Possible applications of osteotropic radiopharmaceuticals in the diagnosis of inflammatory changes in patients with nonspecific hematogenous spondylitis

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Learning objectives

- To show possibilities of gamma scintigraphy in diagnostics of nonspecific hematogenous spondylitis and after spinal reconstructive surgeries.
- To estimate the method's benefits and shortcomings, sensitivity and specificity of radionuclide imagine in diagnostics of hematogenous spondylitises.
- To describe the results of method usage based on a series of 34 patients.
Background

Spondylodiscitis is the main manifestation of haematogenous osteomyelitis and represents 3-5% of all cases of osteomyelitis. The incidence has risen over the years as a result of an increase in the susceptible population, an increase in the number of patients undergoing spinal surgery, and better diagnostic possibilities. The literature refers to an average diagnostic delay of 2-6 months from the onset of clinical signs due to the insidious nature of symptom onset and the high frequency of low back pain in the general population. Diagnosis of spondylodiscitis is based on clinical, laboratory and radiological features and is often difficult to establish. [1]

Modern methods of spinal pathology treatment, including reconstructive surgeries, provide for more opportunities for better disease prognosis, its outcome and patient's life quality.

The clinical task calls for fast pathology detection during edema of bone structures, before their destruction. In this case the treatment may be limited by conservative measures such as physical inactivation, wearing of spinal assistant, antibiotic and detoxication therapy. In more complicated cases when initial stage of destruction is evident, rear hook systems with antibacterial therapy are advised. If patient has a suppurative focus (sequester), pathologic fracture or epiduritis, sanation and decompressing surgery with suppurative focus drainage is recommended with posterior spine fixation. Such patients require massive antibacterial therapy (both local and parenteral). When treatment strategy is being defined it is crucial to take into account additional diagnostic methods which help to assign a patient to a certain class to find the right treatment method. When case is already diagnosed it is important to localize the most intense process.

Scintigraphy with osteotropic radiopharmaceuticals was used for diagnostics of inflammation back in 1970s, but due to low method sensitivity, it is not widely used in modern practice. [2] Present technologies provide higher spatial resolution, which enable to develop methods of more efficient diagnostics of this pathology. The method helps to estimate inflammatory process intensity, to find its source and extent, involvedness of surrounding structures, relation with alterations of bone tissue, which makes the method an important step in development of the most efficient treatment strategy.

The principle of the bone scan is that the tracer that is injected intravenously is incorporated into the bone crystal matrix; the main determinants of the regional deposition are thought to be osteoblastic activity and blood flow. In inflammatory spondylitis the blood flow to the bones and surrounding tissue is increased. This hyperaemia must
contribute to the positive bone scan in inflammation, but local bone remodeling is probably of greater importance. [3]
Imaging findings OR Procedure details

Study of patients with nonspecific hematogenic spondylitis pursued the following objectives:

- To determine connection between active inflammatory process and changes in bone tissue.
- To identify the process location, its extent and intensity.
- To estimate efficiency of radionuclide diagnostic method in treatment.

To solve these issues, we have used 3-phase bone study [4], complied with SPECT investigation.

1. First phase - blood flow estimation. The investigation takes place directly after injection of 750 MBq radiopharmaceutical. Gamma-camera detector is placed over the affected area and dynamic record is obtained within 60 sec. (750 MBq, 60 sec, 1 frame/sec).
2. Second phase - blood pool estimation. Static scintigraphy with 500000 counts set is obtained immediately after the first phase with the same detector position.
3. Third phase - static investigation of skeleton bones in "whole body" mode, is obtained within 3h after injection of radiopharmaceutical. [1]

After that single-photon emission computed tomography (SPECT) is carried out, combined with X-ray computed tomography (CT) of region of interest. On fused image one can determine the affected area, intensity of radiopharmaceutical uptake as compared to healthy tissue, degree of articular apparatus and intervertebral discs involvedness. Comparative analysis of pathological changes in bone tissue based on CT data and radiopharmaceutical uptake data was carried out. In case of repeated investigation, process dynamics is investigated.

