The Surgical Treatment Outcome of Parasagittal and Falcine Meningiomas at Two Teaching Hospitals in Addis Ababa, Ethiopia

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ACRONYMS

AAU…..Addis Ababa University

TASH…Tikur Anbessa Specialized Hospital

MCM…..Myungsung Christian Medical Center

ACA…..Anterior Cerebral Artery

MCA…..Middle Cerebral Artery

GTR……Gross Total Resection

STR……Subtotal Resection

KPS……Karnofsky performance status scale

MRA……Magnetic Resonance Angiography

MRV….Magnetic Resonance venography

Post-op…Postoperative

Preop…...Preoperative

PSM……Parasagittal Meningioma

SG…….Simpson's grade

SSS…….Superior sagittal sinus

WHO….World Health Organization

CE-MRV….Contrast-Enhanced-MRV

PC-MRV…Phase-Contrast MRV

EBL…….Estimated blood loss

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ABSTRACT

Background: The surgical management of parasagittal and falcine meningiomas is challenging due to their proximity to the superior sagittal sinus and cortical draining veins. This nature of the tumors poses several hazards of complication related to surgery. There is a limitation of analyzed and published data on this topic in low-income countries with limited-resource settings.

Objective: This study aims to assess the surgical treatment outcome of parasagittal and Falcine meningiomas at TASH and MCM, Addis Ababa, Ethiopia.

Methods: This is a hospital-based retrospective cohort study of surgically treated Parasagittal and Falcine meningioma patients from August 1, 2015, to July 31, 2019. Data was collected using a well-designed questionnaire, encoded, and analyzed in SPSS version 26. Pearson's chi-square and bivariate analysis were done to identify strongly associated factors with the complications and functional outcome of patients.

Result: A total of 61 patients were operated of which 36(59%) were females. The mean age was 46.1(20 to 78) years. The mean duration of preoperative symptoms was 16.38 (1 to 60) months. Common preoperative clinical findings were headache in 47(77%) patients, motor weakness in 33(54%) patients, seizure in 26(42.6%), and Visual deficit in 17(27.9%) patients. Mean tumor size was 5.9(3.5 to 8) cms. Complete resection (SG I or II) was done in 47(77%) patients and macroscopic GTR(SG I, II, or III) was done in 54(88.5%) patients. Meningothelial was the commonest histologic type in 29(49.2%) and most tumors were WHO G1 in 47(79.9%) patients. There were 46 perioperative complications in 17(27.9%) patients. At the end of follow up 53(86.9%) patients were alive and most (45, 84.9%) of the surviving patients had substantial improvement in functional performance status.

Conclusion: This study showed most of the surviving patients had significant improvement in their functional performance status which was positively related to the degree of tumor resection and a better preoperative functional status of the patients. There is a high rate of perioperative complications and this is strongly related to a longer duration of preoperative symptoms before their first surgery and the intraoperative incidents.

1. INTRODUCTION

1.1 Background and Statement of the Problem

Parasagittal meningioma originates from the parasagittal angle without brain tissue between the tumor and superior sagittal sinus in areas with a higher density of arachnoid granulations. These tumors whose principal attachment is on the Dura mater of the convexity and on the walls of the superior sagittal sinus (sometimes extending to a lesser degree to the falx) were classified as parasagittal meningioma. They account for 20-30% of intracranial meningiomas. Considering the symptoms and the surgical aspects, we divide these tumors into the anterior, middle, and posterior third based on their location on the anterior-posterior dimension of the SSS. The sinus can be partially or completely occluded or only the lateral wall of the sinus can be involved by the tumor. Falcine meningioma arises from the falx cerebri and its main attachment is on the falx sometimes extending into the superior sagittal sinus without reaching the convexity (1,2).

The parasagittal/falcine meningiomas are located in the vicinity of SSS & large cerebral veins that enter the sinus in the proximity of these tumors. These tumors may extend and have different degrees of invasion of the superior sagittal sinus and the higher degree of invasion is a challenge for complete removal and, consequently, for recurrence of these tumors. Subtotal resection is accepted by the scientific community as a risk factor for recurrence but nowadays studies put a challenging judgment on this affirmation, with a large number of cases and no statistical significance between Simpson Grade of resection and rate of recurrence (2,5,14).

Parasagittal/falcine meningiomas occur more commonly in the middle third of the superior sagittal sinus/falcine and are more common in females than males. Depending on the Anteroposterior location of the tumor, they may present with contralateral foot drop, hemiparesis, seizure, mental status change, incontinence, behavioral change, aphasia or can be asymptomatic tumors arising from anterior or posterior third may remain undetected for a long period until mass effect triggers noticeable symptoms(2,4).

The appearance of parasagittal/falcine meningiomas on CT and MR imaging is similar to meningiomas of other locations. Computed tomography can be particularly helpful in assessing changes of the overlying calvaria to aid in the planning of the craniotomy flap. Due to their proximity to the venous sinuses visualization of the venous anatomy is very fundamental before operative planning especially for patency of the sinus and cortical draining veins. Contrast-enhanced MRI in combination with MRA is considered the gold standard for parasagittal meningioma in some institutions. MRA will provide accurate noninvasive visualization of the arterial and venous anatomy. The intraoperative findings being the gold standard to assess the extent of sinus invasion, CE-MRV can provide good visualization of the patency of the SSS and allows an accurate estimation of collateral anastomotic vessels. Hence tumors close to a venous sinus should undergo CE-MRV, which demonstrated a much higher specificity in predicting the status of the sinus as confirmed intraoperative (3,4).

The surgical treatment of these tumors centers on the relationship between the tumor and venous anatomy of the SSS, and the large cerebral veins that enter the sinus in the proximity of these tumors. The propensity for these tumors to invade the venous sinus, or to encase or adhere to cerebral veins, can greatly complicate efforts to achieve the safe, complete removal of the tumor and its involved Dural base. Careful mapping of the craniotomy flap in Parasagittal/falx meningioma is important to avoid venous sinus injury. The Intraoperative management option for the SSS should be planned preoperatively based on the contrast-enhanced MRI with MRV or MRA findings of the degree of sinus invasion. Doppler ultrasonography can also be used intraoperatively for further confirmation of the presence or absence of flow across the affected sinus. The devascularize, debulk, and dissection techniques applied for other meningiomas are also practiced in Parasagittal/falx meningiomas. All vascular structures must be identified before coagulation or dissection. There is a controversy on either doing subtotal resection with coagulation of the residual mass inside the sinus versus complete resection with venous reconstruction for meningiomas with moderate or complete sinus invasion. There is a limitation of published large series of data to provide definitive guidelines for the surgical treatment of such complex cases. Tumors adherent to patent venous structure or artery can be resected with caution preserving the vessel and any residual tumor managed with adjuvant radiotherapy or stereotactic radiosurgery. Modern microsurgical and neuroaesthetics techniques,

neuronavigation, neuro-monitoring, and intensive care improvements help the neurosurgeon to decrease the complication rate after surgery for Parasagittal/falcine meningiomas (4,5,7,20).

