“RETROSPECTIVE STUDY OF OUTCOME OF PATIENTS WITH TENTORIAL MENINGIOMA FOLLOWING MICROSURGICAL RESECTION”

THESIS

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CERTIFICATE

This is to certify that the work incorporated in this thesis titled

" RETROSPECTIVE STUDY OF OUTCOME OF PATIENTS WITH TENTORIAL MENINGIOMA FOLLOWING MICROSURGICAL RESECTION"

for the degree of

M.Ch NEUROSURGERY

has been carried out by DR. GOGRAJ GARHWAL

under my supervision and guidance. The work done in connection with this thesis has been carried out by the candidate himself and is genuine.

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DECLARATION

I hereby declare that this thesis titled ***"Retrospective study of outcome of patients with tentorial meningioma following microsurgical resection"*** is a consolidated report based on a bonafide study during the period 1st January 2003 to 31st December 2017 has been prepared by me under the supervision and guidance of Prof. Mathew Abraham, Prof. and Head, Department of Neurosurgery, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram.

The thesis is submitted to SCTIMST in a partial fulfilment of rules and regulations of M.Ch Neurosurgery examination.

Gograj

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ABBREVIATIONS

TM/TMs	:-	TENTORIAL MENINGIOMA/TENTORIAL MENINGIOMAS
PFM/PFMs	:-	POSTERIOR FOSSA MENINGIOMA/MENINGIOMAS
GOS	:-	GLASGOW OUTCOME SCALE
GCS	:-	GLASGOW COMA SCALE
CSF	:-	CEREBRO-SPINAL FLUID
ICU	:-	INTENSIVE CARE UNIT
CPA	:-	CEREBELLO-PONTINE ANGLE
TF	:-	TENTORIAL FOLD
TFM	:-	TENTORIAL FOLD MENINGIOMA
IAC	:-	INTERNAL AUDITORY CANAL
RMSO	:-	RETROMASTOID SUBOCCIPITAL
MLSO	:-	MIDLINE SUBOCCIPITAL
DVT	:-	DEEP VEIN THROMBOSIS
ETV	:-	ENDOSCOPIC THIRD VENTRICULOSTOMY
VP-SHUNT	:-	VENTRICULOPERITONEAL SHUNT
EVD	:-	EXTERNAL VENTRICULAR DRAINAGE
SSS	:-	SUPERIOR SAGITTAL SINUS

TABLE CONTENTS

INTRODUCTION

INTRODUCTION

Meningiomas are encapsulated and benign tumors with limited numbers of genetic aberrations and their intracranial location and relation to adjacent structures often leads to serious and potentially lethal consequences. The tentorial meningiomas are rare intracranial tumor that very commonly tend to enclose, displace, or compress the adjacent neurovascular structures so surgical excision is a challenge(1). Meningioma account for 33.8% of all primary brain(2). The frequency of meningiomas at different intracranial locations varies from study to study. According to some studies, posterior fossa meningiomas represent 6-15%, cerebellar convexity meningiomas account for approximately 5%, cerebellopontine angle meningiomas for 2- 4%, clivus less than 1% from all intracranial meningiomas(3). Tentorial meningiomas [TM] account around 3–6% of all intracranial meningiomas(4).

The PFM as present with different signs and symptoms and these are depends on location of tumour in posterior fossa. Anatomy of posterior fossa and relationship of posterior fossa neurovascular structures to each other is very complex so surgical management of these meningiomas can be difficult.

The surgical approaches to these tumours depend on location, size, presentation and relationship to adjacent neurovascular structures. There is very high risk of injury to neurovascular structures like cranial nerve, brain-stem and sinuses during surgery so appropriate pre-surgical work-up and decision regarding surgical approach is very crucial.

Post-operatively patient may have neurological deficit which may need long-term supportive care and rehabilitation.

AIMS AND OBJECTIVE

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To study the

- Clinical profile
- Imaging features
- Intra-operative findings
- Post-operative outcome in patients who underwent surgery for tentorial meningioma with follow up of minimum period of 3 months.
- Many patient who undergo neurosurgical procedures, develop postoperative complications and requires long term follow up or re-operation. There are various studies comparing different approaches for different locations of tentorial meningiomas.

MATERIALS AND METHODS

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Study design and patients:-

Present study is a retrospective analysis of patients who underwent surgery for tentorial meningioma. The study recruited subjects who were admitted with diagnosis of tentorial meningioma between the period of 1st January 2003 to 31st December 2017 which are counted backward, at Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum. This study compromised of 102 cases which are counted backward, whose diagnostic preoperative data were retrieved from our data base system for detailed review.

The primary outcome studied was functional and neurological status achieved at discharge and at minimum 3 months. This was measured using Glasgow coma score (GOS).

Inclusion criteria:

- Recordable radiological attachment of tentorial meningioma (Partial or complete)
- Either gender
- No previous surgery for intracranial meningioma
- Single meningioma

Exclusion criteria:

- Patient with inadequate data
- Patient who underwent previous surgery for intracranial meningioma and stereotactic
- Radiosurgery or stereotactic radiosurgery.
- Multiple meningiomas
- Subjects who don't have follow up for minimum period of 3 months
- Pregnant and nursing mothers
- Poor image quality
- No gender, class, caste, ethnic or racial considerations will be used as inclusion or exclusion criteria.

Study Analysis:-

A. GENERAL INFORMATION

- Anonymized Patient ID;
- Age
- Gender
- Family history/Neurofibromatosis

B.CLINICAL DETAILS

- GCS on admission

- Hydrocephalus
- Size of meningioma
- Extent of meningioma
- Cranial nerve involvement
- Time since diagnosis
- Classification: Yaşargil's classification
- Radiological investigations

C. INTRAOPERATIVE EVENTS

- Intra-operative extent
- Calcification
- Hyperostosis
- Vascularity
- Consistency
- Cranial nerve involvement
- Sinuses involvement
- Duration of surgery
- Blood loss

D. POST-OPERATIVE EVENTS

- Infection
- CSF leak
- Pseudomeningocele
- Cranial nerve involvement
- Re-exploration / Decompression
- Duration of the ventilator support
- Duration of ICU stay
- Duration of post-op hospital stay

E. STATUS ON DISCHARGE

- GOS
- Motor and speech status
- Any other deficit

F. STATUS ON FOLLOW UP ON 3 MONTHS

- GOS
- Motor and speech status

- Any other deficit
- Radiological follow up

Statistical analysis: -

Pre-operative, intra operative variables in all patients and post-operative and follow up variables in all operatd cases were evaluated. For analysis of paired nominal variables, McNemar Test, pearson Chi-square test were used. A p value of 0.05 or less was considered statistically significant. All statistical calculations were made with widely available SPSS software (SPSS 22.0).

REVIEW OF LITERATURES

REVIEW OF LITERATURES

Nomenclature and History:-

Dr. Platter in 1614 described the first case of meningioma. He described the tumour as a round, fleshy mass shaped like an acorn and as large as a medium-sized apple, and full of holes. The tumour was covered with its own membrane, had no connection with the matters of the brain, and left behind a cavity after removal. This first clear description of an intracranial tumour is most consistent with encapsulated meningioma(5). The succeeding scholar, Harvey Cushing, coined the term "meningioma" for this tumour.

Cushing clarifies his reasoning in the following comments on tumour designation:-Their cellular composition being in dispute, an "histogenic name" was likely to be misleading; a simple "place-name" comparable to acoustic tumour, was inadequate since the tumours were widely distributed and took their origin from the leptomeninges almost anywhere; a "tissue-name" was therefore sought which, like osteoma, myoma and lipoma, would at least give an unmistakable connotation. *Mesothelioma* was discarded as requiring explanation, *meningothelioma* and *leptomeningioma* as being needlessly cumbersome. Since primary tumours indubitably of pachymeningeal origin and leptomeningeal tumours other than those under consideration are so rare as to cause little if any confusion, the simple and non-committal designation *Meningioma* as a catchword was thought to be suitable and all-embracing.

In 1922 Cushing wrote: “There is today nothing in the whole realm of surgery more gratifying than the successful removal of a meningioma with subsequent perfect functional recovery.”

Cell of origion:-

Harvey Cushing considered that meningeal tumours arose from arachnoidal cap cells. Seven years later, Cushing proposed the term ‘meningioma’ for these tumours and the term achieved global acceptance.

Integrative data from electron microscopy and immunophenotypic studies in normal arachnoid and meningiomas suggest that arachnoidal cap cells are likely to be the precursor cells of meningioma(6).

Etiology:-

Molecular etiology:-

Meningioma cells exhibit a striking similarity to arachnoid cap cells, which are the likely tumour cell of origin. Despite the fact that meningioma has a benign pathophysiology in 95% of cases, like carcinoma it always results from a clonal outgrowth derived from a single cell as exemplified by cytogenetic and array-comparative genomic hybridization (array-CGH) studies(7). Sporadic meningiomas are typically associated with one or more focal chromosomal deletion(s), and atypical and malignant grades tend to have multiple chromosomal copy number alterations consistent with the acquisition of ‘‘mutator’’ mutations which foster genomic instability(8). Deletion and inactivation of NF2 on chromosome 22 is a predominant feature in sporadic meningiomas, and biallelic deletions are common(7). Meningiomas are reported in families of several cancer predisposition syndromes

including those involving the genes NF1, PTCH, CREBBP, VHL, PTEN, and CDKN2A(9).

Risk factor:-

Ionizing Radiations:-

The primary environmental risk factor identified for meningioma is exposure to ionizing radiation with risks from six fold to tenfold reported(10). At high dose levels, data exist for atomic bomb survivors showing a greatly increased risk for meningioma(11). Evidence also exists for lower dose levels. In one of the most well-known studies of ionizing radiation and meningioma risk, children who were given radiation therapy for scalp ringworm in Israel between 1948 and 1960 (the Tinea Capitis Cohort), were observed to have a relative risk of almost 10 for meningioma(12). A number of studies have linked the number of full-mouth dental radiographs to risk of meningioma(13).

Hormones:-

An association between hormones and meningioma risk has been suggested by a number of findings including the increased incidence of post-pubertal disease in women versus men (2:1) with the highest ratio of 3.15:1 during the peak reproductive years, the presence of estrogen, progesterone, and androgen receptors on some meningiomas, an association between breast cancer and meningiomas indications that meningiomas change in size during the luteal phase of the menstrual cycle and pregnancy(14). The study by Vadivelu et al showing regression of multiple meningiomas in a patient following cessation of estrogen agonist therapy(15). Hsu et al. concluded that the presence of nuclear PRs, even in a small portion of tumour

cells, provides a favourable prognosis for patients with meningiomas, and that the PR status is highly inversely correlated with tumour grade and mitotic index but presence of a very small number of ER-containing cells in a few tumours is of no prognostic significance so PR status may be a useful prognostic tool and that it may also play a role in the medical management of these patients(16).

Head trauma:-

Head trauma has been suggested as a risk factor for meningioma since the time of Harvey Cushing, although the results across studies are not consistent.

A population-based case control study by Phillips LE et al. showing an increased risk of meningioma associated with head trauma for both males and females(17). But study by Annegers et al. showing no such association(18). So association of head trauma and meningioma may be an example of detection bias.

Breast cancer:-

Bethke L et. al provided evidence for "common-disease common-variant" model of development of meningioma and an association between breast cancer and meningioma. A number of explanations have been proposed for this association including the presence of common risk factors such as endogenous and exogenous hormones as well as shared genetic predisposition, including variants in DNA repair polymorphisms(19). Custer et al. suggested that the risk of meningioma among women who have experienced breast carcinoma and the risk of breast carcinoma among women who have experienced meningioma are elevated moderately and concluded that shared risk factors may account for the relatively week bidirectional associations(20).

Family history:-

Malmer et al. examined cancer risk in first degree relatives of brain tumour patients in Sweden and reported a two fold increase in meningioma risk to first degree relatives of affected individuals(21). A study by Hemminki et al. using data from the Swedish and Norweigian Registry Databases, reveal an increased risk with increasing numbers of affected first degree relatives with persons having one or two first degree family members with meningioma(22).

A study by Shen et al. concluded that differential diagnosis of multiple meningiomas, distinguishing sporadic and familial forms, with potential clinical implications for the risk of meningioma occurrence in other members of the family(8).

Occupation/diet/allergy:-

An international case/control study by Terry et al. found no association between diet and meningioma(23). Schlehofer et al. also found no association was apparent for meningioma(24).

Viruses:-

A study by Weiss et al. showing two out of seven meningiomas tested in early cell cultures by indirect immunofluorescence staining showed simian virus 40 (SV40)-related tumour (T) antigen. In one tumour 90% of the cells were positive. An additional SV40-related antigen (U) was found in 10% of cells of a third tumour. These findings indicate that the meningioma cells showing a positive reaction are transformed by a papova virus that has at least partly the same antigenic properties as SV40 virus(25). A study by Inoue et al. in which Inoue-Melnick virus (IMV) was

isolated from six of seven human meningioma derived cell cultures while the virus was not isolated from six other brain tumour cell culture. Sera of 145 consecutive neurosurgical inpatients were tested for IMV-neutralizing antibody. Of 26 patients with meningioma, 22 were positive for IMV antibody (84.6%). Of the remaining 119 patients, 16 were positive(26).

Mobile phone use:-

A study Lonn et al. which included 371 (74%) glioma and 273 (85%) meningioma cases and 674 (71%) controls. This study included long-term mobile phone users, and concluded that the data do not support the hypothesis that mobile phone use is related to an increased risk of glioma or meningioma(27). Lahkola et al. also found no association between mobile phone use and risk of meningioma(28).

Classification of posterior fossa meningioma:-

The posterior cranial fossa contains the most complex intracranial anatomy. Initially the lesions in posterior fossa were considered as inoperable but in advancement in imaging, microsurgical techniques and anaesthesia these tumour are now amenable to excision. Meningiomas of this region are surgically complex entities because of their intricate relationship to surrounding neurovascular structures. With improvement in neuroimaging, microsurgical, and neuroanaesthetic techniques, there has been a steady improvement in the results(29). As the aim of surgery of these tumours is maximum and safe excision so to improve surgical outcome of these tumours are classified according to their origin or dural attachment. There are different classifications given for PFMs which are based on location and are very helpful regarding decision for surgical approach. Preoperative evaluation with imagimg is helpful to delineate the location of tumour, relationship with adjacent

neurovascular structures and surgical approach. Appropriate surgical approach for these tumours depend on location and relation with surrounding neurovascular structures like, cranial nerve, brain-stem and venous sinuses.The deep location of these tumours and their close proximity to eloquent neurovascular structures lead to great increase in risks of surgical treatment and it may cause significant morbidity and mortality.

The rationale behind treatment of any meningioma is: to relieve the patient's symptoms and to prevent the adverse consequences of tumour growth. Once the decision is made to operate, the goal of PFM surgery varies with the extent and size of the tumour. With small to moderate sized tumours or those located peripherally at the cerebellar convexity or tentorial edge without sinus involvement, the goal is usually complete removal, whereas with large tumours this goal is much more difficult to achieve, particularly with those tumours that extend in front of the brain stem or have significant involvement of the skull base and venous sinuses. In these tumours, a subtotal resection can be achieved. The decision process following surgery includes the options of radiotherapy or careful observation, with further surgery and/or radiotherapy at the time of progression/recurrence(30).

The first record of a PFM was by Andral in 1833, who incidentally discovered a tumour perforating the tentorium(31). While PFMs have been classified by different authorities in from two to five major groups, Cushing and Eisenhardt, in 1938, proposed the first classification of PFMs(32). Castellano and Ruggiero classified in five class, based on the site of dural origin or attachment(33).

