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Technical Note

Translamina Terminalis Approach to the Hypothalamus Using Supraorbital Craniotomy: Technical Note and Comparison with Other Surgical Corridors

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Mohammed M M Alhoobi and Adnan Khan have the same contribution in this article

Abstract

Objectives: Approaches to the hypothalamus and anterior third ventricle are variable. We present a technical note on access of the hypothalamus using the trans-lamina terminalis approach by supraorbital craniotomy in a patient who had a hypothalamic cavernoma and presented to us with recurrent hemorrhage. **Patients and methods:** The trans-lamina terminalis approach, including anatomical landmarks and surgical steps through a supra-orbital craniotomy, is described and a comparison with other surgical corridors is discussed. **Results:** The supraorbital trans lamina terminalis approach allowed an effective access to the hypothalamic lesions. This approach provided a safe and minimally invasive corridor for gross total resection of the lesion since trespass of viable brain tissue is avoided. One clinical case illustrates the feasibility of the approach allowing complete removal of a cavernoma without surgery related neurological of endocrinological deficits. **Conclusions:** The supra-orbital craniotomy for trans-lamina terminalis approach is a valid surgical choice for hypothalamic lesions. The major strengths of this approach include minimal brain retraction and direct end-on view; however, the long and narrow surgical corridor requires some technical familiarization. The clinical outcomes are comparable to other surgical corridors.

Keywords: *Hypothalamic cavernoma, supraorbital craniotomy, translamina approach*

Introduction

Surgical approaches to the hypothalamus are technically demanding due to its deep location and proximity to vital and eloquent neurovascular structures, including the optic system and anterior cerebral artery apparatus. Several surgical corridors have been utilized for translamina terminalis access to the hypothalamus. The conventional pterional craniotomy constitutes the lateral approach.[1] The intracranial dissection through the lateral approach can either be transcortical or transsylvian. The anterior approach involves either a frontal or bifrontal craniotomy with subfrontal, interhemispheric dissection.[2-4]

With the emergence of key-hole surgery, the anterolateral approach through a supraorbital craniotomy has also been performed.[5,6]

Cavernous malformations (CMs) are low-flow angiographically occult vascular lesions. On histological examination, they are distinct, well-circumscribed lesions composed of a single endothelial cell layer with sinusoidal spaces and without muscular layer or interposing glial or neural tissue,[6,7] having an incidence of 0.3%–0.7% in the general population and representing 10%–20% of all vascular malformations.[8,9] The distribution of CMs within the central nervous system is proportional to the volume of the various compartments. Most occur in the supratentorial compartment (80%), followed by the infratentorial compartment (15%); the remaining 5% occur in the spinal cord. CMs of the optic hypothalamic axis are extremely rare, representing 1% or less of all CMs.[10] The earliest reported lesion was described in 1979 by Klein *et al*.[11] CMs of the hypothalamus are even rarer.

Patients and Methods

Initially, we will provide a technical description of a keyhole supraorbital

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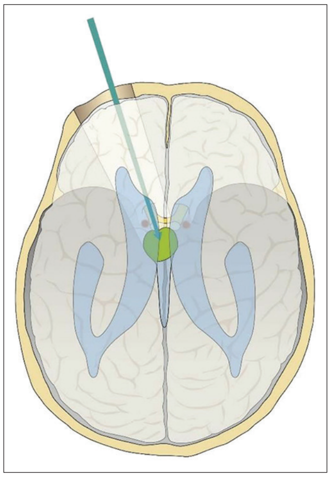

Figure 1.1: Illustration of translamina approach for intrinsic hypothalamic lesions through supraorbital craniotomy, Dissection of the arachanoid membrane at the optico-carotid cistern and intra-chiasmatic cistern allows exposure of lamina terminalis, after opening lamina terminalis hypothalmus and third ventricle can be accessed and lesion can be dissected out

