

Original Article

Comparative Reliability of Cheiloscopy and Palatoscopy in Human Identification and Sex Determination: Among Kerala Population

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Received: 07 April, 2020.

Revised: 20 April, 2020.

Accepted: 29 April, 2020.

Published: 29 June, 2020.

ABSTRACT

Background: The present study was carried out on 200 individuals (100 males and 100 females) among Kerala population (Central Kerala) aged between 18 and 50 years.

Aims and Objectives: To identify palatal rugae pattern and lip print pattern and to compare the rugae and lip print pattern between males and females.

Materials and Methods: In this study, we analyzed the lip print and palatal rugae pattern in males and females using a classification given by Suzuki and Lysell respectively.

Results: Lip prints and rugae pattern are distinct for an individual, the most common type of pattern in male was Type IV. The most common type of pattern in female was Type I. No statistical significant difference was observed in the length and number of rugae between males and females. The present study showed that forwardly placed rugae was more in males than females. The present study successfully established the individuality of the rugae patterns, length, and number.

Conclusion: Cheiloscopy is useful in identifying the gender of the person by studying the pattern left at the crime scene and palatoscopy can be useful in personal identification.

KEY WORDS: *Cheiloscopy, forensic odontology, palatoscopy*

INTRODUCTION

Forensic odontology involves participation of a dental surgeon in assisting legal and criminal issues.^[1] Thus, the use of human palatal rugae and lip print study can also be suggested as an alternative method of identification. Rugae are not damaged from trauma due to their internal position in the oral cavity and are insulated from heat by tongue and buccal mucosa.^[2]

Once formed, they do not undergo any changes except in length and remain in the same position throughout a person's entire life.^[3] The uniqueness, postmortem resistance, overall stability, and additionally low utilization cost make palatal rugae an ideal forensic identification parameter.^[4]

Analysis of the lip prints left at the scene of crime, and their comparison with those of suspected person may also be useful for personal and sex identification.^[5] The theory of uniqueness is a strong point used in the analysis of fingerprints and bitemarks to convince the court of law.

Likewise, lip prints, and palatal rugae patterns are considered to be unique to an individual and hence hold the potential for personal identification as well as sex differentiation.

AIM AND OBJECTIVE

- To identify palatal rugae pattern
- To identify lip print pattern

- To compare the rugae and lip print pattern between males and females
- Find out the uniqueness of rugae and lip print pattern.

MATERIALS AND METHODS

The present study was carried out on 200 individuals (100 males and 100 females) among Kerala population (Central Kerala) aged between 18 and 50 years. Ethical clearance was obtained from the Annoor Dental College and Hospital, Muvattupuzha. All the participants were briefed about the purpose of the study, and an informed consent was obtained from the patients before the start of the study.

INCLUSION CRITERIA

1. All individuals free of congenital abnormalities, inflammation, trauma, or orthodontic treatment are included for the study.

EXCLUSION CRITERIA

1. Patients above 50 and below 10 years
2. Individuals with known hypersensitivity to lip sticks are not included the study

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How to cite this article: Ashok A, Thomas N. Comparative reliability of cheiloscopy and palatoscopy in human identification and sex determination: Among Kerala population. *Int J Forensic Odontol* 2020;5:11-8.

Access this article online

Quick Response Code:



Website: www.ijfo.org

DOI: 10.4103/ijfo.ijfo_6_20

- Subjects with severe malocclusions, palatal asymmetries, and history of surgery for cleft palate and alveolus.

CHEILOSCOPY

The lip print of all the individuals were taken and subsequently analyzed with the help of magnifying lens. The lip print pattern was classified according to the classification given by Suzuki and Tsuchihashi in 1974. Then, the data were collected and analyzed statistically to find the difference between the lip print of males as well as of females.

Technique for taking the lip print

For the lip prints, the participants were asked to sit and then a dark-colored lipstick was applied with a single stroke by the research personnel, gently on the lips, and then the participants were asked to rub their lips for equal spreading of lipstick. After 2 min, a strip of cellophane tape was taken and the glued surface of the cellophane tape was pasted on the lips of the subject. Then, the tape was carefully lifted from the lips from one end to other. Then, the tape was pasted on a bond paper for permanent record.



