

## Lip Prints: An Emerging Tool for Personal Identification

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### Abstract

Lip prints are normal lines or fissures in the form of wrinkles and grooves present in the zone of transition of human lip between the inner labial mucous and outer skin. The appearance of lip prints, like fingerprints vary from persons to persons. The present review highlighted the brief history, anatomy, methods, classification, application and limitations of lip prints in personal identification. The most commonly used method of collection of lip prints using lipstick is noted, however, more promising methods have been reported. The division of lips into four quadrants resulted in on bias assessment of lip print types as the problem of mixture of different patterns is avoided. Despite the large number of proposed classification, the Suzuki and Tsuchihashi classification remains the gold standard in the field of cheiloscropy. Apart from being a forensic tool, lip print may be used as a genetic marker and a diagnostic tool. The limitations associated with lip prints can result from the subject or poor procedure in the process of all which can be taken care of if photographic methods are used with good precautions.

**Keyword:** Lip prints, Technique, Classification, Application, Limitation, Personal identification

### Introduction

Establishment of identity is very much necessary for unknown deceased persons in homicide, suicide, accidents and other catastrophes. It is also necessary for living individuals who are missing persons due to amnesia and culprits hiding his/her identity.<sup>[1]</sup> The use of prints as means of personal identification are some of the common methods in forensic anthropology. Although the most popular prints are fingerprints other prints such as lip prints are also of forensic value.<sup>[2]</sup> Lip prints are normal lines or fissures in the form of wrinkles and grooves present in the zone of transition of the human lip between the inner labial mucous membrane and the outer skin. The appearance of lip prints, like fingerprints vary from person to person.<sup>[3]</sup> The purpose of this review was to bring up to date information on the brief history, classification, methods of collection, application, and limitations of lip prints in personal identification

### Materials and Methods

Direct searching using Google search engine was adopted. This provided room for assessing various databases such as Pubmed, Science-direct, Scopemed, among others. During the search process, certain keywords were used in which alone or in combination, form the headings and subheading of the articles. In order to maintain the focus of the review only, original research and reviewed articles were included. Case report articles were excluded unless where necessary as in the section on application of lip print.

### Brief History of the Study of Lip Prints

The concept of examination of lip prints (cheiloscropy) is an old idea dated back to early 1900.<sup>[2, 4]</sup> Now the idea is receiving more attention among the forensic community because of its potential application in establishing identity. The brief history can be summarized as follows (Table 1):

**Table 1: Brief Facts and Important Landmarks in the History of Lip Prints Examination for Personal Identification**

<b>Years</b>	<b>Facts and Important Landmarks</b>
1902	The biological feature of lip was first described by Fisher. [4]
1930	A study was designed which led to lip print use in criminology.[5]
1932	Edmond Locard, one of France’s greatest criminologists, acknowledged the importance of cheiloscopy.[5]
1950	The possibility of using lip prints in the matter of human identification mentioned. [6]
1960	It was suggested that the fissures and the criss-cross lines in the lips could be divided into different groups (simple and compound), and each group could be further divided into eight subtypes. [7]
1972	A study of 4000 lip prints was conducted and the singularity of lip print was confirmed. [8]
1974	Another study which resulted in a new classification for lip prints. This study, made over a long period of time, enabled the authors to confirm not only lip print singularity but also lip response to trauma; in fact, these authors observed that after healing, the lip pattern was equal to that before the injury occurred. [9, 10]
1981,	The examination of lip print is used as a special technique for the purpose of personal identification.[11]
2000-	A lip patterns was studied to promote the importance of cheiloscopy in forensic science identification.[11, 12]
To date	Several study now try to explore further the potential of lip print as a forensic tool, genetic maker, diagnostic tool among others

