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Original Article

Tuberculum Sellae Meningioma – Multiple Skullbase Approaches: Their Safety And Efficacy

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Abstract

Background: *Tuberculum sellae (T.S.) meningiomas accounts for 5–10% of all intracranial meningiomas. The primary goal of surgery is to improve or at least maintain visual function, but this objective poses a formidable surgical challenge, because of the risk of postoperative visual impairment. The aim of the present study was to evaluate outcome in TSM patients treated microsurgically using multiple skull base approaches such as transcranial approach and extended endonasal transsphenoidal approach.*

Materials and Methods: *This is a retrospective study of 34 patients was aimed to observe the efficacy of the different common approaches by a single neurosurgeon. The approaches were minipterional approach, superciliary keyhole microscopic approach, superciliary keyhole endoscopic assisted approach, bifrontal basal approach and extended endoscopic endonasal approach. All the patients were evaluated preoperatively by visual field analysis and contrast MRI. Postoperative follow-up was done by visual field analysis and by contrast MRI or contrast CT scan of brain.*

Result: *Through transcranial surgery vision improved in 86.20%, static in 10.34% and deteriorated vision in 03.45%. Through transsphenoidal surgery vision improved in 80%, static in 20% and deteriorated in 0%. Through transcranial microscopic approaches (minipterional, minibifrontal basal, superciliary keyhole microscopic) gross total removal was done in 58.82%, near total in 10.34% and partial removal in 03.45%. Through transcranial/ superciliary keyhole endoscopic assisted approach, gross total removal was done in 80% and near total in 20%. Through transsphenoidal approach gross total removal was done in 60%, near total in 20% and partial removal in 20%.*

Conclusion: *Now a days endoscopic assisted key hole superciliary mini craniotomy for resection of tuberculum sellae meningioma is commonly used because of less morbidity and good visual outcome and this can be done without microscopic set up. The endonasal route is preferred for removal of T.S. meningioma when they are mostly sellar and directing towards third ventricle. The major limitation of this approach is a narrow surgical corridor. The gross total removal was better achieved with minibifrontal basal and minipterional craniotomy.*

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Introduction:

Tuberculum sellae (T.S.) meningiomas accounts for 5–10% of all intracranial meningiomas and typically arise from the dura mater of tuberculum sellae, chiasmatic sulcus, and limbus sphenoidale. [1-5] Visual disturbance is the most common clinical presentation, up to 80% according to the series of Schick et al.[6], because of the intimate anatomical relation between tuberculum sellae and the optic apparatus, T.S. meningioma in fact displaces the optic apparatus, and frequently up to 67% cases it invades[7,] the optic canals leading to asymmetric visual field deficit (Fig-01).[8] Other less common symptoms and signs are headache, dizziness, seizures, endocrine disturbance, altered behavior, and cranial nerve deficits.[2, 9–11]

The primary goal of the surgery is to improve or at least maintain visual function, but because of the risk of postoperative visual impairment, this objective poses a formidable surgical challenge with 10–20% of patients experience worsening of preoperative visual function.[9,12] Several authors have reported that unroofing of the optic canal and anterior clinoidectomy can improve visual outcome.[13,14] The aim of the present study was to evaluate outcome in TSM patients treated microsurgically using multiple skull base approaches such as transcranial approach and extended endonasal transsphenoidal approach.