Figure 1: Type I

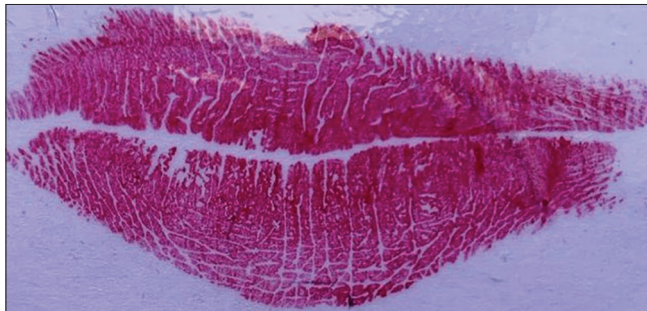


Figure 3: Type 1I

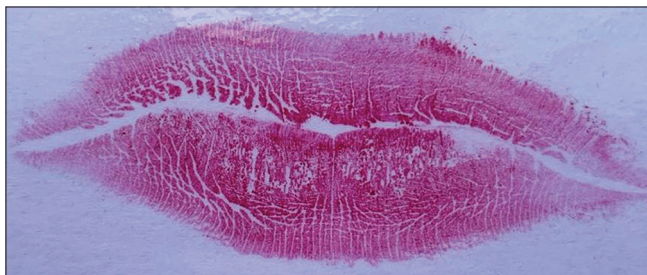


Figure 5: Type 11I

Technique for identification of lip print pattern

Two methods are used for the identification of the lip print pattern:

Quadrant method

The lip prints were divided into four quadrants by a horizontal and a vertical line. The vertical line passes from middle of the frenulum and divides it into equal right and left halves. The horizontal line divides the upper lip from the lower lip. The right upper half is taken as the first quadrant, left upper half taken as the second quadrant, lower left half taken as the third quadrant, and lower right half taken as the fourth quadrant. The lip prints were observed by using a magnifying lens and were categorized into particular type depending on the predominant pattern.

The middle 10 mm of the lower lip was selected and identified with the help of the magnifying lens for sex determination.

To avoid bias, all the lip prints were compiled, analyzed, and interpreted by two examiners to determine the sex and identity of the individual.

Then, the lip print patterns were classified as per Suzuki and Tsuchihashi classification,^[6] which states that

- Type I: Complete vertical groove, i.e. runs across the entire lips [Figure 1]

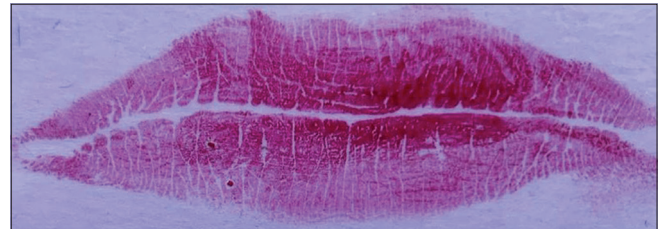


Figure 2: Type 1'

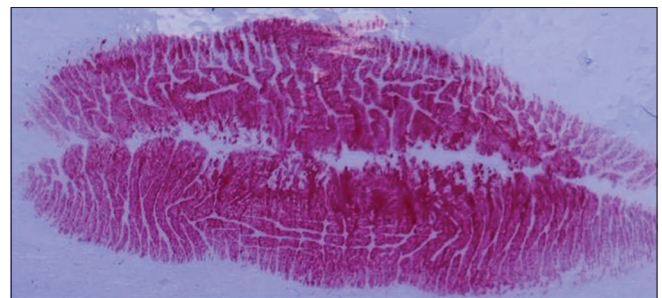


Figure 4: Type 1V

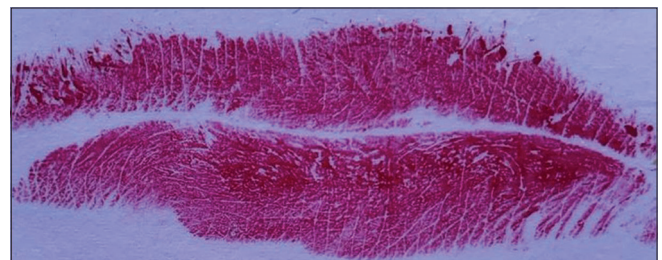


Figure 6: Type V

2. Type I': Incomplete vertical groove, i.e. does not cross the entire lips [Figure 2]
3. Type II: Branched (y shape) [Figure 3]
4. Type III: Intersected grooves [Figure 4]
5. Type IV: Reticular grooves [Figure 5]
6. Type V: Undifferentiated [Figure 6].

