Original Research
Statistical Analysis of Ridge Densities in Fingerprint as a Parameter for Identification of Sex

Authors

Pinki Kumari¹, Aman Kumar², Sanjeev Kumar³, Saroj Kumar Ranjan⁴, Nikhil Goel⁵, Sanjay Kumar⁶

¹Senior Resident, ²Additional Professor, ³Associate Professor, ⁴,⁵JR (Acad), ⁶Assistant Professor

¹,²,³,⁴,⁵Department of FMT, IGIMS, Patna, Bihar, India

⁶Department of Anatomy, Narayan Medical College, Sasaram, Bihar, India

Corresponding Author

Aman Kumar
Email: dramankumarfmt@yahoo.in

Abstract

Introduction: Study of fingerprint is known as Dactylography. It is the process of taking impression of papillary ridges of the fingertips.

Objective: The present study is based on Dactylography in which ridge densities in fingerprints is studied as a parameter for identification of sex.

Material and Method: The study was conducted on 500 healthy people (250 male and 250 female) between ages of 18 and 60 years. Fingerprints were taken using Glass slab inking roller method. The type of fingerprint pattern and ridge density in these patterns was analyzed for sex identification.

Results: The loop pattern of fingerprint was found in in majority (61.20%) of cases. This study also revealed that fingerprint ridge density in female is 13.42 in comparison to male 11.97.

Conclusion: The highest frequency of fingerprint pattern among male and female is Loop (61.20%), and Ridge density in female is more than male.

Keywords: Fingerprint, ridge density, identification.

Introduction

Identification means fixation of Individuality of a person. It is classified as complete (Absolute) or Incomplete (Partial). The criterion for Identification has been termed as Primary & Secondary. The Primary criteria include Fingerprints, DNA, dental characters. The secondary criteria include deformity, marks & scars, X-Rays, personal effects & distinctive clothing. Fingerprint system is the most reliable method for identification. Study of fingerprint is known as Dactylography or Dactyloscopy. Dactylography is the process of taking the impression of papillary ridges of the fingertips. The present study is based on Dactylography in which ridge densities in fingerprints is studied as a parameter for Identification of sex.
Aim & objectives
1. To observe the ridge densities in fingerprints pattern in the person residing in IGIMS, Patna
2. To observe any pattern correlation with gender
3. To observe the gender variation in respect of ridge count

Material & Method
The study was conducted on 500 healthy people, 250 male & 250 female, residing in the campus of IGIMS Patna, Age between 18 years & 60 years. Consent was taken from people.

Exclusion criteria: Person outside of IGIMS, Patna, who refuse consent, Age less than 18 yrs.& more than 60 yrs., evidence of disease or injury leading to change in fingerprint pattern & students studying in IGIMS, Patna were not included in the study.

Materials
1. Cotton Swab
2. Glass plate
3. Fingerprint pads with black Ink
4. Ink roller
5. Magnifying glass
6. Fingerprint ridge counter
7. Measuring ruler

Participants were asked to wash their hand with soap and water and keep his/her arm relax to avoid smearing. The finger bulbs were rolled out on the fingerprints pads in Fingers out Thumb in method.

In this way for each and every individuals the entire prints ten fingers were obtained in the allotted space for that finger on the Proforma. The upper portion of the radial side of the central core region of the prints was chosen for Analysis. A 5mm x 5mm area was drawn on a transparent film & placed on fingerprint samples in the chosen area. The epidermal ridge from corner of the square to the diagonally opposite corner was counted in square only & fingerprints pattern was observed in whole impression.

Results
A Total 500 (250 male + 250 female) person participated in this study. Loop pattern of fingerprint is the most common 306 (61.20%), followed by whorl 140 (28.20%), Arches 42(8.40%) & composite was found in 11(2.20%) participants. Mean fingerprint ridge density 125 mm2 in female is 13.97 & 11.97 in male. In Table 3 & figure 3 shows the observation & t value of fingerprint ridge density in Right hand thumb, index, middle, ring & little finger (male & female) is 14.02, 11.79, 11.09, 9.91, 8.39 respectively, which is statistically significant (p value < 0.001). In Table 4 & figure 4 shows the observation & t value of fingerprint ridge density in Left hand , thumb, index, middle, ring, & little finger is 13.95, 13.69, 10.38, 11.79, 16.62 respectively which is statistically significant (p value < 0.001). In Table 5 shows the comparison of mean fingerprint ridge density in male & female was statistically significant with t – value of 30.996.

