

Surgical Approach to Paranasal Sinus Osteomas: Our Experience in 22 Cases

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ABSTRACT

Objective: Paranasal sinus (PNS) osteomas are rare, but the most common benign bone tumors of the paranasal region that can remain asymptomatic until reaching certain size are usually diagnosed incidentally. This study aimed to evaluate the factors that determine the surgical approach to PNS osteomas.

Methods: This retrospective study included 22 patients who underwent surgery for PNS osteoma between January 2012 and December 2018. Demographic characteristics, tumor location and size, symptoms, surgical techniques, and postoperative complications were analyzed retrospectively. The relationship between the location and size of the osteoma and the surgical approach was investigated.

Results: Of the 22 patients who underwent surgery for PNS osteoma, eight (36.3%) and 14 (63.7%) were women and men, respectively. The mean age of the patients was 39.1 years (range, 21–54 years). Based on their PNS location, osteomas were found in the ethmoid, frontal, maxillary, and both frontal and ethmoid sinuses in 10 patients (45.4%), eight patients (36.3%), three patients (13.6%), and one (4.5%) patient, respectively. The tumor was excised using the osteoplastic flap technique in five (22.7%) patients with frontal sinus osteomas larger than 2 cm in size. A combination of the Caldwell–Luc and transnasal endoscopic techniques was used in three (13.6%) patients with maxillary sinus osteomas. The tumor was excised using the lateral rhinotomy technique in one patient (4.5%) with a giant osteoma in the ethmoid sinus. Osteoma excision was performed using a transnasal endoscopic approach in the remaining 12 patients with ethmoid (n = 9) and frontal sinus (n = 3) involvement.

Conclusions: Although the tendency to perform minimally invasive and less morbid transnasal endoscopic approaches in PNS osteoma surgery is increasing, open surgical techniques and combined approaches should be preferred for ethmoid and frontal sinus osteomas with potential complications and which extend beyond the PNS boundaries. PNS osteoma size and localization, surgical equipment, endoscopic sinus surgery experience, and experience in open surgical techniques are the determinants for the surgical approach in PNS osteoma surgery.

Keywords: Osteoma, osteoplastic flap, paranasal sinus, transnasal endoscopic approach

INTRODUCTION

Osteomas are rare, slowly growing, and benign tumors of the paranasal region originating from bone tissue. Although it can be found in every age group, it is generally seen in the fourth and fifth decades and most frequently in men.¹ Paranasal sinus (PNS) osteomas, which are usually asymptomatic, are detected incidentally on radiographs or tomographies for other medical purposes. Although there is no consensus regarding the etiology of PNS osteomas, theories, such as infections, embryological developmental disorders, and trauma, have been proposed.^{2,3} When PNS osteomas reach a certain size, they may cause various symptoms and findings depending on their location. Headache and facial pain are among the most common symptoms of PNS osteomas.^{3–5} PNS osteomas can grow in the orbital structures and cause diplopia, proptosis, ptosis, and orbital pain. When they extend into the intracranial structures, life-threatening complications, such as cerebrospinal fluid (CSF) leakage, cerebral

abscess, and meningitis, may occur.^{4,6} Based on the histological types, osteomas are divided into three groups: (1) compact, (2) spongy, and (3) mixed types, and the most common form observed is the compact type.⁷ Osteomas are most commonly located in the frontal sinus, and then, in the ethmoid, maxillary, and sphenoid sinuses with decreasing frequency.⁶

Although the definitive treatment for symptomatic PNS osteomas is surgical excision, follow-up is also recommended in asymptomatic cases.^{7,8} Currently, there are two main approaches for the surgical treatment of PNS osteomas, open surgical techniques (osteoplastic flap, Caldwell–Luc, and lateral rhinotomy), and transnasal endoscopic techniques.^{8–12} The authors aimed to present the clinical results in relation to patients who underwent surgery for PNS osteomas and to evaluate the factors that determine the surgical approach in the treatment of PNS osteomas.

