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Palatal rugae comparison between ethnic Javanese and non-Javanese

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Abstract. Palatal rugae patterns are thought to remain unchanged from the beginning of formation until the death of the individual, and as unique as fingerprints. This study aimed to compare palatal rugae between ethnic Javanese and non-Javanese in Indonesia. The study sample consisted of maxillary casts from 47 Javanese and 53 non-Javanese subjects. The patterns of palatal rugae were recorded based on the Thomas and Kotze classification. In the results, the only variable with indicated significant difference between the sample populations was observed in the lower frequency of circular shape rugae for the non-Javanese group. The value of this frequency as a population-level indicator is reduced by the relative rarity of this rugae shape.

Keyword: Palatal rugae, rugoscopy, forensic odontology, ethnic difference

1. Introduction

Palatal rugae are located on the anterior part of the palatum mucosa that spreads in both sides of the palate, behind the papillary incisive [1,2]. The unique pattern of human palatal rugae allows for the use of these patterns in identification of individuals [3]. Palatal rugae patterns are formed in the third month of intrauterine development [4].

The function of palatal rugae is to prevent food from coming out from the mouth, help in mastication process, and to participate in talking and sucking in children. The palatal rugae also play a role in the perception of taste and food texture due to the presence of gustatory and tactile receptors. Palatal rugae have good resistance to changes by disease, physical trauma, thermal insult, decomposition or chemicals because the palatal rugae are protected by lips, cheeks, and teeth [1]. In the case of corpse decomposition, palatal rugae resist post mortem decomposition up to 7 days after death [5].

In the process of individual identification, it may happen that primary identification methods such as analysis of fingerprints, DNA and dental records cannot be used when the victim's body is badly burned and jaws are edentulous. Then alternative methods, like palatal rugae analysis, could help [6]. Apart from each individual having a different palatal rugae morphology, the process of analysis and identification carries low cost [7]. Tooth eruption and tooth extraction have generally no effect on the pattern or position of palatal rugae, although sometimes the rugae close to the alveolar arch may shift position after tooth extraction [8]. The palatal rugae pattern may also change under some conditions such as finger sucking habits in children, and pressure by orthodontic treatment [9]. The present study aims to compare palatal rugae between ethnic Javanese and non-Javanese in Indonesia.



2. Materials and methods

The study was conducted using 100 maxillary casts of 47 Javanese and 53 non-Javanese subjects as samples, taken from Faculty of Dentistry, University of Indonesia. Impression of maxillary arch was obtained using alginate and plaster cast. The sample had inclusion criteria of no orthodontic treatment, free from trauma or palatal asymmetry. Ethical clearance was not applicable. Geometric divider and stainless steel ruler were used for measuring the length of palatal rugae. Patterns of palatal rugae were highlighted by using a sharp pencil under adequate light, and recorded using the Thomas and Kotze classification (1983) [2]. This classification is simple but includes the variables such as length, shape, unification and direction of the palatal rugae.

Groupings of rugae length can refer to three categories: primary rugae (5 mm or more), secondary rugae (3-5 mm), and fragmentary rugae (2-3 mm), and rugae shorter than 2 mm are ignored. The shape of the rugae can be classified into four types: curved, wavy, straight and circular. Straight types is rugae parallel from origin to termination, curved types are curve-shaped rugae, circular types are ring-shaped rugae, and wavy types are wave-shaped rugae. The rugae with two branches are of unification type, classified as diverging if the two rugae coming from the middle are spreading away from the center, and as converging if the two rugae converge in the middle. The direction of each rugae is determined by measuring the angle between the line at the origin of the rugae and the line perpendicular to the median raphe. Forward-directed rugae form a positive angle, backward-directed rugae a negative angle and perpendicular rugae angle remain at 0 degree.

The data were analyzed using SPSS version 16.0. Mann-Whitney testing was mostly applied to analyze the significance of rugae patterns between the ethnic groups, except that independent t-test was used for direction of rugae for which the data was normally distributed. Significance in testing was assumed at $p < 0.05$.

3. Results

The four shape categories of palatal rugae are shown in Figure 1. The total number and mean length of primary, secondary and fragmentary rugae between the ethnic Javanese and non-Javanese groups showed no statistically significant differences (Table 1). A corresponding comparison for total and mean number of the shape of rugae is shown in Table 2, for rugae direction in Table 3, and for rugae unification type in Table 4.

