Prevalence of Maxillary and Mandibular Exostosis in Mississippi Population: A Retrospective Study

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Research Article

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Abstract

Purpose

The objective of this study was to determine the prevalence of exostosis in the Mississippi population.

Methods

Patient archives of the UMMC School of Dentistry between January 2018 and May 2021 were examined. The patients with exostosis were included in the study based on the findings in intraoral photographs, full-moth series (FMS), panoramic radiographs, and cone-beam computerized tomography (CBCT) images of the patients. The patients were excluded from the study if they do not have maxillary or mandibular exostosis. In addition, patients’ age, gender, and ethnic origins as Caucasian, African-American, and Asian were recorded. All data of exostosis was evaluated and categorized according to age, gender, and ethnicity. Multiple logistic regression analysis was performed for more detailed statistical analysis.

Results

A total of 1242 patients were examined for the presence of maxillary and mandibular exostosis. 303 patients were diagnosed to have maxillary and/or mandibular exostosis among the Mississippi population with a prevalence rate of 24.4%. Exostosis was seen more in females (57.4%) compared to males (42.6%). The highest prevalence of exostosis was seen in Caucasians (71.3%), African-Americans (23.8%), and Asians (5%).

Conclusion

High prevalence of exostosis was seen in the Mississippi population. Our findings will help clinicians to be more aware of these bony protuberances and thus better at diagnosing them. This may specifically help oral surgeons, periodontists, and prosthodontists in pre-prosthetic surgery and denture fabrication.

Introduction

Tori (exostosis) is a non-pathological, usually asymptomatic, benign growth of the cortical portion of the bone [1–3]. It is named according to its localization in jaw bones [2, 4]. The most common form of growth of the palatal bone in the midline of the maxilla is called torus palatinus [2, 5]. The form, which is located in the lingual regions of the mandibular premolar and canine teeth and is mostly bilateral, is called torus mandibularis [2, 5, 6]. Apart from these two common forms, it can be observed in vestibule,
buccal or palatal regions of the jaws [7]. These bony protuberances are classified according to their size (palpable, visible, and large) and shape (flat, nodular, spindle-shaped, and lobular) [1, 8].

The etiology of this condition is unknown, but different theories suggest autosomal dominant inheritance and genetics may play a role in the formation of oral exostoses [9]. However, it has been associated with conditions such as tooth clenching, bruxism, or tooth deficiency, which may cause excessive occlusal force or unbalanced occlusal force distribution [10]. In addition, the effect of environmental factors such as vitamin deficiency or a calcium-rich diet on its etiology has also been examined [1, 3]. Although its etiology is still not fully known, it has been reported that the frequency of oral tori may vary depending on conditions such as ethnic origin, gender, and age, according to academic studies [11–14].

Oral exostoses are not considered pathology [4]. There are even cases where related growths are surgically removed for regenerative purposes and used as a donor site for an autogenous bone graft [4, 14]. However, in some cases this anatomical formation creates problems for the patient and the physician [14]. It is known that these bone growths may hinder successful oral hygiene practice of patients or that chewing trauma to the tori region may predispose to conditions such as ulceration in the soft tissue of the patient [1, 15]. In addition, they can create limitations for oral surgeons in terms of surgery and for prosthodontists in prosthetics treatment [14, 16]. For example, it has been reported that the recovery after gingivectomy operations in the region of the mandibular torus is not as desired, causing effects that restrict flap movement and complicate the procedure in dental surgical procedures [1, 14]. In these undesirable cases, the oral tori may need to be surgically removed [17]. Therefore, general dentists, oral and maxillofacial surgeons, periodontists, and prosthodontists should be more alert to these anatomical formations and should not overlook these formations during treatment planning.

This study aimed to determine the prevalence of exostosis in the Mississippi population to provide dental health providers in Mississippi with the most up-to-date and accurate data. There are large discrepancies in statistics regarding the prevalence of maxillary and mandibular tori from across the globe. Part of the goal of this research project was to gather more data specifically from the Mississippi population to have more accurate figures regarding exostosis in this region of the world.

**Material Methods**

The study plan was approved by the Institutional Review Board, The University of Mississippi Medical Center (IRB file number – 2021V0588). All stages of the study were carried out as per the Helsinki Declaration Guidelines.

