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Research Article

Early Visual Outcome of Surgically Treated Anterior and Middle Skull Base Meningiomas: A Prospective Multicenter Observational Study

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Abstract

Background: Meningiomas are the most common primary intracranial tumors. Visual deterioration is the first symptom for most patients with anterior and middle fossa meningiomas. The main aim of surgery is the total removal of the tumor, resulting in improvement or preservation of preoperative visual status.

Objective: To assess a 30-day visual outcome after surgical treatment of anterior and middle skull base Meningiomas.

Methods: Institution-based prospective cross-sectional study was conducted among hospitalized and operated patients from September 1, 2020, to August 31, 2020. Early postoperative visual outcome and associated factors affecting visual outcome were determined using the WHO visual criteria. Bivariate and multivariate correlation analysis was performed to identify associated variables. The p-value of <0.05 was considered significant.

Results: Among the 43 patients enrolled, the majority 40(93%) were females and 27(62.8%) of the patients were under the age of 45. The commonest presenting symptoms were headache and visual impairment in 41(95.3%) and 33(78.7%) of patients respectively. Postoperative visual improvement was found in 21(48.8%) of patients whereas 18(41.9%) of patients had a similar course and 4(9%) of the patients deteriorated. Age, duration of visual deterioration, peri-operative visual status, tumor size, optic canal extension, and Simpson grading of resection were found to have a significant association with visual outcome.

Conclusion: Postoperative visual improvement was found in 21(48.8%) of patients, which is comparable with most studies. The postoperative visual outcome is favorably affected by a shorter duration of visual deterioration before surgery, better preoperative visual status, and tumor size less than 4cm.

***Keywords:** Anterior and middle skull base meningioma, Surgical treatment, Visual acuity, Visual outcome, Ethiopia*

1. Introduction

According to the Central Brain Tumor Registry of the US (CBTRUS), meningiomas constitute the commonest primary brain tumor histology (36.6%) with an incidence rate of 8.03/100000 which increases with age. The female-to-male ratio is 2.27. Histological grading is currently based on the 2016 WHO classification. It puts the overall proportions of WHO I, II (atypical), and III (anaplastic) intracranial meningiomas at 81.1%, 16.9%, and 1.7%, respectively[1].

Meningiomas are benign, slow-growing tumors, whose expansion can result in compression of nearby structures as that of meningiomas in the vicinity of the anterior visual pathways [2]. Visual deterioration is the first symptom of clinical presentation for most patients with anterior and middle fossa meningiomas. The size and the location of the tumor dictate the degree of optic nerve disturbance due to optic nerve compression. The presence of bilateral optic nerve involvement with optic chiasm compression adds to the complexity of the surgical decision-making process[3]–[6].

Though these tumors mostly manifest with visual symptoms; correlation of the visual deficit (nerve, chiasm, or optic tract) with the actual, more focal compression is often found to be difficult [7]. This discrepancy might be explained by the vascular involvement of the optic nerve, rather than direct compression by the tumor [8].

Surgery is the primary treatment modality for these benign tumors offering the possibility of a cure, although it might also cause significant visual complications. The main aim of surgery is the total removal of the tumor, resulting in improvement or preservation of the preoperative visual status [3], [5], [6], [9]. Complete nontraumatic decompression of the optic pathway with full preservation of the attendant delicate blood supply of the optic nerve and chiasm should be the target [3], [5], [9].

Several studies around the world have evaluated the criteria for visual recovery in patients with anterior and middle skull base meningiomas. These studies documented a 25 to 80% chance of visual improvement: depending on tumor size, location, extension, preoperative visual status, duration of symptoms, and surgical technique[3], [4], [6], [7], [10].

A prospective study done in Turkey in 2008 which enrolled 45 patients showed that early post-operative visual outcome was a good predictor for a permanent outcome in operated suprasellar meningiomas (p value=0.001). They also found visual outcomes to be better in patients with preoperative vision >1m finger count and shorter symptom duration before surgery (p-value=0.001).

