

Differentiating Charcot Arthropathy from Acute Osteomyelitis Using Combined Labeled Leukocyte and Technetium 99m Sulfur Colloid Marrow Imaging - Case Study

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Background

- Charcot neuroarthropathy (CN) is a progressive disease that most commonly affects both osseous and soft tissue structures of the insensate diabetic limb¹. Bone scans are commonly used to diagnose CN and osteomyelitis (OM) in the diabetic foot².
- A bone scan uses four phases of imaging: immediate (angiogram), pool, delayed and 24 hours. Positives/negatives in each phase can distinguish between specific pathologies³.
- Technetium 99m-methylene diphosphonate (MDP) scans demonstrate signal uptake during any acute osseous activity. Indium-111 labeled white blood cell scans (WBC) are known to have high sensitivity for leukocyte activity. However, WBC imaging may also show signal uptake during soft tissue infection, leading to false positive for OM⁴.
- Palestro et al demonstrates a combined technique that differentiates between acute Charcot arthropathy and osteomyelitis. In using Tc99m-sulfur colloid scans (SC), bone marrow hyperplasia that is present in the Charcot foot, but absent in osteomyelitis, can be detected^{5,6}.
- The purpose of our case study was to show how clinical information in conjunction with the combined bone scans technique could more accurately differentiate between acute CN and OM.

Method

An MDP scan, an Indium-111 WBC scan, and a Tc99m-sulfur colloid scan were obtained and interpreted by a radiologist. Findings were combined with patient presentation.

- Negative osteomyelitis = congruent signal** uptake between SC and WBC scans.
 - Concordant signal intensity in both WBC and SC scans.
- Positive osteomyelitis = incongruent signal** uptake between SC scans and WBC scans.
 - Intense WBC signal uptake, localized photopenic uptake in SC scan.

Case Description

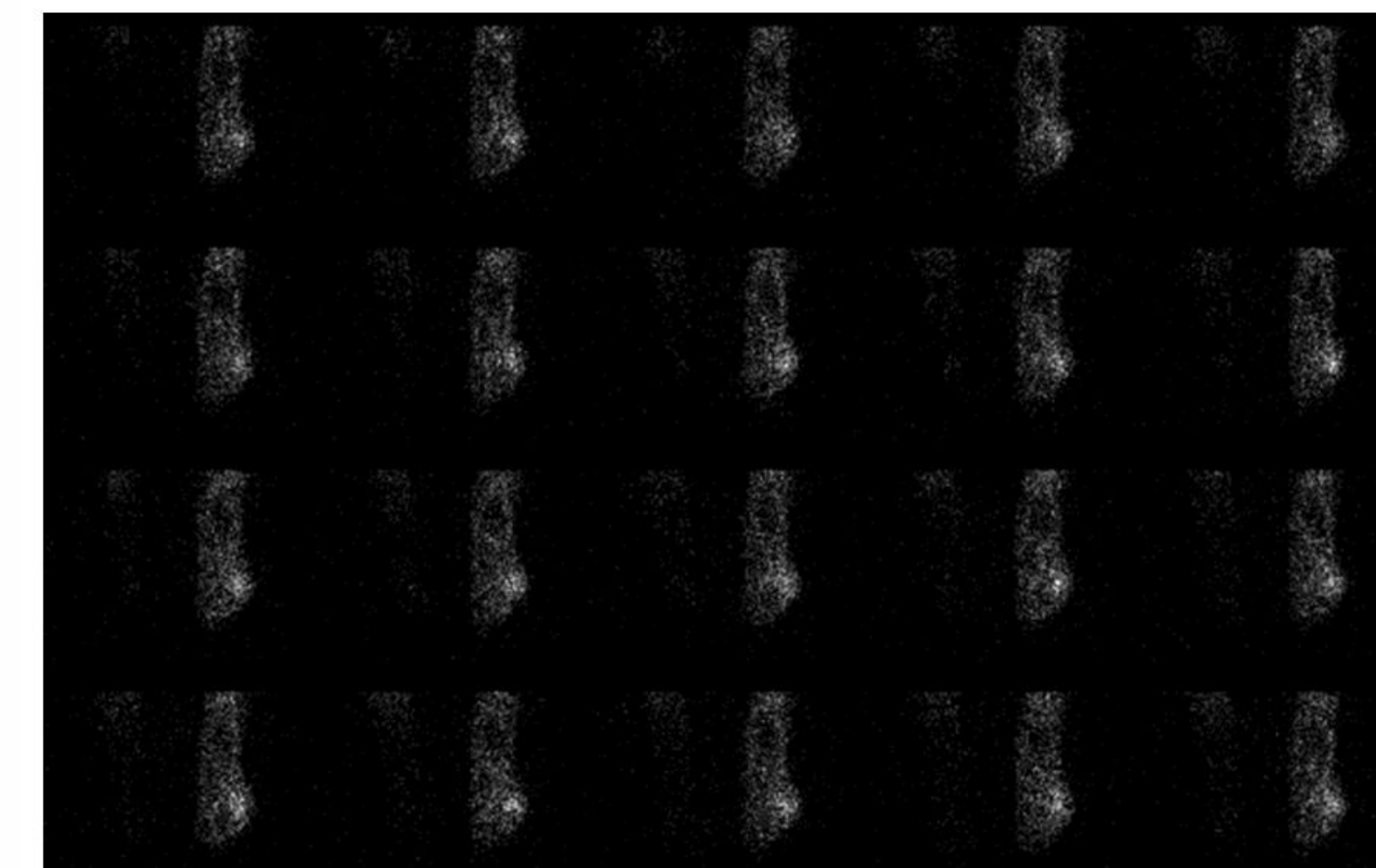
- Patient was a 71 year old male with IDDM, who presented with a chronic ulcer at the right fifth metatarsal. He was previously hospitalized for cellulitis, which extended from his right foot to the distal half of his leg. While hospitalized, radiographs and MRI of the right foot were suggestive of OM. The patient was recommended partial 5th ray resection, but he refused and opted for local wound care. He was later discharged on intravenous antibiotics and followed-up at the UPMC Altoona Wound Care Center.
- Patient was previously treated as an outpatient with CN on the contralateral foot, which lead to the suspicion that his right lower extremity cellulitis was superimposed on Charcot changes on the hospital radiographs and MRI. Additional examination of his hospitalized CRP (0.7 mg/dl) and ESR (34 mm/h) values as compared to his CRP (0.9 mg/dl) and ESR (47 mm/h) values in the wound clinic further pointed to the possibility of active CN^{7,8}. Bone scans were ordered to elucidate the source of bone erosions.



