DERMATOGLYPHICS IN CONGENITAL DEAFNESS

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ABSTRACT

BACKGROUND
Since the development of epidermal ridges and cochlea takes place around the same time, congenital deafness may be linked with pattern of palmar ridges, which is associated with many genetic diseases and congenital defects.

MATERIALS AND METHODS
Digital patterns, digital counts, total finger ridge count (TFRC), Absolute finger ridge count (AFRC), a-b ridge count-done by counting the ridges between point 'a' at the base of index finger to point 'b' base of middle finger, 'a-b' angle connecting three triradial points 'a' t' and 'd' on the palm and palmar pattern were studied.

RESULTS
High proportion of males were seen among deaf children. Ulnar loop predominated in fingertip pattern. Arch pattern was more in digit I and V of left hand and digit IV and I of right hand. Whorls were lower in digit I of both hands and digit V of right hand and was higher in all other digits in deaf males, but female deaf children showed lower frequency in all digits. Atd angle was lower in deaf mute children. Increased TFRC was seen in left hands of deaf children.

CONCLUSION
The present study shows differences in dermatoglyphic patterns in deaf mutes as compared to controls. So it may be useful clinically for early detection of congenital deafness.

KEYWORDS
Dermatoglyphics, Palmar Patterns, Atd Angle ARFC, TFRC.


INTRODUCTION
The term dermatoglyphics is the scientific study of epidermal ridges and their patterns on palms, soles, fingers and toes.1 The dermatoglyphic features are unique for an individual which are laid down permanently during 3rd and 4th months of intrauterine life and remain unchanged except for an increase in size. Dermatoglyphic features are thought to be inherited as autosomal dominant, recessive, single gene or polygenic with complete or incomplete penetrance and variable expression of genes. These features are maintained throughout life. Hence, dermatoglyphic study is in use by law enforcement officials for personal identification and by biologists and anthropologists. Distinct dermatoglyphic features are associated with clinical disorders like congenital heart disease, congenital cataract, chromosomal abnormalities like Down syndrome and genetic disorders like De Lange syndrome. Development of epidermal ridges coincides exactly with the development of cochlea, so dermatoglyphic study in deaf mutes has an important logical bearing.2,3 Deafness is a social and occupational handicap, and can occur at any age.

Congenital deafness means that the impairment was present at the time of birth and include hereditary as well as acquired cases.4,5,6 The general incidence of genetic hearing loss in children is between 1:600 to 1:2000. The average age of identification of hearing loss in these children is two and a half years. This is due to the fact that hearing loss is a silent disorder due to lack of awareness and absence of effective screening procedure. Hence, this study in deaf mutes have been undertaken to assess its effectiveness as a simple inexpensive screening procedure.

MATERIALS AND METHODS
Sample Size
200 children were included in the study. This included 100 children with sensorineural deafness and 100 normal school going children between 5-15 years.

METHODS & MATERIALS
In the study, Ink method of Purvis-Smith was followed to record the finger and palmar prints.7 Printer’s ink, a roller, glass inking slab, a cylinder and good quality paper were used. A small amount of printer ink was applied on the inking slab and was spread into a thin uniform film with a roller. The hand was pressed firmly against the slab. Palmar impressions were recorded from the level of distal crease of the wrist to the fingertips.

For better printing, hollow of the palm, was rolled over a paper covered cylinder. Individual fingertip patterns were recorded and analysed.
I. Qualitative Analysis/Type of Pattern of Fingertips

Using the magnifying hand lens, the patterns were studied from the pattern of fingertips in the left hand continuing to the thumb. The type of pattern of fingerprints in the right hand were recorded in the order starting from the thumb and proceeding towards the little finger. Radial loop and ulnar loop were counted, both separately and jointly.

Palmar Pattern Configuration

Types of pattern in the thenar area and four interdigital areas I, II, III and IV and hypothenar area were recorded. Positions of the digital triradii on both sides were noted and labelled as a, b, c and d starting from the triradius located at the base of digit II and moving towards the triradius associated with the digit V. Number and position of the axial triradius on both sides were recorded.

