

Reliability of Palatal Rugae Pattern in Human Identification

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ABSTRACT

Background: Human identification has become fundamental in all aspects of human relationships, at both social and legal levels. Investigation of mucosal tissues is important, since these structures provide interesting data for identification, such as the hard palate. Transverse palatine folds or palatal rugae (PR), are asymmetrical and irregular elevations of the mucosa located in the anterior third of the palate.

Aims & Objective: To investigate the palatal rugae patterns in males and females of a cross-sectional Daman City Population at Vaidik Dental College and Research Centre, Daman, India and ascertain its use in identification and sex differentiation.

Materials and Method: A total of 200 subjects, 100 males and 100 females were selected, their ages ranging between 20-40 years. Alginate impressions were made of the maxillary arch, poured in dental stone and the palatal rugae were recorded and analyzed based on their length, shape, direction, and unification.

Results: Total number of rugae in females was found to be more than males. Primary rugae were significantly more in males compared to females, whereas the number of fragmentary rugae was found more in females as compared to males. Predominant shape in males and females was found to be curved. No significant difference was observed in the direction and unification pattern.

Conclusion: Assessment of sex can substantially narrow the biological profile for unidentified remains. Rugoscopy can be applicable for forensic identification only when there is available antemortem information for comparison such as dental casts, tracings or digitized rugae patterns. Differences between genders using rugoscopy have been studied by various researchers without any definite conclusions. Larger samples should be examined in detail to further validate the findings of this study.

Keywords: Forensic, palatal rugae, sex determination.

INTRODUCTION

Human identification has become fundamental in all aspects of human relationships, at both social and legal levels. It allows people to preserve their rights and have their duties demanded from both civil and legal standpoints.¹ According to Arbenz,² identification requires demonstrating that a person or one of his or her characteristics being examined is the same as observed in a previous situation. An important aspect refers to the distinction between recognition and identification.³ Recognition may be

considered as an empirical, subjective identification without scientific accuracy. In Forensic Dentistry, it is usually visually conducted by relatives and friends of the victim, thus making this practice highly susceptible to mistakes and failures.^{4,5,6}

Identification is characterized by the utilization of proper techniques and means to find the identity. It may be performed by experienced technicians or by professionals with differentiated and specific knowledge in biology with utilization of a nearly unlimited series of techniques and means to

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determine the human identity.^{7,8} Many scientific methods have been published, such as the investigation of bite marks and of the jaws. However, not only the teeth and bones are useful for identification; investigation of mucosal tissues is also important, since these structures provide interesting data for identification, such as the hard palate and lips, by means of investigation of palatal rugae pattern (rugoscopy and cheiloscopy. Transverse palatine folds or palatal rugae (PR), are asymmetrical and irregular elevations of the mucosa located in the anterior third of the palate, made from the lateral membrane of the incisive papilla, arranged in transverse direction from palatine raphe located in the midsagittal plane. These formations have been used in medicolegal identification processes because of their individual morphological characteristics and stability over time. The palatal rugae appear towards the third 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 The first rugae is distinguished in human embryos of 32 mm CRL next to the incisive papilla. Then, in the prenatal stage are relatively prominent, the PR at birth are well trained with a typical orientation pattern and in adolescence acquire the final feature shape of each individual. The design and structure of PR are unchanged and are not altered by chemicals, heat, disease or trauma, or, if palatal rugae are destroyed, they are reproduced exactly on the same site where they were present.^{10,11} Form, layout and characteristics are not affected by the eruption of the teeth or their loss, but sometimes palatal rugae adjacent to the alveolar arch slightly change their position after tooth extraction.⁸ However, some events may contribute to changes in the pattern of PR, such as finger sucking in childhood and persistent pressure due to orthodontic treatment.^{12,13,14,15} Furthermore, it has been reported that extractions can produce a local effect on the direction of the PR. The objective of the present study was to investigate the palatal rugae patterns in males and females of a cross-sectional Daman City Population at Vaidik Dental College and Research Centre, Daman, India and ascertain its use in identification and sex differentiation.

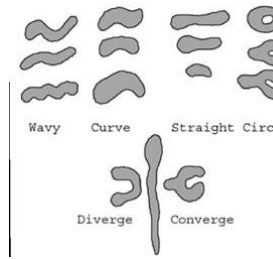


Figure 1: Patterns of palatal rugae based on shape and unification



Figure 2: Tracing of palatal rugae on a cast

MATERIALS AND METHOD

A total of 200 subjects, 100 males and 100 females were selected, their ages ranging between 20-40 years. All subjects were healthy individuals free of congenital abnormalities, inflammation, trauma or orthodontic treatment. To record palatal rugae, alginate impressions of the maxillary arch was made and poured with dental stone. A dental plaster base was made and casts were preserved for interpretation. The outline of the rugae was traced on these casts using a sharp graphite pencil under adequate light (Figure 1). The palatal rugae pattern were then analyzed (Figure 2) on these casts with the help of magnifying lens, using the classification by Lysell. The rugae pattern was classified based on their length, shape, direction, and unification. (A) The rugae were classified based on their length as:

Primary: - 5 mm or more

Secondary: - 3 to 5 mm

Fragmentary: - 2 to 3 mm

Rugae less than 2 mm were disregarded. A ruga's length was determined by measuring its greatest dimension regardless of its shape. (B) The rugae were divided into four types based on their shape as: [Figure 1]

Curved: They had a crescent shape and curved gently. Evidence of even the slightest bend at the origin or termination of a ruga led to it being classified as a curved rugae.

