Original Article

Comparison of Cheiloscopy and Rugoscopy in Karnataka, Kerala, and Manipuri Population

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Abstract

Aims and Objectives: The aim of the study was to evaluate and compare lip prints and palatal rugae pattern in Kerala, Karnataka, and Manipuri population.

Materials and Methods: The study involved 180 individuals (60 each from Karnataka, Kerala, and Manipuri population). Lipstick was used to record lip prints, which were visualized by magnifying lens. Palatal rugae were recorded on maxillary casts of all subjects and analyzed following Kapali S *et al.*'s classification. Statistical Package for the Social Sciences version 20 for Windows software was used for analysis.

Results: Among the study population, 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. In the entire population, males showed Type 3 and females showed Type 1. On analysis of overall rugae wavy, forward and divergence patterns were predominant. On comparison of gender, males demonstrated greater number of wavy and perpendicular rugae, and females had curved, straight, forward, and backward.

Conclusion: Both cheiloscopy and rugoscopy have the prospective to recognize an individual. Cheiloscopy is more reliable than rugoscopy in making out the group and gender of an individual.

Keywords: *Cheiloscopy, forensic identification, Karnataka, Kerala, rugoscopy*

Received : 19-06-18.
Accepted : 30-07-18.
Published : 08-10-18.

Introduction

Human identification has become fundamental in every facet of human relationships, at both social and legal levels.[1,2] Dental identification, fingerprints, and DNA evaluation are possibly the most frequent methods used for identification process. However, these cannot be useful in all circumstances. Therefore, it is essential to apply other and less known methods such as cheiloscopy and rugoscopy for identification.[3-6]

"Cheiloscopy" is the assessment of lip print pattern (LPP). Uniqueness is the feature of LPP, which substantiates its usefulness in various situations. Cheiloscopy may be used as a valuable tool in individual identification.[7,8] Palatoscopy or palatal rugoscopy is the study of palatal rugae pattern (PRP) so as to ascertain a person's identity.[8-10]

Sivapathasundharam *et al*. found Type 3 LPP as a predominant pattern in their study.[7] Nayak *et al*. observed the most common rugae shape as wavy among the males whereas curved and straight shapes in the females.[8] We carried this study to assess and compare the LPP and PRP in Karnataka, Kerala, and Manipuri populations, as these patterns are unique to individuals, thereby helpful in forensic odontology.

Materials and Methods

We included sixty each of Karnataka, Kerala, and Manipuri students in the age group of 18–23 years of Navodaya Educational Institutions, Raichur, Karnataka (Ethical committee clearance; reg. No. ECR/269/Indt/TG/2016). Sample size was calculated using Institute for Experimental Psychology in Dusseldorf, Germany. Total sample size obtained was

Access this article online

Quick Response Code:

Website: www.jispcd.org

DOI: 10.4103/jispcd.JISPCD_223_18

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How to cite this article: Manikya S, Sureka V, Prasanna MD, Ealla K, Reddy S, Bindu PS. Comparison of cheiloscopy and rugoscopy in Karnataka, Kerala, and Manipuri population. J Int Soc Prevent Communit Dent 2018;8:439-45.

178 which was rounded to 180 which was divided into three groups sixty each. Sixty in each group is equally divided into thirty each as males and females.

Inclusion criteria

Inclusion criteria were lips and rugae without any inflammatory disease, trauma, malformation, deformity, and scars.

Procedure

For recording lip prints, individuals were asked to open their mouth widely and applying Vaseline around lips, later in a single motion, lipstick was applied evenly. They were instructed to lightly rub both their lips gently so that lipstick spreads evenly. A 10-cm strip of cellophane tap was cut with scissors. Lip impressions were recorded in the rest position by applying a strip of glued portion of cellophane tape, initially in the center after which uniform pressure was applied toward the corner of the lips. Then, the tape was cautiously removed beginning at one end to the other, evading any smudging of the print and fixed on to a white chart paper. Each individual was given a serial number, which was written on the back to serve as a permanent record. The impression was then observed with a magnifying lens for features such as a number of lines, furrows branching, and combinations [Figure 1]. Tsuchihashi (1970) *et al*.[9] classification was used for LPP and Vahanwala SP, Parekh BK (2000) *et al*.[10] classification was used for determining the gender of participants [Table 1].[7]

Interpretation of lip prints

Each individual's lips were divided into six compartments (1 – upper right, 2 – lower right, 3 – lower middle, 4 – lower left, 5 – upper left, and 6 – upper middle).