PALATOSCOPY

Methods

Patient sampling

The study consisted of 200 individuals, comprising 100 males and 100 females. The patients were distributed in both the age groups in the age range of 18–50 years [Figure 7].

IMPRESSION MAKING AND RUGAE ANALYSIS

Maxillary impression trays were selected according to the shape and size of the patient's arches. Two levels of alginate impression material were taken in the scoop and mixed with 40 mL of water (using a measuring jar provided by the manufacturer), in a water/powder ratio of 40 mL: 15 g, in a flexible rubber bowl with a mixing spatula. A vigorous figure-of-eight motion was used for mixing. The mix was immediately transferred to the impression tray for insertion into the patient's mouth. The tray was held passively and motionless during the setting of impression material. After about 2 min (setting time of alginate), the tray was separated carefully from the teeth to avoid rocking and possible deformation of the fine areas of the impression. Excess material at the periphery was trimmed, and casts were poured subsequently. Dental stone casts were prepared from a total of 200 impressions.

The rugae were delineated using a sharp graphite pencil to make it prominent, and were analyzed macroscopically and recorded according to the classification given by Thomas and Kotze (1983), modification of Lysell's classification (calcorrugoscopy).^[7] To reduce intraobserver bias, each cast was analyzed twice.

CLASSIFICATION OF PALATAL RUGAE

The number of rugae on the right and left side of median palatal raphae was recorded. The size of each rugae was recorded using a divider and a scale measuring the length from one end to the other. The rugae pattern was classified based on their length, shape, direction, and unification.

- A. The rugae were classified based on their length and were determined by measuring its greatest dimension regardless of its shape:
 - Primary (more than 5 mm) and secondary (3–5 mm)
 - Fragmentary (2–3 mm)
 - Rugae <2 mm were disregarded.
- B. The rugae were divided into four types based on their shapes as: (origin is that point of rugae nearest to the midline and termination is the point where the rugae end from the origin).
 1. Curved: They had a crescent shape and curved gently. Evidence of even the slightest bend at origin or termination of rugae is being classified as curved rugae.

2. Wavy: If there was a slight curve at the origin or termination of curved rugae, it was classified as wavy [Figure 8]
3. Straight: They ran directly from their origin to termination
4. Circular: Rugae that formed from a definite continuous ring were classified as circular.

- C. The direction of the rugae was determined by measuring the angle formed by the line joining its origin and termination and the line perpendicular to the median rugae. Forwardly directed rugae were associated with positive angles, backwardly directed rugae were associated with negative angles, and perpendicular rugae were associated with zero angles.
- D. Unification occurs when two rugae are joined at their origin or termination. Rugae were considered diverging if two rugae had the same origin but immediately branched. Rugae with different origins, which joined on their lateral portions, were considered converging.^[8]

All the data were entered in Microsoft excel and analyzed using SPSS package. All the data were presented as frequency and percentage. The lip prints of all participants were taken,



Figure 7: 200 casts



Figure 8: Converging, diverging and wavy rugae

and the statistical analysis was done by the Chi-square test to compare the proportions. Chi-square test has been used to test for association between the variables. $P < 0.05$ was considered significant for all analysis. The same Chi-square test was applied to test the significant difference between males and females for different types of lip print pattern in each quadrant.