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METHODS

This study included 22 patients with PNS osteoma in the Otorhinolaryngology Clinic of the Dr. Ersin Arslan Training and Research Hospital and the Otorhinolaryngology Department of the Faculty of Medicine of the University of Gaziantep between January 2012 and September 2018. The Gaziantep University local ethics committee approved the study protocol. A written informed consent was obtained from all patients. The medical records of the patients were analyzed retrospectively, including data such as age, sex, follow-up, localization, size of the osteoma, symptoms, surgical approach, and complications. Osteoma in all cases was diagnosed using computed tomography (CT) and confirmed by histopathological examination. Magnetic resonance imaging (MRI) was also used in certain cases where the osteoma had invaded the orbit and extended beyond the PNS. Preoperative CT images were examined, and a surgical approach was planned, depending on the location of the osteoma, its size, and whether it had spread beyond the PNS borders.

Depending on the location and size of the osteomas; transnasal endoscopic, lateral rhinotomy (external ethmoidectomy), Caldwell–Luc, and osteoplastic flap techniques were adopted. Combined surgical approaches using transnasal endoscopic and open surgical techniques were preferred in some cases where the osteoma could not be completely removed through the nasal cavity. All patients were operated under general anesthesia. In all patients, the tumor was removed without residues. In patients with giant osteomas in which the tumor could not be removed en bloc, the osteomas were fragmented using an otologic drill and then excised. In patients who underwent surgery using the transnasal endoscopic approach, the nasal mucosa and turbinates were decongested with 0.05% oxymetazoline hydrochloride-impregnated buffers preoperatively. Oxytetracycline hydrochloride pomade-mixed buffers were filled into the nasal cavity postoperatively. In patients with external skin incision, dressings were performed for 1 week, and the sutures were removed thereafter. In patients who underwent the Caldwell–Luc procedure, oral mucosal incisions were closed using absorbable sutures. All patients were administered postoperative prophylactic antibiotics and analgesics, if necessary. Nasal packs were removed on the third day, and the patients were called for a control examination at 3-day intervals in the first week, then once weekly for 2 weeks, followed by follow-ups at the end of the first month, sixth month, and 1 year. The mean postoperative follow-up was 15.8 months (minimum: 8 months and maximum: 27 months).

Main Points

- There are basically three different alternatives for paranasal osteomas: open and transnasal endoscopic approach and their combination.
- Appropriate approach should be determined according to the location and size of paranasal sinus (PNS) osteomas and the surgeon's experience.
- While surgical treatment is recommended for symptomatic PNS osteomas, incidentally detected PNS osteomas are followed.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM SPSS Corp.; Armonk, NY, USA) was used for statistical analysis of the data. Descriptive and statistical analyses were performed. Results are presented as mean (\pm standard deviation), median (range), and per cent.

RESULTS

The medical records of 22 patients diagnosed with osteomas by postoperative histopathological examination were examined retrospectively. The most common types of osteomas were compact ($n = 15$), followed by mixed ($n = 5$) and spongy ($n = 2$) types. The clinical and demographic data of the patients are presented in [Table 1](#). Of the 22 patients who underwent surgery for osteomas, eight (36.3%) and 14 (63.7%) were women and men, respectively. The mean age of the patients was 39.1 years (range, 21–54 years). Based on their location, osteomas were found in the ethmoid, frontal, maxillary, and both frontal and ethmoid sinuses in 10 patients (45.4%), eight patients (36.3%), three patients (13.6%), and one patient (4.5%), respectively. In one patient, ethmoid sinus osteoma had a retro-orbital invasion, causing diplopia and proptosis symptoms. Based on PNS CT measurements, osteoma sizes ranged from 0.5 to 7.5 cm, and the mean was 2.9 cm. The most common symptoms at the time of admission were headache ($n = 14$), followed by periorbital pain ($n = 4$), nasal obstruction ($n = 2$), proptosis and diplopia ($n = 1$), and facial pain ($n = 1$).

