

PALATOSCOPY: A NOVEL TOOL IN HUMAN IDENTIFICATION

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ABSTRACT

Fingerprint, DNA and dental comparisons are probably the most common techniques used in forensic investigation. The use of teeth in postmortem identification has gained prominence over the last half-century. However, it is not possible in the edentulous, therefore palatal rugae can be used as a supplement in establishing a person's identity. In this paper, Palatoscopy technique is discussed which can be used successfully in human identification.

INTRODUCTION

Identifying live or dead people is often a difficult and time consuming process. Identifying living people is sometimes difficult because people do not normally wish to be identified. Therefore, in order to achieve this goal, people disguise their presence in various ways. Identifying the dead raises a whole different set of problems, which relate to; The natural process of decomposition; Scavenger animal actions; The circumstances in which death occurred. Palatoscopy, or palatal rugoscopy, is the name given to the study of palatal rugae in order to establish a person's identity. Due to anatomical position, it is unlikely that the study of palatal rugae could be used in the process of linking a suspect to a crime scene. On the other hand, palatoscopy may be used as a necro-identification technique. As previously mentioned, it will be in these particular circumstances that palatoscopy is most valuable. The possibility of finding antemortem data supports this idea. Nowadays, palatal rugae patterns are considered a viable alternative for identification purposes. Some investigators aim to assess its feasibility with the aid of a computer and a software program. The results so far are good, but expected to be better.

In fact, the Brazilian Aeronautic Minister demands palatal rugoscopy of all its pilots, in order to ensure their identification in case of accident.

HISTORICAL REVIEW

Caldas et al [1] have reported that palatal rugae were first described by Winslow in 1753. However, in 1897 Kuppler was the first person to study palatal anatomy to identify racial anatomic features. In 1932 Palatal rugoscopy was first proposed in 1932, by a Spanish investigator called Trobo Hermosa. In 1937 Carrea developed a detailed study and established a way to classify palatal rugae. One year later, Da Silva proposed another classification. Lysell [2] developed the first classification system for palatal rugae pairs. Lysell as well as Sassouni [3], believed that, in general, the palatal rugae are unchanged throughout life, but found that this does not apply in every aspect. Fiene [4] discovered that the palatal rugae could be helpful in anthropological paternity investigations. In 1983 Brinon, following the studies of Carrea, divided palatal rugae into two groups (fundamental and specific) in a similar way to that done with fingerprints.

In this manner, dactiloscopia and Palatoscopy were united as similar methods based on the same scientific principles and are sometimes complementary: For instance, Palatoscopy can be of special interest in

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those cases where there are no fingers to be studied (burned bodies or bodies in severe decomposition).

ANATOMICAL ASPECTS

The palatal rugae are located on the anterior portion of the maxilla (Figure 1 A to C) [25]. Anatomically, in hard mucosal palate, one can identify an antero-posterior thin central groove, bordered, on each side, by a crest: the palatal raphae. From this crest, laterally, three to seven smaller crests emerge. These crests are called palatal rugae. Palatal rugae are irregular, asymmetric ridges of mucous membrane extending lateral from the incisive papilla and the anterior part of the median palatal raphe [5,6]. Palatal rugae are formed in the 3rd month in utero from the hard connective tissue covering the bone [7].

Hausser E. Zur Bedeutung (1951) [8] suggested with the increase in size of the anterior part of the palate in the early years of life, the length of the rugae and the distance between them increases. The pattern of orientation of the rugae remains unchanged throughout life. The shape, length, width, prominence, number and orientation of palatine rugae vary considerably among people. Once formed, they do not undergo any changes except in length, due to normal growth, remaining in the same position throughout an entire person's life. Not even diseases, chemical aggression or trauma seem to be able to change palatal rugae form [1]. The ability of palatal rugae to resist decomposition changes for up to seven days after death was also noted.

