Variant Anatomy of the Torus Palatinus

12

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12.1 Introduction

The torus palatinus (TP), a benign osseous outgrowth of the oral bony palate, is a bone mass that accrues along the midline of the hard palate. It represents an anatomical variation rather than pathology. TP generally causes no symptoms and needs no treatment. Surgical removal is required in cases of chronic trauma or if there is interference with oral function or denture replacement. TPs have recently been used as autogenous bone graft material for alveolar ridge reconstruction during dental implant treatments (Moraes Junior et al. 2010). They have been reported in different regions and are associated with age, gender, diet, and other environmental factors.

12.2 Classification of TPs

TPs are classified on the basis of their location, size, and shape.

12.2.1 Location

Most TPs are located in the molar-premolar area (Table 12.1). Gorsky (1996) reported that in a younger age group, the majority were located in the molar area. King and Moore 1971 described an age-related change of prevalence of TP from the molar to the molar-premolar area.

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Table 12.1 Predilection site of TP (Gorsky et al. 1996; Sisman et al. 2008; Yildiz et al. 2005)

Year	Location			Study
	Molar (%)	Premolar (%)	Molar-Premolar (%)	
1996	53.8	10	36.2	Gorsky (Gorsky et al. 1996)
2005	62.9	4.4	32.5	Yildiz (Yildiz et al. 2005)
2008	15.4	13.6	66.4	Sisman (Sisman et al. 2008)

Table 12.2 Classification by size (Gorsky et al. 1996; Sathya et al. 2012; Sisman et al. 2008; Yildiz et al. 2005)

Year	Size		Population	Study
	>2 cm(%)	<2 cm(%)		
1996	31.9	68.1	Israel	Gorsky (Gorsky et al. 1996)
2005	8.5	91.5	Turkey school children (southern region of Turkey)	Yildiz (Yildiz et al. 2005)
2008	24.5	75.4	Turkey school children (cappadokia)	Sisman (Sisman et al. 2008)
2012	67.4	32.6	Malaysian	Sathya (Sathya et al. 2012)

12.2.2 Size

The prevalence of TPs <2 cm (68–91%) is much greater than that of larger ones. However, Sathya reported that Asian populations tend to have TPs >2 cm (Sathya et al. 2012) (Table 12.2).

12.2.3 Shape

Morphologically, TPs have assorted shapes: flat (smooth), spindle, lobular, and nodular (Fig. 12.1). The developmental processes resulting in the different shape types are not known. Several reports have revealed that the flat type of TP occurs in 58–63% of cases, the spindle shape in 23–55%, the nodular shape in 1–14%, and the lobular shape in 6–33% (Table 12.3).

12.3 Frequency of TPs

Many researchers have investigated the etiological factors involved in TP, but no consensus has been reached. The etiology of TP is currently thought to involve the interaction of multiple factors.

12.3.1 Race

Many investigators have proposed that racial or ethnic group differences affect the occurrence of TP. The prevalence of TP in various populations has revealed a

