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CASE REPORT

Post-traumatic cyst-like lesion of cortical bone in children

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Abstract
Post-traumatic cyst-like lesions are an infrequent complication of fractures in children. To our knowledge, no more than 30 cases have been reported in the English-language literature. They most commonly affect the distal radius following a greenstick or torus fracture. These cortical defects are often asymptomatic, non-expansile, and typically resolve spontaneously in 1–3 years. They appear proximal to the compression site and are usually identified 2–4 months after a minor fracture. These lesions have a distinct appearance on magnetic resonance imaging (MRI), with intralesional fatty marrow, which may help to differentiate it from other bone lesions. We review the literature and present 3 more cases studied with plain radiographs, computed tomography (CT), and MRI. Post-traumatic cyst-like lesions require no treatment, and therefore recognition of its typical features is crucial to prevent unnecessary invasive procedures.

Keywords Cyst-like lesions · Trauma · Conventional radiography · CT · MRI

Introduction

Post-traumatic cyst-like lesions are a rare complication of fractures in children. To our knowledge, no more than 30 cases have been reported in the English-language literature [1–4]. They most commonly affect the distal radius following a greenstick or torus fracture. Typically, they present as benign radiolucent lesions located adjacent to fracture sites and resolve spontaneously. However, they can be confused with other entities such as osteomyelitis or other aggressive osteolytic lesions. A correct diagnosis is therefore essential to prevent over-investigation and invasive procedures. We review the literature and present 3 additional cases, supported with plain radiographs, CT, and MRI.

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Case reports

Case 1

A 6-year-old boy fell onto his outstretched right hand and presented to the emergency room with pain in his right wrist. Radiographs demonstrated a torus fracture of the distal radius (Fig. 1). Treatment consisted of a below-elbow plaster cast for 4 weeks.

Two and a half months after injury, radiographs documented healing of the fracture and the patient was asymptomatic. However, the presence of a round lucent lesion proximal to the fracture line raised clinical concern (Fig. 2). MRI and CT of the right wrist were performed. CT better depicted this small lesion and its relation to the adjacent bone, confirming its location within the callus (Fig. 3). MRI showed a focal area of increased T1 signal within the dorsal aspect of the distal radius, which corresponded to the radiographic cyst-like image, and demonstrated loss of signal on fat-saturated sequences (Fig. 4). It measured 12 mm × 11 mm × 4 mm (cranio-caudal × transverse × antero-posterior). As it was a new lesion, not present on the radiographic series when the fracture took place, and owing to its imaging features, a

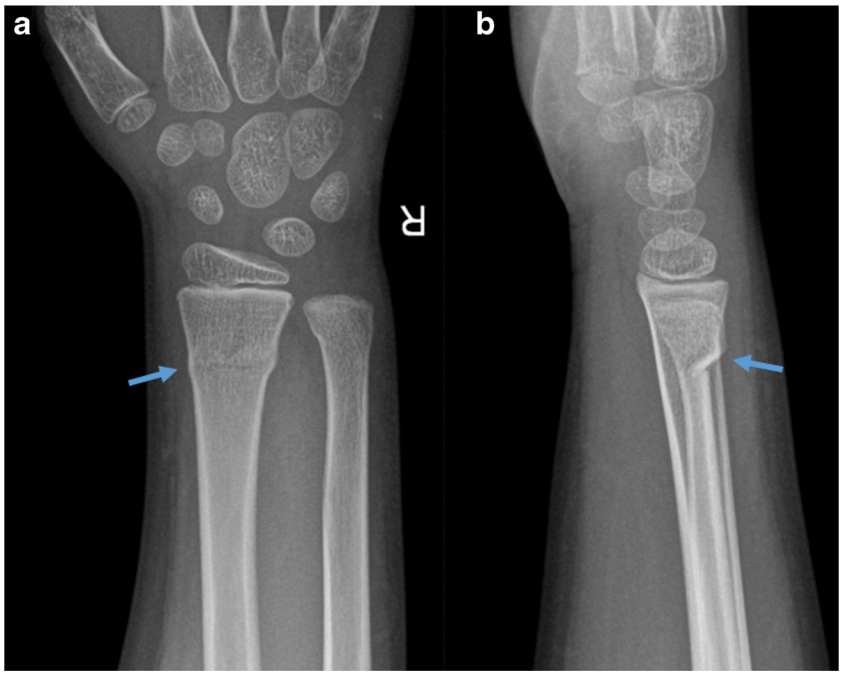

Fig. 1 Radiographs of the right wrist at the time of injury. **a** Postero-anterior and **b** lateral views show a torus fracture of the distal radius (*arrows*) with no significant displacement

post-traumatic cyst was confidently diagnosed on MRI. No further investigation or treatment was required. Follow-up radiographs 15 months after injury showed a significant reduction of the lesion size (Fig. 5).