Osteomas were successfully excised completely using the transnasal endoscopic approach in 12 patients (54.5%), of which nine (40.9%) and one (13.6%) were located in the ethmoid and frontal sinuses, respectively. In patients who underwent transnasal endoscopic surgery, the mean osteoma size was 1.9 cm (range, 0.5–3.8 cm) and 1.5 cm (range, 0.5–2 cm) for ethmoid and frontal sinuses, respectively. The overall mean size of the osteomas removed using the transnasal endoscopic approach was 1.8 cm (range, 0.5–3.8 cm). Of the three cases of PNS osteomas removed using the transnasal endoscopic approach, two were in the frontal sinus inferior wall, and one was in the frontal sinus recess. In one case, a 3.8-cm ethmoid sinus osteoma, causing retro-orbital invasion and diplopia, was completely excised throughout the medial wall of the orbit by using the transnasal endoscopic approach ([Figure 1](#)). In the early postoperative period, proptosis and diplopia resolved rapidly without complications.

The osteoplastic flap technique was preferred in five (22.7%) patients with frontal sinus osteomas >2 cm. The mean size of frontal sinus osteomas excised using the osteoplastic flap approach was 3.9 cm (range, 2.3–5.5 cm). Of the five patients with excised using the osteoplastic flap approach, three had osteomas in the lateral wall of the frontal sinus, one had an osteoma on the posterior aspect of the frontal sinus, and one had an osteoma on the anterior wall of the frontal sinus. In three (13.6%) patients with maxillary sinus involvement, the osteomas originated from the maxillary sinus posterior wall in two patients and from the lateral wall in one patient. The Caldwell–Luc and transnasal endoscopic approaches were used in combination in three patients with maxillary sinus osteomas. A 4.5-cm ethmoid sinus osteoma was removed using the lateral

Table 1. Demographic and Clinical Characteristics of Patients with Paranasal Sinus Osteoma

Patients Number	Age (Years)	Gender	Osteoma Location	Size (cm)	Symptom	Surgical Approach	Follow-Up (Months)
1	21	Male	Ethmoid sinus	1.5	Headache	TE	12
2	37	Female	Ethmoid sinus	0.5	Nasal obstruction	TE	27
3	43	Male	Frontal sinus	2.3	Headache	OF	21
4	52	Male	Frontal sinus	2.5	Periorbital pain	OF	13
5	33	Female	Ethmoid sinus	2.5	Headache	TE	16
6	35	Female	Maxillary sinus	4.5	Headache	CL + TE	17
7	47	Male	Frontal sinus	2.5	Headache	OF	22
8	44	Male	Maxillary sinus	2.5	Nasal obstruction	CL + TE	8
9	38	Female	Ethmoid sinus	2.3	Headache	TE	11
10	37	Female	Maxillary sinus	4.5	Periorbital pain	CL + TE	21
11	54	Male	Frontal + ethmoid sinus	7.5	Headache	OF + TE	18
12	32	Female	Frontal sinus	2	Periorbital pain	TE	24
13	27	Male	Ethmoid sinus	2.5	Facial pain	TE	11
14	49	Female	Frontal sinus	0.5	Headache	TE	14
15	38	Male	Ethmoid sinus	4.5	Headache	LR	23
16	41	Male	Frontal sinus	6.5	Headache	OF	12
17	38	Male	Ethmoid sinus	1.5	Headache	TE	11
18	50	Male	Ethmoid sinus	1.2	Periorbital pain	TE	16
19	41	Male	Frontal sinus	2	Headache	TE	11
20	46	Female	Ethmoid sinus (retroorbital extension)	3.8	Propitosis + diplopia	TE	14
21	49	Male	Ethmoid sinus	1.5	Headache	TE	13
22	26	Male	Frontal sinus	5.5	Headache	OF	14

TE, transnasal endoscopic; CL, Caldwell–Luc; OF, osteoplastic flap; LR, lateral rhinotomy.

