# The Association between Torus Palatinus Development and Oral/Occlusal States in a Group of Healthy Dentate Subjects

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**Abstract**

Torus palatinus is a form of exostosis, most commonly found on midline region of palatum. This study was designed to measure the association between the development of torus torus palatinus (TP) and oral/occlusal states in young healthy dentate subjects. The sample was determined by intending for all students who participated for early exposure practice in this cross-sectional study. The predictor variables were oral symptom (temporomandibular joint noise, tooth clenching/grinding, buccal mucosa ridging, dental attrition, tongue habit), oral anatomy (occlusal vertical dimension), oral function (average occlusal pressure, occlusal contact area and maximum voluntary tongue pressure) in this study. The outcome variable was TP development (present or absent). The other variables were demographic (age, number of residual teeth, weight, gender). These items were compared among the subjects with and without TP using univariate analyses and multiple logistic regression analysis. Statistical analyses were carried out using SPSS System ver.19 for Windows. Among 204 subjects, 102 were male (50.0%). Mean age was 22.4 ± 2.7 years old, mean number of residual teeth was 28.8 ± 2.0, and mean weight was 57.7 ± 9.9 kg. Subjects with torus palatinus were prone to be female, lighter-build, and have tooth clenching/grinding, buccal mucosa ridging. Subjects with torus palatinus had lower occlusal vertical dimension or average occlusal pressure than those without TP. However, maximum voluntary tongue pressure of subjects with torus palatinus was not significantly different from that of subjects without torus palatinus. After adjusting the potential confounders, multiple logistic regression analysis revealed that TP development was related to occlusal vertical dimension and average occlusal pressure ($p<0.05$). This study revealed that TP development induced the change of oral/occlusal states such as occlusal vertical dimension and average occlusal pressure in young healthy dentate subjects. This study will give readers useful information to prevent TP development before middle age.

*Key Words: Torus palatinus, Oral/occlusal state, Occlusal vertical dimension, Occlusal pressure*

## Introduction

Torus palatinus (TP, *Figure 1*) is a form of exostosis caused by the extra development of bone, mainly observed on midline region of the palatum in middle-aged patients [1]. TP is frequently encountered in clinical practice, but it is not considered to be a pathological condition [2]. From functional aspects, TP may affect pronunciation, interfere with swallowing, and cause pain on mucosa under improper/mal-designed prostheses [2]. In addition, it may be also associated with temporomandibular disorder/orofacial pain [3]. Some factors associated to TP development have been reported to be genetic factors such as gender and ethnicity, environmental factors such as the survival rate of teeth and malnutrition, and functional factors such as clenching and grinding [4-6].

We can eliminate some influenced factors such as tooth number and malnutrition when we select young subjects. However, there have been few reports TP development among young subjects. In addition, there have been no studies examining the influence by the change of oral/occlusal states. Therefore, the purpose of this study was to measure the difference of oral/occlusal states in young health dentate subjects with and without TP. We hypothesized that young subjects with TP development have some specific oral/occlusal states. And if so, we will have useful information to prevent TP development until they become middle age. The specific aim of the study was to reveal the differences of oral symptom, oral anatomy, and oral functions.

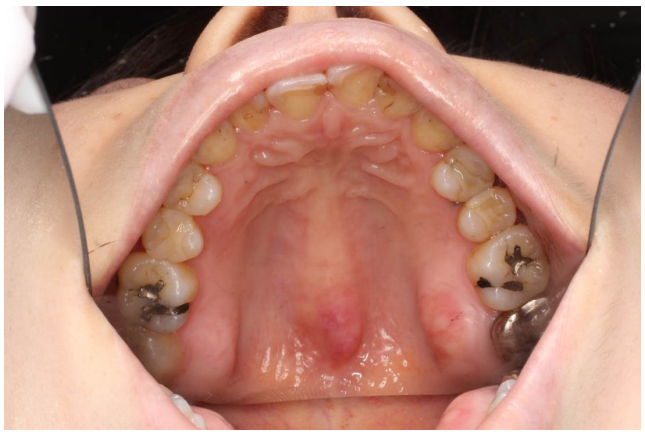

***Figure 1.*** *Torus palatinus (TP). Intraoral view of one subject with TP (two arrows) which is an exophytic nodular bony mass that develops on the middle region of the palatum.*

## Methods

### Study design and sample

To address the research purpose, the authors designed and implemented as a cross-sectional study. The study sample was determined by intending for all students who participated for early exposure practice. The study population was composed of all subjects that was presenting at Hiroshima University School of Dentistry between June 20, 2015 and June 20, 2016.

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Subjects were included in this study sample met these inclusion criteria:

1) Age below 40 years-old;

2) All dentition;

3) No history of orthodontic treatment.