Fig. 2 Two and a half months following fracture, radiographs show callus formation and reveal a new lucent lesion within the dorsal cortex of the radius (*arrow*)

Case 2

An otherwise healthy 6-year-old girl sustained a minimally displaced fracture of the distal radius after falling onto her outstretched right arm (Fig. 6) and was treated with below-elbow plaster cast for 4 weeks.

After 2.5 months, the follow-up radiography showed healing of the fracture and a cyst-like lesion of the distal radius (Fig. 7). She was asymptomatic, blood tests (white blood cell, erythrocyte sedimentation rate, and C-reactive protein) were normal and there were no signs of inflammation.

Corresponding to this radiographic lesion, MRI demonstrated a focal area of increased T1 signal within the dorsal aspect of the distal radius, measuring 4 mm × 3 mm × 3 mm (cranio-caudal x transverse x antero-posterior). It demonstrated loss of signal on fat-saturated sequences (Fig. 8). Mild periosteal thickening was also noted. As it was a new lesion with characteristic imaging features, no further investigation was necessary and a post-traumatic cyst was confidently diagnosed.

Case 3

A 7-year-old boy fell onto his outstretched right hand and presented to the emergency department with a greenstick fracture of the right ulna. Radiographs 2 years before were normal, demonstrating no lesions of the right ulna (Fig. 9). A plaster cast was the treatment of choice (Fig. 10). Three months later, follow-up studies

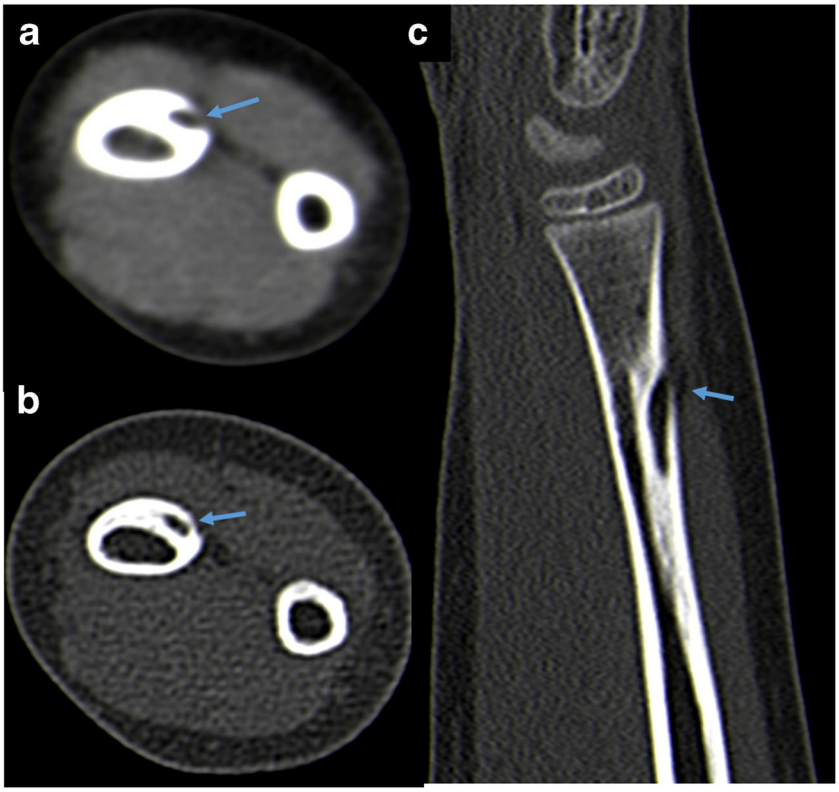

Fig. 3 – **a**, **b** Axial CT and **c** sagittal reconstruction of the lesion at 2.5 months, confirming a cyst-like lesion located within the mineralized dorsal subperiosteal callus of the radius (*arrows*). No residual fracture line is seen

