Spontaneous talar and calcaneal fracture in rheumatoid arthritis: a case report

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ABSTRACT

Rheumatoid arthritis (RA) leads to a progressive weakening of the skeleton which may result in bone fractures. However, spontaneous fractures (exclusive of stress fractures, vertebral collapse, and superficial articular fragmentation) in patients with rheumatoid arthritis have been only occasionally reported in the medical literature. A case of spontaneous talar and calcaneal fracture in rheumatoid arthritis is described. Bone lesions were identified on radiographs, MR images and scintigraphy in a patient with right ankle pain. The absence of episodes of acute trauma, and the presence of acute clinical manifestations should guide the clinical suspicion.

CASE REPORT

CASE REPORT

A 78-year-old female patient with a known diagnosis of RA presented with a 2-month history of calcaneal pain without any history of acute trauma. In this patient RA was diagnosed about 6 years before the onset of the calcaneal pain. During a previous hospital admission her laboratory exams showed increased ESR and positive rheumatoid factor, ANA and anti-citrullinated protein antibodies, but there was no other relevant alteration in blood test (in particular normal C-reactive protein, blood glucose and inorganic phosphate). Urine calcium test was normal. There was no evidence of diffuse and severe osteoporosis, as remarked on the DEXA performed on the femoral bone with the result of a T-score of -0.6. The patient had hypertension, and smoked about 25 cigarettes per day for about 30 years. She reported benefit from DMARD methotrexate treatment (7.5 mg MTX, 1 tbl/week for about 5 years). When necessary, joint pain was treated by NSAIDs, steroids were never used.

Externally acquired ultrasound showed calcific enthesopathy of the plantar fascia, with thickening and hypoechogenicity reported as "fasciitis" (not shown).

Subsequent radiography revealed an area of subtle radiolucent line in the subtalar region of the calcaneus with cortical disruption, compatible with fracture (Fig.1). Furthermore, on x-ray lateral view the posterior region of the talus seemed to be regular, with normal congruence of ankle and tarsal joints. It was also visible a calcific enthesopathy of the Achilles tendon and of the proximal insertion of the plantar fascia. MR examination of the ankle confirmed the fracture of the subtalar region of the calcaneus by showing an irregular hypointense line, surrounded by a less well-defined area of hypointensity due to bone marrow oedema, on T1-weighted images. A similar hypointense area in the posteroinferior part of the talus, with the fracture line extending at the level of the talar neck was seen as well (Fig. 2) on T1-weighted images (these aspects resemble a kissing bone lesion). On the T2-weighted images with fat saturation (Fat Sat), the bone marrow oedema was better evaluated as a hyperintense area (Fig. 3). Triphasic scintigraphy was performed with 99mTC-MDP after five days to date the fractures. Dynamic bone scintigraphy (Fig.4) does not emphasize any particular finding on perfusion images, but it showed an increased tracer uptake at the tibio-tarsal region 3 minutes after 99mTC-MDP infusion (blood-pool), and a higher tracer uptake after 150 minutes (third phase).

The patient was immobilized with the ankle in plaster for about 12 weeks. After 7 months she still had an incomplete ossification of the calcaneal fracture. Further prognostic information was unavailable because of the death of the patient in a car accident.

DISCUSSION

Rheumatoid arthritis (RA) is a chronic, usually progressive, systemic, auto-immune disease of unknown etiology. The main (or hallmark) feature of this condition is an inflammatory arthritis characterized by synovial proliferation that often progresses to symmetric destruction of the articular cartilage and ankylosis of the joints, but it may also cause systemic manifestations. RA with involvement of hands and feet is more common in women than in men [1, 2].

Rheumatoid arthritis has a worldwide distribution. Prevalence has been estimated to be 1% both in Europe and US [3] and it increases with age, approaching 5% in women over age 55. The average annual incidence in the United States is about 70 per 100,000 annually.