1.2. Significance of the Study

Ethiopia is a low-income country with a more than 100 million population and a significantly low number of neurosurgeons and neurosurgical centers. The neurosurgical service in Ethiopia is limited due to the limited number of neurosurgeons and neurosurgical centers. The neurosurgical practice was started in the 1970s by a foreign neurosurgery resident who used to diagnose meningioma by carotid angiography and operated on intracranial tumors and neurotrauma. The first qualified Ethiopian neurosurgeons, trained abroad started to practice at Tikur Anbessa Specialized Hospital in 1990 and 1991. The first neurosurgery training program in Ethiopia was started in 2006 by the collaboration of the Ethiopian/Norwegian team (**6**). Surgery is the only available management option for patients with parasagittal/falcine meningiomas in our set up and there is no processed data about the outcomes of operated parasagittal/falcine meningioma patients in our country. Hence, this retrospective review will demonstrate the outcome of our treatment, common complications, and predictive factors which will help in establishing preoperative workup, optimization, and recommendation for improving the surgical treatment outcome for our patients and post-op adjuvant treatments. It will also serve as a baseline review data for future studies

2. LITERATURE REVIEW

In a retrospective study done to assess the immediate and late surgical outcomes of parasagittal and falx meningiomas of 342 patients of which 215 are parasagittal and 127 with meningiomas of the falx, operated over 30 years. The female to male ratio was (190:152) with mean Patients' age of 47.5 years(5 to 79 years) six (1.7%) patients were under 15 and 167 (48.8%) above 50 years old. Duration of symptoms was less than 12 months in 69%, from 1-2 years in 18%, and longer than 2 years in 13%. Motor and sensory symptoms in 206(60.2%) followed by focal fits in 143(40.8%) and headache in 134(39.2%) were the commonest symptoms. Most patients, 232(67.8%) had Simpson's grade I and 67 (19.6%) Simpson's grade II removal. There were a total of 25(7.3%) operative deaths. Cerebral swelling was the most common cause of death (9 of the 25 deaths) followed by pulmonary embolism (4 cases). The post-op seizure occurred in 42(12.3%) patients, became permanent in 14 patients. Worsening of neurological deficits occurred in 76(23.9%) patients and 54 (17%) had a new deficit (1).

In a retrospective review done for 125 operated parasagittal meningioma patients', women were 81(64.8%) of the patients. The commonest presenting symptom was motor deficit in 41(32.8%) patients, headache in 34(27.2%) patients, seizures in 25(20%) patients. The diagnosis was incidental in 7 (5.6%) patients. WHO grade I tumors were identified in 104 (84.6%) patients, the majority were the meningothelial type. Mean tumor size was 4.86(2 to 8.6) cm. The majority (54.4%) of the tumor was in the middle third of SSS and 19 (15.4%) patients had bilateral tumor extension.

The extent of sinus invasion evaluated with preoperative images (MRI, CT scan, Anglo-MRI, and angiography) and after confirming it intraoperative, the SSS was completely invaded and obstructed in 19(15.4%) patients, partially invaded in 30 (24.2%) patients and not invaded in 75 (60.5%) patients. Postoperative complications occurred in 19(15.2%) patients. Deep vein thrombosis in 14(11.2%), brain edema in 2(1.6%) patients. Most patients who survived to the end of follow-up had satisfactory functional status improvement. At the end of follow-up, there were 83 (71.6%) patients alive without tumor presence or with a stable rest of the tumor, 20 (17.2%) patients with progression or tumor recurrence (2).

A prospective review of 23 patients done demonstrated CE-MRV has much higher specificity in predicting occlusion of the superior sagittal sinus and a more accurate estimation of the collaterals than PC-MRV where the intraoperative finding was used as a gold standard (3).

A retrospective study was done in 68 falx meningioma patients, gross total resection (SG I or II) was achieved in 58(85.3%) cases and showed perioperative complications in 9(13.2%) patients. 59(86.8%) patients achieved a good outcome with no perioperative complications. This study demonstrated gross total tumor resection is presumed to be the single most important predictor of an improved surgical outcome (4).

In another study done to assess results with judicious modern neurosurgical management of parasagittal and falcine meningiomas of 135 patients operated over 18 years period who had at least 1 year of clinical follow-up demonstrated headaches in 24 (17.8%) patients, seizure in 24 (17.8%) patients, and 35(25.9 patients were asymptomatic. The SSS was had significant invasion in 61(45%) cases of which 6(4.4%) cases had complete sinus occlusion. Most (81%) of patients did not experience any perioperative complication and 19% experienced at least one neurological, medical, or surgical complication (5).

In a retrospective study conducted in Milan, Italy on the surgical experience in 108 cases of meningiomas invading the superior sagittal sinus the sinus was obstructed completely in 30(27.8%) patients and partially invaded in 78(72.2%) Patients. This study demonstrated a completely obstructed part of the sinus can be resected without sinus reconstruction with extreme care in preserving the cortical veins, which may offer important collateral drainage. Good results were achieved and Simpson Grade I or II removal was done in 100(93%) patients. Overall, morbidity occurred in 31(28.7%) patients. Subgaleal fluid collection occurred in 11(10.2%) patients, brain swelling in 9(8.3%) patients. The vast majority of patients exhibited marked improvement in functional performance status during follow-up (7).

A retrospective analysis done in 26 patients to evaluate the surgical treatment of parasagittal and falcine meningiomas of the posterior third of the SSS revealed the most common clinical presentation at admission to be visual disturbance in 21(81%) patients of which 19(73%) of the patients had visual field deficit. There were no perioperative deaths or relevant postoperative

complications. Visual field deficit improved or resolved in almost half of the patients during the follow-up period (8).

A retrospective review conducted in meningiomas infiltrating the superior sagittal sinus: surgical considerations of 328 cases showed Superior longitudinal sinus was totally resected in 215(65.6%) patients and marginally resected in 113(34.4%) patients. This study suggested conservative surgery for meningiomas that are infiltrating but not obliterating the superior sagittal sinus. All 328 meningiomas were histologically benign (WHO G1). There was no operative mortality but motor deficits developed in 10 (3%) patients (9).

A parasagittal meningioma follow-up review of 53 patients revealed a 93.7% 5-year survival for females and 79.3% for male patients demonstrating a significant association between female sex and better survival (10).

In a systematic review done in 2018 to assess optimal surgical strategy for meningiomas involving the superior sagittal sinus involving a total of 26 studies, 1614 patients, 65% were females. Majority of tumors (81%) WHO grade I meningioma. Radical resection (SG I) was achieved in 50% of patients, while a GTR (SG I–III) resection was achieved in 90% of cases. A favorable outcome was achieved in 73% of patients treated with an aggressive attitude (SG1) compared to 78% of patients treated with a non-aggressive attitude (statistically not significant). Complication rates were similar except for a higher rate of venous infarct (4% versus 2%) and worsening of preexisting motor deficits (34% versus 13%) in aggressively treated patients (11).

A retrospective review was done in 2010 to evaluate perioperatively and long-term outcomes from the management of parasagittal meningiomas invading the superior sagittal sinus where 100 patients were operated Of which 61 patients were included in the study and followed. Simpson grade I/II resection was achieved in 81% of patients. Complications during the first 30 post-operative days included cerebral venous thrombosis/venous infarction (7%) and air embolism (1.5%). however, when complications for all 110 patients were analyzed incidences of venous thrombosis(3.6%) and air embolism in (0.9%). Recurrence was noted in 11% and no statistically

significant association was found between recurrence and histology, location along the sinus, the extent of sinus involvement, and extent of resection (13).

A review done in 2014 on the surgical treatment of parasagittal and falcine meningiomas invading the superior sagittal sinus with special consideration of the surgical complications and the incidence of tumor recurrence demonstrated aggressive surgical treatment of meningiomas infiltrating the superior sagittal sinus has a high risk of complications with low risk of recurrence and recurrence increases significantly in the case of non-radical tumor excision (14).

In a review report of 51 patients done in 2011 operated parasagittal meningiomas showed 1.78 times higher risk for recurrence in SG IV as compared to SG I-III patients. The postoperative functional performance status outcome was also worse with a higher Simpson grade of resection (15). Another result obtained in two series of intracranial meningiomas, of 235 cases and 97 cases showed recurrence after SG I excisions is 9%, SG II excision is 19% after 10 years follow up & hence with the higher grades of excision the recurrence is higher (16).

A study done on parasagittal meningioma surgery in Egypt in 23 patients operated on between 2010 to 2016 showed GTR (SG I or II) in 15(65%) cases & STR (SG III or IV) in 8(35%) cases. New neurological impairment occurred in 5(21.7%) patients, aggressive brain edema in 3(13%) patients. Two (8.7%) patients died during the perioperative period (17).

