



## A Retrospective Review of Surgery for Skull Base Tumors in a Nigerian Tertiary Hospital

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### Abstract

**Background:** Surgery for skull base tumors is often a challenge due to difficult surgical corridor and multiple cranial nerve and neurovascular involvements, but a different set of challenges exist in this emerging practice environment.

**Aims and Objectives:** To evaluate the emerging patterns and challenges encountered in surgery for skull base tumors in a tertiary hospital Abuja, North Central Nigeria.

**Methods:** Retrospective review of cases of surgery for skull base tumors from July 2013 to August 2018. Simple descriptive statistics was used for data analysis.

**Results:** Only 14 out of a total 37 cases (37.8%) underwent surgery. M:F = 3:4. Mean age 45 years (Range - 26 to 67 years). Common presenting symptoms were headache 9/14 (64.2%), seizures and visual impairment 7/14 (50%) each, anosmia 6/14 (42.8%). Average duration of symptoms before presentation was 20.7 months.

Neurology at presentation were optic nerve palsy 7/14 (50%) and olfactory nerve palsy 6/14(42.8%). Neuroimaging confirmed medial third sphenoid wing meningioma with involvement of the internal carotid artery/optic nerve (ICA/II) in 3/14 (21.4%), lateral two third sphenoid wing meningioma with no ICA/II involvement 4/14 (28.5%), olfactory groove meningioma in 6/14 (42.8%) and Cerebellopontine (CP) angle tumor in 1/14 (7.1%). Operative intervention was pterional craniotomy for excision of sphenoid wing meningioma, sub-frontal approach for olfactory groove meningioma and retro-sigmoid craniotomy for CP angle tumor. Complete tumor resection was achieved in 10/14 (71.4%). Primary hemorrhage was responsible for incomplete resection in 1/4 (25%) while encasement of internal carotid artery and optic nerve was responsible incomplete resection in 3/4 (75%). Most important immediate post op complication was tension pneumocephalus 1/14 (7.1%). Mortality was 1/14 (7%). Anosmia and visual loss did not reverse but headache and seizures subsided in 11/13 (84.6%) survivors. Commonest histopathology picture was meningothelial tissue 12/14 (85.7%). Check neuroimaging at three and twelve months revealed no residual tumor in 9/13 (69.2%) and no further treatments were administered. Residual tumor was observed in 4/13 (30.7%) of survivors requiring gamma knife referral in 3/13 (23.1%) and re-do operation in 1/13 (7.6%).

**Conclusion:** Low compliance to surgery (37.8%) remains a cause for concern. For the consenting ones, late presentation became a constraint to achieving complete resection especially when involved with vital neurovascular structures. Even when feasible complete resection did not necessarily translate to any reversal of cranial nerve deficits but some symptoms such as headache, seizures were improved. Therefore, the need for early presentation and appropriate health policy should be an ongoing advocacy.

**Keywords:** Skull base tumors; Cranial nerve deficits; Craniotomy; Meningothelial

### Introduction

Until the later decades of 20<sup>th</sup> century, lesions located on the base of the skull were considered

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inoperable but recent advances in skull base anatomy, sound application of neuroradiology, introduction of microsurgical techniques, advances in neuroanesthesiology, neuronavigation, endoscopy, high-speed drills, and hemostatic agents have dramatically changed the narrative [1]. The main goal of these techniques is to enhance surgical exposure by means of bony resection in order to minimize the need for brain retraction. A complicated skull base anatomy with multiple foramina transmitting vital neurovascular structures to and from the cranial cavity creates a difficult surgical corridor. The key principle of skull base surgery is to safely deconstruct the bony skull base around the brain to create safe apertures to resect deep-seated pathologies with minimal morbidities.