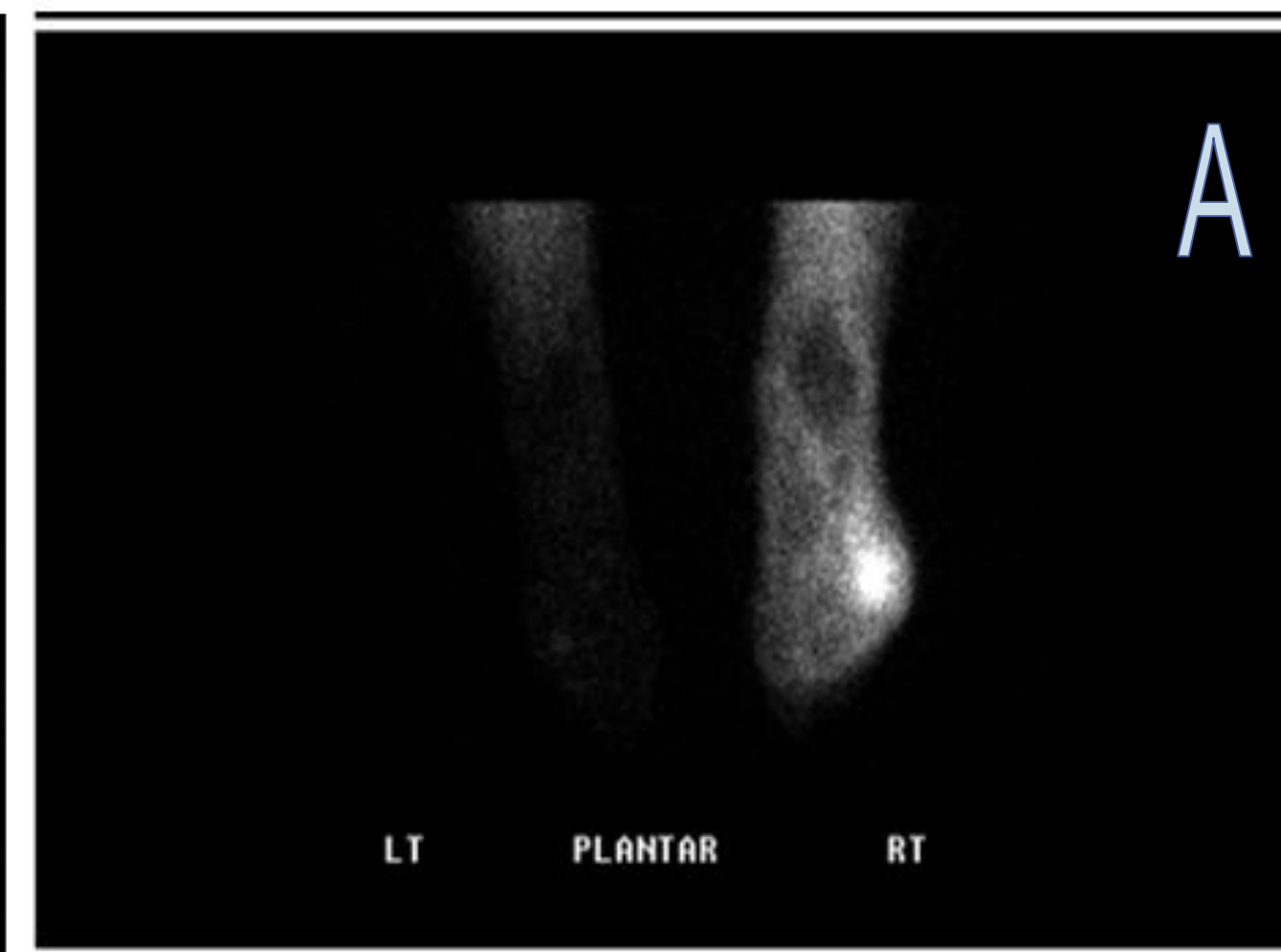
Wound Description

Ulceration at the right 5th metatarsal measured 0.4 x 0.5 x 3.0 cm (length x width x depth). Wound bed was 70% yellow, necrotic, and non-viable tissue with 30% granulation tissue. Erythema and edema indicative of cellulitis was noted with malodor and low serosanguinous drainage. No purulence, fluctuance, sinus tract, or probing to bone was noted.