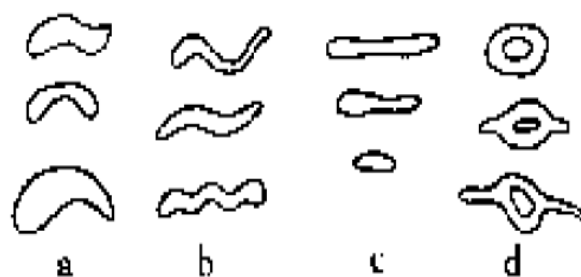


Figure 1. Thomas and Kotze classification of rugae: a, curved; b, wavy; c, straight; d, circular

Table 1. Number and mean length (mm) of palatal rugae in ethnic Javanese and non-Javanese

Type	Javanese	Mean \pm SD	Non-Javanese	Mean \pm SD	p-value ¹⁾
Primary	329	7.00 \pm 1.89	355	6.69 \pm 1.82	0.477
Secondary	78	1.65 \pm 1.93	101	1.90 \pm 1.83	0.358
Fragmentary	49	1.04 \pm 1.27	38	0.71 \pm 1.08	0.176

¹⁾Mann-Whitney test

Table 2. Comparison by rugae shape between ethnic Javanese and non-Javanese

Shape	Javanese	Mean \pm SD	Non-Javanese	Mean \pm SD	p-value ¹⁾
Curved	169	3.59 \pm 2.30	154	2.90 \pm 1.71	0.158
Wavy	121	2.57 \pm 1.51	155	2.92 \pm 1.57	0.338
Straight	120	2.55 \pm 2.25	154	2.90 \pm 1.98	0.260
Circular	47	1.00 \pm 1.46	21	0.39 \pm 0.82	0.045*

¹⁾ Mann-Whitney test

* statistically significant difference

Table 3. Comparison by direction of rugae between ethnic Javanese and non-Javanese

Direction	Javanese	Mean \pm SD	Non-Javanese	Mean \pm SD	p-value ¹⁾
Forward	174	3.70 \pm 2.55	211	3.98 \pm 2.32	0.569
Backward	154	3.27 \pm 2.12	162	3.05 \pm 1.89	0.796
Perpendicular	125	2.65 \pm 2.00	113	2.13 \pm 1.87	0.166

¹⁾Independent t test**Table 4.** Comparison by rugae unification type between ethnic Javanese and non-Javanese

Unification	Javanese	Mean \pm SD	Non-Javanese	Mean \pm SD	p-value ¹⁾
Converging	7	0.14 \pm 0.42	12	0.22 \pm 0.47	0.304
Diverging	21	0.44 \pm 0.69	14	0.26 \pm 0.52	0.137

¹⁾Mann-Whitney test

The only variable with indicated significant difference between the Javanese and non-Javanese sample populations was observed in the circular shape of rugae (Table 2). Otherwise, the two populations appear very similar in their distributions of rugae types, shapes, direction and unification.

4. Discussion

When primary identification methods such as fingerprints, DNA and dental analysis are not applicable or sufficient, secondary identification methods can be useful, such as personal items or descriptions, medical findings, and also palatal rugae analysis [12]. The palatal rugae classifications were first developed by Gorla in 1911 and Trobo in 1932, but the most widely used ones are the classifications by Thomas and Kotze (used here) and by Lysell [1].

There are several methods in inspecting palatal rugae, for example intraoral examination by using mouth mirror, oral photography using intraoral cameras, and calcorugoscopy by making the maxillary dental cast of an individual using alginate and dental stone. The latter method was used here and is common because it is easy, cheap and suitable for comparing individual rugae [11].

In the analysis of palatal rugae, subjective assessment and interpretation may occur between examiners. The effect can be tackled by first doing interobserver assessment by different observers and then intraobserver assessment by the same observer at two different times [13].

This study aimed to compare the characteristics of palatal rugae of two groups within the Indonesian population. The results show that in terms of Thomas and Kotze classification, the most common types of palatal rugae in both Javanese and non-Javanese groups were primary rugae, and the most common rugae shapes were curved, wavy and straight forms. The circular shape was less common, but significantly less common still in the non-Javanese group than in the Javanese group. The frequency of circular shape rugae was the only variable indicating significant differences between the groups, so that otherwise no features in terms of rugae types, shapes, direction or unification were differing between the sample populations. This could be further tested by using larger sample populations.

The observations on the dominant shapes of rugae are in approximate agreement with the study of Kapali *et al* [2] on Australian Aborigines and Caucasians, with the circular shape being least common but nevertheless occurring in the sample populations. This is in contrast with the study of Nayak *et al*

[8] on western and southern Indian population, indicating that the circular shape is not found. The frequency of the circular shape rugae could therefore serve as a population-level indicator, the value of which is however reduced by its relatively low frequency in many populations. This does not preclude identification based on palatal rugae patterns of an individual. Then a common challenge is to find a comparison unless the pattern has been stored as a previous dental cast or its image.

5. Conclusions

The predominant types of palatal rugae in both Javanese and non-Javanese groups were primary, and the most prevalent rugae shapes were curved, wavy and straight forms, the circular form being less common. The circular shape rugae were significantly less common in the non-Javanese than in the Javanese group. Otherwise, no features in terms of rugae type, shape or direction were differing between the sample populations. The predominant direction of rugae in both groups was the forward type. Unification type of rugae was recorded in both groups but at low frequency. It can be concluded that the general differences in palatal rugae the two tested groups are small and limited to relatively minor types of rugae. This does not preclude identification based on palatal rugae, but a common challenge to find a comparison unless the pattern as a previous dental cast or its image has been stored.

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