Superior cerebellar peduncle is differently damaged between progressive supranuclear palsy phenotypes

Maria Eugenia Caligiuri¹, Giuseppe Nicoletti¹, Andrea Cherubini¹, Maurizio Morelli², Gennarina Arabia², Aldo Quatrone¹²

¹Neuroimaging Unit, Institute of Bioimaging and Molecular Physiology (CNR-IBFM), National Research Council, Catanzaro, Italy.
²Institute of Neurology, University “Magna Graecia”, Catanzaro, Italy.

Table of Contents

Introduction

- The superior cerebellar peduncle (SCP) is functionally involved in the cerebello-thalamo-cortical loop in patients with progressive supranuclear palsy (PSP) [1].
- We investigated SCP integrity in the two disease variants, i.e., Richardson’s syndrome (PSP-RS) and PSP-parkinsonism (PSP-P), using an atlas-based, region-of-interest approach.
- In particular, we assessed SCP volume, mean diffusivity (MD) and fractional anisotropy (FA) in patients with PSP-RS, PSP-P and Parkinson’s Disease (PD), and in healthy controls (HC).

Materials & Methods

- Twenty-one patients with PSP-RS (mean age (SD) 71.9 5.9, 57% M), nine with PSP-P (70.1 4.8, all M), twenty with PD (68.9 5.9, 50% M), and thirty HC (69.2 7.2, 47% M) participated in this study.
- MRI protocol included whole-brain 3D T1-weighted and diffusion-weighted images.
- Identification of left and right SCP was carried out by means of a tractography-based probabilistic atlas [2]. Resulting masks were used to calculate volume, average FA and average MD of left and right SCP in all subjects (figure 1).
- Statistical differences in MRI metrics were assessed through analysis of covariance (ANCOVA) with age, sex and brain size as covariates, followed by Tukey’s Honest Significant Difference test. Significance threshold p<0.05 with false discovery rate correction for multiple comparisons.
- Discriminant analysis performed using leave-one-out cross-validation was performed to distinguish PSP phenotypes based on MRI.

Results

- Significant alteration of all SCP metrics (decreased volume and FA, increased MD) was present in patients with PSP-RS bilaterally.
- PSP-P compared to HC showed bilateral MD increase and right SCP volume decrease (and a trend towards significance for left SCP volume (p=0.07)). Compared to PD, PSP-P had decreased SCP volume bilaterally and decreased FA in the right SCP (with a trend towards significance in the left SCP (p=0.08)).
- In the comparison between PSP subtypes, PSP-RS patients had significantly decreased FA values (p=0.02) and significantly increased MD values (p=0.01) in the left SCP.
- Finally, we found a significant increase in FA in PD patients when compared to controls bilaterally.

Conclusions

SCP abnormalities are present in both PSP subtypes, albeit their entity is different across phenotypes: in fact, damage is more severe in PSP-RS than in PSP-P, despite significantly longer disease duration and higher severity of disease in the latter form. Diffusion metrics of the left SCP could separate PSP phenotypes with 70% accuracy.

References

2. de Schotten, Michel; Thiesbaut, Alberto; Batti, Flavio Della; Allen, Matthew; Walshe, Mark; Murray, Robin; Williams, Steven C; Williams, Dachel GM; Murphy, and Marco Carani. *Aving location, asymmetry and inter-subject variability of white matter tracts in the human brain with MR diffusion tractography.* Neurimaging 54, no. 7 (2011): 41-59.