RESULTS

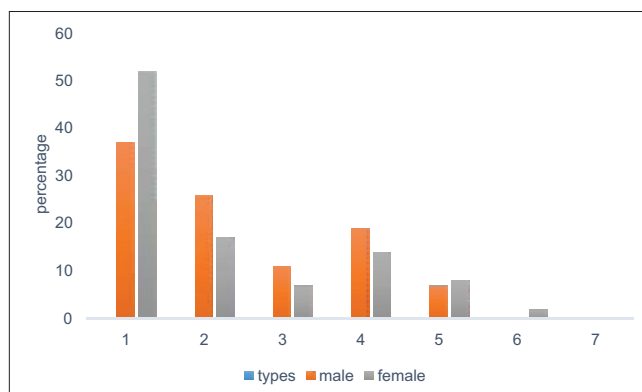
LIP PRINT

The present study was conducted on 200 individuals (100 males and 100 females) among population of Central Kerala. The examination of lip print pattern reveals the following observations.

Table 1 and Graph 1 Show that in quadrant I, on comparing the different patterns in males and females the P value is 0.149, which did not show any significant association with gender.

Table 2 and Graph 2 show that in quadrant II, on comparing the pattern in males and females, the P value is 0.754, which is not statistically significant.

Table 3 and Graph 3 show that in quadrant III, on comparing the lip print pattern in males and females, the P value is 0.036, which is statistically significant.



Graph 1: Showing percentage of distribution of different lip print pattern between male and female in quadrant I

Table 1: Showing percentage of distribution of different lip print pattern between male and female in quadrant I

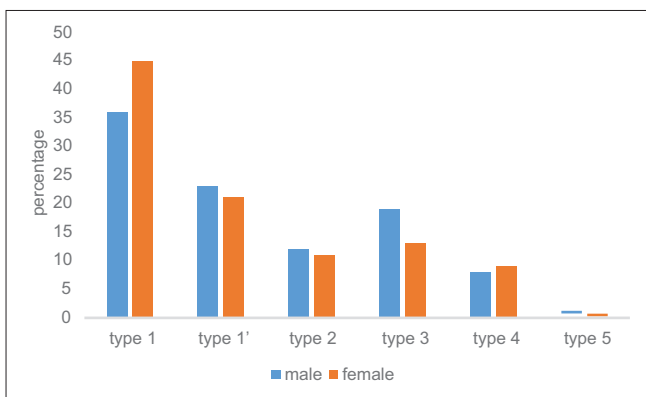
Lip print pattern		Sex		Total	Chi-square value (df)	p
		male	Female			
type 1	Count	37	52	89	8.125 (5)	0.149
	% within sex	37.0%	52.0%	44.5%		
type 1'	Count	26	17	43	21.5%	
	% within sex	26.0%	17.0%			
type 2	Count	11	7	18	9.0%	
	% within sex	11.0%	7.0%			
type 3	Count	19	14	33	16.5%	
	% within sex	19.0%	14.0%			
type 4	Count	7	8	15	7.5%	
	% within sex	7.0%	8.0%			
type 5	Count	0	2	2	1.0%	
	% within sex	0.0%	2.0%			
Total	Count	100	100	200	100.0%	
	% within sex	100.0%	100.0%			

Table 2: Showing percentage of distribution of different lip print pattern between male and female in quadrant II

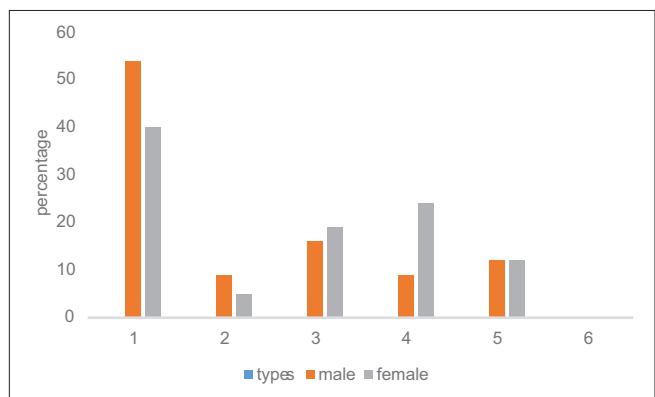
Lip print pattern		sex		Total	Chi-square (df)	p
		male	female			
type 1	Count	36	45	81	2.652 (5)	0.754
	% within sex	36.0%	45.0%	40.5%		
type 1'	Count	23	21	44	22.0%	
	% within sex	23.0%	21.0%			
type 2	Count	12	11	23	11.5%	
	% within sex	12.0%	11.0%			
type 3	Count	19	13	32	16.0%	
	% within sex	19.0%	13.0%			
type 4	Count	8	9	17	8.5%	
	% within sex	8.0%	9.0%			
type 5	Count	2	1	3	1.5%	
	% within sex	2.0%	1.0%			
Total Count		100	100	200	100.0%	
	% within sex	100.0%	100.0%			