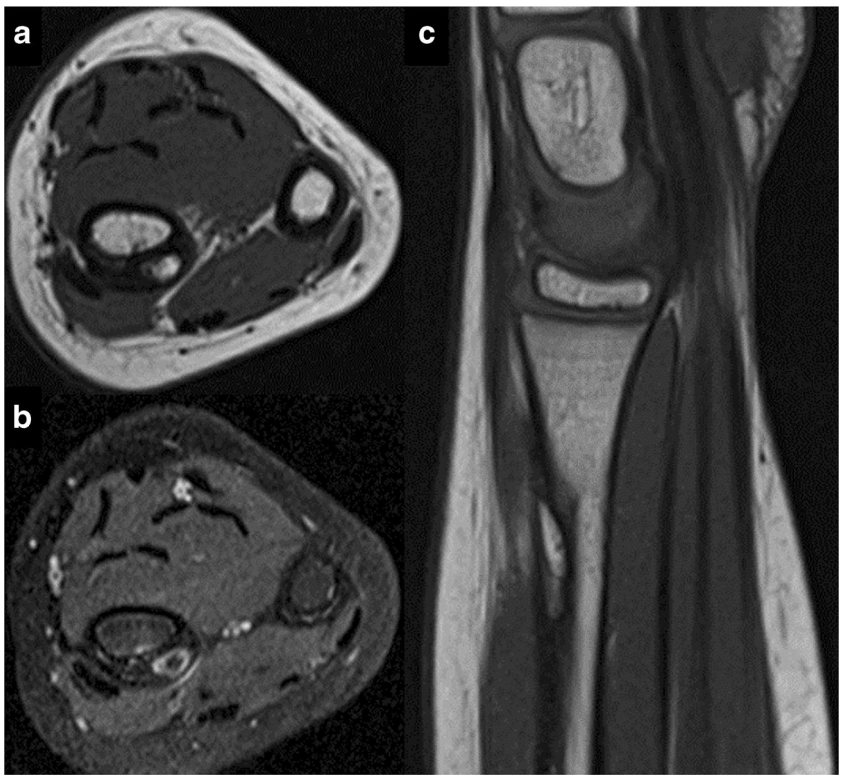

Fig. 4 MRI, 2.5 months after injury. **a** Axial T1-weighted image (WI) and **b** axial fat-suppressed proton density-WI show a round lesion within the thickened cortex of the radius with high T1 signal intensity and loss of signal on fat-saturated sequences, consistent with fat content. There is high proton density-WI signal surrounding the fat-containing lesion, because of a thin layer of hematoma. Notice the mild periosteal reaction. **c** Sagittal T1-WI shows the lesion with fat content located on the dorsal side of the distal radius

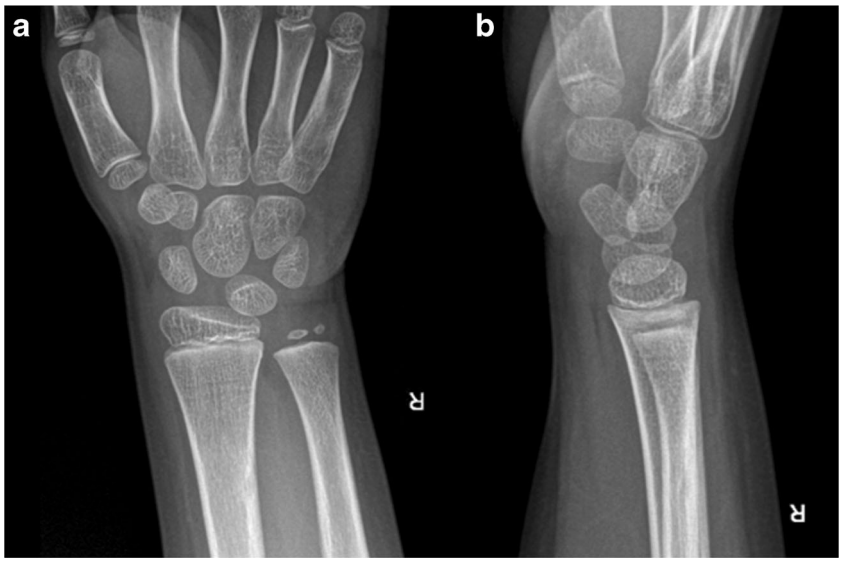

Fig. 5 Radiographs 15 months following fracture demonstrating the near disappearance of the cyst-like lesion, barely visible on the ulnar side of the dorsal cortex of the radius

documented a new lucent lesion of the right ulna (Fig. 11) and a post-traumatic cyst-like lesion was confidently diagnosed.

