TORUS PALATINUS AND TORUS MANDIBULARIS: A LITERATURE REVIEW UPDATE

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Abstract

Torus palatinus and torus mandibularis are common localised bony overgrowths of cortical bone, which are non-pathological. As tori have been widely discovered for ages, there are some new findings in the 21st century. This review aims to summarise the aspect of aetiology, sociodemographic features, clinical features, treatments and functions of tori. A search was performed in PubMed and Google Scholar databases from 1950 until 2022. From the total of 4,150 studies evaluated, 61 articles were included in this review. The aetiology of tori has shown that Y chromosomes and some signal factors (Notch3, SMAD9, LRP5 V171) may affect its occurrence. The prevalence among people of East Asian is higher than among West African heritage, and the age range is 20-50 years old. Clinical features of tori are represented by size, shape and location, and sometimes by symptoms. Patients who need the removal of tori are treated by surgical removal using burs/bone chisel and mallet/peeling it with Er:YAG laser/piezoelectric surgery, plus postoperative anti-inflammatory drugs, which give a good healing effect. In addition, tori can be used as an autogenous bone graft to repair periodontitis bone defects in maxillary sinus lift cases and to increase bone thickness for dental implants. Tori can also be a marker for hyperparathyroidism and bioarcheological investigation. In conclusion, updates on these aspects have been found. However, complex aetiology needs to be further confirmed. Moreover, treatment is worth tracking, and its function as autologous bone deserves to be studied in other body parts.

Keywords: Tori, Torus palatinus, Torus mandibularis, Aetiology, Clinical features

Introduction

Tori within the oral cavity are non-pathological exostosis originating from the localised cortical bone process (1). These exostoses are developed by the process of hypertrophy of the compact bony layer and, sometimes, the spongy bony layer. Fox wrote the first article describing the exostotic changes of the hard palate (2). Torus palatinus (TP) is located at the midline of the hard palate, while torus mandibularis TM) is located at the lingual portion of the mandible (in the cuspid/premolar area) (3). Prevalence of TP and TM varies depending on population, race, age and sex worldwide (4). Its presence can obscure the maxillary sinuses and lower premolars' radiographic characteristics (5). Besides, it can impede the creation and function of both upper and lower dentures from a prosthetic viewpoint, and it may also impact speech, deglutition, and mastication (6, 7).

Although tori has been discovered for many years, there is little literature review available (8) especially on the discovery of genetic aetiology, treatment and function of tori. Therefore, the purpose of this study is to review and summarise the information on tori in the aspect of aetiology, sociodemographic features, clinical features, treatments and functions.

For this review, a literature search was performed in PubMed and Google Scholar databases from 1950 until 2022. The search included all research types, including randomised controlled trials, controlled studies, systematic reviews and observational studies. It also had non-research projects, such as the book. The search

terms used in the search engine were tori, torus palatinus, torus mandibularis, aetiology, gene, prevalence, surgery, or function. After deleting the duplicate items, 4,150 records met the inclusion criteria. The abstracts and full-text of these articles were screened, and 4084 articles were excluded. Sixty-six full-text articles were assessed for eligibility, and five were excluded because their full texts were unavailable. Therefore, 61 full-text articles were included and analysed for this review.

