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

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

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Christopher Miller<sup>1</sup> · Andrew Grainger<sup>2</sup> · Robert Phillips<sup>3</sup> · Mohamed Sabouni<sup>4</sup> · Jeannette K. Kraft<sup>1</sup>

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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.

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

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**Introduction**

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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

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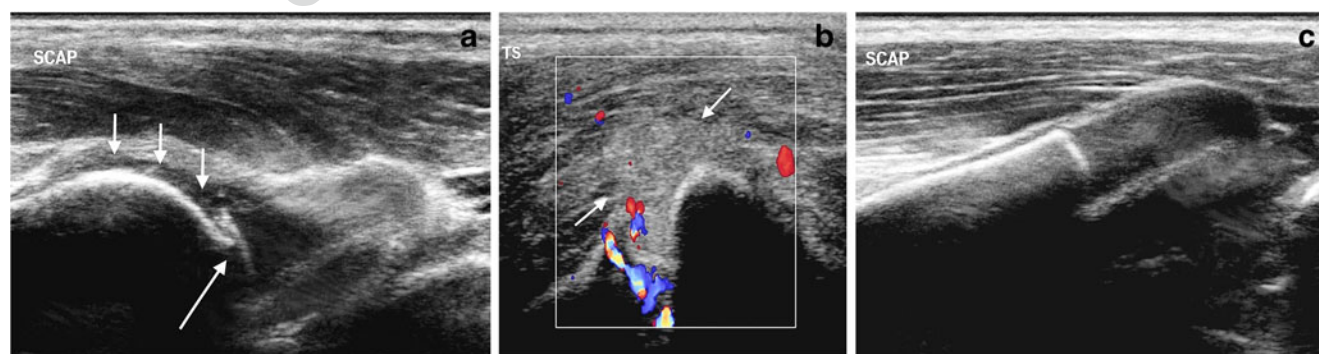
**Fig. 1** Lateral radiograph of a 4-year-old boy with scapular bowing fracture. The inferior tip of the scapula appears mass-like with bony irregularity (*arrow*)

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

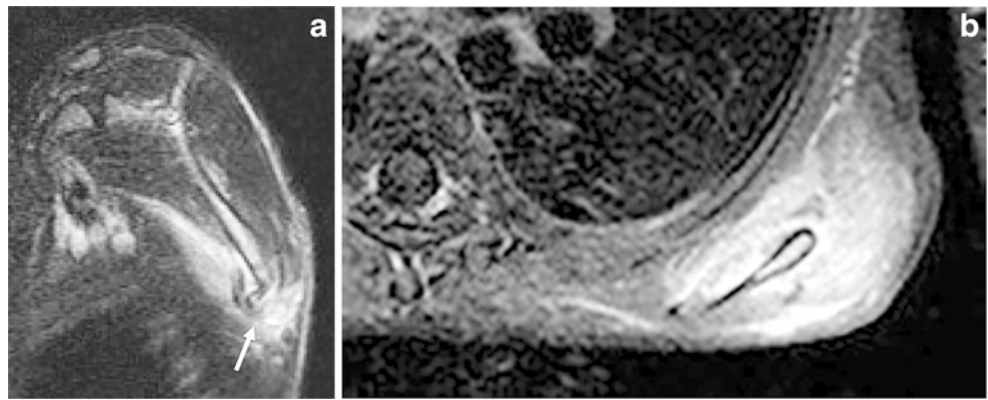
callus formation (Fig. 4). When compared with the normal right scapula, it was apparent that the inferior tip of the scapula had folded inwards in keeping with a bowing or plastic deformation fracture. The boy was managed conservatively as he was pain free. At follow-up 3 months later, a healing fracture



**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



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

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

117 MRI is not commonly used to investigate fractures in  
 118 children. Therefore, an unusual healing fracture in an un-  
 119 usual location is difficult to diagnose by MRI, especially  
 120 in a child referred from oncology clinic. The marked mus-  
 121 cle oedema and enhancement together with early callus  
 122 formation suggested a more aggressive or inflammatory  
 123 lesion (Fig. 3). CT, however, provides superior bone de-  
 124 tail suitable to demonstrate periosteal reaction and callus  
 125 formation. CT is usually reserved for complex fractures  
 126 and preoperative planning, but its multiplanar and surface-  
 127 rendered 3-D imaging capabilities finally revealed the true  
 128 nature of the lesion (Fig. 4). A previous case report details  
 129 a similar situation where a suspicious lesion was seen on  
 130 plain film and MRI, with a bone biopsy only avoided  
 131 when a fracture line was identified on the chest CT per-  
 132 formed for staging purposes [8].

133 In contrast to a reported case of avulsion of the cartilag-  
 134 inous tip of the inferior angle of the scapula that was sur-  
 135 gically treated, our patient was conservatively managed  
 136 with no ill effects to his shoulder and scapular function  
 137 [2]. Chang et al. [1] recently reviewed the literature and  
 138 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



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

150 **Compliance with ethical standards**

151 **Conflicts of interest** None.

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