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PROJECT REPORT

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LATERAL VENTRICULAR TUMOURS -A CLINICOPATHOLOGICAL STUDY

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Programme :	**M Ch NEUROSURGERY**
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CERTIFICATE

I, Dr. N C Prakash hereby declare that I have actually performed or assisted all the procedures listed under the report.

Place : Thiruvanathapuram **Signature:**

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INTRODUCTION

INTRODUCTION

Tumours that arise within lateral ventricles originate from the normal anatomical structures that define this compartment. Ependymal cells & Choroid plexus—including the cuboidal apical cells,basement membrane & fenestrated capillaries with the stroma of connective tissue are the only structures that are strictly within the ventricles.However, the tissue immediately surrounding the ventricular wall & septum pellucidum(including cells of glial or neuronal origin) can give rise to tumours that may grow preferentially into ventricular space.

Uncommonly, immature cellular elements can be trapped within the ventricle during gestation,resulting in lesions such as teratomas & Epidermoid tumours.Rarely metastatic tumours may be found within the lateral ventricle.

Different pathologies have particular predilection for specific regions of lateral ventricles.An appreciation of the probable site of tumour origin & its vascular supply is helpful in differential diagnosis & is instructive in developing surgical strategies for the treatment.

Division of the lateral ventricles into frontal horn,body,trigone, occipital horn & temporal horn not only defines anatomically distinct regions, but also helps in differential diagnosis of intraventricular tumours based on their site of origin & radiological characteristics.

The Frontal horn is a triangular extension of the ventricular space into frontal lobe white matter,located anterior to foramen of munro,surrounded by genu of corpus callosum anteriorly & superiorly,head of caudate nucleus laterally & the septum pellucidum medially.

Body of lateral ventricle extends from posterior edge of foramen of munro to the point where septum disappears & corpus callosum & fornix meet.It is anatomically defined by the corpus callosum superiorly,septum pellucidum & fornices medially & the caudate nucleus & Dorsomedial nucleus of thalamus laterally & inferiorly.

The Occipital horn is demarcated by splenium of corpus callosum superiorly,the alveus & fimbria of hippocampus medially & tail of caudate,tapetum & longitudinal fasciculus laterally.

The roof of the atrium is formed by the body,splenium & tapetum of corpus calosum.Medial wall is formed by two roughly horizontal

prominences one above another,upper prominence-bulb of corpus callosum overlies forceps major & lower prominence-calcar avis,overlies calcarine sulcus.Floor is formed by collateral trigone overlying collateral sulcus.Lateral wall has an anterior part formed by caudate & a posterior part formed by fibers of tapetum.Anterior wall has crus of fornix medially,pulvinar of thalamus laterally.

Temporal horn ends blindly in an anterior wall that is situated immediately behind amygdaloid nucleus. Floor of temporal horn is formed medially by hippocampus, laterally by collateral eminence. The medial part of roof is formed by inferior surface of thalamus & tail of caudate nucleus. Lateral part of roof is formed by tapetum which sweeps inferiorly to form lateral wall. Tapetum separates temporal horn from optic radiations. The only structure in medial wall is choroidal fissure, situated between infero lateral part of thalamus & fimbria of fornix.

The Choroid fissure is located between the thalamus & fornix along the entire course of C-shaped lateral ventricle from foramen of munro to the inferior choroidal point in the temporal horn.The attached choroids plexus serves as a landmark on the floor of body,anterior wall of trigone & medial wall of temporal horn.

Lateral ventricular tumours represents a major neuro-surgical challenge. These lesions located deep inside the brain must be approached from a considerable distance through normal brain tissue.Dissection & brain retraction should be minimized to avoid damage to important brain structures such as thalamus, caudate nucleus, fornix & others.

In general intraventricular lesious are managed by using microsurgical approaches. Knowledge of tumour vascularity,feeders, approach that traverse the normal parenchyma the least, minimizing the complications to the least possible aid in tackling these tumours. In selected cases a neuro-endoscopic, stereotactic approach supplemented with adjuvant mode of treatment might prove to be as effective as microneurosurgery & less invasive.

OBJECTIVES:

1 Report the experience with lateral ventricular tumours at our institute.

2 Analysis of variety of pathologies that arise in lateral ventricles.

3 Correlation of tumour distribution with the age at presentation & location within the different regions of lateral ventricles.

4 List the modes of presentation of various tumours.

5 Analysis of neuro imaging of modalities, features & their correlation with histology.

6 Assess efficacy approaches, based on tumour location & offer ad options.

7 To address the various complications & their avoidance.

8 Determine the outcome & its correlation with tumour histology & approach.

Review of literature:

A variety of pathologies that arise in lateral ventricle are addressed individually.

CENTRAL NEUROCYTOMA

The term central neurocytoma was coined by Hassoun in 1982 [33,] to describe a neuronal tumour occurring in young adults located in supratentorial ventricles resembling oligodendroglionas or ependymomas on light microscopy. Previously most of central neurocytomas were diagnosed as oligodendroglionas & hence true incidence of neurocytomas is difficult to determine.Differentiated neuroblastoma & intraventricular neuroblastoma have appeared in literature as alternative designations [54]. Given the benign course of this tumour, alternative terms are inappropriate.Barbosa et.al have advocated the general use of intraventricular neurocytoma as the most accurate & descriptive term [3].

BIOLOGICAL BEHAVIOUR

Majority of central neurocytomas are generally benign & have favourable outcome.Some recent reports however provide evidence in favour of biological diversity,especially in cases of extraventricular location [68,75,79].These extraventricular sites include the brain parenchyma[68,69],spinal cord [75],pons & in teratoma of ovary.

Tumours with extraventricular location,those with rapid recurrence,anaplastic variants with rapid progression to death & neurocytomas with spinal dissemination are considered atypical neurocytomas [36].

Although neurocytomas generally do not metastasize or invade brain parenchyma,there are reports of cranio-spinal dissemination [17].Yasargil et al have reported malignant forms of neurocytomas that have endothelial proliferation,focal necrosis & a high mitotic rate [82].Although some studies suggested that histological atypia do not necessarily correlate with clinical outcome [30],it seems proliferation marker indices(Ki-67 labelling or MIB-1) have close correlation with clinical behaviour of neurocytomas [2,41].

Soylemezoglu et al compared 36 patients with neurocytomas-Recurrence rate was 22% in patients with MIB-LI <2% & 63% in patients with MIB-LI >2%.Generally MIB-labelling index is reported to range from 0.1% to 8.6%with majority below 2%.

INCIDENCE & CLINICAL FEATURES

45% of Central neurocytomas are diagnosed between ages 20-30 yrs.85% are diagnosed between 10 & 40 yrs.Mean age at presentation is 29 yrs,with an equal ditribution between sexes.Central neurocytomas are estimated to account for 0.1% to 0.5% of all primary brain tumours.Their incidence may be underestimated because they are only recently been recognized & may have been previously misdiagnosed as Oligodendroglioma or Ependymoma [21,31,50].Central neurocytoma may be the most common lateral ventricular tumours in young adults [48].

Central neurocytoma is almost exclusively located in the body or anterior horns.It typically originates in the midline from the septum pellucidum as a friable vascular but well circumscribed tumour.Origin from thalamus,fornix,caudate nucleus & corpus callosum have also been observed [69,83].

As it fills the lateral ventricles there is variable adhesion along the ependymal surface,with occasional extension into 3rd & even 4th ventricle [61].

The resultant obstructive hudrocephalus accounts for most of the presenting clinical signs & symptoms.Memory loss,personality changes & psychosis from bilateral fornix disruption or bifrontal dysfunction are present in one-

quarter of patients [25].Endocrine abnormality from anterior midline compression has also been described[1,56].Three patients have been reported to have an intraventricular hemorrhage from neurocytomas [51,72].

RADIOLOGY:

CT scan demonstrates an isodense entirely intraventricular well circumscribed tumour. Coarse, scattered calcifications are seen in 50% of cases & ocassional intra tumoural hemorrhage has been observed[81]. Enhancement is mild to moderate & inhomogeneous. Hydrocephalus is almost invariable. Tumour often bows the septum & may extend into the third ventricle. Periventricular edema suggesting invasion of parenchyma is rare.

MRI-Isointense lesion on both T1& T2 with areas of heterogenous intensity being due to tumour calcification, cystic spaces & vascular flow voids within the tumour. MRI appears to out perform CT in demonstrating (a)characteristic attachment of tumour to septum (b) confinement of tumour to ventricles & (c) blood vessels within the tumour. Angiography reveals mildly hypervascular mas with moderate blush persisting into venous phase.

PATHOLOGY:

Light microscopiy demonstrates clusters of uniform, round cells with a central round nucleus & a fine chromatin stippling. Clear cells give the honey comb pattern. Cytoplasma is eosinophillic & fibrillary. Calcification is observed within the tumour ,while it predominates in the periphery in oligodendroglioma. The presence of eosinophillic fibrillary zones helps to distinguish neurocytoma from oligodendroglioma. Perinuclear halos may be present & account for same striking similarity to oligodendroglioma. The chromatic pattern is more delicate than that of either oligodendroglioma or ependymoma.

Further evidence of neuronal differentiation includes the presence of neurites on silver impregnation & immunoreactivity for synaptophysin.

Synaptophysin is a glycoprotein of the synaptic vesicle membrane spread around diffusely in a tumour cell neuropile. The immunostaining for synaptophysin & its characteristic repartition between cells is highly specific for neurocytomas[24]. Neuron specific enolase (NSE) is a major neuronal protein whose appearance correlates with neuronal maturity. In contrast to oligodendroglioma & ependymoma, there is a general absence of GFAP staining; except for reactive astrocytes at the periphery. An ultrastructural

neuronal phenotype consisting of micro tubules, dense vesicles, neuro secretory granules & synapses is diagnostic.

Based on anotomical origin & histologic neuronal lineage,neurocytomas are believed to arise from the granular neurons of the small gray nuclei in the septum pellucidum or the neuronal remnants of the sub-ependymal plate of lateral ventricles.

MANAGEMENT & PROGNOSIS:

Treatment generally includes micro-surgical resection & alleviation of the associated hydrocephalus. Gross total resection, where feasible, may achieve a cure or long term control in majority of patients. Most authors agree that post-operative radiation therapy is not indicated if a gross total resection is accomplished[2,47,66]. When residual tumour or recurrence is present,the question of whether to administer Radiotherapy becomes more complex.

Many authors have suggested immediate post-operative radiation therapy for patients with subtotally resected tumours[30,80].In the largest published seriesof central neurocytomas[53], effects of radiotherapy are compared. 5yr local control rates were - 100% with radiotherapy after subtotal resection compared with 50% for those who did not receive radiotherapy(p=.02)

Corresponding survival rates were (5 yr) – 88% & 71% respectively. Post – operative raditherapy has shown to reduce tumour volume & contrast enhancement. Although there was no specifically significant difference in overall survival, results suggest that these tumours are sensitive to RT. Other authors have critisized use of radiation, however,stating that although these tumours may be radiosensitive, carries increased risk of radiation injury but does not provide any clinical benefit[32,49,67].

The current data in the literature do not demonstrate unequivocally that radiotherapy is required because there are reports of patients with extended periods of stable disease (2-7yr) without radiotherapy after total or subtotal resection[54,64,78]. Before 1990, when neurocytomas were initially diagnosed as intraventricular oligodendrogliomas or ependymomas, underwentradiotherapy. However as the more benign nature of neurocytomas became increasingly clear, the frequency of adjuvant radiotherapy diminished, even after STR. There are few reported cases of neurocytomas treated with steriotactic radiosurgery. Bertalansky et al[4] have used gamma knife in 3 patients with recurrence after gross total recurrence. Tumour control was achieved in all cases , significant decrease in tumour volume was seen in all three cases. Neurocytomas have good vascularization, which seems to be responsible for excellent response. Other

effect seems to be direct damage to tumour itself.Neurocytomas are surrounded by CSF & only a small part of tumour has contact with brain tissue.This makes them ideal target for gamma knife radiosurgery.

Lomustine has been tried in treatment of neurocytomas with no significant benefit[36].

V Rajashekhar et al have treated 8 patients with Steriotactic biopsy followed by radiation therapy. 6 patients were found to have good local control & are well & symptom free after 78 months[36].

SUBEPENDYMAL GIANT CELL ASTROCYTOMA:

SEGA is a tumour of lateral ventricle classically associated with tuberous sclerosis. Tuberous sclerosis has a prevalence of about 1 in 10000 & SEGA has been reported in 3-14% of these patients.

SEGA is the most common tumour found with TSC. The others include cerebral hemangioma,spongioblastoma,neurilemmoma & ependymoma[11].

Tuberous selerosis complex or Bournvilles disease is a genetic disorder with AD penetrance characterized by the development of hamartomas in multiple organs.The defective gene is located on long arm of chromosome 9.The brain, kidneys, skin, retina & heart are most often affected. Most patients present with seizures & die because of renal or intracranial lesions.

The earliest clinical feature of TSC which can be detected at birth is depigmented skin macule--most often polygonal in shape, are characteristically Ash leaf or Confetti shaped.Later patients develop facial angiofibromas (Adenoma sebaceum),subungalangiofibromas of finger& toes & Shagreen patches.

Seizures, mental retardation – neonate with TS is often neurologically normal. Later delayed mile – stones may be noted, within 2-3 yrs, seizures, mental retardation become evident. Learning disabilities, impaired social & communication skills, obsessive & hyperactive behavior & schizophrenia may also be prominent features.

Cortical tubers are the most common manifestations of TSC in brain & are most frequently found in frontal lobes along the gray – white matter junction. Sub-ependymal modules are periventricular hamartomas 1 –10 mm in diameter. They are composed of abnormal glial & vascular tissue blanketed by ependymal cells.

SEGA derive directly from overgrowth of sub-ependymal nodules. They represent the most common intraventricular tumour in TSC, but may also appear within the parenchyma secondary to malignant degeneration of a cortical tuber. They typically arise from the terminal sulcus near foramen of munro.

