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REVIEW ARTICLE **OPEN ACCESS**

Cheiloscopy Review

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ABSTRACT
Cheiloscopy is the scientific study of lip prints, which involves the analysis of the ridge patterns on the lips for various purposes such as forensic identification and biometric recognition. The unique and permanent characteristics of lip prints make them useful in personal identification, as they can be used to differentiate one individual from another. Cheiloscopy has become an important tool in criminal investigations, as lip prints can be collected from a variety of surfaces and compared to a database of known lip prints to determine the identity of a suspect. The field continues to evolve and improve with advancements in technology, providing a valuable contribution to the field of forensic science.
Key words: *Forensic, lip prints, identification, cheiloscopy*

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INTRODUCTION

Human identification is of paramount importance and it is indeed challenging considering the fact that every individual has distinctive trait. This requires a combination of different procedures to individualize a person or an object. "Identity" is a set of physical characteristics, functional or psychic, normal or pathological, that define an individual [1]. Furthermore, with so much reliance on law enforcement to provide justice, it's only natural to utilise any physical attribute to identify a suspect. When two things come into contact, according to Locard's exchange principle, material is always transferred from one to the other. This principle states that there is a significant likelihood that traces of a person will be left at the site or that traces from the scene will be carried away on the person. [2]As a result, evidence may be present at the crime scene. The traditional methods for personal identification include anthropometry, finger prints, sex determination, age estimation, measurement of height, and differentiation by blood groups, DNA and odontology [3].

Coincidentally, the oral cavity provides a plethora of options that aid in the identification of patients in a specific cohort. Otoscopy, Dactyloscopy, Cheiloscopy, Poroscopy, Rugoscopy and examination of iris had also been used of late in the biometrics/ identification of subjects. The results can be compared to real-life settings in which tiny populations of people of various ethnic and racial backgrounds are served. The morphological sciences have shown that a variety of anatomical traits can be used to distinguish individuals. In this brief review, we discuss cheiloscopy and their applications in forensic identification and the latest trends in identification using the above mentioned techniques.

CHEILOSCOPY

The pattern of wrinkles on the lips has individual characteristics as fingerprints. The wrinkles and grooves on the labial mucosa (called sulci labiorum) form a characteristic pattern. It can be defined "as a method of identification of a person based on characteristic arrangements of lines appearing on the red part of lips or as a science dealing with lines appearing on red part of the lips". [4]

The lip prints being uniform throughout the life and characteristics of person can be used to verify the presence or absence of a person from the crime, provided there has been consumption of beverages, drinks, usage of cloth, tissues or napkin etc., at the crime scene. [5] However, studying in depth and establishing further facts and truth in lip prints will certainly help as useful evidence in forensic dentistry.

Composition of the Lips

The lips are two mobile, highly sensitive mucocutaneous folds composed of skin, muscles, sebaceous glands and mucous membranes, forming the anterior border of the oral cavity. Anatomically, the labial

structure is formed by the upper lip and the lower lip, joined by the labial commissaries [6]. The upper lip extends from the base of the nasal septum to the commissure and in its middle zone and has a depression called the nasolabial sulcus. In the lower lip, the midline of the mentolabial sulcus, limited between the cutaneous lip and the mentum, is found. On the lips there are two classes of coating: one cutaneous and another mucosa. In the place of union of both, there is a wavy and whitish line, called the lip margin, especially visible in individuals with black skin.The anatomical area known as vermilion lip area is the important area for the study of lip impressions, since it corresponds to the area of the mucosa with a thin epithelium and that presents a thin layer of keratin, well vascularized and devoid of dermal appendages with few glands sebaceous that are covered by lines and grooves that determine the labial pattern. Several criteria are considered in the identification process, such as the thickness of the lips and the shape of the labial commissures [7].

Lip prints were first described by Fischer in 1902. Cheiloscopy (Greek; Cheilos = lips, Skopein = see) is the study of lip prints, an integral part of forensic odontology and investigation technique dealing with the identification of humans, based on lip traces [8].The wrinkles and grooves on the labial mucosa form the characteristic lip print pattern and have been named "sulci labiorumrubrorum" by Tsuchihashi The lip prints are unique and can be identified as early as the sixth week of intrauterine life [9] There are no changes in lip prints during the life of a person.

HISTORY OF LIP PRINTS

R Fischer	First discovered lip furrows	1902
Edmond Locard	Recommended the use of lip print for Person identification	1932
Le Moyne Snyder	Advised the use of lip print for person identification	1950
Dr. Martins Santos in	Classified Lip prints	1960
Suzuki	Reported the measurement of lips, the use and the color of rouge and method of its extraction	1967
Suzuki and Tsuchihashi	Suzuki and TsuchihashiCLassification of lip prints	1971
Mc Donell in	Twins have different lip prints	1972

CLASSIFICATION OF LIP PRINTS

(1) Martin Santos Classification (1966)[10]

- Simple wrinkles
- Straight lines
- Angled lines
- Sineshaped curve.

