Nuclear medicine diagnostics of diseases affecting central nervous system

Department of Nuclear Medicine CSK UM Łódź
Basic diagnostic methods

1) Brain perfusion scintigraphy (SPECT)
2) Imaging of dopaminergic receptors’ distribution in the brain (SPECT or PET)
3) Myeloscintigraphy (cerebrospinal fluid imaging)
Brain perfusion scintigraphy

Radiopharmaceuticals (RPh):  
- $^{99m}$Tc-HMPAO  
- $^{99m}$Tc-ECD  

Mechanism of RPh accumulation:  
- After i.v. injection RPh passes through intact blood-brain barrier and its distribution in the brain is proportional to the regional blood flow
Brain perfusion scintigraphy – normal image

- Cerebellum
- Subcortical nuclei
- Brain ventricles

SPECT
Brain perfusion scintigraphy

Clinical applications:
1. Diagnostics of vascular and vasculodependant brain diseases (especially TIA - transient ischemic attack)
2. Diagnostics and differentiation of dementias
3. Detection of epileptogenic foci
Brain perfusion study

Ischaemic stroke in the left temporoparietal region
Multi-infarct dementia (MID)
Alzheimer’s disease (AD)

- Subcortical nuclei
- Enlarged ventricles
- Decreased perfusion of temporal and parietal lobes

SPECT
Frontal epilepsy

„Cold” focus – between attacks of epilepsy

„Hot” focus – during attack of epilepsy
Imaging of dopaminergic receptors’ distribution in the brain

Radiopharmaceuticals:

For visualization of pre-synaptic distribution of dopamine transporters

- $^{123}$I-DaTSCAN (SPECT)
- $^{99m}$Tc-TRODAT (SPECT)
- $^{18}$F-DOPA (PET)

For visualization of post-synaptic distribution of D2 dopamine receptors

- $^{123}$I-IBZM (SPECT)
- $^{11}$C-racloprid (PET)
Imaging of dopaminergic receptors’ distribution in the brain

Clinical applications:

1. Diagnosis, staging and evaluation of treatment effectiveness in Parkinson’s disease (PD)

2. Differential diagnosis between Parkinson’s and other diseases (eg. essential tremor, Parkinsonian syndromes)
Striatum

„Head” of caudate nucleus

putamen
Normal image

Parkinson’s disease

SPECT

SPECT/CT
Evaluation of Parkinson’s disease advancement

- Normal image
- Decreased, asymmetric uptake in putamens
- Lack of putamen uptake - bilateral
- Progressive reduction of the uptake in "heads" of the caudate nuclei
# Differential diagnosis

<table>
<thead>
<tr>
<th>Differential Diagnosis</th>
<th>TRODAT (dopaminergic, pre-synaptic function)</th>
<th>IBZM (dopaminergic, post-synaptic function)</th>
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<tbody>
<tr>
<td>Healthy patient</td>
<td>![Healthy patient image]</td>
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<td>and also:</td>
<td>![Essential tremor image]</td>
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<td>Essential tremor</td>
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<td>Drug induced PS</td>
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<td>Parkinson’s disease</td>
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<td>Parkinsonism-plus syndromes</td>
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Evaluation of treatment in PD

Before treatment

After treatment
Myeloscintigraphy

Radiopharmaceuticals:
- $^{99m}\text{Tc-DTPA}$

Mechanism of RPh accumulation:
- RPh is administered by a sterile lumbar puncture into the subarachnoid space. It reaches the level of basal cisterns in about one hour after administration.
Myeloscintigraphy

Clinical applications:
1. Localisation of the cerebrospinal fluid outflow
2. Detection of abnormal circulation of cerebrospinal fluid
Cerebrospinal fluid outflow from ethmoidal sinuses