Subjects were excluded if they were suffered from severe periodontitis and tooth pain or had history of orthodontic treatment. There were no subjects excluded by severe periodontitis, tooth pain and history of orthodontic treatment. Prior to this study, we explained the purpose and methodology of the study to the subjects. All subjects signed a consent form before being enrolled in the study. This research was approved by the medical ethics committee of Hiroshima University Hospital (No.920) and was conformed Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) [7].

## Study variables and data collection methods

The predictor variables were oral symptom (temporomandibular joint noise, tooth clenching/grinding, buccal mucosa ridging, dental attrition and tongue habit), oral anatomy (occlusal vertical dimension), oral function (maximum voluntary occlusal force, occlusal contact area, average occlusal pressure and maximum voluntary tongue pressure in this study. Four dentists examined the subjects described below. One of them interviewed (K. K.), one of them assessed oral examination (H. T.), one of them measured occlusal vertical dimension, maximum voluntary occlusal force, occlusal contact area and average occlusal pressure (K. M.), and one of them measured maximum voluntary tongue pressure (T. S.). All subjects were interviewed using our original questionnaire including oral symptom such as temporomandibular joint noise, tooth clenching and grinding. The presence or absence of oral symptom including temporomandibular joint sound, tooth clenching/grinding, and tongue habit were asked as follows;

- Have you ever been noticed clicking/crepitus sound while opening or closing your jaw?
- Have you or anyone ever been frequently or sometimes aware of tooth clenching/grinding at the day and night?
- Does your apex of tongue touch your teeth during swallowing? [8-11].

Buccal mucosa ridging (BMR) was defined as acknowledge of linear thickening at the level where the teeth occlude on the buccal mucosa according to previous report [12]. Dental attrition (DA) was defined as acknowledge of atypical wear patterns on incisal edges and cusp tips and degree which was scored 1~4 in accordance with a modified version of Smith and Knight Tooth Wear Index [3,13]. We measured the occlusal vertical dimension (OVD) as the distance from subnasal point to chin in subjects using vernier caliper (Tsubone's bite gauge, YDM, Tokyo, Japan). The criteria of MVOF, OCA and AOP were follows: Flankfort horizontal plane of each subject was allowed to seat on a dental chair so as to be parallel to horizontal plane and asked to bite a pressure measurement film (DENTAL PRESCALE 50H, GC, Tokyo, Japan) for three seconds at the level of maximum voluntary effort. MVOF, OCA and AOP were analyzed by measuring the density and area of red patches on the film from the three reading that resulted from the occluding pressure, using an occlusal force measuring system (Occluser 709, GC, Tokyo, Japan). The validity, reliability and reproducibility of this method have been described before [14,15]. The criterion of MVTP was follows: The validity, reliability and reproducibility of this method have been described in previous reports [16,17]. We also confirmed the reliability of maximum voluntary tongue pressure (MVTP) measurement in this study. MVTP was evaluated as average of three measurements using handy tongue pressure-measuring device and disposable balloon probe (TPM-01, JMS, Hiroshima, Japan). In each measurement, subjects were asked to compress balloon part of the probe onto their plate with their maximum voluntary effort for seven seconds.

The other variables were demographic (age, number of residual teeth, weight, gender). All subjects were interviewed using our original questionnaire including demographic.

The outcome variable was TP development. The criteria for TP development were determined according to the classification (Gorsky et al.) as more or less than 2 cm [18]. TP development was defined as more than 2 cm and no TP development was defined as less than 2 cm in this study.

### Data analyses

Spearman rank correlation coefficient test, Chi-square test, Mann-Whitney U test were used for the comparison of each variable between the subjects with and without TP, considering significant level of $P<0.05$. After adjusting the confounders, odds ratios (ORS) and 95% confidence intervals (CI) were calculated using multiple logistic regression analysis to reveal the association between an outcome variable and predictor variables. Statistical analyses were carried out using SPSS System ver.19 for Windows (IBMSPSS, Tokyo, Japan).

## Results

A total of 204 subjects were consisted of 102 male and 102 female with the mean age of 22.4 ± 2.7 years old, the mean number of residual teeth of 28.8 ± 2.0 and the mean weight of 57.7 ± 9.9 (*Table 1*). The association between all study variables and the predictor variables were shown in *Table 2*.

