TECHNICAL NOTE

Exposure techniques in endoscopic skull base surgery: Posterior septectomy, medial maxillectomy, transmaxillary and transpterygoid approach

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Exposure techniques in endoscopic skull base surgery have a dual objective: to identify anatomical landmarks to guide the surgeon and to establish a “surgical corridor” from the nostril to the lesion.

Posterior septectomy

Definition

This technique consists of resection of the bony and cartilaginous portions of the nasal septum, generally performed from posterior to anterior and always preserving an anterior strip of quadrangular cartilage (Fig. 1A).

Indications

The indications are:

● large sphenoidotomy, performed to provide access to the sellar region, planum sphenoidale, and clivus; and access to the olfactory cleft;
● access to lesions situated very laterally in the infratemporal fossa: posterior septectomy allows additional angulation of the instruments introduced via the contralateral nostril;
● lesions of the septum itself (malignant tumours);
● creation of a nasoseptal flap: the portion of septum exposed after harvesting the flap is usually resected.

Operative technique

Closure of the defect must be planned before performing posterior septectomy, particularly by creating a nasoseptal flap: this flap, composed of the mucoperiosteal and mucoperichondral lining of the septum, is pedicled on the posterior septal artery, a branch of the sphenopalatine
artery [1]: this flap must therefore be harvested at the beginning of the operation, as any surgical procedure performed in the posterior region of the septum is likely to damage the blood supply of this flap.

The sphenoidal ostium is identified on each side and then enlarged in order to visualize the contents of the sphenoidal sinus. The sphenoidal rostrum is disinserted from the posterior portion of the septum, and resected with a drill or a fine, sharp bone chisel: the upper limit of resection is the line joining the two sphenoidal ostia, and the lateral limits are vertical, from sphenoidal ostium to the floor of the sphenoidal sinus. The window created in the anterior wall of the sphenoidal sinus is then enlarged as required, by cautiously extending the sphenoidotomy superiorly and laterally, exposing the landmarks of the internal carotid artery and optic nerve (and therefore the optiocarotid recess). The extent of the septectomy then depends on the procedure that subsequently needs to be performed.

A limited septectomy is sufficient for a procedure in the sellar region: the posterior and inferior part of the septum is removed with retrograde forceps. A larger septectomy is performed for other types of surgery in the middle fossa or clivus, while preserving about one centimetre of the superior part of the septum in the region of the olfactory cleft to avoid anosmia and cerebrospinal fluid leak. Finally, for procedures on the cribriform plate, the septectomy is extended as necessary, without trying to preserve the superior part of the septum in the region of the olfactory cleft. In every case, an anterior strip of at least one centimetre of septum must be preserved to maintain the shape of the nasal dorsum.

Nasal packing and postoperative care
No particular nasal packing is required; nasal irrigation is prescribed, and repeated debridement of the operative cavity is performed in the surgeon’s rooms throughout the healing period.

Discussion

Advantages
Posterior septectomy allows the surgeon to operate via the two nostrils, and provides sufficient angulation for instruments to access even the most lateral regions: zygomatic recess of the maxillary sinus, infratemporal fossa (Figs. 1B, C). It provides exposure of the left and right anatomical landmarks within the same operative field.

Complications
Posterior septectomy comprises few risks, provided an anterior strip of cartilage is preserved in order to avoid any risk of saddle nose. The specific sequelae of posterior septectomy have never been studied, but the presence of a large single cavity (Fig. 1D) could be expected to contribute to symptoms of “empty nose syndrome”, with persistence of crusting, reported by some patients for several months after the operation [2], sometimes responsible for epistaxis.

Medial maxillectomy

Definition
This technique consists of resection of the medial wall of the maxillary sinus. The limits of resection are: anteriorly, the lacrimal duct, which is exposed and sectioned; posteriorly, the perpendicular plate of the palatine bone and the sphenopalatine foramen; inferiorly, the floor of the nasal fossa and superiorly, the ethmoid sinus (Figs. 2A, B).