Discussion

Buckle or torus fractures result from compression failure of the bone without complete cortical disruption on the tension side of the bone [1]. They have excellent stability and usually heal successfully with cast or splint immobilization.

Post-traumatic cyst-like lesions consist of lucent lesions with no clinical consequence that can usually be identified 2–4 months after a minor fracture in a child [1]. Most are found in the distal radius, with an age range of 2.5 to 15 years [1].

Although the aetiology is still controversial, the most accepted theory involves the transcortical leakage of intramedullary fat. During the fracture, the elastic and loosely attached periosteum of children is easily lifted away from the cortex without disruption.

With the breaking of cortical and trabecular bone, there is release of blood and intramedullary fat, which collects under the unbreached periosteum within the subperiosteal haematoma.

In time, following the bone's physiological remodelling, the reabsorption and ossification of the surrounding haematoma enables the entrapped fat to become visible on

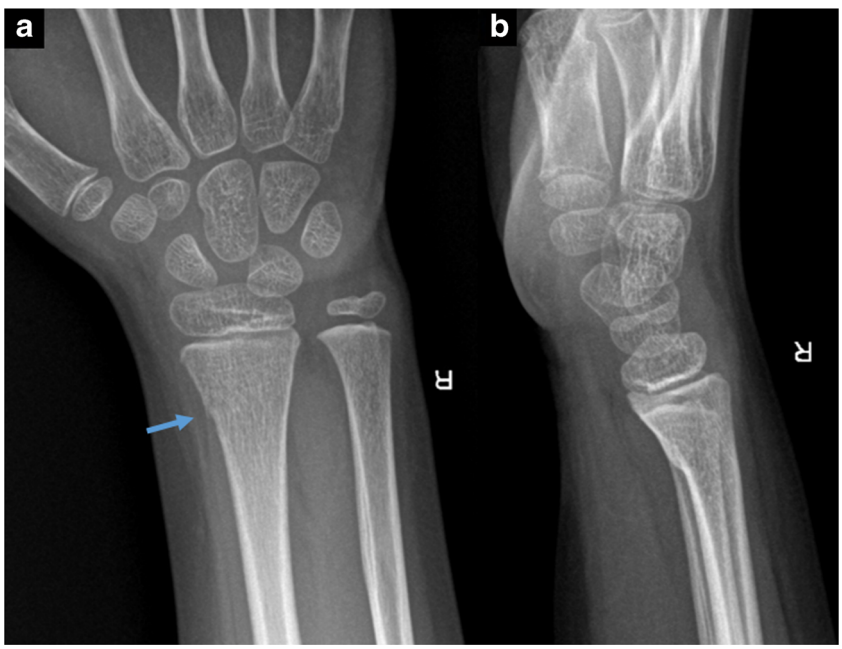

Fig. 6 Radiographs of the right wrist at the time of injury. **a** Postero-anterior and **b** lateral views show a torus fracture of the distal radius with no significant displacement (*arrow*)