**Brief Anatomy of the Lip**

From anatomical point of view, lips can be described as two, highly sensitive mobile folds that surround the oral orifice and form the anterior boundary of the oral cavity. [13] Each lip is composed of skin, muscle, glands and mucous membrane. The lip area is considered as the surface that forms the oral sphincter irrespective of covering (skin or mucosa).[13] The lip can be divided into upper lip (from under the nose and extending laterally toward the cheek from the nasolabial sulcus and a lower lip (bound inferiorly by a prominent groove, the

labiomental sulcus); the two lips are joined at the corners of the mouth (lateral commissure) and separated by the buccal fend.[5, 12, 13] The meeting point of mucosal and skin covering of the lip is termed labial cord, which is white wavy line called vermillion border (Figure 1). In personal identification the area of interest is the mucosal area called vermillion or Klein’s zone. [14] This area has characteristic pattern of wrinkles and grooves that form in a unique features called the lip print. [4]

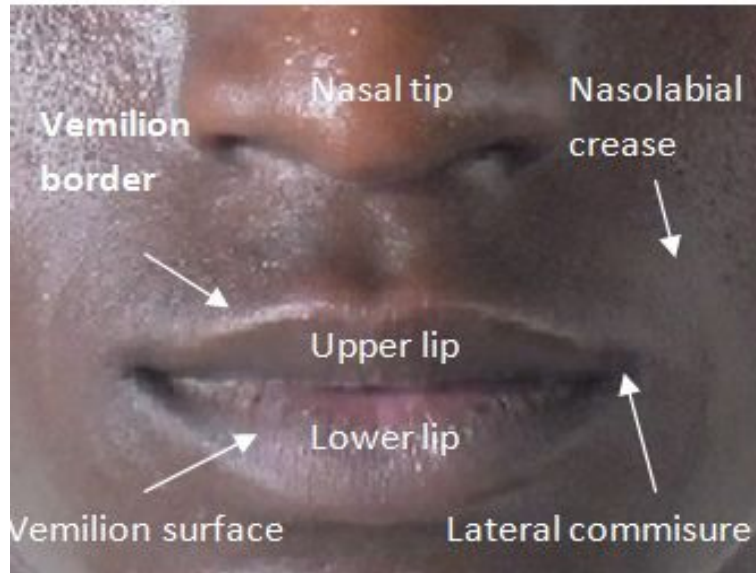


Figure 1: Anatomy of the Lip

### Methods of Lip Prints Collection

Different procedures are employed in collecting lip prints. In all the procedures the lip needs to be clean, free from any dirt. The subject must be in a relaxed state, which can be in form of standing position with the head positioned in Frankfurt plane. [1, 15, 16] The commonly known procedures include the following:

#### 1. Lipstick Methods

A coloured (red or dark pink or brown) lipstick is applied on a single motion evenly over the vermilion surface. Over the lipstick several materials are used to pick up the lip prints:

- i. The glued portion of a cellophane tape strip is placed and the subject is asked to make a lip impression in the normal rest position of the lip by dabbing it in the centre first and then pressing it uniformly toward the corners of the lips. The cellophane strip will then be stuck to the white chart paper for permanent record purpose and then the prints will be visualized by magnifying lens.<sup>[1, 17]</sup> The unglazed white paper will then be pressed uniformly over the lips.<sup>[18, 19]</sup>
- ii. A “hinge” of the folded paper is inserted in a portion between the lips and then the subject is asked to press his/her lips against it. Unfold the paper and analyse the prints using magnifying lens.<sup>[2]</sup>

- iii. A clean microscopic glass slide is placed on the lips and pressed gently in a gentle motion. This will result in picking off the lip prints which is preserved with cellophane tape and analysed using magnifying lens. <sup>[20, 21]</sup> For the indirect impression, the lipstick was applied directly onto a glass slide by moving the glass slide from one corner to the other corner of the lip. This technique of collecting the lip print on the glass slide simulated any trace found at a crime site. This impression was then lifted onto the glued surface of the cellophane tape.<sup>[19]</sup>

It should be noted that the lip prints obtained from any of the three materials can be scanned and stored in computer. In some instances, the scanned images can be cropped, inverted in gray scale and each side can be further divided into equal grids using the ruler in the software and stored in a separate folder as Adobe Photoshop Image file. <sup>[19, 22, 23, 24]</sup>