Indications
The indications are:

- lesions located in the part of the maxillary sinus situated inferior to the inferior turbinate or anterior to the nasolacrimal canal (i.e. 65% of the volume of the sinus [3]);
- lesions implanted on the medial wall of the maxillary sinus and requiring large excision: inverted papillomas, malignant tumours;
- creation of transmaxillary/transpterygoid access.

Operative technique
The inferior section line passes below the inferior turbinate, from the tail to the head of the turbinate, then skirts anteriorly around the head of the inferior turbinate and the
Figure 2 Medial maxillectomy. A. Diagram of the resection with section of the lacrimal duct (blue) and modified medial maxillectomy preserving the lacrimal duct (red). The following anatomical structures are shown on this diagram: lacrimal duct (orange), lacrimal bone (pale blue), inferior turbinate (yellow), maxilla, uncinate process, perpendicular plate of the palatine bone, sphenoid (shaded). B. Diagram of the resection on a photo of an anatomical section. C and D. Anatomical zones accessible to instruments before and after medial maxillectomy. E. Postoperative endoscopic appearance.

Lacral sac to reach the uncinate process. The incision is coagulated preventively: the diode laser fibre allows bloodless section with limited mucosal trauma; electrocautery can also be used. Haemostasis of the region of the tail of the inferior turbinate (or even direct ligation of the sphenopalatine artery, when an ipsilateral nasoseptal flap is not performed) is performed with Dessi bipolar forceps.

The bone is then exposed by gently elevating the mucosal edges. Bone section is performed with a diamond burr until the mucosa of the maxillary sinus is clearly exposed. The nasolacrimal canal, composed in its medial and anterior portions by the maxillary bone and in its lateral and posterior portions by the lacrimal bone (superiorly) and the inferior turbinate (inferiorly), opens into the nasal fossa at the inferior meatus. The lacrimal duct is therefore exposed after drilling the medial aspect of the maxilla, and can then be cleanly sectioned with a cold instrument (scalpel or scissors) to limit the risk of stenotic scarring. In limited procedures, in which exposure of the most lateral and anterior regions of the maxillary sinus is not essential, the lacrimal duct can be preserved by performing the anterior osteotomy just posteriorly to the nasolacrimal canal, corresponding to a modified medial maxillectomy. The medial wall of the maxillary sinus is finally collapsed lateromedially and can then be extracted.

Nasal packing and postoperative care
Same as for posterior septectomy.

Discussion

Advantages

Medial maxillectomy provides wide access to the posterior and lateral walls of the maxillary sinus (Figs. 2C, D); it therefore often constitutes the first step of a transmaxillary/transpterygoid approach. Medial maxillectomy allows effective resection of pedunculated lesions of the medial wall of the maxillary sinus equivalent to that achieved by transfacial approaches, as reflected by the good long-term results in inverted papillomas [4]. Finally, medial maxillectomy simplifies postoperative surveillance of the operative cavity (Fig. 2E).

Limits

Lesions invading the anterior wall of the maxillary sinus remain inaccessible to an exclusively endoscopic approach.

Complications

The only immediate complication, haemorrhage due to injury to the sphenopalatine artery or its branches, is prevented by haemostasis of the region of the tail of the inferior turbinate. Possible sequelae are lacrimal duct stenosis, rare in our experience, and paraesthesiae of the dental hemiarcade due to damage to maxillary intraosseous nerve branches supplying the dental alveoli. Sequelae such as empty nose syndrome are relatively rare after medial maxillectomy.

Transmaxillary and transpterygoid approaches

Definition

These procedures complete medial maxillectomy by resecting the posterior and lateral walls of the maxillary sinus (transmaxillary approach), and drilling of the root of the pterygoid processes (transpterygoid approach) (Figs. 3A, B).

Indications

The transmaxillary approach provides access to the pterygopalatine fossa and infratemporal fossa. The transpterygoid approach, a more complex procedure, is required to provide access to the pterygoid muscles, pterygoid fossa, and to the difficult and exceptional approaches used for the middle cranial fossa and petrous apex [5, 6].

