Awake Craniotomy for mapping of the cortical language areas during brain AVM surgery

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Introduction

Awake craniotomy for removal of intra-axial lesions is a well-established procedure. However, it has not been well characterized for resection of AVM within or adjacent to cortical language areas.

Methods

Patients undergoing awake craniotomy for AVM resection, located within or in proximity to eloquent language areas were included. Surgery was performed with the asleep-awake-asleep protocol. Cortical stimulation was carried out using a 50 Hz bipolar stimulator. Stimulation was initiated at an intensity of 2 mA and increased stepwise by 2 mA to a maximum of 10 mA before claiming a specific cortical region negative for language functions. In positive language site, the area was re-stimulated 3 times to confirm the functional deficit. Language monitoring was conducted by the neurocognitive team, using details of speech production and comprehension

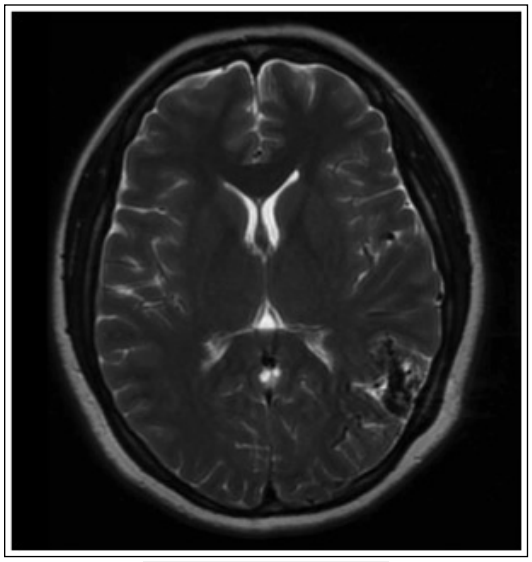
Results

Between Jan 2009 and Feb 2014, thirty eight surgeries for brain AVM resection were performed. Four patients with left sided language area underwent awake craniotomy. Pre-operative functional MRI showed the language activation area approximately 5 mm from AVM nidus in all. The AVM locations were fronto-opercular in two and posterior temporal in the other two. The AVM Spetzler-Martin grade were II (2 patients) and III (2 patients). In 1 patient, complete speech arrest was noticed and care was taken to not to breach that specific zone during microsurgical resection. Complete resection was achieved in all 4 patients. One patient experienced mild post-operative expressive aphasia which improved to normal within 6 weeks. There were no complications related to awake craniotomy and no permanent neurological morbidity, resuting in excellent outcome in all 4 patients.

Example Case

A 38-year-old right handed female was transferred to our institution from a community hospital after experiencing two generalized seizures with a non-contrast head CT scan which was read as normal. She had a mild right hemiparesis and complained of headache, nausea and dizziness over the past two weeks. She had a five-year history of infrequent generalized seizures for which she took levetiricitam and gabapentin. MRI/MRA showed a 2.2x3.5 AVM in the left angular gyrus without hemorrhage. Subsequent cerebral angiogram showed arterial supply predominantly from the left middle cerebral artery via a large temporal division branch and a large upper division angular branch that supplies the nidus in en passage fashion. The left anterior choroidal artery filled a small mesial portion and the left middle meningeal branch supplied a small superficial portion. Indirect filling of the AVM nidus from left posterior cerebral artery posterior temporal and parieto-occipital branches was also demonstrated. There were no intra-nidal aneurysms, but a small 3 mm flow-related left P-comm was noted. Early venous shunting occurred via a large temporal varix, draining to the veins of Labbe and Trolard. In addition, multiple lower flow venous tributaries drained the AVM posteriorly to a parietal cortical vein.

The patient was taken to the OR and after craniotomy and durotomy performed under sedation, the patient was awoken and direct stimulation of the cortex provimal to the AVM was performed. In an area anterior to the AVM in the angular gyrus, speech arrest did occur. This influenced the approach taken during resection to minimize retraction or manipulation of the cortex and white matter in the region of the language "hit". Postoperatively the patient experienced no language deficit whatsoever.



Conclusions

Preoperative fMRI and awake intraoperative cortical mapping in patients with SMG 2-3 AVMs proximal to eloquent language cortex is a viable treatment strategy, and should be offered to select patients. This is especially true when the AVM is unruptured, diffuse or high flow. We believe this methodology is a reasonable and effective compromise of factors providing the least risk neurological deficit while providing higher chances of obliteration. When mapping affects the extent of safe resection and only subtotal resection can be achieved, these dearterialized AVMs may receive adjuvant radiosurgery if deemed necessary.