Table.1 Pattern of Fingerprint

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Male</th>
<th>Female</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop</td>
<td>152 (30.4%)</td>
<td>154 (30.8%)</td>
<td>306 (61.2%)</td>
</tr>
<tr>
<td>Whorls</td>
<td>69 (13.8%)</td>
<td>72 (14.4%)</td>
<td>141 (28.2%)</td>
</tr>
<tr>
<td>Arches</td>
<td>23 (4.6%)</td>
<td>19 (3.8%)</td>
<td>42 (8.4%)</td>
</tr>
<tr>
<td>Composite</td>
<td>6 (1.2%)</td>
<td>5 (1%)</td>
<td>11 (2.2%)</td>
</tr>
</tbody>
</table>

250 (50%)  250 (50%)  500 (100%)
Table 2. Mean fingerprint ridge density in male and female

<table>
<thead>
<tr>
<th>Gender</th>
<th>Mean FP ridge density/25 mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>11.97</td>
</tr>
<tr>
<td>Female</td>
<td>13.42</td>
</tr>
</tbody>
</table>

Table 3. Comparison of fingerprint ridge density (right fingers)

<table>
<thead>
<tr>
<th>Finger</th>
<th>Mean density</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Thumb</td>
<td>12.16 ± 1.22</td>
<td>13.51 ± 0.91</td>
<td>14.02</td>
</tr>
<tr>
<td>Index</td>
<td>12.28 ± 1.24</td>
<td>13.28 ± 0.78</td>
<td>10.79</td>
</tr>
<tr>
<td>Middle</td>
<td>12.33 ± 1.28</td>
<td>13.40 ± 0.83</td>
<td>11.09</td>
</tr>
<tr>
<td>Ring</td>
<td>12.37 ± 0.99</td>
<td>13.20 ± 0.88</td>
<td>9.91</td>
</tr>
<tr>
<td>Little</td>
<td>12.44 ± 1.60</td>
<td>13.48 ± 1.13</td>
<td>8.39</td>
</tr>
</tbody>
</table>
Table 4 Comparison of fingerprint ridge density in left fingers

<table>
<thead>
<tr>
<th>Finger</th>
<th>Mean density</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thumb</td>
<td>12.13 ±1.25</td>
<td>13.51 ± 0.94</td>
<td>13.95</td>
</tr>
<tr>
<td>Index</td>
<td>12.27±1.21</td>
<td>13.56 ± 0.87</td>
<td>13.69</td>
</tr>
<tr>
<td>Middle</td>
<td>12.41 ±1.18</td>
<td>13.35 ± 0.81</td>
<td>10.38</td>
</tr>
<tr>
<td>Ring</td>
<td>12.33±1.23</td>
<td>13.42 ± 0.79</td>
<td>11.79</td>
</tr>
<tr>
<td>Little</td>
<td>12.19 ± 1.20</td>
<td>13.73 ± 0.84</td>
<td>16.62</td>
</tr>
</tbody>
</table>

Discussion
Study of fingerprint is called Dactylography. At the end of 20th week of gestation period fingerprints are permanently developed, while it starts to develop in 13th week of gestation. Fingerprint pattern distribution has been estimated that chances of 2 persons having identical fingerprint impression are about one in sixty four thousand Million population of the World. And even the fingerprints of identical twins are not similar. In Ancient India, ridge pattern study was known as “Samudra Shastra”. The epidermal ridge pattern was classified into “Chakra, Shankya and Padma” which corresponds with the Whorl, Loop, and Arch system of modern classification.

The present study showed the Loop pattern was most frequently observed followed by Whorl, Arches, Composite (Table 1 & figure 1). Gangadhar. M.R, Rajashekhara Reddy.K et al reported that Loop pattern (57.11%) were more common followed by whorls (27.89%) and Arches (15.00%) in general population with significant sex difference. A comparative study conducted by Prukit R et al, on Tribal population of Midnapur
In a study conducted in West Bengal, it was found that Mundas have a higher frequency of whorl and loop patterns while loops are more common in Lodhas. Nithin V et al. found in their study that ulnar loop fingerprint pattern is the most common in the total population along with the sex-wise distribution. These findings are similar to the present study findings loop, followed by whorl, Arches and Composite. In respect to gender wise mean ridge density in male and female, our study found that females having ridge density of 13.42/mm² whereas males having 11.97/25 mm². Similar to this study, Nayak VC et al. reported on Malaysian and Chinese populations where males have 11 or less ridge density and 13 ridge density in females, while Chinese populations show ridge density of 12 as more likely in males and 13 or more ridge density are of females. Dr. Sudesh Gungadin concluded in his study that mean ridge count of 13 in male and 14 ridge count in female, which is again similar to this study. A study conducted by Sandeep V. Binorkar et al. in Nanded district of Maharashtra concluded that in females, the distance between the two ridges is less and or thin as compared to males, therefore responsible for higher ridge density in comparison to males, which is similar to the present study. Contrary to this study, Sayed Yunus Khadri et al. concluded that the mean ridge count in female (12.4) is slightly more than male (12.4). Reddy observed that mean ridge count in females is 13.41 and 12.04 in female, in comparison to this study, our study differs. A study conducted on Spanish Caucasian revealed that ridge density in males is less than 16 and in females equal or more than 17, again supported this study as females have more ridge count than males.

**Conclusion**

The uniqueness of fingerprint pattern is more reliable method of Identification. The fingerprint pattern studied among 500 persons in IGIMS Patna is as follows: The highest frequency of fingerprint pattern among male and female is Loop (61.20%) and Composite (2.20%). Mean ridge density in male is more (13.42) in comparison to male (11.97). Thus it is concluded that ridge density in fingerprint pattern is the best parameter for identification of sex.

**References**