***Table 1.*** *Descriptive summary of study sample.*

| Study Variables | Descriptive Statistics |
|---|---|
| Sample size | 204 (100%) |
| Age (year) | 22.4 ± 2.7 |
| Number of residual teeth | 28.8 ± 2.0 |
| Weight (kg) | 57.7 ± 9.9 |
| Gender - female | 102 (50.0%) |
| Data was presented as n (%) or average ± standard deviation | |

Among the subjects, 111(54.4%) was defined as TP development and 93(45.6%) was not. There were not differences between the subjects with TP and without TP

about age and number of residual teeth. On the other hand, weight was significantly higher in the subjects with TP (56.6 ± 9.9 kg) than without TP (59.0 ± 9.8 kg). Also number of female subjects with TP (68 persons, 66.7%) was significant higher than that of male subjects with TP (43 persons, 42.2%). Also no significant differences were found in temporomandibular joint sound, DA, and tongue habit. However, tooth clenching/grinding and BMR were significantly prevalent in subjects with TP ($p<0.05$). OVD was significant lower in subjects with TP (64.7 ± 5.1 mm) than without TP (66.7 ± 4.9 mm) ($p<0.05$). There was no significant difference of MVOF or OCA between subjects with TP of subjects with TP (532.6 ± 260.2 N, 12.1 ± 6.2 $mm^2$) and without TP (627.2 ± 344.8 N, 11.3 ± 5.7 $mm^2$) ($p<0.05$). On the other hand, AOP of subjects with TP (48.7 ± 20.3 $N/mm^2$) was significantly lower than that of subjects without TP (61.1 ± 26.9 $N/mm^2$) ($p<0.05$) and also, there was no significant difference of MVTP between subjects with TP (41.0 ± 8.7 kPa) and without TP (42.3 ± 9.4 kPa) ($p<0.05$) (*Table 3*).

***Table 2.*** *Study variables versus predictor variables.*

| | **TJN** | **C and G** | **BMR** | **DA** | **TH** | **OVD** | **MVOF** | **OCA** | **AOP** | **MVTP** |
|---|---|---|---|---|---|---|---|---|---|---|
| Age | 0.0029 | p<0.001 | 0.0157 | p<0.001 | 0.1213 | 0.3925 | 0.019 | 0.1077 | 0.6872 | 0.0259 |
| NRT | 0.4338 | 0.1318 | 0.7461 | 0.7422 | 0.8116 | 0.2782 | 0.0148 | 0.011 | 0.5102 | 0.0111 |
| Weight | 0.4144 | 0.0964 | 0.883 | 0.1448 | 0.2786 | p<0.001 | 0.0011 | p<0.001 | 0.2533 | p<0.001 |
| Female | 0.0479 | 0.0702 | 0.7752 | 0.5932 | 0.0702 | p<0.001 | 0.0077 | 0.0029 | 0.3866 | p<0.001 |
| TJN | - | p<0.001 | 0.1483 | 0.0429 | 0.1609 | 0.8967 | 0.7774 | 0.8683 | 0.9124 | 0.1876 |
| C and G | ** | - | p<0.001 | p < 0.001 | 0.9798 | 0.0263 | 0.8755 | 0.3648 | 0.0034 | 0.7377 |
| BMR | | ** | - | 0.1818 | 0.6949 | 0.0317 | 0.2648 | p<0.001 | p<0.001 | 0.215 |
| DA | * | ** | | - | 0.1041 | 0.7945 | 0.2001 | 0.5557 | 0.0654 | 0.976 |
| TH | | | | | - | 0.3235 | 0.5865 | 0.1106 | 0.0028 | 0.0152 |
| OVD | | * | * | | | - | 0.5844 | 0.3206 | 0.0772 | 0.1041 |
| MVOF | | | | | | | - | p<0.001 | 0.0017 | p<0.001 |
| OCA | | | ** | | | | ** | - | p<0.001 | p<0.001 |
| AOP | | ** | ** | | ** | | ** | ** | - | 0.1356 |
| MVTP | | | | | * | | ** | ** | | - |
| * P<0.05, ** P<0.01, Spearman rank correlation coefficient test, Chi-square test | | | | | | | | | | |
| NRT: number of residual teeth; TJN: temporomandibular joint noise; C and G: tooth clenching and grinding; BMR: buccal mucosa ridging; DA: dental attrition; TH: tongue habit; OVD: occlusal vertical dimension; AOP: average occlusal pressure; OCA: occlusal contact area; MVTP: maximum voluntary tongue pressure | | | | | | | | | | |

***Table 3.*** *Study variables versus outcome variable.*

| **Variable Name** | **TP (+)** | **TP (-)** | **P value** |
|---|---|---|---|
| | (n=111) | (n=93) | |
| Age (yr) | 22.3 ± 2.6 | 22.5 ± 2.8 | 0.556 |
| NRT | 28.5 ± 1.9 | 29.1 ± 2.1 | 0.058 |
| Weight (kg) | 56.6 ± 9.9 | 59.0 ± 9.8 | 0.041* |
| Female, n (%) | 68 (66.7) | 34 (33.3) | 0.000* |
| TJN | | | |
| (+) | 30 | 18 | 0.198 |
| () | 81 | 75 | |
| C and G | | | |
| (+) | 43 | 21 | 0.013* |
| () | 68 | 72 | |
| BMR | | | |

