Original Article

A Demographic Study of Palatal Rugae Patterns among North and North East Indian Populations

Annu Saini, Achint Garg

From the Department of Oral
Medicine and Radiology,
ITS Dental College, Hospital
and Research Centre, Noida,
Uttar Pradesh, India

ABSTRACT

Introduction: Palatal rugae are the ridges on the anterior part of the palatal mucosa, present on each side of the median palatal raphe and behind the incisive papilla also. Various studies on different populations reported the unique ruga patterns within each population, which have a significant role in personal identification.

Aim: The aim of the present study is to determine the different patterns and number of rugae in north Indian and North-East Indian populations.

Material and Method: The sample size of the study includes 120 students aged 18–24 years and was divided into two groups comprising sixty north Indian and sixty North-East Indian students, respectively, based on population, with equal gender (thirty males and thirty females in each group) distribution. The variation in rugae pattern was analyzed according to Thomas and Kotze classification.

Results: The results of the present study show that there was a significant difference present in the number of rugae in north and North-East Indian populations, with $P = >0.05$. The predominant shape observed was sinusoidal which was significantly higher in North-East Indian population comparative to North Indian population.

Conclusion: It may be concluded that the ruga pattern may be an additional method of differentiation between the north Indian and North-East Indian populations. A larger multi-ethnic study could be undertaken to validate this claim among various cross ethnic groups.

KEY WORDS: *Demographic study, forensic odontology, North-Indian population, palatoscopy*

INTRODUCTION

"*Physical* evidence cannot be intimidated. It does not forget. It sits there and waits to be detected, preserved, evaluated, and explained"

– Herbert Leon MacDonnell.

The professional responsibility of a dental surgeon to humankind is considered to serve in examination, investigation, diagnosis, and treatment of oral and orofacial lesions of local origin, and oral manifestations of systemic diseases, but the knowledge and information about the oral cavity and the associated structures enable him/her to serve in legal matters as well.

Forensic odontology is a specialty in dentistry which occupies a primary niche within the total spectrum of methods applied to medicolegal identification. Forensic odontology can be defined as a branch of dentistry which deals with the appropriate handling and examination of dental evidence and with the proper evaluation and presentation of dental findings in the interest of justice.[1,2]

Among the various methods such as fingerprints, bite marks, and DNA fingerprinting to verify the presence or absence of a person at the scene of crime, palatal ruga has its own place and importance in the process.

The study of the ruga pattern is known as palatal rugoscopy. Palatal rugae were first described in 1732 by Winslow.[3] Kuppler, 1897, was the first person to study the palatal rugae.[4] The term rugoscopy (palatoscopy) was coined by Trobo Hermosa in 1932.[4] Palatal rugae, also known as rugae palatinae or plicae palatinae transversae, refer to a series of transverse ridges on the anterior part of the palatal mucosa on each side of the median palatal raphe and behind the incisive papillae.[5] Like finger prints and DNA, the palatal rugae also do not change throughout the life of a person.[6] They are resistant to any kind of trauma and temperature variation because of their location in the oral cavity, which is protected by lips, cheeks, tongue, and teeth from external forces.[7] When identification of the deceased gets difficult or fails due to adverse situations, the palatal rugae can be considered as an alternate source for identification.[8]

Address for correspondence:
Dr. Annu Saini, E-mail: annusaini555@gmail.com

Access this article online

Quick Response Code:

Website: www.ijofo.org

DOI: 10.4103/ijfo.ijfo_27_18

Gandikota C *et al.* indicated that the palatal rugae appear toward the 3rd month of intrauterine life, from the covering connective tissue in the palatine process of maxillary bone, and its development and growth is mutually controlled by epithelial–mesenchymal interactions, where specific extracellular matrix molecules are spatiotemporally expressed during development.[9] According to Carrea, ruga pattern is formed by the 12th–14th week of prenatal life, At birth, the palatine rugae are well formed, and the pattern of orientation typical for the person is present and it remains stable throughout the person's life.[9] The first rugae is distinguished in the human embryos of 32 mm crown-rump length, next to the incisive papilla.[9,10]

The pattern of palatine rugae is unique and distinctive for each individual and is reasonably stable during the person's growth. Once formed, it only changes in its length, due to normal growth, staying in the same position throughout the life of a person.[11] Moreover, palatal rugae could resist decomposition for up to 7 days after death.[12-14]

The present study is an attempt to investigate the different pattern and number of rugae and to determine gender difference in North Indian and North-East Indian population.