#### 2. Glass Slide Methods

A microscopic glass slide is placed over the lips. Develop the lip print with dusting fine black carbon powder using ostrich brush. The prints is preserved with a strip of cello tape and analysed using magnifying lens.<sup>[20]</sup> For dusting the excess carbon black powder a fine mouth blow is used instead of ostrich brush.<sup>[15, 21, 25, 26]</sup> The main advantage of this method in addition to accuracy is simplicity and high

level of compliance among the study participants. Also, it is more hygienic than the lipstick methods. However, care has to be taken to avoid contact of fingerprint with glass slide surface. The glass also needs to be handled with care as it may be a potential source of injury to the participant and / or investigator.

### 3. Photographic Methods

The modern approach of collecting lip prints involves use of digital camera. This evolved to overcome some limitations. The mobile nature of the human lips can affect the accuracy of the lip print impressions even with slight variations in the strength or the direction of the pressure applied.<sup>[10]</sup> Lip prints were recorded by direct photography of the lips using a close-up reflex camera with coloured films. A scale divided into centimetres was fixed to the inferior border of the lower lip for groove counting/cm.<sup>[27]</sup> Recently, in another perspective, a digital camera from a fixed distance is also used to photograph the lips of the participant in natural condition (without the application of lipstick, lip fillers, lip gloss or any other cosmetic product). This method is relatively easier and involved no physical contact with the participants in terms of application of lip gloss or lipstick or placement of glass slide as previously used and suggested by others, which can be quite laborious and may be unhygienic.<sup>[16]</sup>

### Analyses of Lip Print

Anatomically the lip can be divided into upper and lower lips.<sup>[13]</sup> For accurate and easy analyses of lip prints, the lip is divided into compartments.

#### 1. One Compartment

In some studies, only the middle portion of the lower lip was taken into account for classification of lip prints since this portion was consistently visible in any trace including criminal scene.<sup>[4, 28]</sup> The determination of the pattern was dependent on the numerical superiority of the properties of the lines in the study area.<sup>[19]</sup> When two pattern overlap the most dominant pattern is considered.<sup>[15]</sup> (Figure 2)

#### 2. Four Compartments

The lips are divided into four quadrants and allotted the digits 1-4 in a clockwise sequence starting from upper right corner of the lip. The upper lip is

therefore divided into right and left upper quadrant and the lower lip is divided into right and left lower quadrant. For each quadrant, there may be more than one type of lip print pattern. This is the most commonly used in the literature.<sup>[1, 2, 10, 16, 18, 29-36]</sup> (Figure 2)

