

Palatal Rugoscopy In Forensic Identification- A Review

Bigyasha Rai

student

Christ Deemed(to be University) Bangalore

Abstract:

Background: Rugoscopy, also referred to as palatoscopy, is a study of palatal rugae and can be utilized to successfully ascertain a person's identification. Several disciplines have used palatal rugae, including genetics, comparative anatomy, forensic odontology and anthropology because of their distinctiveness, postmortem resistance, and stability, palatal rugae seem to have all qualities for perfect identification in forensic. *Aim:* The aim of the study is to identify the importance of palatal rugae in criminal cases. *Conclusion:* Palatal rugae patterns are unique in each and every individual when other forms of identification are unavailable, the distinctiveness and specificity of palatal rugae have been demonstrated to be important for personal identification.

Keywords: Rugoscopy, Palatal Rugae, Forensic identification, Gender identification, Forensic Odontology, Palatoscopy

Introduction:

A study of palatal rugae is known as palatal rugoscopy which is used for identification purposes. The first individual to examine the palate anatomy for the purpose of differentiating races was Kuppler in 1897. However, Trobo Hermosa was the one who first suggested the word rugoscopy (palatoscopy) in 1932 [1]. Palatal rugae (PR) is an unsymmetrical, uneven projection of mucosa in the front part of the palate, transversely organised on both sides in the middle of the palate and back of the incisive papilla (IP) positioned in the middle of the sagittal plane [2]. Palatal rugae develop in the 12th week of pregnancy through the tough connective tissue that covers the bone. The first IP and PR were found within the human embryos with a crown rump length of 32-mm (CRL) [3]. Every person has a different rugae pattern, and each palatal rugae is distinct once it has formed and remains so throughout the person's lifespan [4]. They don't alter at all except for their length, which stops growing at puberty [5]. Palatoscopy refers to the examination of the palatal rugae and is utilized to successfully ascertain a person's identification. Rugoscopy is a procedure that can be used to compensate for dactyloscopy. Several disciplines have used palatal rugae, including genetics, anthropology, forensic odontology, prosthodontics, and orthodontics [6]. In recent years, palatoscopy or rugoscopy has grown in significance and become an effective method for identification after death when dental records are unavailable, such as in cases of people with no teeth or when the body is decomposing [7]. Due to their distinctiveness, postmortem resistance, and stability, palatal rugae have the qualities of identification in forensic cases. Additionally, rugae patterns may be unique to particular racial and sexual groupings, making it easier to identify populations that may be necessary following a natural disaster.

Variations in rugae patterns have been discovered even in populations that are quite similar [8]. Palatal rugae patterns are ethnically diverse and distinctive and if antemortem records are available, the rugae pattern can possibly be a powerful forensic tool in analysing ethnicity [9]. Rugae are a great biometric tool for identifying people. Maintaining an antemortem record of palatal rugae patterns, which could be in the form of current dental casts or photographs as well, is necessary to use this landmark as an extra tool for identification [10]. Palatal rugae shapes are similar but not the same even in monozygotic twins, therefore rugae evaluation can be an additional trustworthy guide for the identification of the identical twin in criminal cases [11].

A particular field of forensic dentistry is sex determination which is crucial, particularly when there is a lack of details regarding the deceased. Determining a person's sex becomes a forensic investigator's primary priority in the process of identifying a person in the case of accidents, chemical and nuclear bomb explosions, natural catastrophes, crime investigations, and ethnic studies [12]. Rugoscopy can also be used for sex determination, according to a study conducted by Gupta et al [13] they found a significant difference in the palatal rugae among the males and females in terms of shape rugae length, number, shape, size, unification and direction in the inhabitants of Sri Ganganagar. Bharath, et al [14] in their study found that the number and pattern of rugae unification between men and women varied significantly. The total number of rugae was somewhat higher in women as compared to men, and females were more frequently found to have a diverging pattern therefore every individual's palatal rugae constitute an intrinsic and fundamental pattern that can be used to determine sex [15]. Also, the overall rugae count in males had a somewhat higher proportion than in females also on comparing the palatal rugae patterns of the family members revealed that although there were some similarities between a few forms in one family, the rugae pattern was not identical, indicating that the role of heredity while determining the orientation of the rugae pattern is uncertain [16].

CLASSIFICATION OF PALATAL RUGAE:

Goria 1911 [17] discovered the first classification scheme which was somewhat basic. He divided the rugae pattern into two categories by describing the rugal zone size and number of rugae in relation to the teeth. Compound rugae with two or more branches were counted as one under this approach. Goria further separated them into two categories: less developed and simpler.

