

Adventitious bursitis in the plantar fat pad of forefoot presenting as a tumoral mass

Hichem Zidani^{1*}, Idan Genah¹, Marick Lae², Valerie Bousson¹, Jean-Denis Laredo¹

1. Department of Radiology, Hôpital Lariboisière, Assistance Publique des Hôpitaux de Paris, Paris, France

2. Department of pathological anatomy and cytology, Institut Curie, Paris, France

* Correspondence: Hichem Zidani, 29 rue Octave Feuillet, 75116 Paris, France
 zidani.hichem@gmail.com

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ABSTRACT

Adventitious bursitis of the plantar fat pad is a common cause of forefoot pain. It may develop at sites where subcutaneous tissue is exposed to friction and high pressure. In the forefoot, adventitious bursitis is usually adjacent to bony prominences of the metatarsal heads. Diagnosis and management of adventitious bursitis usually do not require imaging studies. However, the condition occasionally presents as a solid pseudotumoral mass requiring imaging. Magnetic resonance imaging (MRI) may demonstrate a heterogeneous mass with a solid component exhibiting intermediate to high signal intensity on T2-weighted images and thick nodular enhancement suggesting a neoplastic lesion. We report three cases of adventitious bursitis in patients who complained of a painful palpable mass on the forefoot, with a partially solid and enhancing component seen on MRI. In the first case, a biopsy was performed for the diagnosis of adventitious bursitis. The two other cases exhibited a solid component on MRI. However, a diagnosis of adventitious bursitis was suspected, and it was felt that a biopsy could be postponed. The spontaneous regression of the mass with relative discharge of the forefoot pressure confirmed the diagnosis. With these three cases, we illustrate the MR findings that could suggest adventitious bursitis despite the presence of a solid component and that may obviate the need for pathologic proof.

CASE REPORT

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Case 1

A 60-year-old man, a thoracic and vascular surgeon usually standing during his work and with no remarkable medical history, consulted for a painful plantar mass of the right foot. Clinical examination revealed a palpable solid mass located below the second metatarsal head. The overlying skin was normal. Blood samples indicated no biologic inflammation. Radiographs showed no bone abnormality (Fig. 1a). MRI revealed a well-delineated mass under the second metatarsal head, measuring 20 mm at its largest diameter and

exhibiting intermediate signal intensity on T1-weighted MR images and heterogeneous high signal intensity on T2-weighted MR images (Fig. 1b-d). Gadolinium-enhanced images showed enhancement of a thick peripheral part of the mass but not its central fluid-like part (Fig. 1e). Owing to the partly solid appearance of the mass, a tumor with central necrosis was not excluded and a percutaneous biopsy was decided. Pathology examination of the biopsy showed fibrosis, inflammatory remodeling and a slit-like cavity within collagen sheets that represented an adventitious bursa (Fig. 1f-g). At 3-month follow-up after relative rest, avoiding prolonged

standing and use of a sit during surgery, the palpable mass had markedly decreased in size at physical examination.

Case 2

A 31-year-old woman who typically wore high-heeled shoes at work as an assistant advertising manager consulted for plantar pain of the left foot that had substantially increased after standing for 2 months. She had no remarkable medical history. Clinical examination showed a plantar mass below the second metatarsal head with slight hyperkeratosis but no clinical inflammation. Blood did not show inflammation or increased white blood cell count. Radiographs showed no abnormalities (not shown). Doppler ultrasonography showed a poorly delineated lumpy infiltrate without hypervascularization (Fig. 2a-b). MRI revealed a well-delineated mass measuring 21 mm at its largest diameter surrounding and extending at the plantar aspect of the second metatarsal head and in the adjacent intermetatarsal spaces; the mass exhibited heterogeneous low signal intensity on T1-weighted images and high signal intensity on T2-weighted images (Fig. 2c-e). Gadolinium-enhanced MR images showed enhancement of a thick peripheral part of the mass and a central (fluid-like) non-enhancing part (Fig. 2f).

