Original Article

Assessment and comparison of fingerprints between Kerala and Manipuri populations of India: A forensic study

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Abstract

Background and Objective: The study of the epidermal ridges and the patterns formed by them is known as dermatoglyphics, a word coined by the anatomist Harold Cummins of Tulane University. The potential of fingerprints to determine sex and individual identification has been well exhibited and documented. However, few studies have been conducted using fingerprints for population identification. The objective of this study was to determine predominant fingerprint patterns in males and females in relation to Kerala and Manipuri population and also to compare the fingerprint patterns between these populations.

Materials and Methods: The study sample consisted of 200 subjects, which included 100 Kerala and 100 Manipuri populations in the age group of 18-21 years. Each subject was asked to press their fingertip on the stamp pad and then to the plain chart paper to transfer the fingerprint impression. All the individuals’ fingerprints were identified and classified into loops, whorls, and arches. The data were statistically analyzed using the Z-test.

Results: Loops were found to be the most common fingerprint pattern among the entire study subjects. Manipuri population showed the highest frequency of loops and arches, whereas Kerala population showed more whorls. Further in our study, comparison of all fingerprint patterns between Kerala and Manipuri population revealed a significant difference for whorls and arches.

Conclusion: Difference in the fingerprint patterns between Kerala and Manipuri population exists for whorls and arches. This variation in fingerprints patterns between two populations suggests further study in associating persons to groups in more number of populations.

Keywords
Fingerprints, Kerala population, Manipuri population, population identification

Introduction

The increasing alertness regarding the biometric system of dermatoglyphics pattern is one of the surest methods of identification. The study of the epidermal ridges and the patterns formed by them is known as dermatoglyphics. This word was coined by the anatomist Harold Cummins of Tulane University. The word dermatoglyphics means “a skin carving”.[¹]

The dermatoglyphics patterns of dermal ridges that constitute human fingerprint are produced during early intrauterine life, between the 7th and 21st week of gestation and are fully created at about 7 months of fetus development. It has been reported that ridges are influenced by blood vessel-nerve pairs at the border between the dermis and epidermis during prenatal growth.[²]

Fingerprints gathered at a crime scene can be used to identify the perpetrator of the crime, victims and other persons who touched the surface. Fingerprints scan can be used to validate electronic registration, cashless catering, library access particularly in school and colleges and office attendance. The secretions in the fingerprints contain residues of various chemicals and metabolites which can be detected and used for the identification of forensic purposes.[³]

The potential of fingerprints to determine sex and individual identification has been well exhibited and documented. However, few studies have been conducted using fingerprints for population identification. Fingerprint characteristics depict people and groups. A person can be described approximately by fingerprint patterns and uniquely by fingerprint minutiae.
A group or population can be described largely by fingerprint pattern frequencies. Some studies have shown that the fingerprint patterns produced reveal a population-wise dominance that is, a particular population will show a high proportion of a particular fingerprint type.\(^2,4\)

Hence, this study was aimed at determining and establishing the predominant dermatoglyphics pattern among different individuals in two different populations of India, i.e., Kerala and Manipur.

**Materials and Methods**

**Subjects**

The total sample size consisted of 200 students enrolled in Navodaya Educational trust, Navodaya Dental College, Raichur, Karnataka, comprising of 100 (50 male and 50 female) subjects born and brought up in Kerala and 100 (50 male and 50 female) Manipuri’s, who are born and brought up in Manipur, in the age group of 18-21 years [Figure 1]. Informed verbal consent was taken from each of them, and ethical clearance from the institution was obtained to carry out the study. Students with permanent scars on their fingers or thumbs, with any hand deformities due to injury or disease, were excluded from the study.

**Recording the finger prints**

The materials used were ink pad, white chart paper and magnifying lens [Figure 2]. Each subject was asked to wash their hands thoroughly and then asked to press their fingertip on the stamp pad and then to the plain chart paper to transfer the fingerprint impression. The same method was repeated for all the fingers of both hands. In this way, fingerprints of all the ten digits were taken separately on the respective blocks on the same sheet of paper [Figure 3].

**Examination of the finger prints**

The fingerprint patterns were studied with the help of a magnifying lens and were identified based on the appearance of ridge lines.

In order to classify the fingerprints in this study, the classification scheme proposed by Galton was used depending upon their primary pattern:

1. Loops
2. Whorls
3. Arches.

**Statistical analysis**

The data were analyzed for percentage proportions and compared. Statistical analysis was performed using Z-test and \(P < 0.05\) was considered to be statistically significant.

**Results**

Overall, no 2 or more individuals had a similar type of fingerprint patterns in all the fingers of both hands.

