
The anatomo-functional organization of the hyperdirect cortical pathway to the subthalamic area using in vivo structural connectivity imaging in humans

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Résumé

Objectives:

The subthalamic nucleus (STN) receives direct cortical inputs which constitute the hyperdirect pathway of the basal ganglia circuitry. These cortico-STN projections are supposed to be anatomo-functionally organized. It has been shown in the monkey, that the motor cortices innervate the whole extent of the STN whereas the limbic cortices innervate only its anteromedial part extending more medially outside the nucleus. Tractography studies in humans have identified the motor cortical inputs to the STN, but little is known about the associative and limbic cortical projections. The aim of this study was to investigate the anatomo-functional organization of the hyperdirect pathway in humans originating from the whole cortex to the STN and also to the adjacent medial STN area (med-STN), often called the Sano triangle or posterior hypothalamus, which is a limbic area.

Material & methods:

We used diffusion weighted imaging-based tractography acquired from 30 healthy subjects from the Human Connectome Project. We performed whole-brain probabilistic tractography using MrTrix and extracted streamlines of interest between 39 cortical masks (each mask corresponding to one or several Brodmann areas) and both, the STN and the med-STN to provide track-density maps. Agglomerative clustering was used to classify the voxels of the regions of interest into 3 clusters.

Results:

We found that the STN receives major inputs from the sensorimotor cortices and few inputs from the limbic cortices. On the other hand, the med-STN receives mainly cortical limbic projections and few from the sensorimotor cortices. We found a dominant motor cluster

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located in the posterolateral STN, a limbic cluster located medially in the med-STN, and an intermediate motor-limbic cluster .

Conclusions:

Our findings show that the sensorimotor cortices are predominantly represented in the hyperdirect pathway and project mainly to the posterolateral part of the STN, whereas the great majority of the limbic cortices project to the med-STN.

Mots-Clés: Tractography, DBS, basal ganglia