Analysis of Rugae Pattern in Ranchi and Patna Population

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How to cite the article:
Chandra S, Pandey V, Wasti A, Mangat SS, Bhagat JK, Singh R. Analysis of rugae pattern in Ranchi and Patna population. J Int Oral Health 2016;8(3):362-366.

Abstract:
Background: Pattern of palatal rugae is extremely unique to humans as are fingerprints. As genetics play a role in the determination of palatal rugae, hence these can be used in gender determination as well as population differentiation. The present study was undertaken to analyze the different rugae patterns in Ranchi and Patna population and to find whether palatoscopy is a valuable tool in person identification and gender determination.
Materials and Methods: A total of 200 maxillary study models (100 males and 100 females) which consist of 100 casts from residents of Patna and 100 casts from residents of Ranchi within 15-30 years age group were analyzed. Rugae pattern were examined for the analysis of the quantitative and qualitative characteristics of rugae. Statistical analysis was carried out using Chi-square test and unpaired *t*-test.
Result: Quantitatively, rugae were significantly ($P < 0.05$) more in females than males. No significant difference was established in rugae pattern between the two populations. In reference to shape, wavy pattern preponderated in females and curved pattern in males, followed by a straight, divergent, convergent, and circular pattern. Circular pattern was more in males than females.
Conclusion: The present study concluded that rugae patterns are extremely unique and hence can be used as a supplementary method for human identification and gender determination.

Key Words: Forensic dentistry, Jharkhand, palatal rugae, Patna, person identification

Introduction

Forensic science plays an utmost important role in the human identification, which is one of the most challenging matter that man has confronted. Ascertaining a person's identity is a tough task in case of accidents, acts of terrorism or in mass disaster situations. Fingerprints, DNA comparisons, and dental records are the most frequently used techniques for forensic identification. Although DNA profiling is accurate, it is expensive and time-consuming. Palatal rugoscopy which consists of examining palatal rugae can be utilized in person identification if antemortem dental records exist.[1,2] Studies have suggested palatal rugae as equivalent to fingerprints and are unique to an individual.[3-6]

Palatal rugae are the ridges that occur on the anterior area of the palatal mucosa on both sides of the median palatal raphae and posterior to the incisive papilla.[7,8] After completion of growth of the person, rugae pattern are regarded as constant and consistent in shape throughout the life of the individual. Rugae are well-guarded by other oral structures, i.e. by the teeth, lip, cheek, tongue, bone, and buccal pad of fat from extreme temperature and trauma. Thus, it can withstand any insult from fire, high-impact trauma as well as do not decompose after death up to 7 days.[9-11]

Besides this, rugae may also be particular to racial groups and gender, allowing population identification which is required after a disaster.[12] Kapali *et al.*[4] studied rugae pattern in different ethnic groups of Australian Caucasians and Aborigines and revealed a statistically significant association between rugae shapes and ethnicity, the straight pattern being more frequent in Caucasians while wavy pattern were more frequent in Aborigines. Ibeachu *et al.*[12] carried out a comparative analysis of palatal rugae characteristics among Igbo and Ikwerre ethnic groups of Nigeria and revealed a difference in forms of rugae with varying degrees of preponderance between the two tribes. Thus, the result obtained from this study was apparent evidence of ethnic differences; hence, the occurrence of predominance pattern is population dependent. In view of foregoing studies, the present study aims to determine the quantitative and qualitative pattern of palatal rugae in Patna (Bihar) and Ranchi (Jharkhand) population in India and also to find the predominant pattern if any in the selected groups. These groups were selected for the study as due to cultural differences as well as due to the difference in living style, interest, and demands of indigenous tribal groups which were very different from other people of north Bihar, Jharkhand was separated from Bihar.

Materials and Methods

A cross-sectional study comprised of 200 patients belonging to an age period of 15-30 years, randomly selected, visiting

for dental treatment between July and August 2015. The sample size was equally divided among both the sexes. Prior to commencement of the study informed consent was obtained, and the study protocol was reviewed and approved by Ethical Committee of the Institute. The inclusion criteria applied included healthy individuals free of any congenital aberration, trauma, any inflammation or orthodontic treatment. The exclusion criteria were subjects allergic to impression material, any palatal abnormalities such as cleft palate, subjects wearing partial dentures and individuals subjected to any surgery involving palate.

