

# **NEUROLOGICAL OUTCOMES IN PATIENTS UNDERGOING ENDOSCOPIC SURGERY FOR CRANIOPHARYNGIOMA**

**Dr. AKHILESH GOWDA G B**

**MCh NEUROSURGERY THESIS**

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**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND  
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**NEUROLOGICAL OUTCOMES IN PATIENTS  
UNDERGOING ENDOSCOPIC SURGERY FOR  
CRANIOPHARYNGIOMA**

A THESIS SUBMITTED BY

**Dr AKHILESH GOWDA G B**

TO

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND  
TECHNOLOGY, TRIVANDRUM.

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE AWARD OF

**MCh NEUROSURGERY**

**2023**

## DECLARATION BY THE STUDENT

### CERTIFICATE

I, Dr **AKHILESH GOWDA G B** hereby certify that I had personally carried out the work depicted in the thesis titled, “**NEUROLOGICAL OUTCOMES IN PATIENTS UNDERGOING ENDOSCOPIC SURGERY FOR CRANIOPHARYNGIOMA**”.

No part of this thesis has been submitted for the award of any other degree or diploma prior to this date.

*Akhil Gowda*  
Signature  
25/08/2023

*Dr AKHILESH GOWDA G B,*

*Department of Neurosurgery,*

*SCTIMST, TRIVANDRUM*

Date: 25 /08/2023



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)

Grams : Chitramet, Phone : +91-471-2443152, Fax : +91-471-2550728 / 2446433, E-mail : sct@sctimst.ac.in, Website : www.sctimst.ac.in

### CERTIFICATE BY THE RESEARCH GUIDE

Name of the guide: **Dr Prakash Nair**

Division/Department: **Department of Neurosurgery**

This is to certify that **Dr Akhilesh Gowda G B**, Department of Neurosurgery of this institute has fulfilled the requirements prescribed for the MCh Neurosurgery degree of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.

The thesis entitled, "**NEUROLOGICAL OUTCOMES IN PATIENTS UNDERGOING ENDOSCOPIC SURGERY FOR CRANIOPHARYNGIOMA**" was carried out under my direct supervision. No part of the thesis was submitted for the award of any degree or diploma prior to this date.

\*Clearance was obtained from the Institutional Ethics committee of this institute (**SCT/IEC/1846/MAY/2023**) for carrying out this study.

Date: 25.08.2023

Signature

**Dr Prakash Nair**  
Additional professor,  
Department of Neurosurgery,  
SCTIMST, Trivandrum.



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  
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Grams : Chitramet, Phone : +91-471-2443152, Fax : +91-471-2550728 / 2446433, E-mail : sct@sctimst.ac.in, Website : www.sctimst.ac.in

## CERTIFICATE BY THE RESEARCH CO-GUIDE

Name of the guide: **Dr Easwer H V**

Division/Department: **Department of Neurosurgery**

This is to certify that Dr Akhilesh Gowda G B, Department of Neurosurgery of this institute has fulfilled the requirements prescribed for the MCh Neurosurgery degree of the Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.

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Signature

Date: 25.08.2023

Dr Easwer H V  
Professor & Former HOD,  
Department of Neurosurgery,  
SCTIMST, Trivandrum



श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम  
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Thiruvananthapuram - 695 011, Kerala, India  
(An Institute of National Importance under Govt. of India)

Grams : Chitramet, Phone : +91-471-2443152, Fax : +91-471-2550728 / 2446433, E-mail : sct@sctimst.ac.in, Website : www.sctimst.ac.in

## APPROVAL OF THE THESIS

The Thesis entitled.

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ENDOSCOPIC SURGERY FOR CRANIOPHARYNGIOMA”

Submitted by,

Dr Akhilesh Gowda G B

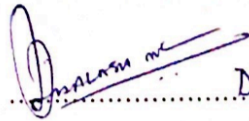
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TECHNOLOGY, TRIVANDRUM

Is evaluated and approved by

  
Dr. PRAKASH NAIR

(Name & Signature of the Guide)

.....  
(Name and signature of thesis  
examiner)

Dr. PRAKASH NAIR/डॉ. प्रकाश नायर  
MS(General Surgery), MCh(Neurosurgery)  
एम्एस (सामान्य चिकित्सा), एमचि (न्यूरोसर्जरी)  
Additional Professor/अवर प्रोफेसर  
Department of Neurosurgery/न्यूरोसर्जरी विभाग  
Sree Chitra Tirunal Institute for Medical Sciences & Technology  
श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान  
Thiruvananthapuram, Kerala, India/त्रिवेन्द्रम, केरल, भारत  
TCMC Reg. No. 38394/टीसीएमसी रजिस्ट्रेशन नं. 38394

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**Dr. Akhilesh Gowda G B**

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## LIST OF ABBREVIATIONS

Abbreviation	Full Form
QoL	Quality of life
ECoG	Eastern Co-operative Oncology group
MRD	Medical records department
EMR	Electronic medical records
EES	Endoscopic Endonasal Surgery
VP Shunt	Ventriculo-peritoneal shunt
ENT	Ear Nose Throat
CP	Craniopharyngioma
ACP	Adamantinomatous craniopharyngioma
PCP	Papillary Craniopharyngioma
GCS	Glasgow Coma Scale
ASA	American Society of Anaesthesiologists
MRI	Magnetic Resonance Imaging
CT	Computed Tomography
Pre -op	Pre operative
Post – op	Post operative
CCSS	Craniopharyngioma clinical status scale
IEC	Institutional ethics committee
TCS	Trans cranial surgery
KPS	Karnofsky performance scale
PDL-1	Programmed death ligand-1
PD-1	Programmed cell death protein
MCA	Middle cerebral artery
ACA	Anterior cerebral artery
PCA	Posterior cerebral artery
ICA	Internal carotid artery
BA	Basilar artery
NASH	Non alcoholis steatohepatitis
GP	Glycoprotein

## SYNOPSIS



**AIM:**

To study the neurological outcome in patients of craniopharyngioma managed by endoscopy surgery

**OBJECTIVES:**

- 1) To study the neurological parameters like visual and endocrinological outcomes in patients undergoing trans-nasal trans-sphenoidal endoscopic surgery for craniopharyngioma.
- 2) To study the clinical spectrum of cases with craniopharyngioma.
- 3) To study the associated complications and recurrence rate in craniopharyngioma cases managed by endoscopic surgery.
- 4) To study the factors determining recurrence and quality of life of craniopharyngioma patients who are undergoing endoscopic surgery.

**BACKGROUND:**

The management of Craniopharyngioma offers a great challenge due to its intimate anatomical relationship with important structures and the need for close follow-up. Endoscopic endonasal surgery (EES) is a widely utilized approach for managing ventral skull base pathologies including craniopharyngioma. Recent studies favour the Endoscopic approach to preserving the patient's Quality of Life. This study aims to assess the Surgical, Visual and Endocrinological outcomes managed by the Endoscopic approach in our institute.

**METHODS:**

A Retrospective review of patients operated on from 2017 to 2023 was included in this study. Pre-operative, operative and Post-Operative Records were retrieved from patient records. Patients undergoing Endoscopic Endonasal Surgery of Craniopharyngiomas are compared for change In Visual, Clinical, Endocrinological and QOL status before and after Surgery.

**RESULTS:**

This series included 57 patients, with 35 Males and 22 Females. 24 Paediatric patients were also included in our study. Among 57 we had 35 fresh cases and 22 recurrent cases. Most of the patients presented with headaches followed by visual disturbances along with hormonal disturbances.

Totally 16 patients had Hydrocephalus which necessitated CSF diversion procedures before surgery. Among our study cohort, 39 (68.4% ) patients underwent Gross total decompression with 14 (24.6%) patients undergoing near total and 4 (7%) patients undergoing subtotal resection. On follow-up, it was found that 18 patients had stable minimal residues with recurrences in 3 patients. Postoperatively 7 patients required radiotherapy and almost all patients required hormonal supplementation. Postoperatively 34 (59.6%) patients had improved vision, 14 had unchanged visual status and only 6 patients had deteriorated vision.

#### **CONCLUSIONS:**

Although craniopharyngioma behaves as a humble and approachable tumour which can be addressed in many approaches/ways, Endoscopic Endonasal Surgery of Craniopharyngioma is a safe albeit technically demanding procedure. Careful dissection of the tumours with the surrounding anatomical structures in consideration will result in acceptable Visual, Clinical and Endocrinological outcomes. Endoscopic Endonasal Surgery is not limited to adults and shows higher resection rates in Paediatric populations. Although this technique is found to be effective in terms of visual and surgical outcomes, CSF leaks and Endocrine dysfunctions like obesity remain a tough challenge. Hence this disease should be considered a lifelong clinical condition rather than a simple disease owing to its frequent follow-ups, long-term hormonal supplementation and the disease's impact on cognitive/QOL status.

# INTRODUCTION



## 1. INTRODUCTION

The craniopharyngioma, a benign tumour (WHO grade I), commonly arises from the remnants of the craniopharyngeal duct (1) (2) .

Annually, the global incidence of craniopharyngioma ranges between 0.5 and 2.5 cases/ 10,00,000 (3).

The bimodal age distribution of patients with craniopharyngiomas is 5–14 years and 50–75 years (3).

Despite making up just 1.2% to 4.6% of all intracranial tumours, craniopharyngiomas are thought to be the most prevalent non-glial intracranial tumour in children, making up 10% of all paediatric brain tumours (4).

As a result of compression/displacement or tumour infiltration/invasion, craniopharyngiomas may show with varied clinical presentations in children and adults. Children with craniopharyngiomas frequently experience delayed symptoms, the majority of which are brought on by the tumour being rather large (5). It is important to note that the survival rates for childhood-onset craniopharyngiomas are high, ranging from 87% to 95% after 20 years. However, it is crucial to acknowledge the potential consequences that may arise, including hypothalamic-pituitary deficits, visual impairment, and neurologic dysfunction. These consequences can have a significant impact on the long-term quality of life for individuals affected by this condition (5).

The surgical treatment of craniopharyngiomas, particularly in youngsters, is debatable (6).

Craniopharyngioma is a neurosurgical condition. Permanent tumour control or cure without exacerbating the symptoms is the aim of therapy. To limit the risk of tumour remaining and recurrence, surgical resection aims to achieve gross total resection (GTR). The third ventricle, the optic nerve, and the hypothalamus are all physically near to the tumour, thus it is important to select the right surgical technique to prevent major postoperative consequences such as hypothalamic-pituitary dysfunction. Endoscopic endonasal surgery (EES) has been frequently used to treat craniopharyngiomas over the past ten years (7).

In order to accurately identify the anatomical components and minimize intraoperative damage, endoscopic surgery can offer a near, high-definition picture. For the surgical removal of craniopharyngiomas, EES has lately been made available. This method has been proven to be crucial in significantly reducing the occurrence of complications when important structures such as the hypothalamus, optic nerves and chiasm, carotid and basilar arteries, the circle of Willis and its associated branches, or the pituitary stalk are affected. It is imperative that this method is utilized in such cases to ensure optimal outcomes (8) (9).

The traditional transcranial methods appear to be being replaced by the EES given the advancement and rising usage of endoscopic procedures. However, further research is required to support this strategy given the low prevalence of craniopharyngiomas (10).

The study analyses the effects of EES on craniopharyngioma patients and evaluates their clinical symptoms, presentation, and tumour characteristics at a tertiary care teaching hospital.

The analysis thoroughly examines the impact of EES on craniopharyngioma patients and meticulously assesses their clinical symptoms, presentation, and endocrinological/visual/ QOL outcomes at a distinguished tertiary care teaching hospital.

## **AIMS AND OBJECTIVES**

### **AIM:**

To study the neurological outcome in patients of craniopharyngioma managed by endoscopy surgery..

### **OBJECTIVES:**

- 1) To study the neurological parameters like visual and endocrinological outcomes in patients undergoing trans-nasal trans-sphenoidal endoscopic surgery for craniopharyngioma.
- 2) To study the clinical spectrum of cases with craniopharyngioma.
- 3) To study the associated complications and recurrence rate in craniopharyngioma cases managed by endoscopic surgery.
- 4) To study the Factors determining recurrence and quality of life of craniopharyngioma patients who are undergoing endoscopic surgery.

## **2. REVIEW OF LITERATURE**

### **CRANIOPHARYNGIOMA**

#### **OVERVIEW**

Craniopharyngiomas (CPs) are rare, benign and humble brain tumours managed primarily with many surgical approaches and radiotherapy also (11)(12).

CPs are located either intrasellar (within the depression in the sphenoid bone that contains the pituitary gland) or suprasellar (above the sella turcica). They originate from remnants of the craniopharyngeal duct epithelium, which is known as Rathke's pouch. This invagination is located at the roof of the developing mouth and gives rise to the anterior pituitary gland.

Although CP can develop anywhere along the pituitary-hypothalamic axis, from the sella turcica to the third ventricle, approximately 50% originate in the fundus of the third ventricle, the infundibulum, and/or the tuberculum cinereum (including the vital hypothalamus) and spread mainly into the third ventricle. A good awareness of the intimate contact of these lesions with the hypothalamic nuclei is important to avoid unnecessary damage to the hypothalamus (13).

#### **2.1 Epidemiology of CP**

CPs constitute around 1.2–4.6% of all intracranial tumours and affect 0.5–2.5 new cases/10,00,000 people annually worldwide (14)(15). However, for unknown reasons, the incidence of CPs is higher in Japan, where there are 3.8 cases per 1 million children every year.

30 to 50 percent of patients with CPs have their diagnosis during their youth or adolescent. Children (under the age of 18) are more likely than adults to develop CPs, which make up 5 to 11 percent of intracranial tumours in this age group (16) (17) (18)(19).

ACP has a bimodal age distribution, with peak incidences in both adults and children between the ages of 5-15 and 45- 60 (19). The APC histological type which is characterised by formation of cyst is most prevalent in children and adolescents (20).

There have been isolated reports of neonatal and foetal instances (21). PCP typically affects an adult patient between the ages of 40 and 55 (22). There haven't been any sex differences found in population-based studies. Although two families have reported CP cases, an underlying genetic vulnerability has not been confirmed (23) (24).

### **2.1.1 Clinical features of CP**

CP's usually do not have the tendency/ propensity to disseminate however, certain case reports in literature have described about the spinal spread of tumour due to intraoperative 'spill' (25).

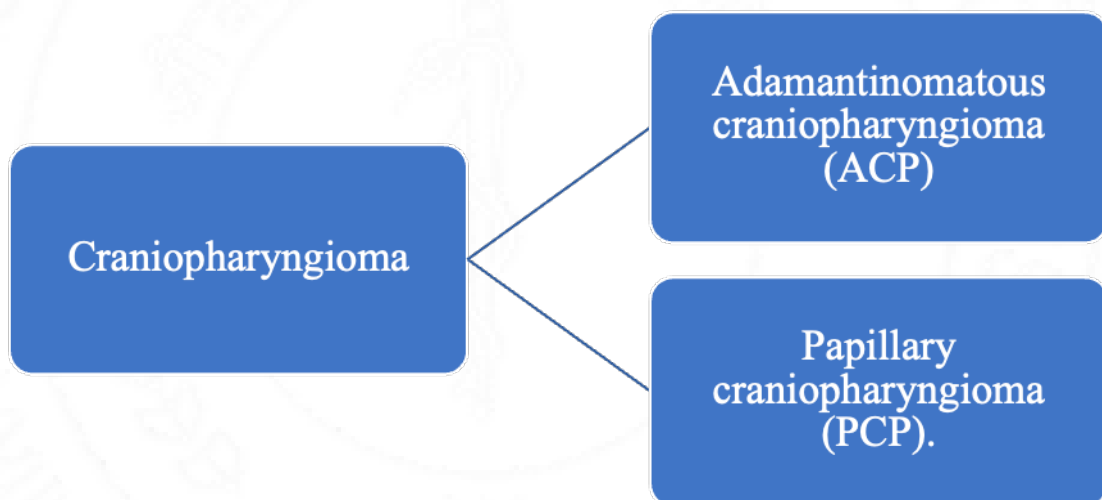
It is highly likely that a child has CP if they experience a number of symptoms, such as headache, vision loss, growth retardation, and polyuria-polydipsia brought on by central diabetes insipidus (wherein a lack of arginine vasopressin from the pituitary gland or hypothalamus results in the production of hypotonic urine). Endocrine abnormalities in adults can lead to problems with sexual function, clinical signs of

high intracranial pressure (such as headaches), and hypothalamus syndrome (which can cause problems with body temperature control, growth, and water balance).

CPs are often of low histological grade (WHO grade I), but because they are often located in the hypothalamus and pituitary and cause damage to these regions as a result of tumours and/or treatment, patients' prognoses and outcomes are frequently poor .

## **2.2 Histopathological presentation of CP**

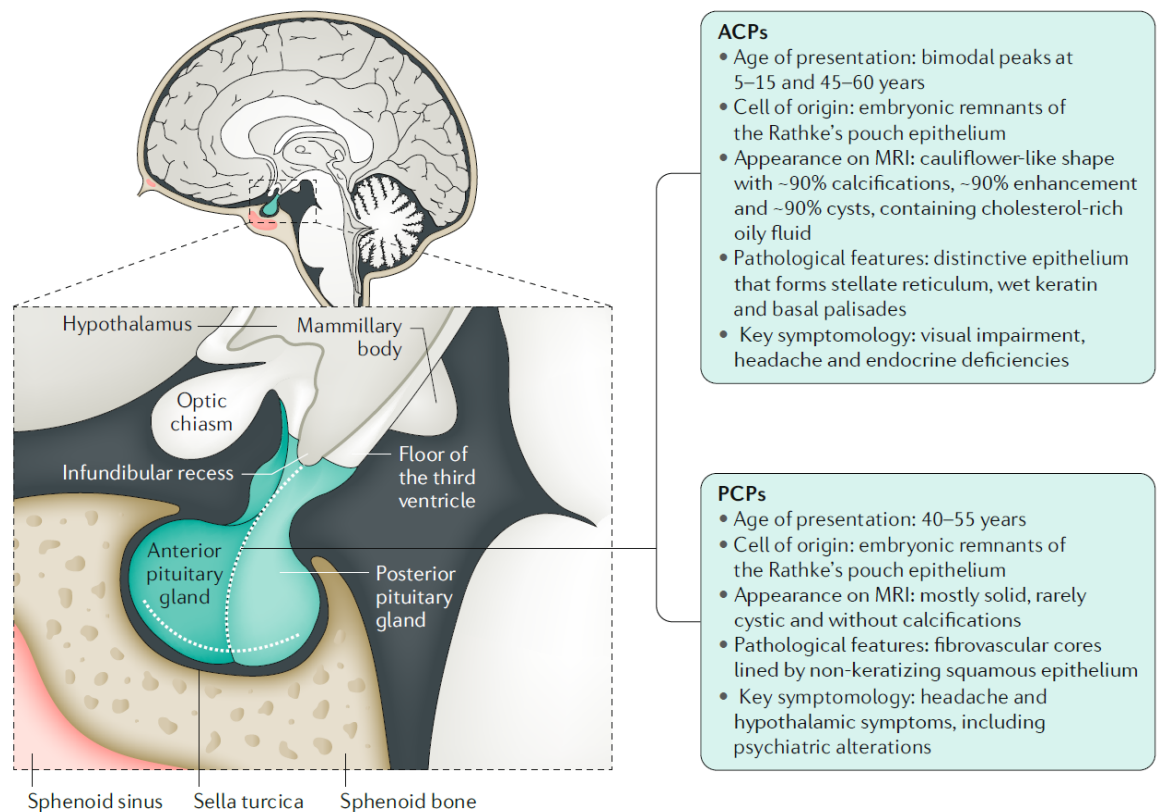
CP's contain two histological subtypes, which differ in their genesis and age distribution(Fig.3.1).



ACPs affect all age groups and are the more common subtype, whereas PCPs are mostly restricted to adults. Based on molecular and histological characteristics, it has been suggested that ACPs have embryonic origins. ACPs are caused by somatic mutations in the  $\beta$ -catenin gene CTNNB1, which enhance  $\beta$ -catenin stability and activate the WNT pathway.

On the other hand, PCPs typically have somatic BRAFV600E mutations that cause the MAPK (mitogen-activated protein kinase) signalling pathway to be activated.

The so-called 90 percent rule, which states that 90% of tumours are primarily cystic, 90% show typically prominent calcifications, and 90% take up contrast media in the cyst walls, can be used to describe the typical combination of imaging features of ACPs; PCPs are more frequently non-calcified and "solid" in nature.



**Figure 2.1: Figure showing Adamantinomatous craniopharyngioma (ACP) and papillary craniopharyngioma clinical and histological features (PCP).**

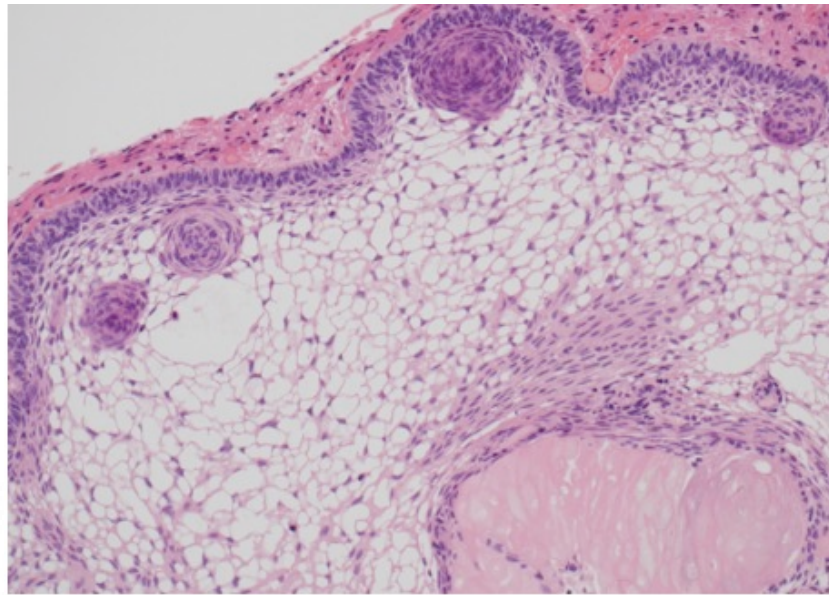
Adamantinomatous craniopharyngiomas have fibrous tissue, calcification, necrotic debris, cystic and/or solid components as gross features macroscopically. The fluid within the cysts, which may have multiple openings, ranges from "machinery oil" to shimmering, cholesterol-rich fluid made up of desquamated squamous epithelial cells that are rich in membrane lipids and cytoskeleton keratin.

They frequently merge into a peripheral zone of dense reactive gliosis and have irregular masses of granular deposits within astrocytic processes, as well as abundant Rosenthal fibre formation in the surrounding brain tissue and vascular structures.

The adamantinomatous type of epithelium is made up of three layers of cells: a distinct palisaded basal layer of small cells with darkly staining nuclei and little cytoplasm; an intermediate layer contains stellate reticulum, with the top layer having abrupt cell divisions faces the cyst lumen (26).

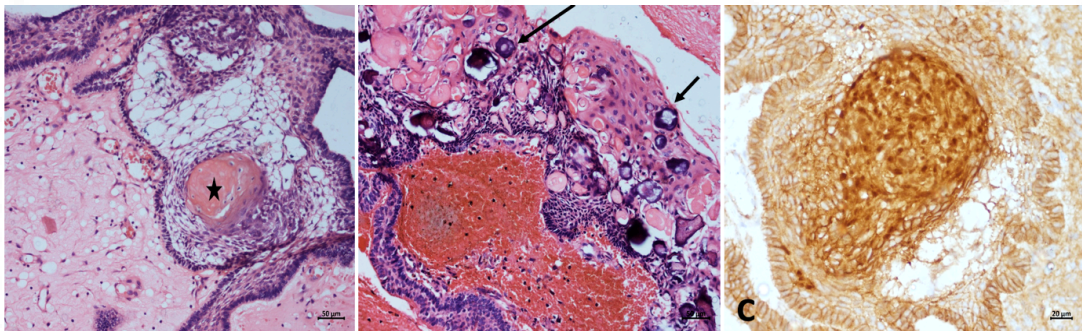
The flat squames form nodules of "wet" keratin that are often severely calcified and present graphically as white specks when desquamated, either singly or in unique stacked clusters.

The keratinous debris may cause an inflammatory and large cell reaction to a foreign substance. The typical adamantinomatous epithelium or the "wet" keratin alone are diagnostic, although the presence of fibro histiocytic response, necrotic debris, calcification, and cholesterol clefts is only suggestive of the diagnosis in small or non-representative specimens (26) (27).



**Figure 2.2:** Microscopic features of adamantinomatous craniopharyngioma (HE x200 magnification).

(The right bottom of this picture shows a well-differentiated epithelium with peripheral palisading, nodular whorls, and pale, areas of microcystic patches known as "stellate reticulum," as well as a pale, eosinophilic "wet keratin" nodule;)

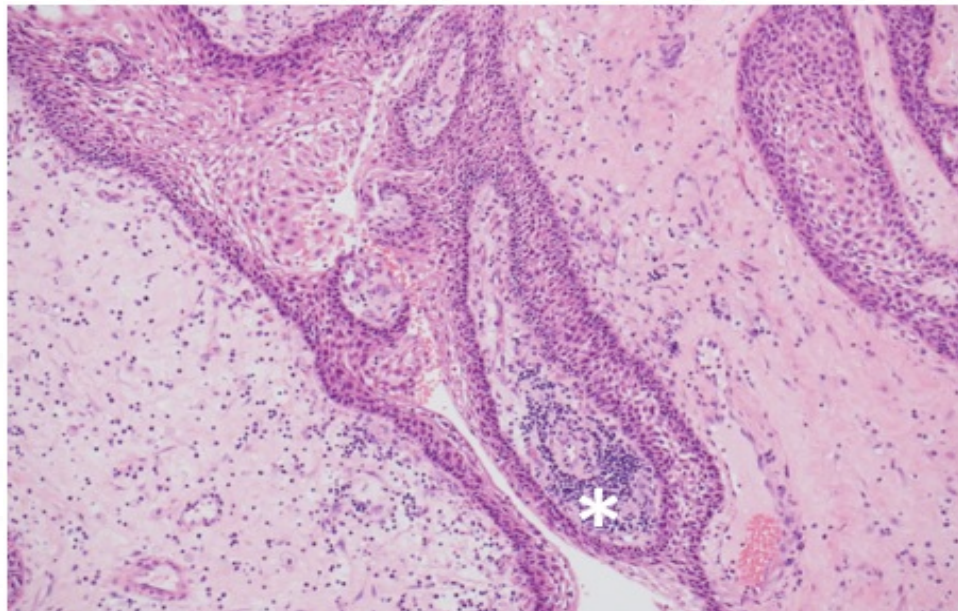


**Figure 2.3:** Adamantinomatous craniopharyngioma: Interconnecting trabeculae of epithelial cells central stellate reticulum cells and wet keratin lobule (asterisk in A), cysts (A) and calcification (arrow in B). Beta-catenin shows nuclear positivity in a cluster of epithelial cells.

Nearly all descriptions of the papillary variation come from adult populations (accounting for 14-50 percent of adult cases but only around 2 percent of paediatric cases) (Figure 2.4).

It is made up of mature squamous epithelium that forms pseudopapillae, an anastomosing fibrovascular stroma, membranous beta-catenin immunoreactivity, and neither peripheral palisading of cells nor stellate reticulin.

However, the absence of a solid component and the presence of significant ciliation and/or mucin production are diagnostic of Rathke's cleft cysts. The differential diagnosis between a papillary craniopharyngioma and a Rathke's cleft cyst may be challenging, particularly in tiny biopsy specimens.



