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Original Research Article

Investigating palatal rugae diversity – a comparative analysis of Bilaspur and Nagpur regions

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ABSTRACT

Forensic odontology plays a key role in person identification in case of mass disasters, criminal investigations, and ethnicity studies, and in identifying decomposed and disfigured bodies, fire victims, and victims of motor vehicle accidents. Rugoscopy is an important specialty, which has been an area of interest for many forensic odontologists. As palatal Rugae are present in all victims and resistant to change (aging, trauma, and so forth) so they act as an ideal for identification. Palatal Rugae are also named Plicae Palatinae transverse or Rugae Palatine. The Palatal Rugae are generally transverse ridges placed in the anterior part of the palatine mucosa. Palatal Rugae are resistant to thermal effects (heat and burn) and decomposition changes because of their internal position in the head. They are used in cases where dental identification is not possible and in patients where other body parts are burnt or decomposed.

Aim: Aim of the study is to identify and analyze different patterns of palatal rugae and gender differences in Bilaspur and Nagpur populations.

Materials and Methods: This study will include a total of 80 dental casts — 40 males and 40 females.

Statistical analysis: The analysis of palatal rugae concerning the number of rugae, shape, length, and unification will be done.

1. Introduction

Forensic odontology is a dental specialty focused on identifying individuals by examining the oral cavity. This field integrates not only dental expertise but also draws on insights from anthropology and forensic medicine. One of the primary objectives of forensic odontology is individual identification, demonstrating significant utility in scenarios such as mass disasters, shipwrecks, violent deaths, and instances involving charred or severely decomposed bodies. Throughout the history of forensic odontology, it has proven its relevance in various situations, although certain uncertainties persist.[1] Forensic odontologists conduct investigative tasks relying on existing pre-mortem information, post-mortem data, and instrumental examinations, including CT scans, cheiloscopy, and palatal Rugoscopy.[2] In the realm of palatal Rugoscopy within forensic odontology, the palatal rugae serve as a crucial identification indicator, particularly in individuals without teeth.[3] It has been noted that the hard palate and its rugae exhibit remarkable stability over time, even in cases of charring or degradation.[4] The transverse ridges situated in the front part of the hard palate, known as palatal rugae, form distinctive anatomical characteristics.[5] Many investigations have recorded the consistent stability of palatal rugae, affirming their utility as a valuable instrument for forensic identification.[6,7] Moreover, indications propose that the uniqueness of palatal rugae assists in racial profiling, as their patterns display specificity within different racial groups. Furthermore, they play a role in determining sex, thereby amplifying their significance in forensic inquiries.[8]

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Several researchers have suggested that palatal rugae possess unique characteristics for each individual, presenting a successful avenue for human identification. Nonetheless, there is disagreement among researchers regarding the feasibility of relying solely on palatal rugae for legal identification. Controversy also surrounds the stability of both quantitative and qualitative rugae characteristics throughout the growth process.[9,10] observed that the distinct pattern of palatal rugae remained unchanged throughout the growth process, maintaining stability from development until the degeneration of the oral mucosa at the time of death.

Van der Linden demonstrated that the length of the anterior rugae does not exhibit growth beyond the age of 10.[11] Similarly, qualitative features such as shape, orientation, and unity persist without significant changes throughout an individual's lifespan.[9] Nonetheless, Hauser and colleagues have proposed that the average count of rugae undergoes moderate changes during adolescence and experiences a substantial increase from the age of 35 to 40 years.[5] On the contrary, Lysell contended that the ruga count decreases starting from the age of 23 and onwards.[12] Certain occurrences can lead to alterations in the pattern of rugae, including instances of trauma, prolonged finger sucking during infancy, and continuous pressure associated with orthodontic treatment or the use of dentures.[12] It has been proposed that variations in the length of rugae as individual's age stem from the fundamental growth of the underlying palate.[5] Moreover, Bailey and colleagues, Almeida and co-authors, as well as Abdel-Aziz and collaborators, reached the conclusion that the repositioning of teeth may influence the locations of rugae points.[13–15] There is a scarcity of research aimed at confirming the dependability of palatal rugae patterns for individual identification, a factor that holds significant potential in the field of forensic sciences. Yet, the utility of Rugoscopy in forensic identification hinges on the existence of accessible ante mortem data for comparison, such as dental casts, tracings, or digitized rugae patterns. Past investigations might not have accounted for the influences of growth, extractions, palatal expansion, or a combination of these factors. The unintentional incorporation of other elements from the cast, such as teeth, edentulous ridge morphology, muscle attachments, vestibular depth, or a combination thereof, might have impacted the findings. Aim of this present study is to differentiate Bilaspur and Nagpur population on the basis of palatal rugae pattern like shape, length, direction and unification. To find uniqueness of the palatal rugae among the individual of this studied population.

