticed by his mother. Earlier that day, he had fallen down stairs and landed on his back without apparent initial sequelae. It was uncertain if the swelling predated the injury. Physical examination revealed a painless lump over the left scapula, with full range of movement at the left shoulder joint. The patient was otherwise well with no significant medical or family history.

Radiographs performed in the emergency department demonstrated an irregular bony mass projecting towards the chest wall from the inferior angle of the scapula (Fig. 1). Routine blood tests including inflammatory markers were normal except for low vitamin D values of 12.7 nmol/L (<30 nmol/L suggests vitamin D deficiency). Blood cultures were negative.

The boy was referred to the paediatric oncology department at our institution as the plain film findings were suspicious for an aggressive bone lesion. A US scan performed 5 days after the initial presentation demonstrated a curved inferior scapular border with an angled cartilaginous tip of the scapula. Associated was an ill-defined mass-like area with increased vascularity and surrounding soft-tissue oedema (Fig. 2). Concerns regarding malignancy triggered further investigations. An MR scan performed 10 days after the initial presentation showed no soft-tissue mass but extensive muscle and soft-tissue oedema surrounding a bony ridge at the inferior angle of the scapula with bone marrow oedema. Post gadolinium marked enhancement was seen in the bone and surrounding tissues (Fig. 3). A CT scan demonstrated a curved scapular tip with surrounding periosteal reaction and early

✉ Jeannette K. Kraft
Jeannette.Kraft@nhs.net

[1] Clarendon Wing Radiology Department, Leeds Children's Hospital, Leeds Teaching Hospitals NHS Trust, Leeds Children's Hospital at The Leeds General Infirmary, Leeds LS2 9NS, UK

[2] Department of Radiology, Chapel Allerton Hospital, Leeds Teaching Hospitals NHS Trust, Leeds, UK

[3] Department of Paediatric Oncology, Leeds Children's Hospital, Leeds Teaching Hospitals NHS Trust, Leeds, UK

[4] Department of Paediatric Orthopaedic Surgery, Leeds Children's Hospital, Leeds Teaching Hospitals NHS Trust, Leeds, UK

Fig. 1 Lateral radiograph of a 4-year-old boy with scapular bowing fracture. The inferior tip of the scapula appears mass-like with bony irregularity (*arrow*)

callus formation (Fig. 4). When compared with the normal right scapula, it was apparent that the inferior tip of the scapula had folded inwards in keeping with a bowing or plastic deformation fracture. The boy was managed conservatively as he was pain free. At follow-up 3 months later, a healing fracture with hard callus formation and a well-rounded inferior scapula tip was demonstrated on a radiograph. Clinical examination revealed normal range of shoulder movement.

Discussion

In contrast to the common types of scapula fractures, which usually require high force, inferior angle fractures can be sustained in isolation and with lower levels of trauma. Fractures of the inferior angle of the scapula are very rare. It should be considered that fractures in such an unusual location may be related to non-accidental injury, especially if there is no history of trauma or, as in our case, the causality is not initially apparent. We identified three previously reported cases in children [1–4]. These papers describe the mechanism of injury as avulsion due to the strong action of periscapular muscles such as serratus anterior or latissimus dorsi. In our case, the mechanism of injury is likely direct trauma with a blow to the lower aspect of the scapula that occurred on the day of presentation to the emergency department. Impact on the edge of a step as the boy fell must have caused inwards folding of the scapular tip in a paediatric-type plastic deformation pattern. The diagnostic difficulty arose from the plain radiographic appearances of an aggressive lesion, which is probably related to the radiographic projection and difficulty in depicting the blade of the scapula in a true lateral projection as can be achieved with CT. Initially, the preceding traumatic event was not given enough consideration to suggest an unusual fracture, leading to further investigations and referral to oncology clinic. Therefore, sonography was performed several days after presentation when the injury had started to heal with increased vascularity and granulation tissue suggesting a more aggressive process. As demonstrated in a case report by Szopinski, Adamczyk and Drwiega [2], the cartilaginous part

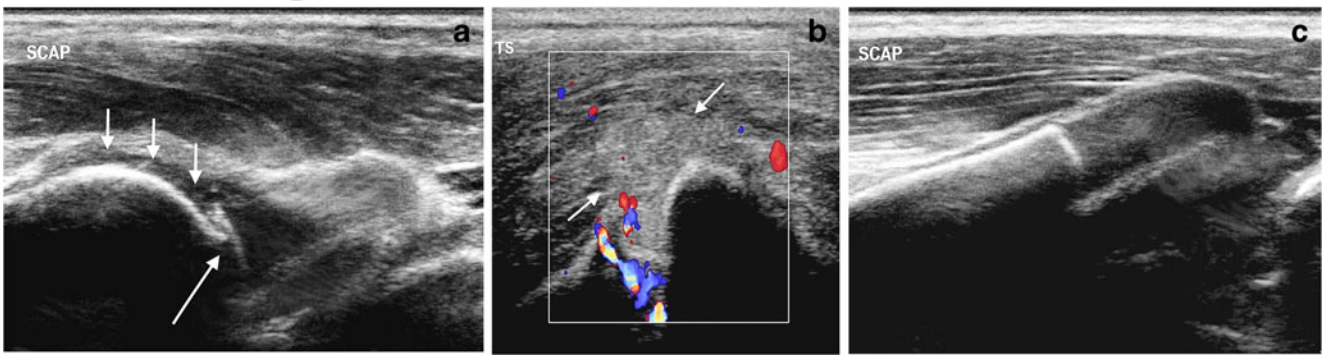

Fig. 2 Sonograms of a 4-year-old boy with scapular bowing fracture. **a** Long section through the inferior tip of the scapula shows a curved scapular edge (*short arrows*) with angulation just above the cartilaginous tip (*long arrow*). **b** Transverse section demonstrates a mass-like area (*arrow*) with increase in vascularity on colour Doppler related to healing of the fracture. **c** Long section through the inferior tip of the right scapula is shown for comparison

