\section{1. Background}

Parkinson’s disease (PD) is one of the neurodegenerative disorders. Motor symptoms of the disease (slowness of movements, rigidity, and tremor) are a consequence of the death of nerve cells in brain structure named substantia nigra (SN). This structure is located in mesencephalon as shown in Fig. 1 (top right). There is currently no cure for the disease and the primary cause of the nerve cells death has not yet been determined. Nevertheless there are several hypotheses trying to explain this process; one of which is iron induced oxidative stress \cite{1}.

The diagnosis of Parkinson’s disease, and also other neurodegenerative disorders, is based on clinical examination. Many attempts are undertaken to find a test that could confirm this clinical diagnosis. Many hopes were attributed to magnetic resonance imaging (MRI) but its importance remains obscure. Unfortunately, until now conventional T1-weighted and T2-weighted imaging did not show significant differences between PD and control \cite{2}. It seems, however, that measurements of longitudinal (T1) and transverse (T2) relaxation times (RT) could have some importance. The absolute values of T1 and T2 RT depend on number of factors (such as: viscosity, water content, ions concentration) one of them being for sure the concentration of iron. According to some authors, T2 RT is decreased in parkinsonian SN compared to control as a result of an increase in the iron concentration \cite{3, 4}. Longitudinal RT was much less studied.

The aim of this study was to compare T1 and T2 RT from SN of patients with clinical diagnosis of PD and age-matched controls.

\section{2. Materials and methods}

15 patients (5 females and 10 males) and 10 controls (3 females and 7 males) were assessed with 1.5 T MRI. The clinical diagnosis was made according to generally accepted criteria \cite{5}. All patients had a moderate severity of the disease (stage 2 according to Hoehn and Yahr scale \cite{6}).

![Fig. 1. Individual steps of T2 image segmentation. Schema of brain stem (top right) is rescaled to fit brain stem in T2 image (top left). From the obtained result (bottom left) the substantia nigra mask (bottom right) is created.](image)

The measurements of T1 and T2 were performed with the use of General Electric 1.5 T Sigma Excite MRI with a head coil using pulse methods. Inversion recovery (IR) pulse sequence was used to measure T1 (TI = 100, 200, 500, 800, 1600, 2400 ms; TR = 10000 ms) and fast spin echo (FSE) pulse sequence was used to measure T2...
(TE = 15, 30, 45, 60 ms; TR = 3000 ms), echo times (TE) were constant. The signal-to-noise ratios based on the TE (15, 30, 45, 60 ms) were 31, 28, 24, 21.

The region of interest (ROI) of SN was determined basing on the anatomical atlas and the picture obtained from IR of each subject studied as shown in Fig. 1. Mask created from schematic brain stem cross-section was rescaled to fit T2 MRI image of proper brain section. The ROI defined this way was used as the mask for determination of the boundary of SN in the following measurements series of the subject.

T1 and T2 relaxation times were calculated from the best fit to experimental points of Eqs. (1) and (2), respectively

\[ M_z(t) = M_z(0) \left(1 - 2e^{-\frac{t}{T_1}}\right), \]  
\[ M_{xy}(t) = M_{xy}(0)e^{-\frac{t}{T_2}}, \]

where \( M_z \) — longitudinal component of the magnetization, \( M_{xy} \) — transverse component of the magnetization.

### 3. Results and discussion

RT’s of control and PD group were calculated as means of single RIs in both groups. Experimental errors were estimated as standard error of the mean. Results are presented in Table. Typical T2 MRI images obtained from both groups are shown in Fig. 2.

![Fig. 2. Transverse relaxation times maps of Parkinsonian (A) and control (B) mesencephalon. Substantia nigra is marked with an arrow. For more details refer to Fig. 1.](image)

<table>
<thead>
<tr>
<th>Relaxation time [ms]</th>
<th>Group</th>
</tr>
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<tbody>
<tr>
<td>T1</td>
<td>Control</td>
</tr>
<tr>
<td>T2</td>
<td>614 ± 21</td>
</tr>
<tr>
<td>T2</td>
<td>58.0 ± 1.4</td>
</tr>
</tbody>
</table>

### 4. Conclusions

MRI study demonstrated that in parkinsonian SN there is a statistically significant decrease of T2 relaxation time compared to control, which is not paralleled by a similar change in T1 relaxation time. This change of T2 relaxation time cannot be explained by a change in the concentration of iron in parkinsonian SN.

### References


