

Management of frontal sinus and frontal recess inverted papilloma: our experience and systematic review

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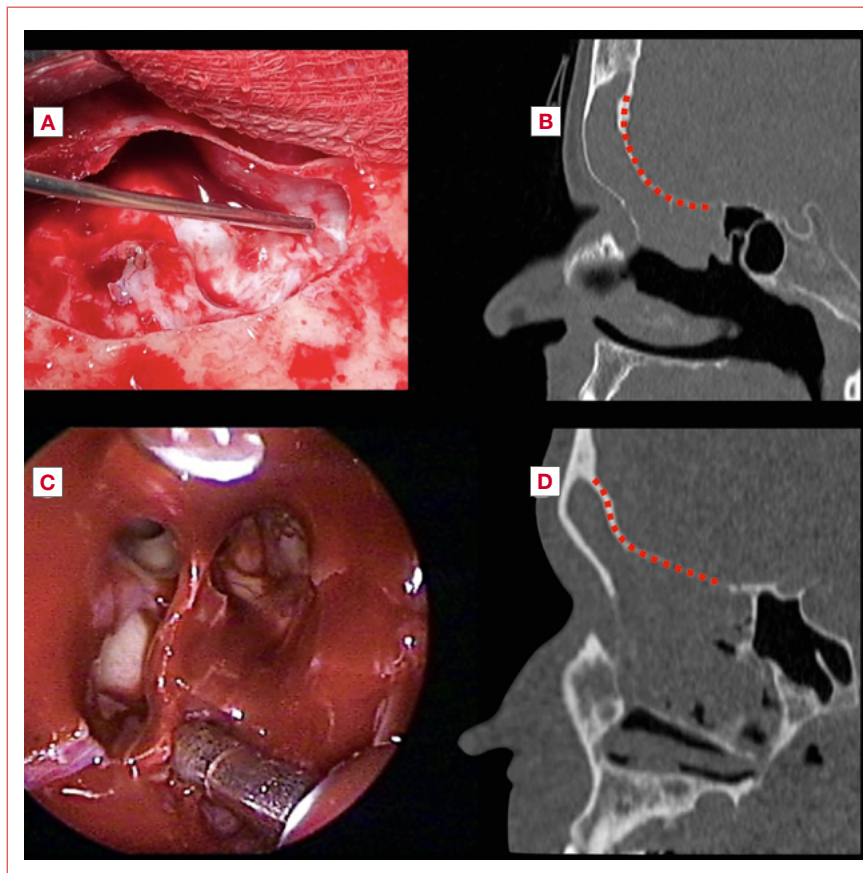
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Cover figure. Two cases from the present series. A-B) Patient treated with combined endoscopic endonasal approach (EEA) and osteoplastic flap technique: A) An intraoperative detail at the end of the resection, revealing a defect in the posterior wall of the left frontal sinus, corresponding to the tumour's insertion point; B) Preoperative radiological detail where the C-shaped conformation of the posterior wall of the frontal sinus is visible; C-D) Patient treated with exclusive EEA: C) Intraoperative detail at the end of resection, obtained through a Draf III procedure; the tumour insertion point resulted at the level of the frontal recess; D) Preoperative radiological detail where the straight conformation of the posterior wall of the frontal sinus is visible.

Summary

Objective. For frontal sinus inverted papilloma (FSIP) management, an endoscopic endonasal approach (EEA) can be combined (or not) with an external approach by an osteoplastic flap (OPF) or with a more conservative open approach. The present study aims to describe our experience in the management of FSIP, focusing on disease-related and anatomical features influencing outcomes and recurrence.

Methods. This case series of FSIP investigated anatomical and disease-related predictors of recurrence associated with EEA or a combined EEA-OPF approach. A systematic review was also performed, selecting publications on IP with the insertion point in the frontal sinus or frontal recess.