They usually present in early teenage years (range 1 – 31 yrs with Av – 13 yrs) with obstructive hydrocephalus or seizures. How SEGA provokes worsening of seizures is unclear. While tubers can apparently act as a seizure foci, it is unlikely that SEGA provokes seizure onset, although hydrocephalus may exaceberate a pre-existing seizure disorder. Di–roco et al have experimentally demonstrated that increased ICP favours activity of an epileptic focus[14].

IMAGING -- CT – scan shows shows an isodense to slightly hypodense tumour that has variable calcification. MRI shows a heterogenous intensity lesion , predominantly hypo on T1 & hyper on T2. they are differentiated from sub-ependymal nodules by their increased size & copious contrast enhancement. Imaging may show cortical tubers & sub-ependymal nodules.

Pathologically, SEGA's are distinct from other astrocytomas. Firstly they are not infiltrative & nearly always intraventricular. Second, the identification of features suggestive of malignancy such as atypia, mitoses, endothelial proliferation & necrosis does not necessarily correlate with poor prognosis. Third, bizarre eosinophillic, uninucleate giant cells, an angiomatous appearance, perivascular pseudo rosettes & psammomatous calcification are typical features. Astrocytic or neuronal origin of this tumour remains controversial. Positive staining with GFAP is seen in most cases. Some

show immunoreactivity for neuron-specific enolase & for neurofilament protein suggesting they may have a neuronal component.

MANAGEMENT:

It has been observed that these tumour increase in volume simultaneously to patients growth & often stabilize after puberty.Consequently older children & adolescents are the preferred age group for surgery.

Obstructive hydrocephalus is a mandatory surgical indication. VP CSF shunt has a major risk of obstruction probably related to high CSF-protein level. Direct surgical removal has the advantage of assuring a normal CSF circulation & obtaining a histological diagnosis. Complete surgical excision is the preferred treatment. But as tumour tends to stop growth after puberty, even a partial resection, restoring CSF circulation can be considered satisfactory[5].

Surgical therapy for epilepsy is rarely indicated[14,71].Improvement in epileptic symptomatology has been observed. Surgery is not accompanied by improvement in psychomotor performance. The use of adjuvant therapies for SEGA has only been anecdotally reported. None of these reports documented a significant positive response to radiotherapy. There are

isolated reports of SEGA occurring without other evidence of TSC--Bonin,Chow et al[11]. But this may represent variable expression of the gene.

SUBEPENDYMOMA:

Rare, slow growing, non-invasive benign tumour located within the ventricular system. Fourth ventricle is the most common site of occurrence followed by lateral ventricles with a rate of supratentorial vs infratentorial location of 3/7. They are more frequently found at autopsy (approx 0.4%) or incidentally at radiological investigation. Only 37% become symptomatic causing CSF flow obstruction, focal neurologic deficit or hemorrhage.

Although origin of subependymoma is uncertain, ultrastructural studies indicate that cell of origin may be the bipotential sub ependymal cells which normally differentiates into ependymal cells or astrocytes[10,39]. Growth into ventricular lumen,lobular architecture,sharp demarcation of underlying brain are characteristic of pure SE & distinguish it from ependymona & mixed ependymona-sub ependymona type which show parenchymal infiltration & loss of demarcation. The scarce vascularization differentiates it from highly vascular central neurocytoma.

It is positive for S-100 & GFAP. Natural history of SE is not well defined, but about 40% undergo slow but progressive growth & become symptomatic. On CT they appear isodense with scarce but homogenous contrast enhancement. Calcification may be seen in 30% & cyst in 25%. On MRI they are iso on T1 & hyper on T2. Surgical treatment is indicated for symptomatic cases & even subtotal removal may result in favourable outcome in most cases. Value of radiotherapy after incomplete removal is not proven & is denied by some authors[40].

CHOROID PLEXUS TUMOURS:

The first description of lateral ventricular CPP was attributed to Guerard in 1833. Choroids plexus tumours are the most common lateral ventricular tumours in children. The overall incidence 0.4-0.6% & in children – 4%. Most are diagnosed in first 5 years & they represent up to 14% of brain tumours in infants.

In children majority are located in lateral ventricle & in adults 4th ventricle is the commonest site. Most are benign papillomas. Although up to 26% are malignant carcinomas[16]. They are usually located in the trigone where choroids plexus is most abundant. Occasionally (7%) they may be bilateral[23].

Most common clinical presentation involves signs & symptoms of hydrocephalus. In Ellenbogen's series- 18% presented with seizures & 20% with hemiparesis.

Increased head circumference, irritability, vomiting & lethargy are usual features in children. However, developmental delays & regression are under-recognized as pointed out by Lena et al[38]. The obstruction of CSF pathways by large tumours, proteinecious CSF resulting from tumour hemorrhage & the overproduction of CSF from the tumour may all contribute to hydrocephalus.

IMAGING-- On CT , CPP are hyper dense to brain & 25% have some degree of calcification[52]. On MRI – lobulated mass which is isointense on T1 & slightly hyperintense on T2. They enhance intensely & homogenously on contrast. Features which suggest Choroid plexus carcinoma(CPC) include

1) Subarachanoid seeding 2) Ependymal disruption from brain invasion

3) Vasogenic edema 4) Cyst formation & 5) Heterogenous enhancement.

Angiography visualizes the feeding vascular pedicles. Trigonal CPP are fed by lateral posterior choroidal artery.

PATHOLOGY:

They are pink to purple with cauliflower appearance. Surface has a frond like irregularity. They are soft friable & very vascular lesions.

Microscopically, composed of numerous delicate papillae covered with simple cuboidal or columnal epithelium. Differentiating feature from normal choloid plexus are cellular elongation & crowding as well as variable shape & location of nuclei. Histologic criteria for CPC are--Parenchymal invasion, necrosis, mitosis, dense cellularity, loss of pappilary architecture. Atypical CPP are those with high mitotic index (1-10/40 hpf), enlarged & irregular nuclei with hyperchromasia.

Inverted CPP have a dark purple surface covered with white lining & are associated with large multiple cysts.

MANAGEMENT:

Patients with CPP are generally cured after total resection. Recurrence rate is <10% after total resection, but 50% are STR. Major surgical risks revolve around the tumour vascularity & the common presence of hydrocephalus. Early obliteration of tumour pellicle is the most crucial step in surgical procedure.

A complete tumour resection does not obviate the need for a diversionary procedure. MG najib et al have used continuous CSF drainage for at least 72 hrs as this allows the surgical debris to drain & surgical corridor to seal. Need for a permanent shunt is based on clinical alterations, ventricular enlargement & more recently, changes in MRI flow velocities study once

drain is clamped. Post-operative Subdural effusions are quite common in patients with massive hydrocephalus & thin cortical mantle.

Filling the ventricular system with physiologic saline, pre-operative VP shunts & use of ventricular drains have all been suggested[6]. Boyd suggested closing the pia around cortical incision[6]. Post-operative radiotherapy remains controversial. It should be reserved for recurrent tumours after complete documented resection[45], older children with unresectable lesion, disseminated CSF disease & CPC.

Recent reports have shown potential benefits of neo-adjuvant chemotherapy in CPC[75]. St. clair et al has reported that pre-operative chemotherapy reduces size & vascularity of CPC[75], thereby allowing complete resection. Role of therapeutic angiography for tumour embolization is controversial at best. Technical difficulty in manipulation of catheters through narrow & tortuous vessels is the main reason for failure. Overall 5 yr survival rate is 88% for CPP & 30-50% for CPC.

GLIOMAS:

Overall gliomas comprise the largest group of lateral ventricular tumours. In addition to choroid plexus tumours, astrocytomas, ependymomas & oligodendrogliomas also occur in lateral ventricles. According to Piepmer et al these tumours comprise nearly 50% of tumours in the lateral ventricle.

Astrocytic tumours are seen in tissues around the ventricles & invading into them. The most common site for tumours which develop a large amount of mass within the ventricle is the thalamus.

Presenting signs & symptoms is dependent on the location & degree of brain infiltration. Tumours in frontal area may cause subtle behavioral changes or headache. In dominant hemisphere, varying degrees of language dysfunction occurs. Lesions in thalamus present with hemiparesis. Occasionally some sensory deficit. Tumours around the occipital horn cause visual defects.

They exhibit a spectrum of differentiation from low grade tumours to glioblastomas. In children & young adults, intraventricular astrocytomas are more common[56]. In older adults, anaplastic astrocytomas & glioblastmas predominate.

On CT low grade astrocytomas are seen as areas of poorly marginated, low attention areas with minimal mass effect. High grade astrcytomas have more varied pattern of attention. Surrounding white matter edema is more common as are hemorrhage, cyst formation & necrosis. Low grade tumours show little or no contrast enhancement, where as glioblastomas & anaplastic astrocytomas have thick irregular areas of enhancement.MRI is helpful in evaluating the degree of differentiation of the astrocytomas.

MANAGEMENT:

There is some disagreement as to best therapy for astrocytomas, particularly the low grade ones. It is essential to have tissue diagnosis which can be obtained by stereotactic biopsy.

If there is an indication to debunk the lesion to diminish increased pressure or perhaps to restore communication in the ventricular system, open surgery should be done.

None of these tumours are totally respectable. Following surgery If the tumour is very well differentiated, patients can be observed until there is evidence of tumour growth or change in appearance on imaging. At that time radiation therapy & chemotherapy can be started. When tumours are found to have anaplastic astrocytomas or glioblastomas, radiation therapy & chemotherapy should be promptly started.

EPENDYMOMAS:

Ependymal neoplasmas account for nearly 5% of primary intracranial brain tumours.Approximately 1/3 occur supratentorially & 2/3 occur

Infratentorially. Most supratentorial ependymomas are located in the periventricular areas. 35% are mostly or entirely intraventricular[18]. Most common site being trigone. They most commonly occur in older children &

young adults[27]. Atleast half the ependymal neoplasmas occur in first 2 decades. Supratentorial ependymonas show a clear male preponderance.

Most patients present with features of increased intracranial pressure. Seizures are described in 1/3 of patients.

Incidence of subarachnoid seeding is very rare compared with 5-17% incidence of infratentorial ependymonas.

Infratentorial ependymonas are more solid, while those occuring supratentorially have more cystic components.

MANAGEMENT:

Microsurgical total resection followed by radiation therapy is the ideal treatment. Recommended dose of radiation is 45-60 Gy over 5-6 weeks. Prophylactic radiotherapy to craniospinal axis is not recommended. Role of chemotherapy is uncertain, however it has been reported to delay recurrence, although cure rate is not increased.

Prognosis:

In adult series of Ringertz & Reymond, 5yr survival was – 31% for supratentorial & 33% for infratentorial tumours.Dohrman et al[15],in childhood, ependymonas reported 5yr survival of 27% of supratentorial & 10% for infratentorial tumours. Philips et al reported 5yr survival of 80% for

supratentorial & 50-60% for infratentorial tumours. All these patients received 4500 rad or more of radiotherapy.

2 most important prognostic factors for survival are 1) Tumour grade &

2) Presence of residual tumour on post operative scan.

OLIGODENDROGLIOMAS:

Oligodendrogliomas occasionally arise within the lateral ventricle. The true incidence is unknown since many of the previously reported tumours are likely to be neurocytomas.

Peak incidence of occurence is in the third decade, a slightly younger population than hemispheric oligodendrogliomas.

Intraventricular oligodendrogliomas are usually in midline, in the body of lateral ventricle. They most often present with features of raised intracranial pressure rather than hemispheric dysfunction.

Intraventricular oligodendrogliomas share may characteristics of astrocytoma. On CT they appear as lesions of low attention often with diffuse calcification & variable contrast enhancement. MRI picture is very similar to the astrocytomas.

MANAGEMENT:

As these lesions are well demarcated,they are amenable to complete resection[29]. In the very well differentiated tumour with little or no astrocytic component, following total removal, majority can be observed with serial imaging. When there is evidence of recurrence or significant astrocytic components radiation therapy is indicated.

MENINGIOMAS:

Menengiomas are the most common tumours within the trigone of lateral ventricles in adults, occasionally extending into temporal horn[44,46].

They represent 0.5 to 5% of all intracranial meningiomas[63]. Intraventricular menengiomas constitute 20 – 30% of all adult intraventricular tumours.

There is predilection for females & on the left side.

Age at presentation is typically in the fifth decade. In children meningiomas are less common but when they occur, upto 17% are intraventricular[13]. A significant percentage (24%) of children with Intraventricular meningiomas have NF-II.

Origin: Intraventricular meningiomas are thought arise from the arachnoid cells which are brought into ventricular system during gestational development. During 5th wk of gestation, the arachnoid elements of the

leptomeningis inviginate into the the ventricular system via the tela choroidea to form choroids plexus & the tela conjunctiva around intracranial vessels.Consequently majority of Intraventricular meningiomas arise in trigone. Some tumours which have no contact with choroid plexus but are suspended on vascular pedicles.These could have originated from tela conjunctiva.

CLINICAL FEATURES-- Headache, personality changes & visual changes are the usual presenting symptoms. Homonymous hemianopia & hemiparesis related to compression of surrounding white matter are the most common signs. Seizures occur in 15-20% of cases.

IMAGING--Characteristics are similar to meningiomas elsewhere, with exception that upto 60% show calcification on CT[28] versus 20% for other intracranial meningiomas52. Occasionally sausage shaped thickening may be seen from involvement of entire length of choroid plexus. Large tumours have peritumoral edema which are thought to be related to the disruption of ependyma. Angiography reveals dilated choroidal pedicle which feels tumour.

MANAGEMENT:

Intraventricular meningiomas are encapsulated & predominantly meningothelial or fibrous & generally do not recur. Total removal is the goal of treatment. This is now routnely accomplished by a microscopic piecemeal fashion,without 10-25% operative mortality reported in older series[7], much of which was due to bleeding or hemispheric injury associated with enbloc resection of large tumours[19]. Adequate control of vascular pedicle, which contains both feeding vessel & venous outflow is of paramount importance.

