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REVIEW

Paranasal sinus osteoma: review of literature

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Abstract

The osteomas are osseous lesions with slow and asymptomatic growth that most of the times is a finding in radiological exams requested for other reason. It's the most common benign neoplasm of the paranasal sinuses. The osteomas are located mainly in the frontal sinus *(37–80%)*, followed by the ethmoidal sinuses (20%), maxillary sinuses and rarely in the sphenoid sinus.

Although osteoid osteoma is rare in paranasal sinuses, it should be considered if there is a bone density mass and complete excision should be performed with care. Although osteomas are benign tumours, they may enlarge progressively and produce complications. Their resection is not free of risks, so there is some controversy about the management of asymptomatic patients.

Endonasal surgery reduces the morbidity of the treatment but the location and size of the lesions do not allow to employ this technique in all cases.

Osteoma is a type of benign bone-forming tumour occurring most commonly in craniofacial skeletal structures, mainly in the nasal and paranasal regions. The frontal sinus (37–80%)[1–6] is most frequent location, followed by the ethmoid 20%[7,10], maxillary sinus, and sphenoid sinus, respectively[1–14]. Sphenoid sinus osteoma is extremely rare[15]. True incidence of these tumours is unclear, since they are frequently asymptomatic and diagnosed incidentally. The reported incidence ranges from 0.01–0.43%[16,17] to 0.1 to 3%[18–20].

Paranasal sinus osteoma is a slow-growing, benign, encapsulated bony tumour that may be commonly asymptomatic, being detected *incidentally* in 1% of plain sinus radiographs or in 3% of sinus computerised tomographic scans[17,21,22].

Although osteomas may occur at any age, they are most frequently found in people over 40 years old[7,10,23–29]. Some authors have reported that the tumour is more common in young adults, with peak incidence from 10 to 20 years[30–32]. This may reflect the fact that the bone grows most rapidly during these years. Male–female ratio ranges from 2:1[25] to 3:1[5]. The greater preponderance of sinus osteomas in men is attributed to men's greater exposure to trauma and the large size of their sinuses[33]. They usually appear as sporadic individual lesions, but they can also be part of the clinical manifestations of Gardner Syndrome (a hereditary disease with autosomal predominance, that associates with intestinal polyposis, epidermal cysts, fibromatosis and osteomas), in which case they are usually multiple and tend to be found on the mandible, the cranium and the long bones[34].

Aetiology and pathology

From an aetiological viewpoint, these lesions have been correlated to abnormal enlargements of embryonal tissues, previous craniofacial trauma, and chronic inflammatory process of nasal and sinus structures, but a specific cause–effect relationship between osteomas and the triggering event still remains to be *defined*[25,29,35,36].

The embryological theory postulates that osteomas arise at the junction of the embryonic cartilaginous ethmoid and membranous frontal bones. But we know that many osteomas arise at sites distant from this junction[37]. Sinusitis has been suspected in the aetiology of osteoma formation, but the incidence of osteoma and infection do not correlate[13]. Trauma is another

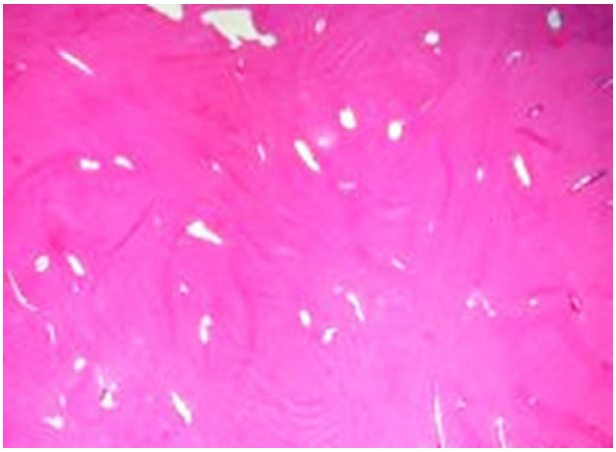

Figure 1 Compact or ivory osteomas are made of mature lamellar bone. They have no Haversian canals.