Results. Among 30 patients included, 18 underwent EEA, while 12 received a combined EEA-OPF approach. During a median follow-up of 37 months, the frontal sinus was cleared of IP in all cases except 2 in the EEA group, who presented a complex posterior wall shape of the frontal sinus. From the systematic review, a combined EEA-OPF approach was associated with a lower risk of recurrence.

Conclusions. A correct indication for a combined EEA-OPF approach is paramount and should integrate all disease-related and anatomical features, including posterior wall shape.

Key words: frontal sinus, inverted papilloma, skull base, endoscopic surgery, osteoplastic flap

Introduction

Sinonasal inverted papilloma (IP) is a benign epithelial tumour classified as part of the sinonasal Schneiderian papilloma category and represents 0.4-7% of all sinonasal tumours. It is characterised by local aggressiveness, high rates of recurrence, and possible association with carcinoma¹, so that a complete surgical IP resection with the drilling of the bony insertion point is mandatory². Extension and origin of the lesion (preoperatively assessed through computed tomography [CT] scan and magnetic resonance imaging [MRI] investigation with a 74-90% accuracy in pedicle identification)³ are the main parameters to consider when tailoring the approach and extension of surgery². The lateral nasal wall is the most common attachment site identified, followed by the maxillary and ethmoid sinuses; the frontal sinus, nasal septum, and sphenoid sinus are infrequent sites of origin³.

Frontal sinus IP (FSIP) is a rare pathology and represents only 2.5-5% of all cases of IP, but is associated with a higher risk of recurrence compared to other sinonasal insertion points^{4,5}. As previously reported⁶, this pathology should be treated with an endoscopic endonasal approach (EEA) whenever possible, due to reliable outcomes and reduced morbidity compared to open approaches⁷. However, unfavourable anatomy with difficult exposure of the tumour's pedicle can require a combined approach⁸. In 2019, Pietrobon et al.⁹ proposed a list of contraindications for an exclusive EEA to reduce the risk of recurrence.

In a trend of trying to push the limits of an exclusive endoscopic approach, this study aims to understand when exclusive EEA is not advisable, analysing personal experience reported in a case series and a thorough review of the literature, which is lacking on this topic.

The present article focuses on disease-related and anatomical features that can influence surgical resection of FSIP and challenge an exclusively endoscopic approach; among these, the role of posterior wall shape is highlighted.

Materials and methods

Case series

A retrospective single-institution case series of FSIP was evaluated in the present study. In detail, patients affected by frontal sinus and frontal recess IP were included. IP with the insertion point in other ethmoidal structures or sinonasal subsites (with the frontal sinus and frontal recess involved by extension only without any insertion) were excluded.

All patients underwent clinical examination with nasal endoscopy, preoperative biopsy, and MRI and CT, which provided information about posterior wall shape, lateral extension of the frontal sinus, anterior-posterior nasofrontal recess extension, and interorbital distance.

Posterior wall shape (Fig. 1) was classified as: 1) “straight configuration”; 2) “C-shaped configuration” (or “curved configuration”) if two components (one vertical and the other horizontal) formed one angle; 3) “S-shaped configuration” if

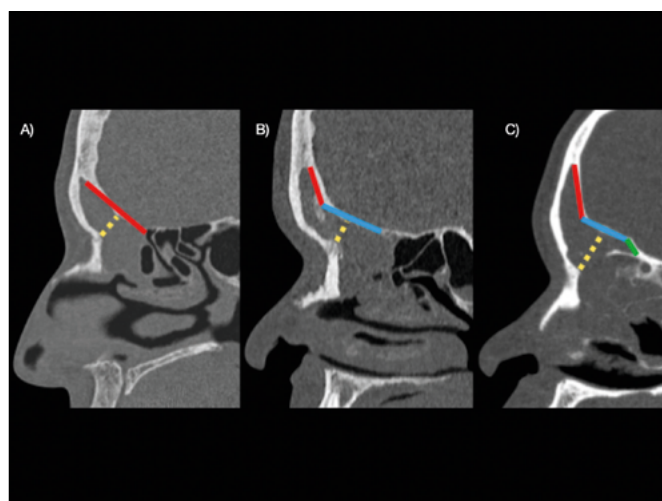


Figure 1. Radiological classification of posterior wall shape. A) Straight configuration; B) C-shape configuration; C) S-shape configuration. Yellow dotted lines represent the antero-posterior nasofrontal recess distance.