PALATAL RUGAE CLASSIFICATIONS

The supposed uniqueness and overall stability of palatal rugae suggest their use for forensic identification. Palatal rugae are used in human identification not only due to their singularity and unchangeable nature, but also due to other advantages, namely their low utilization costs. However, the subjective nature of observation and interpretation within and between observers poses a problem. Nowadays, there are several known palatal rugae classifications.

However, according to several authors, Lysell, in 1955, developed the first classification system for palatal rugae pairs.

Various classification system proposed for Palatoscopy are as outlined below:

Lo´Pez De Le´On Classification (1924) [9]

Dating from 1924, this classification has only historic relevance. The author proposed the existence of a link between a person's personality and palatal rugae morphology. In this manner, there were four known types of palatal rugae:

- B—Bilious personality rugae;
- N—Nervous personality rugae;
- S—Sanguinary personality rugae;

L—Lymphatic personality rugae.

The letters B, N, L, and S, stand for the different personalities. The letters l and r stand for the left and right side of the palate, and are followed by a number, which specifies the palatal rugae number on each side. For instances, a possible rugogram would be Br6; Bl8.

Trobo Classification (1932) [9]

This classification also divides rugae into two groups: Simple rugae, classified from A to F and composed rugae, classified with the letter X. Composed rugae result from two or more simple rugae unions. The rugogram is made from right to left, beginning with the principal ruga (the one closest to the raphae), which is classified with a capital letter. The following rugae are classified with small letters. Finally, the left side of the palate is described using the same criteria (Table 1).

Carrea Palatal Rugae Classification(1937) [10]

This author divides palatal rugae into four different types, as shown in below (Table 2). Palatal rugae are classified only according to their form and no formula (rugogram) is developed.

Da Silva Palatal Rugae Classification (1938) [9]

In this classification, palatal rugae are divided into two groups: simple, from 1 to 6 and composed, resulting from two or more simple rugae. They are named according to each rugae number. It is possible to classify each rugae individually (describing its form), but also to describe all the palatal rugae system (describing each ruga type number), making this a difficult classification to use. (Table 3)

Martins Dos Santos Classification (1946) [10]

Based on the form and position of each palatal rugae, this classification indicates and characterizes the following (Table 4) One initial rugae; the most anterior one on the right side is represented by a capital letter. Several complementary rugae; the other right rugae are represented by numbers; One subinitial rugae; the most anterior one on the left side is represented by a capital letter; several subcomplementary rugae; the other left rugae are represented by numbers. The numbers and letters given to each rugae, relate to its form and can be seen in Table 4.

Basauri Classification (1961) [9]

Like the Trobo classification, this is a very easy classification to use. It distinguishes between the principal rugae, which is the more anterior one (labelled with letters) and the accessory rugae, which concerns all the remaining rugae (labeled with numbers), as seen in Table. The rugogram is elaborated beginning from the right side of the palate. (Table 5)



Cormoy System

This system classifies palatal rugae according to their size, in:

1. Principal rugae (over 5 mm);
2. Accessory rugae (ranging from 3 to 4 mm);
3. Fragmental rugae (with less than 3 mm length).

The form (line, curve, and angle), origin (medial extremity) and direction of each ruga are also described. Possible ramifications are also pointed out. Rugae that share the same origin, interrupted rugae and the incisive papilla are described as well. It is a very complete system. However, its use does not lead to rugogram elaboration, which makes the managing and processing of data difficult.

Correia Classification

Rugae are labeled with numbers or letters, according to their form. The rugogram is formed like a fractional equation. The right side is the numerator and the left side is the denominator. The first right and the first left palatal rugae (initial and subinitial rugae) are classified by a letter and the other right and left (complementar and subcomplementar rugae) are assigned numbers.

