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CASE REPORT

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Post-traumatic cystic lesion following fracture of the radius

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Abstract Post-traumatic cystic lesions are an uncommon complication of fractures in children. They are benign, asymptomatic, non-expansive and tend to resolve spontaneously. Their cause seems to be the invasion of bone-marrow fat by subperiosteal hematoma, which may be visible on radiographs during fracture consolidation of the newly formed subperiosteal bone. The case we present is of cyst formation following a fracture of the distal radius and we evaluate the role of yellow bone marrow in the pathogenesis of the cyst. Its typical features clear differentiation from other lesions, preventing unnecessary and, possibly, invasive examinations.

Keywords Radius · Fracture · Lipid cyst · Radiographs · MRI

Introduction

Post-traumatic cysts are radiolucent lesions that appear adjacent to fracture sites. They can be confused with other pathological entities. To our knowledge, only 20 cases (Table 1) have been reported in previous English-language literature. A correct diagnosis is of importance to prevent over-investigation. The post-traumatic cyst that appears within the newly formed subperiosteal bone is non-expansive and progressively disappears of its own accord [1]. Most likely, the cysts result from inclusion of medullary fat within the subperiosteal hematoma.

Case report

An obese 9-year-old boy sustained a minimally displaced, complete metaphyseal fracture (Fig. 1) of the distal radius and an oblique fracture of the distal ulna after falling onto his outstretched right arm. He was treated with a below-elbow plaster cast for 4 weeks. After a month and a half, in the course of follow-up radiography, a cyst-like lesion of faint definition emerged adjacent to the original fracture site (Fig. 2).

A radiograph obtained 4 months later showed a round lucent area within the newly formed callus at the dorsal aspect of the distal radius (Fig. 3). On admission, initial diagnosis was osteomyelitis (Brodie abscess), but no signs of inflammation, localized tenderness or abnormal blood test (white blood cell, erythrocyte sedimentation rate, C-reactive protein) were found. A CT scan revealed evidence of contents of a fatty density (Fig. 4). Magnetic resonance imaging showed an area of increased signal with density similar to that of fat, which corresponded to the area of the lytic lesion (Fig. 5). No treatment was offered.

Six months later, radiographs were repeated. These showed that the cyst-like lesion had disappeared (Fig. 6) and the distal radius fracture had completely remodeled.

Discussion

The development of lytic lesions after a fracture is uncommon. The transient post-fracture cyst has been described in the orthopaedic literature, where 20 cases have been reported (Table 1). In these cases the most common location of the cyst-like lesion was the distal aspect of the radius, and only two were located in the distal aspect of the tibia [2, 3]. Usually the lesion can be seen on routine follow-up roentgenograms and also as an incidental finding for evaluation of new re-injury after trivial trauma.

The etiology remains controversial. Several studies [1, 2, 3] support the theory of transcortical escape of intramedullary fat. According to this theory, the transient cyst

Fig. 1 The initial radiograph showing minimally displaced complete metaphyseal fracture of distal radius

could be the result of leakage of intramedullary fat during the fracture event, subperiosteally, without disruption of the periosteum. The entrapped fat could subsequently become visible, while the subperiosteal hematoma becomes calcified. In our study, T1-weighted images, saturation T2-weighted images, and CT images demonstrated the presence of fat within the rounded cyst-like lesion, which strongly supports the theory of lipid escape from yellow bone marrow into the subperiosteal hematoma (Figs. 2, 4, 5). This theory is also supported by other authors, based on CT [3] and MR [4] imaging.

The rarity of the lesion is explained by the fact that two conditions must be fulfilled in order for development of a post-fracture cyst. The first is that the fracture must not tear the periosteum but only detach it from bone, an event that usually occurs in children. The second condition is that the cortical defect allows extrusion of the squeezed bone-marrow fat. The time-lag of, at least, 3–4 weeks before the lesion's first appearance is explained by the fact that the surrounding hematoma usually becomes calcified (Fig. 3) after the follow-up period, at which point we tend to examine radiologically a minimally displaced, complete metaphyseal or torus fracture.