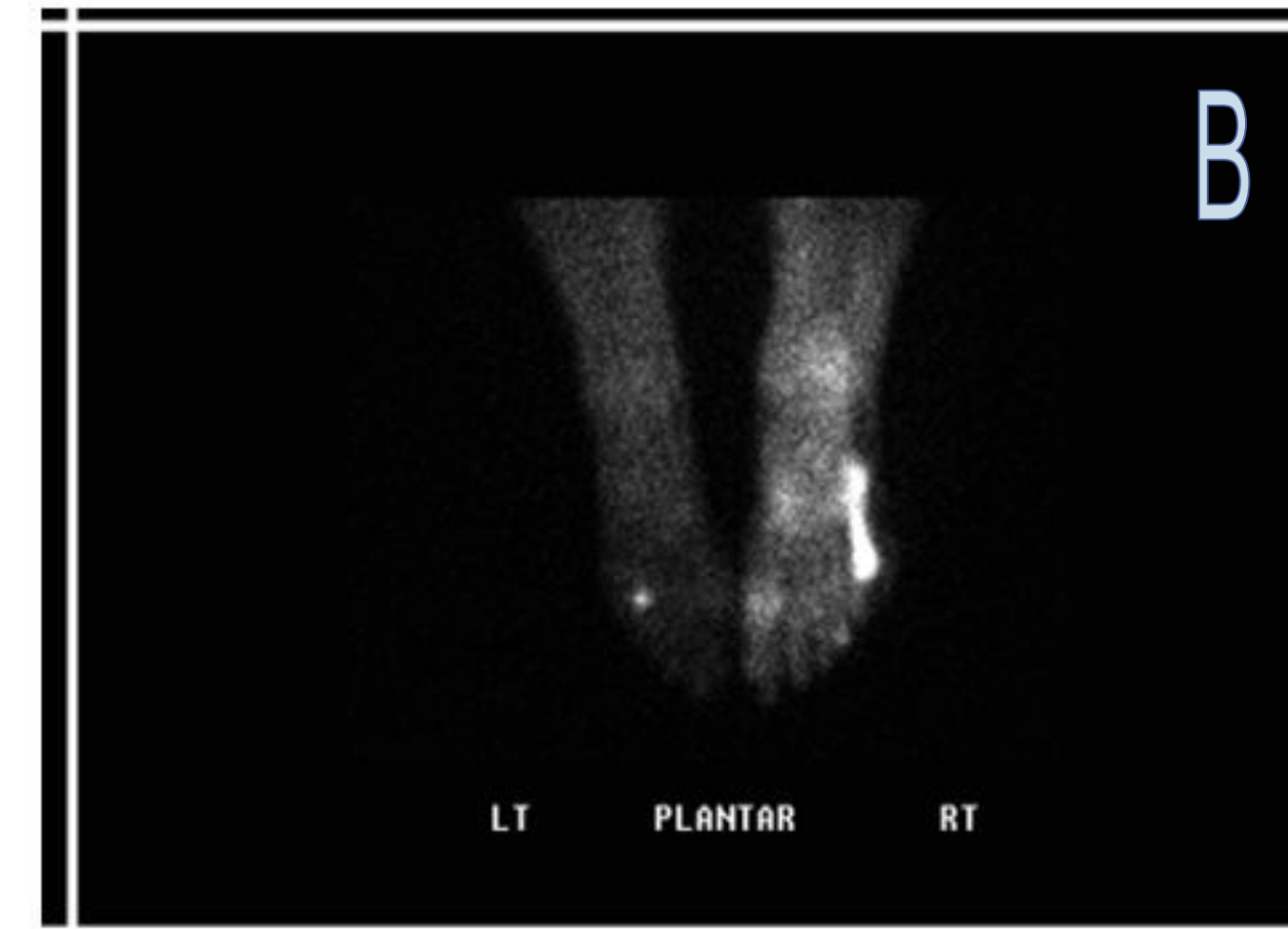
Result



Increased blood flow lateral aspect of the right foot



Blood Pool



Delayed MDP

Figure 1. Tc99m-methylene diphosphonate (MDP) images demonstrated focal increased blood flow at the lateral aspect of the foot.

Figure 2. Hyperemia noted during the pool phase (A) with corresponding uptake along the right 5th metatarsal in the delayed phase (B).