#### 3. Six Compartments

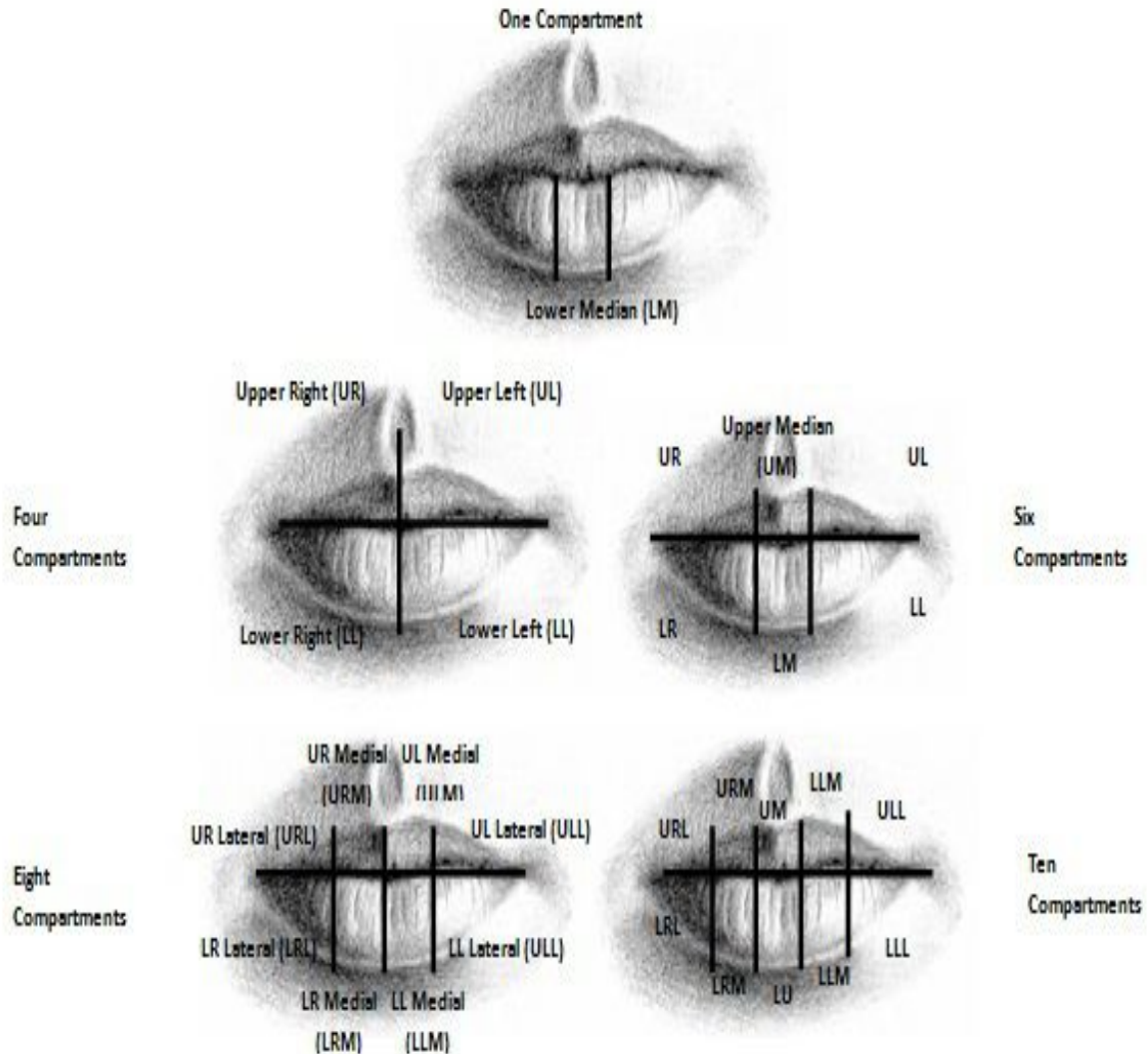
For perfect estimation of lip prints pattern Hassan and Fahmy,<sup>[37]</sup> divided the lips into six compartments. They found that any type might be found at any of the six areas described. In recent time the incidence of the different types of lip prints according to the Suzuki and Tsuchihashi classification are reported from six different compartments.<sup>[38]</sup> (Figure 2)

#### 4. Eight Compartments

The lip print can be divided into two quadrants at the mid line and then, each quadrant can further be divided into two equal parts as medial and lateral. Each segment is named according to the side they are expressed as upper right lateral, upper right medial, upper left medial, upper left lateral, lower right lateral, lower right medial, lower left medial and lower left lateral.<sup>[23, 24]</sup> (Figure 2)

#### 5. Ten Compartments

The division of lips into ten compartments was reported in the study that examined the relationship between fingerprint patterns with lip prints.<sup>[25]</sup> The lip print was then divided into five compartments for both lower and upper lips. The compartments include, upper left lateral, lower left lateral, upper left medial, lower left middle, upper median, lower median, upper, upper right medial, lower right middle, upper right lateral and lower right lateral compartments.<sup>[15, 21, 25, 26]</sup> In addition to more precise and accurate method of estimation this provides room for comparison of lip prints with ten digits of the upper limb. Just like other compartmentalization of lips every individual's segment may not have just one pattern, but this may appear to have a mixture of different patterns. In this condition, only the most dominant pattern was considered for the classification for each segment.<sup>[24, 26]</sup> However, it was reported that if the sums of individual lines were used as then this may have possibly changed the results.<sup>[34]</sup> (Figure 2)