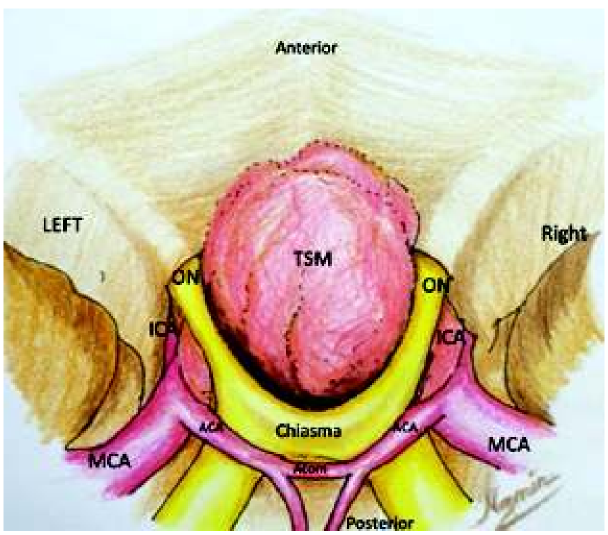

Fig.-1: *Depicted the diagram of T.S. meningioma compressing the optic chiasm backward and downward, internal carotid artery laterally and anterior circulation complex upward. In the figure:* ***TSM****- tuberculum sellae meningioma,* ***ON****- optic nerve,* ***ICA****: Internal carotid artery,* ***ACA****- anterior cerebral artery,* ***MCA****- middle cerebral artery,* ***Acom****- anterior communicating artery.*

Materials and Methods:

This retrospective study was aimed to observe the efficacy of the different common approaches used in different center by a single neurosurgeon. The approaches were minipterional approach, superciliary keyhole microscopic approach, superciliary keyhole endoscopic assisted approach, bifrontal basal approach and extended endoscopic endonasal approach in resecting the tuberculum sellae meningioma. All the patients were evaluated preoperatively by visual field analysis and contrast MRI. Postoperative follow-up was done clinically by visual field analysis at one month and radiologically by contrast MRI at one and at six month. In some cases, if patients were economically not solvent, they underwent contrast CT scan of brain. Tumor removal was measured per-operatively. We have divided the tumor removal into three groups – gross total removal (no visible tumor under microscope or endoscope), near total removal (about 70% tumor was removed) and partial removal (less than 50-70% tumor is removed).

01. Superciliary Key Hole Microscopic Approach:

This technique is a medial approach to get the tuberculum sellae meningioma. The patient was placed in the supine position with head turned 15°-20° to the contralateral side and 15° retroflexed to allow the frontal lobe slightly fell back. Head was fixed using the three-pin head holder. A curvilinear skin incision was made, then one burr hole done on the McCarty keyhole. The craniotomy was made using craniotome with bone flap length about 2 X 2 cm. If the frontal sinus was exposed, the sinus mucosa was removed and cauterized and then was tamponade with gel foam and bone wax, dura was opened under microscope (Pentero, Carl Zeiss, Germany) in semilunar fashion with its base towards the orbital rim.

The frontal lobe was slightly retracted to identify the suprachiasmatic cistern. Then the cistern was opened to drain CSF for adequate brain relaxation. Arachnoid incision was made to open the sylvian fissure from medial to lateral. The opening of sylvian fissure facilitated further dissection to reveal and identify major vital structures such as ipsilateral olfactory nerve, optic nerve, and internal carotid artery with its major branches. In some cases the ipsilateral optic nerve may be covered by the tumor. After the vital structures were secured, the dural attachment was followed to the tumour base for devascularization of the tumor. Tumor mass debulking was done by using controlled suction and disc rongeur.

Indications:

This is the most common approach for T.S. meningioma. We choose this approach when meningioma is small to medium in size, strictly in midline and no or minimum ICA involvement or displacement.

Case: 01

A 45 years old lady was presented with bitemporal field defect along with mild headache. Her MRI revealed tuberculum sellae meningioma. She underwent key hole superciliary mini craniotomy and microscopic removal of tuberculum sellae meningioma. Her postoperative recovery was excellent with better visual outcome (Fig: 02).

02. Minipterional Approach:

Operating Procedure:

This technique is the lateral skull base approach to get to tuberculum sellae meningioma. The patient was positioned supine with the head turned about 30° to the opposite side along the sphenoid wing and slightly retroflexed about 15°. Head fixation was done by using three pin Mayfield head holder. The scalp incision was started just above the tragus, in front of the superficial temporal artery then it continues superiorly behind the hairline and ends near to midline. The skin along with galea aponeurotica was elevated and interfascial dissection of the temporal fascia was done to preserve the frontal branch of the facial nerve. Temporalis muscle was incised down to the periosteum, parallel to the skin incision, then the muscle and the pericranium was reflected inferiorly.

A single burr hole was made in the MacCarty keyhole. The bone flap cut was made with the craniotome, from the MacCarty keyhole through lateral orbital rim, the superficial temporal line, the squamous suture and back to the keyhole. Dura mater was opened in curve fashion with sphenoid wing on its base. The next step was splitting the sylvian fissure to drain the cerebrospinal fluid. A representative case was presented below.

