# Individual Detection of Patients with Parkinson Disease using Support Vector Machine Analysis of Diffusion Tensor Imaging Data: Initial Results[1]

S. Badoud [2-5], D. Nguyen [3], I. Barnaure [1], V. Garibotto[4], K-O Lovblad [1], E.M. Rouiller [5], P.R. Burkhard [2] , S. Haller[1]

## Introduction

Parkinson's Disease (PD) is the second most common neurodegenerative disorder after Alzheimer's disease. Nowadays, brain MR imaging is routinely performed as a diagnostic tool but its use is mostly limited to the exclusion of other pathologies.

Based on the assumption that PD is linked to systemic brain modifications and that some recent investigations in neurodegenerative disorders[2-4] put in light a better sensitivity of white matter DTI tract-based spatial statistics (TBSS)[5] analysis versus gray matter VBM[6], we decided to perform a group level analysis as well as a pattern recognition analysis in order to detect PD patients among subjects with various forms of Parkinsonism at the individual level using support vector machine (SVM) technology.

## Methods

- 40 consecutive patients with parkinsonisim suggestive of PD who had (i) DTI at 3T without motion artefacts, (ii) brain $^{123}$I-ioflupane SPECT (DaTScan) as reference, (iii) extensive neurological testing including followup 17 PD subjects (age range, 67.8 ± 6.7 years; 9 women) and 23 other subjects (age range, 67.2 ± 9.7 years; 7 women) and (iiii) the absence of morphologic findings on brain MR imaging.
- TBSS group level analysis.
- Individual-level analysis including SVM classification.

## Results

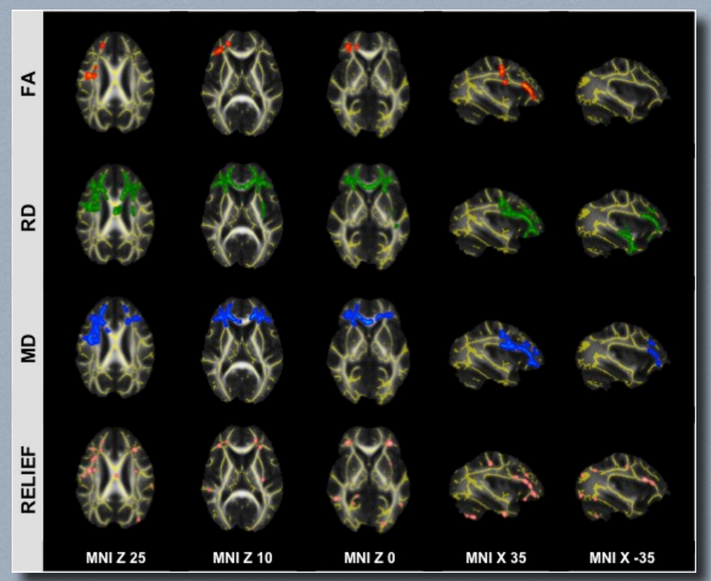


**Figure 1:**
TBSS analysis in PD. Patients with idiopathic PD versus Other had a spatially consistent increase in FA (red) and a decrease in RD (green) and MD (blue) in a bilateral network predominantly in the right frontal white matter. The spatially consistent difference in LD was just below threshold (not illustrated). Gray indicates mean FA value; yellow, average skeleton. FA, RD, and MD clusters are TFCE corrected for multiple comparisons at P <0.05. Supra-threshold voxels are enlarged by using TBSS fill (part of FSL) for illustrative purposes.

### TBSS Group Differences

The PD group compared with the Other group had a significant increase in fractional anisotropy (FA) and a corresponding significant decrease in radial diffusivity (RD) and mean diffusivity (MD), in particular in the right frontal white matter (Fig 1 and On-line Table). The level of significance of FA was slightly lower compared with RD and MD.

Longitudinal (LD) had spatially overlapping changes, which were just below threshold (not illustrated).

The inverse comparisons yielded no supra-threshold clusters.