The radiological criteria used for infectious spondylodiscitis were disc space narrowing or irregular erosion of the vertebral endplates adjacent to the disc space, or both, the destruction of the vertebral end-plates adjacent to the disc space. The scintigraphic criterion for infectious spondylodiscitis was increased uptake in the vertebral bodies on either side of the affected disc space together with increased blood pool activity.[5, 6]

34 patients with nonspecific hematogenic spondylitis were studied with the help of the method. 5 of them were studied before and after treatment within the period from February to July 2012.
Blood flow in affected area was studied; percentage of hyperfixation of product with respect to intact tissue was studied, as well as localization of hyperfixation area, change of intensity of radiopharmaceutical product accumulation after the treatment.

Sensitivity and specificity of whole body scintigraphy was estimated, SPECT and SPECT/CT for the studied group of patients. 28 patients had the diagnostic verified with the help of bacteriologic seeding (Spondylitis was confirmed by microbiology in 28 cases). WB sensitivity was 67%, specificity nearly 42%. SPECT sensitivity was 79%, specificity 47%. SPECT/CT sensitivity was 95%, specificity 77%. Term of scintigraphy reached 14 - 21 days since the disease onset.
Conclusion

Possibilities of whole body investigation in diagnostics of hematogenous spondylitis are limited due to insufficient sensitivity in determining of inflamed tissues. The most efficient method is SPECT/CT, due to possibility of precise process localization (vertebral body or pedicles of arch vertebra), its spread and intensity, which enabled to control treatment efficiency (patient management), and timely correct the treatment strategy. It was found that over 30% of patients needed additional sanitation of the inflammation source after reconstructive spinal surgery. This enabled to timely perform required actions and avoid complicating diseases. (Fig. 1 - 4)

The method may correctly show the process stage, it provides information which cannot be obtained with the conventional visualization methods (x-ray, computer tomography, magnetic resonance imaging), and thus can be recommended as an additional diagnostic method for hematogenous spondylitis.
Fig. 1: Patient #., 66 years old, scintigrams in "whole body" mode show radiopharmaceutical hyperfixation with uptake index of 167%, in projection of the second lumbar vertebra with affection of intervertebral disc. SPECT/CT was carried out, and process was localized in the end plates of L3-L2 vertebral bodies and intervertebral disc. The only radiological findings was disc space narrowing and end plates sclerosis.

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Fig. 2: Patient P., 75 years old, started hospital treatment with severe low back pain syndrome, caused by compression fracture of L2 vertebral body. Scintigramms in "whole body" mode show accumulation of radiopharmaceutical in the area of L2, L3 vertebral bodies with uptake index 159%, that is common for the inflammatory process. The irregular erosion of end plates adjacent to the disc space is observed and disc space was narrowed. After SPECT/CT procedure patient management had been changed from conventional treatment to the sanation and decompressing surgery with suppurative focus drainage.

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Fig. 3: Patient M., 71 years old, axial view. Patient was referred to nuclear medicine department for evaluation of distribution and degree of inflammation process in lumbar
spine for treatment planning. The osteoscintigraphy was performed and SPECT/CT imaging shows radiopharmaceutical hyperfixation in the L5 - S1 endplates and disc space with uptake index of 163%. The radiological findings were irregular end plates erosion and destruction, disc space narrowing. After patient examination sanation surgery was performed.

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Fig. 4: Patient M., 71 years old, reconstructed coronar and sagittal view. Patient was referred to nuclear medicine department for evaluation of distribution and degree of inflammation process in lumbar spine for treatment planning. The osteoscintigraphy was performed and SPECT/CT imaging shows radiopharmaceutical hyperfixation in the L5 - S1 endplates and disc space with uptake index of 163%. The radiological findings were irregular end plates erosion and destruction, disc space narrowing. After patient examination sanation surgery was performed.

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