Buccal and palatal exostoses: Prevalence and concurrence with tori
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Objectives. The aims of this study were to investigate the prevalence and location of oral exostoses and the concurrence of buccal and palatal exostoses with tori.
Study design. With clinical inspection and palpation, 960 Thais were examined for the presence or absence of torus palatinus (TP), torus mandibularis (TM), and exostoses.
Results. Of the 960 subjects studied, 26.9% exhibited exostoses. Exostoses were more common in the maxilla than in the mandible (5.1:1). In addition, most of the exostoses were located on the buccal aspect of the jaws. The prevalence of exostoses increased with age ($P = .000$). Exostoses were significantly more common in men than in women (62.4% vs 37.6%, $P = .000$). Exostoses were concurrent with TM more frequently than with TP (36.2% vs 20.6%). The highest concurrence of exostoses with tori was observed in subjects who had both TP and TM (42.6%).
Conclusions. The occurrence of exostoses is related to increasing age. TM and exostoses may share the same causative factors, and functional influences may contribute. Our findings lend support to the hypothesis that the etiology of exostoses involves an interplay of multifactorial genetic and environmental factors.

Tori and exostoses are nodular protuberances of mature bone, the precise designation of which depends on anatomic location.1 Torus palatinus (TP) and torus mandibularis (TM) are the 2 most common intraoral osseous outgrowths.2,3 TP is a sessile, nodular mass of bone that occurs along the midline of the hard palate. TM is a bony protuberance located on the lingual aspect of the mandible, commonly in the canine and premolar areas. Buccal and palatal exostoses are multiple bony nodules that occur less frequently than tori.1,2,4 Buccal exostoses occur 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.2,5 The histologic features of tori and other types of exostoses are identical.2 These are described as hyperplastic bone, consisting of mature cortical and trabecular bone.1

The etiology of tori has been investigated by several authors; however, no consensus has been reached. Some of the postulated causes include genetic factors,6-9 environmental factors,10-12 masticatory hyperfunction,7,12-16 and continued growth.17 Recently, several authors have postulated that the etiology of tori consists of an interplay of multifactorial genetic and environmental factors.2,12,18,19 Gorsky et al18 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.12,19

The reported prevalence of tori varies among studies, probably because of racial divergences or ethnic group differences.7,9,20-22 The prevalence of TP and TM is higher in Mongoloids than in Caucasoids.7,10,12,20,23,24 Gender differences in the prevalence of tori have also been reported, and most authors found TP more frequently in women, whereas TM was more common in men.7,10,12,20,22,25-28 Tori are frequently observed in young adults and in middle-aged persons.7,12,29 It has been theorized that because some tori are found with some frequency during the middle phase of life, this indirectly suggests not only a genetic cause, but also environmental and functional factors, particularly those related to masticatory stress.12

Reports on the concurrence of TP and TM generally describe a low frequency of occurrence, denoting a nonsignificant correlation.12,20,29 However, Haugen12 reported that the probability of finding a TM in a person with a TP was more than twice as high as in a person without a TP, and vice versa. Based on this evidence, Haugen12 stated that it was difficult to reject a possible causal relationship between the occurrence
of TP and TM. In addition, Reichart et al\(^7\) and Eggen and Natvig\(^29\) demonstrated that the concurrence TP and TM was statistically significant in women.

As with tori, many theories describe the etiology of exostoses. It has been suggested that the bony outgrowth represents a reaction to increased or abnormal occlusal stress to the teeth in the involved areas.\(^1\) A correlation between the occurrence of tori and teeth abrasion has also been reported as significant.\(^13\) Reichart et al\(^7\) detected a strong relationship between dental attrition and the presence of tori in Thais but not in German subjects; however, they stated that functional influences should not be overestimated by this single observation. Kerdporn et al\(^16\) also found a strong association between the presence of TM with occlusal stress indicated by the documentation of the pressure of clenching and grinding. Because buccal and palatal exostoses and TM are similar in morphology and location, Antoniades et al\(^3\) hypothesized that the quasi-continuous model of inheritance may also apply to buccal and palatal exostoses.

Bouquot and Gundlach\(^21\) reported a 0.09% prevalence of buccal exostoses in white Americans, and approximately 73% of the lesions were encountered on the maxillary alveolus. They found no sex-specific differences in prevalence. Larato\(^5\) found palatal exostoses in 30% of their sample, which consisted of human skulls of Mexican origin. The highest occurrence (59.1%) was in adults 55 years old and older. Nery et al\(^30\) examined 681 skulls of 4 ethnic groups and reported a 40.5% incidence of palatal exostoses.