Surgical anatomy basically involves three bones namely sphenoid, temporal and occipital bones with multiple holes of varying sizes that transmit neurovascular structures to and from the brain. The boundaries extend from the roof of ethmoid sinus and orbital plate of frontal bone to the occipital bone. The sphenoid ridge demarcates the anterior cranial fossa from the middle cranial fossa while the petrous portion of the temporal bone is the demarcation between the middle and posterior cranial fossa. Multiple foramina situated on the bones of the skull base transmit vital neurovascular structures especially the twelve cranial nerves, vertebralbasilar and internal carotid arterial blood supply to the brain as well as venous drainage out of the cranial cavity. It is therefore not surprising that tumors situated on the skull base will most likely affect these structures singly or in multiples depending on the location. Common tumors found on the skull base include meningiomas, esthesioneuroblastomas, nasopharyngeal carcinomas, pituitary adenomas, craniopharyngiomas, schwannomas, epidermoid tumors, chordomas, chondrosarcomas and metastases [2]. A sound knowledge of the location and passage of these neurovascular structures provides a guide to the clinical localization of these skull base lesions. The presentation of patients with diseases of the skull base is highly variable because of compartmentalization in to three anatomically distinct sections. The symptoms are therefore specific to the compartment involved but a few are non-specific. As a rough guide, tumors of the anterior compartment may produce headache, anosmia, sinus congestion, or visual disturbances whereas, tumors of the middle compartment may produce derangements of endocrine function or visual changes and headaches and tumors of the posterior compartment produce neck pain, headaches, dizziness, tinnitus, hearing loss, gait imbalance, incoordination, and difficulties with swallowing and talking.

Over the last two decades, the treatment of skull base tumors has evolved from simple observation, to various surgical resection approaches and adjuvant therapies with variable clinical outcomes [1]. It is worth noting that the choice surgical approach is dictated by the compartmentalization of the lesion on the skull base. For example, a subfrontal approach is logical for an olfactory groove meningioma, pterional approach for sellar/parasellar lesions while retrosigmoid approach is appropriate for a lesion situated on the cerebellopontine angle (posterior fossa). Adjuvant treatments are also dictated by extent of tumor resection and histological analysis. These lesions are indeed rare but of an increasing concern and challenge in our emerging practice due to reasons peculiar to our environment including but not limited to socio-economic realities. Adeleye et al. [3] previously reported similar constraints with skull base surgery in this environment. Late presentation with mean symptom duration of 22 months and a corresponding poor clinical status was observed in more than 60% of the patients they studied. The experience gathered

from our initial cases especially the diagnostic and management challenges are worth sharing in this article.

## Aims and Objectives

Aims of this study was therefore to evaluate the emerging pattern, challenges of treatments and the outcome of surgical intervention for skull base tumors in National Hospital Abuja.

## Methods

Ethical approval was sought for and obtained from National Hospital Abuja Institutional Review Board to conduct a retrospective review of case notes from July 2013 to August 2018. Only patients who had surgery for skull base tumors excluding pituitary tumors were selected for this study. The parameters studied were clinical presentation, radiological diagnosis (CT and MRI), surgical approaches, and complications of surgery, histological pattern and outcome of surgery over a follow up period of at least one year. Data were assembled on a spreadsheet and analyzed with simple descriptive statistics and presented in tables.

## Results

Only 14 out of a total presenting 37 (37.8%) cases underwent surgical treatment and are hereby analyzed. The rest are accounted for in Table 1. Age range (26 to 67 years). Mean age was 45 years. M:F = 3:4. Common presenting symptoms (Table 2) were headache 9 (64.2%), seizures and visual impairment 7 (50%) each and anosmia 6 (42.8%). Other documented presenting symptoms were cognitive decline and proptosis (14.2%), sensorineural hearing loss, Gait anomaly and Dysphasia (7.1%). Average duration of symptoms before presentation was 20.7 months (Range one month to 60 months). Central Visual Field (CVF) assessment confirmed unilateral blindness in 4/14 (28%); bilateral blindness in 3/14 (21.5%) while 50% had normal vision (Table 3). Neuroimaging (CT/MRI) in Table 4 confirmed diagnosis of medial third sphenoid wing meningioma

