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Does Intraoperative Microrecording Really Increase the Risk of Hemorrhagic Complications in Deep Brain Stimulation?

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Dear Editor,

Stereotactic surgery represents a highly effective therapy for the treatment of Parkinson's disease and other movement disorders refractory to medical treatment. Despite its demonstrated safety, some rare adverse events could result in potentially disabling outcomes. Among them, hemorrhagic complications (HC) are unarguably the most dangerous and dreaded. In a recent systematic survey of the literature, the most important patient-related factors associated with an increased risk of HC were age and hypertension, whereas risk factors related to surgical technique included the use of intraoperative microelectrode recording (MER), the number of MER penetrations, and the sulcal or ventricular involvement by the trajectory[1]. The incidence of HC in studies adopting MER was significantly higher than that reported with exclusively image-guided approaches[1], [2], [3]. Furthermore, the coexistence of hypertension and MER has been associated to an additional rise of bleeding incidence[4].

Here we describe a large consecutive series of 221 patients undergoing surgery for Deep Brain Stimulation(DBS) lead placement at our institution mainly for advanced Parkinson's disease without the occurrence of HC despite the routinely use of intraoperative MER.

Medical records and postoperative imaging studies of all patients who underwent bilateral DBS lead placement at Torino University Hospital between October 1998 and December 2013 were collected. A written informed consent was obtained for all participants. The procedures consisted of a single-session bilateral stereotactic lead implantation[5], performed under local anesthesia by a single primary surgeon (ML), using the Cosman–Roberts–Wells stereotactic frame (CRW, Integra Radionics, Burlington, MA). Cranial magnetic resonance imaging (MRI)/computed tomography (CT) image fusion (Image Fusion, Integra Radionics and I-Plan Stereotaxy, Brainlab AG, Feldkirchen, Germany) was used for anatomical targeting, adopting the Schaltenbrand-Wahren atlas as a reference[6]. Patients were positioned supine with their head slightly elevated (approximately 15°). A 14-mm burr hole was located along the planned trajectory and specific lead-anchoring systems fixed to the skull (burr-hole ring and cap early in the series; Stimloc, Medtronic, Minneapolis, MN, more recently). The dural and pial entry points were coagulated with bipolar electrocautery and opened sharply. To minimize the risk of HC, a trajectory avoiding sulci, arteries and ventricles was plotted. Intraoperative electrophysiological recording with a single-track MER was performed starting from 10 mm above the anatomical target (Microtargeting Electrodes BP, FHC Inc., Bowdoin, ME, early in the series, and Neuroprobe™, Alpha Omega, Nazareth, Israel, more recently). The electrical signals acquisition was followed by a microelectrode stimulation to evaluate both beneficial and side effects, utilizing the MicroGuide Pro™ system (Alpha Omega). When MER did not reveal a typical neuronal activity and/or microelectrode stimulation highlighted low-threshold side effects, a second or even a third track was performed using the Ben Gun device. During the microrecording and stimulation procedure, cerebrospinal fluid loss was minimized by flooding the surgical field with saline and sealing the burr hole with oxidized cellulose chips. Expert

and trained neurologists examined both beneficial and side effects. Finally, the definitive quadripolar electrode (electrode model 3389, Medtronic) was placed along the best trajectory. In order to screen for surgical complications, all patients underwent an immediate postoperative CT scanfollowed by a cranial MRI 7 days later. In the occurrence of new symptoms suggestive of potential neurological complications additional neuroimaging scans were performed.
As shown in *Table 1*, a total of 442 quadripolar electrodes (procedures) were implanted in 221 consecutive patients affected by Parkinson's disease (130 males, 86 females), essential tremor (3 males) or dystonia (1 male, 1 female). A total of 590 MER tracks were performed (a mean of 1.33 tracks for each procedure; more than 3 tracks in 4 procedures; 3 tracks in 13 procedures; 2 tracks in 109 procedures and 1 track in 316 procedures).

Table 1: Demographic and clinical characteristics of 221 patients undergoing placement of DBS electrodes utilizing intraoperative MER.

	Total	Parkinson's disease	Essential tremor	Dystonia
Patients	221	216	3	2
Electrodes implanted	442	432	6	4
N^{o} of MER tracks	590	575	7	8
Gender (M/F)	134/87 (60.6%/39.4%)	130/86 (60.2%/39.8%)	3/0 (100%/0%)	1/1 (50%/50%)
Age (years)	60.7 ± 6.9	60.6 ± 6.7	72.7 ± 2.9	25.0 ± 1.0
Hypertension	42 (19%)	41 (19%)	1 (33.3%)	0 (0%)

Forty-two patients (19%) suffered form hypertension. The mean age at surgery was 60.7 ± 6.9 years (males 60.8 ± 6.9; females 60.5 ± 6.9). No HC occurred during both intraoperative and postoperative period.

Hemorrhage is one of the most serious side effects in functional neurosurgery, and it is reported to have an overall incidence of up to 5%[1], [2]. In our large series of patients we did not observe any HC, even though the population characteristics – in particular age and hypertension percentage – were similar to those reported in literature[3], [4]. In all procedures, we routinely performed intraoperative electrophysiological monitoring by means of MER, considered a significant bleeding risk factor[1], [3], especially if associated with hypertension[4]. These considerations raise the question of whether other factors could contribute to the increased risk of HC.
Indeed, in this series of patients, a thorough trajectory pre-surgical planning, a sequential multiple tracks MER, and the application of standardized procedures by an experienced team, probably were able to prevent the occurrence of significant hemorrhagic complications.

In conclusion, we suggest that the use of MER in DBS procedures is not necessarily associated with a high risk of HC, given a careful patient selection accompanied by the application of standardized surgical procedures by a trained multidisciplinary team.

Ethical standard

The authors declare that they acted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. All patients included in this survey signed a written informed consent before surgery.

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Financial disclosures and conflict of interest

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