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Chapter X

Endoscopic Approach and Management of Parasellar Lesions

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Abstract

The parasellar region is the location of a wide variety of inflammatory and benign or malignant lesions. A pathological diagnostic strategy may be difficult to establish relying solely on imaging data. Percutaneous biopsy through the foramen ovale using the Hartel technique has been developed for decision-making process. It is an accurate diagnostic tool allowing pathological diagnosis to determine the best treatment strategy. However, in some cases, this procedure may fail or may be inappropriate particularly for anterior parasellar lesions.

Over these past decades, endoscopy has been widely developed and promoted in many indications. It represents an interesting alternative approach to parasellar lesions with low morbidity when compared to the classic microscopic sub-temporal extradural approach with or without orbito-zygomatic removal.

In this chapter, we describe our experience with the endoscopic approach to parasellar lesions. We propose a complete overview of surgical anatomy and describe methods and results of the technique. We also suggest a model of a decision-making tree for the diagnosis and treatment of parasellar lesions.

Introduction

A large variety of lesions either benign or malignant [1] may be located in the parasellar region. The most common are meningiomas and neurinomas but there are also chondrosarcomas, chordomas, epidermoid and dermoid cysts, inflammatory diseases, carcinomas, metastases, lymphoma and many others [2-4]. A specific management is required for each type of lesion. Neuroimaging including MR spectroscopy and diffusion sequences may approach the diagnosis with more or less accuracy, but does not replace pathological and/or cytological assessment. To allow exact diagnosis and adapted management, the percutaneous biopsy through the foramen ovale has been developed. It uses the same approach as that performed for the percutaneous treatment of trigeminal neuralgia, which was first described by Hartel [5]. It is an accurate diagnostic tool avoiding many unnecessary open surgeries. However it may fail for calcified or dense tumors. Another issue is represented by the important frequency of meningeal cells due to meningeal hyperplasia or presence of cartilaginous tissue of skull base inducing pitfalls in diagnosis. Lastly, the trajectories through the foramen ovale limit targeting to the Meckel's cave, the posterior part of the cavernous sinus and the upper part of the petroclival region. The access to the anterior part of the cavernous sinus is difficult. Endoscopy has been developed since 1990's and is more and more used for skull base surgery and therefore may represent a good alternative to percutaneous biopsy for such locations. In this chapter, we present endonasal endoscopic steps to reach parasellar lesions and propose an algorithm to manage such lesions.

Anatomy

Nasal Fossa (Figure 1)

Medially, the septum is a rigid structure, which is the association of the perpendicular plate of the ethmoid on superior plane, the vomer on the inferior plane and the quadrangular cartilage on the anterior plane. Sometimes, there is septal deviation that may complicate surgery. Posteriorly, there are the choanae giving access to the cavum. Laterally, there are three longitudinal folds i.e. the turbinates. The first seen turbinate is named the inferior turbinate. It is attached to the ethmoid. Posterior and above of it, there is the middle turbinate that is a part of the ethmoid. This middle turbinate has its head free and possibly pneumatized (concha bullosa) so may narrow surgical corridor. The superior turbinate is only seen after the mobilization of the middle turbinate as well as the sphenoid ostium. This is the entry point to the sphenoid sinus, located approximately 15 mm above the choanae. Passing just below the sphenoid ostium into the mucosae to reach the posterior septum is the nasal posterior nasal artery. Branch of the spheno-palatine artery, it may be source of postoperative epistaxis and have to be coagulated most of the time.

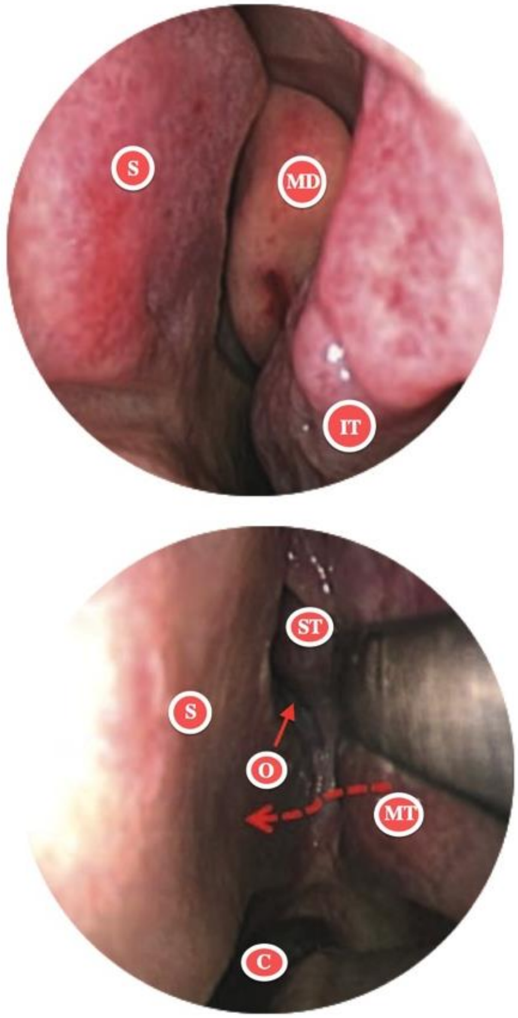

Figure 1. Operative view, nasal anatomy; S: septum; IT: inferior turbinate; MT: middle turbinate; ST: superior turbinate; O: ostium; C: choanae; Red arrow: Nasal posterior artery.

Sphenoid Sinus and Parasellar Anatomy

The sphenoid sinus has a different degree of pneumatization among individuals, as well as the numerous septa variations. The sphenoid sinus is often pneumatized (sellar type) with one or two simple septa. Some individual especially young do not have any sinus (conchal type) [6]. Key landmarks have to be located and understand before doing any surgery in this area (Figure 2). On the midline, from anterior to posterior are the planum, the tuberculum of the sella, the sella turcica and the clivus that is in front of the brainstem. Laterally are the optic nerve, the lateral optico-carotid recess, the paraclinoid segment of the internal carotid (ICA), the cavernous sinus and the clival segment of the ICA (Figure 2).