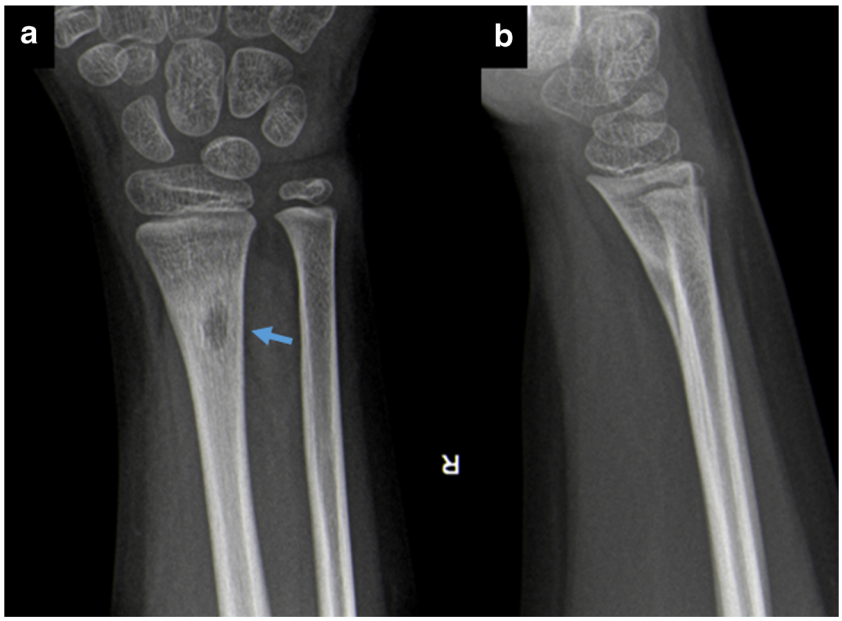

Fig. 7 Radiographs of the right wrist, 10 weeks following injury. **a** Postero-anterior and **b** lateral views where a new lucent lesion within the ventral cortex of the radius is identified (*arrow*)

plain radiographs as a cyst-like, lucent lesion (Fig. 12). This also explains the time-lag of at least 3–4 weeks before their first appearance and the absence of growth of these lesions [5]. The clinical scenario and the demonstration of a fatty content on a new "cystic lesion" on MRI/CT support this hypothesis [4].

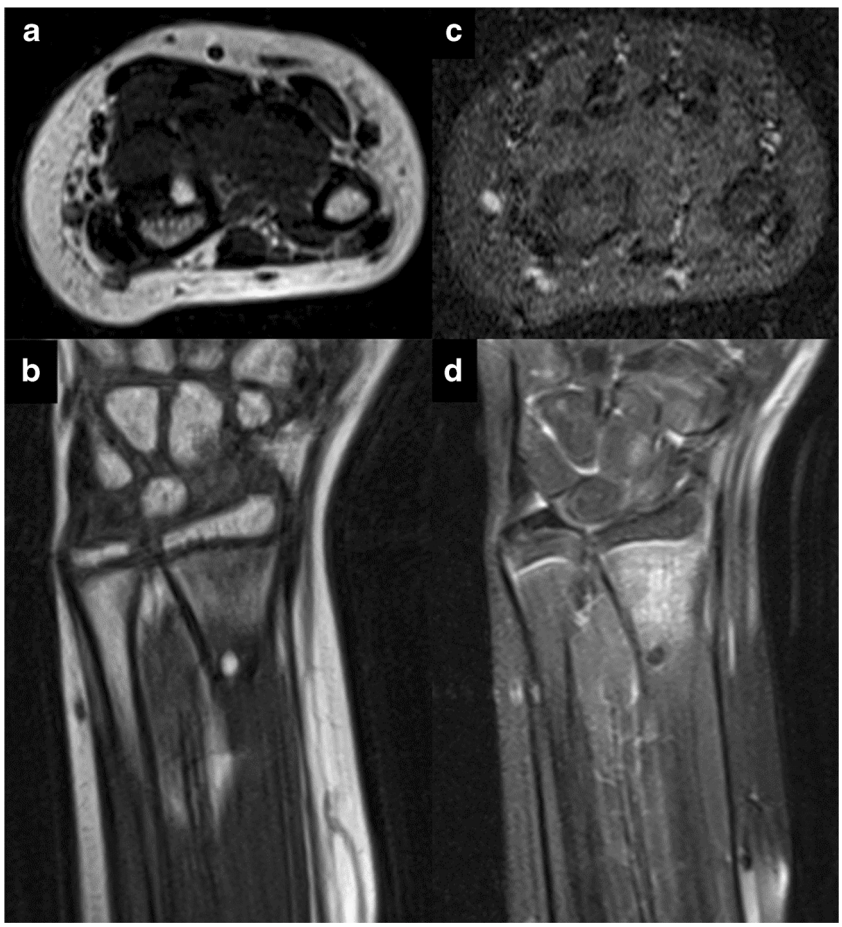

Fig. 8 MRI, 4 months after injury. **a** Axial T1-WI, **b** axial fat-suppressed T1-WI, **c** coronal T1-WI and **d** coronal proton-density (PD)-WI. There is a round lesion within the thickened ventral cortex of the radius with fat content, demonstrated by high T1 signal intensity and loss of signal on fat-saturated sequences. These findings are consistent with a post-traumatic cyst-like lesion of the radius