In a study done at Johns Hopkins University, Visual results were evaluated in 20 patients after microsurgical removal of intracranial meningiomas that had produced visual loss from damage to the anterior visual system. Visual acuity either improved or remained normal in 68.75% (22/32) of eyes examined and worsened in 25% (8/32) of eyes examined. Visual field changes generally paralleled visual acuity changes. Visual results were most closely related to the duration of visual symptoms and not to either tumor size or preoperative visual findings[11].

A study done in Germany in 2001 on 62 patients with anterior and middle fossa meningioma showed visual prognosis was favorably affected by age under 54 years (p <0.025), duration of symptoms of less than seven months (p = 0.037), and the presence of an intact arachnoid membrane around the lesion (p =0.00l). Severe preoperative loss of visual acuity was found to be an unfavorable prognostic factor (p < 0.047)[12].

In a retrospective study done in Egypt, they followed 30 patients with affected visual function and who underwent meningioma excision for 1 year. Of the 30 patients,22 patients had visual improvement over time, 6 of the patients' visual courses stayed the same, and 2 patients were found to have visual deterioration postoperatively. The 1-year follow-up of these patients showed that although there was gradual improvement in vision up to 1 year, a surge of visual improvement was noticed in the early postoperative period, followed by a less steep continuation over 1 year. Younger patients with a short period of visual deterioration have a higher chance of recovery of their visual function.

Although there are many retrospective studies around the world concerning the visual outcome of surgically treated anterior and middle skull base meningiomas, prospective studies are scarce from the continent of Africa and none from Ethiopia. Ethiopia is a low-income country with more than 120 million people and a significantly low number of neurosurgeons. Skull base surgery is only done in the capital city, Addis Ababa. Thus, the result of this study can be used as a benchmark for further research and also inform the management of such patients.

2. Methodology

Study design and setting

A prospective cross-sectional study was conducted in two neurosurgical teaching hospitals; Tikur Anbessa Specialized Hospital (TASH), and Myung Sung Christian Medical Center (MCM) hospital between September 1, 2020, and August 31, 2021. The data were collected using a semi-structured questionnaire. Detailed medical history including comorbidities was obtained. Details of intraoperative variables were obtained on the day of surgery from the OR (Operation room) team. The patients were followed postoperatively for 30 days and postoperative visual status, and other variables were collected.

Participants

All patients who were surgically treated for anterior and middle skull base meningiomas and who consented to the study were included. Patients who did not have a follow-up for at least 1 month, with non-compressive optic neuropathy, died before 1-month post-surgery, received radiotherapy to the tumor site, and had confirmed optic atrophy were excluded.

Study Variables

The dependent variable was postoperative visual status. Independent Variables include age, sex, duration of visual deterioration, KPS, Preoperative visual status, tumor characteristics (size, location, consistency, degree of edema, presence of optic canal involvement, optic canal hyperostosis, WHO grade of tumors, radiologic vascular encasement, and cavernous sinus involvement), duration of surgery, estimated blood loss, Simpson's grade of excision and surgical approach.

Operational Definitions

- Anterior skull base Meningioma: meningiomas arising from the anterior cranial base anterior to limbus sphenoidale including tuberculum sellea meningioma.
- Middle skull base meningiomas: meningiomas arising from the middle cranial base posterior to limbus sphenoidale.
- By definition, the limbus sphenoidale (which is the anterior margin of the chiasmatic sulcus) is the demarcation between the anterior and middle cranial fossa.
- Operating time: time in hours starting from skin incision to skin closure.
- Optochiasmatic complex: complex including the optic nerve and optic chiasm
- Visual acuity Improvement: defined as a change of >=1 line in WHO criteria (Snellen chart and clinical testing).
- Visual acuity deterioration: defined as any degree of decline in the postoperative visual acuity on the WHO criteria (Snellen chart and clinical testing).
- Improvement/ worsening in the post-operative visual field: any amelioration from bitemporal hemianopia to unilateral, quadrantanopia, or normal status or any change from unilateral hemianopia deficit to quadrantanopia or normal, and/or based upon a 30% change to the VF perimeter to avoid inter- and intra-individual variation.
- Improvement in visual outcome: defined by two conditions: both in VA and VF or improvement in one of the two items and no change in the other. If one of the two items improved but the other deteriorated, it is not counted.
- Normal visual acuity: visual acuity 6/24 and better on Snellen's scale.
- Impaired visual acuity: acuity worse than 6/24 to finger counting >1m.
- Blindness: Total blindness is NLP
- Near-total blindness is Finger count at ≤1m - PL,
- Hand motion detection at ≤5 m.
- Normal visual field: where there is no field defect in any of the quadrants tested.
- Impaired visual field: where there is a field defect in any of the quadrants.
- Nontestable visual field: when a patient cannot count fingers at least at one meter and the field cannot be assessed.
- Gross total resection (GTR): is considered for all Simpson grade 1-3 resections.