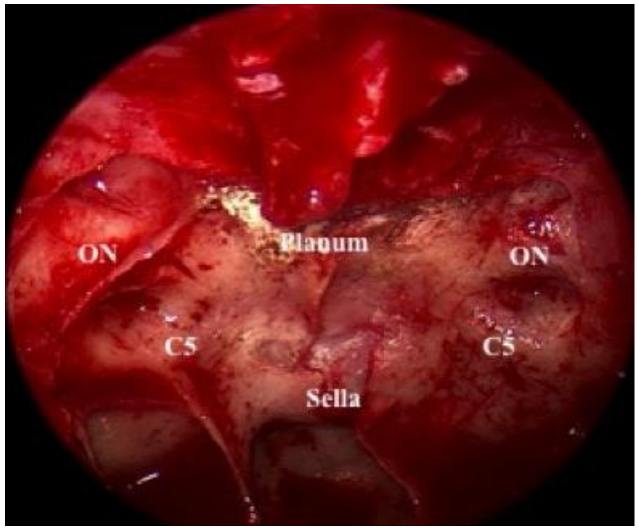

Figure 2. Endoscopic endonasal view inside the sphenoid sinus. Sella turcica on the midline is boarded anteriorly by the planum, and laterally optic nerves (ON) and the parasellar carotid artery (C5).

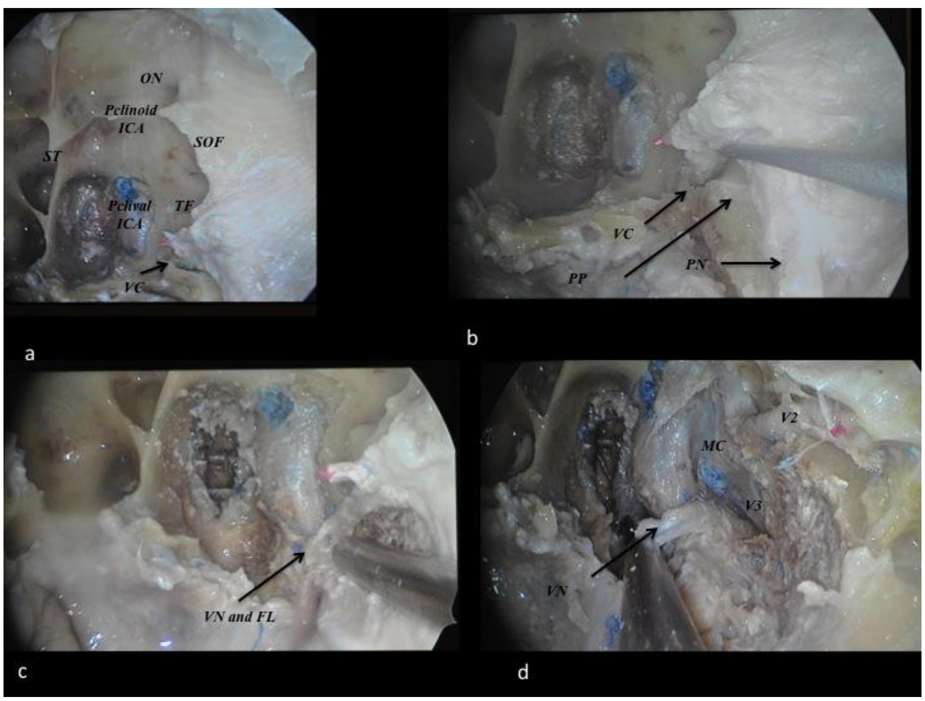

Figure 3. Anatomic study. The sphenoid sinus is largely opened up and the posterior wall of the maxillary sinus removed. A: the vidian canal (VC) is exposed with the paraclival ICA on the back. The usual landmarks can also be identified, the optic nerve: ON, the paraclinoid ICA: Pclinoid. Laterally up is the superior orbital fissure: SOF and below the entry point to the meckel's cave: TF (temporal fossa). The cavernous sinus locates between the Pclinoid and Pclival ICA. B: another view with the pterygoid process: PP with the vidian canal: VC and the palatine nerve and vessels: PN. C: the vidian nerve clearly leads the surgeon to the foramen lacerum and the petrous ICA. D: After removing the bone structure of the lateral sphenoid recess as have to be doing during parasellar surgery. VN: vidian nerve, MC: Meckel's cave, V2 and V3 trigeminal branches.

The parasellar compartment (cavernous sinus – CS -, Meckel's cave – MC -) access requires a large aperture of the sphenoid, the posterior ethmoidal cells and the maxillary sinuses for the MC (Figures 3, 4, 5, 6). The MC entry point is located lateral and up to the paraclival and petrous ICA loops just below the superior orbital fissure.