Compound wrinkles

- Bifurcated
- Trifurcated
- Anomalous

Suzuki and Tsuchihashi in 1970 devised a new classification of lip grooves as [11]:

- Type I – A clear cut groove running vertically across the lip
- Type I' – Partial length groove of type I
- Type II – A branched groove
- Type III – An intersected groove
- Type IV – A reticular pattern
- Type V – Undetermined.

Afchar–Bayat Classification (1979) [12]:

- A1: Vertical and straight grooves, covering the whole lip
- A2: Vertical and straight grooves, but not covering the whole lip • B1: Straightbranched grooves
- B2: Angulatedbranched grooves
- C: Converging grooves
- D: Reticular pattern grooves
- E: Other grooves.

(3) Raynaud's Classification [4]:

- Complete vertical
- Incomplete vertical
- Complete bifurcated
- Incomplete bifurcated

The sex of the individual was determined as given by Vahanwala et al.

1. Type I and I^{I} pattern dominant: Female

2. Type I and II pattern dominant: Female
3. Type III pattern dominant: Male
4. Type IV pattern: Male
5. Type V varied patterns: Male.

Recently for the basis of the classification, only 10 mm portion of the middle part of the lower lip is used [13].

- Linear "L" – if the lines prevail
- Bifurcation "R" – if the bifurcation is dominant
- Reticular "S" – if the lines cross
- Undermined "N" – when no superiority can be established.

Alvarez *et al*. tested developing the latent lip prints using a similar method. According to them, the vermilion borders of the lips have minor salivary glands and sebaceous glands. These glands are associated with hair follicles, with sweat glands in between, and secreting oils. With these secretions and continual moisturizing, it makes the latent lip prints available at most of the crime scenes [14].

Williams also stated that lip prints could be recorded without the use of lipstick or other recording medium, provided a suitable (non-porous) surface had been used which was then developed for prints [15]. In the study of Castello *et al*. on luminous lip prints, Nile Red was considered as a potential developer for latent lip prints. They used a property of luminescence for latent lip print development. Luminescence is specially a useful property for the search of invisible evidences at the scene of a crime [16].

The use of cheiloscopy has been extensively studied in te literature which points towards a definitive cnclusion it is a reliable tool in personal identification and gender determination of an individual.

Thermadam TP et al studied the cheiloscopic patterns of 2112 indivdiuals and concluded that Type 1', Type 1, Type 4, and Type 5 were found to be common lip groove patterns. Males showed predominance on Type 1' and Type 1 lip groove patterns, whereas females showed predominance on Type 4 and Type 5 lip groove patterns. The results were similar when analyzed on upper and lower lips separately on males and females. [17]

Padmavathi et confirmed he role of lip prints in individual identification. Dots, reticular and complex patterns were significant in gender determination. [18]

Table 1 – studies evaluating cheiloscopy as a relaible tool for gender identification

AUTHOR NAME	RESULTS	REFERENCE
Padmavathi BN et al	Dots, reticular and complex patterns were significant in gender determination.	[18]
Thermadam TP et al	Males showed predominance on Type 1' and Type 1 lip groove patterns, whereas females showed predominance on Type 4 and Type 5 lip groove patterns	[17]
Manikya S et al	Most frequent lip print pattern was Type 3 and least was Type 1'. When patterns were compared between groups, Type 3 was the most common in Manipuri and Kerala and Type 3 in Karnataka groups.	[19]
Kautilya D V et al	The most common pattern of lip print among males was Type III while in females, Type I. Thickness of the lip was significantly larger in males compared to females	[20]
Priyadharshini KI et al	Type II pattern of lip prints was common pattern among male and female	[21]
V N et al	Type I pattern was dominant in predicted female.	[22]
Ramakrishnan P	Type I was found to be the most prevalent type. In the female population. Type II, Type III, Type I, and Type V; in the male population	[23]
Basheer S et al	Type II being the most common in males and Type IV being the predominant pattern in females.	[24]
Singh J et al	Type 1, 1′ were most commonly seen in females whereas type 4 and 5 were seen most commonly in males	[25].
Alzapur A et al	In females, Type I and II appear to be equally dominant patterns followed by the Type IV, Type III and Type V patterns while in males, Type I was the predominant pattern followed by Type II, Type V, Type IV, and Type III patterns.	[26].
Bai JKS et al	Type II lip print pattern and loop pattern of fingerprints were the predominant patterns in both males and females,	[27]
Kaul R et al	In females, Type I lip pattern was most commonly found, followed by Type II and Type III. In males, Type I lip pattern was predominant, followed by Type II and Type III	[8]
Multani S et al	Type I was very commong among males and females.	[28]
Gurung S et al	Type I was the most common while Type V was the least common lip print.	[29]
Peeran SW et al	Type I lip print pattern was seen in 53.37% and 60.07% of lip quadrants in males and females,	[30]

