



SIGNIFICANCE OF PALATAL RUGOSCOPY - A REVIEW

Dental Science

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ABSTRACT

Identification of individuals is a challenging task in forensic odontology. In circumstances where identification of an individual by fingerprint or dental record comparison is difficult, the palatal rugae may be considered as an alternative source. Palatal rugae are irregular, asymmetric ridges of the mucous membrane extending laterally from the incisive papilla and the anterior part of the palatal raphe. Palatal rugae patterns are relatively unique to an individual and are well protected by the lips, buccal pad of fat and teeth. They are considered to be stable throughout life following completion of growth & thus, suggest their use for forensic identification.

KEYWORDS

Forensic, Palatal, Rugoscopy

In this world of simulation and impersonation, the identity of a given individual is always questionable in situations of mass massacres and disasters. Many events that take place in the human journey between the wombs to the tomb result in human destruction may it be natural disasters earthquake, tsunami, volcanic eruptions or a manmade disaster like plane crashes, train accidents, and the very recent terrorist attacks, etc. In almost every disaster there is an urgent and pressing need to identify the victims on behalf of the next of kin. In this era of biometrics, digital imaging technology, the future of investigation lies more in the comparative data / techniques like DNA profiling, fingerprints, Cheiloscropy, Rugoscopy (palatoscopy) etc.¹ The professional obligation of a dental surgeon to mankind is not only to serve in diagnosis and treatment of orofacial diseases, but also to serve in determining a person's identity at the scene of crime and disasters with the support of these unique orofacial tissues. A lot of literature is available on forensic odontology tools, but still this branch of odontology is in its infancy stage in India.²

Palatoscopy or Palatal rugoscopy is the name given to the study of palatal rugae in order to establish a person's identity.³ Palatoscopy can be of special interest in those cases when no fingers are available to be studied (burnt bodies or bodies in severe decomposition).⁴ The study of palatine rugae patterns (rugoscopy) in different populations would not only help in identification of an individual, but also aid in gender determination in criminal investigations, natural and man-made disasters, and mass massacres.^{5,6}

According to glossary of prosthodontic terms, palatal rugae is defined as an anatomical fold or wrinkle usually made in the plural sense; the irregular fibrous connective tissue ridges located in the anterior third of the hard palate.⁷ It is also known as plicapalatinae. Palatal rugae appear in the 3rd month of intra-uterine life. Due to its anatomic position, rugae are protected from thermal insults by the tongue and buccal pad of fat. Rugoscopy involves the study of palatal rugae pattern for human identification. Due to the stability and uniqueness of the palatal rugae pattern, it has been considered as one of the relevant parameters for human identification in the field of forensic medicine. Palatal rugoscopy was first proposed by Trobo Hermosa in 1932.⁸ The analysis of palatal rugae was first proposed by Allen in 1889.⁹

In today's brutal world where soft tissue damage is not uncommon, rugoscopy may aid in the necro identification technique of decomposed bodies. The palatal rugae are like fingerprints that do not change during the life of an individual. Palatine rugae are unique and are reasonably stable during the lifetime of an individual.^{1,10} The advantages of palatal rugae as an ideal method of postmortem identification include: First, They are protected from trauma by their internal location & second, No two palates are alike in their configuration. Studies of rugae pattern of twins have showed that they are similar, but not identical.⁴ Despite the ongoing problem of describing palatal rugae pattern, qualitatively and quantitatively, their uniqueness to individuals has been recognized as providing a potentially reliable source of identification.