The University of Mississippi Medical Center School of Dentistry (UMMC SOD) patient archives were used in this retrospective study. Intraoral photographs, full-moth series (FMS), panoramic radiographs, and cone-beam computerized tomography (CBCT) images in the clinic database of patients at UMMC SOD between January 2018 and May 2021 were examined in detail. Patients older than 18 years of age and with oral tori findings were included in the study (Fig. 1–3). A code in EPIC was also used to find patients with exostosis in the patient database. The age, gender, and ethnic origins (Caucasian, African-American,
and Asian) of the patients included in the study were recorded. In addition, it was evaluated in which jaw the relevant anatomical formation was localized (localized only in the maxilla, only in the mandible, or in both). All protected health information was anonymized before the data was compiled.

The data were analyzed with IBM SPSS V 23 (IBM SPSS Statistics for Windows, Version 23.0 Armonk, 2015, NY: IBM Corp.). Multiple Logistic Regression analysis was used for the evaluations and the significance level was taken as \( p < 0.05 \).

**Results**

A total of 1242 patients were examined for the presence of maxillary and mandibular exostosis. 303 patients were diagnosed with maxillary and/or mandibular exostosis among the Mississippi population with a prevalence rate of 24.4%. The ages of the patients with exostosis ranged between 18 and 93. The mean age of the patients was 56 ± 16.2. Exostosis was seen more in females \( (n = 174, 57.4\%) \) compared to males \( (n = 129, 42.6\%) \). A higher prevalence of exostosis was seen in Caucasians \( (n = 216, 71.3\%) \) than African-Americans \( (n = 72, 23.8\%) \), and Asians \( (n = 15, 5\%) \). The number of patients with oral tori in the maxilla only was 30 (9.9%), the number of patients with oral tori in the mandible only was 195 (64.4%), and in both maxilla and mandible was 78 (25.7%).

Out of 300 patients diagnosed with tori, 216 were Caucasian patients. One-hundred-and-twenty-six of them \( (n = 126, 58.3\%) \) were women and 90 of them \( (41.7\%) \) were men. Oral tori was present only in the maxilla in 18 of these patients \( (8.3\%) \), only in the mandible in 138 patients \( (63.9\%) \), and in both jaws in 60 patients \( (27.8\%) \). The mean age of the Caucasian patients was 54.8 ± 15.2 years. There were 72 African-American patients in the study. Thirty-nine of them \( (n = 39, 54.2\%) \) were women and 33 of them \( (45.8\%) \) were men. Oral tori was present only in the maxilla in 12 of these patients \( (16.7\%) \), only in the mandible in 45 patients \( (62.5\%) \), and in both jaws in 15 of them \( (20.8\%) \). The mean age of African-American patients was 48.2 ± 16.9 years. There were 15 Asian patients in the study. Nine of them \( (n = 9, 60\%) \) were female and 6 of them \( (40\%) \) were male. Oral tori was present only in the maxilla in none of these patients, only in the mandible in 12 \( (80\%) \), and in both jaws in 3 of them \( (20\%) \). The mean age of the Asian patients was 51.4 ± 23.5 years (Table 1).
Table 1
Distribution of patients according to ethnicity.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Ethnicity</th>
<th>Caucasian</th>
<th>African-American</th>
<th>Asians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Female</td>
<td>n = 126</td>
<td>n = 39</td>
<td>n = 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>58.3%</td>
<td>54.2%</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>n = 90</td>
<td>n = 33</td>
<td>n = 6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41.7%</td>
<td>45.8%</td>
<td>40%</td>
</tr>
<tr>
<td>Localization</td>
<td>Only maxillary</td>
<td>n = 18</td>
<td>n = 12</td>
<td>n = 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.3%</td>
<td>16.7%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Only mandibulary</td>
<td>n = 138</td>
<td>n = 45</td>
<td>n = 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>63.9%</td>
<td>62.5%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>n = 60</td>
<td>n = 15</td>
<td>n = 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27.8%</td>
<td>20.8%</td>
<td>20%</td>
</tr>
<tr>
<td>Age</td>
<td>Median (min-max)</td>
<td>56 (18–93)</td>
<td>52 (20–75)</td>
<td>51 (24–90)</td>
</tr>
<tr>
<td></td>
<td>Mean ± sd</td>
<td>54.8 ± 15.2</td>
<td>48.2 ± 16.9</td>
<td>51.4 ± 23.5</td>
</tr>
</tbody>
</table>