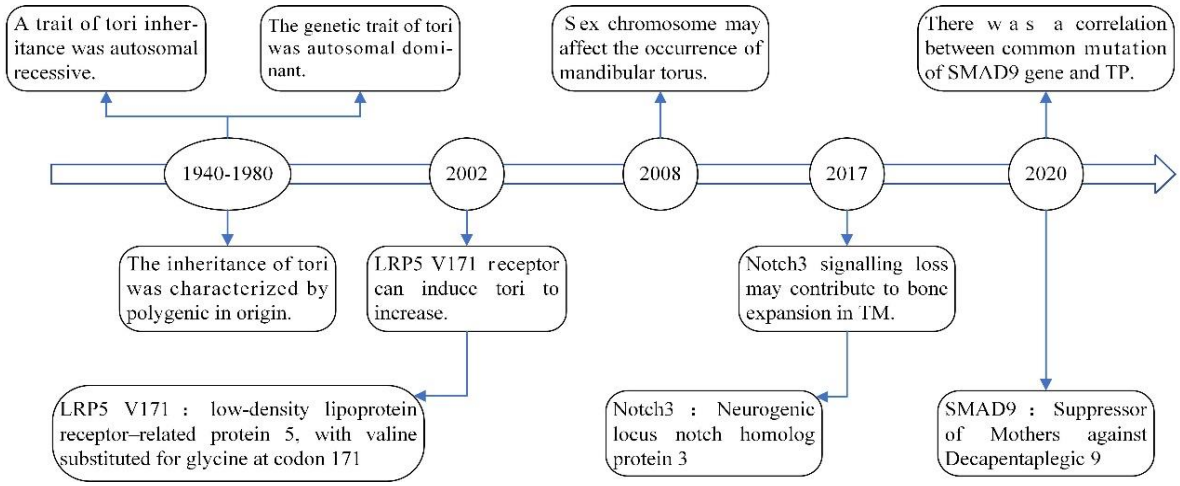

Figure 1 : Updates of tori on hereditary factors

Aetiology and Pathogenesis

The currently recognised aetiology of TP and TM results from multiple factors (4, 9). It is widely accepted that torus variation related to hereditary was 30%, while roughly 70% of the reasons appeared to be environmental influences (10). However, environmental factors must reach a threshold before genetic factors can be expressed (8). Here, the literature will be reviewed from hereditary and environmental factors perspectives.

Hereditary factor

After the 1940s, the aetiology of tori was autosomal recessive inheritance (11), autosomal dominant inheritance (12) or polygenetic in origin (13). Thus, children whose parents exhibited the trait were likelier to demonstrate the characteristics (14). Studies in the 21st century showed that sex chromosomes might affect the occurrence, expression and development of mandibular torus, especially the Y chromosome (15). Besides, Boyden LM et al. (16) unveiled that the LRP5 V171 (low-density lipoprotein receptor-related protein 5, with valine substituted for glycine at codon 171) mutation induces increased bone density with enlarged mandible and torus palatinus. This mutation inhibits the activity of a normal Wnt (Wingless-related integration site) pathway antagonist (16). Notch3 (Neurogenic locus notch homolog protein 3) signalling loss may contribute to bone expansion in TM via accelerated MSC (mesenchymal stem cells) driven osteogenic differentiation in the jaw bone (17). Gregson et al. (18) reported associations between common variation and a rare mutation in the SMAD 9 (Suppressor of Mothers against Decapentaplegic 9) gene and extremely high bone density phenotypes, including the presence of TP. The research updates on the hereditary aspect of tori are shown in Figure 1.

Environmental factor

The main environmental factor is occlusal pressure on the teeth (10). Recent research on occlusal pressure mainly focuses on different age groups and the specific causes of occlusal pressure. Yoshinaka et al. (19) used a pressure-sensitive sheet to test the bite force of the elderly over 60 with tori, and Jeong et al. (20) measured the bite force of 345 patients with tori by bite force recorder. They found that TM was primarily linked to mechanical stimulation from the occlusal interaction (19, 20). Bertazzo-Silveira et al. (21) investigated 575 bruxism patients who experienced teeth grinding, jaw clenching and abnormal tooth wear using questionnaires and clinical examinations. They found that abnormal tooth wear increased the probability of developing tori, particularly the TM (21). In addition, dietary habits, nutritional conditions, and medicines involved in calcium homeostasis, such as phenytoin, are other environmental variables contributing to oral tori development (20).

Sociodemographic Features

Prevalence

The prevalence of TP and TM varies from 0.4% to 61.7% and 1% to 64%, respectively, in different populations across the globe (4). Several studies have already been conducted, and racial disparities in the incidence of oral

ori have been widely established (5, 19). A recent study of a multi-ethnic population discovered that TP is at around double the prevalence among people of East Asian ancestry compared to people of West African heritage, with the difference appearing to be restricted to females (22). Tori has repeatedly been more common among Mongoloids than Caucasians (23).

