The Effect Of Preoperative Embolization On Surgical Outcomes Of Medial Sphenoid Wing Meningioma: A Comparative Study

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Abstract

Objective: This study aims to compare the outcomes of patients undergoing surgery for medial sphenoid wing meningioma with or without preoperative embolization.

Methods: This prospective single-centre observational study was performed over 2 years (1st August 2021 to 30th September 2023) at the National Neurosurgical Referral Centre, Bir Hospital. Patients were allocated to surgery with or without preoperative embolization.

Results: Among the 20 patients operated, 17 were female and 3 were male. The mean age of presentation was 48.2±10.8 years. The presenting symptoms were headache (50%), Visual disturbances (19%), proptosis (9%), seizure (13%), and dizziness (22%). Of the 20 patients in this study, 10 underwent prior embolization of the feeding vessel followed by surgery while 10 underwent upfront craniotomy and excision of mass. The tumor size at presentation was < 3cm in 25%, 3-4 cm in 60%, and >4 cm in 15%. The mean operative time was short in the embolized group [187min vs 234min,(p=0.047)]. The mean blood loss was less in the embolized group 295 ml vs 436 ml p =0.005). Preoperative embolization had a higher rate of gross total tumor resection (100% vs 60 %). The embolization group had a shorter overall hospital stay(5.6 days vs 8.6 days). There is no mortality. However, increased morbidity was observed in the non-embolized group.

Conclusions: The preoperative endovascular embolization of meningiomas is a safe option for medial sphenoid wing meningiomas. The extent of tumor resection, intraoperative blood loss and hospital stay was better in the embolization group compared to the non-embolization group.

Keywords: Clinoidal, Meningioma, Embolization, Outcomes

Introduction

Sphenoid wing meningioma(SWM) comprises 15-20% of intracranial meningiomas.[1] 50% arises from the medial portion. It comprises meningioma on the anterior clinoid and the medial third of the lesser sphenoid wing. Cushing and Eisenhardt classified them as “globoid” and “en plaque”.[2] Surgical management of the SWM is challenging, especially when they invade the cavernous sinus, Internal carotid artery and visual pathway.[3] Most of the medial sphenoid wing meningioma have dual blood supply from internal carotid (cavernous/clinoidal/supraclinoidal) and external carotid branches.[4] Therefore, the deep vascular supply from ICA precludes early devascularization during resection. The Preoperative embolization of meningioma is commonly performed to facilitate surgical removal of the tumor and to reduce intraoperative blood loss and operative time.[5] However, the embolization of the internal carotid branches has the potential risk of ischemic complications. This study aims to evaluate the safety and efficacy of preoperative embolization in medial sphenoid wing meningiomas.

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Methods

All patients treated for medial sphenoid wing meningioma at the Department of Neurosurgery, Bir Hospital from 1st August 2021 to 30th September 2023, were included in this study. Patients with enplaque meningioma, recurrent meningioma, uncertain histological diagnosis, and those who lost to follow-up were excluded.

Clinical evaluation

An interview along with a detailed neurological examination was

performed and findings were noted in preformed proforma. The demographic profile, clinical presentation, presence of visual dysfunction and performance status were documented.

Radiological evaluation

All patients were initially evaluated with a non-contrast Computed tomography (NCCT) head scan. Further tumor details and proximity to nearby critical neurovascular structures were obtained with Magnetic resonance imaging (MRI) Brain with gadolinium enhancement in a 1.5 Tesla machine. The patient with a tumor size >3cm with MRI characteristics of hypervascularity was given the option for preoperative embolization.

Embolization procedure

All patients who were selected for the embolization procedure underwent digital subtraction angiography (DSA) under biplanar fluoroscopy. We used the femoral artery as a vascular access in all cases. A 6 fr Picard diagnostic catheter was used to cannulate the carotid artery. An Envoy guiding catheter was used to cannulate ICA and ECA. The roadmap was taken and a detailed study was performed to assess tumor vascularity, feeder arteries, relationship with major vessels, and collateral circulation from the external and internal carotid arteries. A 2.2 fr microcatheter was advanced over the steerable guidewire (0.014 inches, Synchro) and its tip was placed in terminal feeding arteries as close as possible to the tumor as shown in Figure 1. The embolization agents frequently used were polyvinyl alcohol (PVA) microspheres size 150-450 µm, gel foam and ethylene vinyl alcohol copolymer (ONYX). Postembolization angiography was performed to evaluate additional feeders and to assess the extent of embolization

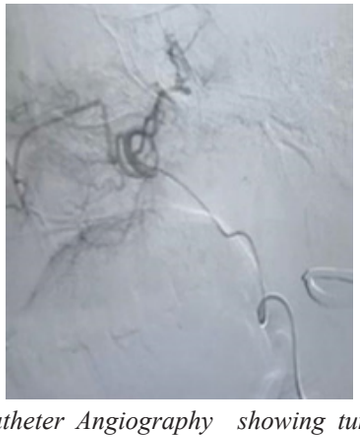

Figure 1. Catheter Angiography showing tumor blush with feeder from Internal Maxillary Artery(IMAX)

