[18F]FDG PET/CT in Necrotizing Fasciitis: A Case Series Investigating the Clinical Utility in a Challenging and Rare Condition

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Abstract

Necrotizing fasciitis is a deadly yet rare soft tissue and skin infection that is usually diagnosed clinically. At times, clinical signs may betray the underlying etiology and masquerade as cellulitis in the early course of the disease. We report four cases with clinical suspicion of necrotizing fasciitis, some after the failure of therapy for cellulitis who underwent 18-F fluorodeoxyglucose positron emission tomography-computed tomography (18-F FDG PET/CT) showing the extent of the disease, showing subclinical sites of involvement in patients with necrotizing fasciitis on baseline scan as well as its role in assessing response to treatment using 18-F FDG PET/CT.

Keywords: *18-F fluorodeoxyglucose positron emission tomography-computed tomography, amputation, diabetic foot, gangrene, necrotizing fasciitis*

Introduction

Necrotizing fasciitis is a rare aggressive skin and soft-tissue infection with a high mortality rate, more commonly an acute process. The most common cause is the direct introduction of an infectious agent (the most common is *Staphylococcus aureus*, Streptococci, and *Clostridium*).[1] Infection typically spreads along the fascial plane which has a relatively low blood supply. These pathogens invade antibacterial mechanisms and disrupt the coagulation system by hijacking acute-phase response, leading to sepsis-induced coagulopathy, and systemic inflammatory response syndrome.[2] The overlying skin and soft tissue are rather unaffected in the early stage of the infection until late. Skin manifestation initially presents as erythematous or bluish-gray discoloration of the skin with progression. This may delay diagnosis and prompt treatment, often leading to a late-stage presentation with a florid spread of disease, spreading to nearby structures, i.e., overlying skin, muscle, and soft tissue nearby and often leading to systemic manifestation, i.e., fever, tachycardia, and sepsis.[3,4]

Diagnosis is mostly established clinically. Imaging may help in cases where the diagnosis is uncertain. Computed tomography (CT) has better contrast than X-ray and anatomical delineation and may help in understanding the extent better. CT, along with ultrasound may guide the directed aspirations. B-mode color Doppler may help in bedside assessment of the disease. Magnetic resonance imaging can be used with caution as it is time-consuming and may delay surgical intervention. Management usually consists of medical management, i.e., suitable antibiotics, and surgical management, i.e., debridement and incision and drainage.[4,5] Prognosis of patients with necrotizing fasciitis is dismal with mortality rates ranging from 20% to 80%. Patients who survive may have significant function deficits.[4]

The use of 18-F fluorodeoxyglucose positron emission tomography CT (18-F FDG PET/CT) is still being explored in guiding the management of necrotizing fasciitis. 18-F FDG PET/CT is used majorly for oncological purposes as well as infection and inflammatory pathologies. The aim of this case series is to explore the use of 18-F FDG PET/CT in guiding the management of patients with necrotizing fasciitis.

Case Reports

Case 1

A 45-year-old man, a known diabetic (not adequately controlled on medication), a

How to cite this article: Baberwal P, Verma P, Shinde P, Basu S. [18F]FDG PET/CT in necrotizing fasciitis: A case series investigating the clinical utility in a challenging and rare condition. Indian J Nucl Med 2024;39:299-303.

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Received: 08-01-2024
Revised: 12-08-2024
Accepted: 19-08-2024
Published: 18-11-2024

