TRANSIENT CYST-LIKE CORTICAL DEFECTS FOLLOWING FRACTURES IN CHILDREN

MEDULLARY FAT WITHIN THE SUBPERIOSTEAL HAEMATOMA

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Asymptomatic cyst-like cortical defects appearing after fractures in children have been occasionally reported. Typically, these defects appear during fracture consolidation, within the newly formed subperiosteal bone, proximal to the fracture line, do not enlarge, and progressively disappear. We have previously shown a fatty density on CT scan within the early cortical defect.

We now present two additional cases in which early CT scans appeared to confirm that these transient cortical defects may consist of fat, and probably result from the inclusion of medullary fat within the subperiosteal haematoma.

Post-traumatic expanding lytic lesions have been reported in the orthopaedic and radiological literature (Levine, Dorfman and Matles 1969; Ginsburg 1974; Kushner, Vance and Kirkpatrick 1979; Dabezies et al 1982; Langer et al 1982; Silverman 1985; De Nayer, Delloye and Malghem 1987). In addition small non-expanding cyst-like cortical defects after fractures in children have been reported in the radiological literature (Caffey 1978; Pfister-Goedeke and Braune 1981; Malghem and Maldague 1986; Phillips and Keats 1986; Resnick, Goergen and Niwayama 1988; Moore et al 1989). These defects are sometimes seen during the consolidation of a minor fracture in a child; they do not cause clinical symptoms and disappear slowly. To our knowledge, no such cases have been reported in the orthopaedic literature.

We present two cases, in which CT scans demonstrated fatty contents; we discuss the pathogenetic significance of these findings.

CASE REPORTS

Case 1. A six-year-old girl sustained a greenstick fracture of the dorsal cortex of the distal radius in February 1986 (Fig. 1a). Some local lucencies were seen in the callus in

radiographs at four weeks (not illustrated), so these were repeated at three months after fracture. There was an $8 \times 1 \times 2$ mm lucency and several smaller defects within the newly formed subperiosteal bone, proximal to the original fracture line (Fig. 1b). A CT scan showed contents of a fatty density, -81 Hounsfield Units (HU), within the main cortical defect, similar to the density (-75 HU) measured within the medullary cavity (Fig. 2). Ten months after the fracture the size of the main defect had decreased (Fig. 1c), and three years after the fracture it had disappeared (Fig. 1d).

Case 2. An eight-year-old boy sustained a greenstick fracture of the distal radius in September 1988 (Fig. 3a). After four weeks there were faintly defined lucent areas within the early mineralised subperiosteal callus (Fig. 3b). At two and a half months there was a well defined $9 \times 3 \times 6$ mm defect as well as some smaller defects (Figs 3c and 3d). All the lucent areas were within the newly formed subperiosteal bone, proximal to the fracture site. A CT scan through the main cortical defect showed a fatty density (-117 HU) within the bone defect, similar to that measured within the subcutaneous fat layer (-113 HU) (Fig. 4a). The density within the medullary cavity at the level of the defect was higher, because of the presence of trabecular bone, but more proximally the density was -85 HU (Fig. 4b). Three months later, the defect was virtually unchanged, and one year after the fracture it had virtually disappeared.

DISCUSSION

We have found 12 typical cases of cyst-like cortical defects after fracture in children in the radiological literature (Pfister-Goedeke and Braune 1981; Malghem and Maldague 1986; Moore et al 1989) and three probable

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Case 1. The initial radiograph (a) shows a minor fracture of the radius. Three months later (b) there is a cyst-like cortical defect (arrow) and several smaller defects (arrowheads) within the newly formed subperiosteal bone, proximal to the fracture line. Radiographs at 10 months (c) and three years (d) show the progressive disappearance of the lesion.

Fig. 2

Case 1. A CT scan at three months shows a fatty density (-81 HU) within the cortical defect (arrow), similar to the density measured within the medullary cavity (-75 HU).

cases (Caffey 1978; Phillips and Keats 1986; Resnick et al 1988). All, except one in the tibia (Malghem and Maldague 1986), occurred after a fracture of the distal radius.

All the well documented cases had no symptoms and, several weeks after fracture, had developed rounded or slightly oval-shaped cortical defects, often multiple, and usually less than 10 mm in diameter. They were seen

strictly within the layer of newly formed subperiosteal bone, that is within the ossified subperiosteal haematoma on the diaphyseal side of the fracture. They had never enlarged, and had disappeared progressively. These typical signs were easily differentiated from post-traumatic osteomyelitis and post-traumatic expanding lytic central lesions.

