

## INDICATION AND LIMITS IN FRONTAL SINUS SURGERY: DECISION CRITERIA

Giacomo Gravante, MD;<sup>1,2</sup> Alberto Gandolfi, MD;<sup>1,2</sup> Michele Piccinno, MD;<sup>1,2</sup> Francesco Di Pierro, MD;<sup>1,2</sup> Luca Volpi, MD;<sup>1,2,3</sup> Maurizio Bignami, MD<sup>1,2,3</sup>

### Affiliations

<sup>1</sup>Division of Otorhinolaryngology, Department of Biotechnology and Life Sciences, University of Insubria, Varese, Italy.

<sup>2</sup>Department of Otorhinolaryngology, ASST Lariana, Como, Italy

<sup>3</sup>Head and Neck Surgery & Forensic Dissection Research center (HNS&FDRc), Department of Biotechnology and Life Sciences, University of Insubria, Varese, Italy.

### CORRESPONDING AUTHOR:

Giacomo Gravante, MD Division of Otorhinolaryngology, Department of Biotechnology and Life Sciences, University of Insubria, Ospedale di Circolo e Fondazione Macchi, Via Guicciardini 9, 21100, Varese, Italy. Phone: (+39) 0332.393278 - Fax: (+39) 0332.393279

E-mail: [giacomo.gravante1@gmail.com](mailto:giacomo.gravante1@gmail.com)

### ABSTRACT

Frontal sinus surgery represents a complicated challenge in sinonasal surgery, due to its proper anatomic features with narrow spaces and its proximity to structures with high risk of complications (orbit, intracranial content, nasolacrimal pathway). Still debated remains the choice of the correct surgical approach, given the choice between an external one, an endoscopic one or a combined procedure. The present report will discuss the three main aspect in the decision-making process of the appropriate surgical approach that should be used: histology, anatomy, and extent of disease. Surgical equipment and techniques refinements empowered endoscopic transnasal surgery in the management of the frontal pathology, allowing less invasive procedures and lower incidence of comorbidities compared to external approaches.

### REPORT

At the time when a surgeon faces the endoscopic sinus surgery, the frontal sinusotomy represents the most challenging step. In general, external surgical approach, endoscopic transnasal surgery or a combined procedure constitute the available ways to dominate the frontal sinus. However, the

understanding of limits and indications is the milestone in deciding the correct surgical approach. Three main elements guide through the correct choice: histology, anatomical factors, and extent of disease. [1]

The first element to be aware of is represented by histology. Frontal sinus pathology includes both benign and malignant disease. The first is represented by inflammatory pathology, cerebrospinal fluid (CSF) leaks, traumatic lesions and benign neoplasms, such as inverted papilloma and osteomas. The latter include primary frontal sinus malignancies, metastases or local extent of sinonasal tumors into the frontal sinus. In such particular cases, the need to obtain oncological radicality, achievable only with the full control of disease extent, doesn't always allow to employ an exclusive endoscopic technique. In particular, limitations precluding an exclusive endonasal approach are: massive involvement of the lacrimal pathway; involvement of the orbit content; invasion of the infratemporal fossa; massive involvement of the frontal sinus, especially in its superior and lateral aspect, or its posterior or anterior bony wall; involvement of bony walls of the maxillary sinus (with exception of the medial one);

nasal bones and palate infiltration; brain parenchymal involvement. Therefore, the gold standard currently remains an external approach, possibly in combination with an endoscopic one. Thus, in general, exclusive endoscopic surgery for frontal sinus carcinomas must be carefully evaluated and selected only in particular conditions and in expert hands. Technological advancement of surgical instrumentations has certainly contributed to extend the surgical limits in such malignant diseases.

