ORIGINAL RESEARCH

Role and Reliability of Cheiloscopy, Rugoscopy and Dactyloscopy in Gender Identification

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Abstract

Introduction: To prove the identity of a deceased in mass disasters is very difficult owing to the distinctive traits of each individual. This requires a combination of different procedures to individualize a person or an object. Although there are many methods which can be employed to determine the sex and identity, none of the individual methods has been proven to show 100% reliability.

Aim and Objectives: This study was undertaken to compare and assess any specific pattern of palatal rugae, lip prints, fingerprint pattern and compare and correlate the reliability of the above mentioned methods in gender identification.

Materials and Methods: 50 males and 50 females were included. The outlines of rugae were traced on the casts using a pencil. For lip prints, lipstick was applied and cellophane tape was used to obtain the impression of the lip. Finger print impressions was obtained using ink. All the impressions were analysed using a magnifying lens. Chi-square test and kappa coefficient test were used for statistical analysis.

Results: Type I, I' lip print patterns were more common in females whereas Type III, IV were common in males. Wavy rugae were frequently seen in females and curved pattern dominated in males. Loop pattern of finger prints predominated in both the genders. Overall, cheiloscopy was more reliable than other methods.

Conclusion: Cheiloscopy is a more reliable tool in gender identification. However, a study with a larger sample is needed to corroborate with the present results.

Keywords: Cheiloscopy, Dactyloscopy, gender identification, rugoscopy

Introduction

Human identification is of utmost importance and undeniably challenging considering the fact that every individual has distinctive trait[1]. Studies utilizing the DNA comparisons are a means of faster, definitive and secure identification process. However, because of its technique sensitivity and less economical nature, it cannot always be used, and sometimes it is necessary to apply different and less known techniques[2]. Further, it would be reasonable to use any physical characteristics or traits to identify the suspect in order to provide justice to the victim[1].

Identifying the deceased persons is very important in order to certify the death and also for personal and legal interests[3]. Moreover, a dental surgeon is obligated to help not only in the examination, investigation and the diagnosis of the oro-facial diseases but also to serve the society in legal matters when required to do so. Hence, the role of a dentist in personal identification, and examination and investigation of the dental evidences in a crime scenario is of paramount importance, as his/her evidence would be very much useful in law and justice[4].

Although there are many methods which can be employed to determine the gender, identity like rugoscopy, cheiloscopy, dactyloscopy, blood grouping etc., none of the individual methods have been proven to show 100% reliability. Therefore this study was designed to compare various such methods.

Having mentioned this, it is also important to acknowledge the drawbacks of the soft tissue parameters like lip and rugae patterns over teeth in forensic identification. Since

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the basic principle for identification is through comparison and exclusion, proper identification only becomes possible in these cases when there is availability of antemortem data for matching. Furthermore, unlike teeth, lip prints, finger prints and rugae patterns are not resistant to trauma and postmortem changes. Also, due to their complex patterns, the results obtained are prone to inter and intra-observer bias. Hence, real-time use of these parameters is contentious and thus limited to research purposes only.

This study aimed to evaluate the palatal rugae, lip prints, fingerprint pattern in 50 males and 50 females, and to compare and assess any specific pattern of palatal rugae, lip prints, fingerprint pattern in males and females. We also aimed to compare and correlate the reliability of the above mentioned methods in gender identification.

Materials and Methods

This is a retrospective study involving a total of 100 subjects, 50 males and 50 females, age ranging between 17-25 years. The subjects were selected from the students of SVS Institute of Dental Sciences, Mahabubnagar. Healthy individuals free of oro-facial congenital abnormalities, inflammation, trauma or on-going orthodontic treatment were included in our study. Individuals with known hypersensitivity to lip sticks and any lesions on the lip, subjects with any history of surgery for cleft palate and alveolus or any palatal and subjects any pathology to the left thumb were excluded from the study.

For recording the lip prints, lips were initially wiped clean using tissue paper following which the lipstick was applied gently using a lipstick applicator from the central to the lateral portion of the upper lip with a single stroke. The subjects were then asked to clutch both the lips to ensure that the lipstick application was uniform. After 2 minutes, the glue portion of the cellophane tape was used to obtain the impression of the lip. This record was immediately transferred on to a white bond paper by gently sticking the cellophane tape. This method, besides serving as patient's permanent lip record could also be safely preserved for subsequent analysis. The lip prints obtained were coded, while noting the name and sex of the respective individuals. At the time of analysis, the details of the subjects were not revealed. Analysis was done by 3 observers as per Tsuchihashi classification in the present study[5] using a magnifying lens. (Figure 1)

Type 1: Clear-cut vertical grooves that run across entire lips
Type 1': Similar to type 1, but do not cover entire lip
Type 2: Branched grooves
Type 3: Intersected grooves
Type 4: Reticular grooves
Type 5: Grooves that do not fall into any of the type 1-4 and cannot be differentiated morphologically (undetermined).

