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CASE REPORT

Osteomyelitis of a sacral neurocentral synchondrosis: a case report of another metaphyseal equivalent

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Abstract

Pelvic osteomyelitis may occur in a *metaphyseal equivalent*, defined as a portion of flat or irregular bone that is adjacent to cartilage. The pelvic bone is known to have several metaphyseal equivalents and of these, the sacroiliac joint is the most frequent site of involvement. However, a sacral neurocentral synchondrosis has not been recognized as a metaphyseal equivalent, and there have been no previous reports describing this as the site of origin of sacral osteomyelitis. We here report two cases of sacral osteomyelitis originating in a neurocentral synchondrosis, another metaphyseal equivalent. We, as pediatric radiologists, should recognize a sacral neurocentral synchondrosis as another metaphyseal equivalent, especially in infants and younger patients.

Keywords Osteomyelitis · Metaphyseal equivalent · Neurocentral synchondrosis

Introduction

Acute hematogenous osteomyelitis is a common pediatric disease [1]; in approximately 10% of cases, it involves the pelvic bones [1]. Pelvic osteomyelitis may occur in a metaphyseal equivalent [2]. A metaphyseal equivalent is defined as a portion of flat or irregular bone that is adjacent to cartilage [3]. The pelvic bone is known to have several metaphyseal equivalents, as follows: sacroiliac joint, ischiopubic synchondrosis, triradiate cartilage, anterior superior iliac spine, ischial tuberosity, pubic symphysis, and iliac crest (Fig. 1) [1, 3]. Among these, the sacroiliac joint is the most frequent site of involvement in the bony pelvis [1, 3]. However, a sacral neurocentral synchondrosis (Fig. 2) [4, 5] has not been recognized as a metaphyseal equivalent, and there have been no previous reports describing this as the site of origin of sacral osteomyelitis. We describe sacral osteomyelitis originating in a neurocentral synchondrosis as another metaphyseal equivalent that has not been previously described.

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Case 1

A 6-year-old boy was referred to our hospital for fever and buttock pain. He had felt a dull pain near his anus and this pain had continued for 3 days before his arrival to the hospital. His pain and fever had been getting progressively worse, making walking difficult. On admission, blood tests showed a slightly increased white blood cell (WBC) count (9600/μl) and a normal C-reactive protein (CRP) value (0.8 mg/dl). Blood culture established no evidence of bacteremia. Eight days after the onset of the chief complaint, he underwent magnetic resonance imaging (MRI) of his hip joints and pelvis on suspicion of acute suppurative arthritis of the hip joint.

MRI showed no definite evidence of hip joint arthritis. However, there was increased signal intensity in the sacral bone marrow on fat-suppressed T2-weighted images (Fig. 3) and decreased signal on T1-weighted images. This high-signal area straddled a tortuous, finely linear, low-signal line comprising a neurocentral synchondrosis of the sacrum (Fig. 3a, b arrow). On gadolinium-enhanced, fat-suppressed, T1-weighted images, there was focal enhancement of the same lesion demonstrated on fat-suppressed T2-weighted images (Fig. 3c–f, arrow). These findings thus suggested the diagnosis of osteomyelitis of the sacrum. There was no evidence of osteomyelitis of any other metaphyseal equivalent, including the sacroiliac joint. He was treated with antibiotics and the clinical course after inpatient therapy was uneventful.

