Original Article

18-F flourodeoxy glucose positron emission tomography-computed tomography imaging: A viable alternative to three phase bone scan in evaluating diabetic foot complications?

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ABSTRACT

Background: This paper is based on the initial findings from a prospective ongoing study to evaluate the efficacy of flourodeoxy glucose positron emission tomography-computed tomography (FDG-PET CT) in diabetic foot evaluation. **Objective:** The aim was to compare the diagnostic accuracies of three phase bone scan (TPBS) and FDG PET-CT (FDG-PET) in diabetic foot evaluation. **Methods:** Seventy-nine patients with complicated diabetic foot (osteomyelitis/cellulitis, Charcot's neuropathy) were prospectively investigated. TPBS (15 mci methylene di phosphonate [MDP] intravenous [IV]), followed by FDG-PET (5 mci IV) within 5 days were performed in all patients. Based on referral indication, patients grouped into Group I, *n* = 36, (?osteomyelitis/cellulitis) and Group II, *n* = 43 (?Charcot's neuropathy). Interpretation was based on intensity, extent, pattern of MDP and FDG uptake (standardized uptake value) along with CT correlation. Findings were compared with final diagnostic outcome based on bone/soft tissue culture in Group I and clinical, radiological or scintigraphic followup in Group II. Results: Group I: For diagnosing osteomyelitis, TP: TN: FP: FN were 14:5:2:2 by FDG PET and 13:02:05:03 by TPBS respectively. Sensitivity, specificity, positive predictive value and negative predictive value (NPV) of FDG-PET were 87.5%, 71%, 87.5% and 71% and 81.25%, 28.5%, 72% and 40% for TPBS, respectively. Group II: charcot's: cellulitis: Normal were 22:14:7 by FDG PET and 32:5:6 by TPBS, respectively. **Conclusion:** Flourodeoxy glucose PET-CT has a higher specificity and NPV than TPBS in diagnosing pedal osteomyelitis. TPBS, being highly sensitive is more useful than FDG-PET in detecting Charcot's neuropathy.

Keywords: Charcot's neuropathy, diabetic foot, flourodeoxy glucose-positron emission tomography, osteomyelitis, scintigraphy, three phase bone scan

INTRODUCTION

Timely diagnosis of diabetic foot complications is of utmost importance for appropriate therapeutic decision making. Differentiating inflamed neuropathic foot from cellulitis or underlying osteomyelitis poses a formidable diagnostic challenge for the podiatry surgeon. Due to the limb threatening nature of diabetic pedal osteomyelitis if not intervened promptly, accurate differentiation between these two entities is of prime importance. The therapeutic strategic change from a conservative approach to an aggressive surgical procedure if required, and/or many other critical decisions such as switching over from oral to parenteral antibiotic therapy are primarily influenced by this differentiation.

Clinically, a neuropathic joint will be swollen, deformed and unstable with overlying skin discoloration. On palpation, the affected foot will be warmer than the other with bounding pulses and sometimes crepitus can be felt if there is extensive bony destruction. Very often a history of trivial trauma can be elicited preceding the swelling. Tarsal bones and tarsometatarsal joints are more commonly affected. If the clinical presentation is not so overt, plain film radiography (PFR) is the primary modality of investigation that is resorted to. PFR can be deceptively

Access this article online

Quick Response Code:

Website: www.ijnm.in

DOI: 10.4103/0972-3919.152946

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normal in early neuropathic joints as 30–60% of bone resorption has to occur before radiographic changes become evident and this usually takes 2–3 weeks. Though the Lisfranc joints or the tarsometatarsal joint's fracture dislocation is the most commonly encountered radiographic finding in advanced neuropathic foot, metatarsophalangeal joints and tibiotalar joints can also be affected.[1] In advanced neuropathic foot, due to the massive bony destruction that ensues due to the repeated stress on an insensitive foot, differentiating severe neuropathic changes from an underlying osteomyelitis radiographically is fraught with problems, especially if there is no associated ulcer. Computed tomography (CT) also relies on structural abnormalities in the bones to detect osteomyelitis, hence cannot be relied upon to diagnose early stages of osteomyelitis.

Pedal osteomyelitis, a common complication in diabetic patients, occurs in up to 15% of diabetics.[2] Though the accuracy of PFR for early diagnosis of pedal osteomyelitis is only 50–60%, it is still used as the initial screening tool in the evaluation of diabetic foot.[3] In more than 90% of the cases, foot ulcers serve as the portals of entry of infection leading to osteomyelitis.[3] In about one-third of the patients, osteomyelitis occurs due to direct extension from surrounding soft tissue infection.

