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A.D. Ryzhkov[1], A.S. Krylov[1], G.N. Machak[2], S.M. Kaspshik[1], A.B. Bludov[1], Y.A. Shchipakhina[1], N.V. Kochergina[1]

MONITORING THE THERAPY OF OSTEOSARCOMA METASTASES WITH SPECT/CT

1. N.N. Blokhin National Medical Research Center, Moscow, Russia. E-mail: krilovas@rambler.ru;
2. Central Research Institute of Traumatology and Orthopaedicsof N.N. Priorov, Moscow, Russia

A.D. Ryzhkov – Leading Researcher, Dr. Sci. Med.; A.S. Krylov – Radiologist, PhD Med.;
G.N. Machak – Dr. Sci. Med., Member of EMSOS; S.M. Kaspshik – Clinical Intern; A.B. Bludov – Researcher, PhD Med;
Y.A. Shchipakhina – Researcher, PhD Med.; N.V. Kochergina – Leading Researcher, Dr. Sci. Med., Prof.

Реферат

A 43-year-old man presented with a history of osteogenic sarcoma of lower third of the right femur bone. In dynamic monitoring (2011–2018) in the Nuclear Medicine Department of N.N. Blokhin National Medical Research Centre of oncology, Moscow, Russia a total of 48 radionuclide diagnostic studies were performed: 24 bone scans, 19 SPECT/CT (areas of interest) and 5 dynamic scintigraphies. The results of radionuclide diagnostics allowed to identify 6 episodes of progression of the underlying condition earlier than X-ray methods of imaging in the form of appearance of new metastases in bones, right lung and continued growth of some previously identified metastases in different periods of observation. Time between relapse detection and treatment ranged from 1 to 12 months. First of all it was because of the clinicians distrust to the results of radionuclide studies that were not confirmed by X-Ray at early stages. During the relapse treatment process patient received standard and innovative therapies: 10 courses of polychemotherapy, two surgeries for endoprosthesis replacement of the right knee and femur, upper lobectomy of the right lung, radiation therapy for metastasis in the left iliac bone (total boost dose – 52 Gy), radiation therapy on the CyberKnife device on metastases in the head of the 7th right rib and metastasis in the right lung, 2 sessions of ultrasonic thermal ablation on the HIFU in the area of metastases in the neck of the right femur,5 courses of bisphosphonates. The method of hybrid imaging of SPECT/CT allowed us to reliably monitor the effectiveness of the therapy. Postradiation changes in osteosarcoma metastases consisted in a decrease bone (pathological) metabolism, while radio-intensity indices did not change. For the first time we observed the effect of ultrasonic thermal ablation in the treatment of bone metastases. The effect of the treatment manifested very quickly and we visualized it as a defect of accumulation of radiopharmaceutical, which is a consequence of damage to the tumor vessels and tissue necrosis. In the observation of osteosarcoma recurrence SPECT with osteotropic radiopharmaceuticals demonstrates advantages over PET with 18F-FDG. Bone scan and SPECT/CT have proven to be reliable methods of dynamic control of a patient with osteosarcoma.

Key words: *SPECT/CT, bone scan, osteosarcoma, CyberKnife, HIFU*

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Research description

Osteogenic sarcoma and its metastases are among the most difficult tumors in treatment. On the one hand we have the improvement of traditional methods of systemic treatment (chemotherapy), and the local methods of treatment, on the other hand, thus allow us to hope that the effectiveness of treatment will increase. Monitoring the state of the disease is carried out using functional imaging methods (bone scan, SPECT, PET) and anatomy imaging methods (CT, MRI). In the past two decades, the hybrid SPECT/CT imaging method is actively introduced into clinical practice. The cause of usage of various methods of diagnostics is the need to obtain information on the state of perfusion of the tumor tissue and cell function, and on the anatomical and morphostructural changes in the focus of the tumor lesion at the same time[1]. Regarding this, it is interesting to use hybrid SPECT/CT method in the diagnosis and control of treatment of osteosarcoma metastases.

The following clinical case demonstrates the potential of bone scan and hybrid SPECT/CT methods in detecting signs of progression and regression of osteosarcoma bone metastases.

Patient (DOB 1976) ICD-10: C49.2 Malignant neoplasm: Connective and soft tissue of lower limb, including hip. Osteosarcoma of the distal right femur p(T2N0M0, stage IIB). Body build: normosthenic type, height 185 cm, weight 71 kg. The patient does not have bad habits. First symptoms of the disease appeared in December 2010 in the form of growing pains in the back of the lower third of right femur. The patient does not connect the appearance of the pain with any trauma. The patient took NSAIDs (without prescription), and this partially relieved the pain syndrome. He was consulted by a traumatologist at the clinic. X-ray of the right femoral bone revealed tumor pathology. A trepanobiopsy was performed, the results were: osteogenic sarcoma, osteoblastic variant. Appointed to N. N. Blokhin National Medical Research Centre of oncology, Moscow, Russia. Reexamination of histological blocks confirmed the diagnosis. Bone scan revealed focal lesion of the distal right femur without signs of secondary lesions in other parts of the skeleton (Fig. 1).

Scintigraphy was carried out in 2 stages. The first stage was a bone scan in 3 hours after the intravenous administration of the radiopharmaceutical ^{99m}Tc-MDP. The scintigraphy was performed in the position of the

Fig. 1. Bone scan on 28.02.2011 anterior (a) and posterior (b) projections. Starting examination.Intense accumulation of the radiopharmaceutical (1245 %) in the distal epimetaphysis of the right femur. No metastatic lesions in other parts of the skeleton

patient lying on his back using low energy high resolution collimator (LEHR). Gamma camera Symbia E or T2 Siemens Company was used. The radiopharmaceutical activity was 444 MBq. The effective dose is 2.5 mSv. The registration of impulses was carried out at an energy peak of 140 keV. The duration of bone scan was 20 minutes (the movement of the table was 12 cm/min). After obtaining a scintigraphic image of the whole body, a visual assessment was made in order to determine the localization of the pathological lesions of accumulation of the radiopharmaceutical and their sizes.

The second stage was SPECT/CT of the zone of interest. Examinations were performed on a hybrid SPECT/CT system Siemens' Simbia T2 (low-energy) system with a 2-sectional CT configuration (slice thickness 5 mm, spiral pitch 1.5 mm, focal spot size according to IAC 60 360–0.8 0 0.4 mm / 8˚, 0,8×0,7 mm / 8˚). Radiation exposure for scintigraphy and CT was calculated according to the Russian guidelines (MU 2.6.1. 3151–13 and MU 2.6.1.2944–11 respectively). Radiation exposure for planar scintigraphy was 2.5 mSv, for SPECT/CT varied from 1.4 to 2.2 mSv. On early stages of observation (2011–2013), the patient underwent 5 three-phase dynamic scintigraphies to assess the perfusion of the primary tumor and its metastases (examinations were conducted during treatment and not reflected in the present work due to non-systematic studies).

In 2011, the patient received a combined treatment: neoadjuvant chemotherapy (2 courses of doxorubicin and cisplatin, 3 courses of cisplatin), after that surgical treatment was performed (03.08.2011): resection of the lower third of the right femur with simultaneous endoprosthesis of the right knee joint (Installed cement titanium endoprosthesis company ProSpon (Czech Republic). The histological conclusion: osteosarcoma of the femur with a therapeutic pathomorphosis (the volume of necrotic tumor 93 %). After surgery, 5 more courses of adjuvant chemotherapy were performed. During a control study (23.10.2012) a solitary metastases in the posterior sections of the wing of the left iliac bone was revealed (Fig. 2).

