PET/CT hypermetabolism in the musculoskeletal system- metastases and beyond

Poster No.: C-0165
Congress: ECR 2015
Type: Educational Exhibit
Authors: D. Zlatareva, I. Kostadinova, M. B. Garcheva-Tsacheva, T. Z. Petrov, V. Groudeva, V. Hadjidekov; Sofia/BG
Keywords: Musculoskeletal bone, PET-CT, Diagnostic procedure, Metastases, Trauma
DOI: 10.1594/ecr2015/C-0165

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR’s endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method ist strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

1. To review the most common hypermetabolic PET/CT findings of the musculoskeletal system, 2. To discuss the differentiation between benign and malignant lesions in bones and muscles

Background

Positron emission tomography with computed tomography (PET/CT) combines the structural and functional information and therefore is more accurate than CT or PET imaging alone. CT allows detailed anatomic localization of metabolic changes. Detection of malignant diseases relies on 18F- FDG PET/CT hypermetabolism (1). Whole-body PET/CT in most of the patients, excluding those with malignant melanoma, is performed from the skull base to the mid-thigh. The critical issue in oncologic patients is the presence of metastases. In daily routine it is not rare to detect musculoskeletal FDG uptake in benign conditions. Using the information provided by PET/CT can help in differentiation between malignant and benign FDG avid lesions.

Findings and procedure details

An important step is to exclude pitfalls and physiological uptakes (2) and then differentiate benign from malignant musculoskeletal findings.

The bone malignancies- primary or metastatic, which have increased metabolism show FDG uptake regardless of their localization in the bone (Fig. 1-2). According to some authors osteolytic bone metastases have a higher glycolytic rate and higher metabolic activity (3). However another study has not found significant differences between metabolic activity of lytic and sclerotic bone metastases (4). Detection of metastases relies on FDG avidity and CT findings and in some patients combination between osteolytic and sclerotic or mixed metastases can be found. In cases of CT negative bone findings focal FDG uptake suggests metastases (Fig. 3-4).

Pitfalls and benign findings

In children and young adults it is necessary to differentiate focal malignant "hot spot" from red bone marrow and growth plates. This could be reported as physiological activity when the distribution is typical according to the patient's age. (Fig. 5-7)
Following the chemotherapy diffuse homogeneous increased metabolic activity in bone marrow could be detected which reflects hyperplastic bone marrow (Fig. 8). The changes are not focal and there is a history of previous chemotherapy. Some patients received chemotherapy and radiotherapy. In the latter bone metabolism of irradiated region is decreased.

The most common causes of benign FDG uptake are muscle contractures, osteoarthritic inflammatory processes, enthesopathies and brown fat. Hypermetabolic foci could be a result from previous intramuscular injection causing inflammatory process. Regarding the stage of the avascular necrosis the FDG uptake can be found. In osteoporotic patients even without history of previous trauma fractures with increased metabolism are reported.

Increased physiologic muscular uptake is found frequently due to muscle contraction. The most common sites are neck muscles and muscles around shoulder (Fig. 9). Patients scheduled to PET/CT are instructed to avoid strenuous exercise 24 hours before their examination. They are also asked to rest after FDG administration and during examination.

Osteoarthritis could be presented as FDG avid or FDG negative reflecting the degree of active synovitis (5). FDG uptake is most commonly detected in degenerative or inflammatory processes intra- or extraarticular. Extraarticular hypermetabolism is detected in tendinopathies, bursitis and enthesopathies (6). The most common sites are acromioclavicular joints, rotator cuff, spine, femoral trochanter and ischial tuberosity (Fig. 10-14). Distinguishing from metastases is possible when analyzing CT images in different planes. FDG uptake close to disc space is mainly corresponding to incidental degenerative change. On follow up study this can be decreased down to normal values. Inflammatory arthropathies like psoriasis or rheumatoid arthritis show FDG uptake in active phase. PET/CT is a marker of disease activity.

Depending on its stage avascular necrosis of femoral head can be presented as hypermetabolic focus (Fig 15-16). At earlier stage when CT and radiography are normal PET/CT can be positive both in femoral head and extraarticular due to synovitis. This is commonly an incidental or already known finding in patients with lymphoma. Distinguishing from dissemination of lymphoma is easy when CT is positive for avascular necrosis or there is an involvement of paraarticular soft tissue. Clinical correlation with referring physician is necessary to plan therapeutic process.