In the beginning, patients with RA usually report joint pain after rest, in addition to joint swelling and stiffness that usually last more than 45 minutes if not modified by treatment. There is simultaneous and bilateral involvement of at least three joint areas, more frequently: proximal interphalangeal, metacarpophalangeal, wrist, and sometimes matatarsophalangeal, elbow, knee, ankle, shoulder. Other findings in RA are the presence of rheumatoid nodules (subcutaneous nodules over bony prominences or extensor surfaces or juxtaarticular regions) and radiographic changes such as bone erosions in the bare areas, where the synovial membrane is in direct contact with bone (late changes).

In 2010 the ACR/EULAR established the classification criteria for RA. The application of these criteria (joint involvement, serology, acute-phase reactants and duration of symptoms) provides a score of 0-10, with a score of ?6 being indicative of the presence of definite RA. In our case the patient reached a score of 7.

The occurrence of spontaneous, pathological fractures in RA has been only occasionally reported in the medical literature and proposed mechanisms for skeletal failure include bone erosions and fragility, perhaps related to steroid medication, osteoporosis, or osteomalacia [4]. Osteopenia in these individuals, particularly those with longstanding disease, has been related to generalized or periarticular osteoporosis, aggravated by such factors as inactivity (or changing levels of physical activity), age, female sex, menopause, lower BMI, high RA disease activity, corticosteroid therapy [5, 6], anatomic site and osteomalacia [7]. This osteopenia leads to structural weakening of the bone, contributing to its failure under normal or abnormal stress.

The lesion studied in our patient involved the posteroinferior part of the talus and the subtalar region of the calcaneum and was almost symmetrically located around the talocalcaneal joint, recalling a kissing bone lesion. Kissing lesions are usually characterized by a coexisting damage to the bone of opposing articular surfaces and they can be related to traumatic facts. Inflammatory events of the joint (such as synovitis) can induce kissing bone lesion too because of the local weakening of the bone tissue nearby the articulation. Since in our patient there was no evidence of generalized osteoporosis (normal T-score), and no evidence of erosions the pathology should probably be attributed to local osteopenia.

Stress fractures can be categorized into: stress reactions (when microfractures are healing and a complete fracture has not yet developed), fatigue fractures (caused by the prolonged cyclical application of abnormal mechanical stresses placed on normal bone), and insufficiency fractures (with physiologic stresses on a weakened skeleton that is deficient in mineral or elastic resistance) [8, 9, 10]. In the case of spontaneous fractures in RA, it is normally considered that these are insufficiency fractures.

The incidence of spontaneous fracture in patient with RA is 9.6 per 1000 person-year, with a predilection for elderly women (F:M = 5:1; peak at 70 years-old). The best known example of such failure under stress is the occurrence of compression fractures of one or more vertebral bodies in patients with RA. The occurrence of insufficiency type stress fractures of the tubular bones of the lower extremity, which are promoted by angular deformity, flexion contracture, and changing levels of physical activity, has also been emphasized [11, 12]. Other examples include fragmentation of the articular surfaces in both large and small joints [13], and the occurrence of fractures through subchondral cystic lesions, especially about the rheumatoid elbow [14].

Conventional radiography can be useful in detecting insufficiency fracture in patient with RA. The osteoporotic bone is usually characterized on x-ray examination by narrowing of the cortical bone and increased radiolucency in particular in juxtarticular region of the bone (even with formation of subchondral cysts). Fracture in these conditions appears such as a radiolucent line inside an abnormal bone, while in serious cases the collapse of the bone induces a change of local anatomy.

Such as fractures that occur on normal bones, these lesions are treated with orthopaedic surgery and/or immobilization, supported by the therapy for RA, but they have a delayed (more than 6-8 weeks) or incomplete heal, leading to disability.

Usually both stress and spontaneous fractures occur in patients with a history of repeated microtraumas in the ankle and foot, and predominantly involve the second metatarsal, the calcaneus and less frequently the navicular bone and the talus [9, 15, 16].