COMMON SURGICAL APPROACHES & COMPLICATIONS:

The diversity of types of lesion, sites of attachment, vascular supply & lateralization in dominant or non-dominant hemispheres are problems that must be addressed in planning an operative approach. Optimal surgical approach is one which 1) Exposes lesion adequately with minimal brain retraction.2) Traverse minimal parenchyma.

3) Provide early access to blood supply.

The operative approaches to lateral ventricle are divided into 1) Anterior

2) Posterior 3) Lateral[60].

Anterior approaches are 1) Anterior transcallosal & 2) Anterior transcortical.

Posterior approaches are 1) Posterior transcoretical & 2) post transcallosal.

Lateral approaches are 1) Temporal & 2) sub-temporal.

They are also generally divided into transcortial & transcallosal.

Transcortical approach often provides the shortest distance to lesion, particularly for tumours within the trigone & temporal horn, but it also risks significant neurological deficits & seizure. When the lesion involves the right lateral ventricle, this approach may be more acceptable.

Middle frontal gyrus approach along its long axis is used for tumours within frontal horn or in anterior portion of body of ventricle. Trans cortical approach is facilitated if the lateral ventricles are enlarged. It is more difficult to expose the opposite side ventricle through transcortical than transcallosal route.In the dominant hemisphere it may result in speech problems(eg:- speech apraxia) even when Broca's area is not disturbed.

Posterior transcortical-parietal approach is utilized for tumours within the trigone & posterior part of body. The cortex is incised in a long axis of superior parietal lobule in the region behind post central sulcus, preferably in a sulcus crossing the lobule. Incision extends from post central fissure to parieto-occipital fissure approximately 3cm from falx & lies medial to majority of visual fibers & parallels their projection.

However visual field loss is a significant problem[19]. Other deficits within the dominant hemisphere include, apraxia, acalculia & deficits in visual spatial

processing. In non-dominant hemisphere they are limited to those in visual-spatial processing. With this approach, blood loss from piecemeal resection must be accepted until the tumour can be resected to the point that it can be gently displaced to allow control of the feeding vessels.

Transtemporal & sub-temporal route. They are used for lesions in the middle or posterior third of temporal horn or lower part of atrium. Cortical incision is through middle temporal gyrus anterior to optic radiations.

An alternative route which minimizes the possibility of damage to optic radiations & speech centers is sub-temporal route in which incision is made in inferior temporal gyrus or occipito temporal gyrus or collateral sulcus.

Lower the approach, the more readily accessible is the anterior choroidal supply to tumours arising in the trigonal area. It is often possible to slip beneath tumours such as meningiomas, after partially debulking them to pick up the medial blood supply from lateral posterior choroidal vessels.

Trans callosal approaches – Anterior & Posterior.

This approach has been utilized since Kempe & Baylock in 1976 reported no new neurologic deficits in 3 patients.

Anterior callosal approach is utilized for lesions within the body & post part of frontal horn. Lesions within the superior part of frontal horn cannot be approached with this approach.

Posterior trans callosal approach is seldom used because of the problem of significant bridging views traversing the field. It is best suited for lesions that extend upward from the atrium or third ventricle through posterior part of Splenium. For approach to atrium, incision is made in the cingulate gyrus behind the postero superior part of corps callosum.

When the callosotomy is limited to anterior-2/3 of the body & genu, transcallosal approach allows the least permanent neurological sequale in reaching the body of lateral ventricle. Memory deficits are most commonly reported following callostomy. However most report that memory deficits are trivial & transient unless fornices are disrupted. Transient disconnection syndrome may occur after callosotomy which includes, mutism, akinesia, apathy, unilateral weakness (leg more than arm), forced grasping, fixed gaze, disinhibition, incontinence & right-left confusion.

Speech & memory deficits following callosotomy are more commonly due to retraction or resection of cortex. Sectioning of splenium in presence of dominent hemianopia can result in alexia. Transcallosal surgery may also be problematic in patients with prior childhood brain injuries which cause functional disorganization & subsequent reliance on inter callosal co-operation. In summary partial section of callosal body sparing splenium or

both splenium & genu, is relatively benign procedure with respect to cognitive functioning.

Since trans callosal approach provides access to both ventricles, lesions located laterally in the body or toward the trigone can be resected through contra lateral callosal approach[37]. It allows for more lateral angle & avoids excessive retraction. Further it allows the left trigone to be approached transcallosally without dominant cortical incision. However potential for bilateral damage is a serious consideration.

While total resection remains the surgical objective, for most ventricular tumours, incomplete removal may be preferable when deep structures such as thalamus is involved or anatomy is grossly distorted. The degree of vascularity may also limit resection. Incomplete surgical resections occur in 33% to 50% of reported cases[56].

Removal of large ventricular tumour & CSF drainage can cause hemispheres to collapse. Replacing air with warm irrigation fluid will reduce the amount of collapse. However sub-dural collection can still occur by persistent ventriculo sub-dural fistula. upto 18% of patients with CPP have required subdural shunt[6].

HYDROCEPHALUS:

Persistent hydrocephalus, even following total tumour removal, is common. In children, the rate of shunt placement following resection of CPP is between 37% & 78%[16]. It is likely that hydrocephalus in young children permanently affects dynamics of CSF reabsorption, despite restoration of normal CSF pathways.

Intra-operative ultrasound can be used for 1) confirming appropriate trajectory for sub cortical dissection. 2) Defining the extent of tumour with respect to operative exposure.

ENDOSCOPY : It can be helpful to examine regions within the ventricle that may contain residual tumour or confirm adequate hemostasis.In general endoscopy is not adequate for removal of lesions other than relatively small cystic tumours. In selected cases, endoscopy is helpful for diagnostic biopsies of tumours.

MATERIALS & METHODS

The patients included in this analysis are 68 cases of lateral ventricular tumours operated in Sree Chitra Tirunal Institute of Medical Sciences & Technology over a period of 15 years between January 1988 to December 2002. The data was analysed & tabulated for incidences, clinical features, specific location within lateral ventricle,radiologic fatures, various appraoaches,histology, follow-up,mortality & morbidity.

CT Scan was done in all cases, MRI in 20 cases & DSA in 7 cases.

All patients underwent surgery with one patient undergoing shunt only.

20 patients were lost for follow-up. Mean period of follow-up was 3 years.Frozen section, microscopy & immunohistochemical studies were major modes of pathological analysis.All cases of central neurocytomas were subjected to synaptophysin immunohistichemistry.Mortality & morbidity in relation to diagnosis, location & approach were analysed.

This study of Lateral ventricular tumours was done retrospectively for 13 years & prospectively for 2 years, spanning a period of 15 years.

68 Lateral ventricular tumours were operated during this period in our institute.

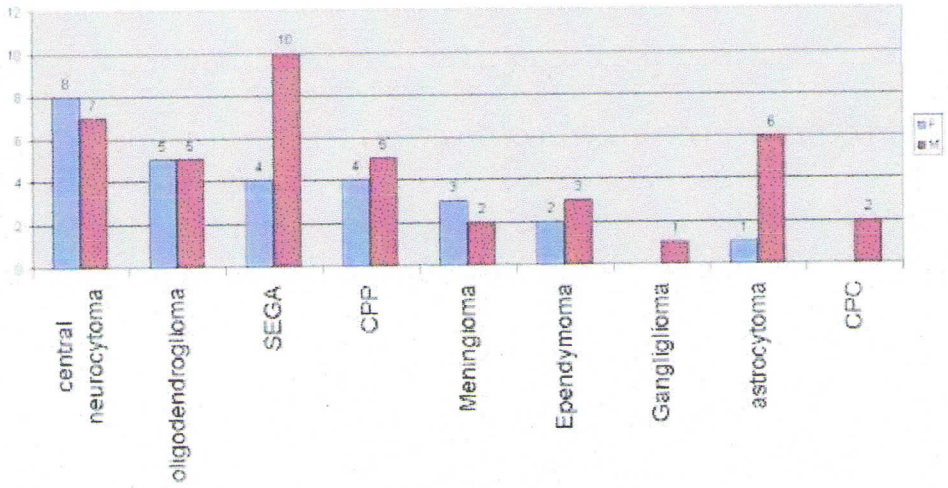
AGE INCIDENCE

Age incidence ranged from 1year to 62 years with mean age of 21.09 years.

SEX INCIDENCE

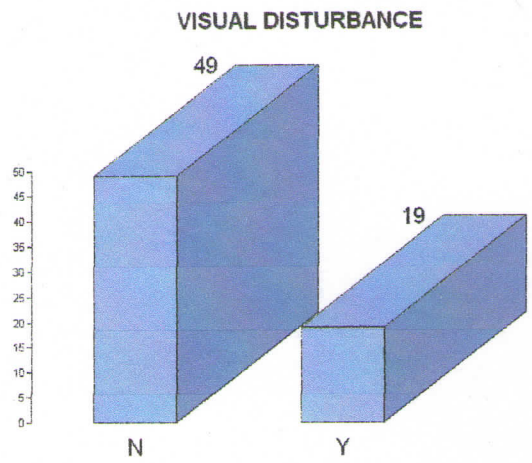
Male to Female ratio was 41:27 in our study.Subependymal giant cell astrocytoma, Choroid plexus tumours, Ependymoma & astrocytoma showed male preponderance & Meningioma showed female preponderance.

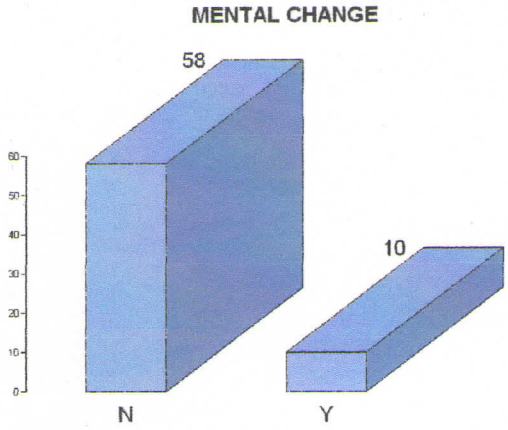
SEX DISTRIBUTION



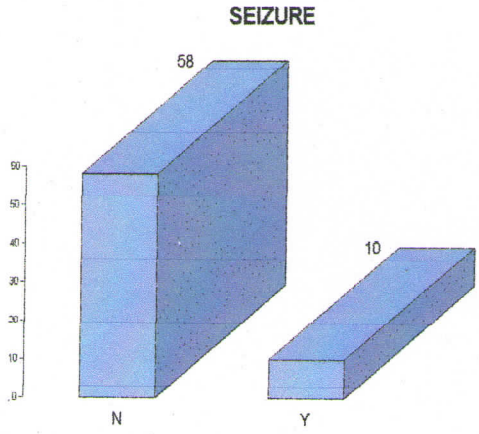
CLINICAL PRESENTATION

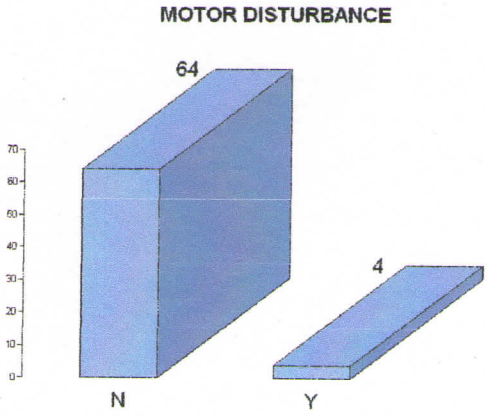
Duration of symptoms ranged from 1 week to 6 years with a mean of 8.6 months.





Raised ICP features were the most common presenting feature with 53(78%) patients presenting with raised ICP features. Visual disturbance was seen in 19(28%) of patients,predominantly in the form of blurring of vision & 7 patients presenting with diplopia & 3 patients presenting with fieldcuts.Blurring of vision was predominantly seen in patients with central neurocytoma & field cut was seen in patients with trigonal meningioma





Mental changes in the form of memory disturbance or behavioural disturbance was present in 10(14.7%) of patients.One patient presented with loss of conciousness.Mental changes were more common in patients with central neurocytoma & astrocytoma.10 (14.7%) patients presented with seizure, all with generalized tonic-clonic convulsions,which included 3

patients of SEGA, 2 each with central neurocytoma,astrocytoma & Choroid plexus carcinoma. & 1 patient with choroids plexus papilloma.

4 (6.6%) patients presented with motor disturbance in the form of hemiparesis.

There were 12 children aged <5 years & increased head circumference was the most common presenting feature in them.

Other presenting symptoms in patients with lateral ventricular tumours included CSF Rhinorrhea, Gait unsteadiness, Diplopia, Impotence, polyphagia, urinary incontinence & upper limb tremors.

Among 14 patients with SEGA, all of them had neurocutaneous markers.Facial angiofibroma was seen in all 14 patient,cortical tubers & subependymal nodules were seen in 2 pateints each.

IMAGING

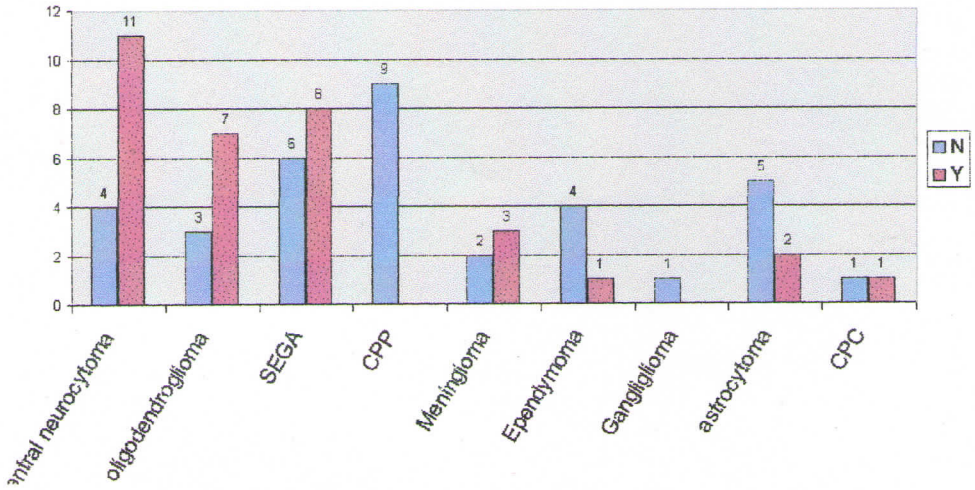
CT Scan was done in all cases.

