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# CONTINUING EDUCATION

# PROCEEDINGS OF THE JOINT MEETING RBRS BONE SECTION AND NEDERLANDSE VERENIGING VOOR SKELETARADIOLOGIE, Leiden, The Netherlands, 25.03.2011 – PART II

## Tumors and tumorlike conditions of the calcaneus: the usual and unusual

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**The calcaneus is an uncommon site for involvement by tumors or tumorlike conditions of bone, although any lesion may involve the calcaneus. The purpose of this paper is to highlight the imaging features of common and uncommon tumors and tumorlike conditions occurring in the calcaneus.**
**Typical case studies will illustrate the imaging findings on different imaging modalities.**

**Key-words: Ankle – Foot – Tumors.**

**Case 1**

*Clinical information:*

Thirty-five-year-old man presents after a motor vehicle accident with an ankle trauma.

*Findings on medical imaging:*

*Diagnosis:*

Based on the typical radiographic findings and location, the diagnosis of *prominent vascular remnant in the calcaneus* can be made.

A subtle subtalar focus of increased T2-signal within the calcaneus is common on MRI of the ankle done for other reasons, and is unlikely to be misinterpreted as a pathological condition. Lesions exceeding a diameter more than 5 mm -however- are only seen in 7% of MR examinations (1).

This normal variant should not be misinterpreted as a significant lesion and should not be biopsied. The typical subtalar location within the calcaneus near the insertion of the cervical and interosseous ligaments in an asymptomatic patient is the clue to the correct diagnosis. The lesion is of high signal on T2-WI and of low signal on T1-WI. Subtle penetration of the superior calcaneal cortex may be seen on CT and/or MRI.


*Fig. 1.* — CT scan of the left ankle. CT scan revealed a fracture of the medial and posterior ankle. Incidentally, a well delineated radiolucent lesion was seen in the calcaneus inferior to the angle of Gissane.
A. Sagittal reformation.
B. On coronal reformation, the lesion seems to be connected with the superior calcaneal cortex by a nutrient foramen (arrow).

**Case 2**

*Clinical information*

Seventeen-year-old man presents after an ankle sprain.

*Findings on medical imaging:*

*Diagnosis:*

The diagnosis of a *simple bone cyst (SBC)* was made.

A SBC is a benign fluid-filled lesion that is usually seen in the long tubular bones (proximal humerus and femur), under the age of 20 years. The calcaneus is involved in approximately 3% of all SBC (2). Calcaneal lesions may occur in patients over the age of 20 years.

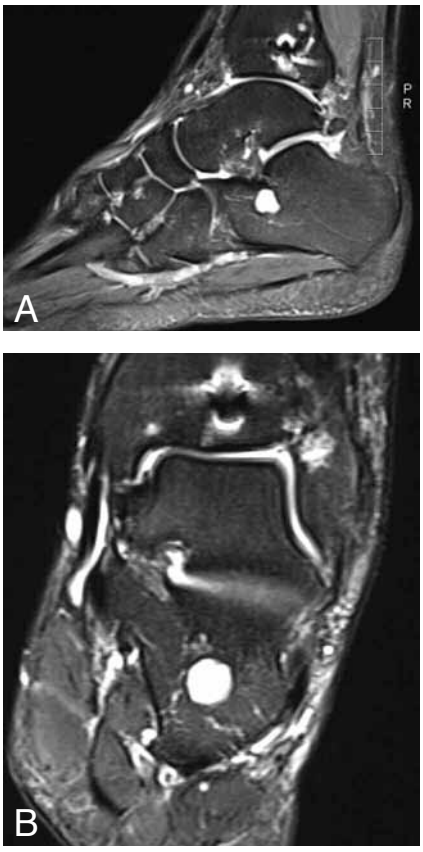



*Fig. 2.* — MRI of the left ankle.
A. Sagittal fatsuppressed T2-weighted image (WI).
B. Coronal fatsuppressed T2-WI. The lesion is hyperintense on T2-WI.