Extensive bony destruction that ensues in a neuropathic foot or joints makes radiographic as well as scintigraphic diagnosis of concomitant underlying osteomyelitis difficult. Magnetic resonance imaging (MRI), though it demonstrates precise anatomical details of the affected foot, differentiating marrow edema of neuropathy from marrow edema of osteomyelitis is difficult.[4] Three-phase bone scintigraphy (TPBS), the most commonly carried out scintigraphic procedure, though highly sensitive (81%) has got low specificity (28%).[5] Labeled leukocyte scintigraphy, has been widely used as a diagnostic tool in the evaluation of pedal osteomyelitis in diabetic patients. The uptake of leucocytes in hematopoietically active marrow even in the absence of infection, thus resulting in reduced sensitivity[6] in chronic osteomyelitis, lead to the concept of combined leucocyte and marrow scintigraphy emerging as a more reliable diagnostic modality in detecting infected neuropathic foot.[7] The complexities and risks associated with leukocyte labeling, lack of technical expertise for the same etc., has finally lead to much interest being generated in evaluating 18F-flourodeoxy glucose positron emission tomography (18F-FDG PET) as a viable alternative in the evaluation of complicated diabetic foot.[8]

Objectives

We attempted to compare the diagnostic accuracies of three phase bone scan (TPBS) and FDG PET-CT in scintigraphically differentiating osteomyelitis, cellulitis and inflamed Charcot's neuroarthropathy in patients presenting with complicated diabetic foot. The prospective investigation was carried out with the prior approval of the hospital ethics committee. Informed written consent from the patients was obtained prior to carrying out the procedure.

Materials

Total of 79, (M: F, 58:21), diabetic patients [Table 1] who presented to the podiatry department with clinical suspicion of diabetic foot (osteomyelitis/Charcot's neuropathy/cellulitis) were prospectively investigated with TPBS and FDG PET-CT.

Inclusion criteria

All Type I as well as Type II diabetics, who presented with painful, edematous foot/feet with or without obvious bony deformities and with or without associated foot ulcers, who were clinically suspected to be cases of inflamed Charcot's neuroarthropathy/cellulitis/osteomyelitis were included in the study. Clinical history regarding history of trauma, duration of diabetes, presence or absence of ulcer, treatment details etc., were recorded.

Exclusion criteria

History of recent surgical procedure in the feet that was < 6 weeks from the day of the study.

METHODS

Based on the referral indication, patients were grouped into two. Group I (?osteomyelitis/cellulitis) and Group II (?Charcot's neuropathy). TPBS was performed after intravenous (IV) injection of 15–20 mci of 99^{m} Technetium labeled methylene diphosphonate (99mTc-MDP). Images were acquired in a SPECT/CT gamma camera (infinia Hawkeye-4, GE Healthcare, Milwaukee, USA). Vascular phase images were acquired using both anterior and posterior detectors, at the frame rate of 1 s/frame × 60 frames in 64 × 64 matrix. Static soft tissue phase images were acquired at the end of vascular phase in a 128 × 128 matrix and 500–700 K counts were obtained. FDG PET-CT was carried out on a separate day (in a GE discovery 8 slice PET-CT) usually within 5 days of TPBS, after injecting 5–6 mci of 18F-FDG intravenously irrespective of the glycemic status of the patient. Images of the feet were acquired for a single bed position of 2 min duration. Low dose CT correlation was used for precise anatomical localization. Standardized uptake value maximum (SUVmax) was calculated according to the body weight and expressed as g/ml. Findings were visually assessed by two nuclear medicine physicians separately.

Interpretational criteria

In TPBS, increased vascularity and soft tissue tracer uptake in the region along with increased skeletal phase uptake in the corresponding bones were reported as diagnostic of acutely inflamed Charcot's arthropathy. However in the clinical setting of an associated foot

Table 1: The observed age profile and distribution of patients in the entire study group of 79

Age group	Males	Females
40–50	9	3
50–60	21	13
60–70	27	3
>70	1	2

Maximum number of patients were males (*n*=34) in the age group 50–60

ulcer, if the intensity of MDP uptake on visual analysis was found to be focal and intense, the same finding was interpreted as suspicious of osteomyelitis. Increased vascularity and soft tissue tracer uptake with no increased uptake in the skeletal phase images were reported as soft tissue inflammation (cellulitis)/infection.

In an FDG PET-CT scan, intense FDG uptake corresponding to the specific bones in patients presenting with an overlying foot ulcer was considered as diagnostic of osteomyelitis. Diffuse FDG uptake that is localized to the soft tissue with no involvement of the bone in the same scenario was reported as soft tissue inflammation/infection. On visual analysis, a diffuse low-grade FDG uptake involving bones and joint spaces were interpreted as diagnostic of Charcot's neuropathy.

End points

Bone/soft tissue culture and sensitivity in patients referred with suspicion of osteomyelitis/cellulitis and clinical improvement after conservative management in Charcot's neuropathy were considered as end points for diagnostic correlation.

