Paediatric post-traumatic osseous cystic lesion following a distal radial fracture

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ABSTRACT

Post-traumatic osseous cystic lesions are a rare complication in children. An aetiology of intramedullary fat seepage through the damaged bone cortex and its entrapment within the subperiosteum has been proposed. These lesions run a benign course and usually resolve spontaneously. The presence of fatty marrow gives it a distinct appearance which aids in its diagnosis and differentiation from other bone lesions. This case demonstrates a fat-fluid level within the subperiosteal cystic lesion in Magnetic Resonance Imaging (MRI) and this is a typical feature of post-traumatic cystic lesion in a child. Recognition of this imaging feature allows for a confident diagnosis, cutting down on unnecessary, potentially invasive investigations.

CASE REPORT

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A 13-year-old boy presented with pain over the left wrist after a fall. Clinical examination revealed tenderness over the joint line over both radius and ulnar aspects ventrally, minimal overlying soft tissue swelling and limited range of movement.

Initial left wrist radiograph showed a fracture line extending to the epiphyseal plate with mild dorsal displacement of the radial epiphysis suggestive of Salter-Harris Type 2 fracture of the distal radius. There was slight widening of the distal radioulnar joint space (Figure 1).

Patient was treated with fibreglass cast for 4 weeks. While follow up radiographs revealed healing process of the fracture (Figure 2), the subsequent radiograph 3 months later yielded a well-circumscribed lucent lesion without surrounding sclerosis adjacent to the site of previous fracture (Figure 3).

No sign of inflammation was noted.

MRI of the left wrist showed a heterogenous subperiosteal cystic structure within the dorsal aspect of the left distal radius, measuring 5 mm (Anteroposterior) x 10 mm (Transverse) x 14 mm (Craniocaudal). It contained an upper layer of T1W hyperintensity (Figure 4A) which was suppressed on fat sat sequence consistent with fat content (Figure 4B). The lower layer was T1W hypointense and T2W hyperintense (Figure 4C) and likely represented a chronic subperiosteal haematoma. This structure was likely to correspond with the lucent lesion seen in prior radiograph. Post contrast study demonstrated mild enhancement along the periosteal reaction and in adjacent soft tissue (Figure 4D, 4E). The MRI features confirmed a fat-fluid level within the subperiosteal cystic lesion in MRI typical of post-traumatic osseous cystic lesion in a child.

No further investigation or treatment was required.

Follow up at 6-12 months was offered to the patient (follow up images not available).

DISCUSSION

Demographics:

Greenstick fractures are the most common injuries in children. A "greenstick" fracture is one that perforates one cortex and ramifies within the medullary bone, and is usually the result of angular forces. Usually, the healing is uncomplicated and does not require long term follow up.

Development of a radiolucent lesion after a fracture is rare. The incidence is unknown. To our knowledge, only 30 cases have been reported in the English language medical literature [1, 2]. Of these lesions, 90% are located in the distal radius with an age range of 18 months to 15 years and an average age of 7.5 years [1].

Clinical & Imaging Findings:

These lesions are asymptomatic, and usually can be seen on routine follow-up of a fracture or evaluation of new re-injury of the same limb after trivial trauma. They usually appear more than one month after the fracture [3].

Axial MRI or Computed Tomography (CT) is sufficient to confirm the diagnosis in atypical cases without the need for biopsy. When imaged months after trauma, bone scans are normal [3,4]. Cross sectional imaging identifies the subperiosteal location, while the longitudinal, coronal and sagittal images show the periosteal stripping and smaller multiple adjacent lesions.

The CT images, T1W and fat-suppressed sequences on MRI show high fat content while the T2W gradient echo sequences show heterogenous signal likely to reflect the 'blooming' effect of hemosiderin or strands of bone across the lesion [5].

Typically the defects do not expand and they usually measure less than 10mm in diameter and are 10mm proximal to the compression fracture. Sequential radiographs show the lesions 'migrating' away from the growth plate. Defects appear rounded or slightly oval shaped, and may be multiple. The lesions are also atypically located opposite to the side of compression [5].

