Clinical Case Report

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Renal osteodystrophy presenting as a metabolic superscan on F-18 FDG PET/CT

A case report

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Abstract

Rationale: F-18 Fluoro Deoxyglucose positron emission tomography and computed tomography (F-18 FDG PET/CT) is a useful modality in the evaluation of patients with malignancies. Increased incidence of lympho-proliferative disorders has been reported in individuals with long-standing end-stage renal disorders treated with renal replacement therapy.

Patient concerns: A 30-year-old male on peritoneal dialysis on account of end-stage renal disease. He had acute rejection of an earlier transplanted renal allograft. He was referred for an F-18 FDG PET/CT based on a clinical suspicion of lymphoma on account of bilateral inguinal lymphadenopathy associated with bilateral pedal swelling.

Diagnosis: Renal osteodystrophy was diagnosed based on diffusely intense F-18 FDG uptake in the axial skeleton, focal uptake in the costochondrial junctions and linear cortical uptake in the appendicular skeleton. No findings suggestive of lymphoma was seen.

Interventions: A diagnosis of renal osteodystrophy with no evidence of a lymphoma prevented futile biopsy of inguinal lymphadenopathy. Patient continued with peritoneal dialysis with no further intervention

Outcomes: Regular follow-up of patient to monitor calcium, phosphate and parathyroid hormone levels. Treatment will be indicated when laboratory results as well as clinical signs and symptoms are suggestive.

Lesson: Metabolic bone disorder such as is seen in renal osteodystrophy should be considered in the differential diagnoses in patients with diffusely increased bone uptake on F-18 FDG PET/CT scan.

Abbreviations: CT = computed tomography, DOTANOC = 1-Nal3-octrotide 1,4,7,10-tetraazacyclododecane-N,N',N",N"'-tetraacetic acid, F-18 FDG = fluorine-18 2-fluoro-2-deoxyglucose, Ga-68 = gallium 68, HIV = human immunodeficiency virus, MDP = methylene diphosphonate, PET = positron emission tomography, PSMA = prostate specific membrane antigen, PTH = parathyroid hormone, Tc-99m = technetium 99 metastable.

Keywords: F-18 FDG PET/CT, metabolic superscan, renal osteodystrophy

1. Introduction

Renal osteodystrophy is a spectrum of diseases affecting the bone in patients with long-standing end-stage renal disease.[1] In most cases, it is characterized by increased bone turnover due to chronic hypocalcemia. F-18 Fluoro Deoxyglucose positron emission tomography and computed tomography (F-18 FDG PET/CT) has been successfully used in the evaluation of malignant and inflammatory processes due to increased metabolic activity that characterized these conditions.[2] In patients with suspected malignancy, F-18 FDG PET/CT offers a complimentary morphologic and metabolic attributes of lesion which may guide biopsy for histological confirmation.

2. Case report

A 30-year-old male with bilateral inguinal lymphadenopathy associated with bilateral pedal swelling and a clinical suspicion of lymphoma. The patient had rejection of a kidney allograft transplanted 1 year earlier and has since been on peritoneal dialysis. End-stage renal disease resulted from obstructive uropathy consequent of a long-standing bladder outlet obstruction.

F-18 FDG PET/CT was done to characterize inguinal lymphadenopathy and determine suitable biopsy site to rule out lymphoma. Figure 1 shows finding at F-18 FDG PET/CT imaging. Images show bilateral inguinal nodes which are small and not FDG-avid and were considered benign. Diffusely intense uptake was seen in the calvarium, mandible, sternum, and spine. Focal uptakes were seen in the costochondrial junctions. Linear FDG accumulation was seen in the cortices of the long bones. The CT showed dense sclerosis of the pelvic bones. The rejected transplanted renal allograft was seen in the right iliac fossa with dense calcification.

Biochemical evaluation revealed: low total serum calcium = 2.07 mmol/L (normal range: 2.15–2.50), low ionized calcium = 1.11 mmol/L (1.16–1.32), high inorganic phosphate = 3.12 mmol/L (0.78–1.42), high parathyroid hormone (PTH) = 327.9

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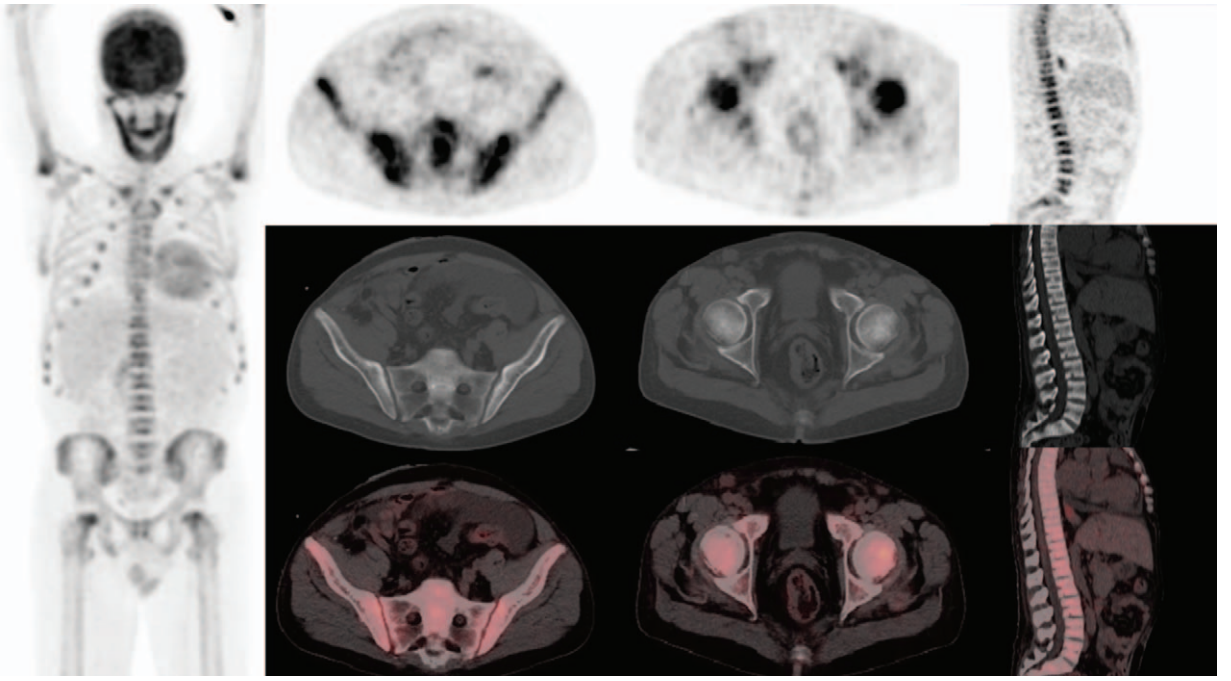