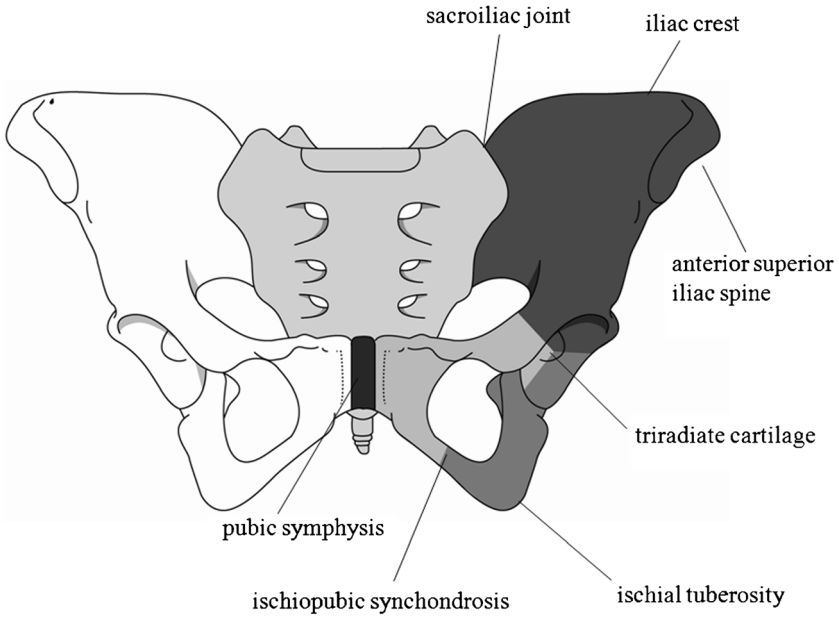

Fig. 1 Distribution of metaphyseal equivalent in the pelvis

Case 2

A 20-month-old male infant was referred to our hospital with fever of unknown origin. On admission, there was subtle left-sided coxalgia on physical examination. Blood tests showed an increased WBC count (16,000/μl) and CRP (16 mg/dl); blood culture identified methicillin-susceptible *Staphylococcus aureus* (MSSA). Nine days after the onset of fever, he underwent MRI of his hip joint and pelvis on suspicion of acute suppurative arthritis of the hip joint.

MRI showed increased signal intensity in the bone marrow on fat-suppressed T2-weighted images of the medial side of the left sacral alar (Fig. 4a–d), and decreased signal on T1-weighted images. This high-signal area extended along a left,

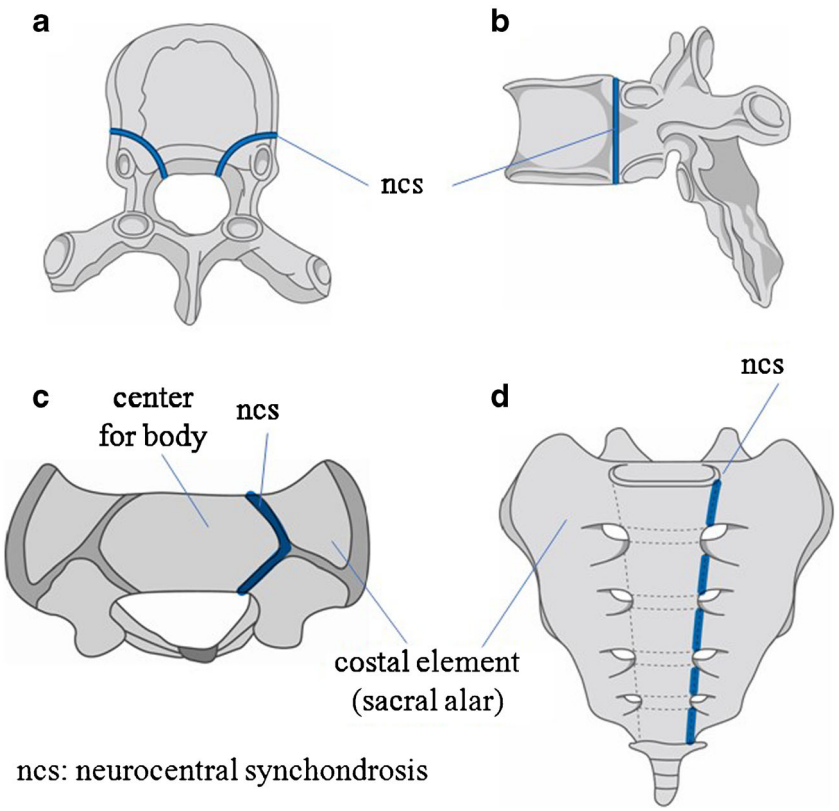

Fig. 2 Drawings indicating the position of the neurocentral synchondrosis in transverse and coronal views. Transverse view (**a**) and lateral view (**b**) of thoracic/lumbar spine, transverse view (**c**), antero-posterior view (**d**) of sacrum. The neurocentral synchondrosis is a cartilaginous growth plate located between the neural arch and the centrum of the vertebra