An alginate impression of the maxillary arch of enrolled subjects was obtained, and the cast was prepared using Type II dental stone. The rugae were marked out on the cast with graphite pencil and were categorized according to Thomas and Kotze classification (Figure 1).[13] The rugae were measured with the help of digital Vernier caliper (0.01 calibration) and according to length were classified into 3 categories: Rugae with more than 5 mm length were considered as primary rugae, with 3-5 mm length as secondary, and with 2-3 mm length as fragmentary rugae. In this study, fragmentary types of rugae were not considered for any of the categorizations. According to form, rugae were classified into four major types: Curved, straight, wavy, and circular (Figure 2). Rugae with simple crescent shape along with a gentle curve were classified as curved type. Rugae extending directly from the area of origin to insertion were considered as straight types. Wavy rugae were serpentine in shape and rugae that demonstrated a definite continuous ring arrangement were categorized as circular. On the basis of unification, rugae can be categorized as converging and diverging (Figure 2). Unification occurs when 2 rugae are attached at their place of origin or termination. Rugae were regarded diverging if 2 rugae had the same origin but immediately branched, whereas rugae with origin at different points but joined at their lateral portions were regarded as converging.[4,14] All the identification and measurements were carried out by a single examiner and measurements were repeated 3 times for each cast and then average measurement was considered as final value.

The data so obtained were analyzed using Statistical Package for Social Sciences version 19.0, and Chi-square test was applied for analysis and association of qualitative characteristics in males and females while unpaired t-test was employed to compare the rugae quantitatively.

Results

The quantitative analysis revealed that rugae were found to be more in number in females as compared to males, which was statistically significant (Table 1). The largest number of rugae was 15, and the least was 7. The qualitative analysis revealed that on the basis of the length of rugae, primary rugae were more prevalent as compared to secondary in both sexes and thus no significant gender differentiation was found ($P = 0.62$).
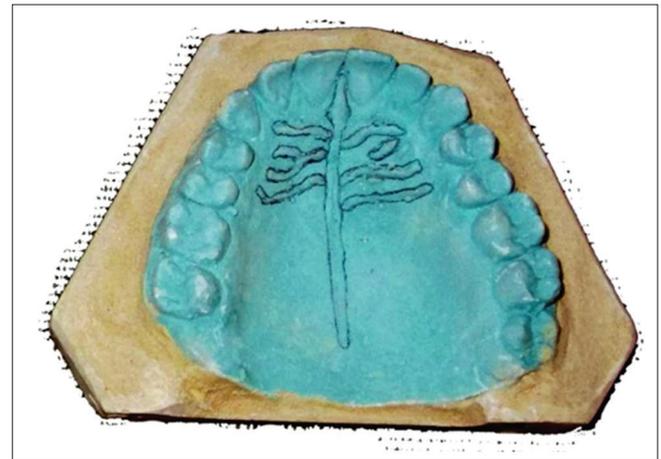

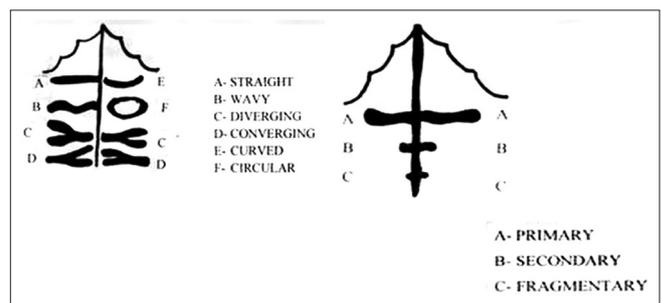**Figure 1:** Palatal rugae pattern analysis using dental casts of subjects.

Figure 2: Pictorial representation of the various shapes and sizes of palatal rugae.