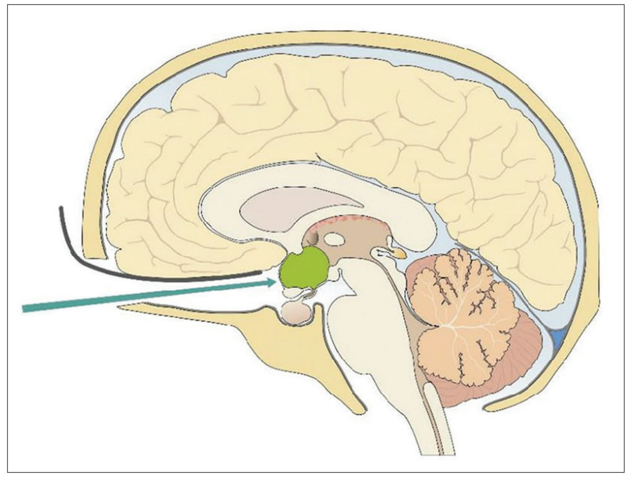

Figure 1.2: Illustration of translamina approach for intrinsic hypothalamic lesions through supraorbital craniotomy, Dissection of the arachanoid membrane at the optico-carotid cistern and intra-chiasmatic cistern allows exposure of lamina terminalis, after opening lamina terminalis hypothalmus and third ventricle can be accessed and lesion can be dissected out

translamina terminalis approach, including operative steps illustrated by one representative case. Next, we review the literature comparing the outcomes of different corridors to the hypothalmus. A literature search was performed in PubMed using the following key words "hypothalmic lesions, "hypothalamic approach," "key hole surgery," "supraorbital craniotomy," and "translamina approach." A full-text review of the articles was subsequently performed. Only the publications describing the translamina terminalis approach to hypothalamic lesions were included for the data extraction.

The literature information included technique, patient characteristics, gross total resection rates, tumor progression, and postoperative outcomes with a focus on visual, endocrine, and neurological complications.

Operative anatomy and technique

With increased emphasis on maximizing cosmetic outcomes, minimizing tissue morbidity and reducing hospitalization stays, there is now increased importance in understanding minimally invasive approaches (i.e., supraorbital craniotomy). The supraorbital craniotomy and its variants essentially provide a combined subfrontal–anterolateral microsurgical approach.

The first supraorbital subfrontal exposure was reported by Krause in the first volume of the surgery for brain and spine (Krause 1908). A similar extradural exposure was done by Fraizer 1913 to sellar and suprasellar area. Such historical and fundamental contributions have been made also by other Pionners such as Durante, Cushing, Heuer, Dandy, Yasargil, Brock and Dietz, Al-Mefty, Zabramski, and Perneczky. Although the supraorbital approach is not a new strategy, technological innovations have enhanced its applicability. The introduction of new tools (e.g., endoscopy and tube shaft instruments) and new approaches (i.e., orbital ridge osteotomy) has improved access to and visualization of cranial base lesions. Ultimately, neurosurgical and technological innovations have aimed to reduce the morbidity under the concept of minimally invasive neurosurgery.[3,12]

The development of finer, more accurate, and angled instruments has been critical for the success of the supraorbital approach and its variants. Similarly, a breakthrough was the use of the surgical microscope complemented with endoscopy-assisted microneurosurgery. The concept of key-hole microsurgery set forth by Perneczky was based on this new technology that contributed to providing several new options.[13]

Endoscopy provides wide-angled panoramic views as well as angled views with different magnifications, thus enabling distinct visualization at the surgical target site.

The use of smaller incisions can have cosmetic, functional, and even psychological benefits for the patient. However, this fact should not limit the final surgical plan in view of the surgical goal.

