



# In vivo Mapping and Comparative Analysis of Human Saccadic Eye Movement Pathways by Diffusion Tensor MRI-based Tractography

Hachemi Nezzar, Joyce Nanjinga Nbekeani, Antoine Tardif, Anna Sontheimer, Jerome Coste, Frédéric Chiambaretta, Jean-Jacques Lemaire

## ► To cite this version:

Hachemi Nezzar, Joyce Nanjinga Nbekeani, Antoine Tardif, Anna Sontheimer, Jerome Coste, et al.. In vivo Mapping and Comparative Analysis of Human Saccadic Eye Movement Pathways by Diffusion Tensor MRI-based Tractography. Research in Vision and Ophthalmology ARVO Annual Meeting, Association for Research in Vision and Ophthalmology (ARVO), May 2016, Seattle, Washington, United States. pp.1672. hal-01658551

**HAL Id: hal-01658551**

**<https://uca.hal.science/hal-01658551>**

Submitted on 8 Nov 2018

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## ***In vivo* Mapping and Comparative Analysis of Human Saccadic Eye Movement Pathways by Diffusion Tensor MRI-based Tractography**

**Hachemi Nezzar**

Dept of Ophthalmology, CHU Clermont Ferrand, Clermont-Ferrand, France  
IGCNC EA 3295, Université d'Auvergne, Clermont Ferrand, France

**Joyce Nanjinga Mbekeani**

Ophthalmology & Visual Sciences, Albert Einstein College of Medicine of Yeshiva University, , NEW YORK, New York, United States  
SURGERY, North Bronx Health Network, NEW YORK, New York, United States

**Antoine Tardif**

Dept of Ophthalmology, CHU Clermont Ferrand, Clermont-Ferrand, France

**Anna Sontheimer**

IGCNC EA 3295, Université d'Auvergne, Clermont Ferrand, France

**Jérôme Coste**

IGCNC EA 3295, Université d'Auvergne, Clermont Ferrand, France

**Frederic Chiambaretta**

Dept of Ophthalmology, CHU Clermont Ferrand, Clermont-Ferrand, France

**Jean-Jaques Lemaire**

NEUROSURGERY, AUVERGNE UNIVERSITY, CHU clermont ferrand, CLERMONT FERRAND, France  
IGCNC EA 3295, Université d'Auvergne, Clermont Ferrand, France

## **Purpose**

Saccadic eye movements (SCM) are under the influence of the basal ganglia (BG) and SCM circuitry within the BG represents a good model for studying pathology in this system. The diagnosis of Parkinson's disease (PD) which affects SCM and its distinction from non-dopaminergic, essential tremor (ET) can be challenging and relies on clinical observations. Diffusion tensor imaging and fiber tractography (DTI-FT) a new MRI technology, can be used to evaluate the presence and integrity of white matter tracts using directional diffusion patterns of water. The purpose of this study is to use DTI-FT to analyze SCM networks within BG and compare PD and ET.

## **Methods**

We analyzed DTI-MRI images of 30 human brains: 20 pre-operative patients undergoing deep brain stimulation treatment for tremors – 10 PD and 10 ET; and 10 healthy control subjects (CS). 1.5 and 3 Tesla MRI were used for the image acquisition and BrainLab iplan 3.0 software used for mapping regions of interest (ROI) and deriving color-coded white matter tracts or tractography. BG pathways known to be involved with SCM were identified and the volume and size of the bundles representing their probabilistic connections measured. For each subject the 4 ROIs of BG: caudate nucleus (CN), external globus pallidus (GPe), substantia nigra (SN) and subthalamic nucleus (STN); pedunculopontine tegmental nucleus (PPN) and superior colliculus (SC) were outlined in both hemispheres. Fiber tracking was applied to analyze the probability of connection between ROI of the two BG. Mann-Whitney test was used to compare BG volumes; ANOVA and Tukey's tests were applied for multiple comparisons. Significance was set at  $p < 0.05$ .

## **Results**

The mean ages were 31.5 years for CS, 62 for PD and 65 for ET. 50% were female in each group. The mean disease duration was 10.5 years (PD) and 15.6 years (ET). The volumes of SN, GPe and CN were significantly larger in CS than both PD ( $p < 0.005$ ). However, the nigro-striatal connectome (neural connections) was reduced by 45.8% in PD and only 2.5% in ET compared to the CS group.

## **Conclusions**

We have shown that DTI-FT can be used for *in vivo* assessment of SCM pathways in BG. This new technology when used to complement routine clinical evaluation may represent a means for diagnosing PD and structurally distinguishing PD and ET. Thereby assisting with determination of targeted treatment regimes.

## Illustrations

Example of acquired 3D images of bilateral CN (green) and SN (purple) connectome.