For classification, the middle part of the lower lip was taken as study area in accordance with Sivapathasundaram et al.[6] because this fragment is always visible. The sex of the individual was determined as per the descriptions given by Vahanwala et al.[7,8].

Type 1, 1' : Pattern dominant-Female
Type 2 : Pattern dominant-Female
Type 3 : Pattern present-Male
Type 4 : Male
Type 5 : Varied pattern-Male

Table 1: Distribution of subjects based on their gender and lip print patterns

Pattern	Male	Female
TYPE 1	3	13
TYPE 1'	6	17
TYPE 2	3	7
TYPE 3	25	7
TYPE 4	11	3
TYPE 5	2	3
TOTAL	50	50

Table 2: Chi-square and Kappa coefficient test to assess gender differences in lip print patterns

Predicted gender with Cheilos-copy		Actual gender		% Agree-ment	Kappa	p-value
		Female	Male			
	F	38	13	75%	0.5	<0.001; Sig
	M	12	37			

p value<0.05 = significant; p value>0.05 = not significant

Table 3: Distribution of subjects based on their palatal rugae patterns

Pattern/Group	Male	Female
NO. OF RUGAE		
Primary	382	387
Total	415	432
SHAPE		
Wavy	21	25
Curved	24	19
Straight	5	6
Circular	0	0
UNIFICATION		
Diverging	19	19
Converging	3	4
Both	2	3
DIRECTION		
Forwardly-directed	23	24
Backwardly-directed	11	8
Perpendicular	6	18

Same patterns in all quadrants - Female

The results obtained were verified from the coded data collected at the beginning of the study. To record palatal rugae, alginate impressions of the maxillary arch were made and poured with dental stone. A dental plaster base was made and casts were preserved for interpretation. The outline of the rugae was traced on these casts using a sharp pencil under adequate light. Rugae pattern were then analysed on these casts with the help of magnifying lens, using the classification by Thomas and Kotze[9]. Rugae were tested for gender using the following parameters:

1. Total number of rugae
2. Number of primary rugae
3. Predominant shape
4. Predominant direction
5. Unification of rugae

The imprint obtained from the left thumb using printer's black ink was transferred on to a white bond paper and analysed using magnification lens. Analysis of finger print was carried out using the most widely accepted Michael and Kucken classification, which classifies finger print pattern as the loop, whorl, arch-like, and composite patterns[10].

Fingerprints were tested for gender by following the results obtained by Bhavana Desai et al[11]. All the analysis was done using SPSS version 16. A p-value of <0.05 was considered statistically significant. Comparison of reliability of the three methods was done using Kappa coefficient.

Table 1 illustrates the distribution of subjects based on their gender and lip print patterns. Graph 1 shows the overall incidence of different types of lip print patterns in males and females. It was observed that Type I, Type I′ and Type II lip print patterns were more predominant in females when compared to males. On the other hand, Type III and Type IV patterns were predominant in males. Table-2 shows that the results obtained with cheiloscopy is statistically significant with a p value of <0.001. The Kappa co-efficient value is 0.5, which depicts moderate agreement. It was found that number of primary rugae and total number of rugae was more in females than males. Also, it was observed that wavy pattern was more predominant in females whereas curved pattern of rugae was more predominant in males. Forwardly directed rugae were seen more frequently in both the genders. In unification, diverging of the rugae was more commonly seen in both females and males. (Table-3, Graph-2). As shown in the Table-4, 52% (26/50) females and 34% (17/50) males were correctly identified with rugae patterns. However, the result was not statistically significant, with a p-value of 0.155. Kappa value for palatoscopy was -0.14, which showed no agreement. Loop pattern of fingerprints were found to be predominant in both the genders, followed by whorl pattern. However, both loop and whorl type of finger print pattern was slightly predominant in males as compared to females and arch type was more predominant in females. (Graph-4, Table- 5). 66% (33/50) of females and 40% (20/50) of males were correctly identified based on finger print patterns which was not statistically significant (p value- 0.534). (Table-6)

Table 4: Chi-square and Kappa coefficient test to assess gender differences in rugae patterns