Radiotherapy of the upper half of the left iliac bone was performed (20.11.2012 – 13.12.2012). Control examination (15.11.2013) a metastasis in the neck of the right femur was suspected on bone scan, but not confirmed by X-ray (Fig. 3). Clinicians made a decision about dynamic observation of the patient. Control bone scan (06.02.2014), showed an enlarging of the lesion in the neck of the right femur and the appearance of an additional focus in the anatomical-projection of the seventh thoracic vertebra. On CT, a concretion was found in the head of the 7th right rib (Fig. 4). The council of physicians has decided that metastatic lesion of the neck of the right femur was proved. Changes in the head of the 7th right rib require dynamic observation. In March 2014 in the Central Research Institute of Traumatology and Orthopaedics of N.N. Priorov, Moscow, Russia, 2 sessions of ultrasound thermoablation on the HIFU on the area of osteoplastic metastasis in the neck of the right femur were conducted (Fig. 5). Control bone scan (15.04.2014) an increase of accumulation of radiopharmaceutical in the 7th right rib (Fig. 6). SPECT/CT of the chest was not performed. The diagnostic CT scan was performed only on 24.06.2014, which resulted in proving another relapse of the disease (Fig. 6).The patient underwent stereotactic radiotherapy on the CyberKnife robotic radiosurgical system (14.07.2014 – 16.07.2014) in the region of the right rib-vertebral articulation of the 7th thoracic vertebra in 3 fractions of 15 Gy. A control check-up (06.10.2014) confirmed the absence of relapse of the disease and the effectiveness of previous treatment (Fig. 7). During 2015, the patient was observed in the clinic without signs of the progression of the disease. 3 control bone scans and SPECT/CT of the pelvis (3) and chest (1) were performed. At the control follow-up (14.03.2016) the recurrence of the disease in the form of metastatic lesions in the apex of the right lung and right femur bone was suspected again (Fig. 8). Clinicians made a decision on dynamic

observation of the patient. Six months later (12.09.2016), forth relapses of the disease – metastases in the apical mode of the right lung and right femur (Fig. 9) were confirmed using the method of radionuclide diagnostics in the patient. However, clinicians found evidence only of metastatic lesion of the right lung proved. The patient underwent stereotactic radiation therapy on the CyberKnife radiosurgical system for metastases in the right lung.

During the control examination (01.03.2017) we found an increase in the accumulation of radiopharmaceutical in the lesion in the right femur and an increase in its size, which was a powerful evidence of a metastatic nature and a reason to start the next stage of the antitumor therapy. The accumulation of radiopharmaceutical in the lesion in the right lung returned to normal levels, which confirms the success of the radiation therapy (Fig. 10). The patient underwent surgery on 15.07.2017: resection of the proximal right femur with total endoprosthesis of the right hip. Nuclear medicine study on 26.06.2017 did not reveal any pathological process (Fig. 11). However after 9 months, during the next control examination (12.03.2018), an increase in the level of accumulation of ^{99m}Tc-MDP in the anatomical projection of the apex of the right hemithorax was detected, it was an additional node with areas of pathological bone formation in the apex of the right lung, a relapse of the disease was suspected (Fig. 12). The patient was left under dynamic observation.

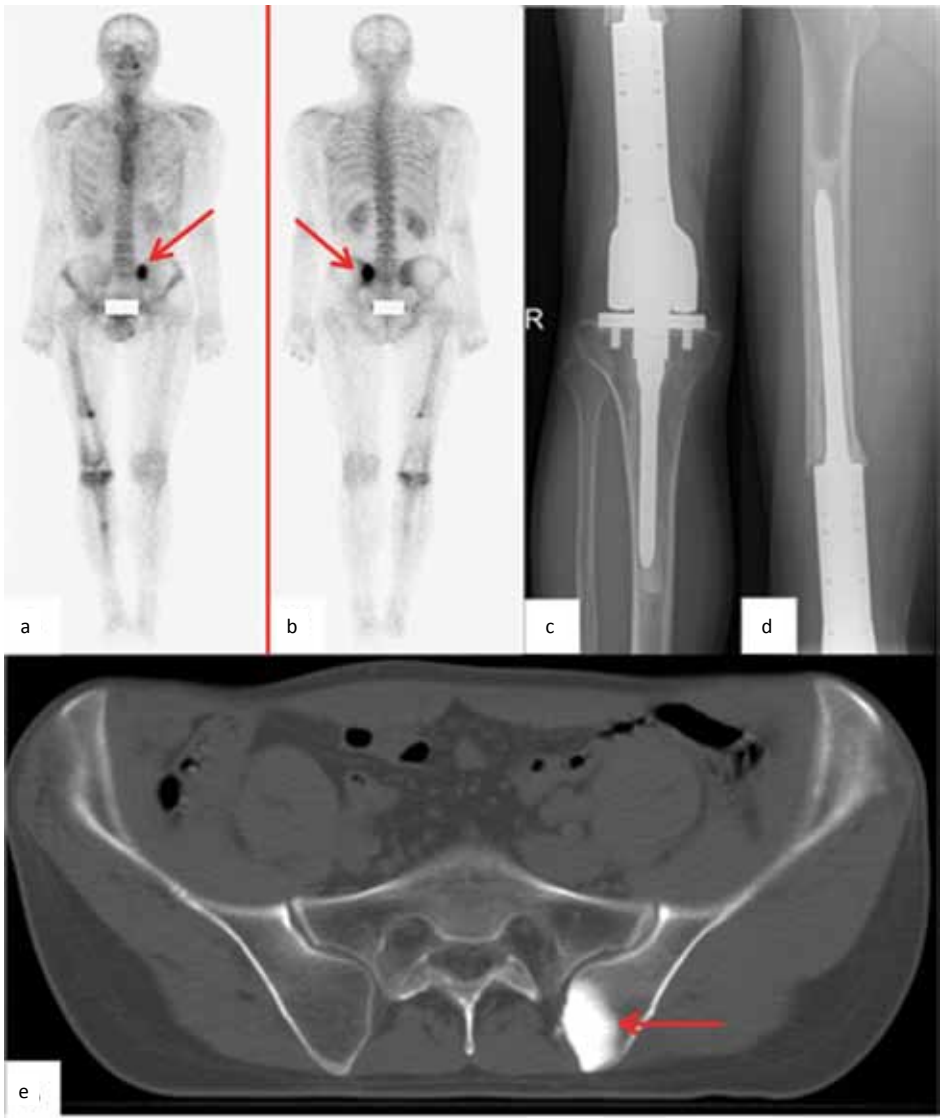

Fig. 2. Control examination on 23.10.2012. State after endoprosthesis replacement of the right knee joint. On the bone scan (a, b) a single focus of hyperaccumulation of the radiopharmaceutical in the wing of the left iliac bone (arrow). Physiologically increased accumulation of the radiopharmaceutical is in the bones that fix endoprosthesis. SPECT/CT was not performed. No pathology revealed on X-ray of the right lower limb in direct projection (c, d). On the axial cuts on CT of pelvic bones (e) in the inner segment of wing of the left iliac bone a high-density lesion (1086 HU) was detected – osteosarcoma metastasis. Progression of the underlying disease I

Fig. 3. Control check up on 15.11.2013. On bone scan (a, b) a small focus of moderate hyperaccumulation of the radiopharmaceutical is determined in the neck of the right femur (arrow) – a new metastasis cannot be excluded. In the medialis part of the left iliac wing, there is a defect in the accumulation of radiopharmaceuticals due to post-therapeutic changes. SPECT/CT was not conducted. On a direct X-ray of the pelvic bones (c), a solid metastasis of osteosarcoma is visualized in the medial part of the left iliac wing (arrow). No pathological evidence in the neck of the right femur