**Figure 2.4: Microscopic features of papillary craniopharyngioma (HE x100 magnification). Asterix depicting a patchy lymphocytic infiltrate in the connective tissue stroma**

### **2.2.1 Survival and late morbidity of CP**

Overall mortality in CP is reported to be three to five times higher than those observed in the general population (28).

Overall survival described in paediatric cohorts ranges from 83% to 96% at 5 years, from 65% to 100% at 10 years and is, on average, 62% at 20 years. In mixed paediatric and adult patient cohorts, overall survival is in the range 54–96% at 5 years, 40–93% at 10 years and 66–85% at 20 years (26).

Several studies have shown that the youngest patients experience better survival than adolescent and adult patients, but others report better outcomes in older patients with CP or similar survival in paediatric and adult cohorts.

Chronic neuroendocrine deficiencies, cerebrovascular illness (such as fusiform dilatations of the carotid artery), and tumour-related and/or treatment-related risk factors, such as progressive disease with numerous recurrences, are linked to long-term morbidity. There are instances in which NASH leads to liver cirrhosis in patients of craniopharyngioma with hypothalamic obesity. In published cohort studies, the standardised overall mortality ranged from 2.88 to 9.28 folds; as compared to the general population, people with CP have a 3- to 19-fold higher rate of cardiovascular death linked to metabolic syndrome (29) (30).

Female CP56 patients had an even greater rate of cardiovascular risk, which may have been brought on by oestrogen deficit brought on by secondary hypogonadism.

### **2.3 Pathophysiology for CP**

The most common location of craniopharyngioma is the sellar/suprasellar region, with 95% of craniopharyngiomas having a suprasellar component. Craniopharyngiomas can compress healthy pituitary tissue, causing deficits in the anterior pituitary hormones in particular. These tumors by compressing the optic chiasm and optic nerves resulting in different spectrum of visual deficits. It can also present with hydrocephalus secondary to third ventricle compression. Significant suprasellar extension may also be accompanied by non-specific intracranial pressure symptoms as headache, nausea, and vomiting.

There have been reports of isolated oculomotor nerve and abducens nerve palsies. Most craniopharyngiomas are supplied by blood from the anterior circulation (1).

Although the pathogenesis of craniopharyngiomas has now no longer been absolutely elucidated, our information on this subject has extended extensively in current years.

Beta-catenin gene (CTNNB1) mutations have been diagnosed in the adamantinomatous subtype affecting exon 3 which encodes the degradation focused on the sphere of beta-catenin; The mutant shape is immune to degradation mainly leading to the accumulation of nuclear beta-catenin protein (a transcriptional activator of the Wnt signalling pathway). Furthermore, the adamantinomatous subtype has significant beta-catenin expression, which suggests that the Wnt signalling pathway has been reactivated and that multiple downstream pathways have subsequently been deregulated.

The immune response is also linked by molecular research to the aetiology of adamantinomatous craniopharyngiomas. These cells exhibit inflammatory symptoms (in both cystic and solid components), and elevated levels of the cytokines Interleukin-6 (IL-6), IL-8, and IL-10 have been found.

Furthermore, the expression of immune-associated genes is increased, and the immune test factor proteins result in programmed Death (PD-L1, PD-1).

For papillary craniopharyngiomas specifically, several studies using whole exome sequencing, next-generation panel sequencing, pyrosequencing and Sanger sequencing have shown the presence of activating mutations withinside the BRAF (V600E) gene; the superiority of which varies in keeping with the sequencing method, typically being among eighty one and 100%.

BRAF mutations can bring about activation of the MAPK/ERK (Mitogen activated protein kinase / Extracellular regulated kinases) pathway, which finally leading to proliferation, cell growth and cell survival(31) (32) (11)(33)(34)(35)(31)(33).

#### **2.4 Diagnosis, screening, and prevention of CP:**

Patients with CP typically present with features of increased intracranial pressure and endocrine abnormalities (36).

A typical work-up should include a review of the patient's and family's medical history, a biochemical evaluation, and a thorough neuroradiological imaging evaluation. Potential differential diagnoses include low-grade gliomas (LGGs), germ cell tumours (GCTs) and cysts of Rathke's pouch, which are frequently characterized

by lower rates of visual impairment, hypothalamic involvement and endocrine deficiencies due to smaller lesion volume at the time of diagnosis. It is also possible to take into account that secreting pituitary adenomas, where symptoms brought on by autonomous hormonal hypersecretion are the main clinical signs.

### **2.7 Neuro-radiological characteristics:**

The solid components (including calcific tissue) and cyst walls of CPs and ACPs may exhibit a range of T1 signals on MRI without contrast, from hypointense to hyperintense.(Fig. 2.5a) (37).

Due to the inhomogeneous distribution of calcifications and the wide individual variation of the MRI signal of calcifications, tumours are typically hypointense and hyperintense on T2-weighted images (Fig. 2.5b).

Therefore, MRI in CPs typically cannot determine the existence or absence of calcifications. The air content of the sinuses in the central skull base also makes it difficult to employ T2\*-weighted or susceptibility-weighted sequences, which are the optimum sequences for identifying calcifications. The proof of calcifications on imaging is also important for the differential diagnosis of other tumours of intrasellar and suprasellar location. Accordingly, despite the desire to avoid the use of X-rays in children, CT is the gold standard for the identification of calcifications in this area (Fig. 2.5c).

Even if the postoperative MRI does not show suspicion of a residual tumour, residual calcification may remain undetected by MRI. The imaging recommendations from the CP trial KRANIOPHARYNGEOM 2007 recommend a postoperative, unenhanced CT of just the tumour area, avoiding the eye lenses (38).

With the presumption that a persistent calcification signifies a persistent tumour, such a CT should identify a persisting calcification that the postoperative MRI missed. The rate of relapse is not always higher at postoperative locations with modest residual calcifications (2 mm in size) than it is at sites without residual calcifications (39).

In our experience, CTs are not performed routinely to avoid irradiation in paediatric patients. However, one patient in our care had an extremely small calcification (<2 mm in size), not detectable on postoperative MRI; after some months, the patient experienced a relapse around the calcification (Fig. 2.5d–f) (40).

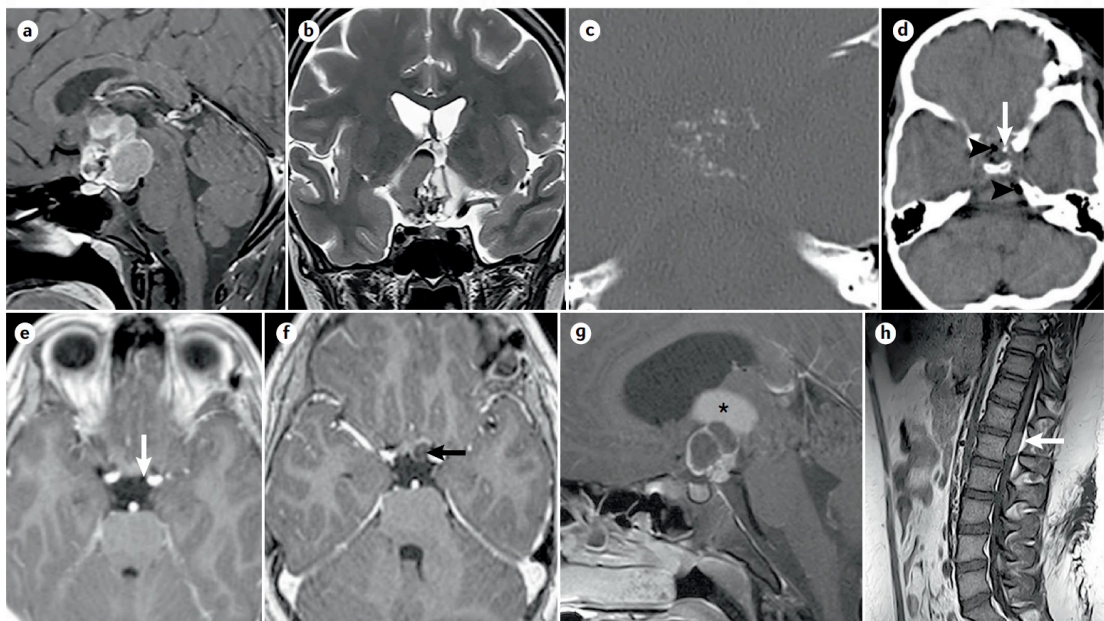
The cysts are filled with an oily fluid (colloid) typically secreted by the tumour epithelium and are, therefore, also highly diagnostic of an ACP (Fig. 2.5g) (41).

In contrast, the imaging-based differential diagnosis of PCP is defined by the fact that PCPs are typically solid or combination solid-cystic round tumours, are uncommonly calcified, typically lack colloid-filled cysts, and tend to affect adults more often than children. Additionally, PCPs with BRAFV600E mutations have been shown to exhibit normal imaging features (42).

Only few reports in the literature have described spinal metastasis of CP (Fig. 2.5h). For risk-adapted decision-making on surgical strategy, a good preoperative MRI scan is crucial to predicting the precise tumour topography and the kind of tumour adherence to the hypothalamus.

This objective can be achieved by evaluating seven basic MRI variables: the position of the hypothalamus in regard to the tumour, the degree of chiasmatic cistern occupation, the mammillary body angle, the type of chiasm distortion, and the tumour shape. the extent of the third ventricle encroachment by the tumour (43)(44).

Hypothalamus positioning around the middle portion of the tumour, a pituitary stalk amputated by the lesion and an elliptical or multilobulated tumour shape are strong predictors of the infundibulo--tuberal and secondarily intraventricular topographies, characterized by strong and extensive CP adhesions to the hypothalamus.



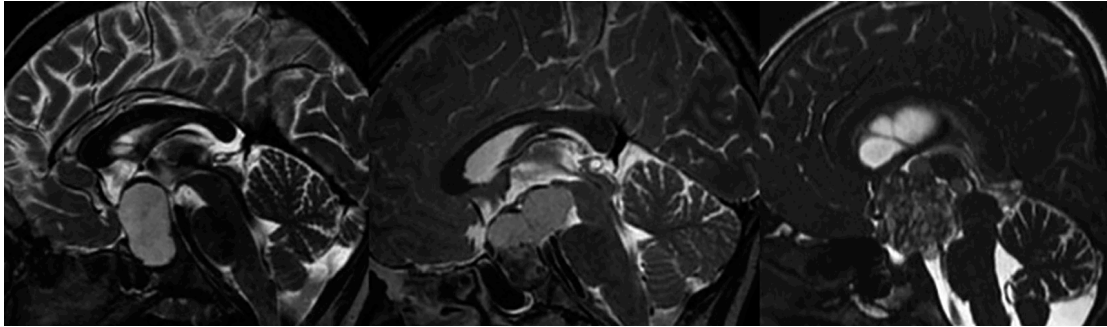
**Figure 2.5(a-h): Neuroradiological characteristics of craniopharyngioma**

## **2.8 Management of CP(45)(46)(47):**

Modern surgical and anaesthetic techniques and equipment, including antibiotics and corticosteroids to reduce infections and inflammation, have improved perioperative morbidity and mortality. The best treatment for CP is that which leads to the least long-term morbidity. Surgery alone, irradiation alone, or—more frequently—a combination of the two—can all be used as forms of treatment. Surgery alone implies GTR and is, therefore, appropriate for tumours that may be completely resected without neurovascular injury and visual impairment. Surgery treatment, particularly for paediatric population, is still debatable and should ideally be properly thought out. It's important to understand that different regions of the world treat CPs differently. Hypothalamic dysfunction with concomitant obesity is a significant factor that has an impact on individuals with ACPs.

Preoperative hypothalamus involvement (Fig. 2.6 ) in the paediatric population raises the possibility of preoperative and postoperative obesity, and hypothalamic damage during surgery raises the possibility of postoperative weight gain. Postoperative weight gain in adults is an issue as well, albeit it is less well understood and reason hypothesised that it is due to the involvement of the hypothalamus (48).

Accordingly, avoiding irreversible hypothalamic damage is a key goal in the treatment of CP. Here, we primarily discuss options available for ACP owing to the considerable evidence base, number of patients and global experience. Some principles of care can be translated to patients with PCP.



**Figure 2.6: CP with hypothalamic involvement: Radiological- MRI preoperative grading**

### **2.8.1 Surgical intervention for CP (1):**

The diagnosis, tumours producing neurologic impairments, pituitary dysfunction, and hydrocephalus all call for surgical surgery. Depending on where the craniopharyngioma is located, endoscopic endonasal transsphenoidal (EET) or other transcranial surgical techniques are the most frequently used. Debatable issues surround the extension of resection.

With no change in the recurrence rates, gross complete resection has been linked to a higher frequency of post-surgical impairments.

In order to choose the appropriate surgical approach, a number of grading systems have been created based on the location of the craniopharyngioma and how it affects nearby tissues. In order to plan the surgical approach, Kassam et al. developed a classification system based on the infundibulum.

This classification includes: Type I tumours- Pre-infundibular, Type II tumours- trans-infundibular, and Type III tumours are retro-infundibular. Third ventricles are where type IV cancers are most frequently found. EET is possible for all types except type IV. With a craniotomy and transcallosal, transcortical, or trans-ventricular methods, the isolated third ventral tumours can be better treated. A very large tumour that is mainly solid, calcified, and vascularly invasive should not be treated with EET (49).

### **Scope of emergency surgery**

The need for an immediate surgical decompression is indicated by increased intracranial pressure and/or vision loss. Due to the tumor's presence in the third ventricle, these instances frequently exhibit the symptoms of biventricular hydrocephalus. By implanting an intracystic catheter and eventually an Ommaya reservoir (an intraventricular catheter device), which allows for repeated aspiration of the cystic colloidal fluid or the administration of intracystic therapy, the issue with cystic components at this level can be resolved (50).

The catheter can provide a useful option to delay more invasive surgery or radiotherapy and can be inserted through open surgery (rarely), a stereotactic operation, or, ideally, an endoscopic method.

A shunt should not be used as a first resort in cases of hydrocephalus since it can sometimes result in sliced ventricles and make later surgery using a ventricular approach more difficult. A direct surgical technique is the only choice in cases with optic chiasm compression with vision loss caused by a solid or calcified component or tumour bulk obstructing the third ventricle (51) (52).

### **Scope of planned surgical resection**

In order to predict postoperative weight gain and, thus, to modify the optimal surgical strategy to protect the hypothalamus as much as possible, risk-adapted treatment with grading systems has been proposed and assessed(51) (53).

The main pre-requisite is a detailed evaluation of preoperative MRI for various anatomical hallmarks for example the location of the anterior communicating artery/location of the optic chiasm, sellar diaphragm, size of the ventricles, the presence of a septum pellucidum, the hypothalamic structures/ floor of the third ventricle and the mammillary bodies. It is also important to look for the angle between the mammillary bodies and the brainstem in case of hypothalamic involvement, which is particularly important for grade 2 tumours to evaluate the displacement of the hypothalamus which guides us to the best surgical approach to tackle the tumour. (Fig. 2.6) (13)(54).

The tumour's adherence to the hypothalamus, which, if removed, can increase the damage to the organ, is another crucial factor to consider. A thorough classification of CP adhesion has been suggested;

CPs associated with the worst outcome were those that had hypothalamic adhesion (to the third ventricle floor and its walls). The preoperative grading system to define hypothalamic involvement is essential when planning a surgical strategy(55)(45).

### **CP's- overview on postoperative hypothalamic damage-**

De Vile et al. established a classification of the degree of the postoperative hypothalamic damage in order to evaluate this damage, which is typically unavoidable given the anatomical location of the majority of these tumours. The approach categorises the damage's severity into three groups based on postoperative anomalies and deficiencies in the third ventricle's floor.(Fig. 2.6). The degree of hypothalamic injury is correlated with the frequency of severe postoperative obesity. In the report by de Vile et al., other outcome factors such as QOL or neuroendocrine deficits were not evaluated. Following that, a number of expanded categories were all published, each of which supported the previously noted correlation between result and degree of hypothalamic damage (56).

#### ***2.8.2 Radiotherapy***

Surgery alone may not be appropriate for tumours that have invaded the hypothalamus (57).

Instead, restricted surgery can be combined with radiotherapy, which is commonly administered via external beam radiotherapy with photons or protons. The amount of the tumour and other factors play a role in determining whether restricted surgery and radiotherapy are acceptable.

Radiotherapy can also be delivered at the time of progression after previous surgery or as part of a planned limited surgery and radiotherapy approach. Tumour control rates after radiotherapy with limited or no surgery are like control rates of GTR or incomplete resection with radiotherapy, with a >90% 10-year overall survival estimated from US Surveillance, Epidemiology, and End Results (SEER) data<sup>169</sup>.

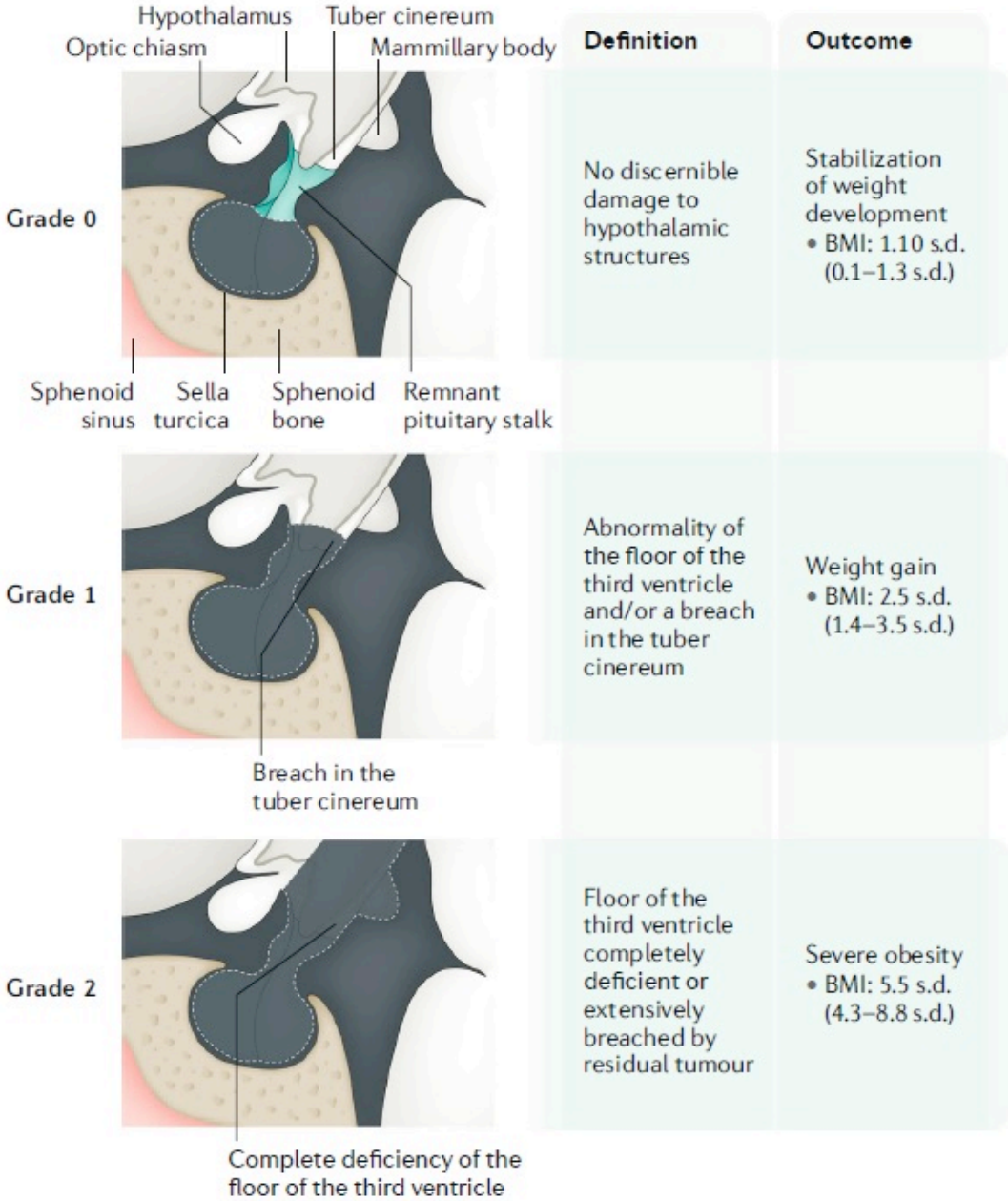
The SEER data analysis, however, did not take a significant number of kids who received final radiation into account or link functional results to treatment. Given the possible side effects, radiation for children must be carefully considered (58).

Cystic craniopharyngiomas are treated with intracavitary radiation therapy (brachytherapy), which involves the stereotactically guided injection of beta-emitting isotopes.. It causes more radiation damage to the cyst than external beam irradiation and shrinks the cyst by damaging the secretory epithelial lining and stopping fluid production.. The efficacy of various isotopes which emit beta/gamma rays has been investigated in a various studies, however none of the isotope meeting the ideal physical and biological criteria. Hence there is no consensus on best suitable therapeutic agent. In a comprehensive evaluation of 66 children who had brachytherapy, 89 percent of those with cystic-only craniopharyngiomas and 58 percent of those with mixed cystic-and-solid components reported a decrease in tumour size.

It is appropriate for most patients regardless of age or tumour type; limited surgery and radiotherapy involve surgery to relieve and prevent symptoms (for example, to lessen visual impairment and mass effect on the brain), improve the patient's ability to tolerate and complete irradiation, and potentially enhance or optimise dose delivery (59).

Partial resection, cyst fenestration or aspiration (although the fluid may reaccumulate), catheter and Ommaya reservoir implantation, or CSF diversion are examples of limited surgical procedures (to restore CSF flow). Diabetes insipidus should be taken into account as an unforeseen effect because limited surgery also lowers the tumour volume for radiation treatment and the radiation dose supplied to

vital normal tissue. The degree of resection can be decreased to the bare minimum required to achieve the goals of the surgery because it hasn't been proven that the amount of residual tumour impacts tumour control after radiotherapy(60).



**Figure 2.7:** Schematic pictorial depicting hypothalamic damage: postoperative radiological grading on MRI

## **2.9 Endoscopic surgeries for Craniopharyngioma – what does the published scientific evidence say?**

In a study by Iranmehr et al., initial experience in the treatment of patients with craniopharyngiomas using an endoscopic approach was published. Retrospective research was done on 29 consecutive craniopharyngioma patients who experienced EES over a 5-year period.

Preoperative pituitary and ocular dysfunction was seen in 89.7 and 86.7% of patients, respectively. In 92.3 percent of the cases following EES, the visual outcome either improved or remained the same; however, in 34.6 percent of the cases, pituitary function remained the same or worsened.

Gross total resection rate was 62 percent. In addition, practically all of the tumours (86.2%) were removed (more than 95 percent of the tumour size resected).

Meningitis and cerebrospinal fluid (CSF) leaks both occurred in four (13.8%) and two (6.9%) of patients after surgery, respectively. Perioperative mortality was seen in two cases (6.9 percent). Four individuals had tumour recurrences on follow-up.

The authors concluded that majority of craniopharyngiomas might be treated with EES with the aim of a maximal and secure tumour excision. Despite the high rates of visual recovery and gross tumour removal, severe issues such as meningitis, CSF leak, and pituitary dysfunction must be addressed(61).

In a retrospective study by Bosnjak et al. reviewed visual, endocrine and neuro-cognitive outcomes in the first consecutive 8 patients (median age 63 years; range 47–73 years) with newly diagnosed craniopharyngioma removed by EES (median follow-up 27 months; range 10–69 months). Gross total resection was achieved in 6 of 8 patients with visual improvement was present in 6 and new endocrinopathy (including diabetes insipidus), appeared in 5 patients. With the exception of the prevalence of new endocrinopathy and the rate of cerebrospinal fluid leakage, the early outcome results of the trial are comparable to the few recent expanded endonasal approach data (62).

More trans infundibular tumours in our collection, where stalk preservation is less frequent, had an impact on this. and by the fact that the first half of the cases did not involve nasoseptal flap or gasket closure. Including data from the literature and ours, expanded endonasal approach shows a trend for improved gross total resection rate with less morbidity, more obviously for visual outcome and quality of life than for endocrine outcome.

A study by Jane Jr et al. reported retrospectively the outcomes of the endoscopic transsphenoidal approach for adults with craniopharyngiomas in whom the goal was gross-total resection. 12 adult patients were included. Gross-total resection was achieved in 42% of cases. However, 83% of patients achieved at least a 95% resection. Postoperatively 44% had permanent diabetes insipidus. of patients. 6 (67%) of 9 patients who developed panhypopituitarism after surgery (with preoperative normal functioning hypothalamic-pituitary axis).

Visual improvement was there in 78% of patients with preoperative visual deficits. Only one patient was treated for meningitis however, no patient in the study had CSF leak. Despite this study group achieved a high rate of radical resection, this group was also associated with a high incidence of new hormonal disturbances requiring hormonal supplementation and regular follow-up (63).

Koutourousiou et al study presents the EES data and analyses the outcomes across both the paediatric and adult age categories. For this trial, 64 patients were eligible— 47 adults and 17 kids. 47 patients had primary craniopharyngiomas and 17 had recurrent tumours when they first appeared. The range of ages for the adult group was 28 to 82 years, while for the paediatric group it was 9 years (range 4-18 years). Gross entire resection rate was 37.5 percent (24 patients); near total resection rate was 34.4 percent (22 patients); subtotal resection rate was 21.9 percent (14 patients); and partial resection rate was 6.2 percent ( 80 percent of tumour eliminated) (4 patients). EES was used as the initial treatment in 9 patients who also received radiation therapy (and radiosurgery in 6 cases). Pituitary function remained the same in 19 (47.5%) of the 40 patients (62.5%) who had pituitary insufficiency, improved or normalised in 8 (20%), and deteriorated in 13 individuals (32.5 percent ).

14 of the 24 people who initially presented with normal pituitary function but later developed new pituitary impairments (58.3 percent ). 19 patients (29.7%) had diabetic insipidus, and following therapy, the condition manifested in 21 patients (46.7%) at the time of first visit.

44 patients (68.8%) experienced visual impairment when they first arrived. In 38 (86.4%) of them, vision returned to normal or even improved following surgery; in 5, it remained unchanged; and in 1, it briefly deteriorated. One patient who had no visual issues prior to surgery experienced brief visual decline after therapy. No one experienced permanent vision loss following surgery. The mean follow-up was 38 months (range 1-135 months).

22 patients (34.4%) had tumour recurrence following EES; these patients underwent repeat surgery six times, radiosurgery once, combined repeat surgery and radiation therapy eight times, interferon once, or were left untreated (6 patients). Surgery-related complications included 15 instances (23.4%) of CSF leaking that required surgical reexploration (13 patients) and/or the installation of lumbar drains (9 patients).

Following the development of the vascularized nasoseptal flap, this leak rate was recently reduced to 10.6%. Antibiotics were administered to five cases of meningitis (7.8%), and there were no subsequent complications. In 7 patients (12.7%), postoperative hydrocephalus resulted in the implantation of a ventriculoperitoneal shunt. Transient cranial nerve palsies occurred in five cases. No operational mortality occurred. With the exception of completely intraventricular tumours, the authors came to the conclusion that EES can be utilised to treat all craniopharyngiomas with the aim of gross-total or maximum safe excision and can produce results that are comparable to those of conventional craniotomies.

Endoscopic endonasal surgery is not just performed on adults; in fact, paediatric patients have higher rates of resection(63)(64).