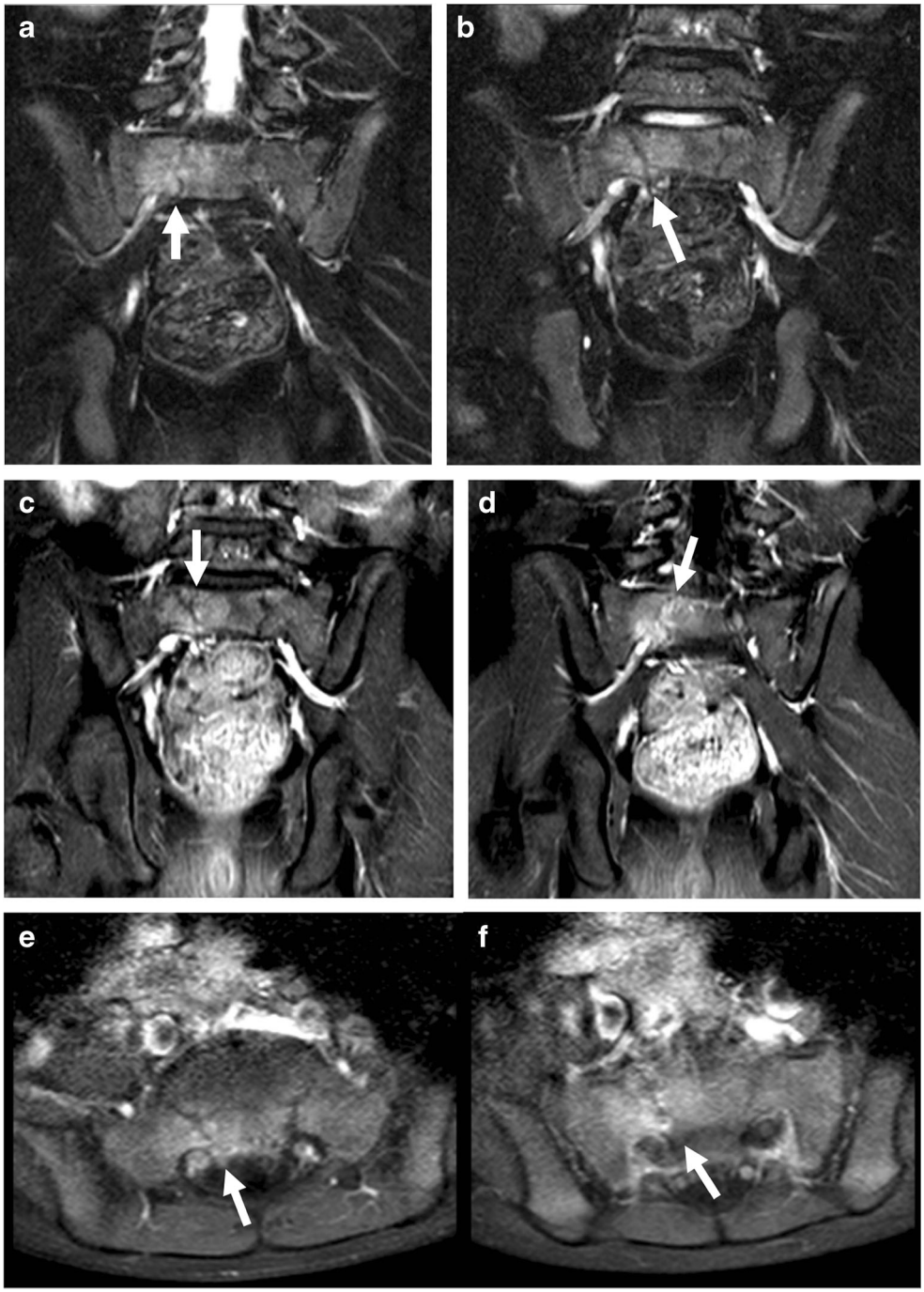

Fig. 3 A 6-year-old boy with fever and sacral pain. He underwent pelvic MRI 8 days after the onset of fever; coronal fat-suppressed T2-weighted image (**a**, **b**), coronal (**c**, **d**), and axial (**e**, **f**) gadolinium enhanced fat-suppressed T1-weighted image. Note increased signal intensity at the sacral bone marrow on fat-suppressed T2-weighted image (**a**, **b**, *arrow*). This high signal area straddled along at tortuous fine linear low signal line as neurocentral synchondrosis of sacrum (**a**, **b**, *arrow*). On gadolinium-enhanced, fat-suppressed T1WI, there was focal enhancement at same lesion demonstrated on fat-suppressed T2WI image (**c**–**f**, *arrow*). Hence, these findings suggested the diagnosis of osteomyelitis of sacrum along right neurocentral synchondrosis

neurocentral synchondrosis of the sacrum, manifesting as bone marrow edema. On gadolinium-enhanced, fat-suppressed, T1-weighted images, there was focal enhancement of the edematous lesion demonstrated on fat-suppressed T2-weighted images (Fig. 4g, h). These findings thus suggested the diagnosis of osteomyelitis of the sacrum. Diffusion-weighted images revealed focal restriction of diffusion in front of a left neurocentral synchondrosis. This area demonstrated low signal centrally and was surrounded by obvious enhancement due to abscess formation (Fig. 4e, f). He was treated with antibiotics and the clinical course after inpatient therapy was uneventful.