Abnormal Patterns

Sydney lines, Simian creases and other abnormal patterns were looked for.

II. Quantitative Analysis

Ridge count of each fingertip and total finger ridge count (TFRC) was done in both hands of study group and controls.

1. Finger ridge counting was done by a straight line connecting the triradial point to the point of core. The ridges containing the point of core and the triradial point are both excluded from the count (Fig. 1).

Every ridge crossing the line is counted including the ridge which terminates just after crossing the line. A ridge terminating before touching the line is not counted. If the ridge bifurcates before or on meeting the line, two ridges are counted. Ridge counts were recorded in order beginning from the little finger and continuing to thumb. The ridge counts of the right hand were entered in order, starting from the thumb and proceeding towards the little finger.

Total Finger Ridge Count (TFRC) - It is the sum of the ridge counts of all ten fingers (Fig. 1).

Absolute Finger Ridge Count (AFRC)

It is the sum of the ridge counts from all the separate triradii on the fingers. TFRC expresses the size of the pattern and AFRC expresses the pattern size and pattern intensity.

a-b Ridge Count

A straight line connecting the digital triradii ‘a’ and ‘b’ is drawn and the ridges in between are counted (Fig. 2).

Fig. 1: Ridge Counting in various Patterns

Fig. 2: a-b Ridge Count

It is measured from the digital triradius ‘a’ to the axial triradius ‘t’ and from this to the digital triradius ‘d’. This determines the axial triradial position (Fig. 3).

Fig. 3: ATD Angle
Statistical Analysis
To test various hypothesis whether the dermatoglyphic patterns in the deaf children were different from those of control groups, the equality of measure was tested statistically by using a small sample test 'Student-t' test, for unpaired unequal independent samples. The values of 't' was computed by using the formula.

\[ t = \frac{\overline{x}_1 - \overline{x}_2}{\sqrt{\frac{n_1 + n_2}{n_1n_2}} \left[ \frac{S_1^2}{n_1} + \frac{S_2^2}{n_2} \right]} \]

RESULTS AND ANALYSIS

Table 1: Distribution of Control and Deaf Children

<table>
<thead>
<tr>
<th>Study Group</th>
<th>Control</th>
<th>Deaf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>50 (a)</td>
<td>65 (b)</td>
</tr>
<tr>
<td>Female</td>
<td>50 (c)</td>
<td>35 (d)</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

A high proportion of males was seen among deaf children (Table 1). \( x^2=4.6, p<0.05 \).

Table 2: Frequency of Fingertip Pattern of Control and Deaf Children

<table>
<thead>
<tr>
<th>Pattern Type</th>
<th>Left Hand Fingertips</th>
<th>Right Hand Fingertips</th>
<th>All Digits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>Ulnar loop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male control</td>
<td>40</td>
<td>22</td>
<td>30</td>
</tr>
<tr>
<td>Male deaf</td>
<td>43</td>
<td>29</td>
<td>40</td>
</tr>
<tr>
<td>Female control</td>
<td>38</td>
<td>14</td>
<td>26</td>
</tr>
<tr>
<td>Female deaf</td>
<td>29</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>Radial loop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male control</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Male deaf</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Female control</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Female deaf</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Arch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male control</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Male deaf</td>
<td>0</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Female control</td>
<td>4</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Female deaf</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Whorl</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male control</td>
<td>14</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>Male deaf</td>
<td>13</td>
<td>34</td>
<td>17</td>
</tr>
<tr>
<td>Female control</td>
<td>9</td>
<td>28</td>
<td>16</td>
</tr>
<tr>
<td>Female deaf</td>
<td>8</td>
<td>17</td>
<td>14</td>
</tr>
</tbody>
</table>

Ulnar Loop – Male Children
Ulnar loop is higher in deaf male children in all digits of both hands except in right 1st digit where it is lower (Table 2).

Female Children
Digit II of left hand showed no variation in the deaf and control group. All other digits showed lesser frequency of ulnar loops.