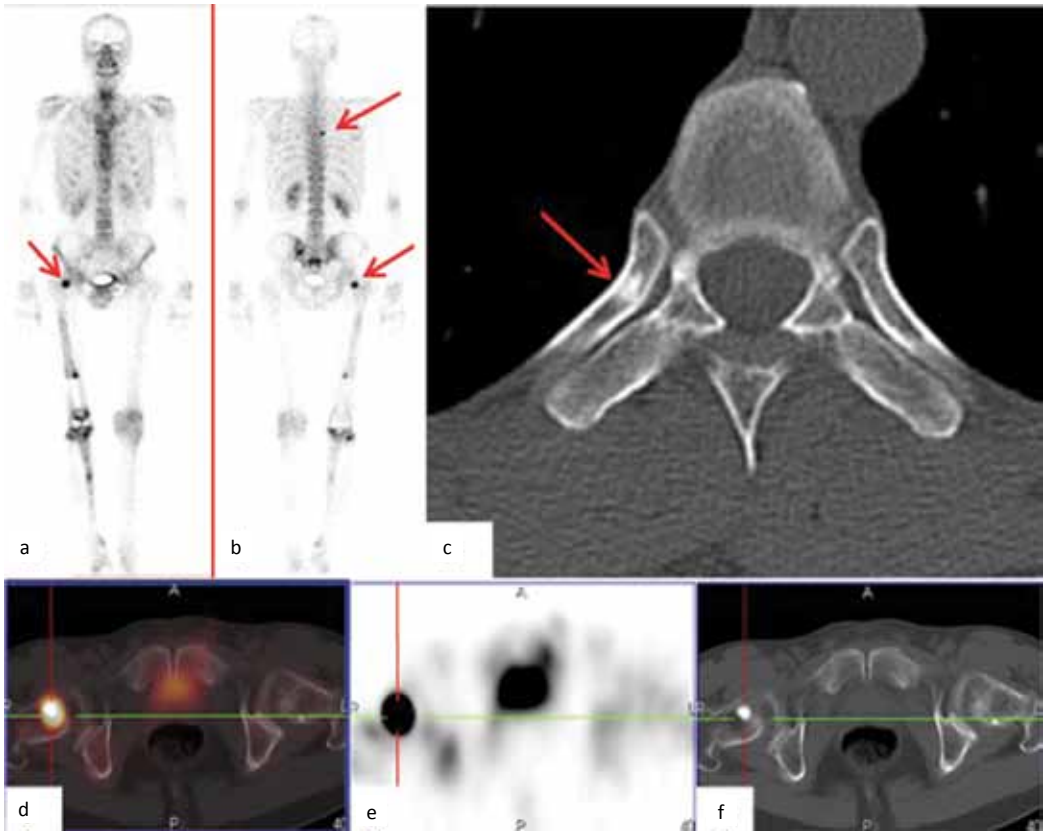

Fig. 4. Control examination on 06.02.2014. Bone scan (a, b) and SPECT/CT of pelvic, axial sections fusion (d), SPECT (e) and CT (f).Increased accumulation of the radiopharmaceutical in the right femur (arrow).On CT, a lesion of bone destruction with a high level of accumulation of (7500 %, 958 HU). Progression of the underlying disease II. An additional focus of radiopharmaceutical hyperaccumulation in the anatomical projection of the right half of Th7. On the axial cuts on CT (c) 07.02.2014, suspicion on metastasis in the head of the 7th right rib

In May 2018, the patient applied to the JCHO Tokyo Shinjuku Medical Center (Japan) for consultation and examination: bone scan and PET/CT (Fig. 13). Changes in the presented bone scan remained without significant dynamics. SPECT/CT was not performed. According to PET/CT a tumor was determined in the apex of the right lung without signs of metabolic activity. A hypermetabolic lesion (SUV = 6,2) was found in the right iliac muscle. In the medialis part of the left iliac bone, a center of osteosclerosis with signs of hypermetabolic activity (SUV = 2,8) was found. The conclusion of the Japanese colleagues on PET/CT: an active tumor tissue in the left ilium and the right iliac muscle. From May to August 2018 the patient did not visit to the oncologist. Control visit to the Nuclear Medicine Department of N.N. Blokhin National Medical Research Centre of oncology, Moscow, Russia (27.08.2018) showed increase in the level of radiopharmaceutical in pathological lesion in the right lung and an increase in their size (Fig.14). Additionally we found the destruction of the 3nd right rib, caused by the effects of postradiation osteoporosis (pathological fracture). An additional compaction of the bone tissue in the left iliac bone, with

Fig. 5. Schematic drawing, reflecting the principle of HIFU therapy. The main mechanism of therapy is thermal ablation of tissues. High energy ultrasound has the unique property of penetrating healthy tissues without damaging them, but when focused by the emitter lens in a small area, it causes an instant, within one second, temperature to 90 °C, enough for coagulative necrosis. So there is a focus of damage and necrosis. At the same time, the surface and surrounding tissues remain intact

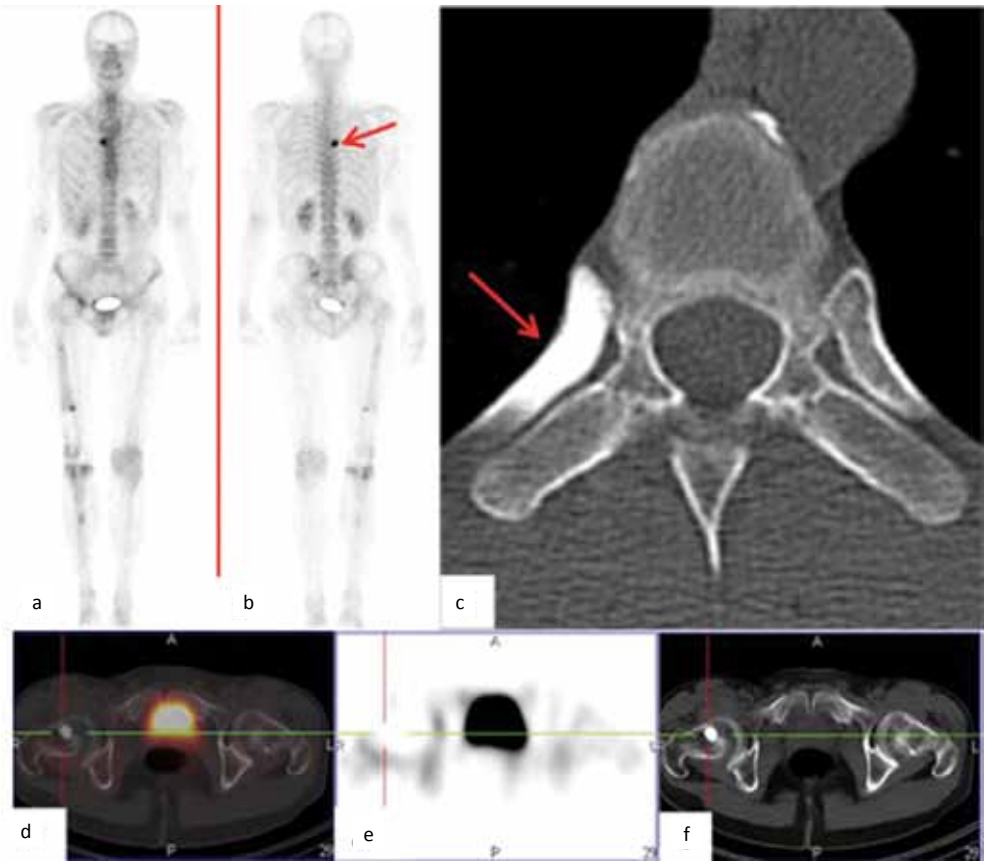

Fig. 6. Control check-up on 15.04.2014. On bone scan (a, b) and SPECT/CT of the pelvis (d, e, f) increased accumulation of in the 7th right rib (arrow). In the neck of the right femur, the center of destruction with low radiopharmaceuticals level of accumulation 44 % (977–1096 HU). Positive dynamics.The state of the left ilium without changes. On the axial cuts on CT (c), performed on 24.06.2014 a plastic metastasis in the head of the 7th right rib (arrow). The progression of the underlying disease III

