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Deep motor cortex cavernoma resection supported by navigational intraoperative monitoring. A case report

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ABSTRACT

Introduction: Cavernomas are benign hamartomas of cerebral and spinal vessels, accounting for less than 1% of all arteriovenous malformations. In general, surgical resection is the treatment of choice for enlarging cavernomas or those associated with medically refractory seizures. Herein, we report a case of an enlarged deep precentral gyrus cavernoma, with a discussion of the surgical approach and the impact of intra-operative neurophysiological monitoring on the preservation of motor function.

Case description: A 30-year-old male was referred to our hospital due to 2-month history of focal seizures. Initial magnetic resonance imaging revealed right precentral cavernoma with minimal right parietal subarachnoid haemorrhage. Revealed the location of the cavernoma deep in the right primary motor cortex. Surgery was performed, trans-sulcal dissection was done with the aid of intraoperative ultrasonography neuro-navigation. The cortical motor map was localized by functional mapping with intra-operative neurophysiological monitoring, including somatosensory evoked potentials (SEP) and motor evoked potentials (MEP). Postoperatively, the left side weakness grade was 4/5, and the Glasgow coma scale was 15. Postoperative imaging confirmed successful resection of the cavernoma and associated hemosiderin ring with no SAH.

Conclusion: The use of preoperative MRI and intraoperative ultrasonography supplemented by neurophysiological monitoring utilizing SEP, MEP, and cortical mapping is essential for the safe resection of paracentral cavernomas.

INTRODUCTION

Cavernomas are benign hamartoma of cerebral and spinal vessels. Its prevalence ranges from 0.1% to 0.8% in the recent literature, accounting for 8-15% of cerebral and spinal arteriovenous

Keywords

trans-sulcal approach,
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malformations. Their formation is related to gene mutations such as CCM1, CCM2, and CCM3, which can occur in hereditary and sporadic forms [5]. They commonly comprise different presentation hemorrhages and calcifications according to age [6]. Intracerebral hemorrhage occurs in 30% of cases as the initial complication, leading to the frequently encountered presentation, seizures, and other neurological deficits [2,9].

Cavernomas can be managed conservatively; surgical resection is the treatment of choice for enlarging cavernomas or those associated with medically refractory seizures [7]. Paracentral Cavernomas are quite challenging cerebrovascular pathological entities owing to the prospects of their surgical resection without adversely affecting the eloquent areas around the central sulcus. Particularly in deep and subcortical cavernomas, wherein it is demanding to localize and excise. Following dissection, immediate impairment in sensory and motor activity may ensue. As such, direct electrical cortical stimulation (DES) for cortical somatosensory and motor mapping is an integral part of surgeries with such lesions to preserve function [12,13].

Herein, we report a case of a 30-year-old male who suffered from a 2-month history of focal seizures caused by an enlarged deep precentral gyrus cavernoma. We discuss the surgical approach and the impact of intra-operative neurophysiological monitoring on the preservation of motor function.

CASE SCENARIO

A 30-year-old male was referred to our hospital due to 2-month history of focal seizures. Initial magnetic resonance imaging (MRI) revealed right precentral cavernoma with minimal right parietal subarachnoid haemorrhage (SAH). The patient was advised to take a single session of stereotactic radiosurgery, but the lesion increased in size in spite.

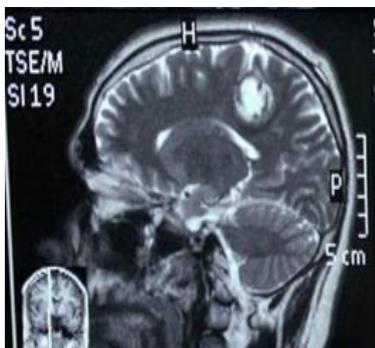
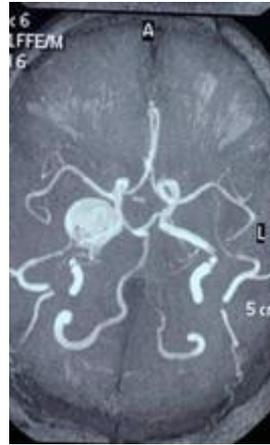


Figure 1. A: Pre-operative sagittal T2-weighted MRI, reveals the location of the cavernoma deep to the precentral gyrus (primary motor cortex).



B: Pre-operative axial MRA, views the relation between the cavernoma and the cerebral vasculature

Pre-operative MRI (Fig.1) revealed the location of the cavernoma deep in the right primary motor cortex. Surgery was performed, trans-sulcal dissection was done with the aid of intraoperative ultrasonography neuro-navigation (Fig.2). The cortical motor map was localized by functional mapping with intra-operative neurophysiological monitoring (IONM), including somatosensory evoked potentials (SEP) and motor evoked potentials (MEP). As the lesion was deep to the precentral gyrus, DES – bipolar mode (Fig.3) identified the face motor area. The area with the lesser corresponding facial motor activity was chosen to start trans-sulcal dissection. Complete resection of the cavernoma with the surrounding epileptogenic hemosiderin ring was achieved with preservation of the eloquent motor area.