Table 1. The posterior fossa meningiomas arise in the following sites (Castellano and Ruggiero classification):-

Class	Site of dural origin or attachment
Class I	Cerebellar convexity
Class II	Tentorium cerebelli
Class III	Posterior surface of the petrous portion of the temporal bone (meningiomas of the CPA)
Class IV	Clivus
Class V	Foramen magnum

Table 2. Sekhar et al. classified in six groups, according to their dural attachment(34)**:-**

Type	Dural attachment
Type I	Cerebellar convexity and lateral tentorial
Type II	lateral petrous ridge and cerebellopontine angle (CPA)
Type III	Jugular foramen
Type IV	Petroclival
Type V	Foramen magnum
Type VI	Unclassified

Table 3. Tentorial meningiomas are classified by Yasargil et al. into five groups(35)**:-**

Group	Location	Site of origin
Group I	Anteromedial	Arising from the apex of the tentorial margin.
Group II	Anterolateral	Arising from the lateral aspect of the tentorial incisural margin.
Group III	Intermediate	Arising from the intermediate aspect of the tentorium remote from the incisura and the dural venous sinuses.
Group IV	Posteromedial	Arising from posteromedial aspect of the tentorium close to straight sinus or venous confluence at the torcula. This group also included the falcotentorial and torcular meningiomas.
Group V	Posterolateral	Arising from the posterolateral aspect of the tentorium close to the sigmoid sinus.

Table 4. Baccui et al. in 2007 classified cerebellopontine angle meningiomas in four types in relation to IAC(36)**.**

Types	Relation to IAC
1	Purely intracanalicular
2	Intracanalicular with CPA extension
3	Intracanalicular with invasion of the surrounding bone
4	Intracanalicular with both CPA extension and invasion of the surrounding bone

Table 5. Hashemi et.al classified the tentorial meningiomas in three types based on the surgical difficulties and on the surgical approaches applied(1)**.**

Type	Origin
I	Dorsal portion of TF
II	Extension into the anterior portion of middle fossa
III	Combination of type I and II

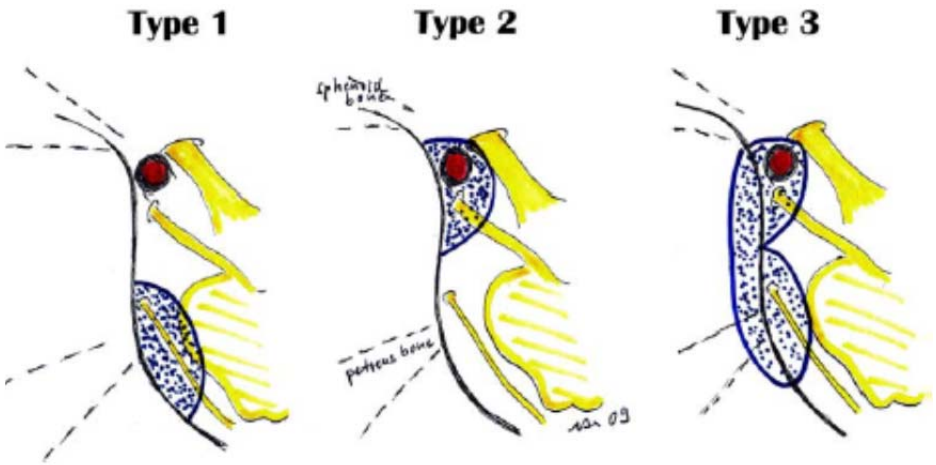


Fig. 1 TFM classification: type I, TF meningiomas with origin in dorsal portion of TF; type II, with extension into the anterior portion of middle fossa; and type III, a combination of type I and II.

Clinical presentation of tentorial meningiomas:-

The Posterior fossa is small space located posterior part of skull accompanying critical neurovascular structures. Any small lesion may cause compression of these neurovascular structures results in devasting or life-threatening for patient. Patient may present with different symptoms and signs according to size and location of tumour and involvement of neurovascular structures. Tentorial

meningioma may present with symptoms and signs due to obstruction of CSF flow resulting hydrocephalus and compression of adjacent structures like cerebellum, brain-stem, cranial nerve and venous sinuses.

TMs can present most commonly with symptoms and signs of intracranial hypertension followed by cerebellar ataxia, long tract signs, and cranial nerve dysfunction. Up to one third of patients may present with chronic hydrocephalus with Hakim-Adam triad (urinary incontinence, gait disturbance and dementia). Hypoacousia is also a common finding, up to 30% of cases, even in cases of tumours remote from the cerebellopontine angle. In these cases, interference with auditory cortical pathways seems to be the most likely cause. Unusual presentations have been reported, such as facial pain, hemifacial spasm, and symptoms related to syringomyelia due to tonsillar herniation(37).

A study by Barrow et al. in 1962 in survey of 24 cases of TM showed supratentorial meningiomas to present with a relatively short period of symptoms suggesting a lateralized cerebral mass lesion. One group of infratentorial tumours gave the picture of obstructive hydrocephalus and had a poor prognosis. Another infratentorial group produced a long history of trigeminal symptoms and demonstrated consistent involvement of the fifth and eighth cranial nerves. They had a better prognosis. A third infratentorial group featured a complex gait disturbance. All the infratentorial tumours presented signs of cerebellar involvement(38). A study by Bassiouni et. al in 2004 found that the main presenting symptoms of the patients (69 women and 12 men) were headache (75%), dizziness (49%), and gait disturbance (46%). The leading neurological signs were gait ataxia (52%) and cranial nerve deficits (28%)(29).

Roberti et. al in 2011 in their 161 cases of PFMs found that head pain (50% of cases) and disturbance of gait (44%) were the most common presenting symptoms, and cranial neuropathies the most common neurological signs on admission(39). Xiu et.al in 2015 in their fourty three cases of tentorial meningioma found that headache (83.7%) was most common symptom followed by vertigo (58.1%), vomiting (41.9%) and blurring of vision (30.2%). Some patients present with the symptoms of seizure, disturbance of consciousness and cranial nerve VII/VIII defect(40). A study by Nanda et.al in 2018 in their fourty one patient found that headache (75.6%) was most common presenting symptom followed by diplopia (17.1%)(41).

Surgical approaches:-

Tentorial meningiomas are classified according to the location and dural attachment. Different surgical approaches are used for safe and maximal surgical excision but due to complex anatomy and their relations to crucial neurovascular structures, surgical excision of TFM is a surgical challenge. According to different locations of TMs different surgical approaches are used to reach the tumour, devascularise and safe surgical excision of tumour but each approach has its own complications.

Table 6. The extent of tumour resection was classified according to the Simpson's grading system for tumour removal(42)**.**

Simpson's Grade	Extend of excision
I	Macroscopically complete removal of the tumour, with excision of its dural attachment, and of any abnormal bone. Where the tumour arises from the wall of a dural venous sinus, such an operation necessarily entails resection of the sinus.
II	Macroscopically complete removal of the tumour and of its visible extensions, with endothermy coagulation (usually to the point of charring) of its dural attachment.
III	Macroscopically complete removal of the intradural tumour, without resection or coagulation of its dural attachment, or alternatively, of its extradural extensions, e.g., an invaded sinus or hyperostotic bone.
IV	Partial removal, leaving intradural tumour in situ.
V	Simple decompression, with or without biopsy.

Occipital trans-tentorial approach:-

This approach was initially described by Horrax and modified by Poppen in 1966 (43) and Jamieson in 1971(44). This procedure may be performed in the sitting the position, the three-quarter prone position is generally preferred, because gravity helps to retract the occipital lobe. The preferred corridor is between the right occipital lobe and falx cerebri and right-sided approach protects the dominant visual cortex from the potential for retraction injury.

The principal anatomic advantage of this approach is that no bridging veins cross from the occipital lobe into the superior sagittal sinus. This fact limits the risk of cortical venous infarction that accompanies the interhemispheric approach as long as the inferior cerebral vein is preserved. Division of the tentorium provides excellent exposure of the collicular plate, thus making the approach well suited for tumours with substantial inferior extension. A potential disadvantage of the approach is that it uses an oblique trajectory for lesions that are essentially midline, creating the potential for the inexperienced surgeon to become disoriented.

Lesions that arise from the posterior leaf of the tela choroidea, the free edge of the tentorium, or the falcotentorial junction displace the galenic system anteriorly or inferiorly and out of the surgeon's view. In this case, the tumour must be internally debulked, knowing that these critical veins are located just beyond the deep capsule. After an adequate decompression is achieved, the tumour capsule may be cautiously dissected and the underlying veins identified. The tumour type, specific location, and degree of invasiveness determine the degree of resection that can be achieved(45).

Subtemporal trans-tentorial approach:-

This procedure was described by Naffziger as a modification of suboccipital exposure for CPA tumour as ideal approach for large tumour but can be used for small tumours. It provides most complete and direct anatomical exposure and allow preservation of neural and otologic structures and facial functions(46).

Retromastoid route:-

The classical retromastoid approach, with unroofing of the transverse and sigmoid sinuses to keep them out of the surgical field and moderate, readily tolerated, cerebellar retraction, affords the simplest access to the region of the CPA. The surgeon must conduct the whole phase of removal through the fissures made by the tentorium and by cranial nerves V, VII-VIII, and IX-XI, all of which may be contused in the process. Supratentorial, subtemporal, and parasellar tumour expansion do not alone disqualify or contraindicate this simple and thoroughly tested approach, which has rewarded many surgeons with excellent results. Access to the area is prepared by the tumor itself, located in the tentorial hiatus, and it can be amplified by resection of the tentorial flap. Thus, even the upper pole of the tumour, if not attached to the parasellar dura, can be dislocated downward and removed by being separated from the arachnoid of the interpeduncular and chiasmatic cisterns. Conventional posterior cranial fossa surgery can be suitable for a select group of petroclival meningioma. Goel et al. mentioned that this approach provides easy and quick exposure of the tumour without any petrous bone drilling and direct and early exposure of the tumour-cranial nerve-brainstem interface facilitating the dissection. The lateral and inferior tumour extensions in relationship to the clivus can be more easily accessed. The site of attachment of the tumour to the dura overlying the posterior face of the petrous apex can be seen directly(47).

Kawase's approach:-

This approach was initially described by Kawase et al. in 1985 for lower basilar artery aneurysm. It is a extradural subtemporal approach to petrous ridge and anterior pyramidal bone removal which give direct access to lower basilar artery.

Advantage of this approach is that there is minimal retraction of temporal lobe and preservation of the temporal bridging veins(48). Later they used this approach for sphenopetroclival meningiomas(49).

Bioccipital-suboccipital approach:-

The patient with a torcular meningioma in which the tumour is surfacing between the angles of the torcula, that is between the cross formed by the SSS, the occipital sinus and bilateral transverse sinuses and margins of the tumour are also attached to the straight sinus this approach is suitable.

Midline supracerebellar infratentorial approach:-

This approach is suitable for infratentorial tumors of the anteromedial, posteromedial groups and the posteromedial group where the tumour extended both supra and infratentorially. After division of bridging cerebellar veins cerebellum will falldown by gravity. The great cerebral vein of Galen and the internal cerebral vein are located superior to the tumour.

Lateral suboccipital infratentorial supracerebellar approach:-

This approach is suitable for infratentorial meningiomas of the intermediate, the posterolateral groups and, posterolateral group in whom the tumour extended both supra and infratentorially where only the infratentorial part was excised. CSF fluid release from the cisterna magna will make the cerebellum lax so that its minimal retraction in the inferior direction will expose the tumour.

Retrosigmoid Suboccipital:-

This approach is suitable for cerebellopontine angle TMs extending along the inferior surface of the tentorium and the petrous bone lateral to the cerebellar hemisphere and medial to the cranial nerves of the CPA.

Combined pre- and retrosigmoid approach and partial petrosectomy :-

This approach is suitable for petro-clivo-tentorial meningioma and exposing subtemporal region and CPA simultaneously. This approach is helpful in preserving the middle ear and the fallopian canal to avoid deafness and injury to the 7^{th} nerve, respectively. The vein of Labbe can be safely preserved due to direct visualization.

Combined supra/infratentorial approach:-

This approach was used initially for a pineal region meningioma by Sekhar and Goel (50). This approach is usually used for the large tumours (diameter > 4.5 cm), extending well above and below the planes of the tentorium or arising from the tentorium, tumours below the plane of cerebellar retraction, tumours encasing important venous structures of the region and tumours that are very vascular, requiring the surgeon to cut around the tumour initially and devascularize it before performing internal debulking. This approach provides a wider exposure and decreases risk associated with retraction. The tentorium acts as a natural barrier for protecting the occipital cortex during the retraction. In TMs with a good arachnoid plane around the lesion, the total removal of the tumour was simpler(51).

This approach provide wide exposure of the tumour along the tentorium and one can visualize the entire tentorium from above and below, facilitating safe and maximum tumour removal and preventing neurovascular structures. After the

complete removal of the tumour and the tentorium, the occipital lobe and the cerebellum are easily visible. The main disadvantage of this approach is the occurrence of air embolism if dine in sitting or semi-sitting positions(52).

Surgical outcome:-

For outcome of patients on follow up we used Glasgow outcome scale which categorised the patients in different category according to their functional status.

Table 7. This scale has five categories from death to good recovery(53)**.**

GOS	Patient status	Description of deficit
1	death	
2	Persistent vegetative state	Remains unconscious and speechless for weeks or months
3	Severe disability (conscious but disabled)	Dependent for daily support by reason of mental or physical disability, usually a combination of both
4	Moderate disability (disabled but independent)	Independent for daily life activities
5	Good recovery	Minor neurological or psychological deficits

RESULTS

RESULTS

Patient demography:-

In this retrospective study we included 102 consecutive patients of tentorial meningioma who underwent surgery in our department from 1st January 2003 to 31st December 2017 which are counted backward. Out of 102 operated cases which counted backward one patient died and three patients were lost to follow up. Therefore, 98 patients are included for final analysis. In this period 2228 patients underwent surgery for meningiomas of intracranial cavity or spinal canal. Out of them 2083 were intracranial meningiomas. Of these intracranial meningiomas, 102 (4.9%) patients have meningiomas based on the tentorium.

Table 8. Intracranial meningioma and their distribution:-

Location of tumour	No. of patient (%)
Intracranial	2083
Tentorial	102 (4.9)

There were 83 female (81.4 %) and 19 male (18.6%) patients with M: F ratio of 4.36:1. Mean age of patients at presentation was 49.17 years (age range 29-76) years with 58.8% of patient presenting in an age between 41-60 years.

Table 9. Distribution of tentorial meningioma in male and female

Gender	No. of patient	Percent (%)
Male	19	18.6
Female	83	81.4
Total	102	100

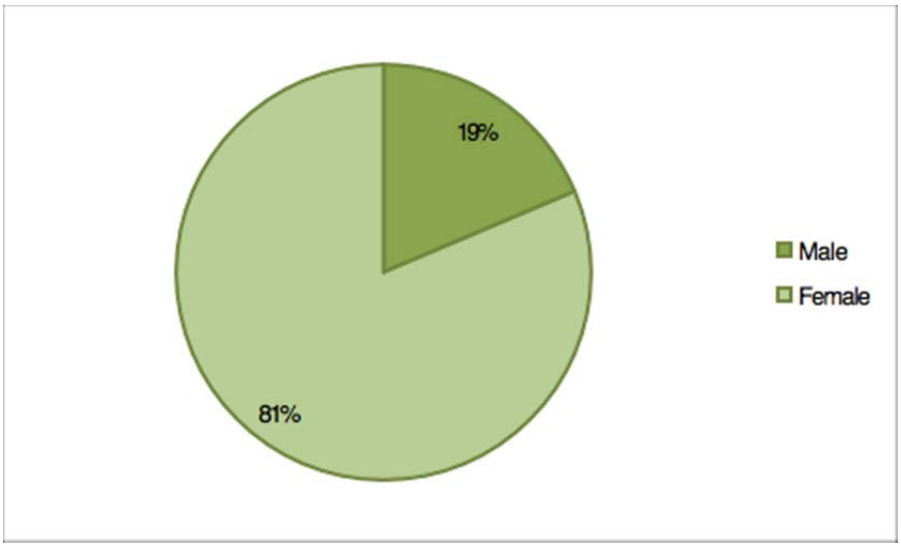


Figure 2. Diagram showing gender distribution of tentorial meningioma.