Another study of 126 cases on the microsurgical treatment of falcine meningiomas operated in china between 2010 to 2016 GTR(SG I or II) achieved in 118(93.6%) cases. Common Post-operative complications were hypokinesia of the contralateral limbs in 18 (14.2%) patients, seizure in 12(9.5%) and hematoma in Five(3.9%) patients(18).

Analysis of attempted radical tumor removal and venous repair in 100 consecutive meningiomas involving the major Dural sinuses showed that Gross-total tumor removal was achieved in 93% of cases, sinus reconstruction done in 45 (65%) of the 69 cases with wall and lumen invasion. There were 3% deaths from brain swelling all after en bloc resection of Sindou type VI meningioma without a venous restoration. This study demonstrated venous reconstruction and venous flow restoration significantly reduces surgical complications (20).

3. OBJECTIVE

3.1. General Objective

- To assess the surgical treatment outcome of patients operated for parasagittal/Falcine meningioma in our two teaching hospitals.

3.2. Specific Objectives

- To describe the clinical and radiologic findings in parasagittal/Falcine meningioma patients
- To describe the patterns of surgical treatment outcome
- To identify common complications
- To Assess the functional performance status of patients at the end of follow up
- To identify associated factors with complications and patient's functional status

4. METHODOLOGY

4.1. Study Area and Period

- The study was conducted at Tikur Anbesa Specialized Hospital which is a teaching hospital of Addis Ababa University and Myungsung Christian Medical Center, a non-profit affiliated center located in Addis Ababa, Ethiopia. Both provide neurosurgical services to patients.

4.2 Study Design

- An institution-based retrospective cohort study was conducted.

4.3. Source Population

- All surgically treated for parasagittal and Falcine meningioma patients from August 1, 2015, to July 31, 2019, in the mentioned institutions.

4.4. Study Population

- All surgically treated parasagittal and falcine meningioma patients who consented to the study.

4.4.1. Inclusion criteria

- All surgically treated patients during the study period who were at least one year past the time of surgery.

4.4.2. Exclusion Criteria

- Patients who had less than a year follow up from the time of surgery.
- Patients whose biopsy result showed different tumor type than meningioma
- Patients with missing medical records
- Patients who lost from follow up and cannot be contacted.
- Patients who do not consent for the study

4.5. Sample Size Determination and Sampling Technique

- The convenience sampling technique was applied; all patients who fulfilled inclusion criteria were included.

4.6. Study Variables

4.6.1. Independent Variables

- Socio-demographic data(age, sex, address)
- Clinical findings at time of admission for surgery, duration of symptoms before surgery
- Functional performance status before surgery based on KPS scale
- Estimated blood loss, duration of surgery, intraoperative incident
- Tumor characteristics (size, location, degree of sinus invasion, WHO grade of tumor).
- Simpson's grade of excision.

4.6.2. Dependent Variables

- Post-operative complications
- Functional status at the end of follow up based on KPS scale

4.6.3 .Operational Definitions

1. Parasagittal meningioma- meningioma in the vicinity of the superior sagittal sinus whose main attachment is on the superior sagittal sinus based on radiologic and intraoperative findings.
2. Falcine meningioma- meningioma whose main attachment is on the falx.
3. Independent-an individual can do the normal activity and can do active work (KPS≥80).
4. Dependent- an individual who cannot do a normal activity or active work(KPS<80).
5. Type of tumor -either parasagittal or falcine meningioma as assigned in this study.
6. Radical resection - equivalent to Simpson's grade I excision
7. Complete resection- equivalent to Simpson's grade I or II excision
8. Gross total resection- equivalent to Simpson's grade I or II or III excision
9. Incomplete resection-equivalent to Simpson's grade III or IV excision
10. Subtotal resection-equivalent to Simpson's grade IV resection

4.7. Data Collection and Analysis

4.7.1. Source of Data

- Charts of the patients, operation notes, discharge summary
- Follow-up records, radiologic studies and histopathology reports
- Patient interview at referral clinic and Contact with phone call

4.7.2. Data Collection

After Receiving Ethical clearance, all patients operated for parasagittal and falcine meningioma were listed out from the operation logbooks of the two study hospitals, and charts were retrieved from the archives of the two hospitals using their medical record number.

A documented standard patient-reported outcome measurement tool was used and the data was collected by a structured questionnaire prepared by the principal investigator. Socio-demographic data and preoperative patient conditions were collected from patient history and physical examination documented by the neurosurgery resident or neurosurgeon at that time. The patient's perioperative condition, status at three months, six months, one year, and at the final of follow-up was recorded in the questionnaire. The operative procedure was collected from an operation note written by the operating neurosurgeon. Post-operative complications and imaging findings were collected from follow up notes documented by the neurosurgery resident or neurosurgeon who has evaluated the patient & imaging archives in the hospital or from the patient on subsequent outpatient visits. Radiologic evidence was collected from the radiology reports attached on the charts as reported by a radiologist or were commented on by the radiologist. By the contact address put on the chart, all the study participants received a phone call to complete the Questionnaire.

4.7.3. Data Analysis and Processing

Data were collected by the principal investigator, checked for completeness, clarity, and was cleaned with due attention. Then it was subjected for analysis to SPSS version 26 software and analyzed. Descriptive summary of the results were done in the form of frequency, percentage, mean, and median with standard deviation. These results were demonstrated in the form of tables, graphs, and charts accordingly. Correlation between variables

was done using Pearson's chi-square correlation analysis for categorical variables to pick variables with statistically significant correlation with p-value < 0.05 considered significant. Then independent variables with p-value < 0.05 on Pearson's chi-square correlation were subjected for binary logistic regression analysis with 95% confidence interval and their level of significance and odds ratio interpreted. Independent scale variables were processed using binary logistic regression analysis and interpreted similarly. The final result is reported by the level of significance using p-value, 95% confidence interval, and adjusted odds ratio. Associations were considered statistically significant if the p-value is < 0.05 with a 95% confidence interval.

4.7.4. Result dissemination plan

Relevant conclusions and recommendations were generated from the analyzed data. The research paper will be submitted to the neurosurgery unit, department of surgery so that the results and the recommendations that are going to be forwarded by this study will be availed as baseline data for plans. The research findings will also be published in a relevant scientific journal and disseminated online. The data will also be used as a baseline for future studies and interventions.

4.7.5. Competing Interest

There was no competing interest in this study.

4.7.6. Ethical Consideration

This study was conducted per the ethical principles stated in applicable guidelines on good clinical practice, whichever represents the greater protection of the individual. It was approved by the research and Ethics Committee of the Department of Surgery. The medical director of the respective hospital and concerned bodies were notified by an official letter. Informed consent was taken from the voluntary study participants and they were informed that the confidentiality of the data provided will be kept.