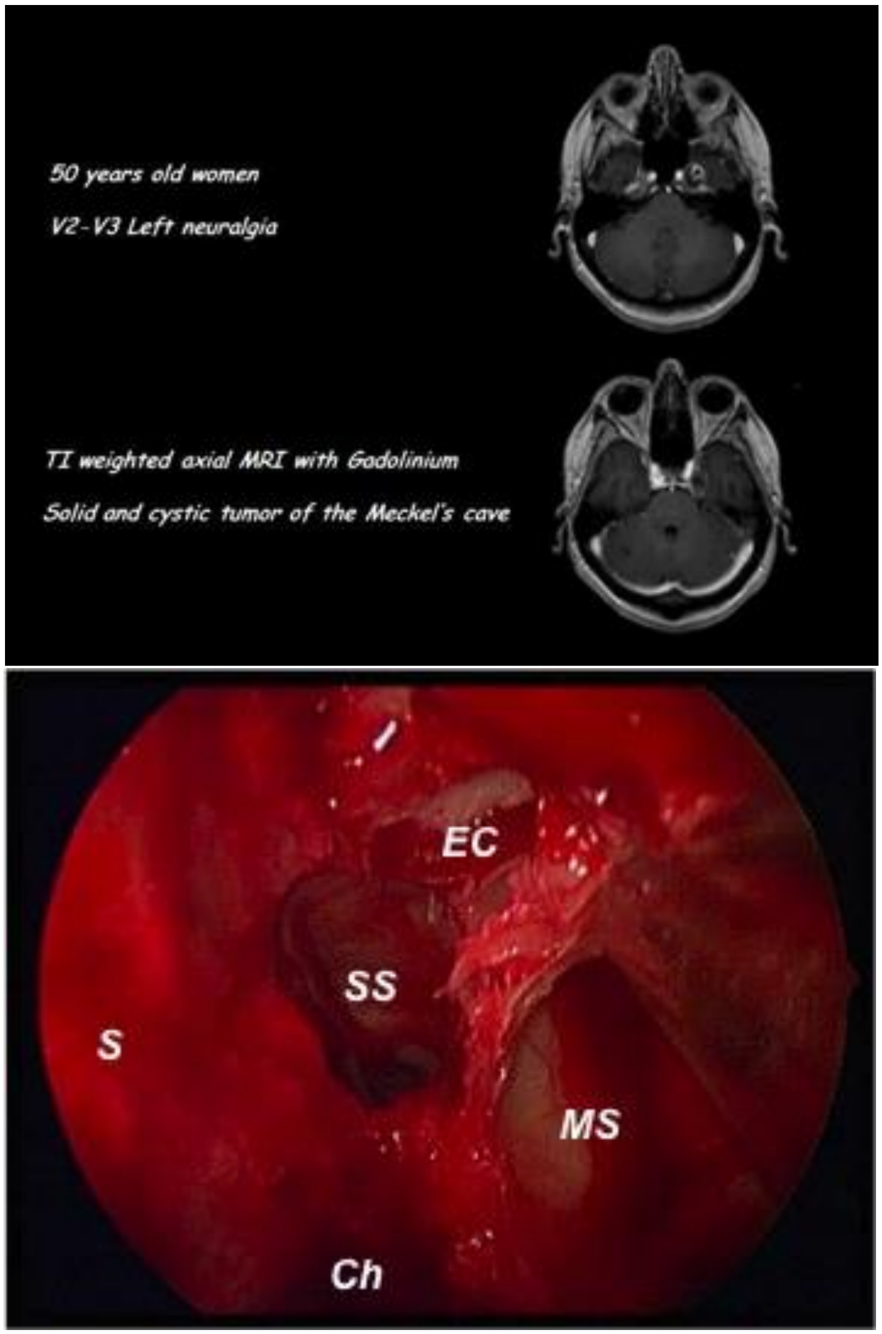

Figure 4. Operative view of a left endonasal approach for a Meckel's cave tumor. S: Septum; SS: Sphenoid Sinus; EC: Posterior Ethmoidal Cells; MS: Maxillary Sinus; Ch: Choanae.

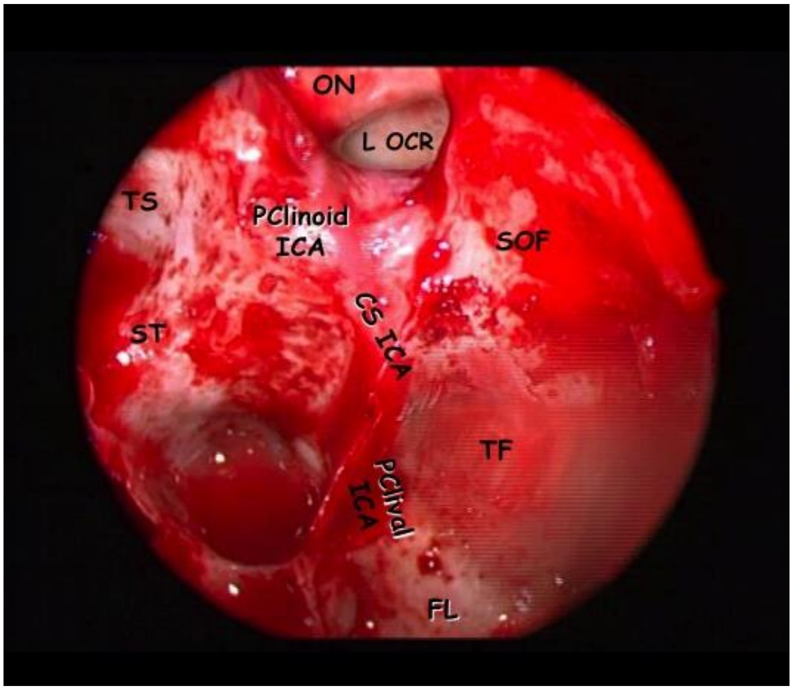

Figure 5. Operative view of the left lateral sphenoid recess in the same patient.
ON: optic nerve; C5: Pclinoid ICA: paraclinoid ICA; Sella: sella turcica; Cav Sinus: cavernous sinus; L OCR: lateral optico-carotid recess; SOF: superior orbital fissure; TF: temporal fossa, entry point to the Meckel's cave; C3: Pclival: paraclival ICA; FL: foramen Lacerum.