Palatal rugae recording procedure

Maxillary arch impressions were made with alginate. Casts were poured and stored for analysis [Figure 2]. The rugae outlines were traced on the casts with a graphite pencil and patterns were evaluated based on Kapali S *et al. (*1983) classification, which includes length, number, shape, and unification of rugae.[7]

Statistical analysis

Results obtained from this study were expressed in proportion. Comparison between groups was done by *Z*-test and Chi-square test. A two-tailed $P < 0.05$ was regarded as statistically significant. Data were analyzed by software SPSS Version 20 (IBM SPSS Statistics for Windows, IBM Corp., Armonk, NY: USA).

Results and Observations

All the lip prints were cautiously observed and patterns were verified. They were found to be unique for every individual and more than one LPP was observed in many individuals. The most frequent LPP was Type 3 (41%) followed by Type 2 (27%) and least common was Type 1' (0.05%) [Table 2]. Comparing LPP in all three population showed that the most frequent one in Karnataka was Type 2 (45%), whereas in Kerala and Manipuri, it was Type 3 (45% and 38%), but the least widespread LPP in Karnataka was Type 4, and in Kerala and Manipuri

Table 1: Vahanwala (2000) *et al*'s. classification for gender determination

Type of pattern	Description and gender
1, 1'	Patterns are dominant - female
2	Pattern dominant - female
3	Pattern present - male
4	Male
5	Varied patterns - male

Same patterns in all quadrants - female

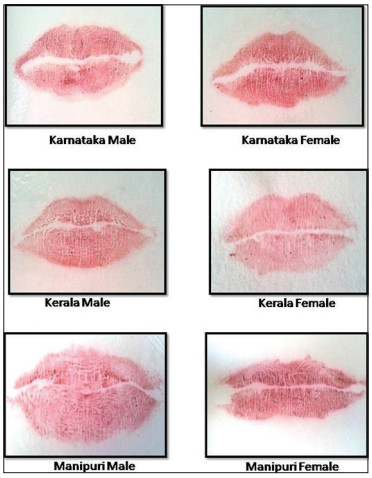


Figure 1: Lip print patterns among three groups

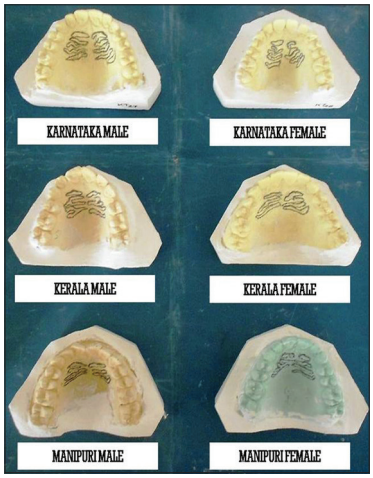


Figure 2: Maxillary arch casts for analysis of palatal rugae

participants, it was Type 1' [Table 3 and Graph 1]. Statistically significant variation in Type 1 (P = 0.024), Type 2 (P = 0.0001), and Type 4 (P = 0.006) was noted on comparison between all the three groups of population.

Gender-wise comparison of the study population revealed most frequent LPP in males to be Type 3 (54.4%) and in females Type 1 (30%) [Graph 2]. A statistically significant difference in Type 1 (P = 0.003) and Type 3 (P = 0.0003) was found.

On comparison, predominant LPP in males was Type 3, followed by Type 2, with a significant difference (P = 0.008). However Type 1 pattern was predominantly seen in Manipuri and Kerala population and Type 2 in Karnataka population, the difference being statistically significant (P < 0.05).

Among Karnataka population, the most frequent LPP in males was Type 3 (53.3%) and in females Type 2 (50%). A statistically significant difference in Type 3 (P = 0.03) was noted, whereas in Kerala population, the most frequent LPP in males was Type 3 (63%) and in females Type 1 (33%), and there was a significant difference in Type 3 (P = 0.004). In Manipuri population, the most frequent LPP in males was Type 3 (47%) and in females Type 1 (43%). There was a significant difference in Type 1 (P = 0.02).

Based on Vahanwala SP, Parekh BK (2000)[10] classification, 55 (61%) males and 53 (59%) females were correctly identified. Twelve individuals showed similar LPP in all compartments, whereas nine individuals showed varied LPP in all compartments [Table 4].