The recent ten years' data has shown that the prevalence of TP and TM in different countries is still within the scope of previous statistics (Table 1). However, the prevalence of tori in the same country is statistically different. For example, in the prevalence of tori in Malaysia, Kumar Singh's study in 2017 (24) found that the prevalence of TP was 27.9% and TM was 8.9%, but Telang in 2019 (5) showed the prevalence of TP and TM were 13.2% and 3.3%, respectively. The prevalence difference may be due to several factors, such as Malaysia being a multi-ethnic country with different prevalence among different races, conflicting tori's definition and identification, and the inconsistency of the proportion calculation method between the studies.

Table 1: Summary of the tori's prevalence in the recent ten years

Study	Year	Country	Sample size, *n*	TP,%	TM,%	TP&TM,%
Sisman et al. (25)	2012	Turkey	91	41.7	-	-
Romanos et al. (26)	2013	United States	1323	-	37.8	-
Patil et al. (27)	2014	India	3087	1.3	6.9	-
Yoshinaka et al. (19)	2014	Japan	664	-	29.7	-
Chiang et al. (28)	2014	China	2050	21.1	24.2	-
Scrieciu et al. (29)	2016	Romania	74	8.1	9.5	4.1
Maduakor et al. (30)	2017	Nigeria	3000	8	4.2	2.5
Kumar Singh et al. (24)	2017	Malaysia	2666	27.9	8.9	4.6
Mirza et al. (31)	2018	Pakistan	1203	11.7	-	-
Telang et al. (5)	2019	Malaysia	4443	13.2	3.3	2.3
Prasad et al. (32)	2020	India	14208	-	1.1	-
Bukanan et al. (33)	2020	Saudi Arabia	1943	30.9	-	-

*TP–Torus palatinus, TM–Torus mandibularis

Age and sex

Most scholars believe that the prevalence of TP is higher in females than in male (5, 25, 29) . The following Table 2 is a gender-specific survey of tori prevalence using a unified algorithm in Malaysia. From the table, studies showed that the prevalence of TP was higher among females in Malaysia.

On the contrary, in Karachi, Pakistan, Mirza et al. found that TP was more prevalent (53.9%) in males (31). Although this phenomenon still occurred for TM, a few authors showed that the prevalence for females was higher than for males (4). However, other studies found it more common among men (5, 9).

Table 2: Summary of the prevalence for gender and age of patients with tori in Malaysia

Study	Year	Gender (prevalence)		Main age (prevalence)	
		TP (%)	TM (%)	TP (%)	TM (%)
Zaw et al. (34)	2009	F (76.8), M (23.2)	-	-	-
Hiremath et al. (8)	2011	F (58.8), M (21.4)	F (3.9), M (7.1)	20-29 (36)	40-49 (12)
Sathya et al. (4)	2012	F (15.7), M (8.4)	F (3.7), M (1.9)	≥40 (42.9)	30-39 (30.2)
Noor et al. (23)	2013	F (39.6), M (33.9)	-	10-19 (54.4)	20-29 (100)
Kumar Singh et al. (24)	2017	F (14.9), M (5.9)	F (1.5), M (2.0)	21-30 (39.2)	21-30 (51.6)
Telang et al. (5)	2019	F (6.3), M (4.6)	F (0.4), M (0.6)	20-29 (25.6)	30-39 (23.8)
Mary Donald et al. (35)	2020	F (34.3), M (13.0)	F (4.6), M (1.9)	21-30 (72.5)	21-30 (85.7)

*TP–Torus palatinus, TM–Torus mandibularis, F–Females, M–Males

For the difference in tori prevalence among different age groups in Malaysia, it was evident that TP was more prevalent in the 20 to 30 years of age group (5, 9). On the contrary, Noor et al. (23) found that the age of TP tended to be younger. Sathya et al. (4) showed the highest incidence was found in the 40 and older age group, but in their study, they divided people over 40-year-old into a group. As for TM, almost half of the studies showed that the highest prevalence was at the age of 20 to 29 years old; the other half showed that

the age group was 30 to 39 years old. However, Hiremath et al. (9) found TM was more common in the 40 to 49 age group (12.5%). In India, Patil et al. (27) found that TM was more common in the 41 to 50-year-old age group (37.9%). Finally, the observations in the United States of America revealed a significant incidence of TM (37.8%), with a mean population age of 40 years (26). Overall, the results of most studies show that the predisposing age of tori is from 20 to 50 years old.

