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Technical note

# Anterior skull base reconstruction after tumour resection using the posterior wall of the frontal sinus

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## ABSTRACT

**Introduction:** The authors describe their experience of surgical closure of the anterior skull base after tumour resection, using the posterior wall of the frontal sinus.

**Material and method:** The authors describe their anterior skull base closure technique performed in three patients after tumour resection. Tumour resection via a transglabellar approach resulted in an anterior skull base defect. Reconstruction consisted of direct implantation of the posterior wall of the frontal sinus without using a bone substitute (except when nasofrontal duct obstruction is required).

**Results:** Three patients were operated by this surgical procedure with complete tumour resection in every case and no infectious complications. This technique was easy to perform, despite one case of persistent CSF leak. Follow-up imaging showed no displacement of the onlay bone graft.

**Conclusion:** Anterior skull base reconstruction after tumour resection using autologous frontal sinus bone graft is easy to perform with a low complication rate.

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## 1. Introduction

Complete resection of anterior skull base tumours often leaves a bone defect, which requires reconstructive surgery to create a watertight separation between sinonasal cavities and the sterile intracranial space. Closure of this defect prevents the risk of cerebral herniation and pneumocephalus [1], while preserving effective sinonasal drainage. The authors report their experience of use of the posterior wall of the frontal sinus to reconstruct the anterior skull base.

## 2. Material and method

Three patients presenting the following criteria were consecutively included and operated at Reims university hospital, France, between 2009 and 2013: tumour site corresponding to the jugum sphenoidale and cribriform plate of the ethmoid and preoperative assessment of the lesions, compatible with transglabellar resection [2] with no radiological signs of invasion of the inner table of the frontal sinus and with a complete posterior bony wall of the frontal sinus.

The first patient (a 61-year-old man) presented with frontal syndrome with disorientation in time and space and anosmia for about two weeks. Radiological assessment (CT and MRI) showed an osteolytic lesion invading the ethmoidal, frontal and sphenoidal sinuses and cribriform plate, surrounded by oedema, suggestive of esthesioneuroblastoma.

The second patient (51-year-old woman) presented with headache, vertigo and anosmia for three years, accompanied by depression and disorientation in time and space for one year. MRI revealed a probable multilobed meningioma of the anterior skull base extending from the jugum to the cribriform plate.

The third patient (66-year-old man) presented with headache, vertigo and anosmia for three years. On admission, he reported the presence of CSF rhinorrhoea for three months. Brain MRI (Fig. 1) suggested esthesioneuroblastoma invading the ethmoid and cribriform plate.

In view of the anterior skull base invasion and the tumour site, it was decided to perform a transglabellar approach, as described by Kleiber et al. [2], in all three patients. External lumbar drainage was performed in the third patient with preoperative CSF rhinorrhoea. A symmetrical incision was performed below the orbital margin through the nasofrontal fold with retraction of skin and subcutaneous tissues. A frontal sinus anterior wall bone flap was raised with an oscillating saw, and the nasofrontal ducts were obstructed with bone substitute and abdominal fat. The frontal

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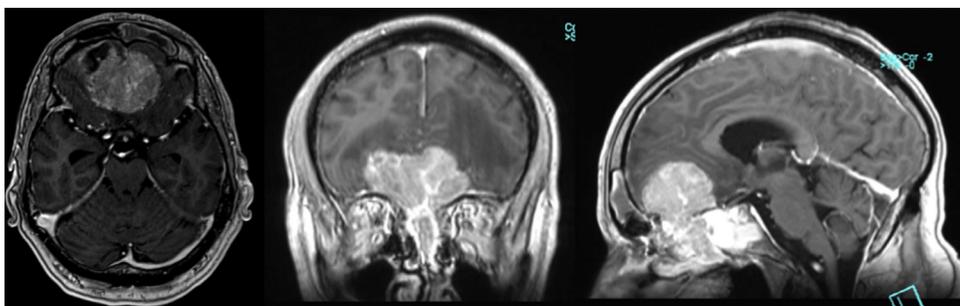


Fig. 1. Preoperative MRI of the third patient with ethmoid esthesioneuroblastoma.

