




Surgical Approach to Frontal and Ethmoid Sinus Osteomas: The Experience of 2 Metropolitan Italian Hospitals

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Abstract

Objectives: The aim of this study was to report the surgical management experience of patients with osteomas of the frontal and ethmoid sinuses performed in 2 metropolitan Italian hospitals between 2012 and 2019. **Methods:** A retrospective chart review of cases of frontal and ethmoid osteomas from the *Ca' Granda Niguarda Hospital* of Milan and the *Policlinico Umberto I University Hospital* of Rome was performed. All patients underwent preoperative computed tomography and, when orbital or intracranial extension was suspected, magnetic resonance imaging. Surgical treatment was performed according to Chiu classification. **Results:** A total of 38 cases of frontal and ethmoid sinus osteomas were included in the study; 22 patients were men and 16 were women. The mean age at diagnosis was 49 years. Seven (18.4%) patients were treated using an open approach; 3 (7.9%) patients underwent open and endoscopic approach; the remaining 28 (73.7%) patients were treated with endoscopic approach. Seven (18.4%) patients had a cerebrospinal fluid leak intraoperatively and were treated with the placement of tissue graft through the defect. The mean follow-up time was 18 months; no recurrence was observed at 12-month follow-up. **Conclusion:** Osteomas of the frontal and ethmoid sinuses can be treated using different techniques, mostly endoscopically. The choice of surgical approach (endoscopic vs open) depends on the location and size of the osteoma, anatomical size, characteristic of the sinus, surgeon's experience, and available existing technical facilities. Cerebrospinal fluid leak is a possible complication of surgery.

Keywords

osteoma, paranasal sinuses, ethmoid sinus, frontal sinus, endoscopic sinus surgery, open approach

Introduction

Osteomas are relatively frequent benign tumors of connective tissues, frequently located in the craniofacial skeleton, more often in the nasal and paranasal sinuses. Osteomas mainly involve the frontal sinus (75%), followed by the ethmoid sinus (20%) and the maxillary sinus (5%).^{1,2}

Osteomas are more common in males (M:F = 2-3:1) with a higher prevalence over 40 years of age; racial prevalence is not reported. Osteomas are also described in the pediatric population.³ The tumor is unilateral in nearly 90% of cases.⁴ Generally, symptoms of ethmoid osteoma occur earlier than frontal sinus osteoma's symptoms because of the cramped nature of the ethmoid sinus.^{4,5}

Considering their rarity, the management and the treatment of osteomas remain unclear. Asymptomatic osteomas and

osteomas of small dimension can be conservatively managed with observation. Tumors that are symptomatic, rapidly growing, leading to facial deformities, causing chronic rhinosinusitis, or extending beyond the frontal sinus should be managed