**Figure 2: Different Methods of Compartmentalisation of Lips for Accurate Estimation and Classification of Lip Prints**

### Classification Scheme of Lip Prints

After dividing the lip into quadrants and or compartments, the next step is classification of lip prints observed in each compartments or quadrants. The various classifications are as follows:

**Table 2: Some of the Commonly used Classification of the Lip Prints**

1. Santos <sup>[7]</sup> classification	2. Suzuki and Tsuchihashi <sup>[9]</sup> classification
1. Simple, when they are formed only by one element; (a) a straight line (R-1), (b) a curve (C-2), (c) an angular form (A-3) (d) or sinusoidal (S-4);  2. Compound, when they are formed by (a) several elements; (b) a bifurcated (B-5), (c) trifurcated (T-6) (d) anomalous (An-7).	1. Type I; a clear-cut groove vertically above the lips, 2. Type II; a partial-length groove of type I, 3. Type III; a branched groove, 4. Type IV; an intersected groove and 5. Type V; a recticular pattern 6. Type V; other types.
3. Renaud <sup>[8]</sup> classification	4. Afchar-Bayat <sup>[39]</sup> classification
1. A Complete vertical 2. B Incomplete vertical 3. C Complete bifurcated 4. D Incomplete bifurcated 5. E Complete branched 6. F Incomplete branched 7. G Reticular pattern 8. H X or coma form 9. I Horizontal 10. J Other forms (ellipse, triangle)	1. A1 Vertical and straight grooves, covering the whole lip 2. A2 Like the former, but not covering the whole lip 3. B1 Straight branched grooves 4. B2 Angulated branched grooves 5. C Converging grooves 6. D Reticular pattern

In addition to classification of individual features of lip prints were reported as eye, closing bottom furcation, hook, delta-like opening, bridge, simple opening, line, closing top bifurcation, dot, pentagonal arrangement, rectangle like, branch like top bifurcation, triangle like, star like bifurcation, group of dots, fence, simple top bifurcation, branch like bottom bifurcation, simple bottom furcation double fence, double eye, hexagonal arrangement, and crossing lines.<sup>[40,41]</sup> The widely used classification to date is Suzuki and Tsuchihashi classification. <sup>[15, 24, 42]</sup> This may be linked to well categorization of the lip prints type and non overlap in classification of different type of lip groove.

### Applications of Lip Prints

#### 1. In Sex Identification

Several studies have reported the association of lip prints with sex. The lip print was reported to vary with sex, which therefore led to conclusion that lip print is a useful tool in sex discrimination.<sup>[16, 21, 24, 29, 30, 33]</sup> The literature report on the sex variability of lip prints was based on the qualitative analyses of the

print pattern type. This qualitative approach may not be enough to predict sex from lip print unless more robust quantitative approach of the study of lip ridges and groove are developed in the future study.

#### 2. As a Genetic Marker and Diagnostic Tool

Lip prints, as one of the dermatoglyphics, have been used as genetic marker in many congenital and clinical diseases.<sup>[43]</sup> It was reported that types (O), (Ib) and (IIb) and the high groove density in patients' lips could be used as genetic markers for the transmission of cleft lip and palate deformity to siblings.<sup>[27]</sup> On the other hand, type (III) can be considered a genetic marker for the health of the offspring if it appears in parents' lips.<sup>[27, 44]</sup> In another perspective it was suggested that total absence of particular pattern in the control group underlines its importance as a phenotypic marker for cleft lip and/or palate in the progeny.<sup>[27]</sup> Additionally, the significant difference in the groove count may be used as an important parameter.<sup>[38]</sup> The lip print patterns of both sexes showed association with hypertension. The frequencies of the intersected and

undifferentiated patterns were higher in the hypertensive than in the normotensive.<sup>[45]</sup>