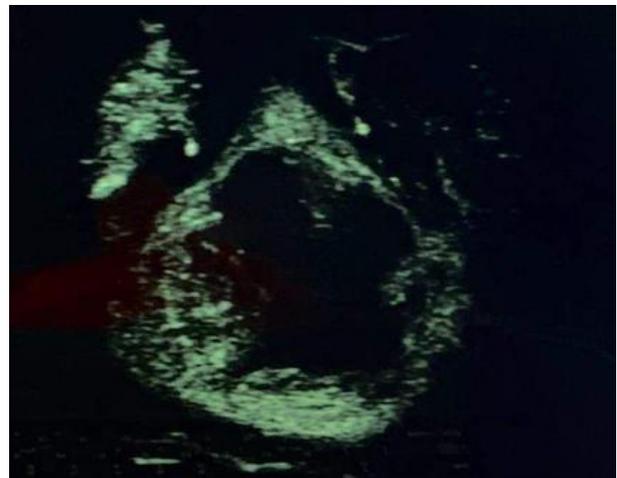


Figure 2. Intra-operative ultrasonography neuro-navigation showing the exact localization of deep motor cortex cavernoma.

Post-operatively, the patient had a seizure due to DES during neuro-navigation and left side weakness grade 4/5, which improved gradually 3 hours later. Glasgow coma scale was 15 (E4V5M6. A postoperative CT scan (Fig.4) confirmed successful

resection of the cavernoma and associated hemosiderin ring with no SAH.

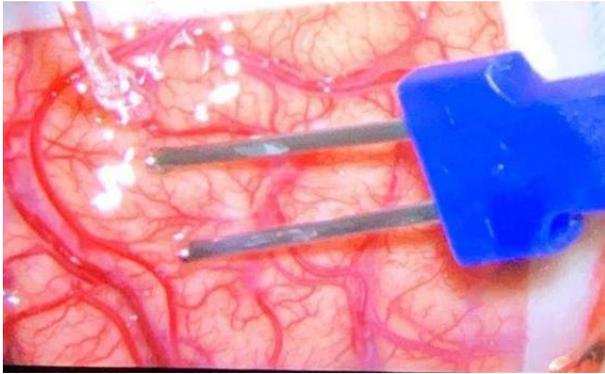


Figure 3. Intra-operative image through the right parietal approach, supine position, direct cortical stimulation – (Penfield method) bipolar mode for motor mapping.

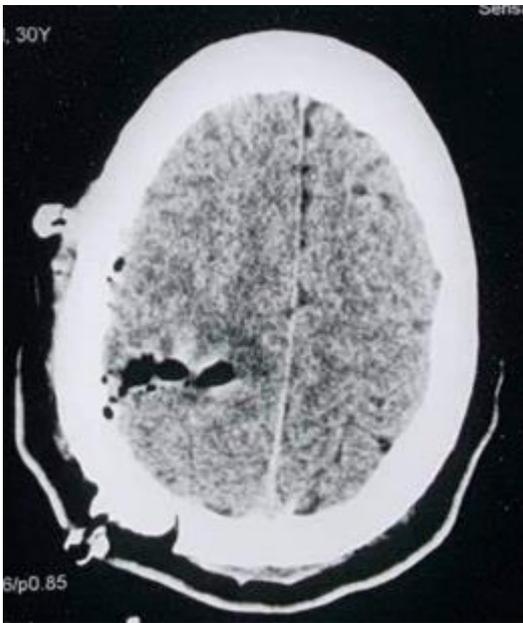


Figure 4. Postoperative axial CT scan, showing the complete resection of the cavernoma

DISCUSSION

Paracentral cavernomas signify a significant challenge to the neurosurgeon, owing to the high risk of complications following its excision, especially in deep and small subcortical lesions, as it involves eloquent areas. Microsurgical operation for symptomatic cavernoma is the management of choice to reduce the frequency of seizures and alleviate the mass effect. But the risk of bleeding, and severe neurological deficits, make this decision difficult. Surgical removal can result in abrupt cortical

damage and consequent sensory and motor function deterioration. Therefore, it is crucial to precisely recognize the anatomical landmarks preoperatively and intraoperatively to preserve vital structures, which can be achieved by the appropriate application of neurophysiological monitoring. In this report, successful removal of precentral cavernoma was accomplished through four vital components; meticulous identification of the lesion, accurate evaluation of motor function, minimally invasive trans-sulcal dissection, and optimal removal of the lesion with the surrounding hemosiderin tissue.

