"COMPHREHENSIVE STUDY OF ENDOSCOPIC MANAGEMENT OF PRIMARY OR SECONDARY INVOLVEMENT OF PTERYGOPALATINE FOSSA IN HEAD AND NECK PATHOLOGIES"

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ABBREVATIONS

PPF	-	Pterygopalatine fossa
ITF	-	Infratemporal fossa
EEA	-	Endoscopic endonasal approach
IMA	-	Internal maxillary artery
PPG	-	Pterygopalatine ganglion
ICA	-	Internal carotid artery
IP	-	Inverted papilloma
IPT	-	Inflammatory pseudotumour
JNA	-	Juvenile nasopharyngeal angiofibroma
SNUT	-	Sinonasal undifferentiated tumors
SPA	-	Sphenopalatine artery
DNE	-	Diagnostic nasal endoscopy
CT	-	Computerized tomography
MRI	-	Magnetic resonance imaging
HPE	-	Histopathological examination

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AIMS AND OBJECTIVES

1. To see the extent of tumor and to correlate it with CT/MRI finding.
2. To get pathological information (Benign or Malignant lesions) by biopsy.
3. To remove any pathologies.

BACKGROUND

Pterygopalatine fossa (PPF) is an inverted pyramidal shaped space present behind the maxillary sinus.

A variety of infectious, vascular, benign, and malignant pathologies are encountered in the PPF. Although primary tumors rarely originate from the PPF, this region can be secondarily involved by locally aggressive lesions of the nose and skull base.

There is a vast differential for primary benign and infectious processes of the PPF.

- Common benign lesions of the PPF include inverted papillomas, juvenile nasal angiofibromas, lipomas, schwannomas, and neuromas.
- Malignant tumors with primary or secondary involvement of the PPF include tumors of epithelial origin such as squamous cell carcinoma, adenocarcinoma, and sinonasal undifferentiated carcinoma; tumors of mesenchymal origin such as rhabdomyosarcomas, neurofibrosarcomas, osteosarcomas, and chondrosarcomas; and lymphomas.

Direct involvement of the PPF by malignant tumors may be secondary to direct extension, perineural invasion, lymphatic metastasis, or vascular seeding.

Accessing the PPF is difficult, which is traditionally approached via an open method, such as lateral rhinotomy, midfacial degloving, facial translocation, transantral maxillectomy, and the Fisch C and D procedures. Although these procedures provide good exposure of the PPF, they are often complicated by unacceptable facial scaring and deformity as well as dysfunction of the facial and infraorbital nerve.

With the advent of endoscopic endonasal surgeries, accessing pterygopalatine fossa is easier with decreased morbidity and mortality compared with open approaches.

PTERYGOPALATINE FOSSA ANATOMY AND SURGICAL APPROACHES

INTRODUCTION

Pterygopalatine fossa is a small inverted pyramidal shaped cul-de-sac present behind the maxillary sinus. It projects medially through the pterygo-maxillary fissure from the infratemporal fossa. It forms a space between the posterior wall of the maxillary antrum in front and the pterygoid extension of the great wing of the sphenoid behind.

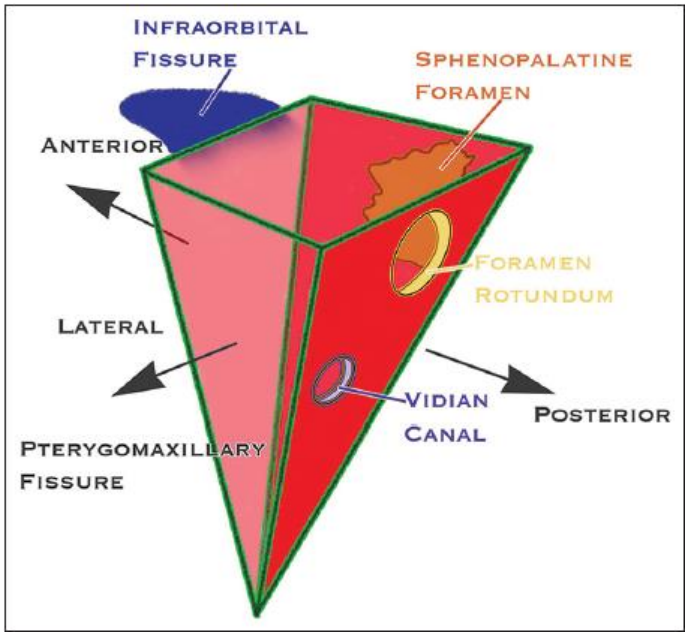

Fig 1: Schematic diagram of left sided view of pterygopalatine fossa (From lateral to medial)

It's bounded by:

- Anterio-laterally – Posterior wall of maxillary sinus.
- Laterally – Pterygomaxillary fissure.
- Posteriorly – Pterygoid plates of sphenoid bone.

- Medially – Perpendicular plate of palatine bone.
- Superiorly – Greater wing of sphenoid bone.
- Inferiorly – pyramidal process of palatine bone.

Measurements, it's widest superiorly and narrowest inferiorly.

- 27 mm in height
- 23 mm in width
- 7.3 mm in depth

Medially the pterygopalatine fossa extends to the lateral wall of the nose, here formed by the vertical plate of the palatine bone, as it bridges the gap between maxilla and medial pterygoid lamina. Superiorly the vertical plate of the palatine bifurcates into a short sphenoidal process posteriorly and a larger orbital process anteriorly that, fusing with the maxilla, forms a strong bony buttress.

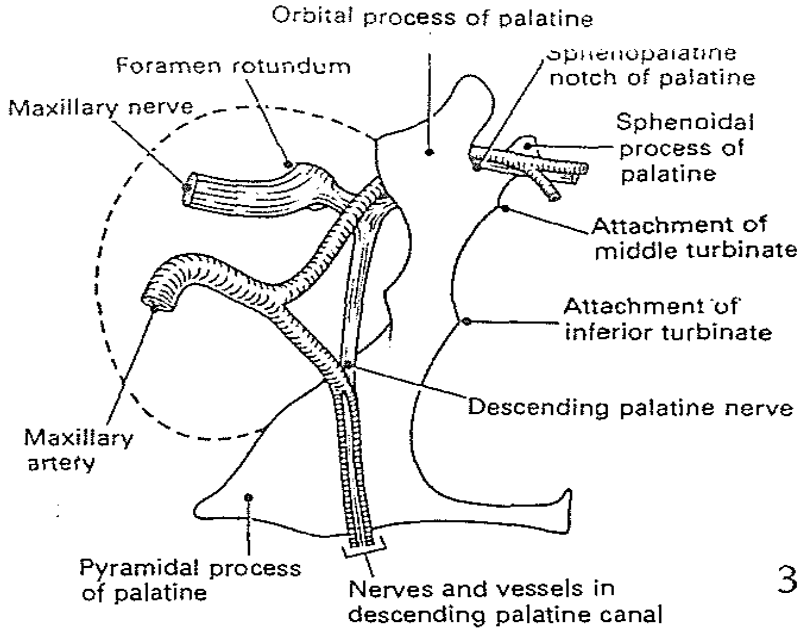

Fig 2: Medial wall of Pterygopalatine fossa (schematic diagram)

The deeply rounded notch between these processes, being roofed by the body of sphenoid bone, forms the sphenopalatine foramen that transmits arteries and nerves from the fossa into the nose just behind the posterior end of the middle turbinate.

This fossa serves as a distribution channel for the nerves and vessels to the face, nose and palate. Thus it contains the third part of the maxillary artery and its terminal branches; the maxillary nerve; the sphenopalatine ganglion and its branches.

Two foramina in this sphenoidal wall, i.e. the foramen rotundum and the pterygoid canal, provide fundamental landmarks. In a narrow

antrum it is better to accept restricted confines than risk difficulty from encroachment of Bichat's pad of fat.

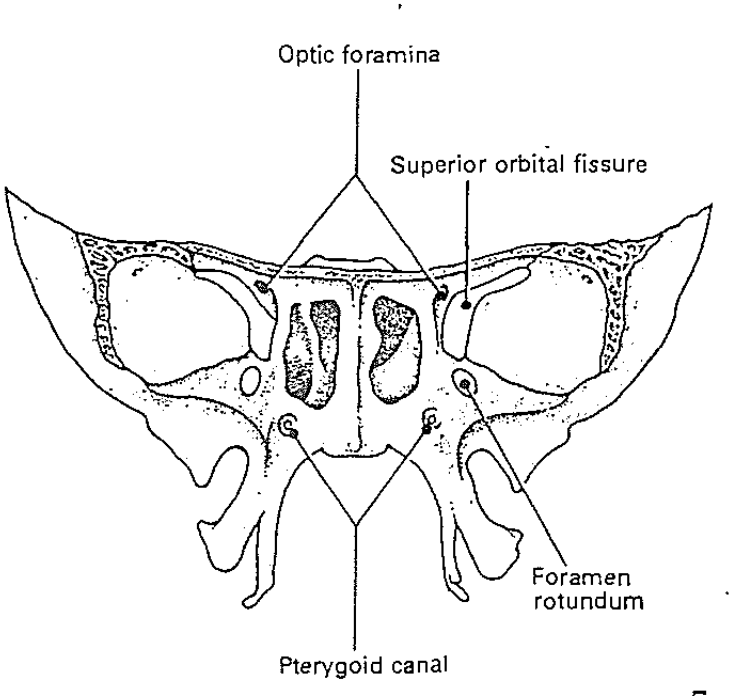

Fig 3: Schematic diagram of posterior wall of pterygopalatine fossa

The foramen rotundum which transmits the maxillary nerve lies just below the upper limit of the fossa and the superior orbital fissure. Hence surgical procedures must not extend above the foramen rotundum thus can prevent injuries to structures in the orbital apex.

The pterygoid canal which transmits the vidian nerve is 1cm long and is ordinarily narrow. Anteriorly this canal widens to a funnel-like mouth similar in size to the foramen rotundum. The mouth of the pterygoid canal lies 8-9 mm below and medial to the foramen rotundum. It is also recessed on a posterior plane, and between these two foramina

there is often a distinct vertical bony ridge. The medial face of this ridge passes backwards to form the lateral aspect of the mouth of the pterygoid canal.

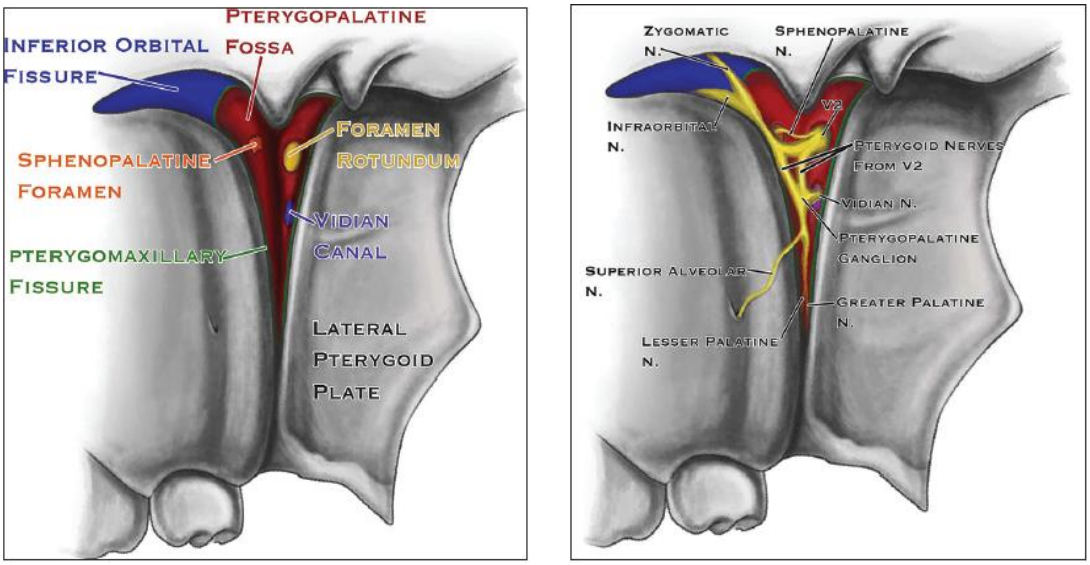

Fig 4: Left pterygopalatine fossa (lateral view – Through pterygomaxillary fissure)

The pterygopalatine canal:

Vertically below the mouth of the pterygoid canal but slightly anterior is the pterygopalatine canal between palatine bone and maxilla. This carries the descending palatine nerves and artery to emerge on the palate via the greater palatine foramen.

Foramen rotundum and infraorbital canal:

A transverse section of the pterygopalatine fossa at the level of the foramen rotundum shows that the line of the infraorbital canal lies well lateral to the foramen rotundum. Hence the maxillary nerve on entering

the pterygopalatine fossa runs laterally and slightly upwards before turning forward through the inferior orbital fissure to continue as the infraorbital nerve within its canal.

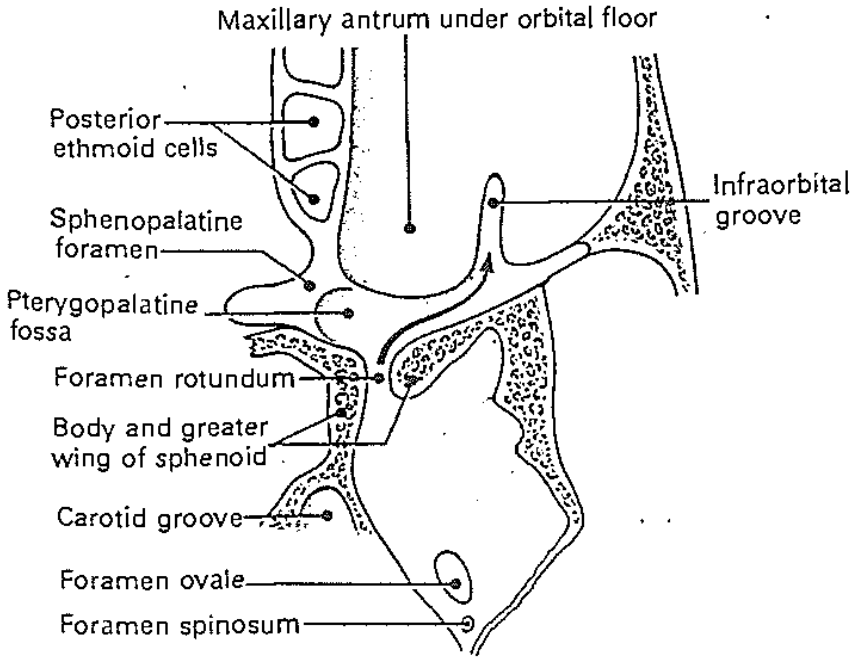

Fig 5: Schematic transverse section through foramen rotundum (arrow shows course of maxillary nerve)

The pterygoid canal and sphenopalatine foramen

The pterygoid canal lies almost in the anteroposterior plane of the medial wall of the antrum. Its transantral exposure is thus dependent upon a medial extension of the posterior antral window by appropriate lowering of its medial buttress.

Transverse section of the pterygopalatine fossa at the level of the pterygoid canal shows that the sphenopalatine foramen (arrow) lies medial and slightly anterior to the mouth of the pterygoid canal. Owing to

the angulation between orbital and sphenoidal processes of the palatine bone, the sphenopalatine foramen is set obliquely to the pterygoid canal. This relationship allows a probe passed through the nose and through the sphenopalatine foramen to enter the pterygoid canal.

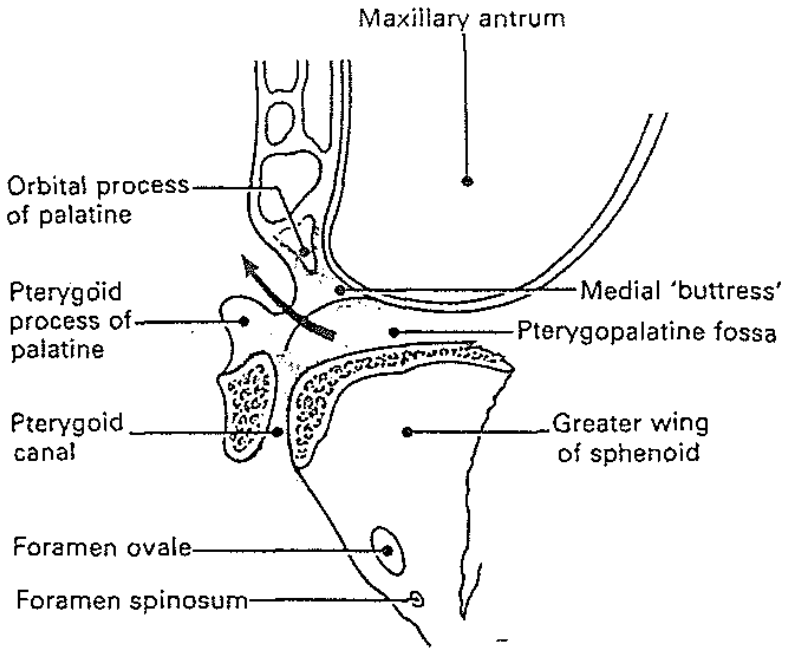

Fig 6: Schematic transverse section through pterygoid canal

Contents:

- Fat
- Internal maxillary artery and its branches
- Pterygopalatine ganglion and its branches
- Vidian nerve
- Maxillary nerve and its branches
- Pterygoid plexus of veins

The vascular and neural structures are located anteroinferiorly and posterosuperiorly, respectively, within the PPF.

SPHENOPALATINE FORAMEN:

Boundaries:

Superiorly - Body of the sphenoid

Anteriorly - By orbital process of palatine bone.

Posteriorly - Sphenoidal process of palatine bone.

Inferiorly - Perpendicular plate of palatine bone.

Oval in shape. Located at the posterior end of the superior meatus or the middle meatus or is bridged by the basilar lamina of the middle turbinate. Sphenopalatine vessels emerges out from pterygopalatine fossa, through the foramen into the nasal cavity.

Internal maxillary artery:

One of the two terminal branches of external carotid artery formed within the parotid gland. When it enters the infratemporal fossa it is divided into three parts by lateral pterygoid muscle. It supplies maxilla and mandibular bones, deep facial areas, cerebral dura matter and the nasal cavity.