Parameters	n (%)		Chi-square value	P value
	Patna	**Ranchi**		
	995	**999**		
Gender				
Male	480	473		
Female	515	526		
Unpaired *t*-test	<0.001	<0.001		
Length				
Primary	861	859	0.5	0.62 NS
Secondary	134	140		
Shape				
Curved	382 (38)	299 (30)	11.2	0.05
Wavy	346 (35)	397 (40)		
Straight	174 (17)	218 (22)		
Circular	8 (0.8)	12 (1.2)		
Converging	24 (2.4)	21 (2.1)		
Diverging	61 (6.1)	52 (5.2)		

Table 1: Analysis of rugae gender number and length of palatal rugae.

NS: Non-significant

The more common forms were curved (38%) and wavy (35%), followed by straight (17.5%), diverging (6.1%), converging (2.4%), and circular (0.8%) in the Patna population, whereas in the Ranchi population, wavy (40%) pattern was more common followed by curved (30%), straight (22%), diverging (5.2%), converging (2.1%), and circular (1.2%). The curved pattern (41%) was more prevalent in males, whereas wavy rugae pattern (38.4%) was more in

females. The particulars of the gender wise distribution of the rugae pattern are provided in Table 2. There was no significant difference found between gender regarding unification for palatal rugae and diverging pattern comprised more percentage than the converging pattern.

Discussion

Palatoscopy or palatal rugoscopy is the term assigned to the study concerning characteristics of palatal rugae to assist in ascertaining a person's identity.[2] Palatal rugae due to their special features have been widely used in population identification. There are several methods to evaluate palatal rugae and among them, intraoral assessment is probably the most frequently used method as it is the easiest as well as cheapest method. However, it can create difficulties if a future comparative analysis is required. The other detailed and complex techniques include oral photography, calcorrugoscopy, stereoscopy, and stereophotogrammetry. However, because of its simplicity, cost-effectiveness, and reliability, the study of the maxillary cast is the most widely used technique.

With a probable exception of a small number of cases where a denture engraved with individual's name is found, it is very improbable that an unknown body would be recognized by utilizing dental method merely from an examination of the cadaver. In every case, the data revealed by postmortem examination is needed to be compared with some pre-existing records of the individual, so that identification could be established. Antemortem dental records in various forms such as old maxillary dentures, dental casts, and intraoral photographs can be used to compare the pattern palatal rugae.

The potential employ of palatoscopy in forensic identification has advantages because of their simplicity, low utilization cost, and reliability.[15-17] Palatal rugae patterns can be adequately characterized to discriminate between individuals as they remain unaltered by chemicals such as ethanol, nicotine, acetylsalicylate; physical irritants and also stable under severe burn cases.[18,19] They are pertinent to edentulous patients, are proved to be the remain similar before and after orthodontic treatment,[5] and remain constant throughout life after completion of growth thus emerging as a reliable aid in forensic science.[19] Some researchers have also determined its viability utilizing computer and a software program.[11] It can be used as

a necro-identification technique. Furthermore, the Ministry of Brazilian Aeronautic keeps record of palatal rugae of all its pilots to aid in their identification in case of accidents.[20]

In the present study, the rugae patterns were analyzed using classification criteria by Thomas and Kotz.[13] This method was found to be realistic, simple to perform as well as less time consuming. The palatal rugae patterns of all 200 individuals were found to be different from one another. Thus, the present study concludes that rugae patterns are extremely individualistic. These findings were inconsistent with the results attained by Hermosilla *et al.*[21] and various other authors[14,18,22] in the similar studies conducted earlier. However, quantitatively somewhat more rugae were found in females than in males and were statistically significant. The result is inconsistent with studies conducted by Shetty and Premalatha,[23] Bharath *et al.*,[19] and Saraf *et al.*[18]

The present study does not found any significant difference in rugae pattern between the Ranchi and Patna population. Ranchi is a capital of Jharkhand and Patna is a capital of Bihar in India. Jharkhand was separated from Bihar due to cultural differences and due to the difference in living style, interest, and demands of tribal groups which were very different from other people of north Bihar.[24] However, due to the migration of people of various castes, races, and tribes in search of work in the capital areas, people share cultural and genetic ethnicity.