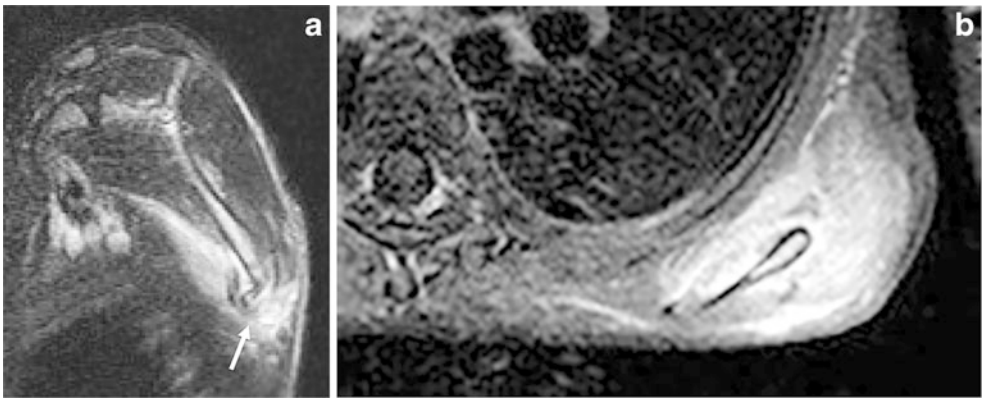

Fig. 3 MR images of a 4-year-old boy with scapular bowing fracture. **a** Sagittal STIR image of the left scapula demonstrates marked soft tissue and muscle oedema surrounded by the folded inferior tip of the scapula *(arrow)*. **b** Axial gadolinium-enhanced T1 fat-saturated image demonstrates prominent enhancement within the soft tissues surrounding the scapular tip

of the scapular tip, which ossifies around puberty, is well-demonstrated with US. Angulation of it in our case probably suggests associated detachment at the bone cartilage interface (Fig. 2). This could be related to direct trauma or an avulsion type component related to the action of the serratus anterior muscle on the inferior aspect of the scapula. Avulsion injuries of the tip of the scapula are rare but have been previously described [1–4]. However, the case presented here is not a simple avulsion injury. Bowing of the scapula was not described in any of the previously published cases we identified and detachment or dysfunction of the serratus anterior muscle would lead to winging of the scapula, which was not observed in our case [1, 5]. Another twocases previously described paediatric-type greenstick fractures in children [6, 7]. Similar to our case, both cases occurred after low-energy trauma. However, these greenstick fractures were associated with significant scapular winging.

In our case, the fracture was stable against the chest wall, which probably explains why the child presented with a painless lump. It is likely that the fracture was initially painful, which was not communicated by the young child. Once a fracture is stabilised, it usually becomes pain free.

MRI is not commonly used to investigate fractures in children. Therefore, an unusual healing fracture in an unusual location is difficult to diagnose by MRI, especially in a child referred from oncology clinic. The marked muscle oedema and enhancement together with early callus formation suggested a more aggressive or inflammatory lesion (Fig. 3). CT, however, provides superior bone detail suitable to demonstrate periosteal reaction and callus formation. CT is usually reserved for complex fractures and preoperative planning, but its multiplanar and surface-rendered 3-D imaging capabilities finally revealed the true nature of the lesion (Fig. 4). A previous case report details a similar situation where a suspicious lesion was seen on plain film and MRI, with a bone biopsy only avoided when a fracture line was identified on the chest CT performed for staging purposes [8].

In contrast to a reported case of avulsion of the cartilaginous tip of the inferior angle of the scapula that was surgically treated, our patient was conservatively managed with no ill effects to his shoulder and scapular function [2]. Chang et al. [1] recently reviewed the literature and identified 10 cases of inferior angle fractures. The review

Fig. 4 CT images of a 4-year-old boy with scapular bowing fracture. **a** Sagittal CT image (bone window) shows angulation of the tip of the scapula with callus formation (*arrow*). **b** 3-D reconstruction demonstrates the folded and rounded tip of scapula (*arrow*) that leads to shortening of the scapular body when compared to the normal right side

included 2 children (a 13- and a 17-year-old) who both had undisplaced fractures successfully managed conservatively. The paper suggests that displaced fractures, however, should be surgically treated to avoid painful non-union [1]. This case illustrates how multimodality imaging can be utilised to reach a diagnosis when plain films reveal unusual appearances and the history is uncertain. Whilst in hindsight US and MRI could have been avoided, neither of these carries a radiation burden. It was important to recognise this rare fracture involving the inferior angle of the scapula and exclude sinister pathology.

Compliance with ethical standards

Conflicts of interest None.

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