First part winds around the neck of mandible and lies between neck of mandible and sphenomandibular ligament and runs along lower border of lateral pterygoid muscle. Second part travels between the two heads of lateral pterygoid muscle and lies superficial to lower head of lateral pterygoid muscle. Third part turns medially enters into the PPF and terminates as sphenopalatine artery.

Branches of first part of maxillary artery are

- Middle meningeal artery
- Accessory middle meningeal artery
- Deep auricular artery
- Anterior tympanic artery
- Inferior alveolar artery

Branches of second part of maxillary artery (muscular branches) are

- Deep temporal arteries
- Masseteric artery

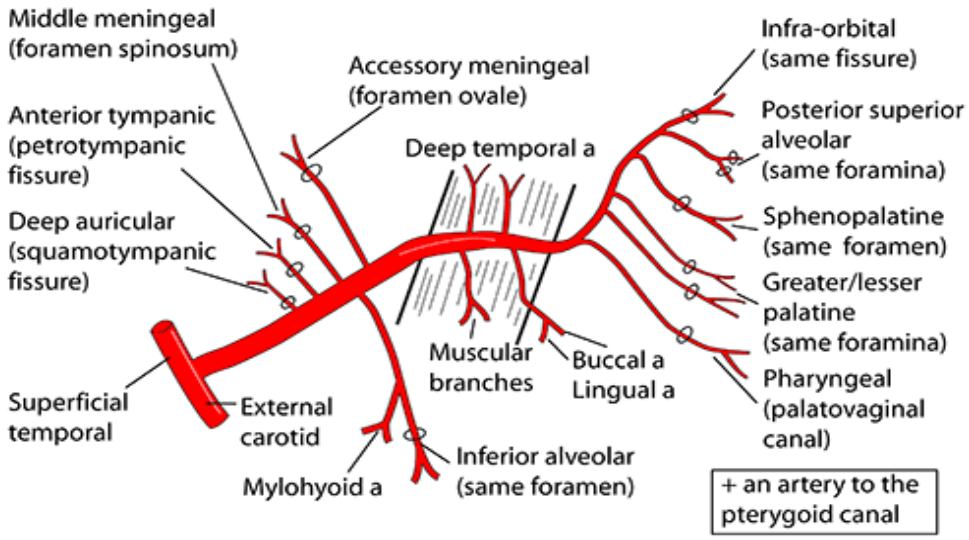

Fig 7: Schematic diagram of internal maxillary artery

- Buccal or buccinator artery
- Pterygoid branches

Branches of third part of maxillary artery are

- Posterior superior alveolar artery
- Inferior orbital artery
- Artery to pterygoid canal
- Pharyngeal branches
- Descending palatine artery
- Sphenopalatine artery

Each of these goes through foramen or canal of same name.

Pterygoid plexus of veins:

It communicates anteriorly with facial vein and superiorly with cavernous sinus. Infection from dental areas drained by pterygoid plexus can go through emissary veins to cavernous sinus.

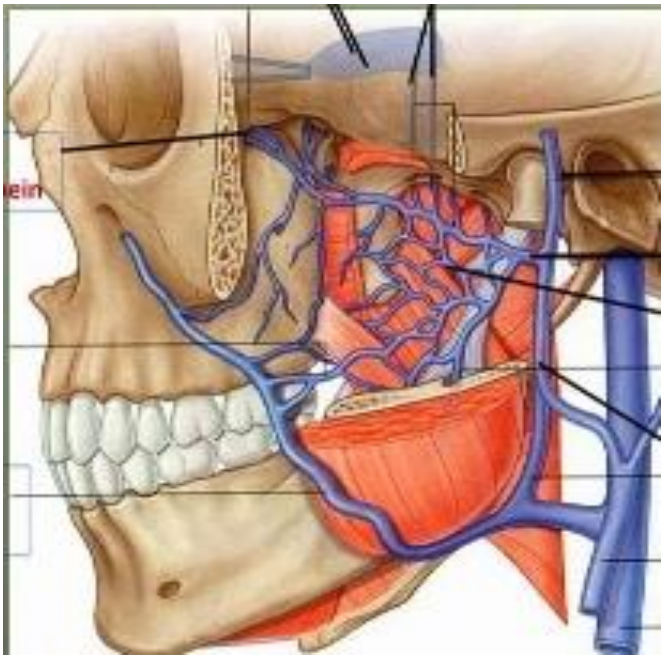

Fig 8: Diagram showing left pterygoid plexus of veins

Maxillary nerve:

It is 2nd branch of trigeminal nerve and is a sensory nerve. Arises from the semilunar ganglion of the trigeminal nerve in Meckel's cave, it lies lateral to cavernous sinus and through the foramen rotundum enters the PPF. Gives branches and roots to pterygopalatine ganglion in PPF. Runs forwards into the floor of orbit as infra orbital nerve, which passes

through the infra orbital grove, infraorbital canal and comes into facial surface of maxilla through infraorbital foramen.

Branches:

- Meningeal branches inside cranial cavity
- 2 ganglionic branches to pterygopalatine ganglion in PPF
- Just before entering the infraorbital groove
    - Posterior superior alveolar branch
    - Zygomatic nerve (From the infraorbital nerve)

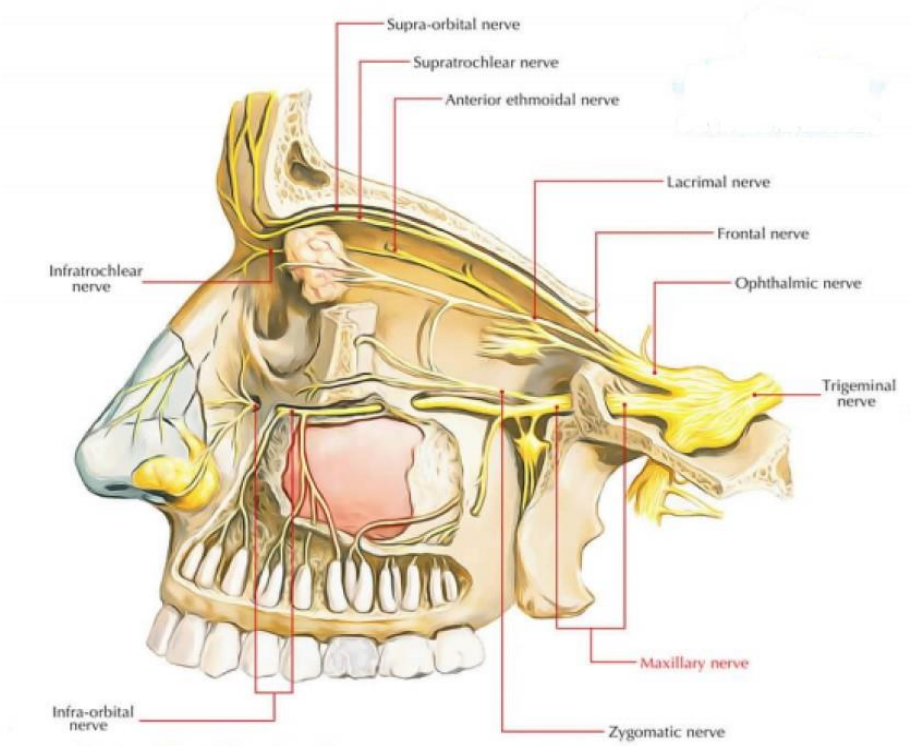

Fig 9: Schematic representation of trigeminal nerve highlighting maxillary nerve

Vidian nerve:

This is also known as nerve of pterygoid canal. It is formed by post synaptic parasympathetic fibres and presynaptic sympathetic fibres. Nerves involved in the formation of vidian nerve are:

- Greater superficial petrosal nerve (Preganglionic parasympathetic)
- Deep petrosal nerve (Postganglionic sympathetic fibres)

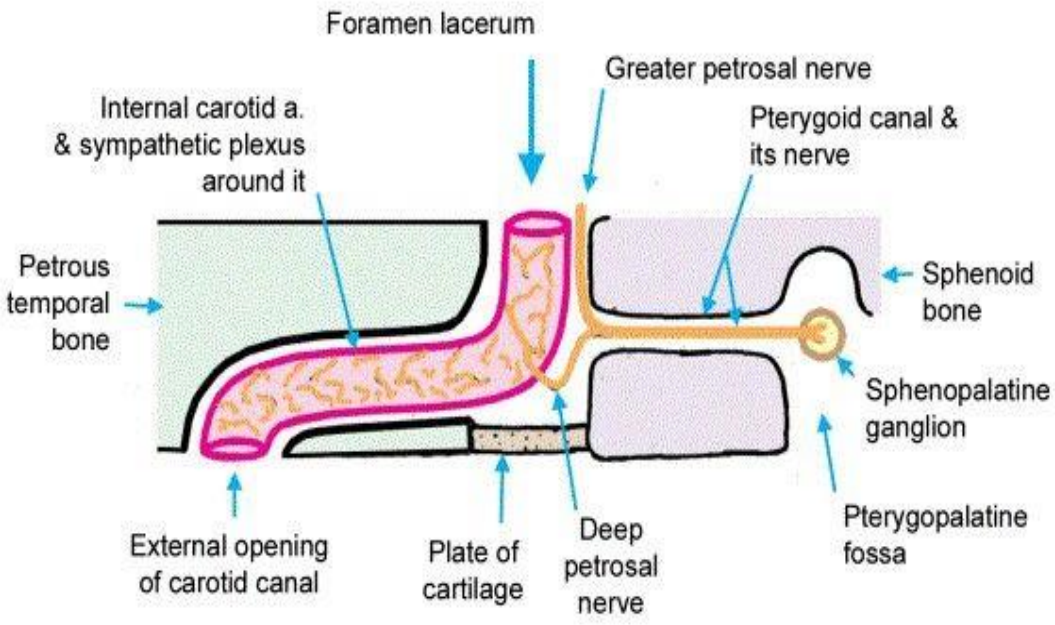

Fig 10: Schematic representation of Vidian nerve

Vidian nerve formed by from these two nerves near foramen lacerum, this area is located in the cartilaginous substance which fills the foramen lacerum.

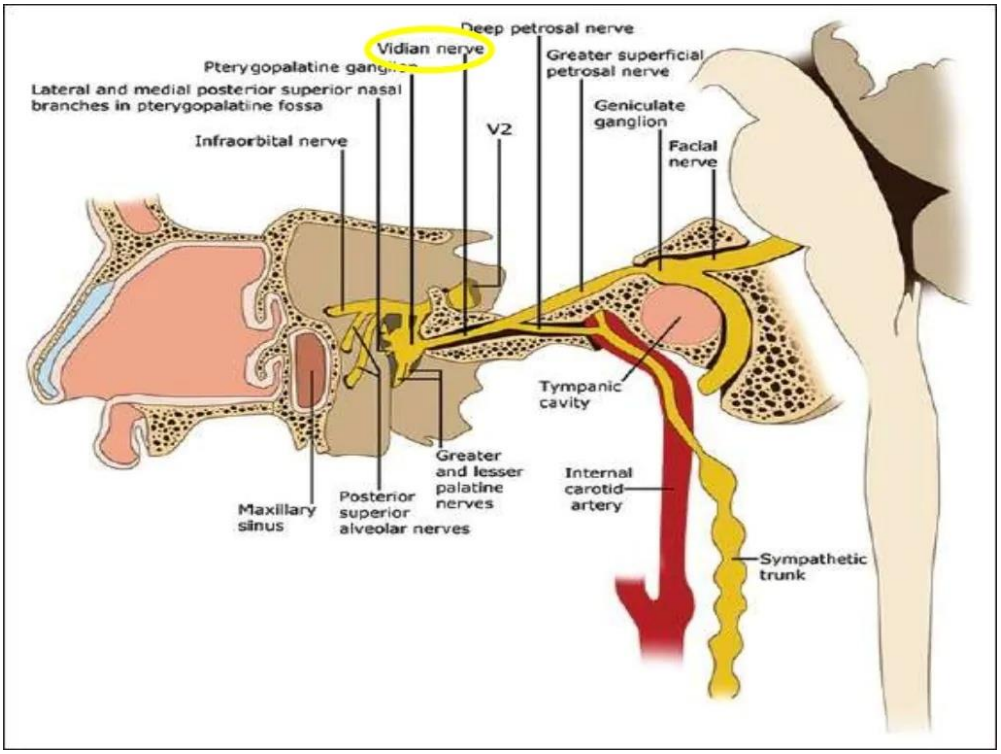

Fig 11: Schematic depiction of Vidian nerve and PPG

Then it runs forwards in the vidian canal, a short bony tunnel formed close to the floor of sphenoid sinus, along with the artery of pterygoid canal. In the PPF it ends at pterygopalatine ganglion.

Pterygopalatine ganglion:

It lies in PPF, and is also known as Hay fever ganglion. It is formed from 3 roots which are

- Sensory root – maxillary nerve gives sensory limbs
- Parasympathetic root – arises from superior salivary nucleus
- Sympathetic root – arises from superior cervical ganglion

Of them parasympathetic and sympathetic roots were contributed by vidian nerve, which in turn is formed by junction of greater superficial petrosal nerve (parasympathetic) and deep petrosal nerve (sympathetic).

It supplies nose, palate, nasopharynx, secretory fibres to and lacrimal gland.

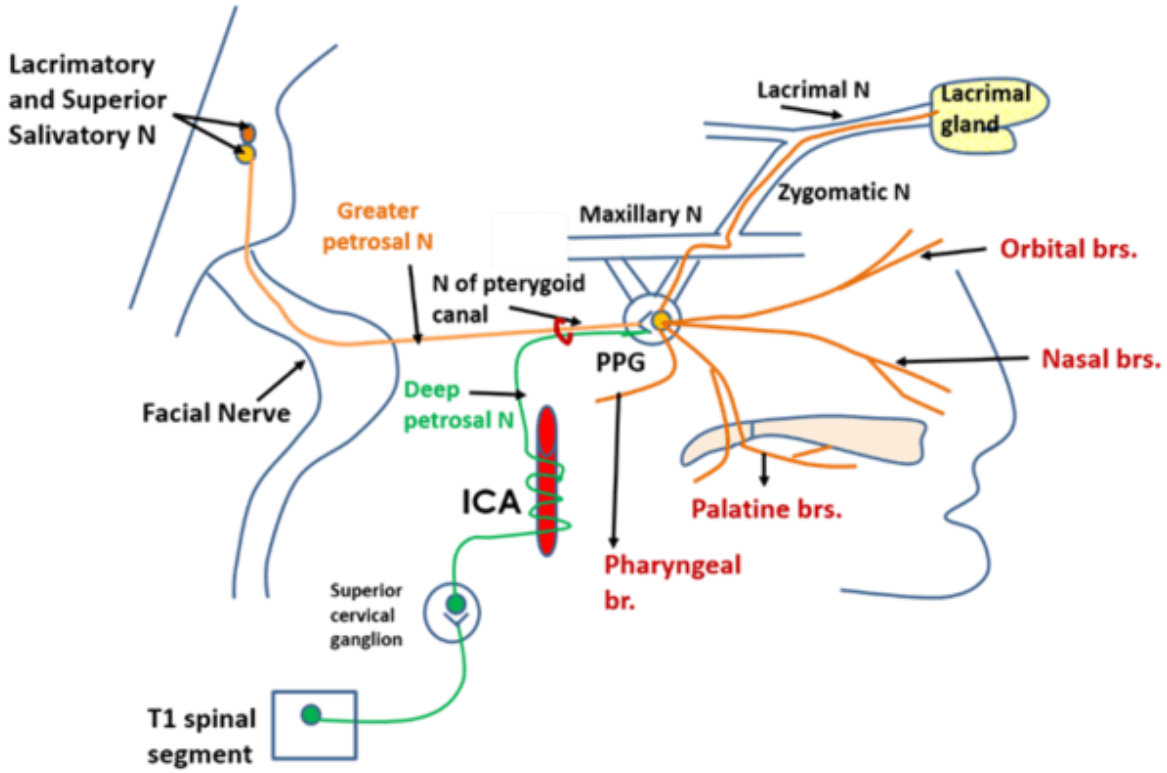

Fig 12: Schematic representation of PPG

Branches of Pterygopalatine ganglion are:

Ascending	**Descending**	**Posterior**	**Medial**
Orbital branches	Greater palatine branch	Pharyngeal branches	Posterio-superior lateral nasal
	Lesser palatine branch		Nasopalatine

- Greater palatine nerve – Descends through greater palatine canal, comes out though greater palatine foramina and supplies mucous membrane of hard palate.
- Lesser palatine nerve - Descends through greater palatine canal, comes out though lesser palatine foramina and supplies mucous membrane of soft palate, uvula and tonsils.
- Orbital branches – Runs through the inferior orbital foramen, and supplies orbital periosteum.