Human identification has become fundamental in all aspects of human relationships, at both social and legal levels. Identification corresponds to a combination of different procedures to individualize a person or an object.¹¹⁻¹² Transverse palatine folds or palatal rugae are asymmetrical, irregular elevations of the mucosa located in the anterior third of the palate. These formations have been used in medicolegal identification processes because their individual morphological characteristics are stable over time.¹³ Palatal rugae appear towards the third month of intrauterine life & its development and growth is controlled by epithelial- mesenchymal interactions.¹⁴ The first rugae are distinguished in human embryos of 32 mm next to the incisive papilla and in the prenatal stage are relatively prominent.^{15,16} The palatal rugae at birth are well trained with a typical orientation pattern and adolescence acquires the final feature shape of each individual.¹⁷ Once they are formed thus, may experience changes in their size due to growth of the palate, but its shape is maintained.¹⁸

Physiologically the palatal rugae are involved in the oral swallowing, participate in speech and suction in children. Its design and structure are unchanged and are not altered by chemicals, heat, disease or trauma, or, if palatal rugae are destroyed, are reproduced exactly on the same site.¹⁹ Usually 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.²⁰ However, some events may contribute to changes in the pattern of palatal rugae, such as finger sucking in childhood and persistent pressure due to orthodontic treatment.²¹ Overall palatal rugae have been considered relevant for human identification due to its stability, being equivalent to the fingerprint, unique for each individual.²² Rugoscopy is also helpful in orthodontic and prosthodontic treatments and diagnosis of diseases.

Researchers have found the task of classification a difficult aspect of studying rugae. Most studies are based on the systems devised by Lysell²³ and Thomas and Kotze²⁴ although they may differ in detail. The subjective nature of observation and interpretation within and between observers poses a problem. Controversy still exists about the stability of quantitative and qualitative characteristics of rugae during growth, and the extent of differences between ethnic groups and sexes. Hauser et al. have suggested that mean rugae count changes moderately in adolescence, then increases markedly from the age of 35 to 40 years.²⁴⁻²⁵ In contrast, Lysell considered that the number of rugae decreased from 23 years of age onwards.²³ English et al. and Peavy and Kendrick noted that the characteristic pattern of the palatal rugae did not change as a result of growth, remaining stable until the oral mucosa degenerates at death.^{9,20} However, trauma, extreme finger sucking in infancy, and persistent pressure with orthodontic treatment and dentures can contribute to changes in rugae pattern. It has been suggested that changes in the length of rugae with age result from underlying palatal growth, however, the anterior rugae do not increase in length after 10 years of age.²³⁻³¹

The earliest reference to rugae was in anatomy text book by Winslow in 1732. earliest illustration of Palatal rugae was probably by Santorini in 1775, wherein he put a drawing depicting 3 wavy lines crossing the midline of palate.⁹ Harrison Allen in 1889 suggested that palatine rugae can be used as an alternative method for human identification.³² The first palatal classification system was put forth by Gorla in 1911. Palatal Rugoscopy was first proposed in 1932, by a Spanish investigator called Trobo Hermosa.³³ In 1937, Carrea developed a detailed study and established a way to classify palatal rugae.³³ One year later, Da Silva proposed another classification and, in 1946, Martins dos Santos presented a practical classification based on rugae location.³⁴

In 1983, Brinon, following the studies of Carrea, divided palatal rugae into two groups (fundamental and specific) in a similar way to that with the fingerprint.³⁴ In this manner, dactiloscopia and palatoscopia were united as similar methods based on the same scientific principles as sometimes, palatoscopia can be of special interest in cases where there are no fingers to be studied.³⁵

Lysell's classification (1955)²³⁻²⁴: This is the most important classification and has been used widely in research involving rugae. It is comprehensive and includes the IP. Rugae are measured in a straight line between the origin and termination and are grouped into three categories:

Primary: 5 millimeters or more.
Secondary: 3-5 mm.
Fragmentary: 2-3 mm.

Rugae smaller than 2 mm are disregarded. The rugae on both sides of the palate are numbered separately from anterior to posterior and classified according to shape, position or origin in relation to the median palatal raphae. Three categories of unification are recognized in this system:

- Common origin diverging laterally;
- Separate origins converging laterally;
- Separate origins converging laterally but involving one primary and one secondary rugae.

Branching, breaks, papillations, annular formations and spirals are counted, while the rugae directions are measured in degrees relative to the distribution of secondary and fragmentary rugae by noting their proximity to the nearest primary rugae while observing the posterior border relationship with the teeth. The clinician measures the IP and classifies it according to one of seven shapes.

