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ORIGINAL ARTICLE

Comparison Between Whole-Body MRI and PET/CT in Pediatric Oncology

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Summary
Introduction. Positron emission tomography/computer tomography (PET/CT) is one of the main imaging tests for solid tumor and metastases diagnostic nowadays. However, PET/CT scanning is related to the risk of ionizing radiation exposure, which is especially harmful for children health. Whole-body MRI (WB-MRI) allows exact evaluation of malignant tumor without the radiation exposure.
Aim of the Study. To compare and evaluate informativity of WB-MRI and PET/CT imaging methods for detection of metastases in children with malignant disease, being treated at Children's Clinical University Hospital, Riga, Latvia. The gained data were also compared to the world data published before.
Material and methods. This retrospective study included all patients in whom both PET/CT and WB-MRI imaging examinations were performed between July 2016 and February 2017 in Latvia. Inclusion criteria were: age under 18 years, histological confirmation of a malignant disease. The study included 10 patients (7 males, 3 females, mean age 11 years 7 months). Two patients underwent both examinations 3 times, resulting in a total of 14 cases.
Results. There were identified three types of tumor: Hodgkin lymphoma (n = 12), non-Hodgkin lymphoma (n = 1), rhabdomyosarcoma (n = 1).
PET/CT mean radiation exposure was 263,2 [95% CI: 202.27 - 324.12] mGy.cm, mean radiotracer dosage was 143,5 [95% CI: 114. - 172.52] MBq.
There were identified 34 lesions: 24 (70%) lymph nodes, 5 (15%) bone lesions, 5 (15%) soft tissue lesions. 21 malignant lesions were detected by PET/CT. 27 lesions were found by WB-MRI. Out of 34 lesions, eighteen were identified by both imaging methods. Both examinations found absence of residual disease in 2 cases.
Eleven lesions were detected by WB-MRI (7 lymph nodes, 1 bone lesion and 3 soft tissue lesions) that were not identified by PET/CT. 5 lesions could not be identified by WB-MRI (2 lymph nodes, 1 bone lesion and 2 soft tissue lesions) that were detected by PET/CT imaging method.
Conclusions. WB-MRI examination should be used before and in addition to PET/CT imagining in children with oncological disease. PET/CT examination results interpretation should be done based on WB-MRI imaging results. WB-MRI could not completely replace PET/CT imaging.
Key words: PET/CT, pediatric oncology.

INTRODUCTION

Approximately 15 700 children are diagnosed with cancer each year. Because of modern treatment and major diagnostic opportunities, more than 80% (90%) of children with the malignant disease survive now more than 5 years. (7, 8)
Exact disease staging, lymph node involvement in pathologic process and distant metastases identification is very important in oncology, since it influences therapy management and prognosis. (10, 14) Positron emission tomography/computer tomography (PET/CT) is one of the main imaging tests for solid tumor and metastases diagnostic nowadays. However, PET/CT scanning is related to the risk of ionizing radiation exposure, which is especially harmful for children health and could lead to development of secondary malignancy. (10, 11) Whole-body MRI (WB-MRI) allows exact evaluation of malignant tumor without the radiation exposure. (3) Some recent studies reported WB-MRI to have equal specificity, and sensitivity compared with PET/CT. (2, 3, 9, 11, 12, 13, 15)

MATERIAL AND METHODS

This retrospective study conducted at Children's Clinical University Hospital and nuclear medicine center "Medvision" Riga, Latvia. All PET/CT examinations were analyzed in children being treated at Children's Clinical University Hospital, Riga, Latvia between July 2016 and February 2017.
Inclusion criteria were: age under 18 years, histological confirmation of a malignant disease (lymphoma or solid tumor), availability of both PET/CT and WB-MRI imaging examinations.
Exclusion criteria were: age above 18 years, examination contraindications (neurostimolator, cardiac pacemaker).
Information about patient age, sex, diagnosis, previous treatment, reasons for examination, ionizing radiation doses, radionuclide dose, interval between both diagnostic tests and both examination descriptions were collected for further data analysis.
Using Microsoft Excel performed statistical analysis and SPSS 22.0 software.

The study included 10 patients (7 males, 3 females, mean age 11 years 7 months). Two patients underwent both examinations 3 times, resulting in a total of 14 cases.

RESULTS

Three histological tumor types were identified: Hodgkin lymphoma (n = 12), non-Hodgkin lymphoma (n = 1), rhabdomyosarcoma (n = 1).

Indications for PET/CT examination were assessment of response to therapy (n = 12), staging (n = 1) and relapse exclusion (n = 1).

Thirteen PET/CT scans were performed after the therapeutic management: 7 - post-chemotherapy, 5 - post-chemotherapy and radiotherapy, 1 after surgical intervention. One PET/CT scan was done prior treatment.

PET/CT mean radiation exposure was 263,2 [95% CI: 202.27 - 324.12] mGy.cm, mean radiotracer dosage was 143,5 [95% CI: 114. - 172.52] MBq.

