

Arch Length and Palatal Rugae: An Adjunct in Gender Discrimination

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Dent J Adv Stud 2019;7:110–113

Abstract

Introduction Palatal rugae or plica palatine are the finger prints of the oral cavity and the arch length varies between males and females. These two parameters constitute an integral part of the anthropometric studies in the realms of dentistry as well as forensic odontology. The aim of this study was to assess whether any relationship existed between the upper arch length and the rugae pattern and whether these two parameters showed any gender differentiation.

Materials and Methods The sample consisted of upper and lower study models of 60 subjects (30 males and 30 females). Arch lengths were measured using a brass wire and rugae were traced on the dental casts and assessed by applying the Thomas and Kotze classification (1983). The data collected was subjected to statistical analysis.

Results The results showed that the maxillary and mandibular arch length dimensions were higher in males than in females; however, the differences were found to be statistically insignificant. The assessment of rugae pattern showed that the male subjects had a higher number of rugae. The differences in rugae pattern distribution for male and female subjects were found to be statistically significant.

Conclusion The palatal rugae pattern and maxillary arch length can be used as an additional method in differentiating gender between human population groups.

Keywords

- ▶ arch length
- ▶ gender discrimination
- ▶ palatal rugae

Introduction

The distinct personality of an individual as a persisting entity is known as personal identity. To establish a person's identity, various methods are used such as fingerprint, retina scans and deoxyribonucleic acid analysis; therefore, when common forensic data are unavailable as in cases of severely mutilated bodies, exhumed bodies, or cases where the post-mortem changes are severe and the identity of a person cannot be determined by the conventional methods, analysis of the palatal rugae may help in establishing the identity of the individual or at least the race to which he or she belongs.¹ Palatal rugae also called "plica palatine" are irregular, asymmetric ridges of mucous membrane extending laterally from the incisive papilla and the anterior part of the palatal raphe is also called the fingerprints of the oral cavity.² Palatal rugae appear in the third month of intrauterine life. Rugae patterns

have been found to be unique and stable structures in the oral cavity, and various studies have shown that the rugae have distinct presentation patterns in different races as well as within the realms of the race itself. There is no change seen in the rugae pattern even after orthodontic treatment as they are protected from trauma and insulated from heat by the tongue and the buccal pad of fat, thus determining their stability in the oral cavity.³

Palatine rugae can be used as internal dental cast reference points for quantification of tooth migration in cases of orthodontic treatment. Palatine rugae could be used to assess the anteroposterior tooth movements and assess the changes in the position of the posterior teeth in the antero-posterior direction that is relevant to the diagnosis and correction of sagittal occlusal abnormalities and arch length discrepancies.⁴

The science of anthropometry has been utilized in diverse fields; different studies on dental anthropometry have utilized arch lengths, facial heights, and rugae patterns as individual parameters.

The arch length may be defined as the distance from the distal point of the most posterior tooth on one side of the upper or lower jaw to the same point on the other side usually measured through the points of contact between adjoining teeth. It has been observed that the arch length varies between males and females with the males usually having a greater arch length than females. In orthodontic literature, studies have been undertaken till date to assess the arch length differences in males and females, but studies combining the palatal rugae variations as well as the arch length discrepancies in males and females are very limited. This study was undertaken to see whether gender differences can be determined using these two parameters.

Objectives

The aim of this study was to evaluate the arch lengths and the rugae patterns and whether these two parameters showed any sexual dimorphism.

Materials and Methods

The present cross-sectional study comprised 60 subjects (30 males and 30 females) who presented to the Department of Orthodontics and Dentofacial Orthopedics of Bhojia Dental College and Hospital, Bhud, Baddi (HP) for fixed orthodontic treatment. Informed consent was obtained from all the subjects after explaining to them the nature of the study. The subjects were selected on the basis of the following criteria.

Inclusion Criteria

1. Fully erupted permanent teeth with the exception of the third molars.

Exclusion Criteria

1. History of facial trauma
2. History of previous orthodontic treatment
3. Cleft palate and lip surgeries
4. Craniofacial abnormalities and endocrine disease.

The sample was divided into two groups (►Table 1).

Methodology

The maxillary and mandibular dental study models were obtained; the upper arch length and the lower arch length were measured using a (0.25 inch) brass wire. The brass wire was contoured to the original arch shape and placed on the occlusal surfaces over the contact points of the

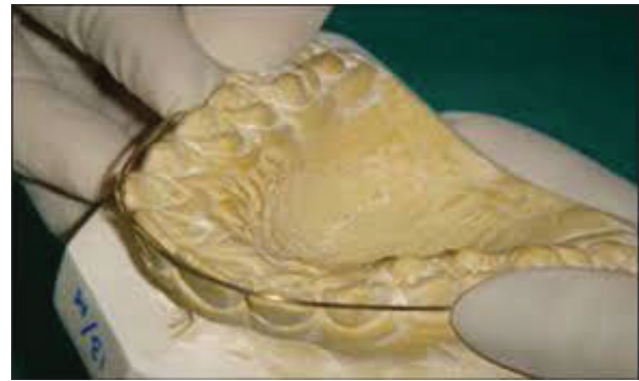


Fig. 1 Measuring arch length using a brass wire.

posterior teeth mesial to the first permanent molars and the incisal edges of the anterior teeth till the second premolar on the contralateral side of the arch (►Fig. 1).