Central neurocytomas were predominantly hypo to isodense on plain scan & enhancing moderately & inhomogenously on contrast. Oligodendrogliomas were isodense on plain & enhancing variably on contrast. SEGAs were iso to slightly hypodense with copious contrast enhancement.Choroid plexus papilloma were predominantly isodense with bright homogenous contrast enhancement.Meningiomas were iso to hyperdense tumours with intense enhancement.Ependymomas were isodense tumours with areas of cystic changes, enhancing inhomogenously on contrast.1 case of ganglioglioma operated in our analysis was isodense on plain with good contrast

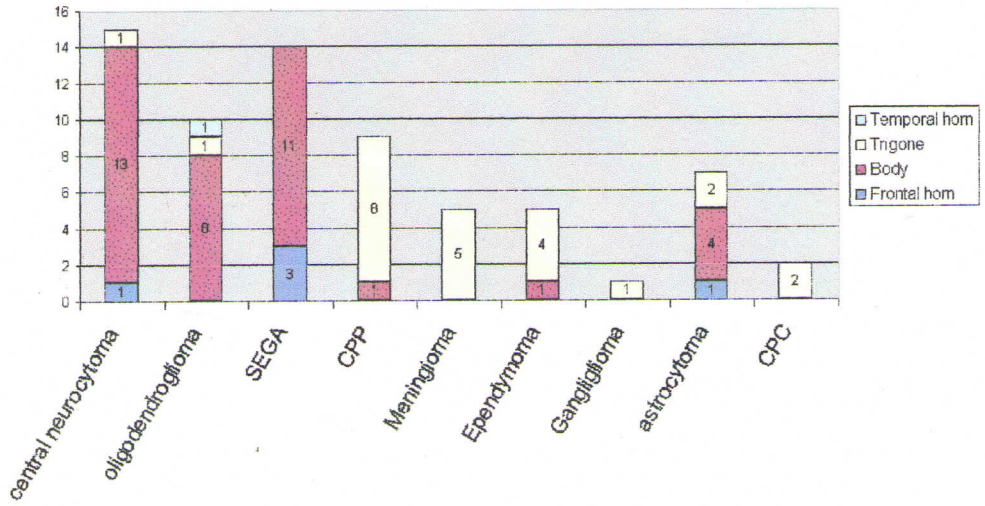
enhancement & calcification.Astrocytomas were hypo to isodense with variable contrast enhancement & areas of necrosis. Choroid plexus carcinomas in addition to intense enhancement had adjacent parenchymal edema.

The incidence of calcification in lateral ventricular tumours was as presented in chart.

CALCIFICATION



LOCATION OF TUMOURS



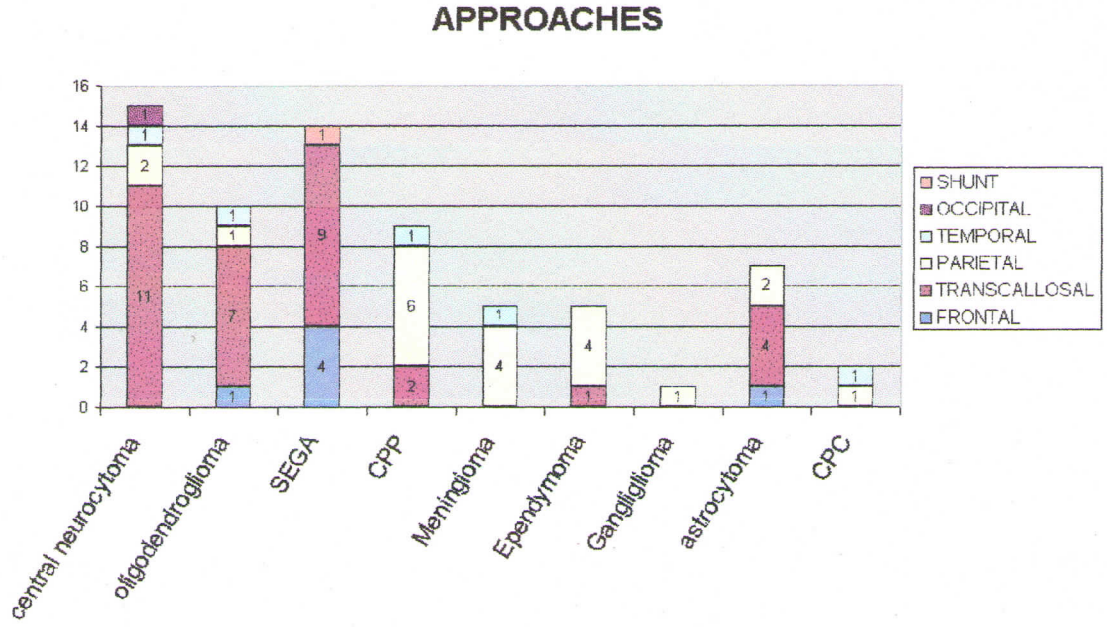
Hydrocephalus was seen in 66(97%) of cases.one case each of SEGA & astrocytoma presented without evidense of hydrocephalus.

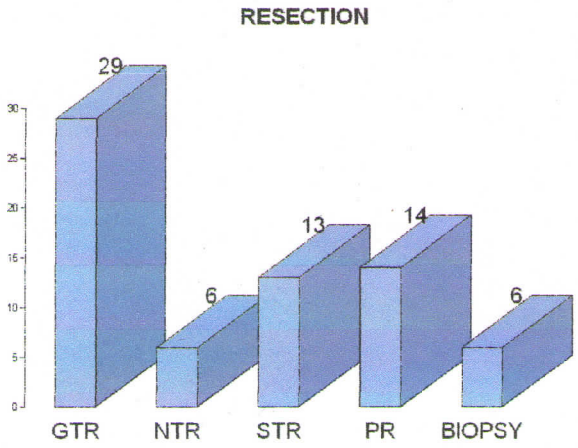
MRI was done in 20 patients as affordability was a limiting factor in many.DSA was done in 7 cases, all in trigonal tumours.All 7 had feeders from posterior choroidal arteries with 3 having feeder from anterior choroidal artery as well.

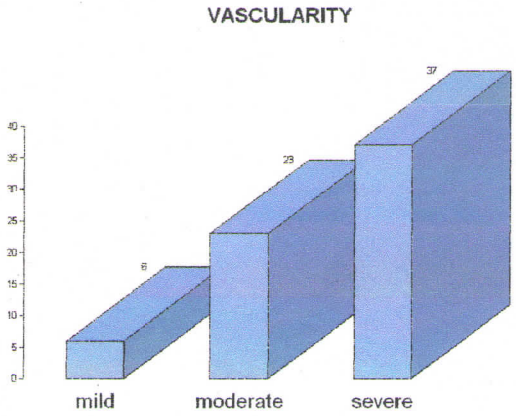
APPROACH

Tumours were located in body—38(56%), & Trigone-24(35%) predominantly. 5(7.5%) were located in frontal horn & 1(1.4%) in temporal horn.Correspondingly 34(50%) were approached Transcallosally,21(31%) were approached through parietal cortical approach.6(8.8%) were operated through frontal transcortical route & 5(7.3%) through middle temporal gyrus route.1 patient of trigonal neurocytoma with predominant occipital horn extension who had homonymous hemianopia was approached through occipital route. 1 patient with SEGA underwent shunt for hydrocephalus & refused surgery.On follow up there is no increase in size of tumour. Gross total resection could be done in 29(43%) & near total resection in 6(8.8%) of patients.Gross total resection was done in 23 (66%) of cases done after 1995 which can be attribyted to better imaging modalities & improved surgical techniques.GTR was possible in all (100%) ependymomas& Meningiomas, & 81% cases of choroids plexus tumours.

Subtotal resection & Partial resection were done in 13(19%) cases each.In 6 (8.8%) patients only biopsy was done due to high vascularity, among which 1 patient with choroids plexus papilloma underwent reexploration where in GTR was done.







Majority (54%) of tumours were highly vascular.

In 14 patients definitive feeder could be identified & coagulated in early part of surgery. Gross total/near total resection was possible in all cases & incidence of complications was also least in this group of patients.

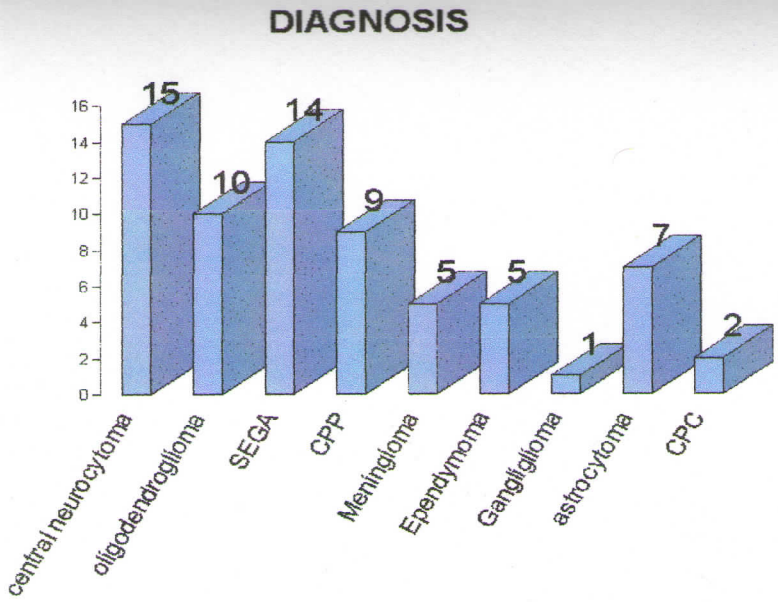
CSF DIVERSION

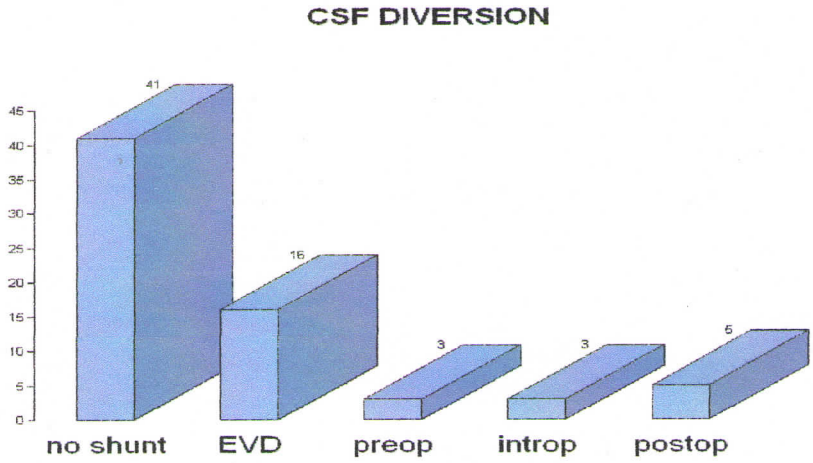
14(20.5%) patients required CSF shunting. 3 of them required preoperatively & 3 along with definitive surgery. 8 pateints required post operatively, & 2 children operated for Choroid plexus papilloma required subduro peritoneal shunt.

DIAGNOSIS

Most common lateral ventricular tumour in general was Central neurocytoma.Most common tumour in <5 year age group was Choroid plexus papilloma. In > 30 year age group patients,most common trigonal tumour was meningioma.

. Synaptophysin Immunohistochemistry was done to confirm diagnosis all central neurocytomas.Among them 3 cases were initially diagnosed as oligodendrogliomas & subsequently turned out to be neurocytomas.1 case was diagnosed as liponeurocytoma of lateral ventricle.Liponeurocytomas are usually described in cerebellum & there are only 3 previous reports of liponeurocytoma in lateral ventricle.