In the present study, curved and wavy palatal rugae forms were found to be more prevalent, followed by straight form, diverging, converging, and circular in the studied population. This was in harmony with the earlier studies conducted by Saraf *et al.*,[18] Paliwal *et al.*,[25] and Mustafa *et al.*[26] among Indian population and by Kapali *et al.*[4] in Australian Caucasians and Aborigines. The present study found curved rugae form were predominant in males while the wavy pattern was more common in females. Jacob *et al.* reported similar findings,[27] whereas Jibi *et al.*[28] reported diverging type were more common in females, and converging type were more prevalent in males in various Indian populations. The present cross-sectional study comprised the palatal rugae records of the patients reporting for dental treatment belonging to Patna and Ranchi and revealed that quantitatively palatal rugae were slightly more in females than males, which is inconsistent with other data obtained from various populations.[4,10,16,19,21] However, Bajracharya *et al.*[29]

City	Gender	Shape					
		Curved	**Wavy**	**Straight**	**Circular**	**Converging**	**Diverging**
Patna	Male	202	149	77	6	14	32
Ranchi		190	194	114	5	15	23
Patna	Female	180	197	97	2	10	29
Ranchi		119	203	104	7	6	29
Total		681	743	392	20	45	113
P value		1.02 NS					
NS: Non-significant							

Table 2: Analysis of different shapes of palatal rugae.

conducted a study in Nepalese subjects to find the association of gender with the pattern and number of palatal rugae and found no statistically significant difference in the palatal rugae number and pattern among the gender groups.

According to the length of the palatal rugae, they were categorized into primary form and secondary and on analysis; their distribution was approximately similar in both the gender. Primary rugae form was predominantly more than secondary rugae form in both the gender and results were similar. Similarly, Shubha *et al.*[30] conducted a study among north and south Indian population of Davanagere city and found no difference in the occurrence of primary and secondary rugae pattern in the studied population. On the contrary, Swetha[31] found that primary rugae pattern was more common in males, whereas secondary and tertiary rugae were more common among females; however, the results were insignificant statistically.

Analysis of rugae shape revealed a wavy pattern to be more prevalent in females, followed by curved, while the curved pattern was found to more prevailing in males followed by wavy, straight, diverging, converging, and circular pattern. Our results are in accordance with data revealed by Shetty *et al.*,[14] however, Paliwal *et al.* reported a predominance of straight patterns in the Indian population.[25]

The present study had a limited sample size of 100 subjects of each population and also study was conducted in capital areas of both states, hence further studies with large population samples and participants enrolled from remote areas of indigenous tribes are required to compare ethnic groups as capital areas consist of migrant population of different areas of state and country. All the rugae patterns assessed in the present study were unique to each participant, and no similarity with any other person was notified, thus revealing the individuality of these patterns.

Conclusion

In the studied population, the primary rugae were more in number, curved and wavy patterns were preponderate in shape. The number and shape of rugae revealed significant differences between the both genders, thus, can be utilized for gender determination. They are observed to be extremely unique to an individual equivalent to fingerprint patterns, and if ante mortem records of rugae are present, they can be used as aid for person identification.