There are several ways to examine palatal rugae.8

1. Intra-oral examination: Most commonly used technique

- Advantages: Easy to perform and cost effective.
- Disadvantages: No records exist with this method which makes future comparison difficult.

2. Photographs and Impression of maxillary arch:

- Advantages: Futures comparisons can be made, easy to perform and cost effective

3. Computer software programs: Superimposition of various digital photographs for comparing rugae pattern can be Performed using various computer software.g, RUGFP-ID, Palatal Rugae Comparison Software (PRCS Version 2.0).

4. Calcorugoscopy or Overlay print: Palatal rugae in maxillary cast can be used to perform comparative analysis

5. Stereoscopy: Can be used to obtain the 3 dimensional image of palatal rugae anatomy

Relevance of Palatal Rugae In Dentistry

- **Landmark in Orthodontic treatment:** It serve as suitable reference points from which the clinician can derive the reference planes necessary for longitudinal cast analysis. Positional changes of posterior teeth in the anteroposterior direction are relevant to the diagnosis and correction of sagittal occlusal abnormalities and arch length discrepancies.³⁶⁻³⁸

- **Palatine rugae in speech and palatal prostheses:**
- Pronunciation of certain letters e.g, "S", "Sh" requires contact of the tongue to palatal rugae. Palatography frequently has served as the basis for determining the shape of the anterior palatal vault most conducive to satisfactory sound articulation.³⁸

- **Palatal vault shape:** Patients whose speech is sensitive to a changed relationship of the tongue to a palatal prosthesis may require surface texture to orient the tongue. The palatine rugae often can serve as a cue. Because the lack of texture on the palatal portion of a complete denture can impede proper articulation, one solution is to add palatine rugae. Unfortunately, the addition of rugae to a prosthesis is not a foolproof method of eliminating speech problems. Landa reported that rugae in dentures are ineffectual or sometimes detrimental to speech if they add unnecessary thickness to the anterior palatal region.³⁸

- **Antero-posterior tooth movement:** Hoggan and Sadowsky investigated the use of the palatine rugae as reference points for measuring tooth movement in a manner comparable with cephalometric superimpositions and concluded that palatine rugae could be used reliably to assess anteroposterior tooth movements.³⁹

Palatine rugae in cleft palate patients:

Early diagnosis of submucosal cleft palate is important. In children too young to tolerate nasendoscopy and videofluoroscopy, the diagnosis depends on the patient's clinical history and intraoral examination findings. Kratzsch and Opitz investigated the relationship of palatine rugae to points(landmarks) and distances on the cleft palate during the period from birth to the time of early mixed dentition. The results of their study indicated that a comparison of distances from the palatine rugae with distances between equivalent points revealed the changes that occurred in the anterior palate during various stages of orthodontic therapy and growth.⁴⁰

Variation of rugae pattern in different ethnic groups, geography and gender:Rugae pattern in individuals definitely show differences, and they are also capable in defining the race, geography and gender of the individual. There seems to be a significant association between rugae forms and ethnicity.

Fahmi FM et al.(2001) had conducted study in Saudi Arabia demonstrated that there was no significant difference in total number of rugae between male and female Saudi Arabians, but significant differences were found in two shapes, the converge type which was found to be higher in females and the circular types were found to be higher in males. ⁴¹ In a study by Seenivasan M et al.(2013) observations were made that the Incidence of primary, secondary, straight and wavy rugae were more in females than male participants, whereas curved rugae had more predilections towards male population. Statistical analysis showed there was no difference in rugae pattern between genders, but there was a statistical difference in the number of the unification type of rugae which was found to be higher among the among the females than the males. In addition, statistical difference was observed between male and female in total number of rugae.⁴² During the comparison of rugae among men and women, many studies revealed that wavy and curved patterns show sexual dimorphism, but converging type of rugae were seen to be higher in females.⁴³

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