Data from 103 patients who underwent EES at two institutions from Italy for the removal of infra- and/or supradiaphragmatic craniopharyngiomas were retrospectively analysed in a study by Cavallo et al.

In 68.9% of the instances, the authors were able to completely remove all lesions, including 78.9% of exclusively infra-diaphragmatic lesions and 66.3% in lesions involving the supradiaphragmatic space. The gross-total removal rate for lesions that had previously undergone surgery was 62.1 percent. Visual disturbances generally improved 74.7 percent of the time, while 2.5 percent worsened. There were no new postoperative defects found. There were 38 new cases of postoperative diabetes insipidus (48.1 percent of 79), and 46.2 percent of patients reported worsening anterior pituitary function overall.

Postoperative CSF leakage was the most frequent complication; its total rate was 14.6 percent, but it dropped to 4 percent in the previous 25 operations due to advancements in reconstructive techniques. The death rate was 1.9%, and the average number of follow-up months was 48. (range 3-246 months).

The endoscopic endonasal approach has developed into a reliable surgical method for the management of craniopharyngiomas, according to the authors' findings. Infra- and supradiaphragmatic midline craniopharyngiomas are well managed here, as is the treatment of lesions that extend into the third ventricle chamber. Although the data in this study demonstrate its effectiveness in a broad patient series, the indications for this method are strictly lesion-based (65).

## MATERIALS AND METHODS



### **3. MATERIALS AND METHODS:**

- The present study was proposed to evaluate the Visual outcomes, health related quality of life, neurocognitive profiles, neurological and endocrinological outcomes of both adults and children with craniopharyngioma following therapy.
- All patients (aged between 1 years to 61 years) who underwent surgical treatment for craniopharyngioma from the year January 2016 till May 2023 at the Sree Chitra Institute for medical sciences and technology, Trivandrum with follow up were considered for inclusion in the study. This study was carried out as per approval of the Institutional Ethics Committee (IEC).
- All pre-operative clinical details, post-operative clinical details, radiological data, surgical procedures, follow up data and adjuvant treatment details of the patient were collected at the follow up and through medical records department of the institute.
- The patients for the study were recruited retrospectively who got operated from the SCTIMST elective neurosurgical operation theatre list and their HPR was proven to be craniopharyngioma .
- All patients details who got evaluated clinically with a history and detailed clinical examination with preoperative MRI / CT scan details were retrieved.

- Our surgical protocol involved intra operative neuro-navigation and lumbar drains for those deemed necessary by the operating surgeon were inserted preoperatively by the anesthesiologists after induction of anesthesia. Rigid 0-degree endoscopes were utilized for the entire procedure. Partial inferior turbinectomy and posterior septectomy were performed in patients to provide improved access for the surgical instrumentation used to perform a bi-nostril technique.

Endoscopic and extended endoscopic approaches were used to tackle tumor intra-operatively. In each case, a multilayer reconstruction of the skull base defect was carried out after the tumour was removed. This reconstruction included thigh fat with or without fascia, surgicel, gelfoam, and the nasoseptal flap.

- As it is a retrospective study, on regular follow up visit to OPD of patient, hormonal tests, height/weight of the patient, the QoL evaluation and visual (confrontation/visual charting/perimetry) tests were performed during the period between 2016 till 2023.
- Present educational and occupational status along with socio-economic background and educational and occupational details of family members, other environmental factors affecting QoL of patients were documented.
- The patients' neurological status, endocrinological status, anthropometry and development were procured through EMR/MRD department. Endocrinological outcome were assessed using hormonal evaluation and accordingly advised by the endocrinologist regarding need for hormone replacement.

## **ANALYSIS:**

The collected data were analysed with IBM SPSS Statistics for Windows, Version 29.0.(Armonk, NY: IBM Corp).To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S.D were used for continuous variables. To find the significant difference between the bivariate samples in Paired groups the Paired sample t-test was used .To find the significance in qualitative categorical data Chi-Square test was used similarly if the expected cell frequency is less than 5 in 2×2 tables then the Fisher's Exact was used. In all the above statistical tools the probability value 0.05 is considered as statistically significant.

Not all variables met the assumptions required for parametric; therefore, non-parametric tests (i.e., Pearson's correlation, Mann-Whitney test, Spearman correlation) were used for all analyses for consistency. Appropriate graphs such as pie charts, bar diagrams and histograms have been constructed.

## RESULTS



## 4. RESULTS

### 4.1 DEMOGRAPHY AND CLINICAL PARAMETERS

This retrospective study included 57 patients with histologically confirmed craniopharyngioma. All these patients underwent surgical treatment in our institute from January 2016 to May 2023, and some completed their adjuvant therapy.

All these patients were under routine follow-up. They were evaluated during the period from 2021 to May 2023. Clinical, endocrinological status, QoL and cognitive status were evaluated as described in the methods section.

The demographic data of these patients were analyzed and tabulated below.

**Table 4a - Age at presentation**

<b>AGE</b>	<b>Number of patients</b>
New born (upto 1 month)	-
Infant (1m-1yr)	-
Toddler (1yr-3yr)	1
Preschool(3yr-6yr)	2
School age (6yr-12yr)	8
Adolescent (12yr-18yr)	13
18-30 yr	11
31-50 yr	16
>50yr	6

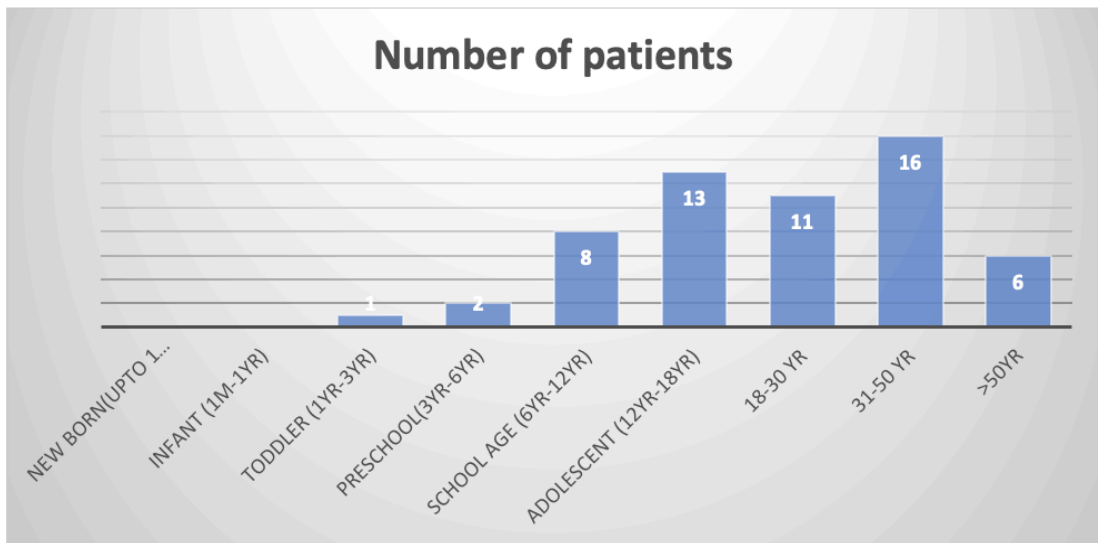


Figure. – Histogram depicting the frequency of age distribution

#### Figure 4a : Histogram of age distribution

Most of the patients belonged to the age group of 31- 50 years i.e., 16 patients followed by the age group of 12-18 years,18-30 years and more than 50 years in that order.

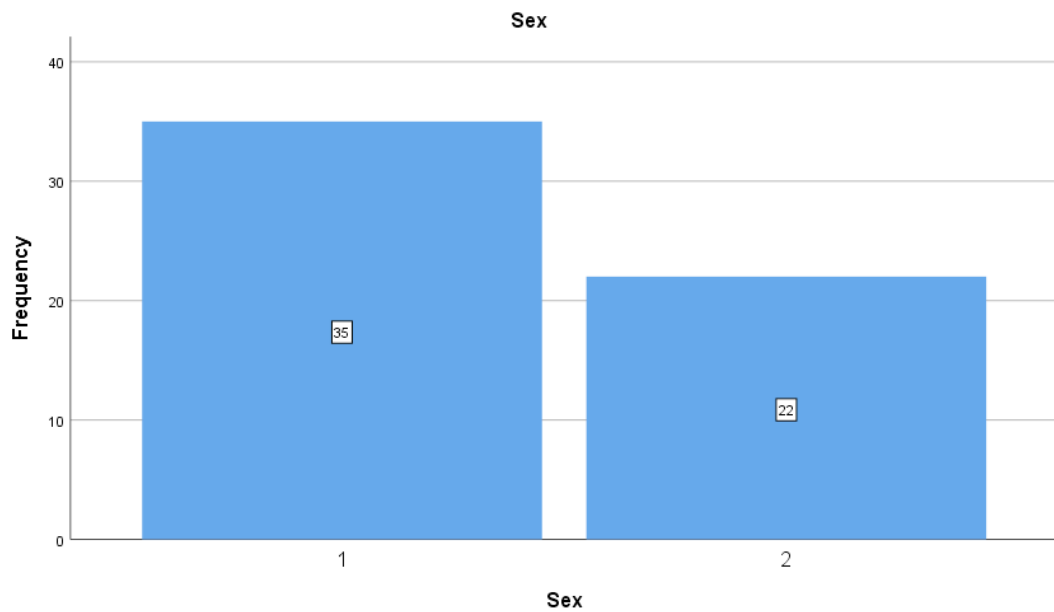
In our cohort, patients ranged in age from 2 months to 56 years, with 2 months being the youngest patient.

**Gender :**

**Table 4b - Gender distribution**

		Sex			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	35	61.4	61.4	61.4
	Female	22	38.6	38.6	100.0
	Total	<b>57</b>	<b>100.0</b>	<b>100.0</b>	

Our cohort comprised 35 (61.4 %) males and 22 (38.6 %) females.



**Figure 4b - Bar diagram depicting gender distribution**

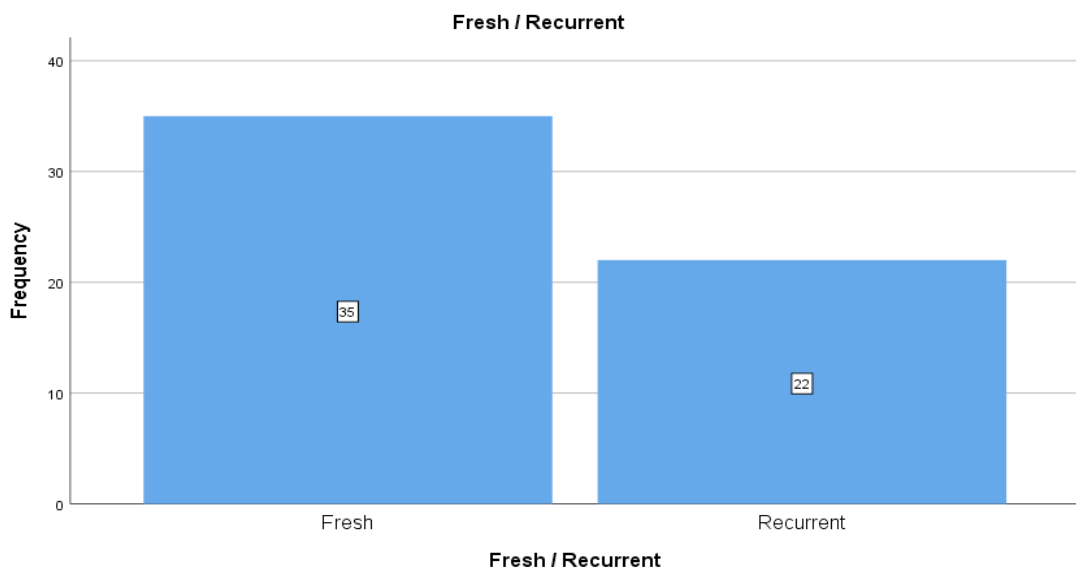
**Primary /recurrent cases:**

In our study, 35 cases (61.4%) were primary and 22 (38.6%) were recurrent.

Recurrent cases were those who had previous trans cranial or microscopic operations.

**Table 4c – primary and recurrent cases**

Fresh / Recurrent					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fresh	35	61.4	61.4	61.4
	Recurrent	22	38.6	38.6	100.0
	Total	<b>57</b>	<b>100.0</b>	<b>100.0</b>	



**Figure 4c - Bar diagram depicting the total number of fresh/recurrent cases**

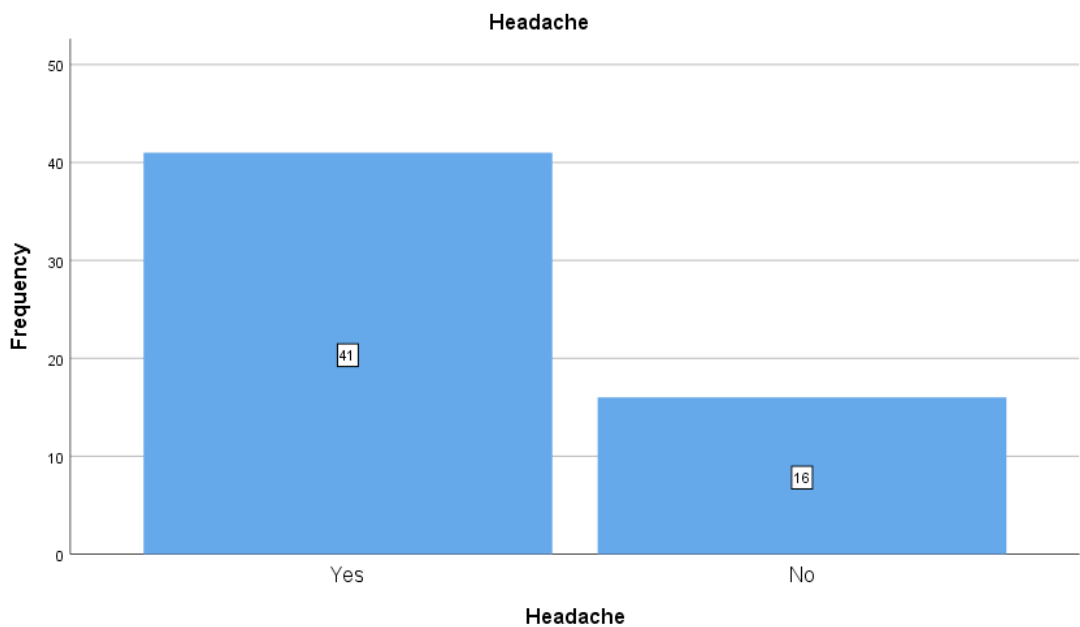
**Clinical features:**

***Headache-***

Out of 57 patients, 41 (71.9 %) had headaches as their chief complaint.

**Table 4d– Headache as the chief complaint**

		Headache			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	41	71.9	71.9	71.9
	No	16	28.1	28.1	100.0
	Total	<b>57</b>	<b>100.0</b>	<b>100.0</b>	



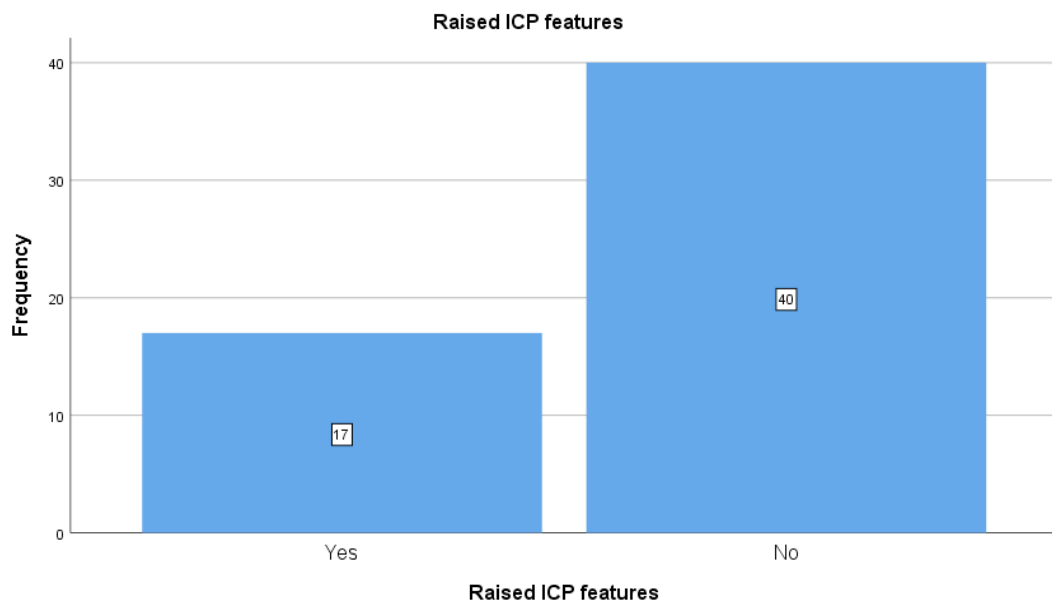
**Figure 4d – Bar diagram depicting the distribution of headache as the chief complaint**

***Raised ICP features -***

In our study, 17 out of 58 patients (29.2%) exhibited high intracranial pressure symptoms such as acute headache, vomiting, visual abnormalities, and papilledema like characteristics.

**Table 4e– Patients presenting with raised ICP features**

Raised ICP features					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	29.8	29.8	29.8
	No	40	70.2	70.2	100.0
	Total	57	100.0	100.0	



**Figure 4e – Graph depicting the distribution of patients presenting with increased ICP features.**

***Pre-op hypothalamic dysfunction-***

Our study found that 61.4% of patients exhibited signs of hypothalamic dysfunction, such as increased thirst and urination, changes in body temperature, alteration in body weight, menstrual irregularities, reduced libido, and delayed secondary sexual characteristics.

**Table 4f. – distribution of hypothalamic symptoms**

<b>Hypothalamic dysfunction</b>	<b>Frequency</b>	<b>Percent</b>
<b>Present</b>	35	61.4
<b>Absent</b>	22	38.6
<b>Total</b>	<b>57</b>	<b>100.0</b>

***Visual disturbances -***

In our study, 75.4% of the participants experienced visual disturbances such as blurring or visual field defects.

**Table 4g– Visual disturbances in our study**

<b>Visual disturbances</b>	<b>Frequency</b>	<b>Percent</b>
<b>Present</b>	43	75.4
<b>Absent</b>	14	24.6
<b>Total</b>	<b>57</b>	<b>100.0</b>

***Fundus examination-***

32 (56.1 %) patients had optic atrophy and 12 (21.1 %) patients had papilledema on fundus examination as per the our study findings.

**Table 4h- Fundus examination findings on presentation.**

<b>Fundus</b>	<b>Frequency</b>	<b>Percent</b>
<b>Normal</b>	13	22.8
<b>Optic atrophy</b>	32	56.1
<b>Papilloedema</b>	12	21.1
<b>Total</b>	<b>57</b>	<b>100.0</b>

***Pre-op hormonal assessment-***

In our study, the majority of patients had hypogonadism (32-56.1%), followed by hypothyroidism and hypocortisolism. Abnormal thyroid hormone levels were found in 29 patients (50.9%), and low cortisol levels were found in 28 patients (49.1%).

In our cohort, among 57 patients 21 (36.8 %) had pre-op diabetes insipidus.

**Table 4i- Cortisol levels**

<b>CORTISOL LEVELS</b>	<b>Frequency</b>	<b>Percent</b>
Normal	29	50.9
Abnormal	28	49.1
<b>Total</b>	<b>57</b>	<b>100.0</b>

**Table 4j – Patients with pre-op DI**

<b>DIABETES INSIPIDUS</b>	<b>Frequency</b>	<b>Percent</b>
<b>Present</b>	21	36.8
<b>Absent</b>	36	63.2
<b>Total</b>	<b>57</b>	<b>100.0</b>

***Pre-op hydrocephalus and pre-op CSF diversion-***

In our study, 16 (28.1 % ) had pre-operative hydrocephalus and 15 patients underwent CSF diversion prior to the endoscopic procedure. One patient underwent surgery upfront in view of visual deterioration.

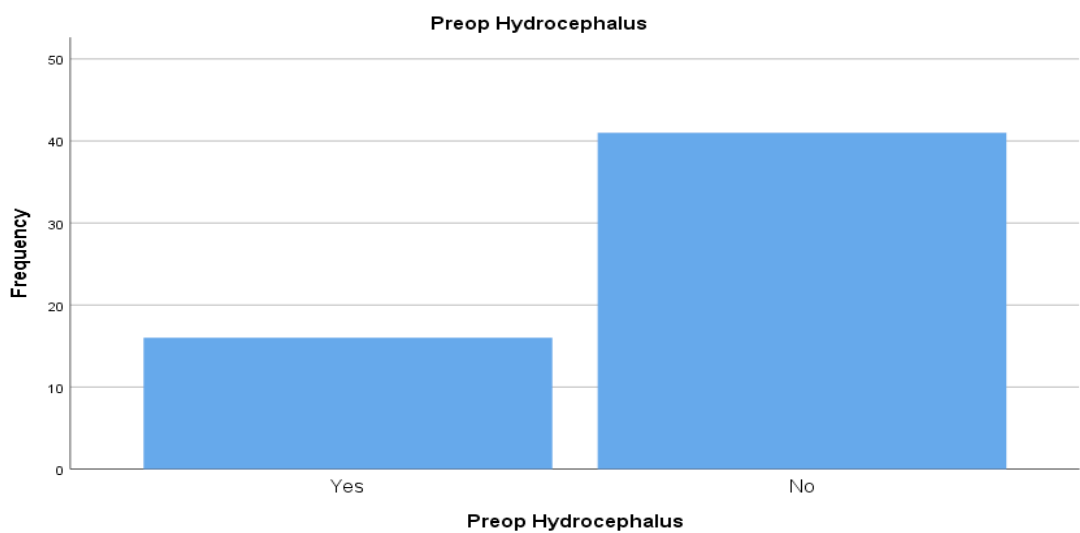
Out of 15, 7 patients underwent shunt, 7 patients underwent septostomy + shunt and 1 patient had External ventricular drainage.

**Table 4k – pre-op hydrocephalus frequency**

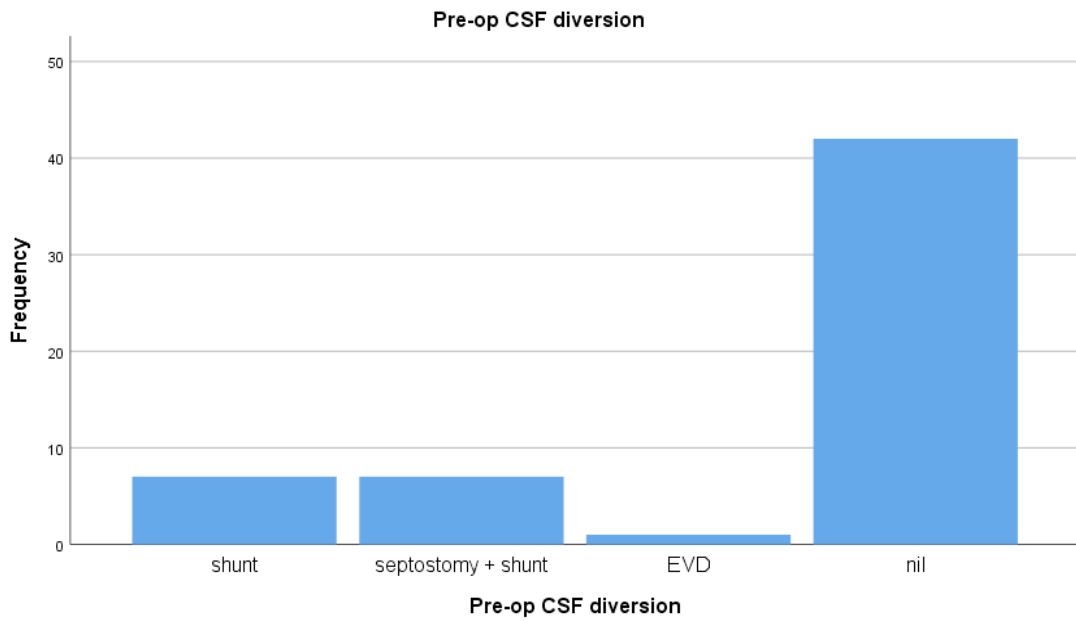
<b>Preop Hydrocephalus</b>					
		<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative Percent</b>
<b>Valid</b>	<b>Yes</b>	16	28.1	28.1	28.1
	<b>No</b>	41	71.9	71.9	100.0
	<b>Total</b>	<b>57</b>	<b>100.0</b>	<b>100.0</b>	

**Table 4l- pre-op CSF diversion**

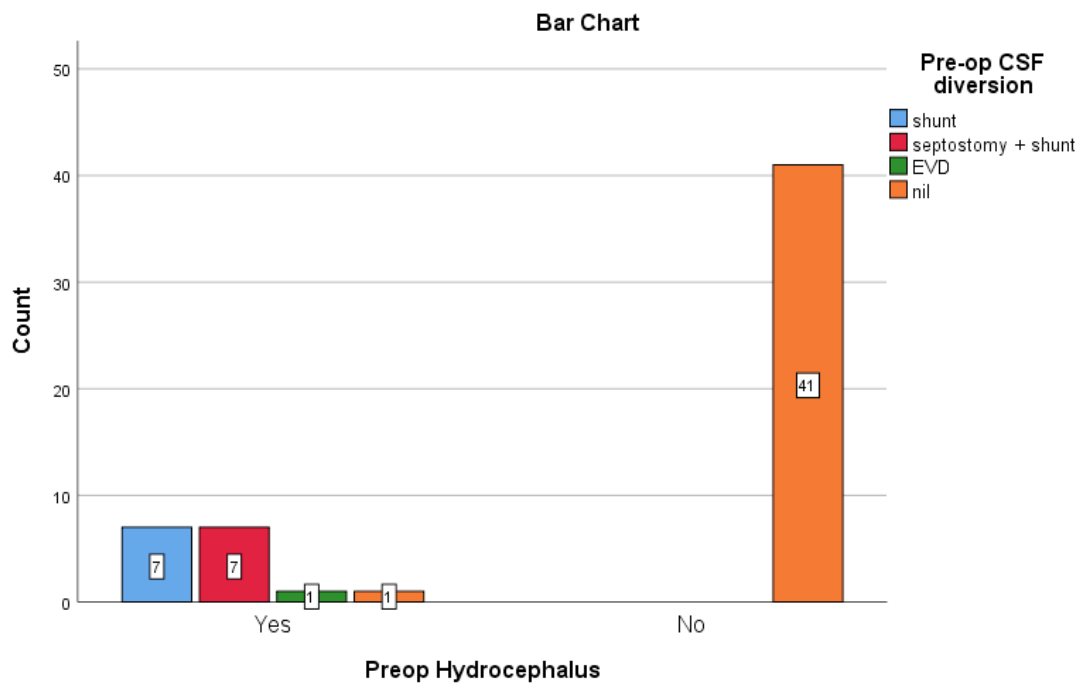
Pre-op CSF diversion					
		Frequency	Percent	Valid Percent	Cumulative Percent
<b>Valid</b>	<b>shunt</b>	7	12.3	12.3	12.3
	<b>septostomy + shunt</b>	7	12.3	12.3	24.6
	<b>EVD</b>	1	1.8	1.8	26.3
	<b>nil</b>	42	73.7	73.7	100.0
	<b>Total</b>	<b>57</b>	<b>100.0</b>	<b>100.0</b>	



**Figure 4f – patients with pre op hydrocephalus**



**Figure 4g- Patients who required various modalities of CSF diversion**



**Figure 4h- Patients who required various modalities of CSF diversion**

## 4.2 TREATMENT PARAMETERS:

### A. Procedure: Endoscopic v/s Extended endoscopic:

In our study, 34 out of 57 patients (59.6%) underwent extended endoscopic procedures, while the remaining 23 (40.4%) required regular endoscopic procedures.