Table 3: Showing percentage of distribution of different lip print pattern between male and female in quadrant III

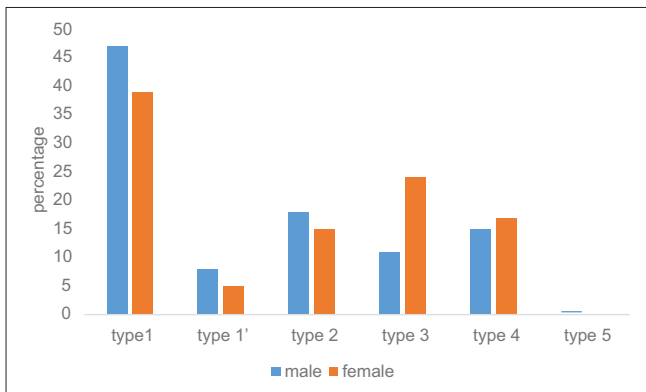
Lip print pattern		sex		Total	Chi- square (df)	p
		male	female			
type 1	Count	54	40	94	10.303 (4)	0.036
	% within sex	54.0%	40.0%	47.0%		
type 1'	Count	9	5	14	7.0%	
	% within sex	9.0%	5.0%	7.0%		
type 2	Count	16	19	35	17.5%	
	% within sex	16.0%	19.0%	17.5%		
type 3	Count	9	24	33	16.5%	
	% within sex	9.0%	24.0%	16.5%		
type 4	Count	12	12	24	12.0%	
	% within sex	12.0%	12.0%	12.0%		
Total	Count	100	100	200	100.0%	
	% within sex	100.0%	100.0%	100.0%		



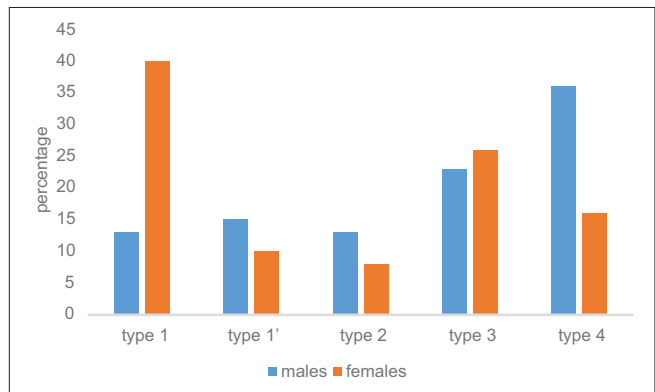
Graph 2: Showing percentage of distribution of different lip print pattern between male and female in quadrant III



Graph 3: Showing percentage of distribution of different lip print pattern between male and female in quadrant I



Graph 4: Showing percentage of distribution of different lip print pattern between male and female in quadrant IV



Graph 5: Comparison of lip print in males and females in middle 10mm for sex identification

Table 4 and Graph 4 show that in quadrant IV, on comparing the lip print pattern in males and females, the *P* value is 0.176, which is not statistically significant.

Table 5 and Graph 5 show that in middle 10 mm of lower lip, in males and females, the *P* value is (0.000) which is statistically significant. Middle 10 mm is mainly used for sex identification.

All the 200 individuals showed different and unique patterns in the four quadrants. Therefore, the uniqueness of lip print

pattern makes it a characteristic of an individual and thereby aids in personal identification and sex determination.

In middle 10 mm of the lower lip, the most common type of pattern in male was Type IV (37%) The most common type of pattern in females was Type I (40%).