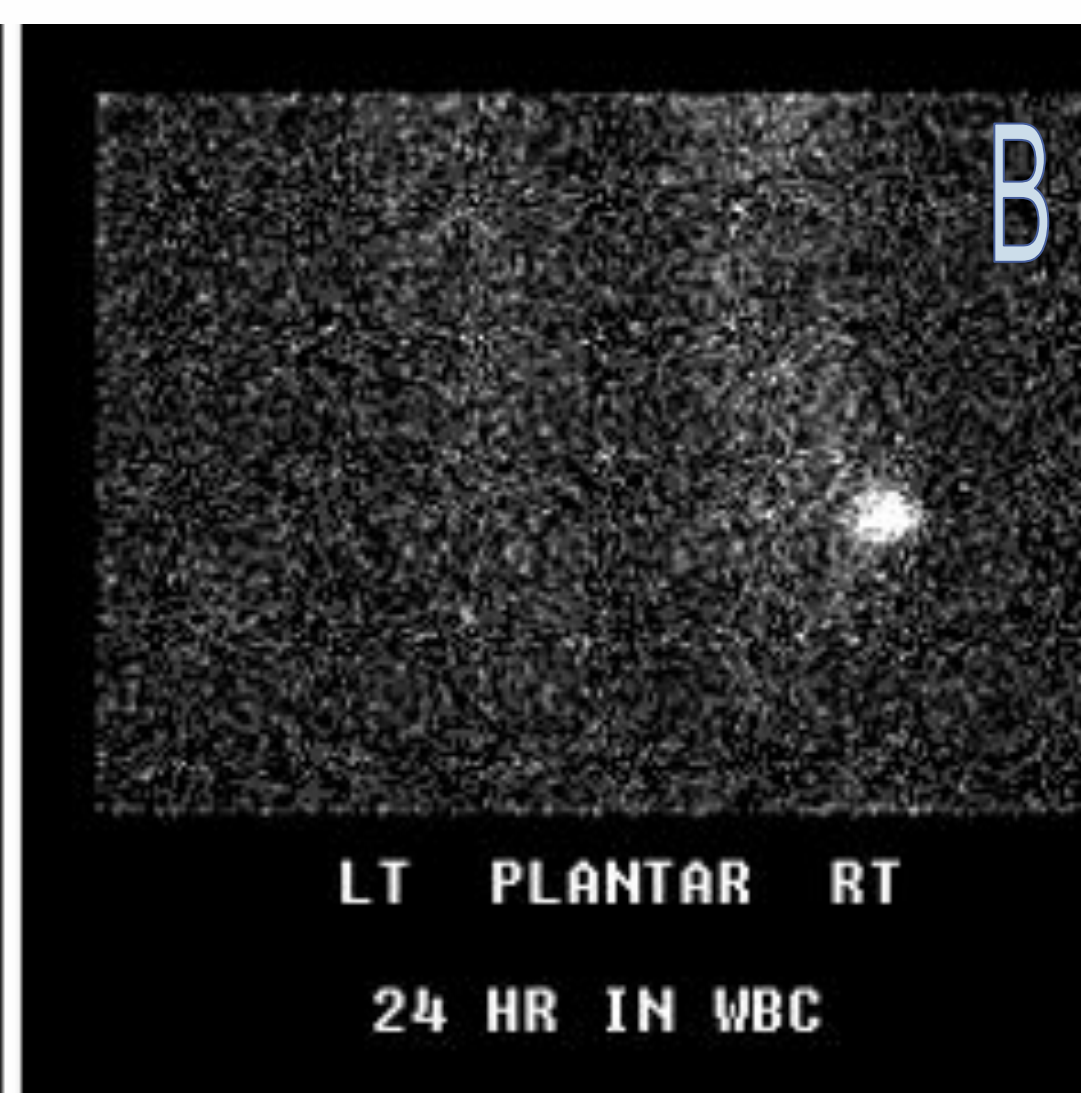