Discussion

Jaramillo described how in flat bones, at the junction of the cartilage and the bone, there are "metaphyseal equivalents," areas with endochondral ossification that are richly vascularized and thus also prone to infection

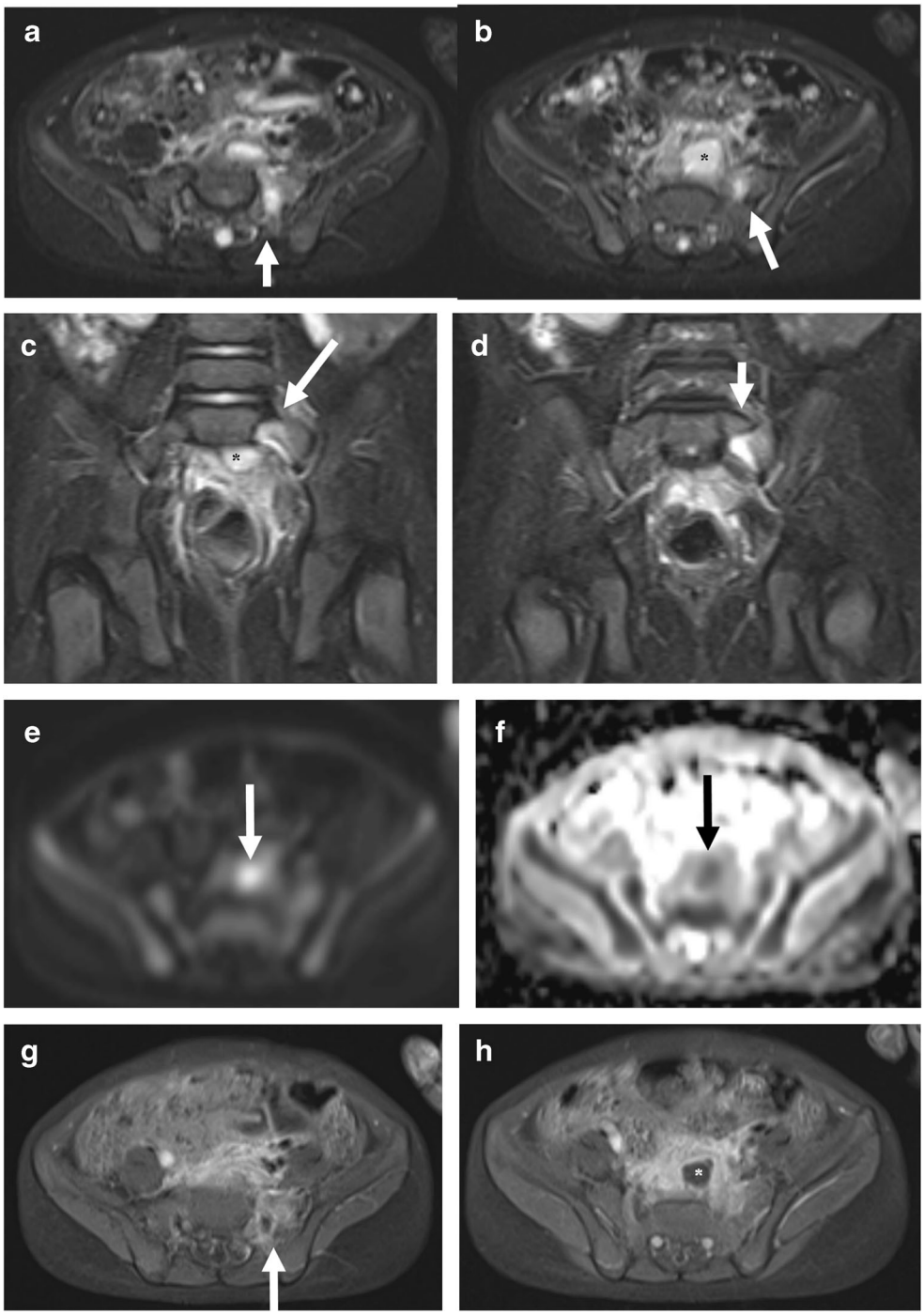

Fig. 4 A 20-month-old infant was referred to our hospital for fever with unknown origin. He underwent pelvic MRI 9 days after the onset of fever; Axial (**a**, **b**), coronal (**c**, **d**) fat-suppressed T2-weighted image, axial diffusion-weighted image (**e**) ADC map (**f**), axial gadolinium-enhanced fat-suppressed T1-weighted image (**g**, **h**). Note increased signal intensity at the medial side of left alar of sacral bone on fat-suppressed T2-weighted image (**a**–**d**, *arrow*). Focal round-shaped high signal lesion was demonstrated in front of a left neurocentral synchondrosis which surrounded by soft tissue with high signal intensity (**b**, *asterisk*). Diffusion-weighted image (**e**) and ADC map (**f**) revealed focal restrict of diffusion in front of left neurocentral synchondrosis (*white and black arrow*). On gadolinium-enhanced fat-suppressed T1WI, there was focal enhancement at edematous lesion demonstrated on fat-suppressed T2WI, suggesting the diagnosis of osteomyelitis of sacrum (**g**, *arrow*). Focal round-shaped area (**h**, *asterisk*) was demonstrated central low signal and surrounded obvious enhancement as abscess formation. There was no inflammatory change at sacroiliac joint. Hence these findings suggested the diagnosis of osteomyelitis of sacrum arose from neurocentral synchondrosis with abscess formation in front of sacrum

[2]. The neurocentral synchondrosis (Fig. 2) is a cartilaginous growth plate located between the neural arch and the centrum of the vertebra [6]. This growth plate is bipolar and contributes to the growth of both the vertebral body and the posterior arch [6]. This area is also known to have sacral stress fracture and insufficiency fracture in adult patients.

In fact, the sacrum and coccyx were noted to develop from 58 to 60 sacral ossification centers and eight coccygeal centers, respectively. These centers were noted to ossify and fuse in an organized temporal pattern from the fetal period up to the age of 30 [7]. Broome et al. reported the age of fusion of the neurocentral synchondrosis at S1 and S2 based on CT findings acquired between the ages of 1 and 7 years of age [7]. Rajwani et al. reported the age of closure of neurocentral synchondroses (C2 to L5) based on MRI findings acquired at 0–15 years of age [7]. The two cases presented here were 1 year and 8 months old, and 6 years old—relatively young,

so the neurocentral synchondrosis at S1 and S2 might not yet have completed its closure.