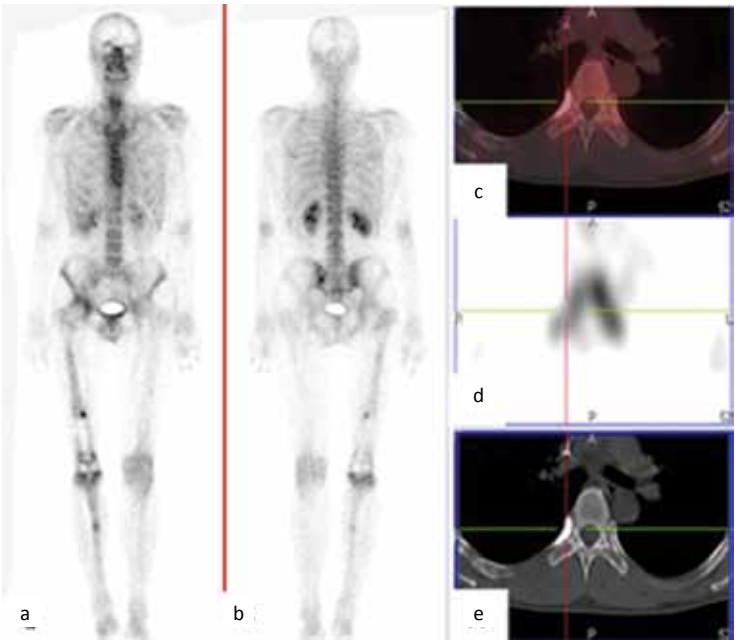

Fig. 7. Control check-up on 06.10.14. On the bone scan (a, b) and SPECT/CT of chest (c, d, e). Lower levels of accumulation of radiopharmaceutical in relation to the normal accumulation in the head of the 7th right rib state after radiation treatment. No new relapse sings

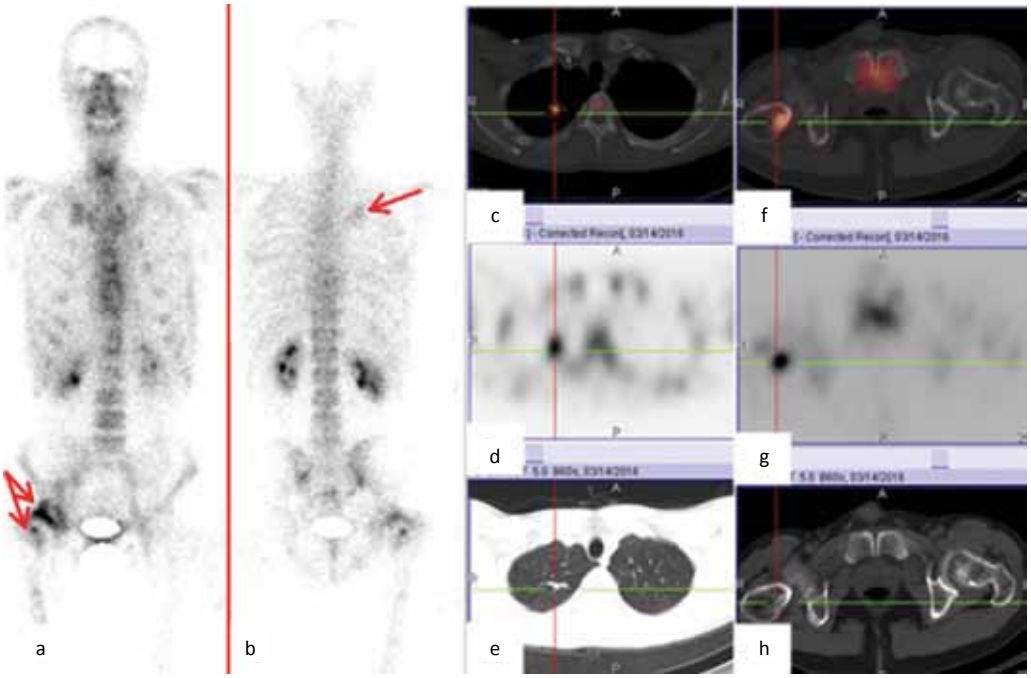

Fig. 8. Control check-up on 14.03.2016. On bone scan (a, b) focus of hyperaccumulation of the radiopharmaceutical in the upper sections of the right hemithorax is determined 300 % (arrow). Unevenly increased accumulation of radiopharmaceutical is noted in the area of the right hip joint (1034 %), with an additional focus in the proximal zone (arrows). The accumulation of radiopharmaceutical in the area of the 7th right rib and the left iliac bone is unchanged. On SPECT/CT of the chest (c, d, e) and pelvis (f, g, h) a tight focus of dense tissue with hyperaccumulation of radiopharmaceutical in the anatomical projection of the apex of the right lung. Previously it is not determined. Focus of hyperaccumulation of the radiopharmaceutical in the proximal zone of the right femur. According to CT, areas of "gentle" compaction of the bone structure. The focus was not previously determined

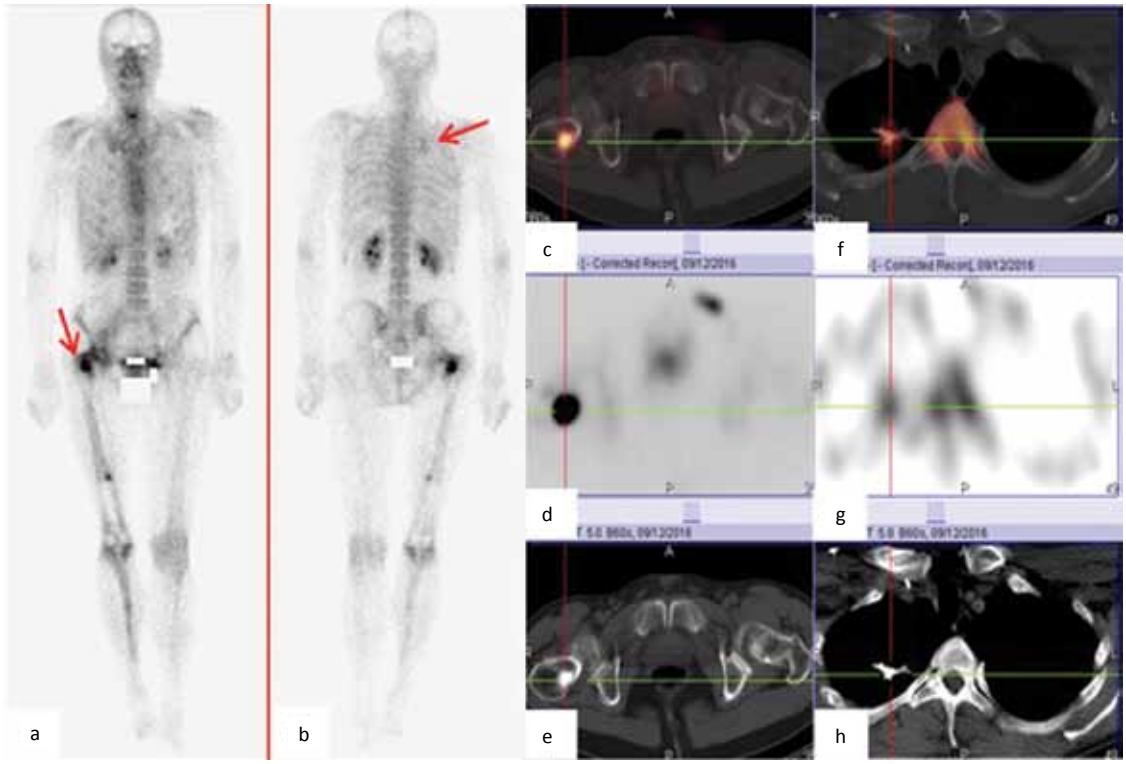

Fig. 9. Control check-up on 12.09.2016. On bone scan (a, b) the focus of hyperaccumulation of the radiopharmaceutical in the upper sections of the right hemithorax (arrow) remains the same. The level of accumulation of radiopharmaceuticals increased in the intertrochanter region of the right femur (arrow). The accumulation of radiopharmaceutical in the area of the 7th right rib and the left iliac bone didn't changed. SPECT/CT of the pelvis (c, d, e) and chest (f, g, h). An increase of the accumulation in the proximal metaphysis of the right femur from 1034 % to 2798 %. On CT osteoblastic lesion, dense compact bone 15×17×22 mm. An increase in the size of the focus in the apex of the right lung, from 38×21×5 mm to 45×33×5 mm and increase of the level of radiopharmaceutical accumulation from 300 % to 350 %. Progression of the underlying disease IV