Kumar LB et al	African males commonly have Type IV and females have Type I lip pattern. Dravidian males have Type IV and females have Type II lip pattern predominant. Mongoloid males have Type IV and females have Type I pattern predominant	[31]
Badiye A et al	Type II lip-print pattern was found to be most predominant in males, while Type IV was found to be most commonly occurring in females.	[32]

However, a meta-analysis by Franco A et al found fifty studies had low risk of bias. Suzuki and Tsuchihashi's technique was the most prevalent among studies. The accuracy of sexual dimorphism through cheiloscopy ranged between 52.7 and 93.5%, while the pooled accuracy was 76.8%. There was no difference between the accuracy to identify males or females. The large spectrum of studies on sexual dimorphism via cheiloscopy depicted accuracy percentage rates that rise uncertainty and concern. The unclear performance of the technique could lead to wrong forensic practice.[33]

Recording of lip prints

A lip print found at the crime scene can be used as evidence to draw inferences about the nature of the incident, the number of participants, the sexes, the use of cosmetics, personal habits, occupational features, and pathological changes to the lips themselves. Particularly if a meal is consumed at the scene of the crime, silverware and crockery objects should be examined for signs of lip prints. Lip prints have really also been found on the surface of windows, artworks, doors, plastic bags, and cigarette ends in real life. The crime scene can be used to trace lip prints using the following techniques. 1. Direct photography in cases when the prints are displayed on glass [34]. Application of fingerprint powders and foil fixing. (Magnetic powder, Cobalt oxide, Silver nitrate, Aluminum powder, and Silver metallic powder)

Disadvantages of Cheiloscopy

The Vermilion border of the lip, where the lip crease pattern is located, is extremely movable, and lip prints may appear differently according on the pressure, direction, and technique used to make the print. The amount of lip gloss applied could potentially have an impact on the print if it is utilised as a recording medium. Additionally, the print was hand traced, which causes issues with reproduction and adds some subjectivity to the comparison[34]. The presence of certain pathological disorders, such as Lymphangiomas, Congenital Lip Fistula, Lip Scleroderma, Melkersson-Rosenthal syndrome, Syphilis, Lip Cheilitis, etc., can render the Cheiloscopic investigation invalid. A comparison study in terms of necroidentification is clearly hampered by the fact that only very seldom do we have antemortem data related to lip prints. The primary characteristic of dental identification is the presence of antemortem information, which is unavoidable in cheiloscopy. Cheiloscopy will therefore only be used to link lip prints to the lips that made them [35].

Kim *et al*conducted a study to show that a lip print is sufficiently used by the measurements of biometric systems. Lip print recognition has been less developed than the recognition of other human physical attributes such as the fingerprint, voice patterns, retinal blood vessel patterns, or the face. Lip print recognition by a CCD camera has the merit of being linked with other recognition systems such as the retinal/iris, eye, and the face. [36]

A new method using multi-resolution architecture is proposed to recognize a lip print from pattern kernels. A set of pattern kernels is a function of some local lip print masks. This function converts the information from a lip print into digital data. Kulkarni et al stated that lip prints can be employed for sagittal jaw relation recognition. A further study on various ethnic backgrounds [37]

Kumar LB et al evaluated the lip print pattern among different races including the Africans, Dravidian, and Mongoloids and also to evaluate reliability in gender determination. [31]

COMBINED

Sisodia M et al correlated and compared cheiloscopy and dactyloscopy with blood group among dental students in the Western Maharashtra population. A statistically significant correlation between lip prints and ABO - Rh as well as between fingerprints and ABO-Rh blood groups. They concluded that fingerprints-ABO blood group and lip prints-ABO blood groups are valuable evidence that can be relied upon in forensic investigations for the identification of the suspect in crime. [38] Although there was a noteworthy association between lip prints, fingerprints and ABO blood group in the present study, variations in the patterns of lip prints, fingerprints and blood groups among different geographic populations exist. These differences could be attributed to substantial mobility and smudging of these prints while recording.

Surath S et al found significant correlation existed between lip print and ABO-Rh factors and between finger prints and ABO-Rh factors [39]

Lip print and blood group

Correlating lip prints with blood groups may be useful in forensic science for more accurate identification of an individual than with the use of lip prints alone Karim B et al in 2013 among 122 subjects found that type II was predominant in A-ve blood group and type III with A+ve blood group.

CONCLUSION

The process for analysing lip prints is relatively easy and cheap. As a result, it might be suggested that the lip prints be utilised as a trustworthy tool for human identification in the field of forensic research. However, further research needs be done to determine the gender of a big number of people of various ethnicities, family members, twins, and siblings. Additionally, a standardised and uniform process must be established for the acquisition, creation, documentation, and computerised analysis of the lip prints.

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Conflicts of interest/Competing interests

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Ethics approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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