**Table 1:** Presenting symptoms.

Presenting symptom	Frequency	Percentage
Headache	9	64
Seizure	7	50
Visual Impairment	7	50
Memory/cognitive decline	2	14.2
Personality changes	2	14.2
Proptosis	2	14.2
Ageusia	1	7.1
Hearing loss	1	7.1
Gait/Imbalance	1	7.1
Dysphasia	1	7.1

**Table 2:** Disposition of Patients presenting with Skull Base Tumors during the study period.

Patient Grouping	Freq	Percentage
Consented for operation and able to bear cost of treatments	14	37.8
Consented for operation but unable to bear cost of treatment. Then lost to follow up	11	29.7
Sought and obtained referral for treatment elsewhere including abroad	7	18.9
Out rightly rejected surgical treatment in preference to traditional/faith healing centers	5	13.5
Total	37	100%

**Table 3:** CVF Assessment.

Visual Impairment	Frequency	Percentage
Unilateral Blindness	4	28.5
Bilateral Blindness	3	21.5
Normal	7	50

**Table 4:** Neuroimaging/Pre-op Diagnosis.

Pre-op Diagnosis	Frequency	Percentage
Medial third sphenoid wing meningioma involving ICA and II	3	21.4
Lateral third sphenoid wing meningioma (no ICA and II involvement)	4	28.5
Olfactory Groove Meningioma	6	42.8
Cerebello-Pontine angle tumor	1	7.1
Total	14	100

**Table 5:** Surgical Approach.

Surgical Approach	Frequency	Percentage
Pterional Craniotomy	7	50
Subfrontal Craniotomy	6	42
Retrosigmoid Craniotomy	1	7.1
Total	14	100

**Table 6:** Reasons for incomplete Resection of tumor.

Encasement of neurovascular structures (ICA/optic nerve)	3	75%
Torrential bleeding from vascular tumor bed	1	25%
Total	4	100%

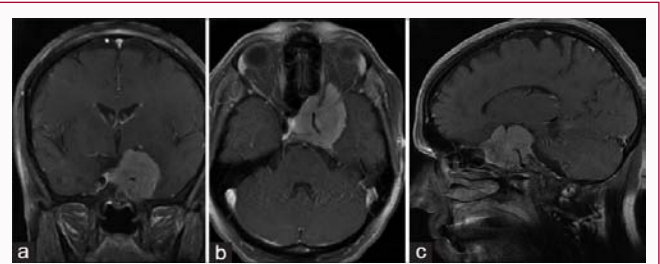
**Table 7:** Significant Intra-op complications.

Major vascular injury with frontal lobe infarction/edema	1	50%
Massive bleeding from highly vascularized tumor bed	1	50%
Total	2	100%

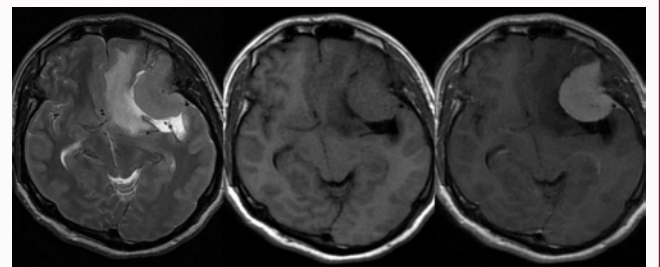
**Table 8:** Histology Report.

Histology Report	Frequency	Percentage
Meningothelial with Psammomatous bodies	12	85.7
Angiomatous Meningioma	1	7.1
Hemangiopericytoma	1	7.1
Total	14	100