*Fig. 3.* — Conventional radiograph of the left ankle.
There is a well delineated radiolucent lesion within the subthalamic area of the calcaneus.

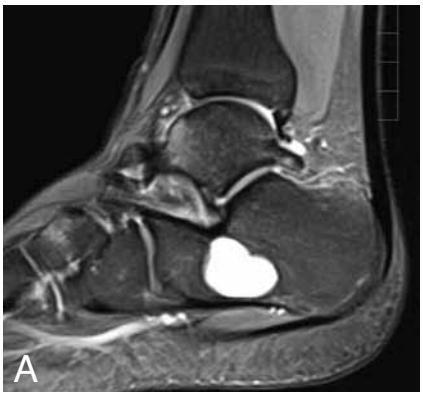





*Fig. 4.* — MRI of the left ankle.
A. Sagittal T2-WI. The lesion is of high signal intensity.
B. Axial T1-WI. The lesion is slightly lobulated and is of low signal intensity.
C. Sagittal fatsuppressed T1-WI after intravenous gadolinium contrast administration. There is subtle peripheral rim enhancement of the lesion.

Plain radiographs reveal a well-delineated radiolucent lesion within the anterior calcaneus.

Pathological fracture is rare at the calcaneus, whereas this complication occurs typically in SBC of the long bones (3). A fallen fragment sign has never been described at the calcaneus. The differential diagnosis with calcaneal pseudocyst or intraosseous lipoma is difficult or even impossible on plain films.

MRI is the preferred technique for further lesion characterization. Although a SBC has been designated with the term solitary or unicameral bone cyst, the contour of the lesion may be slightly lobulated. SBC are of low to intermediate signal intensity on T1-WI and of high signal intensity on T2-WI. After administration of intravenous gadolinium contrast, peripheral rim enhancement is seen.

*Fig. 5.* — Conventional radiograph of the left ankle.
Geographic osteolytic lesion within the anterior part of the calcaneus.

**Case 3**

*Clinical information:*

Forty-eight-year-old man presents after ankle sprain.

*Findings on medical imaging:*

*Diagnosis:*

Based on the signal characteristics of the lesion, similar to fatty tissue, the diagnosis of *intra-osseous lipoma of the calcaneus* was made.

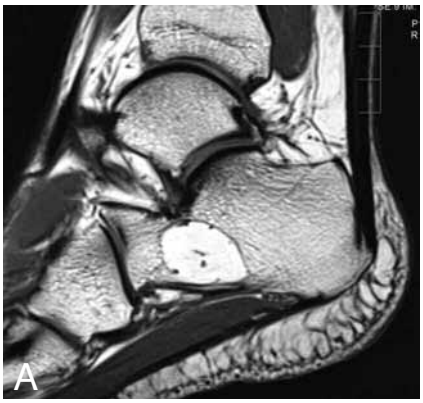
An intraosseous lipoma is a rare benign bone lesion, accounting for at least 0.3% of lesions. The lesion is probably underreported due to the lack of symptoms (4). The calcaneus is involved in up to 30% of cases (2, 4). Intraosseous lipomas of the calcaneus have the same location as SBC or a pseudocyst of the calcaneus.

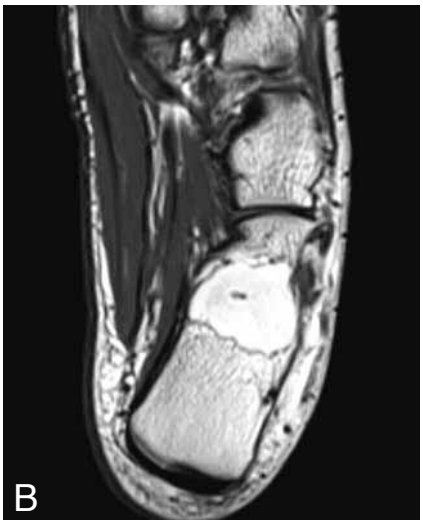
According to Milgram, three consecutive histopathological stages of evolution exist. Stage 1 is composed of viable fat. Stage 2 lesions comprise a mixture of viable fat and areas of partial fat necrosis, whereas stage 3 contains diffuse eosinophilic fat necrosis with extensive calcifications, ossifications or areas of myxoid degeneration.