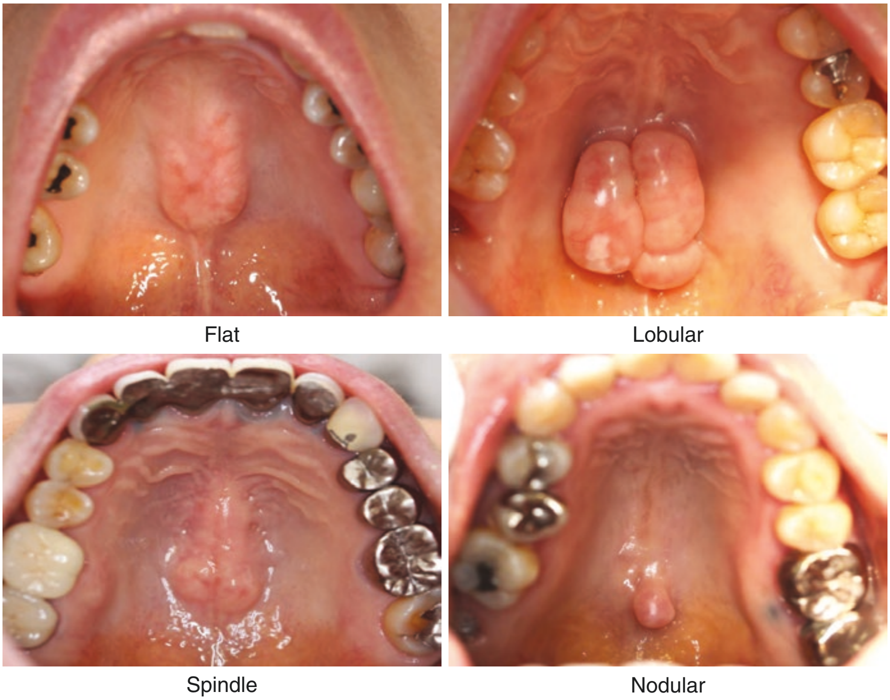

Fig. 12.1 Classification by shape of TP (Sisman et al. 2008; Hiremath et al. 2011; AlZarea 2016)

Table 12.3 Different type of TP

Year	Shape				Study
	Spindle(%)	Nodular(%)	Lobular(%)	Flat(%)	
2008	36.3	0.9	0	62.7	Sisman (Sisman et al. 2008)
2011	54.6	12.1	33.3	–	Hiremath (Hiremath et al. 2011)
2016	22.7	13.6	6.1	57.5	Alzarea (AlZarea 2016)

very wide range (1.4–66%) according to previous reports and a review. The highest prevalence (66%) was found in Asians and Eskimos; the lowest (1.4%) was reported in a study based in Saudi Arabia. It has been suggested that genetic differences could account for the higher prevalence of TP among populations in East Asia and adjacent parts of Central, Southeast, North, and South Asia (Table 12.4).

12.3.2 Age

The occurrence of TP generally increases with age, particularly by the third decade, a period when an individual's peak bone mass is usually achieved.

Table 12.4 Prevalence of TP in origin (Location) (Sisman et al. 2008; Yoshinaka et al. 2010; García-García et al. 2010; Al Quran and Al-Dwairi 2006; Jainkittivong et al. 2007)

Year	Population	Plevalence (%)	Study
1950	Eskimos	66	Woo
1950	Japanese	46.6	Woo
1953	United States	20.8	Kolas
1966	Yugoslavian	49.7	Vidic
1977	Brazilian Indian	10	Bernaba
1983	Malaysian	24.4	Hashim
1984	Singapore	48	Chew
1985	Icelendic, South-Thingeyjarsysla	33.3	Axelsson
1985	Icelendic, North-Thingeyjarsysla	14.6	Axelsson
1987	Saudi Arabia	1.4	Salem
1988	German	13.5	Reichart
1988	Thai	23.1	Reichart
1992	Indian	9.5	Shah
1992	Norway (Oslo)	9.22	Haugen
1994	Norway (Lofoten)	36.1	Eggen
1996	Vietnamese	6	Nair
1996	Israel	21	Gorsky
1999	Southern Thailand	61.7	Kerdpon
1999	Turkish	45.4	Gozil
1999	United States	22.8	Sonnier
2001	African	6.2	Al-bayaty
2001	West Indies	6.6	Al-bayaty
2002	Thai	58.1	Apinhasmit
2003	Black	36	Agnihotri
2003	Caucasian	17	Agnihotri
2004	Turkish	20.9	Cagirankaya
2005	Turkish	30.9	Yildiz (Yildiz et al. 2005)
2006	Jorden	29.8	Al Quran (Al Quran and Al-Dwairi 2006)
2007	Thai	60.5	Jainkittivong (Jainkittivong et al. 2007)
2007	Turky (cappadokia)	4.1	Sisman (Sisman et al. 2008)
2010	Japanese	17	Yoshinaka (Yoshinaka et al. 2010)

12.3.3 Geographical Location

The influence of geographical location on the prevalence of the TP has been shown to result from nutritional factors. Haugen (Haugen 1992) and Eggen et al. (1994) speculated that nutrients in saltwater fish (i.e., omega-3 polyunsaturated fatty acids and vitamin D, the most important osteogenesis factor) could account for the significantly higher prevalence of TP they observed in an island population (36.1% in Lofoten, Norway) than an inland population (9.2% in Oslo, Norway). A similar tendency was observed in Iceland by Axelsson and Hedegaard (1985).