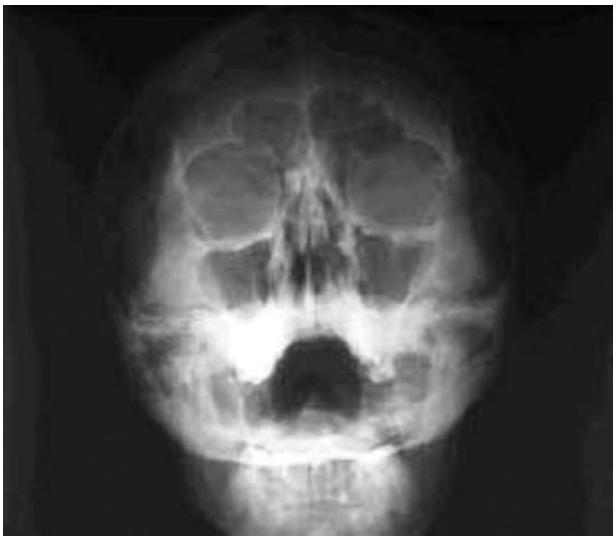

Figure 2 Osteoma in right frontoethmoid region.

factor blamed in the formation of osteomas[37]. However, many patients lack history of trauma.

Osteoma is usually classified into three histologic (Fig. 1) types according to bone formation: eburneous type (hard laminated), cancellous type (spongy), and mixed type (combining features of the eburneous and cancellous type)[27,37,38]. Ivory type lesions contain compact, usually lamellar bone, with scant or no intertrabecular spaces. In the cancellous type, the ratio of bone volume to intertrabecular space decreases and the morphology becomes similar to normal trabecular bone tissue. No significant practical differences are found between these forms of morphology when diagnostic techniques, treatment and prognosis are considered[39–42].

Clinical features

Three variants of osteoma can be distinguished: central, peripheral or extraskeletal. Central osteomas arise mainly from endosteum, whereas peripheral variants originate from the periosteum and the extraskeletal type resides within a muscle. The peripheral type quickly produces swelling, asymmetry and erosion of the surrounding structures. Osteomas are benign, generally slow-growing, bone forming tumours limited almost exclusively to craniofacial and jaw bones. They can be subdivided into bone surface tumours (or exostoses) that primarily involve the cranial vault, mandible, and external auditory canal and the more common paranasal sinus osteomas[43].

The clinical presentation of paranasal osteomas covers a broad spectrum. While most osteomas exhibit very slow or no growth (reported at 1.61 mm/year on average) and tend to remain asymptomatic, around 10% exhibit more rapid growth, resulting in symptoms[9,17,26,44]. Lesions larger than 3 cm in diameter are considered giant tumours[45].

When they produce symptoms, headache or facial pain localised over the area of osteoma is the most common one[27,29] followed by epistaxis[3,45]. The most frequent symptom in patients with osteomas of ethmoidal sinuses is frontal headache or facial pain (53%)[7–9,26,27], frequently secondary to ostium obstruction or infection of the sinus. Sphenoid sinus osteoma's most common clinical presentations are, in decreasing order, headache, invasion and deformity of the orbit, pneumocephalus with possible rhinorrhea and meningitis, and, rarely, abscess formation.

Initially, the osteoma takes the form of the paranasal sinus in which it originates, and with increasing size it invades adjacent orbital and intracranial cavities leading to variety of symptoms and serious complications.

These can be divided into[8,13,33,46–54]:

1 orbital: proptosis, exophthalmos, diplopia, ptosis, vision changes, epiphora and dacryorrhea.

2 intracranial cavities/neurologic: headache, meningitis and brain abscess, intracranial pneumotocele, CSF leak, intracranial hypertension.

3 nasal: anosmia, rhinorrhoea, nasal obstruction, sinusitis and paranasal sinus cyst, mucocele.

