Pedal Abscesses in Patients Suspected of Having Pedal Osteomyelitis: Analysis with MR Imaging[1]

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Abbreviations:
SE = spin echo
SPGR = spoiled gradient-recalled echo
STIR = short-inversion-time inversion recovery

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PURPOSE: To document the expected frequency, location, and size of pedal abscesses in patients with advanced foot infection.

MATERIALS AND METHODS: Images obtained at contrast material–enhanced magnetic resonance (MR) imaging (at 1.5 T) of 161 feet of 51 women and 107 men (mean age, 58.5 years; 82.3% had diabetes) who underwent bone biopsy after MR imaging for possible osteomyelitis were reviewed by two musculoskeletal radiologists working together. Presence, size, and location of abscesses and presence of adjacent skin ulceration were noted. MR imaging criteria for abscess were the following: presence of fluid collection with isointense or hypointense signal on T1-weighted images, fluid-equivalent signal intensity on T2-weighted images, and peripheral rim enhancement. All patients' charts were reviewed for clinical and surgical information.

RESULTS: Thirty-two fluid collections compatible with abscesses were found in 29 (18.4%) of the 158 patients; 26 (90%) of these patients had diabetes (P = .38). Abscess size varied from 1 × 0.5 × 0.4 cm to 3.8 × 3.4 × 2.2 cm (mean = 2.6 × 1.5 × 0.9 cm). Abscesses were located in the forefoot (n = 15), hindfoot (n = 7), toes (n = 3), midfoot (n = 4), or in multiple locations (n = 3). Thirty-one abscesses (97%) occurred near a skin ulcer (distance range, 0-9.1 cm; mean, 1.4 cm). Abscesses were significantly more frequent in patients with osteomyelitis (n = 28, 97%) ($P < .001$) and in feet that had been treated surgically (n = 16, 33%) ($P < .002$).

CONCLUSION: MR imaging revealed abscesses, predominantly in the forefoot, in 18% of patients suspected of having pedal osteomyelitis. Abscesses are significantly more frequent in patients with osteomyelitis and in feet that have been treated surgically.

Treatment of a foot infection may vary considerably depending on the presence of osteomyelitis, necrosis, or an abscess. Whereas osteomyelitis may be treated medically (1,2), the presence of necrosis or an abscess precludes nonsurgical management (3). Magnetic resonance (MR) imaging is being increasingly used in the evaluation of pedal infection because the extent of infection and the presence of osteomyelitis (4–8) can be diagnosed accurately at MR. Therefore, MR imaging considerably influences the treatment decisions of referring physicians (9).

Diagnosis of pedal abscesses with MR imaging has been reported previously (5,10–12), but, to our knowledge, a systematic analysis of the frequency and location of pedal abscesses has not yet been provided. It was the goal of this study to document the expected frequency, location, and size of pedal abscesses in a large group of patients with advanced foot infection.

MATERIALS AND METHODS

Patients

MR images of 161 feet of 158 patients with pedal infection who were clinically suspected of having osteomyelitis (51 women, 107 men; mean age, 58.5 years; range, 20–99 years) were evaluated retrospectively. This group included all patients at our institution who had undergone a pedal MR imaging examination and either surgical or percutaneous bone biopsy after MR imaging to evaluate for osteomyelitis between July 1995 and March 2000. Underlying conditions included diabetes (n = 130, 82.3%), paraplegia (n = 5), previous trauma (n = 4), vascular disease (n = 4), bad hygiene due to mental disorder (n = 3), intravenous drug abuse (n = 2), and other entities such as sickle cell disease, posttraumatic peripheral neuropathy, posttraumatic deformity, postoperative deformity, multiple sclerosis, ingrown toenail, alcohol abuse, frostbite, vascular embolism, and enchondroma (n = 10).

Forty-nine feet had been treated with one or multiple surgical interventions before MR imaging, including débridement (n = 24), toe amputation (n = 13), ray amputation (n = 9), transmetatarsal amputation (n = 4), open reduction of fractures (n = 3), and Chopart amputation (n = 1). The time interval between these surgical procedures and MR imaging examination ranged between 2 days and 6 years (mean, 235 days).