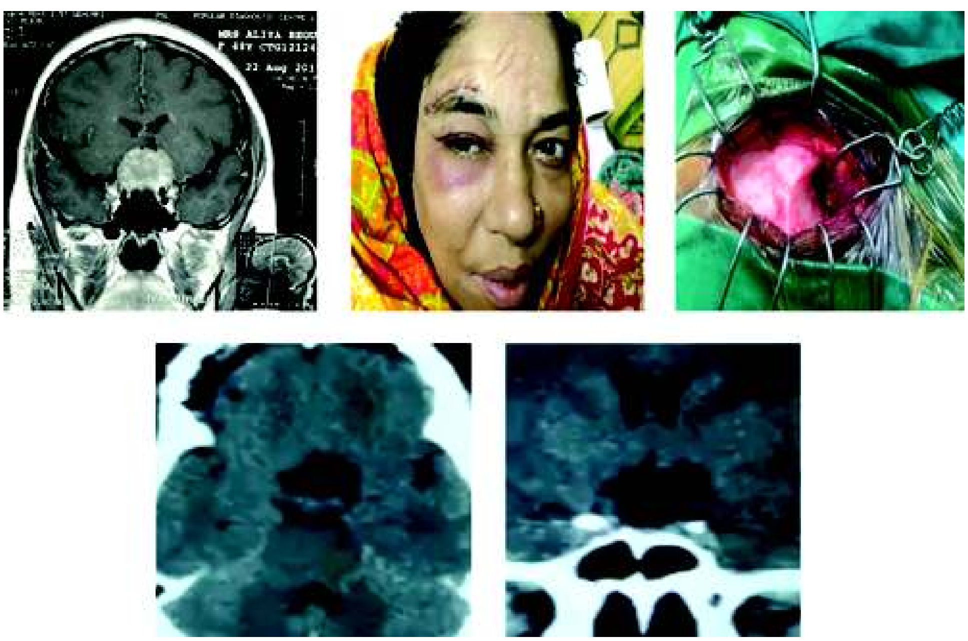

Fig.-2: *(A) Coronal view MRI with contrast showing of a medium size T.S. meningioma. (B) Showing a linear mark (with permission) of superciliary keyhole approach. (C) Per-operative picture of superciliary keyhole exposure showing the frontal bone. (D) Post-operative CT scan of T.S meningioma showing no residual tumour in axial view. (E) No residual tumour in coronal view in post-operative CT scan.*

Indications:

We prefer this approach when the T.S. meningioma has significant extension towards optic canal and optic-carotid recess to the parasellar area. In this case we need to do optic foramen exploration to remove the meningioma from the optic canal and decompress the optic nerve and internal carotid artery.

Case: 02

A 55-Year-old woman presented with gradual left eye blindness and occasional headache. Her MRI revealed T.S. meningioma with left optic canal invasion. She underwent left sided minipterional craniotomy. Optic canal deroofing and anterior clinoidectomy was done, tumour was devascularized from its attachment in the tuberculum sellae. Opticocarotid triangle area was exposed. Tumour was removed by piecemeal fashion through pre-chiasmatic and Opticocarotid angle. Gross total removal of tumor was done. Her post-operative recovery was uneventful. Preoperatively her vision on left eye was hand movement and postoperatively her vision was improved to finger count (Fig: 03).

03. Superciliary Key Hole Endoscopic Approach:

Operating Procedure:

This approach is similar to superciliary keyhole microscopic approach. Here we use 0° endoscope (4 mm wide, 18 cm length, Carl Storz, Germany) as a visualizing tool instead of microscope. Endoscope was held by endoscopic holder (Huidamed, China); the tumour dissection was carried out by micro instruments, micro scissor. Long bipolar forceps was used for cautery. The patient was placed in the supine position with head turned 15°-20° to the contralateral side and 15° retroflexed to allow the frontal lobe slightly fell back. Head was fixed using the three-pin head holder. After Curvilinear skin incision one burr hole was made on the McCarty keyhole. The craniotomy was done using craniotome with bone flap's length about 2 X 2 cm width. If the frontal sinus was exposed, the sinus mucosa would be removed and cauterized followed by packing the sinus with gel foam and bone wax. Dura was opened in semilunar fashion with its base towards the orbital rim. Frontal lobe was slightly