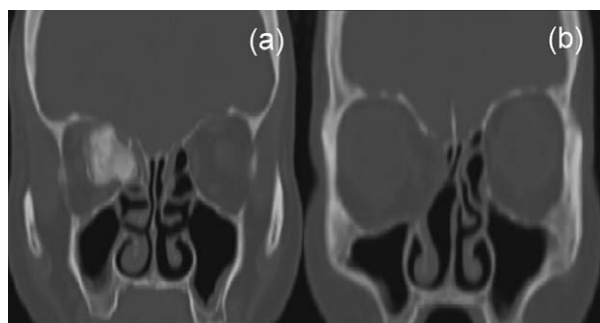
rhinotomy technique in one patient (4.5%). In one patient (4.5%), a 7.5-cm osteoma from the frontal and ethmoid sinuses was completely removed by fragments by using a combination of the osteoplastic flap and transnasal endoscopic techniques (Figure 2). Two patients who presented with nasal obstruction and diagnosed with PNS osteoma underwent both septoplasty and osteoma excision in the same session. The patients were hospitalized for 1 day postoperatively. Nasal tampons were removed after 48–72 hours, and the patients were followed-up by weekly controls every 3 days for the first week and thereafter for a month. Patients who underwent surgery using external approaches were advised to attend for controls every 2 days for dressing during the first week, then called for a weekly checkup for 1 month. Prophylactic oral penicillin was administered for 1 week postoperatively. None of the patients had intraoperative

or early postoperative complications, such as CSF rhinorrhea, massive bleeding, periorbital hematoma, or PNS infection. In one patient who underwent surgery using the osteoplastic flap technique, a local soft tissue infection developed in the third postoperative month due to the titanium plate used for defect repair of the frontal sinus anterior wall. The local infection resolved with antibiotic treatment and did not recur during the 18-month follow-up period. One patient with frontal sinus osteoma resected using the osteoplastic flap approach had numbness in the forehead region.

DISCUSSION

Osteomas are asymptomatic until they reach a certain size; hence, small osteomas are generally diagnosed incidentally.

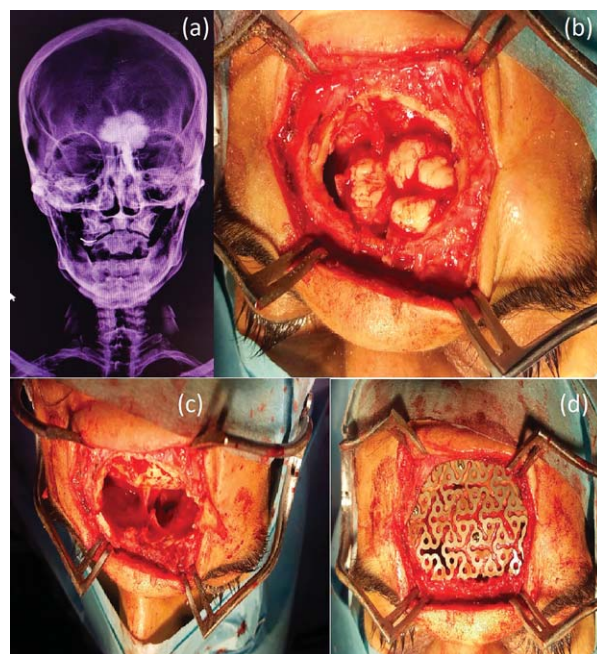
Figure 1. Osteoma surgery with orbital invasion by endonasal endoscopic approach. (a) Paranasal computed tomography (CT) image of the osteoma showing orbital invasion. (b) Paranasal CT image after osteoma excision with an endonasal endoscopic approach.



Symptoms and findings vary according to the location, size, and development rate, and direction of the osteomas.⁶ Osteomas may cause diplopia, proptosis, and periorbital pain due to the involvement of orbital structures; meningitis, CSF rhinorrhea, and cerebral abscess due to intracranial spread; and chronic sinusitis and mucocele due to the disruption of drainage in the PNS.^{8–10} Based on studies in the literature, the most commonly reported symptom of PNS osteomas is headache.^{5,11,12} Nasal mucosal inflammation adjacent to the osteoma, chronic rhinosinusitis due to obstruction of the drainage pathways of the PNS, and compression effect on the structures around the osteoma are factors that may cause headache.^{1,5} In our study, the most common symptom was pain in the head, face, and periorbital regions, which was consistent with the literature. Osteomas are generally diagnosed in the 40–50-year age group and are more common in men.⁸ In this study, male predominance was determined, and age distribution was consistent with the literature. In terms of localization, PNS osteomas originate most frequently from the frontal sinus, followed by the ethmoid, maxillary, and sphenoid sinuses in decreasing frequency.^{6,11,13} By contrast, in a prospective study with a large sample size, the authors argued that osteomas originate most frequently from the ethmoid sinus and then from the frontal, maxillary, and sphenoid sinus.¹ In our study, PNS osteomas were detected more frequently in the ethmoid sinus.

