Recovery from complete hemiplegia following resection of a retrocentral metastasis: the prognostic value of intraoperative cortical stimulation

Case report

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The goal in this study was to determine if intraoperative electrical stimulation mapping is useful during surgical resection of lesions located in the central region, even in cases of preoperative hemiplegia. This 45-year-old man with a retrocentral metastasis from an embryonal carcinoma of the testis suffered an acute complete hemiplegia after intratumoral bleeding. Emergency surgery was performed with the aid of intraoperative motor mapping despite the preoperative deficit. Cortical stimulations (CSs) elicited motor responses, allowing the detection and hence preservation of the primary motor area during tumor removal. Postoperatively, the patient recovered almost completely within 1 week; the tumor resection was total.

It is possible that CSs give an early and valuable prognostic indicator of motor recovery in cases of complete hemiplegia, at least in patients with acute onset and short duration of the deficit. Consequently, if motor responses can be elicited by CSs, it becomes mandatory for the surgeon to respect the primary motor area despite the preoperative hemiplegia, with the aim of preserving the chances of an eventual recovery.

KEY WORDS • functional localization • cortical stimulation • motor cortex • hemiplegia • metastasis • germ cell tumor

Intraoperative brain mapping in which direct electrical stimulations are used has been widely described as a safe, accurate, and reliable method of identification and thereby preservation of eloquent brain areas during surgery in functional regions. Nonetheless, this method was proposed only for patients with normal results or slight deficit on preoperative neurological examination. In this work we report the usefulness of CS in a patient presenting with a complete hemiplegia preoperatively. With CSs we were able first to detect, then preserve the primary motor area by observing the movements induced despite the hemiplegia, and subsequently to predict the postoperative recovery.

Case Report

History. This 45-year-old right-handed man received a diagnosis in June 2000 of disseminated nonseminomatous germ cell tumor (embryonal carcinoma) of the testis, with metastases in the liver and the lung. A CT scan of the brain demonstrated no tumor. The left testicle was excised, then six courses of chemotherapy (bleomycin, etoposide, cisplatin) were administered. The patient returned to normal life with no neurological deficit.

Presentation and Examination. In January 2001, a right hemiparesis and hemihypesthesia occurred, with an acute worsening 6 days later. The patient presented at our institution with headaches and vomiting, and at clinical examination a complete right hemiplegia and right-sided sensory loss were observed. A CT scan demonstrated a left-sided tumor located in the central region, with intratumoral hemorrhage, cyst, and perilesional edema (Fig. 1).

Operation. After induction of general anesthesia with propofol, emergency surgery was performed aided by intraoperative brain mapping in which electrical stimulations were used according to the methodology already described by Duffau, et al. Despite the brain edema after dura opening, CSs were first performed (the motor mapping took approximately 1 minute). Motor responses of the upper limb were induced by stimulating the region immediately in front of the part of the tumor extending to the surface (the region corresponding to the primary motor area covering the cyst). The CSs were performed at an intensity of 16 mA (bipolar probe with 5-mm space between tips, biphasic current, pulse frequency 60 Hz, single-pulse phase duration 1 msec); no movement was elicited at a lower intensity.

Consequently, no attempt was made to evacuate the cyst first, which nevertheless represents the more rapid solution to decrease the brain pressure. On the contrary, to avoid an injury of the motor area despite the preoperative hemiplegia, the hemorrhagic part of the lesion was first removed, with subsequent aspiration of the cyst. Moreover, taking

Abbreviations used in this paper: CS = cortical stimulation; CT = computerized tomography; TMS = transcranial magnetic stimulation.
Prognostic value of intraoperative cortical stimulations

![Image 1](https://via.placeholder.com/150.png?text=Preoperative contrast-enhanced emergency CT scan revealing a left-sided enhancing lesion with intratumoral bleeding and cyst in the central region. The arrow indicates a strip of cortex covering the cyst: intraoperative electrical stimulations revealed that this region corresponded to the primary motor cortex, which was then preserved during the resection.)

Fig. 1. Preoperative contrast-enhanced emergency CT scan revealing a left-sided enhancing lesion with intratumoral bleeding and cyst in the central region. The arrow indicates a strip of cortex covering the cyst: intraoperative electrical stimulations revealed that this region corresponded to the primary motor cortex, which was then preserved during the resection.

![Image 2](https://via.placeholder.com/150.png?text=Immediate postoperative CT scan demonstrating an edema with no residual lesion (no enhanced tumor and no cyst).)

Fig. 2. Immediate postoperative CT scan demonstrating an edema with no residual lesion (no enhanced tumor and no cyst).

...into account the lack of motor response during subcortical stimulations of the anterior wall of the cavity following cyst evacuation, the anterior capsule of the tumor plus a margin of a few millimeters were resected to perform a supracomplete removal.

At the end of the procedure, CSs were again performed but at a lower current intensity to avoid seizures; motor responses of the upper limb were elicited at an intensity of only 10 mA.

