PET/CT in infectious and inflammatory pathology

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Abstract

**PET/CT in infectious and inflammatory pathology.**

**Objective.** To demonstrate the utility of PET/CT in infectious and inflammatory diseases.

**Materials and Methods.** We evaluated retrospectively five patients with infectious and inflammatory pathology, by PET/CT scan (hybrid SIEMENS-BIOGRAPH 16, Siemens, Erlangen, Germany) in the period between January 2009 and May 2011.

**Results.** Case 1: a 68-year-old woman presented with a 6-months duration fever, fatigue, and weight loss. The rheumatologic examination showed a decrease in both radial pulses with no other associated symptoms. She underwent a temporal artery biopsy, which confirmed temporal arteritis. A PET/CT scan showed significant uptake in the thoracic aorta and major branches.

Case 2: An 85-year-old patient with fever of unknown origin (FUO) was studied suspecting osteomyelitis of the hip, but on the contrary, PET/CT demonstrated an avid enhancement indicative of gluteal cellulitis and pneumonia, ruling out bone infection.

Case 3: a 35-year-old woman with evening fever. PET/CT scan showed enlarged multiple FDG-avid mediastinal, axillary and retroperitoneal lymph nodes, as well as diffuse involvement of the spleen with multiple calcifications. Diagnosis of cytomegalovirus infection was confirmed by positive immunoglobulin G and M.

Case 4: a 39-year-old patient with HIV-infection presented with hypercalcemia. PET/CT scan showed buttocks silicone implants with associated avid inflammatory process, confirmed by biopsy.

Case 5: a 45-year-old female with previous history of breast cancer under follow-up presented in recent CT scans enlarged mediastinal and supraclavicular lymph nodes, as well as diffuse multifocal splenic involvement, all of them avid on PET / CT examination. Sarcoidosis was confirmed by a supraclavicular node excision biopsy.

**Conclusions.** PET/CT is a noninvasive diagnostic tool useful for the diagnosis and follow-up of patients with FUO. Especially in patients with vasculitis, it may change decisions without needing a diagnostic biopsy, as it is considered the gold standard procedure for diagnosing these entities. It is also a useful technique for follow-up and treatment monitoring in patients with sarcoidosis.

**Keywords.** Infection. Inflammation. PET/TC.
OBJECTIVE

To demonstrate the usefulness of PET/CT scan in infectious and inflammatory diseases.

MATERIALS AND METHODS

We retrospectively evaluated PET/CT scans performed at our institution (January 2009- May 2011) with SIEMENS-BIOGRAPH 16 hybrid equipment (Siemens, Erlangen, Germany). Five patients were selected: 3 with fever of unknown origin (FUO), 1 with HIV-infection and hypercalcemia and 1 with non-recent history of breast cancer and tomographic findings of probable sarcoidosis infection.

RESULTS

Case 1

Sixty-eight year-old patient with a 6-month history of fever, fatigue and weight loss. Screening for infectious diseases or malignancies was negative. Laboratory tests showed an erythrocyte sedimentation rate (ESR) value of 100 mm/1h. The rheumatologic examination showed a decrease in radial pulses with no other associated symptoms. Because of these findings and clinical suspicion, the patient underwent a temporal artery biopsy, which confirmed temporal arteritis. A PET/CT scan showed significant mural hypermetabolic activity of the thoracic aorta and major branches (Fig. 1).

Fig. 1: FUO: giant cells arteritis. (a) and (d) axial and coronal contrast-enhanced multislice CT showing diffuse thickening of ascending and descending aorta walls. (b) and (e) 3D PET/CT Fusion with enhanced metabolic activity in the walls of both arteries. (c) and (d) axial and coronal PET with max. SUV measurement in the area of highest activity (left posterolateral area of the ascending aorta) of 2.90.
Case 2

Eighty-five year-old patient with FUO, with prolonged hospitalization at an intensive care unit as a result of a stroke. Fever led to suspect osteomyelitis of the hip, and therefore a PET/CT scan was ordered. The scan demonstrated an avid enhancement indicative of gluteal cellulitis and lung disease, ruling out bone infection (Fig. 2).

