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REVIEW

Alveolar exostosis – revisited: A narrative review of the literature

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Abstract An exostosis is a localized, peripheral overgrowth of bone of unknown etiology of benign nature. It may be a nodular, flat or pedunculated protuberance located on the alveolar surfaces of the jawbones. The etiology of oral bony exostosis is still not clear. Racial, autosomal dominant factors, dental attrition, and even nutritional factors have been suggested as having an influence. In the jaws, depending on the anatomic location they are named as torus palatinus (TP), torus mandibularis (TM), or buccal bone exostoses (BBE). The clinical importance of exostosis lies in surgical removal of these to permit proper flap adaptation, most importantly in the posterior maxilla, and to the potential use of the mandibular and palatal tori as sources of autogenous cortical bone for grafting.

Contents

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1. Introduction

An exostosis is a benign, localized, peripheral overgrowth of bone of unknown etiology. It may be a nodular, flat or pedunculated protuberance located on the jawbones' alveolar surface.[1] It frequently occurs in long bones where tendons

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and muscles are inserted. Exostosis or abnormal bone growth within the ear canal is called as Surfer's ear.

In the jaws, depending on the anatomic location they are named as torus palatinus (TP), torus mandibularis (TM), or buccal bone exostoses (BBE), TP that occurs along the midline of the hard palate is a sessile, nodular mass of bone. TM is a bony overgrowth located on the lingual aspect of the mandible, most commonly seen in the canine and premolar areas (Fig. 1). BBE occurs along the buccal aspect of the maxilla or mandible, usually in the premolar and molar areas. Palatal exostoses are found on the palatal aspect of the maxilla, and the most common location is the tuberosity area. Multiple exostoses occasionally occur in the same individual. They may appear as isolated, discrete bony overgrowths on the facial aspect of alveolar bone in young, dentate subjects or as somewhat less usually found multiple exostosis in maxilla (torus palatinus) and in mandible (mandibular tori).[2]

Glickman & Smulow divided buccal alveolar bone enlargement into two subtypes-exostosis and lipping. Though their etiology is unknown, they considered it as buttressing bone formation in response to trauma from occlusion and suggested that such bone formation occurs with the purpose of reinforcing bony trabeculae for functional adaptation (Fig. 2).[3] Other types of bony exostosis have been found associated with unusual postoperative conditions. These exostoses are often encountered during periodontal diagnosis and treatment.

Mandibular and palatal tori are often obvious, and may require removal for prosthetic reasons. In contrast, the more common palatal tubercle is less evident externally but is usually encountered during palatal flap reflection in the posterior maxilla. Schluger et al. stated that flat, shelf-like bony excrescences are commonly found on the palatal alveolar bone from the mesial side of the second molar to the tuberosity.[4] Prichard also noted that discrete osseous nodules are often found on the palatal side of maxillary molars and may require removal during corrective periodontal surgery.[5] He further stated the importance of avoiding damage to the structures in the region of the greater palatine foramen while removing these exostoses. The anatomic location of the tubercle is generally immediately lateral to the greater palatine foramen and palatal to the second to third molar. Removal of this tubercle is often necessary to ensure proper healing, but caution must be exercised to avoid injury to the greater palatine artery. Corn[6] also cited a high incidence of large exostoses on the palatal alveolar process from the first molar to the tuberosity and correlated the presence of palatal exostoses to adverse surgical sequelae such as slow healing following palatal gingivectomies. He indicated that unrecognized palatal exostoses could impede pocket elimination by gingivectomy, and he described a tuberosity flap approach to thin the palatal flap and gain access to the exostoses.[6] Removal of these exostoses may be difficult when compounded by lack of access, restricted opening by the patient, or the relative immobility of palatal tissue. Removal of these exostoses can also assist with the flap adaptation during periodontal surgery. They may also serve as useful sources of autogenous bone for grafting during periodontal[7] or implant surgery or for restoration of alveolar defects. To avoid surgical surprises, careful palpation or sounding of the palatal alveolar bone prior to surgery should be considered to detect this common exostosis as these may present the surgeon with special difficulties in flap management. Sonnier et al.[2] stated that the finding of a high frequency of palatal exostoses in their study specimens is of practical significance with respect to planning periodontal surgery in the posterior maxilla.

