Learning objectives

• To illustrate the spectrum of benign musculoskeletal inflammatory conditions detectable on 18F-FDG PET-CT performed for the purpose of staging or restaging malignant disease.
Background

Combined PET-CT is increasingly performed for the detection and staging of malignant disease owing to the hypermetabolism displayed by malignant cells. Infectious and inflammatory disease, including several inflammatory conditions of the musculoskeletal system have been shown to be 18F-FDG-avid on PET. \(^1\) PET has been shown to be a reliable indicator of disease activity in inflammatory arthropathies especially rheumatoid arthritis with the degree of radiotracer uptake correlating well with clinical symptoms and synovial thickness on ultrasound. \(^2\) Osteoarthritis may or may not exhibit increased radiotracer uptake, depending on the presence or absence of synovitis. \(^1\)

Whole-body PET-CT is traditionally performed from the skull base to the mid-thigh, imaging several joints and common sites of extra-articular musculoskeletal disease, and allowing precise anatomical location of any sites of abnormal radiotracer uptake.

The purpose of this educational exhibit is to illustrate the spectrum of benign musculoskeletal inflammatory conditions detectable on 18F-FDG PET-CT performed for the purpose of staging or re-staging malignant disease.

We performed a retrospective review of all patients presenting to a tertiary referral hospital and regional cancer centre for staging or restaging of malignant disease with PET-CT.

The PET-CT was performed in a dedicated PET-CT unit using an integrated PET-CT scanner (GE Discovery VCT, GE Healthcare, Buckinghamshire, United Kingdom). Patients fasted for six hours prior to scanning and were asked to refrain from physical activity for 24 hours. Blood glucose levels were verified to be below 8.3 mmol/L. Patients were administered 350 +/- 10% megabecquerels (MBq) of \(^{18}\)F-FDG intravenously and after 60 minutes of rest, were scanned from the skull base to the mid-thigh level. The scanning time for emission PET was 3 minutes per bed position. Images were reconstructed using iterative reconstruction.

A non-contrast CT scan of the thorax, abdomen and pelvis, using a standard protocol (120kV, 80 to 120 mA, slice thickness of 3.75 mm, pitch of 0.98, and a tube rotation time of 0.5 seconds per rotation), preceded the PET scan, which was used for diagnostic purposes and for attenuation correction.
FDG accumulation was commonly encountered at sites of degenerative and inflammatory disease, at both intra- and extra-articular locations. Extra-articular disease included both tendinopathy (inflammation of a tendon and its surrounding sheath/paratendon), enthesopathy (inflammation at the site of tendon or ligament insertion into bone), and bursitis. (3)

Acromioclavicular joint

The acromioclavicular joint is a small synovial joint that is predisposed to painful syndromes because of mechanical stress or congenital variations. Common pathologies causing pain include osteoarthritis, os acromiale syndrome and distal clavicle osteolysis, which can usually be identified on the CT portion of the PET-CT. However, FDG accumulation at this joint has been found to be frequent and not related to symptoms in other studies. It has a strong age correlation and most likely represents inflammatory synovial proliferation or other chronic inflammatory processes occurring in aging joints. (4)

Rotator cuff

The rotator cuff muscles supraspinatus, infraspinatus, and teres minor muscles insert at the greater tuberosity of the humerus, while subscapularis inserts at the lesser tuberosity. Focal FDG accumulation can occur adjacent to the tuberosities in the setting of rotator cuff enthesopathy. (5)

Spine

Degenerative spinal disease is a common incidental finding on PET-CT (22% of patients in one series). Degenerative changes are most prevalent in the lumbosacral spine and can be readily recognized on CT and differentiated from spinal metastatic deposits. The severity of the degree of the PET findings correlates with the severity of degenerative disc and facet disease as graded by CT, likely due to the fact that the inflammation that accompanies degenerative disease is evident on PET. (6)

Femoral trochanters
Greater trochanteric pain syndrome is characterized by focal pain and point tenderness over the greater trochanter with effective relief from steroid or anesthesia injection. The condition must likely relates to tendinopathy of the gluteus medius and minimus tendons with or without accompanying reactive bursitis. The condition is typically unilateral and is more common in middle-aged and elderly women. (7)

The bony surface of the greater trochanter consists of four facets: anterior, lateral, posterior, and superoposterior. The gluteus medius muscle attaches to the superoposterior and lateral facets and the gluteus minimus muscle attaches to the anterior facet. The trochanteric bursa covers the posterior facet and the lateral insertion of the gluteus medius muscle. The subgluteus medius bursa is located deep to the gluteus medius tendon. The subgluteus minimus bursa lies in the area of the anterior facet deep to the gluteus minimus tendon and extends medially covering the anterior hip joint capsule. (8).

The myofascial attachments and bursae associated with the greater trochanter may be affected by altered lower-limb biomechanics. Osteoarthritis of the lumbar spine, hip, or knee, iliotibial band tightness or tendonitis, or strain of the hip external rotators may contribute to trochanteric pain by adding stress to the region.