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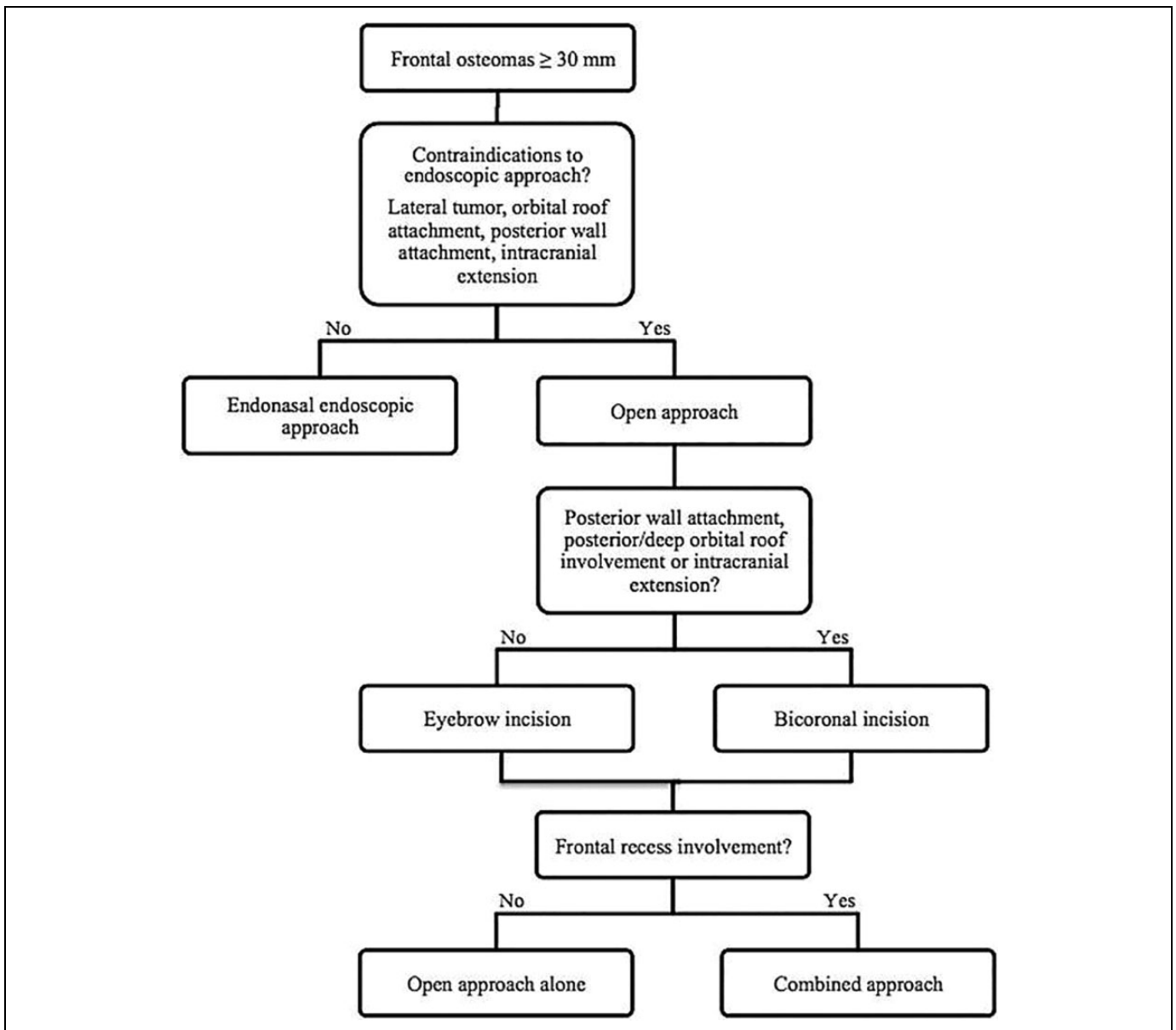


Figure 1. Frontal and ethmoid sinus osteoma: flowchart treatment.

with surgery through an open, endoscopic, or combined approach (Figure 1).

The primary objective of this retrospective study is to describe the surgical experience and the postoperative outcomes of patients with a diagnosis of frontal and ethmoid sinus osteomas treated in 2 public metropolitan Italian Hospitals, the *Ca' Granda Niguarda Hospital* of Milan and the *Policlinico Umberto I University Hospital* of Rome.

Materials and Methods

Our study is based on a retrospective chart review of 38 cases of frontal and ethmoid sinus osteomas, selected from the *Niguarda Ca' Granda Hospital* of Milan and the *Policlinico Umberto I University Hospital* of Rome, Italy, from June 2012

to December 2019 (Table 1). For each patient, we recorded demographics characteristics (gender, age at diagnosis, ethnicity, and comorbidities), tumor location and size, the anatomical extension of the tumor, complications due to tumor invasion of the adjacent structures, and hospital length of stay. According to the literature, tumors larger than 30 mm in diameter were defined as “giant osteomas.”^{6,7} All cases of osteomas were operated by the same 2 surgeons. Informed consent was collected from all patients before surgical procedures.

All patients underwent preoperative computed tomography (CT) scan and, when orbital or intracranial extension was suspected, magnetic resonance imaging (MRI), as the combination of MRI and CT scan allows maximum information for orbital and/or intracranial complication in case of sinonasal tumors.⁸

Table 1. Cases of Frontal and Ethmoid Osteomas Included in the Study.