RUGOSCOPY

The rugoscopy was conducted on 200 individuals (100 males and 100 females) among population of Kerala. The rugae

Table 4: Showing percentage of distribution of different lip print pattern between male and female in quadrant IV

Lip print pattern		sex		Total	Chi square (df)	p
		male	female			
type 1	Count	47	39	86	7.663 (5)	0.176
	% within sex	47.0%	39.0%	43.0%		
type 1'	Count	8	5	13	6.5%	
	%within sex	8.0%	5.0%	6.5%		
type 2	Count	18	15	33	16.5%	
	%within sex	18.0%	15.0%	16.5%		
type 3	Count	11	24	35	17.5%	
	%within sex	11.0%	24.0%	17.5%		
Type 4	Count	15	17	32	16.0%	
	%within sex	15.0%	17.0%	16.0%		
type 5	Count	1	0	1	0.5%	
	%within sex	1.0%	0.0%	0.5%		
Total	Count	100	100	200	100.0%	
	%within sex	100.0%	100.0%	100.0%		

Table 5: Showing percentage of distribution of different lip print pattern between male and female in 10mm of lower lip

Lip print pattern		sex		Total	Chi square (df)	P
		male	female			
type 1	Count	13	40	53	23.821 (4)	0.000
	% within sex	13.0%	40.0%	26.5%		
type 1'	Count	15	10	25	12.5%	
	% within sex	15.0%	10.0%	12.5%		
type 2	Count	13	8	21	10.5%	
	% within sex	13.0%	8.0%	10.5%		
type 3	Count	23	26	49	24.5%	
	% within sex	23.0%	26.0%	24.5%		
type 4	Count	36	16	52	26.0%	
	% within sex	36.0%	16.0%	26.0%		
Total	Count	100	100	200	100.0%	
	% within sex	100.0%	100.0%	100.0%		

Table 6: Total rugae and primary rugae in male and female

	sex	t (df)	Mean SD	P
total_rugae	male	0.932 (198)	8.0000 1.49071	0.352
	female	0.932 (190.26)	7.7800 1.82895	
primary rugae	male	0.671 (198)	7.1000 1.48051	0.503
	female	0.671 (197.98)	6.9600 1.46969	

pattern of all subjects was taken, and the statistical analysis was done by the Chi-square test to compare the proportions. The examination of palatal rugae pattern revealed the following observations.

The number of rugae on the right and left side of males and females did not show a statistical difference but males

in general had more rugae and the left side of the palate showed comparatively more number of rugae than on the right side [Table 6]. The analysis of length of the rugae demonstrated a higher number of primary rugae followed by secondary and fragmented rugae. The mean length of palatal rugae was more in males than females. It was not statistically significant.

The predominant shape in males was wavy and curved followed by straight pattern. The circular shape was rare, but the prevalence was increased in females than males. In females the wavy shape was predominantly seen followed by curved and straight pattern [Table 7].

Applying the same test to observe the different types of rugae patterns in males and female, no significant difference was observed ($P > 0.05$).

All the 200 working casts showed different rugae patterns. Therefore, the uniqueness of palatal rugae pattern makes it a characteristic of an individual and thereby aids in personal identification.

Table 7: Difference in shape of the rugae among males and females

shape		sex		Total	Chi square (df)	P
		male	female			
Wavy	Count	56	55	111	1.525 (4)	0.822
	% within sex	56.0%	55.0%	55.5%		
Curved	Count	31	30	61	30.5%	
	% within sex	31.0%	30.0%	30.5%		
Straight	Count	11	13	24	12.0%	
	% within sex	11.0%	13.0%	12.0%		
Circular	Count	0	1	1	0.5%	
	% within sex	0.0%	1.0%	0.5%		
circular and curved	Count	2	1	3	1.5%	
	% within sex	2.0%	1.0%	1.5%		
Total	Count	100	100	200	100.0%	
	% within sex	100.0%	100.0%	100.0%		

DISCUSSION

LIP PRINT

The prerequisite criteria for any social or legal reason are to identify the individuality as well as sex of the person. Presence of lip print in any crime site can give an evidence related to the suspect, it can also give information about the number of people present at the site of crime. Like fingerprint, lip print is also used as an evidence in criminal investigation cases and also in personal identification.^[9]

Different study gives different opinion about the lip print pattern among the males and females. In the present study, we have used two methods to identify the commonest type of lip print pattern in male as well in female. One is the quadrant methods in which the lip prints were divided into four different quadrants and each quadrant was analyzed separately among male and females. After the analysis, it was noticed that no two or more than two individual have similar type of lip print which means lip print is an important and unique feature of an individual.