Clinical presentation:-

All patients underwent detailed pre-operative clinical, radiological and other pre-surgical evaluation before being taken up for surgery. The most common presenting symptom was headache in 68 (66.7%) patients, out of them 38 patients had infra-tentorial, 18 patients had supra-tentorial and 12 patients had both supra-tentorial and infra-tentorial tumours. Gait ataxia was present in 53 (52%) patients followed by vomiting in 34 (33.3%), blurring of vision in 29 (28.4%), vertigo 22 (21.6) and

hearing loss in 20 (19.6%) patients. Headache, vomiting and gait ataxia were more common in infra-tentorial than supra-tentorial meningioma. Most common clinical sign at presentation was papilledema in 50 (49%) patients followed by cerebellar signs in 40 (39.2%) patients. The trigeminal nerve was most commonly involved in 20 (19.6%) patients followed by the facial nerve in 13 (12.7%) and vestibulocochlear nerve in12 (11.8%) patients.

Table 10 and 11. Presenting symptoms of tentorial meningioma

Symptoms	No. of patient (n)	Percent (%)
Headache	68	66.7
Vomiting	34	33.3
Blurring of vision	29	28.4
Diplopia	6	5.9
Field defect	9	8.8
Facial pain	2	2
Facial numbness	14	13.7
Hearing loss	20	19.6
Tinnitus	10	9.8
Dysphasia	6	5.9
Memory disturbances	8	7.9
Gait ataxia	53	52

Vertigo	22	21.6
Hemiparesis	12	11.8
Seizure	10	9.8

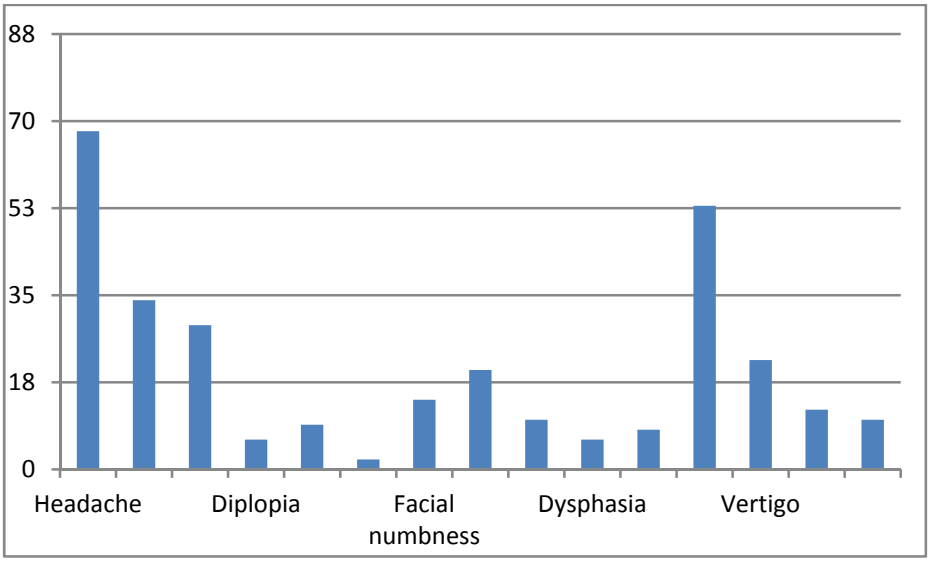


FIGURE 3.:- Distribution of patients accourding symptoms.

Table 11. Relation between symptoms and location of tumour:-

Symptoms	**Location of tumour in relation to tentorium**			**Chi-square(x^2)**	**p-value**
	Supra-tentorial	Infra-tentorial	Both(Supra+ Infra-tentorial)		
Headache	18	38	12	0.429	0.807
vomiting	8	23	3	3.822	0.148
Gait ataxia	13	29	11		

Table 12. Presenting signs of tentorial meningioma

Sign	No. of patient	Percent (%)
Disorientation	8	7.8
Motor aphasia	12	11.7
Decreased visual acuity	21	20.6
Papilledema/optic atrophy	50	49
Hemianopia	14	13.7
Nystagmus	19	18.6
Cerebellar signs	40	39.2

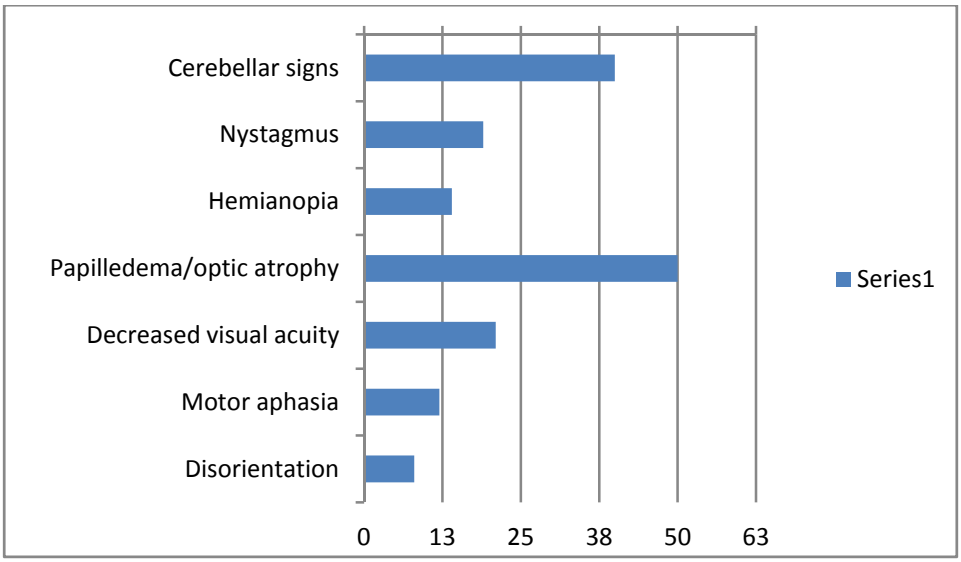


FIGURE 4.:- Distribution of patients accourding signs.

Table 13. Cranial nerve involvement at admission:-

Cranial nerve	Total no. of cranial nerves involved at admission	Percent
Fifth	20	19.6
Sixth	9	8.8
Seventh	13	12.7
Eighth	12	11.8
Lower cranial nerve	8	7.8
Total	62	60.7

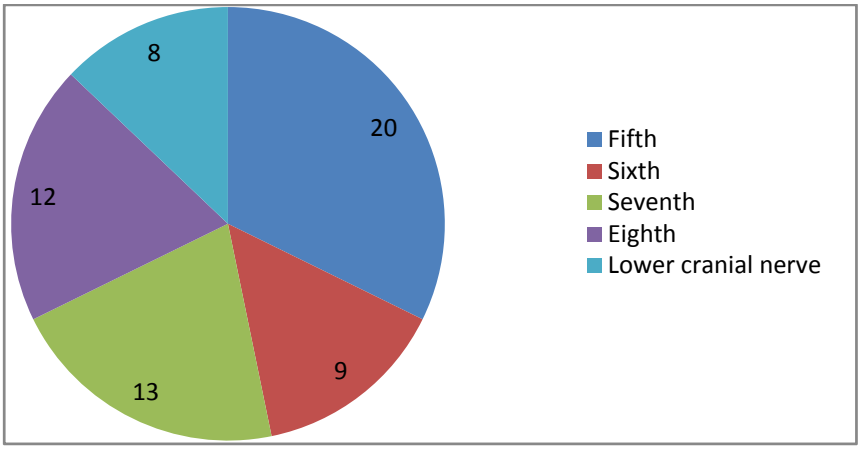


FIGURE 5.:- Distribution of cranial nerve involvement.

All patients underwent pre-operative radiological evaluation to see the location of tumor, size and extent of tumor, hydrocephalus, and relationship to adjacent structures. Pre-operative imaging is helpful in deciding the surgical approach. MRI was done in 99 (97.1) patients, CT was done in 81 (79.4) and in 28 (27.5) patients DSA was performed before surgical intervention. Most common location of tumor

was infra-tentorial location accounting for 56 (54.9%) followed by supra-tentorial in 29 (28.4%). Thirty one (30.4) patients had calcification on CT. Major venous sinuses were involved by tumor in 42 (41.2%) patients, the extent of which was detected on MRV and DSA. Out of that transverse sinus was involved in 23 (22.5%) patients and 14 (13.7%) patients had both transverse and sigmoid sinus involvement.

Table14. Imagings and findings:-

Imagings	No. of patients	Percent (%)
CT	81	79.4
MRI	99	97.1
DSA	28	27.5

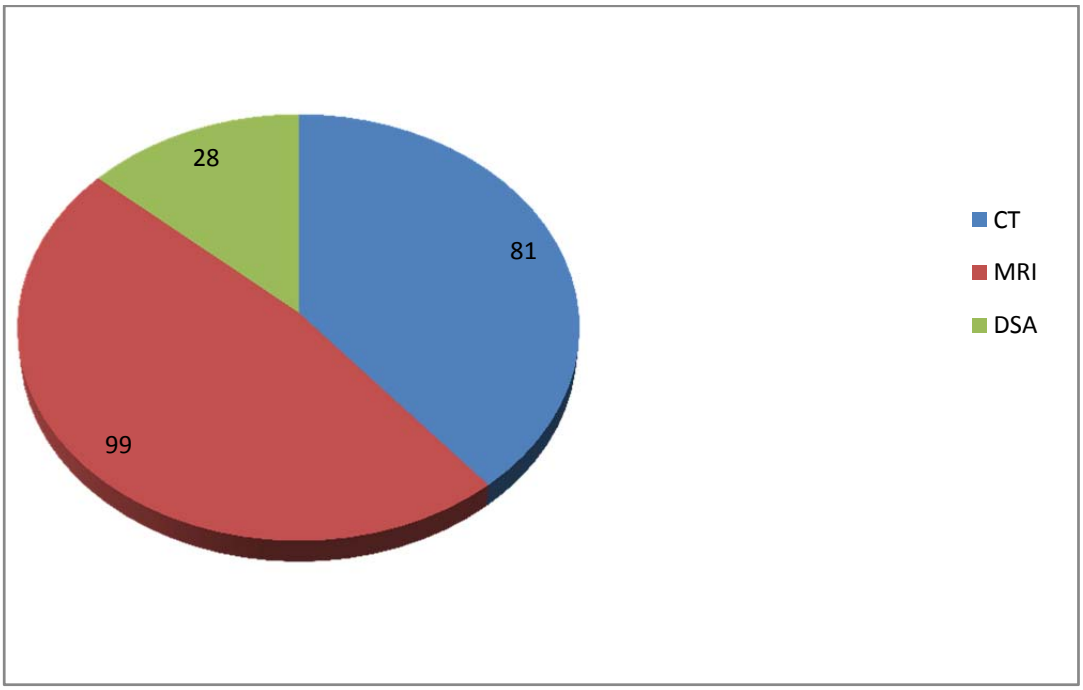


FIGURE 6.:- Radiological investigations in patients of tentorial meningioma.

Table 15. Relation of tumour attachment to tentorium:-

Location	No. of patient	Percent (%)
Supra-tentorial	29	28.4
Infra-tentorial	56	54.9
Both(Supra-tentorial+ Infra-tentorial)	17	16.7
Total	102	100

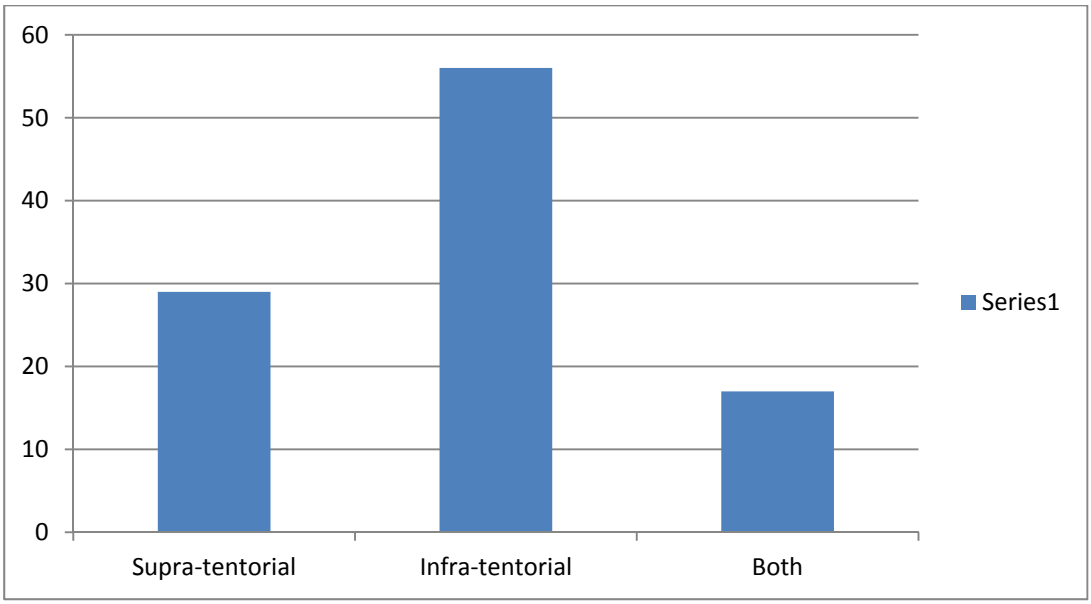


Figure 7 :- Distribution of meningioma accourding tentorial attachment

Location of tumour based on Yasargil's classification:-

Most common location of tumour according to Yasargil's classification was posterolateral (group V) which accounts for 44 (43.1%) patients followed by anterolateral (group II) which was seen in 25 (24.5%) patients.