From our experience with case 1, and owing to the location of the mass, regular use of high-heeled shoes, and clinical and imaging findings, an adventitious bursitis was suspected. During a medical meeting, it was decided to delay a decision for biopsy and to ask the patient to stop wearing the high-heeled shoes. After 2 months, the pain was much alleviated and the mass had almost disappeared clinically.

Case 3

A 35-year-old professional ballet dancer, giving two performances each day, six days a week, consulted for right plantar pain present for 8 months and a plantar mass below the first metatarsophalangeal joint. Radiographs of the foot were normal (Fig. 3a). MRI revealed a well-delineated mass measuring 22 mm at its largest diameter, with heterogeneous intermediate signal intensity on T1-weighted and heterogeneous mostly intermediate signal intensity on T2-weighted MR images under the first metatarsal head (Fig. 3b-d). Gadolinium-enhanced MR sequences showed enhancement of a thick nodular peripheral part of the mass but not a central fluid-like area (Fig. 3e). Tenosynovitis of the flexor hallucis longus was also present (Fig. 3c). During a medical meeting, a diagnosis of adventitious bursitis was considered and a biopsy postponed. The patient was asked to stop the professional dancing activity. At a 2-month follow-up, the metatarsalgias and the palpable mass were markedly reduced.

DISCUSSION

Introduction:

Adventitious bursitis of the plantar fat pad is one of the most common causes of forefoot pain [1]. It develops secondary to chronic microtrauma and shearing forces exerted on the subcutaneous tissue of the plantar forefoot [2]. The

diagnosis and management usually do not require imaging studies [3]. However, the condition may sometimes present as a pseudotumoral superficial mass of the plantar forefoot requiring imaging [2].

We report three cases of adventitious bursitis of the plantar fat pad that presented as a superficial pseudotumoral mass of the plantar forefoot and was partly solid on magnetic resonance imaging (MRI), mimicking a neoplastic process.

Etiology & Demographics:

In contrast to natural superficial synovial bursae such as those of the patella and olecranon, whose aim is to reduce friction between skin and subjacent prominences, adventitious bursitis may appear during adulthood in response to high friction and pressure. Unlike intermetatarsal bursitis, it presents no synovial lining and results from the coalescence of preexisting small spaces within the connective tissue [1].

To our knowledge, only rare reports described adventitious bursitis of the plantar fat pad presenting as a pseudotumoral mass [2, 3]. It is likely, however, that this presentation is not so rare in actual practice.

Adventitious bursitis of the plantar fat pad are commonly located in areas of maximal pressure, namely the heel and beneath the first and fifth metatarsal heads, according to the tripod model. The foot tripod refers to three points of contact that the bottom of the foot makes with the ground. A balance between these points evenly distributes weight on the foot and provides stability. It's also thought that the arches of the foot function optimally when the tripod position is maintained [4]. In one of our patients, the adventitious bursitis was located below the first metatarsal head, whereas in other two, it was located below the second metatarsal head, which is also a high weight-bearing area, especially in individuals with a long second foot ray and a subsidence of the forefoot arch. Among the six symptomatic adventitious bursitis, reported by Studler et al, three were located beneath the first metatarsal head, two beneath the second head and one beneath the third head [1].

Our three patients were exposed to chronic overload of the forefoot due to their profession or the wearing of high-heeled shoes, all recognized factors favoring the occurrence of adventitious bursitis [5].

Clinical & Imaging findings:

Patients consult for a painful plantar mass of the forefoot. The mass is directly located beneath a metatarsal head, in opposition to intermetatarsal bursitis, which is located between the metatarsal heads. Concerning the imaging findings, few studies have focused on the MR appearance of adventitious bursitis of the forefoot [1-3], and, to our knowledge, their possible pseudotumoral appearance has not been described. Our cases appeared as predominantly solid masses with a limited cystic component, which mimicked a tumoral mass, except for their suggestive location. Pathology examination of the biopsy for case 1 showed non-specific reactive tissue alterations with fibrosis, inflammatory

remodeling and a slit-like cavity within collagen sheets that were consistent with adventitious bursa, in agreement with a previous report [1]. Coexistence of fibrosis and inflammatory tissue may account for the heterogeneous signal intensity seen on T2-weighted MR sequences with areas of low and high non-cystic signal intensity. Similarly, three of the six symptomatic cases of adventitious bursitis reported by Studler et al. showed mixed to high signal intensity on T2-weighted images [1]. The largest diameter of the masses in our three cases was 20, 21 and 22 mm; the median largest diameter of the six symptomatic cases reported by Studler et al. was 20 mm [1].