Ethical Consideration

Ethical clearance was obtained from the Institutional Review Board (IRB) of the College of Health Sciences of Addis Ababa University. Informed consent was obtained from the patients. Confidentiality and patient privacy are kept and maintained. All data had been de-identified.

Data Analysis and Interpretation

Data were coded, cleaned, entered, and analyzed using SPSS version 23. Descriptive data analysis like frequency and percentages were calculated for all variables. The mean and mode of patients' age were determined. Crosstabulations and bivariate analyses like chi-square were performed to determine the relationship between independent and dependent variables. Results were presented using tables. Correlation analysis was performed to assess the association between the studied variables. A p-value < 0.05 was considered statistically significant. A full ophthalmological assessment was done preoperatively and in the early postoperative periods. It included visual acuity and visual field testing. The WHO criterion to evaluate vision was applied (Table 1). The visual field could not be assessed in patients who can't count fingers at a 1-meter distance and was assigned as non-testable. The results of postoperative visual findings were recorded as follows: (A) improved, (B) Unchanged, and (C) deteriorated.

Table 1: Criteria for visual changes (Classifications based on the system of Govsa et al).

WHO Category	Degree of Vision Changes	Visual Acuity w/ Correction	Definition
Normal vision	None	6/6- 6/12	6\6-6\12 range of normal vision
	Slight	6/12 – 6/24	6\12-6\24 near normal vision
Low vision	Moderate	6/24 – 6/60	6/24-6/60 moderate\low vision
	Severe	6/60 – FC	6\60-FC at 3-6m
	Profound	FC – HM	FC-HM at 1-3m
Blindness (1 or both eyes)	Near total	PL	FC at<=1m -PL
	Total	NLP	NLP

3. Results

3.1 Patients characteristics

A total of 43 Patients were enrolled in the study of which 37(86%) of them were operated at TASH and 6 patients (14%) were from MCM. Among 43 cases included in the series, females predominate constituting about 40 (93%) of the patients, and male patients were 3 (7%) with a female to male ratio of 13.3:1. The mean age was 41.98 (SD ± 11.428) years ranging from 13 to 70 years. 62.8% of the patients were under the age of 45 years and 37.2% of patients were older than 45 years. The highest number 17(39.5%) of patients were from Addis Ababa, 10(23.3%) came from Amhara region, 7(16.3%) from SNNPR and 6 (14.0%) came from Oromia region. Of the total patients, only 9 patients (21%) had medical comorbidities, with 6 patients having Hypertension (HTN) and 3 patients presenting with Diabetes Miletus (DM). The Karnofsky scale (KPS) was assessed in all patients and 9(20.9%) patients had a score of eighty or less while 34 (79.1%) patients had a KPS of above 80.

Table 2: Sociodemographic and patient characteristics.

Variables		Frequency (%)
Age Mean (42)	≤ 45	27 (**62.8%**)
	> 45	16 (**37.2%**)
Gender	Male	3 (**7%**)
	Female	40 (**93%**)
Hospital	MCM	6 (**14%**)
	TASH	37 (**86%**)
KPS*	70	1 (**2.3**)
	80	8 (**18.6**)
	90	34 (**79.1**)
Comorbidities		9 (**21**)

KPS-Karnofsky Performance scale*

3.2 Preoperative Characteristics

The most predominant symptoms found in our patients were headache and visual impairment presenting in 95.3% and 78.7% respectively. Behavioral change (18.6%), proptosis (16.3%), and seizure (14%) were also prevalent. The mean duration of visual impairment was 11.51 (SD= 8.18) months with the duration ranging from 2 months to 32 months. The majority (65.1%) of the patients were having visual impairment for more than 6 months before they sought medical attention. (Table 3)

Table 3: Duration of visual deterioration and blindness.