MATERIALS AND METHODS

The present study was conducted at the department of oral medicine and radiology. The study population consisted of 120 students aged between 18 and 24 years (sixty students from North India and sixty from North-East India), with equal sex distribution (thirty males and thirty females in each group) [Table 1 and Figure 1]. Individuals without braces, fixed partial dentures, and removable partial dentures were included in the study. Individuals with congenital and inflammatory abnormalities of palate, partial or complete denture wearers, individuals undergoing orthodontic treatment, and those with any palatal erosions/lesions were excluded from the study. Sterile perforated dentulous maxillary stock trays of suitable dimension were selected to record the maxillary impressions of the individuals using irreversible hydrocolloid material. The final impression was washed under running tap water and was poured with Type III gypsum product. The cast obtained was highlighted by using 0.5-mm graphite pencil and analyzed by following the classification of Thomas and Kotze.[3,15-17]

RESULTS

A total of 120 maxillary dental casts obtained from sixty North Indian students and sixty North-East Indian students were examined for the palatal ruga patterns by applying the classification proposed by Thomas and Kotze.[15]
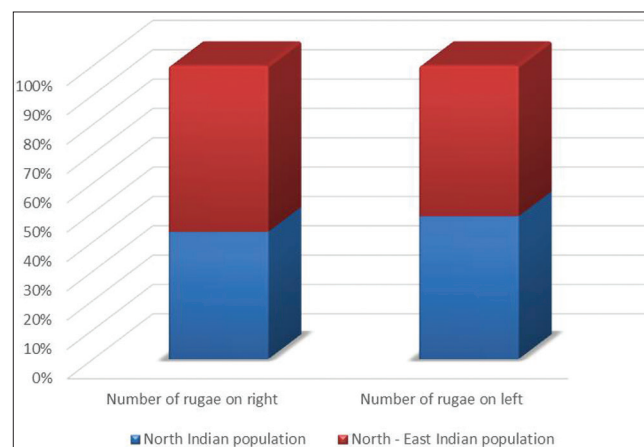
TOTAL NUMBER OF RUGAE

There was a significant difference present between the number of rugae present on the right side with $P = >0.05$.
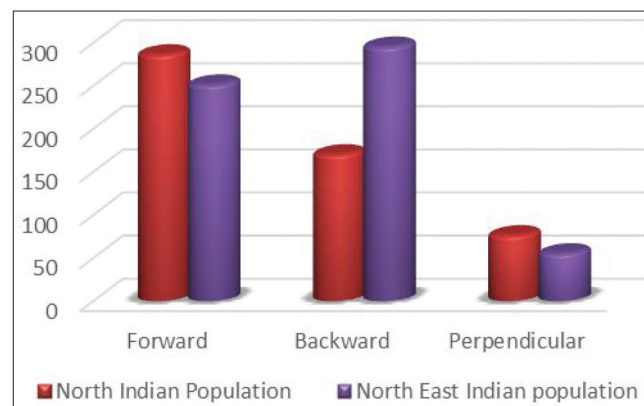
The number of rugae present on the right side is higher in North-East Indian population than in North Indian population [Graph 1].

Graph 1: Number of palatal rugae on the right and left sides in North Indian and North-East Indian populations

Graph 2: Direction of palatal rugae in North Indian and North-East Indian populations
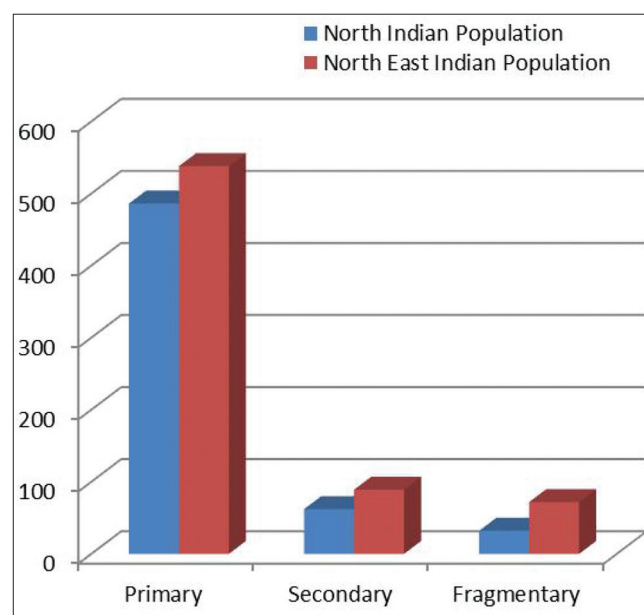
Graph 3: Type of palatal rugae in North Indian and North-East Indian populations