	Sex	Date of birth	Age at diagnosis	Date of surgery	Presence of symptoms	Tumor location	Tumor size (ct)	Chiu grade	Surgical technique
1	M	11/02/1941	71	05/06/2012	Yes	Left frontal sinus	<30 mm	2	Draf 2a
2	M	08/02/1956	56	05/06/2010	Yes	Frontal sinus	<30 mm	2	Draf 2b
3	M	12/11/1972	40	14/09/2012	Yes	Frontal and ethmoid sinuses	<30 mm	3	Draf 3
4	M	07/03/1954	59	26/10/2012	Yes	Right frontal sinus	<30 mm	3	Draf 2b
5	M	10/09/1957	55	02/11/2012	Yes	Right frontal and ethmoid sinuses	<30 mm	3	Draf 2b
6	F	04/10/1974	38	23/11/2012	Yes	Right frontal and ethmoid sinuses	<30 mm	1	Draf 2a
7	F	03/04/1981	32	08/02/2013	Yes	Left frontal sinus	<30 mm	3	Draf 2b
8	M	22/01/1976	37	08/03/2013	Yes	Left frontal and ethmoid sinuses	<30 mm	1	Draf 2a
9	M	08/06/1965	48	03/07/2013	Yes	Both frontal sinuses	>30 mm	4	Open technique
10	F	10/12/1941	72	22/10/2013	Yes	Right frontal sinus	<30 mm	3	Draf 3
11	F	30/01/1984	30	05/11/2013	Yes	Right frontal sinus	<30 mm	2	Draf 2b
12	F	13/05/1947	67	18/11/2013	Yes	Ethmoid sinus	<30 mm	1	Draf 1
13	F	25/08/1968	46	19/05/2014	Yes	Left frontal sinus	<30 mm	3	Draf 3
14	F	20/07/1944	70	11/11/2014	Yes	Left ethmoid sinus	<30 mm	1	Draf 2a
15	F	17/10/1981	33	13/11/2014	Yes	Both frontal sinuses	<30 mm	3	Draf 2b
16	M	21/06/1976	38	18/11/2014	Yes	Left frontal and ethmoid sinuses	<30 mm	1	Draf 2a
17	M	25/06/1969	46	25/05/2015	Yes	Right ethmoid sinus	<30 mm	1	Draf 2a
18	M	07/07/1973	42	29/06/2015	Yes	Right frontal sinus	<30 mm	3	Draf 2b
19	F	14/05/1975	40	01/07/2015	Yes	Both frontal sinuses	>30 mm	3	Open technique
20	M	10/01/1973	43	09/07/2015	Yes	Left frontal sinus	<30 mm	3	Draf 3
21	M	22/09/1998	17	07/10/2015	Yes	Left frontal sinus	<30 mm	3	Open technique
22	F	29/08/1959	57	20/04/2016	Yes	Right frontal and ethmoid sinuses	<30 mm	2	Draf 2a
23	F	10/09/1949	67	14/06/2016	Yes	Right frontal and ethmoid sinuses	<30 mm	2	Draf 2b
24	M	24/10/1958	58	06/07/2016	Yes	Right frontal and ethmoid sinuses	<30 mm	1	Draf 1
25	M	30/04/1949	67	05/10/2016	Yes	Right frontal sinus	>30 mm	4	Draf 3
26	M	25/08/1973	43	18/11/2016	Yes	Left frontal and ethmoid sinuses	<30 mm	1	Draf 1
27	F	13/01/1967	49	21/02/2017	Yes	Posterior ethmoid sinus	<30 mm	2	Ethmoidectomy
28	F	23/07/1962	53	24/02/2017	Yes	Right frontal sinus	<30 mm	3	Draf 3
29	M	30/05/1940	77	07/07/2017	Yes	Both frontal sinuses	>30 mm	3	Open technique
30	F	08/12/1959	56	06/10/2017	Yes	Right ethmoid sinus	>30 mm	3	Ethmoidectomy
31	M	11/01/1996	21	08/11/2017	Yes	Right frontal sinus	>30 mm	3	Open technique + FESS
32	M	22/06/1959	60	12/12/2017	Yes	Both frontal sinuses	>30 mm	4	Open technique + FESS
33	M	13/04/1960	58	04/07/2018	Yes	Both frontal sinuses	>30 mm	3	Open technique
34	M	18/02/1985	34	19/02/2019	Yes	Left ethmoid sinus	<30 mm	2	Ethmoidectomy
35	F	23/09/1986	32	11/06/2019	Yes	Left frontal sinus	>30 mm	3	Draf 3
36	M	02/01/1953	66	18/06/2019	Yes	Left frontal sinus	>30 mm	3	Open technique + FESS
37	F	07/06/1941	78	20/06/2019	Yes	Left frontal sinus	>30 mm	3	Open technique
38	M	09/11/1957	62	25/06/2019	Yes	Right frontal sinus	>30 mm	3	Open technique