Duration of visual deterioration in months	# of Visual impairment pts	Duration of blindness in months	# of Blind patients
<3 months	3(7%)	<3 months	9(20.9%)
3 - 6 months	12(**27.9%**)	3 - 6 months	7(16.3%)
6 - 12 months	6(14%)	6 - 12 months	2(4.7%)
1 - 2 years	9(20.9%)	1 - 2 years	6(14%)
> 2 years	3(7%)	> 2 years	3(7%)
Not applicable	10(23.3%)	Not applicable	16(**37.2%**)
Total	43	Total	43

#- Number

Pre-operative visual acuity was normal in 10(23.3%) individuals and impaired in the remaining 33 (76.7%). Of these 33 patients, 26(78%) of them were blind at presentation (6 had binocular blindness and 21 uniocular blindness) and 7 (12%) of them had low/reduced vision. (Table 4)

Table 4: Preoperative visual acuity findings of study participants.

WHO Category	Degree of Vision Changes	Visual Acuity w/ Correction	Right eye n (%)	Left eye n (%)
Normal vision	None	6\6-6\12 range of normal vision	15 (34.9)	17 (39.5)
	Slight	6\12-6\24 near normal vision	-	-
Low vision	moderate	6/24-6/60 moderate\low vision	1 (2.3)	3 (7)
	Severe	6\60-FC at 3-6m	5 (11.6)	6 (14)
	profound	FC-HM at 1-3m	5 (11.6)	2 (4.7)
Blindness	Near total	FC at<=1m -PL	12 (27.9)	11 (25.6)
	Total	NLP	5 (11.6)	4 (9.3)

The preoperative visual field was normal in only 41 eyes and impaired in 12 eyes. We were not able to test the visual field in 33 eyes pre-operatively because of severe impairment in the visual acuity. Temporal field cut was the commonest field defect observed in 10.5% of the eyes. (Table 5)

Table 5: Pre-op visual field findings of study participants.

Visual field status	Right eye n (%)	Left eye n (%)
Normal	19 (**44.2**)	22 (**51.2**)
ST defect	1 (2.3)	-
IT defect	1 (2.3)	-
Temporal field defect	4 (9.3)	5 (11.6)
Whole field	1 (2.3)	-
Blind	17 (39.5)	16 (37.2)

3.3 Tumor Characteristics

All patients had imaging before surgery including a CT scan and MRI or both. Few patients had also CT-Angiography based on tumor characteristics and the surgeon's need. The origin and precise anatomic localization of meningioma insertion were radiographically defined by pre-operative formal radiologic imaging reports, weekly neuro radiology session discussions, and the surgeon's intra-operative observation. Tumors were located on the right side in 10(23.3%) patients, lateralized to the left in 9(20.9%) patients, and 24(55.8.5%) patients had tumors in the midline location. (Table 6)

Table 6: Tumor characteristics.

Variables		**Frequency (%)**
Tumor Laterality	Left	9 (20.9)
	Right	10 (23.3)
	Midline	24 (**55.8**)
Anterior skull base tumor		11 (25.6)
Middle skull base tumor		32 (74.4)
Tumor size	< 4cm	11 (25.6)
	4cm-6cm	22 (**51.2**)
	> 6cm	10 (23.3)
Vascular encasement	Free	15 (34.9)
	Partial encasement	18 (**41.9**)
	Total encasement	10 (23.3)
Cavernous sinus involvement	Yes	10 (23.3)
	No	33 (**76.7**)

Most of the meningiomas were in the middle skull base which accounted for 74.4%. The three most frequent sites were tuberculum sellae, olfactory groove, and anterior clinoid meningioma each accounting equally 10 (23.3%) of the cases. The rest were Spheno-orbital meningioma 7 (16.3%), lateral and middle sphenoid wing 4 (9.3%), and planum sphenoidale 2 (4.7%). (Table 7)

Tumor size was also estimated in all patients, defined by its largest diameter. The mean tumor size was 5.14cm (1.51 SD) which ranged from 3cm to 8cm. Tumors of medium size (4 to 6cm) were the most dominant and they were found in 22 patients (51.2%). Eleven patients (25.6%) had a tumor less than 4cm in size and only 10(23.3%) had a tumor size of more than 6cm. Total and partial encasement of major vessels were noted in 10 (23.3%) and 18 (41.9%) of cases respectively while the cavernous sinus was invaded in 10 (23.3%) patients.