The most significant classification is that made by Lysell 1955 [3] and has been frequently utilized in rugae-related research. The incisive papillae are included, and it is accurate. Rugae are divided into three types according to how they are measured between the starting point and the ending point in a straight line

1. Primary: 5 mm or more;
2. Secondary: 3 to 5 mm;
3. Fragmentary: 2 to 3 mm;
4. Rugae smaller than 2 mm are not taken into consideration.

Classification by Lopez De Leon 1924 [18]:

The author postulated that the personality and morphology of a person's palatal rugae are related to one another. The known types of palatal rugae are 4 and they include:

B-Bilious personality rugae

N-Nervous personality rugae

S-Sanguinary personality rugae

L-Lymphatic personality rugae.

The letters B, N, S, and L represent the different personalities. The letters L and R, which stand for the left and right sides of the palate, respectively, represent the number of palatal rugae on each side.

Classification of Palatal Rugae by Thomaz and Kotze [19]:

The classification was done on the basis of shape, size, unification and direction. According to the size of palatal rugae, it was divided into: primary, secondary and fragmentary. Similarly, on the basis of shape they were classified as curved, straight, wavy and circular. The type straight ran continuously from start to end. Softly curved form has a straightforward crescent shape. Rugae were categorised as curved if there was even the slightest indication of a bend at their termination or origin. Wavy rugae were twisted and were considered wavy if there was a minor bend at the beginning or end of curved rugae. The rugae had to exhibit a constant ring development in order to be labelled as circular. Classification on the basis of the direction was forward-directed and backward directed which was done by measuring the angle between the median raphe's perpendicular line and the line connecting its origin and termination. Positive angles are related to forward-directed rugae, negative angles to backward-directed rugae, and angles of zero degrees to perpendicular rugae. Lastly, on the basis of unification, they were classified as converging and diverging. Whenever two rugae are joined at their beginning or end, it is known as unification. Diverging unifications were those where two rugae converge from the same starting point but then diverge at some point. Converging rugae were those that had many origins and connected at the lateral parts

Lima 1966 [20] classified palatal rugae into four types: straight, punctuate, curved and composite. Basauri classification of rugae consists of two types namely simple and compound they are further segmented into 10 types which relate to certain shapes: 0, pointed; 1, straight; 2, curved; 3, angled; 4, sinuous; 5, circular; 6, Greek; 7, calyx shaped; 8, racket-shaped; 9, branched [21]. Trobo's categorization was based on the shape, number, size and the position of palatine rugae. The classification based on the shape was divided into two categories: simple and composed. Simple rugae are well-defined and classified as ABCDEF, and the composed rugae were allocated as type X [22].

PALTAL RUGAE IN GENDER IDENTIFICATION:

Various researches have been done to determine gender and ethnicity using palatal rugae [4-9]. A study was done by Subramanian et al [4] on rugae's shape according to Thomas and Kotze (1983) classification and they reported that males have a higher number of wavy and straight patterns, but females demonstrated statistically significant growth in the unification pattern. However, no statistically significant difference between males and females in the length or quantity of rugae was observed. Another study was done by Jagdish Prasad Rajguru et al [6] on palatal rugae of a dentate and dentulous population of South India. Study

revealed that the dentate population exhibited similar traits to the overall population, including wavy, straight and curved patterns. The group of edentulous men displayed the greatest average of wavy patterns and complete absence of circular pattern whereas the highest mean of curved pattern and nonspecific pattern was seen in the edentulous female group. The study reported a significant difference between the male and female pattern. Smriti et al [7] found that in contrast to male, female oral rugae had a higher frequency of round and backwards-directed rugae. Results of the analysis of logistic regression revealed a statistically significant relationship between palatal rugae that are circular, forward and backwards with sex. Similarly, another study conducted by Ibeachu et al [9] on Ethnic Groups of Nigeria demonstrated various population, which included the Igbo and the Ikwerre group, had a distinctive dominating pattern and individual differences and concluded that there is clear proof of sex-related ethnic differences. Rugae is also an excellent biometric tool that can fulfil the objective of identification [10]. Emiliya Taneva et al [11] found that even in identical twins the rugae patterns were not identical they only displayed similarity to some extent proving that rugae patterns are unique to all individuals and therefore a useful tool for identification. Gupta et al [13] in their research concluded that the Palate rugae patterns are individualized, distinctive patterns that aid in identifying the gender of a person. A study conducted by Bharath, et al [14] on Coastal Andhra population reported that a typical number of rugae was somewhat higher in females as compared to males, although this difference was statistically insignificant. This is consistent with the outcomes of Shetty, et al [15]. However, in a study conducted by Indira, et al [16] on the Bengaluru population it was found that the sample's overall rugae count revealed slightly higher males have more rugae than females have in terms of number.