5. RESULT

5.1. Socio-demographic Characteristics

A total of 65 patients were operated on in both hospitals with a preoperative diagnosis of parasagittal or falcine meningioma. Four patients were excluded from the study due to two patients' biopsy results turned out to be hemangiopericytoma and two patient's chart data couldn't be retrieved and couldn't be contacted on the phone call. Hence, 61 Patients of which 54(88.5%) operated at TASH are included in the study. The highest number (47.5%) of the operated patients were from Addis Ababa. Females accounted for 36 (59%) of the patients. The mean age was 46.1(SD ± 13.7) years ranging from 20 to 78 years. Nearly 56% of the patients were less than 50 years old. (Table-1)

5.2. Clinical Presentation

The mean duration of preoperative symptoms at the time of first surgery was 16.38 (SD ±14.5) months ranging from 1 month to 5 years. About two-thirds (65.6 %) of the patients had symptoms of less than two years duration and one-third (34.4%) had symptoms greater than two years duration. The preoperative clinical findings were headache in 47(77%) patients, motor weakness in 33(54.1%), seizure in 26(42.6%) patients, visual deficit in 17(27.9%) patients, incontinence in 9 (14.8%) patients, cognitive dysfunction in 9(14.8%) patients, and skull swelling in 5(8.2%) patients. There was no asymptomatic (incidentally diagnosed) case of parasagittal or falcine meningioma. One or more associated comorbidities were present in 10(16.4%) of the patients, hypertension being the commonest present in 8 patients. Mean preoperative and postoperative hospital stay were 7.8(SD ±6.1) days and 8.3(SD ±7.5) days respectively. (Table-2)

5.3. Preoperative Functional Performance Status

The preoperative functional status assessed based on KPS was ≥ 80 in 32(52.5 %) patients and 27(47.5%) patients had KPS <80 making them unable to do a normal activity or active work but able to live at home with a variable degree of assistance. The preoperative KPS scale was significantly affected by the patient's age and tumor size. On multivariate logistic regression analysis older adult patients whose age was greater than 50 years old (P=0.001, 95% CI, OR 8.449(2.330-30.632) and larger tumor size>5 cm ((P=0.012, 95% CI, OR 8.053(1.567-41.378)

had low preoperative KPS scale. Sex, duration of symptoms, co-morbidity, type of meningioma, degree of SSS invasion, and location of the tumor were not related to the preoperative functional performance status scale (table-3 and 4).

Table 1. Socio-demographic characteristics of the study population

		Number of Patients	Percentage (%)
Hospital	1.TASH	54	88.5%
	2.MCM	7	11.5%
Gender	1. Male	25	41%
	2. Female	36	59%
Age in years	<50	34	55.7%
	>50	27	44.3%
Age in years	≤ 20	1	1.8%
	21-30	5	6.2%
	31-40	21	34.4%
	41-50	7	11.75%
	51-60	20	32.8%
	>60	7	11.5%
Address	Addis Ababa	29	47.5 %
	Amhara	16	26.2 %
	Oromiya	14	23 %
	SNNRP	2	3.3 %

Table 2. Preoperative clinical findings of operated parasagittal and falcine meningioma patients

Clinical Findings	Number of patients			Percentage (%)
Headache	47			77%
Motor Weakness	33			54.1%
Seizure Disorder	26			42.6%
Visual Deficit	17	Field Cut	1	27.9%
		Decreased Acuity	11	
		Complete loss	5	
Incontinence	9			14.8%
Cognitive Dysfunction	9			14.8%
Skull Swelling	5			8.2%
Co-morbidity	10			16.4%
Hospital stay in days				Standard deviation
Preoperative stay in days	7.8			SD ±6.1
Postoperative stay in days	8.3			SD ±7.5

Table 3. Preoperative KPS scale of operated parasagittal and falcine meningioma patients

preoperative KPS scale of patients		
KPS Scale	Count	Percentage (%)
100	0	0
90	5	8.2%
80	27	44.3%
70	27	44.3%
60	2	3.3%
Total	61	100%
KPS Scale	Count	Percentage (%)
≥ 80	32	52.5%
< 80	29	47.5%
Total	61	100%

Table 4: preoperative KPS scale with age and tumor size of operated patients

		preoperative KPS scale		
		≥ 80	< 80	Total
Age range	< 50	24 (70.6%)	10 (29.4%)	34 (100%)
	≥ 50	8 (29.6%)	19 (70.4%)	27 (100%)
Tumor size	<5 cm	11(78.6%)	3(21.4%)	14(100%)
	>5 cm	21(44.7%)	26(55.3%)	47(100%)

5.4. Tumor Characteristics

Tumor size ranged from 3.5 to 8 cm with a mean tumor size is of 5.9(SD ±1.1) cms. Tumor size was larger than 5 cm in 47(77%) patients. Based on Preoperative MRI and operating neurosurgeon's intraoperative identification the principal dural attachment 40(65.6%) of the tumors were diagnosed as parasagittal meningiomas and 21(34.4%) as falcine meningiomas. The middle third was the commonest location accounting for 28(45.9%) of the tumors followed by the anterior third in 23(37.7%) tumors and 10(16.4%) in the posterior third of the superior sagittal sinus. Only 20(32.8%) patients had preoperative MRV imaging done. Depending on the MRI with/without MRV imaging findings and the operating neurosurgeon's intraoperative assessment of sinus occlusion the degree of SSS invasion was categorized into three for surgical management and outcome assessment purposes. Majority, 37 (60.7%) patients had minimal (either no attachment or Sindou type1) sinus invasion, 17 (27.9 %) of the patients had partial (Sindou 2,3 & 4) invasion, 7(11.5 %) patients had complete (Sindou 5 & 6) sinus invasion. Most tumors with size <5 cm (12,85.7%) had a minimal invasion of the SSS, and 22(46.8%) of the tumors with size >5 cm had partial/complete sinus invasion, demonstrating larger tumor size was associated with a higher rate of invasion of the SSS (P=0.030, Pearson chi-square test). A high rate of partial or complete invasion of the SSS was also more common with Parasagittal than falcine meningioma (47.5% versus 23.8%) but not statistically significant (P=0.074, Pearson chi-square test). Histology Report was collected for 59(96.7%) patients and the most common Histologic type was meningothelial meningioma in 29(49.2%) followed by transitional in

10(16.9 %) and atypical in 9(14.8 %) patients. WHO G 1 tumor was diagnosed in 47(79.9%) patients, WHO G 2 in 9(15.3%), and WHO G 3 in 3(5.1 %) of the patients. (Table-5)

Table 5. Tumor characteristics of parasagittal and falcine meningioma patients

Side location of parasagittal/falcine meningiomas		
Right side	26	42.6%
Left side	29	47.5%
Bilateral	6	9.8%
Histologic diagnosis of parasagittal/falcine meningiomas		
Meningothelial	29	49.2%
Transitional	10	16.9%
Fibrous	5	8.5%
Atypical	9	15.3%
Papillary	2	3.4%
Anaplastic	1	1.7%
Others	3	5.1%
Others (1 microcystic, 1 psammomatous, 1 secretory)		

5.5. Patient treatment outcomes

5.5.1. Extent of resection, perioperative outcome, and complications

The extent of tumor resection was graded according to Simpson's grading based on the operating surgeon's note and postoperative CT scan done within 48-72 hours after surgery. Complete tumor resection (Simpson's I or II) was achieved in 47(77%) patients. Macroscopic gross total resection (Simpson's I, II, or III) was done in 54(88.5%) patients. In this study meningiomas with minimal degree of SSS invasion were likely to achieve macroscopic gross total resection (P=0.000), Pearson's chi-square test) where all 37(100%) of the patients who had a minimal invasion of the SSS had a gross total resection. The superior sagittal sinus was managed according to the intraoperative finding of the degree of invasion and site of the tumor. Complete ligation and resection of the SSS were done in 11(18%) of the patients nine of which were in the anterior third of the SSS. coagulation (extensive cauterization with bipolar) was done in

31(50.8%) patients and only tumor removal (coagulation done for purpose of tumor removal only) was done in 19(31.2%) patients. (Table-6)