Predicted gender with Palatoscopy		Actual gender		% Agreement	Kappa	p-value
		Female	Male			
	F	26	33	43%	-0.140	<0.155; NS
	M	24	17			

p value<0.05 = significant; p value>0.05 = not significant

Table 5: Distribution of finger print pattern in males and females

Pattern	Male	Female
Arch	3	7
Whorl	20	17
Loop	27	26

Discussion

The outer surface of the lip has many elevations and depressions which form a characteristic pattern and is referred to as lip prints. The study of these lip print patterns is called as 'Cheiloscopy'. Lip prints are usually obtained at the crime scene from various items like clothing, cups, cigarette butts, window panes, and doors. Lip prints have been accepted as a reliable method in forensic odontology for the identification of an individual. This is done by making the impressions from the middle portion of the lower lip, as it is always visible, and the characteristic patterns are studied[12]. Although two separate sets of lip prints can seem identical, but the pattern in which they branch or intersect with each other is different from the other and thus can be an acceptable and reliable tool for identification purposes[13].

The study of palate in general is called as palatoscopy and the study of the patterns of the grooves and ridges (rugae) of the palate is called as rugoscopy[14]. Rugae are the irregular and asymmetric ridges of mucous membrane seen continuing laterally from the incisive papilla and the anterior part of the median palatal raphe. These rugae serve to transport the food through the oral cavity and they also facilitate chewing process. They also help in the perception of taste, texture of

Table 6: Chi-square and Kappa coefficient test to assess gender differences in finger print patterns

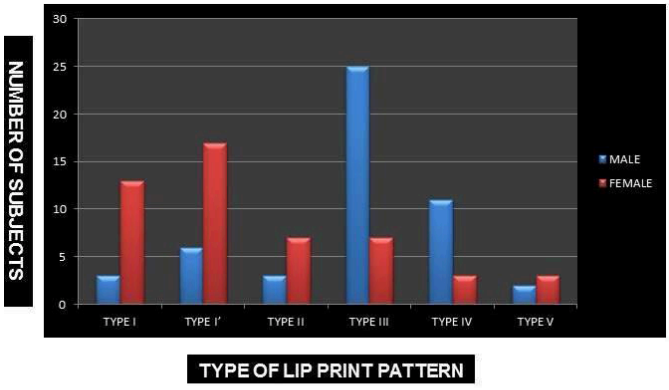
Predicted gender with Dactyloscopy		Actual gender		% Agreement	Kappa	p-value
		Female	Male			
	F	33	30	53%	0.06	<0.534; NS
	M	17	20			

p value<0.05 = significant; p value>0.05 = not significant

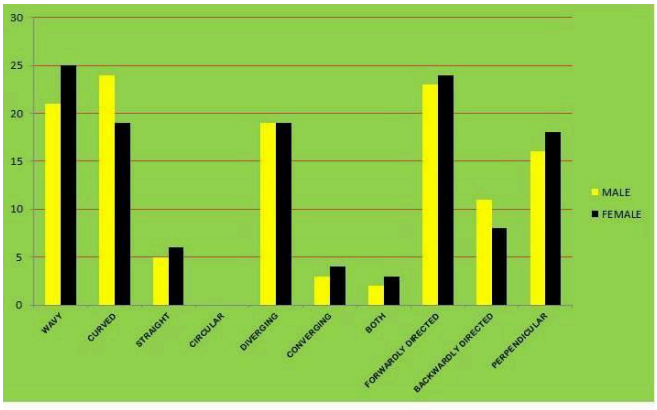
food qualities and the position of tongue due to the presence of gustatory and tactile receptors[15]. In humans, these rugae are formed in the 3rd month in utero and their role is seemingly less important, which explains why their development time is delayed. Moreover, once formed, they do not undergo any changes except in length, due to normal growth, remaining in the same position throughout an entire person's life. The fact that any disease, chemical or mechanical trauma does not seem to change palatal rugae form, makes it a very important tool in forensic odontology[16].

"Dermatoglyphics" is the study of ectodermal ridge pattern on fingers, palm, and soles. This name was given by Harold Cummins in 1926. Finger prints have been analysed since ancient times, but its role in the identification of an individual brought a revolutionary change in the field of crime investigation. Genetic and environmental factors tend to have an effect on the development of these ridges, but however, once formed it does not change throughout life. The certainty of this attribute is understood by the fact that it is unique to each individual and hence has been used for personal identification[17].

