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Original article

PET/CT management in a pediatric oncology center

Prise en charge onco-pédiatrique en TEP/TDM : expérience d'un centre référent en oncologie

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Abstract

Background. – There are increasing indications for PET imaging in pediatric oncology. However, few PET units have reported imaging experience in children, probably due to supposed constraints of organizational procedures and need of sedation practice.
Objective. – To share our experience in the management of ^{18}F-FDG PET/CT imaging in children, as a cancer research center, for which PET/CT can be performed without sedation and with no substantial external radiation hazard for both technologist and the accompanying person.
Materials and methods. – Two hundred and twelve consecutive PET/CT scans performed in 118 children, median age 10.7 years (range 2–18). All PET were carried out without sedation or drug preparation. Parents were allowed to stay with their child wearing an external operational dosimeter. Delivered dose to parent and technologist was registered at the end of procedure.
Results. – PET/CT indications were assessment of lymphoma ($n = 121$), bone ($n = 30$) and soft tissue sarcomas ($n = 19$), neurofibromatosis with suspected malignancy ($n = 8$), head and neck cancer ($n = 8$), gliomas ($n = 8$) and miscellaneous ($n = 18$). Parent's median effective delivered dose was 12.5 µSv (range: 4–50): 18 µSv when child under 5 years, 11 µSv between 6–12 years and 10 µSv when older than 12. Technologist median radiation exposure was 1.23 µSv per patient.
Conclusion. – PET/CT imaging in pediatric oncology is a feasible and non-invasive procedure, and can be performed routinely even in the young children. Sedation could be avoided in most cases, with skilled and trained technologists, implication of both parents and children and reassuring environment. The effective dose delivered to the technologist the accompanying parent is low, with regard to the diagnostic and prognostic PET/CT benefit in children's medical care.

Keywords: PET/CT; FDG; Pediatric oncology; Imaging procedure; Non-invasive; Radiation exposure

Résumé

Contexte. – Devant une évolutivité croissante des indications de TEP/TDM en onco-pédiatrie, peu de centres ont rapporté leurs expériences dans la prise en charge des enfants, notamment en raison des contraintes organisationnelles et de la nécessité de sédations supposées.
Objectif. – Partager notre expérience dans la prise en charge onco-pédiatrique des examens de TEP/TDM, en tant que centre référent en oncologie, examens pouvant être réalisés sans sédation et sans risque de radioprotection pour le personnel soignant et les accompagnants.
Matériels et méthodes. – Deux cents douze examens TEP/TDM consécutifs ont été réalisés chez 118 enfants, âge médian 10,7 ans (2–18), sans sédation ou préparation médicamenteuse. Les parents, autorisés à rester avec leur enfant, ont porté un dosimètre opérationnel. Les doses délivrées aux parents et aux manipulateurs ont été enregistrées à la fin de chaque procédure.
Résultats. – Les indications TEP/TDM sont le bilan de lymphomes ($n = 121$), sarcomes osseux ($n = 30$) et des tissus mous ($n = 19$), neurofibromatoses avec suspicion de malignité ($n = 8$), cancers ORL ($n = 8$), gliomes ($n = 8$) et autres ($n = 18$). La dose délivrée effective médiane au parent était 12,5 µSv (4–50) : 18 µSv si enfant < 5 ans, 11 µSv entre 6–12 ans et 10 µSv si > 12 ans. La dose délivrée effective médiane au manipulateur était de 1,23 µSv par patient.

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Conclusion. – L'imagerie TEP/TDM en onco-pédiatrie est une procédure faisable et non invasive, pouvant être réalisée en routine, y compris pour de jeunes enfants. Une équipe entraînée et rassurante, l'implication des parents et des enfants, ainsi qu'un environnement rassurant permet d'éviter la sédation. La dose effective reçue par les manipulateurs et les parents accompagnants est faible, au regard du bénéfice diagnostique et de prise en charge pour l'enfant.

Mots clés : TEP/TDM ; FDG ; Onco-pédiatrie ; Procédure ; Non invasif ; Dosimétrie

1. Introduction

^{18}F-FDG PET/CT imaging has shown interesting development and additional value in the management of children in oncology, particularly in lymphoma and solid tumors [1–16]. A wide overview of the most frequent indications for PET/CT is detailed in the European Guidelines of Nuclear Medicine in pediatric oncology imaging [17] and in the British Guidelines [18].

However, despite this wide indication range, few PET units have reported imaging experience in children, probably due to the supposed constraints of organizational procedures and sedation requirement.

Nevertheless, PET/CT imaging can be managed in pediatrics as a routine procedure, especially in young children. With a considerable practice in pediatric nuclear medicine, we took advantage of our experience in pediatric scintigraphy acquisition in very young children addressed for ^{123}I-MIBG scintigraphy [19], to set up our PET/CT acquisition protocols, leading to both safe and sedation-free procedures.

The aim of this study was to share our experience in the management of ^{18}F-FDG PET/CT imaging in children, as a cancer research center, for which PET/CT can be performed without sedation and with no substantial external radiation hazard for both technologist and the accompanying person.

2. Materials and methods

2.1. Population

The pediatric oncology and teenager/young adult department of our institution provides medical care for nearly 220 new patients a year, for the treatment of solid cancers, excluding leukemia, from birth all through adolescence and young adulthood.

We reviewed all consecutives ^{18}F-FDG PET/CT scans, performed in children under 18 years in the nuclear medicine department of our institution, between 2012 and 2014 over a total 30 months period.

Children were classified in three age-related categories: group I for children aged 2–5 years, group II for children aged 6–12 years, and group III for children aged 13–18 years.

2.2. PET/CT procedures

The following items will describe the different steps in our PET/CT management, especially in young children, leading to sedation-free and safe procedures.

Reassuring and secure environment is crucial from the beginning of the examination, involving both children and parents, to become active actors during the whole diagnostic procedure.

2.2.1. PET/CT scan appointment

All PET/CT scans indications had been discussed and approved by multidisciplinary medical board session discussions. Both oral and written explanations and recommendations were given to the parents and to the care team regarding the procedure and child preparation at the time of PET/CT imaging setting. Radioprotection instructions were given at time of appointment as well as on imaging day.

2.2.2. Preparation and FDG administration

The child should fast for at least 4 to 6 hours prior to ^{18}F-FDG administration. Only water drinking was allowed and recommended. The child was installed in a warm and quiet room for the FDG administration and the 60 minutes uptake phase to comply before the PET/CT acquisition. Peripheral vein access was preferred when possible, and central venous systems reserved in situations where no peripheral access could be obtained. In-patients were preferred to arrive with an intravenous (i.v.) access already in place. For out-patients children without i.v access, one or two local anesthetic cream patches were installed at least 60 minutes before injection, in order to reduce pain and discomfort, and gain the child's cooperation.

Administered ^{18}F-FDG activities were based and calculated according to the EANM Pediatric Guidelines 2008 recommendations [17] using a 3D mode, adjusted to patient's weight and based on PET/CT device performances (4 MBq/kg), with a minimum activity of 14 MBq.

Parents or accompanying persons were allowed to stay with their child during FDG administration and resting period; after the possibility of pregnancy in the accompanying women had been ruled out. An external operational dosimeter was given to the accompanying person and placed at their chest level for delivered dose measurement, collected and registered at the end of the PET/CT acquisition.

Technologist radiation exposure was measured and analyzed.

2.2.3. Radiation exposure protection

To reduce radiation, we used a lead shield from Medisystem® with 30 mm lead- and 70 mm glass-thickness. Those shields have an adjustable height, placed on wheels and can be easy moved by any technologist. The equivalent