Clinics of Oncology

Review Article

ISSN: 2640-1037 | Volume 4

The Results of Surgical Treatment of Cavernous Sinus Meningiomas

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Received: 22 Apr 2021
Accepted: 10 May 2021
Published: 15 May 2021

Citation:

Seddighi A, The Results of Surgical Treatment of Cavernous Sinus Meningiomas. Clin Onco. 2021; 4(5): 1-4

Keywords:

Cavernous; Meningioma; Surgery; Transcranial; Transsphenoidal

1. Abstract

1.2. Introduction: Cavernous sinus is a venous pathway that contain vital structures. It has been considered no man's land since the advent of neurosurgery. Surgical management of lesions in this location is extremely difficult and unwanted damage to its components may result in irretrievable consequences. Surgical approaches to cavernous sinus meningioma are controversial and evaluation of outcomes according to the extent of resection can lead to better management of these lesions.

1.3. Method and Materials: In this retrospective study, every patient with symptomatic cavernous sinus meningioma who were operated in our center were included. Surgeon decided the approach of surgery. Some were operated with open microsurgery and others with EES. The outcomes, including extent of resection, complications, and recurrences have been observed closely during at least 2 year follow up.

1.4. Results: From 2013 to 2020, 68 patients were operated with cavernous sinus tumors. GTR was achieved in 52.9%, NTR in 32.3%, and STR in 14.8% of cases. KPS score was more than 70 in 82.4% of our patients after surgery. The mortality rate was 5.8 % and the morbidity rate was 7.35 % in our series.

1.5. Discussion: No significant reduction was seen in KPS score of our patients after surgery. Recurrence rate were 7.3%. The best cranial nerve recovery was seen in CN V and the worst one was seen in CN III. It seems that maximum effort should be made to preserve critical structures of cavernous sinus, special those that extend into the petroclival region, while trying to reach maximum resection that is possible.

2. Key Points:

1. Sophisticated skull base surgery
2. Endoscopic and transcranial surgical approaches.
3. No use of radiation.

2.1. Importance of the Study

1. Cavernous sinuses clinically important because of its location, its close relationship to several cranial nerves and the internal carotid artery, and the complex of veins without valves that drain from and to the paired cavernous sinuses. It has been called no man's land and the outcome of surgical procedures has not been rewarding. The importance of our study is the focus on a particularly common pathology, the meningioma of the cavernous sinus.
2. We operated on these cases not only through transcranial approaches but also through endoscopic endonasal approaches. The number of our cases is comparable to other reported large series in respected centers as well as the outcome.

3. We did not use post-operative radiotherapy and radiosurgery in our cases and the therapeutic clinical outcome can be attributed to the surgery.

3. Introduction

The term "Cavernous sinus" first time mentioned in a book in 1734 which name was "An Anatomical Exposition of the Structure of the Human Body". Now, there is not any other name for Cavernous Sinus (CS) in literature [1]. This chamber is actually a venous pathway but it contains cranial nerves (CN) III-VI, sympathetic nerve, and internal carotid artery (ICA) [2]. Sella turcica is located in between of cavernous sinuses and their position is in the antero-lateral of skull base. It has 2 cm length and 1 cm height. Osteo-dural-meningeal compartments of CS are located on the both side of sella turcica [3].

The cavernous sinus has a complex anatomy and contains a number of dominant and vital structures. As a result, surgical management of neoplasms located in this area is very challenging. Because of that, it is also known as "Anatomical Jewel Box" and "Surgical no man's land" [4].

It is necessary to have a good concept of the CS anatomy to explicate the CS syndromes' pathologies [5].

The most common cause of CS syndromes is meningiomas with 41% of all CS lesion [6].

These lesions are an anatomically heterogeneous group of skull base tumors [7-9].

They usually originate from dura of the cavernous sinus. But it can also originate from dura of the sphenoid ridge, petroclival region, clinoid processes, or anterior skull base, and it may extend into the cavernous sinus [7, 9]. Also, invasion stage is a matter of concern in these tumors. CS meningiomas may grow between the layers of CS dura, interadural space, without invading the CS chamber. On the other hand, they may infiltrate into the venous sinus or even involve the cranial nerves and internal carotid artery [10-12].