PALATAL RUGAE ANALYSIS TECHNIQUES:

Currently, there are numerous techniques for analysing palatal rugae. Intra-oral examination is the most used method since it is easy to use and economical. The fundamental drawback of this methodology is the difficulty in comparisons caused by the lack of prior data. For a precise analysis and to solve the comparison problem, oral impressions and oral pictures are needed. The use of dental casts has advantages since it makes analysis easy and affordable. Before creating the dental casts by pouring the dental material, the maxillary imprints are first made on the impression material. Using a pencil or marker, the rugae outline is highlighted on the prepared casts, demonstrating each ruga's form and calculating its length. According to various classification schemes, which vary depending on the researcher and the study plan, rugae are categorised. To get a 3-D view of the palatal rugae's anatomy, other techniques including stereoscopy and superimposing photos of the rugae are also an option [21]. The computerized method for the identification includes Palatal Rugae Comparison Software, a unique piece of software (PRCS Version 2.0). With the help of the MS Paint version 5.1 program, the beginning and end locations of rugae are noted on each of the 100 clinical photographs. It is done according to a precise protocol, with each ruga's medial and lateral ends being plotted first, going from anterior to posterior, beginning at the tip and base of the incisive papilla. Initially, the left side of the rugae is mapped. The plotted points are processed by the software, and data relating to pixel positions is then recorded in a sequential manner. All 100 pictures are kept in the software. Later, individual copies of the same photos are loaded into the programme. The match instruction is delivered in the software after the second batch of photographs have had their points marked. If the photos are already imported into

the computer, the software will search in order to match among already loaded pictures. The software is used to ask five judges a computer expert, three dentists, and a general surgeon—to match the rugae pattern. The outcomes and the amount of time it took each operator to use software to match all the photographs were recorded [22].

FORENSIC APPLICATION

The palatal rugae were initially used in forensics by Allen in 1889, and a number of investigations were conducted to determine how they contribute to individualization. Rugae patterns were chosen because, like fingerprints, they are distinctive for each individual, don't alter over the course of a lifetime, and are very trauma-resistant. The length and shape of the Rugae are used to categorise them. This created the foundation for its application in personal identification, and numerous studies on palatal rugae have been done in this regard [23]. It has been demonstrated that palatal rugae exhibit strong individuality and maintain their shape throughout the course of a lifetime. Pattern of the palatal rugae is known to be as distinctive to a person as his fingerprints [24]. The rugae are extremely trauma and heat-resistant because of their anatomical placement inside the mouth, which is encircled by the lips, cheeks, tongue, teeth, buccal pad of fat, and bone. Therefore they can rely upon to serve as a landmark reference during forensic identification [25]. A study was conducted by Muthusubramanian et al [26] to establish the degree of preservation of the palatine rugae to use as an identification tool for cadavers and burn victims, emulating forensic situations of combustion and decomposition. Patients were assessed within 72 hours of the incident if they had third-degree burns to the panfacial region, which are full-thickness burns with colourful, denatured layers that are dry and painless and typically need skin grafting. Additionally, the state of the palatine rugae was evaluated in human cadavers that had been preserved in a mortuary for seven days minimum at 5 °C with 30 to 40 % relative humidity. Using a palatal mirror, the writers took photos of the palatine rugae. According to the study's findings, approximately 93% of third-degree pan facial burn participants had normal palatine rugae. In 77% of the cadavers of the humans, the investigators did not find any differences in the palatine rugae's surface anatomy or the colour. They came to the conclusion that the palatine rugae may be employed as a marker for forensic identification.

CONCLUSION:

Palatal rugae patterns are unique to each and every individual when other forms of identification are unavailable, the distinctiveness and specificity of palatal rugae have been demonstrated to be important for personal identification. Numerous studies have been done that demonstrate the palatal rugae's uniqueness and its forensic importance in forensic identification. In terms of orientation, length, and shape, no two patterns are ever discovered to be the same therefore palatal rugae act as a crucial tool in forensic odontology for the process of identification.

STATEMENT AND DECLARATIONS:

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Not applicable

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