3 segments (one proximal vertical segment, one median more horizontal, one distal vertical) formed two angles. Antero-posterior nasofrontal recess diameter (Fig. 1) was calculated by measuring the distance between the frontal beak and the posterior wall of the nasofrontal recess. The distance between the nasion and the posterior wall of the frontal sinus was also recorded, referring to the possible antero-posterior extension of a frontal sinusotomy extending the drilling to the entire frontal beak up to the nasion⁹. The lateral extension of the frontal sinus was classified as small, medium, or large if extended in its widest diameter respectively to the medial, central, or lateral third of the orbital roof, respectively (Fig. 2)¹⁰. The interorbital minimal distance was calculated by measuring the minimal distance between the medial wall of the two orbits⁹.

From a surgical point of view, the resection targeted the pedicle insertion, performing EEA (with Draf IIB or Draf III procedures) or a combined EEA-osteoplastic flap (OPF) approach in case of extensive tumour or complex anatomy. Surgical information included IP insertion, presence of intracranial invasion, and surgical approach used.

Statistical analysis

Statistical analysis was performed with SPSS version 24 (IBM Corp. in Armonk, NY, USA). Data are reported as median \pm interquartile range (IQR). Fisher's exact test was used to evaluate the association of posterior wall shape, lateral frontal sinus extension, and intracranial invasion with the recurrence of the IP. A Mann-Whitney U test was used to verify the association of interorbital distance and anterior-posterior nasofrontal recess diameter with recurrence rate. Statistical significance was set at $p < 0.05$.

Systematic literature review

A systematic review was performed in accordance with the Meta-analyses Of Observational Studies in Epidemiology (MOOSE) guidelines. The systematic review was completed in April 2022 through research in the PubMed and Scopus databases using the research string “(Inverted papilloma [mesh] OR Inverted papilloma [tiab]) AND (frontal sinus [mesh] OR frontal sinus [tiab])”.

A Population, Intervention, Comparison, and Outcome (PICO) framework was used to elaborate a review question for which all components would be defined. The following question was formulated: in patients with FSIP, what are the surgical approaches and their relative recurrence rate described in the literature?

A selection was performed including publications on IP with the insertion point in the frontal sinus and the frontal recess, excluding patients with IP affecting the frontal sinus by conti-

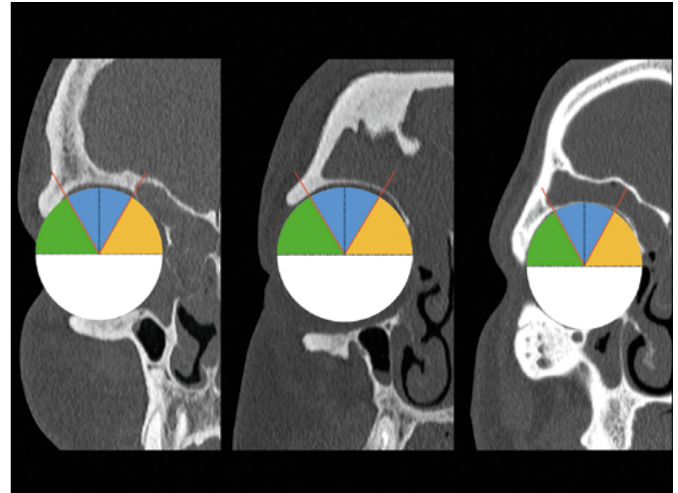


Figure 2. Radiological classification of lateral frontal sinus extension. A) Medial third extension; B) Central third extension; C) Lateral third extension.

guity. Studies in which cases with FSIP were mixed with other tumor locations were excluded. Case reports were not included.