**Table 4m– Patients underwent endoscopic vs extended endoscopic procedure**

<b>Procedure</b>	<b>Frequency</b>	<b>Percent</b>
<b>Endoscopic</b>	23	40.4
<b>Extended endoscopic</b>	34	59.6
<b>Total</b>	<b>57</b>	<b>100.0</b>

Intra-operatively the tumour consistency was predominantly mixed type i.e., 69 % (both solid and cystic type) rather than individual solid or cystic type. Among all these cohorts 77 % (44) of patients had intra-op CSF leak.

Intraoperatively 8 out of 57 patients (14 % ) underwent pituitary transposition and 11 out of 57 (19 % ) patients' pituitary stalk were transected.

Most of the patients required lumbar drain i.e., 36 patients (63.2 %) before the procedure.

For repair and reconstruction of the skull base defect, 44 (72.2 %) patients needed both fat and fascia harvested from the thigh and 9 (15.8 %) needed only fat. For augmentation 55 patients (96.2 %) required Hadad (mucocutaneous) flap.

**B. Degree of Resection and residual tumour with recurrence state:**

In our study, 57 patients underwent resection: 39 (68.4%) underwent gross total resection, 14 (24.6%) underwent near-total resection, and 4 (7%) underwent subtotal resection. Of these, 18 (31.6%) patients had minimal residues and 39 (68.4%) had no residues radiologically. Only 3 (5.3%) patients experienced a lesion recurrence.

**Table 4n– Degree of resection**

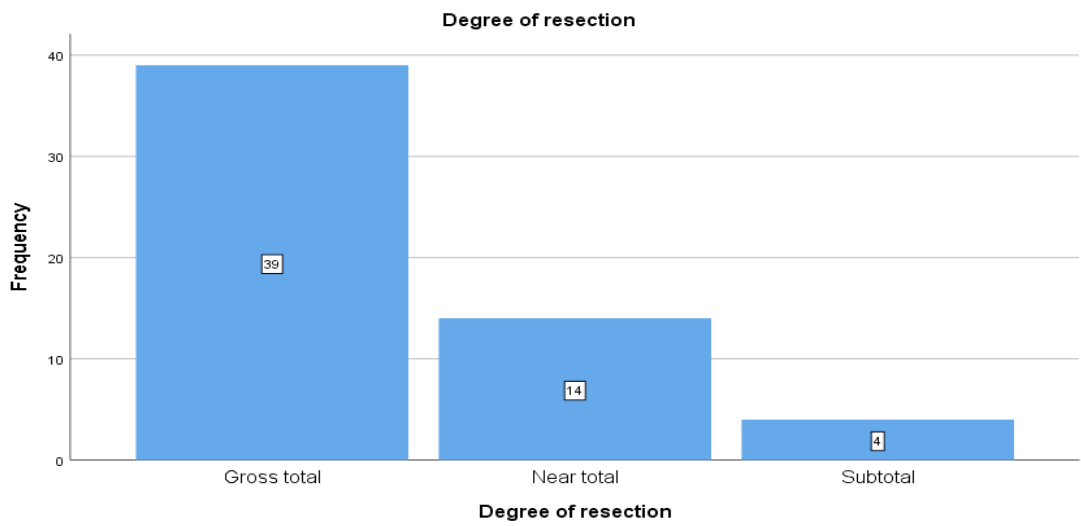
<b>Degree of resection</b>					
		<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative Percent</b>
<b>Valid</b>	<b>Gross total</b>	39	68.4	68.4	68.4
	<b>Near total</b>	14	24.6	24.6	93.0
	<b>Subtotal</b>	4	7.0	7.0	100.0
	<b>Total</b>	<b>57</b>	<b>100.0</b>	<b>100.0</b>	

**Table 4o – Degree of residual tumor**

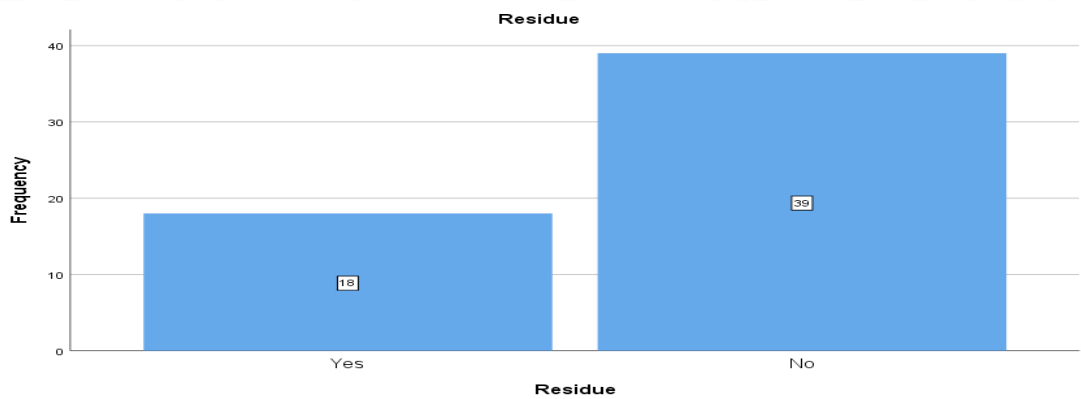
<b>Residue</b>					
		<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative Percent</b>
<b>Valid</b>	<b>Yes</b>	18	31.6	31.6	31.6
	<b>No</b>	39	68.4	68.4	100.0
	<b>Total</b>	57	100.0	100.0	

**Table 4p- Recurrence status**

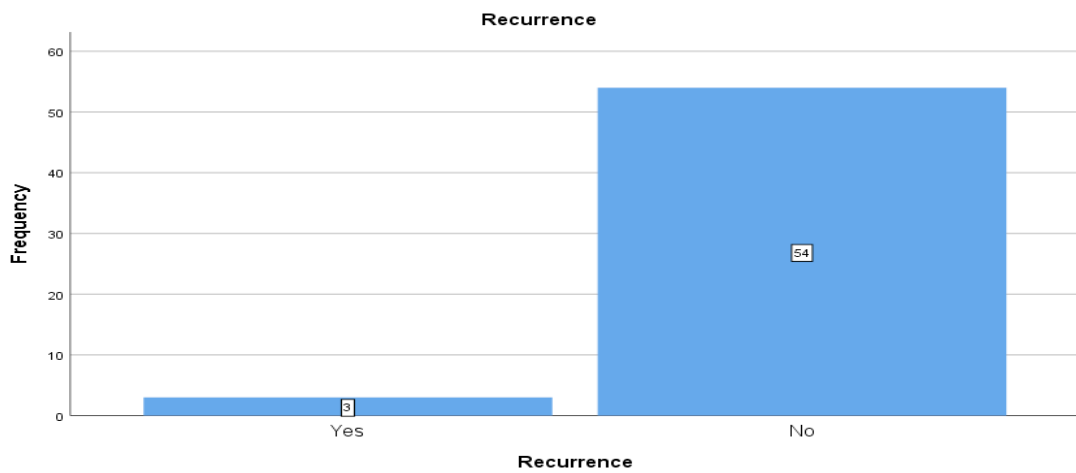
Recurrence					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	5.3	5.3	5.3
	No	54	94.7	94.7	100.0
	Total	57	100.0	100.0	



**Figure 4i- Graph depicting the degree of resection**



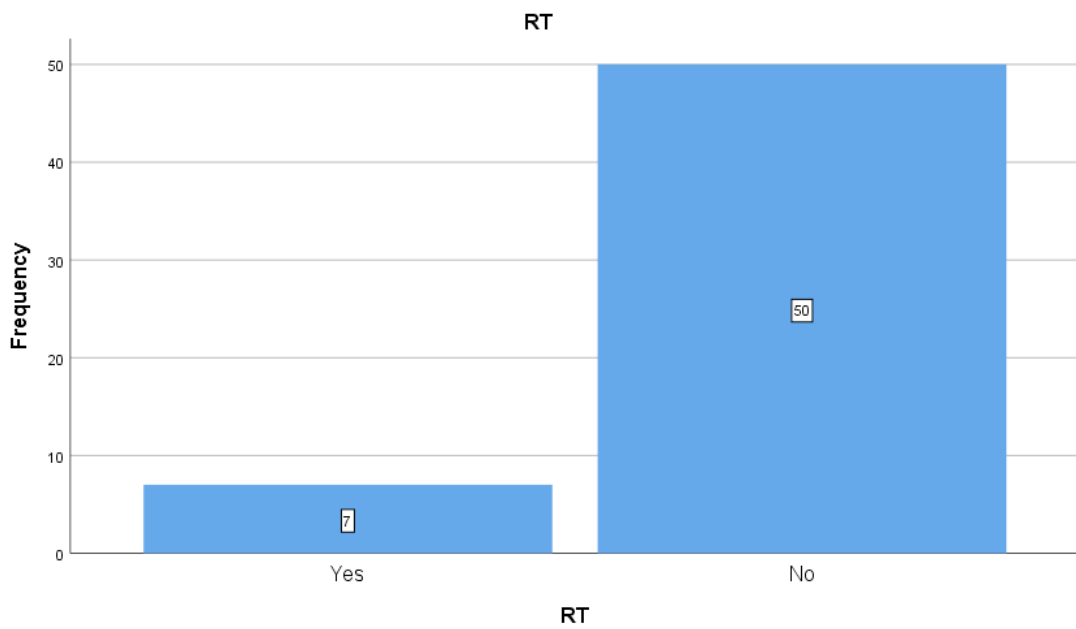
**Figure 4j- Graph depicting the degree of residual tumour**



**Figure 4k – Graph depicting recurrence status.**

**C. Patients requiring adjuvant therapy- radiotherapy:**

Total of 7 (12.3 %) patients who required radiotherapy post-surgery.



**Figure 4l – Patients who required RT**

### 4.3 TUMOUR CHARACTERISTICS:

#### A. Co-relation between Tumour diameter and volume of tumour vs Degree of resection:

Our results show that as the tumour size and volume increases there is a likely possibility of the near and total resection in contrast to small/medium tumours who are getting gross total resection.

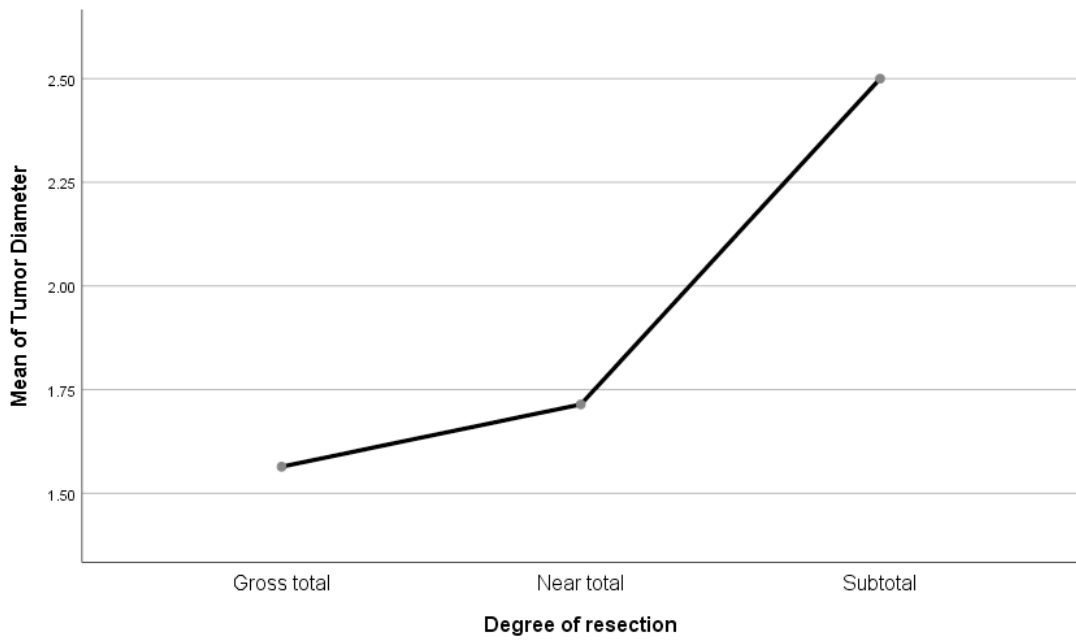
#### ANOVA

**Table 4.3a – Descriptive data depicting various extents of resection when compared to tumour characteristics.**

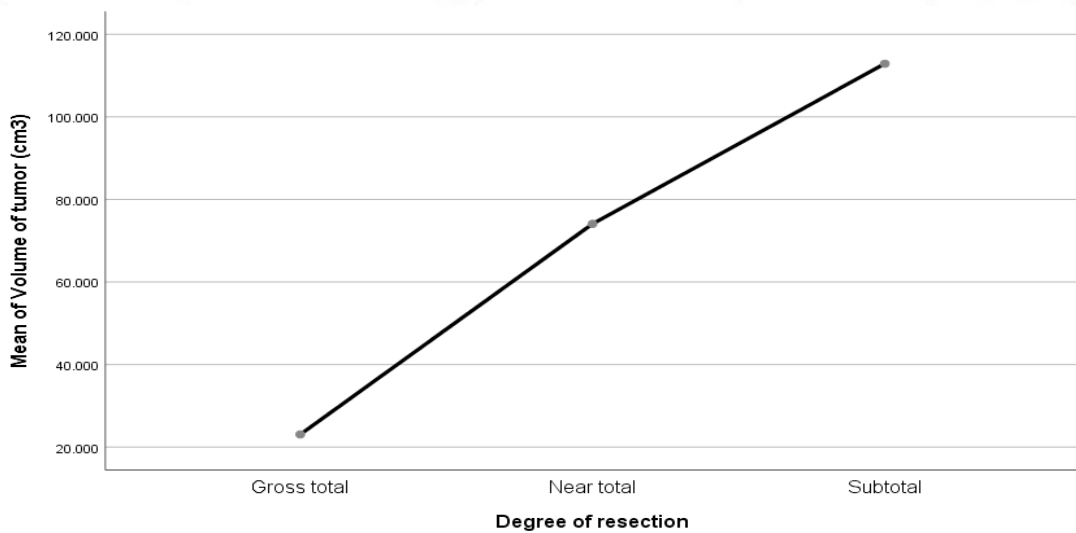
		Descriptives							
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Tumor Diameter	Gross total	39	1.56	.552	.088	1.39	1.74	1	3
	Near total	14	1.71	.825	.221	1.24	2.19	1	3
	Subtotal	4	2.50	1.000	.500	.91	4.09	1	3
	Total	57	1.67	.690	.091	1.48	1.85	1	3
Volume of tumor (cm3)	Gross total	39	23.05964	18.310464	2.932021	17.12408	28.99521	3.240	89.540
	Near total	14	74.08200	131.532056	35.153421	-1.86235	150.02635	7.581	508.518
	Subtotal	4	112.87700	140.399542	70.199771	-110.53000	336.28400	3.458	318.780
	Total	57	41.89442	78.521973	10.400489	21.05974	62.72910	3.240	508.518

**Table 4.3b – Descriptive data depicting the relationship between tumour characteristics variables.**

		ANOVA				
		Sum of Squares	df	Mean Square	F	Sig.
Tumor Diameter	Between Groups	3.220	2	1.610	3.708	.031
	Within Groups	23.447	54	.434		
	Total	26.667	56			
Volume of tumor (cm3)	Between Groups	48493.878	2	24246.939	4.412	.017
	Within Groups	296785.334	54	5496.025		
	Total	345279.213	56			



**Figure 4.3a – Graph depicting relationship between tumour size with the extent of resection**



**Figure 4.3b– Graph depicting relationship between tumour volume with the extent of resection**

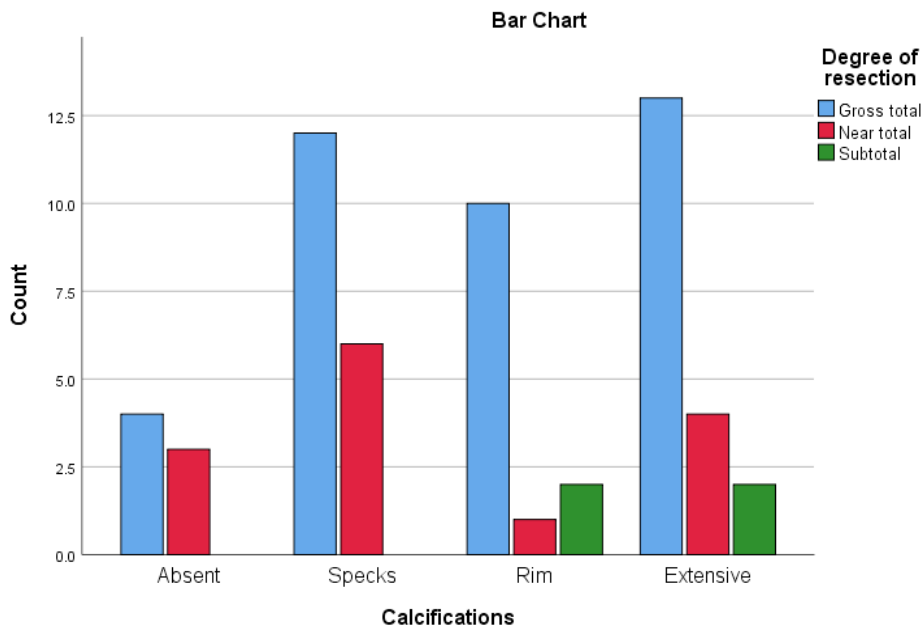
**B. Calcifications:**

50 patients had calcifications in pre-operative imaging in the form of specks/rim or extensive calcifications and 7 people never had calcifications on imaging.

Further, when we compared the presence of calcification affecting the degree of resection through statistical tests, there was no statistical significance between these two factors despite our cohorts who had undergone subtotal resection had both rim and extensive calcification on pre-op imaging.

**Table 4.3c– Cross tabulating presence of calcifications in tumour with degree of resection**

<b>Crosstab</b>					
<b>Count</b>					
		<b>Degree of resection</b>			<b>Total</b>
		<b>Gross total</b>	<b>Near total</b>	<b>Subtotal</b>	
<b>Calcifications</b>	<b>Absent</b>	<b>4</b>	<b>3</b>	<b>0</b>	<b>7</b>
	<b>Specks</b>	<b>12</b>	<b>6</b>	<b>0</b>	<b>18</b>
	<b>Rim</b>	<b>10</b>	<b>1</b>	<b>2</b>	<b>13</b>
	<b>Extensive</b>	<b>13</b>	<b>4</b>	<b>2</b>	<b>19</b>
<b>Total</b>		<b>39</b>	<b>14</b>	<b>4</b>	<b>57</b>



**Figure 4.3c– Graphs depicting tumour calcifications association with degree of resection**

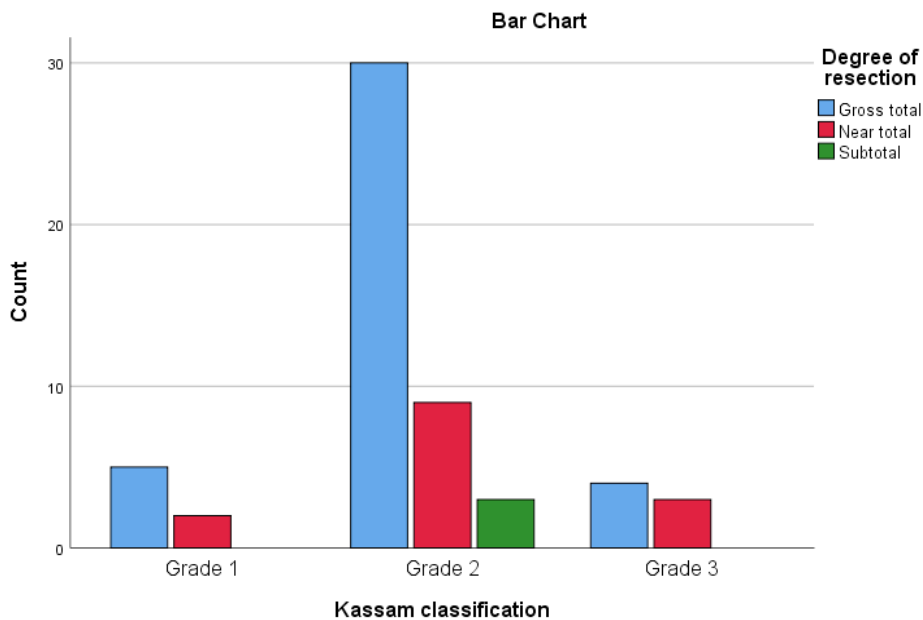
**C. Kassam classification :**

In our study 7 patients are grade I (pre-infundibular), 43 patients were grade II (trans-infundibular), and 7 patients were grade III (retro-infundibular) varieties.

The majority of the patients belonged to the trans-infundibular variety, in which 30 patients underwent gross total resection with 9 patients undergoing a near total and 4 undergoing subtotal resection.

**Table 4.3d: Depicts Kassam grade with Degree of resection**

<b>Crosstab</b>					
<b>Count</b>					
		<b>Degree of resection</b>			<b>Total</b>
		<b>Gross total</b>	<b>Near total</b>	<b>Subtotal</b>	
<b>Kassam classification</b>	<b>Grade 1</b>	<b>5</b>	<b>2</b>	<b>0</b>	<b>7</b>
	<b>Grade 2</b>	<b>30</b>	<b>9</b>	<b>4</b>	<b>43</b>
	<b>Grade 3</b>	<b>4</b>	<b>3</b>	<b>0</b>	<b>7</b>
<b>Total</b>		<b>39</b>	<b>14</b>	<b>4</b>	<b>57</b>



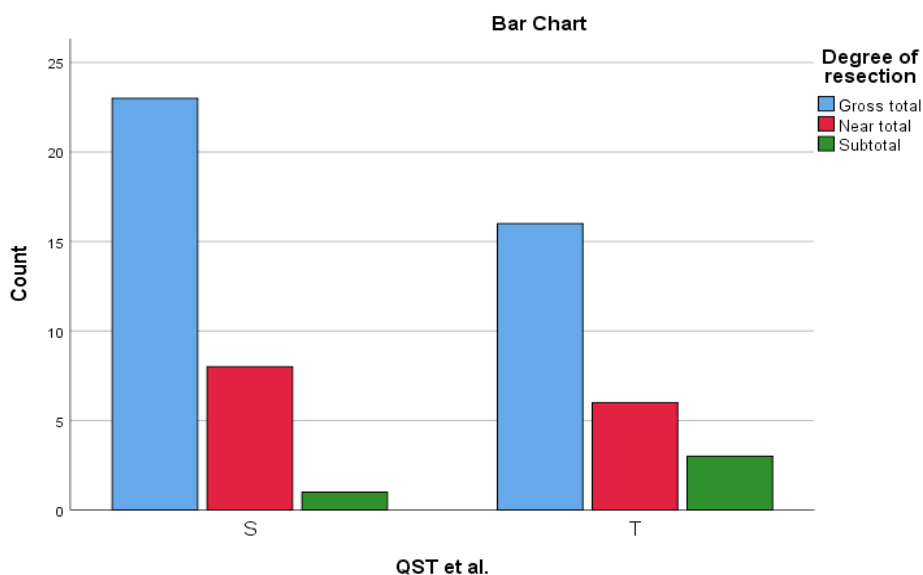
**Figure 4.3d: Depicting Kassam classification with degree of resection**

**D. QST et al. Classification :**

In our study most of the patients i.e., 32 patients were type S variety (pre-chiasmatic and retro-chiasmatic), 25 patients were of type T (intraventricular) varieties.

**Table 4.3e– QST et al classification with degree of resection.**

<b>Crosstab</b>					
<b>Count</b>					
		<b>Degree of resection</b>			<b>Total</b>
		<b>Gross total</b>	<b>Near total</b>	<b>Subtotal</b>	
<b>QST et al.</b>	<b>S</b>	<b>23</b>	<b>8</b>	<b>1</b>	<b>32</b>
	<b>T</b>	<b>16</b>	<b>6</b>	<b>3</b>	<b>25</b>
<b>Total</b>		<b>39</b>	<b>14</b>	<b>4</b>	<b>57</b>



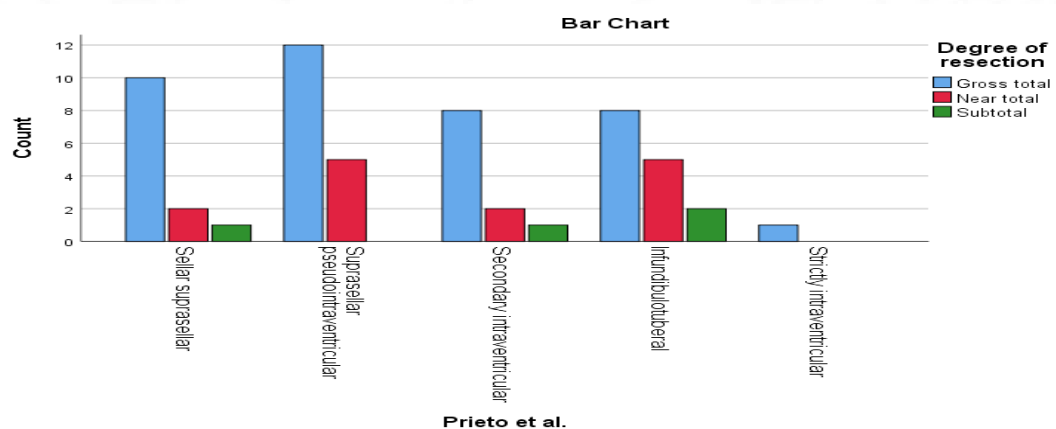
**Figure 4.3e– Histogram depicting type of QST classification with degree of resection.**

**E. Prieto et al. Classification:**

In our study, suprasellar pseudo intraventricular varieties were the majority type i.e., 17 followed by infundibulo-tuberal (15) and sellar- suprasellar variety (13) with the least being secondary intraventricular (11) and strictly intraventricular (1) varieties.

**Table 4.3f– Depicting various type of Prieto classification of craniopharyngiomas with degree of resection**

Crosstab					
Count					
		Degree of resection			Total
		Gross total	Near total	Subtotal	
Prieto et al.	Sellar and suprasellar	10	2	1	13
	Suprasellar pseudo-intraventricular	12	5	0	17
	Secondary intraventricular	8	2	1	11
	Infundibulo-tuberal	8	5	2	15
	Strictly intraventricular	1	0	0	1
<b>Total</b>		<b>39</b>	<b>14</b>	<b>4</b>	<b>57</b>



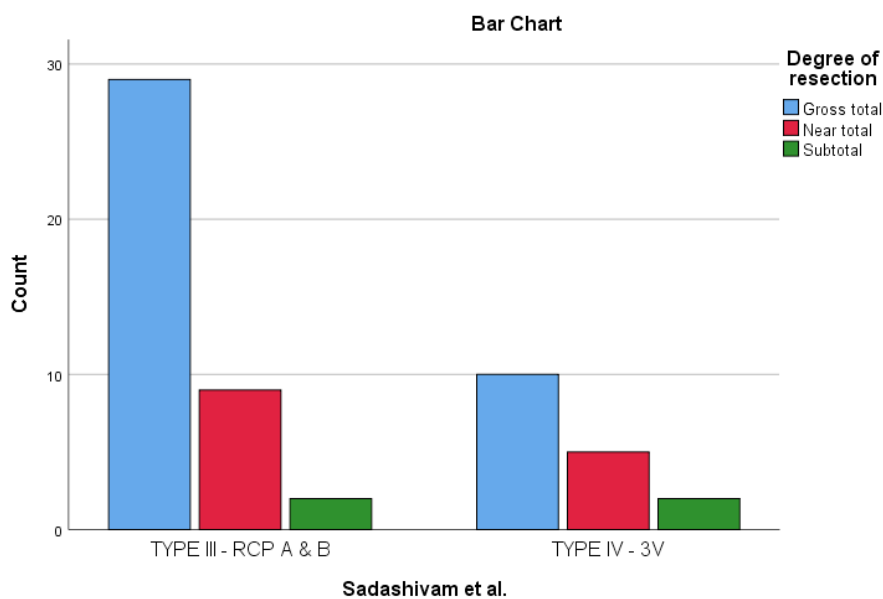
**Figure 4.3f – Histograms depicting various type of Prieto classification of craniopharyngiomas with degree of resection**

**F. Sadashivam et al. classification:**

In our study, almost all of the tumours belonged to type III (both retro chiasmatic tumours, III A & B ) and type IV (third ventricular tumours) i.e., 40 and 17 respectively.