Case 3

Thirty-five year-old patient who presented with evening fever. The patient had a history of mixed connective tissue disease. On physical examination, enlarged axillary lymph nodes were found. PET/CT scan showed multiple fluorodeoxyglucose (FDG)-avid mediastinal, axillary and retroperitoneal enlarged lymph nodes, as well as diffuse involvement of the spleen associated with multiple calcifications. Diagnosis of cytomegalovirus infection was confirmed by positive immunoglobulin G and M (Fig. 3).

Case 4

Thirty-nine year-old patient with a history of HIV infection, who presented with hypercalcemia. PET/CT scan showed buttocks silicone implants with associated avid inflammatory process, confirmed by biopsy (Fig. 4).

Case 5

Forty-five year-old patient with a history of breast cancer 4 years ago (currently under follow-up). The most recent CT scans showed enlarged mediastinal and supraclavicular lymph nodes, as well as diffuse multifocal splenic involvement. A PET/CT scan showed FDG-avid lesions, with no other pathological images associated with the patient’s history of malignancy. Because of the clinical suspicion and tomographic findings, specific markers of sarcoidosis were measured, and diagnosis was confirmed by pathology of a supraclavicular node; therefore treatment was instituted (Fig. 5).

Fig. 2: Cellulitis and pneumonia. FUO. (a) and (b) Axial Multislice CT and PET/CT Fusion showing hypermetabolic focal area on the cellular tissue of the left gluteal region. (c), (d), (e) and (f) Sagittal and axial Multislice CT and 3D PET/CT Fusion: acute lung disease of the right lower lobe associated with pleural effusion. (g) and (h) Axial PET/CT Fusion showing no uptake in the hip, ruling out osteomyelitis.
DISCUSSION

The role of PET/CT in the diagnosis, staging and monitoring of neoplastic conditions is well established. The clinical utility of PET/CT has now expanded to the diagnosis of autoimmune, inflammatory, infectious, as well as non-neoplastic conditions, such as vasculitis, atherosclerosis, and granulomatous conditions (including sarcoidosis and inflammatory bowel disease), in addition to a variety of neurologic disorders.

The availability of new PET radiotracers is expected to expand PET/CT applications to a variety of other clinical domains (1).

There is a growing trend for the use of noninvasive diagnostic tests and efficient therapies for infectious processes. Nuclear medicine procedures are important tools for the evaluation of patients with suspected infection and are useful to confirm such infections. Their strength relies on the fact that they are noninvasive procedures that provide both functional as well as metabolic information early in the course of disease. Their limitations relate to the need for specific radiotracers and the low resolution of images. However, these limitations have been overcome by PET/CT and SPECT/CT.

PET/CT, using FDG, is redefining the diagnostic work up and is currently leading to changes in the management of patients with suspected or known infections (1).

Combined PET/CT enables both diagnosis of infection and determination of its precise localization, facilitating the diagnosis and guiding the appropriate treatment strategy (2).

Accumulation of FDG in activated macrophages and granulocytes makes PET/CT a valuable tool for patients with inflammatory disease. Localization of inflammatory foci in the appropriate soft-tissue or bone structures and the additional anatomical information provided by CT are of great interest. Thus, this test would be indicated for suspected chronic osteomyelitis or for soft-tissue infections, disease entities involving inflammation such as FUO or, in the case of vasculitis, it would demonstrate the infectious foci or sterile inflammatory process.

Unlike Magnetic Resonance Imaging (MRI) and MDCT, in vasculitis, especially in large-cell vasculitis, an extensive avid enhancement can be observed in the wall of the thoracic and abdominal aorta and its major branches.