Investigations

Although plain films (Fig. 2) play a role in the diagnosis of paranasal sinus osteomas, they do not give sufficient information. Paranasal sinus osteoma is detected

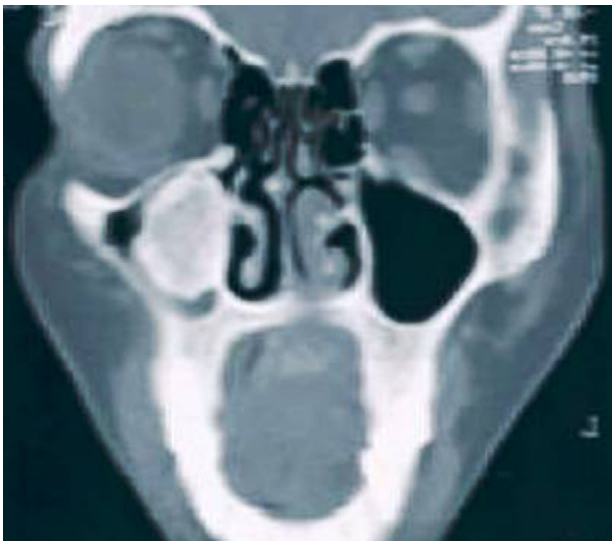

Figure 3 CT scan of osteoma in maxillary sinus.

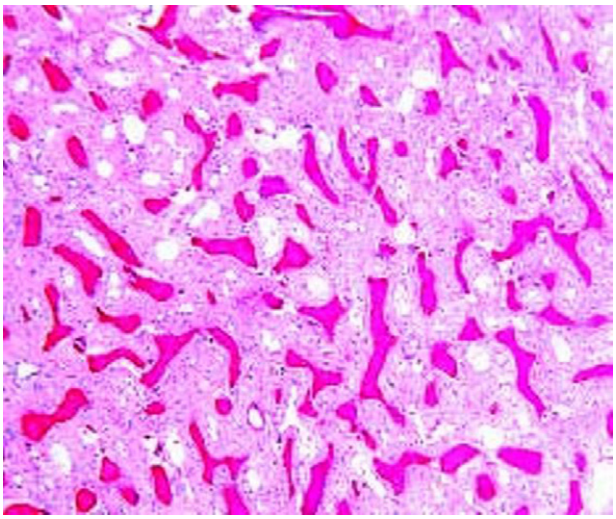

Figure 4 Osteosarcoma low grade with cellular atypia.

incidentally in 0.0018 ~ 1% of plain sinus radiographs and in 3% of sinus computed tomographic images[32,55]. Computed tomography (CT) scan (Fig. 3) is the suggested method for determining the regional anatomy and the extent of the lesion[56]. It is able to show bony borders, erosions and soft tissue involvement as well[57]. Radiographically, osteomas typically manifest as homogenously calcified, lobulated, sharply defined tumours that tend to form polypoid intracavitary growths[58]. The plain film image may show up a radiopaque mass, while the CT scans demonstrate a more variable range of ossification within the lesion. On CT scan, osteomas appear as sharply circumscribed, lobulated, homogenously hyperdense osteoblastic masses that can be either sessile or pedunculated while the cancellous osteomas may have a variable appearance[59]. They characteristically arise within a sinus, conform to the internal contour of the sinus margin and may have a bosselated surface[19,60]. The mass is non-enhancing on CT scans and does not demonstrate any cortical invasion. In contrast, a malignant lesion generally is non-homogenous and is variably enhancing with irregular margins and evidence of lytic bone destruction[61,62].

Magnetic resonance imaging (MRI) is important in the definition of dural or soft tissue involvement. MRI is superior to CT scan in showing optic nerve or optic canal invasion. The orbital extensions are well defined in the coronal and sagittal images, which provide a good evaluation of the roof of the orbit. The relationship of the tumour with the optic canal and optic nerve is well shown in axial sections[50]. The CT appearance of malignant lesions has a range of findings, including intact margins, bone sclerosis, bone erosion, and gross bone destruction, as well as varying degrees of internal calcified or ossified matrix. In general, bone destruction would favour a malignant lesion, as opposed to the bone expansion usually associated with benign lesions.