In the Cappadocia region, the prevalence of TP is much lower than in other regions of Turkey (Sisman et al. 2008). Seafood consumption is not as common in the Cappadocia region as in the other regions studied, and this could again be implicated in the low prevalence. The TP prevalence in Japan in 1950 was approximately

50%, but in a 2010 study, it had decreased to 17% (Yoshinaka et al. 2010). Over that 60-year period, the dietary habits among Japanese changed from the traditional Japanese diet to a Westernized diet. The nutritional factors involved in this significant change could have influenced the prevalence of TP in Japan.

12.3.4 Sex

On the whole, women show a higher prevalence of TP than men (women:men = 1.5–2.0:1) (Table 12.5). This is likely to be attributable to a dominant X chromosome gene (Imada et al. 2014). This higher prevalence in women was observed in Asian populations but not among Indians, where the occurrence was almost equal between men and women. Belsky revealed that postmenopausal Caucasian women with large TPs have higher bone densities than their peers and higher bone densities than much younger women (Belsky et al. 2003).

12.4 Anatomy of Related Structures

12.4.1 Greater Palatine Foramen

A systematic review by Tomaszewska on the relationship between the greater palatine foramen (GPF) and the palatal structures revealed that the GPF was positioned 15.9 ± 1.5 mm from the median palatine suture, 3.0 ± 1.2 mm from the alveolar ridge, and 17.0 ± 1.5 mm from the posterior nasal spine; 74.7% of GFPs were positioned opposite the maxillary third molar (Tomaszewska et al. 2014).

Table 12.5 Prevalence of TP in sex (Sathya et al. 2012; Sisman et al. 2008; Yoshinaka et al. 2010; Yildiz et al. 2005; García-García et al. 2010; Jainkittivong et al. 2007)

Year	Famales (%)	Males (%)	Study
1984	48	48	Chew
1988	15.1	11.7	Reichart German population
1988	28.5	15.8	Reichart Thai population
1992	11.2	6.72	Haugen
1994	39.8	23.7	Eggen
1996	24.9	16.4	Gorsky
1999	67.6	48.1	Kerdpon
1999	25.9	14.8	Sonnier
2001	7.7	4.5	Al-bayaty
2002	67.3	48.8	Apinhasmit
2004	28.2	6	Cagirankaya
2005	34.3	28.1	Yildiz (Yildiz et al. 2005)
2006	47	14	Al Quran (Al Quran and Al-Dwairi 2006)
2007	70.5	48.8	Jainkittivong (Jainkittivong et al. 2007)
2007	5.7	1.8	Sisman (Sisman et al. 2008)
2010	24.6	7.5	Yoshinaka (Yoshinaka et al. 2010)
2012	15.7	8.4	Sathya (Sathya et al. 2012)

12.4.2 Greater Palatine Nerve and Artery

The greater palatine nerve is a bundle of nerves running from the GPF through the palatine canal, along the palatal groove, and communicating with the nasopalatine nerve. Miwa et al. (2018) reported the specific arrangement of the greater palatine nerve and arteries in the molar region. The greater palatine artery usually runs deep to the greater palatine nerve. The distribution of blood vessels and nerves becomes remarkable, and the number of the lateral branches increases at the molar and premolar areas of the palate.

12.4.3 The Thickness of the Bony Palate

Surgeons should be familiar with the normal thickness of the bony palate in order to avoid perforation into the nasal cavity. Kang et al. (2007) reported that the bony palate in the median palatine suture is ≥6 mm thick and that 6–10 mm laterally from the suture the normal bone thickness decreases to ≤3 mm (Fig. 12.2). In removing a wide flat-type TP, surgeons should carefully examine the TP volume and physiological bone thickness by coronal plane computed tomography (CT) images to preclude perforation of the nasal cavity.