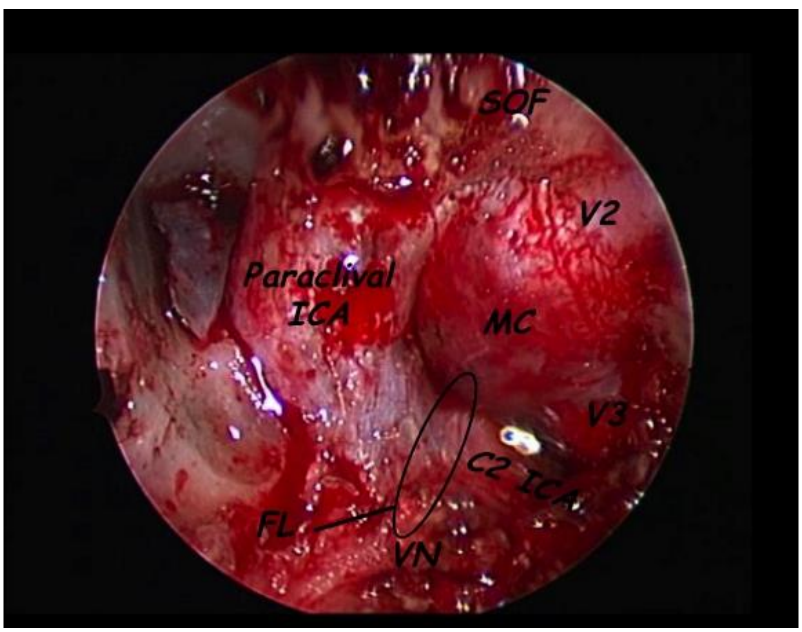

Figure 6. Operative view after removing bones structures. MC: Meckel's cave; VN: vidian nerve; FL: foramen Lacerum; C2 ICA: Horizontal petrous ICA; V2 and V3 trigeminal branches. SOF: superior orbital fissure.

Preoperative Management

Preoperative high-resolution head CT-scan (bone window, slice 1mm in thickness), head MRI, endocrinological assessment for sellar/parasellar lesion and ophthalmological evaluation are systematically performed, as well as an ENT evaluation of the nasal fossas. A CT angiography with occlusion tests [12] is performed when a tumor removal is planned to evaluate the Willis polygone functionality and possibility of vascular occlusion in case of vascular injury. Any suspicion of secondary locations of oncological process must be screened with a whole body CT-Scan and/or PET-Scan.

In all cases of endonasal extended approaches, patients are prepared few weeks before with meningococcal, streptococcus pneumoniae and haemophilus vaccines. Patients undergo polyvidone shower and nasal disinfection with polvidone cream the day before surgery and the morning of the surgery.

Operative Room Settings and Surgical Tools

The authors' endonasal endoscopic procedures derive from Jho [6] and Cappabianca [14], and has been already described in previous publications.

A dedicated instrumentation with straight 0° and angles 30° and 45° endoscopes (diameter 4mm; length: 30 cm or 18 cm) have be especially design for endonasal surgery (STORZ Cappabianca, Kassam, Castelnuevo kits ®). A HD column and endoscope are used from now on. Microprobe Doppler, high-speed bone drills and mucosal shavers are also used.

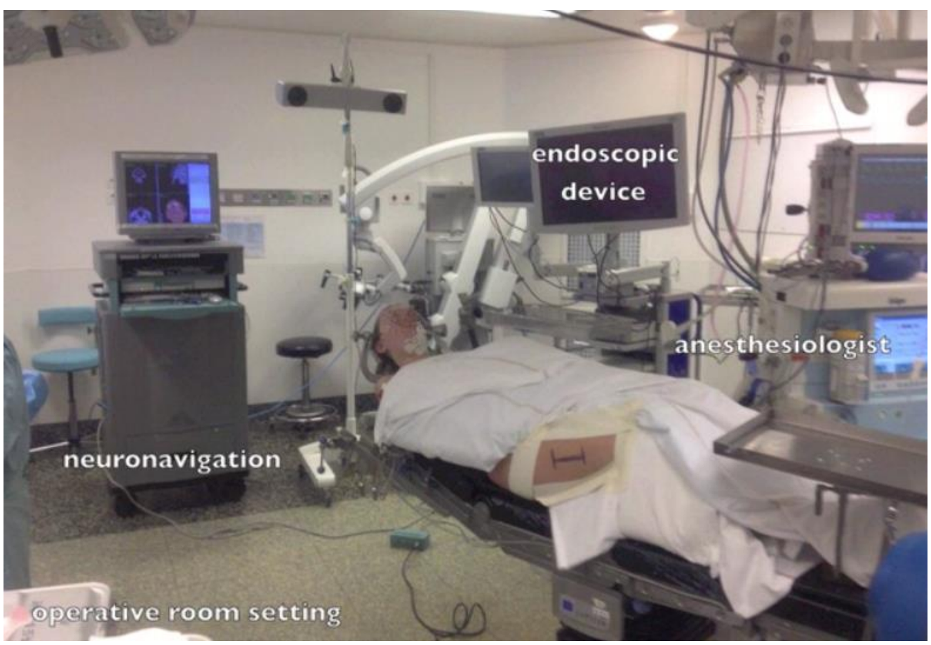

Figure 7. Operative room organization.

Patient is positioned supine with 20° elevation of the trunk and the head fixed with a three-pin Mayfield skull clamp system to be immobile for neuronavigation while right turned to face the neurosurgeon (Figure 7). This positioning is the same than that use for regular pituitary case. We rather prefer this positioning to facilitate the blood falling down during surgery and favor venous drainage. However, some authors use a strict horizontal positioning working either at this head or lateral to the patient.

As seen in the figure 6, the neuronavigation and the endoscopic column face the surgeon the first on the left side, the latter on the right. Neuronavigation is always used for extended approaches with fused CT and MR images.

During the patient positioning, the cottons soaked with an adrenalin and xylocain solution are put on each nasal cavity to favor mucosae retraction and diminish bleeding.