RESULTS

Group I

The 36 patients in Group I who had non-healing ulcers in the foot were referred with a high clinical suspicion of osteomyelitis. Highest incidence of ulcers was seen in the metatarsal head region in 15 patients, followed by ulcer in the distal phalangeal region of great toe/other toes in 12 patients. Five patients presented with an ulcer in hind foot/calcaneal region, and the remaining 4 patients had ulcers corresponding to metatarsal shaft region, cuboid and lateral aspect of midfoot [Table 2].

Flourodeoxy glucose PET-CT scan in this group was diagnostic of osteomyelitis in 19 patients. In the remaining 17 patients in this group, FDG uptake was confined more to the soft tissues alone, thus scintigraphically ruling out osteomyelitis and confirming the presence of cellulitis.

TPBS in the same group was suggestive of osteomyelitis in 27 patients and cellulitis only in 9 patients.

In Group 1, culture and sensitivity were available for 23 patients. Thirteen patients in whom culture was not available were not included in calculating the sensitivity and specificity. Among the 23 patients who were included in calculating culture and sensitivity, 8 patients had ulcer in great toe region, 9 in the region of metatarsal head, 4 in the calcaneal/hind foot region, 1 in the cuboid region and 2 in the lateral aspect of midfoot.

Fasting blood glucose levels showed a wide range of variation in these patients, (lowest 111 mg/dl and highest 324 mg/dl). SUVmax in patients of Group I varied from 3.8 to as high as 12.5 in osteomyelitis.

In diagnosing osteomyelitis, TP: TN: FP: FN of FDG PET-CT were 14:5:2:2 and of TPBS were 13:2:5:3 respectively [Table 3]. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of FDG PET and TPBS for diagnosing osteomyelitis were 87.5%, 71%, 87.5% and 71% and 81.25%, 28.5%, 72% and 40%, respectively [Table 4 and Figure 1].

Group II

Among patients referred with a clinical suspicion of Charcot's neuropathy ($n = 43$), FDG PET-CT was diagnostic of Charcot's arthropathy in 22 and the remaining 14 were adjudged as cellulitis. Seven patients were scintigraphically reported as normal by PET-CT scan.

The pattern of FDG uptake in neuropathic foot was found to be diffuse [Figures 2a-c and 3a-c] when compared to the focal intense FDG uptake seen in patients who were scintigraphically reported as osteomyelitis [Figures 4, Figure 5a-c]. The SUVmax values were found to vary from 1.4 in chronic Charcot's to a maximum of 03 in acutely inflamed Charcot's arthropathy. SUVmax more than 3 ranging up to maximum of 5.4 were seen in patients who had an associated fracture of the tarsal or metatarsal bones. Scintigraphically clear demarcation pattern could be observed in the SUVmax values in normal joints from the neuropathic joints as the unaffected joints in the ipsilateral or contralateral foot showed an SUVmax, which varied from 0.3 to <1.

Table 2: Distribution of the ulcer sites in the entire population in study Group I

Sites of ulcer	Patient distribution
Metatarsal head	15
Distal phalanx of toe	12
Hind foot/calcaneum	05
Metatarsal shaft	02
Cuboid	01
Lateral aspect of midfoot	01

Table 3: The observed TP, TN, FP and FN of TPBS and FDG-PET CT in diagnosing osteomyelitis in the 23 patients where culture and sensitivity were available

	TP	TN	FP	FN
TPBS	13	02	05	03
FDG-PET CT	14	05	02	02

TP: True positive, TN: True negative, FP: False positive, FN: False negative, TPBS: Three phase bone scan, FDG-PET: Fluorodeoxy glucose positron emission tomography, CT: Computed tomography

Table 4: Observed sensitivity, specificity, PPV and NPV of TPBS and FDG-PET CT respectively in diagnosing osteomyelitis

	Sensitivity %	Specificity %	PPV %	NPV %
TPBS	81.25	28.5	72	40
FDG-PET CT	87.5	71	87.5	71

TPBS: Three phase bone scan, FDG-PET: Fluorodeoxy glucose positron emission tomography, CT: Computed tomography, PPV: Positive predictive value, NPV: Negative predictive value

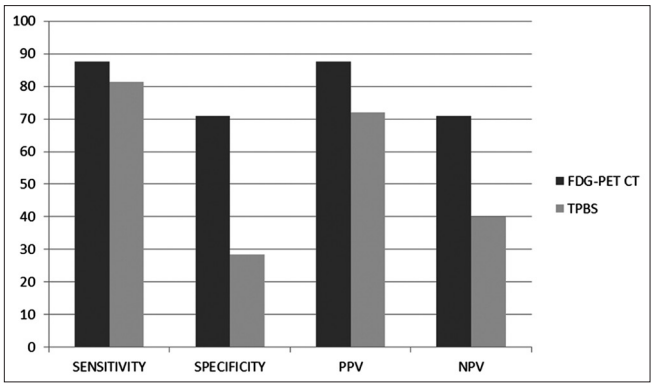


Figure 1: Chart demonstrating sensitivity, specificity, positive predictive value and negative predictive value of flourodeoxy glucose - positron emission tomography computed tomography and three phase bone scan in diagnosing osteomyelitis