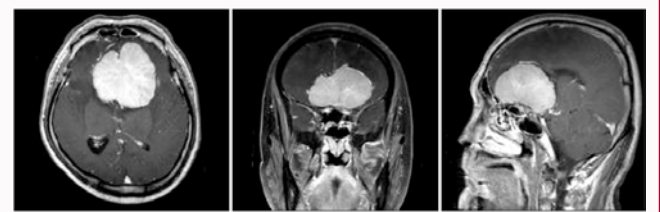
with involvement of the internal carotid artery and optic nerve in 3 (21.4%), lateral two third sphenoid wing meningioma with no neurovascular involvement 4 (28.5%), olfactory groove meningioma in 6 (42.8%) and CP angle tumor in 1 (7.1%). Operative intervention was pterional craniotomy for excision of sphenoid wing meningioma, sub-frontal approach for olfactory groove meningioma and retrosigmoid craniotomy for CP angle tumor (Table 5). Complete tumor resection was achieved in 10 (71.4%). Of the 4 cases with incomplete resection, primary hemorrhage from a very vascular tumor bed was responsible for incomplete resection in 1 (25%) while encasement of internal carotid artery and optic nerve was responsible for incomplete resection (Grade 4) in 3 (75%) in Table 6. The most dreaded intra-operative complication were major vascular injury with a resultant bilateral frontal lobe infarction/edema in one case and massive primary hemorrhage from a very vascular tumor bed in another case (Table 7). Most important immediate post-op complication was tension pneumo-cephalous, malignant brain edema/herniation and CSF leak in 1 (7%) each. Mortality was 1 (7%). Anosmia and visual



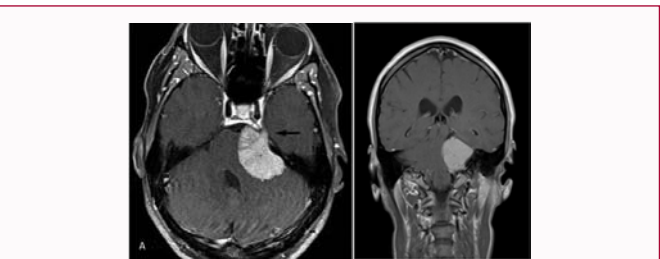
**Figure 1:** T2, T1 and Gad + MRI of Medial third sphenoid wing meningiomas.



**Figure 2:** Gad + MRI of Lateral third sphenoid wing meningiomas.



**Figure 3:** T1 Gad+ MRI of olfactory groove meningiomas.



**Figure 4:** Gad+ MRI of Left CP angle meningioma.

loss did not reverse but headache and seizures subsided in 11 (84.6%) survivors. Delayed post-operative complications were recurrent seizures, communicating hydrocephalus and gait disturbance in 1 (7.6%) survivors. Commonest histopathology (Table 8) picture was meningothelial tissue with psammomatous bodies, WHO I in 12/14 (85.7%). Check neuroimaging at three and twelve months revealed no residual tumor in 9 (69.2%) but significant residual in 4/13 (30.7%). These were the same patients who ab initio had incomplete resection). No further treatments were required in 9/13 (69.2%) while gamma knife referral was made in 3/13 (23.1%) and re-do operation in 1/13 (7.6%).

## Discussion

As depicted in Table 2, only 14 (37.8%) of all eligible cases underwent operation for their skull base tumor and thus were sampled for this study during the period under review. The reasons for non-compliance highlighted financial constraints, preference

for unconventional treatment options and seeking help elsewhere. These constitute a significant challenge which bothers on increasing the numbers for development of skull base practice and training in this environment. It is rather sad to note that a sizeable number were denied treatment due to lack of any insurance in place to cater for them. This may have contributed to seeking less conventional, alternative treatment options and loss to follow up. It is also important to note that some of the patients who sought referral elsewhere including abroad may have done so because they were not convinced of the local expertise based on the available statistics.

For the 14 cases who consented and were treated, the mean age was 45 years (range 26-67 years) with female preponderance of 57%. This pattern is similar to another study which recorded a mean age of 55 years but a much higher female preponderance (80.7%) [4]. It is not clear why meningiomas are commoner in the female sex but perhaps female sex hormones such as estrogens play an important role.