The lateral side of the right thigh is systematically draped in case of need of fascia lata and/or fat harvesting for reconstruction.

Surgical Steps

Two hands working is favored by the authors and a free hand during the nasal phase and with an endoscope holder for the intradural one is also preferred.

Nasal Step

During this step, a rigorous control of the blood pressure (systolic pressure around 10) and high level of sedation and analgesia will be asked to the anesthesiologist to prevent bleeding.

The surgical corridor with large aperture of maxillary, ethmoid and sphenoid sinuses are prepared on the side of the lesion but the two nostrils are used during surgery. When an intradural surgery is planned, a pedicle nasoseptal flap is useful and should have to be done in the opposite nostril.

Indeed, lateral exposition of the maxillary sinus, the pterygopalatin fossa and vidian nerve require cutting the sphenopalatine artery that is the vascular supply of the nasal flap. Moreover if the sphenopalatine artery can be preserved, the flap can be damage or annoying if done on the side of the lesion even placed into the cavum.

Until the opening of the sellar floor, a hand-held short endoscope mainly the 0° or 30° (diameter: 4 mm; length: 18 cm) will be used. The middle and superior turbinates ipsilateral to the lesion are removed by cutting and shaving with high precaution to avoid skull base fracture and CSF leaks during the mobilization of these turbinates. This middle turbinectomy is required to enlarge the nasal corridor thus facilitate access to surgical tools and identification of the sphenopalatine artery just behind the conchal crest. This turbinate will be keep intact and sometimes used for the closure time.

Sinuses Steps (Figures 3-6)

The maxillary, sphenoid and ethmoid sinuses are widely opened up. The posterior thin bone wall of the maxillary sinus is removed to get access to the pterygopalatine fossa. The sphenopalatine artery is coagulated or clipped, drilling or bone punches opens up the great palatine canal at the medial part of the pterygoid process. Pushing away laterally both the sphenopalatine artery and the great palatine nerve lead to the vidian canal that is exactly at the crossing line of the paraclival ICA, pterygoid process and the sphenoid sinus floor (Kassam neurosurgery 2008, Figure 3). Drilling the pterygoid process backward around the vidian nerve will lead to the foramen lacerum. Every effort will have to be made keeping intact the palatine nerve to avoid anesthesia of the ipsilateral superior palate. The conservation of the vidian nerve is trickier and its sacrifice exposes “only” to a dry eye. Exposition of the petrous and paraclival ICA (give the proximal and distal control of the ICA) is necessary as well as bone removal of the lateral wall of the sphenoid recess until the V2 trigeminal branch (Figures 4, 5). All the anatomical landmarks are therefore exposed to begin parasellar surgery.

Is has to be noted that for a tumor biopsy a more simple process can be done with a bone aperture of the lateral wall of the sphenoid recess to get access to the Meckel’s Cave. This is relatively easy to be done especially in sellar sinus type coming from the opposite nostril.

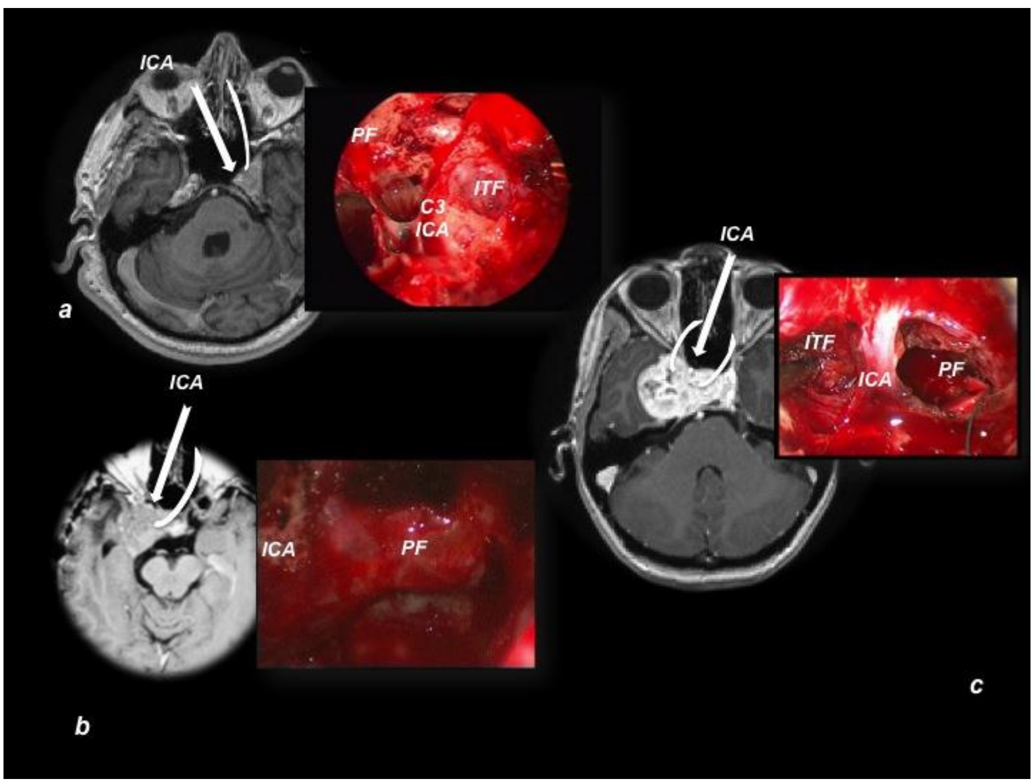

Figure 8. Importance of ICA position.