Our institutional review board determined that this retrospective study could be conducted without requiring acquisition of a formal signed informed consent form from the patient population.

Imaging

MR imaging was performed with a 1.5-T superconducting magnet (Signa; GE Medical Systems, Milwaukee, Wis). An extremity coil was used for 153 feet (field of view, 14–20 cm); a head coil was used for eight patients who underwent imaging of both feet (field of view, 16–20 cm). In these eight patients, only images obtained in the foot that had undergone bone biopsy after MR imaging were included in the study. Images of all feet were obtained in at least two orthogonal planes.

T1-weighted spin-echo (SE) MR images were obtained with one to two signals averaged; repetition time msec/echo time msec, 400–750/10–20; and a matrix size of 256 × 192 or 256 × 256. T2-weighted MR images were obtained by using a fast SE technique with two signals averaged, an echo-train length of eight, 2,000–7,800/75–108 (effective), and a matrix size of 256 × 128 or 256 × 192. Contrast material–enhanced fat-suppressed T1-weighted MR images were obtained in 32 feet with a T1-weighted SE sequence and in 129 feet with a fast multiplanar spoiled gradient-recalled echo (SPGR) sequence with 250/2.1, a flip angle of 90°, and a matrix size of 256 × 128 or 256 × 192. Precontrast MR images of these 129 feet were obtained with the same parameters, including fat suppression. Gadopentetate dimeglumine (Magnevist; Berlex Laboratories, Wayne, NJ), at a dose of 0.1 mmol/kg of body weight, was used as the intravenous contrast agent. For T2-weighted and gadolinium-enhanced T1-weighted SE sequences, fat suppression was accomplished by using selective presaturation of lipid resonant frequency. Fast SE short-inversion-time inversion recovery (STIR) MR images were obtained with an echo-train length of eight; repetition time msec/echo time msec/inversion time msec, 3,000–6,000/20–78 (effective)/150–160; and a matrix size of 256 × 128 or 256 × 192. Fast SE STIR MR images were available for 137 feet; fat-suppressed T2-weighted fast SE images were available for 10 feet.

Image Evaluation

MR imaging criteria for the diagnosis of an abscess were as follows: isointense or hypointense signal compared with muscle tissue on T1-weighted MR images with fluid-equivalent signal intensity on T2-weighted MR images and rim enhancement on gadolinium-enhanced T1-weighted MR images (13,14). MR imaging criteria for the diagnosis of osteomyelitis were based on those described in previous studies (6,15,16): focally decreased signal intensity of marrow on T1- weighted images, focally increased signal intensity of marrow on fat-suppressed T2-weighted and fast SE STIR images, and focal enhancement of marrow on gadolinium-enhanced fat-suppressed T1-weighted images. Diagnosis of skin ulcer relied on recognition of a soft-tissue defect or an interruption of the skin line on any image or plane (17). As described by previous authors (12,18,19), cellulitis was defined as the presence of soft-tissue contrast enhancement, fat signal intensity loss on T1-weighted images, and hyperintense signal compared with muscle on T2-weighted images.

Two musculoskeletal radiologists (W.B.M. and M.E.S.) together reviewed all studies for the presence of abscesses. The number, size, and location of the abscesses were noted. The diameter of each fluid collection was measured at a workstation (Canon Medical Systems, Irvine, Calif) in the transverse, coronal, and sagittal planes. The location of each abscess was noted by using the following four anatomic regions: toes, forefoot (ie, from the metatarsophalangeal joint to the Lisfranc joint), midfoot (ie, from the Lisfranc joint to the Chopart joint), and hindfoot (ie, from the Chopart joint to the ankle joint). When an abscess was seen in the forefoot, the reviewers additionally evaluated whether it was located within the plantar muscle compartment. Location in the plantar muscle compartment was further segmented into location in the medial, central, or lateral compartment, as described in previous reports (20,21). These three plantar muscle compartments extend the whole length of the sole, from the forefoot to the hindfoot (20–25). They are defined by the medial and lateral intermuscular septa that arise from the plantar aponeurosis. The medial plantar compartment contains the muscles of the great toe. The lateral compartment contains the muscles of the fifth toe. The central compartment contains the remainder of the plantar muscles.