Epileptic seizures represent the most periodic symptom of patients with cavernoma. Deep cavernomas have a higher risk of hemorrhage than superficial ones, the blood by-products like iron precipitate in the vicinity of the lesion as hemosiderin stain ring with high epileptogenic latency. This makes the complete removal of the lesion insufficient for patients with epileptic seizures unless the stained tissue is excised. However, the intraoperative surgical decision depends on accounting for all possible complications and postoperative outcomes considering the eloquent area preservation a priority [8].

The trans-sulcal dissection is a harmless and applicable approach to target deep-seated cerebral lesions. It provides pursuing the natural aisles of the brain, the sulci, to obtain better exposure to the lesion and enough dissection depth. Dispensing brain retraction by dissecting the normal brain pathways is safer for gyral layers and confers motor function preservation. No serious complications of the trans-sulcal approach are reported especially with pre-operative MRI, IONM, intraoperative neuronavigation, and brain mapping [3].

Pre-operative CT scan demonstrates a typical hyperdense lesion in the right motor cortex and precentral gyrus around the omega sign of the central sulcus. MRI revealed a focal heterogeneous hyperintensity area deep in the right parietal lobe with a low signal intensity peripheral ring indicating a bleeding episode. Intraoperatively, exact localization was confirmed by intraoperative ultrasonography neuro-navigation; this assisted image guidance is believed to decrease morbidity. It can overcome intraoperative cerebrospinal fluid loss and cortical shifting, improving the neuro-navigation accuracy [10,11]. Proposed direct cortical stimulation by a bipolar handheld probe (Penfield Method) with

a setting of 50 Hz frequency, 5-10 mA current intensity, and 0.3-1 msec pulse duration. Cortical motor mapping was achieved by defining the central sulcus, stimulating the precentral gyrus, and localization of the primary motor cortex (Brodmann area 4) [1]. The area with the lowest face motor function was chosen to start the dissection. Pavia *et al.* reported that the complementary use of cortical motor mapping by DES and neuronavigation are the gold standards in deep lesions resection [8].

After using intraoperative ultrasonography neuro-navigation to visualize the position of the cavernoma, trans-sulcal dissection started by separating cortical vessels and dissecting through the central sulcus – peri omega sign of the right frontal lobe reaching 3 cm trans-sulcal depth (Fig. 5) [4]. Gross excision of the cavernoma with the associated epileptogenic hemosiderin ring was achieved. IONM confirmed intact limb movement after recording multiple responses from abductor pollicis brevis in the upper limbs and abductor hallucis in the lower limbs. Postoperative assessment of functional impairment was calculated by the Karnofsky performance status scale (100 scores). Postoperative observation at the Intensive Care Unit for 24 hours and routine postoperative CT with regular follow-up was done.

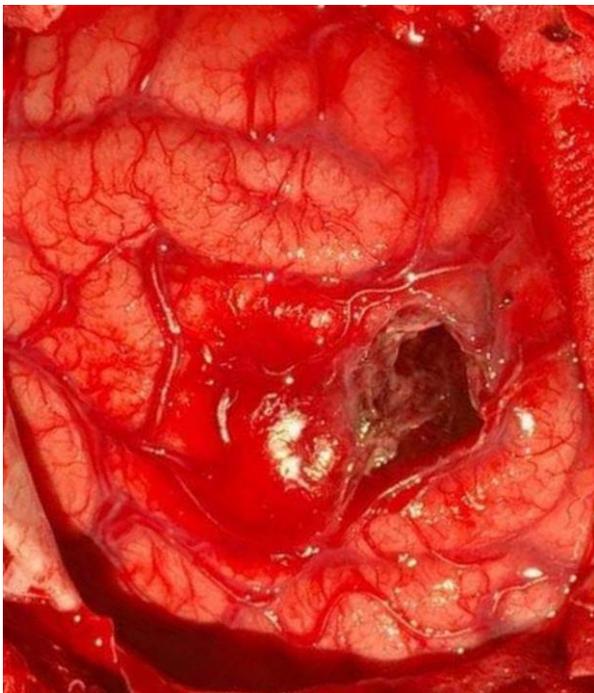


Figure 5. Intra-operative image shows the depth of the trans-sulcal dissection

The supplementary use of preoperative MRI and intraoperative ultrasonography and IONM using SEP, MEP, and cortical mapping is crucial to ensure safe excision of the lesion with preservation of the eloquent area. A trans-sulcal approach based on anatomical and neurophysiological data can provide safe and minimally invasive dissection for removing deep paracentral lesions with the surrounding hemosiderin tissue.

CONCLUSION

In this report, complimentary preoperative MRI and intraoperative ultrasonography supplemented by neurophysiological monitoring using SEP, MEP, and cortical mapping is essential for precise identification of paracentral cavernomas, to discern ominous signs, and to avoid traumatizing the eloquent area.

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