

An Overview of Chelioscopy & Palatoscopy: An Aid in Forensic Investigation

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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 and lip prints can be used as a supplement in establishing a person's identity. In this paper, two unusual techniques: Chelioscopy and Palatoscopy are discussed which can be used successfully in human identification.

Key words: Forensic; Chelioscopy; Palatoscopy

INTRODUCTION

Today, in India, as well as worldwide, crimes of diverse character are on the rise. Both criminals and knowledgeable elite of the public are making use of stylish methodological measures while committing crimes to put forensic scientist, police, and the public off the scene. Hence, the role of crime scene detectives has become more challenging than ever in this civilized modern world.¹The entity of forensic dentistry deals with dental identification of the unknown body. Trauma and the oral tissues involve the interpretation of oral injury and its application to legal matters.²

One of the most interesting emerging method for human identification which originates from the criminal and forensic practice includes Chelioscopy (study of lip prints) and Palatoscopy (study of palatal rugae patterns).³ Cheiloscopy derived from the Greek words chelios= lips, eskochein= see which refers to the utilization of lip prints as means of personal identification.^{4,5} Tsuchihashi et al named the wrinkles and grooves visible on the lips as "Sulci labiorum rubrorum" which are highly sensitive mobile folds, composed of skin, muscle, glands and mucous membrane surround the oral orifice and form the anterior boundary of the oral cavity. The importance of chelioscopy is linked to the fact they are unique, permanent and unchangeable to one person, except in monozygotic twins and feasible to identify lip patterns as early as the sixth week of intra uterine life.^{4,5,6}

Palatal rugae (Plica palatinae transverse) refer to the ridges on the anterior part of the palatal mucosa each side of the

median palatine raphae behind the incisive papilla. Rugae patterns are used in the fields of anthropology comparative anatomy, genetics and forensic odontology.⁷ Palatoscopy or palatal rugoscopy is the name given to the study of palatal rugae in order to establish a person's identity.⁴ Rugae pattern do not change due to growth of an individual and reappears after trauma or surgical removal. Males have better developed rugae compared to females. Palatal mucosa is protected by the lips, cheek and tongue thus often protected from fire and mass disasters. Palatal relief design of the dentures may be used to compare and identify the individuals.⁷

Historical overview of Chelioscopy & Palatoscopy:^{4,6}

Fischer was the first anthropologist to describe the furrows on the red part of the human lips in 1902. In 1930, Diou de Lille developed some studies which led to lip print use in criminology and in 1932, Edmond Locard, one of France's greatest criminologists, acknowledged the importance of Cheiloscopy in crime investigation. In 1950, Le Moyer Snyder, in his book "Homicide Investigation", mentioned the possibility of using lip prints in the matter of human identification. In 1960 Santos suggested that the fissures and the criss-cross lines in the lip could be divided into different groups. In the period between 1968-1971, Suzuki and Tsuchihashi examined 1364 persons at the Department of Forensic Odontology at Tokyo University and established that the arrangement of lines on the red part of human lips is individual and unique for each human being. In 1972 Renaud studied 4000 lip prints and confirmed the singularity of each one, supporting idea of lip print singularity. In 1974, Tsuchihashi and Suzuki proposed a new classification for lip

prints. They further evaluated in other studies, the principles of heredity of furrows on the red part of the lips.

Kuppler in 1897 was the first person to study palatal anatomy to identify racial anatomic features. 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. In 1946, Martin dos Santos presented a practical classification based on rugae location. In 1983, Brinon, following the studies of Carrea, divided palatal rugae into two groups in a similar way to that done with fingerprints. In this manner, dactiloscopia and palatoscopia were united as similar methods based on the same scientific principles and are sometimes complementary, for instance, palatoscopia can be of special interest in those cases where are no fingers to be studied (burned bodies or bodies in severe decomposition).