The same study models were used to analyze the various rugae patterns after delineating them using a sharp graphite pencil. Rugae shapes were categorized on the basis of the classification given by Thomas and Kotze.⁵

According to the size, the rugae were classified into (1) primary rugae (≥ 5 mm), (2) secondary rugae (3–5 mm), and (3) fragmentary rugae (2–3 mm). On the basis of shape, the rugae were classified into (1) curved, (2) wavy, (3) straight, and (4) circular rugae. The number of these rugae were counted and analyzed (►Fig. 2).

Statistical Analysis

The values so obtained were subjected to statistical analysis using SPSS (Statistical Package for Social Sciences) version 15.0 statistical analysis software. The mean and standard deviations were calculated. The differences between males and females for both the parameters were determined and subjected to paired *t*-test.

Results

The study was done on maxillary and mandibular dental study models of 60 subjects that were divided into two groups: group I (males, $n = 30$) and group II (females, $n = 30$). Arch lengths and rugae patterns were evaluated for both the groups.

The descriptive statistics and comparative analysis of arch lengths for group I (males) and group II (females) are depicted in ►Table 2. It was found that males had a higher arch length than females, both in the upper and the lower arch. When the means of arch lengths were analyzed by comparing the groups, it was found to be statistically insignificant ($p > 0.05$).

The descriptive statistics and comparative analysis of different rugae patterns in group I (males) and group II (females) are depicted in ►Table 3. It shows that no significant difference was observed in the rugae characteristics between the right and left side for males and females; hence, they are not being depicted separately. The results show that the females had a higher number of primary rugae than the males but the males showed a higher number of secondary

Table 1 Grouping of sample

Group I	Group II
Males ($n = 30$)	Females ($n = 30$)

Fig. 2 Rugae identification based on shape: (A) curved, (B) wavy, (C) straight, and (D) circular.

Table 2 Descriptive statistics and comparative analysis of arch lengths of males and females

S. no.	Parameters	n	Mean	SD (mm)	SE (m)	Upper bound	Lower bound	p-Value
1	Upper arch length males	30	74.53	4.6	0.81	87	69	0.64
2	Upper arch length females	30	74.1	4.3	0.79	86	66	0.64
3	Lower arch length males	30	64.56	5.5	0.99	74	59	0.51
4	Lower arch length females	30	63.51	5.3	0.95	70	51	0.51

Abbreviations: SD, standard deviation; SE, standard error.

Table 3 Descriptive statistics and comparative analysis of the various rugae patterns in group I (males) and group II (females)

S. no.	Rugae patterns	Gender	n	Mean	Standard deviation	Standard error mean	p-Value
1	Primary rugae	Males	30	2.1000	1.12495	0.20064	0.000
		Females	30	2.1034	1.08050	0.20539	0.000
2	Secondary rugae	Males	30	1.4667	1.22428	0.22352	0.000
		Females	30	1.1034	1.14470	0.21257	0.000
3	Fragmentary rugae	Males	30	0.8333	1.03152	0.19155	0.001
		Females	30	0.7241	1.03152	0.19155	0.001
4	Straight rugae	Males	30	1.1000	1.06188	0.19387	0.000
		Females	30	0.9310	0.99753	0.18524	0.000
5	Wavy rugae	Males	30	0.6000	0.96847	0.17682	0.002
		Females	30	0.4138	0.82450	0.15311	0.012
6	Circular rugae	Males	30	0.4333	0.93526	0.17075	0.017
		Females	30	0.5517	1.08845	0.20212	0.011

and fragmentary rugae. The males showed a higher percentage for straight and wavy rugae, whereas the females had a higher percentage of circular rugae pattern. When rugae patterns of both the groups were compared, the results were found to be statistically significant ($p < 0.05$) (→ **Table 3**).

Discussion

Gender determination is one of the important aspects of human identification as it helps in building the biological profile of

unidentified human remains. One of the most important methods of assessing gender is anthropometry of the face and intra-oral regions. It has been reported that no two palates are alike in their configuration and that the palatal print did not change with time or age. Despite the controversy about the stability of the characteristics of rugae and the extent of differences between ethnic groups and sex, they have been recognized in the field of forensics as a potential source of identification.

The present cross-sectional study was conducted to evaluate differences in the palatal rugae patterns and arch

lengths in male and female patients reporting to the Department of Orthodontics of Bhojia Dental College and Hospital. The study revealed that arch lengths of the males were greater than those of the females that were in concordance with the findings of Shrestha and Bhattarai,⁶ Barrett et al,⁷ Bishara et al,⁸ Huang et al,⁹ and Kallianpur et al.¹⁰ However, this was not statistically significant. The greater arch lengths in males can be attributed to the large jaw size of the males in comparison to the females.

