

ORIGINAL ARTICLE

RUGOSCOPY IN FIVE DIFFERENT ETHNIC GROUPS OF PAKISTANI POPULATION

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ABSTRACT

Background: Rugoscopy is the study of palatal rugae. Palatal rugae are irregular ridges on the mucosal membrane projections extending from incisive papilla to anterior part of palate. They are unique to an individual similar to finger prints. They support in post mortem identification. The aim of this study was to find out predominant rugae patterns and their variations amongst five different linguistic populations of Pakistan.

Method: A Cross sectional comparative study was conducted at different campuses of Out Patient Departments of Ziauddin Hospital and Al-Zohra Welfare Association, Karachi from July 2016 to January 2017. The study population of 456 subjects included five Pakistani races namely Balochi, Punjabi, Pushto, Sindhi and Urdu speaking with age groups between 15 to 55 years. The shapes of rugae were evaluated on dental casts using the Kapali et al's classification. Chi square test was used for association of qualitative variables. A p-value of ≤ 0.05 was considered significant.

Results: There was a significant difference in rugae pattern amongst five ethnicities of Pakistan ($p= 0.010$). The most prevalent rugae shape among Punjabi and Pushto was wavy followed by straight and curved patterns. Among Sindhi and Urdu speaking the most common pattern was wavy followed by curved and straight rugae pattern. Balochi speaking presented with curved, wavy and divergent patterns. The least common among all the races was circular rugae pattern.

Conclusion: This study indicates an association between rugae pattern and ethnic groups. This can be used as an additional tool in forensic identification.

KEYWORDS: Rugoscopy, Ethnicity, Forensic identification.

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INTRODUCTION

Palatoscopy/ rugoscopy is the study of palatal rugae.¹ Rugoscopy was proposed by Allen in 1889 as a method of forensic identification.² The hard palate is a vaulted structure whereas the soft palate is the movable posterior third of the palate.³ Palatal rugae/ plicae palatinae transversae are irregular mucosal projections present at the anterior one third of the hard palate, in the mid-sagittal plane arise from the incisive papilla.⁴⁻⁸ The palatal rugae are surrounded by cheeks, lips, tongue, buccal pad of fats, teeth and bone. These keep them protected from trauma and high temperature.^{7,8} Palatal rugae

are unique to an individual similar to finger prints.^{9,10} Rugae are protected after postmortem insults and are useful for odontometric analysis in medicolegal and forensic identification. They are well preserved even after third degree burns and severe trauma because palatal rugae contain ground substance (mainly Glycosaminoglycan) which is hydrophilic in nature, causing tissue to swell up contributing to maintenance of its shape. Fibroblasts and collagen fibers beneath the thickened epithelium contribute to its stability.^{5,8} Literature review reveals that rugae pattern are unique to ethnic groups and can be successfully used as a medium for racial and gender identification.⁶⁻¹³

Various methods are reported in literature for forensic identification, like visual identification finger printing, DNA testing and rugoscopy. However, visual identification and finger printing are limited by postmortem changes pertaining to high temperature, time and humidity.^{11,12} DNA profiling is accurate, but is expensive and time consuming for use in large population. Rugoscopy is a simple, non invasive and low cost technique which can be used as a supplemental tool for population identification. Thus the objective of this study was to evaluate predominant rugae patterns and their variations amongst five different linguistic populations of Pakistan. Unfortunately there is no data available in our country. Therefore the present study is designed to validate the finding in our local population.

METHODS

A cross sectional comparative study was conducted at different campuses of Out Patient Departments of Ziauddin Hospital and Al-Zohra Welfare Association, Karachi from July 2016 to January 2017. Data were collected using convenience sampling technique. The inclusion criteria for sample selection was subjects belonging to five Pakistani races namely Balochi, Punjabi, Pushto, Sindhi and Urdu speaking with age groups between 15 to 55 years with complete dentition and good oral hygiene. Subjects with a prior history of orthodontic or prosthodontic treatment, history of any severe palatal trauma and congenital syndromes affecting the palate-like cleft palate or any surgical procedures performed on the hard palate were excluded from

our study. WHO sample size estimation calculator was used for evaluating pattern of palatal rugae in a sample of Pakistani population $n = \frac{p q z^2}{d^2}$

A sample size of 456 gave the power of > 80%. Ethical clearance was approved from the university research council for conducting the study. After getting the informed consent form signed, impression of the subject was taken using impression material (alginate) in a perforated tray. After disinfecting the impression, high strength plaster was poured in the impression to obtain the cast (working model). A number was assigned after trimming the cast. The palatal rugae were delineated using 0.5 mm HB pencil under adequate light. Shapes of rugae on palate were recorded according to the classification given by Kapali et al.¹ who described the following rugae patterns (**Figure 1 and 2**).

