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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 disorder, has been described in the literature (2,7,9). We aimed at reporting a GP somatotomy, observed in one parkinsonian patient by dystonic motor side effect assessment during acute stimulation, and related 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, several blocking episodes. Moreover, an important bradykinesia was observed with chin and upper limb tremor.

Surgical technique

Stereotactic MRI. On the first day, the stereotactic 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 × 0.52 × 2.0 mm³ for axial + 2.0 mm³ for coronal + 2.0 mm³ for sagittal. A White matter Attenuated Inversion Recovery (WMI) sequence was used for the coronal plane: 1900 ms, 16 × 14 slices, 1.5 mm slice thickness + 1.5 mm images (the first 10 images). The frame was removed.

Planning: Direct targeting of GP was performed using a stereotactic software (plan; BrainLab, Germany). We identified all the segments of the Globus Pallidus (GP). GP is commonly divided in two parts (L, lateral) and the medial segments, respectively named external GP (GPe) and internal GP (GPI). As an auxiliary sensor or interneuronal microelectrode, in a basal and posterior position, partially separates the GP into a lateral (GPF) and a medial (GPI) subpart (2,4,5,6,6A). With the help of probe view reconstructions, we determined a trajectory, with a double oblique, avoiding the main vessels, going strictly through the pars interna and with an endpoint located at the lower boundary of the structure; we schematically placed the point at the end point at the junction between the 3rd and the 4th quart GP according to its main antero-posterior axis (1). We planned three parallel tracks, a central one centered on the best anatomical target, a 2mm-lateral one and a 2mm-medial one on the left hemisphere.

Implantation surgery. The following day, the stereotactic frame was repositioned. Under local anesthesia, after recording of neuronal activity, an acute stimulation (monophasic, square wave, 700µA, 60µsec) was performed using unshielded tungsten microelectrodes (worsted boron, length 20mm, diameter 4µm), with a microprobe system (Alphen, Germany). We explored the clinical effects every 1 or 2mm (set at 5mm from the distal 10mm on the 3 parallel tracks on each side. Controllased dystonic movements were noted (mean current = 0.37 ± 0.04 mA). On the 6 tracks, 18 GP checkpoints, the involved body parts (face, upper and lower limbs) were matched with the anatomic structures.

Then a quadrupolaire electrode (DBS 3387, Medtronic, USA) was placed on the selected track (the central one for both) with one or two contacts in the clinically most efficient area. Peroperative tale radiographic X-rays controls and postoperative non-stereotactic coronal TGSE MRI acquisitions were performed to control the electrode positioning.

Postoperatively, chronic DBS dramatically improved dyskinesia (electrodes implanted on the central tracks).

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

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

Controlateral dystonic movements were noted during acute intraoperative stimulation and represented as pictures along the distal 10mm on 3 parallel tracks on each side using probe views. Central (C), anterior (A) and lateral (L) tracks 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 surrounding structures are illustrated for the position -8mm, -4mm then 0mm on the central tracks (figures 1a and 1d).

We found inside each structure (GPe, GPi and GPim a rostro-caudal somatotopic organisation

- face • superior part
• upper limb ➤ intermediate part
• lower limb ➤ inferior part.

DISCUSSION

The somatotopy 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 somatotomy 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:

4. Parent M. and A.Parent. 2004. Parkinsonism Relat Disord. 10 mA, T 8, D 18, P 100 μsec and 1300 Hz

Post surgery clinical results.

- Initially, GPI DBS totally abolished dyskinesia. 3 months after the surgery
- Adverse effect: dyskinesia improved by 80% of voltage.
- 6 months post surgery
- 80% improvement on dyskinesia (auto evaluation)
- Minor efficiency on other parkinsonian symptoms
- Somatotopy of stimulation induced dystonia found with the Right DBS electrode (figure 2).

Stimulation parameters: 1.8V, 60µsec and 1300Hz