Access this article online

Website: https://journals.lww.com/ijnm

DOI: 10.4103/ijnm.ijnm_7_24

Quick Response Code:

smoker for 20 years, and with a previous history of left lower limb amputation for gangrene 1 and 1/2 years back and open reduction and right tibia nail insertion in 2009, presented with a wound on dorsum of the right foot since 4 days. It was associated with blackish discoloration of surrounding skin and pus discharge for 1 day and was associated with fever. His blood investigations revealed hemoglobin was 12.0 g/dL, white blood counts were 24,000/mm^3, differential counts were 78%/20% for polymorphs/lymphocytes, and platelets were 2.4 lacs/mm^3. Doppler sonography of the right lower limb did not show any vascular anomalies. He was treated with injectable piperacillin–tazobactam 4.5 g and metrogyl 1 g twice daily followed by right below-knee lower limb amputation. However, his condition was deteriorating. 18-F FDG-PET/CT showed FDG uptake (SUV_{max} 3.21) in the right knee joint associated with gaseous and soft-tissue debris collection within resulting in dilatation of the joint capsule. Mild FDG uptake (SUV_{max} 1.51) is noted in the right periosteal soft tissue surrounding the right femur (till distal half) and right tibia with no reactive changes in the right femur and in subcutaneous tissue with associated necrotic changes. Complete blood counts after 18-F FDG-PET/CT scan revealed hemoglobin was 8.9 g/dL, white blood counts were 19,000/mm^3, and platelet counts were 1.7 lacs/mm^3. He rapidly deteriorated and succumbed to septicemia a month later [Figure 1].

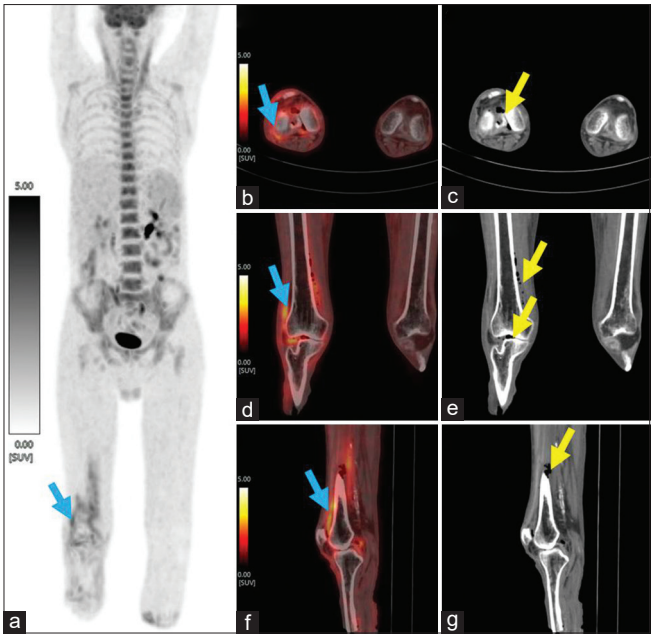

Figure 1: Maximum intensity projection (a) of 18-F fluorodeoxyglucose positron emission tomography-computed tomography (PET/CT) scan of patient (Case 1) with necrotizing fasciitis of right limb. Images (b-g) showing fused PET/CT and CT respectively, in axial (b and c), coronal (d and e), and sagittal view (f and g) of the right lower limb involving subcutaneous tissues, underlying muscles, and right knee articular space (blue arrow), gas on fused PET/CT and CT (yellow arrows). Note is made of diffuse marrow uptake of tracer, which can be attributed to anemic status

Case 2

A 39-year-old man, a known diabetic presented with complaints of swelling of the medial aspect of the left thigh and right side of the neck which increased gradually in size. It was associated with redness of overlying skin, warmth, and restriction of movement associated with fever and chills. His hemoglobin was 11.0 g/dL, white blood counts were 18,700/mm^3, differential counts were 85%/12% for polymorphs/lymphocytes, and platelets were