The radiographic appearance consists of a well delineated radiolucent lesion, often surrounded by a peripheral rim of sclerosis. In stage 3 lesions, intralesional calcifications or ossifications are present. CT is more sensitive than plain films for detection of these calcified or ossified foci.

MRI is superior to detect areas of partial fat necrosis or the development of cystic areas due to myxoid necrosis. The fatty components are of high signal on T1-WI and of low signal intensity on fat suppressed images. Areas of fat necrosis appear hypointense on T1-WI and hyperintense on T2-WI.

The potential relationship between calcaneal pseudocysts (physiological area of trabecular rarefaction within the anterior aspect of the calcaneus, containing fatty bone marrow), an intraosseous lipoma or fatty degeneration within a preexisting benign primary bone tumor (such as a SBC) is still debated (2, 4). This discussion is, however, of no importance because neither of these lesions need any further treatment.





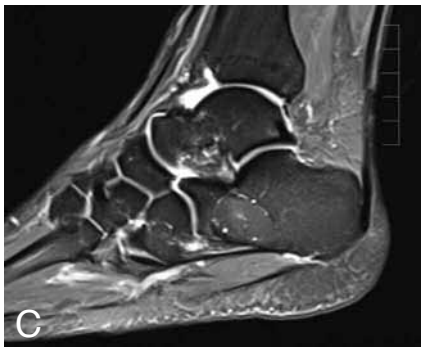


*Fig. 6.* — MRI of the left ankle.
A. Sagittal T1-WI and B. Axial T1-WI. The lesion is of high signal intensity, with some small intralesional areas of intermediate signal intensity.
C. Sagittal fatsuppressed T2-WI. The signal of the lesion is suppressed, except for some small intralesional areas of high signal intensity.

*Fig. 7.* — Conventional radiograph of the left ankle.
Ill-defined sclerosis at the posterior aspect of the calcaneus.

*Fig. 8.* — MRI of the left ankle.
A. Sagittal T1-WI. There is diffuse bone marrow edema within the posterior part of the calcaneus.
B. Sagittal fatsuppressed T2-WI. The bone marrow edema is better seen as high signal compared to normal fatty bone marrow. Note also some adjacent soft tissue edema at the posteroinferior aspect of the calcaneus.
C. Sagittal fatsuppressed T1-WI after administration of intravenous gadolinium contrast. Diffuse abnormal enhancement of the posterior and inferior calaceneus and adjacent soft tissue.

**Case 4**

*Clinical information*

Twenty-one-year-old man with chronic heel pain.

*Findings on medical imaging:*

*Diagnosis:*

*Chronic calcaneal osteomyelitis* was suggested, which was confirmed after surgical debridement of the soft tissue and posteroinferior calcaneus.

Infection of the calcaneus most commonly occurs as a result of puncture wounds, whereas osteomyelitis due to hematogenous spread of infective organisms is predominantly seen in children, but is rare in adults.

In patients with diabetes, osteomyelitis is caused by contiguous spread from an adjacent foot ulcer.

Plain radiographs show areas of bony destruction, bony sclerosis and soft tissue swelling (5).

MRI reveals diffuse bone marrow infiltration of the calcaneal marrow fat. The signal is isointense to muscle on T1-WI and hyperintense on fatsuppressed T2-WI or STIR. The calcaneal cortex may be indistinct and adjacent signal changes are best seen on fluid-sensitive sequences. Areas of bone and adjacent soft tissue infection enhance after administration of intravenous gadolinium contrast. Areas of abscess formation show peripheral rim enhancement, whereas sequesters do not enhance.