Figure 1. MIP image showing increased FDG uptake in axial and appendicular skeleton. Axial slices of the PET, CT, and fused PET/CT through the pelvis and the level of the femoral heads showing increased uptake in sclerotic pelvic bones. Sagittal slice of the PET, CT, and fused PET/CT through the spine showing sclerotic vertebral bones in a manner suggestive of the "Rugger Jersey" appearance. CT = computed tomography, FEG = fluoro deoxyglucose positron, MIP = maximum intensity projection, PET = positron emission tomography.

pmol/L (1.3–9.3) and low hemoglobin = 8.5 g/dL (13.4–17.5), screening for human immunodeficiency virus (HIV) infection was negative.

The ethics committee of the University of Pretoria did not require ethical approval for reporting individual cases. Written informed consent was obtained from the patient for the publication of this case report.

3. Discussion

Renal osteodystrophy is a term that describes the group of bone disorders seen in patients with long-standing end-stage renal disease. Its components include secondary hyperparathyroidism (high PTH, low calcium, and high phosphate levels), osteomalacia, and osteitis fibrosis cystica.[1]

Superscan is a term used to describe the finding of diffusely increased tracer uptake in the skeleton on nuclear medicine imaging. It may be metabolic or metastatic depending on its etiology. Metabolic superscan is commonly demonstrated on Technetium-99m labeled methylene diphosphonate (Tc-99m MDP) bone scan. This is characterized by diffusely increased tracer uptake in the bones with prominence of the appendicular skeletal. This is in contradistinction to metastatic superscan where uptake is more prominent in the axial skeleton.[3] Metastatic superscan has been described on PET imaging using different agents in various human malignancies. These PET agents include F-18 FDG, F-18 labeled Fluoro-choline, Gallium-68 labeled prostate-specific membrane antigen (Ga-68 PSMA), and Gallium-68 labeled 1-NaI3-octrotide 1,4,7,10-tetraazacyclododecane-N,N',N",N"'-tetraacetic acid (Ga-68 DOTA-NOC).[4–7] Metastatic superscans on PET imaging are most commonly seen in hematologic malignancies.[8] In these cases, increased F-18 FDG uptake in the bone is due to bone and bone marrow invasion by malignant cells. In F-18 FDG PET/CT imaging of malignant diseases, diffusely increased FDG uptake in the skeleton may be benign. These benign conditions include anemia with reactive bone marrow activation as well as response to therapy agents such as colony stimulating factors. Chronic anemia is a prominent feature of end-stage renal disease due to deficiency of renal 1α hydroxylase enzyme, the rate-limiting enzyme in the activation of vitamin D. Chronic anemia causes bone marrow expansion and will be seen as increased marrow uptake of tracer on F-18 FDG PET scan. This is different from the pattern of uptake seen in this patient where F-18 FDG uptake is seen in the cortices of the long bones. Similarly, metabolic superscan has been described on FDG PET imaging in patients imaged for malignant diseases.[9,10] Ghesani et al[9] described superscan caused by renal osteodystrophy on F-18 FDG PET/CT in a patient with carcinoma of the breast. Our patient does not have any malignant disease; hence, skeletal uptake of F-18 FDG can be fully attributed to renal osteodystrophy rather than marrow metastases which may produce metastatic superscan.[3] End-stage renal disease leads to loss of the activity of 1α hydroxylase enzyme activity leading to low levels of active vitamin D. Hypovitaminosis D is associated with impaired gut absorption of calcium leading to hypocalcaemia which in turn stimulates parathyroid hormone over-secretion causing secondary hyperparathyroidism. A second impulse for parathyroid hormone over-production is hyperphosphatemia resulting from phosphate retention. High bone turnover, a result of hyperparathyroidism, leads to increased F-18 FDG accumulation in these bones.

The suspicion of a lympho-proliferative disease in this patient was based on the findings of bilateral inguinal lymphadenopathy

associated with pedal swelling as well as the knowledge that malignancies are more common in individual with end-stage renal disease on chronic dialysis or those who are post-renal transplant.[11] No finding suggestive of malignancy was however seen.

4. Conclusion

In patients with end-stage renal disease imaged with F-18 FDG PET/CT, renal osteodystrophy is a differential diagnosis of diffusely increased tracer uptake in the skeleton (superscan).

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