PET/CT and WB-MRI examinations results:

Thirty four pathological lesions were identified: 24 (70%) lymph nodes, 5 (15%) bone lesions, and 5 (15%) soft tissue lesions. Out of 34 lesions, 18 were identified by both imaging methods. Both examinations found absence of residual disease in 2 cases.

PET/CT examination results:

21 malignant lesions (18 lymph nodes, 2 bone lesion and 1 soft tissue lesion) were detected by PET/CT. 5 of them (2 lymph nodes, 1 bone lesion and 2 soft tissue lesions) could not be visualized by WB-MRI (Fig. 1.a, 1.b).

WB-MRI examination results:

27 lesions (22 lymph nodes, 2 bone lesion and 3 soft tissue lesions) were found by WB-MRI. 11 lesions (7 lymph nodes, 1 bone lesion and 3 soft tissue lesions) that were detected by WB-MRI, were not identified by PET/CT (Fig. 2.a, 2.b; 3.a, 3.b).

Comparison between WB-MRI and PET/CT

According to our findings, PET/CT sensitivity is 59%, specificity – 29%. WB-MRI sensitivity is 76%, but specificity only 15%. Fact, that diagnosis of malignant process was based only on radiological examination results should be taken in account. It was not correlated with histological conformation, because it was not able to do biopsy for all this lesions.

Dynamic follow up with both imaging methods were done in 2 cases with interval 2 months. In these 2 cases positive dynamic was diagnosed with both imaging methods.

DISCUSSION

Results of our study are not similar to the findings that are described in the international literature. (1, 3, 4, 5, 10, 16).

There are only some similar researches that compare PET/CT and WB-MRI examinations in pediatric population. S. Krohmer et al. compared PET/CT and WB-MRI with other conventional imaging methods in 24 patients with Hodgkin lymphoma and sarcoma. He concluded that WB-MRI sensitivity is around 96%. (11)

C. Klenk et al. in his research find out that WB-MRI specificity and sensitivity (90.8% / 93.7%) is equal to PET/CT imaging (99.5% / 97.7%). (10)

Antoch et al. concluded that tumor histological type could influence on both examination results. (1)

In our study are several disadvantages:

1) Small amount of patients were analyzed. PET/CT examination is available in Latvia only from February 2016 and thirst examination in children was done only in June 2016.

2) Radiological examination interpretation. In the international similar researches examination results were interpretated by two radiologists. In Latvia examination results are interpretated by one radiologist.

3) In some cases, WB-MRI has been done not for whole body, but only for one particular part of the body. PET/CT examination has been done to whole body

4) As it was mentioned before, it was impossible to biopsy for all diagnosed pathological lesions. Diagnosis was based only on radiological examination results. Ciliberto M. Et al. describe this problem in his research. He analyzed 44 publications and concluded that reference standard selection is big problem in all researches and it could influence the results. (6)

CONCLUSION

WB-MRI examination should be used before and in addition to PET/CT imagining in children with oncological disease. PET/CT examination results interpretation should be done based on WB-MRI imaging results. WB-MRI could not completely replace PET/CT imaging.

CASE I (male, 10 yrs old, diagnosis - Hodgkin lymphoma)

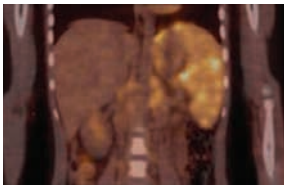

Fig. 1.a. PET/CT scan. Pathological hypermetabolic lesions are visible in spleen tissue

Fig. 1. b. DWIBS with MIP 3D reconstruction. Specific spleen infiltration is not visible

CASE II (male, 9 yrs diagnosis - Hodgkin lymphoma)

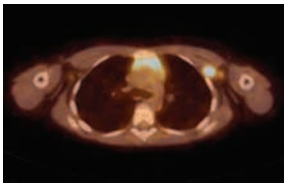

Fig. 2. a. PET/CT shows pathological metabolic activity only in left axillary lymph node

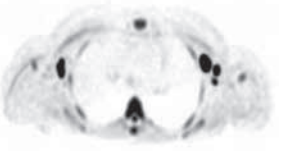

Fig. 2. b. MR DWBIS axial image shows enlarged axillary lymph nodes on both sides of the body. (dxt<sin.)

CASE III (male, 8 yrs, diagnosis – non - Hodgkin lymphoma)

Fig. 3. a. PET image shows hypermetabolic lesion in both femur distal diaphysis and left tibia proksimal metaphysis

Fig. 3. b. DWIBS with MIP 3D reconstruction image shows increased signal intensity in both femur distal diaphysis (dxt.>sin.) that was not valued as pathological. and both tibia proximal metaphysis (dxt.<sin.). Right tibia lesion that is seen in DWIBS image that was valued as pathological is not visible in the PET scan

Conflict of interest: None

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