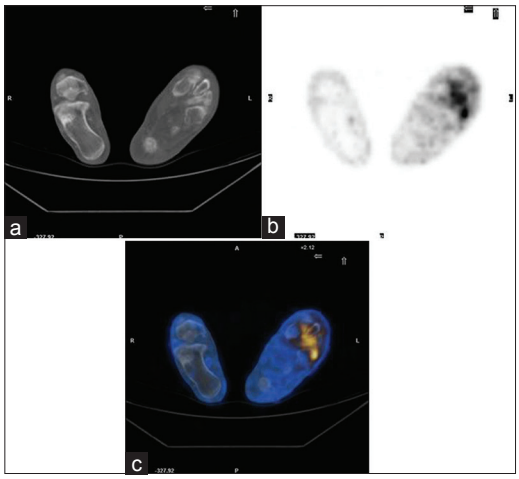


Figure 3: (a) Computed tomography (CT) (b) positron emission tomography (PET) (c) fused PET-CT images of the same patient showing characteristic low grade diffuse flourodeoxy glucose uptake in the left midfoot tarsal bones and tarso metatarsal joints in Charcot's neuropathy

Three phase bone scan diagnosed Charcot's arthropathy in 30 patients in this group, and 5 patients were diagnosed as cellulitis. Two patients who had focal intense uptake in all three phases were diagnosed as osteomyelitis. A total of 6 patients in this group had scans that were reported as normal in TPBS.

All patients in Group II were clinically followed-up for a minimum period of 6 months after conservative management. Few of the patients in this group had radiological follow up with PFR and in some patients TPBS was also done during the follow-up period.

DISCUSSION

The study Group I comprised of patients with nonhealing ulcers who were on medical management for a while and in whom even after a clinical or radiological examination, the physician could not exclude or conclusively establish underlying osteomyelitis. By TPBS alone, being a highly sensitive imaging modality, 27 patients were reported to be diagnostic of osteomyelitis as against 19 patients

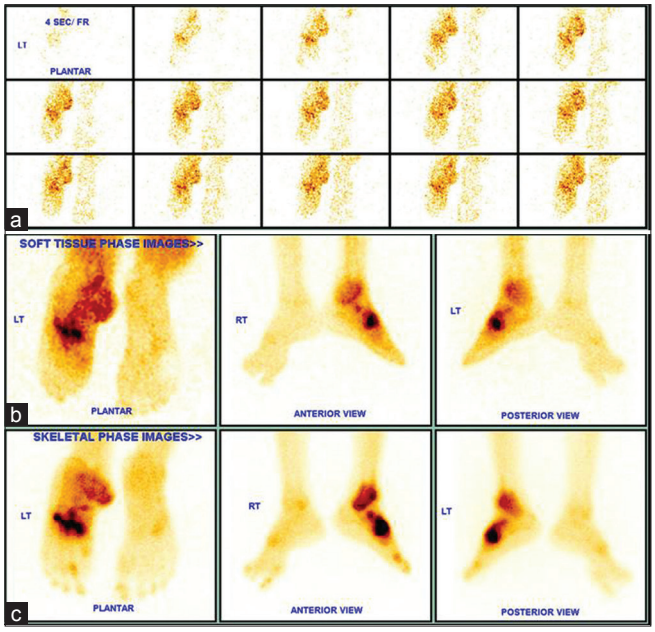


Figure 2: (a) Computed tomography (CT) (b) positron emission tomography (PET) (c) fused PET-CT images of the same patient showing flourodeoxy glucose localization mainly in the soft tissues surrounding the right tarsal bones which is more suggestive of diffuse cellulitis

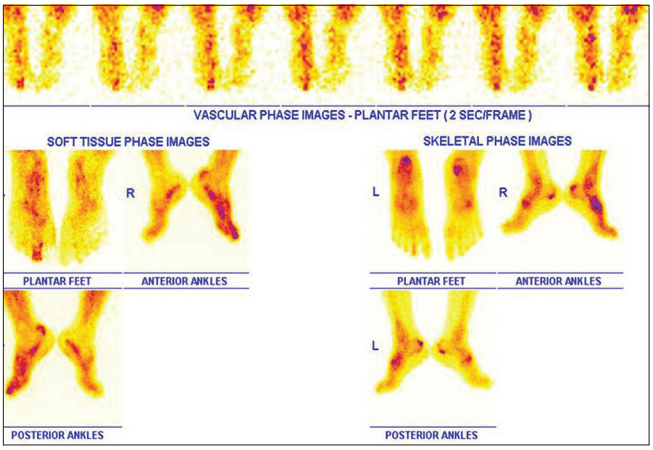


Figure 4: Vascular, soft tissue and skeletal phase images showing increased methylene di phosphonate uptake in the left 2nd toe of a patient presenting with nonhealing ulcer of left second toe