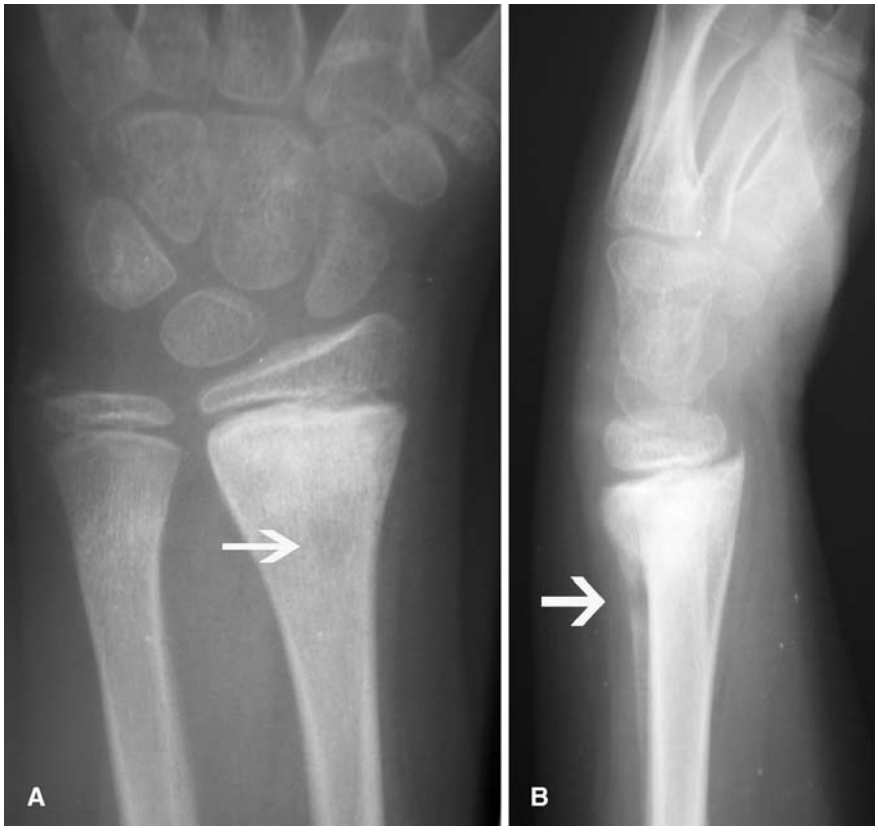

Fig. 2 One and a half months following fracture, radiographs (**A**, **B**) show a faint lucent lesion proximal to the fracture site (*white arrow*)

Fig. 3 Radiograph 4 months after the injury showing well-defined round lucency mimicking a Brodie's abscess

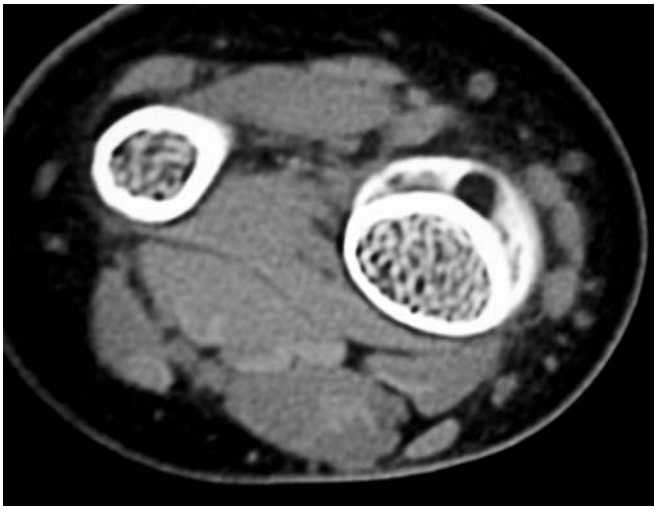

Fig. 4 CT scan of the lesion after 4 months, showing fat within the mineralized dorsal subperiosteal callus