In the early phase of insufficiency fractures, the bone is characterized by oedema, hyperaemia and osteoclastic activity; MR imaging shows a poorly defined, abnormal signal intensity of the bone marrow similar to that of bone contusion with an ill-defined area of hypointensity on T1-weighted images and hyperintensity on T2-weighted images and fat-suppressed images [9, 15]. As lesion develops, as in our case, bone fracture appears on T1-weighted images as a more linear or band-like zone of low signal intensity. The surrounding area of oedema becomes hyperintense relative to marrow fat on T2-weighted images if the MR images are acquired a few weeks after the onset of the symptoms [15]. Moreover the periosteum

is separated from the underlying cortex by hyperintense tissue on T2-weighted images, most likely representing inflammatory reaction [17].

Many conditions may clinically resemble a spontaneous fracture, in particular: bone contusions, osteochondral fractures, osteoid osteoma, osteonecrosis, tarsal coalition and painful accessory bones.

Bone contusion was discarded. Bone contusion is a condition that can occur after a bone trauma. X-ray examination is characterized by the lack of a radiolucent line in the bone (typical of bone fracture) and shows joint effusion. On MR these lesions are seen as geographic and non-linear areas of signal loss on T1-weighted images. CT exam shows a focal hypodensity of the bone marrow due to oedema or to hematoma. It normally resolves in 8-12 weeks [18].

Osteochondral fractures may originate from single or multiple traumatic events, but in this case there is partial or complete detachment of an osteochondral fragment, often with ligament tear. Radiography shows about 50% of small subchondral fracture lines or bone fragments and CT permits a more detailed examination, but cartilage cannot be directly assessed. MR T1-weighted imaging findings are different depending on the stage of the disease: subchondral area of decreased signal intensity (stage I), partial detachment of osteocartilaginous fragment (stage II), complete detachment of the osteochondral fragment (stage III), displacement of the fragment (stage IV). On T2-weighted images the hypointensity of the interface between normal bone and osteochondral fragment indicates healing and stability, while a hyperintense area may indicate fluid interposed and oedema of the bone marrow.

Osteoid osteoma was rejected because it more frequently occurs in young people, and it is characterized, on radiography, by a small central radiolucent area (termed nidus) surrounded by a zone of uniform bone sclerosis and cortical thickening due to endosteal and subperiosteal new bone formation. The central "nidus" has low intensity on the T1-weighted MR images, due to the presence of calcification [19]. The hyperintense area around the "nidus" on T2-weighted images refers to the oedema present in the juxtanidal bone marrow and in the adjacent soft tissues.

Osteonecrosis of the ankle was rejected because it usually occurs in the talus as a consequence of talar neck fractures with vascular compromise of the bone at the level of the sinus tarsi [18]. X-ray demonstrates a radiolucent area in the subchondral bone, surrounded by a rim of sclerosis. Later in the disease course, the subchondral bone collapses. At the CT examination, bone changes can be demonstrated earlier than at radiography with subtle alterations in trabecular patterns, joint spaces and bone contours, whereas a diffuse sclerotic or mixed hypoattenuating-sclerotic pattern outlined by a serpiginous sclerotic line appears later. In late disease, when the bone collapses, the fragment is surrounded by a hypoattenuating area. At MR imaging an area of inhomogeneous signal intensity surrounded by a hypointense band, sometimes with a second band of high signal intensity on T2-weighted images (double line sign), are characteristic findings for osteonecrosis.

Tarsal coalition was discarded because of the absence of talocalcaneal joint involvement. MR imaging can help in the diagnosis of osseous coalition when results from conventional radiography are equivocal (usually seen as enlargement of the anterior process of the calcaneus, talar beak, narrowing of the posterior facet of the subtalar joint, bone fusion). T1-weighted images can reveal a bone marrow contiguity across the fused articulation (osseous coalition), or an area of signal intensity similar to that of fluid or cartilage in the joint space (cartilaginous coalitions), or an intermediate-low signal intensity in the affected joint (fibrous coalition). Bone marrow oedema may be evaluated as a hyperintense area on T2-weighted images.