In this study, the primary rugae were more than the secondary and fragmentary rugae. These results were in accordance with the study conducted by Ahmed and Hamid¹¹ who found out that primary rugae were more predominant followed by secondary and fragmentary.

The study also concluded that the most predominant shape of the palatal rugae seen in both the groups was curved and wavy followed by straight rugae. These results were in accordance with the studies conducted by Asdullah et al¹² and Kapali et al.¹³ It has been reported by Asdullah et al that curved rugae (32.12%) were most commonly seen followed by the wavy type (28.73%) and straight type (23.98%) in Lucknow, India. Kapali et al had found that the most common shape of rugae was wavy and curved, whereas straight and circular types were the least common in Australian Aborigines and Caucasians ethnic groups. However, few studies had contradictory results. Sumathi et al¹⁴ reported that wavy pattern was the most predominant pattern among Pondicherry population followed by straight, curved, and circular pattern. Paliwal et al¹ concluded that wavy pattern was predominantly followed by straight and curved in the Madhya Pradesh population, whereas wavy was followed by curved and straight in the Kerala population. Rugae pattern revealed statistically significant differences in males and females. These changes can be attributed to genetic or environmental variation.

The application of palatal rugae in gender determination could be attributed to low utilization cost, simplicity, and reliability. The above-mentioned interpretations are based on a very limited sample size, therefore, further work on larger samples would be a stepping stone in studying these characteristics not only between the races but also within the populations.

Conclusion

There are many studies on rugae pattern and arch length for gender determination as individual parameters, but studies combining them are scanty. This study was done to assess whether these two parameters can be used separately or in combination with each other to determine gender differentiation. It can be safely concluded that the palatal rugae pattern and maxillary arch length can be used as an additional method in differentiating gender between human population groups.

1. The arch length was found to be greater in males than females, though the result was statistically insignificant.
2. The most predominant shape of rugae was curved and wavy followed by straight rugae pattern in both males and females. Circular rugae were the least common pattern observed in both the groups.
3. Primary rugae are more predominant than secondary and fragmentary rugae.
4. Arch length and the palatal rugae pattern in conjunction can be used as a tool in gender determination.

Conflict of Interest

None declared.

References

- 1 Paliwal A, Wanjari S, Parwani R. Palatal rugoscopy: establishing identity. *J Forensic Dent Sci* 2010;2(1):27–31
- 2 Hemanth M, Vidya M, Shetty N, Karkera BV. Identification of individuals using palatal rugae: computerized method. *J Forensic Dent Sci* 2010;2(2):86–90
- 3 Saxena S, Sharma P, Gupta N. Experimental studies of forensic odontology to aid in the identification process. *J Forensic Dent Sci* 2010;2(2):69–76
- 4 Jibi PM, Gautam KK, Basappa N, Raju OS. Morphological pattern of palatal rugae in children of Davangere. *J Forensic Sci* 2011;56(5):1192–1197
- 5 Thomas CJ, Kotze TJ. The palatal ruga pattern in six southern African human populations, part I: a description of the populations and a method for its investigation. *J Dent Assoc S Afr* 1983;38(9):547–553
- 6 Shrestha RM, Bhattarai P. Dental arch length and arch symmetry analysis of Nepalese permanent dentition. *J Nepal Dent Assoc* 2009;10:110–114
- 7 Barrett MJ, Brown T, Macdonald MR. Size of dental arches in a tribe of Central Australian aborigines. *J Dent Res* 1965;44(5):912–920
- 8 Bishara SE, Treder JE, Damon P, Olsen M. Changes in the dental arches and dentition between 25 and 45 years of age. *Angle Orthod* 1996;66(6):417–422
- 9 Huang ST, Miura F, Soma K. [A dental anthropological study of Chinese in Taiwan (2). Teeth size, dental arch dimensions and forms]. *Gaoxiong Yi Xue Ke Xue Za Zhi* 1991;7(12):635–643
- 10 Kallianpur S, Desai A, Kasetty S, Sudheendra U, Joshi P. An anthropometric analysis of facial height, arch length, and palatal rugae in the Indian and Nepalese population. *J Forensic Dent Sci* 2011;3(1):33–37
- 11 Ahmed AA, Hamid A. Morphological study of palatal rugae in a Sudanese population. *Int J Dent* 2015;2015(1):650648
- 12 Asdullah M, Kandakurti S, Sachdev AS, Saxena VS, Pamula R, Gupta J. Prevalence of different palatal rugae patterns in a sample Lucknow population. *J Indian Acad Oral Med Radiol* 2014;26(4):406–409
- 13 Kapali S, Townsend G, Richards L, Parish T. Palatal rugae patterns in Australian aborigines and Caucasians. *Aust Dent J* 1997;42(2):129–133
- 14 Sumathi MK, Balaji N, Vezhavendhan N, Sathish Kumar G, Shanti V. Palatoscopy among Pondicherry population. *J Sci Dent* 2011;1(2):16–18