TECHNICAL NOTE

Transcribriform and transplanum endoscopic approach for skull-base tumors

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Endonasal endoscopic skull-base surgery has greatly progressed in recent years. Indications, initially dedicated to sellar lesions, have progressively widened. The present study describes an endoscopic technique using an approach via the cribriform plate and planum sphenoidale.

Surgical technique

We shall first describe the initial stage of sellar region exposure, common to all endoscopic approaches to the pituitary and planum sphenoidale and to extended approaches to the olfactory groove. We then distinguish dissection techniques specific to olfactory groove and planum sphenoidale lesions, and conclude with the principles of closure and reconstruction, common to both topographies. The images are taken from a clinical case of planum sphenoidale meningioma with anterior extension towards the olfactory groove (Fig. 1).

Sellar region exposure

Surgery begins with total ethmoidectomy and bilateral sphenoidotomy.

In large-scale skull-base dissection, reconstruction must be leak-proof. A local pediculated flap (usually a nasoseptal flap) for assembly protection should be made available at this point in the procedure and placed either in the cavum or in the maxillary sinus so as to leave the operative field free.

The posterior part of the septum is detached from the sphenoidal rostrum and partially resected using retrograde forceps. The rostrum is then excised, so as to open wide the anterior wall of the sphenoid sinus. The nasal septum resection is continued as appropriate, conserving a strip of anterior cartilage and, in a planum sphenoidale approach, the superior olfactory part of the septum.

Any intrasinus septations are carefully removed, bearing in mind that their insertions are often onto optic or carotid protuberances. It should also be borne in mind that they do not serve as landmarks for the midline (unlike in the sphenoidal rostrum).

The sphenoid sinus mucosa is so far as possible conserved, to accelerate healing. In case of extended approach requiring complex reconstruction, however, it may be...
resected, having checked that the optic nerves and internal carotid arteries are not bare. The following endoscopic landmarks can then be visualized: planum sphenoidale and sellar floor, sellar and clival portions of the carotid protuberances, optic protuberances on either side of the planum sphenoidale.

**Planum sphenoidale**

The planum sphenoidale is drilled between the optic nerve protuberances until the dura mater is exposed, or thinned and then resected by Kerrison forceps.

The planum dura mater is then preventively coagulated by bipolar forceps and opened to expose the supra-sellar spaces. Cappabianca, Cavallo and de Divitiis recommended dividing the supra-sellar spaces into four regions separated by a horizontal plane and a coronal plane through the optic chiasm [1]: depending on tumor topography, care is to be taken to conserve certain neurovascular structures:

- in the suprachiasmatic region (above and forward of the optic chiasm) lie the anterior part of the chiasm and medial part of the optic nerves, the anterior part of the circle of Willis, and the gyrus rectus of the frontal lobes;
- in the subchiasmatic region (below and forward) lie the pituitary stalk and superior part of the pituitary gland, and the superior hypothalamic arteries, internal carotid artery and A1 segment of the anterior cerebral artery;
- in the retrosellar region (below and behind) lie the pons and mammillary bodies with the oculomotor nerves, superior part of the basilar artery and the beginning of the posterior cerebral arteries and the superior cerebellar arteries, with the floor of the 3rd ventricle visible behind;
- finally, the ventricular area (above and behind) becomes accessible after opening the floor of the 3rd ventricle.

**Olfactory groove**

The approach should be completed by Draf 3 nasalization of the frontal sinuses: before any excision, a large cavity from one lamina papyracea to the other needs to be visualized, with the following landmarks above (from front to back): nasalized frontal sinuses with good view of the posterior wall, anterior and posterior ethmoid artery relief, planum sphenoidale between the relief of the optic nerves, and sellar floor.

Excision begins with an osseous stage, using a surgical drill. The resection is traced as appropriate, depending on tumor topography and size. Here, we describe contouring the largest excision feasible under endoscopy.

The anterior trace is at the lower part of the posterior wall of the frontal sinus. It crosses the midline through crista galli, which is the intracranial part of the perpendicular lamina of the ethmoid and should be resected with care (Fig. 2). The lateral traces are at the junction of the papyraceous lamina and the superolateral angle of the ethmoid labyrinth. Care must be taken to identify the anterior and posterior ethmoidal arteries, and to clip or coagulate them before sectioning: any arterial wound can induce intraorbital hematoma if the arterial stump retracts into the orbit. The lateral section trace is continued up to the planum sphenoidale, which is usually preserved.