Palatoscopy in Edentulous Cases

When a victim has no teeth, information for use in personal identification based on methods available in forensic odontology is much more limited than in the case of dentate victims. For edentulous victims, (Fig. 2) [25] some identification methods are available, such as comparing the anatomy of the Paranasal sinuses and comparing bony patterns seen on radiographs. Furthermore, the victims' dentures themselves, can provide us with more personal information with regard to denture making, denture materials, and their unique shapes, for use as ante mortem data or postmortem evidence (Fig. 3) [25]. Among the evidence taken from an edentulous victim, a palatal rugae pattern is one of the unique and relatively obtainable morphological features, and the pattern can be taken not only directly from the hard palate, but also from the mucosal surface of the dentures.

Application of palatal rugae patterns to personal ID was 1st suggested by Allen in 1889. Subsequently, its usefulness has mainly been established in dentate cases. In contrast, the usefulness of this method for edentulous victims has not yet been fully established. Thomas and Wyk proposed the usefulness of rugae pattern for personal identification by comparing its morphological features with the victim's dentures. They successfully identified a severely burnt edentulous body by comparing the rugae to those on the victim's old denture indicating, among other things, that rugae are stable in adult life. However, Jacob and Shalla doubted its usefulness because the accuracy of identification based on palatal rugae tracings was only 79 percent in their trials. M. Ohtani et al in their study analyzed the incidence of obtaining a correct match in such edentulous case, revealed that there were three major

misleading shapes that could give rise to a low rate of correct matches; these are:

1. Severely low and poorly demarcated eminences of rugae,
2. Change of palatal height, and
3. Non-complex rugae pattern.

These features are mainly due to the shape of the edentulous palate itself and rarely due to the dentures, and could lead to difficulties in finding unique points for use in matching rugae patterns. These findings as notified by the authors suggest that an appropriate selection of cases, taking into consideration the above misleading shapes, may establish an increased rate of accuracy for identification with this method, thereby bringing the percentage of correct matches closer to 100 in edentulous cases, which is also the percentage of correct matches previously reported in dentate cases. The use of teeth in postmortem identification has gained prominence over the last half-century; the rugae are well protected by the lips, buccal pad of fat and teeth and hence, survive postmortem insults. Postmortem dental identification is, however, not possible in the edentulous and palatal rugae can be used as a supplement in such instances.

Thus, palatal rugae appear to possess the features of an ideal forensic identification parameter because of their:

1. Uniqueness,
2. Postmortem resistance and
3. Stability

In addition, rugae pattern may be specific to racial groups facilitating population identification (which may be required post-disasters)

ANALYSING AND RECORDING PALATAL RUGAE:

There are several ways to analyze palatal rugae. Intraoral inspection is probably the most used and also the easiest and the cheapest. However, it can create difficulties if a future comparative exam is required. A more detailed and exact study, as well as the need to preserve evidence may justify oral photography or oral impressions. Calc rugoscopy, or the overlay print of palatal rugae in a maxillary cast, can be used in order to perform comparative analysis [9]. By using stereoscopy, one can obtain a three dimensional image of palatal rugae anatomy. It is based on the analysis of two pictures taken with the same camera, from two different points, using special equipment. Another technique is the stereophotogrammetry which, by using a special device called Traste Marker, allows for an accurate determination of the length and position of every single palatal rugae [9]. However, due to its simplicity, price and reliability, the study of maxillary dental casts is the most used technique. [9].

ADVANTAGES OF PALATOSCOPY:

Palatal rugae are used in human identification due occur from orthodontic movement, extraction, aging, and



palatal expansion do not modify the rugae enough to hamper identification [11].

1. Low utilization costs. [10]
2. It is possible to have antemortem data established such as records found in dental practice in different forms (dental casts, old prosthetic maxillary devices and intraoral photographs) to compare with post mortem data. [11]
3. Rugoscopy is rather simple technique not requiring any complex instrumentation [11].