2. Materials and Methods

In this study we have appraise the cast of patients from various dental clinics and hospitals in Bilaspur and Nagpur region. Generally the natives are non-vegetarian in nature. Casts of residents of Bilaspur and Nagpur regions were included and habitats of other regions of Chhattisgarh and Maharashtra were avoided. In total 80 dental casts of upper jaw were collected, which contain rugae pattern out of which 40 belong to Male and 40 to that of female. The casts were pre-made by experienced dental doctors of the patients that came to their clinic for treatment. All the selected casts were free to air bubbles or voids, especially at the anterior 3rd of the palate. To achieve the sample size dental cast were collected from approximately 10-15 dental clinics from all over Bilaspur and Nagpur region. Age group was taken between 18-75 years. The consent from the subjects was dully taken to use the information derived from their dental cast for academic purpose only.

This research was followed using Thomas and Kotze method.[16]

Thomas and Kotze provided an elaborate categorization comprising the following:

2.1. Rugae dimensions and occurrence

1. **Length**: assessed based on the most recent rugal dimension and categorized as primary, secondary, or fragmentary rugae.
2. **Prevalence:** Rugae are identified through counting and recording their numbers in each category (primary, secondary, and fragmentary), not the total count on each side.
3. **Area:** Involves determining the surface area covered by the primary rugae.

2.2. Details of primary rugae

These can be characterized as annular, papillary, crosslink, branching, unification, interruptions, and unification with non-primary rugae.

2.3. Dimensions of rugae pattern

1. Measurement of the distance between the most anterior point on the incisive papilla and the most anterior point on the rugae pattern, irrespective of the side.
2. Measurement of the distance from the incisive papilla to the posterior border of the last primary or secondary rugae.
3. Measurement of the distance from the incisive papilla to the posterior border of the last rugae, encompassing fragmentary rugae as well.

2.4. Divergence angle

Quantified in degrees as the angle between the line created by the medial palatal raphe and the line connecting the incisive papilla with the origin of the rearmost primary or

secondary rugae on one side of the palate.

2.5. Dimensions of dental arch and palate

1. **Width:** The line connecting the tips of the mesio-palatal cusp of the permanent maxillary first molar or deciduous second molar is extended to project a point below and perpendicular to the gingival margin, determining the width.
2. **Depth:** A point below and perpendicular to the line connecting the tips of the mesio-palatal cusp of the permanent maxillary first molar or deciduous second molar on the mid palatal raphe is used to determine the depth.
3. **Center:** The perpendicular distance between the line joining the tips of the mesio-palatal cusp of the permanent maxillary first molar or deciduous second molar and the point on the mid palatal raphe determines the center.

3. Observation and Result

Table 1 shows the number of male samples collected from Bilaspur region and Nagpur region i.e. 20 each within the age group of 20-71 years and 15-56 years respectively. Similarly female samples of both the regions taken into consideration in the present study i.e. 20 each are in the age range of 20-60 years and 19-57 years respectively.

Table 1: Number of male and female samples taken from Bilaspurand-Nagpur region

Region	Male		Female	
	No.	Age	No.	Age
Bilaspur	20	20–71	20	20–60
Nagpur	20	18–56	20	19–57

Table 2 shows the total number of rugae present in males and females of Bilaspur and Nagpur region. The total number of rugae in males in Nagpur region in left side of Palatal rugae with lower and upper limit (2,5) and Female with lower and upper limit (2,5) and in Right side with lower and Upper limit (2,5) in Males and Females with lower and upper limit (2,5). In case of males and females of Bilaspur region the Total number of rugae in left side with lower and upper limit (2,4) in Male and in female (2,4) and in right side the lower and upper limit in males (2,5) and in females (2,4**).** It was observed that the numbers of rugae found in females of Bilaspur region were less than the number of rugae found in females of Nagpur region and the number of rugae in males of Bilaspur region was less in left side then the number of rugae found in males of Nagpur region.