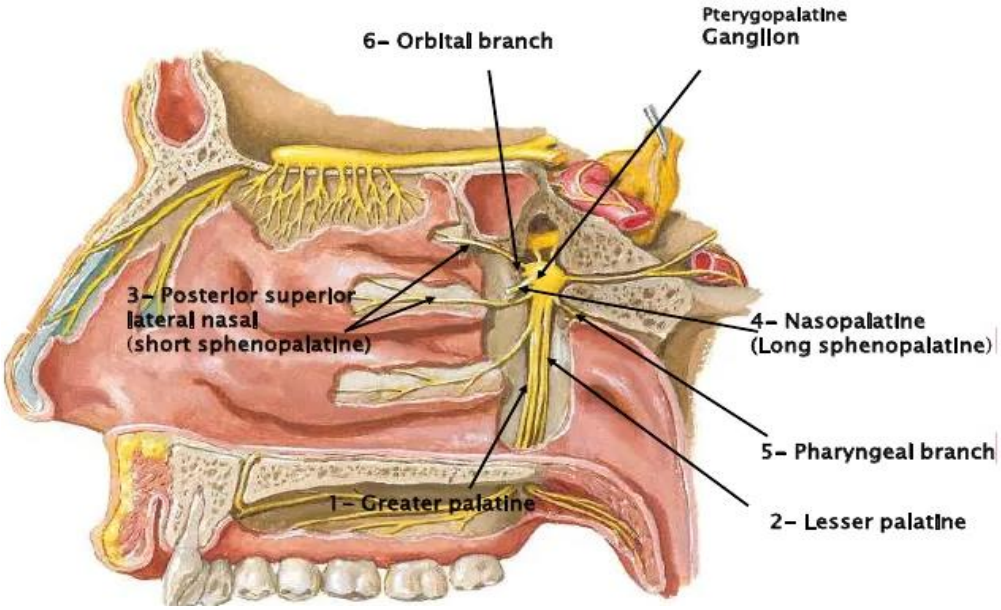

Fig 13: Diagramatic representation of PPG with its branches

- Nasopalatine nerve (Long sphenopalatine nerve) – Runs through sphenopalatine foramen, reach nasal septum and through the incisive canal to come out through median incisive foramen. It supplies nasal septum and gums of upper incisors.
- Posterior superior lateral nasal branch (Short sphenopalatine) – Runs through the sphenopalatine foramen reach nasal septum, and supplies upper posterior part of lateral wall of nose.
- Pharyngeal branches – Runs through Palatovaginal canal and supplies nasopharynx

Brain freeze or ice cream headache are terms used to describe a form of cranial pain or headache which often occurs as a result rapid consumption of cold food / beverages. Cold food comes in contact with

roof of mouth, stimulates the sphenopalatine ganglion that gives the brain impression of very cold environment. As a reflex vasodilation occurs leads to headache (typically lasts around 30 seconds). To avoid this eat cold foods slowly.

Communications:

- Laterally – through Pterygomaxillary fissure to infratemporal fossa, transmitting maxillary vessels
- Vidian canal opens into posterior part of pterygopalatine fossa and contains Vidian nerve & artery
- Palatovaginal canal located medial to vidian canal & transmits pharyngeal branches of maxillary artery
- Foramen rotundum opens posteriorly and contains maxillary nerve
- Sphenopalatine foramen opens medially into the nasal cavity and transmits sphenopalatine vessels & nerve
- Infero-medially, descending palatine canal opens into oral cavity via greater and lesser palatine foramina, transmitting greater and lesser palatine nerves and vessels
- Antero-laterally, inferior orbital fissure communicates with the orbit anteriorly and laterally, transmitting the infraorbital nerve, the zygomatic nerve, infraorbital vessels, veins to pterygoid plexus, and the ophthalmic vein.

Approaching pterygopalatine fossa:

Endoscopic approaches to PPF and Infratemporal fossa (ITF) demonstrates the lateral extent of endonasal approach. The deep and lateral location of these anatomically complex spaces makes it challenging to approach and to address pathology without comprising function. But with recent advancement in nasal endoscopy and imaging and instrumentation have made these inaccessible area accessible using endoscopic approaches.

Traditionally open surgical procedures have involved anteriorly based transmaxillary approach to PPF and laterally based preauricular, FISCH approaches to ITF. Risks of anteriorly based approaches are facial oedema, pain, hypaesthesia, oroantral fistulas, sinusitis, vascular or dental injuries. Further open approaches to these areas are limited by parotid gland, facial nerve, mandible and masticator muscles. Thus endoscopic endonasal approach (EEA) to these areas can provide direct access with better visualization, magnification and early identification of neurovascular structures, and preventing various complications of external approaches with less functional morbidity and good cosmetic result.

Advances in endoscopic techniques and instrumentation have broadened the indications for EEA to PPF with very less morbidity and mortality. These includes the control of epistaxis (by ligation of branches

of internal maxillary artery), vidian neurectomy (for vasomotor rhinitis) and resection / biopsy of benign and malignant lesions involving PPF.

Posterior epistaxis:

In olden days, open approaches to PPF for ligating vessels for controlling posterior epistaxis is challenging and difficult with potential morbidity. Emergence of interventional radiology, angiography and micro-embolization of branches of internal maxillary artery have decreased the need for surgical intervention. After the advancement in EEA to PPF, endonasal ligation of sphenopalatine artery and other branches of internal maxillary artery is reintroduced as safe, efficient and successful surgical intervention, superior to interventional radiological techniques with very less functional morbidity and mortality.

Vidian neurectomy:

The vidian nerve gives sympathetic and parasympathetic nerve fibres to nasal cavity. Transection of the nerve helps in reducing symptoms of rhinorrhoea, sneezing and postnasal discharge. This procedure have recurrence of symptoms in postneurectomy patients as well as concerns over potential dry eye morbidity and have minimal complications included exacerbation of sneezing postoperatively (33%), dry eye symptoms (35%) and nasal crusting (28%). Recent studies have

reported successful result with significant improving rhinorrhoea and nasal obstruction at a mean follow-up of longer than 2 years.

Benign and malignant tumours:

There are many differentials for primary benign, infectious and malignant lesions of PPF. Common benign lesions include inverted papilloma (IP), juvenile nasopharyngeal angiofibromas (JNA), lipoma, schwannoma and neuroma.

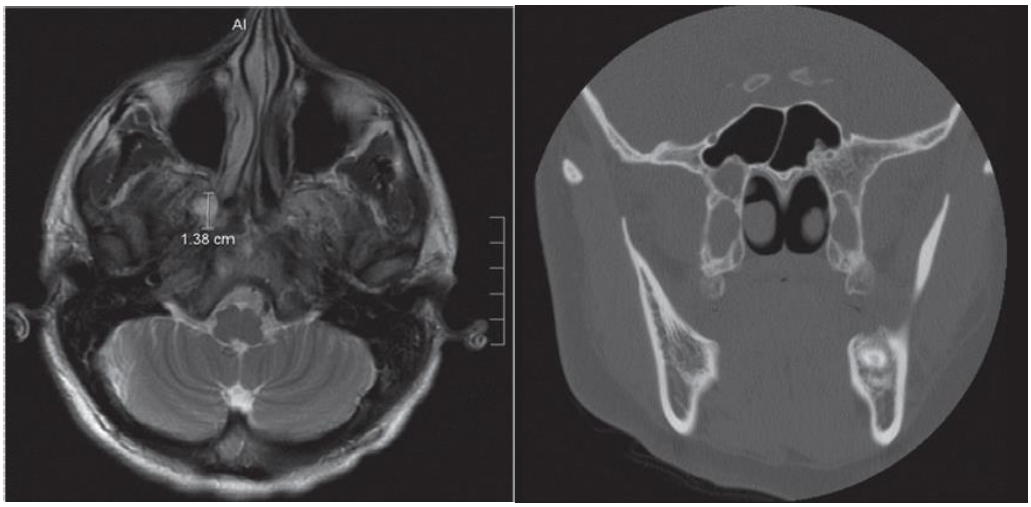

Fig 14: MRI and CT image of primary lipoma in Right PPF.

Successful endoscopic removal of these lesions have been reported in literature. For IPs, recurrence rate with EEA is less (12%) in comparison with open approaches (18%). Similarly successful endoscopic removal for JNAs have been reported, one study of 14 JNA patients, 8 of whom underwent an endoscopic medial maxillectomy for

Radkowski stage IIC or IIIA, were disease free with an average follow-up of 4.1 years.

Malignant tumours of primary and secondary origin in PPF includes tumours of epithelial origin such as squamous cell carcinoma, adenocarcinoma and sinonasal undifferentiated tumours (SNUT); tumours of salivary gland origin such as mucoepidermoid, adenoid cystic carcinoma of parotid gland; tumours of neural origin such as glioma, chordoma; lesions of mesenchymal origin such as rhamdomyosarcoma, nerurofibroma, osteosarcoma and chondrosarcoma; others like melanomas, lymphomas and esthesioneuroblastoma.

Endoscopic resection of malignant tumours involving PPF is controversial, but reports are increasing in literatures. Difficulty is in achieving required negative margins and en-bloc removal of tumours. In spite of aggressive approaches to achieve negative margins by standard craniofacial approaches, recurrence rate is nearly 50%, indicating the goal is not achieved regardless of the approach. Hence, a less morbid and less invasive procedures may be preferable. Finally palliative debulking may be tolerable using an EEA.

Previously described contraindications for EEA for resection of nasal and sinonasal malignancies include bony erosion of skull base, lamina papyraceae, nasal floor, involvement of brain parenchyma or orbit and involvement of PPF or ITF. However these are relative indications

based on the technical expertise of the surgeon. Preoperative imaging CT (bony erosion) and MRI (for orbital or intracranial invasion) are critical for surgical candidacy of the patient with a sinonasal malignancy.

External approaches for PPF:

Traditional approaches are anterior and lateral based. The most common anterior based approach to PPF is transantral maxillectomy. This allows entry into PPF through anterior and posterior walls of maxillary sinus. This technique involves making an incision in the gingivobuccal sulcus, a wide anterior maxillary wall antrostomy inferior to infraorbital nerve, transgression through maxillary sinus to the posterior wall, and removal of bony wall medially and laterally to expose the pterygomaxillary and anterior ITF respectively. Dissection within the PPF and ITF is continued with microscopic guidance.

Other approaches include midfacial degloving, lateral rhinotomy, and extended maxillectomy approaches. The risks of anterior based approaches are pain and facial oedema, hypaesthesia, lacrimal dysfunction, infraorbital nerve injuries, dental injuries (Alveolar necrosis, tooth loss, dental granuloma, and oroantral fistula), and chronic maxillary sinusitis.

Lateral approaches are temporal approach to PPF; preauricular and facial translocation approaches to ITF. Postauricular approaches were described by Fish – divided these into type A, B, and C dissections.

Type A involves a radical mastoidectomy, anterior transposition of facial nerve, and cervical dissection allowing exposure to the posterior ITF, jugular bulb, and vertical petrous carotid artery.

Type B dissection involves exploration of petrous apex, clivus and superior ITF.

Type C approach permits exposure of the nasopharynx, rostral clivus, parasellar area, PPF and anterosuperior ITF.

The preauricular approaches described by Sekhar expose the same anatomic regions which were accessed by type B and C Postauricular Fisch approaches from a pure lateral vector rather than an anteromedial vector.

All the ITF approaches have been well described in the literature and are useful for extracranial lesions with or without intracranial extension. However extensive dissection of soft tissue and bine removal results in complications like masticatory difficulties, trigeminal nerve deficits, cosmetic deformities, facial dysfunction, dental malocclusion and potential intracranial complications as seizures with extended temporal lobe retractions.

Combined endoscopic trans-maxillary transantral approaches to the pterygoid region, lateral sphenoid sinus and orbital apex have been reported. This extolls the benefit of enhanced comfort for surgeon as well as for manoeuvring instruments. However these approaches still risk the complications inherent to the open approaches.

Endoscopic anatomy, approach and technique:

The EEA to PPF and ITF is influenced by the pathology being addressed. A tissue biopsy of a well-circumscribed schwannoma in the PPF requires a different set of surgical steps compared to the resection of a JNA that invades the PPF and ITF.

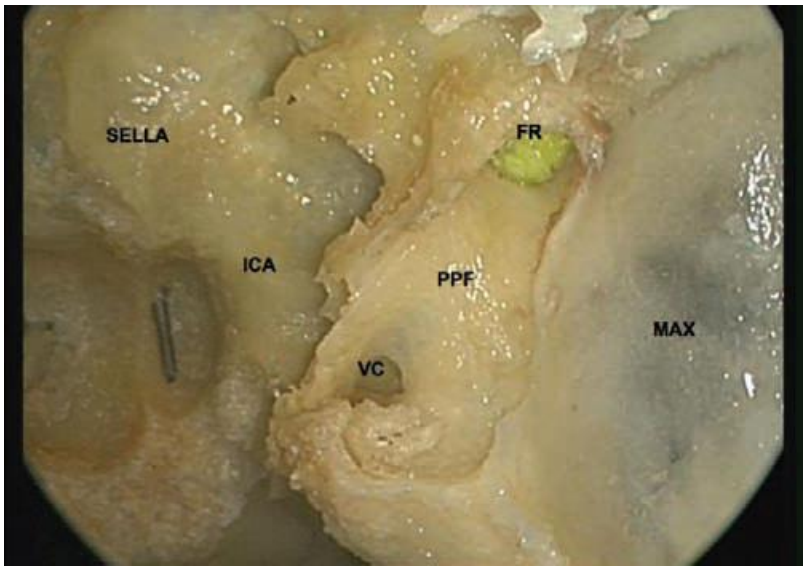

Fig 15: Endoscopic view of posterior wall of left PPF.
(FR - Foramen rotundum, VC - Vidian canal,
MAX - Maxillary sinus, ICA - Internal carotid artery)

Nasal preparation:

The nasal cavity is decongested with 4% lignocaine soaked pledgets in the middle meatus and floor of the nasal cavity. The pledgets are kept in place for 10 minutes or less to decrease absorption and avoid any risk of cardiac toxicity. The patient's head is placed in head ring, elevated above the heart, slightly extended and turned to right (15 degrees).

Using a rigid 0-degree endoscope, the sphenopalatine foramen is located and infiltrated with the 2% lignocaine with 1:100,000 epinephrine to vasoconstrict the terminal branches of sphenopalatine artery. This manoeuver significantly reduces intraoperative bleeding. The uncinate process, root, and anterior face of the middle turbinate and bilateral mucoperichondrial septal flaps are also infiltrated with local anaesthesia.

Septoplasty:

Although the transpterygoid approach is usually unilateral, the procedure is sometimes begun with a posterior septectomy to use the endoscope and surgical instruments through both nostrils. Removal of posterior septum allows for a wider surgical exposure and greater maneuverability for surgical instrumentation. However, a unilateral approach may be used for tissue biopsies of well-circumscribed PPF

lesions, small lateral sphenoid sinus encephaloceles, or pathologies with limited involvement of PPF.

Transpterygoid approach:

Although the transpterygoid approach primarily uses transmaxillary corridor, this procedure requires a total ethmoidectomy and sphenoidotomy to widely expose the lateral wall of nose. This approach starts with uncinectomy, widening of maxillary sinus ostium, a total ethmoidectomy and a sphenoidotomy. Transethmoidal approach is used to enter sphenoid sinus, and the natural ostium is widened. This step is important to provide exposure to resect a lateral sphenoid sinus encephalocele.

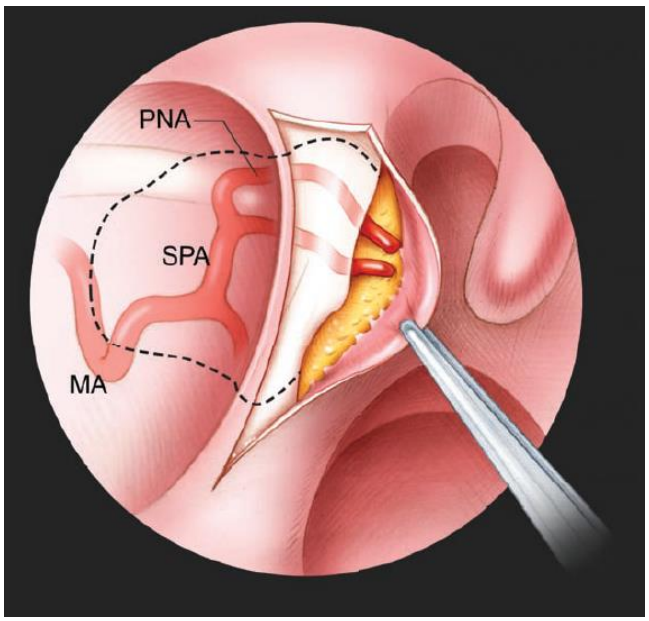

Fig 16: Exposing sphenopalatine foramen to approach PPF

Then maxillary sinus ostium is widened by removing the orbital process of palatine bone (Crista ethmoidalis) and the posteromedial wall of maxillary sinus. This can be done by elevating the mucosa over vertical palatine bone and removal of the bone using any of following instruments (Kerrison rongeurs, Grunwald forceps, drilling with a diamond burr). Then sphenopalatine foramen is identified between orbital process and sphenoid process of palatine bone.

Posterior lateral nasal artery, a branch of sphenopalatine artery, which runs superiorly and medially; posterior septal artery (another branch of sphenopalatine artery) runs inferiorly and laterally towards the anterior surface of sphenoid sinus. These branches are identified and are cauterized with bipolar forceps, ball tip cautery or controlled with clips and sectioned. The sphenoid process of palatine bone is then removed, exposes the medial pterygoid plate and floor of sphenoid sinus. The middle turbinate is usually preserved in most of the times for unilateral approaches to PPF.

Pterygopalatine fossa dissection:

The posterior wall of maxillary sinus is removed from medial to lateral direction thus exposing the anterior aspect of pterygopalatine fossa. Dissection limits are superiorly to the roof and inferiorly up to the floor of maxillary sinus. Then fat in PPF is exposed by incising the thin

fascia covering the PPF. The PPF can be divided into an anterior and posterior compartments. Fat and blood vessels are present in the anterior compartment and neural elements are present in the posterior compartment. Tus vascular anatomy of the PPF can be revealed by gentle dissection of fat in PPF. Smaller vessels can be cauterized using bipolar cautery to provide a bloodless dissection field.

Distal branches of internal maxillary artery is identified, then main internal maxillary artery is identified. The most often described anatomic pattern of these vessels are – the posterior superior alveolar artery and infraorbital artery lies proximally in the PPF and descending palatine, pharyngeal artery, artery of pterygoid canal and sphenopalatine artery lies distally. Anatomical variations can be there, especially in pathologic process they are distorted more often. For the dissection of pterygopalatine ganglion, it is done from medial to lateral direction and sphenopalatine and descending palatine branches are first encountered.