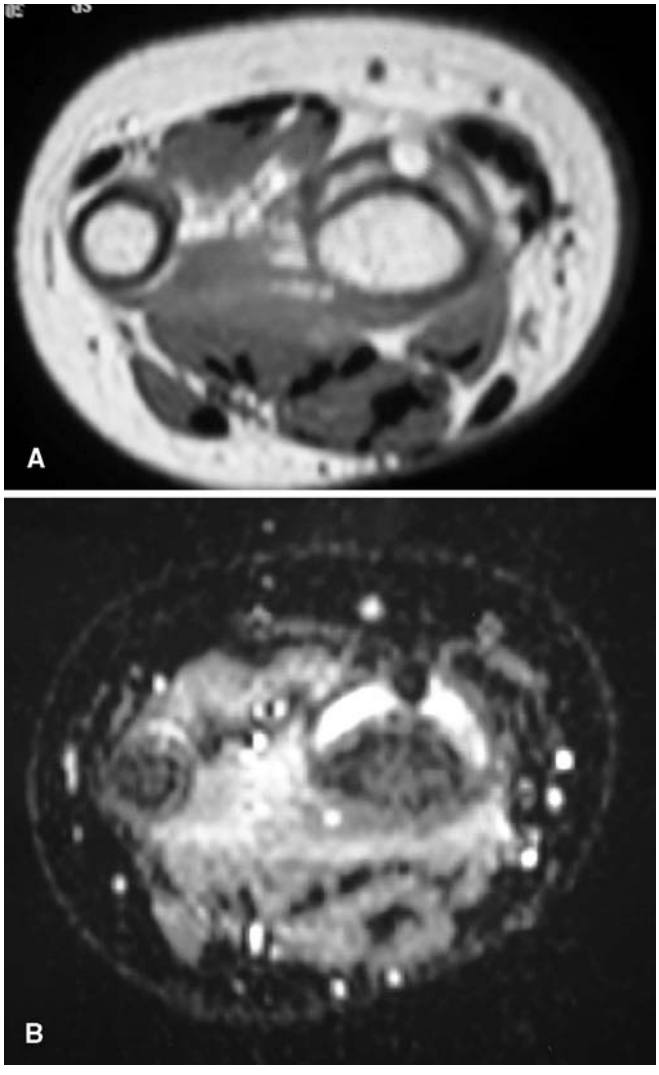

Fig. 5 A T1-weighted image. The round focus of increased signal activity consistent with fat corresponds to the cystic lesion seen on the radiographs. **B** T2-weighted images after 4 months. The post-fracture hematoma under the periosteum is still evident, with the lesion corresponding to fat signal

Bone marrow is housed within the bony trabecular network. The red marrow is active with regard to blood-cell development, whereas yellow marrow, composed of 80% fat, is inactive. The lipid component of marrow provides a useful marker for marrow evaluation with MR imaging. The fat-laden inactive yellow bone marrow found in the epiphyses and apophyses shows a high signal on T1-weighted and an intermediate signal on T2-weighted images. In a healthy person, marrow undergoes conversion from hematopoietically active red to hema-topoietically inactive yellow in a predictable fashion. At birth, all marrow produces blood cells, but by the age of 1 year, marrow in the epiphyses and apophyses changes to inactive yellow marrow. This conversion is from distal to proximal and from the appendicular to the axial skeleton. The adult pattern of bone marrow is reached in the early 20s.

Although Moore et al. [5] found that only red marrow is present in the radial shaft in children younger than 12 years, Malghem [3] believes that the fat is derived from red marrow. Conversion to yellow marrow may be diffuse

Fig. 6 Radiograph taken 6 months after original injury. The ovoid lucency has completely disappeared

or may occur in the form of isolated islands of fatty marrow. We believe that the fat drops come from the yellow marrow, because the converted marrow is typically patchy rather than confluent, and this conversion is from distal to proximal, as proven with MR imaging [5, 7].

The distal metaphysis is not as rigid in the growing child, because it is undergoing extensive remodeling. The cortex is thin and extends further proximally in the skeletally immature. This thin cortex predisposes the metaphysis to unique fracture patterns such as torus and minimally displaced complete metaphyseal fractures. In the radial metaphysis is found abundant bone marrow in trabecular bone, which contributes to bone strength [8] by the restriction of flow of yellow and red marrow through intratrabecular spaces. At the time of the fracture, as the periosteum strips away from bone, the pressurized lipocytes may release lipids, or the less-attached patchy yellow marrow at this age escapes from the fracture gap in the post-traumatic hematoma to produce the appearance of a cyst-like lesion on the radiograph.

The cyst-like lesion should be differentiated from osteomyelitis (Brodie abscess), which may follow even a closed fracture [9] and other benign lesions such as aneurysmal bone cyst or eosinophilic granuloma. Though this innocuous lesion is uncommon, a correct diagnosis at a fracture site with fairly specific CT- and MR-imaging features should prevent further costly and invasive tests.

Table 1 Previous reported cases

Author	Patient numbers and age (years)	Location
Caffey	One patient aged 9	Distal radius
Pfister-Goedeke and Braune	Nine patients age 2.5–15	All distal radius
Maldhem and Maldague	Two patients ages 6 and 10	Distal radius or tibia
Phillips and Keats	Two patients ages 10 and 11	Distal radius or tibia
Malghem et al.	Two patients ages 6 and 8	Distal radius
Moore et al.	One patient age 9	Distal radius
Davids et al.	One patient age 7	Distal radius
Ball et al.	Two patients age 2.5 and 5.5	Distal radius

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