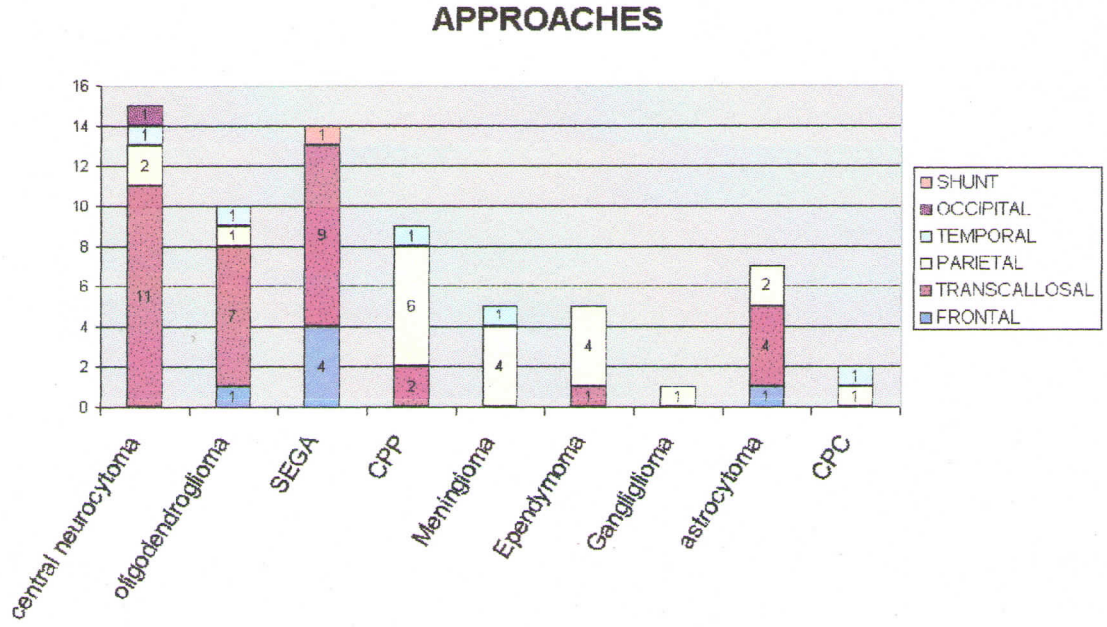


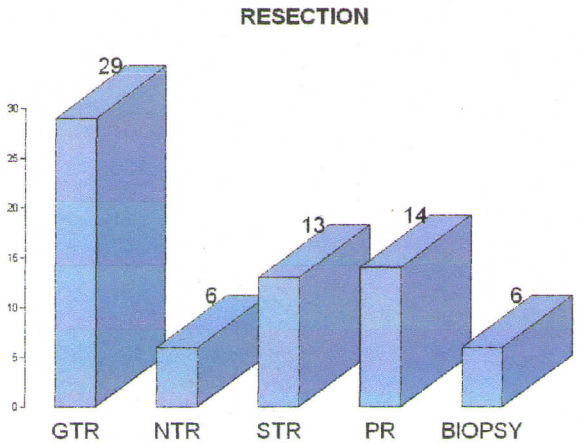
Among 7 patients of astrocytoma,4 were high grade lesions & 3 were low grade gliomas.

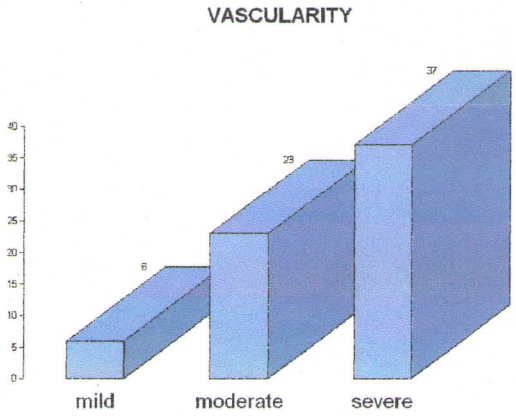
RADIOTHERAPY

Post operative radiotherapy was delivered in 26(43%) of patients.3 patients with central neurocytoma earlier diagnosed as oligodendroglioma & 1 patient of central neurocytoma with PNET component was subjected to radiation. 8(90%) of ologodendrogliomas & 4(80%) of ependymomas

Subtotal resection & Partial resection were done in 13(19%) cases each.In 6 (8.8%) patients only biopsy was done due to high vascularity, among which 1 patient with choroids plexus papilloma underwent reexploration where in GTR was done.

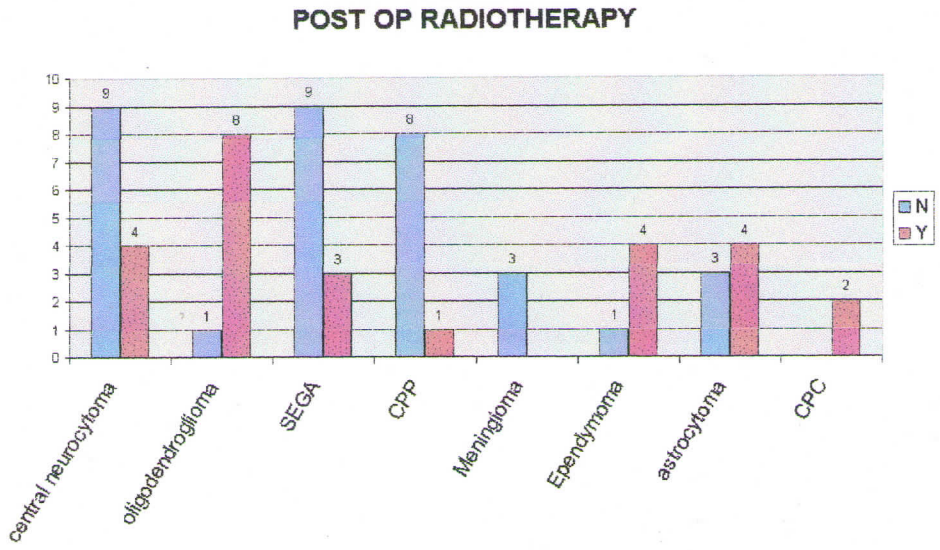


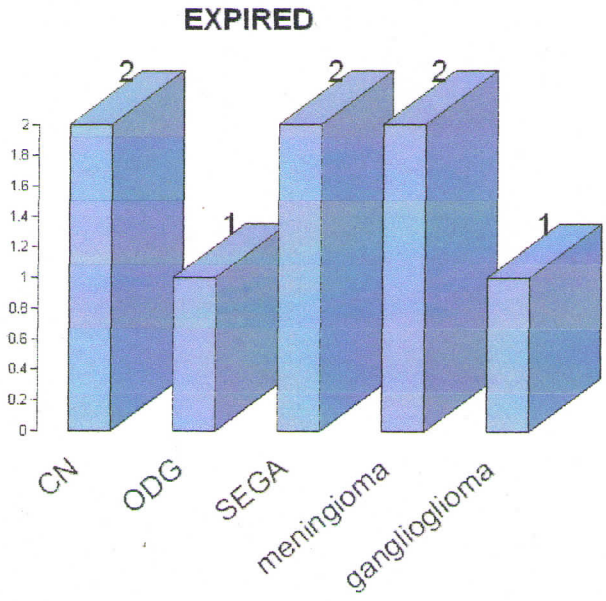




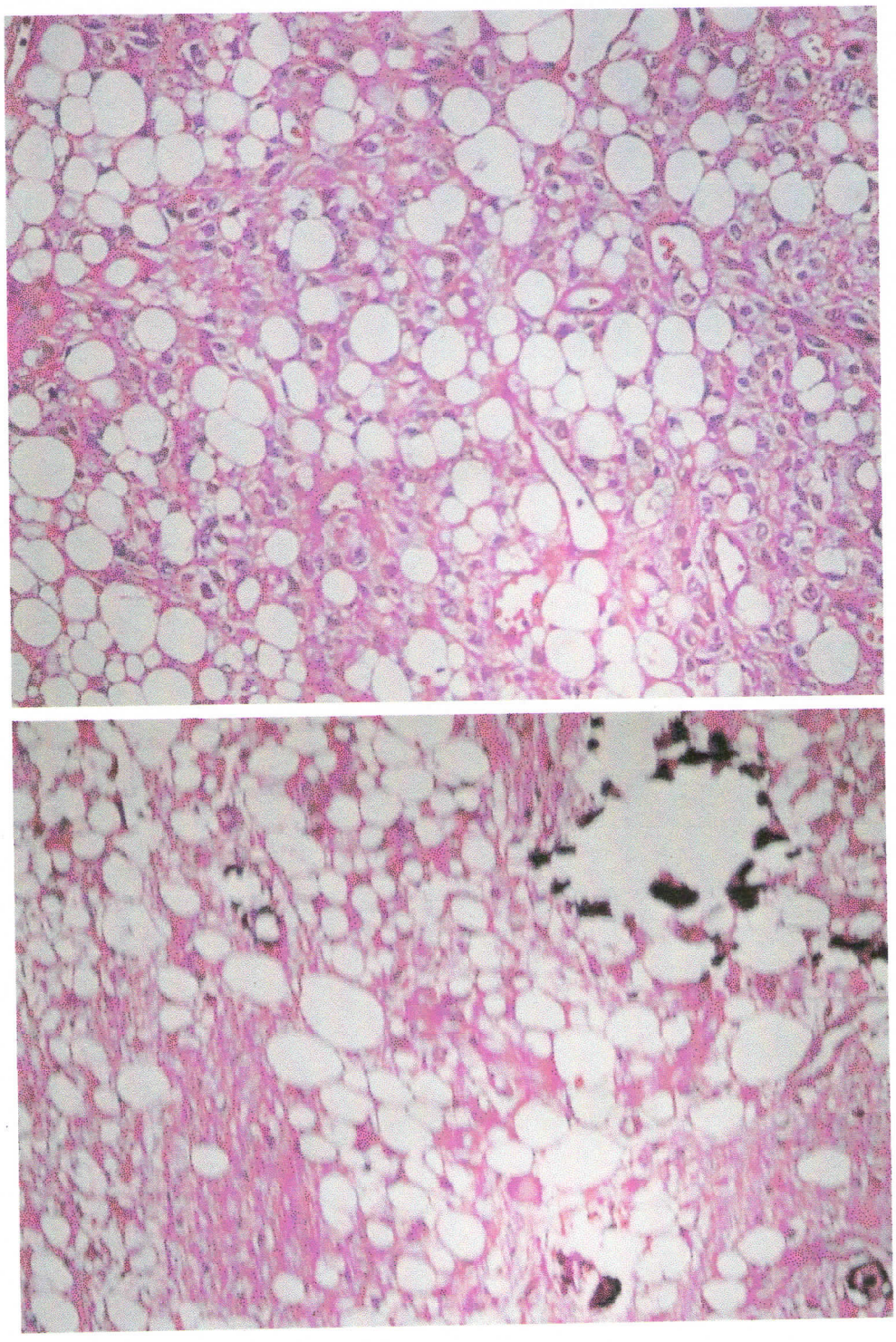
Majority (54%) of tumours were highly vascular.

received radiation. 1 patient of ependymoma refused radiotherapy.All high grade astrocytomas & both choroids plexus carcinomas received radiotherapy.2 patients received chemotherapy, 1 each of oligodendroglioma & high grade astrocytoma.

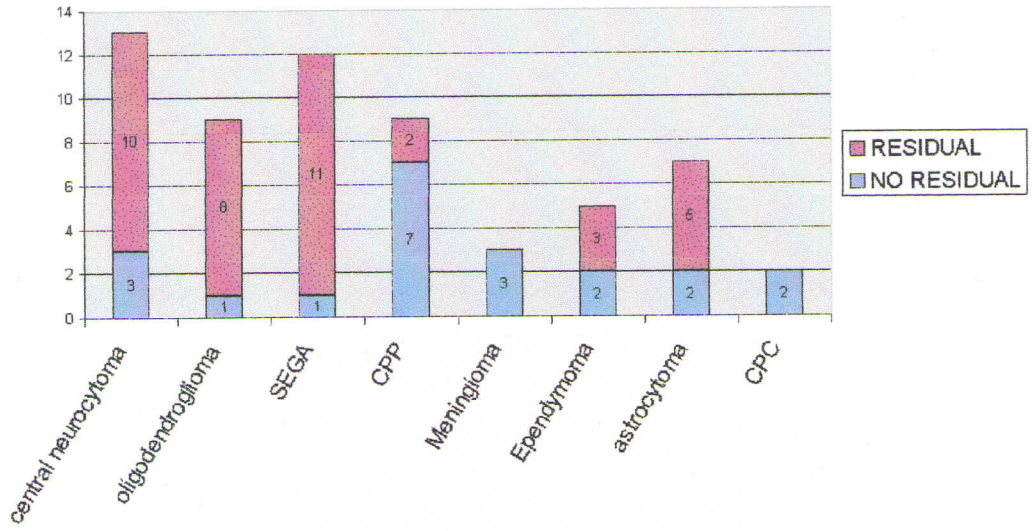




HISTOPATHOLOGY OF LIPONEUROCYTOMA



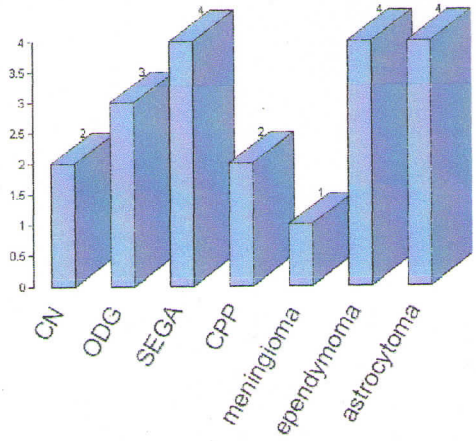
POST-OP CT SCAN



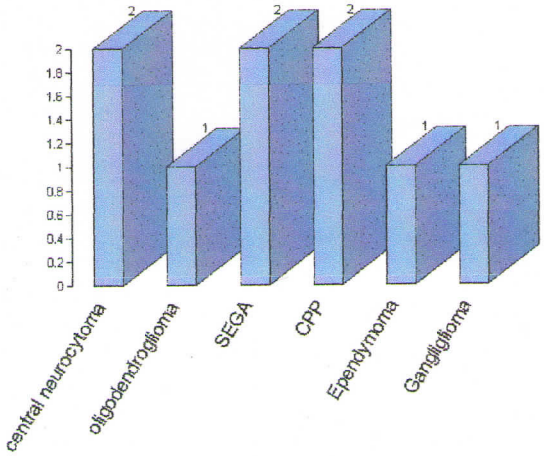
FOLLOW-UP

Follow-up period ranged from 9 months to 13 years, with a mean of 3 years.20(33%) were lost for follow-up after varying periods, which includes all 4 patients of high grade astrocytoma & 4(80%) of ependymomas.

LOST FOR FOLLOW-UP



REOPERATION



MORTALITY/COMPLICATIONS

Post operative seizure was seen in 6(10%), mental changes in 14(23%), motor deficits in 10(16%) of patients. Worsening/new field deficits were seen in 9(15%) of patients.Mortality in our series was 8(11.7%)

Patients.It included 2 patients each of central neurocytoma,SEGA & meningioma & 1 patient each of oligodendroglioma & ganglioglioma.