There were significant differences in the prevalence of exostoses among the 4 ethnic groups. The Oceanian-Asia specimens (representing Mongoloids) showed the highest incidence of palatal exostoses (47.2%), whereas the Africans exhibited the lowest incidence (25%). Based on these findings, Nery et al\(^30\) theorized that a gene may play an important role in the causation of palatal exostoses. Because the highest incidence was reported in the 40- to 55-year-old age group (50.4%), these authors suggested that an oral environment exposed to more rigid functional activities may be a contributing factor. Touyz and Tau\(^31\) reported a 14.5% incidence of palatal exostoses in the skulls of blacks, mixed whites, and Chinese, with a male to female ratio of 3.5:1. Sonnier et al\(^28\) reported a 56% incidence of palatal exostoses in modern American skulls, consisting of whites and African Americans, with a higher prevalence among men of both racial groups and among African-Americans.

In a review of the literature, we found only 3 reported cases describing the concurrence of tori with exostoses. One case each of TP with palatal exostoses was reported by Topazian and Mullen\(^17\) and by Blackmore et al\(^22\) in 1975. Recently, Antoniades et al\(^3\) described a third case of concurrence of TP with palatal and buccal exostoses and surmised that the concurrence of tori with exostoses in the same individual was a rare finding.

**OBJECTIVES**

Although exostoses are not a rare finding, relatively few reports on these structures are available. The information on the concurrence of tori with exostoses is very limited because of the scarcity of cases reported in the literature. From our observations, exostoses and the concurrence of exostoses with tori in our Asian population was not a rare finding (Fig 1). Thus, the aims of this study were to investigate the prevalence and location of the oral exostoses and the concurrence of buccal or palatal exostoses with tori.

**SUBJECTS AND METHODS**

Our sample consisted of 960 Thai dental patients attending the Oral Diagnosis Clinic in the Faculty of Dentistry at Chulalongkom University. In order to give equal weight to all age and sex groups, an equal number of cases for each category was selected at random from the accumulated data. The subjects were divided into 6 age groups: 13 to 19, 20 to 29, 30 to 39, 40 to 49, 50 to 59, and 60 years and older. The mean ages for men and women were 40.1 ± 17.5 years and 39.9 ± 17.4 years, respectively. All subjects were examined by 1 observer (A. J.) for the presence or absence of tori and exostoses. TP, TM, and buccal and palatal exostoses were diagnosed by clinical inspection and palpation. Questionable tori or exostoses were recorded as not present. The type of tori and the location of the exostoses was recorded, and these data were subsequently subjected to statistical analysis. The chi-squared test was used to compare differences between groups. Nonparametric correlation of variables was tested by Kendall’s tau-b test. Significance for differences between groups was set at \(P < .05\).

**RESULTS**

**Exostoses**

Of the 960 subjects studied, 258 (26.9%) exhibited exostoses. There were 34 (3.5%) individuals who presented with both maxillary and mandibular exostoses. Table I describes the distribution and frequency of occurrence of exostoses in the maxilla and mandible. Exostoses were more common in the maxilla than in the mandible (5:1:1). In addition, most of the exostoses were located on the buccal aspect of the jaws. With respect to maxillary exostoses, there were 166 (17.3%) subjects with buccal exostoses, 21 (2.2%) subjects with palatal exostoses, and 57 (11.9%) subjects with both buccal and palatal exostoses. There were 48 (5%) subjects with mandibular exostoses.
Table II shows the distribution of exostoses for various locations according to sex. Exostoses were more common in men than in women (1.66:1). Men also showed a higher occurrence of exostoses in nearly all locations. These differences between these findings were highly significant at all levels of confidence ($P = .000$).

Table III shows the prevalence and distribution of exostoses in 6 age groups. The highest incidence was found in the 60 years and older group (21.7%), whereas the 13- to 19-year-old age group displayed the lowest frequency of occurrence (7.8%). The 30 to 39, 40 to 49, and 50 to 59 year age groups demonstrated a similar frequency of occurrence. Thus the prevalence of exostoses increases with age, indicating a relationship between age and the occurrence of exostoses (correlation coefficient = .123, $P = .000$).