Table 16. Location of tumour based on Yasargil's classification:-

Location (Yasargil's group)	Tentorial attachment			Total (%)
	Supra-tentorial	Infra-tentorial	Both	
Anteromedial (I)	4	3	2	9 (8.8)
Anterolateral (II)	7	15	3	25(24.5)
Intermediate (III)	3	11	4	18 (17.6)
Torcular (IV)	2	3	1	6 (5.9)
Posterolateral (V)	13	24	7	44 (43.1)
Total	29	56	17	102

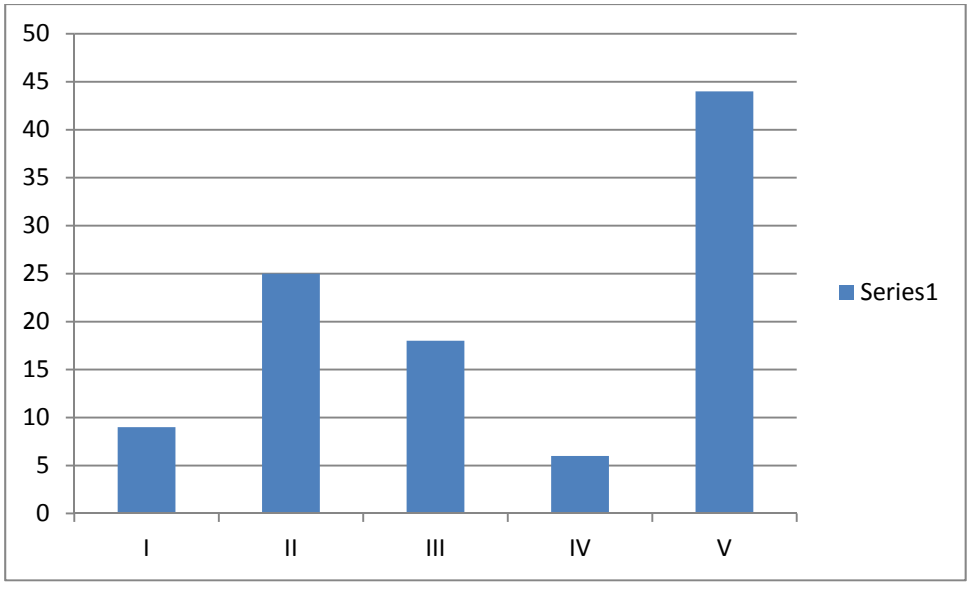


FIGURE 8:- distribution of meningioma based on Yasargil's classification

Table 17. Calcification and sinus involvement by tumour:-

Imaging characteristics	No. of patients	Percent (%)
Calcification	31	30.4
Sinus involvement	42	41.2

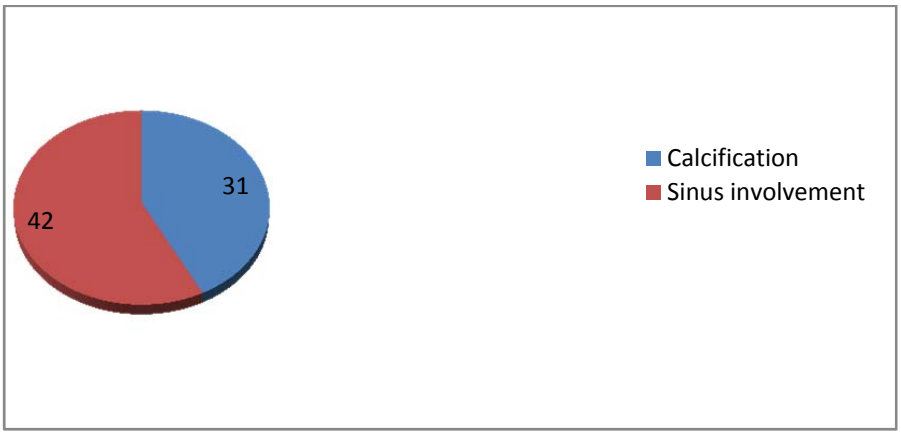


Figure 9:- Radiological findings.

Table 18. Sinus involvement:-

Sinus involved	No. of patients	Percent (%)
Confluence/Torcula	2	2
Transverse sinus	23	22.5
Sigmoid sinus	2	2
Transverse sinus and Sigmoid sinus	14	13.7
Straight sinus	1	1

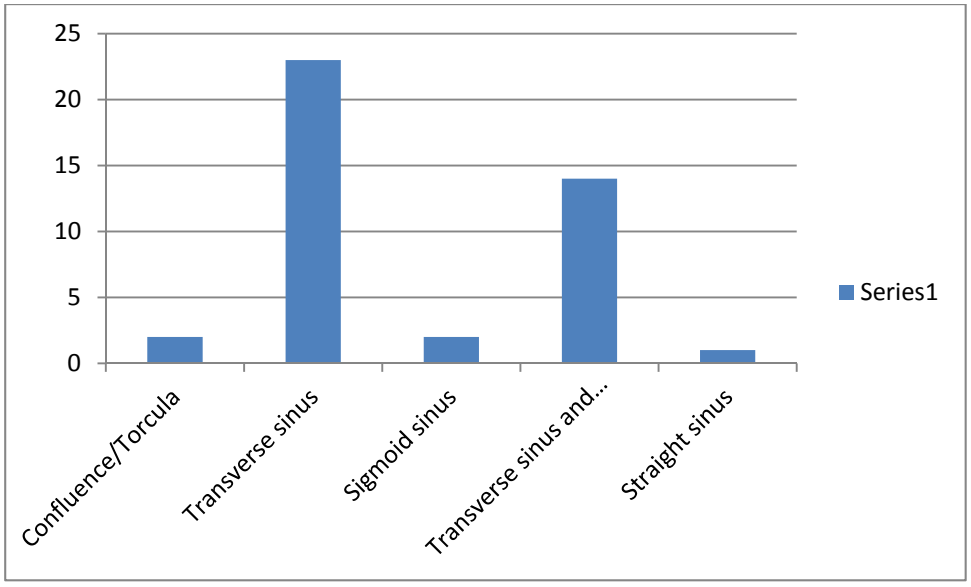


Figure 10. Showing sinus involvement by tumour.

Pre-operative hydrocephalus and CSF drainage procedures:-

In our series, 50 (49%) patients had hydrocephalus at presentation, which was more common in patients with infra-tentorial tumours. Out of them 31 patients had infra-tentorial, 11 patients had both supra-tentorial as well as infra-tentorial and 8 patients had supra-tentorial meningiomas. Infra-tentorial tumours had more hydrocephalus compared to supra-tentorial tumours and this association is significant (p-value 0.019). Of these patients with hydrocephalus, 10 (9.8%) patients underwent preoperative CSF diversion, six patients (5.9%) underwent ventriculo-peritoneal shunt and four patients (3.9%) underwent Endoscopic third ventriculostomy.

Table 19. Relationship between hydrocephalus and location/attachment of tumour:-

Yasargil's group	Tentorial attachment with hydrocepahalus			Total patients with hydrocephalus
	Supra-tentorial	Infra-tentorial	Both	
I	2	2	2	6
II	3	7	2	12
III	0	6	4	10
IV	1	1	0	2
V	2	15	3	20
Total	8	31	11	50
p-value	0.019			

Table 20. Hydrocephalus and CSF drainage:-

	No. of patient	Percent (%)
Hydrocephalus	50	49
Ventriculoperitoneal shunt	6	5.9
Endoscopic third ventriculostomy	4	3.9

Table 21. Size of tumour:-

Tumour size (mm)	No of patients (%)
<25	1(0.95)
26-50	63 (61.7)
51-75	36 (35.3)
>75	2 (1.9)
Total	102

Average size of tumour was 47.47 mm (range- 25mm- 81mm)

Surgical approaches:-

We used different surgical approaches according the location of tumour based. Initially we classified these tumors in three categories and based on this we used the surgical approach. Out of 29 patients who had supratentorial attachment 21 patients underwent supratentorial surgical approach and out of 56 patients who had infratentorial attachment, 47 patients underwent infratentorial approach. Fourty one (40.2%) underwent retromastoid sub occipital (RMSO) craniotomy, 21(20.6%) patient underwent modified Poppen's approach, 15 (14.7%) underwent anterior petrosectomy (Kawase's approach) and in 13 (12.7%) patients paramedian sub-occipital approach was performed. Tumour excision was based on Simpson's grade of excision and grade II was performed in 68 (66.7%) patients, followed by grade I excision in 21 (20.6%) patients. Tentorial attachment was excised in 32 (31.4%) patients.

Table 22. Location of tumour and surgical approach

Tentorial attachment	Surgical approach		Total	p-value
	Supratentorial	Infratentorial		
Supratentorial	21	8	29	<0.001
Infratentorial	9	47	56	
Both	6	11	17	
Total	36	66	102	

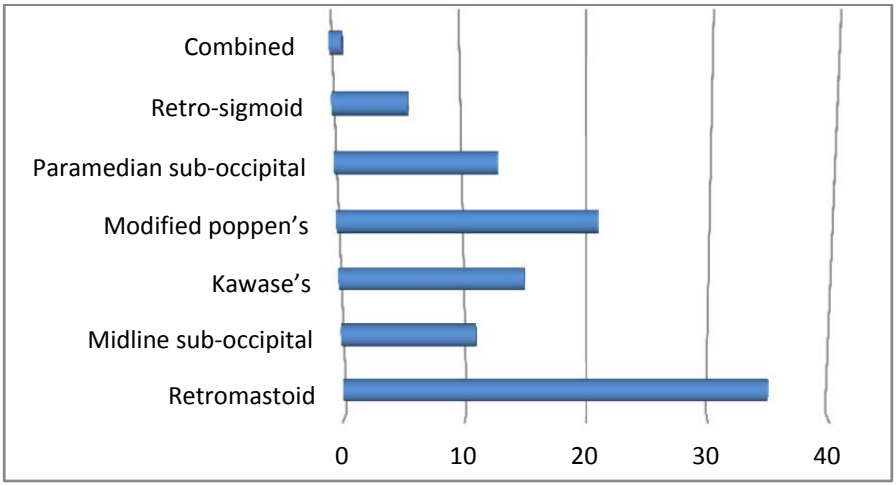


Figure 10. Showing different surgical approaches.

Extent of resection based on Simpson's grade:-

Extent of surgical excision of TM depends on location of tumour and appropriate surgical approach. Our study has 9 patients of Yasargil's group I, out of them 6 patients were operated by Modified Poppen's approach (three patients underwent simpson's grade I, two underwent grade II and one patient underwent grade III excision). 25 patients has Yasargil's group II tumour, out of them 12 patients underwent Kawase's approach (grade I excision in 3, grade II excision in 8 and grade

III in 1 patient) and 7 patients underwent RMSO approach (5 patients grade II, 1 patient grade III and 1 patient grade IV). 18 patients has group III tumour, out of them 7 patients underwent paramedical suboccipital (2 patients grade 1, 5 patients grade II excision), 4 patients underwent modified Poppen's approach, 4 patients underwent MLSO approach and 3 patients underwent RMSO approach. Six patients has group IV tumour, out of them 2 patients underwent MLSO approach (grade II excision), 2 patients underwent Para-median sub-occipital approach (1 patient grade II and 1 patient grade III excision) 1 patients underwent modified Poppen's approach (grade III excision), 1 patients underwent RMSO approach (grade III excision). 44 patients have group V tumour and 30 patients underwent RMSO approach (grade I excision in 3, grade II excision in 24, grade III excision in 1 patient and grade IV in 2 patients), 7 patients underwent modified Poppen's approach (grade I excision in 2 patients, grade II excision in 5 patients), 3 patients underwent Kawase's approach (grade I excision in 1 patient, grade II excision in 2 patients), 2 patients underwent para-median sub-occipital approach (grade II excision achieved in both patients).

Table 23. simpson's grade of excision

Simpson's grade of excision	No. of patients	Percent (%)
I	21	20.6
II	68	66.7
III	9	8.8
IV	4	3.9
Total	102	100

Table 24. Location of tumor, surgical approaches and extent of resection:-

Yasargil's group	Surgical approach	Simpson's grade of excision				Total
		I	II	III	IV	
I	MLSO	0	3	0	0	3
	Modified Poppen's	3	2	1	0	6
II	RMSO	0	5	1	1	7
	MLSO	0	1	0	0	1
	Kawase's	3	8	1	0	12
	Modified Poppen's	1	1	0	1	3
	Paramedian suboccipital	2	0	0	0	2
III	RMSO	1	2	0	0	3
	MLSO	1	2	1	0	4
	Poppen's	1	2	1	0	4
	Paramedian suboccipital	2	5	0	0	7
IV	RMSO	0	0	1	0	1
	MLSO	0	2	0	0	2
	Modified Poppen's	0	0	1	0	1
	Paramedian suboccipital	0	1	1	0	2
V	RMSO	3	24	1	2	30
	MLSO	0	1	0	0	1
	Kawase's	1	2	0	0	3
	Modified Poppen's	2	5	0	0	7
	Paramedian suboccipital	0	2	0	0	2
	Combined	1	0	0	0	1
Total		21	68	9	4	102

Size of tumour and extent of resection:-

Extent of surgical excision depends on size of tumour as larger tumour had extension in different compartment of skull and has poor surgical planes with vital structures. In our study 64 patients has tumour size <50 mm, out of them 59 underwent Simpson's grade I or II and 5 (7.8%) patient underwent grade III or IV excision. 38 Patients who has tumour size >50 mm, out of them 30 underwent Simpson's grade I or II and 8 (21%) patients underwent Simpson's grade III or IV excision. So better excision can be achieved in smaller tumours.

Table 25 and 26. Size of tumour, surgical approach and extent of resection:-

Size of tumour (mm)	Extent of resection				Total
	I	II	III	IV	
<25	0	1	0	0	1
26-50	15	43	3	2	63
51-75	6	23	5	2	36
>75	0	1	1	0	2
Total	21	68	9	4	102

Table 26.

Size of tumor (mm)	Surgical approach	Extent of excision				Total
		I	II	III	IV	
<25	RMSO	0	1	0	0	1
26-50	RMSO	4	21	1	1	27
	MLSO	1	8	0	0	9
	Kawase's	3	7	1	0	11
	Modified Poppen's	5	4	1	1	11
	Paramedian suboccipital	2	3	0	0	5
51-75	RMSO	0	9	2	2	13
	MLSO	0	1	1	0	2
	Kawase's	1	2	0	0	3
	Modified Poppen's	2	6	1	0	9
	Paramedian suboccipital	2	5	1	0	8
	Combined	1	0	0	0	1
>75	Kawase's	0	1	0	0	1
	Modified Poppen's	0	0	1	0	1
Total		21	68	9	4	102

Table 27. Excision of tentorial base:-

Tentorial attachment	No. of patient	Percent (%)
Coagulated	70	68.6
Excised	32	31.4
Total	102	100

Post-operative complications:-

A total of 42 complications occurred and most common complication was pseudomeningocele in 12 patients followed by infection in 8 patients (surgical site infection in 5 cases, meningitis in 2 cases and osteomyelitis in 1 case). Seven patients developed DVT out of them one patient died because of massive pulmonary embolism. Surgical site CSF leak was seen in 5 patients and post-operative hydrocephalus developed in 5 patients. Three patients had operative site hematoma which was evacuated. In one case the bone flap had to be removed due to osteomyelitis. One patient underwent re-exploration for residual tumour in the same hospital admission. Post-operative CSF diversion was done in 7 patients for hydrocephalus and pseudomeningocele. Out of them 4 patients underwent ETV and 2 patients underwent VP shunt. One patient was underwent temporary EVD which was removed later.

Table 28and 29. Post-operative morbidity and mortality:-

Complications	Frequency (n)	Percent (%)
Infection	8	19
CSF leak	5	11.9
Pseudomeningocele	12	28.5
Hydrocephalus	5	11.9
DVT	7	16.6
Bed sore	2	4.7
Total	42	100

Table 29.

	No. of patients	Cause of death
Death	1	Pulmonary embolism

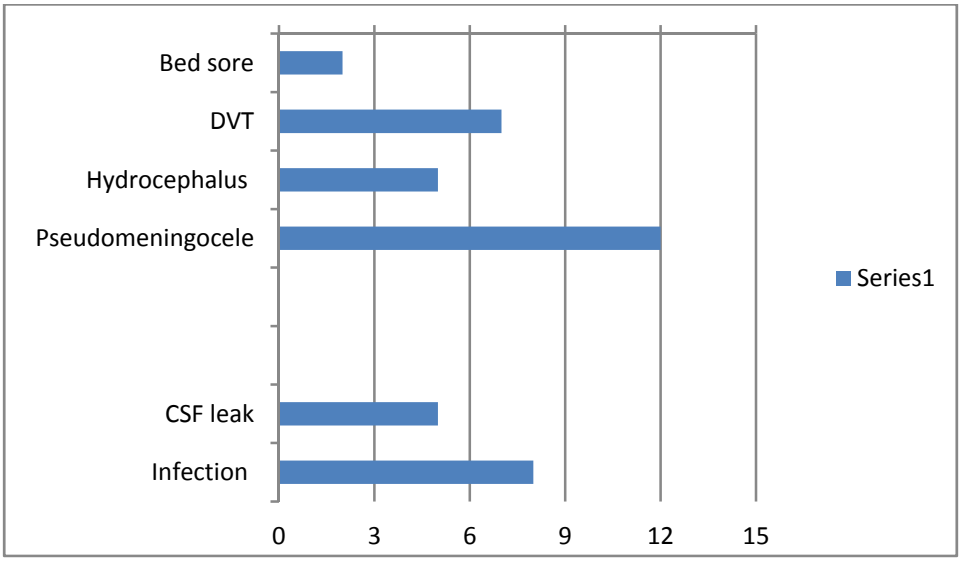


Figure 11:- Showing po-operative complications.