Aetiology:

The aetiology remains controversial. The theory of transcortical escape of intramedullary fat is supported by several studies [6, 7]. The content is likely to be blood, fat or an admixture. During the fracture event, there is release of intramedullary fat droplets floating on blood, which collects under the unbreached periosteum. The fat that leaks out could subsequently become visible as a cystic lesion while the subperiosteal haematoma becomes resorbed and calcified. Fracture healing results in the appearance of callus from the periosteum but separate from the original cortex [4, 7, 8]. The resultant gap gives rise to the apparent defect which is slowly filled by periosteal new bone formation. Eventually this space may become a new medullary cavity.

The rarity of the lesion is likely attributed to several reasons. The first is that the fracture itself needs to be of sufficient severity to produce a cortical breach large enough to allow extrusion of bone marrow fat, but moderate enough to leave the periosteum intact [8]. Secondly these fractures are seldom followed radiographically past the point of clinical union, which is usually before these lesions can be visualized on radiographs.

The loosely attached periosteum in children is thick and relatively more resistant than in adults rendering it more likely to remain unbreached. It is easily stripped and lifted away from the cortex of long bones, but it appears that other factors operate to make the radius the commonest bone to undergo this post-traumatic phenomenon [5].

Treatment & Prognosis:

They have a natural history that leads to resolution between 1 and 3 years depending on the size of the initial lesion. Healing of the initial fracture is not affected by these cysts, nor do they predispose to pathological fractures [3]. Detection of these defects generally causes concern due to their rarity. Typically lesions require no treatment or follow-up, but with the advice that they may cause future discomfort under stress prior to resolution. Review at 6 to 12 months later may be considered to ensure that the lesion remains asymptomatic [3].

Differential Diagnoses:

Osteomyelitis (Brodie abscess)

The main differential in this case is osteomyelitis (Brodie abscess). Common sites of involvement in decreasing order of frequency are long bone metaphysis (femur > tibia > humerus), short bones, pelvis and followed by spine. Absence of radiographic findings does not exclude osteomyelitis. The earliest finding is soft tissue swelling next to the bone. Bony destruction and periosteal reaction may be observed by 7-14 days after onset. MRI is the best advanced imaging choice if the diagnosis is unclear with localized symptoms and there is concern for complications (e.g. abscess). T2W fat-suppressed sequence shows bright marrow and soft tissue oedema. T1W fat-suppressed post-contrast sequence shows rim-enhancing abscesses (intraosseous, subperiosteal and soft tissue). Contrast enhanced CT shows rim enhancement of the abscesses, although less conspicuous than on MRI. Bone CT parallels the radiographs which detects early cortical change.

Eosinophilic granuloma

Eosinophilic granuloma has extremely variable appearance. Most common presentation is solitary, well-defined, lytic, beveled skull lesion without sclerotic rim. Common sites of involvement in decreasing order of frequency are skull, mandible, ribs (expansile lesion), femur, pelvis and followed by spine. Periosteal reaction is variable. MRI shows homogenous low T1W signal and heterogenous high signal in fluid-sensitive sequence. Intense contrast enhancement of marrow abnormality and any soft tissue mass is observed. Periosteal reaction is outlined by high signal on fluid-sensitive and post-contrast imaging. Marrow oedema is seen especially in early active lesions. On CT, beveled edge and sequestra are more easily identified on cranial lesions. FDG PET shows 35% more new or recurrent lesions than radiograph [9].

Aneurysmal bone cyst

Aneurismal bone cysts are thin-walled, blood-filled cystic cavities. Typical location of involvement is metaphysis. Common sites of occurrence in decreasing order of frequency are tubular long bones, lower leg, spinal posterior elements, pelvis, clavicle and ribs. Presentation is geographic eccentric expansile lucent lesion with multiloculation and markedly thin cortex. Periosteal reaction may be observed. MRI shows characteristic fluid-fluid (blood products) containing cavities of differing signal intensity and hypointense rim surrounding the aneurismal bone cyst. On CT, thin cortical rim may be better seen than on radiographs. Septa are visible. Fluid-fluid levels are also seen, however not obvious as on MRI. Studies have shown giant cell-containing lesions such as aneurysmal bone cysts may show a high accumulation of FDG with PET studies [10].