CLASSIFICATION OF LIP PRINTS: ^{4,5}

1- **Santos M** was the first person to devise a classification of lip grooves:

Simple wrinkles:

- Straight line
- Curved line
- Angled line
- Sine – shaped curve

Compound wrinkles:

- Bifurcated
- Trifurcated
- Anomalous

2- **Suzuki K & Tsuchihashi**, devised a classification method of lip prints:

Classification	Groove
• Type I	Complete vertical
• Type I'	Incomplete vertical
• Type II	Branched
• Type III	Intersected
• Type IV	Reticular pattern
• Type V	Irregular

3- **Martin Santos** classification:

A- Simple: When they are formed only by one element; this element can be a straight line (R-1), a curve (C-2), an angular form (A-3) or sinusoidal (S-4).

B- Compound: When they are formed by several elements; they can be bifurcated (B-5), trifurcated (T-6) or anomalous (An-7).

4- **Renaud** lip prints classification:

Classification	Groove type
A	Complete vertical
B	Incomplete vertical
C	Complete bifurcated
D	Incomplete bifurcated
E	Complete branched
F	Incomplete branched
G	Reticular pattern
H	X or coma form
I	Horizontal
J	Other forms (ellipse, triangle)

5- **Afchar – Bayat** lip prints classification:

Classification	Groove type
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A1	Vertical and straight grooves covering the whole lip.
A2	Like the former, but not covering the whole lip.
B1	Straight branched grooves
B2	Angulated branched grooves
C	Converging grooves
D	Reticular pattern grooves
E	Other grooves

Palatal rugae Classification: ^{4,8}

1- **Carrea** Classification: Based on form palatal rugae divided in four different types:

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

2-**Martins dos Santos** Classification: Based on the form and position of each palatal rugae, this classification indicates and characterizes the following:

- 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.

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

3-**Da silva** Classification: Palatal rugae are divided into two groups: Simple, from 1 to 6 and Composed, resulting from two or more simple rugae.

4- **Trobo** Classification: Rugae are divided into two groups: Simple ruga, classified from A to F and Composed rugae, classified with the letter X. Composed rugae result from two or more simple rugae unions.

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

5-**Basauri** Classification: It distinguishes between the principal rugae, which is the more anterior one (labeled with letters) and the accessory rugae, which concerns all the remaining rugae (labeled with numbers).

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

6- Cormoy Classification: Palatal rugae are classified according to their size:

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

7- Thomas & Kotze's Classification:

- 1- Primary rugae- 5 – 10 mm / 10 mm or more
- 2- Secondary rugae- 3 – 5 mm
- 3- Fragmentary rugae- Less than 3 mm

8- Kapali et al Classification: It is classified based on the shape of the palatal rugae:

- Curved
- Wavy
- Straight
- Circular

DISCUSSION

Analyzing and recording lip prints:

Lip prints in a crime scene investigation is very important in establishing the true nature of the facts and link a subject to a specific location if found on clothes or other objects, such as glasses, cups or even cigarettes' butts. When searching for lip prints, one must always consider that not all lipstick smears are coloured; in fact, in recent years the cosmetic industry has been developing new lipsticks which do not leave a visible smear or mark when they come in contact with different items, these are called persistent lipsticks.⁴ Cheiloscropy is a process which provides both qualitative and quantitative results by the examination of system of furrows on the red part of human lips. The investigation of lip prints (both visible and latent) is very useful elementary in resolving a criminal act. Traditional lipstick produces a print that is easily identifiable but lip prints made without lipstick are invisible, requiring reagents that are more sensitive than conventional materials to locate and develop the prints.¹