The iliopsoas muscle inserts at the lesser trochanter and focal FDG accumulation at this point may relate to tendinopathy or iliopsoas bursitis. (9)

Ischial tuberosity

Ischiogluteal bursitis is an often overlooked cause of buttock pain. The bursa is located between the posteroinferior aspect of the ischial tuberosity and the gluteus maximus muscle. Inflammation of the bursa is often due to chronic and repetitive irritation, often in patients with sedentary lifestyles. Moreover, repetitive trauma in cancer patients with gluteal subcutaneous fat loss can lead to inflammation of the bursa. Irregularity of the cortex of the ischial tuberosity or calcification adjacent to the tuberosity may be present on the CT. (10) (11)

Achilles tendon

The Achilles tendon is the most commonly injured tendon in the foot and ankle. (12) The Achilles tendon is protected against inflammatory processes because no true synovial sheath is present. However, the Achilles tendon can be secondarily affected by inflammatory processes involving the retrocalcaneal bursa. Furthermore, involvement of the Achilles paratendon has been noted in systemic inflammatory diseases, such as rheumatoid arthritis. (13) FDG accumulation in the tendon and paratendon may occur in Achilles paratendinitis, and to a lesser extent in tendinopathy. Chronic tendon thickening or calcification may be evident on the CT.
Fig. 2: A corresponding axial CT image of the left acromioclavicular joint shows joint space narrowing consistent with degenerative joint disease.

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Fig. 1: Fused axial PET-CT image shows increased radiotracer uptake at the left acromioclavicular joint with joint space narrowing consistent with degenerative joint disease.

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Fig. 4: A corresponding axial CT image demonstrates degenerative joint disease at the right patellofemoral joint.

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Fig. 3: Fused axial PET-CT image demonstrates increased radiotracer uptake at the right patellofemoral joint.
**Fig. 15:** Axial CT image demonstrates degenerative joint disease at the sternoclavicular joints bilaterally.

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Fig. 5: Fused axial PET-CT image shows radiotracer accumulation in the left infrascapular region.

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**Fig. 12:** Fused coronal PET-CT images demonstrates increased radiotracer uptake in the pectoralis muscles bilaterally in a patient using crutches.

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**Fig. 7:** Fused coronal PET-CT image shows increased radiotracer uptake at the right acromioclavicular joint consistent with degenerative joint disease. Increased uptake in the region of the greater tuberosity suggests rotator cuff enthesopathy.

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**Fig. 19:** Fused axial PET-CT image shows a focus of eccentric radiotracer uptake at the lateral aspect of the left femoral diaphysis.

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Fig. 17: Fused axial PET-CT image shows radiotracer accumulation at the site of healing left-sided rib fractures.

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**Fig. 13:** Fused axial PET-CT image shows increased radiotracer uptake at the right glenohumeral joint.

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Fig. 8: Fused coronal PET-CT image shows increased radiotracer uptake at the hip joints bilaterally with degenerative joint disease.

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**Fig. 10:** Fused coronal PET-CT image demonstrates increased radiotracer uptake at the sacroiliac joints bilaterally suggesting sacroilitis.

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**Fig. 9:** Fused coronal PET-CT image demonstrates increased radiotracer uptake at the left acromioclavicular joint with degenerative joint disease.

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Fig. 6: A corresponding axial CT image shows fibrous soft tissue stranding in the infraspinatus region. Appearances are consistent with elastofibroma derma.

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Fig. 11: Fused axial PET-CT images demonstrates increased radiotracer uptake in the pectoralis muscles bilaterally in a patient using crutches.

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**Fig. 20:** Axial CT image demonstrates a focus of cortical sclerosis at the lateral aspect of the femoral diaphysis. Appearances suggest a stress fracture.
Fig. 14: Fused axial PET-CT image demonstrates increased radiotracer uptake at the sternoclavicular joints bilaterally with degenerative joint disease.

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**Fig. 16:** Fused axial PET-CT image demonstrates increased radiotracer uptake at the left ischial tuberosity consistent with enthesopathy.

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**Fig. 18:** Fused coronal PET-CT images demonstrates increased radiotracer uptake at the right sternoclavicular joint.

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Conclusion

FDG-avid benign musculoskeletal disease is commonly incidentally encountered when interpreting PET-CT performed for the staging of malignant disease. It is imperative that the reporting radiologist be familiar with the spectrum of benign FDG-avid musculoskeletal disease on PET-CT. These conditions can be a source of significant patient morbidity resulting in pain, restricted movement and functional impairment.

Benign skeletal radiotracer uptake may simulate osseous metastatic disease in patients with malignancy and knowledge of potential benign sites of uptake related to athropathy or degeneration may prevent misdiagnosis. Furthermore, many of these conditions may represent a diagnostic conundrum for physicians with the diagnosis only becoming clear on the PET-CT. These incidental benign musculoskeletal conditions should be recognized, reported and clinically correlated by the requesting physician.
References