TEACHING POINT

In the prototypical setting of post-traumatic cyst in a paediatric patient, axial MRI or CT is sufficient to confirm the diagnosis without the need for further management other than reassurance and advise that they may occasionally cause discomfort but resolve with time.

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FIGURES

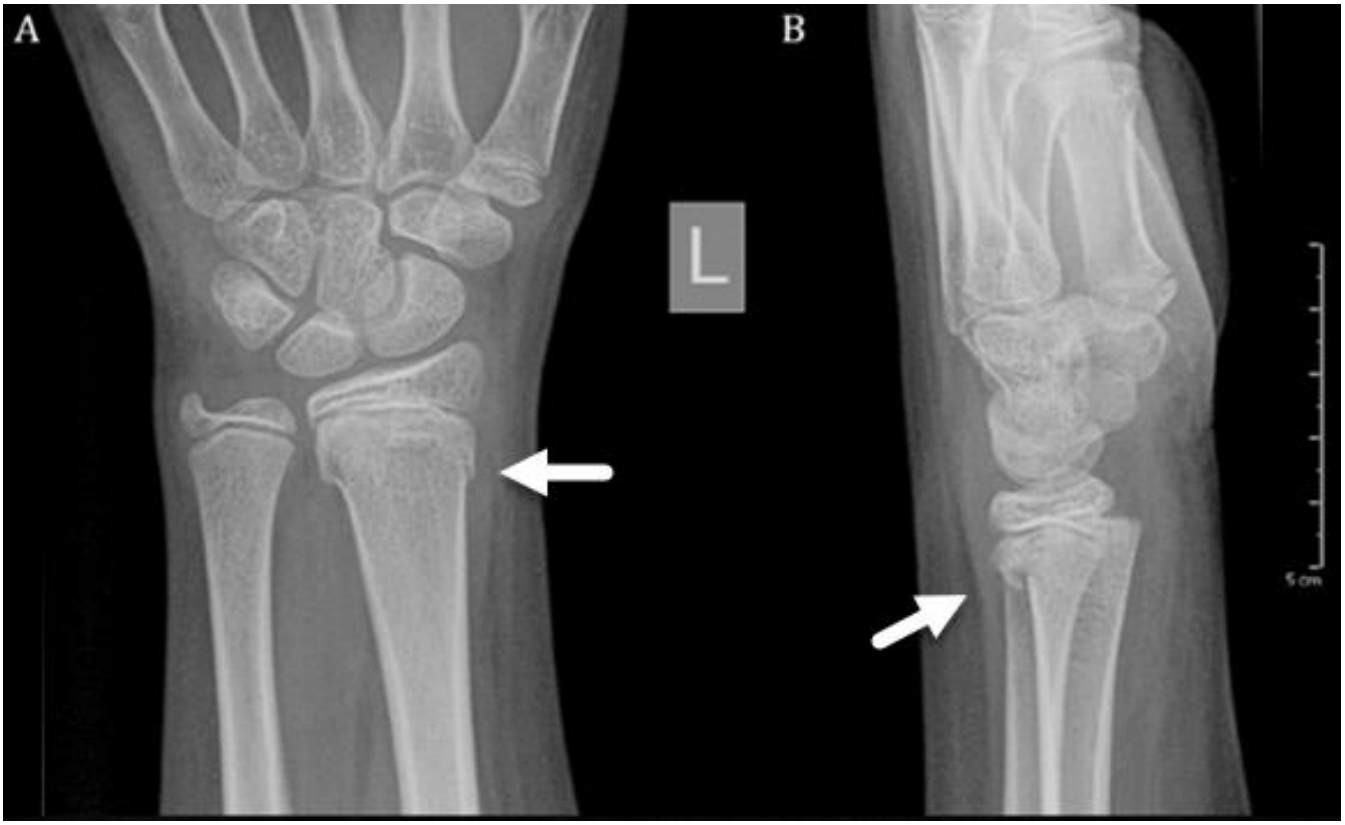

Figure 1: 13-year-old male with post-traumatic osseous cystic lesion following a distal radial fracture.
FINDINGS: A, Posteroanterior and B, Lateral radiographs of the left wrist demonstrate fracture of left distal radius (arrows), where the fracture line appears extending to the epiphyseal plate with mild dorsal displacement of the radial epiphysis suggestive of Salter-Harris Type 2 fracture of the distal radius. TECHNIQUE: Siemens, 45 kVp, 2.4 mAs