Figure 1 Mandibular Tori.

Figure 2 Buttressing bone formation around the teeth subjected to trauma from occlusion.

Buccal exostoses are significant with regards to prosthodontics because they may interfere with denture insertion. Also, buccal exostoses may be traumatized and interfere with oral hygiene procedures.[2] Other exostoses such as mandibular and palatal tori may require surgical removal for prosthetic reasons.

1.1. Prevalence of exostoses

In 1972, Larato studied 145 skulls of Mexican origin and found that 30% of these skulls had palatal exostoses in the posterior maxillary alveolar process.[8] These exostoses were classified as small nodules, large nodules, spikes, sharp ridges, and combinations of the above. No specific measurements of size were recorded. In 1977, Nery et al. examined 680 skulls of various ethnic origins and found that 40.5% had palatal exostoses.[9] They found the highest prevalence in the skulls of European and Oceanic-Asian specimens (46%) while those of African or South American origin had a prevalence of 26%. The exostoses were also classified into 5 categories with respect to size and shape. In one study involving U.S. population, palatal tori were more prevalent among American Indians, Eskimos, and among women. Mandibular tori were also more prevalent in Eskimos and Aleuts, but with similar

prevalence in males and females.[10] A clinical study by King and More reported that African-Americans had approximately 25% fewer mandibular tori than Caucasians. In this study on 100 American males and 100 females, they found that 42% of females and 25% of males had palatal tori, but no significant gender difference was found in the prevalence of mandibular tori.[11] A study of 1272 dry skulls of white, black, and Chinese groups from South Africa by Touyz and Tau[12] found that palatal exostoses occurred most frequently in whites (35%), followed by Chinese (25%) and then in blacks (13%). Haugen found in a clinical study that females had a significantly higher percentage of both palatal and mandibular tori, [13] while Eggen and Natvig[14] and Levesque[15] found a greater percentage of mandibular tori in males. Eggen and Natvig[16] study found a significant correlation between the presence of teeth and the presence of mandibular tori. Eggen[17] found that in dentate patients, the presence of mandibular tori significantly correlated to normal alveolar bone height around teeth. Kolas et al.[18] found the prevalence of palatal tori to be 21%. The prevalence and features of 3 types of exostoses that are commonly encountered during periodontal surgery were studied in a sample of 328 modern American skulls.[2] The relationship to teeth or other skeletal structures was also recorded. Palatal tubercles were observed in 56% of all skulls (69% of all dentate skulls), with higher prevalence among males and African-Americans. Palatal tubercles were commonly associated with second and third molars, and were usually directly lateral to the greater palatine foramen and at mean of distance of 11.4 mm from it.[2] Mandibular tori were observed in 27% of all skulls (42% of dentate skulls), with higher prevalence seen among African-Americans and males.[2] BBE are found less commonly than tori.[10] In contrast to this, a study on 52 skull with intact dentition by Horning, Cohen and Neils[19] observed the presence of BBE or lipping fairly commonly with 76.9% of all the specimens having at least one. BBE were found associated with 7% of all teeth and lipping was found associated with 17.6% of all the teeth. Basha and Dutt reported a rare case of BBE at the angle of the mandible.[20]

1.2. Histological characteristics of exostoses

The histologic features of tori and other types of exostoses are identical.[21] These are described as hyperplasic bone, consisting of mature cortical and trabecular bone.[21,22]