Optic canal hyperostosis was seen in 11(25.6%) patients and optic canal extension was also seen in 25 (58.1%) of the tumors. Both had a significant association with postoperative visual findings with a P= 0.014 for optic canal hyperostosis and P =0.019 for optic canal extension.

Table 7: Clinical Presentation Stratified by Tumor Location.

Tumor Location	**Presentation**							
	Patients (n)	Vision status			Headache	Seizure	Neurocognitive disorder	Proptosis
		Normal	Low vision	Blind				
PSM	2	1	0	1	2	0	0	0
OGM	10	2	1	7	10	1	8	0
LSWM/MSWM	4	3	1	0	4	1	0	0
MSWM	10	3	0	7	10	2	0	0
TSM	10	0	4	6	10	2	0	0
SOM	7	1	1	5	5	0	0	6
Total	43	10	7	26	41	6	8	6

PSM- planum sphenoidale meningioma, OGM- olifactory groove meningioma, LSWM- lateral sphenoid wing meningioma, MSWM- medial sphenoid wing meningioma, SOM- spheno-orbital meningioma.

3.4 Surgical treatment

All operations were carried out using Hudson drill and Gigli saw to remove the free bone flap and basic micro neurosurgical techniques were used for tumor removal. Pterional craniotomy with sub frontal approach was used for 22 cases (51.2%), while bifrontal craniotomy with a sub-frontal route was used for 11 cases (25.6%), Orbital decompression using Pterional approach was performed for 7 (16.3%) patients. The choice of surgical strategies depended on several factors, including tumor size, location, direction of growth, and side of visual deterioration. The side of marked visual deterioration was selected for incision in 96 % of cases, whereas the non-dominant hemispheric side was preferred in bilateral involvement.

The mean surgical time of operation was 5.7 hours (SD 1.8hr) with the minimum and maximum surgical time being 3 and 11 hours, respectively. The mean estimated blood loss was 1204.65 ml (SD 763.5ml) with a minimum blood loss of 300ml and a maximum of 3500ml.

Tumor removal was graded based on Simpson's Grading system. GTR was achieved in 31(72.1%) of the cases. Grade 2 removal was achieved in 30(69.8%%) of the patients, Grade 3 removal was achieved in 1(2.3%) of the patients, and Grade 4 removal was possible in 12(27.9%%) of patients. There was a significant association between Simpson's grade and postoperative visual outcome (p<0.047). The most common WHO grade of meningioma was WHO Grade 1 tumor which was diagnosed in 40(93%) patients, WHO Grade 2 in 2(4.7%) of the patients, and WHO Grade 3 in 1(2.3%) of the patients. There was no statistically significant association between the WHO Grade of tumors and visual outcome.

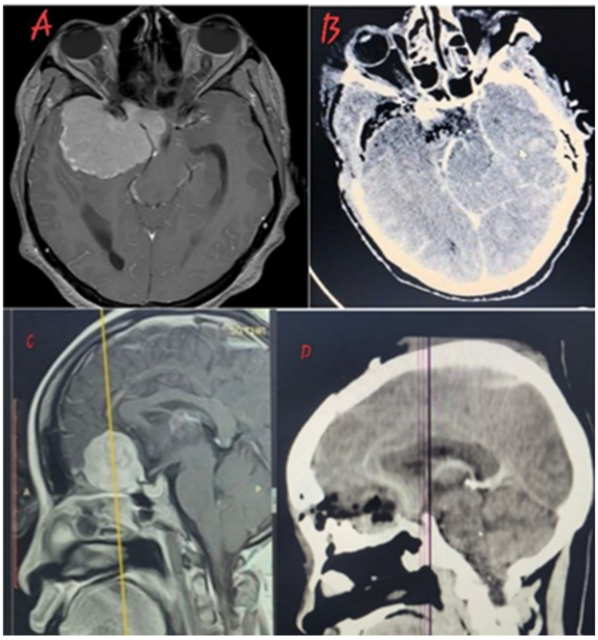

Figure 1: *Case examples*

A, B: Contralateral vision improved ipsilateral unchanged (blind)