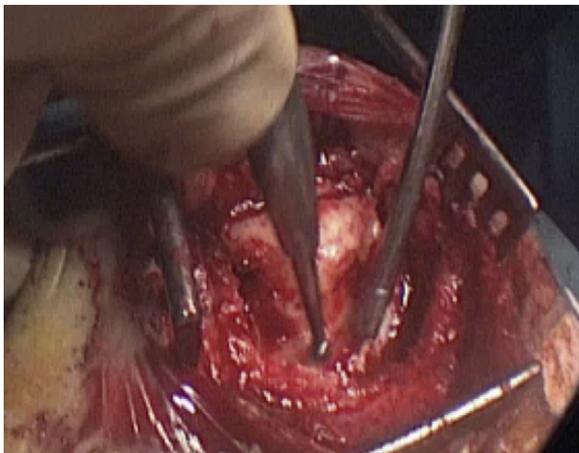


Fig. 2. Harvesting of the inner table of the frontal sinus.

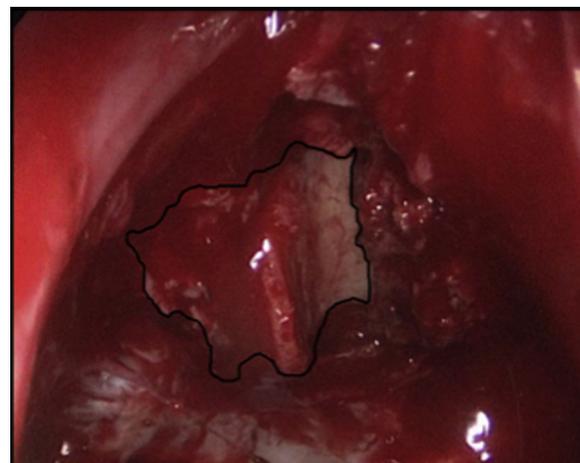


Fig. 3. Intraoperative endonasal endoscopic superior view showing placement of the bone graft.

sinus was cranialized. The periphery of the posterior wall of the frontal sinus was drilled to obtain a one-piece autologous bone graft (Fig. 2).

The tumour was completely resected in all three cases. The invaded crista galli and cribriform plate were resected, leaving an anterior skull base bone defect. When necessary, the dura mater was sutured as tightly as possible. The frontal sinus posterior wall bone graft was placed between the orbital roofs to repair the bone defect after ensuring the absence of macroscopic bone invasion. The bone graft was tailored with the oscillating saw as necessary. All layers were closed with fibrin sealant. No bone substitute was used, except for obstruction of the nasofrontal ducts during the transglabellar approach. The frontal sinus anterior wall was replaced and fixed by a miniplate and screws.

When an endoscopic approach was performed, the position of the graft was confirmed visually (Fig. 3). An external lumbar shunt was placed in the third patient with preoperative CSF rhinorrhoea.

### 3. Results

This reconstruction was performed in three patients between 2009 and 2013. Tumour resection was considered to be macroscopically complete in all patients, with a Simpson grade 2, resection for the meningioma. In every case, the tumour implantation site was the jugum sphenoidale and the cribriform plate of the ethmoid.

Histological examination confirmed the resection of two esthesioneuroblastomas and a WHO grade II meningioma. All patients received preoperative and postoperative corticosteroid therapy. The two patients with esthesioneuroblastomas also received adjuvant chemoradiotherapy.