12.5 Surgical Procedure for the Removal of a TP

A TP can be removed under local anesthesia (lidocaine 2% with epinephrine 1:80,000) or general anesthesia. Briefly, the surgical procedure begins with exposure of the TP, followed by a segmental osteotomy under irrigation, the removal of bone

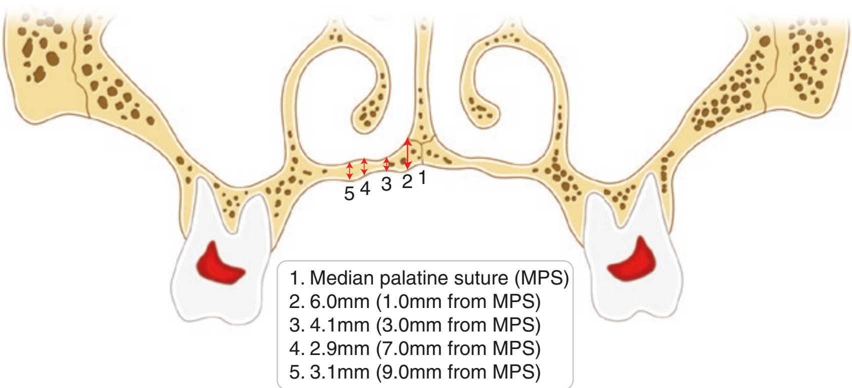

Fig. 12.2 Thickness of bony palate

fragments with a chisel, sutures, and compression. Pathological examination of the bone pieces is used to confirm the TP.

The removal is initiated by making two anterior and posterior oblique incisions (single-Y or double-Y incision) along the midline of the palate. This is designed to avoid injuring the greater palatine artery and nerve and provide access to the surgical field without excessive tension. A full-thickness flap is retracted with bilateral subperiosteal retractors. For a TP with deep grooves, a fine instrument should be used for periosteum peeling so the mucosa will not be torn. For a large TP, releasing the posterior part of the periosteum is easier after the bulk of the TP has been exposed and removed.

The procedure by which the TP is removed depends on its size. A large TP is sectioned with a fissure bur after complete exposure of the surgical field, and the segments are individually removed using an osteotome and mallet. The remaining sharp bony edge is smoothed with a bur or bone file. For small TPs, a large round bur can be used to smooth the bone. After the bone surface has been made smooth, excess soft tissue is trimmed and irrigated with saline, and the flaps are repositioned and sutured with interrupted sutures. Mattress or simple sutures should be used with less tension, and a surgical stent can be used to protect the wound during healing (Fig. 12.3).

When the TP is small, the initial incision is made in the midline. The procedure is then performed in exactly the way described above (Fig. 12.4).

12.5.1 Complications

Iatrogenic complications can occur as a result of manipulation by the surgeon, e.g., perforation to the nasal cavities, nerve and/or artery injuries, bone necrosis due to overheating with surgical drilling, hemorrhage because the branches of the greater palatine artery are injured, and fractures. Surgeons should therefore be properly prepared regarding the management of surgical approaches and possible complications.

12.5.2 Bisphosphonate-Related Osteonecrosis of the Jaw (BRONJ) on TP

Bisphosphonates (BPs) are frequently used to treat osteoporosis, bone metastases of malignant tumors (breast cancer, prostate cancer, and lung cancer), and multiple myeloma (MM) bone destruction. BPs induce the apoptosis of osteoclasts by inhibiting farnesyl diphosphate synthase, leading to suppression of bone resorption and bone remodeling.