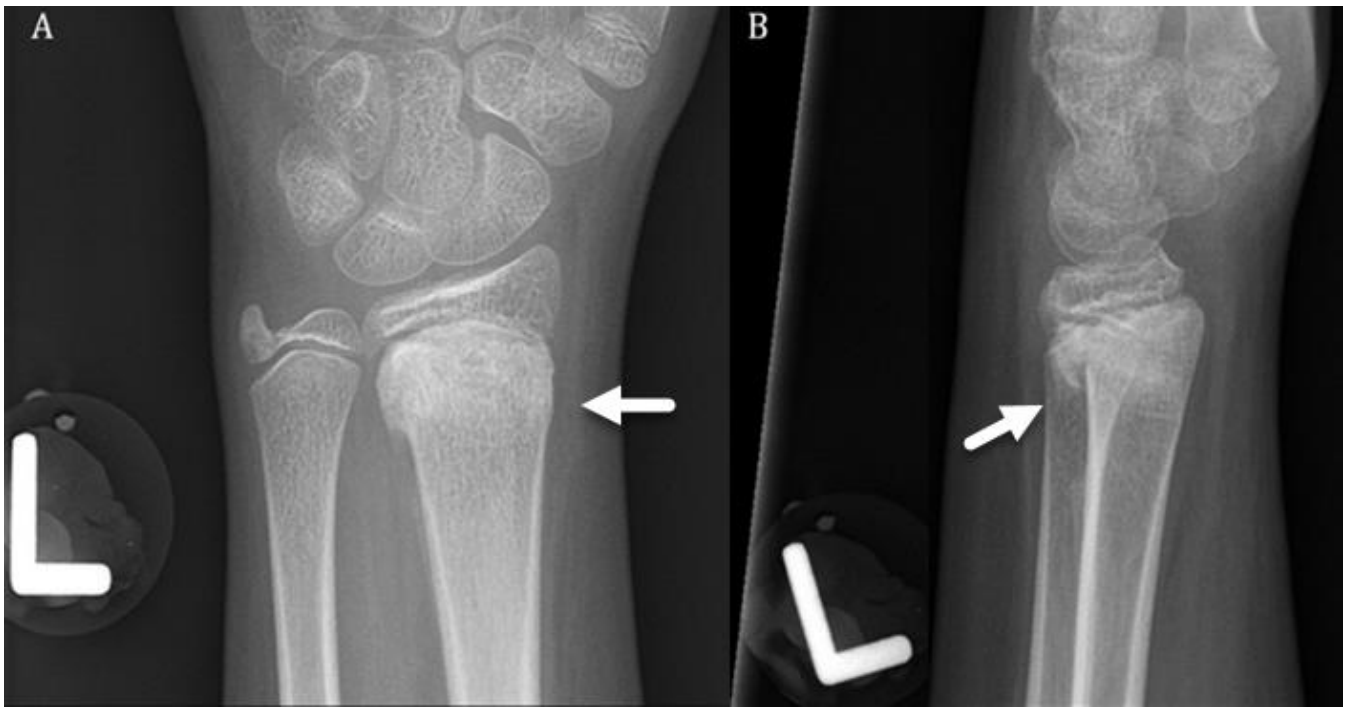

Figure 2: 13-year-old male with post-traumatic osseous cystic lesion following a distal radial fracture.
FINDINGS: A, Posteroanterior and B, Lateral follow up radiographs of the left wrist of the same patient reveal callus formation and periosteal reaction in keeping with healing process of the fracture (arrows), at 4 weeks after being treated with fibreglass cast. TECHNIQUE: Siemens, 45 kVp, 2.4 mAs