Operative technique

Transmaxillary approach

Medial maxillectomy (or at least a large middle meato-
tomy) is first performed to expose the walls of the maxillary sinus [7]. The posterior wall of the maxillary sinus is fractured and resected with Kerrison forceps (Fig. 3C). This resection can be extended laterally to the lateral wall of the maxillary sinus, and medially to the perpendicular
plate of the palatine bone, taking care not to accidentally damage the sphenopalatine artery at this level, as
the perpendicular plate of the palatine bone constitutes the anterior margin of the sphenopalatine foramen. The
sphenopalatine artery and the medial maxillary artery must be identified and, when necessary, coagulated before
performing the transpterygoid approach. At this stage, the fascia enclosing the pterygopalatine fossa can be incised to
access its anterior compartment, containing the maxillary artery and its terminal branches, and its posterior compart-
ment, containing nerves: maxillary nerve, vidian nerve, and pterygopalatine ganglion.

Transpterygoid approach
The anatomical landmarks used to perform transpterygoid access are identified in the pterygopalatine fossa: vidian
nerve, which courses on the floor of the sphenoidal sinus and then in the root of the medial pterygoid plate, is iden-
tified as it emerges from the pterygoid canal; the maxillary nerve is followed from the roof of the maxillary sinus to the
inferior orbital fissure.

The root of the pterygoid process can then be drilled between the lateral limit represented by the maxillary nerve
and the medial limit represented by the vidian nerve, which can be cautiously followed as far as the intrapetrosal intern-
al carotid artery [8]. The transpterygoid approach allows exposure of:

- the lateral wall of the sphenoidal sinus, which is identified after retracting the fat of the pterygopalatine fossa,
  and which can be drilled anteroposteriorly as far as the cavernous sinus [9];
- the third and last region of the infratemporal fossa: the region of pterygoid muscles. This region contains
  medial and lateral pterygoid muscles, and the pterygoid venous plexus, haemostasis of which (essentially
  ensured by prolonged compression) can be difficult [5]. Lateral dissection of this region is particularly
  haemorrhagic and complex, but allows identification of the mandibular nerve, which can be followed as far as
  the foramen ovale.

Nasal packing and postoperative care
Application of a sheet of Surgicel® onto the bleeding surface is generally sufficient to control bleeding. Nasal irrigation is
prescribed during the postoperative period.

Discussion

Advantages
These techniques are particularly useful to provide access to lateral regions of the skull base: they allow the creation of
an anterolateral corridor leading directly to the pterygopalatine fossa and more generally providing access to all
of the infratemporal fossa (Fig. 3B). The working space created by this technique allows four-hand surgery or two-hand
surgery with a scope holder, depending on the surgeon’s usual practice [10]. In our experience, four-hand surgery
is particularly useful in the case of extensive exposure of the skull base: the surgeon can successively operate on se-
veral anatomical regions, followed by the surgical assistant, holding the scope; the surgeon is able to work with two
instruments, for example by exerting traction on the tumour while dissecting it from the adjacent tissue, while the as-
sistant holds the aspirator and the scope (Fig. 4).

Complications
The transmaxillary approach comprises few risks. The transpterygoid approach can cause damage to the maxillary
nerve and sphenopalatine ganglion, causing sensory loss in the territory of the maxillary nerve and ipsilateral dry eye,
respectively.

Limits
Although these approaches provide excellent vision of the exposed regions, transmaxillary/transpterygoid endoscopic
surgery cannot adequately control the internal carotid artery: if this artery is invaded circumferentially by the
tumour, open surgery remains necessary. Certain lesions also remain inaccessible to endoscopic surgery despite creation
of a transmaxillary/transpterygoid approach, for example invasion of the infratemporal fossa extending superiorly to
the temporal fossa above the zygomatic arch.
Endoscopic view of four-hand surgery. During dissection of this juvenile nasopharyngeal angiofibroma in the infratemporal fossa, the surgeon exerts traction on the tumour while dissecting it from the adjacent tissue, while the assistant holds the scope and aspirator.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References