Wavy: If there was a slight curve at the origin or termination of a curved ruga, it was classified as wavy.

Straight: They ran directly from their origin to termination.

Circular: Rugae that formed a definite continuous ring. (C) The direction of the ruga was determined by measuring the angle formed by the line joining its origin and termination and the line perpendicular to the median raphe. Forwardly directed rugae were associated with positive angles, backwardly directed rugae were associated with negative angles and perpendicular rugae were associated with zero angles. (D) Unification occurs when two rugae are joined at their origin or termination. Rugae were considered diverging if two rugae had the same origin but immediately branched. Rugae with different origins, which joined on their lateral portions, were considered converging. Rugae were tested for gender and for both sides of the palate using the following parameters:

- 1.Total number of rugae
- 2.Length of rugae
- 3.Predominant shape
- 4.Predominant direction
5. Unification pattern

RESULTS

The total number of rugae in females was found to be more than males ($p > 0.05$). Considering the length of rugae it was observed that the number of primary rugae were significantly more in males compared to females ($p < .05$), whereas the number of fragmentary rugae were found more in females as compared to males ($p < .001$). However no significant difference was observed in the secondary rugae. The predominant shape in males was found to be curved followed by wavy, straight and circular pattern. The curved pattern was dominant in females, followed by straight, wavy and circular. Significant differences were seen in the curved pattern ($p < .05$) and the circular pattern ($p < .001$). No significant difference was observed in the direction and unification pattern between the males and females ($p > .05$)

DISCUSSION

Determination of sex is the key analysis that forensic investigators perform in order to construct the biological profile of human remains.¹⁵ In this context, the assessment of sex can substantially narrow the biological profile for unidentified remains. Indeed, in most cases, clarification of the

events and later judicial decisions will depend on the precision and the reliability of the identification procedures.¹⁶ routinely, teeth and bones are used for sex determination in forensics but in cases of their absence in identification, mucosal tissues are important since these structures provide interesting data for identification.

The analysis of human palatal rugae has been suggested as an alternative method for identification in 1889 by Allen.¹⁷ English et al.¹⁸ conducted a study to identify 25 individuals undergoing orthodontic treatment. One hundred dental casts were obtained from these patients and identification was then performed by nine examiners by analysis of the palatal rugae pattern. They concluded that the palatal rugae pattern is characteristic enough to differentiate among individuals.

Researchers had found difficulty in the task of classification of the rugae patterns due to the subjective nature of observation and interpretation within and between observers. Since the study of Lysell¹³ specific anatomical investigations on palatal rugae patterns have been reported by many researchers. Numerous classifications have been devised by several authors to record the palatal rugae patterns; among all, the Silva, Carrea, Lysell, Thomas and Kotze classifications are often used in recording the patterns. Thomas and Kotze in their literature highlighted the difficulties in observing, classifying and interpreting the limitless and minute variations in palatal rugae and emphasized the necessity for standardizing the procedures in recording.

Various studies reported the regional variation in the palatal rugae patterns by comparing the patterns in males and females. Dohke and Osato²⁰ reported that among the Japanese, the females had fewer rugae than males. The present study did not show any significant differences in the number of PR in males and females which were in accordance with the study of Kapali et al¹⁴ who also in their study did not reveal any significant differences in the number of primary rugae between Aboriginal males and females.

Nayak et al²¹ in their study on population differentiation using rugae shape have mentioned that discrete variables such as rugae shape are

better suited for the purpose than continuous variables such as rugae length. The present study showed significant differences in length of primary and fragmentary rugae. No significant differences were seen in the direction of the rugae which were in contrast to the study done by Sharma et al.²³

Studies conducted by English et al and El-Fotoh et al proved that rugae pattern was absolutely unique to an individual and could be used for identification. Differences between genders using palatoscopy have been studied without any conclusions. Differences in the shape of the palatal rugae in different races and population have been investigated but no significant sex differences were observed in those studies either.

There is no doubt that Rugoscopy is unique to an individual, thus their use in forensic identification is fairly justified. Rugoscopy is rather simple techniques not requiring any complex instrumentation and can be successfully used in necro-identification. Rugoscopy can be applicable for forensic identification only when there is available antemortem information for comparison such as dental casts, tracings or digitized rugae patterns. Our interpretations are precluded by the small sample size and further research work on larger samples and application of advanced statistical methods is required to validate its use in forensic application.

CONFLICT OF INTEREST

No potential academic conflict of interest relevant to the above article was reported.

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