Distinguishing benign from malignant soft-tissue mass is a critical issue, particularly in the foot, where malignant soft-tissue tumors are not uncommon. According to the literature [5-7], among the most specific MR signs for malignancy prediction is the signal inhomogeneity of the mass on T2-weighted sequences. In all of our cases, the mass exhibited inhomogeneous signal intensity on T2-weighted MR sequences, and a malignant soft-tissue tumor such as a synovial sarcoma was considered in the differential diagnosis, especially in the two youngest patients. Our cases did not exhibit other MR signs suggestive of malignancy, such as size greater than 5 cm and encasement of neighboring neurovascular bundles [8-10].

In our three patients, the mass presented a thick and nodular enhancing wall, and a central fluid-like, non-enhancing area occupied only a limited part of the soft-tissue mass. To some extent, this presentation mimics a malignant process with focal tumoral necrosis but is also suggestive of an inflamed bursitis once the possible presence in this location of adventitious bursitis is known.

Treatment & Prognosis:

A 2-month follow-up with relative rest avoiding sports and long walks as well as high-heeled shoes together with the use of specific sole allowing a relative unloading of the bursitis area results in markedly decrease in size or disappearance of the mass in the majority of cases. Intra-bursal steroid injection through a dorsal approach under ultrasound guidance is an option in intractable cases provided strict asepsis measures are provided. Surgical excision of the bursitis is rarely needed and only in case of conservative treatment failure.

Differential Diagnosis:

Foreign-body granuloma

Foreign-body granulomas are frequent in the plantar fat pad. They usually present as a non-specific mass with low signal intensity on T1-weighted and high intensity on T2-weighted MR images, and peripheral contrast enhancement. The foreign body can sometimes be visualized (blooming artefact).

Giant cell tumor of the tendon sheath

Giant-cell tumors of tendon sheaths usually appear as a well-defined soft tissue mass connected to the tendon sheath exhibiting heterogeneous low-to-intermediate signal intensity on both T1-weighted and T2-weighted MR images depending on their hemosiderin content.

Morton neuroma

Morton neuromas typically present as a tear-shaped, spindle-shaped or dumbbell-shaped mass isointense on T1-weighted images and hypointense on T2-weighted images, in the region of neurovascular bundle on the plantar aspect of the deep intermetatarsal ligament. A widening of the interdigital nerve is a suggestive finding.

Soft tissue sarcoma

Soft tissue sarcomas should be considered in case of a soft tissue mass more than 5cm-large, inhomogeneous signal intensity on T2-weighted images, encasement of neighboring neurovascular bundles or osteolysis of an adjacent bone.

Plantar fibromatosis

Most cases of plantar fibromatosis appear as a soft tissue mass inseparable from the deep aponeurosis and underlying muscles, with predominantly heterogeneous low-to-intermediate signal intensity on T1-weighted and T2-weighted MR images and marked enhancement after gadolinium injection [11]. A fascial tail sign may be present [11].

TEACHING POINT

Adventitious bursitis of the plantar forefoot may mimic a solid tumoral mass at MRI to some extent. However, key findings may allow for a correct diagnosis: location in a plantar area submitted to high weight-bearing pressure, context of professional overload of the plantar forefoot, and rapid decrease in size of the mass with relative discharge of the forefoot or cessation of overloading activities. Knowledge of the possible partial solid appearance of adventitious bursitis and heterogeneous signal intensity on T2-weighted MR sequences is helpful to avoid unnecessary biopsy. However, a biopsy of the mass is still needed if the mass does not decrease in size with rest within the following weeks.