A. T1W MR postcontrast axial image showing huge right medial sphenoid wing meningioma noted is anterior clinoid hyperostosis

B. Postoperative Axial postcontrast CT scan showing gross total tumor excision

C, D: Vision bilaterally improved

C. T1W MR postcontrast sagittal image showing large planum sphenoidale meningioma

D. Postoperative sagittal postcontrast CT scan showing gross total tumor excision.

3.5 Postoperative Visual Outcome

Significant visual improvement was reported in 21(**48.8%**) patients, 18 patients (41.9%) had similar courses, and 4 patients (9.3%) had visual deterioration after surgery. Of the 18 patients who had unchanged visual outcomes, 10 (20 eyes) were intact at presentation and more importantly, remained intact post-operatively. 16 out of 26 pre-operatively blind patients improved and of this 1 patient with small 3 cm tuberculum Sella meningioma and 1 patient with large olfactory groove meningioma improved to near normal visual acuity after surgery. A total of 4 (9.3%) patients with impaired visual acuity (3 of them had only light perception and 1 of them had low/reduced vision) preoperatively, deteriorated to NPL postoperatively. Of the patients who deteriorated post-operatively 2 of them had documented inadvertent optic nerve injury intraoperatively. (Figure 1)

Visual field improvement and visual acuity improvement went hand in hand and there were no patients with visual field improvement and visual acuity deterioration or vice versa. The postoperative visual field was tested in only 33(76.7%) of the patients because the remaining 10 patients had significant visual impairment post-operatively hindering us from testing their visual field. Of the 33 patients eligible for testing, improvement was noted in 20(60.6%) patients, and it was unchanged in 13(39%) patients.

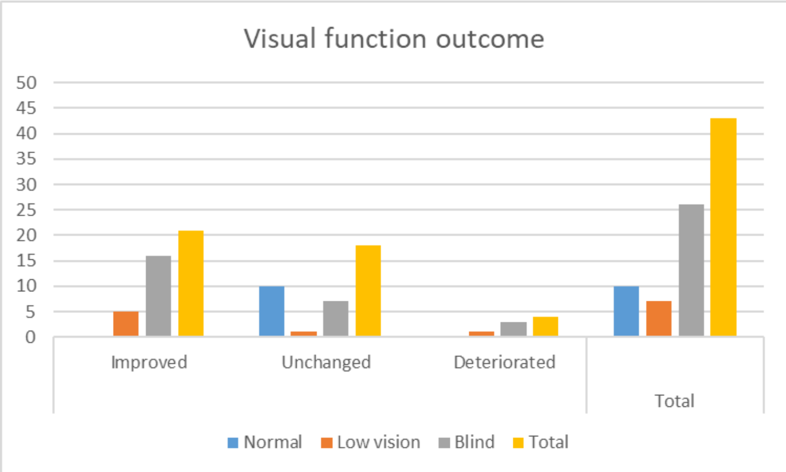

Figure 2: *Preoperative Versus Postoperative visual function outcome.*

3.6 Post-operative visual outcome and associated factors

To determine which independent factors influenced the postoperative visual outcome, the visual outcome was classified into improved, unchanged, and deteriorated. Age, duration of visual deterioration, preoperative visual status, tumor size, optic canal extension, optic canal hyperostosis, and Simpson grading of resection were significantly associated with visual outcome. (Table 8).

Table 8: Bivariate analysis of variables related to postoperative visual out come.