In the second method the middle 10 mm of the lower lip was selected and analyzed, and it was observed that the common pattern in male and female was different. Similar type of observation was reported by many other workers like William,^[9] Sharma *et al.*^[10] Kasparzak^[8] Vahanwala and Parekh^[11] Jaishankar and Jaishankar^[12] Saraswati *et al.*^[13] Patel *et al.*^[14] Narang *et al.*^[15] In our study, type I pattern were found to be predominant in females and type 4 were predominant in males. This result is similar to the study conducted by Babu *et al.* in 2002.^[16]

RUGOSCOPY

The use of palatal rugae in forensic identification is preferred because of their low utilization cost, simplicity and reliability. It is sufficiently characteristic to discriminate between individuals because no two palates are alike in their configuration.^[17] Most of the studies are based on the Thomas and Kotze classification and hence, we used the same method for differentiating the patterns of the rugae. The method was found to be the most practical and easiest to apply compared with other methods.^[7]

In the present study, rugae length was more in males But, did not show much difference in the rugae lengths between the genders, and it was statistically insignificant. This correlates with the results done by Nayak *et al.*^[4] However, the results in Dohke and Osato showed an increase length in the rugae in females.^[18]

There is no statistical difference in the number of rugae in both males and females. Our results also show correlation with Saraf *et al.* wherein the rugae number was same in both males and females.^[19] The number of primary rugae was found to be increased in both the genders followed by secondary rugae. Fragmented rugae constituted a smaller proportion of the rugae patterns. This correlates with the previous literature done by Indira *et al.*, which demonstrated that the length remained the same in both the genders.^[2]

The assessment of rugae pattern in both the groups showed that wavy pattern was predominant, followed by curved and straight patterns. The circular pattern was few in number. This correlates with the previous studies study done by Kapali *et al.* on the assessment of pattern.^[20] Few studies demonstrated that curved pattern is predominant in females. This could be due to the interobserver variations in the analysis of rugae patterns.

No significant difference was found in the unification of rugae between males and females, but a significant difference was observed for the direction of palatal rugae. The present study showed that forwardly placed rugae was more in males than females. The present study successfully established the individuality of the rugae patterns, length, and number. However, major drawback is that large-scale studies are necessary. More research among different ethnic groups is essential for understanding of the role of palatal rugae in forensic odontology.

CONCLUSION

Human identification of unknown individual has paramount importance to society. Our study has proved that cheiloscopy and palatoscopy hold the potential to identify the sex and identity of the individual, as they remain stable over time and

unique to individual. The use of palatal rugae and lip print in forensic identification is preferred because of their low utilization cost, simplicity, and reliability. Palatal rugae are stable and resist decomposition for up to 7 days after death. So, palatal rugae pattern is useful for personal identification. Also, studies have shown that Lip prints are consistent for an individual for life time. Lip prints are helpful for identifying a suspect in crime scene. Research studies and information regarding the use of lip prints as evidence in personal identification and criminal investigation in forensic dentistry are very much scanty. However, further studies should be conducted on a large number of individuals of different races, family members, twins, and siblings in order to achieve more accurate results.

SUMMARY

In Kerala as well as the world today, crimes of different nature are on the rise. Odontology plays an important role in identification of humal remains. Palatal rugae are well protected from trauma and heat. Like fingerprints, palatal rugae and lip print are permanent and unchangeable. The uniqueness, postmortem resistance, overall stability and low utilization of cost makes palatal rugae and lip print as ideal forensic identification parameter.