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FIGURES

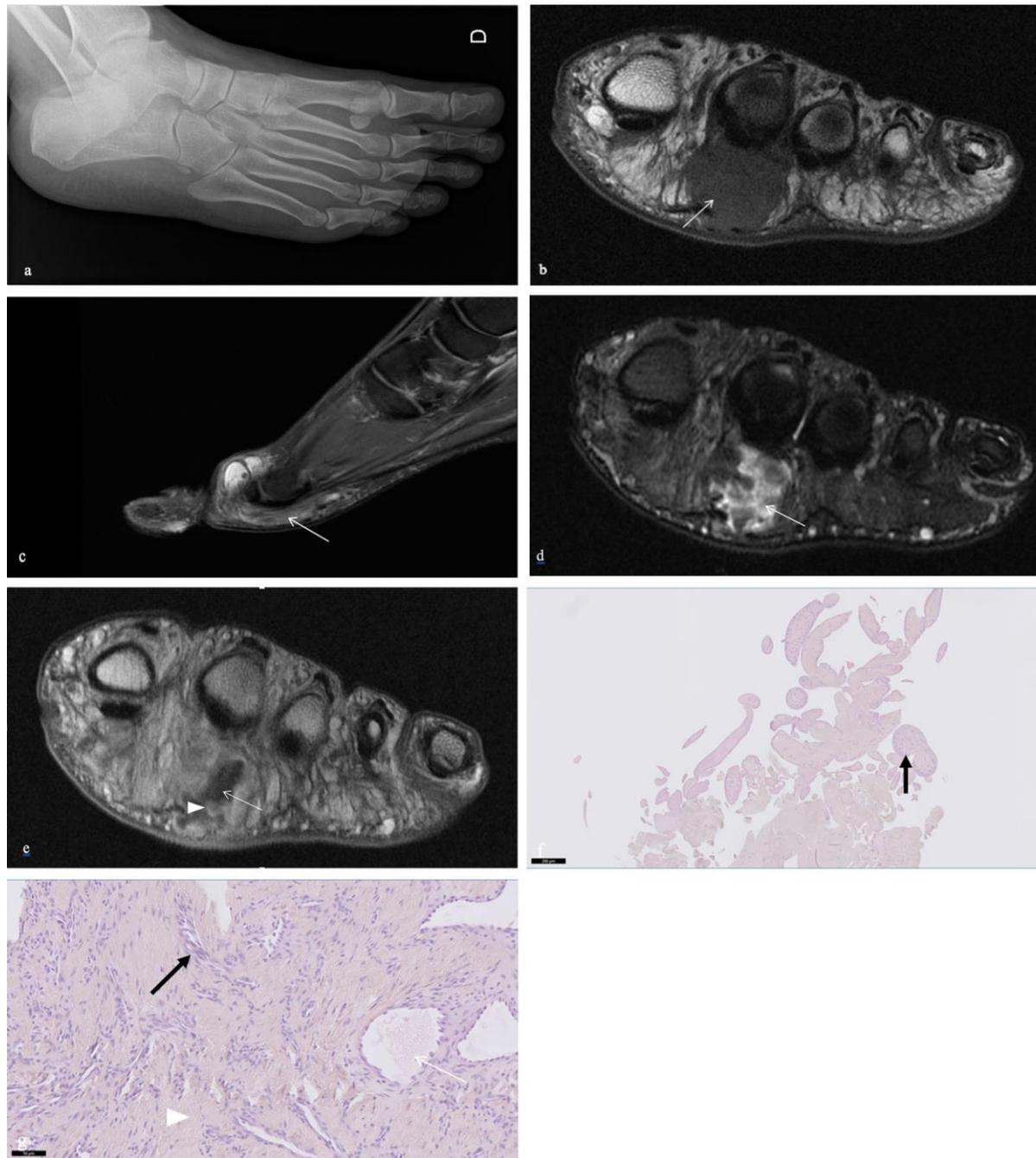


Figure 1: 60-year-old man with adventitious bursitis

Findings: a Conventional right foot oblique radiograph showing no abnormalities. MR images of the forefoot showing a superficial mass below the second metatarsal head (b-e) (straight white arrows). b Coronal T1-weighted MR image showing a round mass of intermediate signal intensity located below the second metatarsal head. c-d Sagittal and coronal fat-suppressed T2-weighted MR image showing a heterogeneous signal intensity mass with an area of low signal intensity (arrow). e Coronal gadolinium-enhanced T1-weighted MR image showing a thick solid enhancing rim (arrowhead) corresponding to the bursal wall contrasting with a hypointense fluid-like central area (arrow). f-g Histo-morphology (HE sections) showing inflammatory histiocytic reaction and dense fibro-vascular tissue without malignant proliferation (black arrow) Slit like cavities (white arrow), inflammatory remodeling (black arrow), fibrosis (white arrow head).

Technique: a Conventional right foot oblique radiograph 46Kv 2mAs. b Coronal T1-weighted MR image of the forefoot. (TR 609ms TE 15ms. Magnet strength: 1.5 Tesla, 3mm slice thickness). c Sagittal Fat-suppressed T2-weighted MR image of the forefoot. TR 1100ms TE 124ms. Magnet strength: 1.5 Tesla, 3mm slice thickness. d Coronal Fat-suppressed T2-weighted MR image of the forefoot. TR 1100ms TE 124ms. Magnet strength: 1.5 Tesla, 3mm slice thickness. e Coronal T1-weighted MR image of the forefoot after administration of 0.2 ml/Kg of Gadoteric acid. TR 609ms TE 15ms. Magnet strength: 1.5 Tesla, 3mm slice thickness. Magnification x1.25.