Radionuclide bone scan can help to differentiate an actively growing lesion ('hot') from a stable lesion ('cold'). Orbital venography has been used to demonstrate compression of the superior ophthalmic vein[33]. Spiral CT helps to give a three-dimensional reconstruction of the tumour[33]. Three-dimensional CT scan helps to define the extension of osteomas[63]. A CT scan is a fundamental tool that not only permits diagnosis but also allows the correct surgical approach to be planned.

The MRI appearance depends on the amount of calcification within the nidus, the amount of oedema in the bone, the size of the fibrovascular zone, and reactive sclerosis. MRI is more sensitive than a CT in evaluating soft tissue and bone marrow changes adjacent to the nidus[64]. However MRI is mostly useful in demonstrating complications (e.g. mucocele, pneumatocele) and in differential diagnosis.

The differential diagnosis of a solitary osteoma includes periosteal osteosarcoma, osteochondroma, periosteal osteoblastoma, ossified periosteal lipoma, and myositis ossificans[65]. Fibrous dysplasia, ossifying fibromas, clival chordomas, cranial base meningiomas and other types of bone tumours must be considered in the differential diagnosis[66–70]. It should also include parosteal osteosarcoma (Fig. 4) – that presents as painful destructive masses with rapid growth, exostoses–bony excrescences considered as

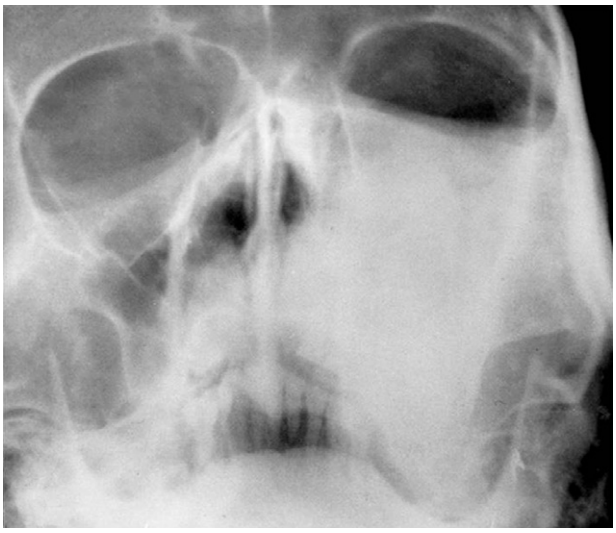

Figure 5 Ground-glass appearance suggesting fibrous dysplasia.

hamartomas that stop growing after puberty, but osteomas may continue growth after puberty[23]. Contrast enhancements in MRI is generally observed in fibrous dysplasia and could cause a difficulty in the diagnosis of osteomas[68,69]. These different lesions may have a similar radiological appearance, but their borders are usually less well defined than those of osteomas[66].

Durmaz *et al*. reported that bone scintigraphy is useful making a differential diagnosis between various bone tumours and that it could detect the lesions not visible in plain radiograms[71].

Fibrous dysplasia (Fig. 5) is a benign proliferation of fibrous tissue and woven bone. It is a slow progressive disorder in which normal bone is replaced by fibrous tissue and immature woven bone. It typically presents in the first 2 decades of life, being more commonly seen in females.

Chen *et al*.[72] have reported on CT imaging characteristics on 46 cases of craniofacial fibrous dysplasia. In this series, Fibrous dysplasia had homogenous sclerotic or ground-glass appearance (Fig. 5) in 34%, mixed sclerotic and lytic appearance in 55%, and predominantly cystic change in 11%. They have classic pattern of ground-glass appearance or mixed pattern on CT.

Ossifying fibromas (Fig. 6) also known as cementoossifying fibroma, and juvenile aggressive ossifying fibroma, represents a locally-destructive neoplasm. Though commonly seen in the mandible in females, it can arise in the paranasal sinuses and skull base, behaving in a more aggressive manner at the intracranial and orbital interfaces[73,74]. CT findings can be fairly distinctive, characterised by circumscribed lesions with a sclerotic eggshell rim and central radiolucency with variable amount of internal calcification.