Most of meningiomas are benign tumors. About 13-26% of all primary intracranial tumors are meningiomas [13]. World Health Organization (WHO) classifies them as grade 1 (benign), grade 2 (atypical), and grade 3 (anaplastic). They are originated from meningiothelial cells (arachnoidal cells) [14]. It can develop in any age, but mostly it happens in middle ages. It is more common in women with a female to male ratio of approximately 2:1 for intracranial meningiomas and 10:1 for spinal meningiomas [15, 16]. The recurrence rate of meningiomas, even after complete removal, is 10 to 32% within 10 years. However, it is completely rare for grade 1 meningiomas and if happens, it will be after long time [17, 18].

In this paper we want to report a surgical series of cavernous sinus meningioma that were operated with 2 surgical methods, open surgery (microsurgical) and Endoscopic Endonasal Surgery (EES).

4. Method and Materials

In this retrospective review, every patient that was operated for CS tumor in our center from July 2013 to November 2020 was included. Necessary imaging, include CT-scan, MRI, MRA, and MRS were performed due to surgeon opinion. An exact physical examination was also accomplished with focus on Visual filed evaluation (by perimetry), Karnofsky Performance Scale (KPS) score, and Modified Rankin Scale. Imaging determined the position of lesions and identified involved structures. Ethics statement: We had the permission of all the patients and the university to uase the data. The informed consent was obtained from all the subjects.

Two approaches were used for surgical resection of these lesions. Some of the patients underwent open surgery and the others operated with EES approach. Deciding what method to use was made due to tumor location, its extent, and possible invasions. In every patient, surgeon tried to maximize amount of resection with conservation of vital structures include cranial nerves and ICA. The extent of resection was analyzed with after surgery neuro-imaging and was reported by an expert radiologist. Follow up were performed during regular visits, physical examination, and imaging for every patient. These sessions were in 1st and 3rd day, 1st week, 1st, 2nd, 4th, 6th, 12th, 18th, and 24th months after surgery. The extent of resection, morbidities including cranial nerve 2-6 impairment, vision (visual field), recurrence, complications, and long-term outcomes were recorded. At last, all data were analyzed with SPSS version 19.

5. Results

From 2013 to 2020, 58 patients were referred with CS tumor to our center. Different signs and symptoms of patients at presentation are mentioned in table 1.

Surgical approaches were chosen by surgeon decision. Among these patients, 36 case were operated with microsurgery approach and 22 patients with EES approach. Among patients that were operated with microsurgery, 14 were male and 22 were female and the mean age of them was 43.5 year. In patients underwent surgery using EES approach, 5 were male and 18 were female with mean age of 47.5 year.

Gross Total Resection (GTR) achieved in 36 cases (52.9%) of all cases and near total resection (NTR) in 22 patients (32.3%). The extent of resection was subtotal in 10 cases (14.8%).

Favorable outcomes, that is KPS score more than 70, was seen in 56 cases of patients after surgery (82.4%). Also 88.3% of patients had post-operative KPS score of more than 60.

The mean follow-up duration was 28 months. Post-operative complications in patients who operated with EES method was CSF leak in just one patient that led to meningitis, however, it was treated well with suitable antibiotics and supportive treatments, without any other consequences. On the other hand, in patients who

underwent open surgery, 4 patients died due to post-surgical complications include 2 pulmonary thromboembolisms, 1 Myocardial infarction, and 1 patient that developed hemiparesis due to carotid territory infarction that finally passed away. Also 2 surgical complications happened. In one patient, major vessel damage occurred that was controlled with packing with fibrin and patty cotton and after surgery developed pseudo aneurysm. It was treated with coiling and proper endovascular intervention. In another case surgeon had to sacrifice right carotid, but it was tolerated quite well.

Vision improvement was seen in 73.5% of patients underwent resection with EES. Among patients who experienced open surgery, 2 cases had recurrence in at least 2 year follow up period.