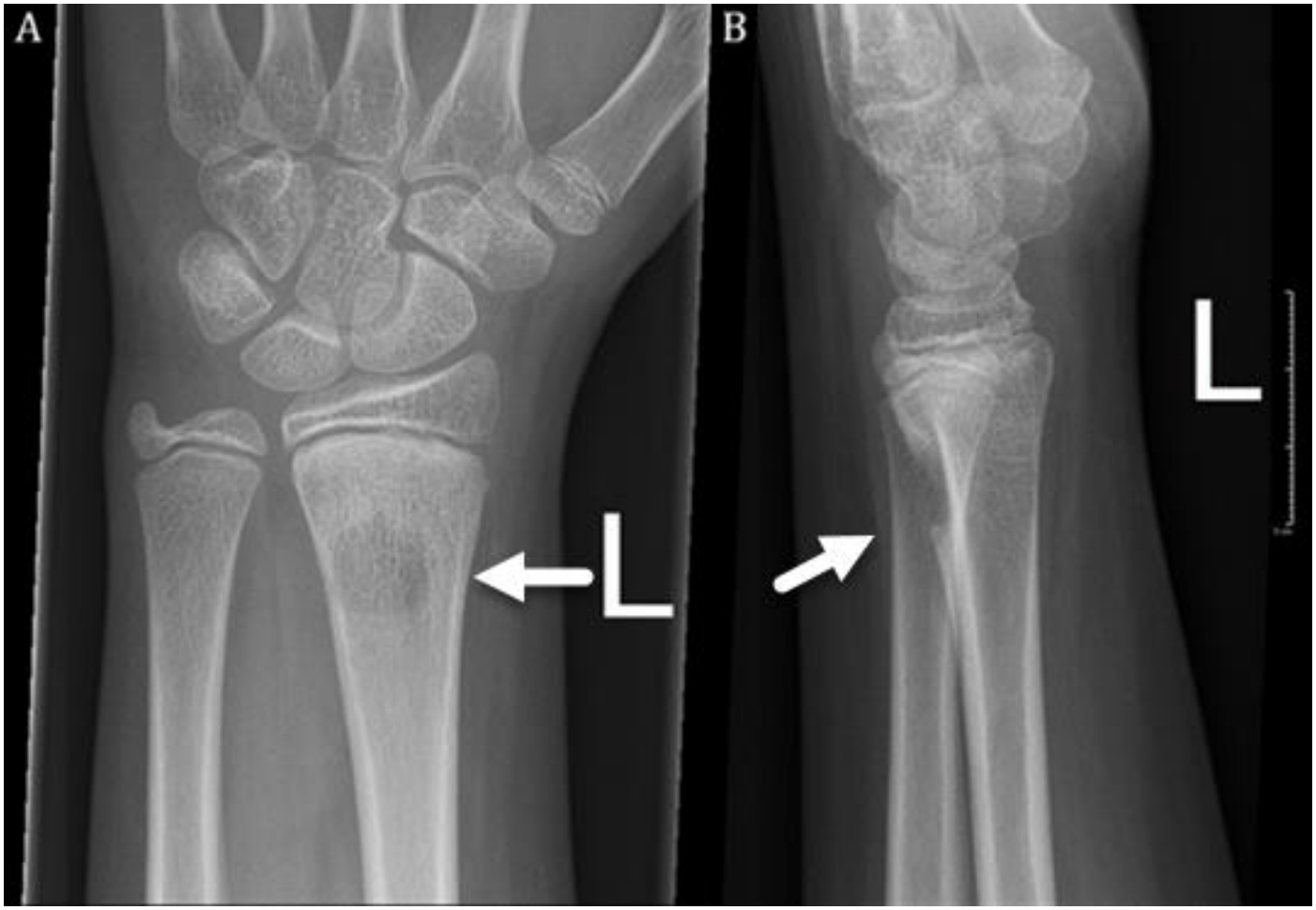

Figure 3: 13-year-old male with post-traumatic osseous cystic lesion following a distal radial fracture.
FINDINGS: A, Posteroanterior and B, Lateral radiographs demonstrate a well-circumscribed lucent lesion (arrows) without sclerotic rim based on the posterior cortex without scalloping adjacent to the prior fracture site at 3 months after the initial injury.
TECHNIQUE: Siemens, 45 kVp, 2.4 mAs