Cavernous Sinus via the Pituitary Fossa Window: Working Medial to the ICA

To approach the parasellar compartment, position of the ICA is of paramount importance (Figure 8). When pushed laterally, the cavernous sinus can be approach using the pituitary fossa. In such situation when the tumor extended laterally, this window has been already enlarged. Once the bone covering the anterior part of the cavernous sinus removed (often very thin because of the tumor growth) and the pituitary fossa opened up, the dura mater can be pushed away laterally and the medial wall of the cavernous sinus exposed (Figures 9, 10).

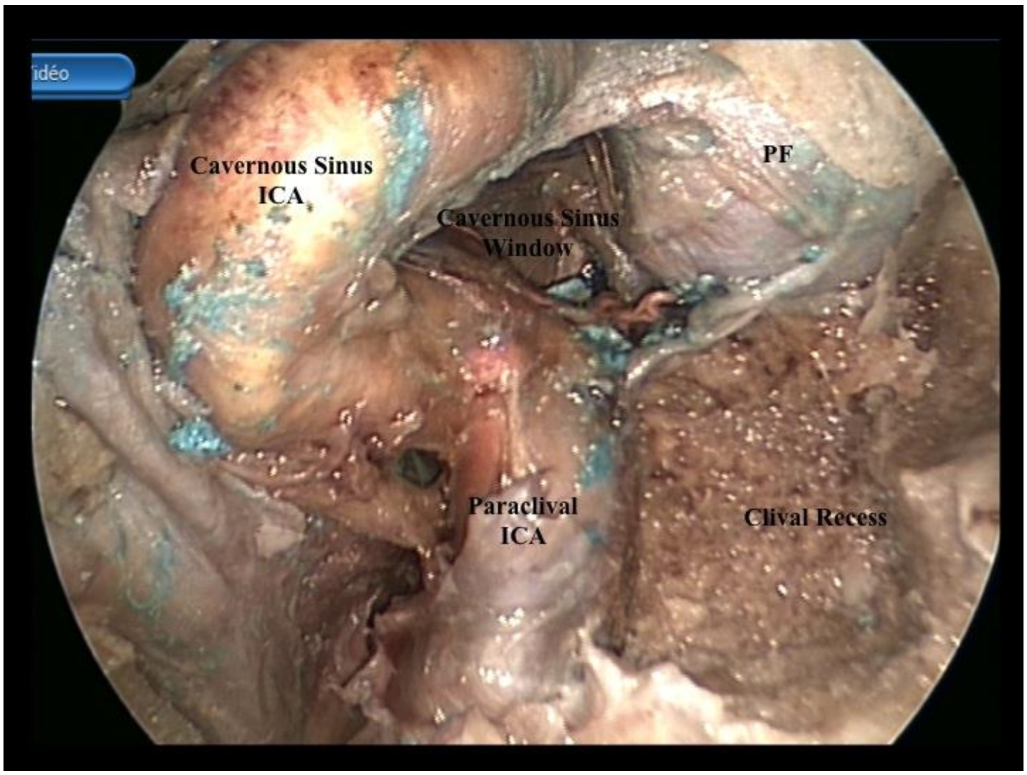

Figure 9. Anatomical study. The pituitary fossa (PF) is one of the entry doors to the cavernous sinus passing behind the anterior ICA loop.

Meckel's Cave Approach: Working Lateral to the ICA

For tumors growing in the Meckel's Cave, the window used is lateral to the paraclival and up to the petrous ICA. The dura mater is opened up behind the V2 trigeminal branch. The tumor removal used regular microsurgical techniques.

In rare case, ICA is on the midline with tumor on each side as in the case of a huge neurinoma presented in the figure 7c and both windows medial and lateral to the ICA will have to be use. In such cases, when tumor are suppose to be highly vascularized and firm, a carotid occlusion or an extra-intra vascular anastomosis depending of the functionality of the Willis polygon is an option to discuss before the tumor removal.

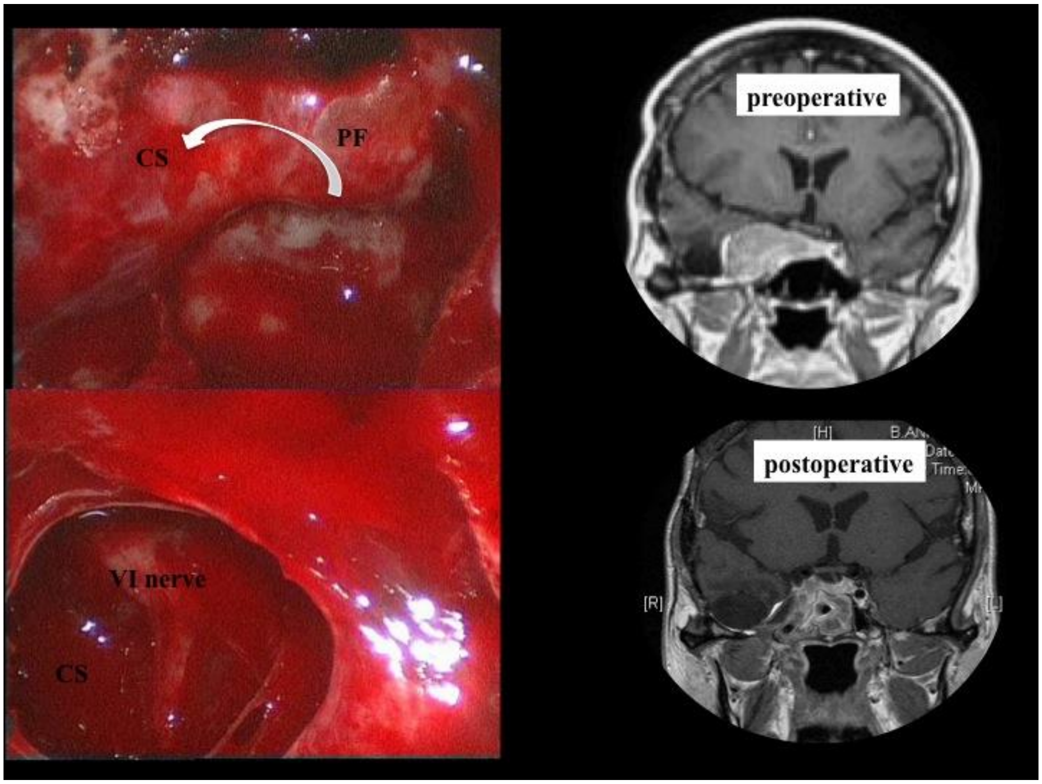

Figure 10. Operative views of a recurrent right cavernous sinus (CS) chondrosarcoma that has been removed using the pituitary fossa window (PF). Ending the removal, an angle 45° endoscope is used to explore the surgical field and the VI nerve visible at the back.