Accessory bone are usually identified with standard radiography that shows the rounded smooth borders of the ossicle while a fractured bone presents sharp, ragged edges. In case of doubt after x-ray, a CT examination can be performed to delineate the bone anatomy more clearly. There is often bone oedema associated to accessory bones (hypointense on T1- and hyperintense on T2-weighted MR images).

MR imaging has been found to be more sensitive than conventional radiography in the detection of occult fractures, particularly in elderly and osteoporotic patients [20].

TEACHING POINT

When evaluating osseous pain in a patient with RA and no definite history of trauma, spontaneous fracture is an uncommon condition to bear in mind. Careful analysis of clinical manifestation and their correlation with imaging findings (traditional imaging supported by CT, MRI and bone scan) can help physicians reach the appropriate diagnosis and prescribe the right treatment even for pathology with an unusual anatomic location.

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FIGURES

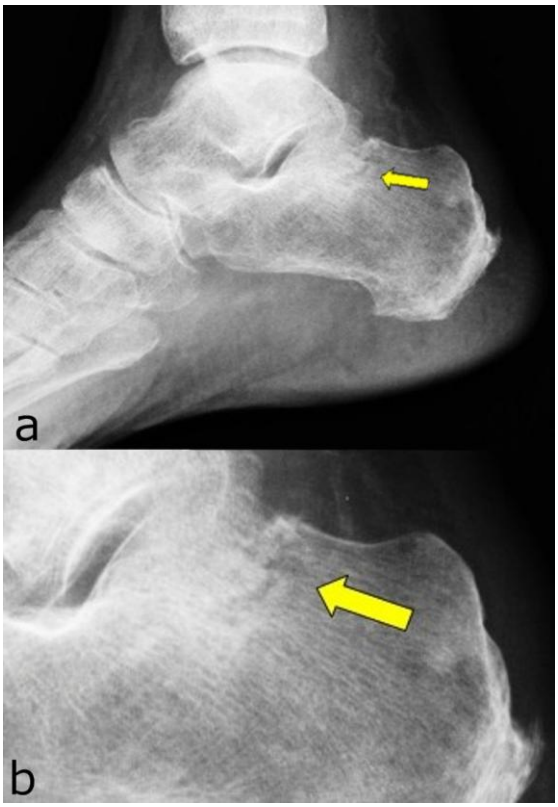

Figure 1. 78-year-old female with RA and spontaneous talar and calcaneal fracture. Lateral view of conventional radiography (a) and magnification view (b) of the ankle showing a subtle radiolucent line in the subtalar region of the calcaneus with cortical disruption. Presence of calcific enthesopathy of the Achilles tendon and of the proximal insertion of the plantar fascia. Regular congruence of visible joints. No pathologic findings are visible in the posterior region of the talus. Presence of a tortuous calicified vessel projecting over the soft tissues posterior to the tibia and ankle (Protocol conventional radiography: 40 kV, 5 mAs)