Table 2: Distribution of lip print patterns in total study population (n=180)

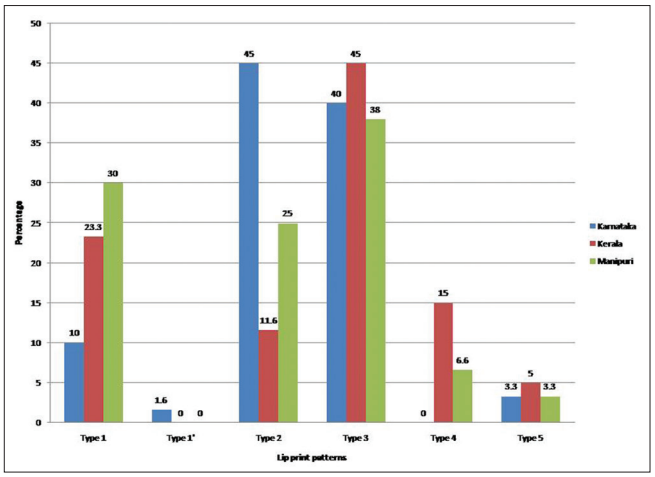
Lip print patterns	n (%)
Type 1	38 (21.11)
Type 1'	1 (0.05)
Type 2	49 (27.22)
Type 3	74 (41.11)
Type 4	13 (7.22)
Type 5	7 (3.88)
Total	180 (100)

Compartment-wise examination of the LPPs of total study population showed Type 3 predominantly in compartment 1, 3, 4, and 6; Type 4 in compartment 2; and Type 1 in compartment 5.

Palatal rugae were compared between gender and population by analyzing the palate for a total number of rugae, predominant shape, predominant direction, and unification of rugae. When the number of rugae was compared between the three populations, a total number of rugae were more in Karnataka (426), followed by Kerala (420) and Manipuri (412) population, and there was no significant difference [Table 5 and Graph 3].

In overall population, the principal shape of rugae was wavy, followed by curved and straight. Most frequent direction was forward, followed by backward and perpendicular. Most common unification was divergence followed by convergence [Table 6 and Graph 4].

On comparison of rugae patterns among three groups, main shape in all groups was wavy, followed by curved and straight; predominant direction in Karnataka and Kerala was forward, followed by backward and perpendicular directions, whereas Manipuri group revealed forward, followed by perpendicular and backward direction [Graph 5]. The predominant unification was divergence followed by convergence in three groups [Graph 6]. Significant difference was

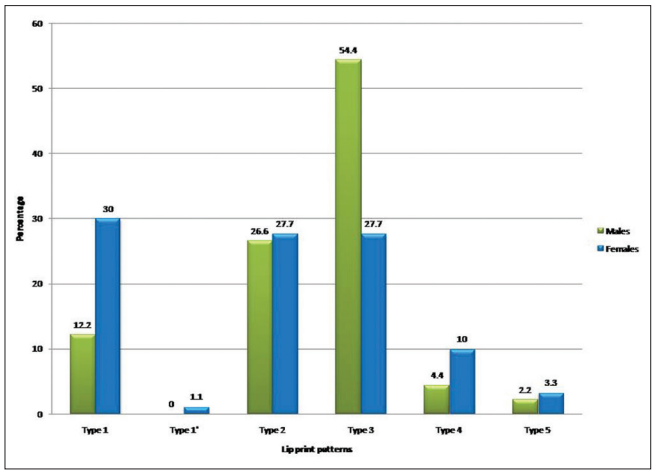


Graph 1: Comparison of lip print patterns among three groups

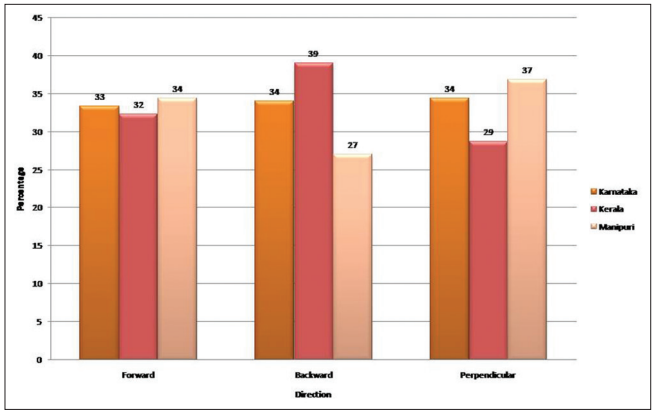
Table 3: Comparison of lip print patterns between Karnataka, Kerala, and Manipuri population (n=180)