Segui MA et al evaluated the latent lip print test produced by four permanent lipsticks which act as new hidden evidence at the crime in contrary to conventional lipsticks, does not leave visible lip prints and thus can be overlooked at the crime scene. They used four print vehicles in their study are ceramics, glass, cotton fabric and paper. Lip prints were left to dwell for different periods and were later developed using aluminum powder, cobalt oxide powder and magnetic powder. They concluded from their study that identifiable lip prints can be obtained up to 30 days after being produced.⁹ Navarro E et al highlighted the effectiveness of lysochromes on the developing of invisible lipstick contaminated lip marks on human skin by using reagents: Sudan III, Oil Red O and Sudan Black which are

effective for obtaining recent latent lip prints on corpse's skin.¹⁰ Luminescence is specially a useful property for the search of invisible evidences at the scene of a crime. Castello A et al reported that luminous lip- prints serve as criminal evidence in their study by using Nile Red as a potential developer for latent lip prints which showed that Nile Red reagent is highly efficient to get latent lip prints on very old prints (over 1 year) also.¹¹

Processing lip prints depends on the anatomical, morphological and histological tissue features of lips. Observation should be the first step when processing lip prints using white and ultraviolet sources. Photographs should be made prior to any processing in order to protect the evidence. According to FBI guidelines, latent prints should be photographed individually with an identification label and a scale; each step in the processing sequence must be photographed. Plumb carbonate is a white powder which can be used as a developer with brush, over smooth, polished, metallic or plastic surfaces. Its only limitation is its use over white surfaces. In such instances, marphil black powder or fat black aniline dyer are better choices since they both have a dark color. Silver nitrate can lead to positive results on non-ideal surfaces, such as untreated wood or cardboard. DFO and ninhydrin are chemical developers also used on porous surfaces. On plastic or waxed surfaces, or on vinyl gloves, using cyanoacrylate dye is a god choice. In photographs, latent prints can be developed using cyanoacrylate dye or an iodine spray reagent.⁴ Castello et al point out that the latent lip prints on paper and developed with Sudan Black which can be used as a potential DNA source for forensic identification.¹²

Utsuno H et al studied the lip prints patterns from cadavers with various causes of death and also to determine the effects of fixation on postmortem changes in lip impressions. They kept cadavers at 21°C in dry conditions but no significant changes were found in anthropometric measurements of the lip region before and after fixation.¹³ Osama R et al emphasized that lip prints on paper are more fixed than those on glass because duration of reliability of lip print on paper may be up to 12 weeks even if exposed to ambient conditions, but duration of reliability of lip print on glass may be up to 9th week if kept in closed container in temperature adjusted around 25 degree Celsius but if exposed to ambient conditions it may be up to 6th week.¹⁴

Bindal U et al evaluated the differences in labial impression over eight years of time among 60 subjects, consisted equal ratio of male and female subjects from the three races of Malaysia and they found that Type II (72.50%) was the predominant pattern in Indian race and the least observed pattern was type III (33.75%). Type I' (71.25%) was the most common pattern observed in Malays race and the least observed pattern was type I (12.50%). Type III (87.50%) was the most common pattern observed in Chinese and the least observed was type IV (0%). Moreover there was no change in lip print pattern over a period of eight years. They highlighted that the lip prints have potential in determining the race and sex of an individual.¹⁵ Nagrale N et al studied lip patterns among 500 males and females aged 1-70 years and found that Type I, I', II patterns were most commonly seen among female, while type III and IV lip patterns were

most predominantly seen among males and type II lip pattern was present in both sexes. They highlighted that lip prints are unique and do not change during the life of a person and can be taken as one of the person identification tool.¹⁶ Obik HI et al analyzed the predominant lip print type in Otolo Nnewi community, Anambra state among 600 subjects (257 male and 343 female) of ages 15 to 34 years according to Renaud's classification. They found that Type J pattern (horizontal grooves with other forms) was found to be predominant in both male (18.3%) and female (22.2%).¹⁷

Ravath MCJ et al analyzed the relationship between cheiloscropy and inheritance of cleft lip &/or cleft palate in their study and found that a new whorl pattern was present in the study group children having cleft lip &/or cleft palate whereas the groove count was higher in the fathers' than in the mothers' prints in the upper lip and vice versa in the lower lip.¹⁸ Karim B et al found no correlation between the distribution of different patterns of lip prints based on Tsuchihashi's classification with different ABO and Rh blood groups in their study.¹⁹ Murugan M et al found no significant association between the lip print and finger print patterns in their study which plays an important role in forensic identification but rather, they can be used to substantiate facts in crimes.²⁰