Although indications for the surgical treatment of PNS osteomas are controversial, there is a general consensus that surgical treatment should be performed for symptomatic patients and rapidly growing osteomas.^{14,15} Savić and Djerić⁸ suggested several indications for the surgical treatment of osteomas from the frontal and ethmoid sinuses, including osteomas extending beyond the frontal sinus boundaries, fast-growing osteomas, disruption of drainage of PNS, nasolacrimal duct involvement, and headache. Georgalas et al.¹⁶ indicated that surgical treatment should be performed in cases where osteomas completely obstruct the frontal recess, cause orbital and neurological symptoms due to intraorbital and intracranial extensions, if the growing osteomas occupies >50% of the

Figure 2. Fronto-ethmoid sinus osteoma resection via combination of osteoplastic flap and transnasal endoscopic technique. (a) X-ray view of the osteoma involving the frontal and ethmoid sinus, (b) intraoperative view of the giant osteoma, (c) appearance of the frontal sinus and frontal recess after osteoma removal, and (d) frontal sinus anterior wall reconstruction using titanium plate.



space in the frontal sinus. Although it is widely accepted that patients with asymptomatic PNS osteomas diagnosed incidentally should be followed-up because they show very slow growth characteristics, in the literature, studies advocating surgical treatment of asymptomatic PNS osteomas also exist as their increasing size may cause potential complications in the later stages of life.¹⁴ In this study, surgical excision was performed in all symptomatic patients with PNS osteoma detected by PNS CT. PNS CT is the gold standard imaging modality for the diagnosis of osteomas. Compact osteomas appear as smooth, hyperdense, noncontrast-enhancing masses on CT. Spongious and mixed types of osteomas are denser than the surrounding bone tissue and appear as heterogeneous bone masses on a CT with partial contrast enhancement.¹ In addition, the most appropriate approach in the follow-up of asymptomatic patients who did not undergo surgery is a periodic evaluation with PNS CT. MRI is recommended to evaluate soft tissue in patients with orbital involvement and intracranial extension of osteomas.¹⁰

Surgical options for PNS osteomas can be classified into three main groups: open, closed (transnasal endoscopic), or a combination of these. Although the surgical approach is not standard for the surgical treatment of PNS osteomas, the surgical approach can be determined preoperatively according to the location and size of the tumor and the surgeon's experience with surgical techniques. Open surgical options include

alternative approaches, such as lateral rhinotomy and external ethmoidectomy for complicated osteomas located in the ethmoid sinus, Caldwell–Luc for osteomas located in the maxillary sinus, and osteoplastic flap or bicoronal flap techniques for osteomas >2 cm in the frontal sinus.¹⁴ All large osteomas outside the frontal sinus can be safely removed in one piece or by fragmentation with the endonasal endoscopic approach.¹⁵ Although open surgical approaches have advantages, such as better surgical vision, ability to use both hands simultaneously, and easier intervention for possible complications, such as bleeding and CSF rhinorrhea, they have several disadvantages compared with the transnasal endoscopic approach, such as being more invasive and resulting in visible scarring due to external surgical incisions, causing higher postoperative pain, resulting in prolonged hospital stays and high postoperative morbidity.¹⁶

The osteoplastic flap and bicoronal flap techniques, which are commonly used, are open surgical methods that provide shorter operative times, wider areas for surgical intervention, and excellent surgical exposure for frontal sinus located osteomas >2 cm.^{14,15} Open surgical approaches allow the complete removal of frontal sinus osteomas without residues; moreover, they provide easier repair of complications, such as defects in the posterior wall of the frontal sinus and CSF rhinorrhea.¹⁵ Despite these advantages, pain and loss of sensation in the frontal region, scar on the skin due to surgical incisions, pain, and cosmetic deformity are among the most important disadvantages of open surgical techniques.¹⁶ In our study, a titanium plate was used to repair the bone defect in the anterior wall of the frontal sinus in a patient who underwent osteoma excision with the osteoplastic flap approach, and a late postoperative soft tissue infection due to the presence of the titanium plate, which was treated with systemic oral antibiotics. In another patient who underwent excision of a frontal sinus osteoma with the osteoplastic technique, a transient temporary loss of sensation in the frontal region improved spontaneously within 6 months postoperatively.