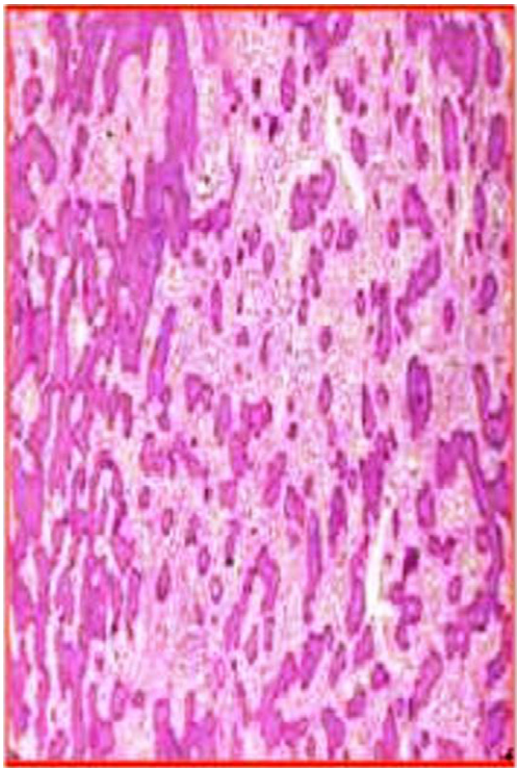

Figure 6 Ossifying fibroma Fibrous connective tissue with varying degree of mineralised material.

Treatment

It is generally agreed that asymptomatic osteomas without intracranial, or orbital extension, or cosmetic deformity require no treatment[75,76]. These should be followed up with serial radiographs to determine any change in size. Sphenoid osteomas are exceptions to this rule and have to be removed as soon as possible due to the slow and gradual enlargement that can lead to compression of the visual pathways[33]. Smith proposed that asymptomatic and minimally symptomatic patients could be followed by serial radiographs but that surgery is indicated if the lesion fills the frontal sinus by more than 50% by volume[13]. Savic *et al*. proposed that ethmoidal sinus osteomas should be resected regardless of their size[7,9,21]. Others have proposed that osteomas should be resected when they are still small in size[45].

The osteomas which require surgery can be operated either by endoscopic surgery, open surgery or by combined method. The choice must consider several

factors such as tumor location, extension, dimension and the experience of the surgeon. The surgical approach must protect the vital structures especially optic nerves and cribriform plate, while optimising the ability to totally excise the osteoma with minimal cosmetic deformity[21,33,77].

Indications for surgery in paranasal osteomas include sphenoid osteomas, irrespective of size, presence of significant symptoms like unexplained headache, recurrent sinusitis, ocular symptoms, neurological symptoms, enlargement seen radiographically, extension beyond confines of the sinus, filling of more than 50% of the volume of the frontal sinus, location near the frontal sinus ostium and cosmetic deformity[21,33,77–80].

Endoscopic surgery can be carried out when osteoma is based on the inferior part of the posterior frontal sinus wall, limited to sinuses without evidence of orbital or intracranial extension. The location of the osteoma in relation to the lamina papyracea, the point of attachment and the size of the osteoma in relation to the size of the frontal recess are considered very important aspects when planning the surgical approach[81].

The majority of ethmoidal osteomas as well as those frontal ones that do not go beyond the limits of the frontal sinus and are located in the posteroinferior wall of it, medial to the lamina papyracea of the ethmoid are easily resected by endoscopy[82]. Other authors consider osteomas that is located medially to a virtual sagittal plane through the medial orbital wall and based inferiorly on the posterior frontal sinus table to be endoscopically resectable[83,84]. If the osteoma is massive, it can be reduced in size with a drill in order to facilitate complete resection[85]. The magnification and the different angled view, which are possible with the use of endoscopes, may facilitate the removal of osteomas[10].

Advantages of endoscopic surgery are excellent cosmetic results without any external incision, shorter duration of operative time, early discharge from hospital, closer and more direct visualisation during operation, minimal soft tissue dissection, and the absence of facial bony disruption[7,8,22,33,39,40,77,79,86,87].