Etiology: The etiology of tori has been investigated by several authors; however, no consensus has been reached. Some of the postulated causes include genetic factors,[22–26] environmental factors,[11,13,14] masticatory hyperfunction,[11,16,27–29] and continued growth.[30] Several authors have postulated that the etiology of tori consists of an inter-play of multifactorial genetic and environmental factors. [13,21,31,32] The role of nutrients in the etiology of tori has been reviewed by Eggen et al.[16] who suggested saltwater fish consumption in Norway possibly supplies higher levels of polyunsaturated fatty acids and Vitamin D that is involved in bone growth which increases the chances of tori. Gorsky et al.[31] surmised that the etiology of this common osseous outgrowth is probably multifactorial, including environmental factors acting in a complicated and unclear interplay with genetic factors. The quasi-continuous genetic or threshold theory states that the environmental factors responsible must first reach a threshold level before the genetic factors can express themselves in the individual; hence, both genetic and environmental factors determine expressivity, making the etiology multifactorial.[13,33] Antoniades et al hypothesized that the quasi-continuous model of inheritance or threshold may also apply to BBE and palatal exostoses.[33] The mechanism for proposed buttressing bone formation phenomenon is still unclear, but evidence suggest that bone flexion could result in the release of bone morphogenic proteins, which could stimulate bone growth, express as thickening, lipping or exostosis at a point of stress.[19] Some observation suggest that the internal functional stresses associated with dental implant may also prevent otherwise expected alveolar bone loss.[34] Studies reviewed by Marx and Garg indicated that mechanical factor of micro strain could have a significant effect on bone modeling. When mechanical loads are low (less than 0.2% deformation), bone atrophy occurs; when normal mechanical loads are experienced (0.2–0.25%) normal bone turnover occurs; when higher mechanical loads occur (0.25–0.4%) bone hypertrophy occurs with increased lamellar bone and when pathologically higher loads are imposed (more than 0.40%) woven bone formation occurs.[7,35] These findings are consistent with those of Pietrokovsky and Massler[36] who observed that following extraction alveolar bone becomes atrophic and resorbs.

1.3. Exostoses as a post operative squeal of dental treatment procedures

Bony exostosis development secondary to soft tissue graft procedures has been reported in a small number of cases as a consequence of shallow vestibules which were treated with the use of skin grafts[37,38] subsequent to connective tissue graft[39] and subsequent to free gingival grafts[40–43] since 1991 when the first two cases were described.

Efeoglu and Demirel state that *'it is also possible that other clinicians might have assumed the thick gingival grafts they saw during their patients' postoperative visits were not thick soft tissue grafts, but were, in reality, exostoses.*[41] Czuszak et al.[42] suggested that this exostoses development may be coincidental and not due to free gingival graft (FGG). Otero-Cagide et al.[43] speculated that the bone formation after an FGG may be the result of a periosteal trauma combination during site preparation and the activation of osteoprecursor cells contained in the connective tissue of the graft.[40] Chambrone and Chambrone[44] suggest that patients presenting tori or any kind of bony exostosis are highly susceptible to bony overgrowth responses.

Echeverria et al.[45] previously noticed that the exostoses that have been related after an autogenous FGG were most commonly located in the cuspid-premolar area. They suggested that the grafted areas may be influenced by factors acting at this level, e.g., excessive forces, surgical trauma and genetic factors. Among the related reports, all the authors suggest that the periosteal trauma seemed to be the main aetiological agent associated with the exostosis development.[37–43] In cases of skin grafts, the occurrence of periosteum fenestration after the graft suture position has also been observed. This surgical trauma can be associated with the liberation of osteoprogenitor cells from the periosteum-bone interface inducing osteogenesis.[43]

Subpontic osseous hyperplasia under fixed partial denture: Caiman et al.[46] showed radiographs of the first case of osseous hyperplasia under a fixed partial denture in 1971. In 1975,

Staphne and Gibilisco[47] showed a similar radiograph of osseous growth under the pontic of a fixed partial denture. Subsequently, in 1981, Strassler[48] demonstrated radiographs of a case with osseous deposition under the pontics of bilateral bridges in the mandibular left and right molar regions.