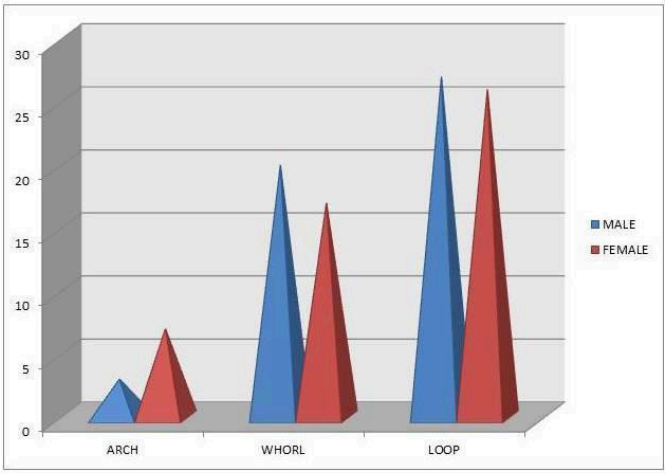
Different patterns of lip prints, palatal rugae and finger prints in 50 males and 50 females were evaluated. It was observed that Type I and Type I′ lip print pattern was more common in females, whereas Type III and IV were more common in males. This observation was similar to the results found by Nagalaxmi et al.[18] who found Type I′ pattern to be more common in females and Type III and Type IV pattern more frequent in males. Nagasupriya et al 4 observed branched lip patterns (Type II) to be more predominant in both males and females which was not in agreement with the present study. Nevertheless, reticular pattern (Type IV) pattern was also found more commonly in males, which was in correlation with the present study. This disparity can be attributed to a different analysis system followed in their study. In another study by Preeti Sharma et al.[19], Type I and I′ lip print pattern was found to be more common in females and Type III and Type IV pattern



Graph 1: Overall incidence of different types of lip print patterns in males and females



Graph 2: Overall incidence of various rugae patterns based on their shape, direction and unification in both the genders.



Graph 3: Overall incidence of various finger prints in both males and females

Fig.1: Materials used for A. Cheiloscopy B. Rugoscopy and C.Dactyloscopy

was more common in males. This was partly in agreement with our findings. Saraswathi et al.[20] found Type III lip print patterns to be more predominant in both the genders which is in contrast with our study. Gazge et al.[21] assessed the lip prints and finger prints patterns using digital methods and found that Type IV pattern was common in males while females showed Type I′ pattern predominantly. These results were in correlation with our results.

The results of this study are in correlation with Sharma et al[19] who in their study noted that total number of rugae and number of primary rugae predominated in females. Also, similar to the present study, wavy pattern of rugae is common in females while curved pattern is more predominant in males. In addition, diverging pattern was common in males and females. However, five cases showing circular or ring forms of rugae were noted in their study, which was in slight contrast to the present study. Our results were well in agreement with the study done by Amit Byatnal et al.[22] who found wavy pattern to be more common in both the genders. Also, similar to the present results, no circular or ring forms were observed in any of their subjects. Rai et al[23] conducted a study on North Indian population and found straight pattern of rugae to be more predominant. This was inconsistent with the present study. This difference could be due to the geographical variations in the rugae patterns of the subjects.

Analysis of the fingerprint pattern of 100 subjects showed that loop pattern was more predominant in both the genders. This was in consensus with Bharadwaja et al[24], Rastogi and Pillai[25], and Nagasupriya et al[4]. Bhavana Desai et al.[11] carried out a study on fingerprint patterns of 200 subjects and observed that loops pattern was more prevalent in all the subjects, followed by whorls and then arch type. This was in agreement with the present results. However, within the gender, loops and arches were found to be more in number in females and whorl pattern in males outnumbered females, which was in slight disagreement with the results of this study. The disparities between the results obtained in this study and other studies could be attributed to the different geographical locations of the subjects and variations in the sample size in those studies.

In the present study, the reliability of cheiloscopy, palatoscopy and dactyloscopy is also tested in gender identification. It is found that cheiloscopy is a more reliable method for gender identification with a kappa value of 0.5 than palatoscopy and dactyloscopy. (kappa value- -0.14 and 0.06 respectively). This is in agreement with Sharma et al.[18] and Dongarwar et al.[26]. However, this comparison is incomplete because the former had compared only cheiloscopy and palatoscopy, and the latter had aimed to check for the reliability of only cheiloscopy.

Conclusion

Determining the sex of a suspect in crime scenario, dead body of an unknown or missing person which has been severely mutilated is often very difficult and time-consuming process. Lip prints, rugae and finger prints are unique to every individual, their use in identification is justified. This research work suggests that cheiloscopy is a more reliable tool in identification of the gender of an individual as compared to other methods like palatoscopy and dactyloscopy. However, a study with a larger sample is needed to corroborate with the present results.

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