Limitations of endoscopic surgery are difficult management of intraoperative complications, such as bleeding and inadequate control of the margins of the lesion. Osteoplastic flap operation, Reidel's operation, and lateral rhinotomy are the main open procedures which have been used for many years. Osteoblastic flap technique should be used for the frontal and ethmoid sinuses osteomas. Reidel's operation may be chosen when the osteoma has destroyed the anterior wall of the frontal sinus, and in extremely large osteomas penetrating into the anterior cranial fossa. Additionally, lateral rhinotomy should be used for very large osteomas affecting the frontal, ethmoid and maxillary sinuses. A dacryocystorhinostomy approach using a mastoid drill and perforating burr has been described[8,38]. Transcoronal removal with an osteotome has been also described[8,76].

Frontal or fronto-ethmoid osteomas are often excised via a frontoethmoidectomy approach (Lynch procedure) or an osteoplastic flap[82,84]. The Lynch procedure has a high failure rate because of subsequent stenosis of the nasofrontal duct; hence the osteoplastic approach is the most widely used technique for frontal sinus osteoma which has a good success rate[88].

The advantages of these open approaches is good visualisation and open access to the frontal sinus that also allows easy obliteration of the sinus if the nasofrontal duct is compromised. The osteoplastic frontal sinus operation after coronal incision is reported to have reduced likelihood when compared to the brow incision of injuring the supraorbital nerve[82].

Disadvantages of open surgery are permanent scar formation, blood loss, mucocele formation, CSF leak, post-operative frontal pain, parasthesia or anaesthesia from supraorbital nerve damage, frontal bossing[58] and fracture of the bone flaps penetrating the anterior cranial fossa and/or damage to the Superior Longitudinal Sinus[21,37,38,77,84,88–90].

For large osteomas of the frontal sinus, the bicoronal approach is recommended. This approach provides an excellent surgical exposure, allowing the complete excision of the lesion, limiting the intra- and post-operative complications, reducing the recurrence rates, and giving an ideal aesthetic result[91].

The supraciliar approach is usually chosen in bald patients or those with little hair and in patients with small sinuses or small osteomas located at the anterior wall of the frontal sinus. The supraciliar approach may not give good aesthetic results and recurrence rates are relatively high.

From the available literature, the surgical technique with lower recurrence rate and better aesthetic results seems to be the bicoronal approach.

Complications are numbness, frontal branch (cranial nerve VII) weakness, dural damage with cerebrospinal fluid leakage, ptosis, diplopia, supraorbital anaesthesia, and rhinoliquoral fistula and damage of the orbital contents or intracranial structures, are quite unusual and have seldom been reported[92].

Surgery is the treatment of choice for symptomatic ethmoid osteomas. Endoscopic transnasal resection is ideal for tumours confined to the ethmoid and nasal

cavity. For large ethmoid osteomas surgical options are lateral rhinotomy, midfacial degloving, osteoplastic flap, external frontoethmoidectomy[21].

The resection of sphenoid tumours has been performed via a variety of approaches, among which the transseptal, transnasal, transethmoid, transmaxillary, and extradural transbasal are the most common, and their choice depends on the expansion of the tumour and the surgeon's experience[93–95]. Nii *et al*.[96] performed sublabial-nasoseptal sphenoidotomy, while Pompili *et al*.[80] the extradural transbasal approach to remove a giant sphenoid osteoma. Noterman *et al*.[94] performed subtotal resection of a large tumour through a frontal extradural approach.

Conclusion

The osteomas of the paranasal sinuses are benign lesions generally asymptomatic but may enlarge to produce complications. Asymptomatic osteoma should be followed up by serial radiographs. The choice of the operative approach and extent of the osteotomy depend on the dimension of the lesion, its relation with the anterior and posterior walls of the sinus, and the dimensions of the sinus. The endoscopic procedure can constitute an important part of surgery undertaken for osteomas. Open surgeries are required for large osteomas.

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