Somatotopy in the GPi: Analysis of Motor Side Effects during Intraoperative Assessment in a Parkinsonian
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Somatotopie observée dans le Gpi: analyse d’effets moteurs indésirables au cours d’une stimulation cérébrale profonde chez un patient parkinsonien
(Somatotopy in the Gpi: Analysis of Motor Side Effects during Intraoperative Assessment in a Parkinsonian)

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INTRODUCTION

A somatotopy inside the human globus pallidus (GP), based on intra operative microelectrode-recordings during passive or active movement and on clinical results of deep brain stimulation (DBS) in movement disorders, has been described in the literature (27,5). We aimed at reporting a GP somatotomy, observed in one parkinsonian patient by dystonic motor side effect assessment during acute stimulation, and to MRI anatomy.

MATERIAL AND METHODS

History
A 65 years old right-handed woman suffered from Parkinson’s disease for 16 years, initially affecting the right upper limb with tremor. Before surgery, dyskinesia was encountered for the upper and the lower limbs, for the trunk with alternatively, severe blocking episodes. Moreover, an important bradykinesia was observed with chin and upper limb tremor.

Surgical technique

(Stereotactic MRI) On the first day, the stereotaxic Leksell G frame (Elekta, Sweden) was placed with its repositioning kit (Leksell repositioning kit, Elekta, Sweden) under local anesthesia. A stereotactic MRI was performed (Sonata 1.5 Tesla, Siemens, Germany) in three orthogonal planes (axial, coronal and sagittal). The voxel size was 0.52 × 0.62 × 2.0 (16.75x16.75x2.56 mm3). An turbo spin echo (TSE) sequence was used for the axial and the sagittal planes: TE = 1070 ms, TR = 10 000 ms, 16 × 16 matrix, 144 images. A White matter Attenuated Inversion Recovery (WARP) sequence was used for the coronal plane: TE = 1070 ms, TR = 10 000 ms, 16 × 16 matrix, 2 × 16 images (256 × 256 matrix). The frame was removed.

Planning: Direct targeting of GP was performed using a stereotactic software (PlanBrainLab, Germany). We identified all the segments of the Globus Pallidus. GP is commonly divided in two parts (4): the lateral and the medial segments, respectively named external GP (GPe) and internal GP (Gpi). An anatomic frame is 1 cm posterior and inferior to the central part of the GPi, i.e. from the internal capsule to the posterior part of the GPi. A small incision was then made and a steel probe introduced from the entry point to the junction between the 1st and the 4th quarter of GP according to its anterior-posterior axis (4). We planned three parallel tracts, a central one centered on the best anatomical target, a 2mm-lateral one and a 2mm-medial one on the left hemisphere, a central one, a 2mm-anterior one and a 2mm-lateral one on the right hemisphere.

Implantation surgery:
The following day, the stereotaxic frame was repositioned. Under local anesthesia, after recording of neuronal activity, an acute stimulation (monopolar, multiple contact) was performed using a multifrequency probe (4 mm diameter, 10 μsec, 2000 Hz, 6-10 amper; DF 3.3 mm). On the 3 tracks, 180 GP checkpoints, the involved body parts (face, upper and lower limbs) were matched with the anatomic structures.

A SOMATOTOPY OF DYSTONIC MOTOR SIDE EFFECTS WAS ENCOUNTERED INSIDE EACH PALLIDAL STRUCTURE

GPe, GPi lateral and GMi medial (GPMi) seemed to be characterized by a segregated body map.

Controlateral dystonic movements were noted during acute intraoperative stimulation and represented as pictograms along the distal 10mm on 3 parallel tracts on each side using probe views. Central (C), anterior (A) and lateral (L) tracts are explored on the Right pallidum and central (C), medial (M) and lateral (L) trajectories on the Left one. A scale represents the 10mm course of the stimulation exploration. (figures 1b and 1c)

Axial slices with surrounded structures are illustrated for the position -8mm, -4mm then 0mm on the central tracts (figures 1a and 1d).

We found inside each structure (Gpe, GPi and GPMi) a rostro-caudal somatotopic organisation

- face
  - superior part
  - intermediate part
  - inferior part.

- upper limb
  - superior part
  - intermediate part
  - inferior part.

- lower limb
  - superior part
  - intermediate part
  - inferior part.

DISCUSSION

The somatotopic organization analysis is an interesting spin-off of intra operative motor side effect analysis. The GP somatotomy related to these clinical conditions has to be confirmed. Studies have reported a somatotopy of clinical effect (dystonia(9), dyskinesia(2)) or a spatial organization of kinesthetic cells in Parkinsonian GP (7). Techniques of localization of clinical effects or anatomical structures should influence the results and have to be refined as proposed with our patent based approach.

References:
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