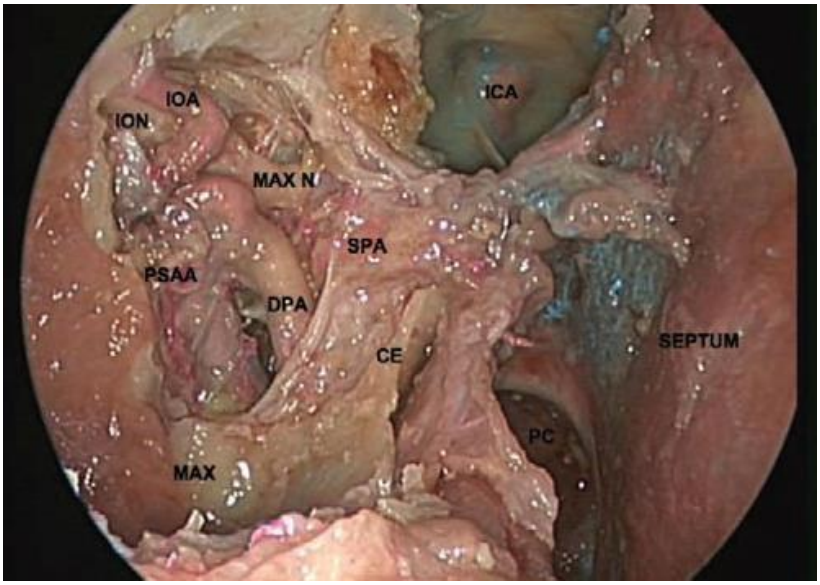

Fig 17: Vascular anatomy of PPF and ITF (MAX – maxilla, CE – Crista ethmoidalis, SPA – Sphenopalatine artery, DPA – Descending palatine artery, PSAA – posterior superior alveolar artery, IOA/ION – Infraorbital artery / nerve, ICA – Internal carotid artery)

The internal maxillary artery (IMA) is identified as it emerges from the lateral and inferior portion of the fossa along the anterior margin of the lateral pterygoid muscle. The posterior superior alveolar artery runs anterior inferior margin of the fossa to enter the maxilla bone. The infraorbital artery (branch of IMA, sometimes from posterior alveolar artery) runs superiorly and laterally, along with inferior orbital nerve it exits the inferior orbital fissure. Arteries which arises from the posterior aspect of IMA, descending palatine artery and Vidian artery, are not seen initially during dissection of PPF.

The descending palatine artery runs along with the greater palatine nerve lies in close relation with surface of palatine bone. Identification of IMA is often difficult because of its tortuosity and the surrounding adipose tissue. The sphenopalatine artery, terminal branch of IMA, is identified retrograde into the fossa helps in identifying other branches of IMA. But identification of branches are sometimes difficult when they are coursing through the tumour / pathology.

The neural structures lies deep to the vascular structures in the PPF. The maxillary nerve, lies at superior margin of the PPF, runs laterally and superiorly to the inferior orbital fissure. Foramen rotundum can be identified by tracing the maxillary nerve posteriorly. Minor branches from the maxillary nerve can be traced contributing to the pterygopalatine ganglion.

The infraorbital nerve, terminal branch of maxillary nerve, divides the PPF and ITF. Medial and inferior to the maxillary nerve Vidian nerve can be identified, which is formed by greater superficial petrosal nerve (parasympathetic fibres from the facial nerve) and deep petrosal nerve (sympathetic fibres of superior cervical ganglion). The Vidian nerve runs through the foramen lacerum from the middle cranial fossa and enters the PPF through the pterygoid canal and ends in the pterygopalatine ganglion.

The pterygopalatine ganglion, which is triangular in shape, lies anterior to the pterygoid canal, superior to greater palatine foramen and posterior to branches of the sphenopalatine vessels. The main branches of PPG are Vidian nerve (superomedially), the maxillary nerve (superolaterally), and the greater palatine and lesser palatine nerves inferiorly. Other neural branches of PPG include the sphenopalatine nerve and pharyngeal branches arising from the medial surface of PPG and the orbital branch arise from the superior surface of PPG.

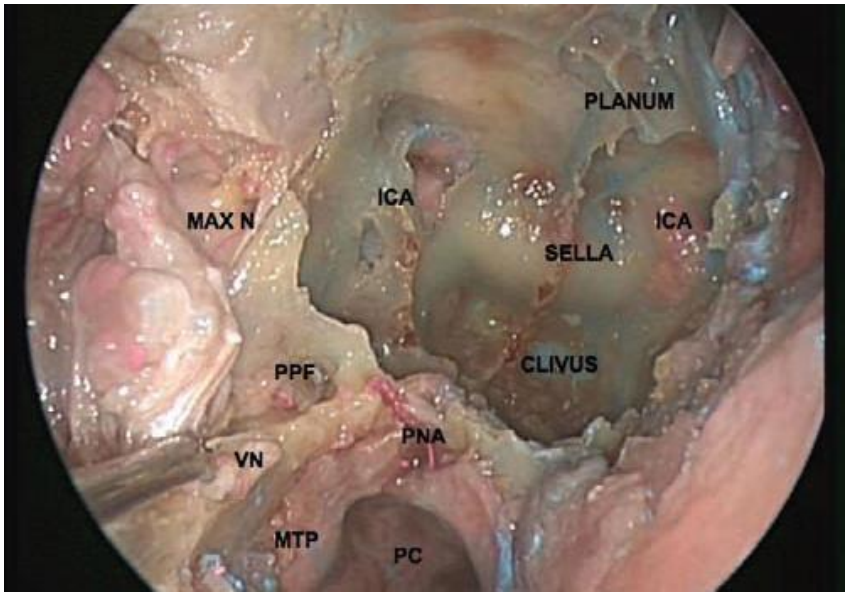

Fig 18: Anatomical relationship of Vidian nerve in PPF and ICA

(PC – Posterior choanae, MTP – Medial pterygoid plate, MAX N – Maxillary nerve, PNA – Posterior nasal artery)

The Vidian nerve, because of its relationship with anterior genu of ICA, deserves better discussion. In a radiologic study of 44 triplanar CT scans, the ICA was consistently in superior and medial aspect of Vidian canal. Because of this anatomic relationship, carotid artery is identified safely by initially drilling on the inferior medial and lateral surface of Vidian canal; this also prevents unwanted injury to the internal carotid artery (ICA). In most of the cases the Vidian canal runs in a medial to lateral direction when drilling in a superior to inferior direction. By the study the mean length of Vidian canal was 18 mm, is about 9.3 mm from the medial pterygoid plate, and is 5.5 mm on average from foramen rotundum.

These anatomic relationships are important both for identifying the Vidian nerve and providing a road map for the skull base surgeon. Exploration of the junction of the medial pterygoid plate with floor of sphenoid sinus is a simple method in identification of Vidian nerve.

Surgical modifications for specific pathologies:

Traditionally approaching PPF and ITF involves medial to lateral EEA, other approaches includes medial transpalatine approach for exposure of the medial PPF, the middle meatal transantral approach for a more lateral exposure of the PPF (here infraorbital nerve is the first

landmark to be identified) and the inferior turbinectomy transantral approach (provides widest exposure to PPF / ITF).

The canine fossa puncture and a staggered septal window techniques provides better exposure to the PPF and better lateral instrumentation. An additional port can be used for endoscope or dissecting instruments through the canine trephine. This also helps in dissecting pathologies of maxillary sinus, PPF or ITF. A staggered transseptal window can serve the similar purpose for lesions involving the anterior maxillary wall or laterally extending into ITF.

The most common pathologies that require EEA to PPF include IPs and JNAs. Small IPs and JNAs arising from nasal cavity involving PPF minimally can easily be addressed by EEA. This may require removal of mass in nasal cavity first before approaching the mass in PPF. As JNAs have tendency to invaginate into bone, the site of origin should be drilled with a diamond burr to prevent recurrence.

Although the endoscopes provides an unsurpassed views of the surgical field, the abundance of fat, anatomic variations and alterations secondary to inflammatory or neoplastic processes and engorged venous plexus may complicate the correct identification of structures during surgery in PPF. Finally, a solid knowledge of anatomy, and its variations,

is necessary to successfully deal the intraoperative and postoperative challenges encountered with EEA.

Surgical considerations for endoscopic resection of JNA:

Endoscopic resection of JAs follows tumour management principles by keeping the specific characteristics of this unique tumour in mind. Basically, the strategy of endoscopic resection takes the following considerations into account:

1. Opening of the maxillary sinus and exposure of its posterior wall are performed early during surgery. The size of the tumour dictates the size of the medial maxillectomy. The bony posterior wall of the maxillary sinus is removed with ‘through cutting’ punches or drills avoiding trauma to the periosteum in the pterygopalatine fossa before resection of the bone is completed. Following incision of the periosteum, the sphenopalatine and maxillary arteries are identified and clipped or coagulated. Early control of the main feeding vessel is of great value to assist further tumour resection. An alternative in early JAs is to push the tumour gently in a medial direction out of the pterygopalatine and infratemporal fossae and to identify the main feeding vessel by this maneuver. In cases where an extended access to the maxillary sinus does not allow exposure of the lateral

tumour border within the infratemporal fossa in advanced JAs, the tumour can be pushed medially with a finger placed externally at the lateral border of the maxillary sinus below the jaw.

2. Resection of the posterior nasal septum is advised to widen the access in endoscopic tumour removal and to define tumour margins at the nasal septum.

3. The anterior sphenoid sinus wall is removed in order to expose the tumour within the sphenoid sinus. For this purpose, a bilateral opening of the sphenoid sinus is usually necessary.

4. Finally, the tumour is dissected directly off the pterygoid base and pterygoid canal regions and the clivus. Troublesome venous bleeding from the bone can be managed at this stage with drilling, chemical haemostatic agents or fine endosurgical diathermy.

5. It is of utmost importance to drill at the pterygoid base and the clivus at the end of surgery in order to avoid residual tumour.

6. Endoscopic dissection should always follow the pseudocapsule in order to avoid injury of the tumour at the surface. Finger-like extensions of the tumour can be gently pulled out along the pseudocapsule.

Step by step considerations for EEA for PPF:

All procedures were performed with patients under general anaesthesia, after decongestion of nasal cavities. The step-by-step surgical procedure is tailored to the tumour extension as follows:

1. Middle meatal antrostomy, trimming of middle turbinate and superior turbinate; antero-posterior ethmoidectomy and sphenoidotomy will be performed. Then antrostomy will be extended to the posterior wall of the maxillary sinus. In some cases inferior turbinectomy, medial maxillectomy or posterior septectomy may be performed individually or in combination as per the need.

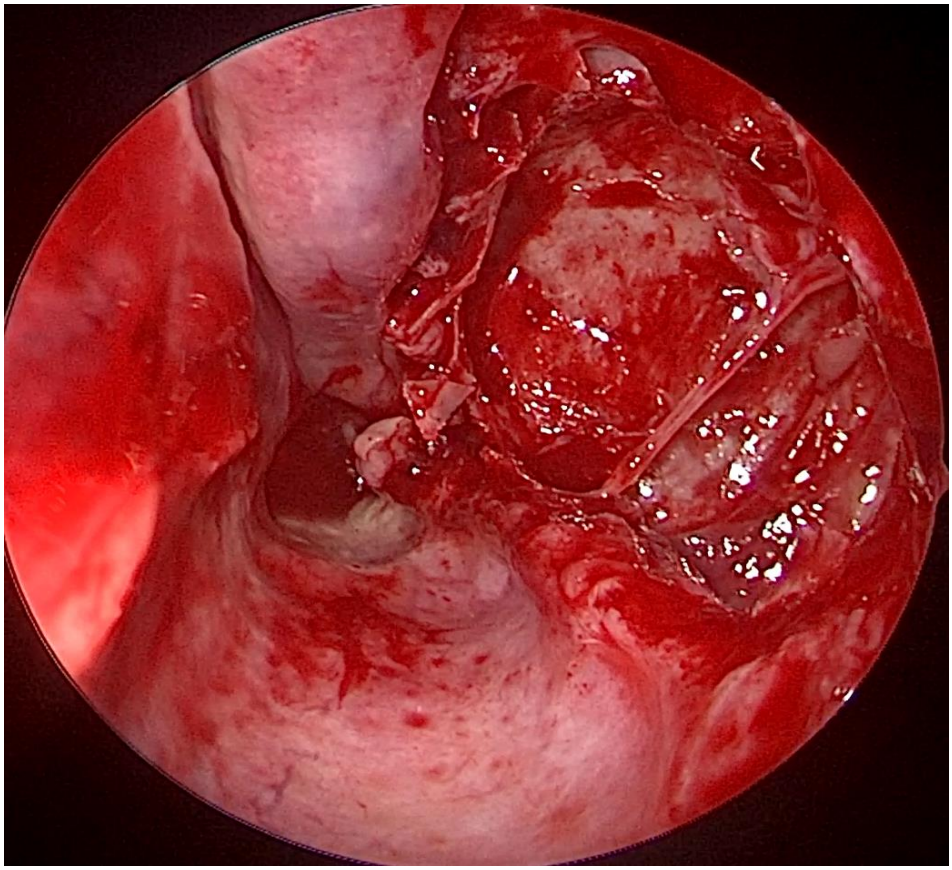

Fig 19: Mega antrostomy and exposing the posterior wall of left maxillary sinus

2. The sphenopalatine foramen and sphenopalatine artery entering the nasal cavity near the tip of the middle turbinate is an important surgical anatomical landmark.

3. Removal of posterior wall of maxillary sinus while preserving the periosteum of pterygopalatine fossa Preservation of the periosteum surfacing the PPF was helpful for subsequent identification of the Vidian nerve medially and the maxillary nerve superolaterally. The extent of the surgical window in the posterior wall depend on the exact

location and extent of the tumor in the PPF. The extent of drilling around the sphenopalatine foramen is also determined based on the extent of PPF involvement.

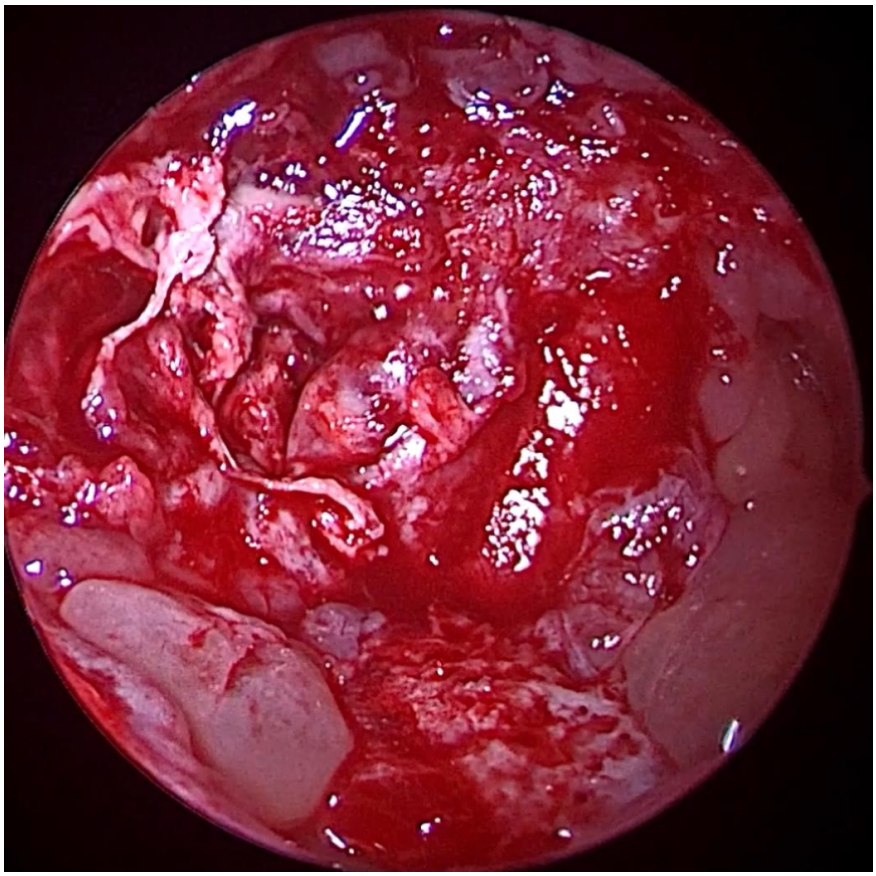

Fig 20: Exposed PPF after posterior maxillectomy

4. After incision of periosteum, first structures to be visualized is fat, then blood vessels, all neural structures lie deeper to the plexus of arteries.

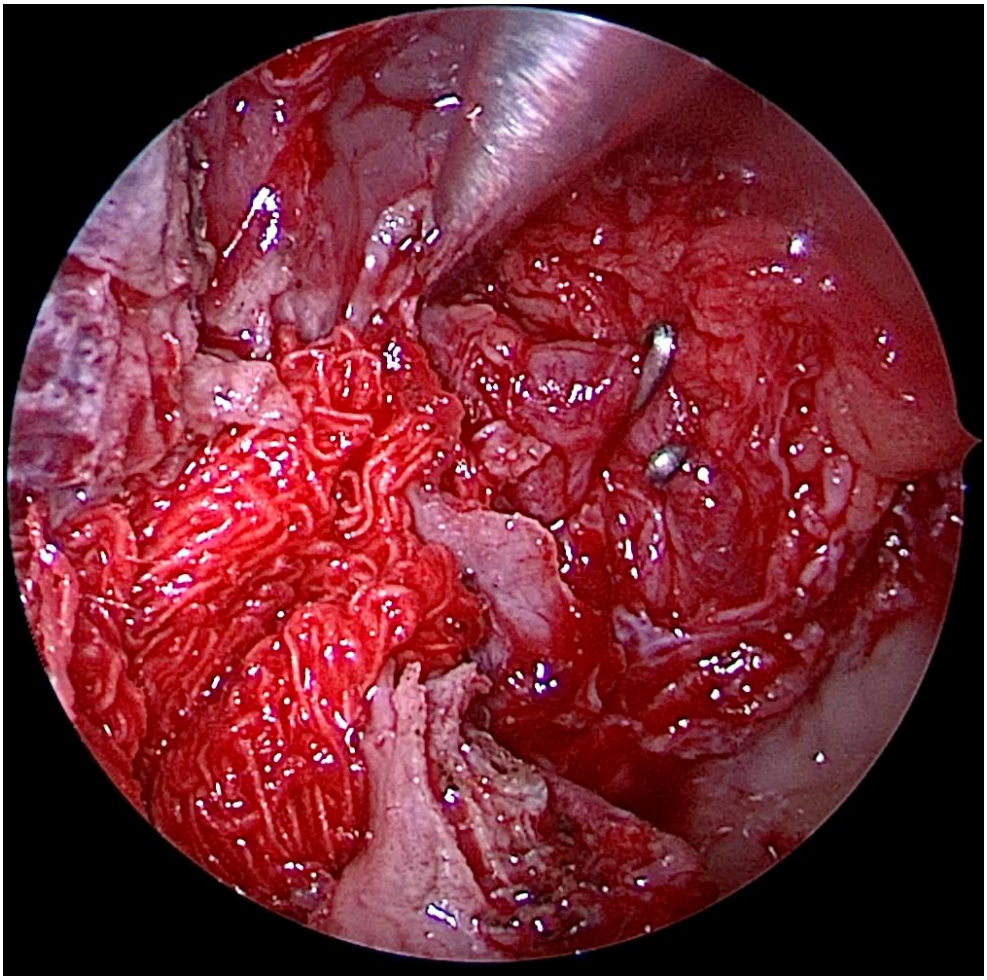

Fig 21: Exposed PPF with mass and feeding vessel (IMA) clipped

5. Careful dissection of tumour / lesion in the pterygopalatine fossa. The final step consists of drilling around the Vidian canal to prevent JNA recurrence. In case of malignancy, the pterygoid root and plates are resected.