No infection, infectious meningitis, or postoperative complications were observed. Watertight closure of the anterior skull base

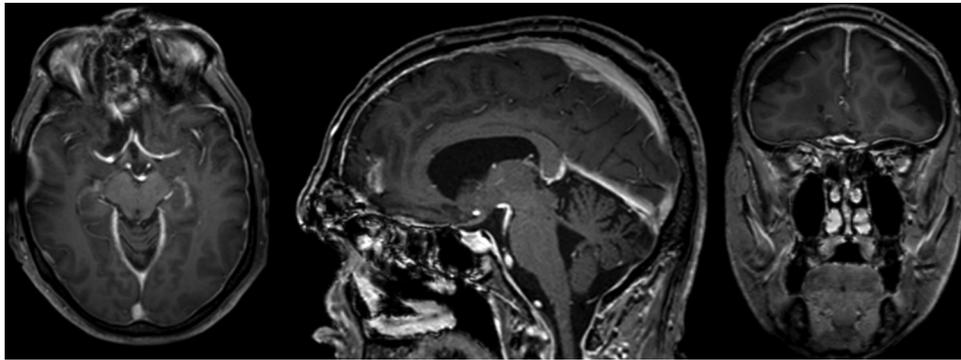
was achieved in every case. Only the patient with preoperative CSF rhinorrhoea required endonasal endoscopic revision to obstruct the nasofrontal ducts with bone substitute without changing the position of the bone graft on the skull base.

Follow-up MRI imaging performed between 12 and 18 months did not show any signs of local recurrence of the esthesioneuroblastomas (Fig. 4), in contrast with the WHO grade II meningioma. CT imaging did not show any displacement of the bone graft (Fig. 5) on postoperative day 5 and then at systematic 1-month and 6-month and subsequent cancer follow-up. Follow-up CT scans did not reveal any signs of radiation necrosis or demineralization of the bone graft.

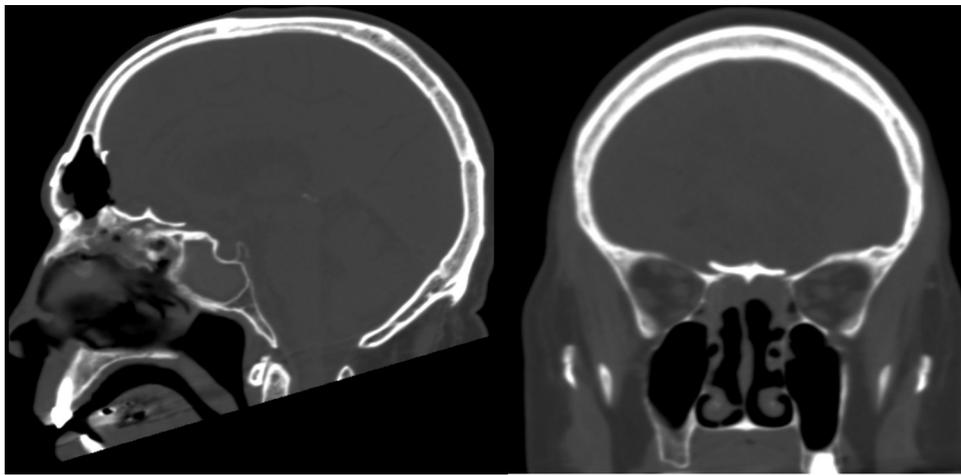
Mean postoperative follow-up was 29 months (range: 18 to 39 months) with a cosmetically acceptable, almost invisible scar (Fig. 6).