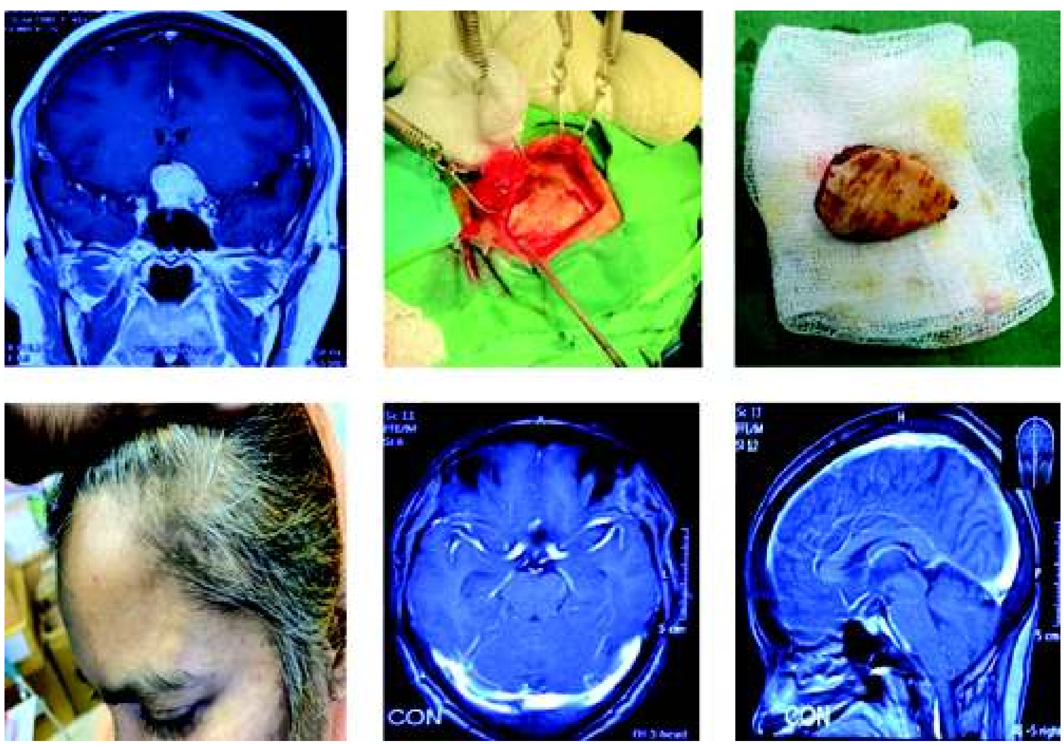

Fig.-3: *(A) Coronal view MRI of a T.S. meningioma showing extension of tumour through Opticocarotid tringle on left side. (B) Mini pterional craniotomy on left side. (C) Small size fronto-temporal craniotomy bone. (D) Showing healed scar. (E) Post-operative axial MRI with contrast shows no residual tumour. (F) Post-operative sagittal MRI with contrast shows no residual tumor.*

retracted to identify the suprachiasmatic cistern and open it to drain the CSF to give more relaxation to the brain. Arachnoid incision was made to open the sylvian fissure from medial to lateral. The opening of sylvian fissure facilitated further dissection to reveal and identify major vital structures such as ipsilateral olfactory nerve, tumour, ipsilateral optic nerve, and internal carotid artery with its major branches. After securing the vital structures dural attachment was followed down to the tumour base for devascularization of the tumor. Tumor mass debulking was done by using controlled suction and disc rongeur.

Indications:

When the T.S. meningioma is extended to sella and mainly occupy the sella and directing posteriorly with no or less A-Com complex encasement we prefer this technique. It gives us direct exposure to sella and tuberculum sella. We do 3 hands approach where 0 degree telescope is held by an endoscopic holder or by an assisting surgeon and the principal surgeon is doing bimanual work under visual guide of the endoscope.

Case: 03

A 35 years old woman was presented with bitemporal field defect. Her MRI revealed T.S. meningioma. She underwent endoscopic assisted superciliary keyhole approach. Tumor was resected in piece meal fashion. Her recovery was excellent and visual improvement was satisfactory (Fig: 04).