Table 30. Post-operative infections:-

Infection	No of patients	Percent (%)
Surgical site	5	62.5
Meningitis	2	25
osteomyelitis	1	12.5
Total	8	100

Table 31. Re-exploration:-

	No. of patients	Percent (%)
Wound re-suturing	2	2
Bone flap removal	1	1
Hematoma evacuation	3	2.9
Residual	1	1
Total	7	6.9

Table 32. Post-operative CSF drainage:-

Procedure	No. of patients	Percent (%)
VP shunt	2	2
ETV	4	3.9
EVD	1	1
Total	7	6.9

Cranial nerve outcome after 3 months follow up:-

In follow up we included only 98 patients because one patient died and three patients were lost to follow up. On admission 62 cranial nerves are involved which was present in 41 patients at 3 months follow up. Post-operatively 29 patients had improvement in cranial nerve function and 33 patients had the same cranial nerve deficits as before surgery. Eight patients developed new cranial nerve dysfunction. Out of these 8 patients who developed new cranial nerve deficit, 5^{th} nerve involvement was seen in one patient, 6^{th} nerve in 2 patients, 7^{th} nerve in 4 patients, 8^{th} nerve in one patient and no patient developed lower cranial nerve deficit post-operatively. On statistical analysis post-operative cranial nerve functions were better, but no cranial nerve had statistically significant improvement.

Table 33 and 34. cranial nerve involvement on follow up

Cranial nerve	Total no. of cranial nerves involved after 3 months follow up (n)	Percent (%)
Fifth	14	34.1
Sixth	6	14.6
Seventh	11	26.8
Eighth	6	14.6
Lower cranial nerve	4	9.7
Total	41	100

Table 34.

Cranial nerve	Preoperative	Post-operative		p-value (McNemar test)
		Not involved	Involved	
5th	Not Involved	76	1	0.07
	Involved	7	13	
6th	Not Involved	85	2	0.453
	Involved	5	4	
7th	Not Involved	79	4	0.754
	Involved	6	7	
8th	Not Involved	83	1	0.07
	Involved	7	5	
Lower cranial nerve	Not Involved	88	0	0.125
	Involved	4	4	

Size of tumour, extent of resection and recurrence:-

Out of 102 patients, 98 patients has follow up and these patient were included in our study. Out of these patients grade I excision was done in 20 patients, grade II excision in 66 patients, grade III in 8 patients and 4 patients underwent grade IV excision. Total 17 patients had recurrence, out of them 5 (25%) patient underwent grade I

excision, 9 (13.6) patients grade II, 1(12.8) patient grade III and 2 (50%) patient underwent grade IV. All patient who had recurrence had sizes between 26mm to 75 mm. Out of 62 patients, 12 (19.3%) patients who had recurrence had tumour size < 50 and out of 36 patients 5 (13.8%) who had recurrence had tumour sizes of 51mm to 75 mm.

Table 35. Size of tumour, extent of resection and recurrence:-

Size of tumour (mm)	**Recurrence**	**Extent of resection**				**Total**
		I	**II**	**III**	**IV**	
<25	No	0	1	0	0	1
	Yes	0	0	0	0	0
26-50	No	10	37	2	0	49
	Yes	5	5	0	2	12
51-75	No	5	18	4	2	29
	Yes	0	4	1	0	5
>75	No	0	1	1	0	2
	Yes	0	0	0	0	0
Total		20	66	8	4	98

Extent of excision (Simpson's grade), WHO grade and recurrence:-

Histopathology report was available in all operated cases and tumour was classified according to WHO classification of meningioma. Out of 102 patients 84 patients has grade I tumour followed by grade II in 16 patients and only 2 patients has grade III meningioma. Of the 98 patients on follow, 20 patients underwent grade I excision, in 66 patients grade II excision, in 8 patients grade III excision and 4 patients underwent grade IV excision. Total 17 patients had recurrence. Out of them 12 (14.8%) patients has grade I tumour, 4 (26.7%) patients had grade II and 1 (50%) patient had grade III tumour. 14 patients who underwent grade I excision had WHO grade I tumour and out of 14 patients 2 (14.28%) patients had recurrence. 58 patients who underwent grade II excision had WHO grade I tumour and out of 58 patients 8 (13.8%) patients had recurrence. 6 patients who underwent grade III excision had WHO grade I tumour and out of 6 patients 1 (16.6%) patients had recurrence. 3 patients who underwent grade IV excision had WHO grade I tumour and out of 3 patients 1 (33.3%) patient had recurrence. 5 patients who underwent grade I excision had WHO grade II tumour and out of 5 patients 3 (60%) patients had recurrence. One (100%) patient who underwent grade IV excision and had WHO grade II had recurrence. One (100%) patient who underwent grade II excision had WHO grade III tumour had recurrence. So patient who underwent grade I or II excision and had WHO grade I tumour has less recurrence compare to who underwent grade III or IV and had WHO grade II or IV. So recurrence of tumour depends on grade of excision and WHO grade.

Table 36 and 37. Extent of excision (Simpson's grade), WHO grade and recurrence:-

WHO grade	No. of patients	Percent (%)
I	84	82.3
II	16	15.7
III	2	1.96
Total	102	100

Table 37

WHO grade	No. of patients	Recurrence (n)	Percent (%)
I	81	12	14.8
II	15	4	26.7
III	2	1	50
Total	98	17	

Table 38. Extent of excision, WHO grade and recurrence of meningioma:-

WHO grade	Recurrence	Simpson's grade of excision				Total
		I	II	III	IV	
I	No	12	50	5	2	69
	Yes	2 (14.28)	8 (13.8)	1 (16.6)	1 (33.3)	12 (14.8)
II	No	2	7	2	0	11
	Yes	3 (60)	0	0	1 (100)	4 (26.6)
III	No	1	0	0	0	1
	Yes	0	1 (100)	0	0	1
Total		20	66	8	4	98

Adjuvant therapy and re-surgery:-

Total 5 patients underwent re-surgery for recurrence. 81 patients had WHO grade I tumour and out of them, 4 (4.9%) underwent re-surgery and 1(6.6%) patient out of 15 patients who had WHO grade II underwent re-surgery. Total 11 patients received radiotherapy out of them 5 (6.2%) had WHO grade I, 4 (26.6%) had WHO grade II, 2 (100%) had WHO grade III meningioma. Two patients (one has WHO grade I and one has WHO grade II) who had recurrence underwent re-surgery followed by adjuvant therapy.

Table 39, 40 and 41.Adjuvant therapy and re-surgery:-

WHO grade	Re-surgery	Simpson's grade of excision				Total
		I	II	III	IV	
I	No	13	55	6	3	77
	Yes	1	3	0	0	4 (4.9%)
II	No	4	7	2	1	14
	Yes	1	0	0	0	1 (6.6%)
III	No	1	1	0	0	2
	Yes	0	o	0	0	0
Total		20	66	8	4	98

Table 40:-Patients with recurrence and surgical approaches for recurrences:-

Patients with recurrence	Yasargil's group	1st surgical approach	surgical approach for recurrence
1	3	Kawase's	Kawase's
2	2	Kawase's	Kawase's
3	3	Paramedian suboccipital	Modified poppen's
4	3	MLSO	Paramedian suboccipital
5	2	Kawase's	Kawase's

Table 41.

WHO grade	Adjuvant therapy	Simpson's grade of excision				Total
		I	II	III	IV	
I	No	12	56	5	3	76
	Yes	2	2	1	0	5 (6.2%)
II	No	3	6	2	0	11
	Yes	2	1	0	1	4 (26.6%)
III	No	0	0	0	0	0
	Yes	1	1	0	0	2 (100%)
Total		20	66	8	4	98

Patient outcome on follow up:-

We used the GOS and cranial nerve function improvement for physical and neurological outcome on follow up. On admission the average GOS of 102 patients was 4.70(range:-2-5), on discharge it was 4.57 (range:-2-5) and on 3 months follow up average GOS of 98 patients was 4.81(range:-2-5). GOS improved after 3 months of surgery but there was no significant difference at the end of 3 months. Although after 3 months 8 patients developed new cranial nerve deficit but overall there is improvement in cranial nerve function but it was not significant.

DISCUSSION

DISCUSSION

Since the first case of meningioma described by Dr. Platter in 1614 and first record of a PFM was by Andral in 1833 as found incidentally. The TM has been treated by many neurosurgeons with different surgical approaches based on locations. Surgical mortality was high for TM and different series have different mortality rate. So these meningiomas are classified to prognosticate and feasibility of surgical excision according to location of tumour. As in advancement in imagings, microscopical undersanding and in neuroanesthesia, surgery for these tumour become treatment of choice and surgical morbidity and mortality decreased significantly.

The incidence of TM in our study was 4.9% which is comparable to reported incidence of 3-6%. A study by Guidetti et al.(54) found the incidence of 4.8% in their 61 cases.

Table 42. incidene of tentorial meningioma in different series

Authors	Year	No. of patients	% of TM
Barrow's et. al(38)	1962	24	3
Guidetti's et. al(54)	1988	61	4.8
Sammi's et al(55)	1996	25	3
Bret's et al.(4)	2000	27	6
Bassiouni's(29)	2004	81	7.7
Shukla et al.(56)	2009	37	6.01
Present study	2018	102	4.9

In the present study the age range of the patients were between 29 –76, the mean age of patient with TM was 49.17 years with 58.8% of patients are in age between 41 to 60 years. 25 (24.5%) patients were aged <40 years, out of which 1(1%) patients was less than 30 years of age. 17 (16.7) patents were aged > 60 years. A study by Guidetti et al.(54) showing that the mean age of TM is 50.7 with range of 27-72 years and majority of patients (68.8 %) were between 40 to 60 years of age. A study by Xiu et al. (40) in 43 patients showing that the age ranged from 27 to 78 years with a mean of 52.2 years.

Table 43. Age of patients of tentorial meningioma in different series

Authors	Year	No. of case	Age range	Mean age
Sekhar et al.(57)	1984	27	22-72	52
Guidetti's et. al(54)	1988	61	27-72	50.7
Sammi's et al(55)	1996	25	28-72	52
Bret's et al.(4)	2000	27	30-77	53
Bassiouni's et al.(29)	2004	81	18-72	55
Hashmi's et al.(1)	2010	21	39-73	56
Xiu et al.(40)	2015	43	27-78	52.2
Present study	2018	102	29-76	49.17

A study by Bassiouni et al.(29) in 2004 in 81 patient found that TM is more in female compare to male. In their study out of 81 patient 69 were female and 12 were male with ratio of 5.75:1. Sekhar et al.(57) in 1984 in 27 patients found female to male ratio of 3.5:1. Study by Nanda et al. (41) in 41 patients showing female

preponderance with female to male ration of 3.5:1. We also found female dominance of TM with female to male ratio of 4.36:1.

Table 44. Gender distribution of tentorial meningioma in different series

Authors	Year	No. of case	M:F ratio
Barrow's et. al.(38)	1962	24	3.8:1
Sekhar et al.(57)	1984	27	3.5:1
Guidetti's et. al.(54)	1988	61	2.0:1
Sammi's et al.(55)	1996	25	2.57:1
Bret's et al.(4)	2000	27	2.85:1
Bassiouni's et al.(29)	2004	81	5.75:1
Shukla et al. (56)	2009	37	1.17:1
Hashmi's et al.(1)	2010	21	4.25:1
Xiu et al. (40)	2015	43	5.14:1
Nanda et al. (41)	2018	41	3.55:1
Present study	2018	102	4.36:1

In our study the most common presenting complaint was headache in 68 (66.7%) patients followed by gait ataxia in 53 (52%). Bassiouni et al. (29) also found that headache was the presenting symptom in 75% patients followed by dizziness (49%) and gait disturbances (46%). A study by Nanda et al. (41) in their study of 41 patients found that most common presenting symptom was nonspecific headache (75.6% of patients). In our study Most common presenting sign was papilledema in 50 (49%) followed by cerebellar signs in 40 (39.2%) patients. Fifth cranial nerve was most

commonly involved in 20 (23.2%) patients followed by 7th in 13 (20.9%) The most common sign was gait ataxia.

Table 45. most common presentation of TM in different series

Author	Years	No. of patients	Most common symptom (%)	Most common sign (%)	Most common cranial nerve involved (%)
Bassiouni's et al.(29)	2004	81	Headache (75.3	Gait ataxia (51.9)	8th (13.6)
Shukla et al. (56)	2009	37	Headache (89.2)	Cerebellar signs (70.3)	2nd (43.2)
Nanda et al.(41)	2018	41	Headache (75.6)		
Present study		102	Headache (66.7)	Gait ataxia (52)	5th (23.2)

Mulitiple classifications are given in the literature for TM. In present study we classified the TM base on Yasargil's classification. Most common location of tumour according to Yasargil's classification was posterolateral (group V) which accounts 44 (43.1%) patient followed by anterolateral (group II) in 25 (24.5%) patients. Most common location of tumour was infra-tentorial accounting for 56 (54.9%) followed by supra-tentorial in 26 (28.4%). A study by Barrow et al. (38) in 24 cases showing that 16 cases had predominantly infratentorial and 8 cases had supratentorial attachment. A study by Shukla et al. (56) in 37 patients, out of 28 primary TM,

supratentorial location in two patients infratentorial in 20 patients and both supratentorial and infratentorial in six patients. Similar study showing that 14(37.8%) patients had tumor in postero-lateral location followed by posteromedial in 8 (21.6%) patients.

Table 46 and 47. Location of tentorial meningioma in different series

Author	Year	Location of tumour			Total
		Supra-tentorial	Infra-tentorial	Both	
Barrow et al. (38)	1962	8	16		24
Guidetti et al. (54)	1988	23	25	13	61
Sammi et al. (55)	1996	11	14		25
Bret et al. (4)	2000	4	17	6	27
Bassiouni's et al. (29)	2004	15	59	7	81
Xiu et al. (40)	2015	20	19	4	43
Present study	2018	29	56	17	102

Table 47.

Authors	years	Yasargil's group					Total
		I	II	III	IV	V	
Bret et al. (4)	2000	10	7	3	3	4	27
Shukla et al. (56)	2009	3	1	2	10	14	30
Present study	2018	9	25	18	6	44	102

Location of tumor and it's relation to hydrocephalus and cranial nerve involvement:-

In our study 50 patients had hydrocephalus, out of them 31 patients had infratentorial tumour and this association between hydrocephalus and infratentorial tumour is significant (p-value- 0.019). Out of these 50 patients 10 patients underwent pre-operative CSF drainage (VP shunt in 6 patients, ETV in 4 patients). Patient with Yasargil's group V has more hydrocephalus compare to other groups. A study by Barrow et al. (38) in 24 patients, 16 patients has infratentorial tumour and out of them 6 patients had hydrocephalus. A study by Markharam et al. (58) in 1955 in 29 patients of posterior fossa, 13 patients had ventriculomegaly. A study by Bret et al. (4) in 27 patients showing ventricular dilatation in 13 patients and 8 patients underwent CSF diversion. Study by Xiu et al. (40) in 43 patients showing hydrocephalus in 8 patients. Cranial nerve involvement was more common in tumour located infra-tentorially.