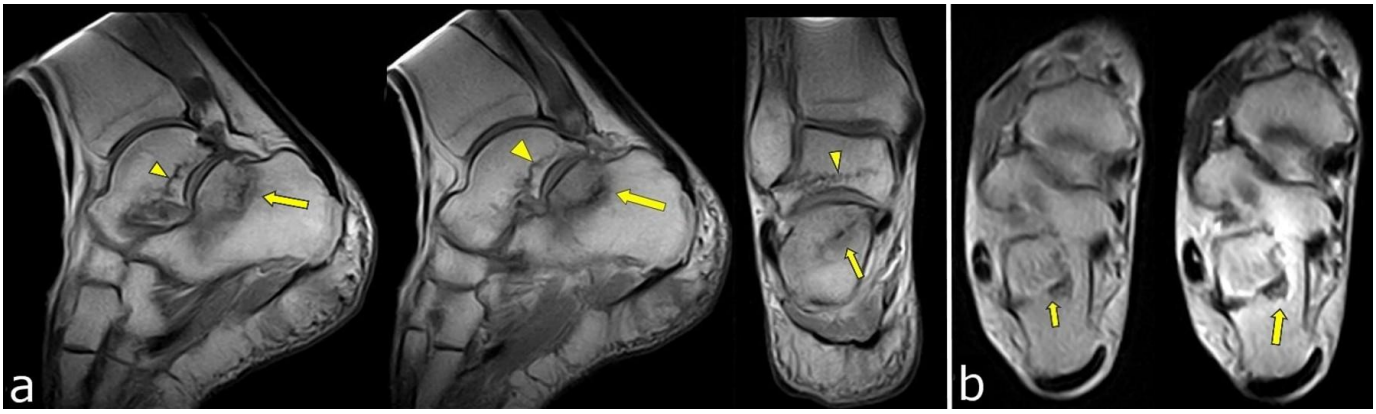

Figure 2. 78-year-old female with RA and spontaneous talar and calcaneal fracture. MR Imaging; FSE and TME sequences. Sagittal and coronal T1 (2a) and axial PD-T2 (2b) -weighted MR images showing irregular, hypointense line of fracture in the subtalar region of the calacaneus, surrounded by a less well-defined area of hypointensity due to bone marrow oedema and hyperaemia (arrow). Presence of irregular hypointense line in the posteroinferior part of the talus extending at the level of the talar neck, compatible with intramedullary bone fracture (arrow head). Muscle tissue, tendons and the other osseous structures present normal signal intensity. (Protocol MRI: 2a. FSE sequence. Sagittal 1,5 Tesla magnet, TR: 640 msec, TE: 14 msec ; Coronal 1,5 Tesla magnet, TR : 440 msec, TE : 12 msec; 2b. TME sequence. Axial 1,5 T, TR : 3440 msec, TE1 : 45 msec, TE2: 102 msec)