FDG uptake can be detected in the place of intramuscular application of medicament, which has led to inflammation (Fig. 17). Diagnosis is based on localization and typical appearance on CT.

In osteoporotic patients even without history of trauma or in minor trauma fractures can be detected (Fig 18-19). Differentiation between simple fractures and malignant ones could be difficult and overlap between malignant and benign FDG uptake is known (5). In cases of follow up PET/CT bone metabolism of simple fracture return to normal within 3 months.
Images for this section:
Fig. 1: Fig. 1 A 50 year-old woman after left mastectomy. PET/CT on sagittal plane detects bone metastases in vertebral bodies and spinous processes as well as in a sternum.
**Fig. 2:** Fig. 2 Same patient as on Figure 1. Sagittal CT image demonstrates sclerotic, mixed (sternum) and CT negative metastases (sacrum).

**Fig. 3:** Fig. 3 Axial PET/CT of 76 year-old women after left mastectomy with known bone metastases. Restaging. Bilateral FDG uptake of both iliac bones
**Fig. 4:** Fig. 4 Corresponding axial CT image shows osteolytic lesion involves right iliac bone with no detectable lesion of left iliac bone.
**Fig. 5:** Fig. 5 PET image of 10 year-old boy with Hodgkin lymphoma. Maximum Intensity Projection (MIP), coronal plane. Physiologically increase uptake at the borders bone-cartilage of the ribs bilaterally, iliac bones, vertebra and growth plates.

![PET image of a boy with Hodgkin lymphoma](image)

**Fig. 6:** Fig. 6 Same patient - coronal PET/CT demonstrates uptake in pelvic bones and both proximal femoral bones.
Fig. 7: Fig. 7 Same patient - coronal CT presents typical appearance for patient's age.
**Fig. 8:** Fig. 8 Sagittal PET/CT of 61 year-old women with Hodgkin lymphoma after chemotherapy. Notice diffuse homogeneous FDG uptake in bone marrow which reflects hyperplastic bone marrow.

**Fig. 9:** Fig. 9 PET/CT of 43 year-old woman with uterine cervical carcinoma. Image shows bilateral contractions of sternocleidomastoid muscles.
**Fig. 10:** A 49-year-old woman with breast cancer. Sagittal PET/CT image detects FDG uptake at level L2-L3 suggesting degenerative disc disease.
Fig. 11: Fig. 11 Corresponding CT image clearly shows findings typical for degenerative disc disease. CT image helps to differentiate from metastases and infectious spondylodiscitis.
**Fig. 12:** Fig. 12 PET/CT demonstrates increased FDG uptake close to trochanter region bilaterally which relates to tendinopathy.
**Fig. 13:** A 65 year-old woman with right breast cancer. PET/CT shows increased FDG uptake in both acromioclavicular joints with narrowing of joint space.
**Fig. 14:** Corresponding CT image of the left acromioclavicular joint demonstrates narrowing of joint space and sclerosis consistent with degenerative joint disease.
Fig. 15: Fig. 15 CT of the 47 year-old male patient with Hodgkin lymphoma. There are bilateral changes of the both femoral heads, more prominent on the left, consistent with aseptic necrosis.
Fig. 16: Fig. 16 Same patient as on Figure 15. PET/CT shows bilateral FDG uptake.
**Fig. 17:** Fig. 17 A 60 year-old woman with uterine cervical carcinoma. On PET/CT increased focal FDG uptake in left gluteal region represents abscess formation due to intramuscular application of remedy.
**Fig. 18:** Fig. 18 PET/CT of 55 year-old woman with lung cancer reveals focal hypermetabolism of 7th left rib.
**Fig. 19:** Fig.19 Reconstructed volume rendering (VR) CT image. White arrow indicates site of healing fracture. Non fused CT image helps to distinguish from metastasis.
Conclusion

Radiologist and nuclear medicine specialist should be familiar with malignant and non-malignant FDG uptakes in the bones and muscles. Benign hypermetabolic changes have to be differentiated from bone metastases which is essential in cancer staging.

Personal information

Dora Zlatareva, M.D., Ph.D.

Department of Diagnostic Imaging

Medical University, UMBAL Aleksandrovska, Sofia

1, Georgi Sofiiski Blvd

1431 Sofia, Bulgaria

E-mail: dorazlat@yahoo.com

References