SURGICAL APPROACH AND EXCISION OF TUMOR:-

Surgical approach for TM depends on location, size, relation with adjacent neurovascular structures. So adequate presurgical radiological evaluation is necessary for safe and maximum resection. In our study we also used different approaches according to tumour location. Tumour arising from anteromedial aspect of tentorium or arising from apex of tentorium are better to approach through Modified Poppen's approach. Anterolateral tumors have better grade of excision through Kawase's approach. Tumor of intermediate group have better excision through paramedian suboccipital approach. Tumor which has attachment to torcula or posteromedial group can approached by MLSO approach or paramedian suboccipital accourding to lateral

extension of tumour. Tumours of the posterolateral group had better excision through RMSO approach.

Post-operative complications and mortality:-

In post-operative course total 42 complications occurred and most common complication was pseudomeningocele in 12 patients followed by infection in 8 patients (SSI in 5 cases, meningitis in 2 cases and osteomyelitis in 1 case). Seven patients developed DVT out of them one patient died because of massive pulmonary embolism and rest six patients managed with anticoagulant. Surgical site CSF leak was seen in 5 patients which were resutured and post-operative hydrocephalus developed in 5 patients who underwent CSF drainage procedures. Three patients had operative site hematoma which was evacuated. One patient had bone flap removal following osteomyelitis and one patient underwent re-exploration for residual before discharge. Patients with meningitis managed with antibiotics. Post-operative CSF drainage procedure was done in 7 patients for hydrocephalus and pseudomeningocele. Out of them patients underwent 4 patients underwent ETV, VP shunt was done in 2 patients and 1 patient was underwent EVD temporarily which was removed later. A study by shukla et al. (56) in 37 patients has complications 10 (27.02%), including 3 death. In this study most common complication was CSF leak in 6 patients.

Extent of excision and recurrence:-

In our study we found that patient who had simpson's grade I and II excision and WHO grade I tumour have less recurrence compare to who had simpson's grade III or IV and WHO grade II or III tumour. We have recurrence in 17 patients, Out of them 12 (14.8%) patients has grade I tumour, 4 (26.7%) patients had grade II and 1 (50%) patient had grade III tumour. 2 (14.28%)patients who has recurrence underwent grade

I excision and had WHO grade I tumour. 8 (13.8%) patients had recurrence underwent grade II excision and had WHO grade I tumour. One (16.6%) patient who underwent grade III excision had WHO grade I tumour had recurrence. One (33.3%) patient who underwent grade 1V excision had WHO grade I tumour had recurrence. 5 patients who underwent grade I excision had WHO grade II tumour and out of 5 patients 3 (60%) patients had recurrence. One (100%) patient who underwent grade IV excision and had WHO grade II had recurrence. One (100%) patient who underwent grade II excision had WHO grade III tumour had recurrence. So patient who underwent grade I or II excision and had WHO grade I tumour has less recurrence compare to who underwent grade III or IV and had WHO grade II or IV. So recurrence of tumour depends on grade of excision and WHO grade. We found similar results indifferent series showing high recurrence in high simpson's grade of excision III and IV and with WHO grade III.

Table 48. Recurrence of tentorial meningioma in different series

Author	Year	No. of follow up patients	No. of patients with Recurrence
Sekhar et al. (57)	1984	27	4
Guidetti et al. (54)	1988	42	4
Bassiouni et al. (29)	2004	81	7
Present study	2018	98	17

Mortality:-

Surgical mortality was high for TM in initial series but due to advancement in imaging, microsurgical techniques and neuroanesthesia morbidity and mortality decreased in subsequent series and different series have different mortality rate. There was one mortality in our series due to massive pulmonary embolism following deep venous thrombosis.

Table 49. Mortality in different series of tentorial meningioma

Author	Year	Total no. of patients	No. of operated cases	Mortality rate (%)
Cushing and Eisenhardt (32)	1938	15	14	14
Campbell and Whitfield (59)	1948	5	5	20
Castellano and Ruggiero(33)	1953	21	21	20
Markham et al.(58)	1955	29	29	24
Barrow et al. (38)	1962	24	24	29
McCarty and Taylor et al. (60)	1979	20	20	25
Sekhar et al. (57)	1984	27	27	7
Guidetti et al.(54)	1988	61	61	9.8
Bassiouni et al. (29)	2004	81	81	2.5
Shukla et al. (56)	2009	37	37	8.1
Aguiar et al.(61)	2010	30	30	3
Xiu et al. (40)	2015	43	43	0
Present study	2018	102	102	1

Follow up:-

In our study the minimal follow up was 3 months. Our minimal follow up was 98 days and maximum was 5236 days with median of 1024.5 day. On follow up every patient underwent detailed clinical evaluations and imaging if required. We used the GOS (Glasgow outcome scale) for follow up clinical evaluation. There was no fixed protocol for follow up imaging. Patients who are symptomatic underwent imaging. Who had recurrence on follow up imaging and was symptomatic underwent re-operation or adjuvant therapy.

Study limitation:

The present study is a retrospective study and is limited by its inherent drawbacks. The surgery was performed by multiple surgeons with different surgical experiences and surgical approach was decided by themselves. There have been slight modifications in the surgical techniques practiced by individual surgeons; however, all surgical approaches have been described in a standardized manner. There is wide range of follow up period and no fixed protocol for follow up. Over all we are comfortable with the reliability of the information that we were able to extract from the medical records, and took care to note when specific data were insufficient. Probably there was also an element of referral bias.

Only large prospective study can overcome these weaknesses.

CONCLUSION

Conclusion

Classification of TM according to their location and relation to adjacent vital structures is important aspect regarding surgical approaches, safe and maximum excision and post-operative consequences. So these patients need adequate pre-operative evaluation to approach the tumour. If the tumour is adherent to vital structures it is wise to leave residual to preserve these vital structures to avoid serious morbidity and mortality. Postoperative morbidity and mortality depend on extent of excision and the WHO grade. Because these are slow growing tumour so residual and recurrence can be treated by adjuvant therapy and re-surgery.

REPRESENTATIVE CASES

REPRESENTATIVE CASES

CASE 1

This is a 65 years old male patient presented with complaints of vertigo. Patient evaluated outside with MRI and diagnosed to have infratentorial and Yasargil group I meningioma. Patient underwent modified Poppen's approach and Simpson's grade I excision done. Post-operative CT- scan showing no residual and follow up MRI showing no recurrence.

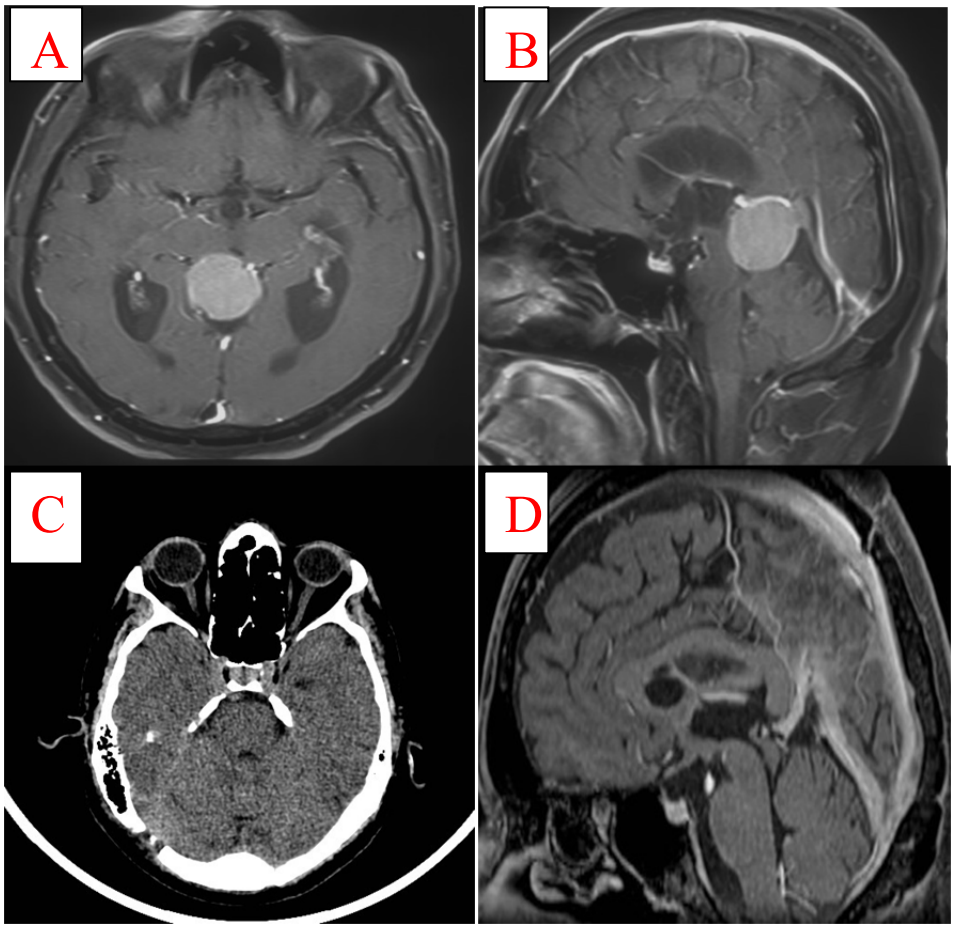


Figure 12:- A. Contrast MRI showing contrast-enhancing lesion at tentorial apex (Yasargil group I). B. Showing lesion compressing Vein of Galen, C. showing post-op CT-scan showing craniotomy defect and D. showing follow up sagittal MRI showing no recurrence.

CASE 2

This is a 46 years old female patient presented with complaints of decrease hearing in left ear for 18 months. Patient evaluated CT-head and diagnosed to have infratentorial and Yasargil group II meningioma. Patient underwent Kawase's approach and Simpson's grade I excision done. Post-operative CT- scan showing small hematoma in operative cavity but no residual seen.

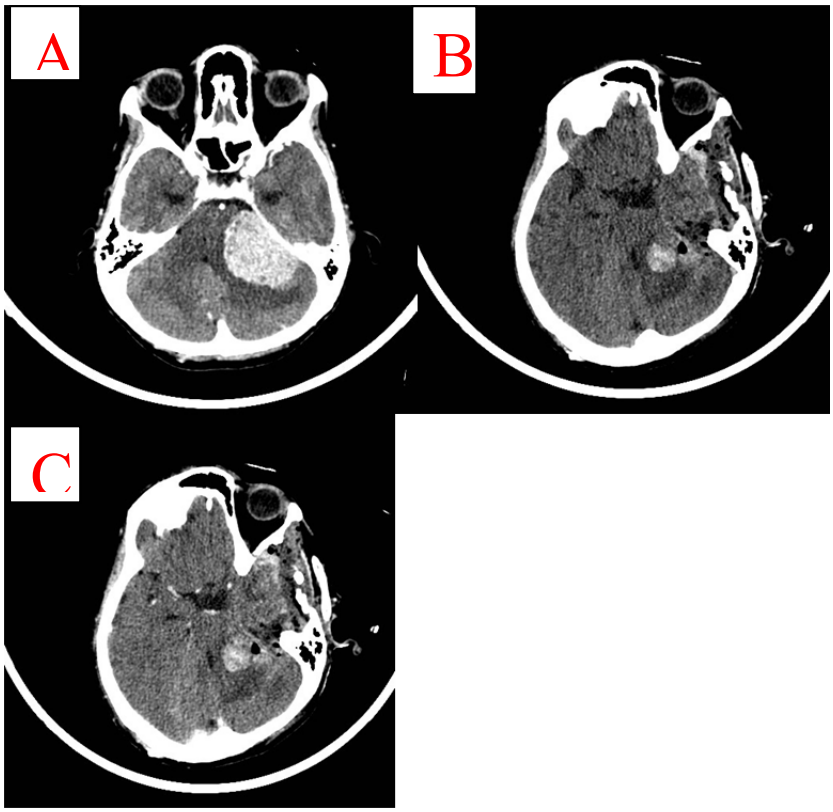
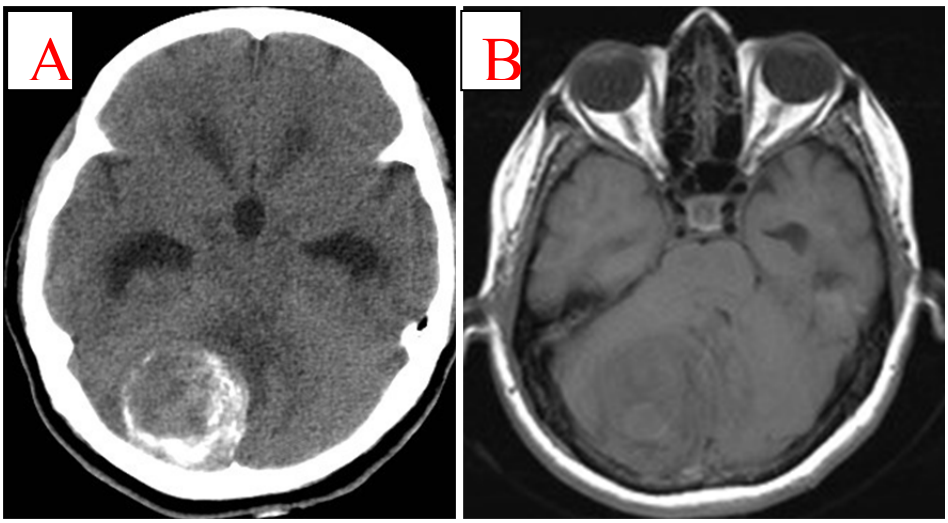
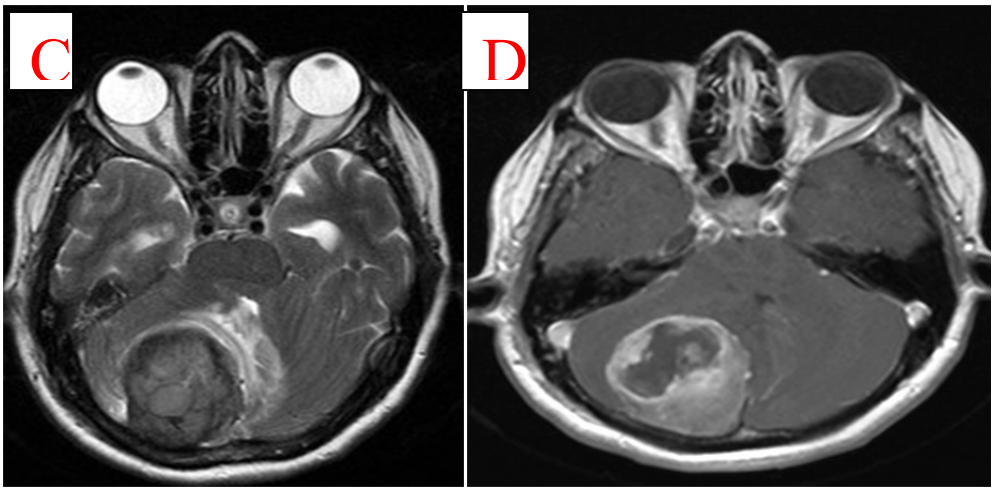


Figure 13:- A. Yasargil group II meningioma, B. Post-op plain CT- head scan showing craniotomy defect and small hematoma in operative cavity, C. contrast CT-head showing no residual lesion.

CASE 3

This is a 38 years old female patient presented with complaints of headache for 3 years and recent onset left hemiparesis. Patient evaluated with CT- head showing calcified lesion and MRI with MRV showing lesion located infratentorialy and Yasargil group III. MRV showing obliteration of right transverse sinus. Patient underwent right paramedian suboccipital approach and Sipmson's grade I excision. Post-operative CT- scan showing no residual or hematoma. CT- head of another patient showing lesion with hydrocephalus who underwent pre-operative left sided VP shunt and later underwent definitive surgery.