Result:

The study was held in the department of neurosurgery, BSMMU and some other private hospitals from 2015 to 2020. We obtained 34 patients with TSM, 28 (82.35%) were females and 6 (17.64%) were males. Patient's Age distribution was between 11 and 65 years. Most of the patient were aged between 31 to 50 years (61.76%). Mostly used approach was transcranial microscopic (70.58%), then transsphenoidal (14.70%) and transcranial/superciliary keyhole endoscopic assisted (14.70%). Through transcranial surgery vision improved in 86.20%, static vision in 10.34% and deteriorated vision in 03.45%. Through transsphenoidal surgery vision improved in 80%, static in 20% and deteriorated in 0% (Table-3). Among transcranial approach CSF leak was in 06.89% and meningitis in 10.34% and transsphenoidal approach CSF leak was in 20% and meningitis in 20% and there was no mortality in both approach (Table–2). In our series

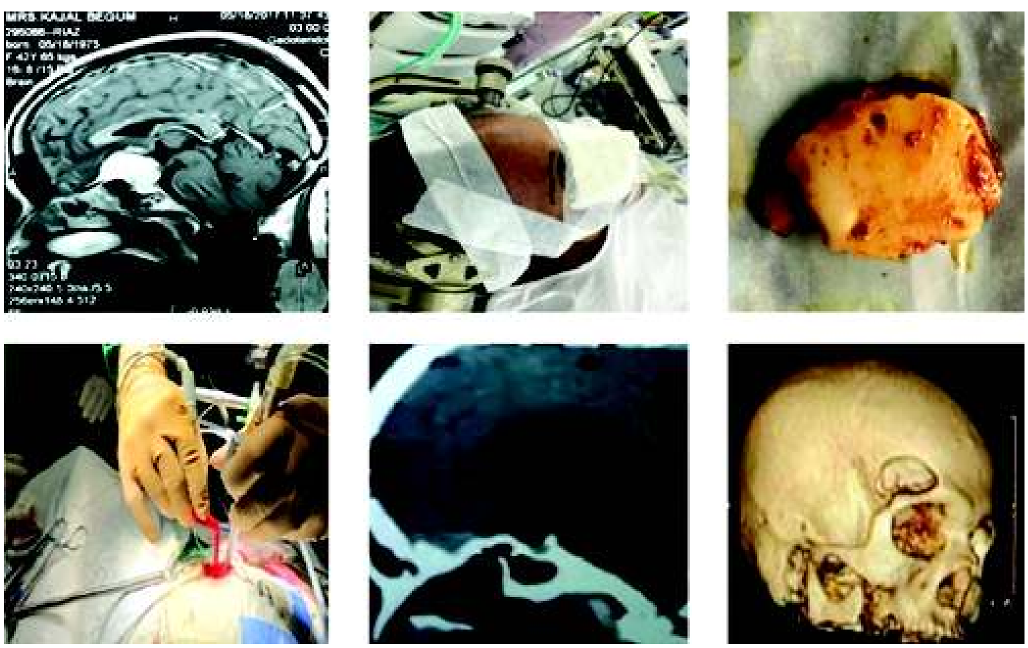

Fig.-4: *(A) Sagittal view MRI with contrast shows medium size T.S meningioma. (B) Planning for superciliary keyhole endoscopic approach. (C) Small piece of frontal bone in keyhole approach. (D) Picture shows three hand technique in superciliary keyhole endoscopic assisted approach. (E) Post-operative CT scan in sagittal view showing no residual tumour. (F) Post OP CT scan with area of bony mark to show the superciliary keyhole approach.*

through transcranial microscopic approaches (Pterional, minibifrontal basal, superciliary keyhole microscopic) gross total removal was done in 58.82%, near total in 10.34% and partial removal in 03.45%. Through transcranial/superciliary keyhole endoscopic assisted approach, gross total removal was done in 80% and near total in 20%. Through transsphenoidal approach gross total removal was done in 60%, near total removal was done in 20% and partial removal was done in 20% cases (Table-2).