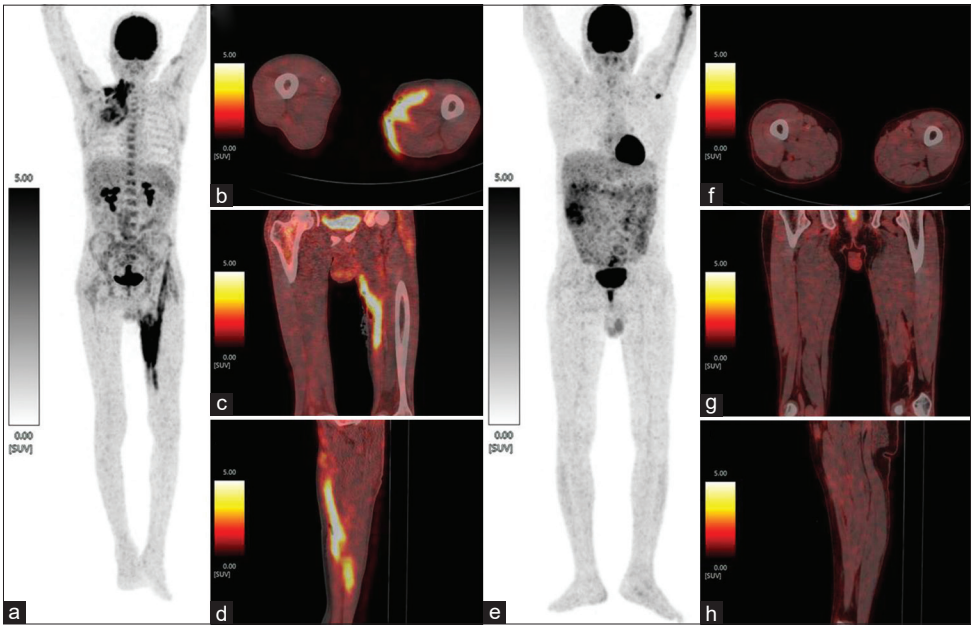

Figure 2: Maximum intensity projection of 18-F fluorodeoxyglucose positron emission tomography-computed tomography (PET/CT) scan of patient (Case 2) with necrotizing fasciitis of left thigh and right shoulder pretherapy (a) and after completion of medical therapy (e). Images (b-d) showing fused PET/CT in axial view pretherapy (b-d) and posttherapy of left thigh limb involving subcutaneous tissues and underlying muscles and images (f-h) showing fused PET/CT in axial view post therapy showing a complete response of left thigh infection and right shoulder infection site (blue arrow)

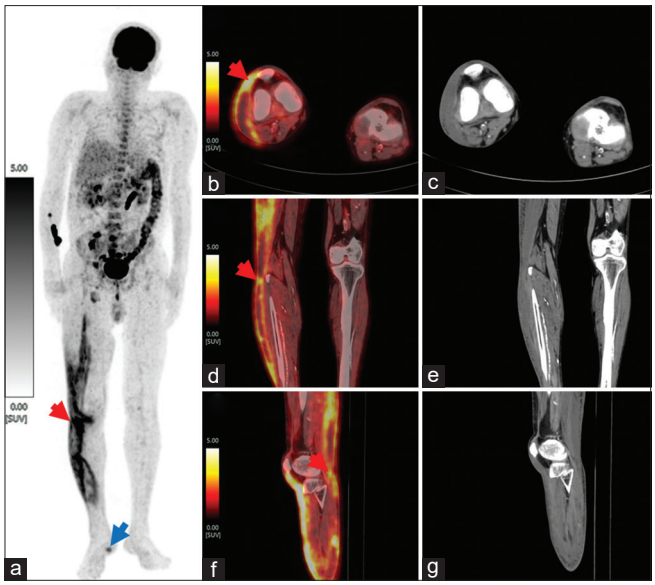

Figure 3: Maximum intensity projection (a) of 18-F fluorodeoxyglucose positron emission tomography-computed tomography (FDG PET/CT) scan of patient (case 3) with necrotizing fasciitis of right leg (red arrow). Images (b-g) showing fused FDG PET/CT and CT respectively, in axial (b and c), coronal (d and e), and sagittal view (f and g) of the right lower limb showing necrotizing fasciitis involving subcutaneous tissues and underlying muscles with associated edema. A focal FDG uptake is noted in the plantar aspect of the right foot