Oral tori was present in only the maxilla in 30 patients and 27 of these patients (90%) were female and 3 of them (10%) were male. Eighteen of the patients (60%) with tori in the maxilla were Caucasian and 12 of them (40%) were African-American. The mean age of the patients with oral tori in only the maxilla was 51.9 ± 12.4 years. The number of patients with oral tori only in the mandible was 195, and 99 of them (50.8%) were female, and 96 of them (49.2%) were male. In addition, 138 of these patients (70.8%) were Caucasian, 45 of them (23.1%) were African-American, and 12 of them (6.1%) were Asian. The mean age of the patients is 54.1 ± 16.6. Oral tori was present in both jaws of 78 patients and 48 of these patients (61.5%) were female and 30 of them (38.5%) were male. Of the patients with oral tori in both jaws, 60 of them (77%) were Caucasian, 15 of them (19.2%) were African-American, and 3 of them (3.8%) were Asian. The mean age of the patients with oral tori in both jaws was 51.1 ± 16.9 years (Table 2).
Table 2
Distribution of patients according to the localization of oral tori.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Localization</th>
<th>Only maxillary</th>
<th>Only mandibulary</th>
<th>Both jaw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Female</td>
<td>n = 27,</td>
<td>n = 99</td>
<td>n = 48</td>
</tr>
<tr>
<td></td>
<td></td>
<td>90%</td>
<td>50.8%</td>
<td>61.5%</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>n = 3</td>
<td>n = 96</td>
<td>n = 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10%</td>
<td>49.2%</td>
<td>38.5%</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Caucasian</td>
<td>n = 18</td>
<td>n = 138</td>
<td>n = 60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60%</td>
<td>70.8%</td>
<td>77%</td>
</tr>
<tr>
<td></td>
<td>African-American</td>
<td>n = 12</td>
<td>n = 45</td>
<td>n = 15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40%</td>
<td>23.1%</td>
<td>19.2%</td>
</tr>
<tr>
<td></td>
<td>Asians</td>
<td>n = 0</td>
<td>n = 12</td>
<td>n = 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0%</td>
<td>6.1%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Age</td>
<td>Median (min-max)</td>
<td>50 (29–67)</td>
<td>58 (20–93)</td>
<td>51.5 (18–87)</td>
</tr>
<tr>
<td></td>
<td>Mean ± sd</td>
<td>51.9 ± 12.4</td>
<td>54.1 ± 16.6</td>
<td>51.1 ± 16.9</td>
</tr>
</tbody>
</table>

Multiple logistic regression showed that the probability of a patient having exostosis in the mandible was not dependent on patient age (p = 0.59) or Asian heritage (p = 0.99), but it was dependent on patient gender (p < 0.001) and Black heritage (p = 0.04). The best predictor of mandibular exostosis was the following model:

\[
\text{logit}(P) = \log \left( \frac{P}{1 - P} \right) = 4.091 - 2.113 \times \text{female} - 0.989 \times \text{black}
\]

Where \( P \) is the probability of a patient having exostosis and \text{female} and \text{black} are both dichotomous observational variables (0 = False or 1 = True). This model had a predictive accuracy of 90%.

Multiple logistic regression showed that the probability of a patient having exostosis in the maxilla was not dependent on patient age (p = 0.08) or on Asian heritage (p = 0.18) or Black heritage (p = 0.98), but it was dependent on patient gender (p < 0.001). The best predictor of maxillary exostosis was the following model:

\[
\text{logit}(P) = \log \left( \frac{P}{1 - P} \right) = -1.068 + 0.79 \times \text{female}
\]
Where $P$ is the probability of a patient having exostosis and *female* is a dichotomous observational variable (0 = False or 1 = True). This model had a predictive accuracy of 64%.

**Discussion**

In the present retrospective study, the prevalence of oral exostosis in the Mississippi population was evaluated and we tried to interpret which ethnic, age range, and gender population has higher prevalence of this anatomical formation. As a result, a higher rate of maxillary and mandibular exostosis was found in females and Caucasians in the Mississippi population. In addition, it was concluded that the tori observed in the mandible were statistically significantly higher in women and African-Americans.