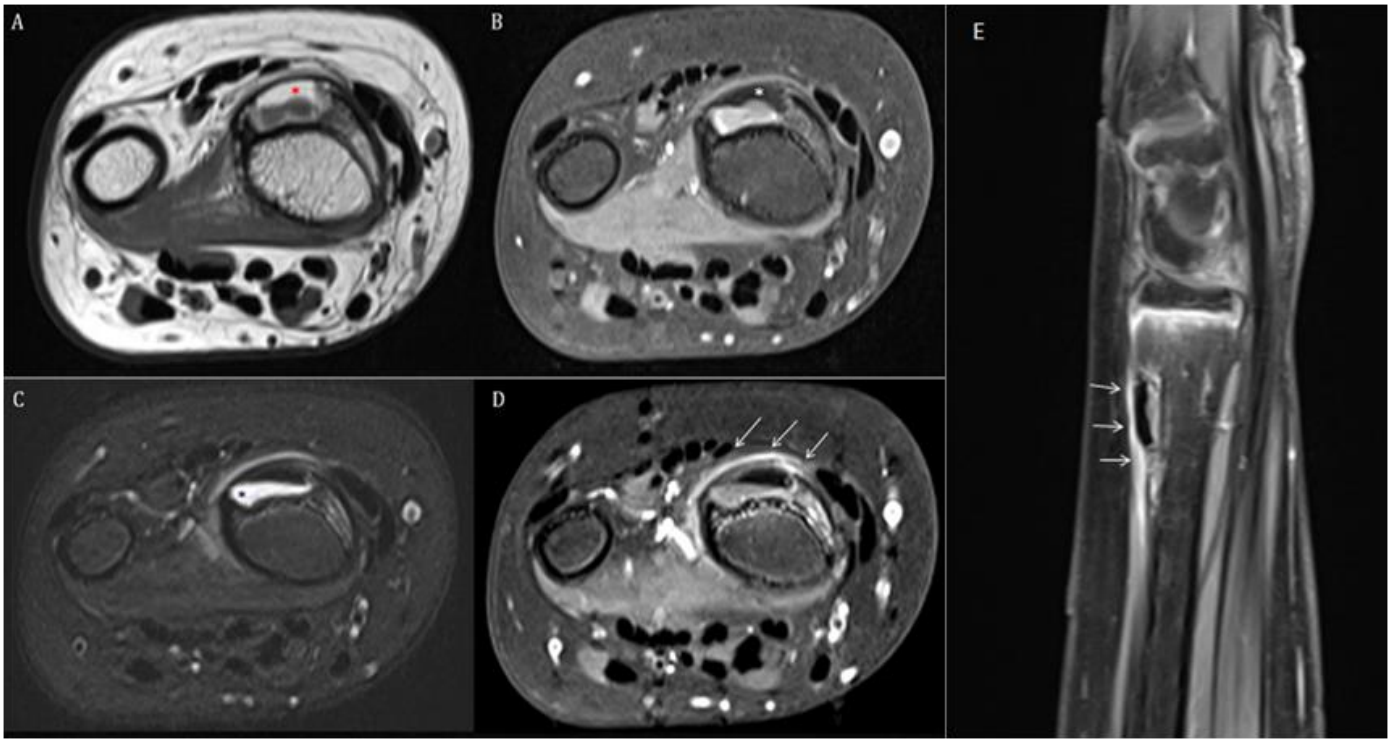

Figure 4: 13-year-old male with post-traumatic osseous cystic lesion following a distal radial fracture.
FINDINGS: Axial T1-weighted MR image (A) and axial T1-weighted fat-suppressed MR image (B) of the same patient's wrist demonstrating a subperiosteal cystic lesion along the dorsal cortex, containing an upper layer of high T1-weighted (red asterisk) and low T1-weighted fat-suppressed signal intensity (white asterisk) consistent with fat content. Axial T2-weighted fat-suppressed MR image (C) of the same patient's wrist showing the lower layer of high T2-weighted signal intensity (black asterisk) and low T1W signal (seen in A) likely to represent chronic subperiosteal haematoma. Axial T1-weighted fat-suppressed post intravenous gadolinium (D) demonstrates mild enhancement along the periosteal reaction and in adjacent soft tissue (arrows). Sagittal T1-weighted fat-suppressed post intravenous gadolinium (E) demonstrates mild enhancement along the periosteal reaction and in adjacent soft tissue (arrows).
TECHNIQUE: MRI. Magnetic Strength: 3.0 Tesla. Axial T1W: TE 12ms, TR 750; Axial T1W fat-suppressed: TE 12ms, TR 750; Axial T2W fat-suppressed: TE 79ms, TR 3410; Axial T1W fat-suppressed post contrast: TE 13, TR 650; Sagittal T1W fat-suppressed post contrast: TE 12, TR 700. Contrast: Intravenous Dotarem 10mls.

Etiology	During the fracture event, there is release of intramedullary fat droplets floating on blood, which collects under the unbreached periosteum.
Incidence	Unknown. To our knowledge, only 30 cases have been reported in the English language medical literature.
Gender ratio	Unknown
Age predilection	18 months to 15 years old. Average age of 7.5 years.
Risk factors	No known risk factors.
Treatment	No treatment is required. Follow up after 6 to 12 months to ensure the lesion remains asymptomatic.
Prognosis	Resolution between 1 and 3 years depending on the size of the initial lesion.