by FDG PET-CT. So 8 patients who were labeled as osteomyelitis in TPBS were found to be showing diffuse FDG uptake confined more to the surrounding soft tissues than in the involved bone, thereby ruling out osteomyelitis in them [Figures 6a, b and Figure 7a-c]. The co-registration of PET and CT images was found to be extremely useful in accurately pinpointing the involved bones as well as in differentiating bony uptake from the surrounding soft tissue uptake [Figures 8a, b and Figure 9a-c].

Correlation of tissue culture and sensitivity with scintigraphic findings of the 23 patients in this group revealed that FDG PET-CT has a higher specificity (71%) and NPV (71%) in detecting osteomyelitis when compared with TPBS (28.5% and 40% respectively). This finding is of valuable importance in

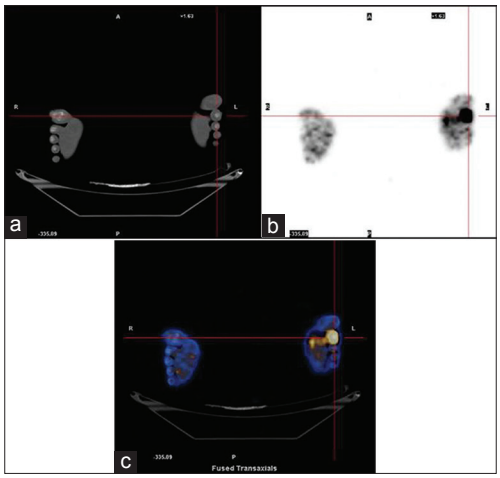


Figure 5: (a) Computed tomography (CT) (b) positron emission tomography (PET) (c) fused PET-CT of the same patient showing intense focal flourodeoxy glucose uptake corresponding to the distal phalanx of left second toe suggestive of osteomyelitis

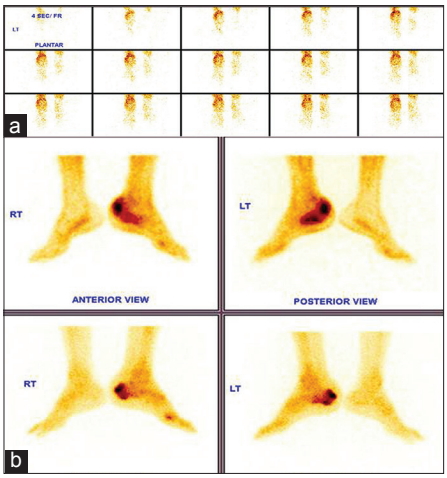


Figure 6: (a) Vascular phase images showing increased vascularity in left heel region and Figure 1 (b) Soft tissue and skeletal phase images showing diffuse increased methylene di phosphonate (MDP) uptake in the left calcaneum in three phase MDP bone scan of a suspected case of left calcaneal osteomyelitis

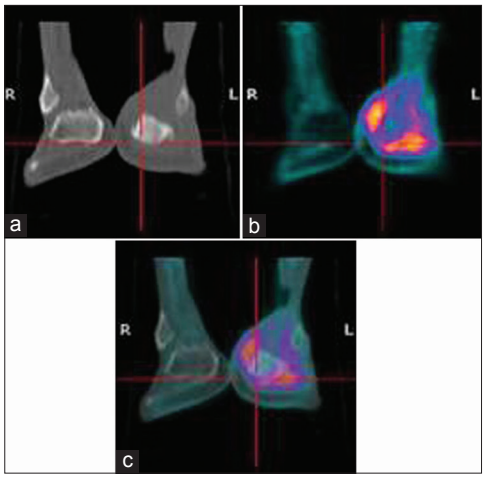


Figure 7: Three phase bone scan showing increased vascularity (a) and soft tissue and skeletal phase images (b) showing increased methylene di phosphonate uptake in the left mid foot of a patient with clinically inflamed left Charcot's foot