We also evaluated whether abscesses of the forefoot or midfoot met the criteria for central plantar space abscesses, described in the clinical literature (26) as fluid collections centered around the tendons of the flexor digitorum muscle group.

The presence and location of ulcers were noted. It was then determined whether an abscess was in direct contact with the cellulitis surrounding the ulcer base. If the abscess was contiguous with the cellulitis around the ulcer base, then the abscess was thought to arise from a contiguous infection due to skin ulceration; the distance from the ulcer to the abscess was measured at a workstation.

Clinical Information

Review of the charts and surgical reports of all patients was performed by the same author (H.P.L.). Associated conditions noted on the chart, such as diabetes mellitus and peripheral vascular disease, were recorded for all patients. We also reviewed whether the evaluated feet had been treated with surgery before or after the MR imaging examination and noted the type of procedure and date of surgery. The reports of pathologic and microbiologic examination of collected bone samples were reviewed. We also noted if the presence of an abscess was confirmed in the surgical reports.

Statistical Analysis

Statistical comparison of the frequency of abscesses in patients with and without osteomyelitis and in patients with and without diabetes was performed with the Fisher exact test. Statistical comparison of the frequency of abscesses in patients

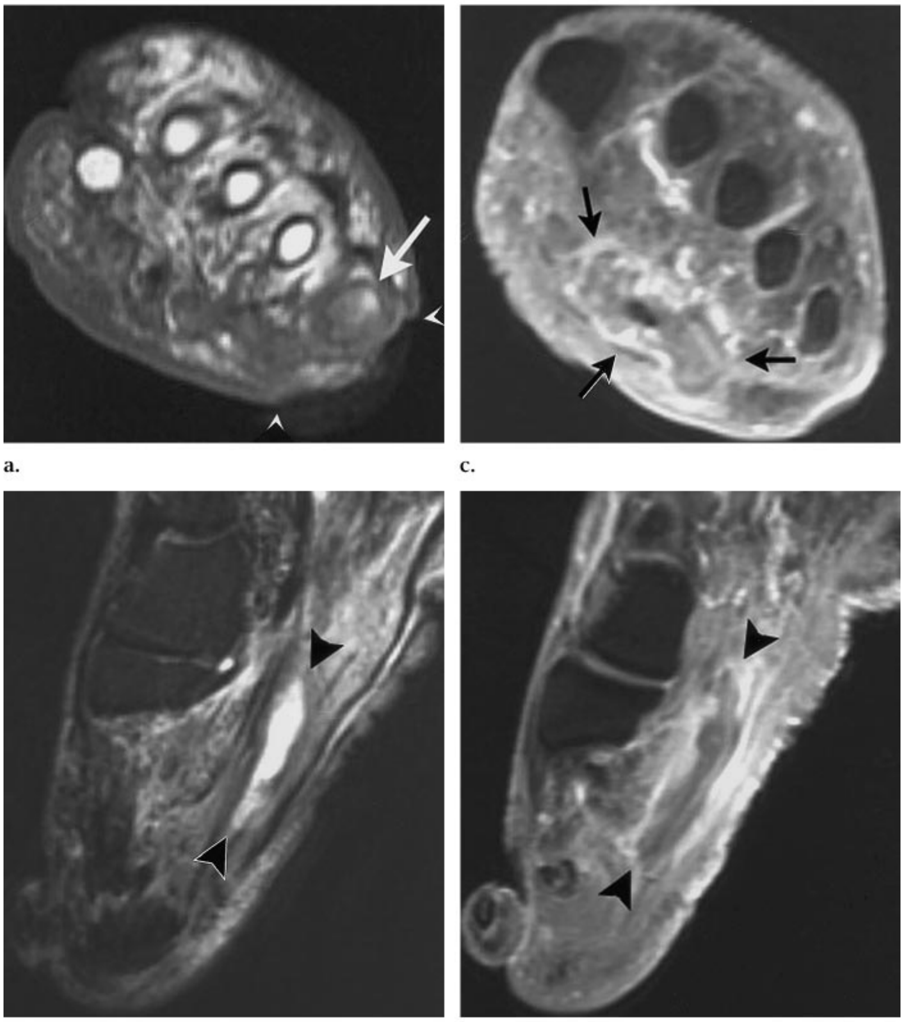


Figure 1. MR images in a 73-year-old diabetic patient with a central plantar space abscess that originated from proximal spread of infection along the flexor tendons. **(a)** Coronal T1-weighted SE image (400/10) of the left forefoot reveals a large skin defect representing an ulcer (between arrowheads). There is an area of hypointense signal (arrow) in the proximal shaft of the fifth metatarsal bone, indicating osteomyelitis. **(b)** Sagittal T2-weighted fast SE STIR image (6,000/75/150) reveals a hyperintense collection of fluid (between arrowheads) in the central plantar compartment directly below the flexor tendons; this collection of fluid is compatible with an abscess. **(c)** Coronal T1-weighted contrast-enhanced fast multiplanar SPGR image (250/2.1; flip angle, 90°) reveals rim enhancement (arrows) around the abscess in the central plantar compartment. **(d)** Sagittal T1-weighted contrast-enhanced fast multiplanar SPGR image (250/2.1; flip angle, 90°) reveals a large hypointense collection of fluid (between arrowheads) in the central plantar compartment; the presence of rim enhancement indicates that the fluid collection is a plantar space abscess.