Results

Case series

Thirty patients with FSIP were included whose general, radiologic-, and disease-related information is reported in Table I. Eighteen patients (60%) underwent EEA, while in 12 (40%) patients a combined EEA-OPF approach was used. Among the latter, 2 patients were initially addressed to EEA, and converted intraoperatively to combined EEA-OPF. An erosion of the posterior wall of the frontal sinus with intracranial invasion was found in four patients: three underwent combined EEA-OPF, while in the other patient the breach was in the lowest part of the wall and addressed endoscopically. None of these cases presented dural invasion or cerebrospinal fluid leak and a dural reconstruction was not needed.

The median follow-up was 37 months (IQR 16-76). Three patients (10%) experienced recurrence, on average 37 months after the previous surgery; two (who received EEA) recurred inside the frontal sinus, while the other patient (treated with the EEA-OPF approach) had a recurrence in the olfactory cleft. These patients underwent a second surgery; one patient with frontal sinus recurrence was managed with a coronal approach, while the others underwent an exclusive endoscopic approach. The patient who received a secondary combined approach recurred after 10 years; the others remained free from disease.

Table I. Characteristics of the case series.

	N (% or IQR)
Sex	
Male	19 (64%)
Female	11 (36%)
Median age (years)	57 (46-63)
Previous sinonasal surgery	
Yes, for previous IP	11 (36.7%)
Yes, for other pathologies	7 (23.3%)
No	12 (40%)
Insertion point	
Posterior wall	5 (16.7%)
Infundibulum	4 (13.3%)
Orbital roof	4 (13.3%)
Anterior wall	3 (10%)
Lateral recess	1 (3.3%)
Medial wall	1 (3.3%)
Diffuse insertion in the frontal sinus	1 (3.3%)
Unknown	11 (36.8%)
Lateral frontal sinus extension (in relation to the orbital roof)	
Medial third	4 (13.3%)
Central third	19 (63.4%)
Lateral third	7 (23.4%)
Posterior wall shape	
Straight	4 (13.3%)
C-shaped	15 (50%)
S-shaped	7 (23.3%)
Unknown	4 (13.3%)
Interorbital distance (median in mm)	22.2 (20.4-24.9)
Anteroposterior recess distance (median in mm)	8.7 (7.3-11.8)
Approach	
EEA	18 (60%)
EEA-OPF	12 (40%)
Median follow-up (months)	37 (16-76)
Recurrence	
Yes	3 (10%)
No	27 (90%)
Postoperative complications	
Yes	14 (46.7%)
Mucocoeles	13 (92.8%)
Inflammatory stenosis	1 (7.2%)
No	15 (50%)
Unknown	1 (3.3%)

EEA: endoscopic endonasal approach; OPF: osteoplastic flap; IQR: interquartile range.

There was no significant association between posterior wall shape, lateral frontal sinus extension, intracranial invasion, interorbital distance, or anterior-posterior nasofrontal recess diameter and recurrence of the IP during follow-up. Of note, the two patients who had a recurrence in the frontal sinus during follow-up presented a C-shaped posterior wall of the frontal sinus.

The comparison between endoscopic and combined approaches (EEA-OPF approach) is shown in Table II. No significant difference emerged between the two groups in terms of age, sex, laterality, lateral frontal sinus extension, posterior wall shape, interorbital distance, anterior-posterior nasofrontal recess diameter, follow-up time, or recurrence.

Systematic review

A literature search of PubMed and Scopus databases using the string described retrieved 153 papers on PubMed and 234 on Scopus. Among these, 13 studies respected inclusion criteria^{5,8,9,11-21}. Including the population in the present study, 195 patients affected by FSIP have been described from 1996 to 2022, with a mean follow-up of 36 months (Tab. III).

Analysing these papers together with the present study, pedicle insertion was found in 94 patients (48.2%, Table III); the posterior wall was the main insertion point in the frontal sinus, followed by the infundibulum and orbital roof.