Radial loop – Male Children
Higher in digit III of left hand and digits IV and I of right hand. The radial loop pattern were found to be absent in I, II, IV, V of left hand and digits V, III, II of right hand.

Female Children
Higher in digits IV and V of left hand and digits V of right hand. Digit IV of right hand showed no variation in the deaf and control group. Radial loop patterns were found to be absent in digits I, II, III of both hands.

Arch
Male children Arch pattern showed higher frequency in digit I, V of left hand and digits IV and I of right hand. Lesser frequency was seen in digits II and III of left hand and digits V and III of right hand, whereas no variations in arch pattern was noted in digits III of left hand and digit II of right hand.

Female Children
Arch pattern frequency was lower in digits I, III, IV and V of left hand and digit III of right hand. Higher frequency of arch pattern was seen in digit II of left hand and digits I and II of right hand and was significantly higher in right index finger.

Whorls – Male Children
Lower frequency of whorl pattern is noted in digit I of both hands and digit V of right hand and a higher frequency in all other digits. Whorl pattern was significantly lower in digit I of right hand.
Female Children
Showed lower frequency of whorl pattern in all digits than female controls.

<table>
<thead>
<tr>
<th>Study Group</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>Mean Control</td>
<td>51.2</td>
<td>53.0</td>
</tr>
<tr>
<td>S.D.</td>
<td>± 18.7</td>
<td>± 19.1</td>
</tr>
<tr>
<td>Mean Deaf</td>
<td>54.4</td>
<td>56.3</td>
</tr>
<tr>
<td>S.D.</td>
<td>± 17.4</td>
<td>± 18.5</td>
</tr>
</tbody>
</table>

Table 3: Total Finger Ridge Count (TFRC) of all Digits in 100 Control and 100 Deaf Children

Increased TFRC in left hands of deaf children (Table 3).

Fig. 4: AFRC of all Digits in the Study Group
AFRC is increased on left hands of female deaf children (Fig. 4).

Fig. 5: Atd Angle
Lower atd angle was seen in both male and female children in both hands (Fig. 5). Atd angle was significantly lower in left hand of deaf male children. $t = 2.14; p = 0.016$.

A-B Ridge Count

Fig. 6: A-B Ridge Count shows no Significant Change

<table>
<thead>
<tr>
<th>Palmar Areas</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>Hypothenar</td>
<td>Control</td>
<td>Deaf</td>
</tr>
<tr>
<td>Th/I$_1$</td>
<td>C</td>
<td>6</td>
</tr>
<tr>
<td>I$_2$</td>
<td>D</td>
<td>6.15</td>
</tr>
<tr>
<td>I$_3$</td>
<td>C</td>
<td>8</td>
</tr>
<tr>
<td>I$_4$</td>
<td>D</td>
<td>154</td>
</tr>
<tr>
<td>I$_4$</td>
<td>C</td>
<td>40</td>
</tr>
<tr>
<td>I$_4$</td>
<td>D</td>
<td>36.92</td>
</tr>
</tbody>
</table>

Table 4: Percentage of Palmar Pattern Configuration in Control and Deaf Children of both Sexes
Hypothenar and I1 area showed increased frequency of patterns in left and right hands of both male and female deaf children (Table 4).

Pattern in I2 was significantly lower in left hands of deaf male children, and in both hands of deaf female children. I3 and I4 area also showed significantly decreased frequency of patterns in both hands of deaf male and female children.

DISCUSSION

Finger Ridge Pattern

A high frequency of ulnar loops is seen in both hands of deaf children and a higher frequency of whorls in both hands of deaf male children as compared to controls, in conformity with ref.6,9 Loops form 70% pattern, whorls 25% and arches 5%.10 A lower frequency of radial loops and arch patterns was noted. Ulnar loops are common than radial loops in deaf mates,11,12,13 which is similar to our study.

AFRC

No significant change was noted in deaf male children. In female deaf children, left hand showed increased AFRC similar to Anu.3 and right hand showed reduced AFRC as against Anu.3

A-b Ridge Count

Determined by heredity,13,14 no significant change noted here.