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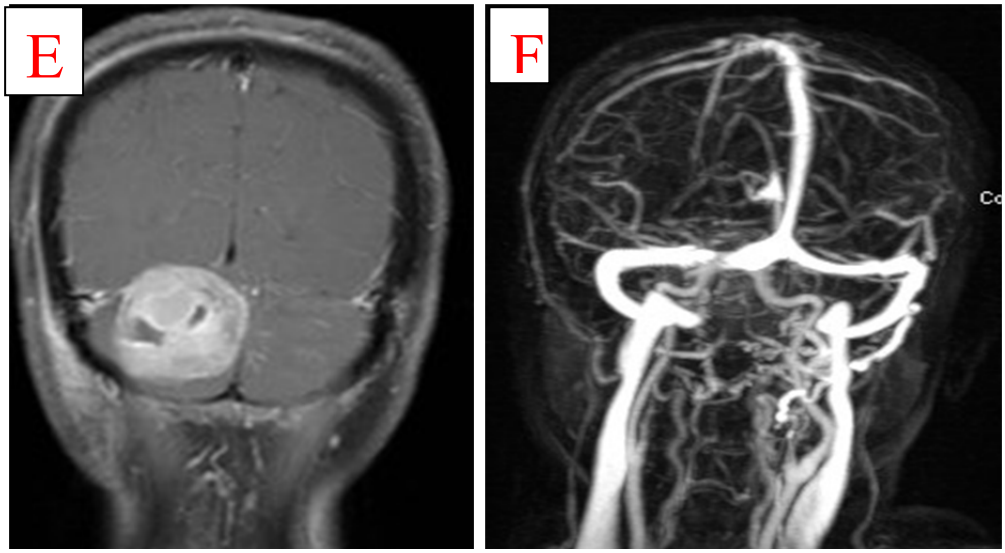
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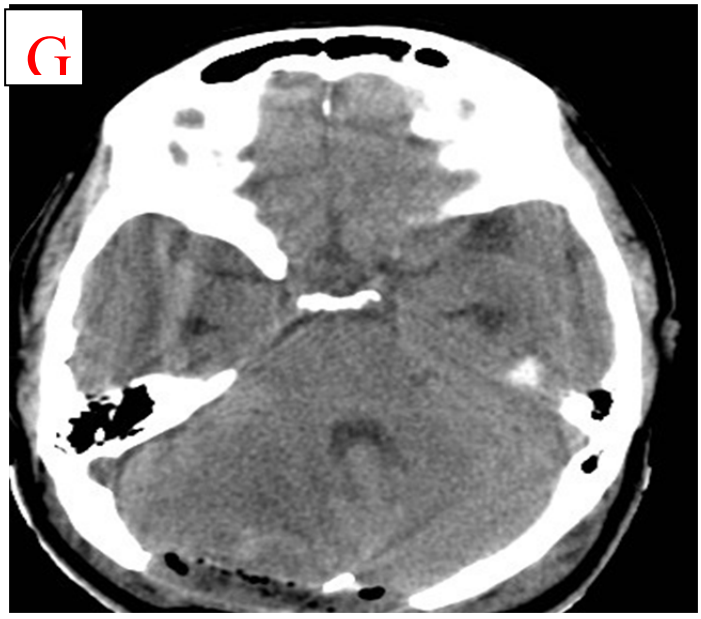
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Figure 14:- A. Yasargil type III calcified meningioma, B. T1-MRI showing hypointense T2- heterogenous hypointense lesion (C), D and E. Heterogenous contrast enhancing AXIAL and CORONAL MRI. F. MRV Showing obliteration of right transverse sinus, G. Showing post-op CT- scan showing right paramedian suboccipital craniectomy defect.

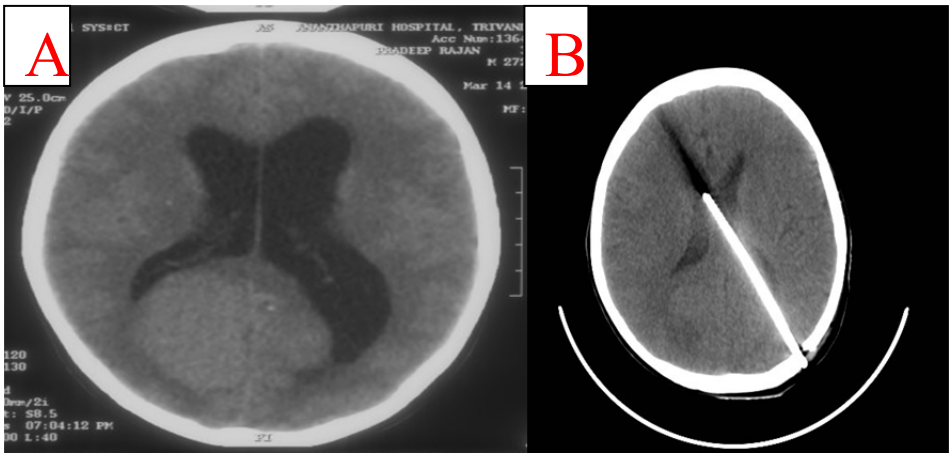

Figure 15 :- A, Showing Yasargil type III meningioma with hydrocephalus, B. Showing ventriculoperitoneal shunt-in-situ.

CASE 4

This is a 39 years old female patient presented with headache for 1 year. Patient evaluated with MRI with MRV and diagnosed to have infratentorial and Yasargil group IV meningioma. MRV showing partial obliteration of sinus confluence. Patient underwent right paramedian suboccipital approach and Simpson's grade II excision done. Post-operative CT- scan showing no hematoma or residual.

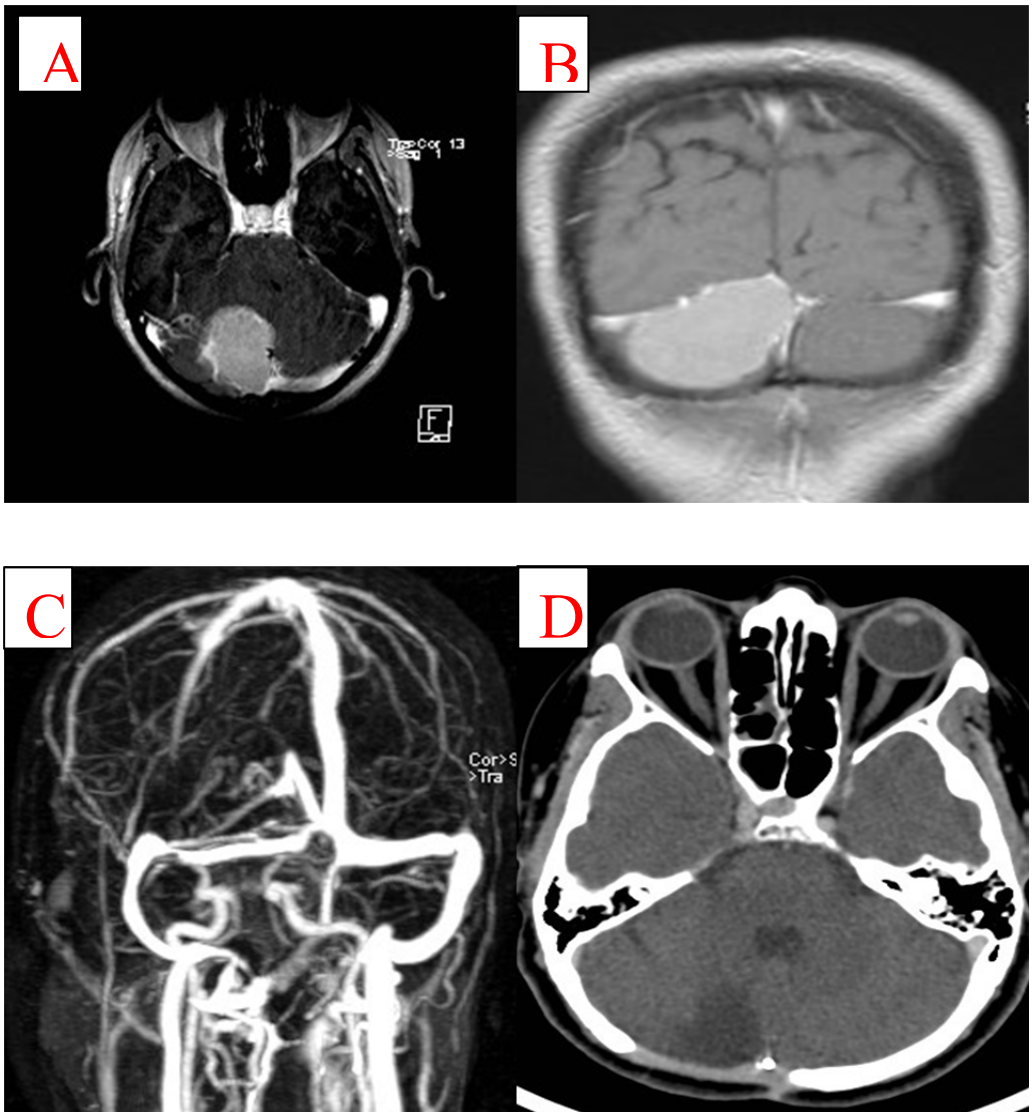

Figure 16 :-A and B. Axial and coronal contrast-MRI showing Yasargil group IV meningioma, C. MRV showing obliteration of sinus confluence, D. post-op CT showing no residual lesion/hematoma.

CASE 5

This is a 50 years old female patient presented with complaints of headache for 6 years. Patient evaluated with MRI and diagnosed as a case of infratentorial and Yasargil group V meningioma. Patient underwent RMSO approach and Simpson's grade II excision done. Post-operative CT- scan showing no residual tumour.

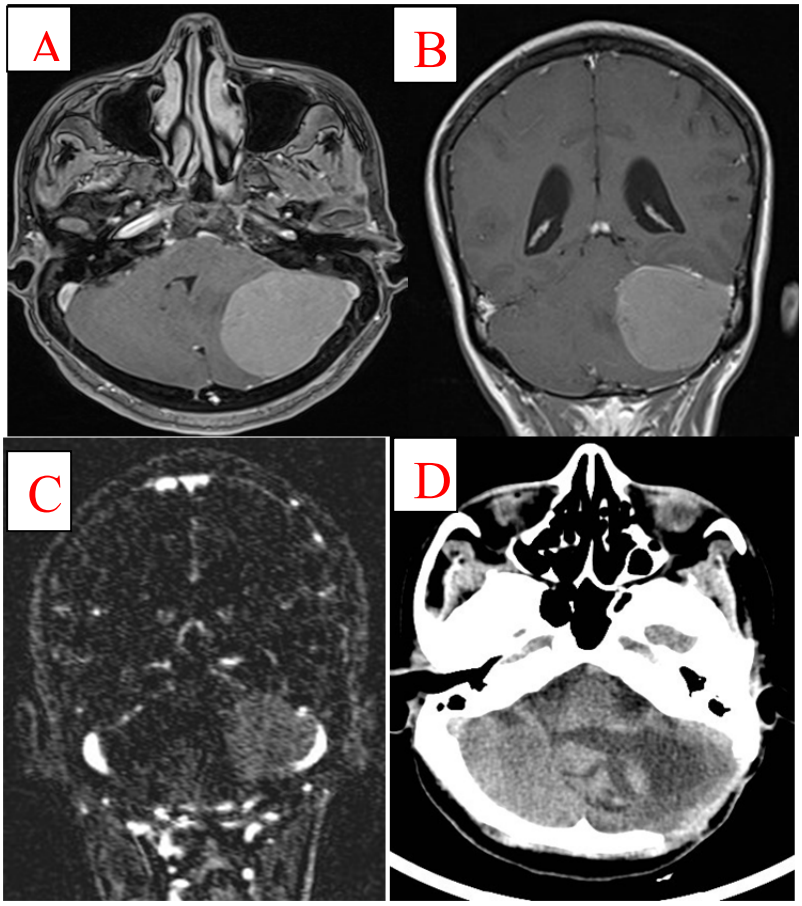

Figure 17 :- A and B showing axial and coronal contrast-MRI showing contrast-enhancing lesion, C. MRV showing compression and lateral displacement of left transverse sinus.D. Post-op CT-scan showing cranictomy defect which was approached through left RMSO approach.

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BIBILOGRAPHY

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ANNEXURE

Proforma

A. GENERAL INFORMATION

- Anonymized Patient ID;
- Age
- Gender
- Family history/Neurofibromatosis

B. CLINICAL DETAILS

- GCS on admission
- Hydrocephalus
- Size of meningioma
- Extent of meningioma
- Cranial nerve involvement
- Time since diagnosis
- Classification: Yaşargil's classification
- Radiological investigations

C. INTRAOPERATIVE EVENTS

- Intra-operative extent
- Calcification
- Hyperostosis
- Vascularity
- Consistency
- Cranial nerve involvement
- Sinuses involvement
- Duration of surgery
- Blood loss

D. POST-OPERATIVE EVENTS

- Infection
- CSF leak
- Pseudomeningocele
- Cranial nerve involvement
- Re-exploration / Decompression
- Duration of the ventilator support
- Duration of ICU stay
- Duration of post-op hospital stay

E. STATUS ON DISCHARGE

- GOS
- Motor and speech status
- Any other deficit

F. STATUS ON FOLLOW UP ON 3 MONTHS

- GOS
- Motor and speech status
- Any other deficit
- Radiological follow up

श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम
तिरुवनन्तपुरम - ६९५०११, केरल, इंडिया
SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM
Thiruvananthapuram - 695 011, Kerala, India
(An Institute of National Importance under Govt. of India)
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Institutional Ethics Committee
(IEC Regn No. ECR/189/Inst/KL/2013)

SCT/IEC/1038/APRIL-2017

29.05.2017

Dr. Gograj Garhwal
Senior Resident
Department of Neurosurgery
SCTIMST, Thiruvananthapuram

Dear Dr. Gograj Garhwal

The Institutional Ethics Committee reviewed and discussed your application to conduct the study entitled "RETROSPECTIVE STUDY OF OUTCOME OF PATIENTS WITH TENTORIAL MENINGIOMA FOLLOWING MICROSURGICAL RESECTION (IEC/1038)" on 15th April, 2017.

The following documents were reviewed:

Original submission

1. *Covering letter addressed to the Chairperson, IEC, SCTIMST dated 04.04.2017 with check list*
2. *Forwarding letter from HOD dated 04.04.2017*
3. *TAC Approval Letter*
4. *IEC Application Form*
5. *Project Proposal*
6. *Proforma*
7. *Declaration Form*
8. *CV of Principal Investigator and Co-Principal Investigators*

Revised submission

1. *Covering letter addressed to the Chairperson, IEC, SCTIMST dated 22.05.2017 with check list*
2. *TAC Approval Letter*
3. *IEC Application Form*
4. *Copy of forwarding letter from HOD dated 04.04.2017*
5. *Project Proposal*
6. *Proforma*
7. *Copy of Declaration Form*
8. *CV of Principal Investigator and Co-Principal Investigators*

The following members of the Ethics Committee were present at the meeting held on 15th April, 2017 a G. Parthasarathi Board Room, AMCHSS, SCTIMST

SL. No.	Member Name	Highest Degree	Gender	Scientific /Non Scientific	Affiliation with Institution(s)
1.	Dr. R V G Menon	M Tech, PhD	Male	Lay Person (Chairman)	No
2.	Dr. Kala Kesavan. P	MBBS, MD	Female	Basic Medical Scientist	No
3.	Dr. Rema M. N	MD	Female	Basic Medical Scientist	No
4.	Dr. S S Giri Sankar	LL.M. Ph.D.	Male	Legal Expert	No
5.	Dr. Aneesh V Pillai	BA. LLB (Hons.), LLM, Ph. D, SET (Law)	Male	Legal Expert	No
6.	Mr. Satheesh Chandran	MSW, PGDPM	Male	Lay person/ NGO/ Social Scientist	No
7.	Smt. Sathi Nair	MA (English Literature)	Female	Lay Person	No
8.	Dr. P. Manickam	BSMS, MSc (Epid)., PhD.,	Male	Health Science Expert/ Social Scientist	No
9.	Dr. V. Raman Kutty	M D, M Phil, M P H	Male	Health Sciences Expert/Clinician	Yes
10.	Dr. K R S Krishnan	M.E., Ph.D.	Male	Medical Technology	Yes
11	Dr.Harikrishnan S	MD, DM (Cardiology) DNB (Cardiology)	Male	Clinician	Yes
12.	Dr. Mala Ramanathan	PhD	Female	Social Scientist (Member Secretary)	Yes

IEC Decision

The IEC approved the conduct of the study in the present form.