Oculo-motor Nerves Monitoring (Figure 11)

As previously mentioned, the key point to control is the ICA to prevent dramatic vascular damage. The neurological prognosis is mainly to the oculo-motor nerves and surgeon cannot trust the anatomy largely modified when the tumor growth. The V3 can be easily monitored. Mini recording electrodes are from now on available and can be placed inside the lateral and superior rectus muscles to monitor the III and VI nerves. The IV nerve monitoring is not developed yet. A short conjunctival incision is use to accurately place the electrodes without significant morbidity.

Closure Step

For a biopsy, there is not reconstruction to be made and no nasal packing necessary.

For a parasellar surgery, most of the time tumors are extradurally and we have less CSF leakage issue except if tumor extended to the petroux apex.

For an intradural surgery, the closure time is critical and all efforts have to be made to rebuild all anatomical planes. The same multilayer technique is used whatever the extended endonasal approaches.

We rather prefer use fibrin glue injected inside the surgical field than fat. Over plugging is avoided and injection of fibrin glue stopped as soon as CSF exit interrupts. No inlay graft is used but 2 onlay layers of resorbable artificial dura mater placed extradurally. A posterior septal bone piece when available or the middle turbinate can be used for bone reconstruction keep in place by fibrin glue. The nasoseptal flap is placed to cover all bone surfaces. Fat harvested from the tight or belly plugs at this end the sphenoid sinus. Bilateral nasal packing is placed for 2 to 3 days when extensive nasal surgery has been performed to ensure hemostasis and avoid synechias.

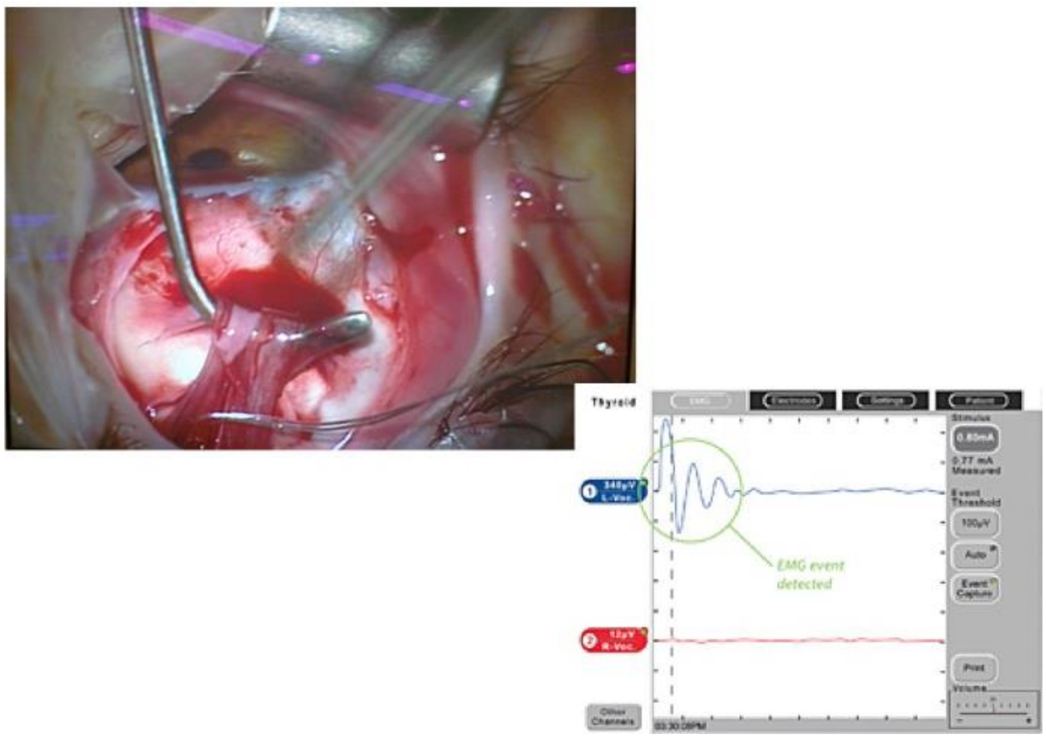

Figure 11. The recording electrode has been put in place inside the lateral rectus muscle after a trans-conjunctival incision.

Postoperative Management – Complications

After such procedures, patients are monitored in an intensive care unit during at least the 24 first hours and undergo control CT-scan or MRI at day 1.

Endocrinological and ophthalmological tests are performed to assess improvement or deterioration of these functions. Corticosteroid replacement is given each time the pituitary gland was involved during surgery until the endocrine check. Permanent DI is reported in 1% to 5% [15-18, 22, 23] in case of pituitary sella involvement.

A three days lumbar puncture is favored to lumbar drainage in case of intradural surgeries.

Daily nasal instillations are started as soon as the nasal packing is removed to treat crusting rhino-sinusitis and used for weeks or months. If a CSF leakage is checking, nasal instillations are postponed until to be sure of the wondering of the skull base.