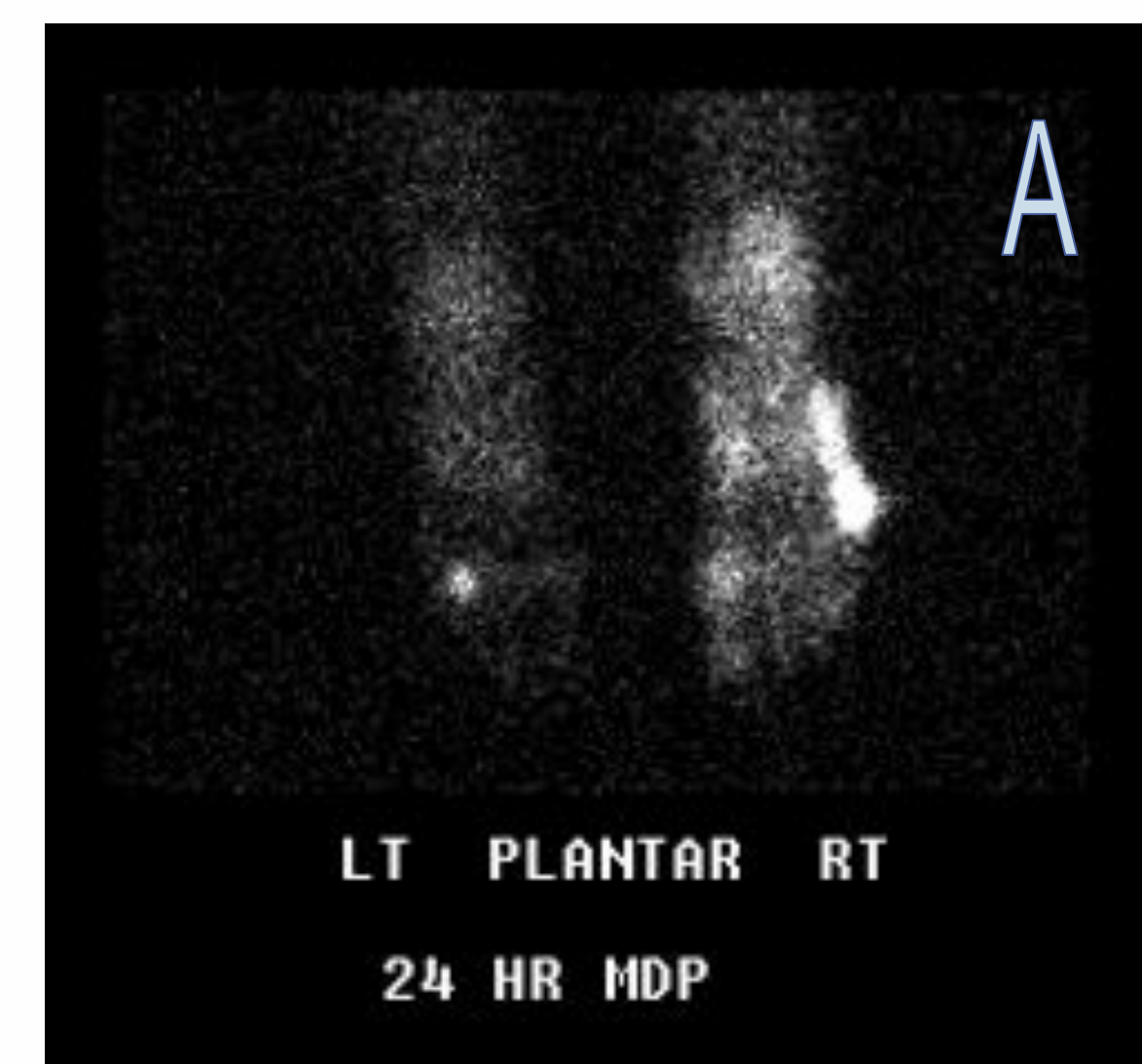