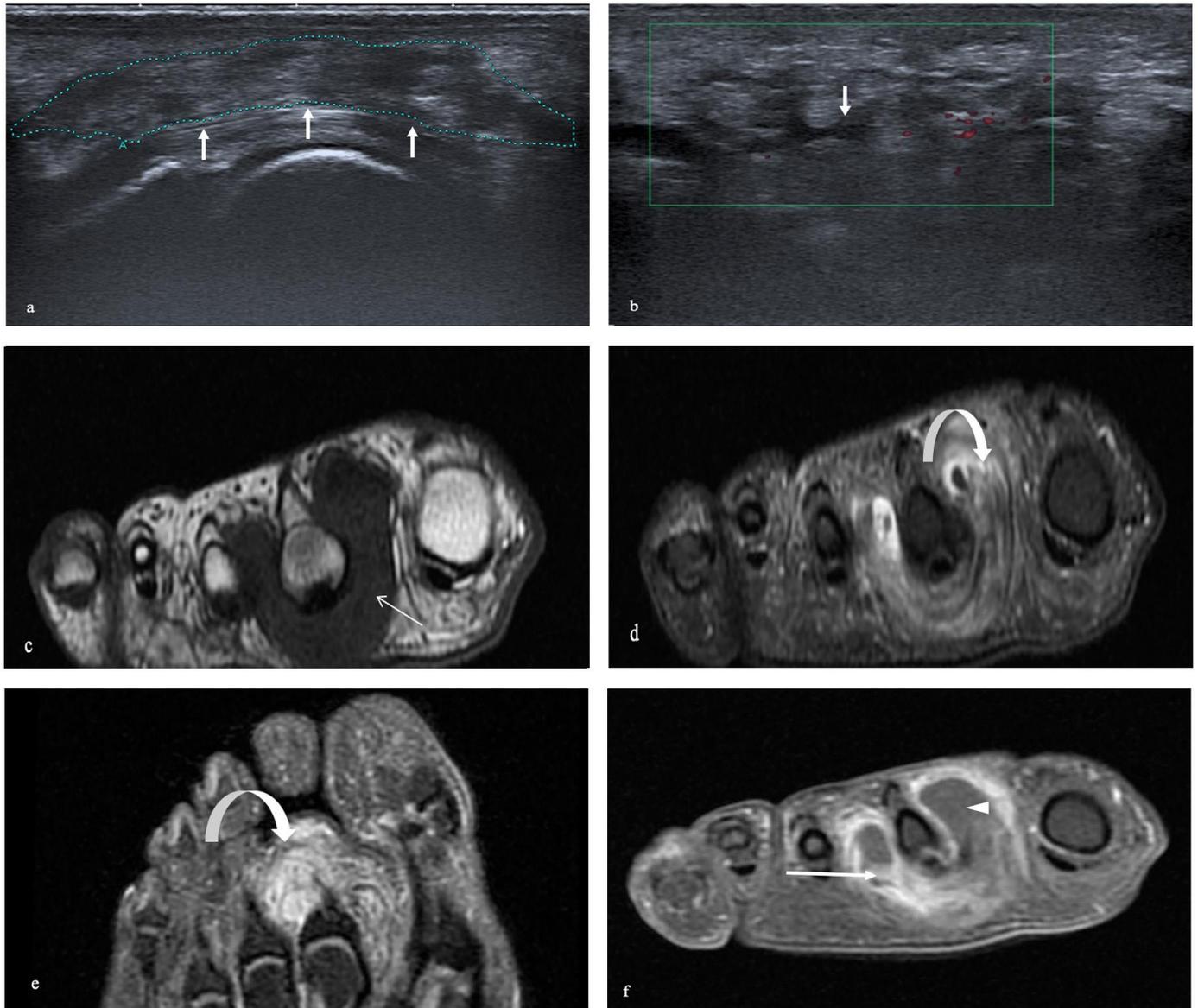


Figure 2: 31-year-old female with adventitious bursitis at the plantar aspect of the second metatarsal head and in the adjacent intermetatarsal spaces

Findings: a-b Doppler ultrasonography showing a poorly delineated lumpy infiltrate without vascularization at the plantar aspect of the forefoot, centered below the second metatarsal head (arrows). c Coronal T1-weighted MR image showing a well-delineated hypointense mass surrounding the lateral, plantar and medial aspects of the second metatarsal head (straight arrow). d-e Coronal and axial fat-suppressed T2-weighted MR images showing a heterogeneous mass (curved arrow) exhibiting mostly intermediate signal intensity with areas of high and low signal intensity. f Gadolinium-enhanced T1-weighted MR image showing a thick nodular enhancing wall (straight arrow) with central non-enhancing areas (arrowheads).

Technique: a-b Doppler ultrasonography sagittal view conducted with the use of linear transducer of high frequency (15Mhz). c Coronal T1-weighted MR image of the forefoot. TR 609ms TE 15ms. Magnet strength: 1.5 Tesla, 3mm slice. d Coronal fat-suppressed T2-weighted MR image of the forefoot. TR 1100ms TE 124ms. Magnet strength: 1.5 Tesla, 3mm slice. e Axial fat-suppressed T2-weighted MR image of the forefoot. TR 1100ms TE 124ms. Magnet strength: 1.5 Tesla, 3mm slice. f Coronal T1-weighted MR image of the forefoot after administration of 0.2 ml/Kg of Gadoteric acid. TR 609ms TE 15ms. Magnet strength: 1.5 Tesla, 3mm slice thickness. Magnification x1.25.