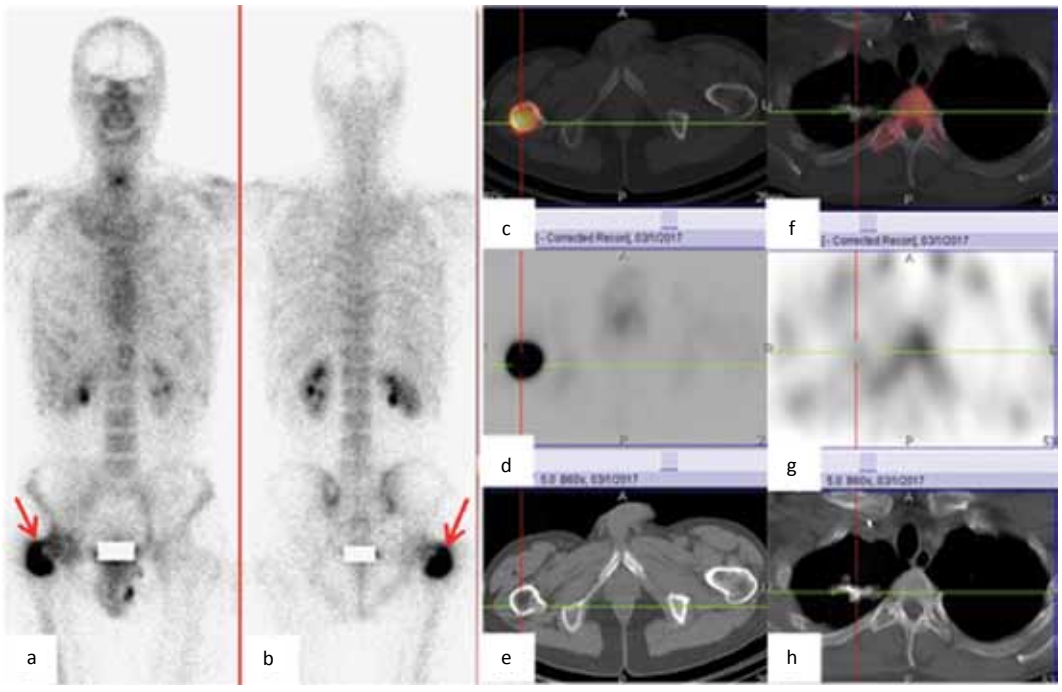

Fig. 10. Control check-up on 01.03.2017. Bone scan (a, b) and SPECT/CT of the pelvis (c, d, e) and chest (f, g, h). Hyperaccumulation of the radiopharmaceutical in the area of the proximal right femur. On CT scan, the lesion increased in size 4.5×4×3.3 cm. Progression of the underlying disease V. Accumulation of radiopharmaceutical in the lesion in the right lung normalized

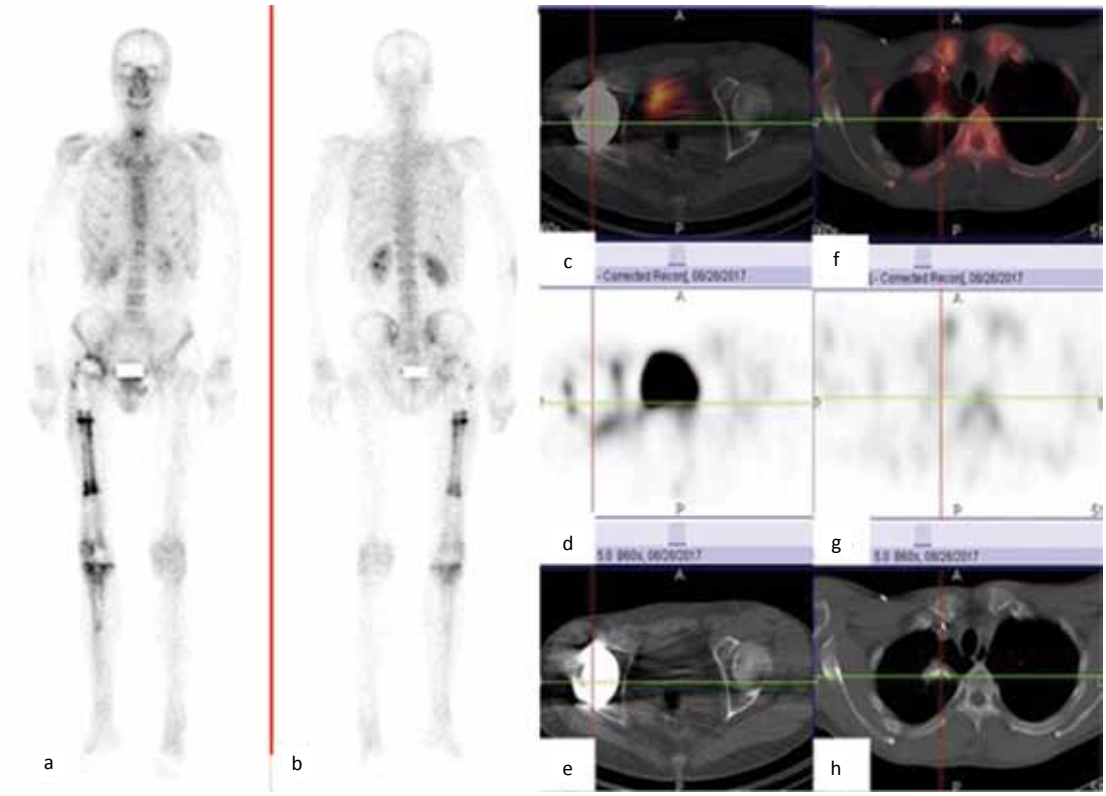

Fig. 11. Control check-up on 06.26.2017. State after resection of the proximal right femur with total endoprosthetic replacement of the right femur 03.15.2017 bone scan (a, b) and SPECT/CT of the pelvis (c, d, e) and chest (f, g, h).Hyperaccumulation of the radiopharmaceutical in the bones fixing the endoprosthesis and the surrounding soft tissues of the right thigh. On CT ossification – postoperative changes. No pathological accumulation of radiopharmaceuticals has been detected in other sites, no additional bone destruction zones have been found

hyperaccumulation of the radiopharmaceutical anteriad to the previously treated metastasis was detected. It is confirmed the sixth relapse of the disease. According to the ultrasound (28.08.2018) no enlarged retroperitoneal, iliac and inguinal lymph nodes were detected.

Postoperative scars with no signs of relapse. The area of increased accumulation of 18F-FDG in the right iliac muscle corresponds to the attachment site of resected and hemmed iliac muscle to the inner wall of the pelvis (the state after the endoprosthesis of the right femur) – reactive changes. The patient was discussed at the multidisciplinary team meeting. Decision: upper lobectomy of the right lung and dynamic observation of the metastases in the left ilium. Surgical treatment was carried out on 18.09.2018 (right lung lobectomy). Histology: in lung tissue, metastatic growths of osteosarcoma of a high degree of malignancy.

Control examination (21.02.2019) no signs of underlying disease progression. No change in the left ilium, postradiation osteonecrosis suggested. We continued dynamic observation of the patient.