Biopsy was never clinically justifiable, but in a possibly similar case at 20 weeks after fracture Caffey (1978) found a collection of blood with some multinucleated giant cells surrounded by cancellous bone. Several hypotheses for the cause have been made. Pfister-Goedeke and Braune (1981) considered that these lesions represented resorption cysts within an excessive periosteal reaction. However, our case 2 showed that the defects develop at the time of early ossification of the subperiosteal haematoma, prior to any resorption. Phillips and Keats (1986) consider subperiosteal haemorrhage will eventually calcify or resorb. Moore et al (1989) regard the aetiology as uncertain.

In one of our previously published cases, CT scans suggested fatty contents at three months after fracture (Malghem and Maldague 1986). We suggested that the cortical defects could result from the inclusion of drops of medullary fat in the subperiosteal haematoma which often accompanies greenstick fractures. These fat inclusions would appear as defects when the subperiosteal haematoma ossifies (Fig. 5). This hypothesis was agreed by Resnick et al (1988), but disputed by others. Phillips and Keats (1986) were uncertain about the significance of a CT number corresponding to fat, because of the

Figure 3. Case 2. Greenstick fracture of the radius (a) showing a discrete hypodense layer adjacent to the shaft (arrowheads). Four weeks later (b), there are lucent areas (arrowheads) within the early mineralised subperiosteal callus. At two and a half months one large cyst-like cortical defect (arrow) and some smaller ones (arrowheads) are clearly shown (c and d).

Fig. 4a

Fig. 4b

Case 2. Figure 4a - A CT scan two and a half months after fracture shows a fatty density (-117 HU) within the main cortical defect (arrow), similar to the density (-113 HU) measured within the subcutaneous fat (arrowhead). Figure 4b - More proximally in the shaft, another CT view shows a fatty density (-85 HU) within the medullary cavity (arrow).

difficulty of obtaining reliable CT numbers within or adjacent to dense cortical bone. However, we were able to demonstrate that most scanners can provide the reliable recognition of the highly negative density of fat within the medullary cavity or within a cortical defect in a tubular bone (Malgheem and Maldague 1987). CT scans are known to distinguish with accuracy between the negative values for the medullary fat and the positive values produced by the intramedullary extension of a tumour (Berger and Kuhn 1978; Destouet, Gilula and Murphy 1979; Genant et al 1980; Coffre et al 1985), a bone marrow metastasis (Helms et al 1981), or osteomyelitis (Kuhn and Berger 1979). Moore et al (1989) question

whether there is sufficient intramedullary fat in the radius at this age, since there is only red marrow in the radial shaft in children under 12. However, the conversion from red to yellow is progressive and fat drops may be derived from red marrow. This fatty component in the shaft is confirmed by the negative density range on CT (Berger and Kuhn 1978).

Our two new cases provide additional information. We found fatty densities shortly after the appearance of the lesions, at three and two and a half months respectively. This seems to be the rule when CT is performed early. By contrast, later CT scans may show a higher density, when the lesion is disappearing and

Fig. 5

Pathogenetic hypothesis. A cortical break allows medullary fat drops to enter the subperiosteal haematoma (A). These fat drops may become confluent (B). When the subperiosteal haematoma ossifies, cyst-like cortical defects become evident on radiographs (C).

becoming ossified (Malghem and Maldague 1986). We also showed the CT density of fat in the medullary cavity of the shafts (see Figs 2 and 4b), proving that in children the radial shaft does contain a significant amount of fat.

The inclusion of medullary fat drops within the subperiosteal haematoma accounts for the main characteristics of these transient cortical defects: multiplicity,

lack of enlargement, and location within subperiosteal bone near the fracture site. The time-lag of at least three to four weeks before their first faint appearance is because standard radiographs cannot show them until the surrounding haematoma becomes calcified.

Greenstick fractures are common in children, so the rarity of such defects may seem surprising. There may be several reasons for this. The fracture needs to be moderate enough to leave the periosteum intact, usually seen only in children because their periosteum is tough but easily detached, but severe enough to produce a cortical defect which will allow extrusion of bone marrow. If the break is too small the medullary fat cannot escape, but if there is a periosteal tear, the medullary fat can diffuse into the neighbouring soft tissues. An additional factor is that mild greenstick fractures are rarely followed up radiologically for long enough to allow fatty cortical defects to be seen.

Conclusions. Transient cyst-like cortical defects following fractures in children are benign lesions without clinical importance. Knowledge of their typical features enables them to be clearly differentiated from other lesions. They appear to result from the inclusion of medullary fat within the subperiosteal haematoma.

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