PROBLEMS WITH PALATOSCOPY

Palatoscopy is a technique that can be of great interest in human identification. In fact, contrary to lip

prints, it is possible to have antemortem data established such as records found in dental practice in different forms (dental casts, old prosthetic maxillary devices and intraoral photographs). However, palatoscopy might not be so useful in crime scene investigations in the linking of suspects to crime scenes. In fact, this kind of evidence is not expected to be found in such circumstances. Another aspect of palatoscopy that one must consider is the possibility of rugae pattern forgery. In a case report, Gitto et al. described a method where palatal rugae were added to a complete denture in order to improve speech patterns in some patients. This process can lead to false identity exclusion due to misleading antemortem data.

Figure 1 A. A clinical picture of palatal rugae



Figure 1 B and C. Cast showing the palatine rugae

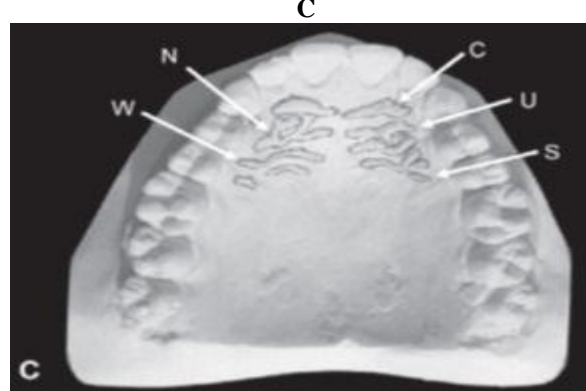
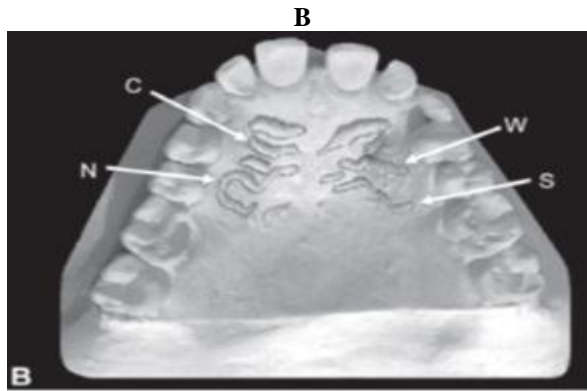


Figure 2. Radiograph of an edentulous patient showing para-nasal sinuses



Figure 3. Mucosal surface of maxillary denture showing palatine rugae



Table 1. Trobo Classification

Classification	Rugae type
Type- A	Point
Type-B	Line
Type-C	Curve
Type-D	Angle
Type-E	Sinuuous
Type-F	Circle

Table 2. Carrea palatal rugae classification

Classification	Rugae type
Type I	Posterior anterior directed rugae
Type II	Rugae perpendicular to the raphe
Type III	Anterior- posterior directed rugae
Type IV	Rugae directed in several directions

Table 3. Da Silva palatal rugae classification

Classification	Rugae type
1.	Line
2.	Curve
3.	Angle
4.	Circle
5.	Wavy
6.	Point

Table 4. Martins dos Santos classification

Rugae type	Anterior position	Other positions
Point	P	0
Line	L	1
Curve	C	2
Angle	A	3
Circle	C	4
Sinuuous	S	5
Bifurcated	B	6
Trifurcated	T	7
Interrupt	I	8
Anomaly	An	9

Table 5. Basauri classification

Principal rugae classification	Accessory rugae classification	Rugae anatomy
A	1	Point
B	2	Line
C	3	Angle
D	4	Sinuuous
E	5	Curve
F	6	Circle
X	7	Polymorphic

CONCLUSION

In forensic odontology, cheiloscopy and palatoscopy is upcoming technique for human identification. Few studies using palatal rugae as a means of forensic identification are found in literature. However, the idea of rugae being unique to an individual is promising and deserves further investigation.

The day is not far when palatoscopy will be considered important forms of transfer evidence, and shall compliment fingerprints for identification of individual and sex determination.

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CONFLICT OF INTEREST: None



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