Discussion

In this article, we demonstrated advantages of SPECT/CT method with osteotropic radiopharmaceuticals over other diagnostic methods, including PET/CT with FDG, in the control of the patient with osteogenic sarcoma. The presented patient was repeatedly examined, bone scan from the first appointment to the clinic in 2011 to the present day [2, 3]. The results of radionuclide diagnostics allowed to identify 6 episodes of progression of the underlying disease in the form of the appearance of new metastases in the bones, in the right lung and the continued growth of old focuses at different periods of observation and in some cases several months earlier than the radiological imaging methods.Time between relapse detection and treatment ranged from 1 to 12 months. First of all it was because of the clinicians distrust to the results of radionuclide studies that were not confirmed radiologically at early stages. Only at the first recurrence of the disease, the X-ray data, combined with the results of scintigraphy, made it possible to start therapy. Whereas during next relapses, the average period was 6 months.

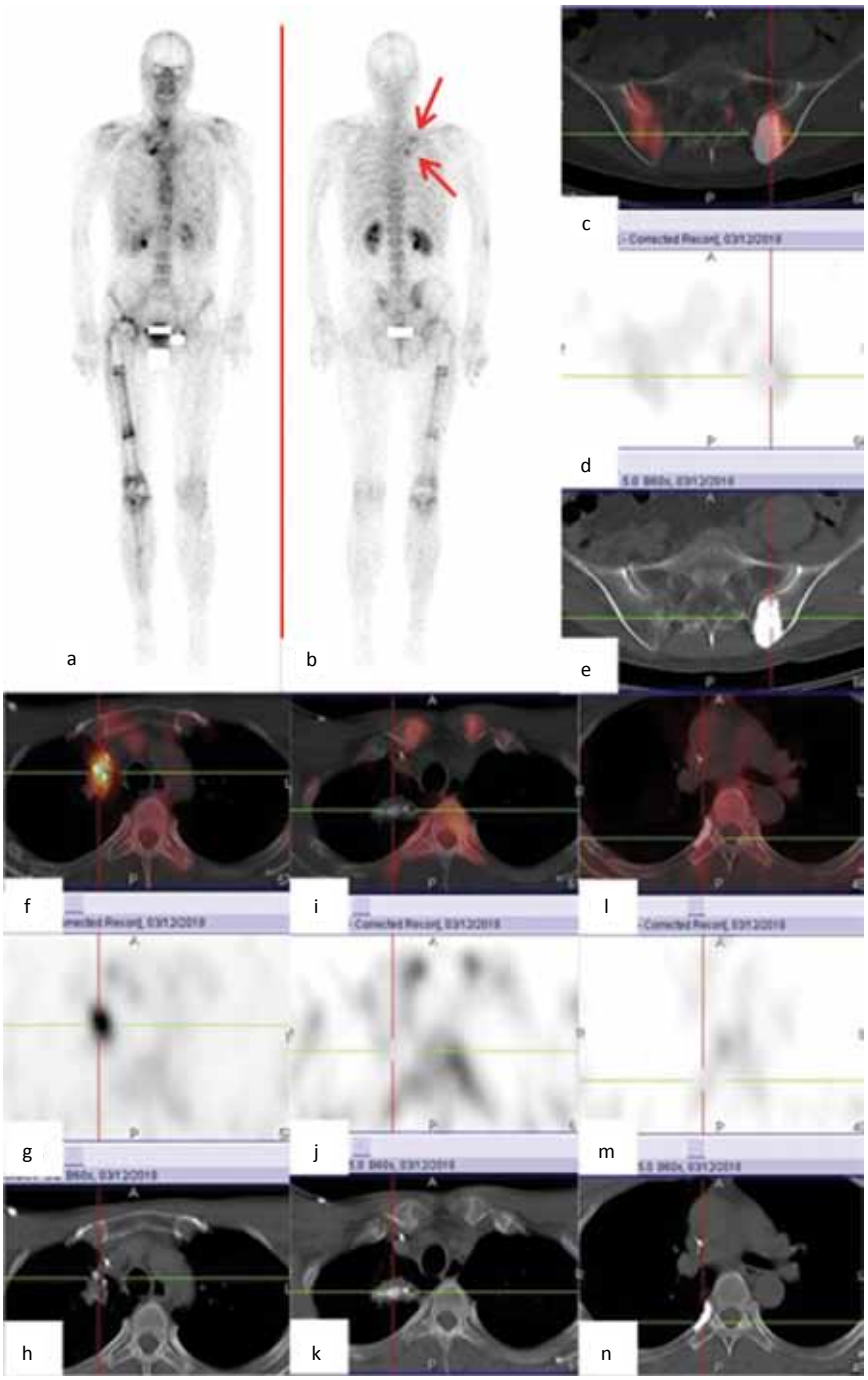

Fig. 12. Control check-up on 12.03.2018. Bone scan (a, b) and SPECT/CT of the pelvis (c, d, e) and chest different levels (f-n). On bone scan in the anatomical projection of the apex of the right hemithorax, increased accumulation of osteotrophic radiopharmaceutical (arrows) manifested again. SPECT/CT showed an additional node of pathological osteogenesis in the apex of the right lung, extremely suspicious in a relapse of the disease (f, g, h). In previously identified metastases in the right lung, the level of accumulation of radiopharmaceuticals returned to normal level (i, j, k).In the 7th right rib (l, m, n) and the left ilium (c, d, e) metastases in the phase of complete reparation, with no signs of osteometabolic activity