Table 1: Showing Male Female distribution in the study		
Gender	North Indian population	North-East Indian population
Male	30	30
Female	30	30

DIRECTION OF RUGAE

The number of backward rugae was more in North-East Indian population comparative to North Indian population, with $P = >0.05$ [Table 2 and Graph 2].

There was no statistically significant difference present between the two populations regarding the type of ruga pattern [Table 3 and Graph 3].

PREDOMINANT RUGAE SHAPE

Out of six shapes of rugae, the sinusoidal-shaped rugae were comparatively higher in North Indian population than in North-East Indian population [Table 4].

SEX DETERMINATION

On comparing males and females of North Indian population, the significant difference observed was in the shape of rugae. The point-shaped rugae were more common in males of North Indian population comparative to the females of the same population. The primary rugae were significantly high in males of North-East Indian population than females of the same population, and the number of converging-type rugae was also significantly high in males than females of the North-East Indian population [Graph 4].

DISCUSSION

Forensic identification of human as alive or dead includes determination of various parameters such as age, sex, race, or geographical area. Palatal rugoscopy is one such tool employed successfully in identifying an individual based on the rugae pattern analysis as it is proven to be unique in shape, length, width, prominence, number, and orientation among individuals. Variation also exists in the right and left sides of the same person, i.e., no bilateral symmetry exists in the rugae pattern. Therefore, rugae patterns can be used in individual identification by comparing the postmortem ruga
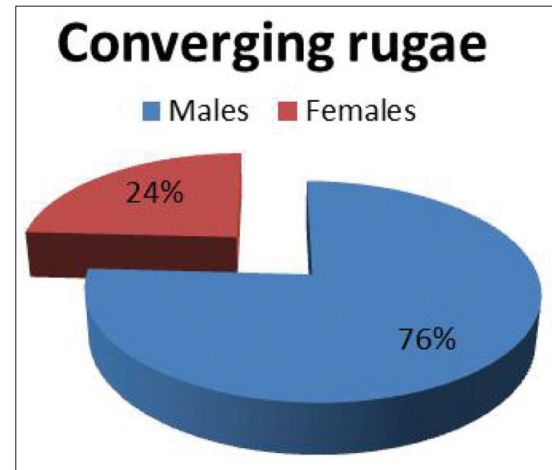
Graph 4: Unification of palatal rugae in males and females

Pair	Number of palatal rugae	Paired differences					t	df	Significant (two-tailed)
		Mean	SD	SEM	95% CI of the difference				
					Lower	Upper			
Pair 1	Number of rugae on right	−1.48333	2.62641	0.33907	−2.16181	−0.80486	−4.375	59	0.000
Pair 2	Number of rugae on left	−.28333	2.70650	0.34941	−0.98250	0.41583	−0.811	59	0.421

Table 2: Descriptive statistics of number of palatal rugae

SD: Standard deviation, SEM: Standard error of mean, CI: Confidence interval

Pair	Type of palatal rugae	Paired differences					t	df	Significant (two tailed)
		Mean	SD	SEM	95% CI of the difference				
					Lower	Upper			
Pair 1	Primary rugae	0.58333	3.61396	0.46656	−0.35025	1.51692	1.250	59	0.216
Pair 2	Secondary rugae	−2.08333	3.24320	0.41870	−2.92114	−1.24553	−4.976	59	0.000
Pair 3	Fragmentary rugae	0.35000	1.87603	0.24219	−0.13463	0.83463	1.445	59	0.154