with and in patients without previous surgical interventions in the infected foot was performed with the χ^2 test. Our study was conducted after approval to review patient images and medical charts was obtained from the institutional review board of our hospital.

RESULTS

Thirty-two fluid collections compatible with abscesses were found in 29 (18.4%) patients. Of the 29 patients with abscesses, 26 (90%) had diabetes. In the study population of 158 patients, 130 (82.3%) had diabetes (P = .38). Abscesses were not significantly more frequent in diabetic patients (P = .38) as determined with Fisher exact test analysis. Each of the other three patients with abscesses had one of the following associated conditions: intravenous drug abuse, posttraumatic infection, or paraplegia.

The size of the abscesses ranged from 1 × 0.5 × 0.4 cm to 3.8 × 3.4 × 2.2 cm, with a mean size of 2.6 × 1.5 × 0.9 cm. Abscesses were found in the following locations: forefoot (n = 15, 47%), hindfoot (n = 7, 22%), midfoot (n = 4, 12%), and toes (n = 3, 9%). Three abscesses involved more than one region of the foot: forefoot and toe (n = 2, 6%) or midfoot and hindfoot (n = 1, 3%).

Fifteen of the 17 forefoot abscesses were completely (n = 7) or partially (n = 8) located in plantar muscle compartments. Two abscesses in the forefoot were subcutaneous. The most frequently involved plantar compartment was the central compartment (n = 8), followed by the lateral compartment (n = 7) and the medial compartment (n = 4) (four abscesses involved two compartments simultaneously). Most abscesses that involved the central compartment were located at its periphery. Only three of these fluid collections were centered around the tendons of the flexor digitorum muscle group as described in the surgery literature (26,27) (Fig 1). These three abscesses originated from a nonhealing amputation of the fourth digit and from plantar ulcers below the fifth and second metatarsal heads.

Three (9%) of the 32 abscesses were intraosseous (Fig 2), with one each involving the calcaneus, the medial cuneiform bone, and the distal tibia. All abscesses except for one were associated with an ulcer (97%). One patient who was an intravenous drug abuser and who had endocarditis had hematogenous osteomyelitis, with a small intraosseous abscess of the distal tibial epiphysis. Twenty-eight abscesses were within 2.5 cm from the ulcer; all forefoot and toe abscesses were included in this group. In three patients with extensive infections of the hindfoot and midfoot, distances from the abscess to the ulcer ranging from 3.6 to 9.1 cm were measured; however, all three abscesses were contiguous with the soft-tissue infection originating from the skin ulcer base.