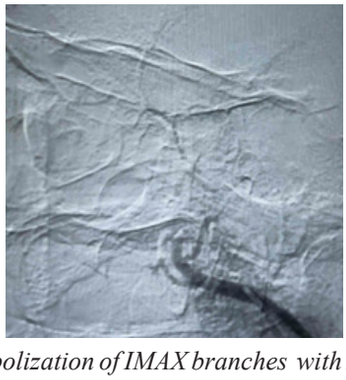

Figure 2. Embolization of IMAX branches with PVA and gelfoam with flow stasis and subsequent disappearance of tumor blush

Operative procedure

All operations were performed by a single surgeon via a transcranial approach. Patients who underwent preoperative embolization of the feeding arteries had surgical resection within 48 hours. A standard pterional craniotomy with a transylvian approach was employed for all tumors. Per-operative findings were noted as described by the operating surgeon. Intraoperative findings, operative time, operative blood loss, and extent of resection were documented. The tissue was sent for histopathological analysis. Postoperatively patient was managed in the ICU and the NCCT head was done on the following day.

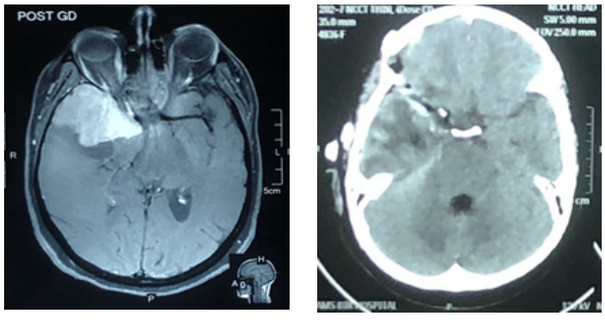

Figure 3.
(a)Post gadolinium MRI showing vividly enhancing right medial sphenoid wing meningioma
(b) Noncontrast postoperative scan showing complete resection of meningioma

Follow up

Patients were followed up postoperatively for 6 months. MRI brain with contrast was done postoperatively at 6 months to determine residual tumour or recurrence.

Data analysis

All data were entered in preformed proforma. Data analysis was performed with IBM SPSS statistics for Windows version 22.

Results

A total of 20 patients underwent medial sphenoid wing meningioma resection during the reviewed period. The mean age of presentation was 48.2±10.8. In addition, 17 were female and 3 were male. The median duration of symptoms before diagnosis was 6 (2 to 23) months. The most common symptoms at the time of presentation were headache (50%), Visual disturbances (20%), proptosis (10%), seizure (20%), and dizziness (35%). Of the 20 patients in this study,10 underwent prior embolization of the feeding vessel followed by surgery while 10 underwent upfront craniotomy and excision of mass. The most commonly used embolization agent was Polyvinyl alcohol (PVA) particles with gel foam pledgets as shown in Table 2. Embolization of the external carotid artery feeder was done in all 10 cases. (Table 3)

Table 1.Baseline characteristics

Variables	Embolization group	Non embolization group	P-Value
Age	46.6±13	50.5±13.8	0.55
Gender (Female/Male) %	8/2 (80%)	9/1(90%)	
Tumor size	3.8 ± 1.08	4.3 ± 1.01	
Vessel encasement (MCA/ACA/ICA)	4	2	0.38
Tumor laterality (Left /Right)	7/3	2/8	

Table 2.Embolization agents

Method of embolization	%
PVA	20
PVA and Gelfoam Pledgets	60
ONYX(Ethyl Vinyl Alcohol Copolymer)	10
N-butyl cyanoacrylate (NBCA)	10

Table 3. Feeder Vessels embolized

Case	Feeder vessels	Feeder vessels embolized
1	Inferolateral trunk(ILT),Ophthamic artery(OphA), Internal maxillary artery (IMA)	IMA
2	Middle meningeal artery(MMA) , accessory meningeal artery(AMA), Supraclinoidal ICA	MMA ,AMA
4	Artery of superior orbital fissure, ILT, Meningohypophyseal trunk(MHT), IMA	IMA
5	MMA, AMA, OphA, MHT	MMA , AMA
6	Artery of foramen rotundum, MMA, AMA, ILT	MMA, AMA
7	Supraclinoidal ICA, MMA, IMA, MHT	IMA, MMA
8	Artery of superior orbital fissure,Recurrent meningeal artery,IMA,OphA	IMA
9	MMA, AMA, ILT, Ophthalmic artery, Supraclinoid ICA	MMA, AMA
10	Sphenoid branch of MMA, AMA, ILT, OphA	MMA

The extent of resection in the two groups was compared in Table 4. All the patients in the embolization group had gross total resection while 40% of patients in the non-embolization group had a subtotal resection.

The operative duration, intraoperative blood loss and overall hospital stay were statistically low in the embolization group (p-value <0.05). However, the need for intraoperative blood transfusion was similar as illustrated in Table 5.