REVIEW OF LITERATURE

Endoscopic techniques are evolved for the evaluation and management of the sinonasal disease over the past two to three decades. Various experiences with endoscopy have led its application to regions beyond the paranasal sinuses, including different areas of skull base.

One such region of skull base which acquired the focus of a variety of endoscopic procedures is approaching PPF. This region is an inverted pyramidal shaped space present between posterior wall of maxillary sinus and the pterygoid plates. It communicates with middle cranial fossa, nasopharynx, nose, ITF, oral cavity and orbit through various fissures, foramens and canals.

Many infectious, primary or secondary neoplastic lesions (Both benign and malignant) can happen in PPF. This witness the need for surgical entry into the PPF. Surgical manipulation must be done with caution as this space is complex and has variety of neural and vascular structures as discussed in above sections. {1-3}

Accessing the PPF is difficult, which is traditionally approached via an open method, such as lateral rhinotomy, midfacial degloving, facial translocation, transantral maxillectomy, and the Fisch C and D procedures. These procedures provide good exposure of the PPF, but they are often complicated by unacceptable facial scaring and deformity as well as dysfunction of the facial and infraorbital nerves.

The PPF is a region that can be involved with a variety of pathological processes because of its proximity to the oral cavity, nasal cavity, orbit, and intracranial space.1 Obtaining access to this region can be difficult and has traditionally been performed through anterior and lateral approaches using open techniques. Because these open approaches can be associated with a fair amount of morbidity, the endonasal endoscopic approach recently has been introduced as a minimally invasive alternative. {4, 5}

Thus endoscopic approaches have been adopted as a basic approach for the treatment of benign sinonasal tumors, such as inverted papilloma or juvenile nasopharyngeal angiofibromas {6, 7}, also for many other pathologies involving PPF.

Seth J. Isaacs and Parul Goyal et al (2007)"have performed endoscopic dissections of cadaveric heads and defined the location of neurovascular structures. The sphenopalatine foramen (SPF) served as the primary intranasal landmark to the pterygopalatine fossa (PPF). Mean distances from the SPF were measured with the following results: SPF to sphenopalatine ganglion (SPG), 4 mm medially and 6 mm laterally; SPF to foramen rotundum (FR), 7 mm; and SPF to vidian canal (VC), 2 mm. The internal maxillary artery followed an irregular and inconsistent

course, making it difficult to define a reliable landmark for its location in the fossa.

They concluded that the important neural structures of this area are consistently located superior to the sphenopalatine foramen and medial to the infraorbital nerve. Injury to these neural structures can be avoided by entering the fossa inferior to the sphenopalatine foramen along a vertical line drawn inferiorly from the infraorbital canal prominence". {9}

No consistent endoscopic landmarks were found for the course of the internal maxillary artery in the PPF. Its course through the PPF is tortuous and variable, creating a high risk of injury during endoscopic dissection. {8, 1, 9}

Battaglia et al have performed extensive study with 37 patients during 13 year period. He used EEA for biopsy and resection of lesions from PPF. This have been reported in many literature. {10}

Plzak et al (2017) and team studied a total of 13 patients who underwent EEA for PPF masses. His results were no recurrence during the follow-up period, no complications and only one residual tumour (JNA remained in cavernous sinus was stable).

They concluded that low frequency of complications and higher efficacy of resection support the use of EEA as a feasible, safe and beneficial technique for the management of masses in PPF.

They also stated that "the fundamental pre-requisites for EEA for PPF

- Thorough preoperative evaluation by imaging (MRI/CT)
- The availability of adequate technical equipment
- Adequate experience and skill of surgeon". {11}

Abuzayed et al concluded in his study that "the PPF is one of the most anatomically complicated space with vital vascular and neural structures. These structures should be dissected with care during endoscopic approach to PPF. Neural structures should be preserved to reduce surgical morbidity. Vascular complications is due to injury to branches or directly to internal maxillary artery, thus management of massive blood loss is one of the limiting steps of EEA to PPF". {12}

Hidenori Yokoi et al (2015) reported an 83 year old patient who had an inflammatory pseudotomur in maxillary sinus and orbital cavity with left PPF as principal site. Imaging confirmed the same. They have done EEA to PPF for biopsy and histopathological evaluation. And the

patient was diagnosed to have inflammatory pseudotumour with immune histochemical study. {13}

Sonam tashi and Bela purohit et al (2016) in their study concluded that the PPF is a 'central station' in the deep face where various neurovascular crossroads meet; it acts as a relay terminus for the spread of tumour, infection, and inflammation from one deep neck space to another. Their study serves to concisely review the anatomy of PPF and to highlight the possible advantages and disadvantages while imaging PPF pathology. {14}

Betul emine et al concluded in his study that a thorough evaluation of PPF requires one to be familiar with bony landmarks, relevant anatomy and communications is essential for minimizing intraoperative complications and morbidity. {15}

Vlad budu et al (2016) concluded in his study that the PPF is anatomically difficult area to access surgically, but with the advent of modern techniques we can do better surgical approaches and achieve better quality of life. By the use of modern endoscopic approaches we can reduce postoperative pain and oedema and fewer neurovascular complications thus improving the postoperative course of patient. Thus

surgical techniques have made extensive progress in this area of surgery, and complete resection of tumour from PPF is possible. {16}

Han Zhou et al (2015) said in his study that surgery is warranted, in patient with schwannoma involving sinonasal tract and PPF, demonstrating long term survival. Although number of patients is limited in their retrospective investigation, results showed that FESS is the best choice of treatment, very valid treatment modality. {17}

Xin Chun Jian et al (2005) concluded from his study that it is difficult to select the proper surgical procedure for complete resection of tumours in PPF. He used modified Barbosa approach to resect primary and secondary tumours of PPF, and this helped in complete exposure of PPF area. {18}

In our study we used EEA for PPF tumours, and is found to be useful in complete exposure and reducing morbidity.

Kirtane et al (1984) concluded in his study that in the preganglionic section of the vidian nerve by transnasal approach is possible. As the sphenopalatine foramen and funnel shaped anterior opening of vidian canal is in same horizontal plane, landmark is easy and clear cut by identifying the ethmoidal crest and presence of

sphenopalatine vessels pinpoint the position of sphenopalatine foramen. Dissection of fat in PPF, maxillary artery and maxillary nerve and sphenopalatine ganglion were made easy with this approach. {19}

In our study we did the EEA in dissection of PPF, for taking biopsies from PPF, and complete excision of tumours from PPF and found to be effective with very less morbidity and mortality.

Alexandre et al reported a case of young male with dermoid cyst in PPF, had undergone EEA and removed ovoid lesion from PPF and sent for HPE, which was conclusive of dermoid cyst. He also concluded that EEA was used to remove any tumour in PPF and successfully removed any lesions in PPF. {20}

Klossek et al in his study reported a case of schwannoma of PPF, and presented preoperative evaluation management and postoperative follow-up of that patient. He proposed EEA for this lesion of PPF via nasal fossa and maxillary sinus and found to be useful. {21}

Karkas et al (2020) in his study on cadaveric dissections, discussed that as for approaching PPF and ITF, its access had been classically provided by many external approaches: transzygomatic, transmaxillary, transmandibular, preauricular subtemporal and infratemporal approaches. But lesions in PPF and ITF can easily be

approached with EEA. Best lesion to be removed by EEA is JNA, schwannoma, hemangiopericytoma. For these EEA is very less morbid compared with sublabial incision, nostril collapse and maxillary osteotomies. {22}

Oakley et al (2016) in his study on EEA to PPF and ITF summarized that the endoscopic resection of PPF and ITF malignancies allows excellent visualization and manipulation of tissues in the anatomically complex area, compared with open approaches. EEA allows an easier recovery and easy transition to adjuvant chemotherapy as it have less morbidity. Surgeons should have wide access to ensure better maneuverability and easy visualization of the tumour in PPF and ITF as well as surrounding normal structures. This helps in complete resection of tumour and good postoperative surveillance. {23}

Hyo Jin Chung et al (2019) in his study on analysis of surgical approaches for skull base tumours, discussed that skull base tumours have been challenging to surgeons owing to their location, complex surrounding structures. Moreover, due to their deeper location, masses in skull bases grow continuously for a longer period of time before presenting clinically, many a times results in delayed diagnosis. Complete

resection of tumour is mainstay of treatment, however it is important to choose better surgical approach with less morbidity.

In his study he have done midfacial degloving, maxillary swing, modified nasomaxillary swing, infratemporal fossa and combined tranzygomatic approaches in various cases of skull base tumours involving PPF and ITF. He mentioned that surgeons should consider postoperative facial scars in growing individuals, both physically and psychologically, before selecting the procedure. He concluded that the recent advances in minimally invasive surgical procedures limits the use of aggressive surgical approaches that were used previously. {24}

In our study using EEA for PPF is very advantageous, as it has very less morbidity and mortality on comparing with any open surgical approaches.

Masataka et al in his study on modified lateral approach to pterygopalatine fossa discussed that there are two main extra-oral approaches for PPF – anterior and lateral approach. Although lateral approach is advantageous compared with anterior approach in terms of cosmetics, numbness of lower lip may occur after surgery due to sacrifice of mental nerve. In conventional lateral approach, vertical incision is made at centre of lower lip, then a lateral flap is elevated with sacrifice of

mental nerve. In his study, he introduced a modification of lateral approach, he made the vertical incision at corner of the mouth and then a lateral flap is elevated with preservation of mental nerve. {25}

In our study we used EEA to approach PPF area, no damage to mental nerve, thus very less morbidity and mortality.

Narayanan Janakiram et al (2016) in his study "binostril four handed endoscopic technique without embolization ensures the safe and effective excision as shown by complete tumor removal, decreased intraoperative blood loss and low recurrence rates. Intraoperative hemostasis can be achieved by devascularization of tumor by ligation of the feeder vessels prior to tumor manipulation". {28}

MATERIALS AND METHODS

STUDY DESIGN:

Observational cross sectional study

STUDY SETTING:

The study was conducted at Upgraded Institute of Otorhinolaryngology,

Rajiv Gandhi Government General Hospital,

Chennai – 600003

STUDY SAMPLE: 20

ETHICAL COMMITTEE CLEARANCE:

Obtained from the Institutional ethical committee.

STUDY PERIOD:

October 2020 to September 2021

METHOD:

Patient with lesions involving PPF undergone endoscopic endonasal approach to reach the PPF. Based on the imaging and histopathological findings the endonasal approach was modified as per the need. This approach was used to do the following:

1. For comparing the extent with CT/MRI finding
2. Confirming the pathology by HPE by either biopsy or en-masse removal
3. Removal of pathologies in PPF

It was also used in follow-up of the patients who were previously operated.

INCLUSION CRITERIA:

1) Age group: >12 years to <70 years
2) Both sex- male and female
3) Imaging showing :
   a. Any soft tissue mass in the pterygopalatine fossa
   b. Obliteration / Absence of fat in pterygopalatine fossa
   c. Widened sphenopalatine foramen / PPF
4) No intracranial intradural involvement

EXCLUSION CRITERIA:

1) Age group: <12 years and > 70 years
2) Regional or systemic dissemination
   a. Spread to temporal fossa (laterally)
   b. Spread to upper pharyngeal space with or without internal carotid artery encasement (posteriorly)

c. Spread to orbit, cavernous sinus & middle cranial fossa (superiorly)
d. Spread to hard palate (inferiorly)

3) Patient not willing for surgery / who are not fit for surgery.

MATERIAL:

Patient attending UIORL with complaints of epistaxis, nasal discharge, facial pain / numbness, nasal obstruction or CT/MRI finding of involvement of PPF. They undergone EEA for disease clearance from PPF. Study was conducted in Department of UIORL, RGGGH / MMC – between.

Detailed clinical history and clinical examination was done for all the 20 patients. DNE and CT-PNS with or without contrast were done in all the patients. MRI-PNS with or without MRA/MRV was done in selected patients.

A proforma was prepared to record the history, clinical examination and investigations, surgical procedure done, histopathological examination and follow-up of patients.

Cases were studied for comparing the imaging finding with the intraoperative finding, confirming with the histopathological examination, recurrence rate and morbidity.

Postoperative follow-up was done with DNE for the patients under study.

PROFORMA

DEMOGRAPHIC DATA:

NAME: DATE:

AGE/SEX:

IPNO:

CHIEF COMPLAINTS:

COMORBID CONDITIONS:

CLINICAL EXAMINATION:

NOSE:

External contour

Anterior rhinoscopy

Posterior rhinoscopy

Airway patency test:

Cold spatula test

Cottonwool test

Cottle's test

Others:

ROUTINE INVESTIGATIONS:

DNE:

CT PNS:

SURGICAL PROCEDURE DONE:

HISTOPATHOLOGICAL EXAMINATION:

FINAL DIAGNOSIS:

DATA COLLECTION:

- Complete history taking and clinical examination
- Diagnostic nasal endoscopy
- CT-PNS
- MRI brain with PNS cuts
- Surgical procedure notes
- Follow up

Surgical procedure done:

All the patients were underwent EEA approach for PPF lesion resection. Basic endoscopic sinus surgery was done initially, then based on the pathology and extent of lesion different endonasal approaches were used.

For a case with inflammatory pseudotumor in the PPF, first maxillary antrostomy done and the same widened to visualize the posterior wall of maxilla then posterior maxillectomy was done. Periosteum incised, lesion and other structures in PPF were seen. Thus lesion from PPF was excised and sent for HPE.

For the patients with JNAs initial maxillary antrostomy done, then anterior and posterior ethmoidectomy done, then mass was dissected from surrounding structures. Since all the cases have PPF involvement, endoscopic modified denkers were done for all of them to visualize the posterior wall of maxilla and the same was removed after that periosteum incised and feeding vessel was identified and clipped or ligated or cauterized. Posterior septectomy was done in some case with nasopharyngeal involvement and for using four handed endoscopic technique. In cases with sphenoid sinus involvement, sphenoid sinusotomy was done. Tumour was dissected from the surrounding structures and removed in-toto.

For cases with invasive mucormycosis, first maxillary antrostomy was done, then anterior and posterior ethmoidectomy was done. If sphenoid sinus involved, sphenoid sinusotomy was done. Mega antrostomy was done, posterior wall of maxilla visualized and same removed. Lesion in PPF was removed.

Additionally, in patient with ITF involvement, prelacrimal approach was done, lateral dissection of PPF and ITF was done.

Also, in patients with premaxillary involvement or anterior wall of maxilla involvement, endoscopic modified denkers was performed and posterior wall of maxilla visualized. Posterior maxillectomy done and dissection of PPF was done. Lesions from PPF was removed in toto.

Endoscopic endonasal approach:

Position of patient - Patient in supine with 15 degree head end elevation

Nasal packing – Packed with cottonoids soaked in 4% lignocaine and 1 in 10,000 adrenaline solution. Done 15 minutes before surgery.

Nasal cavity was first visualized with 0 degree rigid rodlens endoscope. Local infiltration, with 2% lignocaine and adrenaline (1 in 10,000) premixture, was done in root of middle turbinate, uncinate process, nasal septum and posterior end of middle turbinate.

The procedure started with uncinectomy, wide middle meatal antrostomy. Complete ethmoidectomy and sphenoid sinusotomy were done.

The posterior wall of maxillary sinus, which was thinned in some JNAs and eroded in some invasive mucormycosis patients, was removed and the PPF is exposed.

The attachments of the mass were easy to delineate due to excellent direct visualization using endoscope. The sphenopalatine artery or IMA, feeding vessel, was either ligated or clipped or cauterized and the attachments were systematically released.

In some patient prelacrimal approach or endoscopic modified denkers approach were used to approach the PPF. These approaches let the surgeon a good visualization of the PPF even with 0 degree endoscope and hence the dissection of PPF were done using 0 degree endoscope itself.

The lesions involving the PPF were removed fully by the EEA. Anterior nasal packing and in some cases posterior nasal packing was done once the surgery was over. Packs were removed after postoperative day 2 or 3.

For approaching the PPF, three different endonasal approaches were used. After basic endoscopic sinus surgery they were used

- Megaantrostomy in inflammatory pseudotumour (IPT) and Invasive mucormycosis cases
    - After widening the middle meatal antrum, it was widened further superiorly upto floor of orbit, posteriorly upto posterior wall of maxilla, inferiorly upto floor of nose after removing the inferior turbinate and anteriorly upto lacrimal duct thus making megaantostomy.

- Prelacrimal approach in invasive mucormycosis
    - After making megaantrum, lacrimal bone was drilled infront of the lacrimal duct or without making the megaantrum, medial wall of maxilla was drilled between anterior wall of maxilla and lacrimal duct thus making the prelacrimal approach.