The clinical presentation (Table 2) of skull base tumors varies greatly depending on the compartmentalization and biological behavior. There are general symptoms of raised ICP such as headache which was the commonest at presentation. But the specific symptoms are more helpful in localizing the tumor. For example, anosmia was recorded in all the cases olfactory groove meningioma, unilateral visual field loss was recorded in all three cases of medial sphenoid wing meningiomas due to encasement of the optic nerve. It is also important to note that bilateral visual failure may have also resulted from prolonged hydrocephalus and raised ICP associated with the long-standing tumor in view of the often-late presentation. Proptosis was recorded in sphenoid wing meningioma due to extension into the orbital wing by the tumor itself or associated bony hyperostosis of the surrounding posterior and lateral orbital wall. Hearing impairment and balance/gait abnormalities were more associated with the CPA angle tumor which may have compromised the eighth cranial nerve responsible for hearing and balance. It was rather worrisome that the average time to presentation was 20.7 months (range from one month to 60 months from onset of symptoms) from the perceived time of onset. Living in false denial, prolonged interphase with faith healers/fake prophets/self-acclaimed miracle workers, delays at referral hospitals due to poor diagnostic capacity, high cost of treatment in the absence of any decent health insurance scheme were factors that were identified to be particularly responsible for late presentation. Consequently, some patients return only at advanced stages of the disease and therefore render complete cure difficult if not impossible.

Radiological evaluation confirmed that 50% (7/14) of tumors were sphenoid wing meningiomas. Sphenoid wing meningiomas account for approximately 20% of supratentorial meningiomas [5]. Three of the seven (Sphenoid Wing Meningiomas) SWM (42.8%) were situated on the medial third of the sphenoid wing and caused encasement and compression of the optic nerve as well as the supraclinoid portion of the internal carotid artery (Figure 1). The classical triads of SWM have been long recognized to include proptosis, visual impairment and ocular paresis [6]. But this will only be found in medial third tumors sufficiently large to encase the optic nerve and extend into the orbital cavity and cavernous sinus to involve relevant structures. Those were the cases that presented with visual impairment and proptosis in addition to other features of raised ICP. The rest were SWM situated on the lateral third of the sphenoid wing (Figure 2). They all had seizures due to pressure and irritation of the adjacent

temporal and frontal lobes. The pressure is as a result of the often-large size of the tumor due to late presentation and also complicated by peri-tumoral vasogenic edema which is often extensive into the temporal and frontal lobes. This mass effect and vasogenic edema may also explain the personality changes and memory impairments observed in some patients considering the regional anatomic roles of both temporal and frontal lobes in cognition, memory and other higher mental functions. Olfactory groove meningiomas (Figure 3) were the next commonest tumors recorded in this series comprising 6/14 (42.8%). They arise over the cribriform plate and fronto-sphenoid suture and comprise approximately 10% of intracranial meningiomas [7]. All six patients had anosmia although that was not their initial presenting complaint but was extracted in retrospect during the course of clinical evaluation. Most patients are often not aware loss of sense of smell until specific enquiry is made or specific tests performed. Anosmia being reported in hindsight by a significant number of patients with olfactory groove meningioma and not usually a common primary complaint has been previously documented [8]. It is also important to note that olfactory groove meningiomas often present late with apathy, sporadic seizure and personality changes noticed by close relations. This is because the tumor grows very slowly and often attains large size before features of raised ICP such as headache appear [9]. The reasons for late presentation have been enumerated earlier. Apathy and personality changes are features of frontal lobe dysfunction. OGMs typically originate from the midline but as they grow in size, they have a tendency to deviate to one side and compress the undersurface of the adjacent frontal lobe and also the optic nerve and chiasm from on top causing visual impairment. It has been noted to cause Foster-Kennedy syndrome of unilateral optic atrophy and contralateral papilledema in a small fraction of cases [8] but this was not observed in this study. Only one case of Cerebello-Pontine Angle (CPA) tumor was found in this study (Figure 4). It was avidly contrast enhancing with a dural tail and did not particularly have any impressive relationship with the internal acoustic meatus. These features were in keeping with meningioma. One of every 10 intracranial tumors originates in the Cerebello Pontine Angle (CPA), most of which are schwannomas and meningiomas. Distinguishing them has clear prognostic and surgical considerations. Involvement of the Internal Acoustic Canal (IAC), jugular foramen, bony structures, Cranial Nerve (CN), brainstem invasion are important treatment considerations in this location. Preservation of all the neural and vascular structures is usually the goal. As observed in this study, hearing impairment, and gait imbalance suggest pressure on the vestibulocochlear and perhaps the cerebellum and brain stem. Swallowing difficulties suggest vagal and glossopharyngeal nerve compromise