2 patients of central neurocytomas died due to significant intraventricular hemorrhage. Oligodendroglioma patient sustained frontal lobe contusion, underwent lobectomy, developed ventriculitis & subsequently expired.1 patient with SEGA developed septicemia & died. 2 patients with meningioma & 1patient of SEGA died due to torrential bleeding during surgery.

Mean hospital stay was 21.5 days which included variable periods of preoperative waiting period.

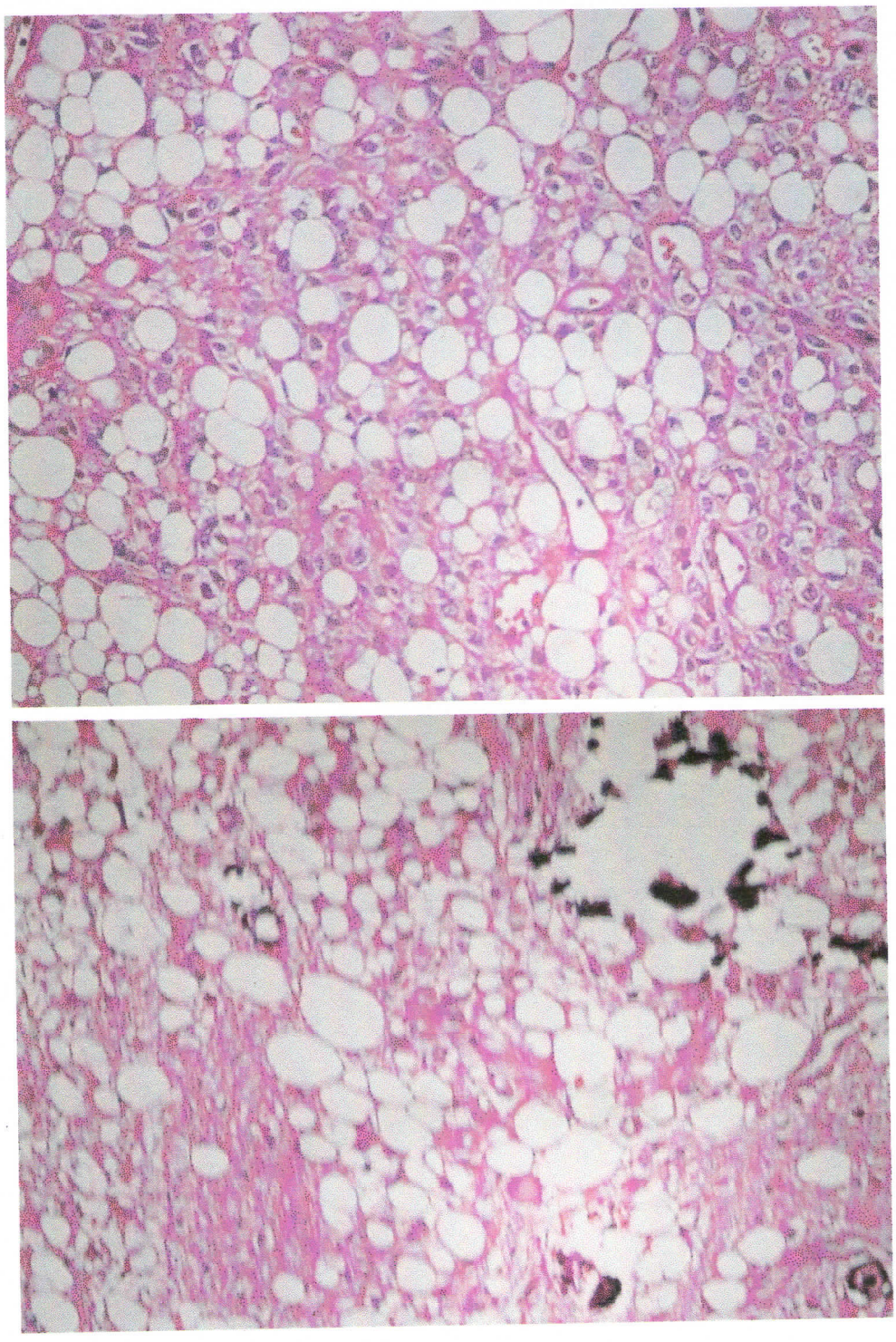
Post operative showed residual lesion in 39(65%) of patients.Among them 24 were operated before 1995 & 15 were operated after 1995.

Among 6 patients with seizures post operatively, only 2 had recurrent seizures & were well controlled with AEDs. Motor deficits improved in 6 of 10 patients with deficits & mental changes in 7 of 14 patients,field cuts improved in 3 of 9 patients with field deficit post operatively.

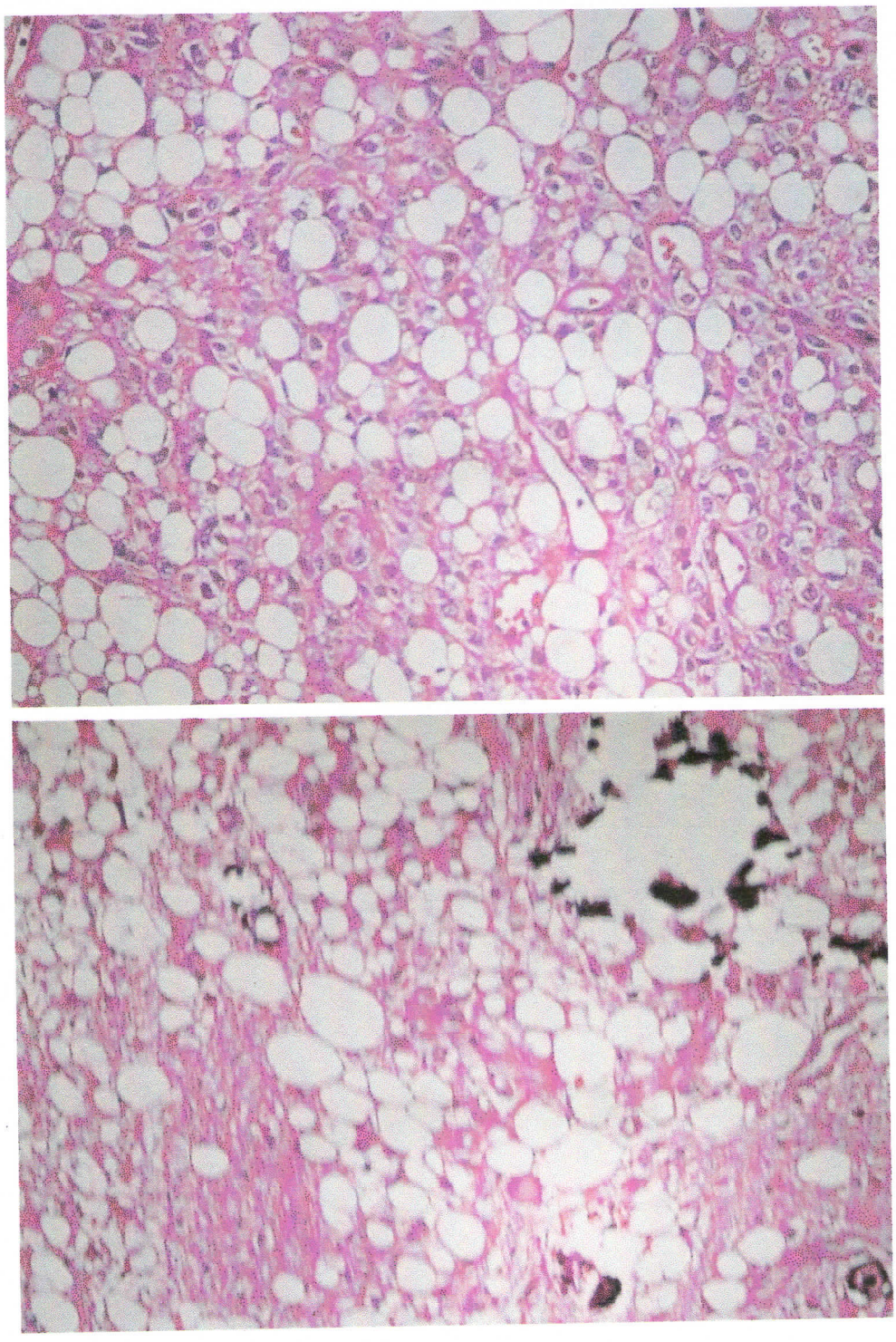
Follow-up CT scan was done in 50 cases & 4 patients showed increase in size & underwent reoperation. 1 patient with central neurocytoma showed small intraventricular bleed & was managed conservatively.

Totally 9(13.2%) patients underwent reoperation which included 2 patients each of central neurocytoma,SEGA & CPP & 1 patient each of oligodendroglioma,ependymoma & ganglioglioma.Among them 4 patients died subsequently which included 1 each with neurocytoma, oligodendroglioma,SEGA & ganglioglioma.