Analyzing and recording palatal rugae:

The palatal rugae has been considered relevant for human identification due to its stable, being equivalent to the fingerprint, unique for each individual and study on the identification of persons is called palatoscopy or palatal rugoscopy. Koneru A et al highlighted that palatal rugae can be used as a reliable complementary technique for the forensic identification because of its significant association between shapes and gender; shapes and ethnicity.²¹ Fahmi FM et al also stressed that palatoscopy can be used as additional method of identification in cases of crimes or aircraft accidents.²²

There are several ways to analyze palatal rugae. Intraoral inspection is probably the most common, easy and less expensive in comparison to other various techniques but it is not standard if a future comparative exam is required. Calcarrugoscopy, or the overlay print of palatal rugae in a maxillary cast, can be used in order to perform comparative analysis. By using Stereoscopy based on the analysis of two pictures taken with the same camera, from two different points, using special equipment by which a three dimensional image of palatal rugae anatomy can be obtained. Stereophotogrammetry is another method by using a special device called Traster Marker which allows an accurate determination of the length and position of every single palatal ruga. However, due to its simplicity, price and reliability, the study of maxillary dental casts is the most used technique.⁴

Kapali S et al compared the number and pattern of rugae in Australian Aborigines and Caucasians and found straight forms being more common in Caucasians, whereas wavy forms in Aborigines and emphasized that there was significant association between rugae forms and ethnicity.⁸ Abdellatif AM et al concluded from their study that palatal rugae shape have significant differences between the Egyptian and Saudi populations, moreover discriminant

function analysis allowed differentiation of the populations based on discrete variables of rugae shape rather than continuous variables of rugae length.²³

Various researchers in India conducted the palatal rugae studies among different population of Indians. Nayak P et al highlighted the importance of palatal rugae shape differences between the Indian populations in their study which showed that wavy and curved were the most prevalent rugae shape, followed by straight rugae. Unifications were few in number while circular rugae were not observed.²⁴ IDA- Mumbai also conducted the study is to determine the palatal rugae pattern in Indian population and concluded that the curved rugae were frequently found in individuals followed by the straight, wavy and the circular.²⁵ Paliwal A et al compared the palatal rugae patterns in 2 different populations of Madhya Pradesh and Kerala in India and found that the wavy pattern is more prevalent followed by curved, straight, unification, circular, and nonspecific. Straight rugae pattern on the right side of the palate in the male subjects was found to be significantly predominant in the MP population, whereas wavy shape was predominant in Keralites; however, rugae patterns on the right side of the palate in female subjects exhibited no significant difference.²⁶ Kotrashetti VS et al compared palatal rugae between two groups from geographically different regions of India with basic origin from Maharashtra and Karnataka state by following Kapali et al and Thomas and Kotze et al classification and the results showed significant difference in wavy, circular and divergent pattern between the two populations with mean number of rugae was greater in females as compared to males with straight pattern.²⁷

Gondivkar SM et al compared the different morphological rugae patterns in males and females of western Indian population and showed a highly significant difference in the sinuous and primary type while the male had a significant difference in the unification with the predominant direction of the rugae was found to be forward relative to backward.²⁸ Kamla R et al compared the rugae patterns in males and females of different age groups of Lucknow city, including twins, siblings and their parents by using Kapali et al classification and found that no two palates are alike in their configuration and once formed, moreover they do not undergo any changes except in length due to normal growth, remaining in the same position throughout a person's entire life.²⁹

Shetty M et al conducted the study to determine any gender difference in palatal rugae pattern belonging to Mangalore city population by applying Thomas & Kotze classification and found that gender wise, there were no significant differences in the total number of rugae but the incidence of curved, straight and forwardly directed rugae were more among females than males, while that of wavy, perpendicular and backwardly directed rugae were more among males.³⁰ Kumar S et al concluded that wavy pattern is most common rugae pattern among Puducherry population. No significant difference in rugae pattern was noted among the male and female group. Rugae pattern is unique to each individual and can be an effective tool in human identification.³¹