Lip print patterns	Karnataka (%)	Kerala (%)	Manipuri (%)	Total (%)	χ^2	P
Type 1	6 (10)	14 (23.3)	18 (30)	38 (21.11)	7.47	0.024
Type 1'	1 (1.6)	0	0	1 (0.05)	2.01	0.36
Type 2	27 (45)	7 (11.6)	15 (25)	49 (27.22)	17	0.0001
Type 3	24 (40)	27 (45)	23 (38.3)	74 (41.11)	0.59	0.74
Type 4	0	9 (15)	4 (6.6)	13 (7.22)	10.1	0.006
Type 5	2 (3.3)	3 (5)	2 (3.3)	7 (3.88)	0.297	0.86

$P \leq 0.05$ - significant; $P > 0.05$ - not significant



Graph 2: Comparison of lip print patterns gender wise



Graph 4: Comparison of direction of rugae in three groups

Table 4: Accuracy of cheiloscopy in gender identification* (*n*=180)

Participants	Diagnosed correct	Diagnosed wrong	Percentage
Males	55	35	61.1
Females	53	37	58.9
Total	108	72	100

*Gender identification according to Vahanwala (2000) classification

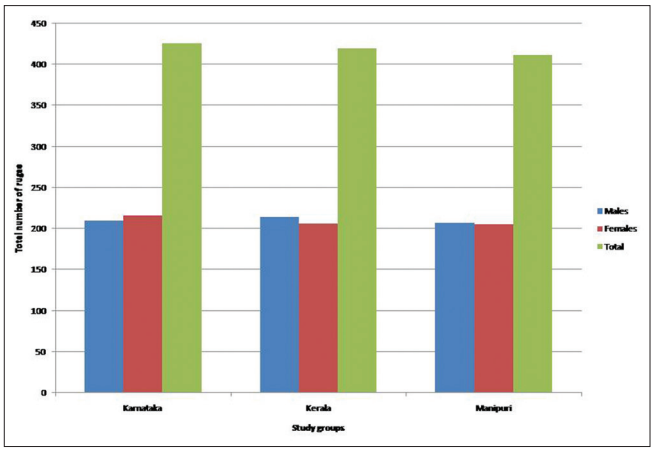
Table 5: Distribution of total number of rugae in Karnataka, Kerala, and Manipuri population (*n*=180)

Gender	Karnataka	Kerala	Manipuri	χ^2	*P*
Males	210	214	207	0.23	0.88
Females	216	206	205		
Total	426	420	412	0.27	0.92

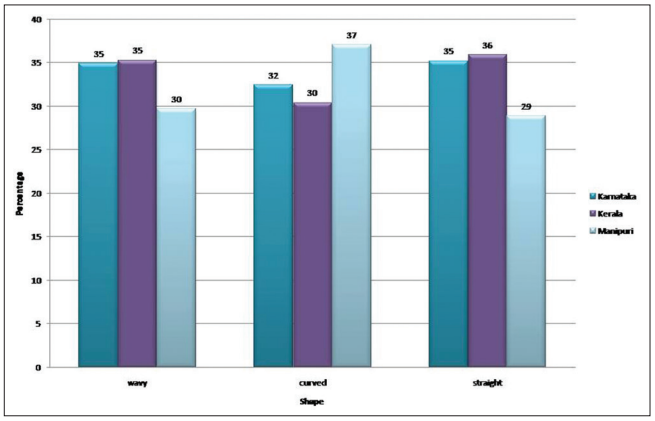
P≤0.05 - significant; *P*>0.05 - not significant

observed in backward (P = 0.003) and perpendicular direction (P = 0.05).