- A. Straight (run directly from their origin to termination)
- B. Curved (crescent shaped and curved gently)
- C. Wavy (slight curve at the origin and termination of the rugae)
- D. Circular (rugae forming a ring)
- E. Unification (rugae with two arms) may be diverging or converging. It is further classified into two categories
 - Diverging: when two arms of rugae begin from the same origin and bifurcate transversely.
 - Converging: when two arms of rugae arise from different origin and converge transversely.

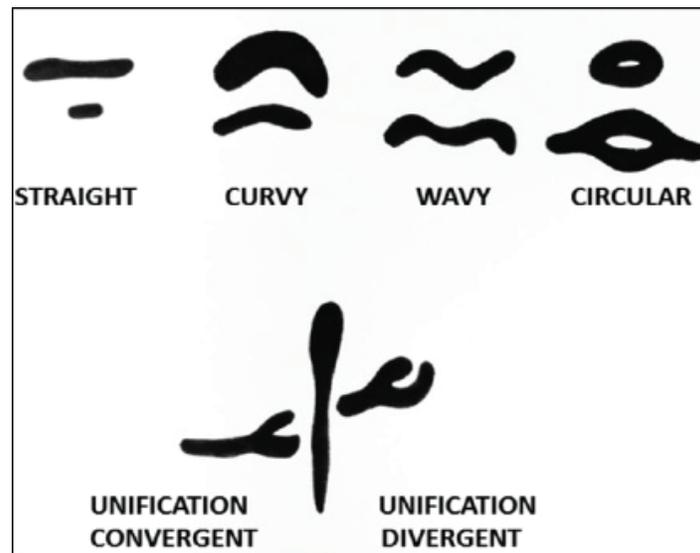
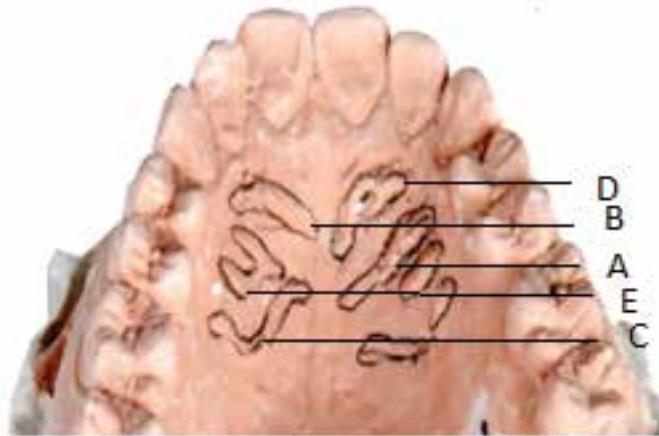


Figure 1: Diagrammatic representation of different types of rugae pattern. Adapted from J Forensic Sci by Santos, C. et al., (2)



A =Straight rugae
B = Curved rugae
C =Wavy rugae
D =Circular rugae
E = Unification rugae

Figure 2: Different types of rugae pattern delineated on maxillary cast.
 Adapted from J Forensic Sci by Santos, C. et al., (2)

The recorded data was compiled, recorded in a spreadsheet computer (Microsoft Excel 2007) then was exported to the data editor of SPSS version 20.0. Chi square test was used for association of qualitative variables. A p-value of < 0.05 was considered significant.

RESULTS

Out of 456 participants who underwent this study 21.5% were Punjabi speaking, 21.1% were Sindhi speaking, 20.8% were Pushto speaking, 19.7% were Urdu speaking and 16.2% were Balochi speaking as depicted in Table 1.