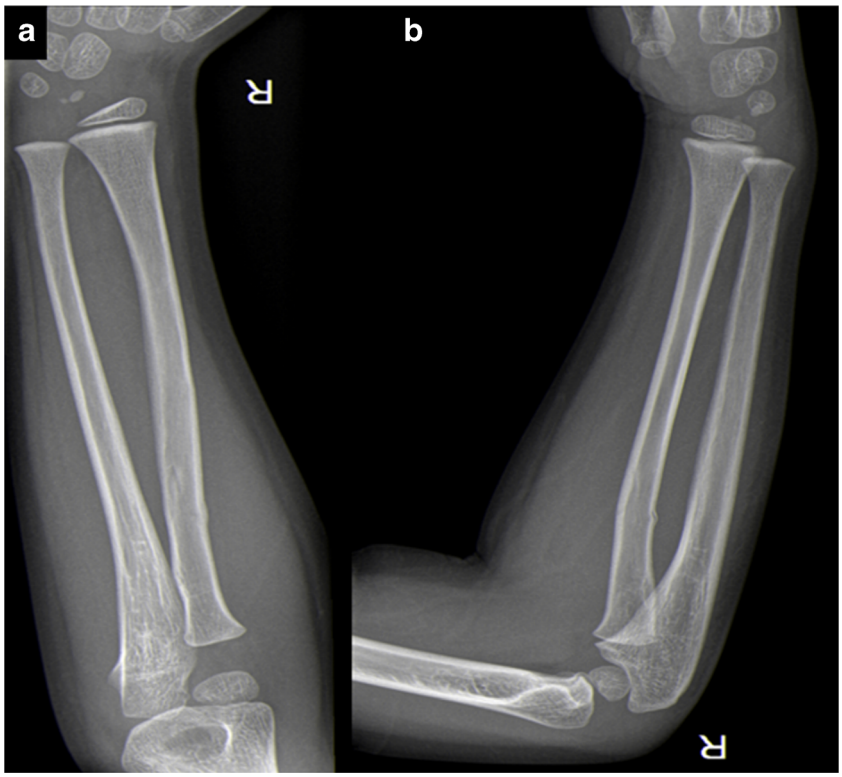

Fig. 9 **a** Postero-anterior and **b** lateral view radiographs of the right forearm, 2 years before fracture, showing the absence of bone lesions

Fig. 10 Radiographs of the right forearm 2 weeks following injury. **a** Postero-anterior and **b** lateral views demonstrate a greenstick fracture of the right ulna (*arrow*), with minimal displacement and no associated bone lesions