**Table 4.3g– Sadashivam et al type of classification of craniopharyngiomas with the respective extent of resection.**

Crosstab					
Count					
		Degree of resection			Total
		Gross total	Near total	Subtotal	
Sadashivam et al.	TYPE III - RCP A & B	29	9	2	40
	TYPE IV - 3V	10	5	2	17
Total		39	14	4	57



**Figure 4.3h– Histograms depicting Type of craniopharyngiomas according to sadashivam et al classification with extent of resection.**

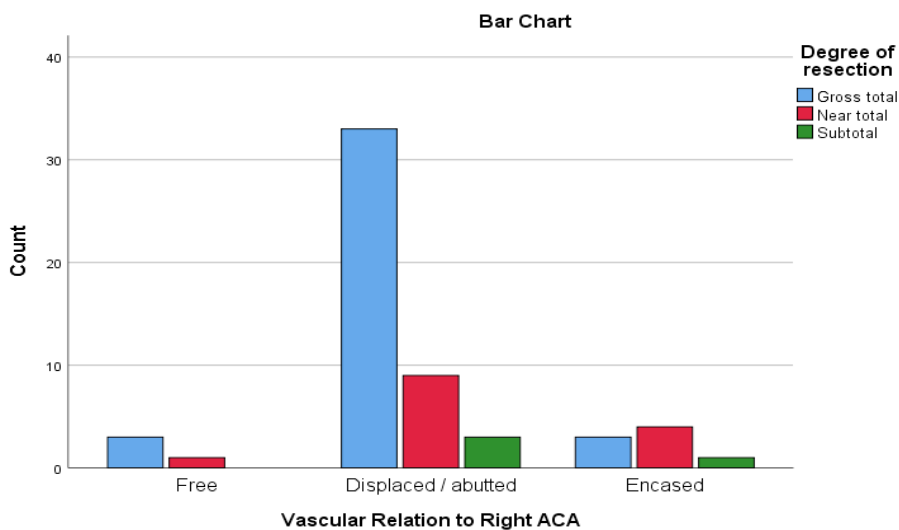
**G. Vascular relations:**

**Vascular Relation to Right ACA to Degree of Resection:**

Even though it was statistically insignificant, most patients who underwent near total, subtotal resection of the tumour had either displaced or encased right ACA with the tumour.

**Table 4.3i– Depicting vascular relation of right ACA to the tumour with degree of resection**

Crosstab					
Count					
		Degree of resection			Total
		Gross total	Near total	Subtotal	
Vascular Relation to Right ACA	Free	3	1	0	4
	Displaced / abutted	33	9	3	45
	Encased	3	4	1	8
Total		39	14	4	57



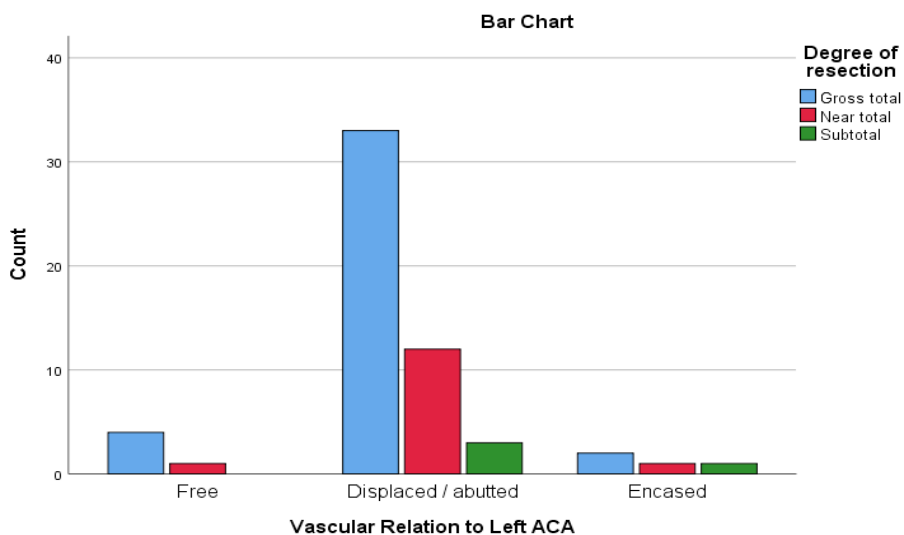
**Figure4.3i- Histogram depicting vascular relation of tumour to right ACA to degree of resection**

**Vascular Relation to Left ACA and Degree of Resection:**

Even though it was statistically insignificant, most patients who underwent near total, subtotal resection of the tumour had either displaced or encased left ACA with the tumour.

**Table 4.3j- vascular relation of tumour to left ACA to degree of resection**

<b>Crosstab</b>					
<b>Count</b>					
		<b>Degree of resection</b>			<b>Total</b>
		<b>Gross total</b>	<b>Near total</b>	<b>Subtotal</b>	
<b>Vascular Relation to Left ACA</b>	<b>Free</b>	<b>4</b>	<b>1</b>	<b>0</b>	<b>5</b>
	<b>Displaced / abutted</b>	<b>33</b>	<b>12</b>	<b>3</b>	<b>48</b>
	<b>Encased</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>4</b>
<b>Total</b>		<b>39</b>	<b>14</b>	<b>4</b>	<b>57</b>



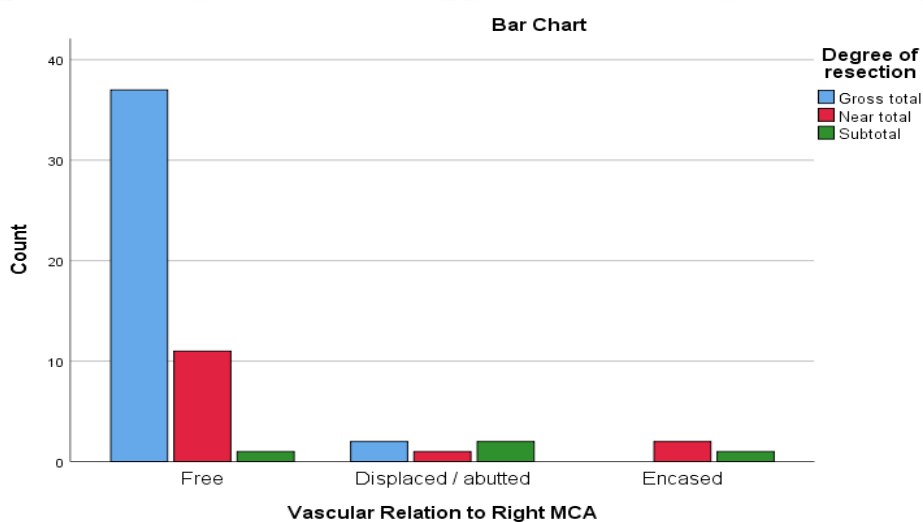
**Figure 4.3j- Histogram depicting vascular relation of tumor to left ACA to degree of resection**

**Vascular Relation to Right MCA and Degree of Resection:**

The patients who had tumour free from right MCA had undergone gross total resection in almost all cases except one case. Even though it was statistically insignificant, most patients who underwent near total, subtotal resection of the tumour had either displaced or encased right MCA with the tumour.

**Table 4.3k- Vascular relation of tumour to right MCA and degree of resection**

Crosstab					
Count					
		Degree of resection			Total
		Gross total	Near total	Subtotal	
Vascular Relation to Right MCA	Free	37	11	1	49
	Displaced / abutted	2	1	2	5
	Encased	0	2	1	3
Total		39	14	4	57



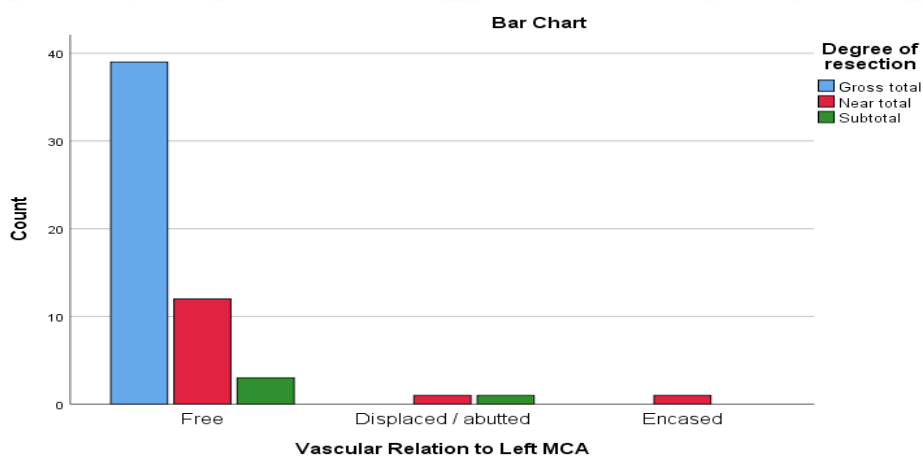
**Figure 4.3k- Histogram depicting vascular relation of tumour to right MCA and degree of resection**

**Vascular Relation to Left MCA and Degree of Resection:**

The patients who had tumours free from left MCA had undergone gross total resection in almost all cases except 3 cases. Even though it was statistically insignificant, most patients who underwent near total, subtotal resection of the tumour had either displaced or encased left MCA with the tumour.

**Table 4.3I- Depicting vascular relation of tumour to left MCA and degree of resection**

Crosstab					
Count					
		Degree of resection			Total
		Gross total	Near total	Subtotal	
Vascular Relation to Left MCA	Free	39	12	3	54
	Displaced / abutted	0	1	1	2
	Encased	0	1	0	1
Total		39	14	4	57



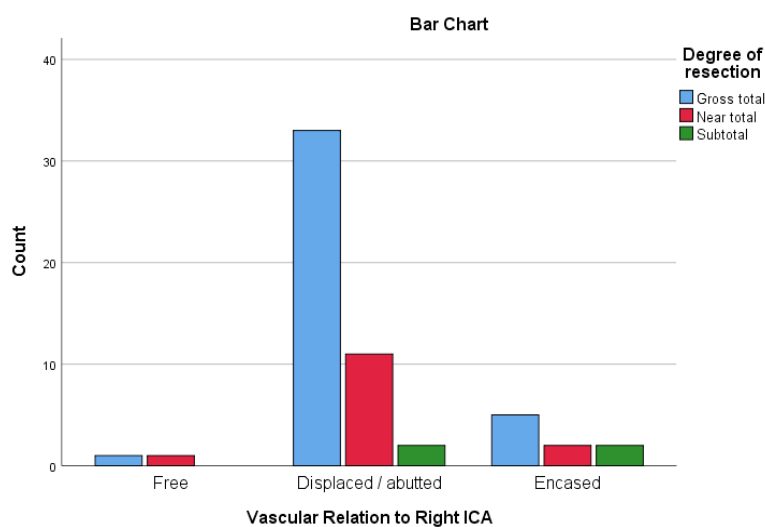
**Figure 4.3 I- Histogram depicting vascular relation of tumour to left MCA and degree of resection**

### Vascular Relation to Right ICA and Degree of Resection:

The patients who had tumours free from right ICA had undergone gross total resection in almost all cases. Even though it was statistically insignificant, most patients who underwent near total, subtotal resection of the tumour had either displaced or encased right ICA with the tumour.

**Table 4.3m- Depicting vascular relation of tumour to right ICA and degree of resection**

Crosstab					
Count					
		Degree of resection			Total
		Gross total	Near total	Subtotal	
Vascular Relation to Right ICA	Free	1	1	0	2
	Displaced / abutted	33	11	2	46
	Encased	5	2	2	9
Total		39	14	4	57



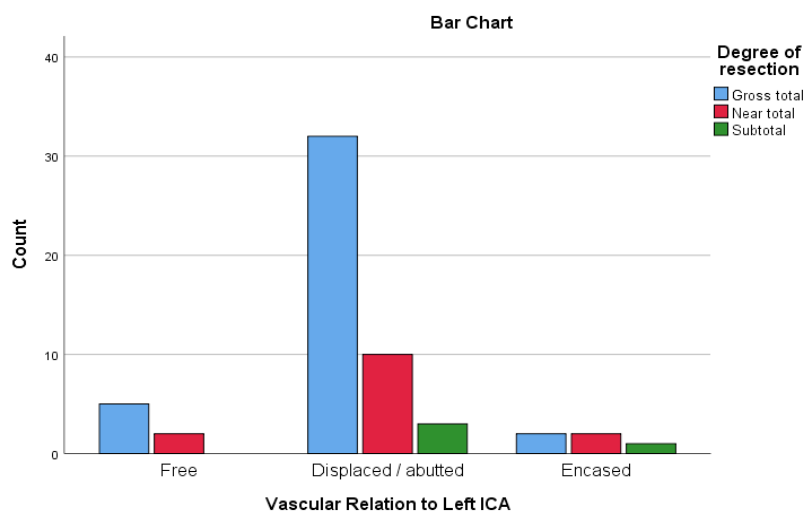
**Figure 4.3m- Histogram depicting vascular relation of tumour to right ICA and degree of resection**

### Vascular Relation to Left ICA and Degree of Resection:

The patients who had tumour free from left ICA had undergone gross total resection in almost all cases. Even though it was statistically insignificant, most patients who underwent near total, subtotal resection of the tumour had either displaced or encased left ICA with the tumour.

**Table 4.3n- Depicting vascular relation of tumour to left ICA and degree of resection**

Crosstab					
Count					
		Degree of resection			Total
		Gross total	Near total	Subtotal	
Vascular Relation to Left ICA	Free	5	2	0	7
	Displaced / abutted	32	10	3	45
	Encased	2	2	1	5
Total		39	14	4	57



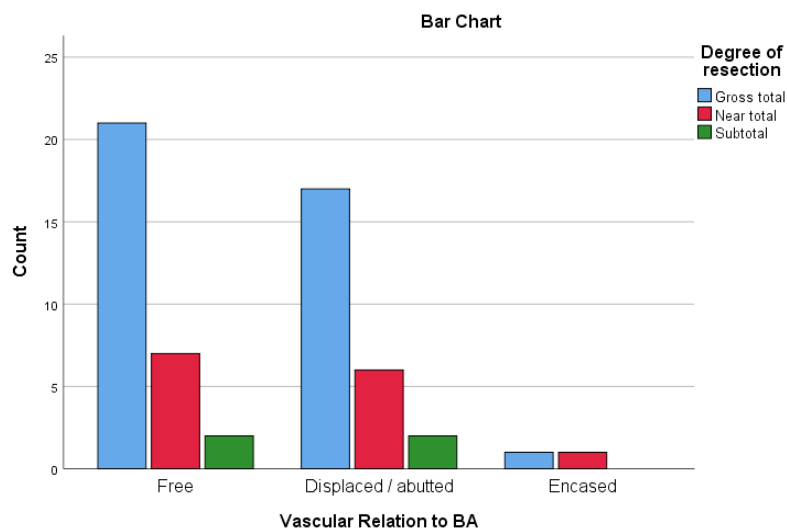
**Figure 4.3n- Histogram depicting vascular relation of tumour to left ICA and degree of resection**

**Vascular Relation to BA and Degree of Resection:**

Even though it was statistically insignificant, most patients who underwent near total, gross total resection of the tumour had either displaced or free BA with the tumour, unlike the tumours that had an intimate relation with other vascular structures (except right and left PCA)

**Table 4.3o- Depicting vascular relation of tumour to BA and degree of resection**

Crosstab					
Count					
		Degree of resection			Total
		Gross total	Near total	Subtotal	
Vascular Relation to BA	Free	21	7	2	30
	Displaced / abutted	17	6	2	25
	Encased	1	1	0	2
Total		39	14	4	57



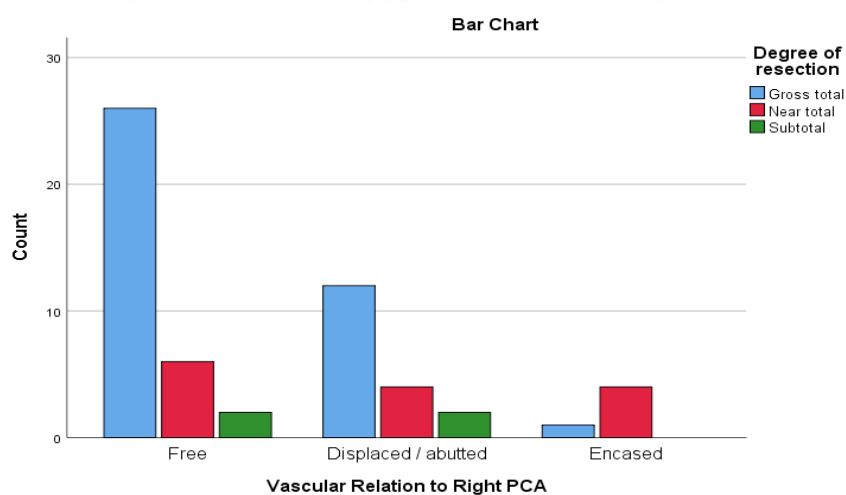
**Figure 4.3o- Histogram depicting vascular relation of tumour to BA and degree of resection**

### Vascular Relation to Right PCA and Degree of Resection :

Even though it was statistically insignificant, most patients who underwent near total, gross total resection of the tumour had either displaced or free right PCA with the tumour, unlike the tumours that had an intimate relation with other vascular structures (except BA and left PCA)

**Table 4.3p- Vascular relation of tumour to right PCA and degree of resection**

Crosstab					
Count					
		Degree of resection			Total
		Gross total	Near total	Subtotal	
Vascular Relation to Right PCA	Free	26	6	2	34
	Displaced / abutted	12	4	2	18
	Encased	1	4	0	5
Total		39	14	4	57



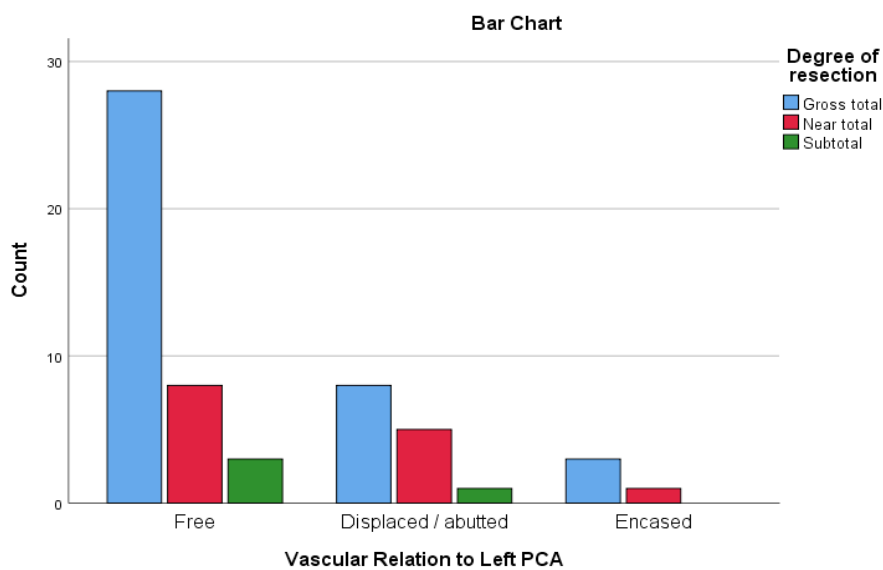
**Figure 4.3p- Histogram depicting vascular relation of tumour to right PCA and degree of resection**

### Vascular Relation to Left PCA and Degree of Resection:

Even though it was statistically insignificant, most patients who underwent near total, gross total resection of the tumour had either displaced or free left PCA with the tumour, unlike the tumours that had an intimate relation with other vascular structures (except right and BA)

**Table 4.3q- Vascular relation of tumour to left PCA and degree of resection**

Crosstab					
Count					
		Degree of resection			Total
		Gross total	Near total	Subtotal	
Vascular Relation to Left PCA	Free	28	8	3	39
	Displaced / abutted	8	5	1	14
	Encased	3	1	0	4
Total		39	14	4	57



**Figure 4.3q- Histogram depicting vascular relation of tumour to left PCA and degree of resection**

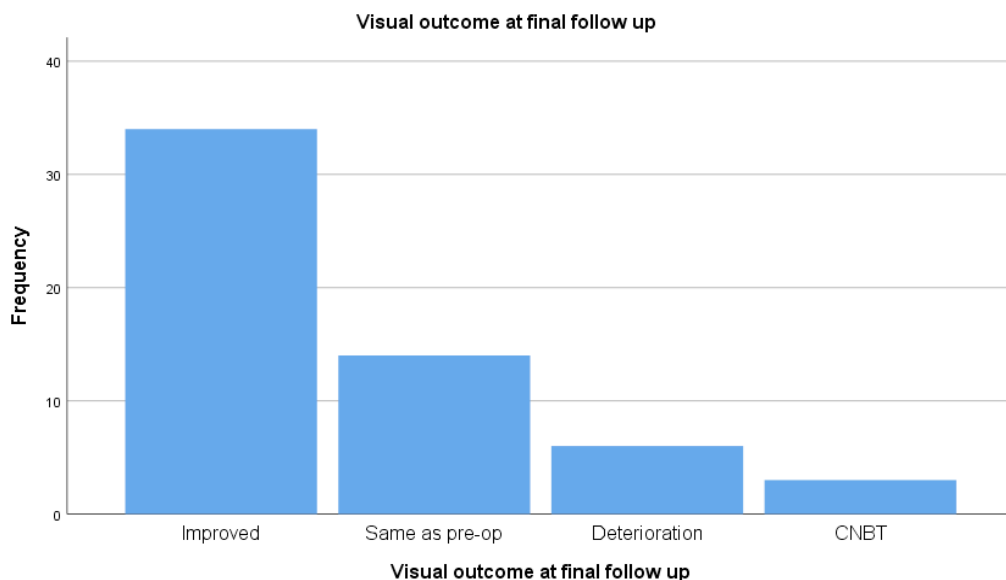
#### 4.4 POST-OPERATIVE OUTCOMES

##### A. Visual outcomes of patients ( at last follow up) :

In our study, post-operatively 34 patients had improved vision (60%), 14 (24.6%) had stable vision as compared to pre-op, and 6 (5.3 %) patients had deterioration of vision. However, 3 patients vision was not able to test due to various reasons (poor sensorium, death etc)

**Table 4.4a– Visual outcomes at final follow-up**

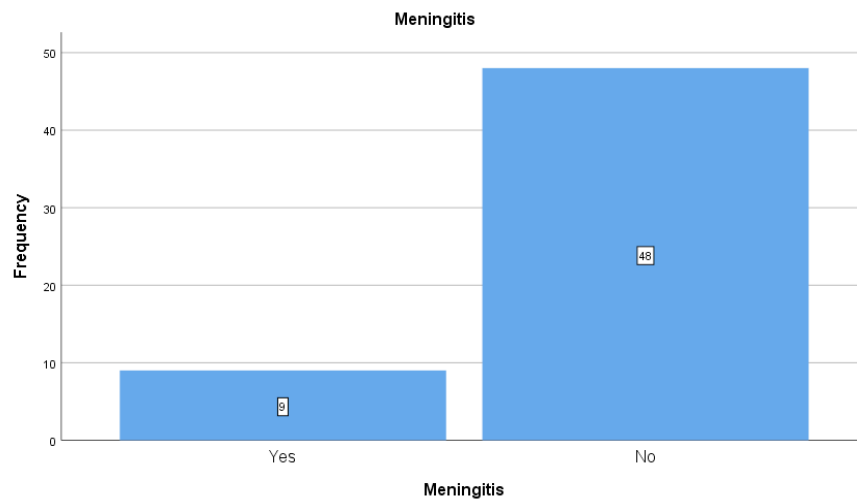
Visual outcome at final follow-up					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Improved	34	59.6	59.6	59.6
	Same as pre-op	14	24.6	24.6	84.2
	Deterioration	6	10.5	10.5	94.7
	CNBT	3	5.3	5.3	100.0
	<b>Total</b>	<b>57</b>	<b>100.0</b>	<b>100.0</b>	



**Figure 4.4a- Histogram depicting visual outcomes at last follow up**

### B. Meningitis :

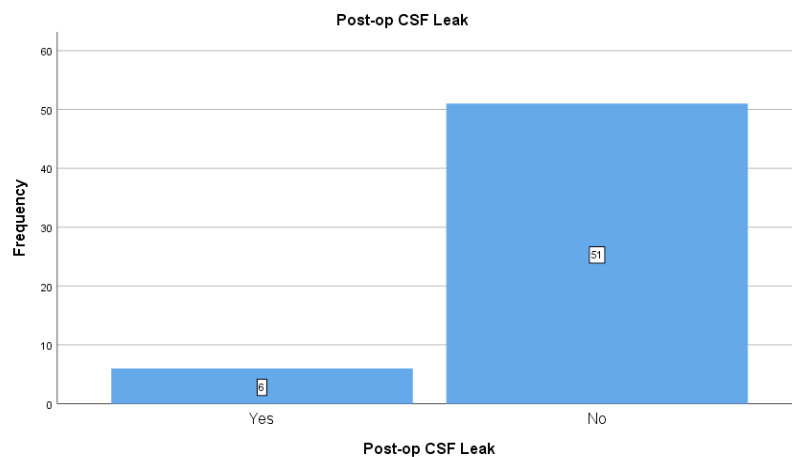
In our study, 9 (15.8 %) patients had Meningitis (culture proven- microorganisms growth).



**Figure 4.4b – Histogram depicting patients who developed meningitis postoperatively.**

### C. Post-op CSF leak:

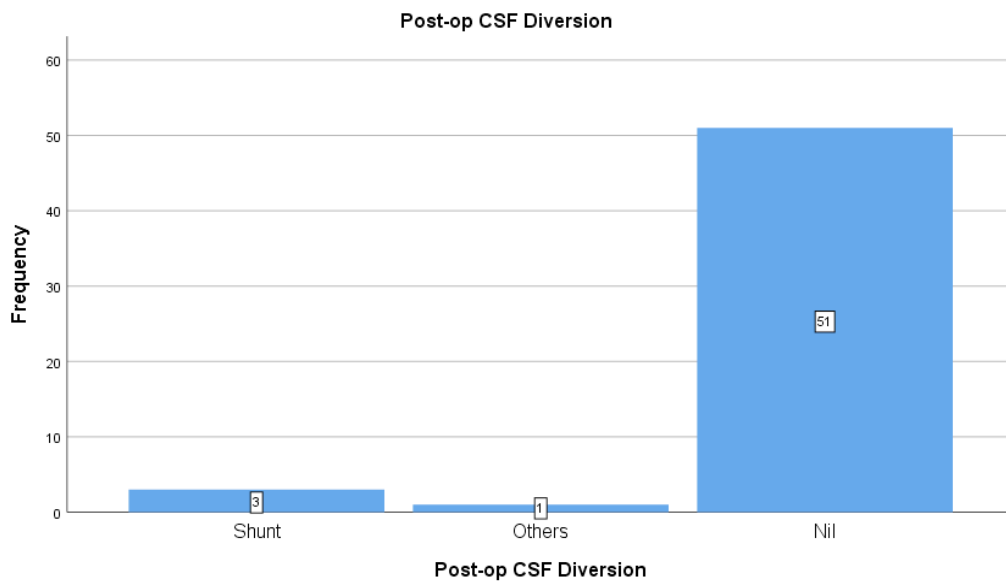
Among 57 patients 6 (10.5 %) had CSF leak and underwent endoscopic assisted repair of the defect.