Rajguru JP *et al* found that most predominant patterns were straight, wavy and circular with similar distribution between male and female dentate population while there is varied pattern between the sexes of edentulous population.³² Manjunath S *et al* found in their study that the Indian females had more number of rugae on the right side of the palate than the male counterparts. Curved and straight shapes were predominant among the females whereas the wavy pattern was more common among the males as per classification by Thomas and Kotze and concluded that their uniqueness to individuals has been recognized as providing a potentially reliable source of identification.³³ Byatnal A *et al* conducted the study in five different Indian states i.e. Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh and Maharashtra to analyze differences in the palatal rugae patterns and to identify gender wise changes in the palatal rugae shapes in different populations of India. They found that wavy type of palatal rugae pattern is the most predominant variant in five different study groups in both the genders.³⁴

Indira AP *et al* compared palatal rugae patterns based on Martin dos Santos' classification to assess the individuality of rugae pattern and found that each individual had different rugae patterns including dizygous twins and the rugae patterns were not symmetrical, both in number and in its distribution.³⁵ Virdi M *et al* conducted the study to determine the effect of growth, on palatal rugae patterns in paediatric patients over a period of time and found that palatal rugae patterns are unique and do not change. Therefore, palatal rugae pattern are sufficiently characteristic to discriminate between individuals.³⁶ By the use of match up to digital photographs of the palate against the images of cast models of the maxilla photographed with and without highlighting of the palatal rugae by using free image-editing software to identify the pairs is very efficient for human identification as highlighted by Santos KC *et al* in their study.³⁷

Shukla D *et al* and Pateria AH *et al* studied the stability of palatal rugae by matching before and after fifty orthodontic pre- and post treatment casts and they analyzed that the morphology of palatal rugae remains stable throughout life.^{38, 39} Wichniewski C *et al* correlated between the fingerprints and the palatal rugae in their study by using Vucetich's method for the fingerprints analysis and the Carrea's method was utilized for the analysis on palatal rugae. They found that the external clip was the most common pattern among fingerprints on the right hand (48,39%), on the opposite side the internal clip had major incidence (50,54%). The pattern type IV was observed as the most common among the palatal rugae (42,55%) but no statistical correlation was found involving palatal rugae.⁴⁰

Problems with Chelioscopy & Palatoscopy:

The lip print is produced by a substantially mobile portion of the lip. This fact alone explains the reason why the same person can produce different lip prints, according to pressure, direction and method used in taking the print. Another factor to be considered is the existence of some pathological conditions (lymphangioma, congenital lip fistula, lip scleroderma, Merkelson-Rosenthal syndrome, syphilis, lip chelitis, among others), which can invalidate the chelioscopic study. One must also consider the possibility of

postmortem changes of lip prints from cadavers with various causes of death. The main feature for dental identification is the existence of ante mortem data which cannot be expected in chelioscopy. Therefore, the only use of chelioscopy will be to relate lip prints to the lips that produced them.^{4, 8}

There is considerable debate on various methods used for palatal rugae identification like intraoral inspection, study of models (palatoscopy), calcorugoscopy or overlay print, stereoscopy, stereophotogrammetry. Limitations of palatoscopy as this method is not the primary source of forensic investigation and it can be utilized as an adjunctive source for human identification. In fact, contrary to lip prints, it is possible to have ante-mortem data in different forms (dental casts, old prosthetic maxillary appliances & intra oral photographs). However pictures might not be so useful in decomposed body in crime investigation.^{4, 32} 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 ante mortem data.⁴¹

CONCLUSION

For this the forensic odontologist must have broad and basic background knowledge of forensic aspect of dentistry because dental evidence is the most valuable and reliable method. Since the scope of forensic odontology is very challenging therefore oral health professionals should be trained in forensic odontology and can make unique contributions in the administration of justice, which is the key note of democracy.

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