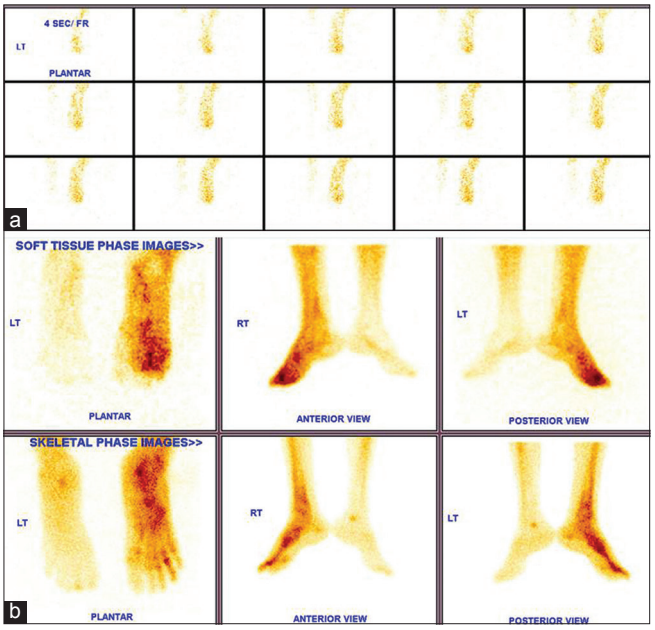


Figure 8: Three phase bone scan in a patient presenting with diabetic foot clinically with (a) vascular phase showing increased vascularity and (b) soft tissue phase images showing increased soft tissue methylene di phosphonate (MDP) uptake in right foot, especially in fore foot suggestive of cellulitis and skeletal phase images showing mildy increased MDP uptake in right mid foot suggestive of probable early Charcot's neuropathy

therapeutic decision making to the podiatry surgeon as the further treatment strategy whether to manage conservatively/institute aggressive antibiotic therapy/surgical debridement or even carry out surgical amputation is adopted based on the presence or absence of osteomyelitis. Two patients who were falsely positive by FDG PET-CT in this group had significant deep seated soft tissue inflammation, however the bone curettings sent for culture was negative. Prolonged and repeated antibiotic therapy with broad spectrum antibiotics is probably retrospectively attributed to be the reason behind 2 false negative FDG PET-CT scans in this patient group. However, this requires further validation by observing the pattern of FDG uptake in proven pedal osteomyelitis in a larger subset of patients who are on antibiotic therapy.

Analysis of the available studies published so far on the utility of FDG PET in diabetic foot syndrome shows that most of the studies have compared FDG-PET alone or PET-CT with MRI, PFRs or with WBC scintigraphy.

One of the largest published data till date evaluating the usefulness of FDG in the evaluation of diabetic foot syndrome is by Nawaz *et al.* in 2010.[9] Here comparing FDG PET images with MRI and PFRs in 110 patients, they found that PET alone had a higher specificity (93%) and NPV (94%) in accurately diagnosing diabetic foot complications when compared to MRI. Here, the total number of patients with the histopathological confirmation of the final diagnosis was not

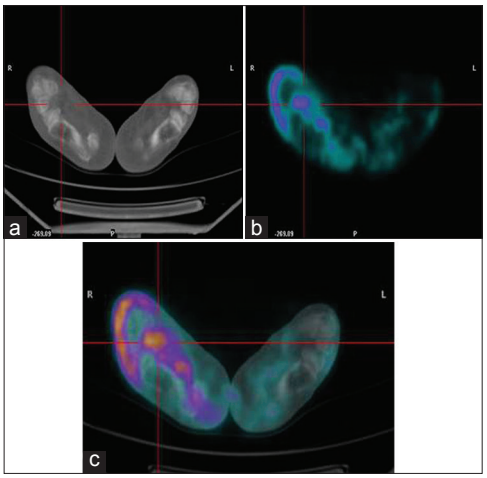


Figure 9: (a) Plain computed tomography (CT), (b) positron emission tomography (PET) alone and (c) fused PET-CT images of the same patient showing diffuse increased soft tissue tracer uptake in deep soft tissues surrounding the left calcaneal bone suggesting deep seated soft tissue inflammation/infection and ruling out osteomyelitis

provided. The investigators had concluded that FDG PET is a highly specific imaging modality in diagnosing osteomyelitis in diabetic foot.

Basu *et al*.[8] in their prospective study in 63 patients with PET alone found FDG PET to be highly useful in diagnosing osteomyelitis as well as in differentiating it from Charcot's foot. Here, histopathological confirmation of the final diagnosis was provided in 10 patients.

Keidar *et al*.[10] who used FDG PET-CT in evaluating diabetic foot reported an accuracy of 94% in diagnosing osteomyelitis in 14 patients with 18 suspected sites of infection. Here, PET-CT correctly localized 8 foci of FDG uptake to be in the bones in 4 patients thus indicating osteomyelitis. Five sites of FDG uptake in 5 patients were limited to the infected soft tissues, thus excluding osteomyelitis. Histopathologic confirmation of the final diagnosis was available only for 2 sites.