Concurrence of tori with exostoses

Table IV shows the association between the presence or absence of tori and exostoses. Of 258 subjects with exostoses, 234 (90.7%) had tori concurrent with exostoses, and only 24 (9.3%) subjects had no tori but exhibited exostoses. This difference showed a strong association between the occurrence of exostoses and the presence of tori (correlation coefficient = .129, $P = .000$). Also, exostoses were concurrent with TM significantly more frequently than with TP (39.5% vs 28.5%, $P = .000$).

Table V summarizes the occurrence and location of exostoses in subjects who had tori. Of the 418 subjects with TP, 86 (20.6%) exhibited exostoses. In this TP group, there were 84 (20.1%) subjects with maxillary exostoses and 7 (1.7%) with mandibular exostoses. With respect to maxillary exostoses, 62 (73.8%) subjects had buccal exostoses, 10 (11.9%) subjects had palatal exostoses, and 12 (14.3%) subjects had both buccal and palatal exostoses.

Fig 1. Concurrence of TP and TM with multiple exostoses in Thai male, aged 56, showing large lobular TP and extensive bilateral palatal exostoses (A), multiple nodular torus mandibularis (B), and multiple buccal exostoses (C) along the right and left buccal surfaces of maxillary and mandibular alveolar ridges.

Table I. Distribution of subjects with exostoses in maxilla and mandible

<table>
<thead>
<tr>
<th>Location</th>
<th>Buccal</th>
<th>Palatal</th>
<th>Buccal/palatal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxilla</td>
<td>166 (17.3%)</td>
<td>21 (2.2%)</td>
<td>57 (11.9%)</td>
<td>244 (25.4%)</td>
</tr>
<tr>
<td>Mandible</td>
<td>48 (5%)</td>
<td>–</td>
<td>–</td>
<td>48 (5%)</td>
</tr>
</tbody>
</table>

There were 34 patients with exostoses in both maxilla and mandible.
Of the 105 persons with TM, 38 (36.2%) exhibited exostoses. In this TM group, there were 35 (33.3%) subjects with maxillary exostoses and 12 (11.4%) with mandibular exostoses. Regarding the maxillary exostoses, there were 27 (77.1%) subjects with buccal exostoses and 8 (22.9%) subjects with both buccal and palatal exostoses.

Of the 270 persons with TP concurrent with TM, 110 (40.7%) exhibited exostoses. In this TP and TM group, there were 103 (38.1%) subjects with maxillary exostoses and 26 (9.6%) with mandibular exostoses. Regarding the maxillary exostoses, there were 61 (59.2%) subjects with buccal exostoses, 9 (8.7%) subjects with palatal exostoses, and 33 (32.1%) subjects with both buccal and palatal exostoses.

Among the subjects with exostoses, exostoses were found most frequently in persons with TP concurrent with TM (42.6%).

**DISCUSSION**

We included buccal and palatal exostoses in this study and reported a prevalence of 26.9%. Previous investigators focused only on palatal exostoses, and their reported prevalences ranged from 0.09% to 56%.²¹⁻²₈,³⁰,³¹ In our study, the prevalence of palatal exostoses was 8.1%, which is lower when compared with other reports.²⁻⁵,²⁸⁻³¹ This difference may be attributed to the different populations studied. Racial and ethnic differences have been shown in other studies of exostoses.²⁸⁻³¹ Another variable may be that our study was performed on living subjects, whereas others used skulls. Also, when these bony prominences are very small, they may be impossible to detect in vivo because the area where the palatal alveolar process meets the hard palate is covered by a thick wedge-shaped layer of gingival tissue. Interestingly, the present investigators found that buccal exostoses were much more common than palatal exostoses in Thai subjects. In addition, 5.9% of our subjects exhibited both buccal and palatal exostoses.

**Table II.** Distribution of exostoses for various locations according to sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Subjects with exostoses</th>
<th>Buccal</th>
<th>Palatal</th>
<th>Buccal/palatal</th>
<th>Mandible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>161 (62.4%)</td>
<td>99</td>
<td>10</td>
<td>41</td>
<td>37</td>
</tr>
<tr>
<td>Women</td>
<td>97 (37.6%)</td>
<td>67</td>
<td>11</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>258 (100%)</td>
<td>166</td>
<td>21</td>
<td>57</td>
<td>48</td>
</tr>
</tbody>
</table>

Some subjects exhibited exostoses in more than one location.

*Chi-squared value = 21.711; degree of freedom = 1; P = .000.