The classic supraorbital approach – also called the frontolateral-basal approach – is the classic technique described by Perneczky.[14] This approach provides access to the orbital roof, anterior clinoid process, posterior clinoid process, the roof and lateral wall of the cavernous sinus, the basal portion of the frontal lobe, gyrus rectus, sylvian fissure, temporal lobe, uncus, hippocampus, and cranial nerves CN1, CNII, CNIII, and CNIV as well as the middle cerebral artery with its branches above the viewing plane along the sphenoid ridge, A1, Acom and proximal A2 segments and the posterior cerebral arteries in their proximal segments [Figures 1.1 and 1.2].[3,13]

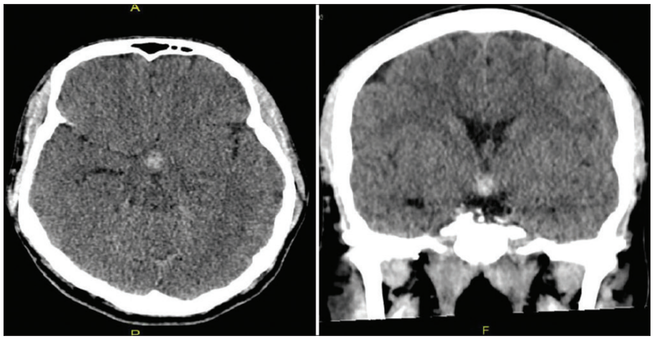

Figure 2.1: Non contrast CT image axial (left) and Coronal (right) shows showed a globular mass lesion at the region of the hypothalamus/floor of the third ventricle

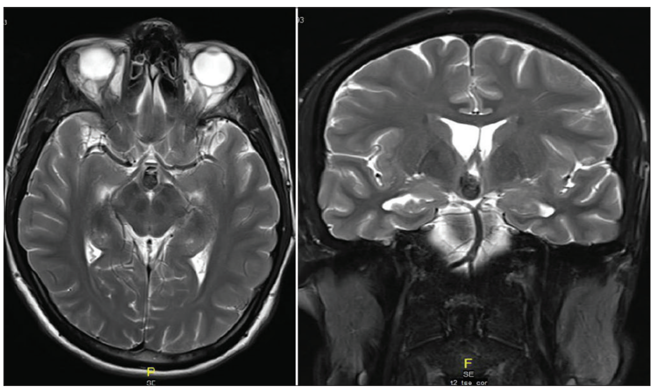

Figure 2.2: T2WI MRI Axial (left) and Coronal (right) shows showed a globular mass lesion at the region of the hypothalamus/floor of the third ventricle anterior to tuber cinereum and posterior to the optic chiasm extending into the interpeduncular cistern. It measured about 1.2 cm × 0.7 cm × 1.5 cm in A-P, transverse, and craniocaudal dimensions, respectively

Case

Case study

We present the case of a 29-year-old male who had been previously well and presented to the emergency department with a 1-week history of moderate-to-severe headache associated with nausea and vomiting. There was no reported history of loss of consciousness or seizures.

A thorough clinical examination failed to reveal any neurological deficits; the patient was conscious and alert. His baseline blood workup was unremarkable. A computed tomography (CT) of the head without contrast was done in ER, and it showed a hyperdense lesion on the floor of the third ventricle raising the possibilities of a calcified or the vascular lesion [Figure 2.1].

CT of the head [Figure 2.1] was followed by an magnetic resonance imaging (MRI), which showed a globular mass lesion at the region of the hypothalamus/floor of the third ventricle anterior to tuber cinereum and posterior to the optic chiasm extending into the interpeduncular cistern. It measured about 1.2 cm × 0.7 cm × 1.5 cm in A-P, transverse, and craniocaudal dimensions, respectively. The lesion appeared to be distant from the signal void of the basilar artery tip and anterior communicating arteries and showed heterogeneous signal in T1, T2/fluid-attenuated inversion recovery images [Figure 2.2]. Blooming was seen in susceptibility-weighted imaging sequence suggestive of hemorrhagic byproducts, which correlated with the CT appearance with density around 80 H.U.

The differential diagnoses included hamartoma, cavernoma, germinoma, or less likely subependymoma.

The patient was admitted to neurosurgery for close neurological observation and further management. Over the next few days, he continued to have intermittent mild headache but remained fully conscious and neurologically intact. It was initially decided to manage the patient conservatively with serial neurological examination and imaging as an outpatient. On the day of tentative discharge, the patient developed severe headache associated with nausea and vomiting. Clinically, he remained the Glasgow Coma Scale 15/15 and had no neurological deficits.