The range of Primary rugae in Males and Females of Nagpur and Bilaspur regions are shown in this table. The range of primary rugae in Males of Nagpur region in left side were 5.25mm- 17.80mm and in Females were (6.06-17.14) while in right side in Males (5.43-17.13) and in Females (6.68-18.63). In case of Males and female of Bilaspur region the range of primary rugae in left side with lower and upper limit in males (5.97- 19.14) and in females (5.12-16.99) and in right side with lower and upper limit in males (5.20-19.54) and in females (5.73-16.59). it was observed that the range of rugae of females in left side lower limit is greater (6.06) then the rugae of males of Nagpur region and Bilaspur region males and females and the upper limit of left side is greater in males (19.14) of Bilaspur region then males of Bilaspur and Nagpur region males and females. In case of right side lower limit females of Nagpur is greater (6.68) then male of Nagpur region and Bilaspur region males and female (Table 3).

Table 2: Lower and upper limit of rugae observed in the sample

Region	Sex	Left		Right	
		Lower Limit	Upper Limit	Lower Limit	Upper Limit
Nagpur	Male	2	5	2	5
	Female	2	5	2	5
Bilaspur	Male	2	4	2	5
	Female	2	4	2	4

Table 3: Range of primary rugae

Region	Sex	Left		Right	
		Lower Limit	Upper Limit	Lower Limit	Upper Limit
Nagpur	Male	5.25	17.80	5.43	17.13
	Female	6.06	17.14	6.68	18.63
Bilaspur	Male	5.97	19.14	5.20	19.54
	Female	5.12	16.99	5.73	16.59

Table 4 shows predominant shape of male and female of Bilaspur and Nagpur region. Wavy pattern is seen with higher frequency in both the regions i.e. Male: Female of Nagpur region in both left and right side is (26,27): (30,30) and that of Bilaspur region is ratio (25,27) : (23,35). Straight pattern is seen with second higher frequency then curve and wavy. Circular and non- specified patterns are not seen in both regions.

Table 5 shows comparison of percentage of convergence in both male and female samples of Nagpur and Bilaspur regions. The convergence of rugae in Nagpur region were observed to be 10% and 5% (males and females) in left side and in right side is 10% in both the sexes. In Bilaspur region the convergence of rugae in males and female in left side is 5% and 0 in right side is 5% in both males and females. It was observed that males of Nagpur region have greater (10%) convergence of rugae then females of Nagpur region and Bilaspur region males and females.

Table 6 shows divergence of rugae in males and females of Nagpur and Bilaspur region. In Nagpur region divergence of rugae in male and females in left side is 20% and 55% and in right side 30% and 65%. In Bilaspur region divergence of

Table 4: Predominant shape

Region	Sex	Straight		Curve		Wavy		Unification	
		Left	Right	Left	Right	Left	Right	Left	Right
Nagpur	Male	23	20	8	8	26	26	6	9
	Female	20	12	8	9	30	30	11	15
Bilaspur	Male	18	14	12	18	19	24	7	7
	Female	20	9	12	14	23	37	9	3

Table 5: Convergence of rugae

Region	Sex	Left	Right
Nagpur	Male	2	2
	Female	1	2
Bilaspur	Male	1	1
	Female	0	1

rugae in males and females in left side is 30% and 45% and in right side is 30% and 10%. It was observed that females of Nagpur region have greater (55% in left and 65% in right side) divergence of rugae then males of Nagpur and Bilaspur region males and females.