Postoperative clinical and radiological follow-up with endoscopic examination and CT scan was performed at 12-month intervals in all patients. The choice of the surgical technique—whether open, endonasal endoscopic approach, or a combination of both—was based on tumors size and extension, according to Chiu classification (Table 2).⁹

Results

Demographic Characteristics

A total of 38 cases of histologically confirmed frontal and ethmoid sinus osteomas were recorded and included in this retrospective study: 22 (57.9%) patients were men and 16 (42.1%) were women. The mean age at diagnosis was 49 (range 17-77 years) years. All patients were of Caucasian race.

Table 2. The Frontal Sinus Osteoma Staging System of Chiu et al.⁹

Grade	Characteristics
I	Base of attachment is posterior–inferior along the frontal recess. Tumor is medial to a virtual sagittal plane through the lamina papyracea. Anterior–posterior diameter of the lesion is less than 75% of the anterior–posterior dimension of the frontal recess.
II	Base of attachment is posterior–inferior along the frontal recess. Tumor is medial to a virtual sagittal plane through the lamina papyracea. Anterior–posterior diameter of the lesion is greater than 75% of the anterior–posterior dimension of the frontal recess.
III	Base of attachment is anteriorly or superiorly located within the frontal sinus AND/OR tumor extend lateral to a virtual sagittal plane through the lamina papyracea.
IV	Tumor fills the entire frontal sinus

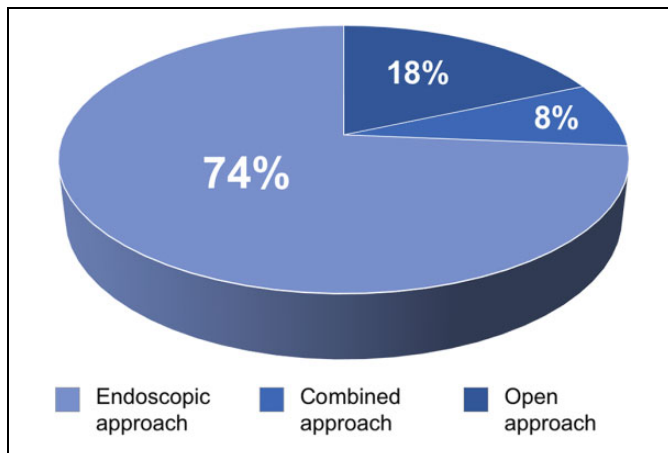


Figure 2. Patients treated with different surgical techniques in our study.

Tumor Characteristics

All cases presented at least 1 major symptom including facial pain (70%), heaviness and dullness of the head (65%), rhinorrhea (45%), nasal obstruction (25%), diplopia (5%), and orbital complications such as exophthalmos and proptosis (2.7%). Frontal sinus was the most common affected (70%); 12 (31.6%) patients were affected by giant osteomas.

According to Chiu classification, the grade at the moment of the diagnosis was as follows: grade I in 8 patients; grade II in 7 patients; grade III in 20 patients; and grade IV in 3 patients. All patients were surgically managed by the same 2 operators. The mean time of hospital length of stay was 3 days in case of uncomplicated endoscopic sinus surgery and 9 days in case of open approach.

Localization

Tumor localization was distributed as follows: 23 (14 males and 9 females; 60.5%) patients presented osteomas in the frontal sinuses, 6 (2 males and 4 females; 15.8%) cases had osteomas in the ethmoidal complex, and 9 (6 males and 3 females; 23.7%) patients presented osteomas in both frontal and ethmoidal sinuses.

Surgical Approaches

Thirty-eight osteomas in 38 patients were removed surgically. Seven (18.4%) patients were treated using the open approach due to (a) narrow frontal ostium; (b) narrow interorbital distance; or (c) extensive extrasinus extension. Three (7.9%) patients with voluminous ethmoidal osteomas and orbital extension or giant osteomas involving the frontal–ethmoidal recess underwent a combined open and endoscopic approach. Twenty-eight (73.7%) patients were treated with the endoscopic approach (Figure 2).