The bone resection stage is followed by the dural stage. At this point, it is recommended, before incising the dura mater, to detach it from the underlying bone laterally over the ethmoid roof or from the orbits: the space thus created facilitates positioning of the extradural intracranial reconstruction layer. The dura mater can then be sectioned facing the bone section. The block of bone and dura mater is then mobilized and progressively lowered, dissecting the dura mater or the tumor from the underlying cerebral tissue (Fig. 3). Lowering the block draws the olfactory bulbs, and then the olfactory tracts in the olfactory sulcus, between the inferior parts of the superior and medial frontal gyri. The tracts are sectioned and the block is removed. If necessary, it can be fragmented for extraction via a nostril, or via the rhinopharynx and mouth.

**Reconstruction and closure**

The situation here is of an opening with a large dura mater defect and high risk of CSF leakage. Reconstruction therefore has to be especially painstaking, aiming to reconstruct the various planes of the skull-base (Fig. 4).

Initial arachnoid plane reconstruction should if possible be performed intradurally, with autologous (fascia lata) or heterologous material (Neuro-Patch®): a large fascia lata

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**Figure 1** T1-weighted MRI sequence, axial (A), coronal (B) and sagittal (C) slices: aspect compatible with meningioma of the planum with anterior extension toward the olfactory groove.
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Figure 2 Exposure of frontal dura mater (DM) after rasping the cribriform plate (CP); the anterior boundary of rasping is the posterior wall of the frontal sinus (PWFS) and crista galli (CG) in the medial part, and the lateral boundary is the superior angle of the lamina papyracea (LP).

Figure 3 Dissection of underlying cerebral tissue meningioma. FL: frontal lobe; DM: dura mater; T: tumor (meningioma).

Figure 4 Reconstruction ideally comprises three layers: intradural, intracranial extradural, and extracranial.

fragments can be slid into the defect, applied over the dural edges and held by biologic glue. Observing the graft movement under heartbeat confirms leak-proof assembly.

A second intracranial dural layer is then formed using dura substitute, bone substitute or another layer of fascia lata, middle or inferior turbinate stripped of its mucosa, or other autologous material.

Finally, leak-proofness can be considerably enhanced using a local pediculated flap (turbinal or especially nasoseptal flap).

Contention is required to ensure assembly stability during healing: i.e., for some 10 days. There are several options: a sheet of reinforced Silastic fixed as an arch in the nasal cavity and supported by a series of fat wicks; a balloon inflated in the nasal fossa; or a sheet of Dura Seal® may in some cases be sufficient.

Discussion

These endoscopy techniques are indicated for a wide variety of lesions, and above all in tumoral pathologies, whether benign (meningioma, craniopharyngioma or pituitary macroadenoma with suprachiasmatic extension) or malignant (adenocarcinoma, olfactory esthesioneuroma) [2,3]. Morbidity seems to be less than with craniofacial...
resection. It must be borne in mind, however, that there have been no prospective randomized studies to show benefit in comparison with conventional approaches in malignant tumor surgery [4]. In congenital (meningoencephalocele) and traumatic pathologies, on the other hand, endoscopy has been shown to be at least as effective as an external approach [5].

The approach enables the set of anatomic landmarks to be identified to guide excision. On a sellar approach, the surgical corridor might be no more than a nasal fossa; in extended approaches, in contrast, a cavity large enough for 4-hand surgery must be created [6], by ethmoidectomy or resection of the septum. The excision stage begins with drilling the skull-base to expose the dura mater. In case of malignant tumor, resection will be oncological, with mucosal resection and drilling at a distance from the tumor. The exposed dura mater is sectioned within the healthy area, and invaded dura mater is removed en bloc with the bone (or bone lysis) in contact with the lesion. In malignant sphenoidal tumor, total macroscopic exeresis of the tumor is performed before the dural stage is undertaken, so as to minimize metastatic dissemination in the CSF. In benign tumors on the intracranial side of the skull-base, the bone facing the insertion pedicle is completely drilled away; the navigation system determines the area with precision. The exposed dura mater can then be coagulated to devascularize the tumor. An endonasal approach is thus particularly well suited to olfactory meningioma and craniopharyngioma [7].

Anterior stage and planum sphenoidale resection involves a high risk of CSF leakage due to the open cavity just below the defect and the lack of counterpressure. There is no consensus as to the method of reconstruction [5]. The most widespread attitude is to reconstruct with several successive layers [8,9]. Synthetic materials such as fibrin glue, which are resorbable over the medium term, serve especially to ensure temporary leak-proofness to improve assembly integration. The nasoseptal flap does not provide leak-proofness as such; it does, however, help consolidation of the underlying reconstruction and cicatrization and has also been shown to improve postoperative quality of life [10], accelerating nasal cavity re-epithelialization, thereby limiting symptoms such as dry nose and crusty secretion. It is, however, formally contra-indicated in malignant tumor.

Disclosure of interest

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

References