An urgent CT head [Figure 2.3] and MRI [Figure 2.4] revealed an increase in size of the previously described hyperdense lesion at the floor of the third ventricle/hypothalamus with extension into the interpeduncular cistern, measuring 2.2 cm × 1.4 2.2 cm (previously 1.1 cm × 1 cm), with a new diffuse hyperdense aspect suggestive of acute hemorrhage into the lesion, increasing the possibility of a cavernoma with intralesional bleed.

After the second hemorrhage, we decided to remove the lesion microsurgically. The CT and MRI were reviewed, and the advantages and limitations of different approaches to the lesion were discussed. We concluded to access the lesion through a supraorbital keyhole approach through the lamina terminalis.

The head is elevated around 15 degrees and positioned in retroflexion allowing gravity assisted self-retraction of frontal lobe. The degree of retroflexion depends on the target lesion, if the lesions is in proximity to frontal skull base it requires around 10-15 degree while lesions in the hypothalamus and third ventricle require 25-30 degree retroflexion. Thereafter, the head is rotated around 45-60 degree for the approach of lesions around the lamina terminalis, less rotation (around 15 degree) is required for approaching lesions for the ipsilateral temporomesial region, the sylvian fissure and MCA. Finally, the head is flexed about 10 degree to the contralateral side. Within the eyebrow the skin incision is marked lateral to the supra-orbital notch and extending to the frontal process of the zygomatic arch. Transeyebrow skin incision wasmade extending from the supraorbital notch to the lateral aspect of the eyebrow just below the superior temporal line. Dissection is carried out below the subcutaneous flap cranially, medially and laterally to expose the underlying muscles.

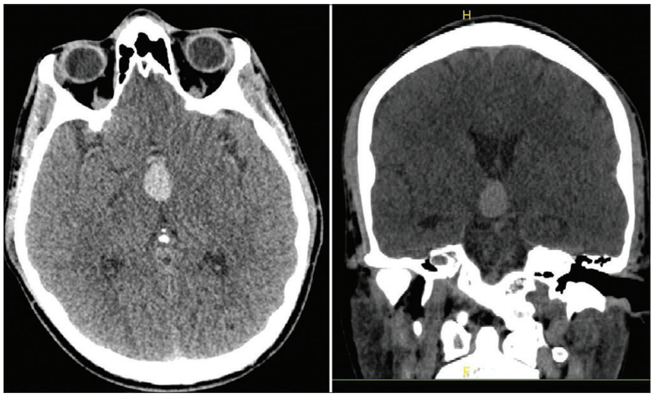

Figure 2.3: Non contrast CT image axial (left) and Coronal (right) revealed an increase in size of the previously described hyperdense lesion at the floor of the third ventricle/ hypothalamus

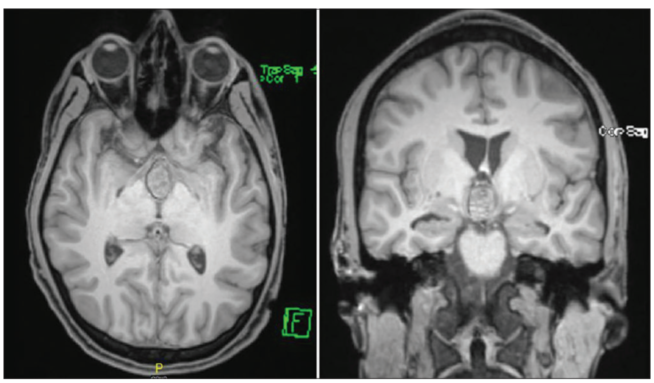

Figure 2.4: T1WI MRI Axial (left) and coronal (right) revealed an increase in size of the previously described hypo-intense T1WI lesion at the floor of the third ventricle/ hypothalamus with extension into the interpeduncular cistern, measuring 2.2 cm × 1.4 2.2 cm (previously 1.1 cm × 1 cm), suggestive of acute hemorrhage into the lesion, increasing the possibility of a cavernoma with intralesional bleed.