Seven patients were treated with a type III frontal sinusotomy (Draf III) procedure, 8 with a Draf IIb, 7 with a Draf IIa, 3 with a frontal sinusotomy (Draf I) approach, and 3 patients

were treated with a frontal ethmoidectomy (Lynch procedure). In all cases, the site of origin of the lesion was drilled.

Surgical Complications and Disease Recurrence

A dural breach with cerebrospinal fluid (CSF) leak was reported in 7 (18.4%) patients; in 6 cases, CSF leak occurred intraoperatively, while in 1, it occurred postoperatively. In all cases, CSF leak was due to large tumor dimension (giant osteoma) and diffusion (tumor infiltration of the skull base and/or intracranial extension). All patients were treated with the placement of tissue graft (fascia lata or nasoseptal flap based on the posterior septal artery) through the defect.

The mean follow-up time was 18 months. One (2.6%) case of disease recurrence was reported (giant osteoma of the frontal sinus) 22 months after surgery.

Discussion

Paranasal sinus osteomas are benign tumors generally arising in the frontal sinus. Histologically, 3 different patterns of osteoma can be recognized. The ivory type, also known as “eburnated” osteoma or “compact” osteoma, is the most common and it is composed by dense bone lacking Haversian system (Figure 3). The mature type, also known as osteoma “spongiosum,” appears as a normal bone, including trabecular bone often with marrow cancellous bone. The mixed osteoma contains a mixture of both the ivory and the mature types.

There is no reported evidence on differences in site of occurrence, clinical symptomatology, or propensity for recurrence between the different types of osteomas.⁹ Osteomas have a slow growth rate ranging from 0.44 to 6.00 mm per year, are mostly asymptomatic, and are often discovered as incidental findings on radiographic imaging in 3% of CT sinus scans and in 1% of sinus radiographs.^{10,11}

The symptomatology depends on the size, localization, and extension of the neoplasm. The most common symptom is due to the obstruction of the drainage pathways of the sinus and is represented by frontal progressive headache (70.8%), followed by facial pain, facial deformity, epiphora, proptosis, and diplopia. Less commonly, osteomas can lead to chronic sinusitis, intracranial mucocele, or the erosion of nearby structures, such as cranium and orbit causing meningitis, brain abscess, CSF leak, and orbital complications.¹⁰⁻¹³

The etiology of osteomas is still unclear. Three causes have been proposed: embryological (Gardner syndrome with coexistence of intestinal polyps and familial adenomatous polyposis), traumatic (treatments within nose and paranasal sinuses), and infectious.^{14,15}

Computed tomography imaging represents the gold standard for evaluation and planning of the surgical management in case of sinonasal osteomas. Osteoma appears as a well-circumscribed mass occupying the paranasal sinus or, less commonly, exophytically growing out of a sinus with a variable density, from very dense cortical bone-like to less dense with a ground-glass appearance^{2,16} (Figure 4). Magnetic resonance