The transnasal endoscopic approach, which offers minimally invasive surgery for the treatment of PNS osteomas, has been increasingly adopted in appropriate cases. Compared with open surgical techniques, the transnasal endoscopic approach results in scarless surgery, less pain, shorter hospital stays, low postoperative morbidity rates, and lower complication rates.^{12,13} However, Rokade and Sama reported that the endoscopic transnasal approach is quite risky and challenging in patients with osteomas that fill $>75\%$ of the frontal sinus and erode the posterior wall of the frontal sinus or in patients with a history of meningitis and CSF rhinorrhea.¹² After endoscopic surgery, the anatomical structures of the nose and the drainage pathways of the sinuses were significantly preserved, and consequently, no deterioration of PNS function was observed. Castelnovo et al.¹⁷ reported that the transnasal endoscopic approach is not appropriate for the surgical treatment of patients with PNS osteomas, exceeding the ethmoidal sinus boundaries and showing orbital invasion, osteomas not arising from the inferior wall of the frontal sinus and frontal recess, or osteomas in the anterior or inferior maxillary sinus and >2 cm in size. In addition, the transnasal endoscopic approach is not an appropriate surgical technique for PNS osteomas that

erode the posterior wall of the frontal sinus and show intracranial extension. By contrast, some studies suggest that transnasal endoscopic excision of large osteomas in the frontal sinus and osteomas in the upper medial wall of the maxillary sinus is feasible in suitable cases with large frontal recesses.¹⁸ Seiberling et al.¹⁹ reported that they successfully performed surgery in 23 patients with large frontal sinus osteomas with the transnasal endoscopic approach. Although the transnasal endoscopic technique has many advantages, it is not considered an appropriate option in intraorbital and intracranial extension osteomas due to the possibility of complications, such as intraorbital hemorrhage and CSF rhinorrhea. Although it is endoscopically possible to intervene in complications, such as CSF rhinorrhea and periorbital hemorrhage, it increases morbidity.^{17,18} However, in our study, in a patient with a 3.8-cm osteoma with retro-orbital invasion exceeding the ethmoid sinus margins, the tumor was successfully removed completely using the transnasal endoscopic approach. Although the size and location of the osteoma have an impact on determining the surgical approach, the experience of the surgeon performing the surgery is also an important determining factor in choosing the surgical approach.

Finally, in this study, tumor excision was successfully performed using the transnasal endoscopic approach in patients with osteomas not exceeding 2 cm in size located in the frontal sinus inferior wall and recess. The tumor was excised using the osteoplastic flap approach in patients with osteomas >2.5 cm in size and located in the posterior and lateral regions of the frontal sinus. PNS osteoma was excised by using lateral rhinotomy in a patient with ethmoid sinus involvement and lateral extension. Serious major complications, such as periorbital hemorrhage, orbital injury, and CSF rhinorrhea, did not occur. In a patient who underwent open surgery for giant frontal sinus osteoma, soft tissue infection was developed in the third postoperative month due to the titanium plate used to defect repair and was treated with systemic oral antibiotics. During the follow-up period, no complications, such as reactions to a foreign body or explanation related to titanium plate use, were observed.

CONCLUSION

Open, transnasal endoscopic, and combined approaches for PNS osteomas have been described, and the decision regarding the surgical approach is determined based on the tumor location, size, and invasion to adjacent structures. Although there has been an increased tendency to apply the transnasal endoscopic approach in PNS osteoma surgery in recent years, open surgical techniques and combined approaches should be preferred for ethmoid and frontal sinus osteomas exceeding the PNS boundaries and have a potential for complications. In selecting the surgical approach, size and localization of the osteoma, surgical equipment, and surgeon's experience in endoscopic sinus surgery and open surgical techniques are also determinant factors.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Gaziantep University. (Approval date/number : 27.03.2017/88)

Informed Consent: Written informed consent was obtained from all patients who participated in this study.

Peer-review: Externally peer-reviewed.