Figure 3. Increased uptake at the region of the fifth metatarsal bone on the MDP scan (A) corresponding to the increased uptake on the MDP scan (B).

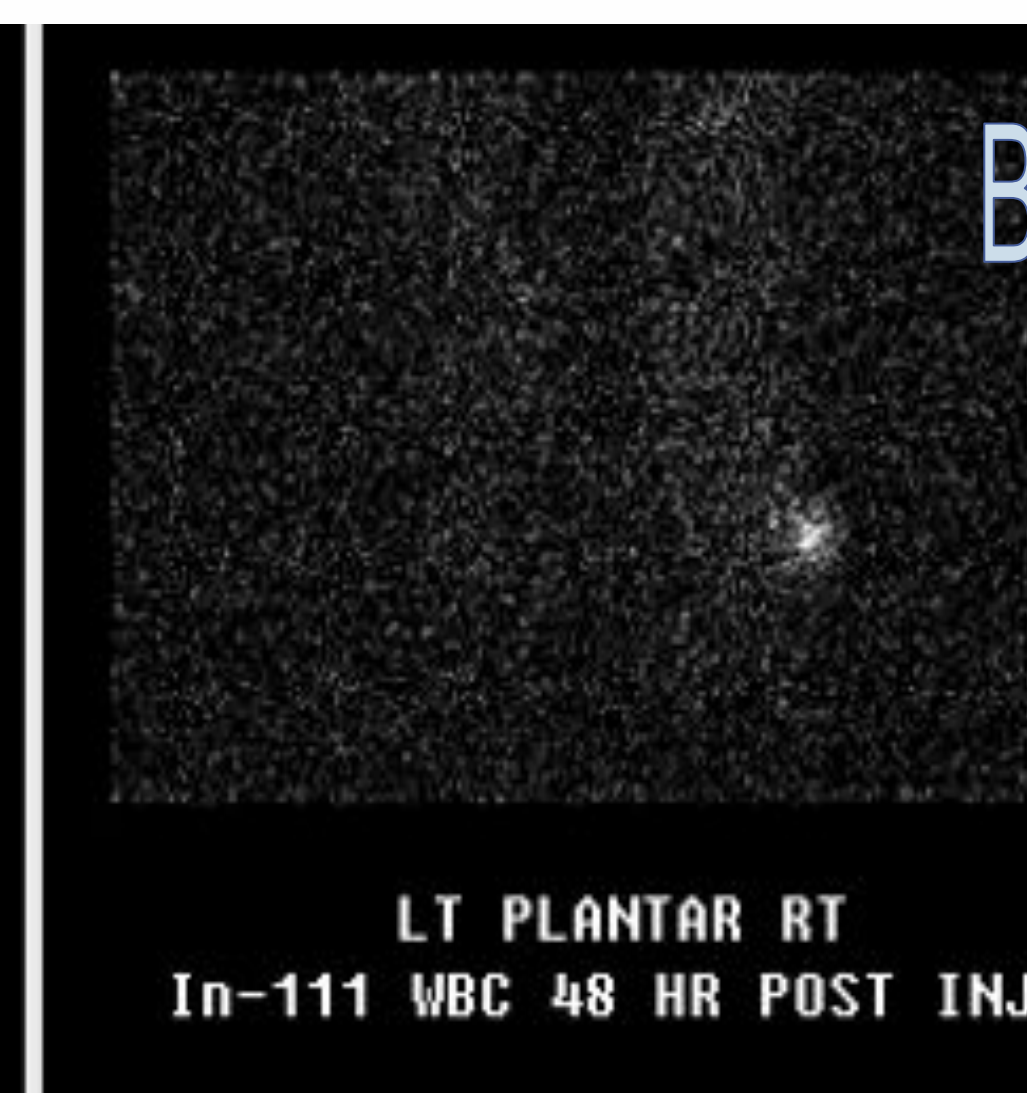
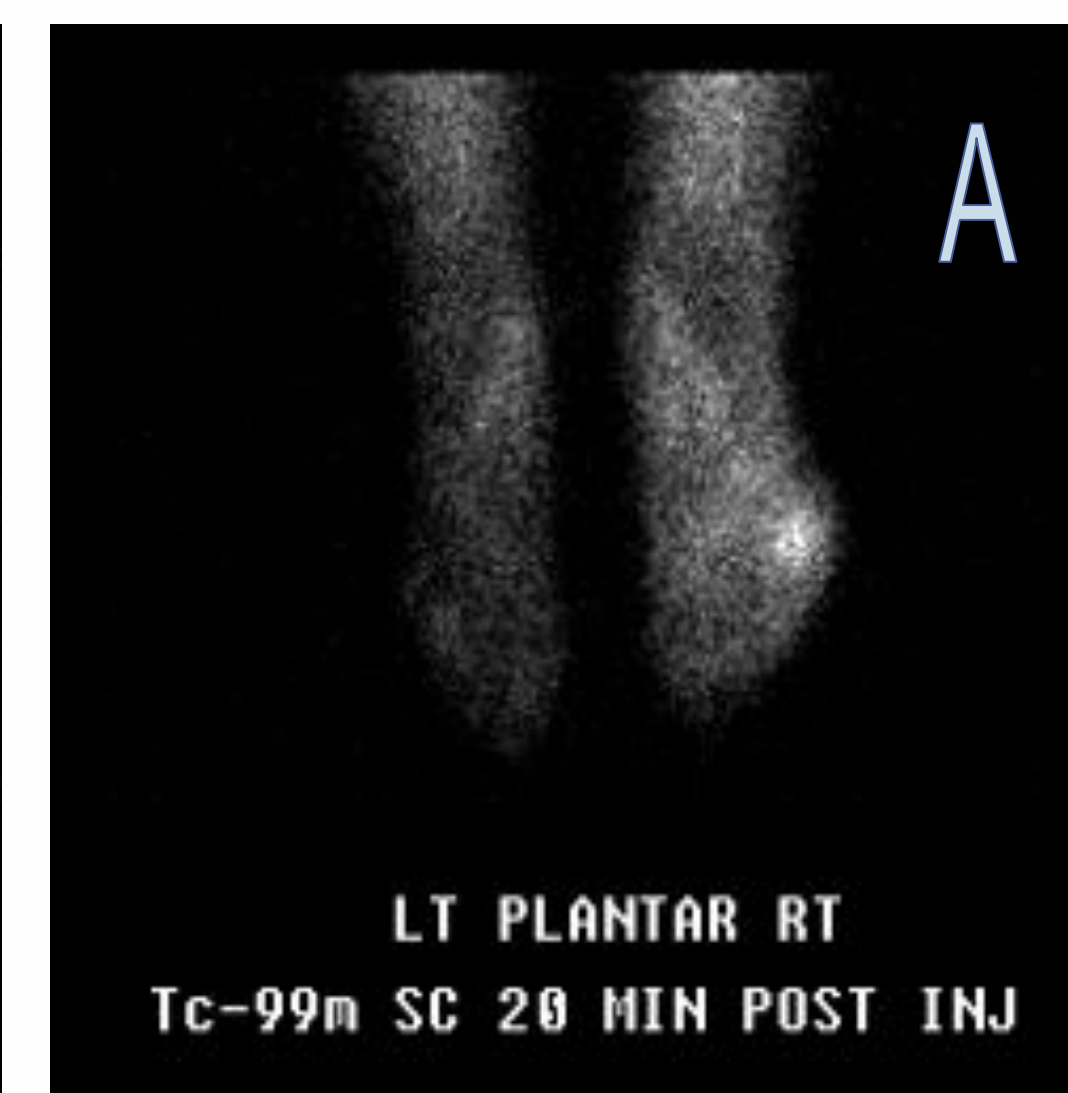