In 2003, Marx reported the first case of osteonecrosis of the jaw in a patient with cancer and osteoporosis who had been treated with BPs (Marx 2003). Subsequently, many investigators have reported similar cases of osteonecrosis of the jaw following treatment with BPs; the condition was eventually named bisphosphonate-related osteonecrosis of the jaw (BRONJ). The inhibition of bone remodeling by BPs

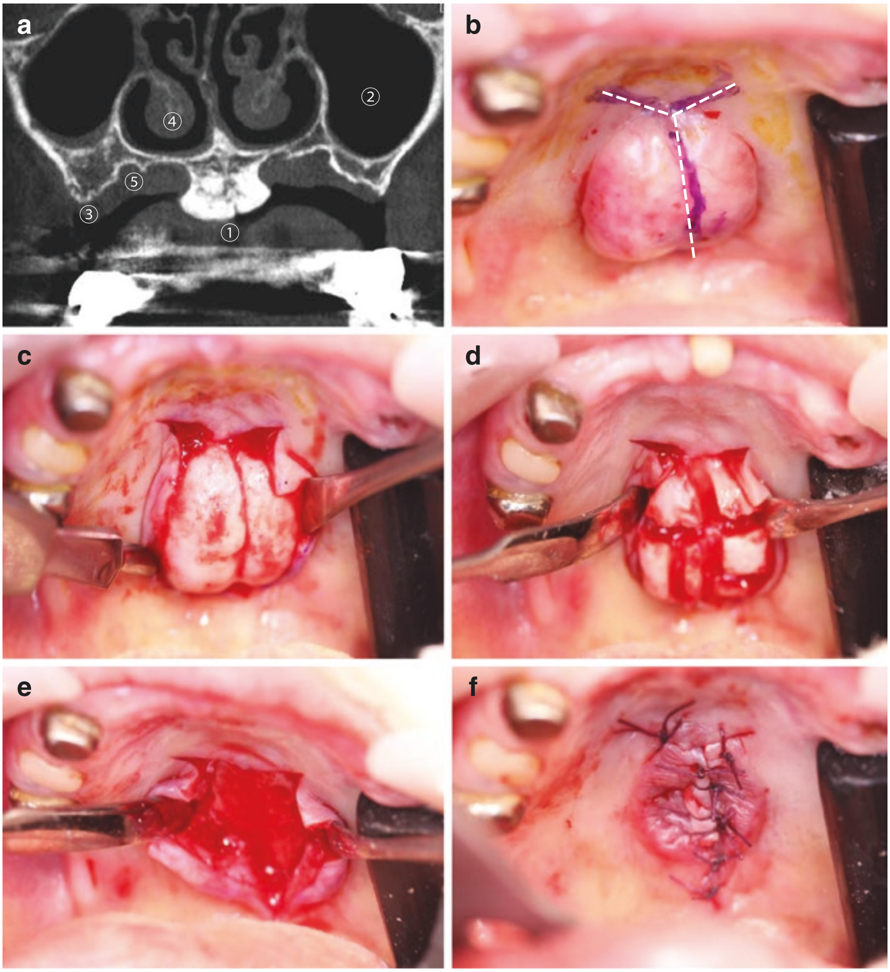

Fig. 12.3 Surgical procedure for removal large TP. (**a**) Coronal CT image of TP: 1. TP; 2. Maxillary sinus; 3.Alveolar bone; 4. Nasal cavity; 5. Palatine grooves. (**b**) Single Y incision. (**c**) Periosteum peeling. (**d**) Segmental osteotomy. (**e**) View of the hard palate after the surgical removal of the TP. (**f**) Suture

interferes with healing and increases the likelihood of infection. BRONJ frequently occurs in the mandible or maxilla in association with tooth extraction or periodontal surgery. However, Godinho and Kaneko reported cases of BRONJ in individuals with TPs (Godinho et al. 2013; Kaneko and Takahashi 2014). Large TPs, especially the lobular type, are covered by a thin and poorly vascularized mucosa. In these cases, healing after a traumatic injury will be inhibited and a bacterial infection can develop. This could be a risk factor of BRONJ in TP cases. There is no consensus regarding the treatment of BRONJ in individuals with a TP. However, discontinuation of BP administration and surgical removal of the TP should be considered in cases of intractable pain associated with BRONJ.