Burkes et al.[49] reported clinical and radiographic findings of nine cases with bone growth in an edentulous region of the posterior mandible covered with a pontic, and proposed that the reasons for such bone growth could include genetic predetermination, functional stresses, and chronic irritation. Evaluation of the 12 cases reported in the above-mentioned reports revealed that osseous hyperplasia under the pontic of a fixed partial denture was seen only in adults, in the mandibular molar or premolar region with a variety of pontic designs. A case of osseous hyperplasia under the pontics of fixed partial dentures in right and left mandibular first molar regions was presented.[50] Radiographs showed hemispherical radio opacities on the alveolar ridges. Histological examination revealed the lesions were composed of a dense mass of mature bone with well-developed lamellae and haversian systems, viable osteocytes in lacunae and a few marrow spaces filled with loose fibrous connective tissue.[50] Lorenzana and Hallmon reported a case of subpontic osseous hyperplasia occurring on the edentulous ridge beneath a fixed partial denture replacing a mandibular first molar in a 56 year old women, which was surgically removed. They reported no re-occurrence even after 1 year postoperatively.[51] Islam et al. reported 3 cases of subpontic hyperplasia. Out of the 3 cases, one of the case was on bisphosphonate and the authors speculated that the benign bone overgrowth under the pontic could be due to the medication that the case received.[52] Aydin et al. presented three cases of subpontic hyperplasia occurring on the edentulous ridge beneath a fixed partial denture. One of the case presented by them had the hyperplasia in the maxillary arch, the second case in the dental literature[53] and the first being reported by Frazer et al.[54] Conservative surgical removal with bony recontouring and with relief of prosthesis-induced mechanical stresses is the treatment of choice, with occasional recurrences expected.

A case report[55] reported a case of exostosis following a traumatic blow and speculated it to be due to combination of trauma, occlusal stresses and genetic factors. Another case report[56] reported a case of alveolar exostosis following orthodontic implant placement.

1.4. Clinical management of alveolar exostosis

Owing to their benign innocuous nature, exostosis in majority of cases does not necessitate any surgical intervention unless in the event of tissue trauma, periodontal or prosthodontic complications. Intra-oral bony growths of all types, present a clinical challenge for the dental team attempting to perform periodontal surgery in the posterior maxilla. Careful surgical planning while keeping the basic flap design and the gingival anatomy in mind would definitely culminate satisfactory outcome for both the clinician and the patient. When treatment is elected, the exostosis may be chiseled off of the jaw or removed by bone-burr cutting/smoothing through the base of the bony lump. Further while attempting to capture accurate detail for final impressions of crown and bridge, removable prosthetics, oral appliances, accurate opposing models, study models, and whitening trays, stock impression trays often cannot be seated to the depth, because of the interference by these bony anatomical variants. These bony protuberances may cause pain during the impression making, as there is often only a thin oral mucous membrane covering these osseous protuberances which is easily irritated.[57] Mandibular tori can present significant challenges for endotracheal intubation[58] and laryngoscopy.[59] Lingual tori and palatal exostosis may also limit the space for the tongue and can result in speech impediment. Boksman and Carson presents a new approach to taking impressions of exostosis, torus mandibularis, torus palatinus and mal-positioned teeth, which incorporates the use of a disposable heat mouldable tray.[60] Even though these bony areas can create a clinical challenge with impression making, these areas are prime sites for harvesting autogenous bone for bone grafting for dental implants placement,[61] alveolar ridge augmentation and maxillary sinus lifting,[62] periodontal osseous defect [63] and can be used for multiple reconstructive uses such as nasal reconstruction.[64]

2. Conclusion

An exostosis is described as a localized peripheral overgrowth of bone, the base of which is continuous with the original bone. The etiology of oral bony exostosis is still not clear. Race, autosomal dominant factors, dental attrition, and even nutritional factors have been suggested as having an influence. Exostoses should be differentiated from an osteoma, an uncommon finding which produces a similar clinical, radiographic, and histologic picture. Osteomas are benign, developmental neoplasms which induce proliferation of dense, compact or coarse, cancellous bone usually in an endosteal or periosteal location. A patient should be evaluated for Gardner syndrome if they present multiple bony growths or lesions not in the classic torus or locations. Intestinal polyposis and cutaneous cysts or fibromas are other common features of this autosomal dominant syndrome.The clinical importance of exostosis lies in surgical removal of these to permit proper flap adaptation, most importantly in the posterior maxilla, and to the potential use of the mandibular and palatal tori as sources of autogenous cortical bone for grafting.

Conflict of interest

None.

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