Most patient were presented with bitemporal field defect. Some were blind in one eye and in six cases (17.64%) were blind in both eyes. Mostly used approaches were transcranial microscopic (minipterional, minibifrontal basal, superciliary keyhole microscopic) - (70.58%), then transsphenoidal (14.70%) and transcranial/superciliary keyhole endoscopic assisted (14.70%). Most of the tumor were small (<3 cm) to medium (3-6 cm) sized. Large size tumor (more then 6cm) only constitutes 2 in number. (Table-1)

Vascular encasement was present in 11 (32.35%) cases and no vascular encasement in 23 (67.64%) cases. Vascular encasement was mainly in the form of arachnoid adhesion of the tumour with blood vessels. In few cases there were circumferential adhesion of blood vessels to tumour.

Table-I

Distribution of Tumour Size (N-34)

	No. of Patients	
Size	Frequency	Percentage
<3cm	15	(44.11%)
3- 6 cm	17	(50%)
>6cm	2	(5.88%)
Total:	34	100%

Table-II

Distribution of Complication (N-34)

	No. of Patients (%)	
	Transcranial	Transsphenoidal
CSF leak	2(06.89%)	1(20%)
Meningitis	3(10.34%)	1(20%)
Vascular injury	Nil	Nil
Wound infection	2(06.89%)	Nil

Through transcranial microscopic approaches (minipterional, minibifrontal basal, superciliary keyhole microscopic) gross total removal was done in 58.82%, near total in 10.34% and partial removal in 03.45% cases. Through transcranial/superciliary keyhole endoscopic assisted approach gross total removal was done in 80% and near total in 20% cases. Through transsphenoidal approach gross total removal was done in 60%, near total in 20% and partial removal in 20% cases (Table-3). The cause of partial or incomplete removal was due to tough or fibrous variety of tumour and in some cases difficulty in dissection in case of vascular encasement.

Table-III

Distribution of Extent of Tumour Removal (N-34)

	No of Patients (%)		
	Transcranial Microscopic	Transcranial/ Superciliary Keyhole Endoscopic Assisted	Transsphenoidal
Gross total	20(58.82%)	4(80%)	3(60%)
Near total	3(10.34%)	1(20%)	1(20%)
Partial	1(03.45%)	0	1(20%)

Table-IV

Distribution of Visual Outcome (N-34)

	No. of Patients (%)	
	Transcranial	Transsphenoidal
Improved Vision	25(86.20%)	4(80%)
Static vision	3(10.34%)	1(20%)
Deteriorated vision	1(03.45%)	0(%)

Through transcranial surgery vision improved in 86.20%, static vision in 10.34% and deteriorated vision in 03.45%. Through transsphenoidal surgery improved vision in 80%, static vision in 20% patients and there was no deterioration of vision (Table-8).

Among transcranial approach CSF leak was in 06.89% and meningitis was in 10.34% patients and among transsphenoidal approach CSF leak was in 20% and meningitis was in 20% patients (Table–4). There was no mortality in this study.

Table-V

Comparison Of Multiple Skull Base Approaches In TSM In Different Series

Series (ref.no)	No of cases	Approach	Gross total removal	Visual outcome improved	Complication mortality
Al-Mefty and Smith, 1991 (33)	35	Transcranial	91%	25%	8.6
Mathiesen and Kihlstrom, 2006 (34)	29	Transcranial	90%	75.9%	0%
Jho, 2001 (37)	1	Endoscopic endonasal transphenoidal	100%	100%	0%
Dusick et al., 2005 (38)	7	Microsurgical endoscopic assisted	57.14%	Not recorded	0%
de Divitiis et al, 2007 (39)	44	Transcranial	86.4%	61.4%	0%
	11	Endoscopic endonasal	83%	71.4%	0%
Palani et al., 2012 (40)	41	Transcranial	73%	27%	4.9%
Our Series 2021	24	Transcranial microscopic	58.82%	86.20%	0%
	5	Transcranial endoscopic	80%	86.20%	0%
	5	Extended endonasal transsphenoidal approach	60%	80%	0%

Discussions:

The neurological, visual, and long-term outcome of TSM is determined by the success of the surgical endeavor. The extent of the surgical resection of the tumor will determine the tumor recurrence and regrowth.

A preponderance of tuberculum sellae meningiomas in women has been uniformly observed.[21- 24] In our series also most of the patients were female (82.35%).

