# Differences between patients with Parkinson's disease and healthy controls detected by high spatial resolution 3D-MRSI at 3 T

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## Introduction

Parkinson's disease (PD) is characterized by a degeneration of the neurons in the substantia nigra (SN) which leads to a neurological disorder of the extrapyramidal system. However, the causes for neuronal loss are not yet understood and the clinical assessment is very difficult. Proton MRSI is a specific tool for non-invasive evaluation of neurodegenerative diseases and provides biochemical information about the investigated tissue (1). However, the SN is a very small sized region inside the midbrain with high iron content. Therefore, low quality spectra are expected in the SN relative to other brain regions. The few published studies about MR spectroscopy in the region of the SN in PD used single-voxel spectroscopy at 1.5 or 4 T with volumes between 2.2 and 6 ml (2-4). The goal of this study was to develop an optimized 3D-MRSI protocol with a higher spatial resolution at 3 T for the measurement of the SN in patients with PD and healthy controls and to evaluate the diagnostic value of the method.

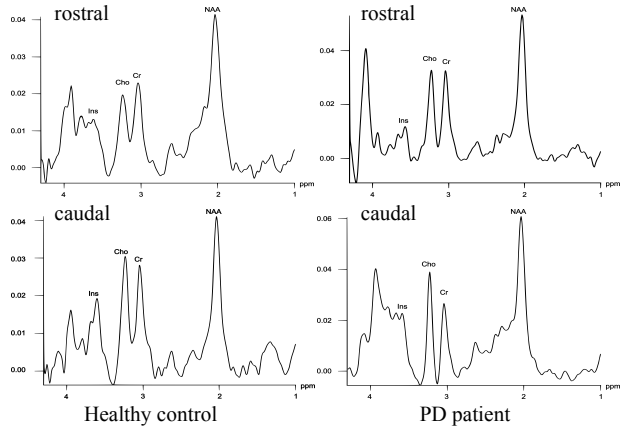


***Figure 1:*** *[1]H-MRSI spectra in the rostral and caudal regions of the SN of healthy control and PD patient acquired from 0.25ml volumes. NAA = N-acetylaspartate, Cr = creatine, Cho = choline, Ins = inositol*

## Material and Methods

17 subjects between 51 and 79 years have been included. Nine PD patients (mean 69 years) with disease durations between 4 and 25 years and eight age-matched neurologically healthy controls (mean 66 years) were examined. All MR examinations were carried out on a 3T MR whole-body scanner (Magnetom Tim Trio, Siemens Healthcare, Erlangen) with 32-channel or 12-channel head coil. The proton 3D-MRSI was performed using a point resolved spectroscopy pulse sequence (TE/TR = 30/1350 ms). The volume of interest was fitted to the size of the midbrain so that the region of the SN was located in the same voxels in all subjects. The resulting voxel size without interpolation was 6×6×7 $mm^3$ so that two enclosed voxels defined the region of the SN in the sagittal direction. Automatic and manual shimming procedure for optimization of magnetic field homogeneity and automatic adjustments of frequency and transmit power was performed. The total acquisition time was approximately 30 minutes. To avoid differences in data post-processing and curve fitting (for signal integration by the Syngo software package on the MR scanner) a fixed post-processing protocol without phasing and with an automatic baseline correction was used for all subjects. The metabolite/creatine ratios in the rostral and caudal regions of the SN were calculated. Neither connection of different coil load nor scaling on water signal was performed. Also no corrections for the relaxation times $T_1$ and $T_2$ as well as for the voxel composition were needed for intra-individual results.

## Results

3D-MRSI in the rostral and caudal regions of the SN was feasible with a voxel size of 0.252 ml and reproducible values for the metabolite/creatine ratios could be obtained in all subjects. The spectral quality in PD patients and healthy controls was similar based on the full width at half maximum for the NAA signal (16 ± 2.4 Hz in controls, 17 ± 2.3 Hz in PD patients). Typical [1]H-MRSI spectra are shown in figure 1. In all investigated healthy controls the intra-individual NAA/Cr ratios are higher in the rostral than in the caudal region of the SN without significant differences in the Cr levels. In contrast to the controls in all examined PD patients the intra-individual NAA/Cr ratios are lower in the rostral than in the caudal region of the SN with a clearly lower Cr level in the caudal region. These described differences in the intra-individual NAA/Cr ratios are shown in figure 2. However, an overlap exists in the inter-individual NAA/Cr ratios between the two groups as seen in figure 3.

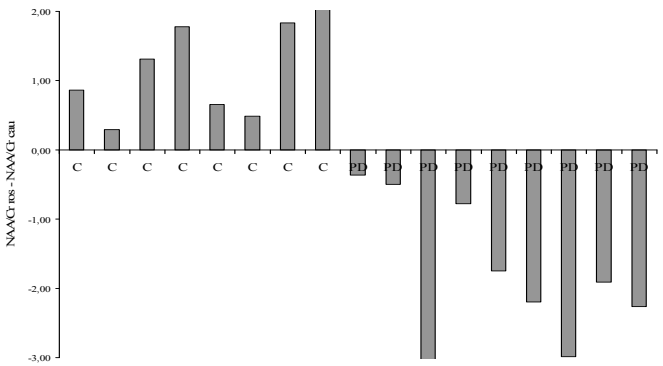


***Figure 2:*** *Differences between the NAA/Cr ratios rostral and caudal for each healthy control (C) and each patient with PD (PD).*

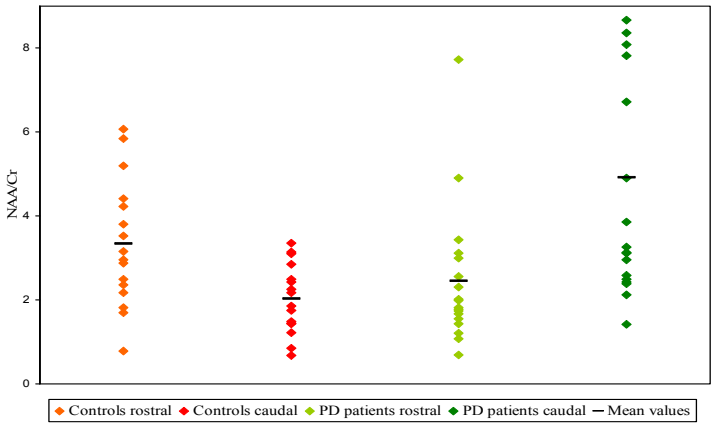


***Figure 3:*** *Distribution of rostral and caudal NAA/Cr ratios in healthy controls and PD patients.*

## Discussion

We have demonstrated the feasibility to obtain short echo [1]H-MRSI spectra of a good quality in the region of the SN with a very high spatial resolution of 0.252 ml at 3 T. For the first time we divided the SN in a rostral and a caudal part. Our results show clear differences between the intra-individual NAA/Cr ratios in the rostral and caudal region of the SN in PD patients compared to healthy controls. A further advantage of this method is that no "absolute" or group-specific metabolite levels are needed for inter-individual results. Only the intra-individual changes are relevant for the differentiation between healthy controls and patients with PD. Our results suggest that aspects of the pathophysiological process at the SN in patients with PD can be assessed by 3D-MRSI with high spatial resolution at 3 T.

## References

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