Venous drainage pattern analysis of medial sphenoid wing meningiomas related to surgical planning

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ABSTRACT

Background: Medial sphenoid wing meningiomas involved to the anterior clinoid process (APC) and located medial on the lesser and greater wing of the sphenoid. Surgical planning of medial sphenoid wing meningiomas must be carefully considered, which in skull base surgery has emphasized the essential of venous preserving and the morbidity when accidentally sacrificed.

Objective: This study aimed to understand the characteristic venous drainage pattern of medial sphenoid wing meningiomas and correlate with surgical planning

Methods: A retrospective analysis evaluation was performed on 7 patients with medial sphenoid wing meningiomas using digital subtraction angiography (DSA) to determine the venous drainage system characteristics before surgery. Classification of the venous drainage pattern from sylvian veins was divided into cortical type, sphenobasal type and cavernous type. Clinical information and

postoperative complication were retrospectively reviewed using the patient's medical and surgical records.

Results: Based on the 7 surgical cases, 5 cases found as cortical type, sphenobasal type was found in 2 cases and did not find the cavernous type. The average tumor volume of cortical and sphenobasal type was 47,7 cm³, 36 cm³ respectively. In this study, one surgical complication was identified, frontal intracerebral hemorrhage (ICH) from postoperative computed tomography (CT) scan evaluation in patients who diagnosed with sphenobasal type.

Conclusion: Complication because venous damage in cases of Medial sphenoid wing meningiomas was rare. However, surgical strategies that aimed to avoid venous complications influenced by venous preservation and a good understanding of venous characteristics.

Keywords: Meningioma, Medial sphenoid wing meningioma, Skull base surgery, Venous drainage

Cite This Article: Pribadi, M.A., Hakim, M.W., Suroto, N.S., Susilo, R.I., Haq, I.B.I. 2020. Venous Drainage Pattern Analysis of Medial Sphenoid Wing Meningiomas Related to Surgical Planning. *Indonesian Journal of Neurosurgery* 3(2): 63-67. DOI: [10.15562/ijn.v3i2.124](https://doi.org/10.15562/ijn.v3i2.124)

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Received: 2020-04-13
Accepted: 2020-06-28
Published: 2020-08-01

INTRODUCTION

The most common primary brain tumor is meningiomas. Arachnoidal cells of the leptomeninges are the origin of meningiomas and may arise wherever the cells are.¹ In the United States between 2002 and 2006, it was reported that meningiomas were the primary brain tumor which has the most cases of all primary brain and central nervous system tumors, with percentage 33.8%. Data from the Central Brain Tumor Registry of the United States (CBTRUS) reported that females have a twofold higher incidence.² Sphenoid ridge meningiomas represent approximately 20% of supratentorial meningiomas, among which less than half arise from the medial ridge of the sphenoid. The tumor was first described in 1910 by Frotscher and Becker as an autopsy finding in a 72-year-old man. Medial sphenoid wing meningiomas involved in the anterior clinoid process (APC), located medially on the lesser and greater wing of the sphenoid and represent a distinct entity.³ Giant

anterior clinoidal meningiomas as globular tumors with a maximum diameter of 5 cm or larger, cantered around the APC, which is usually hyperostotic. Surgical procedure must be considered carefully, because of many essential structures around the anterior clinoid process, such as the artery of internal carotid, nerve of optic, its branches, perforators, and the system of diencephalic.⁴ Al-Mefty's study for clinoidal meningiomas resulted in a classification based on advances in microsurgical anatomy that are widely accepted.⁵