Surgical treatment was uneventful in 44(72.1%) patients throughout the perioperative period. Intraoperative incidents occurred in 10(16.4%) patients and all of them developed one or more postoperative complications. There were a total of 46 perioperative complications in 17(27.9%) patients. Excluding one patient who died intraoperatively, there were 45 postoperative complications in 16(26.7%) patients. Patients who died in the hospital were three (4.9%), one patient with Middle third Sindou1 PSM died during surgery suddenly due to cardiac arrest possibly from an air embolism. Another patient with middle third bilateral Sindou 6 PSM died after surgery from irreversible hypovolemic shock secondary to massive bleeding. A third patient with posterior third right side Falcine meningioma died 6 weeks after surgery due to postoperative complications (re-operated two times for epidural hematoma and wound infection, developed ventilator-associated pneumonia) and finally died of multi-organ failure secondary to septic shock. Post-op New or worsened motor weakness occurred in 8(13.3%) patients, most were transient and improved in 7 of the patients at the time of discharge. New-onset seizures developed in two patients. A total of 58(95.1%) of the operated patients were discharged from the hospital. The presence of intraoperative incidents was associated with worsening or developing of new postoperative weakness (P=0.035, Pearson's chi-square test). Binary logistic regression analysis was done to pick variables associated with perioperative complication and there was a significant statistical association between duration of illness and risk of developing perioperative complication. Patients presenting with two or more years duration of illness had a higher risk of developing complications (p=0.016 OR 4.286 [95 %CI 1.313-13.984]). The occurrence of the intraoperative incident also has a statistically significant association with developing postoperative complications (P=0.0001 Pearson's chi-square test). Age, sex, preoperative KPS scale, tumor type, tumor size, degree of sinus invasion, the extent of resection, and duration of surgery, the volume of EBL did not have a statistically significant association with an intraoperative incident or perioperative complications. (table -7 and 8)

Table-6. Simpson's degree of resection of parasagittal/falcine meningioma patients

Simpson's resection	Number	Percentage		Extent of resection	Number	Percentage
Grade I	14	23%		Complete resection	47	77%
Grade II	33	54.1%		Incomplete resection	14	23%
Grade III	7	11.5%		Extent of resection		
Grade IV	7	11.5%		GTR	54	88.5%
Total	61	100%		STR	7	11.5%

Table-7. Perioperative complications in operated parasagittal and falcine meningioma patients

Complication	Number of patients
New neurologic deficit	8
New seizure	2
Brain edema	3
Hematoma	3
Cranial infection(wound infection, meningitis)	6
CSF Leak	3
Pneumonia	4
DVT	1
Sepsis	1
Multiorgan failure	1
Air embolism	1
Hypotension	6
Brain swelling	4
Death	3
Total	46

Table 8. Pearson's chi-square correlation between different variables and perioperative complications in parasagittal/falcine meningioma patients

Variable	P-value	Variable	P-value
Age	0.740	Intraoperative incident	0.0001
Sex	0.552	Degree of sinus invasion	0.180
Tumor size	0.544	Extent of resection	0.465
Duration of symptoms	0.013	Duration of surgery	0.400
Preoperative KPS scale	0.277	Estimated blood loss	0.699
Co-morbidity	0.877		
Duration of symptoms categorized as <2 years and ≥ 2 years			

There were 12 reoperations done in a total of 6 patients. The reoperations done were 5 for residual tumor, 3 for post hematoma, 02 for wound infection with epidural abscess, 2 for CSF leak. From these patients, one patient who was reoperated three times for residual tumor, epidural hematoma, wound infection died in hospital 6 weeks after the first surgery.

5.5.2. Clinical outcomes during third month postoperative follow up

Follow up documentation regarding improvement, worsening or new onset of symptoms was collected and analyzed from the follow-up chart note written by a neurosurgeon or neurosurgery resident and from phone call data collected from the patient. All the discharged patients were alive and available through the third month follow up visit. Headache improved in 43(97.7%) of the 44 patients who had a preoperative headache and survived through the third month. of the 32 patients who had preoperative motor weakness and survived through the third-month weakness resolved in 1(3.1%) patient and improved in 28(87.5%) patients. Incontinence resolved in 3(37.5%) and showed improvement in 5(62.5%) patients. The visual deficit was the same as the preoperative status in 8(50%) patients and improved in 8(50%) patients. All patients with cognitive dysfunction whose main symptom was frontal lobe symptoms had to average to very good improvement. Seizure disorder was the same as the preoperative status in all patients with seizures preoperatively and the postoperative period. Only a few patients improved their functional performance status on their third-month follow-up visit. (Table- 9 and 10)

5.5.3. Clinical outcomes during sixth month postoperative follow up

There was one patient who died in the fourth month after surgery from severe Anemia secondary to sepsis after he was admitted for community-acquired pneumonia in a nearby hospital. Follow up documentation for 57 patients who survived up to the sixth month was analyzed from the chart, radiology archives, and phone calls data collected. There was a significant improvement in headache, motor weakness, cognitive dysfunction, and functional performance status. Patients functionally independent with KPS scale ≥ 80 were 47(82.5%) of the patients who survived through the sixth month. A total of 31(54.4%) of the patients had a CT scan or MRI done and there was one patient with recurrence of the tumor. This patient had Simpson grade 2 excisions of anterior third bilateral, atypical (WHO grade 2) meningioma and developed a new-onset headache, worsening of his weakness, and incontinence. Surgery was not done due to his poor functional performance status.(Tables-9 and 10)

5.5.4. Clinical outcome at one-year postoperative follow-up

There were two dead patients at 8 and 11 months after surgery from recurrence of the tumor in one patient and the second patient had sudden death at home due to an unknown cause. This patient had completely resolved preoperative weakness and headache. Her cause of death does not look related to her surgically treated disease. At the end of one year, follow-up from there were 55(90.2%) patients. Headache completely resolved in 38 patients making the total number 52(94.5%) patients with no headache at the end of a one-year follow-up. Cognitive dysfunction is completely resolved in all patients. At the end of one-year motor weakness resolved in 17(54.8%), improved in 11(35.5%) of the patients who had a preoperative motor weakness, and survived through one-year postoperative follow-up. There was worsening of weakness in two patients. The number of functionally independent patients with KPS ≥ 80 were 45 (82%) of the total patients who survived through one year postoperative follow up. Recurrence occurred in one patient who had SG II excision of anaplastic PSM 11 months after surgery. The other two patients had regrowth Simpson's Grade IV resected falcine meningioma at 8 months and 12 months from the time of operation respectively. It was papillary type in histology in both cases; one was reoperated and in the second patient surgery was differed due to low functional performance status.(Tables- 9 and 10)

5.5.5. Clinical outcomes at the final follow up

The mean duration of follow-up was 28.2 (SD ±13.6) months ranging from 0 to 60 months.

At the end of follow up there were 53(86.9%) Patients alive; 51(83.6%) of them without tumor or with stable rest of the residual tumor and 2(3.3%) with non-operated tumor recurrence. A total of 8(13.1%) patients died. 3(4.9%) patients died during the perioperative; one patient from air embolism intraoperative, one patient immediately postop from hypovolemic shock secondary to massive bleeding, one patient 6 weeks after surgery from multiorgan failure secondary to septic shock. Three (4.9%) patients died from tumor recurrence. One patient died from sepsis of chest focus three months after surgery and one patient died suddenly at home from an unknown cause.