Considering the 143 surgical procedures explicitly described (71.1%), a classification was proposed dividing them into EEA, a combined approach with osteoplastic flap (EEA-OPF), or an external approach without osteoplastic flap (EEA-EAWO, external trephination, or external fronto-ethmoidectomy techniques). EEA was the most frequent approach performed, followed by EEA-OPF and EEA-EAWO. Thirty-seven (18.9%) patients experienced recurrence, most after EEA-EAWO (Tabs. IV-V).

Discussion

In the last decades, sinonasal IP treatment has evolved from an exclusively open surgery towards complete resection through an exclusive endoscopic transnasal approach²². Notwithstanding, there are limitations to a purely endoscopic approach to FSIP: due to its challenging localisation, in selected cases, external approaches are advocated for complete tumour resection²³. The present case series selected IP with radiological or intraoperative evidence of insertion point in the frontal sinus and the frontal recess to investigate this aspect, excluding other tumours involving the frontal sinus and frontal recess by extension only. These inclusion criteria were chosen to select a comparable population with a homogeneous risk of recurrence.

Combined EEA-OPF emerged as the technique with the least risk of recurrence, followed by EEA, while combined EEA-EAWO was associated with poor results. Although EEA is tempting for the low rate of related comorbidities⁹, combined EEA-OPF has to be considered in some situations. The preoperative choice of the approach should be based on disease-related and anatomical features⁹, among which the posterior wall shape might be included. Nonetheless, in some cases of difficult intraoperative management of the tumour, the preoperative indication to EEA might be converted to open surgery with OPF. In two patients of the present case series, the surgical approach was intraoperatively converted due to far lateral extension in the frontal sinus. Both cases had a complex shape of the posterior frontal wall, which might have contributed to reducing the manoeuvring space. Surgical management of FSIP ranges from an EEA, eventually combined with conservative external approaches (mainly trephination and fronto-ethmoidectomy) or more aggressive procedures (OPF). A coronal approach for OPF is more invasive, and many authors advocate for an exclusive EEA. As far as we know, only one systematic review compared these surgical approaches 10 years ago²³: despite a small population, a low recurrence rate associated with the combined EEA-OPF technique was seen. In the present study, combined EEA-OPF was the most effective technique in the treatment of FSIP: in our case series, no recurrence inside the frontal sinus was seen after a combined EEA-OPF approach, while 2 frontal sinus recurrences occurred in patients who underwent exclusive EEA. In the EEA-OPF group, the only recurrence was in the olfactory cleft, which is an uncommon location and accessible endoscopically. In our systematic review, the available publications support this evidence, with recurrence inside the frontal sinus being more frequent after EEA (15.7%) in comparison with a combined EEA-OPF approach (4.7%). This comparison is not straightforward because of the different indications of the two approaches, as the EEA-OPF approach is usually reserved for more locally extended IP or more complex anatomy. However, it is interesting to compare the outcomes of these two techniques in light of the fact that the combined EEA-OPF approach was the one associated with a lower recurrence rate, despite its more advanced indications. In this optic, according to our data and those described in the literature, the more locally extensive the papilloma, the more aggressive surgical approach is warranted by a good local recurrence rate. Nonetheless, the approach that was mostly associated with frontal sinus recurrence was combined EEA-EAWO (50% recurrence rate), which is probably due to the poor view provided by these techniques. These results suggest that EEA-EAWO should not be the main approach chosen for the management of FSIP.

Table II. Comparison between EEA and a combined EEA-OPF approach in the population.