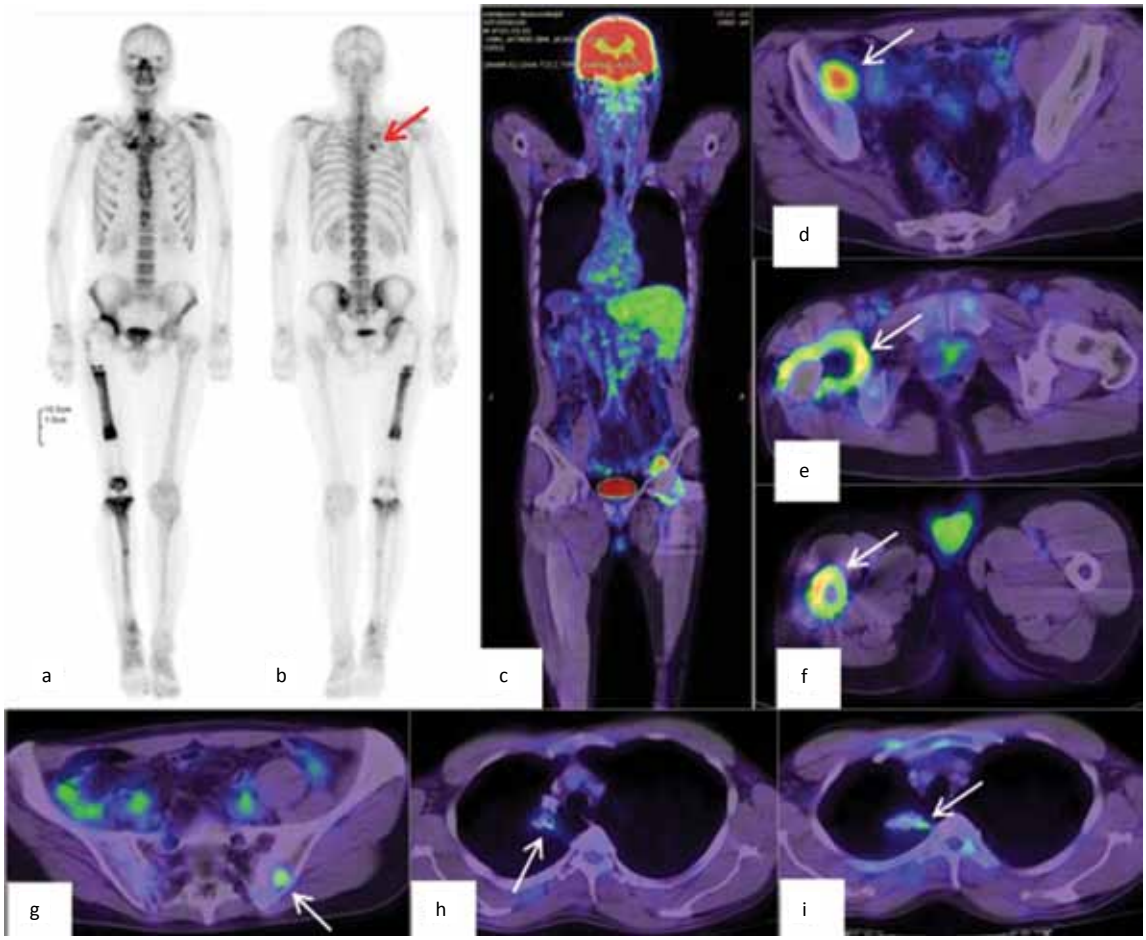

Fig. 13. Presented bone scan (a, b) on 16.05.2018 and PET/CT (c-i) on 14.05.2018 (translation). On the bone scan hyperaccumulation of the radiopharmaceutical in the apex of the right hemithorax remains without dynamics from 12.03.2018. On PET/CT (h, i) a calcified tumor is determined without pathological accumulation of 18F-FDG in the apex of the right lung (arrow). Pathological hyperaccumulation of ^{18}F-FDG in the right iliac muscle, a lesion (d) with (SUV = 6,2). In the medial part of the left iliac bone (g), a concretion with signs of hypermetabolic activity (SUV = 2,8). Hyperaccumulation of the radiopharmaceutical caused by reactive changes around the endoprosthesis of the right femur (e, f). Impression: active tumor tissue in the left ilium and the right iliac muscle

Thus with the lesion in the neck of the right femur the observation period was 1 year.

It is well known that bone scan has high sensitivity and low specificity in detecting bone metastases, on the contrary CT scan has relatively lower sensitivity and high specificity. Hybrid SPECT/CT method, is able to identify nuances that could not be identified or interpreted incorrectly if this methods used separately. The possibility of simultaneous use of these two diagnostic modalities can significantly improve the diagnostic efficiency of the radionuclide diagnostic method.

Osteogenic sarcoma has high tropism to bone seeking of radiopharmaceuticals. In addition, osteosarcoma is the only tumor which extraosseous metastases also accumulate osteotropic radiopharmaceuticals during bone scan [4]. This is explained by the fact that its metastases in soft tissues (in most cases we are talking about lung lesions) at the final stage of their development acquire histopathological properties similar to bone tissue – the ability of pathological osteogenesis. Our patient has a variant of osteoblastic osteosarcoma with a high degree of calcification of both the primary tumor and its metastases in the bones and lung.

Such features of the pathophysiology of the tumor are clearly demonstrated by the possibilities of PET/CT and SPECT/CT performed within a similar time frame during the development of 6 recurrences of the disease before the start of therapy. So 18F-FDG has intensively accumulated in those areas of the tumor where the process of osteogenesis has not been completed yet. PET has a false-positive result due to incorrect identification of the inflammatory focus. The Japanese colleagues did not take into account previous surgical intervention. SPECT/CT showed a high level of accumulation of osteotropic radiopharmaceuticals in those areas of the tumor, where active ossification occurs (dense focuses) and moderate

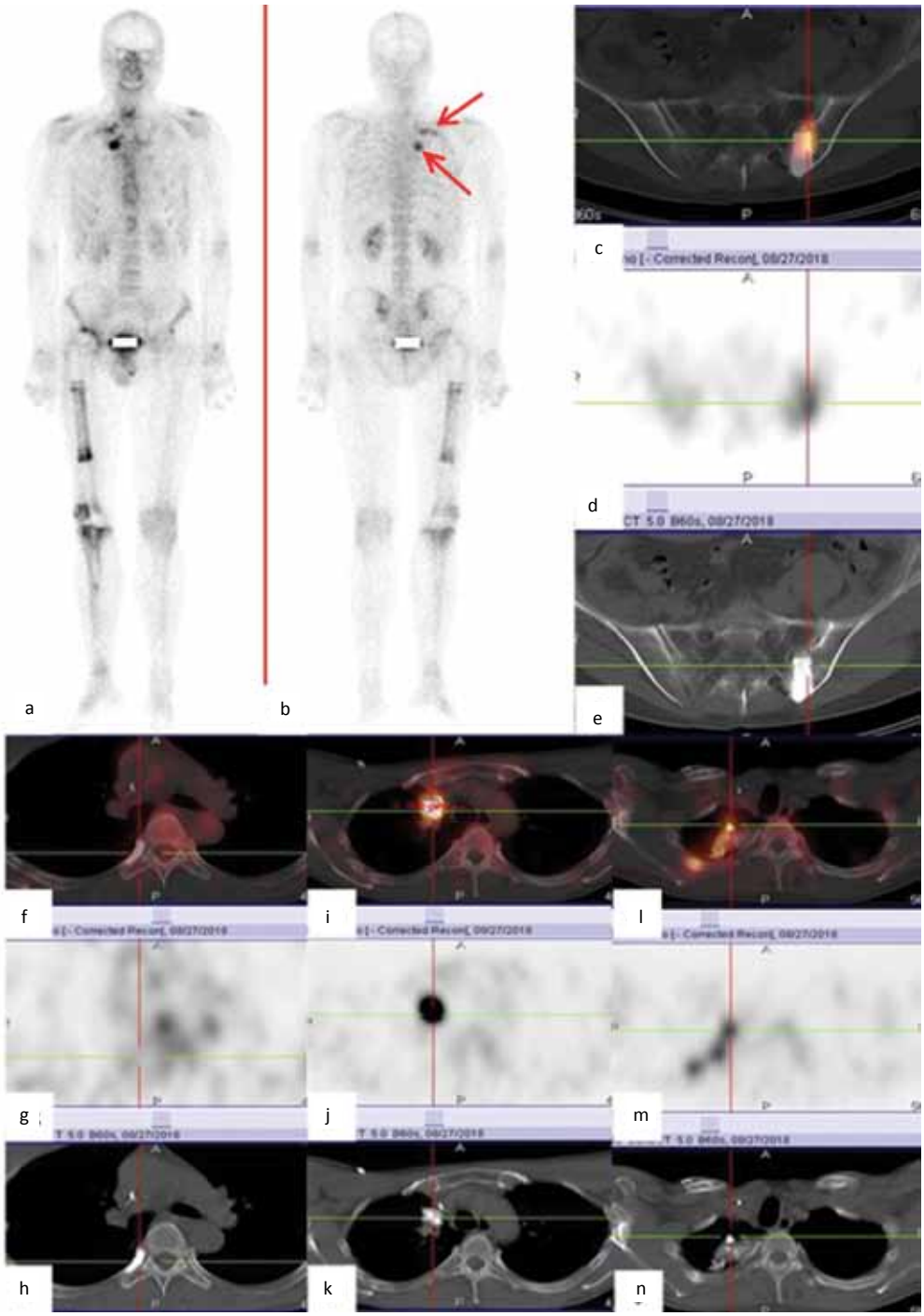

Fig. 14. Control examination on 27.08.2018, bone scan (a, b) and SPECT/CT of the pelvis (c, d, e) and chest (f-n). On bone scan pathological focus of hyperaccumulation of the radiopharmaceutical in the apex of the right hemithorax (arrows). Compared with the presented Tokyo bone scans the accumulation level of the radiopharmaceutical has increased. On SPECT/CT there is an increase in the accumulation of radiopharmaceutical in pathological focuses and an increase in their size. Additionally we found a focus of accumulation of the radiopharmaceutical in the posterior segment of the 3nd right rib with bone destruction on CT – pathological fracture caused by post-radiation osteoporosis (l, m, n). In the medialis part of the wing an additional osteosclerotic formation was formed with hyperaccumulation of the radiopharmaceutical near previously treated metastasis (i, j, k). Metastasis in the head of the 7th right rib in the phase of complete reparation (f, g, h)

in less dense areas, excluding the accumulation of reactive changes in the right iliac muscle in the area.