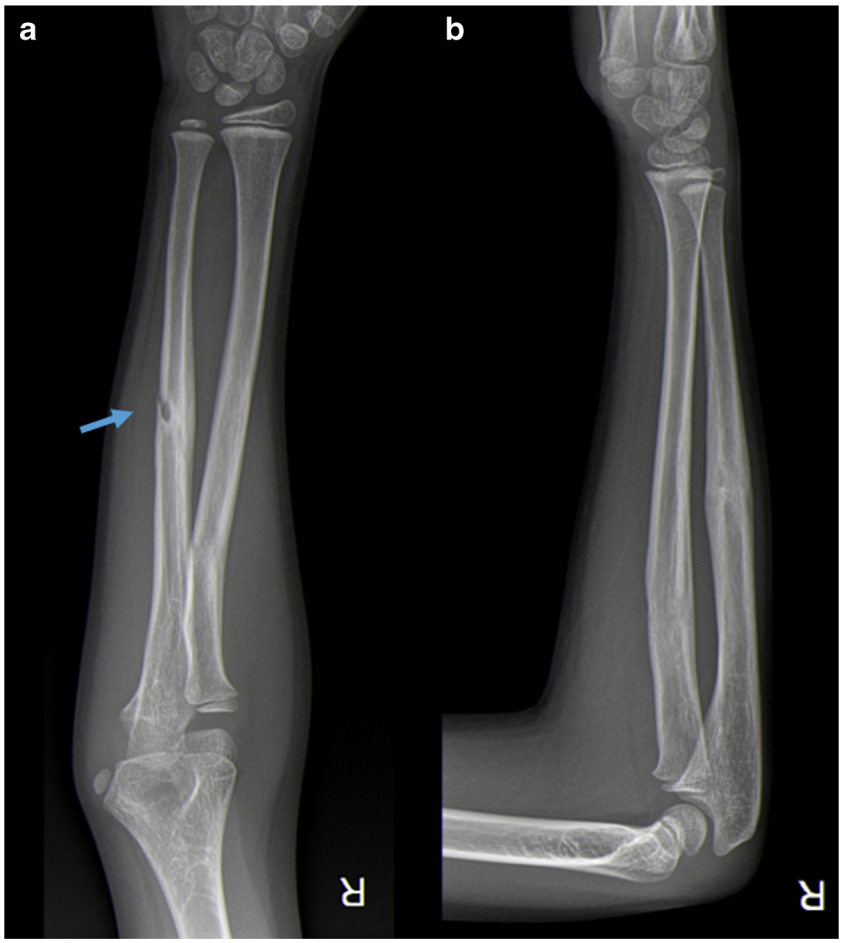

Fig. 11 **a** Postero-anterior and **b** lateral view radiographs 3 months following fracture where a new lucent lesion of the right ulna appears (*arrow*)

Despite the fact that distal radius fractures are common in children, few post-traumatic cyst-like lesions are described in the literature. One of the reasons might be because these fractures are rarely followed radiographically past the point of clinical union [1]. This means that, when formed, these lesions might be occult unless the patient has a long-term imaging follow-up or is evaluated for pain or re-injury of the same limb [3]. In addition, the fracture must be sufficiently severe to produce a cortical breach large enough to allow bone marrow fat extrusion, but small enough to keep the periosteum intact [5].

Generally, these cortical defects are non-expansile, measure less than 10 mm and are located 10 mm proximal to the compression fracture [4]. They are rounded- or oval-shaped and may be multiple [3]. Post-traumatic cyst-like lesions can rarely be located opposite the site of compression [4]. Sequential radiographs show the lesions migrating away from the growth-plate [4].

Both MRI and CT can confirm the diagnosis without the need for biopsy, demonstrating subperiosteal location, periosteal stripping, and intralesional fat [4]. Bone scans are normal when imaged a few months after trauma [3, 6]. A regular mature lesion exhibits high fat content (lower [negative] densities on CT images and high-intensity signal on T1-weighted images (WI) with loss of signal on fat-suppressed sequences on MRI [3]). These lesions often have homogeneous signal characteristics. If performed, T2-WI gradient echo sequences can show heterogeneous signal that probably corresponds either to the "blooming" effect of hemosiderin (as a breakdown product of haemorrhage), or to strands of bone across the lesion producing low-signal areas within the lesion [4].

The main differential diagnosis is osteomyelitis (Brodie abscess). The earliest radiographic finding is adjacent soft-tissue swelling. Bony destruction and periosteal reaction may occur 7–14 days after onset, but the absence of radiographic findings does not exclude osteomyelitis. MRI is the best imaging method if the diagnosis is unclear or if complications are suspected, particularly in children. Post-contrast T1-WI show rim-enhancing abscesses and fat-suppressed T2- or proton density-WI show bright marrow and soft-tissue oedema. Other differential diagnoses include eosinophilic granuloma and aneurysmal bone cyst [1, 3]. Eosinophilic granuloma has a diversity of presentations, but rarely affects the forearm. MRI shows homogeneous low T1-WI signal and heterogeneous high signal on a fluid-sensitive sequence. Aneurysmal bone cyst consists of an eccentric expansile