The largest reported series so far where FDG-PET CT was used to evaluate diabetic patients with clinically suspected osteomyelitis is by Kagna *et al*.[11] They evaluated 39 diabetic patients with 46 suspected sites of foot infection. Final diagnosis was done based on histopathology and bacteriological confirmation of the surgical specimens as well as with clinical and imaging follow-up. They reported a sensitivity, specificity and accuracy of 100%, 92% and 95% respectively in a patient based analysis for the diagnosis of osteomyelitis in diabetic foot.

Our study, to our knowledge is the second largest study reported so far where 36 patients of suspected osteomyelitis were evaluated with hybrid FDG PET-CT imaging. The findings in 23 patients in whom histopathology correlation were available were used to determine the usefulness of PET-CT in diagnosing osteomyelitis in diabetic foot. We found that, the sensitivity and PPV of FDG PET-CT to be 87.5% in diagnosing osteomyelitis, which was comparable to the reported sensitivities. FDG PET-CT was found to have a definitely higher specificity and NPV than TPBS.

The wide variation in SUVmax values observed in this group, from lowest 3.8 to as high as 12.5 agrees with the observation by Basu *et al*.[8] in their series where it was found that SUVmax at the sites of osteomyelitis in diabetic foot ranged from 2.9 to 6.2. However, the fact that in patients who were on prolonged therapy with broad spectrum antibiotics, SUV values can be deceptively low and may lead to false negatives has to be emphasized here as observed in the 2 patients in our study group.

Keidar *et al*.[10] in their study had reported that proper glycemic control is not an essential factor/prerequisite in infection imaging with FDG PET-CT as the investigators had found that there was no relationship between the glycemic status and the degree of FDG uptake. Fasting blood glucose levels in our study group showed wide range of variation, lowest 111 mg/dl to highest 324 mg/dl. The patient with the highest fasting blood sugar value of 324 mg/dl showed an SUVmax of 4.16 in the involved bone and was later on proved to be a culture positive for infection. This re-iterates the fact that the degree of FDG uptake in infected bones is not affected by the blood glucose levels of the patient.

The high sensitivity of TPBS is again reflected in the scintigraphic outcome of the patients in second group as well where among the 43 patients who were referred with a clinical diagnosis or a suspected diagnosis of Charcot's neuropathy, FDG PET-CT diagnosed Charcot's in 22 and cellulitis in 14 patients, whereas TPBS detected Charcot's arthropathy in 30 patients and cellulitis in only 5 of them.

The pattern of FDG uptake in neuropathic foot was found to be diffuse [Figures 2a, b and Figure 3a-c] when compared to the focal intense uptake seen in osteomyelitis [Figures 4 and Figure 5a-c]. The SUVmax values were found to vary from 1.4 in chronic Charcot's to <3 in acutely inflamed Charcot's arthropathy. Basu *et al*. had also identified a low degree of diffuse FDG uptake in Charcot's arthropathy, which was clearly distinguishable from normal joints in their patients. In the FDG PET-CT images in our patient groups, we additionally observed that a higher SUVmax >3 ranging up to maximum of 5.4 were seen not only in underlying osteomyelitis but it could also be observed in patients of advanced Charcot's athropathy who had an associated fracture of the tarsal or metatarsal bones. Hence in patients with advanced neuropathic foot, associated fractures of the tarsometatarsal bones which are encountered frequently can give rise to elevated SUV values. Correlation with the co-registered CT images helps to identify the underlying fracture pathology thereby eliminating false positive diagnosis of osteomyelitis based on SUV values in such a scenario.

In the study Group II, TPBS was found to be more sensitive and useful than FDG PET-CT in detecting early Charcot's neuropathy

as it incrementally diagnosed early neuropathic foot in 08 more patients thereby warning the clinician to bring about more stricter glycemic controls in them and to adopt preventive conservative measures like off-loading of the foot or advising molded foot wear in them so as to help prevent further clinical or symptomatic deterioration. Clinical followup of these patients over a period of 1-year after various conservative management strategies showed significant improvement in many and no overt deterioration of the neuropathic status were noted in them.

LIMITATIONS OF THE STUDY

Primary limitation of the study is the small sample size of only 79 patients. Of the 36 patients in Group I, tissue samples for culture and sensitivity were obtained only in 23 patients, which further reduced the sample size used to calculate specificity and sensitivity in this group. Planar images and not hybrid SPECT-CT was used in the third phase of the bone scan, which is an inherent limitation of this study as Hybrid SPECT-CT, if it were employed, due to its superior specificity would have perhaps contributed more to the diagnostic accuracy of TPBS.