Findings on Imaging	• Cross sectional imaging identifies the subperiosteal location, while the longitudinal, coronal and sagittal images show the periosteal stripping and smaller multiple adjacent lesions. • The CT and MRI T1W and fat-suppressed sequences show high fat content; T2W gradient echo sequences show heterogenous signal likely to reflect the 'blooming' effect of hemosiderin or strands of bone across the lesion. • Typically the defects do not expand and they measure less than 10mm in diameter and are 10mm proximal to the compression fracture. Sequential radiographs show the lesions 'migrating' away from the growth plate. Defects appear rounded or slightly oval shaped, and may be multiple. The lesions are also atypically located opposite to the side of compression. • Bone scans are normal.

Table 1: Summary table for paediatric post-traumatic osseous cystic lesion following a distal radial fracture.

Entity	Imaging findings		
	MRI	**CT**	**PET**
Osteomyelitis (Brodie abscess)	MRI T2W fat-suppressed sequence shows bright marrow and soft tissue oedema; and T1W fat-suppressed post-contrast sequence shows rim-enhancing abscesses (intraosseous, subperiosteal and soft tissue).	Contrast enhanced CT shows rim-enhancement of abscesses (less conspicuous than on MR); Bone CT detects early cortical change.	Increased metabolic activity
Eosinophilia granuloma	MRI shows homogenous low T1W signal and heterogenous high signal in fluid-sensitive sequence. Intense contrast enhancement of marrow abnormality and any soft tissue mass is observed. Periosteal reaction is outlined by high signal on fluid-sensitive and post-contrast imaging. Marrow oedema is seen especially in early active lesions.	On CT, beveled edge and sequestra are more easily identified on cranial lesions.	FDG PET shows 35% more new or recurrent lesions than radiograph.
Aneurysmal bone cyst	MRI shows characteristic fluid-fluid (blood products) containing cavities of differing signal intensity and hypointense rim surrounding the aneurysmal bone cyst.	On CT, thin cortical rim may be better seen than on radiographs. Septa are visible. Fluid-fluid levels are also seen, however not obvious as on MRI.	Studies have shown giant cell-containing lesions such as aneurysmal bone cysts may show a high accumulation of FDG with PET studies

Table 2: Differential diagnosis table for paediatric post-traumatic osseous cystic lesion following a distal radial fracture.

ABBREVIATIONS

CT = Computed tomography
MR = Magnetic Resonance
MRI = Magnetic Resonance Imaging

KEYWORDS

Post-traumatic; osseous; cyst; fracture; Magnetic Resonance Imaging