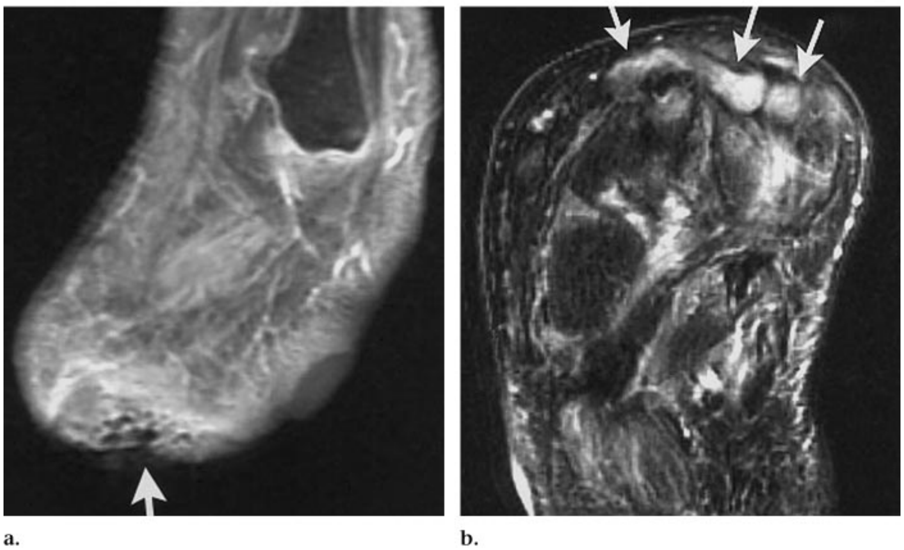
Review of the culture reports from the bone biopsies revealed the following findings: no microbiologic testing performed in 55, no growth in 26, isolation of one bacterium per bone biopsy in 30, isolation of two bacteria per bone biopsy in 30, isolation of three bacteria per bone biopsy in 24, and isolation of four bacteria per bone biopsy in two (two bone samples were removed from each of six feet). The following gram-positive cocci were found in 83 cultures: *Staphylococcus aureus* in 63 (58%), enterococci in 22 (20%), coagulase-negative staphylococci in seven (7%), streptococci in six (6%), and others in 10 (9%). The following gram-positive rods were found in 23 cultures: coryneform bacteria in 21 (91%) and *Lactobacillus* in two (9%). The following gram-negative rods (Enterobacteriaceae) were found in 22 cultures: *Proteus* in 12 (55%), *Citrobacter* in three (14%), *Serratia* in three (14%), *Escherichia coli* in two (9%), and *Klebsiella* and *Morganella* in one each (4.5%). The following other gram-negative rods (not Enterobacteriaceae) were found in 12 cultures: *Pseudomonas* in eight (67%), *Acinetobacter* in three (25%), and *Achromobacter* in one (8%). The following anaerobes were found in five cultures: *Bacteroides* in three (60%) and *Prevotella* in two (40%).

MR images in all but one (n = 28, 97%) of the 29 patients with abscess showed evidence of adjacent osteomyelitis. Abscesses were significantly more frequent ($P < .001$) in patients with osteomyelitis, as determined with the Fisher exact test. Review of histologic and microbiologic reports confirmed osteomyelitis in 26 (90%) of these patients and excluded osteomyelitis in the patient who had a negative MR imaging result. In one patient with MR imaging evidence of osteomyelitis, results of a bone biopsy were negative. However, these results were considered false-negative in the presence of a positive bone scan, and the patient was treated for osteomyelitis. In the other patient, who had a hindfoot abscess, diagnosis at MR imaging of an absence of calcaneus osteomyelitis was confirmed at histologic examination, but the possibility that adjacent talus osteomyelitis was present, which was suspected at MR imaging, was not evaluated with bone biopsy.