In addition to high sensitivity and specificity in detecting recurrences of osteosarcoma, SPECT/CT allowed to monitor the effectiveness of the treatment. Post radiotherapy changes in osteosarcoma metastases manifested in decreased bone tissue metabolism below normal levels. At the same time, the Hounsfield intensity did not change. This observation demonstrates the obvious benefits of SPECT/CT in the diagnosis and follow-up of patients with metastatic bone lesions and suggests a wider application of this method.

Summary

1. The patient during the observation made 26 visits to the Nuclear Medicine Department of N. N. Blokhin National Medical Research Centre of oncology, Moscow, Russia. 48 examinations with osteotropic radiopharmaceuticals: 24 bone scan, 19 SPECT/CT, 5 dynamic studies.

2. Bone scan and SPECT/CT allowed us to identify 6 episodes of progression of the underlying disease in the form of metastatic lesions of the skeleton and right lung, as well as continued growth of certain old metastasis at different times of observation and 6 months (average) earlier than X-rays and CT.

3. Hybrid SPECT/CT is a demonstrative method capable of detecting nuances that could not be identified or misinterpreted when modalities applied separately, thus increase the diagnostic efficiency of the radionuclide method.

4. For the first time we observed the effect of ultrasound thermoablation in the treatment of bone metastases [5]. The effect of treatment manifested very quickly. Defect of accumulation of radiopharmaceutical is a result of damage to the tumor vessels and the manifestation of tissue necrosis.

5. Post radiotherapy changes in osteosarcoma metastases showed in the reduction of bone (pathological) metabolism [6]. Hounsfield intensity units do not change.

6. We demonstrate the advantage of SPECT with osteotropic radiopharmaceuticals over PET with 18F-FDG in the observation of osteosarcoma recurrence.

REFERENCES

1. Krzhivitsky PI, Kanaev SV, Novikov SN, Zhukova LA, Ponomareva OI, Negustorov YuF. SPECT-CT in the diagnosis of metastatic skeletal lesion. Problems in Oncology. 2014;60(1):56-63. (Russian).
2. Ryzhkov AD, Ivanov SM, Shiryaev SV, Krylov AS, Stanyakina EE, Kochergina NV, et al. SPECT/CT radiation in treatment of bone metastases of osteosarcoma. Problems in Oncology. 2016; 62(5):654-9. (Russian).
3. Ryzhkov AD, Shiryaev SV, Machak GN, Kochergina NV, ShchipakhinaYaA, Krylov AS, et al. SPECT/CT in Treatment Monitoring of Bone Metastases of Osteosarcoma with Ultrasound Thermal Ablation Method. Medical Radiology and Radiation Safety. 2016;61(5):54-8. (Russian).
4. Mebarki M, Medjahedi A, Menemani A, Betterki S, Terki S, Berber N. Osteosarcoma pulmonary metastasis mimicking abnormal skeletal uptake in bone scan: utility of SPECT/CT. Clin Nucl Med. 2013;38(10):392-4. DOI: 10.1097/RLU.0b013e318266cdcb.
5. TerHaar G. HIFU Tissue Ablation: Concept and Devices. Adv Exp Med Biol. 2016;880:3-20. DOI: 10.1007/978-3-319-22536-4_1.
6. Nasarenko AV, Ter-Arutyunyants SA Stereotactic radiation therapy (SRT) in the treatment of primary and metastatic bonelesions. Bone and Soft Tissue Sarcomas, Tumors of the Skin. 2016(1):36-44. (Russian).

For citation: Ryzhkov AD, Krylov AS, Machak GN, Kaspshik SM, Bludov AB, Shchipakhina YA, Kochergina NV. Monitoring the Therapy of Osteosarcoma Metastases with SPECT/CT. Medical Radiology and Radiation Safety. 2019;64(4): 76-88. (English).

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А.Д. Рыжков[1], А.С. Крылов[1], Г.Н. Мачак[2], С.М. Каспшик[1], А.Б. Блудов[1], Я.А. Щипахина[1], Н.В. Кочергина[1]

МОНИТОРИНГ ЛЕЧЕНИЯ МЕТАСТАЗОВ ОСТЕОСАРКОМЫ С ПОМОЩЬЮ ОФЭКТ/КТ*

1. Национальный медицинский исследовательский центр онкологии им. Н.Н. Блохина Минздрава РФ, Москва.
E-mail: krilovas@rambler.ru;
2. Национальный медицинский исследовательский центр травматологии и ортопедии имени Н.Н. Приорова Минздрава РФ, Москва

А.Д. Рыжков – в.н.с., д.м.н.; А.С. Крылов – к.м.н., врач-радиолог; Г.Н. Мачак – д.м.н.,член Европейского общества по изучению костно-мышечных опухолей; С.М. Каспшик – клинический ординатор; А.Б. Блудов – н.с., к.м.н.; Я.А. Щипахина – н.с., к.м.н.; Н.В. Кочергина – в.н.с., д.м.н., проф.

Реферат

Представлен клинический случай наблюдения с 2011 по 2018 гг. мужчины 1976 г. рождения с диагнозом остеогенной саркомы нижней трети правой бедренной кости. В процессе динамического наблюдения в лаборатории радиоизотопной диагностики НМИЦ онкологии им. Н.Н. Блохина пациенту проведено 48 радионуклидных диагностических исследований: 24 остеосцинтиграфии в режиме всего тела, 19 ОФЭКТ/КТ зоны интереса и 5 динамических сцинтиграфий. Результаты радионуклидной диагностики позволили первыми выявить 6 эпизодов прогрессирования основного заболевания в виде появления новых метастазов в костях, правом легком и продолженного роста отдельных ранее выявленных метастазов в разные сроки наблюдения, причем раньше, чем рентгенологическим методом визуализации. Время от обнаружения рецидива заболевания по данным сцинтиграфии до начала терапии составляло от 1 до 12 мес. Связано это, в первую очередь, с недоверием клиницистов к результатам радионуклидных исследований, не подтвержденным на ранних этапах рентгенологически. В процессе лечения рецидивов основного заболевания пациент получил следующие стандартные и инновационные виды терапии: 10 курсов ПХТ, две операции по эндопротезированию правого коленного сустава и бедренной кости, верхняя лобэктомия правого легкого, дистанционная лучевая терапия на метастаз в левой подвздошной кости (СОД 52 Гр), лучевая терапия на аппарате «Кибернож» на метастаз в головке 7-го правого ребра и метастаз в правом легком, 2 сеанса ультразвуковой термоаблации на аппарате HIFU в области метастаза в шейке правой бедренной кости, введение бисфосфонатов – 5 курсов. Метод гибридной визуализации ОФЭКТ/КТ позволил надежно контролировать эффективность проводимой терапии. Постлучевые изменения в метастазах остеосаркомы заключаются в снижении костного (патологического) метаболизма, тогда как показатели радиоденситивности не изменяются. Впервые наблюдали эффект ультразвуковой термоабляции при лечении метастазов в костях. Эффект от лечения проявляется очень быстро и наглядно в виде дефекта накопления РФП, который является следствием повреждения сосудов опухоли и проявлением некроза тканей. Продемонстрировано преимущество ОФЭКТ с остеотропным РФП над ПЭТ с ^{18}F-ФДГ в наблюдении рецидива остеосаркомы. ОСГ и ОФЭКТ/КТ показали себя надежным методом динамического контроля за пациентом с остеогенной саркомой.

Ключевые слова: *ОФЭКТ/КТ, сканирование скелета, остеогенная саркома, Кибернож, фокусированный ультразвук высокой интенсивности*

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