### 3. Practical Applications of Lip Prints

A case of traffic accident investigated by Lelan V. Jones, Los Angeles police department in which an injured woman's left lip print was seen on the left front fender of the accident car. The owner of the car denied the incident. On cheiloscopy examination from prints on the left front fender of the car it was concluded that the woman was hit by the alleged auto-mobile.<sup>[6]</sup> The lip prints were identified on an envelope and compared with those of the suspect. Lip prints were noted on the undergarments and were studied with the help of colour test and ultraviolet rays.<sup>[46]</sup> Federal Bureau of Investigation (FBI) has successfully identified a male bank robber who uses female disguises including lipstick.<sup>[47]</sup> Lip traces found on a glass door at the scene of a murder led to lip print examination. At this time, the usefulness of the lip traces for criminal identification was proven.<sup>[40]</sup> A criminal investigation where lip prints were found on drinking glasses and it happened to be the only available sign of identity.<sup>[2]</sup>

### Limitations of Lip Prints Examination

Several problems were reported in the literature regarding lip prints examination. Some are as result of the subject activities during the procedure while others as result of procedures. However, some resulted from the combination of the two factors.

#### 1. Subject Associated (Intrinsic):

Lip prints involve a mobile portion of the lip and a person can produce different lip prints according to pressure and direction.<sup>[22]</sup> However, the pattern of the prints will not differ but the size of the print can vary with differences in pressure and direction. The lip prints can be influenced by inflammation and abnormalities such as infections, cysts, and tumours among others.<sup>[41]</sup> The inflamed lips may not produce lip patterns and similarly, abnormal lip may not produce lip prints within the normal patterns,<sup>[41]</sup> in fact, any debris on lip surface may alter the lip print recording.<sup>[40]</sup> Lip print patterns depend upon whether the mouth is opened or closed. In closed mouth position, lip prints exhibit well-defined grooves while in later position of the mouth exhibits ill-defined lip prints which may be difficult to interpret.<sup>[48]</sup> It was also suggested that loss of

support due to loss of anterior tooth may alter the pattern of lip prints.<sup>[48]</sup> Lack of ante mortem data for lip prints is also an additional factor that may limit the application of lip prints.<sup>[41]</sup> As such Lip prints have to be obtained within 24 hours after death to prevent the postmortem changes of the soft tissues.<sup>[49]</sup>

#### 2. Methods Associated (Extrinsic)

Another common problem associated with lip prints examination is smudging or spoiling of lip prints leading to unidentifiable marks.<sup>[4]</sup> It was reported that up 10% of all the lip prints collected may be spoiled, the maximum being in the first and second compartments of the males. This can be linked to the presence of prominent facial hair among men.<sup>[1]</sup> Application of thick layer of lipstick and over stretching of the cellophane on the lip surface may alter the recordings. Anatomic position of labial grooves close to vermilion border is a movable zone, so prints made may differ in appearance which depends upon the pressure applied and the direction of the pressure.<sup>[3, 40]</sup> The inter-observer variability is another factor that may lead to differences in the lip prints recording.<sup>[49]</sup>

### Conclusion

The present review highlighted the brief history, anatomy, methods, classification, application and limitations. It can be concluded that the use of lip print in establishing identity is an old concept that is receiving more attention in recent times due to need for increase number of evidences in personal identification. The most commonly used method of collection of lip prints is using lipstick. However, a more promising method which involves using digital camera may soon gain popularity due to the numerous advantages it has over the old conventional methods. The division of lips into four quadrants resulted in unbiased assessment of lip print type as the problem of mixture of different patterns is avoided. Despite the large number of proposed classifications, the Suzuki and Tsuchihashi classifications remain the gold standard in the field of cheiloscopy. Apart from being a forensic tool, lip print may be used as a genetic marker and diagnostic tool. The limitation associated with lip prints can result from the subject or from poor procedure in the process all of which can be taken care of if photographic method were used with careful precautions.

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