The communication patterns between the cavernous sinus and the Superficial middle cerebral vein (SMCV) from Tanoue's study were classified into 4 types: Type A was defined as SMCV connects with the sphenoparietal sinus proximal and flows into the frontal aspect of the cavernous sinus. Type B, SMCV connects with the cavernous sinus at the lateral aspect independently. Type C, SMCV connects with the pterygoid plexus via the middle cranial fossa while moving downward. Type D, SMCV connects with the superior petrosal sinus or

transverse sinus through the tentorial sinus.⁶

The majority of published studies on Medial sphenoid wing meningiomas concern the results of the surgical treatment of the tumors. No much information is available on the importance of venous drainage patterns in Medial sphenoid wing meningiomas for patients who will undergo surgical intervention. Many articles discussed about anatomical consideration and classification of venous drainage, while study whether there is a relationship between the classification of a venous drainage system and surgical strategy is not available yet. The latest article, Nagata, classified the venous drainage pattern from the sylvian veins into three groups, cortical type, sphenobasal type, or cavernous type, to consider appropriate surgical strategy. Cortical venous drainage classification was defined when the Sylvian vein drains out directly into the cortical vein direction, not into the sphenoparietal, sphenobasal, and cavernous vein direction (Figure 1A). Sphenobasal venous drainage classification was defined when the Sylvian vein drains its flows from the pterygoid plexus to the foramen ovale (Figure 1B). And cavernous venous drainage classification was defined when the Sylvian vein drains its flows directly into the cavernous sinus via sphenoparietal sinus (Figure 1C).⁷

The skull base surgery technique explains the importance of venous preserving and the morbidity when this venous accidentally sacrificed during surgery. Some papers reported complication of venous can occur whenever the pattern of venous drainage is changed or obstructed by the tumor. This study aimed to find the characteristic of Medial sphenoid wing meningiomas vein in Indonesia, especially East Java, which is expected to have benefits in determining the surgical strategy to get a better result.

METHODS

This retrospective analysis study from 122 patients with medial sphenoid wing meningioma in an outpatient clinic at Dr. Soetomo Academic Medical Center Hospital, Surabaya, Indonesia during period April 2012 until March 2019. The preoperative

imaging was analyzed from the location and size of the tumor found in the database. Digital subtraction angiography (DSA) was used to analyze the pattern of venous drainage according to the classification described previously. The pattern of venous drainage was examined in 13 patients only, but 6 patients refused to perform surgery. 115 patients who did not perform surgery either DSA were excluded. The classification of venous drainage was categorized according to the drainage pattern of the Sylvian vein into the major draining vein, whether cortical, sphenobasal, or cavernous type. Clinical information and postoperative complication were retrospectively reviewed using the patient's medical and surgical records.

Skull base surgery of temporofrontal or orbitozygomatic approach was used to this group of medial sphenoid meningioma patients. The extent of resection was based on a subjective surgical impression of gross total resection (GTR), subtotal resection (STR), and partial resection (PR) obtained from a surgeon's surgical record. Postoperative computed tomography (CT) scan was also reviewed to confirm tumor removal.

RESULTS

This study included 7 patients from April 2012 to March 2019 with medial sphenoid wing meningiomas who underwent preoperative DSA to examine the characteristics of the venous drainage system and operated at Dr. Soetomo Academic Medical Center Hospital, Surabaya, Indonesia. The patient's demographic data were described in Table 1. Patient's ages ranged from 38-65 years, with an average of 47 years. The average of tumor volume was 47,7 cm³ for cortical type, 36 cm³ for sphenobasal type. The most common presenting symptoms were visual deterioration and headaches.

Analysis from the total of 7 cases, 5 cases showed the cortical type of sylvian venous drainage (71,4%) with four cases invasion to the cavernous sinus, then 2 other cases showed the sphenobasal type (28,6%) with no invasion to the cavernous sinus and did not found type of cavernous. The average tumor volume of the cortical type was 47,7 cm³ and the sphenobasal type tumor was 36 cm³, see Table 2.