- Endoscopic modified denkers approach was used in JNA and invasive mucormycosis cases.
    - Vertical incision was made in mucosa over medial wall of maxilla above the anterior end of inferior turbinate, mucosal flap elevated. Anterior wall and medial sturt of medial wall

of maxilla drilled out, thus entering the maxillary antrum, and thus obtaining the best surgical exploration and instrumentation.

Specimen obtained from the surgery were sent for HPE and findings were compared with preoperative findings.

OBSERVATION

In this study on 20 patients with different pathologies in PPF, the clinical provisional diagnosis as follows

- Inflammatory pseudotumour – 1 case (5%)
- Juvenile nasopharyngeal angiofibroma – 5 cases (25%)
- Invasive mucormycosis – 14 cases (70%)

13 were male patients and 7 were female patients

Clinical presentation:

- 7 patients presented with facial pain and 3 patients with facial numbness
- 6 patients epistaxis
- 8 patients with nasal discharge and 4 with nasal obstruction
- 4 patients with double vision
- 2 with trismus and 1 case with cheek swelling

Imaging finding:

- 18 patients have involvement of PPF in CECT PNS itself, and all patients with MRI PNS taken showed involvement of PPF

- 1 patient had lesion in nasal cavity by CT PNS while 2 patients had lesion in nasal cavity by MRI
- 5 patients had lesion in nasopharynx by both CT and MRI PNS
- 15 patients have involvement of paranasal sinuses; since MRI was not taken in all the patients, 9 patients had PNS involvement.
- 1 Patient had erosion of anterior wall of maxilla by CECT PNS and 1 had ITF involvement
- While in MRI, 1 case have premaxillary involvement and 2 had ITF involvement.

The diagnosis were made based on the clinical history, examination, DNE and CT-PNS / MRI-PNS findings. Final diagnosis was made with HPE after surgery.

Surgery done:

Endoscopic sinus surgery was done in all the patients

- Modified denkers approach was done in JNA cases
- Megaantrostomy was done in inflammatory pseudotumour case and 11 cases of invasive mucormycosis
- Prelacrimal approach was done in 2 cases with invasive mucormycosis

- Modified denkers approach was done in 1 case of invasive mucormycosis

Histopathological examination:

The following HPE findings were noted and confirmed post-surgery

- Inflammatory pseudotumour – 1 case (5%).
- Invasive mucormycosis – 14 cases (70%).
- Juvenile nasopharyngeal angiofibroma – 5 cases (25%).

Adjuvant therapy:

- Injection Liposomal Amphotericin B for all 14 cases of invasive mucormycosis.
- Other cases needed no adjuvant therapy.

DISCUSSION

In our study on EEA to PPF, 20 cases with lesions of PPF were randomly selected. Thorough clinical history and examination was done for all the patients. They were evaluated with DNE, CECT PNS and MRI PNS. Endoscopic endonasal approach was done to explore the PPF.

Jan Plzak et al {11} in his study endoscopic endonasal approach for mass resection in PPF, Out of 13 patients in his study, 11 were males and 2 were females. Mean age was 21.8 (range 15-56) years.

In our study, out of 20 cases 13 were male (65%) and 7 were female (35%) patients. They were between 12 years of age and 70 years. All JNA cases were between 12 and 20 years, all invasive mucormycosis cases were between 36 and 68 years of age, mean age was 41.1 years.

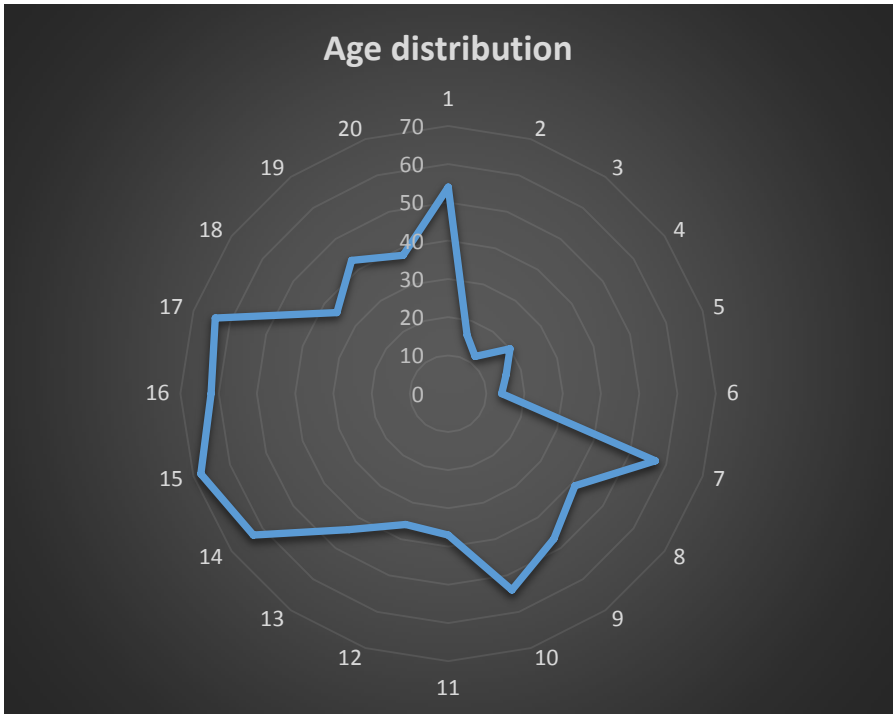

Fig 22: Radar diagram showing age distribution of cases in our study

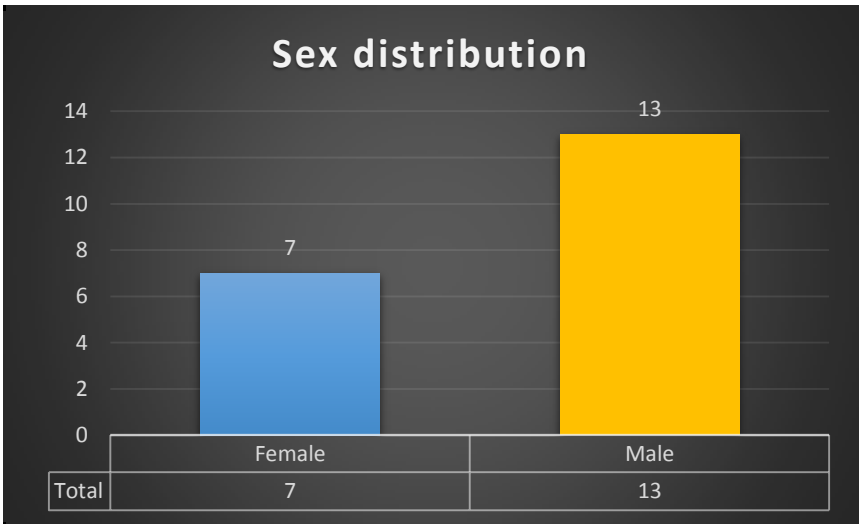

Fig 23: Bar diagram showing sex distribution of cases in our study

In our study, epistaxis was commonest presentation in JNA cases. While in invasive mucormycosis cases facial pain and numbness was common presentation. Inflammatory pseudotumour was also presented with facial pain. Many patients also presented with nasal obstruction and nasal discharge. Some presented with some other unrelated symptoms like cheek swelling and double vision.

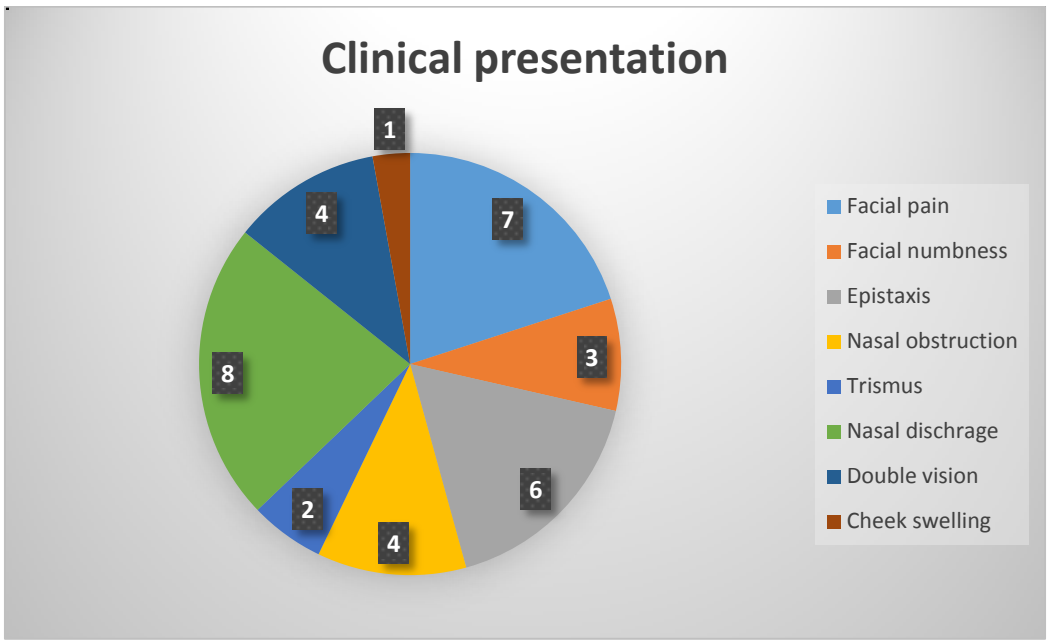

Fig 24: Pie chart showing different clinical presentation in our study

Most of the patients with JNA as provisional diagnosis present with epistaxis as one of their presenting compliant, except one case who have nasal obstruction and nasal discharge as his primary complaint.

Symptoms	Clinical presentation
Facial pain	7
Facial numbness	3
Epistaxis	6
Nasal obstruction	4
Trismus	2
Nasal discharge	8
Double vision	4
Cheek swelling	1

Table 1: Frequencies of clinical presentation of cases in our study

Many patients with invasive mucormycosis presents with facial pain (57%) and some with facial numbness and one patient with trismus. Others present with nonspecific complaints like nasal obstruction and nasal discharge. Some even present with symptoms of associated structure involvement like double vision, cheek swelling.

Jan Plzak et al {11} in his study endoscopic endonasal approach for mass resection in PPF, observed the following symptoms. Unilateral nasal obstruction in 12 patients, epistaxis in 6 patients and pain in four patients. Also one patient in his study with smaller schwannoma had no symptoms and was diagnosed incidentally by MRI.

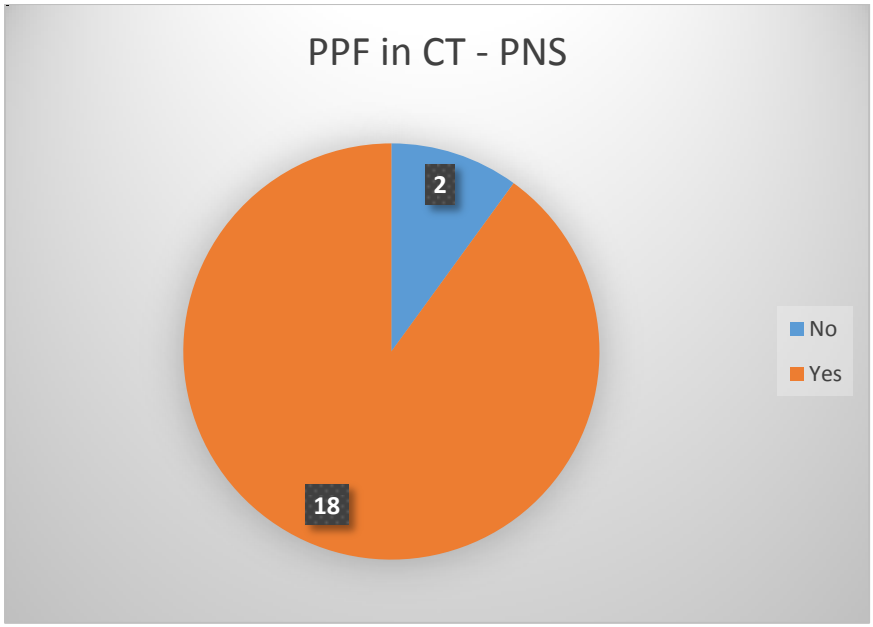

Fig 25: Pie diagram showing PPF involvement in CT-PNS

They were evaluated with DNE, CT-PNS and MRI-PNS. DNE showed mass in nasopharynx extending into nasal cavity in cases with JNA, while mucosal necrosis or purulent discharge in invasive mucormycosis cases.

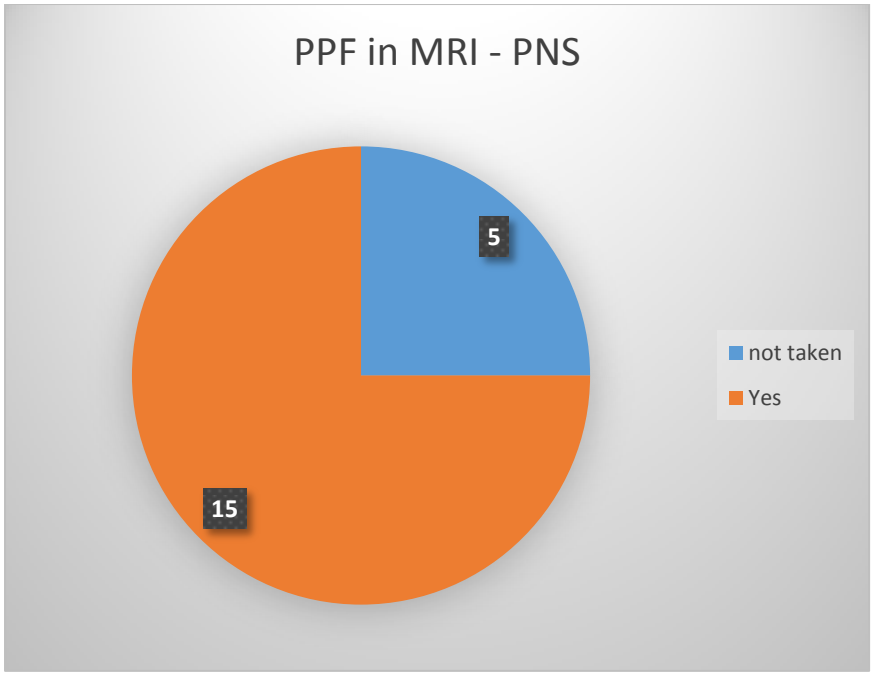

Fig 26: Pie diagram showing PPF involvement in MRI-PNS

All patients were taken Contrast enhanced CT PNS, showed involvement of PPF, only 2 patients with mucormycosis has no CT evidence, but they have PPF involvement in MRI PNS. All patients were undergone DNE at the initial phase of diagnosis itself. The diagnosis were made on the basis of clinical history, DNE finding, CECT and MRI PNS which were taken after the clinical examination of the patient.

Imaging finding	CT-PNS	MRI-PNS
PPF involvement	18	15
Mass lesion (JNA) – Anterior bowing of posterior wall of maxilla	5	5
widened PPF	3	2
Fat stranding	8	5
Erosion of Posterior wall of maxilla	4	3
Not taken	Nil	5

Table 2: Imaging finding frequencies in cases in our study

Common CECT PNS findings in our study were:

- Contrast enhanced vascular mass in PPF in JNA cases, with widened PPF and SPF, anterior bowing of posterior wall of maxilla.

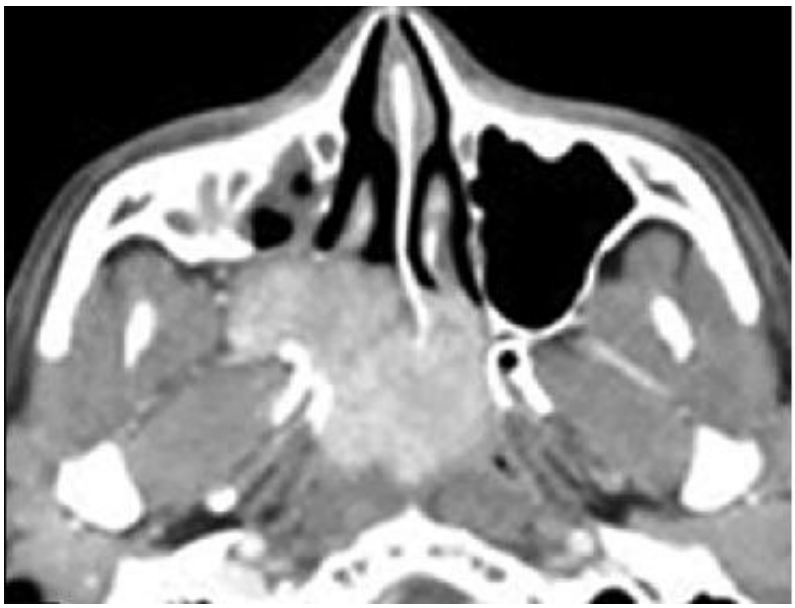

Fig 27: CECT image showing mass vascular lesion in right PPF – JNA

- In invasive mucormycosis patients:
    - Erosion of posterior wall of maxilla
    - Obliteration of fat / fat stranding
    - Widened PPF

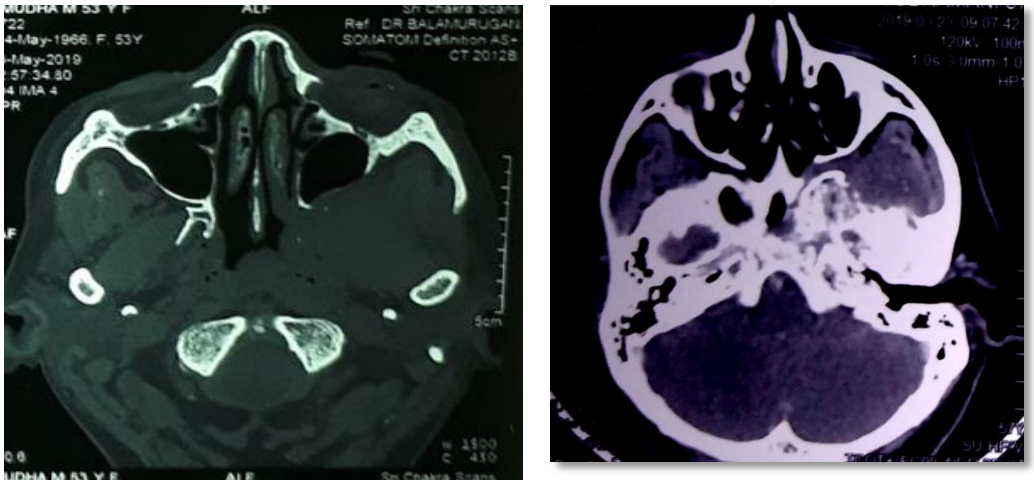

Fig 28: CT images showing widening of left PPF

- In the solo case of inflammatory pseudotumour widened PPF and obliteration of fat was the CECT finding in our study.