Variables		**Postoperative visual outcome**				
		Improved	Unchanged	Deteriorated	Total	P-value
Age	</=45	18	7	2	27	0.009
	> 45	3	11	2	16	
Duration of visual deterioration	<3month	3	0	0	3	0.01
	3-6month	12	0	0	12	
	6-12months	3	1	2	6	
	1-2years	3	6	0	9	
	>2years	0	1	2	3	
	Intact	0	10	0	10	
Preoperative visual acuity status	Normal	0	10	0	10	0.01
	Reduced	5	1	1	7	
	Blind	16	7	3	26	
Tumor size	<4cm	9	2	0	11	0.001
	4-6cm	12	10	0	22	
	>6cm	0	6	4	10	

Table to be continued...

Simpson grade of resection	grade 2	18	11	1	30	0.047
	grade 3	1	0	0	1	
	grade 4	2	7	3	12	
Optic canal hyperostosis	Yes	2	6	3	11	0.014
	No	19	12	1	32	
Optic canal extension	Yes	6	10	4	20	0.019
	No	15	8	0	23	

4. Discussion

There are only a few published papers in Africa regarding the postoperative visual outcome of surgically treated anterior and middle skull base meningiomas. In our country, there is no published study on this subject matter as to the author's knowledge. There is one research done on the outcome of 100 skull base meningiomas operated at Tikur Anbessa Specialized Hospital, Addis Ababa, which was published in 2019. They reported significant visual improvement in 33 patients (39%), 48 patients (57%) had a similar vision and 3 patients (3.5%) had visual deterioration postoperatively from the eligible 84 patients who were enrolled in the research. However, this patient pool included posterior skull base meningiomas too, which makes it difficult to compare with our research[13].

In our study, the postoperative visual outcome was improved in 21(48.8%) of the patients, unchanged in 18(41.9%) and 4 (9.3%) patients deteriorated postoperatively. A comparable proportion of outcomes was also reported in other studies [14]–[17]: As Yasargil[16] and Ohata et al.[17] concluded, respectively, improvement of vision was noted in 50% and 66%, while in 17% and 28%, it remained unchanged, and deterioration was noted in 10% and 25%. Whereas according to a study done in Egypt in 2020, 30 patients were enrolled, and they found that 22(73.3%) patients had visual improvement over time, 6(20%) of the patients' visual course stayed the same, and 2(6.7%) patients were found to have visual deterioration[18]. They reported the postoperative outcome after one year of follow up which might have contributed to the higher postoperative visual improvement compared to our research.

We identified seven factors that have a statistically significant correlation with the postoperative visual outcomes. These include age, duration of visual deterioration, preoperative visual acuity status, tumor size, Simpson grade of resection, optic canal hyperostosis, and optic canal extension (Table 8).

Postoperatively VA was improved in 66.6% of the patients under 45 years of age, whereas VA improvement was observed in only 18 % of the patients over 45 years of age. Our finding showed younger patients (age < 45 years) have better postoperative visual function recovery ($p < 0.009$) which is in line with the findings of other studies[6], [7], [12], [14], [18]. This might be because the predominant reason for visual acuity reduction in younger patients was compressive optic neuropathies, which are more likely to be rectified after resection of the tumor as compared with the ischemia and vasculopathy on top of compression in older patients[19].

The mean duration of visual impairment was 11.51 (SD= 8.18) months with the duration ranging from 2 months to 32 months, which was relatively shorter in tumors originating from locations close to the optic canal and optic chiasm like clinoidal and tuberculum sellae meningioma than in tumors originating from more distant areas like olfactory groove and lateral and middle sphenoid wing meningiomas. The duration of visual deterioration had a statistically significant association with postoperative visual outcome (*P= 0.01*), which is comparable with other studies[12], [20]. The majority of the patients (65.1%) had visual impairment for more than 6 months before they sought medical attention and all 15 patients (100%) in whom the duration of visual symptoms lasted less than 6 months attained postoperative improvement (Table 7). This figure decreased to 50% in patients whose symptom duration was between 6 and 12 months and to 25% in those patients with a duration longer than 1 year making this finding statistically significant (*P= 0.01*), the longer the duration the more likely permanent injury with less chance of improvement.

Our study showed a statistically significant association between preoperative visual acuity status and postoperative visual outcome (*P =0.01*). The better the preoperative VA, the better the postoperative VA observed. In the first 1 month after surgery, there was an improvement of VA in 71.4% of patients with slight and moderately reduced preoperative VA whereas postoperative VA improvement was observed in only 37.2% of patients with severe preoperative VA damage due to tumor compression.