Table 3: Summary of surgical indications, preoperative clinical features and surgical methods on tori

Surgical indications	Preoperative clinical features	Surgical methods
- Functional discomfort (51) -Medically treated gag reflex of tori (51) - Obstructive sleep apnea (48) - Narrowing of the airway at the level of the tongue base (48) - Prosthetic instability (51) - Perturb phonation, ulceration of the mucosa, pain (46) - Difficulty chewing and chronic trauma (47) - Articulation disorder (52) - Feeding and swallowing interference (53) - Movement disorder of the tongue (52) - Mucosal inflammation or Osteonecrosis (54)	- A large palatal torus covered by two erosive plaques associated with a discrete whitish plaque. (51) - A median palatal torus which prevents the fitting of a completely removable prosthesis. (46) - Painless masses, lingual frenulum was trapped in the area that had been narrowed by the bilateral masses. (52) - A highly extensive mandibular torus is not painful but uncomfortable speech. (49) - A thin layer of oral mucosa covering mandibular tori, aching on palpation. (50) -TM are large with signs of mucosal inflammation. (54) - The soft palate could be visible, however, the tongue position prevented visibility of the palatal arches. (48) - The nasopharyngeal inlet is found to be narrowed using flexible fiberoptic endoscopy. (48)	- Osteotomy could be performed after Y incision in the middle of the palatal mucosa. (51) - Excision with Er: TAG laser under local anaesthesia. (46) - Wearing away the TP with surgical burs. (46) - Piezoelectric surgery under local anaesthesia. (50) -Tori could be removed by piezotome, and bone is smoothened by round bur. (54) - The tori could be resected with burs, chisels, and a mallet, and any sharp edges are ground away. (47) - A guiding groove could be created using a fissure bur, and the torus can be removed with a bone chisel and mallet. (52)

*TP–Torus palatinus, TM–Torus mandibularis

Clinical Features

Classification

The classification of tori was varied in the earlier years, but most researchers used size, shape and position to determine the type of tori (36-38). The shape of TM was widely accepted based on the number of nodes: unilateral single, unilateral multiple, bilateral single, and bilateral multiple (39). Until recent years, Telang et al. (5) has used a new standard to represent the shape of TM according to clinical observations: nodular and band-like. Few researchers have attempted to categorise the location of tori, especially TM (10, 38, 40). Currently, some researchers have used tooth areas to indicate the location of tori (9, 23, 29, 41)

Dental and medical implications of Tori

The most common symptom is that the existence of tori increases the difficulty of denture making, which can affect the denture's retention (6). Other effects related to the oral cavity include the tori can displace and inhibit tongue movement, interfere with mastication and impair speech (7). Food retention around the tori can cause an increase in plaque formation and periodontal disease (42). Patients with large tori frequently experience recurrent mucosal ulcers and inflammation due to trauma from hard food items (43). Other medically related implications include the displacement of the tongue causing obstructive sleep apnea, which sometimes can be fatal (44), painful ulceration and osteonecrosis of the tori in patients receiving bisphosphonates for osteoporosis and cancer treatment (45) as well as interference with endotracheal intubation during general anaesthesia (46).

Treatment and Function

Treatment

Case reports in the literature have shown a few indications for tori removal; torus may be indicated for surgical removal due to pain (47), difficulty in chewing, presence of chronic trauma (48), and causing obstructive sleep apnea (49). Goncalves et al. (50) surgically removed the torus mandibular of a 45-year-old man whose pronunciation was affected. By carving a groove in the superior lesion region and chiselling, an intrasulcular lingual incision from the molar to the contralateral molar side of the bone volume was meticulously removed in three distinct blocks (50). A 34-year-old woman suffered from torus mandibular pain for a long time, Sorrentino et al. (51) used piezoelectric surgery to remove exostosis, and stitches were applied. A 67-year-old woman was referred to the clinic for TP removal; Rocca et al. (47) chose to smooth it with Er: YAG laser. The postoperative medication included antibiotics, analgesics and anti-inflammatory drugs, the prognosis was good and there was no sign of inflammation (47, 51). The indications, preoperative clinical features and surgical methods of the operation are summarised in Table 3.