Most of the patients who survived to the end of follow-up had substantial improvement in functional performance status where 45(84.9%) patients were independent with a KPS scale of ≥ 80 able to do a normal activity and active work. Only 8(15.1%) patients were functionally dependent with a KPS scale of < 80 who are unable to do a normal activity or active work. There were a total of 33(54.1%) patients with preoperative motor weakness and most patients had resolved or improved their weakness at the end of follow up with 21(72.4%) patients completely resolved weakness, 6(20.7%) patients improved, one patient the same as preoperative weakness and one had worsened weakness. During the preoperative period, there were 26 (42.6%) patients with seizure disorder started on treatment. At the end of follow up 8(30.8%) patients had complete resolution of the seizure and their treatment discontinued, 5(19.2%) patients had improvement in their seizure disorder. There were a total of 17(27.9%) patients with a visual deficit during the preoperative period. At the final follow-up evaluation, 5(31.5%) patients had complete resolution, 3(18.7%) patients had improvement of visual deficit and 8(50%) had the same visual status as the preoperative period. There were a total of five regrowth/recurrence cases, two were reoperated and two are alive with the tumor as surgery was differed due to their low KPS scale and one patient died before he was operated on. (Tables-9 and 10)

Table 9. Final follow up status of operated parasagittal and falcine meningioma patients

		Preoperative	3rd month	6th month	One year	Final follow up
KPS scale	100	0	0	0	9	22
	90	5	6	16	25	10
	80	27	29	31	10	13
	70	27	22	9	9	7
	60	2	1	1	2	1
	Total	61	58	57	55	53
		Preoperative	3rd month	6th month	One Year	Final Status
Functional status based On KPS Scale	≥ 80	32 (52.5%)	35 (60.3%)	47(82.5%)	45 (82%)	45 (84.9%)
	< 80	29 (47.5%)	23 (39.7%)	10(17.5%)	10 (18%)	8 (15.1%)
	Total	61 (100%)	58 (100%)	57(100%)	55 (100%)	53 (100%)

	Final follow up status of patients	Total count(percentage)	
Status of patients	Alive free of disease	51 (83.6%)	53 (86.9%)
	Living with recurrence(regrowth)	2 (3.3%)	
	Perioperative death	3 (4.9%)	8 (13.1%)
	Death due to Recurrence	3 (4.9%)	
	Death from other causes	2 (3.3%)	

Table 10. Final of follow up motor status of parasagittal and falcine meningioma patients

Motor weakness	preoperative	Discharge	3rd month	6th month	One year	Final follow up
Absent	28	26	26	25	24	24
Present	33	20	2	1	1	1
Improved	0	5	28	23	11	6
Resolved	0	0	1	6	17	21
Worsened	0	6	1	2	2	1
New weakness	0	2	0	0	0	0
Total	61	59	58	57	55	53

5.5.6. Clinical outcomes at the final follow up -statistical associations

Pearson's chi-square analysis was done for age, sex, duration of symptoms, admission KPS, duration of preop dexamethasone, duration of surgery, EBL, tumor size, tumor location, degree of sinus invasion, grade of tumor resection, WHO grade, comorbidity perioperative complications and other variables with mortality and the final follow up KPS scale of patients.

Mortality: There was a statistically significant association between WHO grade of the tumor (P=0.03), Age(P=0.009), Sex(0.037), and mortality demonstrating higher grade of the tumor, older age above 50 years old and male sex had a greater risk of mortality. KPS scale, tumor size, tumor location, degree of sinus invasion, co-comorbidity, and perioperative complication were not significantly associated with overall mortality. From the variables with p-value < 0.05 on Pearson chi-square analysis, bivariate logistic regression analysis showed older age above 50 years old is associated with increased risk of death (P=0.027 OR 11.550) and age analyzed as a continuous variable there was 6.8% increased risk of death with each increase of age in years. High WHO grade of tumor was also associated with increased risk of mortality on bivariate logistic regression analysis with (P=0.011 OR 11.250). Female sex (P=0.048 OR 5.368) was a predictor of better survival on bivariate regression analysis (Table-11)

Regrowth/recurrence: A total of five regrowth/recurrence occurred with a mean time of 18.6(ranges from 6 to 39) months. High WHO grade of the tumor had a high risk of recurrence (P=0.0001 Pearson chi-square analysis) and macroscopic GTR (SG I, II or III) was associated with a low rate of recurrence (p=0.047 Pearson chi-square correlation). There was no association between age, sex, tumor size, tumor location, degree of sinus invasion, and risk of recurrence.

Final follow up functional performance status: Pearson's chi-square analysis showed a statistically significant association between complete (Simpson's G I or II) resection (p=0.013) and macroscopic gross total (Simpson's G I, II or III) resection (P=0.001) with better functional performance status at the end of follow up. Functionally independent patients during the preoperative period were also likely to be independent at the end of follow up with (P=0.001). There was no significant association between patient age, sex, duration of symptoms, co-morbidity, perioperative complication, and final functional status. There was no significant association between tumor size, the extent of sinus invasion, tumor location, WHO grade, and final functional performance status. Bivariate regression analysis done for associated variables

showed complete resection (P= 0.021, OR 6.667) and macroscopic gross total resection (P=0.004, OR 14) are associated with the better end of follow up KPS scale. (Table-12)

Table 11. Variables and their level of significance with overall mortality

Variable	P-value	Exp(B)	95% CI for Exp(B)	
Age 1	0.027	11.550	1.322	100.921
Age 2	0.033	1.068	1.005	1.134
WHO grade	0.011	11.250	1.757	72.016
Sex	0.048	5.368	0.985	29.267
Age 1: above or less than 50 years old. Age 2: age as scale variable				
		Alive	Dead	Total
Age in years	<50	33 (97.1%)	1(2.9%)	34(100)
	>50	20 (74.1%)	7(25.9%)	27(100%)
	Total	53 (86.9%)	8(13.1%)	61(100%)
WHO grade	Low grade	45 (95.7%)	2(4.3%)	47(100%)
	High grade	8 (66.7%)	4(33.3)	12(100%)
	Total	53 (89.8%)	6(10.2%)	59(100%)
Sex	Female	34 (94.4%)	2(5.6%)	36(100%)
	Male	19 (76%)	6(24%)	25(100%)
	Total	53 (86.9%)	8(13.1%)	61(100%)

Table 12. Variables' level of significance with final follow up functional performance status

Associated Variables	P-value	Exp(B)	95% CI for Exp(B)	
			Lower limit	Upper limit
Extent of resection 1	0.021	6.667	1.337	33.251
Extent of resection 2	0.004	14.0	2.281	85.938

Associated variables		Final follow up KPS scale of alive patients		
		Independent	Dependent	Total
Extent of resection 1	Complete	36(92.3%)	3(7.7%)	39(100%)
	Incomplete	9(64.3%)	5(35.7%)	14(100%)
	Total	45(84.9%)	8(15.1%)	53(100%)
Extent of resection 2	GTR	42(91.3%)	4(8.7%)	46(100%)
	STR	3(42.9%)	4(57.1%)	7(100%)
	Total	45(84.9%)	8(15.1%)	53(100%)
Extent of resection 1(complete versus incomplete) Extent of resection 2 (GTR versus STR)				

6. DISCUSSION

6.1. Patient Characteristics

This study demonstrated parasagittal/falcine meningioma is more common in females composing 59% of the patients. The female to male ratio could be variable but most studies were done on parasagittal and/or falcine meningiomas show a higher of percentage female patients ranging from 55.5% to 80% of all patients (1,2,3,7,8,11,13,14). This study also demonstrates similar figures to most pieces of literature. The mean age was 46.1 (SD ± 13.7), median 45 years which shows a younger patient population as compared to most works of literature which demonstrated a mean age range of 51.9 to 57.86 years(2,7,8,9,11,20). More than half(55.7%) of patients in this study are younger than 50 years old possibly due to a larger proportion of the younger age population in our study population.

6.2. Clinical Presentation

The mean duration of preoperative symptoms at the time of first surgery was 16.38 (SD ±14.5) months. The most common presenting symptoms were headache in 47(77%) patients which has a similar pattern to multiple studies (4,5,17,18,22) followed by motor weakness in 33(54.1%) and seizure in 26 (42.6%) patients. Other studies also show headache, motor weakness, and seizure to be the three commonest symptoms despite the inconsistency of which precedes the other in percentage (1,2,9,10,19). There was not an asymptomatic or incidentally diagnosed patient in this study. Some literature reported a variable number of asymptomatic or incidentally diagnosed parasagittal and/or falcine meningioma ranging from 5.6% to 25.9% of all patients (2,5,24).

There were 32(52.5 %) patients who are independent (KPS≥ 80); able to do a normal activity and active work with minor or some symptoms of a disease and 27(44.3%) patients were dependent (KPS <80); unable to do a normal activity or do active work. The percentage of functionally independent patients at admission is lower than studies done in different countries (2, 9, 10, 24). This can be due to delayed presentation of symptoms (9, 22) and a larger-sized tumor in this review (2, 6, 9) which had a significant association with low preoperative KPS scale.