Neuroimaging modalities that were deployed in all cases to achieve the above diagnosis were CT and MRI. CT scan details the osseous anatomy, including areas of hyperostosis. Meningiomas typically appear hyperdense relative to the brain parenchyma and enhance avidly after administration of contrast. Paranasal sinus extension through the skull base is well demonstrated on CT scans, particularly on coronal views. It is the imaging of choice in studying skull base involvement. CT angiography was particularly useful in cases of possible neurovascular encasement such as the medial third sphenoid wing meningioma. It helped to delineate the extent of encasement of the neurovascular structures especially the internal carotid artery and its branches as well as the cavernous sinus by the tumor. Digital subtraction angiography was not available for



advanced neurovascular studies in terms of delineating the core feeder vessels for pre-op embolization when considered appropriate. This was another challenge with skull base surgery in this emerging center. Both MR imaging and MR angiography also defines with high clarity the relationship of the tumor with the neurovascular structures but is particularly poor with the osseous anatomy of the skull base. Meningiomas commonly appear isointense to gray matter on T1-weighted sequences and iso- or hyperintense on T2-weighted sequences. Avid enhancement associated with a dural tail after administration of Gadolinium is also seen due to high vascularity [10].

The high cost of these essential neurodiagnostic services where available in relation to the patients often abysmally low socioeconomic status makes diagnosis and treatment difficult and this constitutes another challenge in this emerging practice. This is because some patients who could potentially benefit are either denied treatment early or completely.

Because of their size, mass effect and associated neurological deficits, surgical treatment was the preferred choice. Operative approach was pterional craniotomy for sphenoid wing meningioma, sub-frontal approach for olfactory groove meningioma and retrosigmoid approach for CP angle tumor. Detailing the microsurgical anatomy of these skull base approaches is beyond the focus of this article but an overview was already outlined in the introductory section. Although not usually feasible, the aim of management is complete excision at all times. For cases in which complete resection poses a great risk of injury to neurovascular structures, the goal changes to maximum safe removal of the tumor [11]. Complete tumor resection was achieved in 10/14 (71.4%). 3/4 (75%) cases of incomplete resection were medially located sphenoid wing meningiomas with high risk neurovascular structures close by. The other was the CP angle tumor which not only exhibited torrential hemorrhage; it distorted the lower cranial nerve anatomy and also encased the blood vessels normally found in the CP angle to preclude further dissection. It has been reported though those skull base meningiomas are often believed to have a higher rate of recurrence due to often associated incomplete resection [12]. But it is definitely better to achieve partial tumor removal than to cause irreversible damage to the patient.

In this study, a check contrast enhanced MRI at three months and one-year follow-up confirmed residual tumor in four cases out of the 13 survivors. In view of the high tendency to tumor progression, there was an absolute need for further treatments. Whereas one of the four were suitable for further surgery, three were safer with radiosurgery referral. The extent of tumor resection has often been used as a predictor of recurrence and the location of the meningioma influences the extent of resection [12]. In 1957, Simpson observed that the recurrence of meningiomas correlated well with the extent of tumor removal (Simpson's grade) [12]. The recurrence rates were 8% for grade I, 16% for grade II, 29% for grade III, and 42% for grade IV. Since Simpson's study, various others have confirmed that the extent of surgical resection has strong prognostic influence on local recurrence [13]. For the nine cases who achieved complete resection (Simpson Grade 1 resection), there has not been any recorded recurrence at 12 months follow up. All six olfactory groove meningiomas were completely resected in this series. This is in keeping with findings elsewhere in which despite often large size, all olfactory groove meningioma was completely resected [14]. This is partly due to the fact that the arachnoid membrane separates these lesions from nearly

all the vital neurovascular structures especially the internal carotid artery, anterior cerebral arteries, optic nerves and chiasma and thus provides a clear demarcation zone for safe dissection.