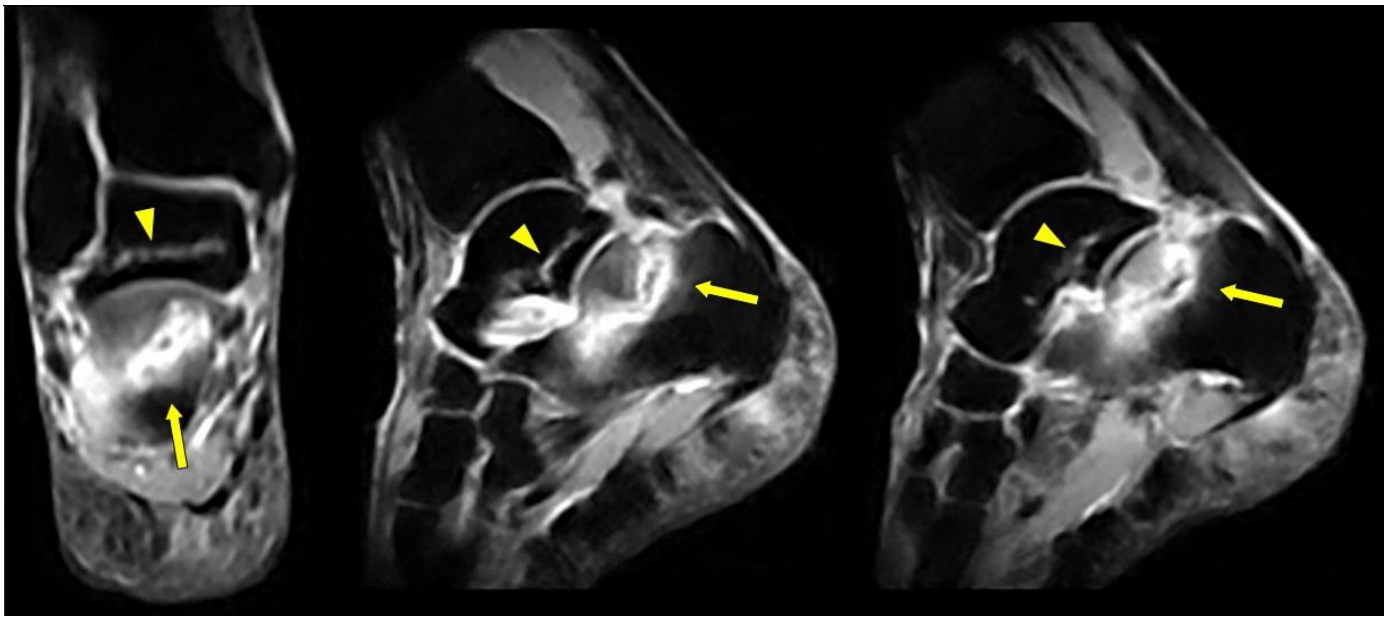

Figure 3. 78-year-old female with RA and spontaneous talar and calcaneal fracture. MR Imaging; FSE sequences with fat saturation (Fat Sat). Coronal and sagittal T2-weighted images showing hyperintense line in the lower-posterior talus (arrow head) compatible with trabecular bone injury; line of fracture in the upper-anterior calcaneus due to bone fracture, surrounded by a wide hyperintense area related to bone oedema (arrow) more visible in the anterior and sub-talar portion of the calcaneus. Muscle tissue, tendons and the other osseous structures present normal signal intensity. (Protocol MRI: Coronal 1,5 Tesla magnet, TR: 5140 msec, TE: 71 msec; Sagittal 1,5 T, TR: 4560 msec, TE: 75 msec)

Figure 4. 78-year-old female with RA and spontaneous talar and calcaneal fracture. Tracer uptake at the right tibio-tarsal region in all phases of the dynamic scintigraphy with an higer radioisotope uptake in the calcaneus. Images related to the third phase of this exam show a wider tracer uptake (4a: blood-pool, seen in anterior view on the left side and in left-lateral view on the right side of the picture; 4b: third phase, seen in anterior view on the left side and in left-lateral view on the right side of the picture). These aspects seem to be related to high osteoblastic and osteoclastic activity after the occurrence of a bone fracture. (Protocol bone scintigraphy: 99mTC-MDP, dose: 740 MBq; images acquired during tracer infusion, after 3 minutes and after 150 minutes)

Etiology [1]	Structural weakening of the bone in RA (RA is a chronic systemic auto-immune disease)
Incidence[4]	9,6 per 1000 person-year among RA patients
Female:male ratio [4]	5:1
Age predilection [4]	Over fifth decade of life, with a peak at 70 year-old
Risk factors [4]	Age, oral corticosteroids, body weight and height, sex, anatomic site
Treatment	Orthopaedic surgery and/or immobilization (associated to drug treatment for RA)
Prognosis	Delayed heal than fracture in non-RA patients (more than 6-8 weeks), and may compromise function leading to disability
Findings on imaging	X-ray: Area of subtle lucency with cortical disruption. CT: Fracture line with a focal callus formation and endosteal thickening around the fracture site with occasional increased medullary cavity density and adjacent soft-tissue swelling [16]. MRI: Ill-defined hypointense area on T1W, then becomes an irregular hypointense line. Hyperintense area on T2W and fat-suppressed images. Periosteal callus formation: hypointense line running parallel to the cortex [14]. Bone scintigraphy with ^{99m}TC-MDP: high tracer uptake