**Figure 4.4c – Histogram depicting patients who developed CSF leak postoperatively.**

**D. Post-op CSF diversion:**

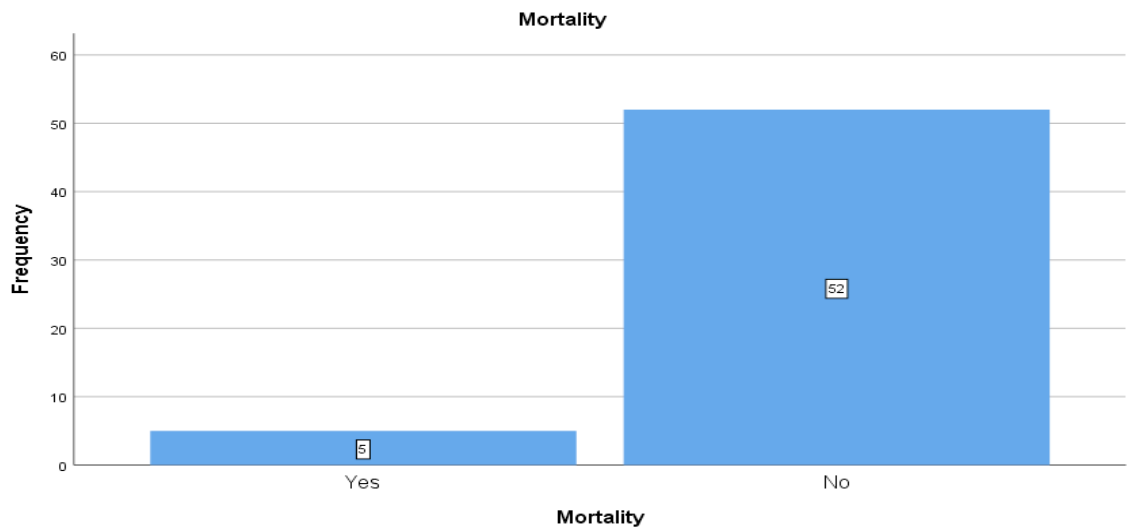
Among 57 patients, 4 patients underwent CSF diversion. In which 3 patients underwent shunt and 1 patient ETV postoperatively.



**Figure 4.4d – Histogram depicting the requirement of post-operative CSF diversion**

### E. Mortality :

In our study, a total number of patients who died are 5 (8.8 %) among 57 cohorts. Amongst those 2 patients died after 2 years with the cause being unrelated to the primary disease and 2 (1 fresh case & 1 was recurrent case) patients died due to meningitis complicating into septic shock (within 28 days of admission). One patient who developed DVT on follow-up and developed pulmonary embolism despite after starting anti coagulant therapy.

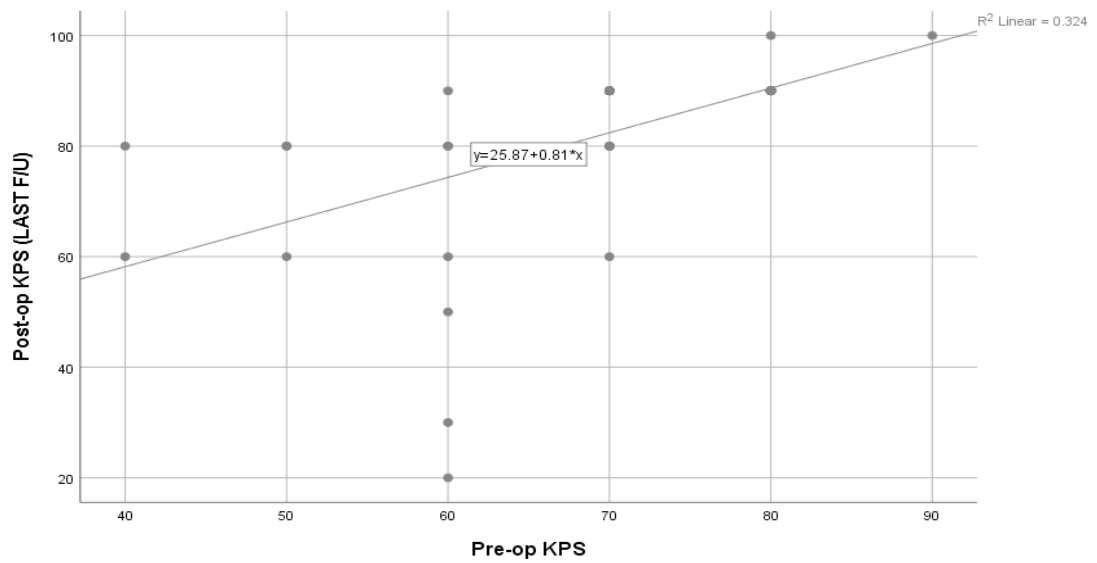


**Figure 4.4e– Mortality data in our study**

## 5 POST OP OUTCOME VARIABLES:

### A. Karnofsky performance score (KPS):

Pre-op N-CCSS * Post-op N-CCSS Crosstabulation							
			Post-op N-CCSS				Total
			N1	N2	N3	N4	
Pre-op N-CCSS	N1	Count	13	1	0	0	14
		% within Pre-op N-CCSS	92.9%	7.1%	0.0%	0.0%	100.0%
		% within Post-op N-CCSS	33.3%	6.7%	0.0%	0.0%	24.6%
	N2	Count	26	11	1	1	39
		% within Pre-op N-CCSS	66.7%	28.2%	2.6%	2.6%	100.0%
		% within Post-op N-CCSS	66.7%	73.3%	50.0%	100.0%	68.4%
	N3	Count	0	2	0	0	2
		% within Pre-op N-CCSS	0.0%	100.0%	0.0%	0.0%	100.0%
		% within Post-op N-CCSS	0.0%	13.3%	0.0%	0.0%	3.5%
	N4	Count	0	1	1	0	2
		% within Pre-op N-CCSS	0.0%	50.0%	50.0%	0.0%	100.0%
		% within Post-op N-CCSS	0.0%	6.7%	50.0%	0.0%	3.5%
Total	Count	39	15	2	1	57	
	% within Pre-op N-CCSS	68.4%	26.3%	3.5%	1.8%	100.0%	
	% within Post-op N-CCSS	100.0%	100.0%	100.0%	100.0%	100.0%	



**Figure 4.5a - Graph depicting pre and post-op KPS score**

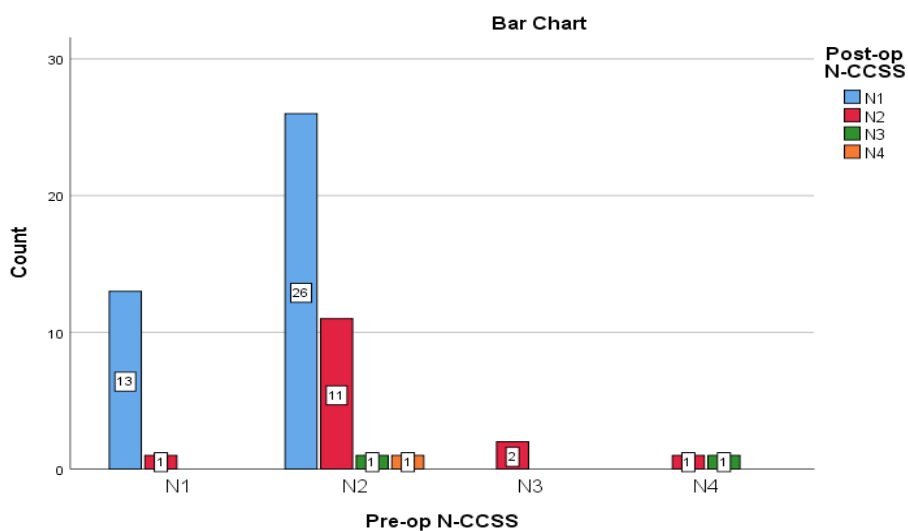
Paired Samples Statistics							
		Mean	N	Std. Deviation	Mean difference	t	p-value
<b>Pair 1</b>	<b>Pre-op KPS</b>	70.58	52	10.921	-12.308	-6.86	<0.001
	<b>Post-op KPS (LAST F/U)</b>	82.88	52	15.509			

The p-value of <0.001 is lesser than the significance level of 0.05, indicating that there is statistically significant association between pre-operative KPS and post-operative KPS scores. The data does provide enough evidence to conclude that there is a statistically significant association between pre-operative KPS and post-operative KPS scores.

**B. Pre- and post-op N- CCSS score:**

**Table 4.5b - comparing pre & post op N-CCSS significance**

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	23.980 <sup>a</sup>	9	.004
Likelihood Ratio	17.575	9	.040
N of Valid Cases	57		



**Figure 4.5b - Histogram comparing pre & post op N-CCSS scores**

The p-value of 0.004 is lesser than the significance level of 0.05, indicating that there is a statistically significant association between pre-operative and post-operative N-CCSS scores. The data does provide enough evidence to conclude that there is a statistically significant association between pre-operative and post-operative N-CCSS scores.

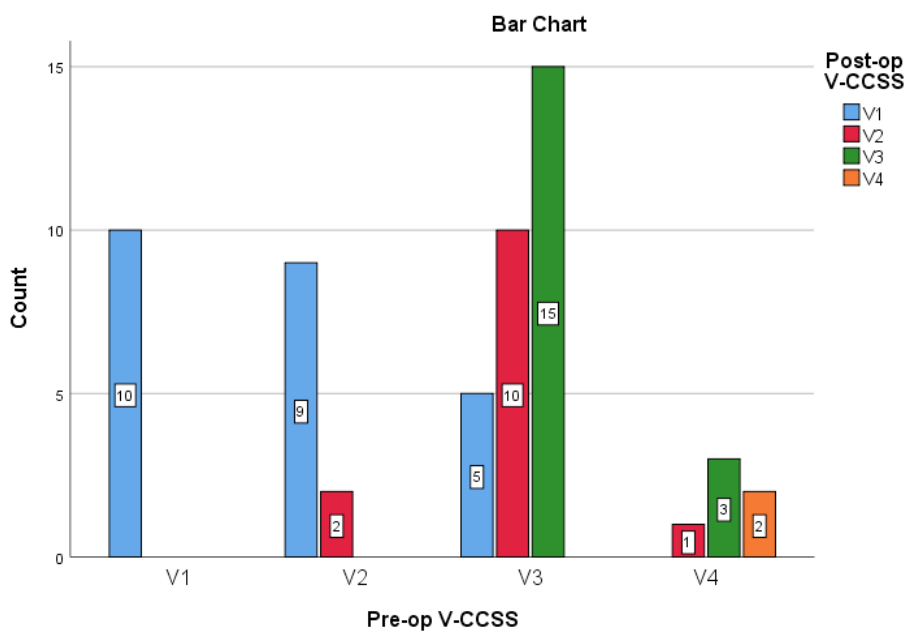
**C. Pre and post-op V - CCSS score:**

**Table 4.5c - cross tabulation comparing pre & post op V-CCSS scores**

<b>Pre-op V-CCSS * Post-op V-CCSS Crosstabulation</b>							
			Post-op V-CCSS				Total
			V1	V2	V3	V4	
Pre-op V-CCSS	V1	Count	10	0	0	0	10
		% within Pre-op V-CCSS	100.0%	0.0%	0.0%	0.0%	100.0%
		% within Post-op V-CCSS	41.7%	0.0%	0.0%	0.0%	17.5%
	V2	Count	9	2	0	0	11
		% within Pre-op V-CCSS	81.8%	18.2%	0.0%	0.0%	100.0%
		% within Post-op V-CCSS	37.5%	15.4%	0.0%	0.0%	19.3%
	V3	Count	5	10	15	0	30
		% within Pre-op V-CCSS	16.7%	33.3%	50.0%	0.0%	100.0%
		% within Post-op V-CCSS	20.8%	76.9%	83.3%	0.0%	52.6%
	V4	Count	0	1	3	2	6
		% within Pre-op V-CCSS	0.0%	16.7%	50.0%	33.3%	100.0%
		% within Post-op V-CCSS	0.0%	7.7%	16.7%	100.0%	10.5%
Total	Count	24	13	18	2	57	
	% within Pre-op V-CCSS	42.1%	22.8%	31.6%	3.5%	100.0%	
	% within Post-op V-CCSS	100.0%	100.0%	100.0%	100.0%	100.0%	

**Table 4.5d - table comparing pre & post op V-CCSS significance**

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	50.658 <sup>a</sup>	9	.000
Likelihood Ratio	51.594	9	.000
N of Valid Cases	57		



**Figure 4.5c- Histogram comparing pre & post op V-CCSS scores**

The p-value of 0.000 is lesser than the significance level of 0.05, indicating that there is statistically significant association between pre-operative and post-operative V-CCSS scores. The data does provide enough evidence to conclude that there is a statistically significant association between pre-operative and post-operative V-CCSS scores.

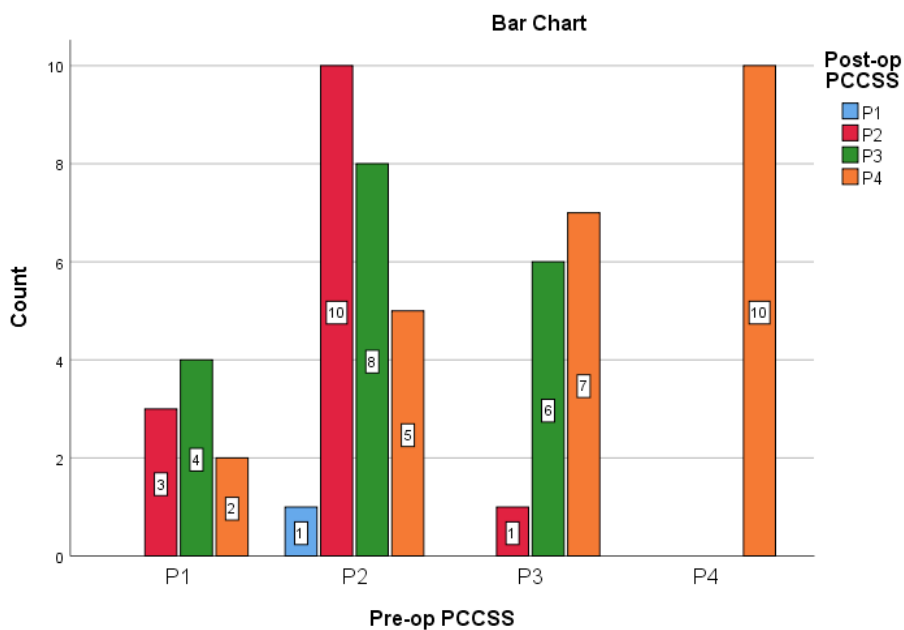
**D. Pre and post-op P - CCSS score:**

**Table 4.5e- cross tabulation comparing pre & post op P-CCSS scores**

<b>Pre-op PCCSS * Post-op PCCSS Crosstabulation</b>							
			Post-op PCCSS				Total
			P1	P2	P3	P4	
Pre-op PCCSS	P1	Count	0	3	4	2	9
		% within Pre-op PCCSS	0.0%	33.3%	44.4%	22.2%	100.0%
		% within Post-op PCCSS	0.0%	21.4%	22.2%	8.3%	15.8%
	P2	Count	1	10	8	5	24
		% within Pre-op PCCSS	4.2%	41.7%	33.3%	20.8%	100.0%
		% within Post-op PCCSS	100.0%	71.4%	44.4%	20.8%	42.1%
	P3	Count	0	1	6	7	14
		% within Pre-op PCCSS	0.0%	7.1%	42.9%	50.0%	100.0%
		% within Post-op PCCSS	0.0%	7.1%	33.3%	29.2%	24.6%
	P4	Count	0	0	0	10	10
		% within Pre-op PCCSS	0.0%	0.0%	0.0%	100.0%	100.0%
		% within Post-op PCCSS	0.0%	0.0%	0.0%	41.7%	17.5%
Total	Count	1	14	18	24	57	
	% within Pre-op PCCSS	1.8%	24.6%	31.6%	42.1%	100.0%	
	% within Post-op PCCSS	100.0%	100.0%	100.0%	100.0%	100.0%	

**Table 4.5f- table comparing pre & post op P-CCSS significance**

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	24.510 <sup>a</sup>	9	.004
Likelihood Ratio	29.040	9	.001
N of Valid Cases	57		



**Figure 4.5d- Histogram comparing pre & post op P-CCSS scores**

The p-value of 0.004 is lesser than the significance level of 0.05, indicating that there is statistically significant association between pre-operative and post-operative P-CCSS scores. The data does provide enough evidence to conclude that there is a statistically significant association between pre-operative and post-operative P-CCSS scores.

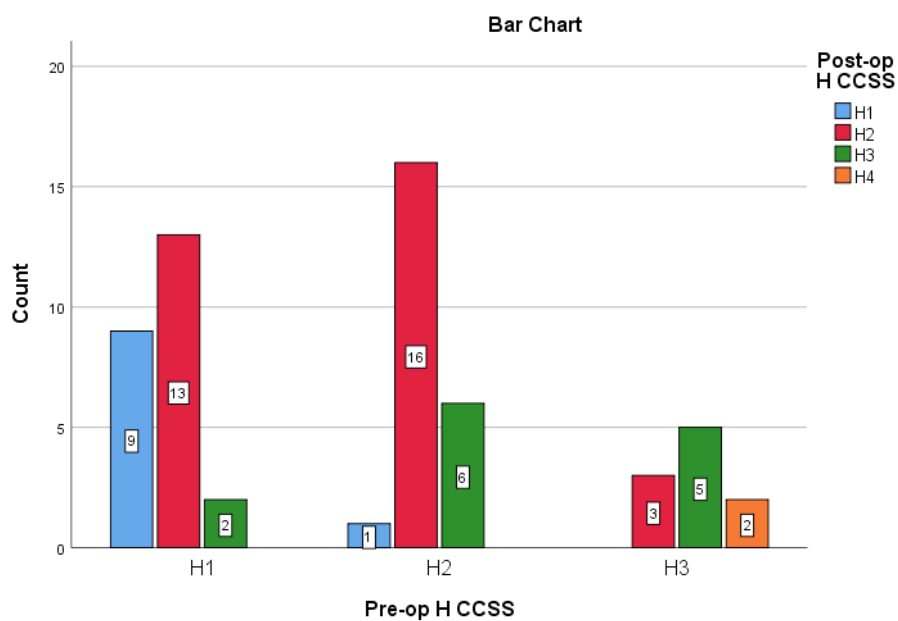
**E. Pre and post-op H - CCSS score:**

**Table 4.5g - cross tabulation comparing pre & post op H-CCSS scores**

<b>Pre-op H CCSS * Post-op H CCSS Crosstabulation</b>							
			Post-op H CCSS				Total
			H1	H2	H3	H4	
Pre-op H CCSS	H1	Count	9	13	2	0	24
		% within Pre-op H CCSS	37.5%	54.2%	8.3%	0.0%	100.0%
		% within Post-op H CCSS	90.0%	40.6%	15.4%	0.0%	42.1%
	H2	Count	1	16	6	0	23
		% within Pre-op H CCSS	4.3%	69.6%	26.1%	0.0%	100.0%
		% within Post-op H CCSS	10.0%	50.0%	46.2%	0.0%	40.4%
	H3	Count	0	3	5	2	10
		% within Pre-op H CCSS	0.0%	30.0%	50.0%	20.0%	100.0%
		% within Post-op H CCSS	0.0%	9.4%	38.5%	100.0%	17.5%
Total	Count	10	32	13	2	57	
	% within Pre-op H CCSS	17.5%	56.1%	22.8%	3.5%	100.0%	
	% within Post-op H CCSS	100.0%	100.0%	100.0%	100.0%	100.0%	

**Table 4.5h- table comparing pre & post op H-CCSS significance**

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	26.413 <sup>a</sup>	6	.000
Likelihood Ratio	25.451	6	.000
N of Valid Cases	57		



**Figure 4.5e- Histogram comparing pre & post op H-CCSS scores**

The p-value of 0.000 is lesser than the significance level of 0.05, indicating that there is statistically significant association between pre-operative and post-operative H-CCSS scores. The data does provide enough evidence to conclude that there is a statistically significant association between pre-operative and post-operative H-CCSS scores.

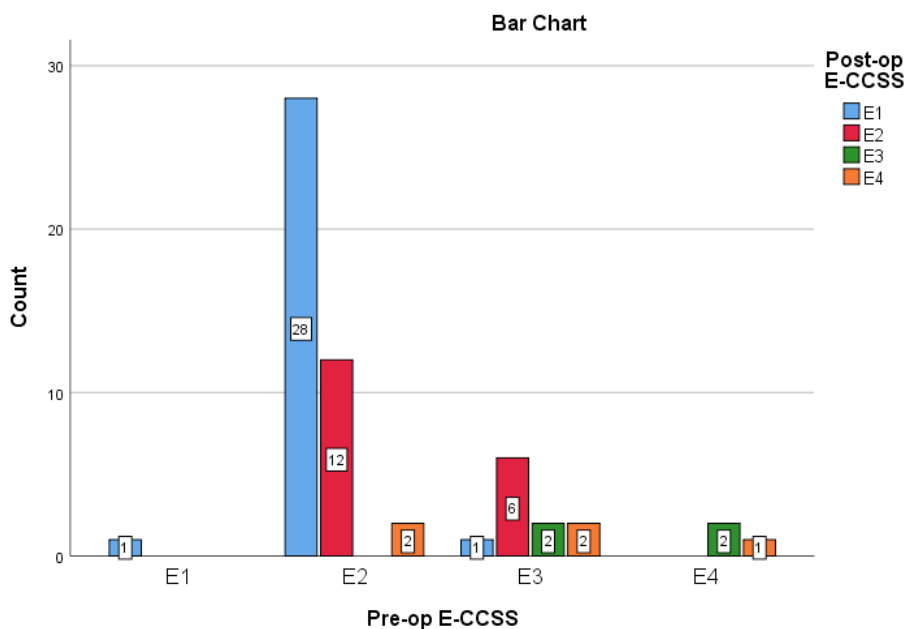
**F. Pre and post-op E - CCSS score:**

**Table 4.5i- cross-tabulation comparing pre & post op E-CCSS scores**

<b>Pre-op E-CCSS * Post-op E-CCSS Crosstabulation</b>							
			Post-op E-CCSS				Total
			E1	E2	E3	E4	
Pre-op E- CCSS	E1	Count	1	0	0	0	1
		% within Pre-op E-CCSS	100.0%	0.0%	0.0%	0.0%	100.0%
		% within Post-op E-CCSS	3.3%	0.0%	0.0%	0.0%	1.8%
	E2	Count	28	12	0	2	42
		% within Pre-op E-CCSS	66.7%	28.6%	0.0%	4.8%	100.0%
		% within Post-op E-CCSS	93.3%	66.7%	0.0%	40.0%	73.7%
	E3	Count	1	6	2	2	11
		% within Pre-op E-CCSS	9.1%	54.5%	18.2%	18.2%	100.0%
		% within Post-op E-CCSS	3.3%	33.3%	50.0%	40.0%	19.3%
	E4	Count	0	0	2	1	3
		% within Pre-op E-CCSS	0.0%	0.0%	66.7%	33.3%	100.0%
		% within Post-op E-CCSS	0.0%	0.0%	50.0%	20.0%	5.3%
Total	Count	30	18	4	5	57	
	% within Pre-op E-CCSS	52.6%	31.6%	7.0%	8.8%	100.0%	
	% within Post-op E-CCSS	100.0%	100.0%	100.0%	100.0%	100.0%	

**Table 4.5j- table comparing pre & post op E-CCSS significance**

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	34.973 <sup>a</sup>	9	.000
Likelihood Ratio	31.121	9	.000
N of Valid Cases	57		



**Figure 4.5f- Histogram comparing pre & post op E-CCSS scores**

The p-value of 0.000 is lesser than the significance level of 0.05, indicating that there is statistically significant association between pre-operative and post-operative E-CCSS scores. The data does provide enough evidence to conclude that there is a statistically significant association between pre-operative and post-operative E-CCSS scores

**G. Pre and post-op Wen et al score:**

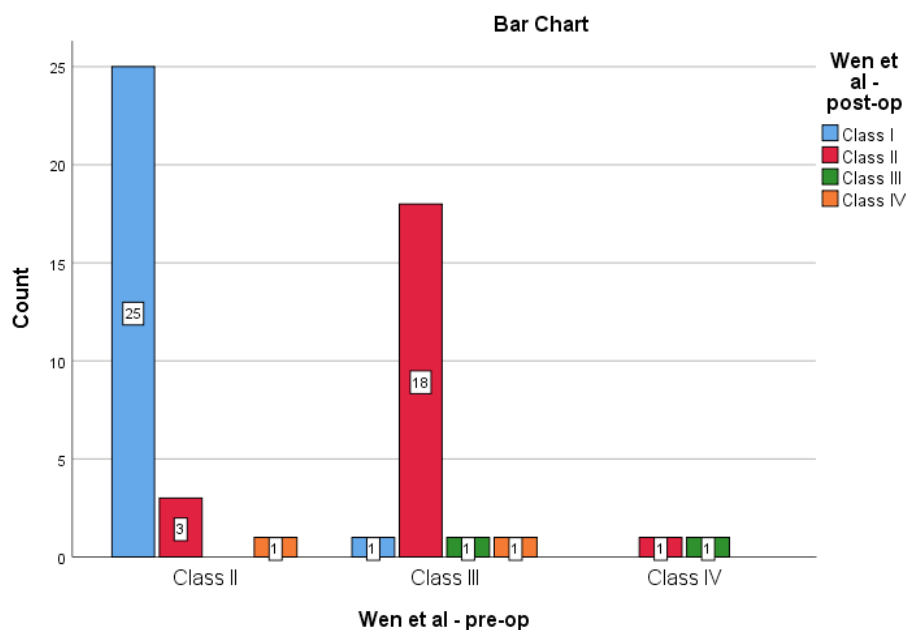
**Table 4.5k- cross-tabulation comparing pre & post op wen et al scores**

<b>Wen et al - pre-op * Wen et al - post-op Crosstabulation</b>							
			Wen et al - post-op				Total
			Class I	Class II	Class III	Class IV	
Wen et al - pre-op	Class II	Count	25	3	0	1	29
		% within Wen et al - pre-op	86.2%	10.3%	0.0%	3.4%	100.0%
		% within Wen et al - post-op	96.2%	13.6%	0.0%	50.0%	55.8%
	Class III	Count	1	18	1	1	21
		% within Wen et al - pre-op	4.8%	85.7%	4.8%	4.8%	100.0%
		% within Wen et al - post-op	3.8%	81.8%	50.0%	50.0%	40.4%
	Class IV	Count	0	1	1	0	2
		% within Wen et al - pre-op	0.0%	50.0%	50.0%	0.0%	100.0%
		% within Wen et al - post-op	0.0%	4.5%	50.0%	0.0%	3.8%
Total	Count	26	22	2	2	52	
	% within Wen et al - pre-op	50.0%	42.3%	3.8%	3.8%	100.0%	
	% within Wen et al - post-op	100.0%	100.0%	100.0%	100.0%	100.0%	

**Table 4.5I- table comparing pre & post op wen et al significance**

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	45.954 <sup>a</sup>	6	.000
Likelihood Ratio	45.600	6	.000
Linear-by-Linear Association	19.668	1	.000
N of Valid Cases	52		

8 cells (66.7%) have an expected count that is fewer than 5. The predicted count must be at least 0.8.