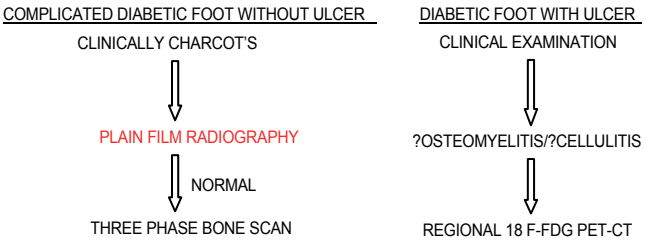
Patients in Group II were primarily followed-up clinically, though a few of them had undergone PFR and TPBS during follow-up period to assess the response to therapy. More objective therapy response could have been obtained if all of them underwent follow up scans. Quantification methods like target to background ratios in follow up TPBS can more precisely and conclusively document therapeutic responses in Charcot's neuropathy patients who are managed conservatively.

The additional radiation exposure to the patient resulting from PET-CT imaging is another factor that needs to be mentioned. However, the low-dose CT with reduced voltage and current beam used only for anatomical localization purposes helps to minimize this exposure to a certain extent. Last but not the least, the additional cost that a patient has to incur while undergoing an FDG PET-CT scan has to be kept in mind. Here again, the positive clinical benefits have to be weighed prudently against the monetary implications which can be used to filter the correct subset of patients in whom the study is rightfully indicated.

CONCLUSION

Differentiating osteomyelitis from noninfected neuropathic foot is a diagnostic dilemma to the clinician in routine podiatric practice. Clinical examination, probe to bone test, PFR notwithstanding, diagnostic uncertainty still arises, thus precluding appropriate therapeutic procedures quite often. FDG PET-CT due to its higher specificity than TPBS in suspected osteomyelitis can definitely be considered as a one stop shop in throwing light on this perennial problem by more or less accurately differentiating cellulitis from osteomyelitis or by ruling out osteomyelitis. On the other hand, in suspected Charcot's neuropathy, TPBS is found to be more sensitive and can help detect Charcot's at an early stage, which can caution the clinician to adopt proper conservative management and hence that further ongoing damage can be arrested or its onset can be delayed.

PROPOSED ALGORITHM FOR EVALUATION OF DIABETIC FOOT COMPLICATIONS BASED ON THE OBSERVATIONS FROM OUR STUDY



REFERENCES

1. Palestro CJ, Love C. Nuclear medicine and diabetic foot infections. Semin Nucl Med 2009;39:52-65.
2. Wheat J. Diagnostic strategies in osteomyelitis. Am J Med 1985;78 (6B):218-24.
3. Tomas MB, Patel M, Marwin SE, Palestro CJ. The diabetic foot. Br J Radiol 2000;73:443-50.
4. Craig JG, Amin MB, Wu K, Eyler WR, van Holsbeeck MT, Bouffard JA, *et al.* Osteomyelitis of the diabetic foot: MR imaging-pathologic correlation. Radiology 1997;203:849-55.
5. Dinh MT, Abad CL, Safdar N. Diagnostic accuracy of the physical examination and imaging tests for osteomyelitis underlying diabetic foot ulcers: Meta-analysis. Clin Infect Dis 2008;47:519-27.
6. Shauwecker DS. Osteomyelitis: Diagnosis with In-111 labelled leucocytes. Radiology 1989;171:141-6.
7. Palestro CJ, Mehta HH, Patel M, Freeman SJ, Harrington WN, Tomas MB, *et al.* Marrow versus infection in the Charcot joint: Indium-111 leukocyte and technetium-99m sulfur colloid scintigraphy. J Nucl Med 1998;39:346-50.
8. Basu S, Chryssikos T, Houseni M, Scot Malay D, Shah J, Zhuang H, *et al.* Potential role of FDG PET in the setting of diabetic neuro-osteoarthropathy: Can it differentiate uncomplicated Charcot's neuroarthropathy from osteomyelitis and soft-tissue infection? Nucl Med Commun 2007;28:465-72.
9. Nawaz A, Torigian DA, Siegelman ES, Basu S, Chryssikos T, Alavi A. Diagnostic performance of FDG-PET, MRI, and plain film radiography (PFR) for the diagnosis of osteomyelitis in the diabetic foot. Mol Imaging Biol 2010;12:335-42.
10. Keidar Z, Militianu D, Melamed E, Bar-Shalom R, Israel O. The diabetic foot:Initial experience with 18F-FDG PET/CT. J Nucl Med 2005;46:444-9.
11. Kagna O, Srour S, Melamed E, Militianu D, Keidar Z. FDG PET/CT imaging in the diagnosis of osteomyelitis in the diabetic foot. Eur J Nucl Med Mol Imaging 2012;39:1545-50.

How to cite this article: Shagos GS, shanmugasundaram P, Varma AK, Padma S, Sarma M. 18-F flourodeoxy glucose positron emission tomography-computed tomography imaging: A viable alternative to three phase bone scan in evaluating diabetic foot complications?. Indian J Nucl Med 2015;30:97-103.

Source of Support: Nil. **Conflict of Interest:** None declared.