Abscesses were found in 16 (33%) of the 49 feet that had previously been treated with surgery (Fig 3). Abscesses were significantly more frequent in feet after surgery ($P < .002$), as determined with χ^2 analysis. Previous surgeries in the 16 feet included the following procedures: débridement (n = 6), transmetatarsal amputation (n = 4), toe amputation (n = 3), ray amputation (n = 2), and internal fixation (n = 1). Eight of these surgical procedures (débridement, n = 5; toe amputation, n = 2; ray amputation, n = 1) had been performed within 21 days before the MR imaging examination; all abscesses were seen in the region of the previous surgical procedure. The other eight patients had undergone surgery between 3 years and 69 days before the MR imaging examination; reinfection in the same area treated previously with surgery was seen in two patients, and chronic persistent infection was seen in two patients. In the other four patients, infection occurred away from the postoperative site.

Figure 2. MR images in a 53-year-old man with diabetes, a chronic heel ulcer, and no response to conservative treatment with antibiotics and local wound care. **(a)** Transverse T1-weighted contrast-enhanced fast multiplanar SPGR image (250/2.1; flip angle, 90°) of the hindfoot shows an ulcer (between white arrowheads) with a sinus tract (arrow). Adjacent to the sinus tract are two rim-enhancing lesions (black arrowheads) that represent plantar hindfoot abscess. **(b)** Sagittal T1-weighted SE image (430/12) of the hindfoot displays the ulcer (white arrow) in a different plane and reveals the extent of surrounding cellulitis (black arrow), which appears hypointense. Note the hypointense area (arrowhead) in the bone marrow of the calcaneus; this feature is suggestive of an intraosseous abscess. **(c)** Transverse T2-weighted fat-suppressed fast SE image (6,500/90) shows a hyperintense collection of fluid (arrow) in the calcaneus with surrounding marrow edema. **(d)** Sagittal T1-weighted contrast-enhanced fast multiplanar SPGR image (250/2.1; flip angle, 90°) shows the sinus tract (arrow) with rim enhancement originating from the ulcer base and extending into the posterior plantar compartment. The presence of rim enhancement (arrowhead) in the calcaneus indicates the formation of an intraosseous abscess.

All 29 patients with abscess underwent surgery within 19 days (mean, 5 days) after the MR imaging examination. These procedures included débridement (n = 12), ray amputation (n = 9), toe amputation (n = 3), transmetatarsal amputation (n = 2), above-knee amputation (n = 2), and below-knee amputation (n = 1). The presence and location of an abscess were confirmed in 11 surgical reports. Four reports described the presence of necrosis in the area where an abscess was seen at MR imaging. All four areas of necrosis



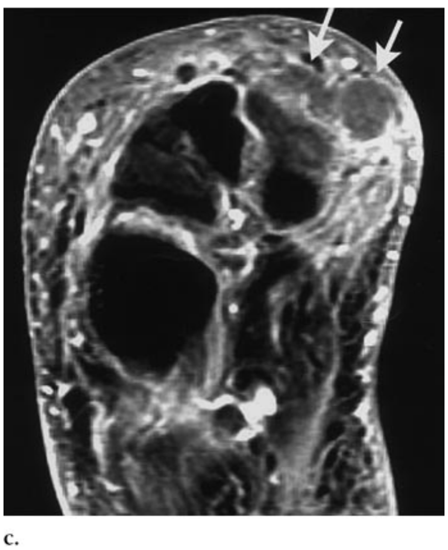


Figure 3. MR images in a 53-year-old man with diabetes who had undergone transmetatarsal amputation of the forefoot 3 months previously and who presented with reulceration at the lateral plantar aspect of the amputation. **(a)** Sagittal oblique T1-weighted contrast-enhanced fast multiplanar SPGR image (250/2.1; flip angle, 90°) of the forefoot reveals a skin defect (arrow) at the anterolateral border of the transmetatarsal amputation. **(b)** Transverse T2-weighted fast SE STIR image (4,800/60/150) reveals that an abscess (arrows) extends subcutaneously to the medial aspect of the transmetatarsal amputation. **(c)** Transverse T1-weighted contrast-enhanced fast multiplanar SPGR image (250/2.1; flip angle, 90°) confirms the presence of an abscess (arrows) with discrete rim enhancement.

were located in the plantar muscle compartments of the forefoot in patients with diabetes mellitus. The majority of the rest of the patients underwent amputations, and the site of infection was not explored; therefore, the presence of an abscess was not mentioned in the surgical reports.