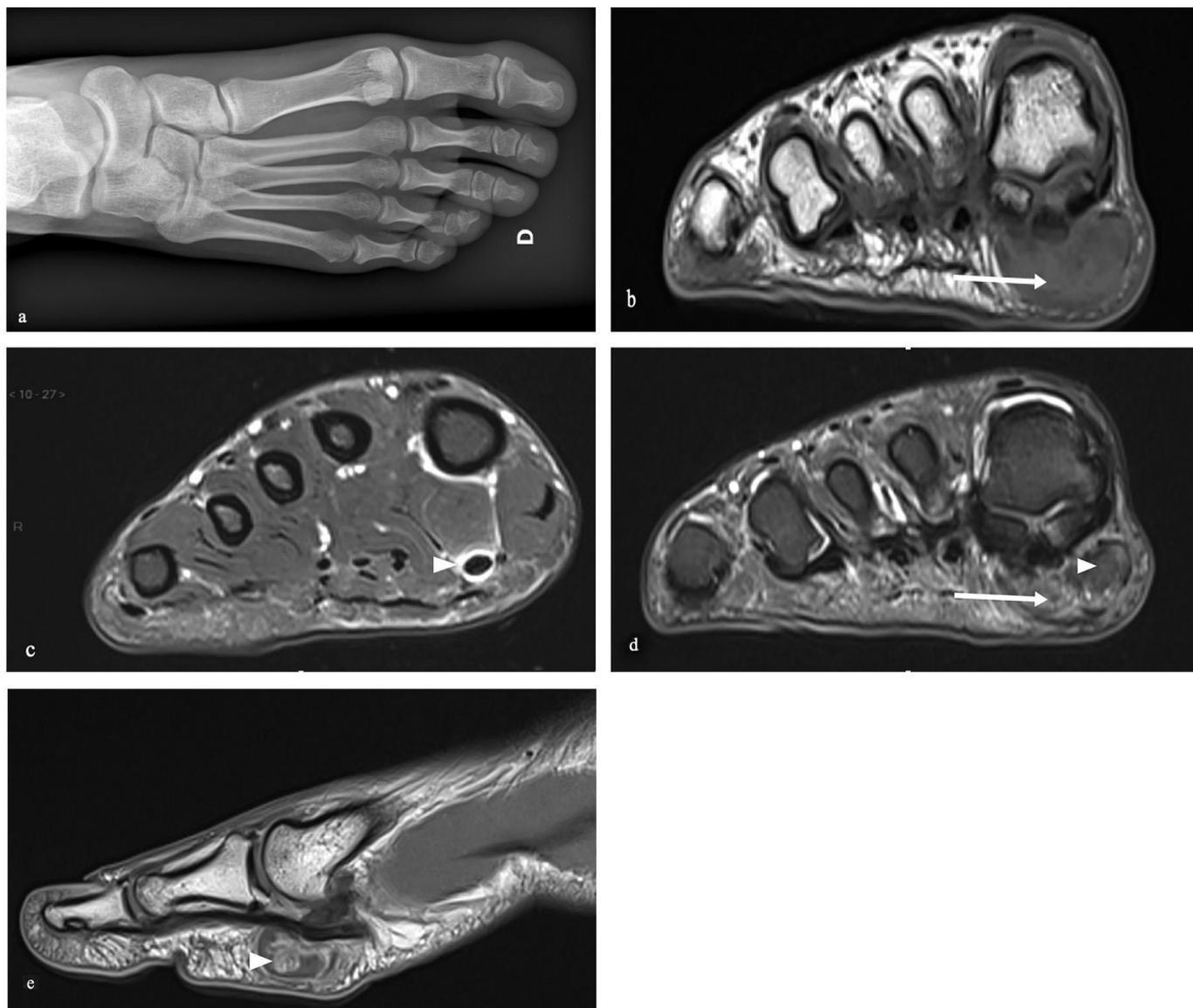


Figure 3: 35-year-old man with adventitious bursitis of the forefoot.

Findings: a Conventional antero-posterior radiograph of the right foot showing no abnormalities. b-d: MRI of the forefoot demonstrating a well-delineated mass developed below the first metatarso-phalangeal joint. b Coronal T1-weighted showing an intermediate signal-intensity mass. c Coronal fat-saturated T2-weighted images showing a tenosynovitis of the flexor hallucis longus (arrowhead) d Coronal fat-saturated T2-weighted images showing a heterogenous mass with high (straight arrow) and low signal intensity (arrowhead). e Sagittal gadolinium-enhanced T1-weighted MR image showing a partial nodular enhancement of the mass (arrowhead).

Technique: a Conventional antero-posterior right foot radiography 46Kv 2mAs. b Coronal T1-weighted MR image of the forefoot. TR 609ms TE 15ms. Magnet strength: 1.5 Tesla, 3mm slice. c, d Coronal fat-suppressed T2-weighted MR image of the forefoot. TR 1100ms TE 124ms. Magnet strength: 1.5 Tesla, 3mm slice. e Coronal T1-weighted MR image of the forefoot after administration of 0.2 ml/Kg of Gadoteric acid. TR 609ms TE 15ms. Magnet strength: 1.5 Tesla, 3mm slice. Magnification x1.25.