Table 1. Summary table for spontaneous fractures in rheumatoid arthritis

Differential diagnosis	X-ray	CT	MRI	Others
Spontaneous fracture	Area of subtle lucency with cortical disruption	Fracture line (later, focal callus formation and endosteal thickening around fracture site). Adjacent soft-tissue swelling [16]	Ill-defined hypointense area on T1W, then irregular hypointense line. Hyperintense area on T2W and Fat Sat images. Periosteal callus: hypointense line parallel to the cortex [14]	Bone scans: localized area of radioisotope uptake
Bone contusion	Negative in most cases [14]. Local thickening due to swelling/effusion	Supplementary method to evaluate joint effusion. Hypodense bone marrow due to oedema or hematoma	Reticular hypointense areas on T1W images and hyperintense on T2W and Fat Sat images [14]	
Osteochondral fracture	Shows about half of all lesions. Small subchondral fracture line or bone fragment or subchondral cysts. Joint space width seen on weight-bearing radiographs has been used as a proxy for cartilage integrity	Shows bony fragments and cysts. Bone oedema or cartilage defects not visible. CT arthrography, shows cartilage lesions at least as well as MR arthrography	T1W: Subchondral low signal intensity (stage I); partial/complete detachment of osteocartilaginous fragment (stage II/III); displacement of the fragment (stage IV). T2W: Healing and stability if interface normal bone-osteochondral is hypointense. Hyperintensity may indicate fluid interposed (instability) [14]	Bone scans show an area of radioisotope uptake at the site of the lesion
Osteoid osteoma	Central, small radiolucent area (nidus) surrounded by uniform bone sclerosis and cortical thickening (endosteal and subperiosteal new bone formation)	Demonstrate the nidus and the other elements more precisely than radiography	Nidus hypointense on T1W, hyperintense on T2W with calcification (as nodular intranidal hypointensity). T2 hyperintense signal in the juxtanidal marrow and soft tissue (oedema)	

Table 2: Differential diagnosis for spontaneous fracture in rheumatoid arthritis (continued on next page)

DD	X-ray	CT	MRI	Others
Osteonecrosis	Radiolucent area in the subchondral bone, surrounded by a rim of sclerosis. Later the subchondral bone collapses. Necrotic bones appear more radiopaque than the surrounding osteopenic bones	Subtle alterations in trabecular patterns, joint spaces and bone contours (early disease). Diffuse sclerotic or mixed hypoattenuating-sclerotic pattern outlined by a serpiginous sclerotic line; hypoattenuating area surrounding a collapsed fragment (late disease)	Areas of inhomogeneous signal intensity surrounded by a hypointense band, sometimes with a second band of high signal on T2W . After subchondral collapse, low signal intensity without an obvious demarcating interface is seen on both T1 and T2W [14]	Bone scans: localized area of radioisotope uptake. Secondary osteonecrosis is usually bilateral, so bilateral symmetric uptake may be read incorrectly as degenerative changes or as a negative study
Tarsal coalition	Tarsal coalition "C-sign" on the lateral radiograph, elongation of the anterior process of the calcaneus (anteater sign), talar beak, narrowing of the posterior facet of the subtalar joint, bone fusion	More precise evaluation than radiography of the extent of coalition, narrowing of bone surfaces and reactive sclerosis. Shows bony bridge in osseous coalition	T1W: bone marrow contiguity across fused articulation (osseous coalition); signal intensity similar to fluid or cartilage in the joint space (cartilaginous coalitions); intermediate-low signal intensity in the affected joint (fibrous coalition). T2W: hyperintensity due to bone marrow oedema	
Painful accessory bones	Rounded smooth borders as opposed to fractures (sharp ragged edges). Standard radiographs often allow identification and classification of the ossicles	Can delineate bony anatomy more clearly. CT is ordered if plain X-rays are inconclusive and fracture is suspected	Reveals the presence of bone oedema (hypointense on T1W and hyperintense on T2W) and the presence of cortical bone all around the osseous element (hypointense on all sequences)	

Table 2 (continued): Differential diagnosis for spontaneous fracture in rheumatoid arthritis

ABBREVIATIONS

ACR/EULAR - American College of Rheumatology/European League Against Rheumatism
ANA - Anti Nuclear Antibodies
BMI - Body Mass Index
CT - Computed Tomography
DEXA - Dual Energy X-ray Absorptiometry
DMARD - Disease-Modifying Anti-Rheumatic Drugs
ESR - Erythro-Sedimentation Rate
Fat Sat - Fat Saturation
MR - Magnetic Resonance
MTX - Methotrexate
NSAID - Non-Steroid Anti-Inflammatory Drugs
RA - Rheumatoid Arthritis

KEYWORDS

Rheumatoid arthritis; spontaneous fracture of the talus; fracture of the heel; talar and calcaneal fracture; magnetic resonance imaging

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