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Original Article

Two-Staged Approach for Giant Hypervascular Meningioma Resection

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Abstract

Introduction: Giant meningiomas represent very uncommon and challenging tumors. Surgical morbidity is high due to the difficult and complex approaches to devascularize these hypervascular lesions. In the present series, we demonstrate a two-staged approach for surgical resection of giant hypervascular meningiomas. **Patients and Methods:** Four such patients having giant hypervascular meningiomas between July 2017 and June 2019 were taken in the present study. There were two falco-tentorial, one anterior and middle parasagittal and falcine meningioma, and one sphenoid wing with convexity meningioma. **Results:** In the first stage, only the hypervascular bone was removed, and the dura was coagulated and excised. In the definitive stage, usually undertaken 5–8 days following the first surgery, the meningioma was excised, leading to Simpson's Grade 2 excision in two and Grade 3 excision in the remaining two patients. There was one mortality of a previously operated malignant meningioma (histopathologically proven), owing to a cardiac event in the patient, while the other three were discharged without any new neurologic deficit. **Conclusion:** Two-staged approach for giant meningiomas represents a safe and effective surgical management, tolerable for the patient and more comfortable for the neurosurgeon.

Keywords: *Giant meningioma, hypervascular, staged approach*

Introduction

Meningiomas are generally considered histologically benign tumors that typically present as an intracranial extracerebral dural lesion with homogeneous contrast enhancement on magnetic resonance imaging (MRI). The therapeutic management of meningiomas is primarily surgical and aims at maximal tumor removal as the complete removal of the tumor and its dural tail, which is important for later disease control and to obtain a pathological diagnosis.[1-3] Depending on the size, location, and anatomical relationship of the tumor with the surrounding structures, achieving a complete resection can be challenging. The extent of resection is quantified using the Simpson scale.[4]

Giant meningiomas in itself present a great challenge to the neurosurgeon. With its wide attachment to the dura, its hypervascular nature, and at times, the edema around atypical meningiomas, two-staged resection of these giant hypervascular meningiomas paves a wonderful path for its resection. The removal of hypervascular bone with the opening of dura in the first stage, followed by definitive resection of the tumor in the second stage, presents an invariably better way toward giant hypervascular meningioma resection.

We present our initial series of giant meningioma patients resected by the two-staged approach.

Patients and Methods

A total of four patients between July 2017 and June 2019 having giant meningioma were recruited for the study. There were three male patients, and the one female patient was a recurrent case of right falcotentorial malignant meningioma. The age range of these patients varied from 22 to 45 years. There were 1 falcotentorial, 1 falcine and anterior/middle 1/3 parasagittal and 1 sphenoid wing with convexity meningioma in male patients. All the patients were operated in a two-staged approach, owing to the severe edema and hypervascular nature of the tumor. Only the hypervascular bone was excised along with the opening of the dura in the first stage, followed by a definitive second stage of complete removal of tumor after 5–8 days.

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Illustrative case 1

A 22-year-old male presented to us with a headache. He was conscious, with no motor or sensory deficits. Contrast-enhanced MRI of the brain suggested a giant left tentorial contrast-enhancing tumor with falx attachment posteriorly [Figure 1a-c]. At the time of the first surgery, there was significant bleeding from the bone itself. The bone was removed, dura was coagulated and opened, and the wound was closed [Figure 1d]. The patient was taken intubated to the intensive care unit (ICU) where he was extubated after 6 h. He was then later placed for definitive surgery 8 days after the first procedure. The patient was placed on 3-pin fixation in a lateral position, and the previous wound was opened. The tumor was extremely vascular, with attachment to the falx medially and tentorium inferiorly. The falcine and tentorial attachments were coagulated and removed completely, and the tumor was excised in toto [Figure 1e]. Although we never advocate in toto tumor excision in such large space-occupying lesions (SOLs), given the vascularity of this particular tumor, we decided to take it out in a single piece following its devascularization [Figure 2]. Postoperatively, the patient was intact without any neurological deficit. Approximately 5 months after surgery, the patient started developing pseudomeningocele [Figure 1f], giving the appearance of a doubleheader. The patient was planned for a shunt insertion, followed by cranioplasty, and was discharged later on. At present, he is doing well without any deficits.