Gender wise comparison showed that males had mostly wavy pattern and females had curved and straight



Graph 3: Distribution of total number of rugae in three groups



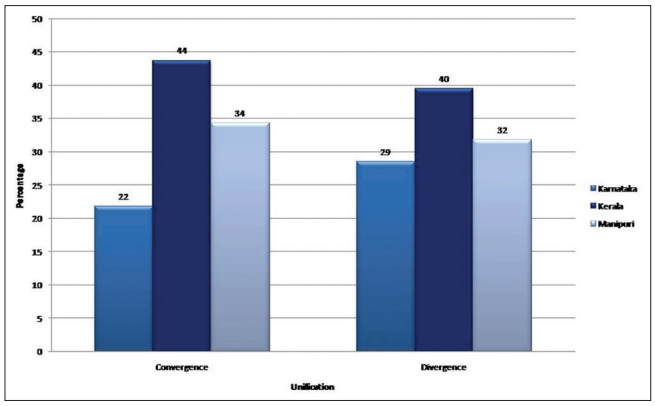
Graph 5: Comparison of shape of rugae in three groups

patterns. Females revealed more number of forward and backward rugae, whereas males had more number of perpendicular rugae. Males showed more number of divergent rugae and females convergent rugae. On comparison of rugae patterns in males between three groups, backwardly directed rugae showed a significant difference. Females showed backwardly directed rugae and was statistically significant.

On comparison of rugae patterns on both sides of the entire study population, wavy pattern was more in number on the left side and curved and straight rugae on the right side. A significant difference in straight rugae (P = 0.02) was observed. Forward rugae were more in number on left side and backward and perpendicular type on the right side. Statistically significant difference was seen in forward and backward rugae (P = 0.0001). Convergent rugae were more on the left in comparison to right side and divergent rugae was in the same number.

Discussion

Conventional methods for personal identification comprise anthropometry, fingerprints, age, sex



Graph 6: Comparison of unification of rugae in three groups

Table 6: Comparison of palatal rugae patterns in overall, Karnataka, Kerala, and Manipuri population (*n*=180)

Rugae patterns	Karnataka	Kerala	Manipuri	Total	χ^2	*P*
Shape						
Wavy	201	203	200	575	0.181	0.91
Curved	175	164	171	539	0.599	0.74
Straight	50	51	41	142	1.13	0.57
Direction						
Forward	163	158	168	489	0.97	0.61
Backward	136	156	108	400	11.5	0.003
Perpendicular	127	106	136	360	6.13	0.05
Unification						
Convergence	7	14	11	32	0.615	0.735
Divergence	52	72	58	182		

P≤0.05 - significant; *P*>0.05 - not significant

determination, and blood groups. These methods have proven successful in many cases. LPP and PRR are one among the other methods, which may help in personal identification because of their uniqueness.[8-12]

We carried this study to analyze and compare LPP and PRP in three groups (Karnataka, Kerala, and Manipuri) to determine their uniqueness in individuals. Over all, Type 3 pattern was the most common pattern in the entire population. It is similar to studies of Sivapathasundharam *et al*., Prasad and Vanishree, who showed Type 3 as a predominant pattern.[11]

In Karnataka population, the most common LPP was Type 2 (45%) followed by Type 3. Rastogi and Parida[13] revealed the most common pattern to be Type 2. Contrast to this, Verghese *et al*.(2011)[14] conducted a study on Karnataka population and concluded that the most common pattern was Type 4. In Karnataka group, most common LPP was branched pattern (Type 2) and the least common pattern was reticular pattern (Type 4). Most common LPP in Kerala was Type 3 (45%) followed by Type 1 (24%). Mathew *et al*. found that the most frequent LPP was Type 1.[12] In Kerala population, most frequent LPP was intersecting pattern (Type 3) and the least frequent was partial length vertical grooves (Type 1').

Most common LPP in Manipuri was Type 3 (38%) followed by Type 1 (30%). Prasad *et al* (2011)[11] found that the most frequent LPP in Manipuri was Type 3 and Koneru *et al.* (2013)[15] in their study found Type 1. In Manipuri population, most frequent LPP was intersecting pattern (Type 3) and the least was partial length vertical grooves (Type 1').

There was a significant difference in Type 2 LPP among groups, suggesting that it may be one of the factors which help to differentiate Karnataka population from Kerala and Manipuri. Statistically significant difference was observed seen in Type 1 and Type 4, indicating that these types help to establish the population.

In the entire study population, most common LPP in males was intersecting pattern (Type 3) and in females was vertical grooves (Type 1). The difference may be helpful in determination of sex of the individual. Intragroup comparison among both the genders revealed that males can be differentiated from females in all the groups based on predominant patterns considerably.