	X-Ray	US	MRI	Pattern of contrast enhancement
Adventitious bursitis of the plantar fat pad of the foot	Diffuse thickening of soft tissue. No osteolysis	a poorly delineated lumpy infiltrate without vascularization.	A well-delineated mass measuring around 2cm in size with heterogeneous intermediate-to-low signal intensity on T1-weighted, and heterogeneous mostly intermediate signal intensity on T2-weighted MR images	Heterogeneous thick peripheral enhancement with a central non-enhancing area
Foreign body granuloma	Foreign body visible if radiopaque	foreign body	A non-specific mass with low signal intensity on T1-weighted images and high intensity on T2-weighted images. The foreign body can sometimes be visualized (blooming artefact).	Peripheral contrast enhancement
Giant cell tumor of the tendon sheath	Normal or pressure erosion of neighboring bone	Connection to the tendon sheath	A well-defined soft tissue mass connected to the tendon sheath exhibiting typically low to intermediate signal intensity on both T1-weighted and T2-weighted MR images depending on the hemosiderin content.	Intense heterogeneous contrast enhancement
Morton neuroma	Normal	a well-defined hypo-echoic mass in the plantar soft tissues at the level of the metatarsal heads	A tear-shaped, spindle-shaped or dumbbell-shaped mass isointense on T1-weighted images and hypointense on T2-weighted images, in the region of neurovascular bundle on the plantar aspect of the deep intermetatarsal ligament. A widening of the interdigital nerve is a suggestive finding.	Moderate contrast enhancement
Soft tissue sarcoma	Possible osteolysis of neighboring bones	A large heterogeneous mass	Size greater than 5cm. Inhomogeneous signal intensity on T2-weighted images. Encasement of neighboring neurovascular bundles.	Heterogeneous enhancement
Plantar fibromatosis	Normal	Hypoechoic or mixed echoic fusiform mass in the subcutaneous tissues superficial to the echogenic plantar fascia, either medially or centrally located	Well-defined mass superficially but inseparable from the deep aponeurosis and underlying muscles. Heterogeneous mass predominantly low-to-intermediate signal intensity on T1-weighted and T2-weighted images. Possible fascial tail sign	heterogeneous enhancement of variable intensity

Table 1: Differential diagnosis table for adventitious bursitis of the forefoot

Etiology	Chronic microtrauma and shearing forces exerted on the subcutaneous tissue of the plantar forefoot
Incidence	To our knowledge, this is one of rare reports in the medical literature describing this phenomenon. It is likely, however, that the paucity of reports belies a higher prevalence in actual practice.
Gender	No gender predilection.
Age	Adult
Risk factors	Adventitious bursitis of the foot is commonly located in areas of maximal pressure, namely the heel and beneath the first and fifth metatarsal heads. Exposure to chronic overload of the forefoot due to some professional occupations exposing to prolonged standing or wearing of high-heeled shoes.
Treatment	Avoid chronic overload and high heeled shoes. In addition to oral medications, intrabursal steroid injections through a dorsal approach under ultrasound guidance is an option in intractable cases provided strict asepsis measures are provided. Surgical excision of the bursitis is rarely needed and only in case of conservative treatment failure.
Prognosis	The mass was markedly reduced or totally disappeared within some months of treatment.
Findings on imaging	Location: commonly located beneath the head of the first and the fifth metatarsal head.
	US: a poorly delineated lumpy infiltrate without vascularization.
	MRI: a well-delineated mass measuring with heterogeneous intermediate or low signal intensity on T1-weighted MR images and heterogeneous mostly intermediate signal intensity on T2-weighted MR images. Gadolinium-enhanced MR sequences showed enhancement of a thick nodular peripheral part of the mass but not a central fluid-like area

Table 2: Summary table of adventitious bursitis of the forefoot

ABBREVIATIONS

MRI: Magnetic Resonance Imaging
US: Ultrasound

KEYWORDS

Adventitious bursitis; forefoot; plantar fat pad; soft tissue tumor; MRI; pseudotumoral mass; soft tissue mass

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