References

1. 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.
2. Caldas IM, Magalhães T, Afonso A. Establishing identity using cheiloscopy and palatoscopy. Forensic Sci Int 2007;165(1):1-9.
3. Nayak P, Acharya AB, Padmini AT, Kaveri H. Differences in the palatal rugae shape in two populations of India. Arch Oral Biol 2007;52(10):977-82.
4. Kapali S, Townsend G, Richards L, Parish T. Palatal rugae patterns in Australian aborigines and Caucasians. Aust Dent J 1997;42(2):129-33.
5. English WR, Robison SF, Summitt JB, Oesterle LJ, Brannon RB, Morlang WM. Individuality of human palatal rugae. J Forensic Sci 1988;33(3):718-26.
6. Almeida MA, Phillips C, Kula K, Tulloch C. Stability of the palatal rugae as landmarks for analysis of dental casts. Angle Orthod 1995;65(1):43-8.
7. Snell RS. Clinical Anatomy by Regions, 8th , Philadelphia, PA: Lippincott Williams and Wilkins; 2008.
8. Indira A, Gupta M, David MP. Usefullness of palatal rugae patterns in establishing identity: Preliminary results from Bengaluru city, India. J Forensic Dent Sci 2012;4:2-5.
9. Acharya AB, Sivapathasundaram B. Forensic odontology. In: Rajendran R, Sivapathasundaram B, (Editors). Shafer's Textbook of Oral Pathology, 5th ed. New Delhi, India: Elsevier Publications; 2007. p. 886.
10. Muthusubramanian M, Limson KS, Julian R. Analysis of rugae in burn victims and cadavers to simulate rugae identification in cases of incineration and decomposition. J Forensic Odontostomatol 2005;23:26-9.
11. Segelinck SL, Goldstein L. Forensic application of palatal rugae in dental identification. Forensic Exam Spring 2005;14:44-7.
12. Ibeachu PC, Didia BC, Arigbede AO. A comparative study of palatal rugae patterns among igbo and ikwerre ethnic groups of Nigeria: A University of Port Harcourt Study. Anat Res Int 2014;2014:123925.
13. Thomas CJ, Kotze TJ. The palatal ruga pattern: A new classification. J Dent Assoc S Afr 1983;38(3):153-7.
14. Shetty SK, Kalia S, Patil K, Mahima VG. Palatal rugae pattern in Mysorean and Tibetan populations. Indian J Dent Res 2005;16(2):51-5.
15. Pueyo VM, Garrido BR, Sánchez JS. Odontología Legaly Forense, Masson, Barcelona: Quintessence Int; 1994. p. 277-92.
16. Sumathi MK, Balaji N, Vezhavendhan N, Sathish KG, Shanthi V. Palatoscopy among Pondicherry population. J Sci Dent 2011;1:16-8.
17. Abou EI-Foots MM, Hemma EI-Sharkawy GZ. A study of palatal rugae pattern (rugoscopy) in an Egyptian population. Egypt Dent J 1998;44:3177-84.
18. 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(1):14-9.
19. Bharath ST, Kumar GR, Dhanapal R, Saraswathi T. Sex determination by discriminant function analysis of palatal rugae from a population of coastal Andhra. J Forensic Dent Sci 2011;3(2):58-62.
20. Campos ML. Rugoscopia Palatina. Available from: http://www. pericias-forenses.com.br. [Last accessed on 2015 Nov 12].

21. Hermosilla VV, Valenzuela JS, Lopez MC, Galdames IC. Palatal rugae: Systematic analysis of its shape and dimensions for use in human identification. Int J Morphol 2009;27:819-25.

22. Fahim FM, Al-Shamrani SM, Talic YF. Rugae pattern in a Saudi population sample of males and females. Saudi Dent J 2001;13:92-5.

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

24. Available from: https://www.quora.com/why-was-Jharkhand-separated-from-Bihar. [Last accessed on 2015 Nov 12].

25. Paliwal A, Wanjari S, Parwani R. Palatal rugoscopy: Establishing identity. J Forensic Dent Sci 2010;2(1):27-31.

26. Mustafa AG, Allouh M, Islam T, Raed A. Morphometric analysis of palatal rugae among Jordians: Further evidence of worldwide palatal rugae individuality. Aust J Forensic Sci 2013;46:53-63.

27. Jacob RF, Shalla CL. Postmortem identification of the edentulous deceased: Denture tissue surface anatomy. J Forensic Sci 1987;32(3):698-702.

28. Jibi PM, Gautam KK, Basappa N, Raju OS. Morphological pattern of palatal rugae in children of Davangere. J Forensic Sci 2011;56(5):1192-7.

29. Bajracharya D, Vaidya A, Thapa S, Shrestha S. Palatal rugae pattern in Nepalese subjects. Orthod J Nepal 2013;3(2):36-9.

30. Shubha C, Sujatha GP, Ashok L, Santhosh CS. A study of palatal rugae pattern among North and South Indian population of Davanagere city. J Indian Acad Forensic Med 2013;35(3):219-22.

31. Swetha S. Palatal rugae pattern in varied adult Indian population of males and females. J Pharm Sci Res 2015;7(9):736-9.