Vasculitis is an inflammatory process involving

![Fig.3: Evening fever and enlarged axillary lymph nodes: CMV. (a) Coronal PET 3D map. (b) and (c) Coronal PET-CT Fusion and Multislice CT. (d), (e), (f) Axial PET-CT Fusion. (g) and (h) Axial PET-CT Fusion and Multislice CT. Multiple FDG-avid mediastinal, axillary and retroperitoneal lymph nodes. Additional lymph node locations are seen near the splenic hilum associated with a diffuse enhancement of metabolic activity and multiple splenic micronodular calcifications.](image-url)
Fig. 4: Hypercalcemia, silicone implants associated with inflammatory process. (a), (b), (c), (d) Sagittal and axial Multislice CT and PET-CT Fusion. (e) Axial PET. (f) and (g) Coronal PET 3D map: multiple solid and hypermetabolic processes on the subcutaneous cellular tissue of the lower gluteal region, predominantly on the left (arrows), with maximum SUV of 3, as an expression of an inflammatory process proven by biopsy in one of them. A significant enhancement of metabolic activity is incidentally observed in the gluteal muscle groups and in the muscles of both thighs, related to previous history of extreme physical activity. No uptake in all other muscle groups.

Fig. 5: Mediastinal lymph node enlargement: sarcoidosis. (a) and (b) color coronal PET/CT and PET 3D maps showing hypermetabolic, multiple and splenic mediastinal lymph node involvement. (d) and (d) coronal and axial contrast-enhanced multislice CT. splenic micronodular involvement. (e), (f) and (g) Axial PET-CT Fusion images shows mediastinum and upper abdomen, where avid lymph node locations are evident in different groups of the mediastinum, with diffuse hypermetabolic involvement of the spleen.
blood vessels, with lymphocytic infiltration to the vessel wall and reactive damage of adjacent structures. FDG-PET/CT may demonstrate the inflammation of vessels when their diameter is larger than 4 mm.

Increased FDG uptake in large thoracic vessels has been shown to be a highly specific sign of vasculitis, showing all vessels involved in a single examination.

Furthermore, PET/CT can be reliably used to monitor treatment response (sensitivity of 77-92%, and specificity of 89-100%), as FDG uptake correlates with markers of disease activity, and at the same time it permits to assess the extent of involvement of all body vessels.

Vascular FDG uptake was seen not only in 84% of patients with biopsy-proven giant-cell vasculitis (especially in the subclavian arteries), but also in the thoracic aorta, abdominal aorta and femoral arteries.

In untreated patients with atypical presentations of giant-cell arteritis (such as weight loss, fever, malaise or limb claudication), in which the arterial inflammation probably does not involve the temporal artery, FDG-PET is the diagnostic technique of choice.

FUO is defined as documented temperatures of more than 38.3 degrees C for longer than 3 weeks, and with failure to reach diagnosis despite one week of inpatient investigations.

FDG accumulates in infections, malignancies and inflammatory diseases (the three main causes of FUO).

This technique is extremely valuable, as it is a non-invasive method of depicting the whole body, enabling us to diagnose the cause of FUO. PET/CT is of additional value in critically ill patients because it can rule out an infection requiring prolonged antibiotic therapy or drainage.

In patients with HIV and FUO, PET/CT is a very valuable tool, especially when CT anatomical data are added to FDG-PET findings. This technique is destined to become the procedure of choice, especially when a definite diagnosis cannot be achieved by other methods.

Sarcoidosis is a chronic multisystem disorder of unknown etiology, which is characterized by the accumulation of T lymphocytes, mononuclear phagocytes, and noncaseating epitheloid granulomas in affected organs (frequently the lung). This condition typically affects young adults, with a higher prevalence in blacks and in women.

This disease shows a wide range of imaging features and can be diagnosed by a variety of techniques (including standard radiography, MDCT, 67Ga scans and PET/CT).

FDG uptake in sarcoidosis is nonspecific and can mimic other disease processes, including lymphoma and metastatic disease. When combined with imaging features on other techniques, such as MDCT, FDG uptake can be useful in monitoring therapeutic response.

CONCLUSION

PET/CT is a noninvasive diagnostic tool for the diagnosis and follow-up of patients with FUO. In the case of vasculitis, it is considered the gold standard procedure because of its diagnostic capacity, as it may change patient management with no need for biopsy. In addition, it is useful for monitoring the response to treatment and evaluating the extent of disease in patients with sarcoidosis.

References

The authors declare no conflicts of interest.