

7c

PET in pediatric solid tumors

C. Franzius (Munster)

This presentation reviews the applications of positron emission tomography using ^{18}F -Fluoro-deoxy-glucose (FDG PET) and the combination of PET and computed tomography (PET-CT) in the evaluation of solid tumors in children and adolescents.

Tumor entities

Thirty-eight per cent of all pediatric malignancies are leukemias, followed by brain tumors (15 %), lymphomas (12 %), neuroblastomas (8 %), soft-tissue sarcomas (8 %), osseous sarcomas (6 %), and others (13 %). The focus of this presentation will be on osteosarcomas, Ewing tumors, soft-tissue tumors, and neuroblastomas.

Musculoskeletal tumors: osteosarcomas, Ewing tumors, and rhabdomyosarcomas

Staging

Good results are documented for the staging of Ewing tumors (1). However, in the detection of pulmonary metastases CT is superior to FDG PET in this tumor entity as well as in other musculoskeletal tumors. In rhabdomyosarcoma, preliminary experiences using FDG PET for staging are very promising.

Prognosis

Several studies have shown that initial FDG-uptake of primary sarcomas is a prognostic parameter. In a retrospective study including 209 patients, multivariate analyses showed that the maximum SUV information is a statistically significant independent predictor of patient survival (2).

Therapy control

In primary osseous sarcoma, response to neoadjuvant chemotherapy can be evaluated using FDG PET. In addition, FDG PET seems to be superior to skeletal scintigraphy in this clinical setting. In a recent study, posttherapeutic SUV correlated with histopathologic assessment of response and potentially could be used as a noninvasive surrogate to predict response in patients (3).

In all studies, the standard of reference was the histologically assessed grade of tumor necrosis after resection of the primary tumor. Up to now, there are no data concerning the early assessment of therapy response, for instance after one or two cycles of chemotherapy.

Diagnosis of recurrences

The detection of a local relapse is frequently hampered by post-therapeutic changes after surgery, chemotherapy, and/or radiotherapy. Furthermore, prosthesis material may affect image quality using CT or MRI. In several studies it has been proven that FDG PET has both, a high sensitivity and specificity in the detection of local recurrences of bone and soft-tissue sarcomas. Furthermore, FDG PET can visualize distant recurrences within the same examination.

Neuroblastomas

There are only limited literature data concerning PET in neuroblastoma. In a first published study in high-risk neuroblastoma patients, FDG PET was equivalent or superior to I-123-mIBG scintigraphy in the detection of tumor manifestations. Promising are specific PET tracer for tumors of the sympathetic nervous system such as the C-11 labeled noradrenaline analog meta-hydroxyephedrine (C-11-HED) and the F-18 labeled L-(3,4-dihydroxyphenyl)-alanine ([F-18]F-DOPA).

PET-CT

In the last years, the combination scanners PET-CT have been introduced in the clinical routine. Up to now, there are no studies evaluating the diagnostic improvement of the combined PET-CT in comparison to separately acquired PET and CT in solid tumors in childhood. In a first publication of experience with

PET-CT in childhood sarcomas, PET-CT has been found to be helpful in the detection of unsuspected and unusual metastatic sites of several of pediatric sarcomas (4).

Comparison of whole-body FDG-PET with whole-body MR Imaging

In a study from our own department 39 children and adolescents with various malignomas were examined using FDG-PET, skeletal scintigraphy, and whole body MR imaging for the detection of bone metastases. Sensitivities were 90 % using FDG-PET, 82 % using MR imaging, and 71 % using skeletal scintigraphy on a lesion-based analysis. However, most false positive lesions were diagnosed by FDG-PET. Additionally, 77 % of all extraosseous metastases were true positive with FDG-PET compared with 25 % using whole body MR imaging (5).

Conclusion

The limited data demonstrate that prospective multicenter studies analysing the benefit of FDG PET and PET-CT in paediatric solid tumors are necessary.

References

1. Franzius C, Sciuk J, Daldrup-Link HE, Jürgens H, Schober O. FDG-PET for detection of osseous metastases from malignant primary bone tumors: comparison with bone scintigraphy. *Eur J Nucl Med Mol Imaging* 2000; 27:1305-1311.
2. Eary JF, O'Sullivan F, Powitan Y, et al. Sarcoma tumor FDG uptake measurement by PET and patient outcome: a retrospective analysis. *Eur J Nucl Med Mol Imaging* 2002; 29:1149-1154.
3. Hawkins DS, Rajendran JG, Conrad EU, Bruckner JD, Eary JF. Evaluation of chemotherapy response in pediatric bone sarcomas by [F-18]-Fluorodeoxy-D-glucose positron emission tomography. *Cancer* 2002; 94:3277-3284.
4. McCarville MB, Christie R, Daw NC, Spunt SL, Kaste SC. PET/CT in the evaluation of childhood sarcoma. *Am J Roentgenol* 2005; 184:1293-1304.
5. Daldrup-Link HE, Franzius C, Rummeney EJ, Laukamp D, Sciuk J, Jürgens H, Link TM. Whole body MRI for detection of bone marrow metastases in pediatric patients: comparison with skeletal scintigraphy and FDG-PET. *Am J Roentgenol* 2001; 177: 229-236.