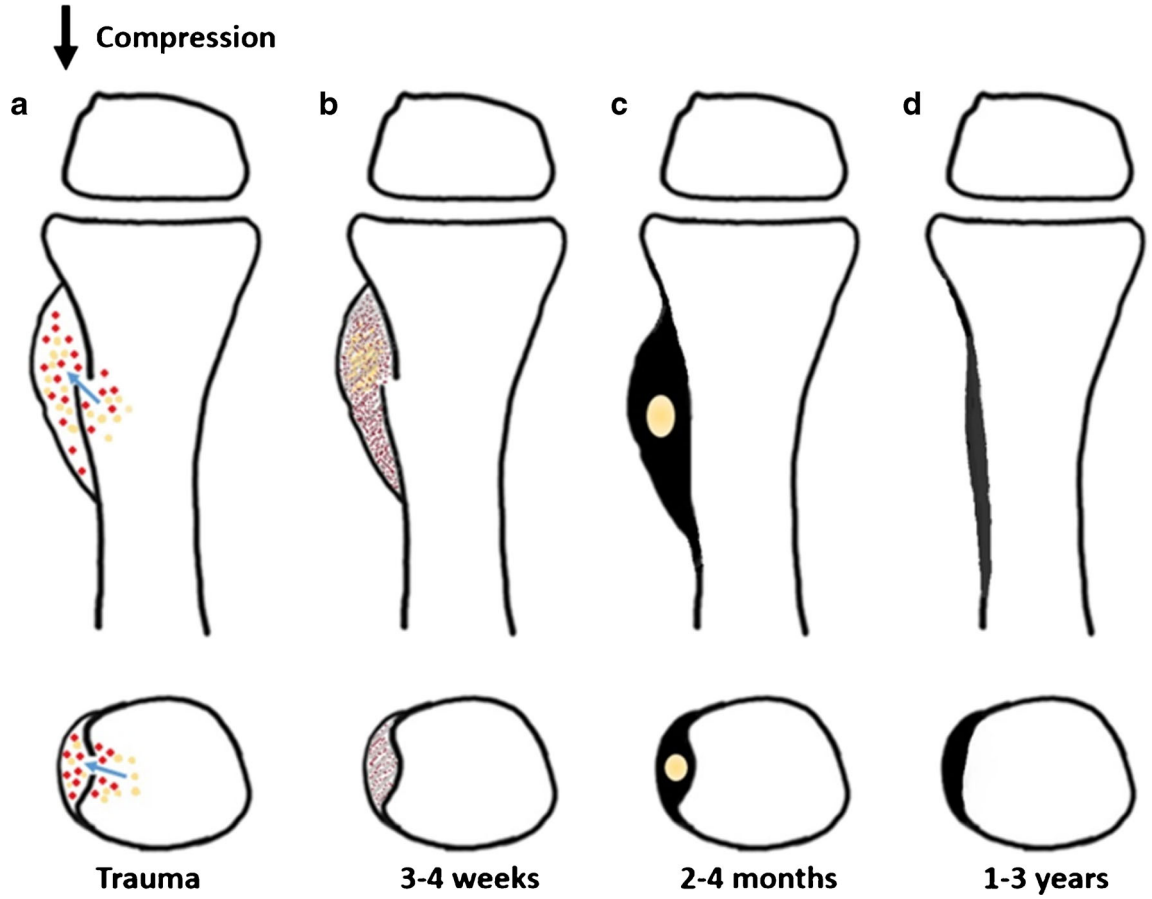

Fig. 12 **a–d** Illustrative model for the transcortical leakage of the intramedullary fat hypothesis. Subperiosteal accumulation of blood and marrow fat under the unbreached periosteum creates a subperiosteal haematoma. Posterior reabsorption enables the entrapped fat to become visible on plain radiographs as a "cystic" cortical lesion. It resolves spontaneously 1–3 years after trauma

lucent lesion that normally involves the metaphysis. It typically has a fluid–fluid level of different signal intensity and a hypointense rim.

Clinical history, physical examination, and review of previous radiographs are essential to exclude unrecognized pre-existing lesions or pathological fractures.

Post-traumatic cyst-like lesions are frequently asymptomatic, have no influence on fracture healing, are not associated with pathological fractures, and require no treatment [6]. When followed radiographically, they resolve spontaneously in 1–3 years [3]. In most cases, the typical radiographic appearance of a cyst-like lesion near a healing fracture in a child should make the diagnosis. If needed, MRI or CT can be used to confirm it and prevent unwarranted investigations.

Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflicts of interest.

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