Table 3: Descriptive statistics of the type of palatal rugae

SD: Standard deviation, SEM: Standard error of mean, CI: Confidence interval

Pair	Shape of palatal rugae	Paired differences					t	df	Significant (two-tailed)
		Mean	SD	SEM	95% CI of the difference				
					Lower	Upper			
Pair 1	Point	−0.18333	1.46706	0.18940	−0.56231	0.19565	−0.968	59	0.337
Pair 2	Line	−.41667	1.94232	0.25075	−0.91842	0.08509	−1.662	59	0.102
Pair 3	Curved	0.28333	2.39414	0.30908	−0.33514	0.90181	0.917	59	0.363
Pair 4	Angular	−0.20000	0.73184	0.09448	−0.38905	−0.01095	−2.117	59	0.039
Pair 5	Circular	0.03333	0.68807	0.08883	−0.14442	0.21108	0.375	59	0.709
Pair 6	Sinusoidal	4.00000	2.60378	0.33615	3.32737	4.67263	11.900	59	0.000

Table 4: Descriptive statistics of shapes of palatal rugae

SD: Standard deviation, SEM: Standard error of mean, CI: Confidence interval

Figure 1: Graph showing male:female ratio

details with the antemortem records.[3] In the present study, the ruga pattern was classified based on its length, shape, direction, and unification. The statistical analysis was done by applying paired t-test.
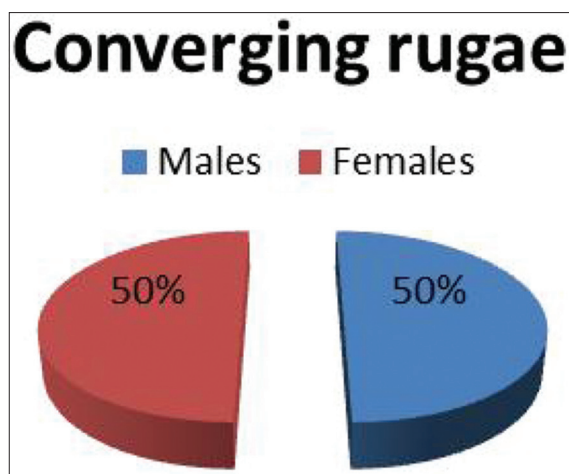
The results of the present study show that the number of rugae present on the right side was more in North-East Indian population than in North Indian population. The number of backward-type rugae was less in North Indian population comparative to North Indian population. Out of the six shapes of rugae, the sinusoidal type of rugae was comparatively higher in number in North Indian population than in North-East Indian population. There was no significant difference present on comparing the ruga pattern in females of both the population. The number of rugae on the right side was more in males of North-East Indian population. The number of primary rugae was less in North Indian population. On comparing males and females of North Indian population, the point-shaped rugae were more common in males of North Indian population comparative to the females of the same population. The primary rugae were significantly high in males of North-East Indian population than females of the same population. The number of converging type of rugae was also significantly high in males than females of the North-East Indian population. Although palatal rugae are a unique identity, the difference observed in the studied population could be due to the difference in the geographical and climatic conditions and lifestyle of the two populations.

In a previous study by Abeer M on Egyptian and Saudi children, a significant difference was observed in the shape of palatal rugae between the two populations.[18] In another study done by Kapali *et al*. on Australian Aborigines and Caucasians, the results of the study showed significant difference in the ruga pattern of the two populations (straight forms were more common in Caucasians, whereas wavy forms were more common in Aborigines).[15]

In a similar study conducted by Surekha *et al*. on Manipuri and Kerala populations, Manipuri population showed predominantly curved shape than the Kerala population and was statistically significant.[19]

According to a study conducted by Sharma, mild reduction of space among the rugae or even shortening or elongation depending on the extent of the intervention performed. There was no remarkable damage in any such case. However, it should be highlighted that the palatal rugae may be changed by different factors, such as wearing complete dentures, procedures that may cause trauma, cleft palate, fibrous tissue, and calluses; however, these factors do not impair identification.[20] In another study by Damstra *et al*., the authors reported vertical changes of the medial ruga points in patients who had undergone rapid maxillary expansion.[21]

Hence, palatal ruga pattern is unique to each individual and can be used as an adjunct in forensic odontology for identification of individuals.