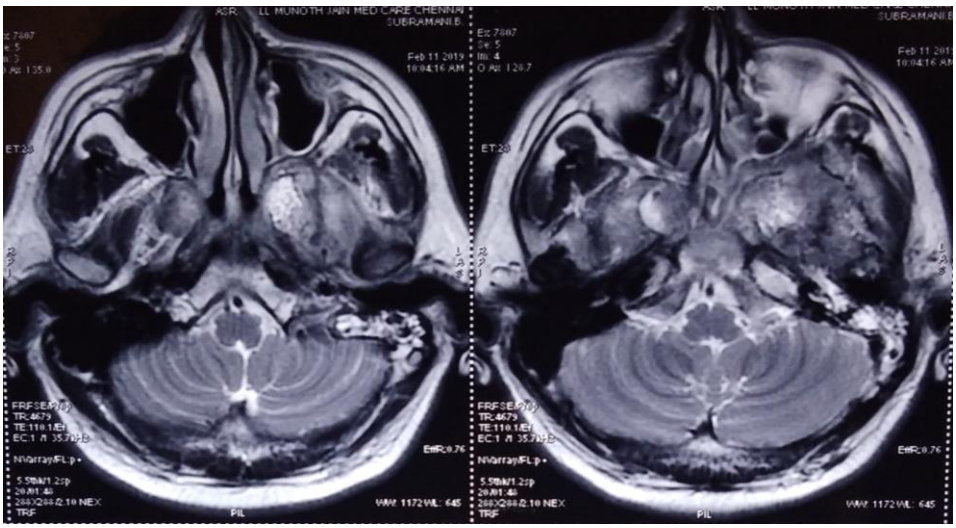

Fig 29: MRI image showing fat stranding in left PPF and wide left PPF

EEA was used to explore the PPF. In all JNA cases endoscopic modified denkers was done to explore the posterior wall of maxilla then posterior maxillectomy and PPF exploration.

Diagnosis	Surgical approach done	Intraoperative finding	No. of cases
JNA	Endoscopic modified denkers	Vascular mass in PPF	5
IPT (Inflammatory pseudotumour)	Megaantrostomy	Obliterated fat, with tumour in PPF	1
Invasive mucormycosis	Megaantrostomy	Purulent discharge	2
	Prelacrimal	Obliterated fat	3
	Endoscopic modified denkers	Necrosed tissues	5
		Thrombosed vessels	4

Table 3: Implicating surgical procedures done and intra-op finding

Surgical procedure done:

In all the five JNA cases endoscopic modified denkers approach was used to approach the PPF. Since it was a vascular tumour, for a wide exposure and exploration of tumour in PPF this approach was used.

Steps of procedure done in these JNA cases:

- Basic FESS which includes – uncinectomy, middle meatal antrostomy, anterior ethmoidectomy and inferior turbinectomy.

- Endoscopic modified denkers approach – Vertical incision made in the lateral wall of nose above the anterior end of inferior turbinate, mucosal flap elevation and drilling of the anterior wall of maxilla.

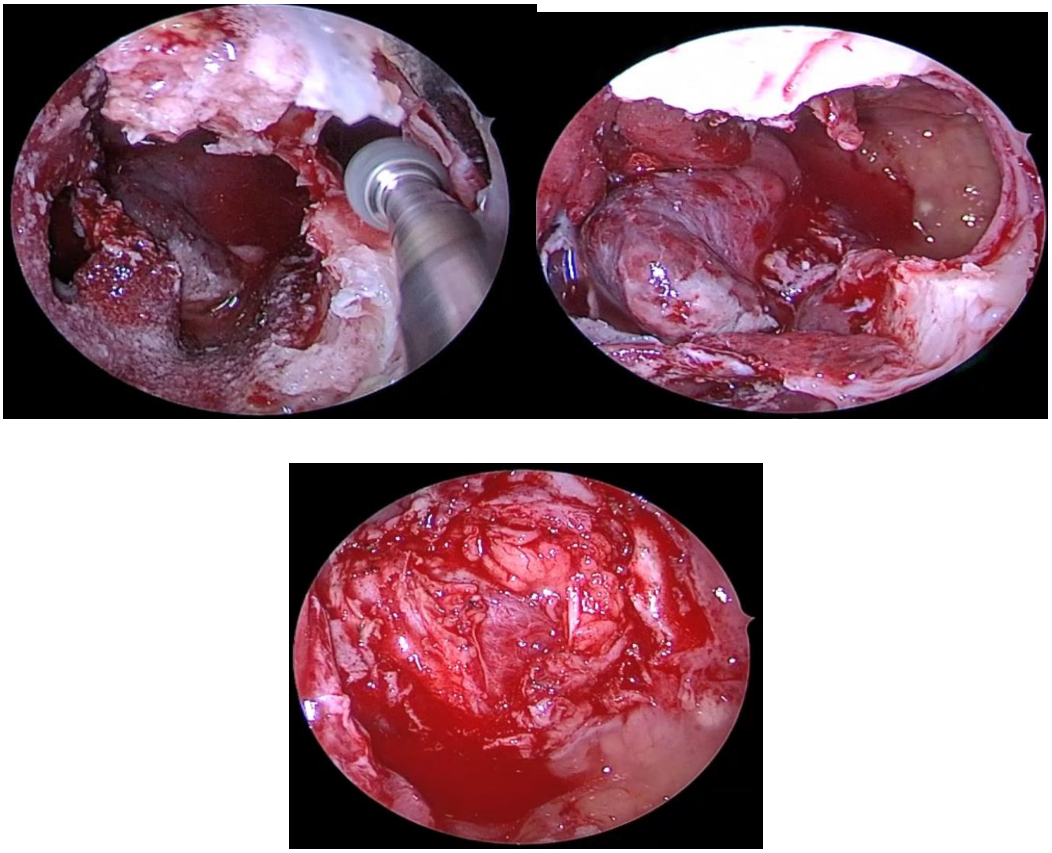

Fig 30: Showing drilling of anterior wall of maxilla & exposing the PPF with mass

- Exposing posterior wall of maxilla and removal of the same.
- Incising the periosteum, exposing the PPF and then ligation of feeding vessel, dissection of tumour from the surrounding tissues and delivering the tumour.
- Posterior septectomy was done in few cases for better exposure.

In the inflammatory pseudotumour (IPT) case, the megaantrostomy approach was used to approach the PPF. After a basic FESS, inferior turbinectomy and megaantrostomy was done. Then tumour was dissected from the PPF after exposure of the PPF.

Steps in endoscopic excision of IPT:

- Basic FESS including – uncinectomy, middle meatal antrostomy
- Anterior ethmoidectomy
- Inferior turbinectomy

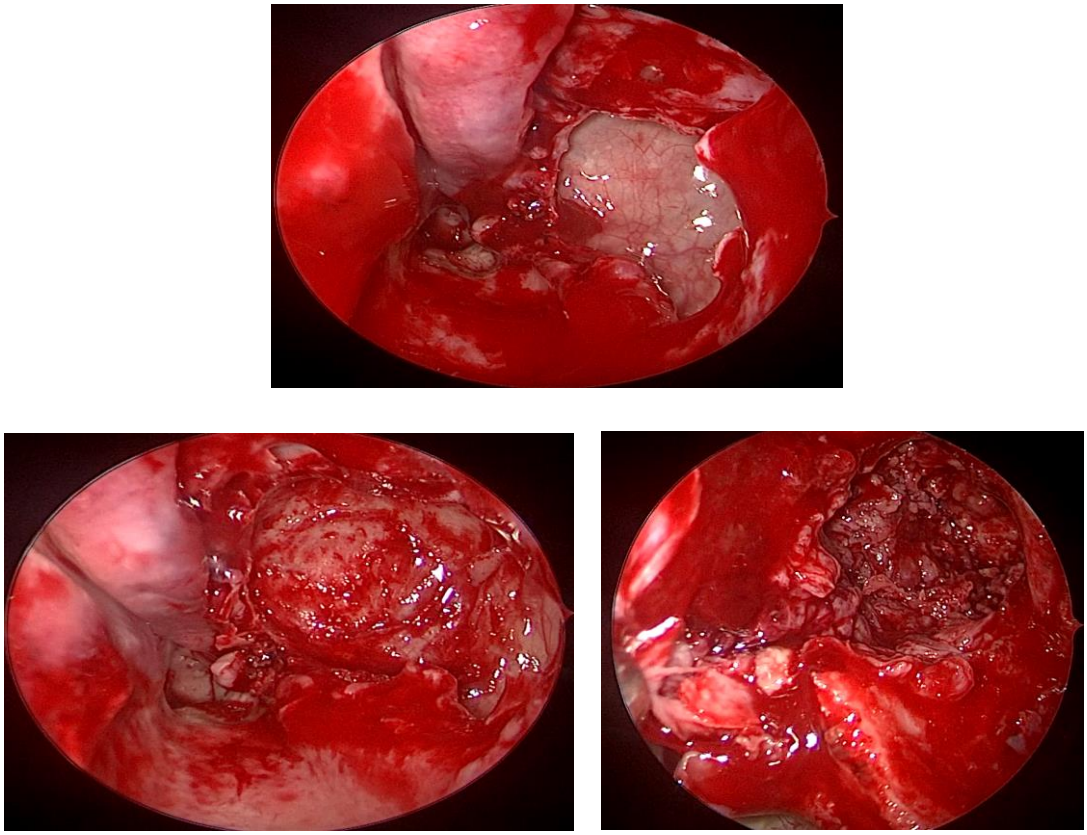

Fig 31: Showing wide MMA, Megaantrostomy and PPG after tumour removal.

- Widening of maxillary antrum, megaantrostomy was done.
- Exposure of the posterior wall of maxilla, stripping of the mucosa over it and removal of the posterior wall.
- Exposure of the PPF, dissection of the tumour from PPF.

In the 14 cases with invasive mucormycosis, 3 different approaches for PPF clearance was done. Basic endoscopic sinus surgery was done, then posterior wall of PPF was exposed by 3 different endonasal approaches. PPF clearance was done.

Steps in PPF clearance in invasive mucormycosis cases:

- Endoscopic sinus surgery including – uncinectomy, middle meatal antrostomy, and ethmoidectomy or sphenoid sinusotomy based on the CT involvement of these sinuses.
- Approaching posterior wall of maxillary sinus or the PPF
    - Megaantrostomy was done in cases with disease limited to maxillary sinus and PPF

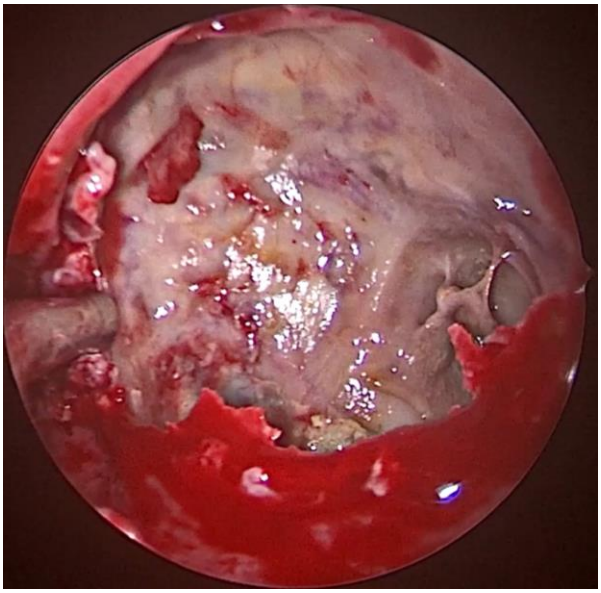

Fig 32: Intra-op image showing the megaantrostomy to approach left PPF

    - Prelacrimal approach was done in cases with lesion involving the maxillary sinus, PPF and lateral limit of PPF or the ITF

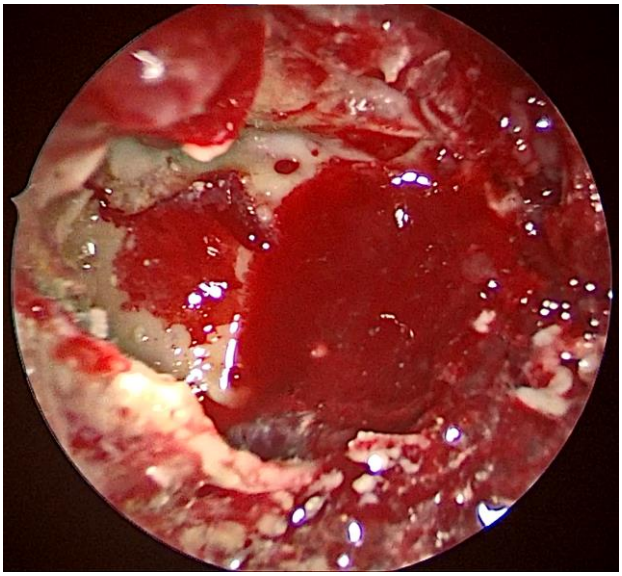

Fig 33: Intra-op image showing prelacrimal approach to left PPF

- Endoscopic modified denkers was done in cases with involvement by either erosion of anterior wall of maxilla or premaxillary involvement in addition to the PPF involvement.

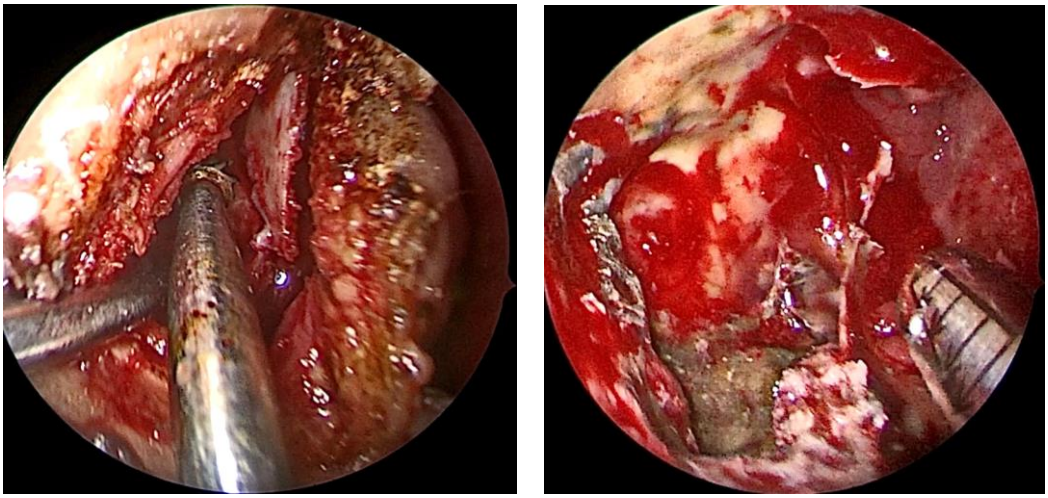

Fig 34: Intra-op image showing the modified denkers approach to right PPF

- By these approaches, PPF was explored and the lesion was cleared.

Histopathological finding:

Jan Plzak et al {11} in his study endoscopic endonasal approach for mass resection in PPF, one case was malignant (Sinonasal undifferentiated tumour), 12 benign cases which included 10 JNAs and 2 Schwannomas.

The mass or lesion dissected and removed from the PPF in our study were sent for histopathological examination. HPE findings were same as that of preoperative diagnosis

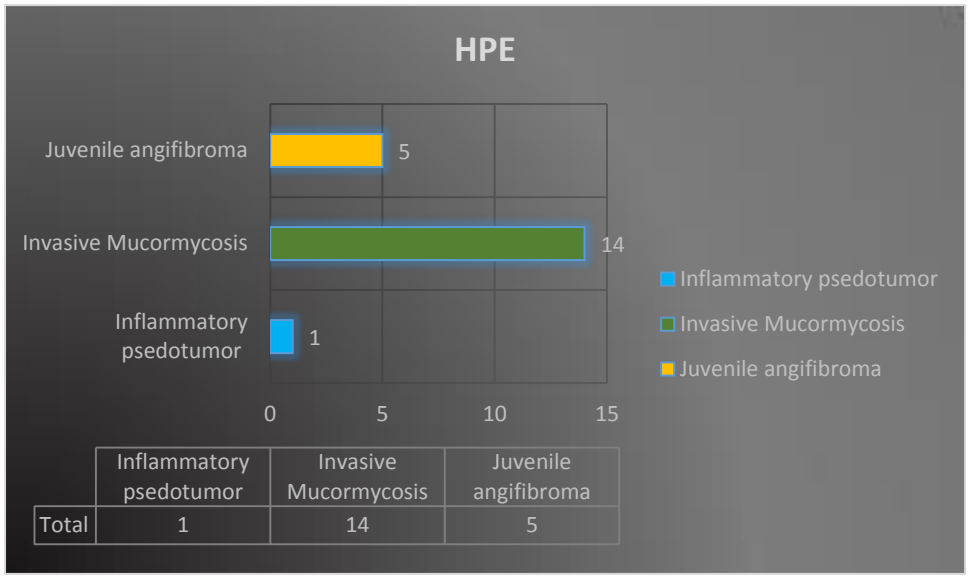

Fig 35: Bar diagram showing the HPE findings in our study

Out of 20 cases – 70% cases were invasive mucormycosis, 25% JNAs and 5% inflammatory pseudotumour (IPT). HPE finding was consistent with the provisional diagnosis.