Figure 4. Increased uptake on the SC scan at the region of the fifth metatarsal bone (A) concordant with the increased uptake on the Indium scan (B).

Interpretation and Treatment Plan

Bone scan interpretation

- Figure 3A showed a broader signal uptake pattern in the right foot than the uptake of Figure 3B, suggesting that there was osseous activity beyond the right 5th metatarsal head.
- Figure 4A (marrow scan) exhibited similar signal intensity and distribution as compared to Figure 3A (MDP scan), suggesting that marrow hyperplasia was responsible for the uptake pattern of figure 3A.
- Figure 4A (marrow scan) demonstrated signal intensity at the right 5th metatarsal head that was **congruent** to the uptake of Figure 4B (WBC scan). This suggested that the combined scans were **negative for OM**.
 - A positive OM finding would result in a *photopenic* distribution at the right 5th metatarsal head on the SC scan, which would remain photointense on the WBC scan.

Treatment plan

Clinical findings suggested that the infection was restricted to soft tissue. Bone scans further suggested that there was acute CN in absence of OM. Patient was recommended to discontinue IV antibiotics and follow a strict offloading protocol in a FORS® pixelated offloading innersole. His ulcer was closed in 7 weeks with standard wound care.

Discussion



Figure 5. Wound closure (left) was achieved with pixelated shoe-based offloading (right) in 7 weeks.

- Combined WBC and SC bone scan imaging supported the suspicion of CN over acute OM at the right fifth metatarsal. In our case study, the patient had cellulitis, in which the WBC scan yielded focal uptake at the right 5th metatarsal head. Alone, this could have been suggestive of acute OM. However, incorporating the SC scan with the WBC scan showed that signal uptake in the right foot had a wider distribution than just the metatarsal head, reducing the suspicion for acute OM due to broader osseous activity⁶. Based on the patient's history with CN on the contralateral limb, along with the use of combined scans, it was deduced that that patient was experiencing CN changes. He was treated successfully using standard wound care with no need for antibiotic therapy.
- The leukocyte scan requires extracting WBCs from the patient and tagging them with indium-111 before injecting them back into the patient intravenously⁴. WBC-labeled scans localize leukocytes to areas of recent infection. However, due to its limited resolution, the distinction between bone and adjacent soft tissue infection may be compromised and lead to false positive results of OM. Additionally, WBC imaging interpretation is often complicated when discerning between hematopoietically active marrow and OM^{5,6}.
- Tc99m-labeled sulfur colloid accumulates specifically in bone marrow following its injection. SC scans show potential in differentiating between marrow and infection when determining the cause of leukocyte accumulation in the neuropathic joint. SC scan localizes to bone marrow, resulting in photointense signals during hematopoietically active processes (CN) and photopenic uptake during boney necrosis (OM)⁹.
- Traditional MDP scans and WBC-labeled scans yield valuable information about osseous and soft tissue pathology. However, results are at times complicated by the lack of specificity. Combining MDP, WBC, and SC bone scans provide better insight in determining the type of osseous processes in question. However, combined scans are not without limitations. Abnormal WBC response or migration to site of infection will not yield useful information in marrow imaging⁶. Proper SC preparation is paramount since image quality may be disrupted with poor technique. Additionally, a skilled radiologist who is familiar with the combined scans technique is needed for accurate interpretation.
- Using the combined labeled leukocyte and Tc99m-sulfur colloid bone marrow imaging technique requires a high index of suspicion for CN. However, we are optimistic that these scans will help physicians to better distinguish between an infectious boney process and a neurogenic disease.

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