This is comparable with the findings of other studies[9], [10], [18], [19], [21]–[23]. For instance, Zevgaridis et al.[12] found postoperative VA recovery in 77.7% of patients with mildly and moderately reduced preoperative VA compared to 45.8% improvement in patients with severe preoperative VA damage. Studies also showed patients with less severe preoperative visual loss present with a lesser degree of optic nerve and chiasma involvement with tumor intraoperatively[9], [14], [19]. Therefore, postoperative chances for visual improvement after surgical decompression are much better.

In this study, the average tumor size was 5.14cm (1.51 SD) ranging from 3cm to 8cm. This is significantly higher compared with other studies which reported mean tumor size of 3.2cm[12] and 3.1cm[10]. This might be due to the late presentation of most of our patients and the limited facility and expertise to make early diagnoses. Longer waiting periods even after diagnosis might have also contributed. Several authors found a smaller tumor size (<3cm or < 4cm) to be significantly associated with better visual outcomes[15], [17], [23], [24]. Whereas in other research, postoperative visual outcome was not influenced by tumor size[2], [20], [22]. We found out that tumor size has a significant association with visual outcome (*P= 0.001*), evidenced by the significant visual improvement in 81% of patients with tumor size <4cm, whereas only 54% of patients with tumor size of 4-6cm had visual improvement and none of the patients with tumor size >6cm had improvement, 40% of these patients rather showed deterioration from their preoperative visual status.

In our study, the site of the tumor, tumor consistency, and surgical approach had a non-significant impact on the postoperative results which do not match the results of Schick and Hassler[20].

Our study showed a significant association between optic canal extension and postoperative visual outcome (p-value < 0.019). Tumor extension into the optic canal was seen in 19(44.2%) of our patients, of these 52% had no change in postoperative visual outcome while 21% of patients showed visual deterioration and only 26.3% of patients had visual improvement. Many recent reports advocate for extradural anterior clinoidectomy and optic canal decompression early in the operation as the best way to achieve a favorable visual outcome[5], [6], [10], [24], [25]. The claim is that early release of the optic nerve allows its safe manipulation and handling during tumor dissection. Also, extradural anterior clinoidectomy has the added advantage of increasing the surgical corridor through the optic carotid angle. In our studies, because of a lack of necessary gadgets and maybe expertise, neither anterior clinoidectomy nor optic canal decompression was ever done which has probably resulted in a lack of significant improvement in this group of patients.

Our study also showed a significant association between Simpson grading of resection and postoperative visual outcome (*P= 0.047).* The better the Simpson grade of resection, the more likely postoperative visual improvement. Most of our patients with higher Simpson grade resections are those with tumor extension into the optic canal hence lack of significant postoperative improvement. Thus, we strongly recommend a complete tumor resection and anterior clinoidectomy and/or optic canal decompression with tumor removal for possible preservation of preoperative visual status and achieving postoperative improvement.

Because of a small sample size, it is impossible to perform multivariate analysis, thereby making it difficult to identify independent predictors of postoperative visual outcomes.

5. Conclusion

The study showed postoperative visual outcome was improved in 21(48.8%) of the patients, unchanged in 18(41.9%) and, 4 (9.3%) patients deteriorated postoperatively. The postoperative visual outcome is favorably affected by a shorter duration of visual deterioration before surgery, better preoperative visual status, and a smaller tumor size of less than 4cm. Subtotal tumor resection, tumor extension into the optic canal, and optic canal hyperostosis are associated with unfavorable postoperative visual outcomes. Extradural anterior clinoidectomy, optic canal unroofing, and decompression might increase gross total resection rate and hence postoperative visual outcome.

Conflict of Interest

The authors declare no conflict of interest.

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None

Authors contributions

S.G: Data collection, Methodology, Conceptualization, Writing original draft, Analysis

A.S: Conceptualization, Methodology, Supervision, Validation

Y.H: Data curation, Analysis, Reviewing and editing

F.T: Reviewing and editing

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