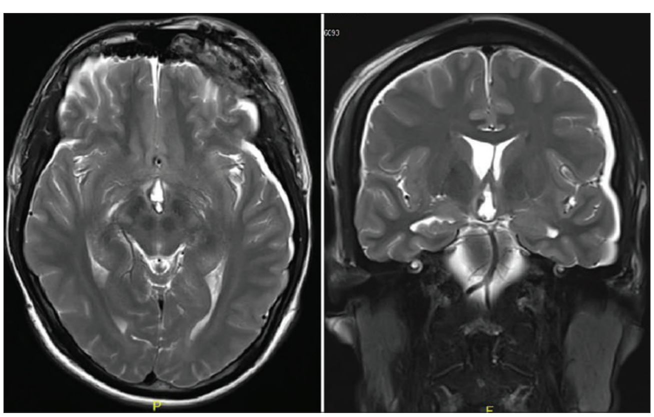

Figure 2.5: T2WI MRI Axial (left) and coronal(right) shows complete resection of the previoulsy mentioned hyperintense T2WI lesion

The frontal muscles are cut parallel to the orbital rim using a scalpel. The temporalis muscle is stripped out from its origin and retracted laterally. A supraorbital craniotomy was carried out. After removal of the bone flap the inner side of the orbital rim is drilled using high speed drill to increase working angles and facilitate the use of the microscope and microsurgical instruments. The dura is bluntly dissected from the orbital roof with Penfield dissectors and then the peaks of the orbital roof are drilled down to improve intraoperative visualization and working angles. Then dura is opened in a curvilinear fashion, and reflected Thersafter paddies are used to protect the undersurface of the frontal lobe until the ipsilateral optic nerve is seen. inferiorly. CSF is drained after dissection of the chiasmatic and optico-carotid cisterns, which allow s the frontal lobe to deflate spontaneously, avoiding the need of aggressive frontal lobe retraction. After dissection of the arachanoid membrane at the optico-carotid cistern and intra-chiasmatic cistern, the ipsilateral supra-clinoid ICA, A1, optic nerves and optic chiasm are exposed. Then midline of Lamina terminalis is sharply opened using microdissectos, CSF Drainage will help in further brain relaxation, this give access to the third ventricle. From this trajectory the hypothalmus can be accessed. By changing the microscopic viewing angles, a hypothalamic surface of approximately 3 cm diameter is in clear view [Figures 1.1-1.3]. Neuronavigation was used to confirm the location of the grossly reddish-brown lesion. The most prominent part of the lesion consistent of hematoma, which could be removed straightforwardly. Subsequently, the cavernoma wall was carefully dissected off the surrounding tissue, and the cavernoma was resected in a piecemeal fashion. An endoscope was used to inspect the surgical field for any remnants of the cavernoma. Careful hemostasis of the surgical field was ensured followed by thorough irrigation. The dura, bone, and skin were closed in standard fashion. The surgery was uneventful. Postoperatively, the patient did well and had a good recovery. There were no neurological or endocrine deficits.

Postoperative MRI brain [Figure 2.5] showed no residual mass lesion and no collateral damage to the hypothalamic region or floor of the third ventricle.

Histopathology showed a hemorrhagic lesion that consists of back-to-back dilated thin-walled blood vessels surrounded by the brain tissue showing extensive gliosis, hemosiderin laden macrophages as well as chronic inflammatory infiltrate, particularly around blood vessels. The diagnosis of a cavernous hemangioma was established.

Discussion

Different surgical corridors have been used to access the hypothalamus and anterior third ventricle through the lamina terminalis, including pterional, bifrontal interhemispheric, and supraorbital.