There are similar studies in the literature evaluating the prevalence of oral tori in different populations [5, 7, 10, 12, 18–27]. When these studies are examined, it was seen that the frequency of these bone growths differs from population to population. Although many studies showed populations such as Jordan [10], Japan [18, 19], Turkey [12], Taiwan [20], Morocco [21], Romania [22], Nigeria [23], Malaysia [24], Thailand [5, 7], Norway [26], and Ghana [27] are mainly affected by oral tori, the number of studies conducted on the US population are very few. In one of these studies, Austin et al. (1965) reported that 19.5% of African Americans in the USA had palatal tori [17, 28]. In another study, Woo (1950) found that the prevalence of palatal tori was 37% in African-Americans, 45% in White Americans, and 47% in Mongolians in the USA [17, 29]. In the current study, not only palatal tori but also all oral tori in the oral region were evaluated and it was reported that oral tori was observed in 24.4% population in Mississippi. In another study conducted in the USA, Sonnier et al. (1999) analyzed 328 modern American skulls and recorded the presence of mandibular tori, palatal torus, and palatal tuber [14]. It was reported that of 254 Caucasian skulls, 63 (24.8%) mandibular tori and 58 (22.8%) palatal tori were observed [14]. In the same study, 25 of 74 African-American skulls had mandibular tori (33.8%) and 9 of them had palatal tori (12.2%) [14]. In the current study, it was reported that mandibular tori can be found at a higher rate in African Americans, similar to the findings of this study [14]. The prevalence of oral tori, the etiology of which depends on genetic and environmental factors, is already expected to be higher in certain populations and ethnic origins [11–14]. As per our knowledge, the current study is the only study conducted on this subject on the Mississippi population. In this respect, it will shed light on the literature and increase the awareness of clinicians on this issue.

In the current study, it is seen that the percentages of oral tori are quite different in different ethnic origins. These results suggest that ethnic origin is an important factor in this anatomical formation. Similarly, El Sergani et al. (2020) evaluated 625 European Ancestry, 377 West African Ancestry, and 100 East Asian Ancestry, that is, a total population of 1102 individuals, in terms of torus palatinus prevalence in their study [17]. Although the same population was not evaluated in the current study, Sergani et al., (2020) reported that the prevalence is higher, especially in East Asian women [17]. This result supports the idea that not only ethnicity but also gender may affect the prevalence. Sergeant et al., (2020) found in their study that the torus palatinus was seen in higher prevalence in women, which is consistent with the current study [17]. Similar to these findings, it has been reported that palatal tori localized in the maxilla
has a higher prevalence in females in many studies examining populations of European, African, and Asian origins. Haugen et al., (1992) examined palatal tori in a study conducted in Norwegians and found that it was observed at a rate of 11.2% in women and 6.7% in men, that is, it had a higher prevalence in females [30]. There is information that this anatomical formation is higher in women in Black Americans [17, 28], Thais [5] and Ghanaians [27], i.e. similar results have been reported. Although palatal tori was not directly examined in the current study, it can be said that the prevalence of tori in the maxilla is similar to these studies in that it was found to be higher in women.

Many similar studies support that the incidence of oral tori may vary in different populations. For example, Kumar Singh et al. (2017) examined the prevalence of oral tori in Malaysia in another study [4]. In this study, the oral tori was examined in 3 different ways: torus palatinus, torus mandibularis, and exostosis [4]. They reported that oral tori was observed at a rate of 33% in the population they examined [4]. They found that the torus palatinus was most common in women, and the torus mandibularis and exostosis were more common in men [4]. The torus palatinus is most common in women, which is consistent with the other mentioned studies and the current study [4, 5, 17, 28]. In addition, in the present study, it was observed that the torus palatinus was higher in Malawians than in Chinese and Indians [4]. They reported that a high rate of oral tori was observed in the study groups and that physicians should be mindful of these anatomical formations in cases such as prosthesis planning.

