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Relationships between MRI anatomy and electrophysiological spontaneous unitary recordings in the subthalamic region during stereotactic surgery for severe idiopathic Parkinson's disease

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Objective. In the subthalamic area, the subthalamic nucleus (STN) is the main target for deep brain stimulation (DBS) in idiopathic Parkinson's disease (PD). We aimed at analysing relationships between the MRI anatomy and spontaneous neuronal activity in order to confirm the potential of microelectrode recording to assist in the determination of the optimal surgical target.

Methods. Thirty trajectories were analysed. Procedures (8 bilateral surgeries) were performed under local anaesthesia after identification on 1.5T MRI (T2 weighted) of anatomical structures, STN, above STN (zona incerta, forel's fields) and substantia nigra (SN). Spontaneous neuronal activity was recorded (30 seconds, 0.5 mm step), simultaneously along the distal 10 mm on a central (covering optimally STN) and on a 2 mm anterior track. Intra operative X-Ray controls checked that the exploration tracts followed the planned trajectories. Chronic DBS (on central tract 14 times out of 16) dramatically improved PD. We calculated cell numbers and mean firing rates (MFR, average firing on 30 seconds) on 276 isolated neurons (after threshold and principal component analysis) regrouped according to anatomical structures. MFR were compared with a non parametric statistical test.

Results. 60% of spontaneously active cells were in the dorsal and lateral STN. MFR increased entering STN and SN ($p < 0.03$): 5.88 ± 1.06 spike.sec⁻¹ above STN; 9.23 ± 1.22 spike.sec⁻¹ in STN; 14.46 ± 2.32 spike.sec⁻¹ in SN.

Conclusions. Anatomical boundaries and unitary recordings seem to be linked. We found a maximum number of spontaneously active neurons in the dorsal and lateral STN which is also known as a good surgical target for DBS in severe PD.