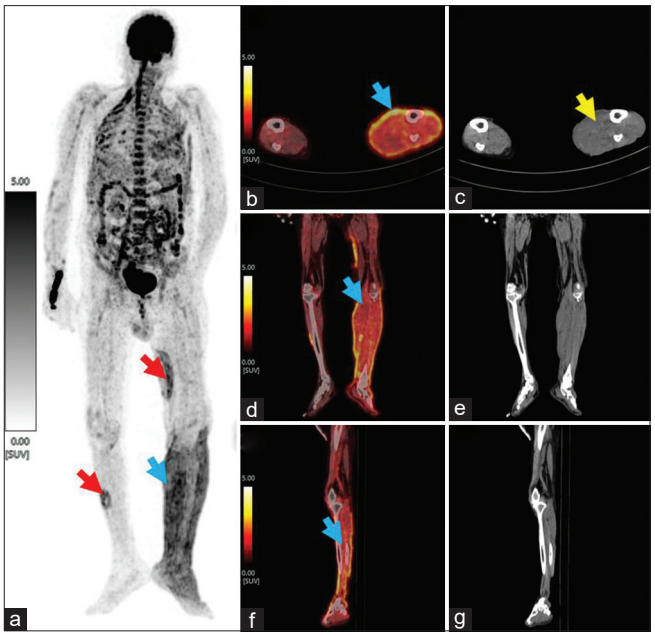

Figure 4: Maximum intensity projection (a) of 18-F fluorodeoxyglucose positron emission tomography-computed tomography (PET/CT) scan of patient (Case 4) with necrotizing fasciitis of left lower. Images (b-g) showing fused PET/CT and CT respectively, in axial (b and c), coronal (d and e), and sagittal view (f and g) of left lower limb involvement of skin, subcutaneous tissues, and underlying muscles. Bulky muscles can be appreciated in PET/ CT images (Blue arrow) and CT images (yellow arrow). Other foci of involvement were also picked up on PET scan (red arrow). Note can be made of increased diffuse marrow tracer uptake

2.7 lacs/mm^3. Erythrocyte sedimentation rate (ESR) was 42 mm/h and C-reactive protein (CRP) was 89 mg/L. Ultrasonography of the left thigh was suggestive of myositis with intramuscular extension in the medial aspect of the thigh with bulky Sartorius. An echogenic collection was noted extending into the subcutaneous plane. A muscle biopsy of the left thigh was suggestive of acute on chronic inflammatory etiology. GeneXpert for pus did not show any mycobacterium tuberculosis. Pus culture showed methicillin-resistant *S. aureus* which was sensitive to clindamycin and ceftriaxone. 18-F FDG-PET/CT showed uptake (SUV_{max} 7.6) noted in the right paravertebral region at the level of C3–D3 vertebral body, intermuscular and intramuscular planes associated with subcutaneous fat stranding, ulceration of overlying skin, subcutaneous emphysema. A similar finding was noted in the anterior and the medial compartment of the left thigh (SUV_{max} 7.4) in the intermuscular and subcutaneous planes; associated gas bubbles were noted in the left bulky sartorius muscle. He was treated with injectable clindamycin 900 mg four times daily for 2 weeks and surgical debridement. Follow-up scan done after 1 year showed a complete metabolic and anatomical response of the previously mentioned right paraspinal and left medial thigh [Figure 2].

Case 3

A 56-year-old gentleman, a known diabetic and hypertensive on medication presented with black induration of the right lower limb. His hemoglobin was 9.1 g/dL, white blood counts 13,700/mm^3, differential counts 90%/9% for polymorphs/lymphocytes, and platelets were 1.7 lacs/mm^3. ESR was 61 mm/h and CRP was 162 mg/L. F-18 FDG-PET/CT scan done to assess disease extent showed FDG avid cutaneous and subcutaneous soft tissue on the lateral aspect of the right lower limb (SUV_{max} 7.77) extending from distal one-third of tibia extending to proximal one-third of the femur. A focal FDG uptake is noted in the plantar aspect of the right foot (SUV_{max} 3.82) associated with subcutaneous fat stranding which was a subclinical lesion. With findings being suggestive of necrotizing fasciitis, the patient was started on injectable piperacillin–tazobactam 4.5 g and injectable metronidazole 1 g twice daily and underwent fasciotomy with surgical debridement of necrotic tissue. The patient improved clinically with minimal functional deficits [Figure 3].