	EEA	EEA-OPF
	N (% / IQR)	N (% / IQR)
Number of patients	18 (60%)	12 (40%)
Median age (years)	55 (45-62)	63 (54-78)
Previous sinonasal surgery		
Yes, for previous IP	6 (33.3%)	5 (41.7%)
Yes, for other pathologies	5 (27.8%)	2 (16.6%)
No	7 (38.9%)	5 (41.7%)
Insertion point		
Infundibulum	3 (16.7%)	1 (8.3%)
Posterior wall	3 (16.7%)	2 (16.7%)
Anterior wall	2 (11.1%)	1 (8.3%)
Lateral recess	1 (5.6%)	-
Medial wall	1 (5.6%)	-
Orbital roof	2 (11.1%)	2 (16.7%)
Diffuse insertion in the frontal sinus	1 (5.6%)	-
Unknown	5 (27.8%)	6 (50%)
Lateral frontal sinus extension (in relation to the orbital roof)		
Medial third	2 (11.1%)	2 (16.7%)
Central third	12 (66.7%)	7 (58.3%)
Lateral third	4 (22.2%)	3 (25%)
Posterior wall shape		
Straight	2 (11.1%)	2 (16.7%)
C-shaped	9 (50%)	6 (50%)
S-shaped	5 (27.7%)	2 (16.7%)
Unknown	2 (11.1%)	2 (16.7%)
Inter-orbital distance (median in mm)	22.3 (20.6-25.4)	21.2 (19-25.1)
Anteroposterior recess distance (median in mm)	8.3 (6.9-11.3)	10 (7.9-12.6)
Follow-up (months)	32.5 (14-43.7)	40.5 (17.7-132.7)
Recurrence		
Yes	2 (11.1%)	1 (8.3%)
Inside frontal sinus	2 (100%)	-
Outside frontal sinus	-	1 (100%)
No	16 (88.9%)	11 (91.7%)
Postoperative complications		
Yes	6 (33.3%)	8 (66.7%)
Mucoceles	5 (83.3%)	8 (100%)
Inflammatory stenosis	1 (16.7%)	-
No	12 (66.7%)	3 (25%)
Unknown	-	1 (8.3%)

EEA: endoscopic endonasal approach; OPF: osteoplastic flap; IQR: interquartile range.

Table III. Systematic review of the literature on frontal sinus inverted papilloma.

Year	Author	No. of patients	Pedicle insertion	Surgical approach	Follow-up (mean)	Recurrence (percentage)	Failed surgical approach	Complications
2004	Chandra et al. ¹¹	4	Not univocal	1 combined 3 endoscopic	11 months	0		No
2005	Dubin et al. ⁸	6	Not univocal	1 osteoplastic	13.5 months	1 (16.6%)	1 EEA-OPF	No
				4 combined				
				1 endoscopic				
2007	Woodworth et al. ¹²	19	9 frontal sinus	5 combined	40 months	6 (31.6%)	4 EEA (inside frontal sinus)	Not univocal
			10 frontal recess	14 endoscopic				
2008	Zhang et al. ¹³	9	9 nasofrontal recess and infundibulum	9 endoscopic	15.1 months	0		0
2009	Yoon et al. ¹⁴	18	1 anterior wall	11 endoscopic	36.6 months	4 (22.2%)	3 EEA 1 EEA-EAWO	Not univocal
			6 medial wall	7 combined				
			5 diffuse					
			5 posterior wall					
			1 lateral wall					
2009	Sham et al. ¹⁵	3	3 nasofrontal recess	1 endoscopic	Not specified for subpopulation	2 (66.6%)	1 EEA 1 EEA-OPF	Not univocal
				2 combined				
2010	Lombardi et al. ¹⁶	11	Not univocal	6 endoscopic	53.8 months	2 (18.2%)	2 EEA	Not univocal
				5 combined				
2015	Healy et al. ¹⁷	26	9 posterior wall	Not well described (for sure 4 EEA + TREPH)	Not well described	4 (15.4%)	4 EEA-EAWO	Not univocal
			2 anterior wall					
			1 medial wall					
			1 interfrontal cell					
			11 orbital roof					
			1 supraorbital cell					
8 not univocal								
2016	Adriaensen et al. ¹⁸	12	Not univocal	12 endoscopic	42 months	2 (15.4%)	2 EEA	Not univocal
2017	Ibrahim et al. ¹⁹	10	2 nasofrontal recess	5 combined	24 months	0		1 CSF leak
			3 posterior wall	5 endoscopic				
			5 orbital roof or anterior wall or lateral recess					