Table 4. Extend of resection in embolization and non-embolized group

Extend of resection	Embolization group	Non embolization group
Gross total resection	10	6
Subtotal resection	0	4

Table 5. Relationship between embolization and surgery related factors

Surgical factor	Embolization group	Non embolization group	p-Value
Operation duration	187±44.84	234.5±55.9	0.047
Intraoperative blood loss	295±89.69 ml	436±139.5 ml	0.05
Blood transfusion	0.6 ±0.6	1.4 ±1.07	0.10
Hospital Stay	5.6±0.26	8.60±1.95	0.03

Postoperative morbidity was more frequently observed in the non-embolized group which were tumor bed hematoma (20%), transient hemiparesis (20%) and visual deterioration (10%). In 6 month follow-up, Vision improvement was noted in 3 out of 4 patients with preoperative visual field deficit and remained unchanged in one. No complications related to embolization were observed. The histopathological findings of all cases are as Table 6.

Table 6. Histopathology

Histopathology	Number of patients
Transitional	7
Meningothelial	6
Fibroblastic	4
Angiomatous	2
Atypical	1

Discussion

Sphenoid wing meningioma accounts for 15-20% of total intracranial meningioma.1, 6 Cushing and Eisenhardt were the first to describe sphenoid wing meningioma, categorizing globoid tumours into 3 subgroups a)medial b) middle and c) lateral.[7] The meningioma arising in the inner third of the sphenoid wing is challenging owing to the proximity to the critical optic apparatus and blood vessels.[8] Therefore, clinoidal meningioma is notorious for incomplete removal, increased morbidity and high recurrence rate.[6]

Skull base meningioma often receives supply from the dural branch of the Meningohypophyseal, Inferolateral trunk and Internal maxillary artery.[4] The deep vascular supply precludes early devascularization during resection. The preoperative embolization devascularizes the tumor and induces necrosis which makes the tumor amenable to aspiration and facilitates gross total resection. These arteries also supply the vasa nervosum of cranial nerves placing them at risk of ischemia during embolization.[9] The use of small PVA microspheres(45-150µm)

may lead to intratumoral haemorrhage due to draining vessel occlusion.[10] In our series, we did embolization of the Internal maxillary artery, middle meningeal artery, and accessory meningeal artery and there were no embolization-related complications. In the study by Rasper et al, embolization-related complications occurred in 6 cases (2.9%). There were 2 cases of arterial dissection, 1 of thromboembolic stroke, 1 of facial nerve palsy, 1 of scalp infarction, and 1 of iodine allergy requiring abortion of the procedure.[11] However, Waldron et [12] in the series of 119 skull base tumors, both ICA and ECA dural feeders were embolized without any complications.

The optimal timing of surgery following embolization varies with the embolizing agent used. After embolization the ischemic tissue undergoes necrosis. Earlier studies with proton spectroscopy showed a maximal peak of broad aliphatic signals in 4 days of embolization suggestive of extensive tissue necrosis.[13] This observation was used to determine the optimum timing of surgery after tumor embolization. Meningioma embolized with PVA softened in 7-9 days.[14] With absorbable embolic agents like Gelfoam, there is a risk of recanalization so early surgery within 72 hrs is advised.[15]

In this study, all dependent variables evaluating the clinical efficacy of the procedure (estimate blood loss, 295 cc versus 436 cc; number of transfusions, units 0.6 versus 1.4 units; surgical resection time, 187 minutes versus 234 minutes; and length of hospitalization, 5.6 days versus estimated intraoperative blood loss, operative duration and hospital stay were statistically significant. Our observation contradicts the findings of Rasper et al in which preoperative embolization of meningioma did not alter the operative duration and degree of resection between the two groups.[11]

The rate of recurrence for medial SWM is regarded as one of the highest for intracranial meningiomas. Nakamura et al reported recurrence in 7.7% of Group I tumors (medial sphenoid wing meningioma involving cavernous sinus) and 27.5% of Group II tumors (tumors not involving cavernous sinus) during a mean follow-up period of 69.3 months.[16] Nakamura et al could achieve 92.3% GTR in group I and 14.5% in group II tumors. We could achieve a GTR of 100% in the embolization group and 60% in the nonembolized group.

The limitation of this study is that it was a comparative observational study in a single centre with a small sample size. Therefore, further randomized study is advised to determine the role of preoperative embolization on the extent of tumor resection and overall postoperative recurrence-free survival in medial sphenoid wing meningiomas.

Conclusions

The preoperative endovascular embolization is a valuable adjunct to surgical resection for large medial sphenoid wing meningiomas. It reduces intraoperative blood loss, and operative time, improves the extent of tumor removal, and reduces overall hospital stay. When available strong consideration should be made for preoperative embolization of medial sphenoid wing meningioma with deep-seated vascular supply which is difficult to access surgically.

Conflict of interest

There are no conflicts of interest.

Declaration of patient consent

The author confirms that written consent from the patient/patient guardian was obtained to publish the images and clinical details to be reported in the journal.

Ethical approval

The IRC granted ethical approval.

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