Atd Angle

Showed a reduction in both hands of deaf children as against Suresh.15

Palmar Patterns

Hypothenar and I1 area showed increased frequency of pattern in deaf children, mainly arches in the former and loops in the latter.2

TFRC

A higher TFRC in left hands of both male and female deaf children and lower TFRC in right hands of deaf female children (Table 3) as observed by Suresh.15 Average ridge count in deaf children is 129-145.13

All digits showed high frequency of ulnar loops except digit I of right hand which showed a lower frequency in deaf males. Maximum frequency found was in digit I of left hand in deaf males. Deaf females showed lower frequency of ulnar loops in both hands.

Radial loops were absent in digits I, II, IV, V of left hand and digits II, III, IV of right hand in deaf male children, and absent in digits I, II, III of both hands in deaf females. Arch pattern showed higher frequency in digits I, V of left hand and IV and I of right hand in males, and in digit I and II of right hand in females.

Lesser frequency was seen in digits II, III of left hand and digits V and III of right hand in males. Lower frequency was also seen in digits I, III, IV and V of left hand and digit III of right hand in females. Arches increase on 3rd, 4th and 5th digits in congenital deaf patients and as a whole.15

Whorls

A high frequency of whorls were noted in all digits except in digit I of both hands and digit V of right hand in deaf males. Female deaf children showed lower frequency of whorls in all digits of both hands.

According to Athanikar, central pocket whorls on 3rd 4th and 5th digits are more on left hands in congenital deaf persons. Digit I presents highest incidence of whorls. Studies by Chaturvedi and Kumar, showed that central pocket whorls were absent on thumbs in deaf patients of genetic causes, which is similar to our study.

Pattern intensity index is an expression of average number of triradii per individual.14 It reflects the presence of complexity of pattern types but pattern intensity index in deaf mutes showed no significant variation.

Dankmeijer’s index is the % of arch/% of whorl x 100. Dankmeijer’s index in this study is higher in both male and female deaf children. This indicates a higher percentage of arches in deaf children as observed by Cummins and Midlo (1943).16

Palmar Pattern

The areas include the sites of volar pads and include the thenar area, 4 interdigital areas and hypothenar areas. The thenar and first interdigital areas are usually considered as one area in dermatoglyphics.

TFRC

Higher TFRC was seen in left hands in most cases, there is no pattern in Th/I1 area. In our study, 6.15% of deaf male children showed pattern. Loops in I1 of both hands, compared to 6% in left hand and 4% in right hand. Female deaf children showed increase in loop pattern in I1 areas: 5.71% compared to 2% in normal girls. According to Athanikar, loops are more common in thenar area in deaf children which is in accordance to our study.

The second interdigital area I2 showed significantly lower frequency of patterns in left hand of deaf male children and both hands of deaf female children. True patterns are rare in I2 areas.8 as in our study. I3 and I4 showed decreased frequency of pattern in both hands of deaf male and female children as compared to control. Percentage of I4 pattern was more than other areas among deaf children. Loop pattern is more common in I3 areas in deaf children whereas it is more in I4.

Hypothenar area showed increased frequency of patterns in both deaf children in both hands. Arches are the most frequent pattern in the hypothenar areas.

Loops were more common in both male and female children. TFRC was lower in right hands of female deaf children.

AFRC

Showed no significant change in deaf males but was increased in left hands of female deaf children and lower on right hands. A-b ridge count showed no significant change. Atd angle was lower in deaf children which was very significant in left hands as said by Athanikar.

CONCLUSION

A high proportion of males were seen among deaf children. A higher frequency of ulnar loops in deaf males and a lower frequency of ulnar loops in deaf female children. Whorls showed a higher frequency in both hands of deaf males, and a low incidence of arch and radial loop in both hands of deaf male and female children. Increased frequency of arches seen in hypothenar area in deaf children, higher TFRC in left hands of both sexes, lower atd angle in both hands of deaf children.
REFERENCES