Treatment of tori involves removal using complex surgical intervention, which is costly and risky, as the patient may suffer from hematoma, excessive bleeding, infection and other potential risks (1). Therefore, it is not recommended to treat if it is asymptomatic.

Function

Previous literature mainly emphasised the influence of tori, and its functions have been mentioned in recent years. Bezamat et al. (56) mentioned that tori could be an efficient marker for an increased bone mass phenotype and hyperparathyroidism. Hassan et al. (57) used mandibular tori and full-thickness flap to treat the intraosseous defect of periodontitis and found that the mandibular tori was more effective as an autogenous bone graft to treat the defect. Neiva et al. (58) established acceptable bone height and breadth for implant implantation by using mandibular tori as autogenous graft material for horizontal bone augmentation and sinus lifting operations. Redor et al. (59) found that tori's bone and bone graft alternatives were comparable in terms of elemental composition and crystal compounds. Wang et al. (60) used torus block bone graft for vertical ridge augmentation. Torus mandibularis is a non-metric feature frequently documented in bioarcheological research. It is often included in a non-metric trait to analyse the biological distance between populations (61). The research updates of tori's function are summarised in Figure 2.

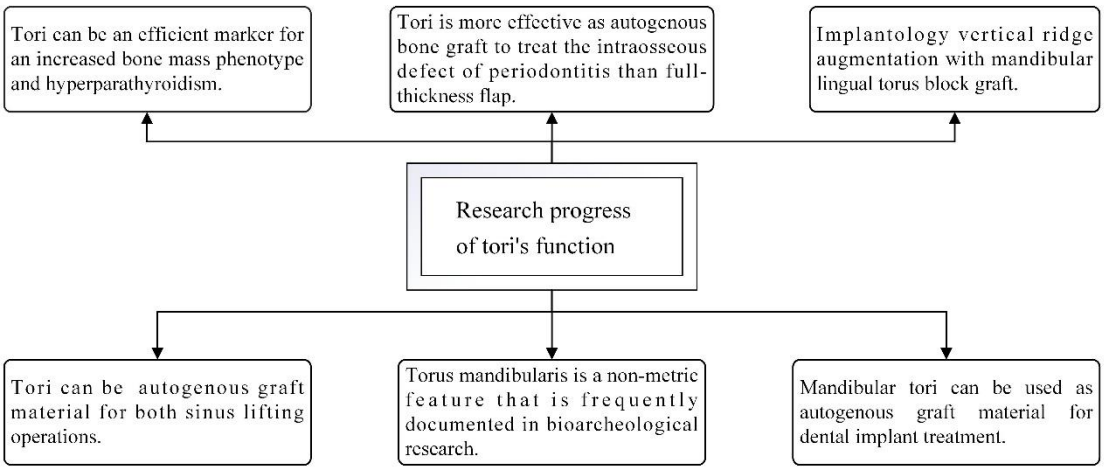

Figure 2: Summary of updates on tori's functions

Conclusion

The aetiology of TP and TM is the result of multiple factors. After the 21st century, researchers found that Y chromosomes, signal factors (Notch3, SMAD9, LRP5 V171) and some environmental factors can influence its appearance. The prevalence of TP and TM still varies from 0.4 to 61.7% and 1% to 64%, respectively. However, East Asian races and 20-50 years old people are more likely to have tori. It may affect speech, mastication, denture construction and, in some cases, cause potential risks to patients' lives. If there is no clinical symptom, excision is not recommended. At the same time, different surgical methods combined with drug therapy to remove tori have been verified. The research on tori as a function has made a breakthrough, such as autogenous bone graft for periodontitis bone defects, maxillary sinus lift and bone graft before implant placement, a signal factor in the phenotype of bone mass increase, hyperparathyroidism and biological archaeological research.

The development in aetiology, prevalence, treatment and function of tori has been found. However, the complexity of the aetiology needs to be confirmed, the survey method of prevalence needs to be standardised, and further follow-up is required after the treatment. Furthermore, as tori can be used in autogenous bone transplantation, it deserves to be studied in other organs.

Conflict of interests

The authors declare no conflicts of interest involved.

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