CONCLUSION

The use of palatal rugae in personal identification is of paramount importance in judicial procedures and legal settings. Its internal position, antemortem resistance, uniqueness, and regional variation provide a potentially reliable source of identification to the researchers. The use of palatoscopy for personal identification may narrow the field for identification process and give better results in conjugation with other methods of personal identification such as fingerprints and cheiloscopy. A larger multi-ethnic study with larger sample size and wide age range should be carried out to substantiate the findings of the present study. As palatal ruga fulfill all the five elementary technical requirements of an identification process (unicity, individuality or variability, immutability, perennity persistence, practicability, and possibility of classification), it warrants legal acceptance as an adjunctive identification method in the court of law.

CONFLICTS OF INTEREST

There are no conflicts of interest.

REFERENCES

1. Saxena S. Rugoscopy – An emerging aid for personal identification – A review. Indian J Dent Sci 2013;5:150-3.
2. Saraf A, Bedia S, Indurkar A, Degwekar S, Bhowate R. Rugae patterns as an adjunct to sex differentiation in forensic identification. J Forensic Odontostomatol 2011;29:14-9.
3. Krishanappa S. Palatal rugae. Palatal rugoscopy: Implementation in forensic odontology – A review. J Adv Med Dent Sci 2013;1:53-9.
4. Rajguru JP, Nagaveni SS. Study of palatal rugae pattern (rugoscopy) in Chennai population. Indian J Forensic Odontol 2012;5:93-6.
5. Babu GS, Bharath TS, Kumar NG. Characteristics of palatal rugae patterns in west Godavari population of India. J Clin Diagn Res 2013;7:2356-9.
6. Shetty M, Premalatha K. Study of palatal rugae pattern among the student population in Mangalore. J Indian Acad Forensic Med 2011;33:112-5.
7. Shukla D, Chowdhry A, Bablani D, Jain P, Thapar R. Establishing the reliability of palatal rugae pattern in individual

identification (following orthodontic treatment). J Forensic Odontostomatol 2011;29:20-9.

8. Madhankumar S, Natarajan S. Palatal rugae pattern for gender identification among selected student population in Chennai, India. J Sci Res Rep 2013;2:491-6.

9. Gandikota C, Venkata YP, Challa P, Juvvadi SR, Mathur A. Comparative study of palatal rugae pattern in class II div 1 and class I individuals. J Pharm Bioallied Sci 2012;4:S358-63.

10. Venegas VH, Valenzuela JS. Palatal rugae: Systematic analysis of its shape and dimensions for use in human identification. Int J Morphol 2009;27:819-25.

11. Shetty M. Study of palatal rugae pattern among the student population in Mangalore. J Indian Acad Forensic Med 2011;33:112-5.

12. Chopra A, Rao NC, Gupta N. Palatal rugae and arch length: A tool in gender determination. Univers Res J Dent 2013;3:54-9.

13. Caldas IM, Magalhães T, Afonso A. Establishing identity using cheiloscopy and palatoscopy. Forensic Sci Int 2007;165:1-9.

14. Shetty D, Juneja A, Jain A, Khanna KS, Pruthi N, Gupta A, *et al.* Assessment of palatal rugae pattern and their reproducibility for application in forensic analysis. J Forensic Dent Sci 2013;5:106-9.

15. Kapali S, Townsend G, Richards L, Parish T. Palatal rugae patterns in Australian aborigines and Caucasians. Aust Dent J 1997;42:129-33.

16. Kamala R. Palatal rugae pattern as an aid for personal identification: A forensic study. JIAOMR 2011;23:173-8.

17. Rajan VP, John JB, Stalin A, Priya G, Abuthagir AK. Morphology of palatal rugae patterns among 5-15 years old children. J Pharm Bioallied Sci 2013;5:S43-7.

18. Abeer M, Salwa M. Comparative study of palatal rugae shape in two samples of Egyptian and Saudi children. Pediatr Dent J 2011;21:123-8.

19. Surekha R, Anila K, Reddy VS, Hunasgi S, Ravikumar S, Ramesh N, *et al.* Assessment of palatal rugae patterns in Manipuri and Kerala population. J Forensic Dent Sci 2012;4:93-6.

20. Sharma G. Lip prints & palatal rugae-markers of individuality in forensics. J Indo Pac Acad Forensic Odontol 2011;2:27-32.

21. Damstra J, Mistry D, Cruz C, Ren Y. Antero-posterior and transverse changes in the positions of palatal rugae after rapid maxillary expansion. Eur J Orthod 2009;31:327-32.