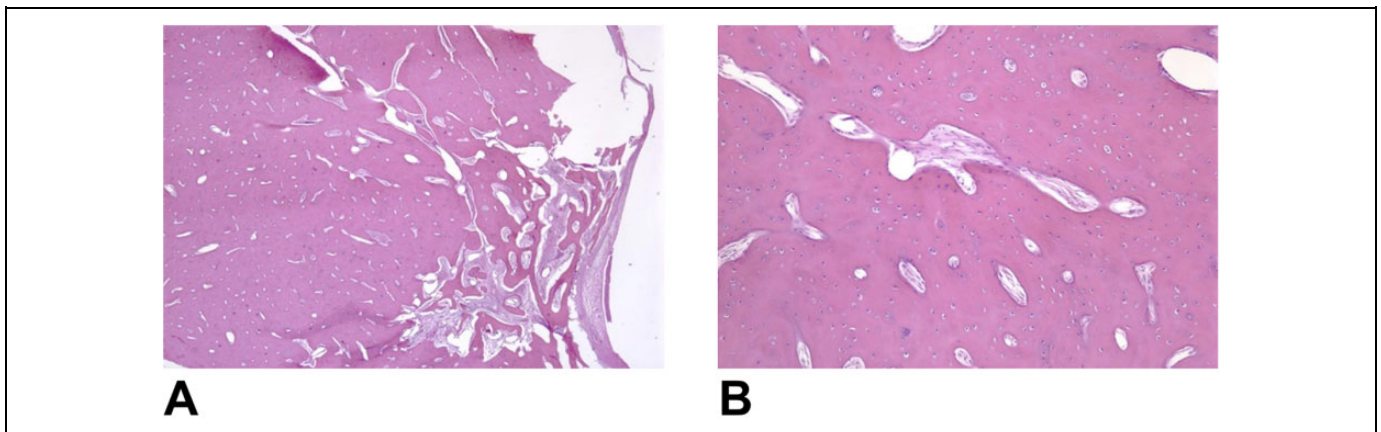


Figure 3. A and B, Histological sections of ivory type osteoma (H&E $\times 100$).

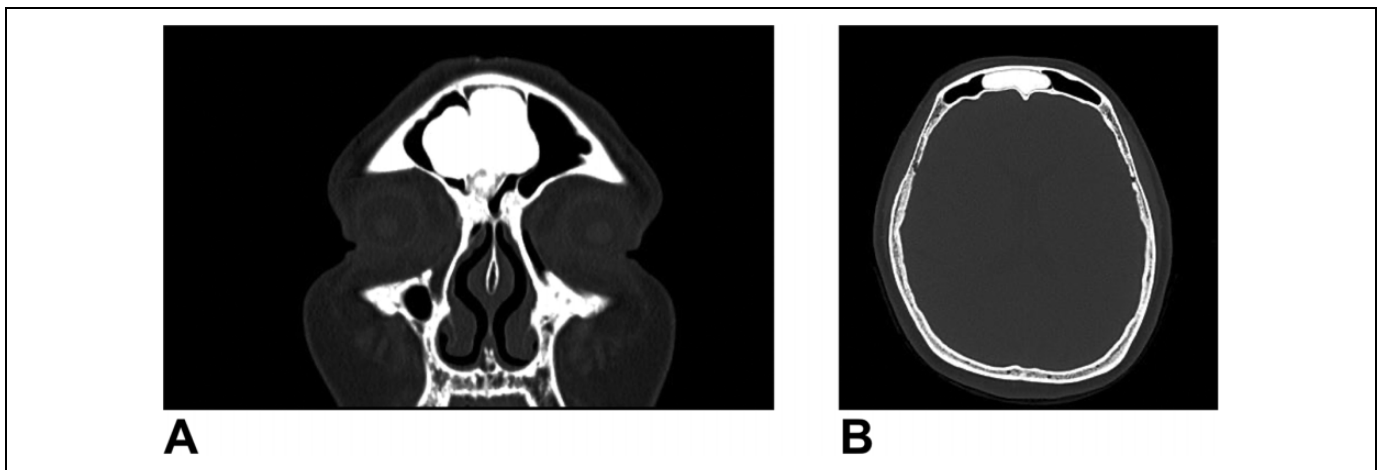


Figure 4. A and B, Computed tomography (CT) scans show a well-circumscribed mass with a variable density occupying the paranasal sinuses.

images can help outlining retained secretions from tumor and should be performed when orbital or intracranial extension is suspected (Figure 5).^{2,16}

Asymptomatic osteomas can be managed conservatively, except when more of the 50% of the sinus is involved and in case of fast-growing tumors ($>1/1.5$ mm/year).¹⁷ In all other cases, a surgical management is required. The choice of the surgical approach for frontal and ethmoid sinus osteomas depends on the sinus dimensions and anatomy, on the size and localization of the tumor, on the presence of complications, on the length of surgical time, and on the surgeon's personal experience.

Frontal and ethmoidal sinus tumors can be approached using an open technique, an endonasal endoscopic drill-out, and a combination of both according to the grading system proposed by Chiu et al⁹ or that by Savic and Djerić.¹⁸ In all cases, the aim of the surgical approach is to remove the neoplasm without damaging adjacent structures.