DISCUSSION

Clinical evaluation of the extent of a chronic foot infection may be difficult (28), and MR imaging is frequently used for evaluation of concomitant osteomyelitis and abscess formation (6). Excellent soft-tissue contrast and the possibility of examining infectious processes in various planes with contrast enhancement make MR imaging the method of choice for evaluating abscess formation (18). Diagnosis of an abscess precludes conservative treatment, and surgical incision or drainage must be performed to avoid progressive local tissue loss (11). MR imaging allows precise preoperative localization and evaluation of the extent of fluid collections. This allows the surgeon to plan targeted and limited surgical interventions and avoid potentially harmful empiric explorations (10,11,29).

Nearly one-fifth of our patients showed evidence of abscess formation at MR imaging. In those patients who had previously undergone foot surgery, this percentage rose to nearly one-third. Previous researchers of MR imaging in smaller patient groups have reported a prevalence of abscess ranging from 10% (30) to 50% (8,31), depending on patient selection. Because our patient population included only patients clinically suspected of having osteomyelitis who underwent bone biopsy after MR imaging, the prevalence of abscess may be higher than in the average population referred for MR imaging. In the clinical literature, to the best of our knowledge, only one study analyzed the prevalence of abscesses in foot infection (28). In a population of 300 diabetic patients with "major" foot infections, 240 (80%) had an abscess in "the deep spaces of the foot," 24 had dorsal cellulitis, and 36 had a perforating ulcer. The difference in the prevalence of abscess formation between this study and ours may be due predominantly to patient selection. The discrepancy could also be due to modern therapy regimens, because close monitoring of foot ulcers at specialized clinics leads to earlier intervention and a decrease in untreated advanced infections and associated complications (32,33).

More than half of all abscesses in our group were located in the forefoot. The majority of these abscesses involved the plantar muscle compartment. Involvement of the lateral compartment was nearly as frequent as was involvement of the central compartment; the medial compartment was least commonly involved. Our data differ substantially from those of previous reports, which describe predominant involvement of the central plantar compartment and rare involvement of the medial and lateral compartments (26–28). Abscesses of the medial and lateral compartments have been reported to originate predominantly from plantar ulcerations, as observed in our study (27,28). Central plantar space abscesses, on the other hand, were reported to originate almost exclusively from ulcerations either in the pad of the toes or in the web spaces (26–28). In these studies, spread of infection was reported to follow the flexor tendons or the lumbrical muscles into the central compartment, causing abscesses around the tendons of the flexor digitorum longus muscle (27) (Fig 1). However, in a more recent clinical study of 42 plantar abscesses, the majority of fluid collections originated from ulcerations (34). We observed central plantar space abscesses with spread of infection along the tendons of the flexor muscle group in only three patients. Most central plantar space abscesses in our patient group originated directly from plantar ulcerations, and these abscesses were located at the periphery of the central compartment.

It has been reported that in bedridden patients, pus gravitates to the proximal end of the central plantar space, toward the region of the medial malleolus; this phenomenon may allow the proximal spread of infection along the flexor tendons to the calf (26). We did not observe this on MR images in our population; this may be attributed to the fact that patients with pedal infection may nowadays present with less advanced infection.

More than one-third of our patients had abscesses in the hindfoot and midfoot. Interestingly, abscess formation in these locations has rarely been mentioned in previous reports on abscesses. It is important to realize that abscesses in the midfoot and hindfoot are not rare but may occur with nearly the same frequency as abscesses in the forefoot. A typical condition that causes midfoot infection is collapse of the arch due to Charcot arthropathy—the so-called rocker-bottom deformity.