Table III. *continues*

Year	Author	No. Patients	Pedicle insertion	Surgical approach	Follow-up (mean)	Recurrence (percentage)	Failed surgical approach	Complications
2019	Pietrobon et al. ⁹	16	Not univocal	5 endoscopic	43 months	1 (6.3%)	1 EEA-EAWO	Not univocal
				11 combined				
	Choi et al. ²⁰	23	Not univocal	Not well described	Not well described	3 (13%)	2 EEA 1 EEA-OPF	Not univocal
	Sham et al. ²¹	18	5 interfrontal septum	12 endoscopic	43 months	9 (50%)	6 EEA 3 EEA-EAWO	1 CSF leak
			6 posterior wall	6 combined				1 orbital hematoma
			4 infundibulum					3 stenosis
			3 orbital roof					

EEA: endoscopic endonasal approach; EAWO: external approach without osteoplastic flap; OPF: osteoplastic flap; CSF: cerebrospinal fluid; TREPH: trephination.

The literature and the current study aim to identify situations where a combined EEA-OPF approach should be considered. It is worth noting that the present systematic review did not include the transpalpebral craniotomy endoscopic-assisted approach described by Albathi et al.²⁴. While this approach is interesting, with good potential in the management of inverted papilloma laterally extended in the frontal sinus and hybrid features between EEA-OPF and EEA-EAWO approaches, the choice of excluding it was dictated by the small number of patients described in the literature. Disease-related features should be included in these considerations such as erosion of the anterior wall of the frontal sinus, a breach in the posterior wall with extradural intracranial extension, and histological evidence of squamous cell carcinoma in IP⁹. There is a consensus in pedicle-oriented resection for IP²²: if the pedicle is located on the lateral roof of the orbit, anterior wall, upper half of the posterior wall, or diffuse, then EEA might fail to control the disease⁹. In this case series, as in our literature review (Tab. IV), the posterior wall of the frontal sinus was the most frequent insertion point⁹.

In the present case series, posterior wall shape was evaluated as a novel anatomical parameter, since the posterior wall insertion could be more difficult to address in case of complex configurations. Indeed, a distal vertical component of the wall is difficult to manage endoscopically, considering the curvature of surgical instruments often required to approach the frontal sinus with endoscopic surgery.

Herein, three different configurations are proposed based on the presence of directional components. C and S shapes (characterised by a well-represented distal vertical portion) are considered the most endoscopically challenging,

Table IV. Global population description (review including our case series)

	N (%)
Insertion point	
Described (%)	94 (48.2%)
Posterior wall	28 (29.8%)
Infundibulum	19 (20.2%)
Orbital roof	19 (20.2%)
Medial wall	14 (14.9%)
Anterior wall	6 (6.4%)
Diffuse insertion in the frontal sinus	6 (6.4%)
Lateral recess	2 (2.1%)
Not univocal	101 (51.8%)
Approach	
Described (%)	143 (73.3%)
EEA	83 (58%)
Combined	59 (41.3%)
EAWO	16 (27.1%)
OPF	43 (72.9%)
Exclusive external approach	1 (0.7%)
Not univocal	52 (26.7%)
Mean follow-up (months)	36
Recurrence	
Yes	37 (18.9%)
Inside frontal sinus	23 (62.2%)
Outside frontal sinus	9 (24.3%)
Not univocal	5 (13.5%)
No	158 (81.1%)

EEA: endoscopic endonasal approach; EAWO: external approach without osteoplastic flap; OPF: osteoplastic flap.

Table V. Sites of recurrence by surgical technique performed (including our case series).