6.3. Tumor Characteristics

The middle third followed by the anterior third is the commonest tumor location in 45.9% and 37.7% respectively showing similar figures with most studies (2,7,11,14,24). Mean tumor size in other studies ranged from 2.6 cm to 4.86 cm in many works of literature (2,6,7,18) which is smaller than the tumor size in this study where mean tumor size was 5.93cm (3.5 to 8 cm).

The degree of SSS invasion is assessed by the intraoperative findings as a gold standard. The diagnostic accuracy of contrast-enhanced(CE-MRV) in identifying the patency of the SSS has high specificity than PC-MRV(3). Noteworthy is that MRI, MRV, or angiography will not necessarily yield a confident evaluation of sinus invasion, and neither further workup but surgical inspection intraoperatively can solve this Uncertainty(8). In this study there was minimal invasion (Sindou type1) in 37 (60.6 %) patients, moderate sinus invasion (Sindou 2,3 & 4) in 17 (27.9 %) of the patients and complete invasion (Sindou 5 & 6 in 7(11.5 %) patients. The pattern of the report and the extent of sinus invasion is highly variable and inconsistent among studies and our study has shown a comparable degree of sinus invasion with some studies (2,5). The rate of complete invasion was lower in our study (8,11,17,20). The degree of sinus invasion, presence of collateral veins, adjacent arterial vessels are not adequately investigated preoperatively in this study due to resource limitation and this might be a limiting cause to take it as a reliable figure.

The histologic diagnosis on microscopic examination showed meningothelial meningioma in 29(49.2%), transitional in 10(16.9 %), and atypical in 9(14.8 %) patients. WHO G1 tumors accounted for 47(79.9%) patients. Most works of literature' microscopic reports show meningothelial and transitional as the two most common histologic types like our study and the proportion of low grade and high-grade meningiomas are also comparable to our study's figure(2,5,7,9,11).

Complete tumor resection (Simpson grade I or II) was done in 47(77%) and macroscopic GTR (Simpson grade I, II, or III) was achieved in 54(88.5%) patients. The extent of Simpson Grade I or II resection reported in this study was lower than some studies which reported a rate of 81% to 94%(4,13,18) and similar to another study which reported a rate of 74%(8). Macroscopic GTR which was defined as a radiological undetectable tumor on post-op imaging (Simpson grade I, II or III) achieved in a systematic review was 90% comparable to our study (11) and

another review also reported a GTR rate of 89.6% (24). The majority of recent studies report a higher rate of more aggressive resection of the tumor regardless of the extent of sinus invasion (2,7, 13,18). This could be due to the use of intraoperative neuronavigation techniques.

6.4. Complications

A total of 46 perioperative complications occurred in 17(27.9%) patients. Excluding one patient who died intraoperatively, there were a total of 45 postoperative complications in 16(26.7%) patients which is consistent with kinds of literature (7,8,9,11) which reported a postoperative complication rate of 23.1% to 28.7% in contrast to other reviews (1,9,13,24) which reported a low postoperative complication rate which varies from 3% to 7.8% in total. Other literature reported a complication rate of 13.2% and 19% (4,5). New or worsened motor weakness was the commonest postoperative morbidity which occurred in 8(13.3%) patients which is higher than most published literature (5, 7, 9, 10). A review done in south Korea in 68 cases reported a rate of 11.8% (4) and a systematic review of 26 articles also showed a higher rate of postoperative motor weakness in 18% of the patients (11). The similarity in the new/worsened motor weakness is it was transient in most patients in our study and the mentioned studies.

In our study perioperative complication was strongly associated with longer duration preoperative symptoms greater than 2 years. Postoperative complications were also strongly associated with the intraoperative incident where all the patients with the intraoperative incident. developed one or more post-op complications. Patients with the intraoperative incident also had a strong risk of developing new or worsened motor weakness in our study.

Table 13: Postop complications in parasagittal and/or falcine meningioma of different studies

Author/year		Cases	Complication	Death
S. Giombini, MD. et al/1984	1	342	7.8%	7.3%
F. Di Meco, M.D. et al/2004	7	108	28.7%	1.85%
Emanuela Caroli et al/2006	9	328	3%	0
B.oscarColli,MD,PhD etal/2006	10	53	26.4%	1.9%
Abat Sahlu, MD et al/2020		61	26.7%	4.9%
Sang-Bong Chung et al/2007	4	68	13.2%	1.4%
Raza et al./2010	13	61	7%	1.5%
Michael e. Sughrue, M.D./2011	5	135	19%	0
Antonio Biroli et al/2012	8	26	23.1%	0
EnricoGiordan et al/2018	11	1614	24%	2%
Lingyang Hua et al /2020	24	192	16.8%	0

6.5. Patient Outcome at the final follow up

At the end of follow up a total of 53(86.9%) patients were alive, 51(83.6%) without tumor or with stable rest of the residual tumor and 2(3.3%) with non-operated tumor recurrence. A total of 8(13.1%) patients died. High WHO grade of the tumor, older age, and male sex was had a strong association with mortality in our study. Overall survival rate was highly inconsistent in most researches due to the highly variable duration of follow-up (2, 5, 8, 10,20,24). On bivariate binary logistic regression analysis; older age, a high WHO grade of the tumor were strong predictors of mortality/low survival in our study. Female sex also showed to have a strong association with a better survival on bivariate regression analysis (P=0.048 OR 5.368). Older age, higher histology grade were strong predictors of mortality/low survival, and female sex a better predictor of overall survival in multiple pieces of literature (2,7,8,10,24).

Most of the surviving patients in this study had substantial improvement in KPS scale where 45 (84.9%) patients were independent, able to do a normal activity and active work with a KPS score $\geq$ 80 and 8(15.1%) patients had a variable degree of dependence with KPS scale < 80, unable to do a normal activity or active work. This significant improvement in functional

performance status at the end of follow-up after surgical management was supported by most published literatures in different settings (2, 4, 8, 10, 13, 15, 23).

In our study higher preoperative KPS scale (P=0.001) was associated with a better final follow-up KPS scale. On Bivariate regression analysis patients with complete tumor resection (P= 0.021, OR 6.667) and macroscopic gross total resection (P=0.004, OR 14) had better functional performance status at the end of follow-up favoring aggressive tumor resection as a good predictor of better functional status. More aggressive tumor resection as a good predictor of an improved surgical outcome was revealed in some studies (4, 15, 24). On the contrary, a systematic review showed a better clinical outcome achieved in patients treated with a non-aggressive approach(aggressive 73% versus non-aggressive 78%) but was not statistically significant(p-value > 0.05). published reviews that reported on KPS status demonstrated that good preoperative KPS has associated with better follow-up KPS or more satisfactory quality of life (2, 23, 25).

6.6. Tumor Regrowth/Recurrence

Regrowth /recurrence occurred in 5(8.5%) patients with a mean time to recurrence of 18.6(8-39) months and an overall mean duration of follow-up of 28.2 months. The rate of recurrence was higher in most published studies ranging from 11.2% to 47% which is comparably higher with the longer duration of follow up which ranged from 36 months to 25 years. This study showed WHO grade of the tumor (P=0.0001) and the subtotal degree of tumor resection (P=0.047) had a statistically significant association with the regrowth/recurrence of the tumor. It is universally accepted and demonstrated by multiple published studies that WHO grade of the tumor(1,2,7,10,11) and less aggressive degree of resection(4,7, 9, 10,15, 16,21) are strong predictors of recurrence in parasagittal/falcine meningioma.