Postoperative Outcome. Postoperative recovery was rapid and favorable, beginning with reappearance of voluntary movements of the hand 3 hours after extubation, then of the lower limb 12 hours later. The patient recovered to almost normal status within 1 week, walking unaided and holding objects with his right hand. Two weeks later, his recovery was total, with fine finger movements again possible. On immediate postoperative CT scans we confirmed the total tumor removal; there was no residual enhancement after contrast injection (Fig. 2). Histological examination revealed the tumor to be a metastasis from a nonseminomatous embryonal carcinoma of the testis. No recurrence was found outside the brain, and local adjunctive radiotherapy was chosen.

Discussion

Intraoperative electrical stimulations are used by many surgeons during resection of lesions located in the central region, to identify the cortical primary motor area and the corresponding subcortical corticospinal pathways.\(^{1,2,4-6,11}\)

To my knowledge, however, these series included reports of brain motor mapping only in patients with normal results or moderate hemiparesis on preoperative neurological examination, because the goal was to preserve the function existing before surgery (and sometimes to allow a postoperative improvement in cases of hemiparesis caused by compressive lesions). Indeed, it seems logical to think that in a patient with a complete hemiplegia, CS might not elicit any motor response.

In fact, this case shows that involuntary movement can be induced by direct CS, that is, that electrophysiological (and likely biochemical) properties of pyramidal cells can be preserved to passively produce the muscular contraction, even when voluntary movements are impossible. This might be explained by an inhibition of the motor circuitry due to vascular phenomena secondary to the compression of the primary motor area by the tumor, but without definitive destruction of these networks. Indeed, the hemiplegia does not seem to be related in this case to a dysfunction of the premotor or supplementary region, because the tumor had a retrocentral location, and its edema involved essentially the primary motor area itself, as demonstrated on the preoperative CT scan, and because the pattern of clinical recovery was not typical of a supplementary motor area syndrome as classically described.\(^{11}\)

Therefore, the main clinical implication of such an observation is that the hemiplegia can resolve if CS still elicits motor responses: intraoperative CS seems to represent an early and valuable prognostic indicator of motor recovery, by testing the anatomofunctional integrity of the corticospinal pathways. Indeed, although it is well known that hemiplegia due to an ischemic stroke or direct tumor infiltration of the primary motor cortex would portend a worse prognosis than in cases of compression of this area, it was nevertheless recently shown using functional imaging that some patients with poststroke hemiplegia may retain the ability to use motor imagery to activate partially damaged motor areas corresponding to the impaired hemibody, leading to secondary recovery.\(^{13}\) Thus, the possibility of functional restoration is sometimes difficult to assess using classic clinicoradiological data.

Moreover, CS seems also able to give indirect information about the level of damage to the primary motor area throughout the surgical procedure, via the threshold of current intensity necessary to induce the movement. Indeed, in this case, the intensity decreased from 16 to 10 mA, respectively, before resection (when the patient was clinically hemiplegic) and after tumor removal (when the patient recovered). A predictive value of CS was previously suggested by investigators who used the noninvasive method of TMSs; Cruz Martinez, et al., recently observed within the first few days after stroke in 20 patients that TMS may be a prognostic indicator of hand function recovery, because all patients with early response to TMS achieved good motor function in the following months.
Taking into account this predictive aspect of intraoperative CS, brain mapping should lead the surgeon to modify the extent of resection when motor responses are elicited, even in cases of preoperative hemiplegia. Specifically, the primary motor area should be preserved if detected on CS, as it is in patients who have no neurological deficit before surgery. In our patient, although it seemed logical to remove the solid portion of the tumor first because it extended to the cortical surface, whereas the cyst was covered by a rim of cortex, it was nevertheless tempting to evacuate the cyst first to obtain an immediate decrease of pressure from the major brain swelling, rather than preserve a thin rim of cortex in a patient with hemiplegia. Moreover, cortical and subcortical stimulations may be used to aid in resection according to functional as well as anatomical boundaries, allowing us to optimize the quality of tumor removal; this maximization is justified because the surgeon knows that the patient will recover. Indeed, as in brain tumors in general, in cases of metastasis from testicular neoplasms (an unusual but more frequent entity because survival is prolonged due to advances in chemotherapy7), an extensive resection will produce better results.14 Thus, the use of CS allows a better functional and survival prognosis.

Conclusions

Cortical stimulations may represent an early and valuable prognostic indicator of motor recovery in cases of complete hemiplegia, at least in patients with acute onset and short duration of the deficit. Consequently, if motor responses can be elicited by stimulations, it becomes mandatory for the surgeon to respect the primary motor area despite the preoperative hemiplegia, with the aim of preserving the chances of an eventual recovery. Experience in a larger group of patients is necessary to confirm this preliminary report: thus, the more systematic use of intraoperative CS, even in patients with a major motor deficit, should be considered.

References


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