Liu *et al.* describe a variety of operative approaches for the surgical removal of optic pathways and hypothalamic CMs. In their series, an anterolateral approach (pterional, orbitozygomatic, or frontotemporal) was used in 76% of patients, and a midline transcranial approach (transbasal subfrontal or transbasal interhemispheric) in 17%. One patient underwent a frontoparietal approach, one a transcortical transventricular approach, and one an eyebrow keyhole craniotomy approach.[15]

Suzuki *et al*., published a series in 1984 which includes 17 patients of hypothalamic and anterior third-ventricular lesions using the anterior frontal interhemispheric approach. Thirteen gross total resections were achieved, diabetes insipidus occurred in 13 patients, and hyperthermia in one patient. Visual disturbances were not recorded.[16]

In 1999, Fahlbusch *et al.* published a series of 58 patients with craniopharyngiomas accessed through a pterional/translaminar approach. Gross total resection was achieved in 29 patients; no data was published on visual or endocrine complications.[17]

The supraorbital craniotomy is essentially an entry point to a subfrontal surgical corridor hovering above the lateral half of the orbital roof. The bony opening leading to this trajectory may also be achieved through a semi-circular skin incision along the hairline, as it is used for the pterional approach; however, this involves a much larger skin, muscle, and bone exposure. The eyebrow incision allows direct and fast access to the supraorbital craniotomy, its technique is straight forward, and it has proven to show excellent cosmetic results.[18]

The surgical corridor, which is opened by the eyebrow incision and supraorbital craniotomy, provides direct access toward the lamina terminals and the third ventricle beyond. The area of the hypothalamus can easily be visualized, especially for the lesions along the midline and on the contralateral side. In addition, a good line of sight to the interpeduncular cistern allows access to the pituitary stalk and the surrounding neurovascular structures.[19]

In our patient, we chose the supraorbital eyebrow translamina terminalis approach for several reasons. We avoided the interhemispheric transventricular endoscopic approach mainly because the ventricular size was small, and the endoscope movements in the narrow corridor would have put the fornix at the high risk of injury. In addition, the transcortical trajectory carries the risk of developing seizures. Both types of complications would have been catastrophic since our patient is young and had neither presented with behavioral or memory problems nor with seizures.

We also refrained from a classic subfrontal approach, which carries the following risks: (1) loss of olfaction due to bilateral frontal lobe retraction, (2) risk of sacrifice of the anterior superior sagittal sinus, which may lead to brain edema, and (3) opening of the frontal sinus, which can increase the risk of infection and sinonasal cerebrospinal fluid leakage.

In our case, a 20° head rotation allowed approximately vertical instrument position and optimal contralateral exposure. The surgical trajectory through the supraorbital craniotomy allowed straightforward dissection of the lamina terminals nearly without retraction of the frontal lobe and subsequently enabled reaching the contralateral hypothalamus. A larger craniotomy is neither necessary toward the midline nor toward pterional. The use of an endoscope can significantly augment the field of view provided by the microscope and should always be used for inspection of the surgical target before and after resection. Despite the rather narrow size of the surgical corridor through the 2 cm × 3 cm supraorbital craniotomy and the 8–10 cm depth of the surgical field, the microsurgical maneuverability was not restricted. On the contrary, the edges of the craniotomy provide an excellent rest for the tube-shaft instruments and the endoscope.[19,20]

Conclusion

After a careful analysis of clinical and radiological data in selected patients, a contralateral supraorbital keyhole approach through the lamina terminals may allow safe and effective excision of hypothalamic lesions, including cavernomas. The major strengths of this approach are low access-related morbidity, minimal brain retraction, and direct end-on view. The long and narrow working distance may require some familiarization to the use of tube shaft instruments. Endoscopy provides precise visualization of the surgical target structures.

Consent and IRB approval

Patient consented and agreed for the publication of his case and IRB approval was obtained from the institute.

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Conflicts of interest

There are no conflicts of interest.