Remarks:
The Institutional Ethics Committee expects to be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent and asks to be provided a copy of the final report.

There was no member of the study team who participated in voting / decision making process. The ethics committee is organized and operated according to the requirements of Good Clinical Practice and the requirements of the Indian Council of Medical Research (ICMR).

Sincerely,

MRamanathan

Mala Ramanathan
Member Secretary, IEC

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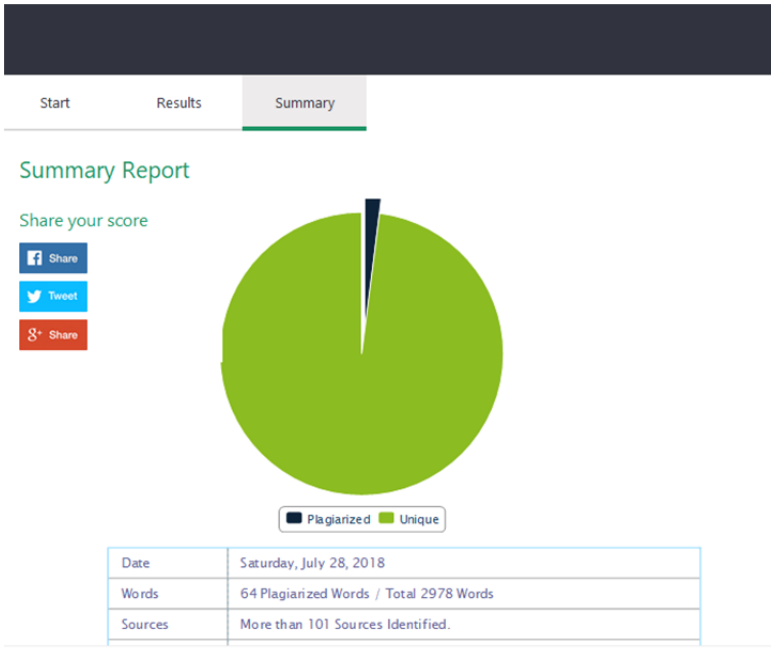

INTRODUCTION:- Meningiomas are encapsulated and benign tumors with limited numbers of genetic aberrations and their intracranial location and relation to adjacent structures often leads to serious and potentially lethal consequences. The tentorial meningiomas are rare intracranial tumor that very commonly tend to enclose, displace, or compress the adjacent neurovascular structures so surgical excision is a challenge(1). Meningioma account for 33.8% of all primary brain(2).

surgeons; however, all surgical approaches have been described in a standardized manner. There is wide range of follow up period and no fixed protocol for follow up. Over all we are comfortable with the reliability of the information that we were able to extract from the medical records, and took care to note when specific data were insufficient. Probably there was also an element of referral bias. Only large prospective study can overcome these weaknesses.

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6	5	4	3	2	1	sl no
63	46	37	73	51	57	age
1	2	2	2	2	1	Gender (M:-1, F:-2)
1	2	2	3	1	2	attachment:- superior:-1, inferior:-2, both:-3
2	2	5	5	3	2	yasargil
2408	5236	1032	2596	2975	95	no. of follow up days
0	0	1	0	1	0	headache(no:-0, yes:-1)
0	0	1	0	0	0	vomiting(no:-0, yes:-1
0	0	1	0	0	0	Blurring of vision(no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	0	diplopia (no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	1	field defect(no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	0	facial pain (no:-0, yes:-1, could not be tested:-2)
1	1	0	0	0	0	facial numbness (no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	0	hearing loss (no:-0, yes:-1, could not be tested:-2)
1	0	0	0	0	1	tinnitus (no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	0	Dysphagia (no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	0	Memory disturbances (no:-0, yes:-1, could not be tested:-2)
0	1	0	1	0	1	Gait ataxia (no:-0, yes:-1, could not be tested:-2)
0	0	0	1	0	0	Vertigo (no:-0, yes:-1, could not be tested:-2)
0	1	0	0	0	0	Hemiparesis (no:-0, yes:-1, could not be tested:-2)
0	0	0	0	1	0	Seizure (no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	0	Disorientation (no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	0	Motor aphasia (no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	0	Decreased visual acuity (no:-0, yes:-1, could not be tested:-2)
0	1	0	1	0	0	Papilledema/optic atrophy (no:-0, yes:-1, could not be tested:-2)
0	1	0	0	0	0	Hemianopia (no:-0, yes:-1, could not be tested:-2)
0	1	0	0	0	1	Nystagmus (no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	0	3rd (no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	0	4th (no:-0, yes:-1, could not be tested:-2)
1	1	0	0	0	0	5th (no:-0, yes:-1, could not be tested:-2)
0	1	0	0	0	0	6th (no:-0, yes:-1, could not be tested:-2)
0	1	0	0	0	0	7th (no:-0, yes:-1, could not be tested:-2)
0	0	0	0	0	0	8th (no:-0, yes:-1, could not be tested:-2)
0	1	0	0	0	0	LCN (no:-0, yes:-1, could not be tested:-2)
0	1	0	1	0	1	Cerebellar sign (no:-0, yes:-1, cnbt:-2
4	7	24	36	12	84	Duration of disease (months)
15	15	15	15	15	15	GCS
5	4	5	5	5	5	GOS
0	1	0	0	0	0	Hydrocephalus (no:-0, yes:-1)
0	0	0	0	0	0	Pre-op CSF drainage (no:-0, vp-shunt:-1, ETV:-2)
45	38	44	36	29	37	Size of tumor (max. diam. In mm)
1	1	0	1	1	1	CT (not done:-0,done:-1)
0	0	0	0	0	0	Calcification:-CT/MRI(no:-0, yes:-1)

1	1	1	1	1	1	1	MRI (not done:-0,done:-1)
1	0	0	0	0	0	0	DSA (not done:-0,done:-1)
1,4							FEEDER(ECA:-1, MCA:2, PCA:-3, MMA:-4, MHT:-5, VA:6, PICA:-7, APhA:-8
0	0	3	2	0	4	4	Sinus involvement/MRV (not involved:-0, CONFLUENCE/TORCULA:-1, TS:-2, SS:-3, TS+SS:-4, Straig
3	3	1	1	4	5	5	Surgical approach :- RMSO:-1, MLSO:-2, Kawase:-3, Poppens:-4, suboccipital:-5, combined:-6
1	1	2	2	1	2	2	(surgical approach(supratentorial:-1, infratentorial:-2, combined:-3)
2	2	1	1	2	2	2	Tentorial base (coagulated:-1, cut/excised:-2)
1	2	2	2	1	1	1	Extent of resection (Simpson's grade of excision)
0	0	0	0	0	0	1	Infection (ssi:-1, meningitis:-2, Osteomyelitis:-3)
0	0	0	0	0	0	0	CSF Leak (no:-0, yes:-1)
0	0	0	1	0	0	0	Pseudomeningocele (no:-0, yes:-1)
0	0	0	1	0	0	0	Hydrocephalus(no:-0, yes:-1)
0	0	0	2	0	0	0	Post-op CSF drainage(VP Shunt:-1, TP Shunt:-2, EVD:-3)
0	0	0	1	0	0	0	Re-exploration(Wound resuturing:-1, bone flap removal:-2, Hematoma evacuation:-3, residual:-4)
0	0	0	0	0	0	0	DVT(No:-0, yes:-1)
0	0	0	0	0	0	0	Bed sore(no:-0, yes:-1)
5	4	4	5	5	5	5	GOS at discharge
5	2	5	5	5	5	5	GOS after 3 months follow
0	0	0	0	0	0	0	cranial nerve 4th
1	1	0	0	0	0	0	5th
0	1	0	0	0	0	0	6th
0	1	0	0	0	0	0	7th
0	0	0	0	0	0	0	8th
0	1	0	0	0	0	0	LCN
6	5b	6	5a	5b	5b	5b	Histopathology (NA:-0,Transitional(T):-1, fibroblastic(F):-2. Angiomatous(A):-3, Meningothelial(M):-4,
2	1	2	1	1	1	1	WHO Grade
0	0	0	1	1	0	0	Residual (No:-0, yes:-1)
1	1	0	0	0	0	0	Recurrence (No:-0, yes:-1)
1	1	0	0	0	0	0	Re-surgery (No:-0, yes:-1)
1	0	0	0	0	0	1	Adjuvant (no:-0, RT:-1, CT:-2, RT+CT:-3)

7	35	1	2	5	2977	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	4	15	5	1	0	61	1	0
8	50	1	1	1	1045	1	1	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	6	15	5	0	0	52	0	0
9	61	2	2	4	2387	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	12	15	5	1	0	54	1	0
10	55	1	2	5	401	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	12	15	5	1	0	54	1	0
11	60	2	1	4		1	1	2	2	2	2	2	2	2	2	2	1	0	0	0	1	1	2	1	0	2	2	2	2	2	2	2	2	2	8	1/7	2	1	2	40	1	0
12	40	2	3	5	2738	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	12	15	5	1	1	41	1	0
13	61	2	2	5	1736	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12	15	5	1	0	55	1	0
14	40	2	2	1	4649	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	6	15	5	1	0	40	1	1
15	55	2	3	1	98	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	15	5	1	0	38	1	0
16	65	2	1	5	987	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	15	5	0	0	46	1	0
17	47	2	3	3	4550	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	24	15	5	1	0	63	1	1
18	44	2	3	1	4572	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12	15	5	1	1	35	1	0
19	53	2	2	2	3952	1	1	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	18	15	5	0	0	56	1	0
20	40	2	1	5	516	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	15	5	0	0	36	1	1
21	40	2	2	5	4522	0	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	8	15	5	1	0	49	0	0
22	44	1	1	1	1710	1	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	24	15	5	1	0	30	1	0
23	42	2	2	5	3702	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	15	5	1	0	38	1	1
24	37	2	3	3	3658	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	15	5	1	0	54	0	0
25	52	2	2	5	1988	1	1	1	0	0	0	1	1	1	1	0	1	0	0	0	0	0	1	1	0	1	0	0	1	0	1	1	1	1	98	15	5	1	0	48	1	1
26	46	1	2	5	2363	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	15	5	0	0	52	1	1
27	41	2	2	3	116	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	12	15	5	1	0	55	1	0
28	54	2	1	4	792	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	15	5	0	0	35	1	0
29	47	2	2	3	94	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	1	18	15	5	1	0	57	1	0
30	44	2	1	2	3730	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	4	15	5	0	0	53	0	0
31	35	1	3	4	522	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	15	5	0	0	67	1	0
32	50	2	3	5	3917	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12	15	5	1	0	47	1	1
33	58	2	2	3	3744	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	6	15	5	1	0	40	0	0
34	46	2	1	5	453	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	24	15	5	0	0	34	1	1
35	56	2	1	5	3625	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2	15	5	1	0	45	0	0
36	48	2	1	3	1687	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	36	15	5	0	0	49	1	1
37	68	2	1	1	1021	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	7	15	5	0	0	80	1	0
38	50	2	1	5	3290	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	36	15	5	1	0	58	1	0
39	76	2	2	3	234	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0	1	18	15	5	0	0	50	1	1

1	0		2	6	3	2	1	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	0	5a	1	0	0	0	0	
1	1	3	3	4	1	1	1	0	0	0	0	0	0	1	0	5								6	2					NO F/U
1	1	4,6	2	5	2	2	3	0	0	1	0	0	0	0	0	5	5	0	0	0	0	0	0	5a	1	0	1	0	0	
1	0		2	1	2	2	2	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	2	1	0	0	0	0	
1	1		0	4	1	2	3	0	0	0	1	0	0	1	0	2								5a	1					DIED:-PTE
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1	0		2	5	2	1	2	0	0	1	0	0	0	0	0	5	5	0	0	0	0	0	0	5a	1	0	0	0	0	
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1	0		0	1	2	1	2	0	0	0	0	0	0	0	0	5	5	0	1	0	0	0	0	1	1	0	1	0	0	
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1	0		2	1	2	1	2	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	7	1	0	0	0	0	

40	42	1	2	3	3345	1	0	1	1	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	12	15	5	1	0	51	0	0
41	55	2	2	3	3572	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	15	5	1	0	40	1	0
42	61	2	2	2	1093	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	1	12	15	5	1	0	33	1	0
43	29	2	2	5	3002	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	24	15	5	0	0	44	1	1
44	44	1	2	3	1256	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	36	15	4	0	0	32	1	0
45	55	2	1	2	723	1	1	0	0	0	0	0	0	0	1	2	0	1	0	1	1	0	2	1	0	0	0	0	0	1	0	0	2	2	1/12	2	1	0	73	1	0
46	48	2	1	5	3109	1	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	15	5	0	0	25	0	0
47	50	2	2	5	1147	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	12	15	5	1	0	49	0	0
48	39	2	2	4	1117	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	6	15	5	0	0	42	1	0
49	62	2	2	2	174	1	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	4	15	5	1	0	28	1	1
50	55	1	2	5	981	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	5	15	5	0	0	40	1	0
51	38	2	2	3	2838	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0	0	0	0	0	0	0	2	36	15	4	1	2	45	1	1
52	57	2	1	2	93	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	12	15	5	1	0	63	1	1
53	33	2	1	5	584	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	2	2	2	2	2	2	2	2	2	2	1/6	2	0	0	63	0	1
54	51	2	2	3	176	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	24	15	5	0	0	34	1	0
55	45	2	2	5	276	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	6	15	5	0	0	38	1	0
56	56	2	1	2		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	15	5	1	0	54	1	0
57	47	2	3	2	2171	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	3	15	5	0	0	50	1	1
58	36	2	3	2	668	0	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	1	1	0	1	0	1	5	15	5	1	1	62	1	1
59	46	2	2	5	2266	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	36	15	5	0	0	39	1	0
60	67	2	1	5	560	0	0	0	0	1	0	0	0	0	0	1	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0.5	15	4	0	0	60	1	1
61	31	2	2	2	2280	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	15	4	0	0	41	1	0
62	48	2	2	5	2070	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	15	5	0	0	36	1	1
63	45	2	2	4	426	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	15	5	0	0	39	0	0
64	49	2	2	5	2132	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	24	15	5	1	0	50	0	0
65	47	1	2	2		0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	3	15	4	1	0	47	1	0
66	54	2	2	5	340	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	15	5	1	0	50	1	0
67	38	1	1	2	2007	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	15	5	0	0	47	1	1
68	53	2	2	5	1294	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	15	5	0	0	41	0	1
69	29	2	2	1	365	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	15	5	1	2	54	0	0
70	48	2	2	5	347	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	15	5	1	0	55	0	0
71	39	2	1	5	1726	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	15	5	0	0	41	0	0
72	55	2	1	2	410	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0.5	15	5	0	0	53	0	0

1	0		0	5	2	2	2	0	0	0	0	0	0	0	0	4	5	0	0	0	0	0	0	1	1	1	0	1	1	
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1	1		0	5	2	1	1	0	0	0	0	0	0	0	0	5	4	0	0	0	0	0	0	10	2	0	1	0	0	
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