When sex was evaluated in the populations combined, males and females showed predominantly loops (52% and 54%) and...
whorls (40% and 40%), respectively. Females have a higher incidence of loops (54%) and whorls (40%), whereas males showed a higher incidence of arches (8%). Comparison of all fingerprint patterns between males and females using the Z-test showed a significant difference ($P = 0.002$) only for arches [Table 1] suggesting that loops and whorls were almost equally distributed in both males and females.

In the Kerala population, loops were found to be predominant (51%), followed by whorls (44%) and arches (5%). In Kerala males, whorls (44%) and arches (7%) were predominant than Kerala females, whereas loops (55%) were predominant in Kerala females. Statistical comparison of all fingerprint patterns between males and females in Kerala population showed significant differences ($P < 0.001$) only for arches [Table 2].

In the Manipuri population, loops were found to be predominant (55%), followed by whorls (37%) and arches (8%). Manipuri females showed a higher frequency of loops (54%), whorls (37%) and arches (9%) than Manipuri males. Statistical comparison of all fingerprint patterns between males and females in Manipuri population showed no significant difference [Table 3].

When the overall patterns were evaluated among the entire study subjects (in both Kerala and Manipuri subjects), loops were found to be the most common fingerprint pattern having 53% when compared to other types of fingerprint patterns. Manipuri population showed the highest frequency of loops (55%) and arches (8%) than Kerala population. However, Kerala population showed more whorls (44%) than Manipuri population. The z-test comparison of all fingerprint patterns between Kerala and Manipuri population revealed a significant difference for whorls (0.001) and arches (0.001) [Table 4].

### Discussion

Cummins found that the configurations of ridge pattern are determined partially by heredity and in part by accidental or environmental influence which create stress and tension in their growth during fetal life. Finger ridge pattern are extremely heritable, durable and age independent human traits. Dermatoglyphics traits are those which are inherited as individual specific traits. They are supposed to play an important role in the human biological research. These traits are very much useful in population identification studies.

When a group comprises related persons, the genetic basis of fingerprints produces common qualitative and quantitative fingerprint uniqueness within the group. These common characteristics allow for differentiation between endogamous groups. Forensic anthropology is sated with examples detailing the dermatoglyphic differences among endogamous groups based on race, religion, geography, or caste.

During the past century, it has been apparent that diverse populations reveal wide variations in the frequency of fingerprints. These typescripts are usefully employed for the study of ethnic variation, genetic and human biology. Thus in the present study, an attempt is been made to evaluate the predominant fingerprint patterns in Kerala and Manipuri population.

On the analysis of fingerprint patterns in males and females of entire study subjects, loops were predominant, followed by whorls and arches. Our results were in accordance with that of Rastogi and Pillai, Mehta and Mehta and Nithin et al. Females have a higher incidence of loops and whorls, whereas males showed a higher incidence of arches. This was in accordance to Ekerette et al. who showed that females have higher loops than males of Akwaibom state of Nigeria.

Comparison of all fingerprint patterns between males and females showed a significant difference only for arches in our study. Similarly, Sangam et al., in 2011 presented a study revealed that there were significant sex differences in the distribution of the fingerprint pattern in the region of Andhra Pradesh. The reasons for sexual dimorphism observed in the dermatoglyphics patterns, can be supported by the fact that differences in

### Table 1: Comparison of finger print patterns between males and females across both populations of the study

<table>
<thead>
<tr>
<th>Patterns</th>
<th>Males (%)</th>
<th>Females (%)</th>
<th>Total (%)</th>
<th>Z score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loops</td>
<td>501 (52)</td>
<td>564 (54)</td>
<td>1065 (53)</td>
<td>−1.106</td>
<td>0.267</td>
</tr>
<tr>
<td>Whorls</td>
<td>385 (40)</td>
<td>417 (40)</td>
<td>802 (40)</td>
<td>−0.143</td>
<td>0.889</td>
</tr>
<tr>
<td>Arches</td>
<td>78 (8)</td>
<td>55 (6)</td>
<td>133 (7)</td>
<td>2.496</td>
<td>0.002 (S)</td>
</tr>
</tbody>
</table>

$P>0.05$ is not significant, while $P<0.05$ is significant

### Table 2: Comparison of finger print patterns between males and females of Kerala population

<table>
<thead>
<tr>
<th>Patterns</th>
<th>Males (%)</th>
<th>Females (%)</th>
<th>Total (%)</th>
<th>Z score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loops</td>
<td>246 (49)</td>
<td>270 (55)</td>
<td>516 (51)</td>
<td>−1.911</td>
<td>0.056</td>
</tr>
<tr>
<td>Whorls</td>
<td>222 (44)</td>
<td>214 (43)</td>
<td>436 (44)</td>
<td>0.177</td>
<td>0.0857</td>
</tr>
<tr>
<td>Arches</td>
<td>38 (7)</td>
<td>10 (2)</td>
<td>48 (5)</td>
<td>4.057</td>
<td>0.001 (S)</td>
</tr>
</tbody>
</table>