### SVM Individual Classification Analysis

SVM analysis of FA provided a correct classification between PD versus Other with accuracies of up to 97.50 ± 7.54%. The spatial distribution of the most discriminative voxels (features) overlapped substantially with the results of the group- level TBSS analysis as illustrated in Fig 1 and Table 2.

**Table 2: Individual SVM classification of PD based on DTI FA TBSS**

17 PD, 23 Other: Chance Rate of Classification Accuracy, 57.5% (23/40)[a]

| No. of Features | Accuracy | TP Rate | FP Rate | TN Rate | FN Rate |
|---|---|---|---|---|---|
| 100 | 97.50 (7.54) | 0.94 (0.19) | 0.00 (0.00) | 1.00 (0.00) | 0.06 (0.19) |
| 250 | 95.50 (10.29) | 0.90 (0.25) | 0.00 (0.00) | 1.00 (0.00) | 0.11 (0.25) |
| 500 | 96.25 (9.65) | 0.91 (0.24) | 0.00 (0.00) | 1.00 (0.00) | 0.09 (0.24) |
| 750 | 97.25 (7.86) | 0.94 (0.20) | 0.00 (0.00) | 1.00 (0.00) | 0.07 (0.20) |
| 1000 | 96.25 (9.65) | 0.92 (0.23) | 0.00 (0.00) | 1.00 (0.00) | 0.09 (0.23) |

**Note:**—TP indicates true-positive; FP, false-positive; TN, true-negative; FN, false-negative.
[a] Accuracy, TP, FP, TN, and FN rates for individual classifications using an SVM classifier with the indicated number of selected features for the individual classification of PD versus Other. Note that the accuracy is calculated as the average accuracy of 10 repetitions using 10-fold cross-validation (average and SD).

## Conclusions

**We propose the current study as the initial results that show the feasibility of performing SVM individual classification of DTI data in PD, which may merit future prospective and larger scale follow-up studies.**

## References

1.Haller, S. et al. Individual Detection of Patients with Parkinson Disease using Support Vector Machine Analysis of Diffusion Tensor Imaging Data: Initial Results. AJNR Am J Neuroradiol (2012).doi:10.3174/ajnr.A3126
2.Karagulle Kendi, A. T., Lehericy, S., Luciana, M., Ugurbil, K. & Tuite, P. Altered Diffusion in the Frontal Lobe in Parkinson Disease. AJNR Am J Neuroradiol 29, 501–505 (2008).
3.Nave, Della, R., Ginestroni, A., Tessa, C. & Salvatore, E. Brain white matter tracts degeneration in Friedreich ataxia. An in vivo MRI study using tract-based spatial statistics and voxel-based morphometry. Neuroimage (2008).
4.Haller, S. et al. Combined analysis of grey matter voxel-based morphometry and white matter tract-based spatial statistics in late-life bipolar disorder. J Psychiatry Neurosci 36, 391–401 (2011).
5.Smith, S. M. et al. Tract-based spatial statistics: voxelwise analysis of multi-subject diffusion data. Neuroimage 31, 1487–1505 (2006).
6.Ashburner, J. & Friston, K. J. Voxel-based morphometry--the methods. Neuroimage 11, 805–821 (2000).

Hôpitaux Universitaires de Genève

1 Service neuro-diagnostique et neuro-interventionnel DISIM, University Hospitals of Geneva, Switzerland
2 Department of Neurology, Geneva University Hospitals and Faculty of Medicine, Universityof Geneva, Switzerland
3 Centre Diagnostic Radiologique Carouge, 1b Clos de la Fonderie, 1227 Carouge, Switzerland
4 Nuclear medicine and molecular imaging unit, DISIM, Geneva University Hospitals and Faculty of Medicine, University of Geneva, Switzerland
5 Dept. of Medicine, Unit of Physiology, University of Fribourg, Fribourg, Switzerland

8th FENS FORUM OF NEUROSCIENCE
14-18 July 2012, Barcelona, Spain

Read the article!