Some of our results were diverse to other similar studies, which might be due to lower sample size and considering the area of interest. Most of the studies considered a lower-middle portion of the lip and others divided four quadrants and studied the lip patterns.

Based on Vahanwala SP, Parekh BK (2000)[10] classification, 55 (61%) males and 53 (59%) females were correctly identified.[14] Individuals who had similar patterns in all compartments were considered as females, whereas nine individuals showed varied patterns and were considered as males. Kumar *et al*.[16] carried a study on cheiloscopy for gender determination, and 95.55% and 97.77% were rightly recognized as males and females, respectively. Hence, reliability of LPP in determining the gender was considerable.

Portion-wise study of LPP among the groups revealed that Karnataka population was different from other two populations considering the compartments 1, 3, 4, and 6. This shows that not only the middle portion but also the other portions to be considered. Comparison between both sexes within the groups demonstrated no variation on compartment-wise analysis.

Analysis of LPP showed that, in the entire population, males and females can be differentiated on the basis of LPP. It is as well probable to differentiate between groups based on the predominant lip pattern and compartment-wise analysis to a considerable extent.

Palatal rugae study revealed that the total number of rugae was greater in Karnataka, followed by Kerala and Manipuri population. Nevertheless, no statistically significant difference was observed in the total number of rugae. Paliwal *et al*.[17] observed that the difference in a total number of rugae among the two groups showed no statistical difference.

In the entire study population, predominant shape of rugae was wavy, followed by curved and straight. Paliwal *et al*.[17] in their study found that wavy pattern was predominant, followed by curved and then straight.

In the entire study population, most frequent rugae direction was forward, followed by backward and perpendicular. Paliwal *et al*.[17] in their study observed forward, followed by backward and perpendicular direction.

In the whole population, most common unification was divergence followed by convergence. Paliwal *et al*.[17] found that the most common unification is divergence followed by convergence.

On comparison of PRP between the three populations, main shape in all groups was wavy, followed by curved and straight. Predominant direction was forward, followed by backward and perpendicular in Karnataka and Kerala, whereas Manipuri group showed forward followed by perpendicular and backward directions. The predominant unification was divergence followed by convergence in all the three groups. Statistically significant difference was observed in backward and perpendicular direction. Analysis of PRP revealed no much variation between the groups except for the significant backward and perpendicular rugae patterns.

Males showed more number of wavy patterns, whereas females showed more number of curved and straight patterns. Our study results were similar to Nayak *et al*.[8] They observed the most common rugae shape as wavy among the males, whereas curved and straight shapes in the females. This may aid to distinguish gender.

On comparison of gender within the groups, there was a significant difference only in backward PRP in Karnataka population. This suggests that PRP is not considerable for distinguishing gender within the groups.

When we compared right and left side of the entire population, a more number of wavy and forward rugae patterns were on the left side, whereas curved, straight, backward, and perpendicular patterns were on the right side. Left side had more convergent rugae, whereas divergent rugae were same on both sides. There was a significant difference in straight rugae and forward and backward rugae. Paliwal *et al*.[17] observed that right side had significantly more number of wavy rugae in males. This is explained by the phenomenon of regressive evaluation, dominating the right side of the palate.

Analysis of PRP showed no much variation between the populations except for the significant backward rugae pattern. Males and females also showed no significant difference except for backward rugae. The right side of the palate had more number of rugae than the left side with significant difference in straight, forward, and backward rugae. This indicates that although it is unique, it is hard to distinguish between population and gender considering the rugae patterns.

The present study revealed that both cheiloscopy and rugoscopy can be used to identify an individual; LPP is more consistent in the identification of the sex of an individual as compared to PRPs. LPP and PRP in combination give better results compared to lip prints or palatal rugae alone.

Key findings

This study clearly demonstrates that LPP and PRP are unique to each individual and have potential as a supplementary tool, along with the dentition, to establish the identity of an individual. Cheiloscopy and rugoscopy stand as potential techniques in identifying an individual compared to DNA fingerprinting which is cumbersome. In future, further larger sample (as this is the main limitation of our study) between different populations should be studied in combination with other methods such as fingerprints, DNA comparison, and dental characteristics to narrow the field for identification and give better results.

Conclusion

LPP and PRP are genotypically determined and stay unaffected from birth to death. Hence, these methods can be extensively used in forensic odontology for accurate identification. Finally, this study concludes that the LPP and PRP may be used precisely as an additional method of differentiating populations.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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