As noted in many other series, in our study most of the patient were aged between 31 to 50 years (61.76%).[23-25] Younger patients tolerated the surgical procedure better than older patients. Systemic factors, such as hypertension and diabetes mellitus, could affect the surgical procedure and outcome to a certain degree. The extent of visual deficit was the single most important factor that determined the course of surgery. The more extensive the involvement of the optic nerve as depicted by the extent of visual deficit, the more intense the relationship of the optic nerve and the internal carotid artery and its branches with the tumor, and consequently, the more difficult the dissection. Visual symptoms arise early and usually are slowly progressive.[26-30] We have noticed with longer duration of visual symptoms, tumors were relatively firm and the relationship with adjoining structures was more intense.

Various authors have considered the size of the tumor to be a crucial factor that indicates possible surgical difficulties. [15, 17, 20, 23, 24, 31, 32] Large tumors cause more severe stretching of the adjoining nerves and vessels, and consequently, the resections were more difficult in our series.

Al-Mefty and Smith series (1999) had shown 91% resection rate, 25% visual improvement and 8.6% mortality.[33] Mathiesen and Kihlström series (2006) had revealed 90% resection rate, 75.9% visual improvement and 0% mortality[34] (Table -5).

In our series, through transcranial surgery vision was improved in 86.20%, static was in 10.34% and was deteriorated in 03.45% cases. Through transsphenoidal surgery vision was improved in 80%, was static in 20% and was deteriorated in 0% cases.

Visual recovery was better in patients whose preoperative vision was relatively good which corresponds with others.[21,35,36] In most of the cases the pituitary stalk was separated from the tumor with a well-defined arachnoid plane and was never encased by the tumor.

In our series through transcranial microscopic approaches (minipterional, minibifrontal basal, superciliary keyhole microscopic) gross total removal was done in 58.82%, near total in 10.34% and partial removal in 03.45%. Through transcranial/superciliary keyhole endoscopic assisted group gross total removal was done in 80% and near total in 20%. Through transsphenoidal approach gross total removal was done in 60%, near total in 20% and partial removal in 20%. The cause of partial or incomplete removal was tough or fibrous variety of tumour and in some cases difficult in dissection in case of vascular encasement. There was no mortality.

Meta-analysis of different series by de Divitiis et al. revealed that visual improvement was 58.4% and worsening in 12.9%, lesion removal rate 87.6%, CSF leak rare and mortality 2.7% in transcranial group and visual improvement was 75% and worsening in 0%, lesion removal rate 93.1%, CSF leak 20% and mortality 3% in transsphenoidal approaches.[39] In current series visual improvement is better and worsening of vision is lower, CSF leak in transsphenoidal surgery is similar in comparison to the meta-analysis. Mortality in our series is nil.

Conclusion:

We always prefer keyhole approaches as there is minimal brain retraction, small incision, less duration of hospital stay and more cost effective for the patient. In our study we have found tumor size and its extension, vascular encasement plays a significant role in the choice of approach. In case of large tumor (>6 cm) it is better to do minibifrontal basal craniotomy and interhemispheric approach. If the tumor is small to medium size (<6 cm) with no lateral extension or no vascular encasement and tumor mostly sellar and directing towards third ventricle then extended endoscopic endonasal approach is superior due to less retraction of frontal lobe. The major limitation of this approach is a narrow surgical corridor and demanding cranial base repair. In case of unilateral extension of the tumor, gross total removal was better achieved with minipterional or superciliary key hole approach. Superciliary key hole endoscopic approach is superior to microscopic superciliary key hole approach. Endoscope provides better magnification than microscope and better visualization of all the corners which could not be seen with microscope. We have found better visual outcome and less morbidity with this approach, but there is a learning curve- both for the surgeon and for the assistant. We have found the rate of complication is more in endonasal approach due to difficult skull base repair and CSF leak, however it is still difficult to comment due to small sample size in our series. Bleeding during the surgery can be significantly minimized by early coagulation of the attached dura with bipolar electrocautery. Visual outcome usually depends on the pre-operative visual condition and manipulation of optic apparatus during surgery. The arachnoid covering over optic nerve, optic-chiasm and anterior circulation artery must be kept intact in order to improve the visual function post operatively.

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