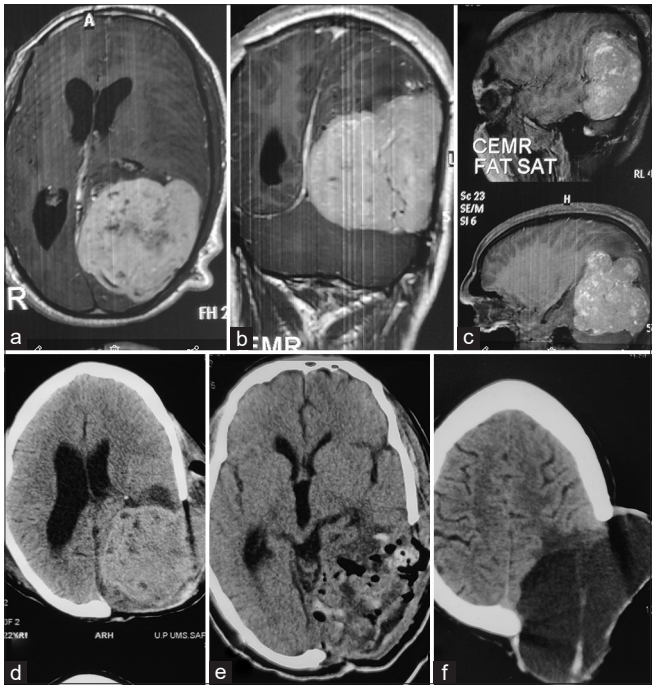

Figure 1: (a-c) Contrast-enhancing axial, coronal, and sagittal magnetic resonance images of the falcotentorial tumor, (d) following the first stage of surgery after resection of hypervascular bone and dural opening, (e) noncontrast computed tomography image following complete tumor removal after the second stage, (f) pseudomeningocele formation

Illustrative case 2

A 40-years-old male, a close relative of the first patient, presented with headache and bilateral blindness. He was conscious and alert with no motor or sensory deficit with a negative perception of light in both eyes. Contrast-enhanced MRI suggested a right sphenoid wing and frontotemporal convexity SOL with intense vascularity [Figure 3a and b]. At the time of the first surgery, injection tranexamic acid was started prior to surgery. There was severe bleeding from the bone. A decompressive hemicraniectomy was performed, sphenoid ridge was drilled, and the dura was coagulated and opened. There was severe brain bulging at this point of time. The wound was closed with the plan of tumor removal in the second stage [Figure 3c]. He was then later planned for a second definitive surgery after 5 days. The patient was placed supine with the head turned to the right side by 30° with malar prominence placed highest. The previous wound was opened. The tumor was found extremely vascular, fibrous, attached to the dura and sphenoid ridge. Piecemeal removal of the tumor was then performed with complete removal of the involved dura and bone. A small portion of tumor overlying Sylvian vessels had to be kept intact. There was an injury to the temporal branch of the middle cerebral artery, which had to be clipped [Figure 3d]. Augmented duraplasty using a pericranial patch and G-patch was performed. The patient woke up approximately 8 h following surgery, with some weakness in the left side of the body, which gradually improved over a period of time.

Results

There was Simpson's Grade 2 resection of the tumor in two cases (1 falcotentorial and 1 sphenoid ridge meningioma) and Simpson's Grade 3 excision in the remaining two cases (1 recurrent malignant meningioma and 1 falcine and anterior/middle 1/3 parasagittal meningioma). There was 1 mortality of recurrent falcotentorial meningioma, owing to a cardiac event. The remaining three patients

Figure 2: In toto resection of the falcotentorial meningioma

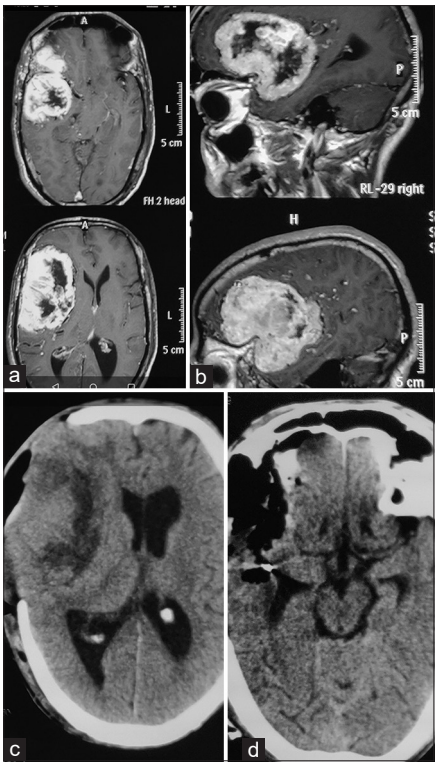

Figure 3: (a) Contrast axial magnetic resonance imaging, (b) contrast sagittal magnetic resonance images of the right sphenoid wing and convexity attachment, (c) noncontrast computed tomography scan after the first surgery with hypervascular bone removal with dural opening, and (d) following tumor removal after second definitive surgery

were extubated postoperatively in the ICU without any additional neurological deficit. Augmented duraplasty was performed in all using pericranial patch and G-patch. The bone flap was not replaced back after surgery in any of these cases.

Discussion

The rationale behind this staged approach is that we have found when using a transcranial single-stage approach, the brain edema and necessary retraction required for resection lead to brain injury, oftentimes readily identified on diffusion-weighted MRI, which are associated with different degrees of cognitive impairment. The skull base bone involved is usually not removed via transcranial approaches.

Despite requiring a second surgery, this staged approach allows a true total resection (including the affected bone), and in the transcranial stage, the brain is more relaxed with less edema, reducing the need for retraction, which may lead to a better outcome.