Table 1: Distribution of ethnicities among study population

Ethnic Groups	N(%)
Punjabi	98 (21.5)
Sindhi	96 (21.1)
Pushto	95 (20.8)
Urdu	90 (19.7)
Balochi	74 (16.2)

N= 456

Table 2: Comparison of Rugae Pattern amongst Five Ethnic Groups of Pakistan

Rugae Pattern	Punjabi speaking N (%)	Sindhi speaking N (%)	Pushto speaking N (%)	Urdu speaking N (%)	Balochi speaking N (%)	p-value
Curved	20(20.4)	27(28.1)	11(11.6)	25(27.8)	25(33.8)	0.010*
Wavy	39(39.8)	28(29.2)	51(53.7)	36(40)	21(28.4)	
Straight	22(22.4)	19(19.8)	17(17.9)	18(20)	10(13.5)	
Circular	02 (2)	02 (2.1)	05 (5.3)	01 (1.1)	00	
Divergent	07 (7.1)	11 (11.5)	6 (6.3)	06 (6.7)	12 (16.2)	
Convergent	08(8.2)	09(9.4)	05(5.3)	04(4.4)	06(8.1)	

* Level of significance < 0.05

The most prevalent rugae shape among Punjabi and Pushto speaking population was found to be wavy followed by straight and curved rugae patterns. However, in Punjabi speaking individuals it was followed by convergent, divergent and circular rugae whereas in Pushto speaking individuals it was followed by divergent and equal number of convergent and circular rugae. Sindhi and Urdu speaking groups presented with similar rugae pattern that is, the most prevalent was found to be wavy followed by curved, straight, divergent, convergent and circular rugae. Whereas, the most prevalent rugae pattern in Balochi population was curved followed by wavy, divergent, straight, convergent and circular rugae. The least common rugae shape among all the races was found to be circular. There was a significant difference in rugae pattern amongst five ethnicities (p -value = 0.010) as shown in **Table 2**.

DISCUSSION

Forensic dentistry plays an important role in modern day investigation for post mortem identification.^{14-16,25} The oral cavity has features that help in personal identification. Palatal rugae pattern are unique in their morphology.^{17-19,26,27} Several studies have reported racial differences in palatal rugae pattern which may help to identify the population especially in disaster victims.^{28,29,30} Pakistan, because of its geographical location and sharing borders with various countries has great influx of immigrants and multiple ethnic groups are found in Pakistan. So instead of broad grouping of population different small, well defined clusters of population are more meaningful in creating a forensic database in Pakistan. Therefore, this study was designed to find predominant rugae patterns and their variations amongst five well defined geographically divergent races of Pakistani population.

In the present study the most prevalent rugae pattern among Punjabi and Pushto speaking populations was wavy followed by curved and straight types. However, in our study, the fourth prevalent rugae shape in Pushto speaking was divergent followed by equal number of convergent and circular rugae. Whereas, Punjabi speaking the fourth prevalent rugae shape was convergent followed by divergent and circular type. So it is the fourth prevalent rugae where we can differentiate between Pushto and Punjabi speaking population. These results were not comparable to the study by Suhartono et al,²² in Indonesian population where straight and curved types dominated.

Balochi speaking differed from other four Pakistani races by having highest frequency of curved rugae pattern followed by wavy pattern. In contrast the study done by Sharma et al in Indian population

of Meerut,¹⁹ reported the predominance of wavy followed by curved and straight rugae patterns. Population differences of rugae patterns have been reported by several comparative studies.¹⁶⁻²² This raises the question about the role of genetic and environmental effects on racial differences.

In our study identical rugae pattern was observed in Sindhi and Urdu speaking populations. We could not find any study showing similar rugae pattern among two populations. This may be due to dietary or environmental factors. As Urdu speaking have migrated from India and are settled in the province of Sindh, this could be the reason that these two linguistic populations show similarity in their rugae pattern. The results of this study are comparable with study conducted by Byatnal et al¹¹ in different populations of India. They reported similarity among rugae patterns of two Indian ethnic groups. The results of this study are contradictory with the result obtained by Shanmugan et al,⁵ in North and South Indian population where different rugae pattern were found among two populations.

The least common pattern was circular among all Pakistani races. African and European population groups revealed greater number of unification and circular type which is in contrast to our study results.⁶ This is comparable to the results of study conducted in India by Selvamani et al,²⁰ who also found circular being the least prevalent pattern among all races. The role of genetics and environmental factors and their effect on rugae pattern needs further related studies on our local population.

CONCLUSION

We conclude that out of five Pakistani ethnicities rugae pattern of Balochi speaking is completely different from other races. Urdu and Sindhi speaking cannot be differentiated on the basis of rugae pattern. Punjabi and Pushto speaking also cannot be differentiated on the basis of first three rugae pattern. It is the fourth prevalent rugae which differentiate between Pushto and Punjabi speaking. A limitation of our study was a smaller sample size due to unavailability of participants. Therefore, this analysis is considered as preliminary. Nevertheless it is believed that the rugae shape have great utility in population differentiation and should be examined in detail in larger sample to further validate the study.

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