In forensic odontology oral cavity mainly teeth plays a key role. But palatal rugae serves as a tool for identification in edentulous patients also. Lip print at a crime scene help to find out the number of people involved and the pathological changes of lips and sex of the individual. Analysis of lip prints left at the scene of crime and their comparison with suspected person may be useful for identification.

In the present study, evaluation of lip print pattern has proved that cheiloscopy can be used for personal identification and sex determination as they remain unchanged overtime and unique to an individual. After analysis of palatal rugae pattern we can conclude that palatal rugae can be used for personal identification.

ACKNOWLEDGMENT

The authors would like to thank the Indian Council of Medical Research (ICMR).

FINANCIAL SUPPORT AND SPONSORSHIP

This study was financially supported by the ICMR.

CONFLICTS OF INTEREST

There are no conflicts of interest.

REFERENCES

- Fahmi FM, Al-Shamrani SM, Talic YF. Rugae pattern in a Saudi population sample of males and females. *Saudi Dent J* 2001;13:92-5.
- Indira AP, Gupta M, David MP. Rugoscopy for establishing individuality. *Indian J Dent Adv* 2011;3:427-32.
- Bansode SC, Kulkarni MM. Importance of palatal rugae in individual identification. *J Forensic Dent* 2009;1:77-81.
- Nayak P, Acharya AB, Padmini AT, Kaveri H. Differences in the palatal rugae shape in two populations of India. *Arch Oral Biol* 2007;52:977-82.
- El Domiaty MA, Al-gaidi SA, Elayat AA, Safwat MD, Galal SA. Morphological patterns of lip prints in Saudi Arabia at Almadinah Almonawarah province. *Forensic Sci Int* 2010;179.e1-179.e9.
- Gupta A, Sharma N, Jain SK, Khatun SS. Cheiloscopy: A tool for sexual dimorphism in india. *Int J Anat Res* 2016;4:2577-83.
- Thomas CJ, Kotze TJ. The palatal rugae pattern: A new classification. *J Dent Assoc S Afr* 1983;38:153-7.
- Kasprzak J. Cheiloscopy. In Siegel JA, Saukko PJ, Knupfer GC. *Encyclopedia of Forensic Sciences*. London: Academic Press; 2000;358-61.
- Williams TR. Lip prints Another means of identification. *J Forensic Indent*, 1991;41:190 4.
- Sharma P, Saxena S, Rathod V. Cheiloscopy: The study of lip prints in sex identification. *J Forensic Dent Sci* 2009;1:24-7.
- Vahanwala SP, Parekh BK. Study of lip prints as an aid to forensic methodology. *JIDA* 2000;71:268-71.
- Jaishankar S, Jaishankar N. Lip prints in personal identification. *JIADS* 2010;1:23-6.
- Saraswati TR, Mishra G, Raganthan K. Study of lip prints. *J Forensic Dent Sci* 2009;1:28.
- Patel S, Paul I, Madhusudan AS, Ramesh G, Sowmya GV. A study of lip prints in relation to gender, family and blood group. *Int J Oral Maxillofac Pathol* 2010;1:4-7.
- Narang SR, Arora CP, Randhawa K. Cheiloscopy as an aid to forensic methodology. *Indian J Compr Dent Care* 2011;1:57-60.
- Babu NC, Premalatha BR, Jude J. Cheiloscopy: A new aid for sex identification in forensic science. *Indian J Forensic Odontol* 2009;2:131-6.
- Abou El-Fotouh MM. El-Sharkawy GZ. A study of palatal rugae pattern (rugoscopy) in an Egyptian population. *Official J Egypt Dent Assoc* 1998;44:3177.
- Dohke M, Osato S. Morphological study of the palatal rugae in Japanese 1. Bilateral differences in the regressive evaluation of the palatal rugae. *Jpn J Oral Biol* 1994;36:125-40.
- Saraf A, Bedia S, Indurkar A, Degwekar S, Bhowate R. Rugae patterns as an adjunct to sex differentiation in forensic identification. *J Forensic Odontostomatol* 2011;29:14-9.
- Kapali S, Townsend G, Richards L, Parish T. Palatal rugae patterns in Australian aborigines and Caucasians. *Aust Dent J* 1997;42:129-33.