

Rugoscopy- Science of Palatal Rugae: A Review

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ABSTRACT

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. The purpose of this paper is to identify / recognize the role of dentist as a helping hand in the identification of an individual after a thorough study of one's rugae pattern. Information was collected from scientific articles published on the databases SciELO, MEDLINE and PUBMED in last 25 years, as well as technical books and guidelines of international committees. Palatal rugae serve as a reference landmark and could be used in the identification. Results of several studies show a significant association between rugae forms and different races so it can be used as an important forensic tool.

KEYWORDS: Human identification, Palatal Rugae, Rugoscopy

INTRODUCTION

Forensic Odontology is a specialty in dentistry which occupies a primary niche within the total spectrum of methods applied to medico-legal identification. Forensic odontology can be defined as a branch of dentistry which deals with the appropriate handling and examination of dental evidence and with the proper evaluation and presentation of dental findings in the interest of justice.¹ 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.² 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.³

According to the Glossary of Prosthodontic Terms, rugae are anatomical folds or wrinkles (usually used in the plural sense); the irregular fibrous connective tissue located on the anterior third of the palate. They are also called "plica palatinae" or "rugae palatine."⁴ Palatoscopy or palatal rugoscopy is the name given to the study of palatal rugae in order to establish a person's identity.⁵

Palatal rugae appear towards the third month of intrauterine life & its development and growth is controlled by epithelial- mesenchymal interactions.⁶

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The first rugae are distinguished in human embryos of 32 mm next to the incisive papilla and in the prenatal stage are relatively prominent.^{7,8} The palatal rugae at birth are well trained with a typical orientation pattern and adolescence acquires the final feature shape of each individual.⁹ Once they are formed thus, may experience changes in their size due to growth of the palate, but its shape is maintained.¹⁰

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.¹¹ 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.¹² 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.¹³ Overall palatal rugae have been considered relevant for human identification due to its stability, being equivalent to the fingerprint, unique for each individual.¹⁴ 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 Lysell¹⁵ and Thomas and Kotze¹⁶ 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.¹⁷ In contrast, Lysell considered that the number of rugae decreased from 23 years of age onwards.¹⁵ 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.^{12,18} However, trauma, extreme finger sucking in infancy, and persistent pressure with orthodontic treatment and dentures can contribute to changes in rugae pattern.^{15,19} 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.^{15,17,20,21} Despite the ongoing problem of describing palatal rugae patterns qualitatively and quantitatively, their uniqueness to individuals has been recognized in forensic science as providing a potentially reliable source of identification.

Twin studies have revealed that rugae patterns have an underlying genetic basis.¹⁵ Thomas and Kotze were also able to discern different rugae patterns in southern African populations implying different genetic origins.²²⁻²⁴

HISTORICAL REVIEW

The earliest reference to rugae was in anatomy textbook by Winslow in 1732 and was first illustrated by Santorin in 1975.¹⁸ Harrison Allen in 1889 suggested that palatine rugae can be used as an alternative method for human identification.²⁵ Palatal Rugoscopy was first proposed in 1932, by a Spanish investigator called Trobo Hermosa²⁶. In 1937, Carrea developed a detailed study and established a way to classify palatal rugae.²⁶ One year later, Da Silva proposed another classification and, in 1946, Martins dos Santos presented a practical classification based on rugae location.²⁷

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.²⁷ In this manner, dactyloscopy and palatoscopy were united as similar methods based on the same scientific principles as sometimes, palatoscopy can be of special interest in cases where there are no fingers to be studied.²⁸

Classification of Rugae

The first system of classification was developed by Gorla in 1911 and was rudimentary. He categorized rugae pattern in two ways: specifying the number of rugae and specifying the extent of the rugal zone

relative to the teeth. In this system, compound rugae of two or more branches were counted as one. Gorla further distinguished two types: simple or primitive and more developed.²⁹

Lysell's classification in 1955 is the most important, and has been used widely in research involving rugae.¹⁵ It is comprehensive and includes the incisive papillae. 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 to 5 mm;
- Fragmentary: 2 to 3 mm;
- Rugae smaller than 2 mm are disregarded.

This is rather simplified picture of the intricate form that rugae usually present. Therefore, Thomas and Kotze further detailed them as branched, unified, cross linked, annular, and papillary, among others.¹⁶

In 1955, Carrea categorized four main types of rugae according to direction, giving roman numerals, with sequence according to Arabic numerals and the shape denoted by letters.²⁶ The classification of rugae by Basauri consists of two groups: simple and compound, which is subdivided into 10 types that describe particular shapes: 0, pointed; 1, straight; 2, curved; 3, angled; 4, sinuous; 5, circular; 6, Greek; 7, calyx shaped; 8, racket-shaped; 9, branched.³⁰

The classification by Lima consists of four main types: punctuate, straight, curved and composite.³¹ This classification used to describe the rugae patterns was based on those described by Lysell¹⁵ and Thomas and Kotze.¹⁶ (Fig 1)