**Case 5**

*Clinical information*

Fifty-three-year-old female presenting with nonspecific heel pain and increased tracer uptake on bone scintigraphy at the left calcaneus.

*Findings on medical imaging:*

*Diagnosis:*

Based on the characteristic radiographic findings and the age of the patient, the diagnosis of *monostotic Paget's disease* was made. The disease usually affects middle aged or older patients. Three phases of radiographic severity can be distinguished. An early lytic phase may

*Fig. 9.* — The lateral radiograph of the ankle shows slight enlargement of the calcaneus with thickening of the bony trabeculae.

be followed by a mixed lytic-sclerotic and a late osteoblastic phase. The radiographic hallmarks include enlargement of the calcaneus, trabecular and cortical thickening (5).

**Case 6**

*Clinical information:*

Eight-year-old male presenting with nonspecific heel pain and increased tracer uptake on bone scintigraphy at the left calcaneus. The patient was referred for MRI.

*Findings on medical imaging:*

*Diagnosis:*

After biopsy of both bone and soft tissue components of the lesion and histological examination of the specimen, the diagnosis of *Ewing Sarcoma (ES)* was made. ES and primitive neuroectodermal tumor (PNET) were originally described as distinct clinicopathologic entities, but are currently considered as part of the same spectrum of neoplastic disorders. Most tumors occur between the age of 5 and 25 years, with a peak between 10 and 20 years. Rarely, the tumor develops in adults older than 30 years.

The preferred sites are the long bones of the lower extremity. The calcaneus is a less common site of involvement.

On radiographs or CT, ES involving the bone is mostly mixed sclerotic-lytic.

The most characteristic finding on MRI is the presence of a large soft tissue mass (6). Current treatment of localized disease consists of initial multiagent neoadjuvant chemotherapy, followed by wide or radical surgery and/or radiotherapy. Calcaneal lesions show poor longterm survival (4, 7).

**Case 7**

*Clinical information:*

Thirteen-year-old girl presenting with nonspecific heel pain was referred for conventional radiographs and MRI of the ankle.