### 4. Discussion

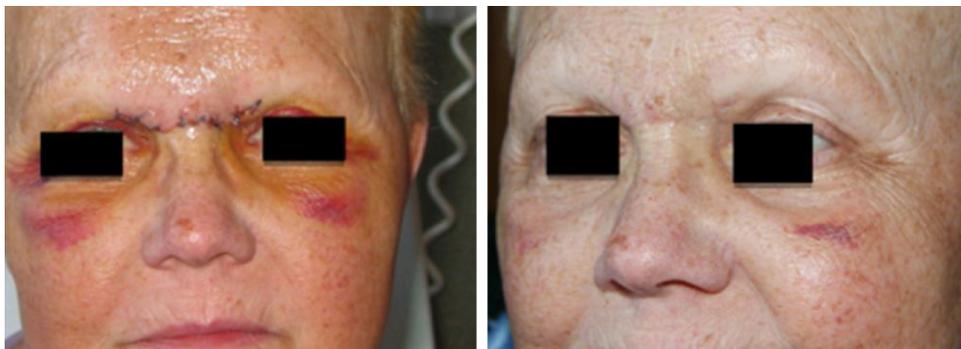
Anterior skull base reconstruction after tumour resection is a challenging procedure for the surgeon due to the lack of available tissue for local reconstruction. However, precise reconstruction of the cranial defect, adapted to the extent of tumour resection, is essential to prevent postoperative complications, as reported in the literature [1]. No anterior skull base reconstruction procedure has been shown to be superior to another [3] and a combination of several techniques is usually performed to achieve watertight closure. Use of the posterior wall of the frontal sinus requires the use of galea or pericranium to ensure watertight closure of the defect, as routinely performed by a number of authors [4]. Due to the endogenous nature of the surgical reconstruction described here, and although it remains limited, it allows good healing and decreases the risk of



**Fig. 4.** Postoperative MRI 13 months after resection of an ethmoid esthesioneuroblastoma in the third patient.



**Fig. 5.** Postoperative CT scan: no displacement of the bone graft.



**Fig. 6.** Cosmetic results in the second patient on postoperative days 1 and 15.

postoperative complications. Autologous reconstruction also facilitates postoperative radiotherapy.

Most authors use a bone graft to prevent cerebral herniation. However, autologous bone graft reconstruction is not always possible [5] and, depending on the size of the defect, several materials may be used, such as bone substitute (hydroxyapatite), titanium plates or porous polyethylene (Medpor®) [6]. These techniques are generally used for small defects not requiring solid material, while our technique can be used to reconstruct larger anterior skull base defects. The use of tissue transfer has also been reported [7], but these endoscopic procedures are more complex, longer, and more difficult to learn. They can also mask local recurrence during radiological follow-up and sometimes leave an unsightly scar when a second incision is required.

We use autologous biological material, which is less expensive and associated with a lower risk of infection [8]. We have not experienced any difficulties in placement of the posterior wall of the frontal sinus and no signs of displacement have been observed on postoperative imaging (Fig. 5). This approach allows a reduction of the high postoperative complication rate (about 36%) observed in this type of surgery for this tumour site (35.5% of early complications and 54.8% of late complications) [9]. This technique ensures good quality watertight closure, which is essential to avoid cerebrospinal fluid leak: only one patient required endonasal endoscopic surgical revision for CSF rhinorrhoea that was already present preoperatively, despite preoperative external lumbar drainage. This risk of CSF rhinorrhoea is about 5% [9] and can be as high as 41% depending on the surgical technique used.

The main postoperative complication after this type of surgery is anosmia, reported in more than 75% of cases [10], but two of our patients described this symptom before surgery. Finally, no case of meningitis, the most common infectious complication, was observed in our three patients. The complication rate is higher in a context of adjuvant radiotherapy [3].

The main limitations of this surgical procedure concern tumour invasion or anatomical absence of the posterior wall of the frontal sinus. We have used this technique on only a limited number of patients, but it appeared to be simple to perform and useful to prevent postoperative complications after resection of anterior skull base tumours.

## 5. Conclusion

Reconstruction of an anterior skull base defect using the posterior wall of the frontal sinus after tumour resection is reliable, easy to perform and economic. The autologous bone material is adapted to this procedure, associated with a low complication rate and low morbidity. This technique also preserves sinonasal functions with a good cosmetic result. This technique should be considered more often whenever it is feasible.

## Disclosure of interest

The authors declare that they have no competing interest.

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