Most important immediate post op complication was tension pneumocephalus, malignant brain edema/herniation and CSF leak in 1/14 (7%) each. Pneumocephalus complicating craniotomy is often reported as benign [15]. But in the unusual case reported, it rather presented with features of worsening headache, deterioration in consciousness and an episode of seizure four days post-surgery after initial recovery. A check CT brain confirmed tension Pneumocephalus with Mount Fuji sign. Surgical treatments including emergency needle aspiration, drilling of burr holes, craniotomy etc have all been described, a rather simpler measure using face mask to deliver normobaric hyperoxia with 100% inspired oxygen facilitated minimally invasive resorption of pneumocephalus [16]. In combination with anti-seizure medications, patient remained stable and a further check CT brain two weeks later showed a near complete resolution of the pneumocephalus. Cerebrospinal Fluid (CSF) leaks are well-known and complications of intracranial procedures with a reported incidence of 7.7% [17]. And despite the number of techniques and developments for dural closure, the problem of CSF leaks remains evident. Several complicated methods of dural repair have been described including the use of dural substitutes and sealants. In our environment these agents are either difficult to source or exorbitant. Fortunately, the index case responded to simple continuous lumbar drain and the fistula was observed to be closed in five days.

Clearly the commonest histopathology finding in this study was meningothelial tissue with psammomatous bodies, WHO Grade I in 12/14 (85.7%) and one cases each (7%) of angiomatous meningioma WHO II and hemangiopericytoma. It is not surprising the finding above because it was already an established fact that intracranial meningiomas constitute 15% to 20% of primary brain tumors [18]. And of these, 20% to 30% are situated on the skull base [19]. The obvious limitation of this study is that the numbers are really small and does not reflect the whole spectrum of skull base tumors. However, it probably displays the commonest ones in our environment and is a step towards building our local data base and patterns. Perhaps when the numbers increase, we will begin to see others in a changing pattern but meningiomas will probably continue to feature prominently.

Aside clinical and radiological surveillance, no further treatments were required in 9/13 (69.2%) who did not display any residual or recurrent tumors at three and twelve-months check scans.

But for the 4/13 (30.7%) with significant residual tumors ab initio following incomplete resection, gamma knife referral was considered more appropriate in 3/13 (23%) but a re-do operation in 1/13 (7.6%). The aim at all times has been to safely remove as much of the tumor as possible but when complete resection is not possible or safe, radiation therapy is indicated [20]. It is important to reemphasize that it is better to live with some residual tumor on the skull base than to suffer unacceptable complications including death from an overzealous attempt to achieve complete resection.

## Conclusion

Although the numbers are really small, and cannot represent the known spectrum of skull base tumors, working through the challenges enumerated in the above account constitute a major constraint in the development of a skull base practice in this environment. In particular

is the financial constraint in the absence of any organized health insurance policy. This puts a major strain on timely application of modern diagnostic scans and treatment. Consequently, patients who should potentially benefit from early treatment are forced to present late or seek alternative options in faith healing centers amongst others with disastrous consequences. A fraction of the few who can afford treatment locally are constrained to seek help elsewhere especially abroad on the premises that not enough numbers have been achieved locally to guarantee adequate experience and expertise. However, in spite of the myriad of challenges enumerated above and many more, continuous advocacy is in place to improve early presentation and provide subsidy in the overall cost of treatment in order to improve the numbers and generate the much-desired flow. This will hopefully increase local expertise for efficient services, research and training. From the much we have done so far, we found that meningioma located on the sphenoid wing and olfactory groove were the commonest. It was also observed that late presentation in this environment often renders complete resection often not feasible for obvious reasons. Furthermore, even when resection becomes feasible, it did not necessarily translate to automatic reversal of already established neurological deficits. However, up to 80% recorded some symptomatic relief. Therefore, we will continue to advocate for early surgery for skull base tumors.

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