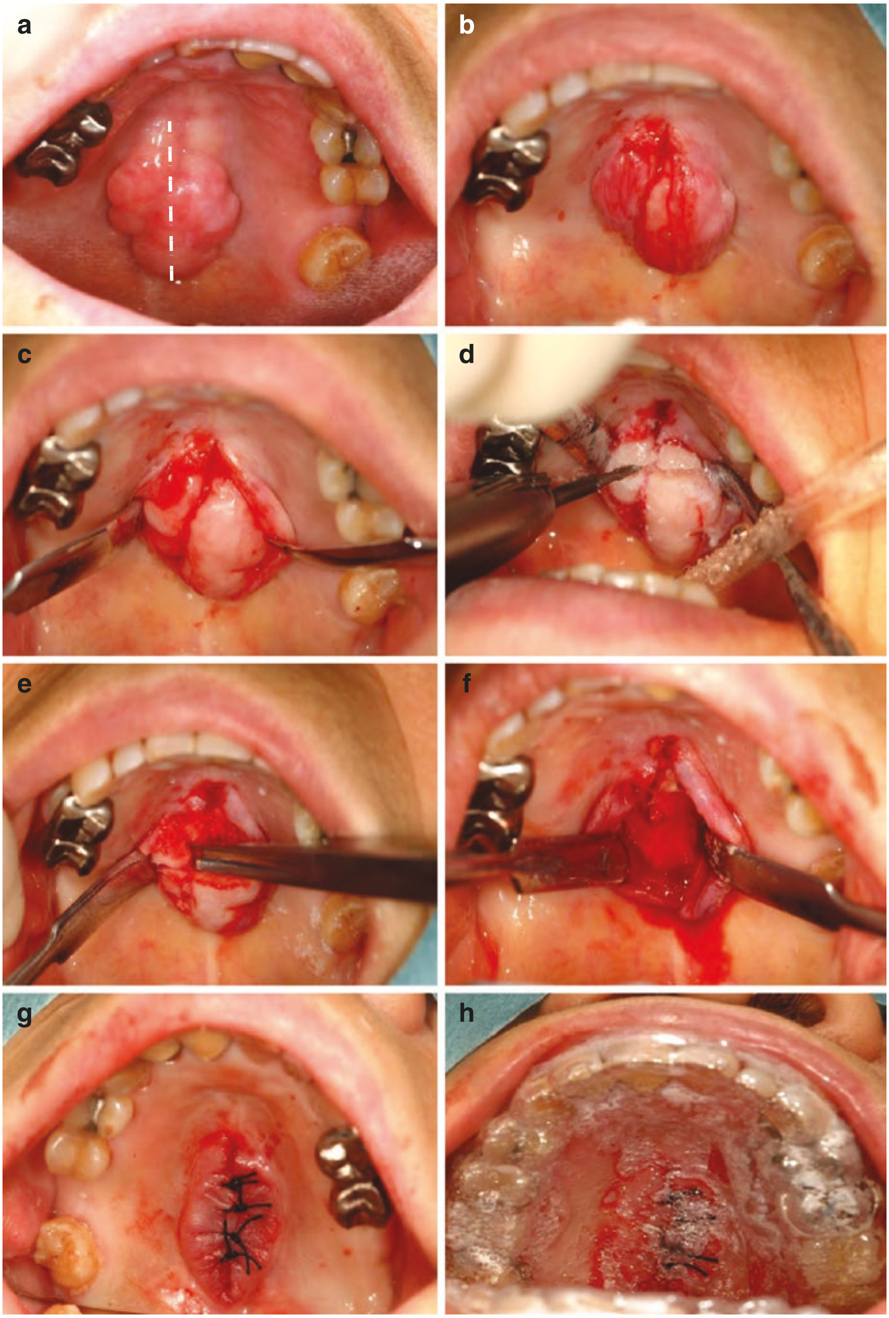

Fig. 12.4 Surgical procedure for removing small TP. (**a**) Straight incision line. (**b**) After straight incision. (**c**) Periosteum peeling. (**d**) Segmental osteotomy. (**e**) Removal of bone pieces with osteotome. (**f**) View of the hard palate after surgical removal of the TP. (**g**) Suture. (**h**) Surgical protector placement

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