Table 6: Divergence of rugae

Region	Sex	Left	Right
Nagpur	Male	4	6
	Female	11	13
Bilaspur	Male	6	6
	Female	9	2

4. Discussion

Establishing an individual's identity can be a challenging task, and fingerprints and dental records are considered the most scientifically reliable methods for identification. This study aimed to investigate the number, patterns, and predominant types of palatal rugae in the Bilaspur and Nagpur regions. The research also sought to identify any gender-based differences in rugae patterns within these selected areas. The study underscores the uniqueness of rugae as a potential identifier. It is important to note that this method of identification is applicable only when there is available ante mortem data of palatal rugae, as the comparison is based on both ante-mortem and post-mortem records in dental identification. Antnal et al. (2014)[17] conducted a study on palatal rugae patterns in 500 subjects from Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh, and Maharashtra. The results, analyzed using Chi-square analysis, revealed variations in rugae patterns among different states and genders. Wavy patterns were predominant across the studied states, while straight and curved patterns exhibited regional and gender-based differences. Unification rugae were the least common, and circular patterns were absent in the populations studied.

In the current study, palatal rugae patterns were classified based on the Thomas and Kotze classification system. The investigation involved 40 samples from Bilaspur and 40 from Nagpur, with a focus on converging and diverging patterns. Wavy patterns were consistently dominant in both males and females, followed by straight and curved patterns. The study revealed variations in the frequency of rugae patterns between Nagpur and Bilaspur regions, emphasizing the uniqueness of palatal rugae in individual identification. Circular and unspecified patterns were not observed in either region.

5. Conclusion

Human identification is one of the main focuses of forensic odontologists. Dental identification is mainly based on the comparison of ante-mortem and post-mortem records.

This study involved a total of 40 samples from each region. Wavy patterns were observed with a higher frequency in both regions, with the male-to-female ratio for the Nagpur region being (26, 27): (30, 30) on both the left and right sides. In the Bilaspur region, the ratio was (25, 27): (23, 35). The straight pattern was the second most frequent, followed by the curve and wavy patterns. Circular and unspecified patterns were not detected in either region. Additionally, an H-shape pattern was noted in the Nagpur region, and circular/non-specified patterns were absent in both regions.

6. Conflict of Interest

None

7. Source of Funding

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The consent from the subjects was dully taken to use the information derived from their dental cast for academic purpose only.

References

1. Bruce-Chwatt RM. A brief history of forensic odontology since 1775. *J Forensic Leg Med*. 2010;17(3):127–30.
2. Rai B, Kaur J. Evidence-based forensic dentistry. and others, editor. Springer Science & Business Media; 2012.

3. Jain A, Chowdhary R. Palatal rugae and their role in forensic odontology. *J Invest Clin Dent*. 2014;5(3):171–8.
4. 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(1):26–35.
5. Hauser G, Daponte A, Roberts MJ. Palatal rugae. *J Anat*. 1989;165:237–49.
6. 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.
7. Lanteri V, Cossellu G, Farronato M, Ugolini A, Leonardi R, Rusconi F, et al. Assessment of the Stability of the palatal rugae in a 3D-3D superimposition technique following Slow Maxillary expansion (SME). *Scientific Reports*. 2020;10(1):2676.
8. Pakshir F, Ajami S, Pakshir HR, Malekzadeh AR. Characteristics of palatal rugae patterns as a potential tool for sex discrimination in a sample of Iranian children. *J Dent*. 2019;20(1):1–9.
9. 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.
10. Peavy DC, Kendrick GS. The effects of tooth movement on the palatine rugae. *J Prosthet Dent*. 1967;18(6):536–42.
11. Van Der Linden F. Changes in the position of posterior teeth in relation to ruga points. *Am J Orthod*. 1978;74(2):142–61.
12. Pateria DA, Pateria K. Palatal rugae a stable landmark-A comparison between pre and post orthodontic patients. *Int J Dent Clin*. 2011;3(4):9–12.
13. 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.
14. Bailey LJ, Esmailnejad A, Almeida MA. Stability of the palatal rugae as landmarks for analysis of dental casts in extraction and nonextraction cases. *The Angle Orthodontist*. 1996;66(1):73–8.
15. Aziz HA, and NES. Palatal rugae area: a landmark for analysis of pre- and post-orthodontically treated adult Egyptian patients. *East Mediterr Health J*. 2001;7(1-2):60–6.
16. Patil MS, Patil SB, Acharya AB. Palatine rugae and their significance in clinical dentistry: A review of the literature. *J Am Dent Assoc*. 2008;139(11):1471–8.
17. Shetty M, Premalatha K. Study of palatal rugae pattern among the student population in Mangalore. *J Ind Acad Foren Med*. 2011;33(2):112–5.

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