Patients must be aware that nasal crusting syndrome is systematic for months in case of large sinuses aperture. When opening up a sinuses, the aperture have to be large for a better post-operative drainage [17]Nasal vascular complications are reported in 0.7% to 7% of cases and are either major bleedings secondary to sphenopalatine artery (endovascular management) or minor epistaxis (nasal packing) [15-18].

Fracture of the sphenoid bone, injury of the optic nerves or lesions of the carotid artery [19] are less rare complications. Injury to the internal carotid artery typically occurs during aggressive surgery of either macroadenomas extending in the cavernous sinus or huge and firm tumors encasing the ICA. These lesions are exceptional (0% to 0.68%) but may be responsible of death [20]. Intracranial hemorrhage is very rare and results from operative ICA lesion, carotid-cavernous fistulas or pseudoaneurysm with secondary rupture [21]. Each surgery with parasellar tumor removal planned have to benefit from a preoperative vascular check up that have to be done also in case of an operative suspicion of vascular damage.

The most annoying complication is obviously the occurrence of CSF leaks and meningitis rates that pedicle flap and the multilayer technique for closing help to decrease below to 10%.

Management Strategy

Further management is based on histopathological patterns of the tumors. Meckel's cave and cavernous sinus surroundings is the location of a wide variety of lesions either benign or malignant. Some inflammatory and benign processes may mimic other aggressive tumors [1, 24]. Each type of lesion requires individual consideration for management that may be medical, oncological or aggressive surgery. Clinical findings and neuroimaging is not always sufficient to make an exact diagnosis and may induce unnecessary aggressive procedure with high morbidity. The percutaneous biopsy through the foramen ovale should be performed in cases of tumor located in the posterior part of the cavernous sinus, upper part of the petroclival region and the Meckel's cave because the needle inserted through the foramen ovale can reach these regions. This diagnostic tool has a high sensitivity and specificity. Messerer et al.[24] reported an excellent kappa coefficient correlation between histological diagnosis at biopsy and open craniotomy. The advantage is a far lower morbidity than the transcranial route. However, in a series of 50 patients, 14% of these procedures were unproductive. In these cases, we recommend the use of endoscopy to make biopsy. The endoscopic procedure is also recommended in cases of lesions located at the anterior part of the cavernous sinus, which cannot be reached by the percutaneous needle. In cases of necessary surgical removal after histopathological results, the endoscopic approach is also recommended.

Figure 12 shows the algorithm proposed by the authors.

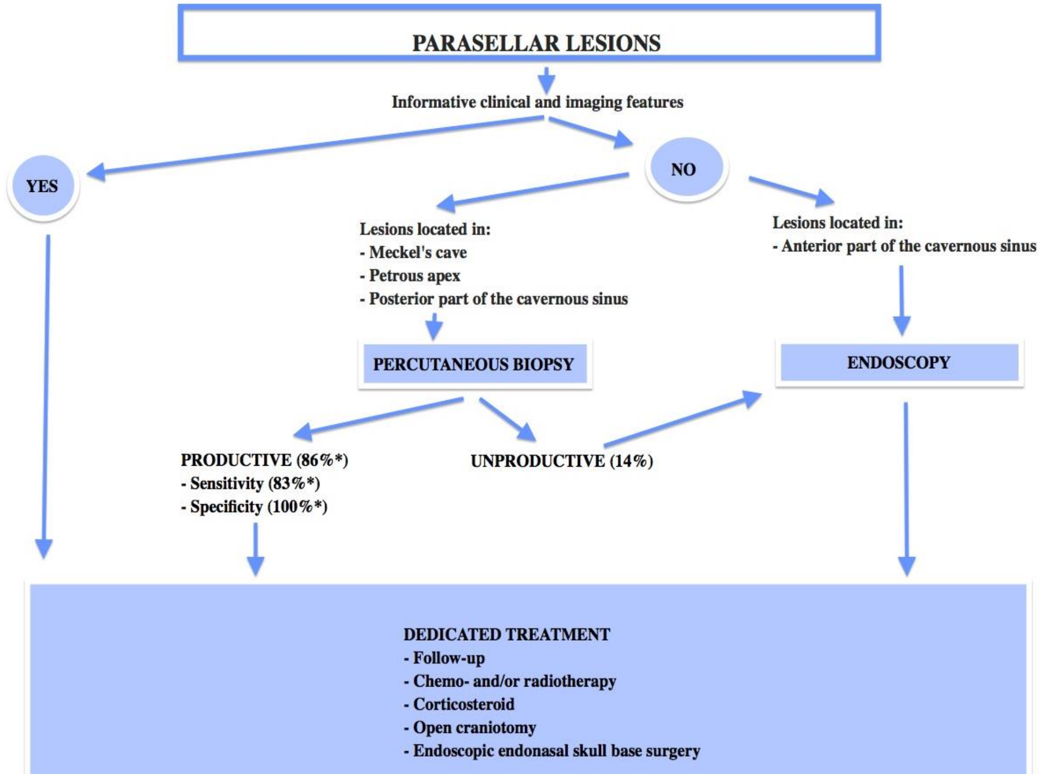

Figure 12. Flow diagram for decision-making process.

Conclusion

The parasellar region is the location of a wide variety of lesions. Clinical and neuroimaging findings are often insufficient to provide an accurate diagnosis. The diagnosis certainty is required as each lesion has its individual management. Percutaneous biopsy of these lesions through the foramen ovale avoids unnecessary aggressive procedure but it is sometimes unproductive. Percutaneous biopsy is also not suitable for lesions located anteriorly to cavernous sinus. Endoscopy allows an additional approach to biopsy and orientates management. Endoscopy may also be used in lesion removal, keeping in mind that conventional aggressive craniotomies are still required in selected cases.

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