Our results confirm that an external approach is generally indicated in the following cases: large osteomas filling the frontal sinus, location of the tumor lateral to a sagittal line passing through the lamina papyracea (grade III-IV), osteoma

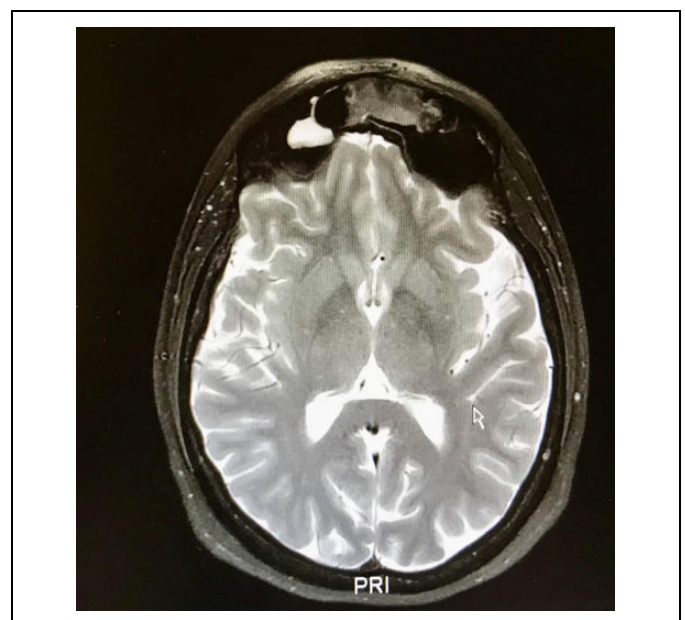


Figure 5. Magnetic resonance imaging (MRI) shows retained secretions from tumor.

involving the orbital roof, or with intracranial extension, anterior–posterior diameter of the frontal sinus smaller than 10 mm.^{19,20}

However, patients' compliance to the open technique is lower due to incision scars, higher morbidity, and frontal pain. Moreover, this approach is frequently associated with post-operative edema in frontal region and with a longer hospital length of stay.

The endoscopic technique is related to a shorter recovery period, obviates the need for external incisions, and decreases morbidity rates; on the other side, it requires a longer time of training and a greater experience of the surgeon. As proposed by Chiu et al and Lee et al, and as confirmed in our experience, a pure endoscopic approach may be preferred in case of osteomas involving exclusive the ethmoidal sinus or for frontal and frontal–ethmoidal osteomas located in the medial of a virtual line drawn on the lamina papyracea (grade I and II).^{20–22}

The combined approach should be preferred in case of involvement of the frontal–ethmoidal recess and whether the possibility to restore the correct mucous drainage from the frontal sinus persists.^{20–22} In our experience, a combined approach was performed in patients with giant osteomas extended from the right frontal sinus toward the ethmoid and whose recurrence was detected during follow-up (1 patient).

Another variable that should be considered is the length of surgical time. Indeed, although endoscopic approach usually can be longer than the open procedure, surgical time can be particularly prolonged in cases of solid ivory-type osteomas, as reported by Seiberling and colleagues in a study of 23 patients undergone to endoscopic resection of a frontal sinus osteoma.²³

If a CSF leak occurs, closure of the defect can be performed using a variety of grafts: We mostly use dural substitutes and fibrin glue or local mucosal flap (middle or inferior turbinate) with onlay technique. To avoid recurrence, as universally supported in literature, an appropriate surgical technique should be selected.²⁴ In fact, the main reason for recurrence is incomplete removal of the osteoma tissue during surgery due to an insufficient burring, an inadequate surgical visualization of the entire surgical field and surgeon's inexperience.²⁵

Limits of the Study

This study has several limits. The first is related to the small sample size and the heterogeneity of our sample. The limited sample size may also be responsible of the very high rate of CSF leaks reported in our study; this percentage is higher than that reported in the literature for larger case series. Last, we considered as giant osteomas the ones with a diameter >30 mm; this may have affected how results were reported.

Conclusion

Osteomas of the frontal and ethmoid sinuses can be treated using different techniques. The choice of surgical approach (endoscopic vs open) depends on the location and size of the

osteoma, anatomical size, characteristic of the sinus, surgeon's experience, and available existing technical facilities. In all cases, the site of origin should be drilled in order to avoid lesions' recurrence.

Cerebrospinal fluid leak is a possible complication of any surgical approach and should be treated intraoperatively. The surgical osteoplastic flap method is recommended in case of intracranial involvement (mostly about posterior wall of frontal sinus), lateral extension in the frontal sinus, and intraorbital involvement. Surgical osteoplastic flap method remains the main technique in case of endoscopic approach's failure.

Authors' Note

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of Conflicting Interests


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