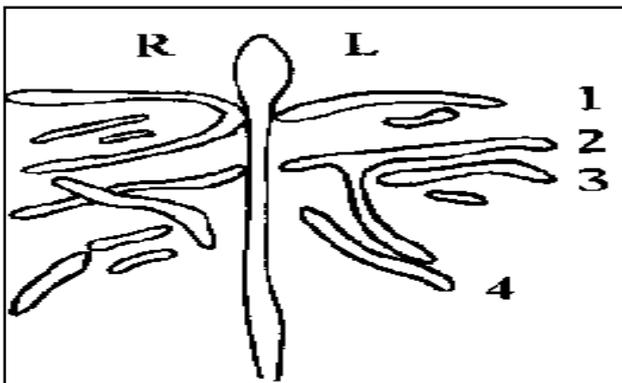


Fig 1: Rugae pattern and position

Rugae length was recorded under magnification with a slide calliper to an accuracy of 0.05 mm following the descriptions of Thomas and Kotze.²⁸ Having determined the length of all the rugae three categories were formed:

- Primary rugae: (A-5 to 10 mm; B-10 mm or more)
- Secondary rugae: 3-5 mm
- Fragmentary rugae: less than 3 mm. (All rugae more than 1 mm long were recorded under the fragmentary ruga category).

The shapes of individual rugae were classified into four major types: curved, wavy, straight and circular. (Fig 2)

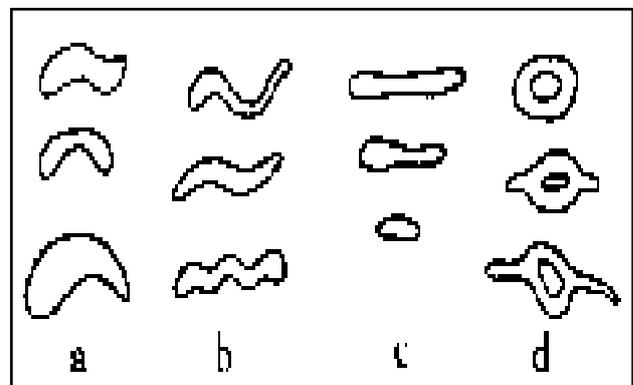


Fig 2: Rugae Shapes

Straight types ran directly from their origin to termination. The curved type had a simple crescent shape which curved gently. Evidence of even the slightest bend at the termination or origin of rugae led to a classification as curved. The basic shape of the wavy rugae was serpentine; however, if there was a slight curve at the origin or termination of a curved rugae it was classified as wavy. To be classified as circular, rugae needed to display a definite continuous ring formation.

The direction of each primary rugae was determined by measuring the angle between the line joining its origin and termination and a line perpendicular to the median raphe. Forward-directed rugae were associated with positive angles, backward-directed rugae with negative angles, and perpendicular rugae with angles of zero degrees.

Unification occurs when two rugae are joined at their origin or termination. Unifications in which two rugae began from the same origin but immediately diverged were classified as diverging. Rugae with different origins which joined on their lateral portions were classified as converging.

Trobo classified palatal rugae according to shape, number, size and position.³²

Shape Analysis: The shape of the palatine rugae was registered according to the classification of Trobo.³² This classification also divides rugae into two groups: Simple rugae, classified as ABCDEF, where rugae shapes are well defined, and Composed rugae, classified as type X, with a polymorphisms variety (these rugae composed result of the union of two or more simple rugae). Then he made a rugograma, from the right side and then the left side, starting with the main ruga (closest to the palatal raphe), which was classified with a capital letter, and then rugae were classified with lower case letters. (Fig 3)



Fig 3: Calcorrugoscopy in plaster model

Number analysis: There were all palatal rugae that were totally bounded in calcorrugoscopy.

Size analysis: Using a digital caliper (0.01mm) found the maximum longitudinal diameter of all palatal rugae accounted, according to the corresponding type under the classification of shape.

Position analysis: To analyze the position of the palatal rugae were standardized photographs of models obtained and using Photoshop software

(Adobe ® Photoshop ® CS4) palate was divided into quadrants, with the aim of obtaining the coordinates position of palatal rugae; for this, six horizontal lines:

- I. Transverse line passing through the palatal cervical third of the central incisors.
- II. Transversal line that goes from the mesial side of the right lateral incisor to the mesial side of the left lateral incisor.
- III. Transverse line through the mesial side of the right canine and reaches to the mesial side of the left canine.
- IV. Transverse line through the mesial side of the right first premolar and reaching to the mesial side of the left first premolar.
- V. Transverse line through the mesial side of the right second premolar and reaching to the mesial side of the left second premolar.
- VI. Transverse line through the distal side of the second premolar and reaching to the right side of the distal left second premolar.

Based on these lines between the areas they were named as follows:

- Between lines I and II.
- Between lines II and III.
- Between lines III and IV.
- Between lines IV and V.
- Between lines V and VI.

CONCLUSION

Located in the anterior half of the roof of the mouth, palatal rugae serve as a reference landmark in various dental treatment modalities and could be used in the identification of submucosal clefts. Palatine rugae can be used to assess the amount of anteroposterior tooth movement, because they remain stable during a person's life. Moreover, the results of several studies show a significant association between rugae forms and different races. Palatine rugae are unique to individual can therefore be used for individual identification in forensic odontology.

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