	EEA (83 patients)	EEA + EAWO (16 patients)	EEA + OPF (43 patients)
Recurrence inside frontal sinus	13 (15.7%)	8 (50%)	2 (4.7%)
Recurrence outside frontal sinus	6 (7.2%)	2 (12.5%)	1 (2.3%)
Not univocal recurrence site	3 (3.6%)	1 (6.2%)	1 (2.3%)
Total	22 (26.5%)	11 (68.7%)	4 (9.3%)

EEA: endoscopic endonasal approach; EAWO: external approach without the osteoplastic flap; OPF: osteoplastic flap.

and the patients experiencing recurrence in our population were all characterised by one of these configurations. The management of the posterior wall was also difficult if the anteroposterior diameter of the frontal sinus was insufficient or the interorbital distance was poor. The combination of these three parameters made the approach to the frontal sinus even more challenging, even if it was not statistically associated with an increased risk of recurrence in this case series. As an integration to the algorithm proposed by Pietrobon et al.⁹, the combination of these parameters should strengthen the contraindication for an EEA.

Among anatomical features, a lateral extension of the FS cannot be considered an absolute contraindication to exclusive EEA, coherently with the development of a laterally expanded frontal sinus endoscopic approach through orbital transposition, allowing to reach far lateral lesions²⁵. Even if in the present study all these parameters could not be independently associated with an increased risk of recurrence (probably due to the small sample), a global evaluation of disease-related and anatomical features should be pivotal in choosing between EEA or a combined EEA-OPF approach. Nowadays, indications are not unique, and the choice of approach depends on many factors, including surgical skills and the experience of the surgical team with each technique, which can lower the risks of complications. The duration of surgery is another important factor to consider in this balance: in some patients, it is not recommended to prolong surgery excessively, for reasons related to general anaesthesia. In relation to the fact that transnasal endoscopic resections can be very long if the anatomy is unfavourable, this may be a factor leading to an open approach, in consideration of the experience of the surgical team. In particular, this article highlights the importance

of considering the global anatomical complexity when selecting the surgical approach. The assessment of the posterior wall shape is proposed as part of the balance along with the features proposed by Pietrobon et al.⁹, especially when other factors (a small anteroposterior distance and a poor interorbital space) co-participate in challenging the endoscopic posterior wall management. In this balance, the surgical skills and the experience with each technique can be relevant.

The main strength of our study is the substantial number of cases and combined EEA-OPF procedures (compared with the literature). Furthermore, our research benefits from an extensive and prolonged follow-up. Moreover, the systematic review included highly selected studies to focus exclusively on FSIP. However, the retrospective nature of the present study should be noted as its main weakness. Further multicentric and prospective studies are needed to provide a standardised indication to a combined EEA-OPF approach.

Conclusions

FSIP is a challenging disease to treat, which is frequently characterised by difficult surgical management and a higher recurrence rate in comparison with other localisations of IP. Although EEA remains the most widely used technique for its low rate of comorbidities, a combined EEA-OPF approach is useful for complex cases and to prevent recurrence. Lastly, a risk-benefit balance should be considered: a combined EEA-OPF approach should include all disease-related and anatomical features, as well as an assessment of posterior wall shape. Further studies with larger populations and meta-analyses are warranted to reach a standardised indication for a combined EEA-OPF approach.

Conflict of interest statement

The authors declare no conflict of interest.

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Author contributions

PG, AV, BV: made substantial contributions to conception, design and acquisition of data, drafted the article, revised it critically for important intellectual content, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved; PH: made substantial contributions to conception of the data,

revised it critically for important intellectual content, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethical considerations

Data were collected in respect of local institutional review board recommendations (Comité Ethique et de Protection des Personnes Ile de France IV, Hôpital Saint-Louis-Lariboisière-Fernand Widal, CNIL #2225234). The research was conducted ethically, with all study procedures being performed in accordance with the requirements of the World Medical Association's Declaration of Helsinki. Written informed consent was obtained from each participant/patient for study participation and data publication.

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