Case 4

A 66-year-old man with no comorbidities, presented with severe left lower limb pain and induration in the left limb for a week. His hemoglobin was 10.4 g/dL, white blood counts were 17,000/mm^3, differential counts were 78%/20% for polymorphs/lymphocytes, and platelets were 2.3 lacs/mm^3. ESR was 48 mm/h, and CRP was 106 mg/L. The patient was administered injection cephalexin 500 mg QID and clindamycin 300 mg TID for 10 days. However, he deteriorated on medical management. 18-F FDG-PET/CT revealed FDG uptake (SUV_{max} 6.14) in the subcutaneous plane of the left leg. Similar such focal uptake was noted

in the proximal one-third of the leg in the subcutaneous plane (SUV_{max} 4.11). FDG avid (SUV_{max} 4.65) ulcerated lesion was seen with full tissue necrosis showing a breach in the skin base formed by the medial compartment of thigh muscles. Diffuse F-18 FDG uptake was noted in the bone marrow. The patient was started on injectable piperacillin–tazobactam 4.5 g and injectable metronidazole 1 g twice daily. The patient succumbed to septic shock 2 months later [Figure 4].

Discussion

Necrotizing fasciitis is rare and it belongs to a broader class of infections known as skin and soft-tissue infections, which also involve ailments such as cellulitis and erysipelas. Patients with necrotizing fasciitis may have pain disproportionate to physical findings. The presence of overlying edema and bullae helps to discriminate between necrotizing infections and other soft-tissue infections.[6] In our study, which evaluated the utility of 18-F FDG-PET/CT in necrotizing fasciitis, imaging before definitive medical management helped in analyzing the extent of the disease and set up a baseline for future evaluations. There are few case reports suggesting the use of 18-F FDG-PET/CT in this condition.[7] Sonavane and Basu illustrated a young patient's irrecoverable, debilitating condition secondary to necrotizing fasciitis with characteristic 18-F FDG-PET/CT findings.[8]

Patients with comorbidities like diabetes mellitus tend to have a worse prognosis as two of our four patients who expired were known diabetics with uncontrolled blood sugar levels. Similar findings were noted in the study by Cheng *et al*.[9] On 18-F FDG-PET/CT scan, it was noted that involvement of deeper tissues such as muscles and joint spaces carried a grim prognosis than that of patients without muscle or joint space involvement. In our study, patients 1 and 4 who had deep tissue involvement could not survive within 2 months of baseline 18-F FDG-PET/CT scan despite the intensive medical and surgical management. 18-F FDG-PET/CT covers the whole body, and therefore, it may also help in assessing other sites of infection which have not clinically manifested yet. Patient 2, who had followed up postcomplete medical management showed a complete clinical response and the 18-F FDG-PET/CT scan showed similar findings which helped to know the response of infection to antibiotic therapy, constituting a supplementary role to clinical evaluation. Another finding was that there was no significant correlation between SUV_{max} values and the prognosis of the patient.

However, the limitation of our study was a relatively small number as it is a rare disease. It could not statistically establish a positive cost-benefit analysis for guiding the management of necrotizing fasciitis. Many of the patients were known diabetics and uncontrolled blood sugar levels tend to diminish the sensitivity and specificity of 18-F FDG-PET/CT, as seen in preclinical and clinical studies.[10,11]

Conclusions

This study has elaborated on the utility of 18-F FDG-PET/CT and its drawbacks in evaluating patients with necrotizing fasciitis, taking into account, many factors associated with it. Our study provides a proof of concept showing subclinical sites of involvement in patients with necrotizing fasciitis on baseline scans as well as its role in assessing response to treatment using 18-F FDG-PET/CT. Further prospective studies with a larger number of patients may provide statistically significant results to corroborate our findings.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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