The second element in the decision-making choice of surgical technique concerns anatomical factors. Anatomic and surgical knowledge applied to imaging scans is crucial. In particular, computed tomography (CT) and magnetic resonance imaging (MRI) help to identify anatomical landmarks and the extent of the disease. When approaching the frontal sinus, it is mandatory to know the configuration of the frontal recess (FR), the dimensions of the frontal sinus and the relation with surrounding structures. When studying the frontal sinus recess, it is important to evaluate *agger nasi* and *bullae ethmoidalis* dimension. When analyzing the frontal sinus dimension, it is crucial to know that a small antero-posterior diameter (<1 cm) and a small interorbital distance is a relative contraindication to endoscopic frontal sinus surgery [2]. Orbital transposition or superior eyelid corridor may represent valid minimally invasive approaches in order to overcome relative contraindications [1,3-5]. Finally, when evaluating the relation with the surrounding structures, it is essential to state the presence of septal spur, middle turbinate and lamina papyracea conformation, *Haller cell*, lateral lamella inclination and insertion of uncinata process, paying particular attention to its

insertion on lateral lamella which can lead, if traumatized, to an iatrogenic fistula.

The third element to consider before defining the definitive surgical approach is the site and extent of the disease, that will discern between a conservative or demolition surgery. If the disease is limited to the FR, an endoscopic type I Draf, consisting in an anterior ethmoidectomy and clearance of frontal recess, could be performed. When the disease extends beyond the FR and a wider radicalization is needed, an endoscopic frontal sinusotomy with the removal of the frontal sinus floor (type IIA, IIB, IIC and III Draf) is imperative.[6] Actually, the definitive surgical route, in some cases, is finally dictated by intraoperative findings. It's in fact advisable, especially for those cases with massive frontal sinus and/or supraorbital cell involvement, to indicate, in the informed consent, the possibility of an intraoperative switching from an endoscopic to a combined endoscopic-transcranial approach.

To note, both techniques, endoscopic and external, present advantages and disadvantages.

Endoscopic surgery shows many advantages such as: a better visualization of anatomic structures, no cutaneous scars, less postoperative morbidity, limited blood loss (when considering the anterior compartment), and shorter hospitalization time [7,8]. However, disadvantages include a difficult management of potential intraoperative complications, such as massive bleeding, and inadequate control of lesion limits; moreover, endoscopic surgery forecasts a long learning curve, as well as very sophisticated instrumentation [9,10].

External open surgery, on the other side, is still mandatory in certain conditions listed before, where exclusive endoscopic management is inadequate. In such

cases, different surgical techniques are described in literature as the harvesting of an osteoplasty flap (OPF), the lateral rhinotomy approach, Lynch procedure, trephination technique and superior eyelid corridor [11,12]. Advantages related to open surgery are a wide surgical field, a better control of neoplasm excision and intraoperative complications. However, it can lead to a longer hospitalization time and impairment of the cervico-frontal branch of the facial nerve. [1] Cases of frontal sinus pathology encroaching and possibly crossing the anterior or posterior bony wall of the frontal sinus, with intracranial extension or subcutaneous involvement, should be treated using traditional transcranial approaches, such as Riedel's procedure, that consists in removing the anterior wall and floor of frontal sinus, and its modification according to Mosher's, with removal of the sinus posterior wall. [13,14] However, this procedure leads to forehead cosmetic defects subsequently fixed with a deferred surgical reconstruction. The indications to perform a Riedel-Mosher technique can be schematized in: failure of other surgical treatment; infections of the anterior/posterior walls (osteomyelitis) with or without cutaneous fistula; complex fractures of the anterior/posterior walls; some tumors of the frontal sinus; revision surgery after failure of OPF; self-resorption of frontal bone (post-craniotomy); osteo-dural decompression for cerebral edema and/or intracranial hypertension). [15]

Surgical instrumentations and recent technologic advantages represent the available tools for the surgeon to reach and control frontal sinus pathology. [16] Furthermore, the evolution of visual systems offers an increasingly clear vision of nasal structures. In this context, ARTipCruise VITOM 3D 4K, composed of a robotic arm with a high-quality

camera, allows to reproduce excellent images with a three-dimensional surgical perspective. Finally, neuronavigation systems, both magnetic or optical, are useful tools in orienting the surgeon in the absence of anatomical landmarks, complex anatomy, widespread pathology or selected revision surgeries [17].