HISTOPATHOLOGY OF LIPONEUROCYTOMA

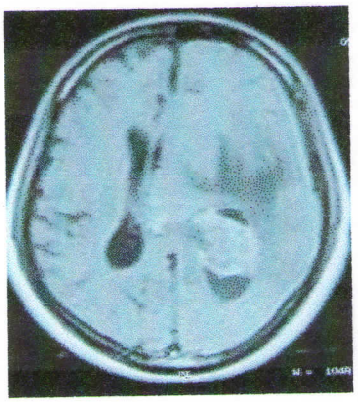


HISTOPATHOLOGY OF LIPONEUROCYTOMA

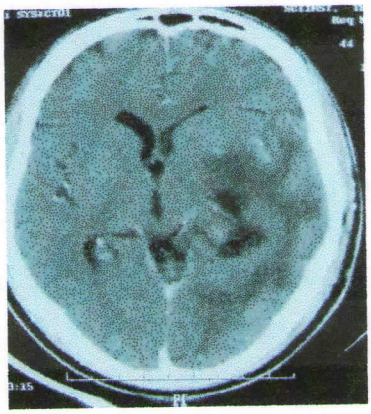


TRIGONAL GLIOMA

Pre operative

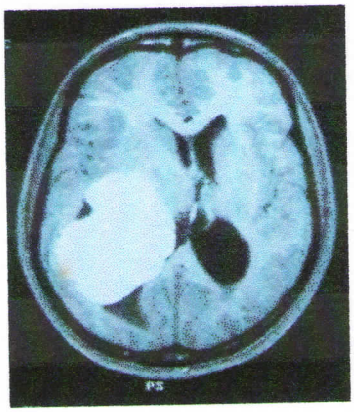


Post operative

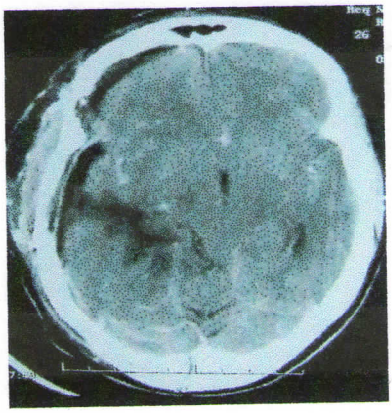


TRIGONAL MENINGIOMA

Pre operative

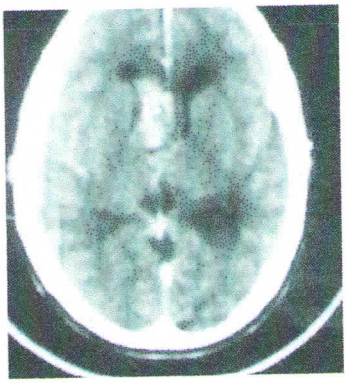


Post operative

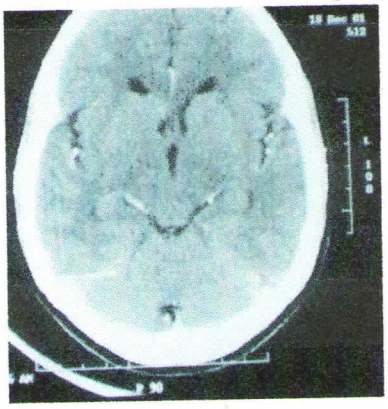


NEUROCYTOMA

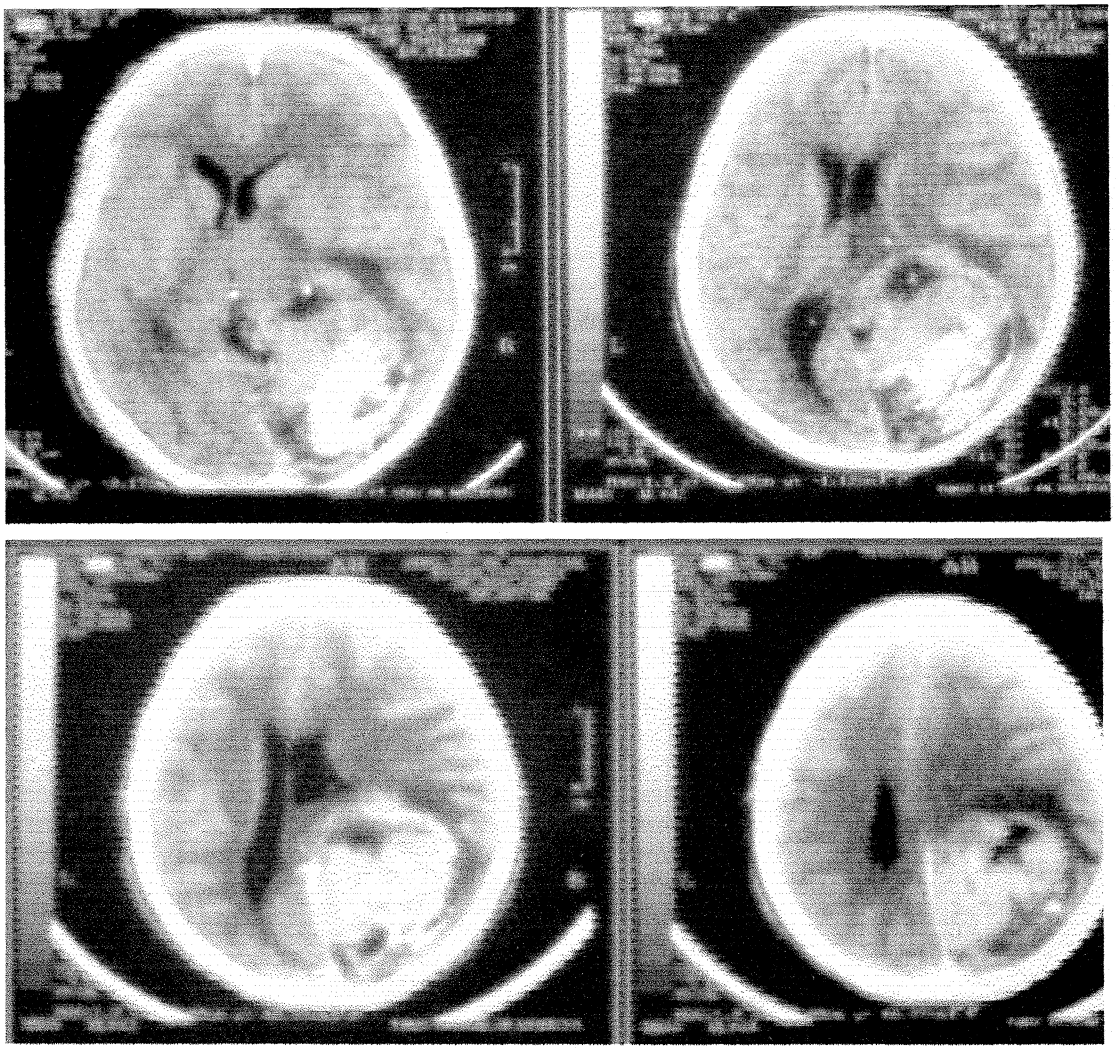
Pre operative



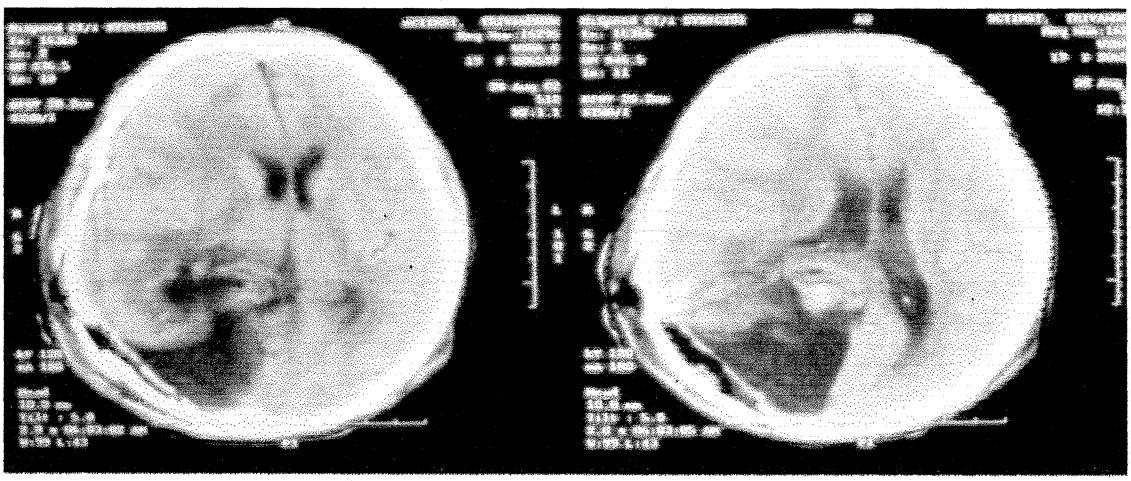
Post operative



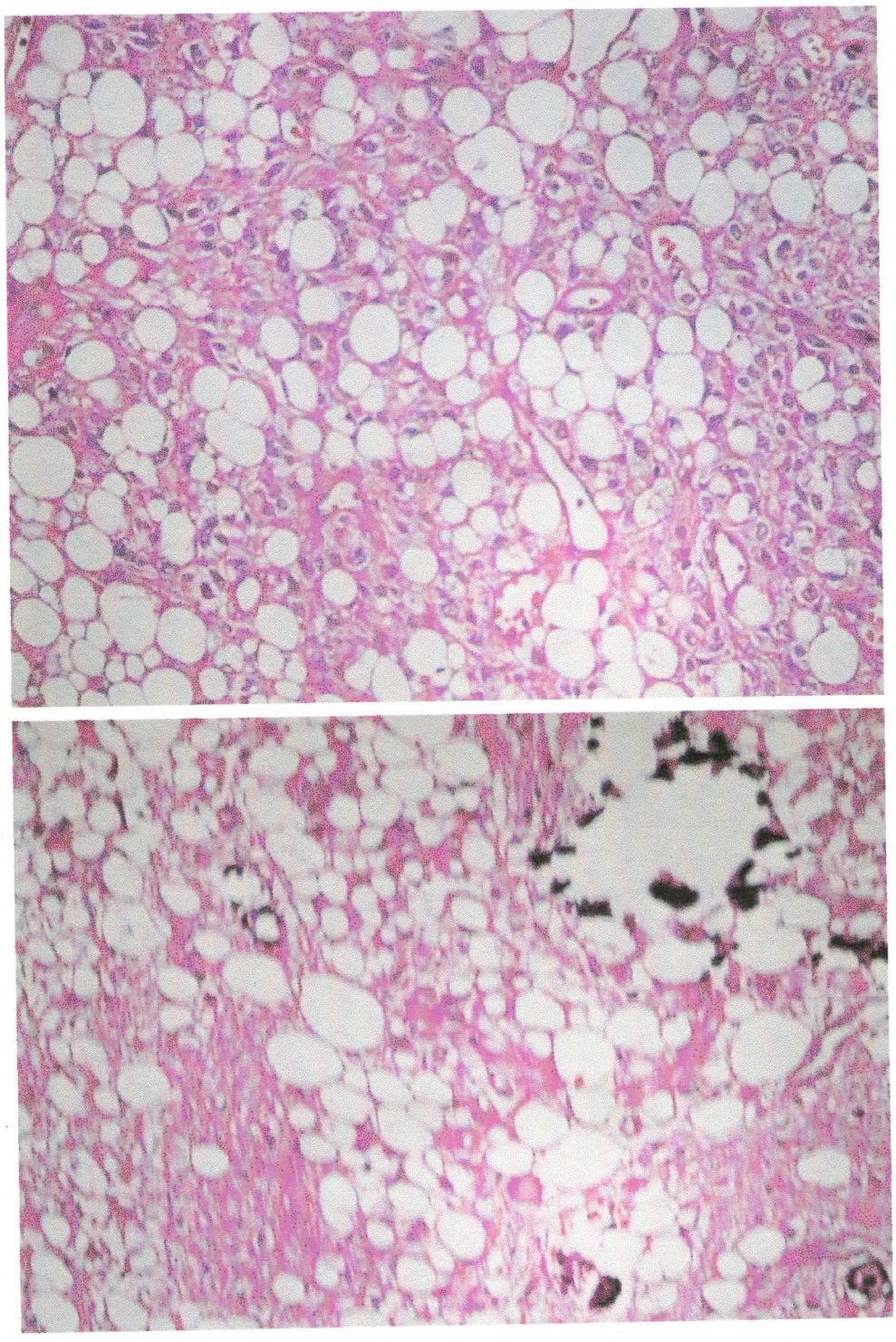
PREOPERATIVE CT SCAN OF CENTRAL LIPONEUROCYTOMA



POSTOPERATIVE CT SCAN OF CENTRAL LIPONEUROCYTOMA

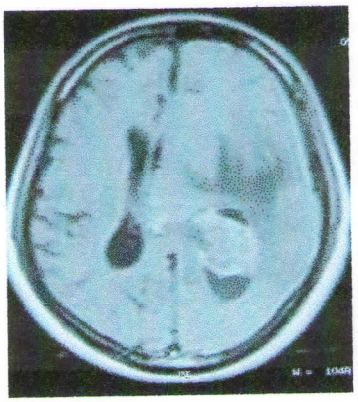


HISTOPATHOLOGY OF LIPONEUROCYTOMA

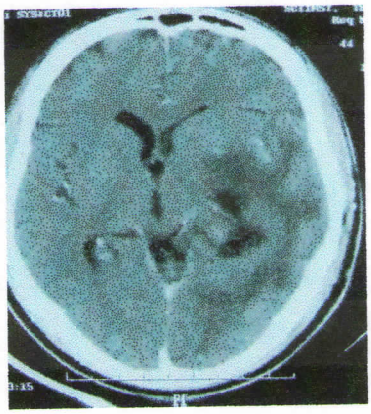


TRIGONAL GLIOMA

Pre operative

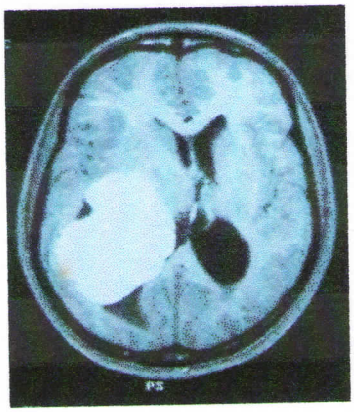


Post operative

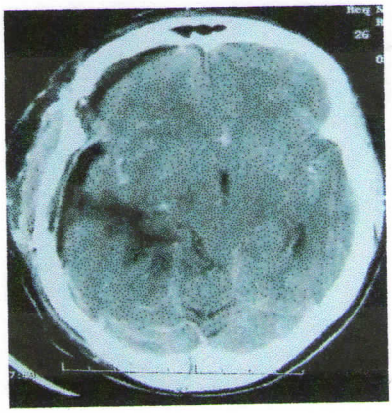


TRIGONAL MENINGIOMA

Pre operative

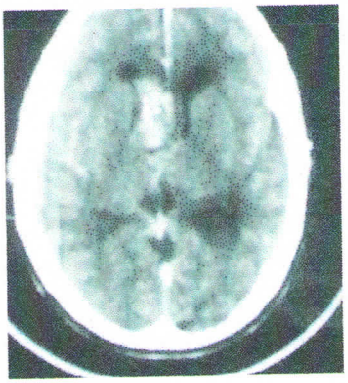


Post operative

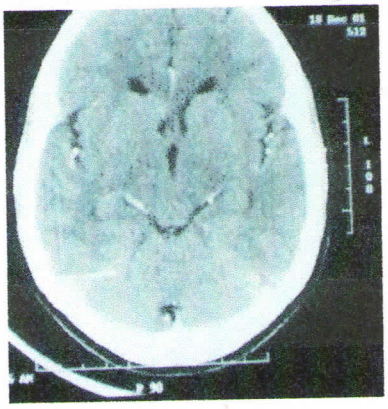


NEUROCYTOMA

Pre operative



Post operative



DISCUSSION

A variety of pathologies arise in the lateral ventricles & most demonstrate relatively benign biological behaviour. They are distinguished by their specific lateral ventricular location, imaging characteristics, & patients age at presentation.

VENTRICULAR LOCATION				
AGE (yrs)	FRONTAL HORN	BODY	TRIGONE	TEMPORAL HORN
<5	PNET	CPT	CPT	CPT
5-30	Astrocytoma SEGA	CN ODG	Ependymoma	Ependymoma Astrocytoma
>30	Glioblastoma	Subependymoma Astrocytoma	Meningioma Metastasis	Meningioma

Classification of common lateral ventricular tumours by location & age

VENTRICULAR LOCATION				
AGE (yrs)	FRONTAL HORN	BODY	TRIGONE	TEMPORAL HORN
<5	1CN 1SEGA	2 SEGA 1CPP	5 CPP 1 Ependymoma 1 Astrocytoma	
5-30	2 SEGA 1 Astrocytoma	9 SEGA 8 CN 7 ODG 3 Astrocytoma 1Ependymoma	3 Ependymoma 3 CPP 1 CPC 1 CN 1 Meningioma 1 Astrocytoma	1 ODG
>30		5 CN 2 ODG 1 Astrocytoma	4 Meningioma 1 ODG 1 CPC 1 Astrocytoma	

Classification of lateral ventricular tumours by location & age in this study

Most of tumours occurring in the body were extending into frontal horn & hence definitive site of origin is difficult to evaluate.Combining body & frontal horn as a single entity, location of lateral ventricular tumours in this study compares well with Piepmer study[55].1 case of oligodendroglioma occurred in temporal horn which is a rare site of occurence.We did not encunter subependymoma,metastasis, lymphoma & PNET, though 1 case of central neurocytoma with PNET component was diagnosed .

CENTRAL NEUROCYTOMA

85% of central neurocytomas are diagnosed between 10 & 40 years with an equal sex distribution[55].In our study 85.7% of patients were in the same age group & female to male ratio was 8:7. Neurocytomas are almost exclusively located in the body or the frontal horns.Results of this study are concordant with reported literature except for 1 case which occurred in trigone.

Central neurocytomas may be the most common lateral ventricular tumours in young adults[48]. In our study neurocytomas along with SEGA are the most common lateral ventricular tumours.Synaptophysin IHC, an evidence of neuronal differentiation, was done retrospectively in 3 cases

of Oligodendroglioma & all of which turned out to be positive.Hence, the incidence of neurocytoma may be under reported.

The 2000 W H O has included cerebellar liponeurocytoma in the category of glioneuronal tumors of the central nervous system. Once termed medullocytoma and considered an embryonal tumor, a variant of medulloblastoma, its indolent behavior and morphologic features prompted this nosologic change. Biphasic in appearance, the tumor consists of well-differentiated neurons with the cytology of neurocytes in addition to a population of lipidized cells resembling mature adipose tissue. Such tumors occur in older adults and have a relatively good prognosis. Linking the concept of liponeurocytoma to its occurrence in the cerebellum unnecessarily obscures the existence of similar neoplasms at other sites, such as among classic central neurocytomas of the lateral and third ventricles. Indeed, two such cases have briefly been reported.