Getting out giant hypervascular meningiomas in two-staged procedures even serves better in those patients who have a infiltrating hypervascular bone and at centers where facilities of embolization are not available. Removing hypervascular bone and opening of the dura to lax the brain and coming later to deal with the tumor in the second stage also serve the purpose to avoid undue retraction to the brain and help to cope with the patient with the blood loss and the increased time of surgery.

As neurocatheterization laboratory facilities were not available at our center, we regret that digital subtraction angiography could not be performed on our patients to give a better delineation of the hypervascular external carotid vasculature in these subsets of patients. However, we can well appreciate the hyperintensity in the bone on MRI overlying the tumor in these patients, which gives a very salient identification of the hypervascular nature of bone in these cases.

The extreme vascular nature of these tumors at times restricts to take it out in piecemeal fashion, until complete devascularization of its blood supply, especially in falcine and tentorial meningiomas. We do not recommend early debulking in such tumors, at the expanse of huge blood loss. Taking out the whole blood supply in the meningioma by coagulating its attachment serves the purpose. Once the attachment has been coagulated, piecemeal, or in toto removal of these giant meningiomas, all depend on the brain swelling at that particular point. It is in the best interest to take out in piecemeal fashion, however, in cases with severe brain bulge, the tumor needs to be taken out in toto to give it ample space sooner than later.

In cases of giant hypervascular sphenoid wing meningiomas, usually, there is an enormous size of the middle meningeal artery running below the bone and an increase size of the superficial temporal artery running over the bone. The bone in itself develops many deficient places with bleeding through them, which can be controlled only with bone wax or monopolar cautery at times. Removing the bone, one can very well appreciate the increased size of the middle meningeal artery with collaterals running around it and causing severe torrential bleeding at times. Even after cautering mixed martial arts, there is sever oozing over the dura due to the hypervascular nature of the tumor, as is evidenced beautifully by the multiple flow voids. The dura needs to be cauterized via bipolar forceps completely over the tumor to secure bleeding. However, as it is being coagulated, the dura also shrinks and that may land a difficulty in the already edematous brain. Hence, after securing the bleeding from the dura, it needs to be opened as fast as possible and coagulating its vascular supply.

Our hospital does not have the facility of preoperative embolization and remains a significant problem in most of the Southeast Asian hospitals where there is a huge load of patients with not enough infrastructure. Of course, in the absence of embolization facilities, this two-staged procedure is an appreciable solution to reduce the blood loss and time of surgery, vis-à-vis in a single sitting. We do really appreciate the advantages of preoperative embolization, particularly in these patients, but given the lack of such

facilities in most of our centers and the financial constraints involved, we highly recommend removing the bone and opening of the dura in the first stage, followed by removal of tumor in the second stage.

Although the authors would love to be able to tell these patients that there is one right approach, the stage of our understanding and the quality of data available simply make this impossible to do with integrity. We sincerely think that the patient is best served by consulting a center at which preoperative embolization facilities for these tumors are also available, ensuring that there are no inappropriate biases that would induce the treating team to force the patient in one direction. The patient must decide on a strategy that allows him to accept excellent results if they are achieved but also accept problems if they arise. This can only happen if the patient is fully informed of all the options and the uncertainty that remains in the data that support them.

Although meningiomas are considered to be benign tumors, recurrence is observed frequently, with rates that vary between series.[5-7] The best-accepted factor for the prediction of recurrence is the 1957 Simpson grading system for completeness of resection,[4] which evaluated invasion of the venous sinuses, tumor nodules in adjacent dura, and infiltration of unresected bone by meningothelial cells as chief causes for recurrence. The recurrence rates that Simpson refers to were 9% for Grade I, 16% for Grade II, 29% for Grade III, 39% for Grade IV, and 100% for Grade V. In addition, some histological characteristics of malignancy favor recurrence. These are peritumoral brain edema,[8,9] increase of neovascularization,[10] cellular pleomorphism, nuclear atypia, the presence of macronuclei, atypical mitoses, necrosis, and brain invasion.[6,11]

Meningiomas with skull-base location and bone invasion were less often completely resected. This is unsurprising as these locations can be technically more challenging due to their restricted surgical access and vicinity to vascular and/or neurological structures.[12-15] Bone invasion was another significant independent factor of poor resection quality. This infiltration requires additional drilling of the bone close to the dural insertion, often on the skull flap. In certain cases, bone invasion management represents a major part of the surgical procedure, for instance in spheno-orbital meningiomas where the extent of bone invasion and cavernous sinus involvement may not allow complete removal.[16] In our series, all the patients had a bony invasion with hypervascular bone which needed to be resected, followed by dural coagulation, due to excessive dural bleed and devascularize the tumor's blood supply. In all these tumors, there was significant brain bulging with the opening of the dura and inadvertently had to be closed for a second surgery to avoid brain injury due to retraction and brain bulge.

Conclusion

Two-staged surgical approach for giant hypervascular meningiomas presents an effective way to deal and resect these tumors, which is much safer to the patient and more comfortable to the operating surgeon. In some locations where preoperative embolization is not allowed by the system of medical service, two-staged surgical approach for excision of giant hypervascular meningiomas is a very effective method.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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