All the invasive mucormycosis patients were given with injection liposomal amphotericin B 100 to 300mg per day for atleast 30 days

including pre and postoperative period. JNA patients in our study were not in need of any adjuvant therapy or revision surgery.

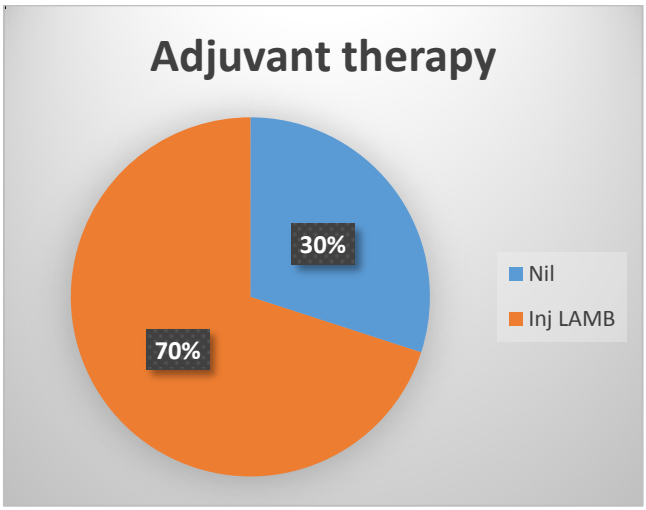

Fig 36: Pie chart showing percentage of patients given with adjuvant therapy.

All these patients were in follow-up for atleast 6 months postoperatively. They were underwent clinical examination and diagnostic nasal endoscopy. Out of the 20 cases in our study, 18 cases including all JNA cases had no recurrence of disease. Only 2 out of 14 invasive mucormycosis had recurrent disease, that too patient had involvement in sphenoid sinus and ITF and not in the PPF.

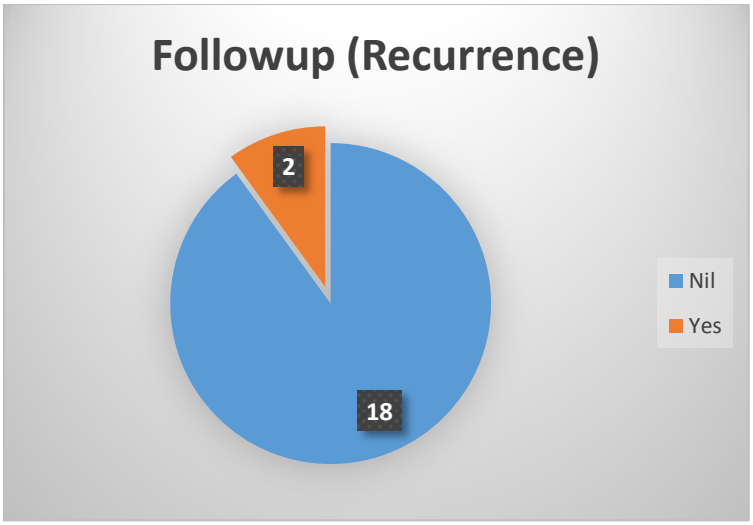

Fig 37: Pie chart showing recurrence rate in our study

All the 20 cases in our study were alive until November 2021, which was the end of study. Thus the mortality rate is zero in our study. Compared with the traditional open approaches to PPF, in EEA to PPF – no incision is needed, thus no scars postoperatively; comparatively less duration of hospital stay; better improvement from symptoms and also very less recurrence. Thus the morbidity is very less compared with the open approaches.

Thus EEA to PPF is very much helpful in removing pathologies from the PPF and for taking biopsies from the PPF. The imaging findings by CT/MRI is comparable and almost similar with that of the intraoperative findings in our study. Also patients who underwent surgery by EEA are followed-up for atleast 6 months postoperatively. Follow-up of the patients in our study shows that the mortality is zero with very less morbidity.

CONCLUSION

In our study of 20 patients with pterygopalatine fossa lesions, more number of cases are invasive mucormycosis in this pandemic of covid-19. Before Invasive mucormycosis it is Juvenile nasopharyngeal angiofibroma.

Males are most commonly affected.

Most common clinical presentation is facial pain and numbness followed by nasal discharge, epistaxis, nasal obstruction and facial swelling.

Most common Computed tomography finding in pterygopalatine fossa mass is anterior bowing of the posterior wall of maxilla. While in invasive mucormycosis it is obliteration of retromaxillary fat / fat stranding.

Different Endoscopic Endonasal approaches are used to approach the pterygopalatine fossa. The minimal procedure needed is megaantrostomy. Prelacrimal approach is used for invasive mucormycosis cases. For approaching pterygopalatine fossa in JNAs and in pterygopalatine fossa with infratemporal fossa involvement endoscopic modified denkers is the best approach as it has good surgical exploration and best instrumentation (as we remove the medial strut also).

For benign lesions of pterygopalatine fossa, complete removal gives best cure rate. Well cleared pterygopalatine fossa and infratemporal fossa lesions with adjuvant therapy with Liposomal Amphotericin B have best results in invasive mucormycosis.

Inspite of being a hidden area Endoscopic Endonasal approaches can be used to approach pterygopalatine fossa. Endoscopic modified denkers approach gives the best surgical exploration of pterygopalatine fossa.

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PATIENT CONSENT FORM

Title of the Project **: "COMPHREHENSIVE STUDY OF ENDOSCOPIC MANAGEMENT OF PRIMARY OR SECONDARY INVOLVEMENT OF PTERYGOPALATINE FOSSA IN HEAD AND NECK PATHOLOGIES"**

Institution : Upgraded Institute of Otorhinolaryngology,
Madras Medical College,
Chennai – 600003.

Name : Date :

Age : IP No. :

Sex : Project Patient No. :

The details of the study have been provided to me in writing and explained to me in my own language.

I confirm that I have understood the above study and had the opportunity to ask questions.

I understood that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without the medical care that will normally be provided by the hospital being affected.

I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s).

I have been given an information sheet giving details of the study.

I fully consent to participate in the above study.

_____	_____	_____
Name of the subject	Signature	Date
_____	_____	_____
Name of the Investigator	Signature	Date

INFORMATION SHEET

We are conducting **"COMPHREHENSIVE STUDY OF ENDOSCOPIC MANAGEMENT OF PRIMARY OR SECONDARY INVOLVEMENT OF PTERYGOPALATINE FOSSA IN HEAD AND NECK PATHOLOGIES"**

at the Upgraded Institute of Otorhinolaryngology, Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai – 600003.

In this study endoscopic management of pterygopalatine pathologies was done

At the time of announcing the results and suggestions, name and identity of the patients will be confidential.

Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.

The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of Investigator **Signature of Participant**

Date:

ஆராய்ச்சி தகவல் தாள்

ஆய்வு செய்யப்படும் தலைப்பு :

தலை மற்றும் கழுத்து நோய்க்குறியீடுகளில் டெரிகோபாலட்டின் ஃபோசாவின் முதன்மை அல்லது இரண்டாம் நிலை ஈடுபாட்டின் எண்டோஸ்கோபிக் அறுவை சிகிச்சை பற்றிய விரிவான ஆய்வு.

ஆராய்ச்சியாளர் பெயர் :

பங்கேற்பாளர் பெயர் :

சென்னை ராஜீவ் காந்தி அரசு மருத்துவமனைக்கு, இந்த ஆராய்ச்சியின் நோக்கம்.

நீங்கள் இந்த ஆராய்ச்சியில் பங்கேற்க நாங்கள் விரும்புகிறோம். இந்த ஆராய்ச்சியால் உங்கள் சிகிச்சைக்கு பாதிப்பு ஏற்படாது என்பதை தெரிவித்துக் கொள்கிறோம்.

இந்த ஆராய்ச்சியின் முடிவுகளை அல்லது கருத்துக்களை வெளியிடும் போதோ அல்லது ஆராய்ச்சியின் போதோ தங்களது பெயரையோ அல்லது அடையாளங்களையோ வெளியிடமாட்டோம் என்பதையும் தெரிவித்துக்கொள்கிறோம்.

இந்த ஆராய்ச்சியில் பங்கேற்பது தங்களுடைய விருப்பத்தின் பேரில் தான் இருக்கிறது. மேலும் நீங்கள் எந்நேரமும் இந்த ஆராய்ச்சியிலிருந்து பின்வாங்கலாம் என்பதையும் தெரிவித்துக்கொள்ளலாம்.

இந்த ஆராய்ச்சியின் முடிவுகளையும் நோயின் தன்மைப்பற்றியும் ஆராய்ச்சியின் போது அல்லது ஆராய்ச்சியின் முடிவின் போது தங்களுக்கு அறிவிப்போம் என்பதையும் தெரிவித்துக்கொள்கிறோம்.

ஆராய்ச்சியாளர் கையொப்பம் பங்கேற்பாளர் கையொப்பம்

தேதி:

சுய ஒப்புதல் படிவம்

ஆய்வு செய்யப்படும் தலைப்பு :

தலை மற்றும் கழுத்து நோய்க்குறியீடுகளில் டெரிகோபாலட்டின் ஃபோசாவின் முதன்மை அல்லது இரண்டாம் நிலை ஈடுபாட்டின் எண்டோஸ்கோபிக் அறுவை சிகிச்சை பற்றிய விரிவான ஆய்வு.

ஆராய்ச்சி நிலையம் : இராஜீவ் காந்தி அரசு பொது மருத்துவமனை மற்றும்
சென்னை மருத்துவக் கல்லூரி,
சென்னை - 600 003.

பங்கு பெறுபவரின் பெயர் : உறவுமுறை :

பங்கு பெறுபவரின் எண். :

மேலே குறிப்பிட்டுள்ள மருத்துவ ஆய்வின் விவரங்கள் எனக்கு விளக்கப்பட்டது. என்னுடைய சந்தேகங்களை கேட்கவும், அதற்கான தகுந்த விளக்கங்களைப் பெறவும் வாய்ப்பளிக்கப்பட்டது.

நான் இவ்ஆய்வில் தன்னிச்சையாகத்தான் பங்கேற்கிறேன். எந்தக் காரணத்தினாலோ எந்தக் கட்டத்திலும் எந்த சட்ட சிக்கலுக்கும் உட்படாமல் நான் இவ்ஆய்வில் இருந்து விலகிக் கொள்ளலாம் என்றும் அறிந்து கொண்டேன்.

இந்த ஆய்வு சம்மந்தமாகவோ, இதை சார்ந்த மேலும் ஆய்வு மேற்கொள்ளும்போதும் இந்த ஆய்வில் பங்குபெறும் மருத்துவர் என்னுடைய மருத்துவ அறிக்கைகளைப் பார்ப்பதற்கு என் அனுமதி தேவையில்லை என அறிந்து கொள்கிறேன். நான் ஆய்வில் இருந்து விலகிக் கொண்டாலும் இது பொருந்தும் என அறிகிறேன்.

இந்த ஆய்வின் மூலம் கிடைக்கும் தகவல்களையும், பரிசோதனை முடிவுகளையும் மற்றும் சிகிச்சை தொடர்பான தகவல்களையும் மருத்துவர் மேற்கொள்ளும் ஆய்வில் பயன்படுத்திக் கொள்ளவும் அதைப் பிரசுரிக்கவும் என் முழு மனதுடன் சம்மதிக்கிறேன்.

இந்த ஆய்வில் பங்கு கொள்ள ஒப்புக்கொள்கிறேன். எனக்குக் கொடுக்கப்பட்ட அறிவுரைகளின்படி நடந்து கொள்வதுடன், இந்த ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்றும் உறுதியளிக்கிறேன். என் உடல் நலம் பாதிக்கப்பட்டாலோ அல்லாத எதிர்பாராத வழக்கத்திற்கு மாறான நோய்க்குறி தென்பட்டாலோ உடனே அதை மருத்துவ அணியிடம் தெரிவிப்பேன் என உறுதி அளிக்கிறேன்.

பங்கேற்பவரின் கையொப்பம்..... இடம்..... தேதி
கட்டைவிரல் ரேகை

பங்கேற்பவரின் பெயர் மற்றும் விலாசம்.....

ஆய்வாளரின் கையொப்பம்..... இடம்..... தேதி

ஆய்வாளரின் பெயர்.....

Sl.no	Name	Age/Sex	Symptoms	Diagnosis	Imaging		Surgery done	Extension	Adjuvant therapy	HPE	Followup (Recurrence)
					CT PNS	MRI					
1	Amudha	54/F	Lt side facial pain	Inflammatory pseudotumour	Lt PPF involved	-	Lt FESS, PPF Clearance	Lt PPF	Nil	Inflammatory psedotumor	Nil
2	Arokiyaraj	16/M	Rt nose bleeding	Juvenile angiofibroma	Rt PPF, NP	Rt SPF, PPF, NP	Endoscopic excision of mass	Rt NC, NP, PPF	Nil	Juvenile angifibroma	Nil
3	Manoj	12/M	Lt nose bleeding	Juvenile angiofibroma	Lt PPF, NP	Lt PPF, NP	Endoscopic excision of mass	Lt NC, NP, PPF	Nil	Juvenile angifibroma	Nil
4	Pushparaj	20/M	Lt nasal obstruction, nose bleeding	Juvenile angiofibroma	Lt PPF, NP, SS	Lt NC, NP, SPF	Endoscopic excision of mass	Lt NC, NP, PPF	Nil	Juvenile angifibroma	Nil
5	Sachin	16/M	Lt nose bleeding	Juvenile angiofibroma	Lt NP, PPF	Lt NC, NP, SPF, PPF	Endoscopic excision of mass	Lt NC, NP, PPF	Nil	Juvenile angifibroma	Nil
6	Venkatesan	14/M	Lt nasal obstruction, nose bleeding	Juvenile angiofibroma	Lt NC, NP, PPF, SS	Lt NC, NP, SPF, PPF, SS	Endoscopic excision of mass	Lt NC, NP, PPF, SS	Nil	Juvenile angifibroma	Nil
7	Subramani	57/M	Lt facial pain, difficulty in opening mouth	Mucormycosis	Lt PPF, ITF	Lt PPF, ITF	Endoscopic PPF, ITF clearance	Lt PPF, ITF	Inj LAMB	Invasive Mucormycosis	Nil
8	Kumar	41/M	Lt nasal discharge	Mucormycosis	Lt MS, ES, PPF	-	ESS, PPF clearance	Lt MS, ES, PPF	Inj LAMB	Invasive Mucormycosis	Nil
9	Malliga	47/F	Rt nasal discharge	Mucormycosis	Rt MS, ES, PPF	-	ESS, PPF clearance	Rt MS, ES, PPF	Inj LAMB	Invasive Mucormycosis	Nil
10	Faruk nisha	54/F	Rt facial pain, double vision	Mucormycosis	Rt MS, ES, PPF	-	ESS, PPF clearance, MO	Rt MS, ES, PPF	Inj LAMB	Invasive Mucormycosis	Nil
11	Manimegalai	37/F	Lt nasal discharge, double vision	Mucormycosis	Lt MS, ES, PPF	-	ESS, PPF clearance, MO	Lt MS, ES, PPF	Inj LAMB	Invasive Mucormycosis	Nil

12	Sabari raj	36/M	Lt Facial pain, double vision	Mucormycosis	Lt MS, ES, PPF	Lt MS, ES, PPF, ITF	ESS, PPF/ITF clearance, MO	Lt MS, ES, PPF, ITF	Inj LAMB	Invasive Mucormycosis	Nil
13	Ilavarasi	44/M	Rt Nasal discharge, double vision	Mucormycosis	Rt MS, ES, PPF	Rt MS, ES, PPF	ESS, PPF clearance, MO	Rt MS, ES, PPF	Inj LAMB	Invasive Mucormycosis	Yes
14	Murugan	63/M	Rt nasal obstruction, facial pain	Mucormycosis	Rt MS, PPF	Rt MS, PPF	ESS, PPF clearance	Rt MS, ES, PPF	Inj LAMB	Invasive Mucormycosis	Nil
15	Ambika	68/F	Rt facial pain	Mucormycosis	Rt MS, ES, SS, PPF	Rt, MS, ES, SS, PPF	ESS, PPF Clearance	Rt MS, ES, SS, PPF	Inj LAMB	Invasive Mucormycosis	Nil
16	Padmanaban	62/M	Rt nasal discharge	Mucormycosis	Rt MS, PPF	Rt MS, PPF	ESS, PPF clearance	Rt MS, ES, PPF	Inj LAMB	Invasive Mucormycosis	Nil
17	Rukmani	64/F	Rt Cheek swelling, nasal discharge	Mucormycosis	Rt MS, PPF, Anterior wall erosion	Rt MS, ES, PPF, Premaxillary	ESS, PPF clearance, Denkers	Rt MS, ES, PPF, Anterior wall of maxila	Inj LAMB	Invasive Mucormycosis	Nil
18	Akila	36/F	Rt Nasal discharge, facial pain	Mucormycosis	Rt MS, ES, SS	Rt MS, ES, SS, PPF	ESS, PPF clearance	Rt MS, ES, SS, PPF	Inj LAMB	Invasive Mucormycosis	Nil
19	Srinivasan	43/M	Lt nasal obstruction, nose bleeding	Mucormycosis	Lt MS, ES, SS, PPF	Lt MS, ES, SS, PPF	ESS, PPF clearance	Lt MS, ES, SS, PPF	Inj LAMB	Invasive Mucormycosis	Nil
20	Gnanaprakasam	38/M	Lt nasal discharge	Mucormycosis	Lt MS, ES	Lt MS, ES, PPF	ESS, PPF clearance	Lt MS, ES, PPF	Inj LAMB	Invasive Mucormycosis	Yes

Rt – Right, Lt – Left, MS – Maxillary sinus, ES – Ethmoid sinus, SS – Sphenoid sinus, PPF – Pterygopalatine fossa, ITF – Infratemporal fossa, NP – Nasopharynx, NC – Nasal cavity, MO – Medial orbitotomy, Inj.LAMB – Injection Liposomal amphotericin B