In another study, the prevalence of buccal and palatal exostoses was examined in the Thai population [7]. Similar to the current study, bone growths in the maxilla and mandible were evaluated separately. Bone growth was observed in 26.9% of the 960 individuals studied. The percentage of oral tori in the Mississippi population was also recorded as 24/2%, a very similar result [7]. It has been found that tori localized in the mandible is more common and the prevalence of both the maxilla and mandible is higher in males [7]. We think that the contradictory results on this subject in the literature may vary depending on the population studied. In this study conducted in the Thai population, it is seen that the possibility of exocytosis increases with age [7]. On the other hand, Savoir et al. (2019) similarly, in the study they conducted in Jordan, it was observed that the prevalence of oral tori increases with age, and it appears most often in the 50s [16]. In the present study, the presence of oral tori was examined in a wide age group aged between 18 and 91 years, and similarly, it was observed that there was a higher prevalence in older ages. The mean age of the people with Tori was found to be 56 ± 16.2. There are also studies that conflict with these findings. For example, Jainkittivong et al., 2007, reported that both mandibular and palatal tori appear most frequently in the third decade of life in their study of Thai population. [25]. In the study conducted by Telag et al. in Malaysia, it was reported that grandchildren were mostly seen between the ages of 20–29 [24].

The present study has similar results to many studies in the literature and presents the prevalence of oral tori in the Mississippi population but it has some limitations. The most important of these is the diagnosis of retrospective clinical records rather than clinical examination. Although retrospective studies are carried out more easily and in a short time, and at the same time allow the scanning of larger archives, there is a risk that some dental conditions that should be diagnosed with clinical findings are
overlooked in these studies. For example, in some studies, oral toriies have been classied according to their size, and it is seen in these studies that there are smaller sizes of oral toriies diagnosed only by palpation [1, 8]. It is very difficult to diagnose them retrospectively only from photography and radiography. We think this tori size may have been overlooked in the current study. The second biggest limitation is the evaluation of the toriies by classifying them as only maxillary and mandibular. In terms of a more comprehensive interpretation of the study, it would be more accurate to evaluate it as palatal tori, mandibular tori, buccal/labial-lingual/palatal exocytosis, as in many studies in the literature [2, 4]. In the current study, classication as only upper and lower jaw tori may have caused deviations in some prevalences. Despite all these limitations, the current study is the first study conducted in the Mississippi population as far as we know, and is very valuable in this respect. In similar studies to be conducted in the future, larger patient populations should be included in the study and should be evaluated with clinical examination. In addition, while evaluating different races, it would be benecial to comment on the prevalence in this way by screening a similar number of patients from all races as much as possible.

Conclusion

A high prevalence of exostosis was seen in the Mississippi population. This study's findings may help clinicians to be more aware of these bony protuberances and thus better diagnose them. This is important for oral surgeons, periodontists, and prosthodontists in pre-prosthodontic surgery and denture fabrication. In addition, this research has the potential to lead to research on the agents that cause these types of bone growth in the maxillofacial region in the near future.

Declarations

Acknowledgments: None

Ethical Approval: The study plan was approved by the Institutional Review Board, The University of Mississippi Medical Center (IRB file number – 2021V0588). All stages of the study were carried out as per the Helsinki Declaration Guidelines.

Competing interests: There are no relevant competing interests to report.

Authors' contributions:

L Wilson: Protocol/project development, Data collection/management

D Snyder: Protocol/project development, Data collection/management

J Griggs: Protocol/project development, Data collection/management

S Kurt-Bayrakdar: Data analysis, Manuscript writing/editing

IS Bayrakdar: Data analysis, Manuscript writing/editing
R Jagtap: Protocol/project development, Data collection or management, Data analysis, Manuscript writing/editing, Supervision

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**Availability of data and materials:** None.

**References**


Figures
Figure 1

Intraoral photos of patients with tori, a. Intraoral photograph of a patient with maxillary tori, b. Intraoral photograph of a patient with mandibular tori.
Figure 2

Panoramic radiography images of patients, a. Panoramic radiography of a patient with maxillary tori, b. Panoramic radiography of a patient with mandibular tori.
Figure 3

CBCT cross-section images of patients, a. CBCT sagittal section image of a patient with maxillary tori, b. CBCT coronal section image of a patient with maxillary tori, c. CBCT axial section image of a patient with mandibular tori.