**Table III.** Distribution of exostoses for various locations according to age groups

<table>
<thead>
<tr>
<th>Age group (y)</th>
<th>Subjects with exostoses</th>
<th>Buccal</th>
<th>Palatal</th>
<th>Buccal/palatal</th>
<th>Mandible</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-19</td>
<td>20 (7.8%)</td>
<td>12</td>
<td>2</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>20-29</td>
<td>40 (15.5%)</td>
<td>26</td>
<td>3</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>30-39</td>
<td>44 (17.1%)</td>
<td>22</td>
<td>6</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>40-49</td>
<td>50 (19.4%)</td>
<td>32</td>
<td>7</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>50-59</td>
<td>48 (18.6%)</td>
<td>33</td>
<td>2</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>60 and older</td>
<td>56 (21.7%)</td>
<td>41</td>
<td>1</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>258 (100%)</td>
<td>166</td>
<td>21</td>
<td>57</td>
<td>48</td>
</tr>
</tbody>
</table>

Some subjects exhibited exostoses in more than one location.

Correlation coefficient = .123; P = .000.

**Table IV.** Association between presence or absence of tori and exostoses

<table>
<thead>
<tr>
<th>Status</th>
<th>Exostoses</th>
<th>Presence</th>
<th>Absence</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP</td>
<td>86 (33.4%)</td>
<td>332 (47.3%)</td>
<td></td>
</tr>
<tr>
<td>TM</td>
<td>38 (14.7%)</td>
<td>67 (9.5%)</td>
<td></td>
</tr>
<tr>
<td>TP/TM</td>
<td>110 (42.6%)</td>
<td>160 (22.8%)</td>
<td></td>
</tr>
<tr>
<td>No torus</td>
<td>24 (9.3%)</td>
<td>143 (20.4%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>258 (100%)</td>
<td>702 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

Correlation coefficient = .129; P = .000.
al,30 who found that the prevalence of exostoses increases with age. Therefore, we have concluded that the occurrence of exostoses is related to increasing age. In our study, the occurrence of exostoses appeared to be stable during the middle phases of life (30 to 59 years), increasing slightly in the 60 years and older group. This finding is in agreement with Larato5 but contrasts with Sonnier et al,28 who noted the prevalence of exostoses decreased after 50 years of age and who correlated this decreasing trend with edentulism. We also surmise that functional influences may contribute to the development of exostoses. We observed an increasing correlation between marked exostoses and a significant attrition of teeth in some older subjects. This may be a similar phenomenon as that which occurs in subpontic hyperostosis, which postulates that stress causes the crestal alveolar bone to grow under the pontic along a vector opposing the forces of occlusion.33,34 Therefore, altered function may lead to exostosis development in genetically predisposed populations.

We observed the highest concurrence of exostoses and tori in subjects who had concurrence of TP and TM. The concurrence of palatal and buccal exostoses was also found in 5.9% of subjects in our study. This evidence supports the suggestion by Nery et al30 that this group may represent a general multiple exostoses syndrome.

Sonnier et al28 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. On the contrary, we found more buccal exostoses than palatal exostoses in our sample population. 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.

**CONCLUSIONS**

We have concluded that the occurrence of exostoses is associated with age. TM and exostoses may share the same causative factors. Our findings support the theory that the etiology of exostoses is multifactorial including genetic and functional influences. In cases of coexistence of multiple exostoses and tori, this group may represent a general multiple exostoses syndrome.

**REFERENCES**


**Table V. Distribution of exostoses for various locations in subjects who had tori**

<table>
<thead>
<tr>
<th>Status</th>
<th>Subjects with exostoses</th>
<th>Buccal</th>
<th>Palatal</th>
<th>Buccal/palatal</th>
<th>Mandible Buccal</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP (n = 418)</td>
<td>86 (20.6%)</td>
<td>62</td>
<td>10</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>TM (n = 105)</td>
<td>38 (36.2%)</td>
<td>27</td>
<td>0</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>TP/TM (n = 270)</td>
<td>110 (40.7%)</td>
<td>61</td>
<td>9</td>
<td>33</td>
<td>26</td>
</tr>
<tr>
<td>Total (n = 793)</td>
<td>234 (28.2%)</td>
<td>130</td>
<td>19</td>
<td>53</td>
<td>45</td>
</tr>
</tbody>
</table>

Chi-squared value = 52.70; distribution factor = 3; P = .000.

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