In the previous literature on osteomyelitis of the pelvis, the mean age was 10.3 years in Connolly's series and the age ranged from 8 to 13 years in Haliloglu's series [1, 8]; the age-distribution of pelvic osteomyelitis was thus much older than with osteomyelitis of long bones, where there is a peak incidence in infancy [3]. The age of susceptibility to pelvic osteomyelitis is thought to be older than the age at which closure of the sacral neurocentral synchondroses occurs. This might be one possible reason for the absence of reports of osteomyelitis in a sacral neurocentral synchondrosis in the literature.

The differential diagnosis based on imaging findings includes ankylosing spondylosis, juvenile idiopathic arthritis, chronic recurrent multifocal osteomyelitis, and sacral metastasis.

As mentioned above, the sacrum was noted to develop from 58 to 60 sacral ossification centers, allowing for many possible origins of osteomyelitis, including a neurocentral synchondrosis.

In summary, we, as pediatric radiologists, should recognize a neurocentral synchondrosis as yet another metaphyseal equivalent in the sacrum. Although the incidence of this condition is thought not to be as common as is the case with the sacroiliac joints, it may still occur, especially in infants and young children.

Compliance with ethical standards

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

References

1. Connolly SA, Connolly LP, Drubach LA, Zurakowski D, Jaramillo D. MRI for detection of abscess in acute osteomyelitis of the pelvis in children. Am J Roentgenol. 2007;189:867–72.
2. Jaramillo D. Infection: musculoskeletal. Pediatr Radiol. 2011;41(Suppl 1):S127–34.
3. Nixon GW. Hematogenous osteomyelitis of metaphyseal-equivalent locations. Am J Roentgenol. 1978;130:123–9.
4. O'Rahilly R, Muller F, Meyer DB. The human vertebral column at the end of the embryonic period proper. 4. The sacrococcygeal region. J Anat. 1990;168:95–111.
5. Gray H. a. 4. The sacral and coccygeal vertebrae in: anatomy of the human body. Philadelphia: Lea & Febiger; 1918. Bartleby.com, 2000. https://www.bartleby.com/107/24.html. Accessed 23 Aug 2018.
6. Rajwani T, Bhargava R, Moreau M, Mahood J, Raso VJ, Jiang H, et al. MRI characteristics of the neurocentral synchondrosis. Pediatr Radiol. 2002;811–816:32 78.
7. Broome DR, Hayman LA, Herrick RC, Braverman RM, Glass RBJ, Fahr LM. Postnatal maturation of the sacrum and coccyx: MR imaging, helical CT, and conventional radiography. Am J Roentgenol. 1998;170:1061–6.
8. Haliloglu M, Kleiman MB, Siddiqui AR, Cohen MD. Osteomyelitis and pyogenic infection of the sacroiliac joint. MRI findings and review. Pediatr Radiol. 1994;24:333–5.