A large operative view was obtained in cortical type patients. There is a surgical complication, headache, and prolonged length of stay, that happened. Frontal ICH was found from postoperative CT scan evaluation in the sphenobasal type patients. Gross total removal was obtained by 40% (2/5) in the cortical type. Subtotal removal was possible in 20% (1/5) of the cases rever to cortical type venous drainage. While partial removal possible in 40% (2/5) cases refer to the cortical type

Figure 1. The Classification of venous drainage pattern from sylvian vein.⁷

Table 1. Clinical data from 7 patients with medial sphenoid wing meningiomas who underwent preoperative DSA And Surgery

Patient					Tumor						
No	Age	Hormonal Contraceptive Exposure	Drainage Type	Presenting Symptoms	Size (mm)	Volume (cm ³)	Cavernous Sinus Invasion	Previous Resection	Surgical Approach	Surgical Complications	Extent of Resection
1	65	Unknown	Cortical	None	25x32x4	16	Yes	No	Temporofrontal	None	STR
2	50	Yes (10 years)	Sphenobasal	Visual deterioration	45x40x50	45	No	No	Temporofrontal	Frontal ICH	PR
3	42	Yes (13 years)	Cortical	Altered mentation, Headache, Visual deterioration	30x23x37	12,76	No	No	Orbitozygomatic	None	GTR
4	38	Yes (14 years)	Cortical	Headache, Visual deterioration, hearing disorder	53x47x50	62,27	Yes	No	Orbitozygomatic	None	GTR
5	40	Yes (10 years)	Cortical	Headache, Half body weakness, Facial palsy	64x69x54	119	Yes	No	Orbitozygomatic	None	PR
6	47	Yes (1 years)	Sphenobasal	Visual deterioration, headache	32x34x34	18	No	No	Temporofrontal	None	PR
7	32	Yes (5 years)	Cortical	Decrease of consciousness, Right body weakness, Headache	60x64x45	86	Yes	No	Temporofrontal	None	PR

Table 2. Drainage pattern from sylvian

	Type of Cortical	Type of Sphenobasal	Type of Cavernous
No. of patients	5	2	0
Cavernous sinus invasion	4	0	0
Tumour volume (cm ³)	47,7	36	0

Table 3. The extent of resection in venous drainage group

	Cortical type	Sphenobasal type	Cavernous type
GTR	2/5 (40%)	0/2 (0)	0/0
STR	1/5 (20%)	0/2 (0)	0/0
PR	2/5 (40%)	2/2 (100%)	0/0

GTR, gross total removal; STR subtotal removal; PR, partial removal

and 100% of cases refer to sphenobasal type, see Table 3. However cortical type had a large operative view but we couldn't do total resection because of the large size of the tumour with encasement of perforators. Sphenobasal type had less view than cortical type and difficult to mobilize/ retract

temporal lobe because of the anchor of temporal dura mater to cavernous.

The first illustrative case from 47 years old female with blurred at left eye since 6 months ago, see Figure 2. The patient had a history of progressive headache. (A) Preoperative imaging showed large medial sphenoid wing meningiomas, extended into the cavernous sinus partially. (B) Preoperative DSA showed loss of the superficial sylvian vein and rerouting of venous drainage to the collateral venous plexus in the middle fossa was established, sphenobasal type. (C) Total resection of postoperative CT scan with contrast was showed.

The second illustrative case from 38 years old female with visual deterioration and hearing disturbance, see Figure 3. The patient had a history of progressive headache. (A) Preoperative imaging showed large medial sphenoid wing meningiomas, involving the sinus of cavernous and extended suprasellar. (B) Preoperative digital subs traction angiography showed the sylvian vein was drained to the cortical vein primarily was established as cortical type.

Figure 2. The illustrative case from type of sphenobasal

Figure 3. The illustrative case from type of cortical

DISCUSSION

Consideration of the anatomic structure is a part of a preoperative assessment to get the optimal surgical strategy. The importance of venous preservation has been emphasized especially in skull base surgery. The purpose of this study is to classify the medial sphenoid wing meningiomas by the drainage system of venous from the vein of sylvian to prevent postoperative complication and show how important cerebral angiography in the preoperative surgical planning. This study which