$P>0.05$ is not significant, while $P<0.05$ is significant

### Table 3: Comparison of finger print patterns between males and females of Manipuri population

<table>
<thead>
<tr>
<th>Patterns</th>
<th>Males (%)</th>
<th>Females (%)</th>
<th>Total (%)</th>
<th>Z score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loops</td>
<td>255 (56)</td>
<td>294 (54)</td>
<td>549 (55)</td>
<td>0.454</td>
<td>0.653</td>
</tr>
<tr>
<td>Whorls</td>
<td>163 (36)</td>
<td>203 (37)</td>
<td>366 (37)</td>
<td>−0.610</td>
<td>0.542</td>
</tr>
<tr>
<td>Arches</td>
<td>40 (8)</td>
<td>45 (9)</td>
<td>85 (8)</td>
<td>0.244</td>
<td>0.810</td>
</tr>
</tbody>
</table>

$P>0.05$ is not significant, while $P<0.05$ is significant

### Table 4: Comparison of finger print patterns between Kerala and Manipuri population

<table>
<thead>
<tr>
<th>Patterns</th>
<th>Kerala population (%)</th>
<th>Manipuri population (%)</th>
<th>Total (%)</th>
<th>Z score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loops</td>
<td>516 (51)</td>
<td>549 (55)</td>
<td>1065 (53)</td>
<td>−1.479</td>
<td>0.139</td>
</tr>
<tr>
<td>Whorls</td>
<td>436 (44)</td>
<td>366 (37)</td>
<td>802 (40)</td>
<td>3.194</td>
<td>0.001 (S)</td>
</tr>
<tr>
<td>Arches</td>
<td>48 (5)</td>
<td>85 (8)</td>
<td>133 (7)</td>
<td>−3.321</td>
<td>0.001 (S)</td>
</tr>
</tbody>
</table>

$P>0.05$ is not significant, while $P<0.05$ is significant
heritability and developmental variation among sexes might account for these patterns.\(^\text{[10]}\)

In the Kerala population, loops were found to be predominant, followed by whorls and arches. In Kerala males, whorls and arches were predominant than Kerala females, whereas loops were predominant in Kerala females. Further statistical comparison of all fingerprint patterns between males and females in Kerala population showed significant differences only for arches.

In the Manipuri population, loops were found to be predominant, followed by whorls and arches. Manipuri females showed a higher frequency of loops, whorls and arches than Manipuri males. However, statistical comparison of all fingerprint patterns between males and females in Manipuri population showed no significant difference. These results were similar to the study done by Qayyum et al. in Rawalpindi.\(^\text{[11]}\)

When the overall patterns were evaluated among the entire study subjects (in both Kerala and Manipuri subjects), loops were found to be the most common fingerprint pattern. Manipuri population showed the highest frequency of loops and arches than Kerala population. However, Kerala population showed more whorls than Manipuri population. Further in our study, comparison of all fingerprint patterns between Kerala and Manipuri population revealed a significant difference for whorls and arches. This difference in the frequencies of fingerprint patterns in two populations can be explained by the fact that dermatoglyphics traits are steadily inherited and show slow changes within a population, but because of genetic admixture, the variability might be highly evident. The fact that this trait is said to be influenced by many genes, the effect of genetic admixture may increase the prevalence of the gene heterozygosity.\(^\text{[12]}\)

A thorough search of the literature has revealed no single study done in India emphasizing on the comparison of fingerprints in Kerala and Manipuri population. Thus, our study remains the first study evaluating the predominant fingerprint pattern in two populations of India. However, there are quite a few studies done in other countries such as Namouchi in Tunisian population, Sabir et al. in North African populations suggesting that fingerprint can be used for population identification.\(^\text{[2]}\)

**Conclusion**

Dermatoglyphics has long been documented as a scientific and valuable method for medico-legal, anthropological and genetic studies. As the inheritance of dermatoglyphic patterns is polygenic, frequencies of arches, loops and whorls may vary between populations. Thus in our study difference in the fingerprint patterns between Kerala and Manipuri population exists for whorls and arches. This variation in fingerprints patterns between two populations suggests further study in associating persons to groups in more number of populations.

**References**

1. Pillay VV. Text Book of Forensic Medicine & Toxicology. 15\textsuperscript{th} ed. Hyderabad: Paras Medical Publishers; 2009. p. 53-94.