References

1. King TT. Removal of intraventricular craniopharyngiomas through the lamina terminalis. Acta Neurochir (Wien) 1979;45:277-86.
2. Behari S, Banerji D, Mishra A, Sharma S, Sharma S, Chhabra DK, *et al*. Intrinsic third ventricular craniopharyngiomas: Report on six cases and a review of the literature. Surg Neurol 2003;60:245-52.
3. King TT. Removal of intraventricular craniopharyngiomas through the lamina terminalis. Acta Neurochir (Wien) 1979;45:277-86.
4. Shi XE, Wu B, Fan T, Zhou ZQ, Zhang YL. Craniopharyngioma: Surgical experience of 309 cases in China. Clin Neurol Neurosurg 2008;110:151-9.
5. Kurokawa Y, Abiko S, Ikeda N, Ideguchi M, Okamura T. Surgical strategy for cavernous angioma in hypothalamus. J Clin Neurosci 2001;8 Suppl 1:106-8.
6. Little JR, Awad IA, Jones SC, Ebrahim ZY. Vascular pressures and cortical blood flow in cavernous angioma of the brain. J Neurosurg 1990;73:555-9.
7. Rigamonti D, Drayer BP, Johnson PC, Hadley MN, Zabramski J, Spetzler RF. The MRI appearance of cavernous malformations (angiomas). J Neurosurg 1987;67:518-24.
8. Moriarity JL, Wetzel M, Clatterbuck RE, Javedan S, Sheppard JM, Hoenig-Rigamonti K, *et al*. The natural history of cavernous malformations: A prospective study of 68 patients Neurosurgery 1999;44:1166-71.
9. Porter RW, Detwiler PW, Spetzler RF, Lawton MT, Baskin JJ, Derksen PT, *et al*. Cavernous malformations of the brainstem: Experience with 100 patients. J Neurosurg 1999;90:50-8.
10. Hassler W, Zentner J, Wilhelm H. Cavernous angiomas of the anterior visual pathways. J Clin Neuroophthalmol 1989;9:160-4.
11. Klein LH, Fermaglich J, Kattah J, Luessenhop AJ. Cavernous hemangioma of optic chiasm, optic nerves and right optic tract. Case report and review of literature. Virchows Arch A Pathol Anat Histol 1979;383:225-31.
12. Cushing H. Technical methods of performing certain cranial operations. Surg Gynecol Obstert 1908;6:227-46.
13. Quiñones-Hinojosa A, Supraorbital craniotomy and its variants. Schmedic and Sweet Operative Neurosurgical Technique. 6th edition, 2012:1. p. 428.
14. Perneczky, Reisch, Robert Supraorbital approach. Keyhole Approaches in Neurosurgery, 2008:1. p. 37-53.
15. Liu JK, Lu Y, Raslan AM, Gultekin SH, Delashaw JB. Cavernous malformations of the optic pathway and hypothalamus: analysis of 65 cases in the literature. Neurosurgical Focus, 2010:29;E17. doi:10.3171/2010.5.focus10129.
16. Suzuki J, Katakura R, Kitahara M, Mori T. The interhemispheric trans-lamina terminalis approach to tumor of anterior part of the third ventricle. No Shinkei Geka 1984;12:27-34.
17. Fahlbusch R, Honegger J, Paulus W, Huk W, Buchfelder M. Surgical treatment of craniopharyngiomas: Experience with 168 patients. J Neurosurg 1999;90:237-50.
18. Reisch R, Marcus HJ, Hugelshofer M, Koechlin NO, Stadie A, Kockro RA. Patients' cosmetic satisfaction, pain, and functional outcomes after supraorbital craniotomy through an eyebrow incision. J Neurosurg. 2014;121:730-734. doi:10.3171/2014.4.JNS13787.
19. Singh H, Essayed WI, Jada A, Moussazadeh N, Dhandapani S, Rote S, *et al*. Contralateral supraorbital keyhole approach to medial optic nerve lesions: An anatomoclinical study. J Neurosurg 2017;126:940-4.
20. Perneczky A, van Lindert E. Keyhole Concepts in Neurosurgery: With Endoscope-assisted Microsurgery and Case Studies. Stuttgart: Thieme; 1999.