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REFERENCES

1. Erdogan N, Demir U, Songu M, et al. A prospective study of paranasal sinus osteomas in 1889 cases: Changing patterns of localization. *Laryngoscope*. 2009;119:2355-2359. [\[CrossRef\]](#)
2. Horikawa FK, Freitas RR, Maciel FA, et al. Peripheral osteoma of the maxillofacial region: A study of 10 cases. *Braz J Otorhinolaryngol*. 2012;78:38-43. [\[CrossRef\]](#)
3. Cokkeser Y, Bayarogullari H, Kahraman SS. Our experience with the surgical management of paranasal sinuses osteomas. *Eur Arch Otorhinolaryngol*. 2013;270:123-128. [\[CrossRef\]](#)
4. Ishii T, Sakamoto Y, Miwa T, et al. A giant osteoma of the ethmoid sinus. *J Craniofac Surg*. 2018;29(3):661-662. [\[CrossRef\]](#)
5. Gulsen S. An extremely rare cause of headache; osteoma of the Middle concha bullosa. *J Craniofac Surg*. 2019;30(7):e622-e623.
6. Watley DC, Mong ER, Rana NA, et al. Surgical approach to frontal sinus osteoma: A systematic review. *Am J Rhinol Allergy*. 2019;33(5):462-469.
7. Erdoğan O, Ismi O, Tezer MS. A rare cause of headache: Pneumatized nasal septum osteoma. *J Craniofac Surg*. 2017;28(8):745-747.
8. Savić DL, Djerić DR. Indications for the surgical treatment of osteomas of the frontal and ethmoid sinuses. *Clin Otolaryngol Allied Sci*. 1990;15:397-404.
9. Buyuklu F, Akdogan MV, Ozer C, et al. Growth characteristics and clinical manifestations of the paranasal sinus osteomas. *Otolaryngol Head Neck Surg*. 2011;145:319-323. [\[CrossRef\]](#)
10. Humeniuk-Arasiewicz M, Stryjewska-Makuch G, Janik MA, et al. Giant fronto-ethmoidal osteoma—Selection of an optimal surgical procedure. *Braz J Otorhinolaryngol*. 2018;84:232-239. [\[CrossRef\]](#)
11. Cheng KJ, Wang SQ, Lin L. Giantosteomas of the ethmoid and frontal sinuses: Clinical characteristics and review of the literature. *Oncol Lett*. 2013;5:1724-1730. [\[CrossRef\]](#)
12. Rokade A, Sama A. Update on management of frontal sinus osteomas. *Curr Opin Otolaryngol Head Neck Surg*. 2012;20:40-44. [\[CrossRef\]](#)
13. Schick B, Steigerwald C, el Rahman el Tahan A, et al. The role of endonasal surgery in the management of frontoethmoidal osteomas. *Rhinology*. 2001;39:66-70.
14. Pagella F, Pusateri A, Matti E, et al. Transnasal endoscopic approach to symptomatic sinonasal osteomas. *Am J Rhinol Allergy*. 2012;26:335-339. [\[CrossRef\]](#)
15. Vishwakarma R, Joseph ST, Patel KB, et al. Giant frontal osteoma: Case report with review of literature. *Indian J Otolaryngol Head Neck Surg*. 2011;63(Suppl. 1):122-126. [\[CrossRef\]](#)
16. Georgalas C, Goudakos J, Fokkens WJ. Osteoma of the skull base and sinuses. *Otolaryngol Clin North Am*. 2011;44:875-890. [\[CrossRef\]](#)
17. Castelnovo P, Valentini V, Giovannetti F, et al. Osteomas of the maxillofacial district: Endoscopic surgery versus open surgery. *J Craniofac Surg*. 2008;19:1446-1452. [\[CrossRef\]](#)
18. Arslan HH, Tasli H, Cebeci S, et al. The management of the paranasal sinus osteomas. *J Craniofac Surg*. 2017;28(3):741-745. [\[CrossRef\]](#)
19. Seiberling K, Floreani S, Robinson S, et al. Endoscopic management of frontal sinus osteomas revisited. *Am J Rhinol Allergy*. 2009;23:331-336. [\[CrossRef\]](#)