## CONCLUSIONS

- Frontal sinus surgery is the most difficult step in sinonasal surgery and a deep anatomical knowledge is crucial.
- The choice of the surgical approach is based on histologic features, anatomy and extent of disease.
- Advantages in surgical equipment and techniques refinements have allowed further expansion of endoscopic surgical indications
- Traditional external approaches must be part of the surgical background, as some cases are not amenable to an exclusive endoscopic transnasal approach

## REFERENCES

1. Castelnovo P, Giovannetti F, Bignami M, Ungari C, Iannetti G. Open surgery versus endoscopic surgery in benign neoplasm involving the frontal sinus. *J Craniofac Surg.* 2009 Jan;20(1):180-3. doi: 10.1097/SCS.0b013e318191cf04.
2. Pietrobon G, Karligkiotis A, Turri-Zanoni M, et al. Surgical management of inverted papilloma involving the frontal sinus: a practical algorithm for treatment planning. *Acta Otorhinolaryngol Ital.* 2019

- Feb;39(1):28-39. doi: 10.14639/0392-100X-2313.
- 3.Karligkiotis A, Pistochini A, Turri-Zanoni M, et al. Endoscopic endonasal orbital transposition to expand the frontal sinus approaches. *Am J Rhinol Allergy*. 2015 Nov-Dec;29(6):449-56. doi: 10.2500/ajra.2015.29.4230.
- 4.Kopelovich JC, Baker MS, Potash A, Desai L, Allen RC, Chang EH. The hybrid lid crease approach to address lateral frontal sinus disease with orbital extension. *Ann OtolRhinolLaryngol*. 2014 Dec;123(12):826-30. doi: 10.1177/0003489414538767.
- 5.Beigi B, Vayalambone D, Kashkouli MB, Prinsley P, Saada J. Combined external and endonasal approach to fronto-ethmoidal mucocele involving the orbit. *J CurrOphthalmol*. 2016 Mar 7;28(1):37-42. doi: 10.1016/j.joco.2016.01.007.
- 6.Draf, W. Endonasal micro-endoscopic frontal sinus surgery: The fulda concept. *Oper. Tech. Otolaryngol. Neck Surg*. 2, 234–240 (1991).
- 7.Tomenzoli D, Castelnuovo P, Pagella F, et al. Different endoscopic surgical strategies in the management of inverted papilloma of the sinonasal tract: experience with 47 patients. *Laryngoscope*. 2004 Feb;114(2):193-200. doi: 10.1097/00005537-200402000-00003.
- 8.Weber R, Mai R, Hosemann W, Draf W, Toffel P. The success of 6-month stenting in endonasal frontal sinus surgery. *Ear Nose Throat J*. 2000 Dec;79(12):930-2, 934, 937-8 passim.
- 9.Chiu, A. G. Frontal sinus surgery: its evolution, present standard of care, and recommendations for current use. *Ann. Otol. Rhinol. Laryngol. Suppl*. 196, 13–19 (2006).
- 10.Weber, R., Draf, W., Keerl, R., Behm, K. & Schick, B. [Long-term results of endonasal frontal sinus surgery]. *HNO* 44, 503–509 (1996).
- 11.Constantinidis, J., Weber, R., Brune, M., Draf, W. & Iro, H. [Cranialization of the frontal sinus. Indications, technique and results]. *HNO* 48, 361–366 (2000).
- 12.Iannetti, G., Cascone, P., Valentini, V. & Agrillo, A. Paranasal sinus mucocele: diagnosis and treatment. *J. Craniofac. Surg*. 8, 391–398 (1997).
- 13.Vural, E., Suen, J. Y. & Hanna, E. Intracranial extension of inverted papilloma: An unusual and potentially fatal complication. *Head Neck* 21, 703–706 (1999).
- 14.Mohan, S., Nair, S., Sharma, M., Nilakantan, A. & Malik, A. Inverted papilloma of frontal sinus with intracranial extension. *Med. journal, Armed Forces India* 71, S152-5 (2015).
- 15.Pietrobon, G. et al. Frontal sinus ablation (Riedel-Mosher’s procedure): indications and role in the endonasal endoscopic era. *Rhinology* 57, 293–302 (2019).
- 16.Castelnuovo, P., Pistochini, A. & Locatelli, D. Different surgical approaches to the sellar region: focusing on the ‘two nostrils four hands technique’. *Rhinology* 44, 2–7 (2006).

17. Stankiewicz, J. A., Lal, D., Connor, M. & Welch, K. Complications in endoscopic sinus surgery for chronic rhinosinusitis: a 25-year experience. *Laryngoscope* 121, 2684–2701 (2011).