We encountered 1 case of liponeurocytoma occurring in lateral ventricle.

Raised ICP features are the most common presenting features with memory loss being described in 25% of patients & results of our study are quite similar.

CT scan demonstrates an isodense entirely intraventricular well circumscribed tumour.Coarse, scattered calcifications are seen in 50% of cases[21]. Calcifications were seen in 71% of our cases.

Majority of central neurocytomas are generally benign & have favourable outcome. Gross total resection, may achieve a cure or long term control in majority of patients. Most authors agree that post-operative radiation therapy is not indicated if a gross total resection. Existing data in the literature do not demonstrate clearly that radiotherapy is required, because there are reports of patients with extended periods of stable disease without radiotherapy after subtotal resection[54].But some authors have suggested radiotherapy for subtotally resected tumours. In this study 5(33.3%) underwent GTR/NTR. Radiotherapy was given in 3 cases which were initially diagnosed as oligodendroglioma.Among 10 cases with residual tumour,2 expired in postoperative period due to Intraventricular hematoma,2 were lost for follow up & 6 cases are stable.even without adjuvant radiotherapy.

SUBEPENDYMAL GIANT CELL ASTROCYTOMA

Subependymal giant cell astrocytomas are intraventricular tumours classically associated with Tuberous sclerosis though few reports of

them occurring without evidence of Tuberous sclerosis are reported.(Bonin et al,Chow et al).In this study all 14 patients had Facial angiofibroma & 2 each had cortical tubers & subependymal nodules.

They usually present in early teenage years (range 1 – 31 yrs with Av – 13 yrs) with obstructive hydrocephalus or seizures. Average age of presentation in this study was 13 years, with 3 patients presenting with seizures.

Imaging showed variable calcification in 8 (57%) of cases & are differentiated from subependymal nodules by their copious enhancement which was seen in all our cases.

Pathologically they are distinguished by the characteristic eosinophillic giant cells,perivascular pseudorosettes & psammomatous calcification.

Obstructive hydrocephalus is a mandatory surgical indication. 1 patient underwent shunt & 2 underwent biopsy only & these patients were subjected to radiotherapy.5 patients with residual tumour on postop CT scan were followed up without radiation & are stable without evidence of growth of residual. The use of adjuvant therapies have been occasionally tried in SEGA.But none of these reports documented a significant positive response to radiotherapy.

CHOROID PLEXUS TUMOURS

Choroid plexus tumours are the most common lateral ventricular tumours in children.Most are diagnosed within 5 years of age &In our study 6(66%) were diagnosed in children <5 years.2(18%)cases of choroid plexus carcinoma were seen in the present study in comparision to 26% malignancy reported by Ellenbogen, 1989.They are usually located in the trigone.1. & in this study 10(91%) were in trigone & 1 was arising from body of lateral ventricle.

Most common clinical presentation are those of hydrocephalus & children usually present with increased head circumference & irritability,a fact in observed in this study aswell.2(18%) patients presented with seizures, consistent with Ellenbagen's series.

Vasogenic edema & Heterogenous enhancement,the features which suggest Choroid plexus carcinoma(CPC),were present in both cases of malignanct choroids plexus tumours.Angiography was done in 3 cases which showed feeding pedicles from lateral posterior choroidal vessels.

2 cases of CPC showed mitosis, necrosis & loss of papillary architecture consistent with reported malignant features.

Early obliteration of tumour pellicle is the most crucial step in surgical procedure & it was possible in 6(55%) of choroids plexus tumours.A complete tumour removal generally cures the patient with CPP & role of radiation is controversial.It should be reserved for patients recurrent tumours after complete removal,disseminated CSF disease & CPC.In this study GTR was possible in 9(82%) of cases with both CPC receiving radiotherapy.1 patient with CPP was initially diagnosed as ependymoma & received radiation.After reoperation for residual it diagnosis was revised as CPP & total excision was done.

GLIOMAS

Astrocytic tumours are seen in tissues around the ventricles & invade into them.The most common site with large amount of mass within ventricles is the thalamus.In this study pure thalamic gliomas & those with insignificant extension into vemtricles were not considered.

They exhibit a spectrum of differentiation from low grade tumours to glioblastomas. In children & young adults, intraventricular astrocytomas are more common. In older adults, anaplastic astrocytomas & glioblastomas predominate.7 cases of astrocytomas were seen in our

study,with 5 cases occurring in <30 year age group.Among them 3 were low grade tumours. Both cases occurring in elderly age group were high grade gliomas.Most common location was body(57%).

Following surgery,if the tumour is very well differentiated, patients can be observed until there is evidence of tumour growth or change in appearance on imaging.When tumours are found to have anaplastic astrocytomas or glioplastomas, radiation therapy & chemotherapy should be promptly started.All 3 cases of low grade astrocytomas are kept under follow-up & are stable without adjuvant treatment.High grade tumours were all subjected to radiation therapy & 1 patient received chemotherapy.

EPENDYMOMA

The tumor arises in areas of ventricular angulation from rests of ependymal cells that extend into adjacent white matter (Sanford, 1997).

The mean age of patients at diagnosis is 22 years, with bimodal peaks at ages 5 and 34 years (Swartz, 1982). Most tumors arise in a young pediatric population. Females account for 64% of cases. In our study mean age at diagnosis was 13.4 years & M:F ratio was 3:2.

Supratentorial tumors typically arise near the trigone of the lateral ventricle (Sun, 1999; Han, 1984). In our study,4(80%) of ependymomas occurred in trigone & 1(20%) occurred in body of lateral ventricle.

Many histological grading schemes have been proposed for ependymomas. Although the classic subdivision into cellular, epithelial, and papillary types has been shown to be without any prognostic significance, there is still debate regarding the importance of anaplastic criteria such as necrosis, mitosis, endothelial proliferation, and nuclear pleomorphism. What is generally agreed on, however, is that the anaplastic variant is much more common both in the adult age group and in the supratentorial compartment[9] In our study 2(40%) were anaplastic ependymomas.

Radiation therapy is commonly administered to intracranial ependymomas after surgical resection.Several studies have reported increases in survival after postoperative radiation. 4 of our patients received radiotherapy & 1 patient refused radiotherapy. But,Schwartz et al think that after radiographically confirmed GTR of a benign supratentorial tumour, postoperative radiation is not necessary because recurrences can be easily treated with reoperation.

Several studies of intracranial ependymomas have reported better 5- and 10-year survival rates for patients who present at an older age[26]. With respect to location, several authors have stated that location is not a significant factor, with 10-year survival rates between 40 and 69% for both supra- and infratentorial tumors in all age groups[26,58,76]. Schwartz et al opine that adult patients with supratentorial tumors can survive much longer than would be expected from the literature despite frequent recurrences. This is likely attributable to lower operative morbidity and aggressive reoperation for recurrent local disease.In our study 4 patients were lost for follow-up & 1 patient underwent gross total redection & postoperatively received radiotherapy is stable after 3 years.

OLIGODENDROGLIOMA

Oligodendrogliomas are infrequent glial neoplasms & occurrence of intrea ventricular oligodendrogliomas is even rarer.In the lateral ventricle they usually arise from septum pellucidum.In our study 9(81%) occurred in body in relation to septum pellucidum & 1 each were found in trigone & temporal horn.

Perinuclear halo and "chicken-wire" pattern, although considered classic histological features of oligodendrogliomas are unreliable as sole criteria for diagnosis. Nuclear regularity and roundness and an eccentric rim of

eosinophilic cytoplasm lacking obvious cell processes are more constant features. Many of previously diagnosed oligodendrogliomas may turn out to be central neurocytomas ,on doing Synaptophysin IHC.In this study Synaptophysin IHC was done in 3 cases & all cases turned out to be positive & hence diagnosis was changed to central neurocytoma.

Recent studies suggest that for prognostic purposes, the spectrum of oligodendrogliomas should be stratified into two groups, low grade and high grade(grade 2 & grade 3).Also prognosis of mixed oligoastrocytomas & corresponding anaplastic astrocytomas is different.

In a recent comparative study examining survival of treated patients as a function of histological grading, median survival and 5- and 10-year survival rates were found to be the same for anaplastic oligodendroglioma and anaplastic oligoastrocytomas. The median survival was 4.5 years, and the 5- and 10-year survival rates were 45% and 15%, respectively. In comparison, the median survival was 2 years for anaplastic astrocytoma and 0.8 year for glioblastoma multiforme

Oligodendrogliomas respond frequently and sometimes durably to chemotherapy[22].Loss of chromosomes 1p & 19q are associated with better chemosensitivity. Furthermore, as demonstrated by Remsen et al[59]

and others, the sequencing of chemotherapy and radiotherapy is extremely important in the production of neurocognitive deficits. It is widely accepted that less toxicity is produced when both treatments are delivered sequentially, especially if chemotherapy is the initial treatment modality, and a suitable time break (at least 1 wk) is allowed between the two modalities.Patients with anaplastic oligodendroglial lesions and anaplastic oligoastrocytic lesions can be treated with chemotherapy (PCV) regimen, or any other regimen of proven benefit) as the first adjuvant modality. If radiation therapy is then contemplated, an adequate time lapse (at least 1 wk) should separate the two treatment modalities

The role of postoperative radiation therapy in oligodendroglioma is much debated. Some studies concluded that postoperative radiotherapy might be of benefit in "low grade oligodendroglioma although a consensus for such a benefit remains elusive[8,34]. In recent years, a growing number of studies found no benefit in early irradiation of low-grade lesions[20,35].However radiotherapy may have a role in anaplastic oligodendroglioma.In this study except for 1 patient all others received radiotherapy & 1 was subjected to chemotherapy.With more conclusive evedence of benefit of chemotherapy ,more patients may be subjected to chemotherapy.

MENINGIOMA

Menengiomas are the most common tumours within the trigone of lateral ventricles in adults.In our study among patients aged >30 years meningiomas accounted for 4 out of 7(57% of cases.) In our study there was predilection for females(3:2) & on the left side(4:1),similar to reports of literature(Pipemer et al)

At presentation usually they are of big size due to paucity of early symptoms.They usually present with raised ICP features & field defects.In our study Raised features were present in all cases & field cuts were observed in 40% of patients.1 case was operated elsewhere & was referred to us with significant residual lesion.They are very vascular & control of vascular pedicle is of utmost importance. There were 2 (40%) mortality among intraventricular meningioma cases due to extreme vascularity.In the remining 3 cases where vascular pedicle control was obtained early ,total tumour resection was possible & all of them are doing well on follow-up without recurrence.

SURGICAL APPROACHES

There are several general surgical principles for virtually all operative procedured for lateral ventricular tumours. The importance of adequate preoperative planning-including an assessment of the likely pathology,the options of approach & the contingencies needed to manage potential intraoperative complications cannot be overstated.It is instructive to remember that most lateral ventricular tumours cause headache,gait abnormalities & cognitive problems consistent with the presence of a large tumour mass &/or obstructive hydrocephalus.These neurologic deficits are often the result of the stretching of white matter fiber tracts & serve as a warning that excessive retraction for better exposure or to control bleeding can have disastrous consequences. Therefore, selection of the optimal surgical approach to expose the lesion adequately & provide early access to the blood supply, accomplished by adequate brain relaxation during dissection, are principles that are valid for any procedure for these tumours. Although many ventricular tumours can grow to 5 to 6 cm in size, it is clear that the operative exposure can(& must) be much smaller.Careful preservation of the interface between the tumour & the ependymal surface, & delivery of the tumour into the area of exposure following internal decompression, makes it possible to

deliver large lesions through relatively small incisions.In our study majority were located in Body-56% & Trigone-35%. Correspondingly approach was transcallosal in 50% & transcortical parietal in 31% of cases.Callosotomy in case of transcallosal approach was limited to 2cm & cortical incision was also limited to <3 cm.Transcallosal incision avods the cortical incision & subsequent increased risk of seizure & neurological defecits.But it is associated with the problem of bridging veins limiting the exposure & disconnection syndromes.Incidence of post operative sezure was 5% for transcallosal approach & 12% for transcortical approach.Memory impairment was more common in transcallosal approach (14%) compared to transcortical approach(9%). However limiting the callosotomy to <2 cm minimizes the incidence of complications.Five Trigonal tumours with predominant temporal extension were approached through cortical incision in middle temporal gyrus & post operative visual field deficits were recorded in 2 patients.1 patient with significant occipital horn extension & preoperative homonymous hemianopia was approached through occipital route & tumour removal was accomplished without any additional deficits

Defenitive feeder was identified & coagulated during early part of surgery in 14 cases & gross total or near total resection was possible in all cases.post operatively incidence of complications is less & mean hospital stay was 18 days compared to 21.5 days overall, among these 14 patients.This again reemphasizes the need for early feeder control.

Persistent hydrocephalus, even following total tumour removal, is common.In our study 14(20.5%) patients required CSF shunting, with 6 patients requiring it post operatively for persistent hydrocephalus & 2 patients of CPP requiring subduro peritoneal shunt

CONCLUSIONS

1. Most tumours exhibit benign biological behaviour & must be approached aggressively.
2. Central neurocytoma is the most common lateral ventricular tumour in young adults.
3. Synaptophysin immunohistochemistry must be done in all cases of suspected oligodendroglioma to rule out or confirm central neurocytoma which carries a better prognosis.
4. Central neurocytoma & Subependymal giant cell astrocytoma with asymptomatic recurrences can be observed.
5. Tackling feeders earliest alleviates morbidity & mortality in Meningioma.
6. Mortality is slightly high as study comprised of heterogenous group of tumours & spread over long periods & operated by different surgeons.
7. Surgical approaches must be tailored according to location & to accommodate existing neurologic deficits & to avoid additional neuropsychological sequale.

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