In our patients, 16 person had CN III palsy, 5 patients had CN V paresis, and 4 cases had CN IV and/or VI palsy before surgery. CN III improved partially in 3 patients and improved completely in 2 cases. CN V paresis completely recovered in 4 patients (after 3 months), but 1 patient lost her teeth as a result of CN V palsy. CN IV and VI were convalesced in 2 patients. One new CN VI palsy occurred after EES.

Table 1: Frequency of the clinical presentations in our cases with cavernous sinus meningioma.

Sign or symptom	Percent
Headache	73.5
Retro-orbital pain	44.1
Ophthalmoplegia	41.2
Visual field defect	30.8
Paresthesia in V1 and V2 territories	10.3
Exophthalmus	17.6
Cerebral infarction	5.9
Seizure	7.35

6. Discussion

Although surgical management of CS meningioma improved, using new methods and technologies like EES and better surgical microscopes, it is still completely challenging due to complex process and considerable risk of morbidities [17, 19-23].

Several possible reasons have been proposed in the literature. First one is damage to the fine blood supply of CNs (especially ocular nerves) during dissection of the lesion [24, 25]. The other one is infiltration of tumor to CNs and adventitia of the ICA and also involvement of arachnoidal plane; moreover, Sacrificing ICA may lead to severe morbidity or mortality [10-12].

DeMonte et al. reported the outcomes of aggressive resection of CS meningioma. They reported 76% GTR rate in 41 patients that were operated with open surgery method; however, 5% of them got recurrence within 5 years after surgery. The complications rate was high. Ten new cranial defect occurred in 7 patients, that is about 24.3%, and the mortality rate was 4.8% [26].

In a series of 119 patients that had CS meningioma, they achieved 61% GTR, nevertheless 10% recurrence in GTR group and 15% recurrence in other patients happened. According to their report, the mean KPS score of their patients decreased from 90 to 80. They also reported 21% CSF leakage, 5% cerebral infarction that just one third of them were related to ICA occlusion and subsequent embolism, 3% brain hematoma or contusion, 4% infection, and 14% pituitary dysfunction (most of them transient) [17].

In another series, O'Sullivan et al. reported just 20.5% GTR among 39 patients who underwent open surgery of CS meningioma resection. Besides, they reported 17.6% new cranial nerve defect and just 5.1% improvement in cranial nerve function [23].

On the other hand, a surgical series of 38 patients with CS meningioma, 24 patients with Hirsch Grades 0 and 1 and 14 patients with Hirsch Grades 2 to 4, reported by Abdel-Aziz et al. They achieved GTR in 58% patients and STR in 42% patients. The patients' KPS score after long term follow up were same in 29%, improved in 63%, and worsened in 8%. They also reported 10.5% recurrence and 5.2% complication rate. They had 55% CN III dysfunction before surgery that decreased to 16% after long term follow up [7].

In a series reported by Sindou et al. in 2007, 100 cases of CS meningioma underwent surgical resection. In 88 of them, extracavernous resection with or without partial intracavernous debulking were performed. They showed that the recurrence rate was just 13% in patients who achieved STR [18].

In our patients, 85.2% of all patients reached GTR or NTR that is comparable with other series.

Recurrence rate was 7.3% in our patients. In our series, the best recovery rate was for patients who had CN 5 palsy and the worst recovery was in patients suffering CN III palsy that is unlike Abdel-Aziz series [7]. The cause of this difference may be for follow up duration. The morbidity rate was 6.9% in our series that is less than mentioned reports. It may be because of using EES in medial lesions that induce less aggression in CS. We did not see any significant reduction in KPS score in our patients.

7. Conclusion

If feasible, maximum effort should be made by neurosurgeon for GTR and NTR; as our results showed favorable post-operative neurological outcomes in patients underwent GTR and NTR.

On the other hand, maximum effort should be made to preserve adjacent neuro-vasculature, special attention to tumors that extend into the petroclival region, as injury to these structures may result in devastating outcomes. Special attention should directed to reconstruction of anatomic barriers of Cavernous sinus to prevent CSF leakage and subsequent potential infections.

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