7. STUDY LIMITATION

This is a single-center retrospective analysis with inherent limitations of the retrospective study method. The sample size is limited and hence grouping grade 2 and grade 3 tumors as high grade might affect the difference in outcome and recurrence analysis. The duration of follow-up is also relatively short and a longer period of follow-up is needed primarily to assess the risk of tumor recurrence. There are only a few or limited articles on parasagittal and/or falcine meningioma published from low-income countries.

8. CONCLUSION

This study has demonstrated most of the surviving patients (84.9%) had substantial improvement in their functional performance status which was positively related to the more aggressive degree of tumor resection and a better preoperative functional status of the patients. This improvement is similar to reviews done in most settings. Nearly all patients also improved or completely resolved their preoperative headache, motor weakness, and cognitive dysfunction. The rate of perioperative complications (27.9%) is high as compared to most international data reports and this was strongly related to a longer duration of preoperative symptoms prior to their first surgery. The high rate of intraoperative incidents (16.4%); all developed postoperative complications. The study also identified a higher frequency of larger tumor size, low preoperative functional status of patients. There were zero recurrences in patients who had Simpson's grade 1 resection and 28.6% recurrence rate in these having Simpson's grade 4 resection patients. None of the patients received adjuvant radiotherapy.

9. RECOMMENDATIONS

- In most patients degree of sinus was based on intraoperative findings only. Preoperative venogram and/or arteriogram imaging studies is mandatory for proper planning
- Minimize Intraoperative incidents with adequate preoperative preparation
- Improve neurosurgery service access to decrease the preoperative delay

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Appendix

I. Questionnaire

1.Socio-demographic data

Name		Age in years	
Sex	MRN	Tel NO	
Address			
Hospital	A.TASH		
	B.MCM		

2. Clinical features at admission

Duration of illness in months	
Headache	1.Yes 2.No
Motor weakness	1. Yes 2.no
Seizure	1. Yes 2.no
Sensory deficit	1.yes 2.no
Incontinence	a. bowel b. bladder c. both
Visual deficit	1. none 2.field cut 3. decreased 4. complete loss
Mental status/behavioral change	1.yes 2.No
Skull swelling	1.yes 2.no
GCS	1.14,15 2.9-13 3.3-8
Chronic medical illness	1. HTN 2.DM 3. Asthma 4.other 5.none
Date of admission	Preoperative hospital stay in days
Dates of surgery(1^{st} &/or 2^{nd})	
Surgery time in hours	Date of discharge
Karnofsky performance status scale	
Biopsy result(list of histologic types & WHO grade)	

3. Preoperative imaging findings and operative procedure

Tumor location	1.anterior third 2. middle third 3. posterior third
Side of the tumor	1. right side 2. left side 3. Bilateral
Tumor size in centimeters	
Based on CT/MRI/INTRAOP Type of the tumor	1.Parasagittal meningioma 2.Falcine meningioma
MRV done	1. yes b. no
Status of the SSS From MRV/INTRAOP	1.minimal invasion (Sindou 1) 2.partial invasion (sindou 2,3,4) 3.complete invasion(sindou 5 & 6)
Preop Dexamethasone	1.<1 week 2.1-2 weeks 3>2 weeks
Simpson's Grade of resection	1. grade I 2.grade II 3.. grade III
	4. .grade IV 5. grade V
Intra op accident	1. brain swelling 2. hypotension 3. uncontrollable bleeding 4. other 5.none.
Estimated Blood loss in ml	
What was done to the SSS	1.none. 2.coagulated/cauterized 3.ligation&resected

4. Early post-op status & complication

Post-op motor status	1.same 2. improved 3.worsened 4.new weakness 5.none		
Post Op GCS	1.14-15 2.9-13 3.3-8	Post Op	1.ward 2.ICU
Post op seizure status	1.none 2.same 3.improved 4.worsened 5.new onset seizure		
Post Op CT complication	1.none 2.hematoma 3.infarction 4.brain edema 5.other specify		
Post op complication	1.none 2.infection 3.DVT 4.CSF leak 5.others specify		
Infection	1.none 2.meningitis/ventriculitis 3.Pneumonia 4.Absces		
Reoperation	1.none 2. hematoma evacuation 3. residual tumor		
	4.wound revision or abscess evacuation 5.DC		

5. Condition at time of discharge

Headache	1.same 2. improved 3.worsened		
Motor at discharge	1.same 2. improved 3.worsened 4.new weakness		
Incontinence	1. same 2.improved 3. worsened 4. new incontinence		
GCS		**KPS**	
Visual deficit	1.none 2.same 3.improved 4. worsened 5.new visual deficit		

6. Follow up at 3rd-month post Op

Headache	1. same 2. improved 3. worsened 4.new headache		
Motor weakness	1. same 2.improved 3. Worsened 4.new weakness 5.none		
Seizure	1.none 2.same 3. improved 4.worsened 5.new seizure		
Incontinence	1.none 2.same 3.improved 4. worsened 5.new onset incontinence		
Personality change	a. improved b. same c. worsened		
GCS		KPS	
Visual deficit	1.none 2.same 3.improved 4. worsened 5.new visual deficit		
Any new development			

7. Follow up at 6th-month post-op

Headache	1.none 2. same 3. improved 4. worsened 5.new headache		
Motor weakness	1. same 2.improved 3. Worsened 4.new weakness 5.none		
Seizure	1.none 2.same 3. improved 4.worsened 5.new seizure		
Incontinence	1.none 2.same 3.improved 4. worsened 5.new onset		
Personality change	a. improved b. same c. worsened		
GCS		KPS	
Visual deficit	1.none 2.same 3.improved 4. worsened 5.new visual deficit		
Control CT/MRI	1.not done 2. normal 3. regrowth 4. Recurrence		

8. Final follow up status

Headache		1.none 2. same 3. improved 4. worsened 5.new headache	
Motor weakness		1.none 2.same 3.imoroved 4.resolved 5.worsene 6.new weakness	
Seizure		1.none 2.same 3. improved 4.worsened 5.new seizure	
Incontinence		1.none 2.same 3.improved 4. Resolved 5.worsened 6.new onset	
Personality change		a.improved b. same c. worsened	
GCS		KPS	
Visual deficit		1.none 2.same 3.improved 4. Resolved 5.worsened 6.new deficit	
Radiotherapy(in 1 year)		1.yes 2.no	
CT/MRI	1.not done 2. normal 3. Same 4.regrowth 5. Recurrence		
Death	1.yes 2.no if yes mention cause of death		

II . Simpson's grade of resection

Grade I	macroscopically complete removal with excision of dural attachment and abnormal bone (including sinus resection when involved)
Grade II	macroscopically complete with endothermy coagulation (Bovie, or laser) of dural attachment
Grade III	macroscopically complete without resection or coagulation of dural attachment or of its extradural extensions (e.g. hyperostotic bone)
Grade IV	partial removal leaving tumor in situ
Grade V	simple decompression (± biopsy)

III. **Karnofsky performance status scale**

100	Normal. No complaints. No evidence of disease.
90	Able to carry on normal activity. Minor signs or symptoms of disease
80	Normal activity with effort. Some signs or symptoms of the disease.
70	Care of self. Unable to carry on normal activity or to do active work
60	Requires occasional assistance, but is able to care for most of his needs
50	Requires considerable assistance and frequent medical care
40	Disabled. Requires special care and assistance
30	Severely disabled. Hospitalization is indicated although death not imminent
20	Hospitalization necessary, very sick active supportive treatment necessary
10	Moribund. Fatal processes progressing rapidly.
0	Dead

IV. Sindou grading system for meningioma invasion of the superior sagittal sinus.

Type I	attachment to lateral wall of sinus
Type II	Invasion of the lateral recess.
Type III	Invasion of the lateral wall.
Type IV	Invasion of lateral wall and roof.
Type V	Total sinus occlusion, contralateral wall spared.
Type VI	Total sinus occlusion, invasion of all walls.