Purely subcortical tumors in eloquent areas: awake surgery and cortical and subcortical electrical stimulation (CSES) ensure safe and effective surgery

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Introduction

To analyze the efficacy and safety of cortical and subcortical electrical stimulation (CSES) and awake surgery to approach purely subcortical tumors in highly functional locations, particularly in guiding the choice of the best transcortical path.

Methods

Prospective analysis of the surgical, neurological, and radiological outcome of patients harboring supratentorial, subcortically located brain tumors or vascular malformations who are operated on through awake surgery and CSES. Functional magnetic resonance (fMR; either sensory-motor or language, based on the location) was performed in order to confirm the proximity to functional cortical areas. Major white matter tracts were investigated by MR diffusion tensor fiber tracking (DTI-ft). The Rankin modified score was chosen to express the pre and postoperative functional neurological status. Immediate postoperative MR was used to evaluate the extent of resection.

Results

Twenty patients were selected. The main distance of the tumors from the cortical surface was 18.2 mm (range 9 -48 mm). Neuronavigation was used to show the most direct route to the tumor (transsulcal or transgyral), but CSES was fundamental to adapt the surgical corridor to the functional topography both cortically and subcortically.

If the transgyral route was chosen, CSES helped to detect a non-eloquent area. When a transsulcal route was preferred, CSES documented the presence or absence of function in the deep sulcus. The transient postoperative morbidity was 76.4%, but at last follow-up (range 4-20 months), all the patients regained preoperative status and 2 improved. Postoperative MR demonstrated complete resection in all cases.

Conclusions

Approaching purely subcortical tumors requires microsurgical skills, but in eloquent areas, functional topography monitoring is mandatory to allow safe surgery. CSES in an awake patient is a method that produces very good results in terms of resection and neurological outcome.

Learning Objectives

To use direct brain mapping with cortical and subcortical stimulation to create safe corridors through the brain and remove purely subcortical tumors in eloquent areas.

References

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Up Figure . A 69-year-old right-handed female. Transient speech disturbances. No impairment on neuropsychological tests. A) A contrast enhancing inhomogeneous mass was found in the left inferior fronto-parietal white matter that extended deep to the cortico-spinal tract (CST). B) DTI-ft demonstrated the vicinity of the CST to the deep and anterior aspect of the mass. C) Intraoperative CSES (1, 2: speech arrest; 7: anarthria; 6: motor area of the mouth; 8,9: oral apraxia). Blank tags refer to a gyrus that the neuronavigator indicated as the most direct approach to the tumor. D) A little cortectomy was sufficient to reach and remove the tumor. Subcortical stimulation revealed the presence of the CST that constituted the deepest boundary. E and F) Postoperative MR with (E) and without (F) gadolinium confirmed total resection. The patient had a completely uneventful postoperative course

Down figure. 46-year-old female, 2 episodes of hemorrhage and left hemiparesis. A) MRI: bleeding enhancing tumor in the periventricular white matter underneath the central area. DTI-ft of the cortico-spinal tract B) Intraoperative: motor area of the arm,forearm, face; sensory-motor area of the hand. Blue arrow: central vein. C) Subcortical dissection was alternated with stimulation, leaving the anteriorly descending motor pathway of the arm and trunk (11, 12, 13) (retractors are applied only to show the subcortical findings. D) The tumor is completely removed (Fig. E and F, postoperative MR). Postoperatively, the patient experienced left hemiparesis, predominantly at the lower limb. G-H-I) At 3 months follow-up, the patient showed no weakness. Histology: breast cancer metastasis.