talks about the characteristic of venous drainage in sphenoid wing meningioma patients also is the first study conducted in Indonesia. According to the report, the pattern of sylvian vein in adults generally as 46-69% type of cavernous, 11-30% type of sphenobasal, and 4-19% type of cortical. Tumor growth significantly alter the sylvian venous drainage pattern, our study found the pattern of sylvian vein as a type of cortical (71,4%), two cases showed the type of sphenobasal (28,6%) and no cavernous type found. The result almost the same with Nagata report: (1) cortical type 63,6% (drain into a cortical vein), (2) sphenobasal type 27,3% (drain into pterygoid plexus), and (3) cavernous type 9,1%(directly drain into cavernous sinus).⁷ But in this study, only found two types of vein drainage, cortical type, and sphenobasal type, it's because of all the patients that came to our hospital have a large size of the tumor. As the tumor gets bigger, it causes obstruction and gradual compression which resulted in the creation of other pathways such as the Labbe and Trolard veins, so this study just showed the cortical and sphenobasal type. Also, important to know that there are no cases of venous occlusion due to tumor growth that shows clinical symptoms, because the occlusion of the vein progress slowly, not acute. However, remove the main vein with acute obstruction can cause severe damage to the brain, coagulation, and cutting sinus of sphenoparietal made larger view for a surgeon to access medial sphenoid wing meningiomas with optimal brain retraction. But, if angiography study shows the main drainage pathway is the sinus of sphenoparietal, that is very harmful to sacrifice it and make the surgery more difficult.⁸

One patient reported had intraoperative bleeding with sphenobasal type. In this case, the temporofrontal approach and partial resection were performed. Retraction of the brain stronger might be required for this technique and venous infarction because the dura is attached to the cavernous sinus at the pathway entrance of the sphenoparietal sinus. In this case, found two pitfalls : (1) The temporofrontal approach results in a severe retraction of the cortex when the tumor enlarges towards superior ³50mm. If the lesion harbors a significant suprasellar component the orbitozygomatic approach affords an excellent exposure of the suprasellar extent of the tumor with minimal frontal lobe retraction.⁹ (2) Separation of the sphenoparietal sinus from the sinus of cavernous has the potential to obstruct sylvian vein. However, there are likely to be patients that require a tailored surgical approach to prevent the complication of venous. Nagata et al, recommend the dura peel-off technique for sphenobasal type before performed

extradural clinoidectomy. This technique gives the advantage of a large workspace in the base of medial. The tumor size in sphenobasal type was large enough; therefore, it provides quite enough space after the procedure peel-off and debulking was complete, also there was no cavernous invasion found.⁷

On intraoperative examination using angiography, it was found that patients with the cortical type of venous drainage pattern did not have a patent sphenoparietal sinus. So intraoperatively, sphenoparietal sinus cannot be differentiated are innate, hypoplastic, or blockage by the tumor growth. Clinoidectomy extradural was easier to perform, due to the absence of an anchor between the dura and base temporal lobe. Morphological changes lead to obtaining wide space in the area around the temporal lobe and the sphenoid wing region. The availability of wide space was useful for resection of the tumor. However, surgical for cortical type was the easiest than the others, this type was difficult for GTR because of the invasion of the cavernous sinus. In this study, all invasion of cavernous had in cortical type, 4 of 5 patients (80%).

CONCLUSIONS

Management operative of Medial sphenoid wing meningiomas required a thorough understanding of its anatomy and blood vessels to achieve the desired result. Complication because venous damage in cases of Medial sphenoid wing meningiomas was rare. However, a good understanding of venous characteristics can influence surgical strategies that aimed to avoid venous complications. In this study, cortical type drainage is the most common type of drainage found. Its property has made cortical type venous more manageable compared to others. In the end of this study, we suggest to performed cerebral angiography in the preoperative surgical planning of medial sphenoid wing meningiomas patients.

DECLARATIONS

FUNDING

There is no funding available

CONFLICT OF INTEREST

The authors declare no conflict of interest

ETHICAL APPROVAL

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AUTHORS' CONTRIBUTIONS

All the author were equally contributed in manuscript writing, literature research, manuscript editing and final manuscript. All of the content in the manuscript have been approved by all authors.

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