**Figure 4.5g - Histogram comparing pre & post op wen et al scores**

The p-value of 0.000 is lesser than the significance level of 0.05, indicating that there is statistically significant association between pre-operative and post-operative wen et al scores. The data does provide enough evidence to conclude that there is a statistically significant association between pre-operative and post-operative wen et al scores.

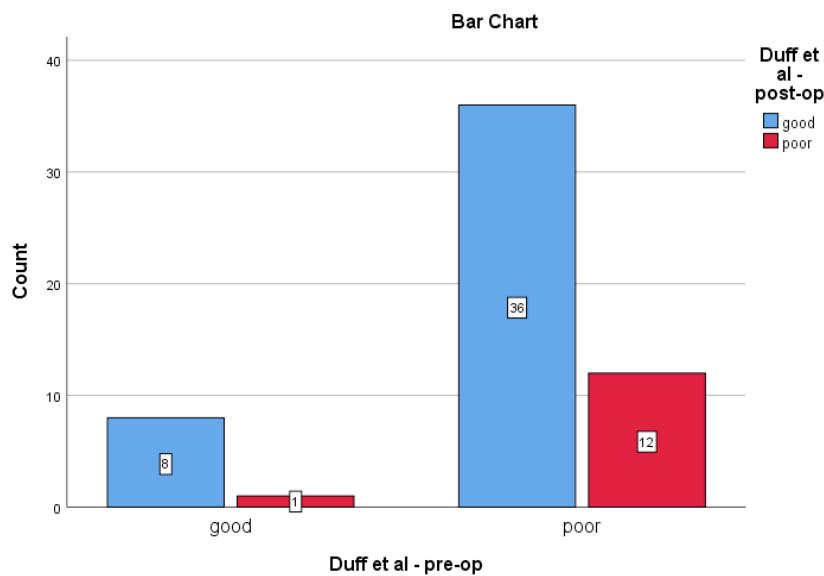
**H. Pre and post-op Duff et al scores:**

**Table 4.5 m- cross-tabulation comparing pre & post-op duff et al scores**

<b>Duff et al - pre-op * Duff et al - post-op Crosstabulation</b>					
			Duff et al - post-op		Total
			good	poor	
Duff et al - pre-op	good	Count	8	1	9
		% within Duff et al - pre-op	88.9%	11.1%	100.0%
		% within Duff et al - post-op	18.2%	7.7%	15.8%
	poor	Count	36	12	48
		% within Duff et al - pre-op	75.0%	25.0%	100.0%
		% within Duff et al - post-op	81.8%	92.3%	84.2%
Total		Count	44	13	57
		% within Duff et al - pre-op	77.2%	22.8%	100.0%
		% within Duff et al - post-op	100.0%	100.0%	100.0%

**Table 4.5n - table comparing pre & post op duff et al significance**

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.830 <sup>a</sup>	1	.362		
Continuity Correction <sup>b</sup>	.229	1	.632		
Likelihood Ratio	.947	1	.330		
Fisher's Exact Test				.668	.335
N of Valid Cases	57				



**Figure 4.5h- Histogram comparing pre & post op duff et al scores**

The p-value of 0.362 is greater than the significance level of 0.05, indicating that there is no statistically significant association between pre-operative and post-operative duff et al scores. The data does provide enough evidence to conclude that there is no statistically significant association between pre-operative and post-operative duff et al scores.

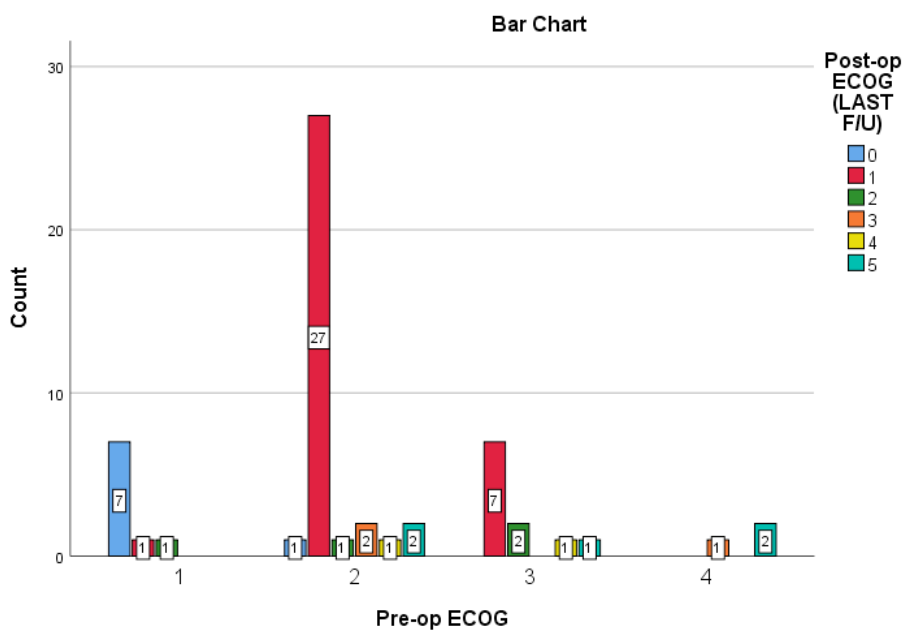
**I. Pre and post-op ECOG scores:**

**Table 4.5o- cross-tabulation comparing pre & post-op ECOG scores**

Pre-op ECOG & Post-op ECOG (LAST F/U) Crosstabulation									
		Post-op ECOG (LAST F/U)						Total	
		0	1	2	3	4	5		
Pre-op ECOG	1	Count	7	1	1	0	0	0	9
		% within Pre-op ECOG	77.8%	11.1%	11.1%	0.0%	0.0%	0.0%	100.0%
		% within Post-op ECOG (LAST F/U)	87.5%	2.9%	25.0%	0.0%	0.0%	0.0%	15.8%
	2	Count	1	27	1	2	1	2	34
		% within Pre-op ECOG	2.9%	79.4%	2.9%	5.9%	2.9%	5.9%	100.0%
		% within Post-op ECOG (LAST F/U)	12.5%	77.1%	25.0%	66.7%	50.0%	40.0%	59.6%
	3	Count	0	7	2	0	1	1	11
		% within Pre-op ECOG	0.0%	63.6%	18.2%	0.0%	9.1%	9.1%	100.0%
		% within Post-op ECOG (LAST F/U)	0.0%	20.0%	50.0%	0.0%	50.0%	20.0%	19.3%
	4	Count	0	0	0	1	0	2	3
		% within Pre-op ECOG	0.0%	0.0%	0.0%	33.3%	0.0%	66.7%	100.0%
		% within Post-op ECOG (LAST F/U)	0.0%	0.0%	0.0%	33.3%	0.0%	40.0%	5.3%
Total	Count	8	35	4	3	2	5	57	
	% within Pre-op ECOG	14.0%	61.4%	7.0%	5.3%	3.5%	8.8%	100.0%	
	% within Post-op ECOG (LAST F/U)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	

**Table 4.5p- table comparing pre & post op ECOG scores significance**

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	61.115 <sup>a</sup>	15	.000
Likelihood Ratio	47.077	15	.000
Linear-by-Linear Association	16.174	1	.000
N of Valid Cases	57		



**Figure 4.5i – Pre-op and post-op ECOG comparison**

The p-value of 0.000 is lesser than the significance level of 0.05, indicating that there is statistically significant association between pre-operative and post-operative ECOG scores. The data does provide enough evidence to conclude that there is a statistically significant association between pre-operative and post-operative ECOG scores.

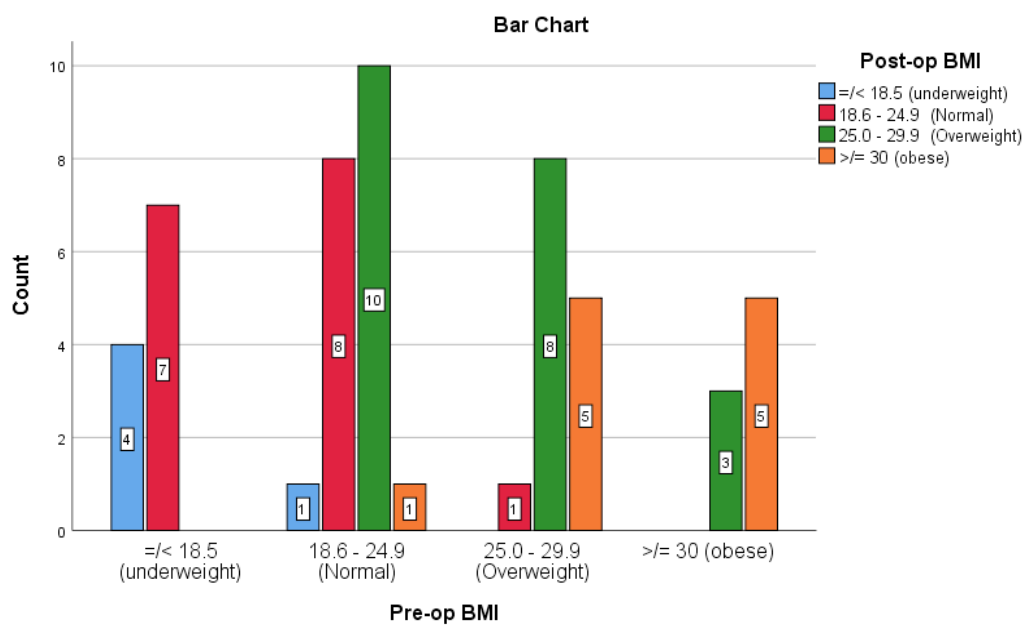
**A. Pre and post-op BMI scores comparison :**

**Table 4.5q- cross-tabulation comparing pre & post-op BMI scores**

Pre-op BMI * Post-op BMI Crosstabulation							
			Post-op BMI				Total
			=/< 18.5 (underweight)	18.6 - 24.9 (Normal)	25.0 - 29.9 (Overweight)	>/= 30 (obese)	
Pre-op BMI	=< 18.5 (underweight)	Count	4	7	0	0	11
		% within Pre-op BMI	36.4%	63.6%	0.0%	0.0%	100.0%
		% within Post-op BMI	80.0%	43.8%	0.0%	0.0%	20.8%
	18.6 - 24.9 (Normal)	Count	1	8	10	1	20
		% within Pre-op BMI	5.0%	40.0%	50.0%	5.0%	100.0%
		% within Post-op BMI	20.0%	50.0%	47.6%	9.1%	37.7%
	25.0 - 29.9 (Overweight)	Count	0	1	8	5	14
		% within Pre-op BMI	0.0%	7.1%	57.1%	35.7%	100.0%
		% within Post-op BMI	0.0%	6.3%	38.1%	45.5%	26.4%
	>/= 30 (obese)	Count	0	0	3	5	8
		% within Pre-op BMI	0.0%	0.0%	37.5%	62.5%	100.0%
		% within Post-op BMI	0.0%	0.0%	14.3%	45.5%	15.1%
Total	Count	5	16	21	11	53	
	% within Pre-op BMI	9.4%	30.2%	39.6%	20.8%	100.0%	
	% within Post-op BMI	100.0%	100.0%	100.0%	100.0%	100.0%	

**Table 4.5r- table comparing pre & post op BMI scores significance**

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	39.438 <sup>a</sup>	9	.000
Likelihood Ratio	45.370	9	.000
Linear-by-Linear Association	28.639	1	.000
N of Valid Cases	53		



**Figure 4.5j- Histogram comparing pre & post op BMI scores**

A chi-square test was conducted to determine if there is a statistically significant association between obesity status before and after the surgery. The results of the test showed a significant chi-square value ( $\chi^2 = 39.438$ ,  $p < 0.001$ ), indicating that there is a difference in the distribution of obesity status before and after the surgery.

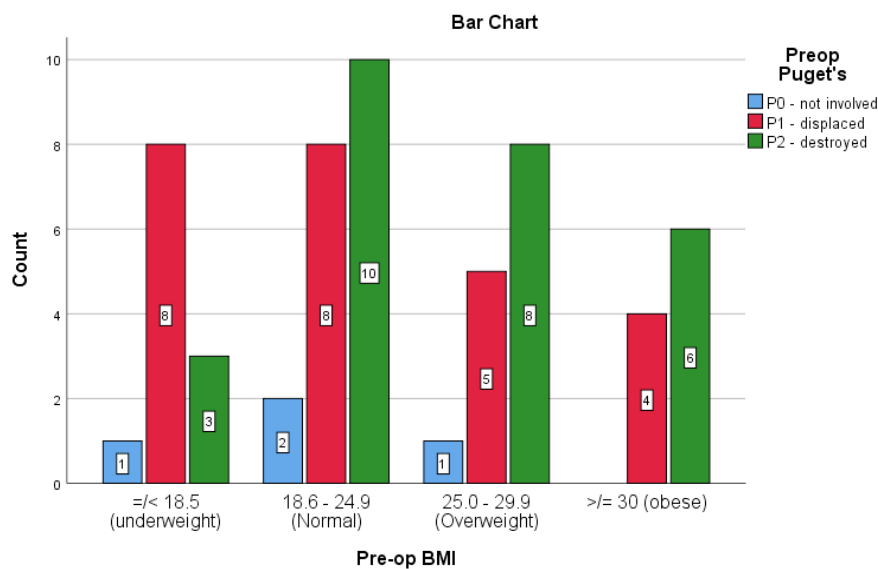
**B. PRE-OP BMI AND PRE-OP PUGET'S CO-RELATION:**

**Table 4.5s- cross-tabulation comparing pre-op puget's classification & pre-op BMI scores**

<b>Pre-op BMI * Preop Puget's Crosstabulation</b>						
			Preop Puget's			Total
			P0 - not involved	P1 - displaced	P2 - destroyed	
Pre-op BMI	≤/ < 18.5 (underweight)	Count	1	8	3	12
		% within Pre-op BMI	8.3%	66.7%	25.0%	100.0%
		% within Preop Puget's	25.0%	32.0%	11.1%	21.4%
	18.6 - 24.9 (Normal)	Count	2	8	10	20
		% within Pre-op BMI	10.0%	40.0%	50.0%	100.0%
		% within Preop Puget's	50.0%	32.0%	37.0%	35.7%
	25.0 - 29.9 (Overweight)	Count	1	5	8	14
		% within Pre-op BMI	7.1%	35.7%	57.1%	100.0%
		% within Preop Puget's	25.0%	20.0%	29.6%	25.0%
	≥/ = 30 (obese)	Count	0	4	6	10
		% within Pre-op BMI	0.0%	40.0%	60.0%	100.0%
		% within Preop Puget's	0.0%	16.0%	22.2%	17.9%
Total	Count	4	25	27	56	
	% within Pre-op BMI	7.1%	44.6%	48.2%	100.0%	
	% within Preop Puget's	100.0%	100.0%	100.0%	100.0%	

**Table 4.5t- chi square tests-pre-op Puget's classification & pre-op BMI scores**

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.539 <sup>a</sup>	6	.604
Likelihood Ratio	5.333	6	.502
Linear-by-Linear Association	2.822	1	.093
N of Valid Cases	56		



**Figure 4.5k: Histogram on comparing pre-op Puget's classification & pre-op BMI scores**

The p-value of 0.604 is greater than the value of significance, indicating that there is no statistically significant association between pre-operative BMI and pre-operative Puget's classification. The data does not provide enough evidence to conclude that there is a statistically significant association between pre-operative BMI and pre-operative Puget's classification.

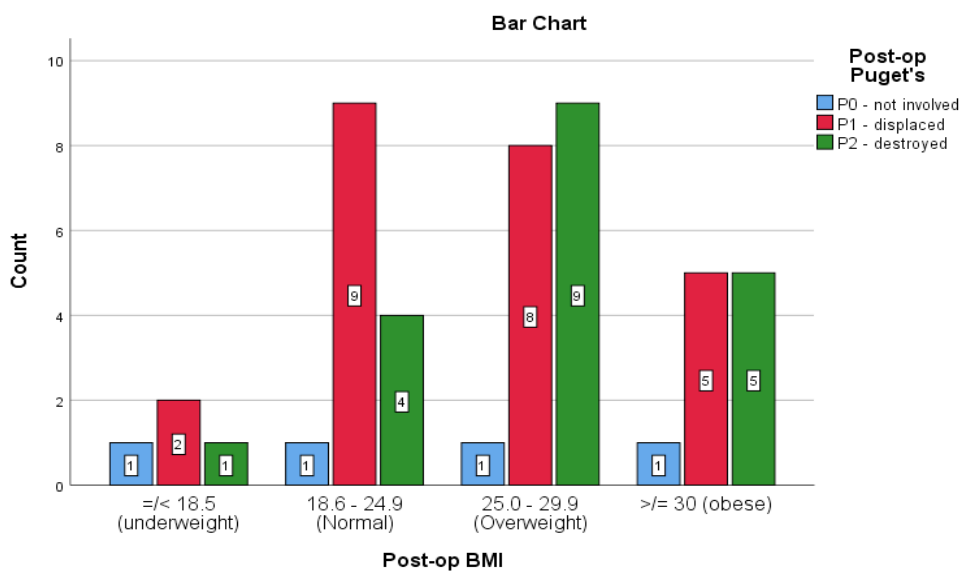
**C. POST-OP BMI AND POST-OP PUGET'S CO-RELATION:**

**Table 4.5u- cross-tabulation comparing post-op Puget's classification & post-op BMI scores**

<b>Post-op BMI * Post-op Puget's Crosstabulation</b>						
			Post-op Puget's			Total
			P0 - not involved	P1 - displaced	P2 - destroyed	
Post-op BMI	=< 18.5 (underweight)	Count	1	2	1	4
		% within Post-op BMI	25.0%	50.0%	25.0%	100.0%
		% within Post-op Puget's	25.0%	8.3%	5.3%	8.5%
	18.6 - 24.9 (Normal)	Count	1	9	4	14
		% within Post-op BMI	7.1%	64.3%	28.6%	100.0%
		% within Post-op Puget's	25.0%	37.5%	21.1%	29.8%
	25.0 - 29.9 (Overweight)	Count	1	8	9	18
		% within Post-op BMI	5.6%	44.4%	50.0%	100.0%
		% within Post-op Puget's	25.0%	33.3%	47.4%	38.3%
	>= 30 (obese)	Count	1	5	5	11
		% within Post-op BMI	9.1%	45.5%	45.5%	100.0%
		% within Post-op Puget's	25.0%	20.8%	26.3%	23.4%
Total	Count	4	24	19	47	
	% within Post-op BMI	8.5%	51.1%	40.4%	100.0%	
	% within Post-op Puget's	100.0%	100.0%	100.0%	100.0%	

**Table 4.5v- chi square test:post-op Puget’s classification & post-op BMI scores**

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.399 <sup>a</sup>	6	.757
Likelihood Ratio	3.020	6	.806
Linear-by-Linear Association	1.337	1	.248
N of Valid Cases	47		



**Figure 4.5I: Histogram on comparing post-op Puget’s classification & post-op BMI scores**

The p-value of 0.757 is greater than the significance level of 0.05, indicating that there is no statistically significant association between post-operative BMI and post-operative Puget's classification. The data does not provide enough evidence to conclude that there is a statistically significant association between post-operative BMI and post-operative Puget's classification.

## DISCUSSION



## 5. DISCUSSION

Due to the extensive surgical and medicinal procedures, including radiotherapy, required for the treatment of craniopharyngiomas, patients with these conditions make up a special cohort.

Although patient survival after therapy for malignant tumours is improving, the majority of research reflects the degree of resection and results in terms of tumour control over time. However, the focus has been gradually changing away from the idea of merely surviving and toward achieving a higher quality of life.

Usage of the endoscope gives the neurosurgeon a more expansive, wide, panoramic volumetric exposure of the skull base than is possible with more conventional microscopical transsphenoidal methods, theoretically improving the extent of resection while offering a safety profile not possible with microscopy/other approaches alone.

As a result, some writers have discussed the use of an endoscope in conjunction with microscopic resections to improve imaging of any residual tumour(66)(67).

In our study, the results of 57 craniopharyngioma patients who received care at SCTIMST between January 2016 and May 2023 and who completed their indicated adjuvant therapy were assessed. All these 57 patients had histologically proven cases of adamantinomatous craniopharyngioma

They underwent evaluations on their follow-ups from May 2021 to May 2023. We examined the clinical, endocrinological, quality-of-life, and cognitive status of the patients from using electronic medical records and evaluated them at their respective follow-ups.

## **DEMOGRAPHY:**

### ***Age at presentation:***

In our cohort, most of the patients belong to either 10-18 years or 31 to 50 years showing bimodal distribution which is comparable to the other studies in the literature.

### ***Gender:***

Males make up most of the cohorts. 22 women and 35 men, or 61.4% and 38.6% respectively, made up our cohort. In our study, pediatric cohorts averaged 24 people.

### ***Primary /recurrent cases:***

In our study, 35 cases (61.4%) were primary and 22 (38.6%) were recurrent. Recurrent cases were those who had previous transcranial or microscopic operations.

### **Headache:**

In our cohort, Out of 57 patients, the majority i.e., 41 (71.9 %) had headaches as their chief complaint(68).

If we take a look at what was performed with the aid of Muller et al. , it was reported that approximately 50% of patients had headache and elevated intracranial pressure (69).

## **INCIDENCE OF PRE-OP NEUROLOGICAL, VISUAL AND ENDOCRINE DEFICITS**

### *Pre-op raised ICP complaints ( headache and vomiting):*

In our study, 17 out of 58 patients (29.2%) exhibited high intracranial pressure symptoms such as acute headache, vomiting, visual abnormalities, and papilledema-like characteristics. Take a look at what was performed with the aid of Muller et al. (69), it was reported that approximately 50% of patients had elevated intracranial pressure.

### *Pre-op Visual complaints:*

In our study, 75.4% of participants reported visual disturbances, including blurring or visual field defects. Look at the study performed by Muller et al. (69) found visual impairment in approximately 50% of patients.

### *Pre-op hypothalamic dysfunction:*

Our study found that 61.4% of patients exhibited signs of hypothalamic dysfunction, such as increased thirst and urination, changes in body temperature, alteration in body weight, menstrual irregularities, reduced libido, and delayed secondary sexual characteristics. Elliot et al. reported hypothalamic dysfunction in 35% of patients in 2010 (70).

### **PRE-OP HORMONAL ASSESSMENT:**

In our study, most patients had hypogonadism (32-56.1%), followed by hypothyroidism and hypocortisolism. Abnormal/ deranged thyroid hormone levels were found in 29 patients (50.9%), and low cortisol levels were found in 28 patients (49.1%).

In our cohort, among 57 patients 21 (36.8 %) had pre-op diabetes insipidus.

Studies by Caldarelli et al. (2005) and Muller et al. (2008) reported that 40-87% of patients had at least one hormone deficiency. Take a look at what was performed with the aid of Muller et al. (2008) and Elliott et al. (2010) found that 17-27% of patients in their series had DI (69)(70) (71)..

### **THE EXTENT OF RESECTION:**

In patients with craniopharyngioma, the close proximity of critical brain structures such as the optic apparatus, pituitary, hypothalamus, and brainstem increases the risk of long-term morbidity. Therefore, our approach involves aiming for gross-total resection in most cases, with sub-total/near resection reserved for specific instances. Our approaches either involved simple endoscopic approaches or extended endoscopic approaches.

In our study, 34 out of 57 patients (59.6%) underwent extended endoscopic procedures, while the remaining 23 (40.4%) required regular endoscopic procedures.

***The outcome, tumor control rates compared to other series:***

In our study, 57 patients underwent EES surgery: Among which, 39 (68.4%) underwent gross total resection, 14 (24.6%) underwent near-total resection, and 4 (7%) underwent subtotal resection. Of these, 18 (31.6%) patients had minimal residues and 39 (68.4%) had no residues radiologically. Only 3 (5.3%) patients experienced a lesion recurrence.

A study by Di Rocco et al. (72) reported a recurrence rate of 7% after gross total removal and 50% after subtotal/partial excision of craniopharyngioma in children. The study included 54 children, with gross total removal in 78% of patients, subtotal in 17%, and partial in 5%.

In 2007, study done by Puget et al. (5) found that 53% of the 66 children in their study experienced tumour recurrence, with rates of 36% and 54% after GTR and STR, respectively (73).

Ohmori et al. included 27 children in 2007 and reported recurrence rates of 16.1% was for the gross total resection cohorts, 51.1% for the subtotal resection without radiation therapy group, and 33.5% for the group who underwent subtotal resection with radiation therapy group (74).

***Visual outcomes compared to other studies in literature:***

In our study out of 57 patients, 34 (60%) showed improved vision with worsening in 6 (5.3%), while vision remained the same compared to pre-op status in 14 (24.6%) patients.

Elliott et al. reported vision improvement in 56.5% of patients and visual deterioration in 25%. Zhang et al. found vision improvement in 42% of patients and worsening in 5% post-surgery(39) (75).

**Table 5.1 : comparing visual outcomes in various studies (70)(72)(73)(75)(76)**

<b>STUDIES</b>	<b>VISION IMPROVEMENT (%)</b>	<b>VISION WORSENING (%)</b>
<b>Elliott et al. 2010 (14)</b>	56.5	25
<b>Shi et al. 2008 (19)</b>	42	5.5
<b>Zhang et al.2008 (18)</b>	42	5
<b>Puget et al. 2007 (16)</b>	68	21
<b>Di Rocco et al 2006 (15)</b>	44	11
<b>OUR STUDY</b>	60	6

***Endocrine outcomes:***

In our study, we found that the majority of patients experienced persistent hypocortisolism and hypothyroidism following surgery. Additionally, 38 patients required Minrin/Desmopressin supplementation for DI, with 3 of them having transient DI.

We conducted a study on patients undergoing hormone replacement therapy and found that over 90% required one or more hormonal replacements. These patients were prescribed replacement medications based on recent hormonal evaluation and endocrinologist advice. Our study highlights the need for regular assessment and treatment for patients with hormonal deficits, particularly pediatric patients.

We observed that a small proportion of patients in our series were either untreated or incompletely treated for endocrine dysfunction during follow-up. This highlights the importance of assessing overall outcomes in these patients, beyond just tumor control. Hormonal dysfunction can have subtle symptoms but can significantly impact daily functioning, growth, and well-being, especially in children. Optimal hormonal replacement is crucial for ensuring good outcomes in these patients..

Caldarelli et al. reported post-operative endocrine dysfunction in 42 out of 52 patients during the post-op period. In the late period, 31 patients presented with hypopituitarism and received hormone replacement therapy (71,77). Of the 52 patients, 28 were prescribed hydrocortisone medication for adrenal insufficiency, 24 were prescribed thyroid hormone replacement, and 21 received GH therapy for short stature, which was comparable to our series.

According to Jung et al. (2010), 92.8% of 13 patients received total hormone replacement therapy with steroid, levothyroxine, and desmopressin, while 7.2%

received GH replacement and one patient received thyroid hormone replacement(78).