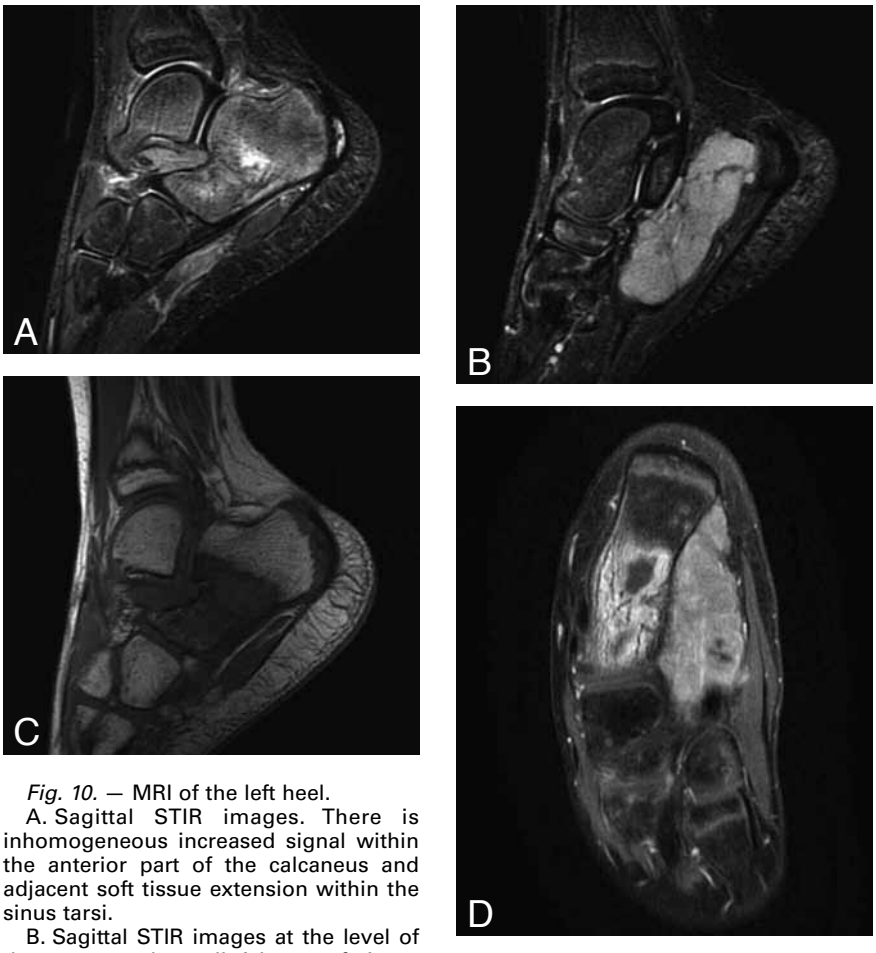



*Fig. 10.* — MRI of the left heel.

A. Sagittal STIR images. There is inhomogeneous increased signal within the anterior part of the calcaneus and adjacent soft tissue extension within the sinus tarsi.

B. Sagittal STIR images at the level of the sustentaculum tali. A huge soft tissue mass at the plantar aspect of the calcaneus is present.

C. Sagittal T1-WI. There is a large area of bone marrow replacement within the anterior part of the calcaneus with relative sparing of the posterior part. Note also extension within the sinus tarsi.

D. Axial fatsuppressed T1-WI after administration of intravenous gadolinium contrast. There is heterogeneous enhancement of both the osseous and soft tissue mass.

*Findings on medical imaging:*

*Diagnosis:*

After biopsy of both bony and soft tissue components of the lesion and histological examination of the specimen, the diagnosis of *osteosarcoma (OS)* was made.

OS is the most common primary malignant tumor of bone in adolescents and young adults, accounting for approximately 40-60% of all primary malignant bone tumors.

Less than 1% of OS arise in the calcaneus (5).

The tumor may also be the result of malignant transformation of benign lesions such as Paget's disease, fibrous dysplasia or after previous irradiation.

Radiographically, intramedullary calcaneal OS is similar to conventional osteosarcoma, with presence of osteoid matrix, aggressive periosteal reaction

*Fig. 11.* — Conventional radiograph of the right ankle.

The lateral radiograph of the ankle demonstrates osteosclerosis of the posteroinferior aspect of the calcaneus, irregular delineation of the inferior cortex and spiculated periosteal reaction (arrow).

*Fig. 12.* — MRI of the right heel.

A. Sagittal T1-WI. There is a huge area of bone marrow replacement within the calcaneus and adjacent soft tissue mass at the plantar aspect of the calcaneus.

B. Sagittal fatsuppressed PD-WI. The osseous and soft tissue components of the lesion are of high signal intensity.

C. Sagittal T1-WI after administration of intravenous gadolinium contrast. There is diffuse enhancement of the lesion within the calcaneus as well as heterogeneous enhancement of the adjacent soft tissue mass (arrows).

(such as a sunburst type periosteal reaction) and soft tissue extension. Besides areas of sclerosis and mineralization, there are often associated areas of lytic bone destruction.

MR imaging is performed to assess the intra- and extraosseous components of the lesion. Lesions are of low to intermediate signal intensity on T1-WI and are of heterogeneous signal intensity on T2-WI. Mineralized areas are of low signal, whereas other components are of high signal intensity. Foci of central hemorrhage are of high signal on all pulse sequences. Fat-suppressed T1-WI after intravenous administration of gadolinium contrast are particular helpful for preoperative local staging.

Treatment of OS includes a combination of preoperative and postoperative chemotherapy, wide surgical excision and radiation therapy (4).

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