All abscesses of the toes and forefoot were related to contiguous infections from skin ulcers. Measurement of the distances from the ulcers to the abscesses revealed that most abscesses were in close vicinity to the ulcer; this included all toe and forefoot abscesses. In the midfoot and hindfoot, however, distances between ulcer and abscess of up to 9.1 cm were recorded in patients with extensive infections.

Only one MR imaging examination in our group revealed no evidence of osteomyelitis adjacent to an abscess. This correlation was statistically highly significant ($P < .001$) and reflects the fact that both osteomyelitis and abscess formation represent late complications of infection. Previous researchers have also noted this frequent coexistence of abscesses with osteomyelitis (16,18).

Foot infections in diabetic patients can be caused by many bacterial species, either alone or in combination (1,35). Results of bacterial cultures in published reports have varied, largely because of differences in the types of patients enrolled and in the culture methods used (35). Routine clinical cultures of specimens from diabetic foot infections yield approximately 1.8 isolates per patient (36), whereas careful tissue sampling and dedicated microbiologic testing reveal up to 4.8 isolates per patient (37). It has been shown in several past studies that anaerobic organisms are important in pedal infections and can be isolated in up to 90% (38,39) of patients if sampling and culturing are performed correctly. Only five bone samples in our study showed anaerobic bacterial growth; this infrequent isolation of anaerobes may be due primarily to technical problems during the transport and the culture of our bone samples.

In our study, four surgical reports described necrotic tissue at the site where an abscess was diagnosed at MR imaging. It is therefore possible that some areas that show signal intensity characteristics at MR imaging that are compatible with those of abscesses may represent necrotic, liquefied tissue and surrounding contrast-enhanced granulation tissue instead of pus collections. Because our results are based on a review of reports, without direct comparison of the MR images with the intraoperative situation, the value of this finding may be limited. Further investigation of the actual composition of areas that show signal intensity characteristics at MR imaging that are similar to those of abscesses would require a prospective study.

Considering the experience we gained in reviewing the MR images in our study, we advocate administration of a gadolinium chelate in the evaluation of pedal infection with MR imaging for several reasons: As shown in our study, many fluid collections are small and are easier to detect on contrast-enhanced, fat-suppressed images. Abscesses can be obscured on T2-weighted MR images in diabetic patients, in whom there is typically a diffuse signal intensity increase in subcutaneous and muscle tissue on T2-weighted images due to edema (40,41). Abscesses in these patients may be recognized only on contrast-enhanced images. In our study, approximately one-fourth of patients were referred for MR imaging after recent surgery. Postoperative changes may be better differentiated from infection on contrast-enhanced, fat-suppressed MR images (16).

Some limitations apply to our study: We evaluated a selected patient group with advanced infection, which may have led to a higher frequency of pedal abscesses than would be encountered in a randomized population. Also, we evaluated a high number of patients who had recently undergone surgery; this may also have led to a higher frequency of pedal abscesses due to persistent infection. The presence of a suspected abscess on MR images was confirmed at surgery in fewer than half of our patients. Surgical correlation was performed with a review of the surgical reports, which did not allow us to directly compare the radiologic findings with the intraoperative findings.

In conclusion, almost all pedal abscesses represent areas of contiguous infection with adjacent skin ulcerations. Most toe and forefoot abscesses are situated close to the ulcer, whereas midfoot and hindfoot abscesses may be up to several centimeters away from the ulcer. Abscesses are seen in nearly one-fifth of patients with advanced pedal infection, occur almost exclusively in conjunction with osteomyelitis, and are significantly more frequent in feet that have been treated surgically. Although the forefoot is the most frequent location, nearly 50% of abscesses occur in the midfoot and in the hindfoot. A minority of fluid collections that have MR signal intensity characteristics of abscesses may actually represent necrosis surrounded by granulation tissue.

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