Poretti et al. (79) studied endocrinological outcomes in 25 pediatric craniopharyngioma patients post-surgery in 2004. They found that 24 of 25 children required hormonal replacement therapy, including long-term thyroid hormone replacement in 21 patients. Adrenal hormone supplementation was administered to 19 patients and 20 patients received growth hormone.

Muller et al. (80) reported in 2008 that 85-95% of patients suffer from multiple deficits of hypothalamic-pituitary function after craniopharyngioma resection. Complete restoration of preoperatively deficient hormonal function occurs in only a few cases. Diabetes insipidus occurs in 80-93% of patients with complete resection, and growth hormone deficiency occurs in 75% of cases. However, GH deficiency was only noted in around 7 out of 24 children in our series.

**Table 5.2: depicting requirement of hormonal replacement/supplementation in various studies (71,78–80)**

<b>STUDIES</b>	<b>HORMONAL REPLACEMENT (%)</b>
<b>Mulleret al. (13)</b>	85-95
<b>Caldarelli et al. (20)</b>	80.7
<b>Jung et al. (21)</b>	92.8
<b>Poretti et al. (22)</b>	96
<b>OUR STUDY</b>	>90

## **MORTALITY:**

In our study, a total number of patients who died are 5 (8.8 %) among 57 cohorts which was less when compared to others in literature (1,2,3,4).

Amongst those 2 patients died after 2 years with the cause being unrelated to the primary disease and 2 (1 fresh case & 1 was recurrent case) patients died due to meningitis complicating into septic shock (within 28 days of admission). One patient who developed DVT on follow-up and developed pulmonary embolism despite after starting anti-coagulant therapy.

### ***Factors affecting Quality of life:***

Müller et al. in 2013, Laffond et al. in 2012, and Zada et al. in 2013 reported that several factors were associated with a decreased quality of life, including tumor recurrence, multiple surgeries, hypothalamic involvement, high BMI, hydrocephalus, and early onset (80–82).

In our study, we observed that children who underwent VP shunt due to hydrocephalus experienced more emotional and behavioral problems than those who did not. Additionally, these children had difficulties in social functioning, which affected their social activities and ability to interact with peers. It is likely that this could be the long-term effect of hydrocephalus, which occurred prior to tumour surgery. However, it has been treated with a VP shunt.

Poretti et al. (2004) found that patients with craniopharyngioma had lower quality of life, particularly in the social and emotional functioning domain. Factors impacting the quality of life included large tumors infiltrating or displacing the hypothalamus, patients with hydrocephalus, children with young age at diagnosis, and patients who had multiple operations due to tumor recurrence (79).

Our study shows that there is a significant improvement in patients in post-op KPS, N-CCSS, V-CCSS, P-CCSS, H-CCSS E-CCSS, WEN et al scores when compared pre-operative scores respectively.

**Table 5.3: Comparison of diverse collection in phrases of range of patients, the quantity of tumour resection, postoperative development in vision, CSF leak, diabetes insipidus, and hypopituitarism (83)**

Series	Number of patients	Gross total or near total excision (%)			Improvement of vision(%)	CSF leak (%)	DI (%)	Hypopituitarism(%)
		GTR	STR	TOTAL				
<b>Frank et al.2006</b>	10	70	10	80	75	20	30	0
<b>De Divitiis et al.2007</b>	10	70	20	90	90	20	30	17
<b>Gardner et al.2008</b>	16	73	18	91	93	58	8	18
<b>Campbell et al. 2010</b>	14	29	64	93	86	36	7	57
<b>Jane et al.2012</b>	12	42	41	83	78	8	44	67
<b>Leng et al.2013</b>	26	86	9	95	77	3.8	42	38
<b>Cavello et al 2013</b>	12	66.7	25	92	78	17	67	25
<b>Koutourousiou et al.2013</b>	64	37.5	34.4	72	86	23	47	58
<b>Cavello et al.2014</b>	103	69	25	94	75	14.6	48	44
<b>Y R Yadav et al 2014</b>	44	59	25	84	77	9	14	9
<b>OUR STUDY</b>	57	68.4	7	75.4	60	10.5	66.6	90

**Table 5.4: Comparison of various series After the surgery, there have been notable enhancements including improved vision, absence of cerebrospinal fluid leakage, resolved diabetes insipidus, and eradicated hypopituitarism.**

Authors and year	Number of patients	Tumour size >2cm (%)	Post op endocrinology DI(%) / HP (%)	Post op ophthalmology		GTR (%)	CSF Leak (%)
				No deficit (%)	Improved(%)		
<b>Cappabianca et al., 2002</b>	4	NR	NR	NR	NR	100	NR
<b>Frank et al., 2006</b>	10	80	60/100	40	70	70	30
<b>Laufer et al., 207</b>	4	75	100/100	NR	NR	100	0
<b>De Divitiis et al., 2007</b>	10	NR	60/60	30	50	70	20
<b>Stamm et al., 2008</b>	7	NR	85.7/NR	57.1	67	57	29
<b>Gardner et al., 2008</b>	16	81.3	56.3/88.3	50	75	50	58
<b>Cavallo et al., 2009</b>	22	91.0	72.7/91	36.4	68.1	40.9	13.6
<b>Dehdashti et al., 2009</b>	6	NR	50/NR	16.7	80	16.7	33.3
<b>Campbell et al., 2010</b>	14	85.7	64.3/57.1	42.9	85.7	28.6	35.7
<b>OUR STUDY 2023</b>	<b>57</b>	<b>&gt;90</b>	<b>66.6/90</b>	<b>24.6</b>	<b>60</b>	<b>68.4</b>	<b>10.5</b>

Pituitary function and weight gain/obesity are controlled by the hypothalamus. The paraventricular and supraoptic nuclei, located in the anterior-ventral area of the hypothalamus near the infundibulum, affect pituitary function. On the other hand, hypothalamic nuclei involved in autonomic nervous functions, such as feeding, sleep cycles, and sexual activity, are located in the posterior-dorsal area. Therefore, a hypothalamic dysfunction could lead to pituitary dysfunction, depending on the tumour's extension to the upper hypothalamic area.

Various classifications estimate preoperative hypothalamic involvement. Puget et al. classified it by preoperative MRI and postoperative MRI extent of involvement of the hypothalamus. We tried to correlate pre-op involvement/post-op involvement of the hypothalamus with obesity, allowing the evaluation of surgical invasiveness (73). However, our study did not reveal any statistically significant correlation between obesity and pre-op/post-op hypothalamic involvement of the tumour. There was a significant change in body weight in our cohorts with obesity over the follow up may be due to hormonal supplementation.

## SUMMARY AND CONCLUSIONS



## 6. SUMMARY

- Our study included 57 (24 pediatric, 33 adult) patients who are operated from January 2016 to May 2023 in our institute through endoscopic transnasal surgery.
- In our study, 35 cases (61.4%) were primary and 22 (38.6%) were recurrent. Recurrent cases were those who had previous trans cranial or microscopic operations.
- Most of the patients presented with headache as the major complaints followed by hormonal disturbances and visual disturbances .
- Our study found that 61.4% of patients exhibited signs of hypothalamic dysfunction, 36.8% had preop DI and nearly half of the patients had thyroid dysfunction/hypocortisolism.
- In our study, 16 (28.1 % ) had pre operative hydrocephalus and 15 patients underwent CSF diversion prior to the endoscopic procedure. One patient underwent surgery upfront in view of visual deterioration. Out of 15, 7 patients underwent shunt , 7 patients underwent septostomy + shunt and 1 patients had External ventricular drainage.
- In our study, 34 out of 57 patients (59.6%) underwent extended endoscopic procedures, while the remaining 23 (40.4%) required regular endoscopic procedures.
- In our study, 57 patients underwent surgery: 39 (68.4%) had complete removal, 14 (24.6%) had almost complete removal, and 4 (7%) had partial removal.

- Of these cohorts, on follow-up 18 (31.6%) patients had minimal residues and 39 (68.4%) had no residues radiologically. Only 3 (5.3%) patients experienced a lesion recurrence.
- Our findings indicate that larger tumours are more likely to be completely or nearly removed compared to small/medium tumours.
- Our study did not find any statistically significant correlation between tumour characteristics (such as calcification, size, vascular relation to MCA/ACA/PCA, and location) and total resection or recurrence rates. However, these factors may still have practical implications, although our sample size was limited.
- Our study contained majority of the tumors were of Kassam's grade II. Tumors were belonged to type S variety (QST et al classification) and infundibulo-lateral/sellar-supra sellar/retro-chiasmatic varieties as per sadashivam et el, Prieto classification etc.
- According to our study, a significant 60% of patients experienced enhanced vision post-surgery, while 24.6% maintained their vision and 5.3% witnessed a decline in vision. Regrettably, vision testing could not be conducted for 3 patients due to complications such as poor sensorium and mortality.
- In our study, after the operation, 10.5% of patients experienced a cerebrospinal fluid leak, 15.8% developed meningitis, and 4 patients underwent CSF diversion.
- In our study, out of 57 patients, 5 (8.8%) died. Two died after 2 years due to unrelated causes, while two died within 28 days of admission due to meningitis complicated by septic shock. One patient developed a pulmonary

embolism despite anticoagulant therapy after 6 months.

- In our study, we observed significant improvement in postoperative scores for KPS, Wen et al, N-CCSS, V-CCSS, P-CCSS, H-CCSS, and E-CCSS when compared to preoperative scores, which was also statistically significant.

## **CONCLUSIONS**

Although craniopharyngioma is a relatively humble tumor that can be approached through various methods, this study sheds light on the outcomes of patients who undergo endoscopic endonasal surgery.

The rate of ophthalmological and endocrinological dysfunction after craniopharyngioma resection is significantly affected by the extent of resection and surgical approach used.

Although not all tumors can be treated with an endonasal endoscopic approach, this small case series suggests that it can be effective in preserving endocrine function and improving visual recovery, while also achieving substantial tumor removal. Other case studies in the literature show favorable outcomes in ophthalmology and endocrinology after resection.

A minimally invasive endoscopic technique can safely and effectively treat craniopharyngiomas with outcomes comparable to traditional transcranial approaches, when used in appropriately selected patients.

The endoscopic endonasal approach provides excellent visualization of the suprasellar space, including sub- and retro chiasmatic areas, as well as the stalk-infundibulum axis. This axis serves as a gateway to access the third ventricle chamber when directly involved by a lesion.

Despite postoperative CSF leaks being a leading cause of temporary morbidity, meningitis-like complications and an increased risk of delayed chronic hematoma, successful results in terms of visual function and tumor removal provide strong counterarguments.

Postoperatively craniopharyngioma patients may develop weight gain, obesity, cognitive disturbances, and alterations in quality of life due to surgery or other causes. These are all questionable factors that should be considered regardless of the approach taken.

Although there are promising reports on using this technique to operate on several patients, conclusive results of large cohorts on the completeness of lesion removal, adequate follow-up, recurrence rate, and endocrinological outcomes are not yet fully available, which delays an objective judgment. Still lot of experience on large number of patients is needed to determine the effectiveness of this technique.

Although advancements in tumor treatment have been made, there are still hindrances such as tumor size, the depth of the operative field, hemorrhage management, osteodural defect reconstruction, a steep learning curve, and the availability of specialized instruments. However, upcoming technological advancements are anticipated to enhance the quality of instruments employed, such as high-definition monitors and cameras, improved illumination and image quality, dedicated low-profile instruments, and chip-stick technology.

In the realm of medical advancements, endoscopic surgery offers a promising alternative to traditional treatments for craniopharyngiomas and other masses located above the sella turcica. This approach boasts a reduced risk of harm to critical areas such as the optic apparatus, neurovascular structures, and hypothalamus.

Endoscopic endonasal surgery (EES) has shown to have minimal complications and a high success rate in the removal of craniopharyngiomas, while also maintaining hypothalamic function for a longer duration. Recent

studies indicate that EES is poised to become the preferred surgical approach, surpassing the traditional craniotomy.

Though Endoscopic surgery outcomes in terms of visual and endocrinological aspects seems better there is a dire need for long-term prospective studies assessing cognitive functions, QOL scores and other aspects including paediatric cohorts.

Due to its prolonged post-operative follow-up, hormonal disturbances, impairment of QOL/cognitive disturbances Craniopharyngioma should be considered as a life-long disease rather than a clinical condition.

## LIMITATIONS

- This study included small sample size.
- This study lacked evaluation of cognitive scores (although we could perform neuropsychology assessment only in a few pediatric patients)
- Due to the COVID pandemic, follow-up assessment was heterogeneous initially.
- A comparison of outcomes between transcranial and endonasal approaches was not made.
- Our study has limitations, such as short follow-up and a small patient sample. Future studies should include more patients and detailed questionnaires to evaluate the quality of life after long-term observation.

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## 8. REFERENCES:

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**ANNEXURES:**



## CURRICULUM VITAE

Last Name	First Name	Middle Name
<b>G B</b>	<b>AKHILESH</b>	<b>GOWDA</b>
Date of Birth (dd/mm/yy) :30/05/1991		Sex : MALE
Study Site Affiliation (e.g. Principal Investigator, Co-Investigator, Coordinator) : PRINCIPAL INVESTIGATOR, SCTIMST		
Professional Mailing Address (Include Institution name)		Study Site Address (Include Institution name)
DEPT OF NEUROSURGERY, SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY THIRUVANANTHAPURAM KERALA 695011		DEPT OF NEUROSURGERY, SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY THIRUVANANTHAPURAM KERALA 695011
Telephone (Office):		Mobile Number: 8151889754, 6362545950
Telephone (Residence): 8431804858		Email- (51),drachilles7@gmail.com
Academic Qualifications (Most recent qualification first)		
Degree/Certificate	Year	Institution, Country
MS GENERAL SURGERY	2018	LOKMANYA TILAK MUNICIPAL MEDICAL COLLGE & LOKMANYA TILAK MUNICIPAL GENERAL HOSPITAL SION, MUMBAI-400022, INDIA.
MBBS	2014	RAICHUR INSTITUTE OF MEDICAL SCIENCES, RAICHUR, KARNATAKA, INDIA, 584102
Details of professional registration: (MCI/State Registration/Bar Council / DCI/etc. including Registration Number and Year of Registration		
THE TRAVANCORE-COCHIN COUNCIL OF MODERNMEDICINE		
REGISTRATION NUMBER: 79082		
YEAR OF REGISTRATION: 2021		

Month and Year	Title	Institution/Company, Country
JANUARY, 2021	SENIOR RESIDENT, NEUROSURGERY	SCTIMST, INDIA
2018, 2019	SENIOR RESIDENT, GENERAL SURGERY	LTMMC & GH, MUMBAI, MAHARASHTRA, INDIA

Brief summary of relevant research experience:

1. BMJ: CASE REPORT 2019/ PUB MED CASE REPORTS - “HANDLEBAR SIGN” IT’S NOT JUST A BRUISE!

(Dhakre VW, Kadam SB, Gowda A, et al Handlebar sign: a bruise with underlying visceral injury BMJ Case Reports CP 2019;12:e231835)

2. AJNS: PTERIONAL APPROACH FOR ANTERIOR SKULL BASE MIDLINE MENINGIOMAS AGAINST “THE MERRIER” APPROACH- AN INSTITUTIONAL EXPERIENCE.

(Gowtham M, Gowda AGB, Rajeev SP, Abraham M, Easwer HV. Pterional Approach for Anterior Skull Base Midline Meningiomas against "The More The Merrier" Approach: An Institutional Experience. Asian J Neurosurg. 2023 Jun 12;18(2):265-271. doi: 10.1055/s-0043-1768575. PMID: 37397053; PMCID: PMC10310447)

3. BJNS: ATYPICAL TERATOID RHABDOID TUMOUR IN THE THIRD VENTRICLE OF A YOUNG ADULT- A RARE PRESENTATION.

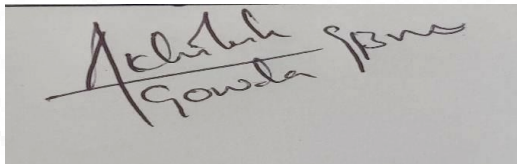
(Ram Kishan Nekkanti, Easwer Hariharan Venkat, Gowtham Matham, Akhilesh Gowda G B & Rajalakshmi Poyuran (2023) Atypical teratoid rhabdoid tumour in the third ventricle of a young adult – a rare presentation, British Journal of Neurosurgery, DOI: 10.1080/02688697.2023.2239919)

2)MS THESIS (2018): COMPARATIVE EFFICACIES OF FNAC, TRUCUT BIOPSY & SONOMAMMOGRAM TO THE FINAL HISTOPATHOLOGY IN A CLINICALLY SUSPECTED BREAST SWELLINGS.

### Conferences and Presentations

- Central Travancore Neurocon, NSI Kerala October 2022 Poster Presentation :  
UNIQUE PRESENTATION OF OCCIPITAL CONDYLE GIANT CELL TUMOR AS OCCIPITAL CONDYLE SYNDROME – A REVIEW
- Cadaveric workshop on transforaminal lumbar spine endoscopy -2022
- Chitra Neurosurgical Society : Symposium presentation - POSITIONING IN NEUROSURGERY
- IFNE-HYDERABAD (INTERIM MEETING 2022) :  
ENDOCRINOLOGICAL OUTCOMES OF CRANIOPHARYNGIOMA SURGERY-Paper presentation
- INTERIM Skull basecon April 2023 Poster presentation :
  - i) NEUROLOGICAL OUTCOMES IN PATIENTS UNDERGOING ENDOSCOPIC SURGERY FOR CRANIOPHARYNGIOMA
  - ii) ANTERIOR TRANS PETROSAL APPROACH FOR RIGHT VENTRAL PONTINE CAVERNOMA VIA PERITRIGEMINAL ZONE – CASE REPORT
- Prof Damodar Rout Oration. Chitra Neurosurgery Update, February 2023
- Prof RM Varma Memorial Oration , Neurosurgery CME , May 2023

Signature:



25/08/23  
TRIVANDRUM

## APPENDIX A- INSTITUTIONAL ETHICS COMMITTEE APPROVAL



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)

Grams : Chitramet, Phone : +91-471-2443152, Fax : +91-471-2550728 / 2446433, E-mail : sct@sctimst.ac.in, Website : www.sctimst.ac.in

### Institutional Ethics Committee (IEC Regn No. ECR/189/Inst/KL/2013/RR-21)

SCT/IEC/1846/MAY/2023

15.06.2023

Dr. Akhilesh Gowda GB  
Senior Resident  
Department of Neurosurgery  
SCTIMST, Thiruvananthapuram

Dear Dr. Akhilesh Gowda,

The Institutional Ethics Committee held on 20<sup>th</sup> May 2023, reviewed and discussed your application to conduct the study titled "NEUROLOGICAL OUTCOMES IN PATIENTS UNDERGOING ENDOSCOPIC SURGERY FOR CRANIOPHARYNGIOMA" (IEC/1846).

The following members of the Ethics Sub-committee were present at the meeting held on 20<sup>th</sup> May, 2023

SL. No.	Member Name	Highest Degree	Gender	Scientific /Non Scientific	Affiliation with Institution(s)
1.	Smt. Sathi Nair	MA (English Literature)	Female	Lay Person	No
2.	Dr. Pradeep S	MBBS, MD	Male	Basic Medical Scientist	No
3.	Dr. Christina George	MD Psychiatry	Female	Clinician	No
4.	Adv. Priya Kaimal	LLM, MBL	Female	Legal Expert	No
5.	Dr. P. Manickam	BSMS, MSc (Epid)., PhD	Male	Health Science Expert/ Social Scientist	No
6.	Dr. Manikandan.S	MBBS,MD,PDCC	Male	Clinician	Yes
7.	Dr. Srinivas G	PhD	Male	Basic Medical Scientist (Member Secretary)	Yes

**The following documents were reviewed:**Original submission

1. Covering letter addressed to the Chairperson/Member Secretary ,IEC,SCTIMST dated 08.05.2023 from Dr. Akilesh Gowda G B, Senior Resident, Department of Neurosurgery, SCTIMST
2. Covering letter addressed to the Chairperson / Member Secretary, IEC, SCTIMST dated 08.05.2023 from Dr. Prakash Nair Associate Professor, Department of Neurosurgery, SCTIMST
3. Covering letter addressed to the Chairperson /Member Secretary, IEC, SCTIMST dated 08.05.2023 from Dr. Easwer, HV, Professor and HOD, Department of Neurosurgery, SCTIMST
4. Study Proposal
5. IEC Application Form
6. Declaration Form
7. Covering letter addressed to the Chairperson, IEC, SCTIMST dated 01.08.2022
8. Covering letter addressed to the Chairperson, IEC, SCTIMST dated 22.11.2022 Dr. Easwer, HV, Professor and HOD, Department of Neurosurgery, SCTIMST
9. Covering letter addressed to the Chairperson, IEC, SCTIMST dated 22.11.2022 from Dr. Prakash Nair, Associate Professor Department of Neurosurgery, SCTIMST
10. Proforma
11. Patient Information Sheet in English and Malayalam
12. Informed Consent Forms in English and Malayalam
13. CV of PI and Co-PI
14. Checklist Form

Revised submission

1. Covering letter addressed to the Chairperson/Member Secretary ,IEC,SCTIMST dated 12.06.2023 from Dr. Akilesh Gowda G B, Senior Resident, Department of Neurosurgery, SCTIMST
2. Covering letter addressed to the Chairperson/Member Secretary ,IEC,SCTIMST dated 08.05.2023 from Dr. Akilesh Gowda G B, Senior Resident, Department of Neurosurgery, SCTIMST
3. Covering letter addressed to the Chairperson / Member Secretary, IEC, SCTIMST dated 08.05.2023 from Dr. Prakash Nair Associate Professor, Department of Neurosurgery, SCTIMST
4. Covering letter addressed to the Chairperson /Member Secretary, IEC, SCTIMST dated 08.05.2023 from Dr. Easwer, HV, Professor and HOD, Department of Neurosurgery, SCTIMST
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11. Covering letter addressed to the Chairperson, IEC, SCTIMST dated 22.11.2022 from Dr. Prakash Nair, Associate Professor Department of Neurosurgery, SCTIMST
12. Proforma
13. CV of PI and Co-PIs
14. Checklist Form

**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,



**Dr. G. Srinivas**  
Member Secretary, IEC



**MEMBER SECRETARY**  
INSTITUTIONAL ETHICS COMMITTEE (IEC)  
SCTIMST, THIRUVANANTHAPURAM

## **APPENDIX B - PAPERS AND POSTERS FROM THIS THESIS**

- **IFNE-HYDERABAD (INTERIM MEETING 2022) :**

ENDOCRINOLOGICAL OUTCOMES OF CRANIOPHARYNGIOMA SURGERY-**Paper presentation**

- **INTERIM Skull basecon- KOCHI (April 2023) :**

NEUROLOGICAL OUTCOMES IN PATIENTS UNDERGOING ENDOSCOPIC SURGERY FOR CRANIOPHARYNGIOMA - **Poster presentation**

- **EANS-BARCELONA 2023 (SEPTEMBER 24-28 ) UPCOMING**

NEUROLOGICAL, VISUAL, COGNITIVE OUTCOMES IN PATIENTS UNDERGOING ENDOSCOPIC SURGERY FOR CRANIOPHARYNGIOMA- **poster presentation**

## APPENDIX C – TABLES & SCORES USED IN STUDY

### CCSS SCORE BY ELLIOTT ET AL.

**TABLE 1: Proposed CCSS**

Domain & Score	Criteria
<b>N-CCSS</b>	
1	no deficits or seizures
2	mild deficits (cranial nerve palsy, well-controlled seizures)
3	moderate deficits (mild hemiparesis w/ independent ambulation, moderately controlled seizures)
4	severe deficits (moderate-to-severe hemiparesis, major stroke, significant abulia, or lethargy)
<b>V-CCSS</b>	
1	normal VA & VFs
2	mild acuity deficits or field cut
3	unilat blindness, homonymous hemianopia, or bitemporal hemianopia
4	bilat blindness or nearly functional blindness
<b>P-CCSS</b>	
1	normal anterior & posterior pituitary function
2	mild anterior pituitary dysfunction (1 or 2 hormone supplements)
3	DI w/ or w/o mild anterior pituitary dysfunction (1 or 2 hormone supplements)
4	DI & panhypopituitarism
<b>H-CCSS*</b>	
1	normal hypothalamic function
2	postop obesity (BMI >+2 SD), lack of behavioral/psychological symptoms
3	obesity (BMI >+2 SD) w/ hyperphagia, or memory disturbance or BMI >+3 SD w/o frank hyperphagia behaviors
4	extreme obesity (BMI >+4 SD) & hyperphagia, behavioral disturbances (such as rage episodes), & disturbances of thermoregulation, sleep-wake cycles, or memory
<b>E-CCSS</b>	
1	excellent academic performance &/or occupational success
2	good academic performance at grade level &/or maintaining employment†
3	behind in grade academically, requires significant tutoring, or inability to maintain consistent employment‡
4	completely dependent on others for self-care (cannot perform ADLs), IQ <80, severe cognitive deficits

\* Modified version of scale proposed by De Vile et al.<sup>12</sup>

† Meeting or exceeding developmental milestones for preschool-aged children.

‡ Not meeting age-appropriate developmental milestones for preschool-aged children.

*FUNCTIONAL CLASSIFICATION SCALE BY WEN ET AL.*

**TABLE 2: Functional classification scale\***

Class	Criteria
I	grossly normal & independent mild hormonal disturbances seizures well controlled w/ medication
II	independent panhypopituitarism mild-to-moderate visual compromise cranial nerve deficits mild psychological dysfunction
III	partially dependent serious visual compromise serious neurological deficits (hemiparesis, refractory seizures) learning disabilities or poorly controlled psychological disorders
IV	entirely dependent on others for self-care

\* Based on data in the article by Wen et al.

*FUNCTIONAL OUTCOME SCALE BY DUFF ET AL.*

Outcome	Criteria
good	alive at follow-up examination no major motor deficit related to op or tumor progression functional vision Katz Grade A (able to perform basic ADLs) Karnofsky Performance Scale score $\geq 80$ no more than 1 yr behind in expected school grade employability for adults of working age absence of debilitating psychological or emotional problems
poor	all patients not meeting the "good" criteria

\* Based on data in the article by Duff et al.

*QST , PRIETO AND SADASHIVAM ET AL. CLASSIFICATION OF TUMORS*

	Our Classification	Origin	Features
<b>QST classification<sup>22</sup></b>			
Q type	Intrasellar CPs (type 1)	Below diaphragma sellae	The suprasellar arachnoid membrane limits the superior pole
S type	Prechiasmatic CPs (type 2) & RCPs (type 3)	Along the PS (above the diaphragma sellae)	Arachnoid & 3VF are located above, & dura is below the tumor
T type	Intraventricular CPs (type 4)	At the 3VF	Occupies the 3VC
<b>Prieto classification<sup>23</sup></b>			
Sella-suprasellar	Prechiasmatic & retrochiasmatic tumors (types 2 & 3a)	Along the PS (above the diaphragma sellae)	Suprasellar tumors w/ sellar extension; they do not displace or invade the 3VF
Suprasellar pseudointraventricular	Retrochiasmatic tumors (type 3a)	Along the PS	No sellar extension; 3VF is displaced superiorly
Secondary intraventricular	Retrochiasmatic tumors (type 3b)	Along the PS	Extra- & intraventricular components are present
Infundibulotuberal & strictly intraventricular variants	Third ventricular tumors (type 4)	At the 3VF	They occupy the 3VC; 3VF may or may not be invaded by tumor

PS = pituitary stalk; 3VC = third ventricular cavity.

## APPENDIX D - PLAGIARISM CHECK REPORT



### PLAGIARISM SCAN REPORT

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