| | | | |
|---|---|---|---|
| (+) | 80 | 42 | 0.000* |
| () | 31 | 51 | |
| DA | | | |
| (+) | 23 | 16 | 0.525 |
| () | 88 | 77 | |
| TH | | | |
| (+) | 30 | 34 | 0.144 |
| () | 81 | 59 | |
| OVD (mm) | 64.7 ± 5.1 | 66.7 ± 4.9 | 0.004* |
| MVOF (N) | 532.6 ± 260.2 | 627.2 ± 344.8 | 0.055 |
| OCA ($mm^2$) | 12.1 ± 6.2 | 11.3 ± 5.7 | 0.479 |
| AOP ($N/mm^2$) | 48.7 ± 20.3 | 61.1 ± 26.9 | 0.001* |
| MVTP (kPa) | 41.0 ± 8.7 | 42.3 ± 9.4 | 0.302 |
| Data was presented as n (%) or average ± standard deviation | | | |
| * P<0.05, Mann-Whitney U test, Chi-square test | | | |
| TM: torus mandibularis; NRT: number of residual teeth; TJN: temporomandibular joint noise; C and G: tooth clenching and grinding; BMR: buccal mucosa ridging; DA: dental attrition; TH: tongue habit; OVD: occlusal vertical dimension; AOP: average occlusal pressure; OCA: occlusal contact area; MVTP: maximum voluntary tongue pressure; OVD: occlusal vertical dimension; AOP: average occlusal pressure; OCA: occlusal contact area; MVTP: maximum voluntary tongue pressure | | | |

***Table 4.*** *Summary of regression model.*

| Study Variable | β Coefficient | 95% Confidence Interval | P value |
|---|---|---|---|
| OVD | -0.0747 | -0.1495 | 0.0122* |
| AOP | -0.0214 | -0.0428 | 0.0011** |
| * P<0.05, A multiple logistic regression analysis was used. | | | |
| OVD: occlusal vertical dimension; AOP: average occlusal pressure | | | |

From the results of *Tables 2 and 3*, weight, female, tooth clenching/grinding and BMR were calculated as the potential confounders and was excluded from predictor variables before multiple logistic regression analysis. Multiple logistic regression analysis revealed that OVD and AOP were significantly associated with TP (P<0.05) (*Table 4*).

## Discussion

The purpose of this study was to measure the difference of oral/occlusal states in young health dentate subjects with and without TP. We hypothesized that young subjects with TP development have some specific oral/occlusal states. And if so, we will have useful information to prevent TP development until they become middle age. The specific aim of the study was to reveal the differences of oral symptom, oral anatomy, and oral functions. The results of this study demonstrated that TP development was significantly associated with OVD and AOP among young healthy dentate subjects. It may indicate that TP development induced the change of oral/occlusal states.

TP was associated with weight and female among the young subjects in this study. The gender difference for TP development is consistent with the results of a previous study [6]. However, it has not been reported to be association between TP development and weight in previous report. The subjects with TP would be lighter-build than subjects without TP, because the number of female subjects with TP were significantly large.

TP was not associated with temporomandibular joint sound, DA, and tongue habit among the young subjects in this study. On the other hand, subjects with TP was prone to tooth clenching/grinding and BMR. These oral parafunctions are significantly associated with bruxism [18,19]. Bruxism can change oral/occlusal states such as tooth clenching/grinding and BMR across the years [12,20]. It may the reason why TP development was closely associated with tooth clenching/grinding and BMR in middle-aged subjects.

OVD of the subjects with TP was significantly smaller than that of the subjects without TP. OVD was reported to be closely associated with jaw size as genetic factor [21]. TP development may suggest the possibility of genetic factor such as small OVD like weight, because the number of female subjects with TP were significantly large in this study.

Based on the results from this study, there was no significant difference between TP development and MVOF or OCA. TP development was not associated with MVOF in middle-aged subjects, too [22]. However, we have shown that

TP development was closely associated with AOP. AOP was calculated by MVOF per OCA [23]. AOP was closely associated with masticatory ability [24]. The reduced mastication ability and increased masticatory movement by reduced state of AOP may induce TP development. It may be the reason why AOP was closely associated with TP development. However, we have to perform further study to demonstrate the association between TP and masticatory function to demonstrate this hypothesis.

Our study samples were relatively small and recruited from mostly Asian students in Hiroshima University, which may limit the ability to extrapolate these results of our limited data to the general population of young adults in all races. However, the prevalence of TP development or gender difference were similar to other studies [25,26]. Therefore, we think the difference of race is not severely associated with our results. Also we did not examine malocclusion such as crowding, overjet, overbite, and cross bite.

## Conclusion

TP development was significantly associated with OVD and AOP, which may indicate the change of oral/occlusal states even in young subjects.

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**Disclosure**

The authors declare no conflicts of interest with respect to the authorship and/or publication of this article.

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