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, 'atd' 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 AFRC, TFRC.

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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.

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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 fingertips 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_1, I_2, I_3 and I_4 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 little finger.

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

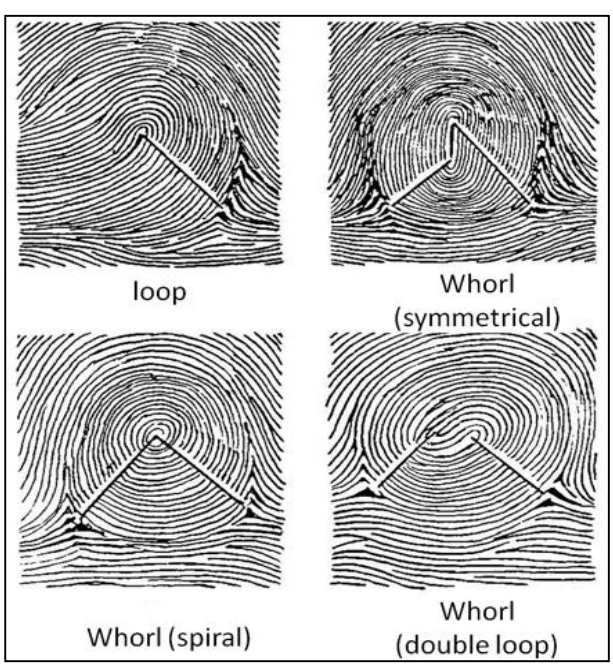


Fig. 1: Ridge Counting in various Patterns

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).

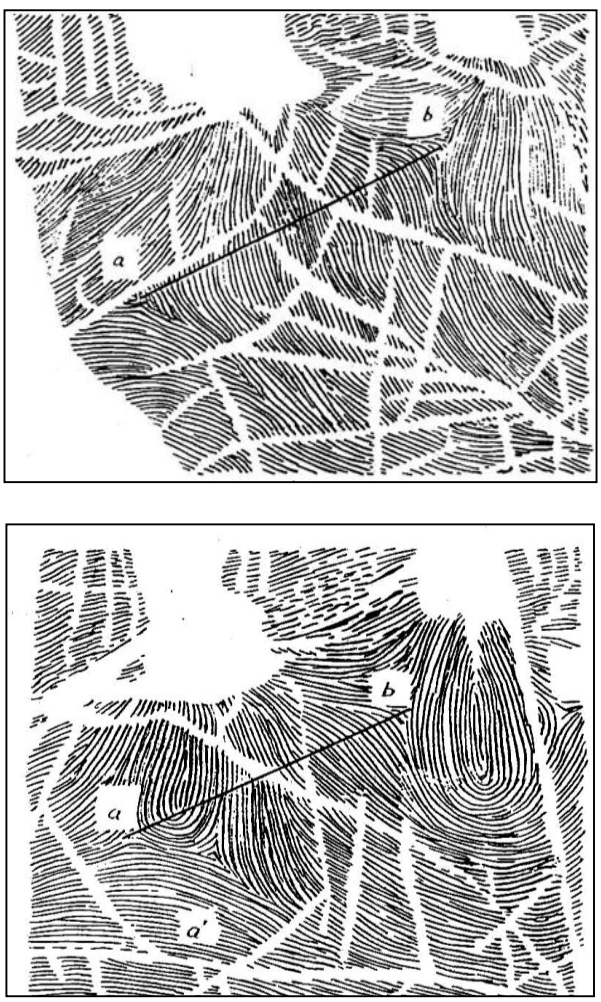


Fig. 2: a-b Ridge Count

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).

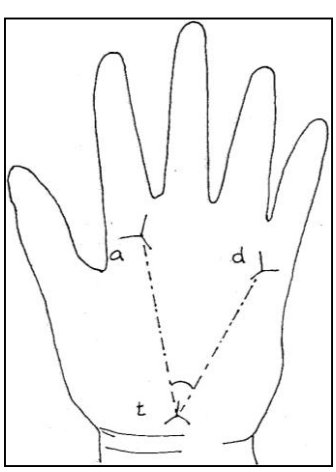


Fig. 3: ATD Angle

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.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{n_1 + n_2}{n_1 x n_2} \frac{[n_1 - 1)S_1^{\,2} + (n_2 - 1)S_2^{\,2}}{n_1 + n_2 - 2}}}$$

X_1 and X_2 sample mean

S_1 and S_2 sample standard deviation

n_1 and n_2 sample sizes

Nonparametric Mann-Whitney U test was applied when 't' test was not possible and equivalent, Z value was computed.

RESULTS AND ANALYSIS[1]

Study Group	Control	Deaf
Male	50 (a)	65 (b)
Female	50 (c)	35 (d)
Total	**100**	**100**

Table 1: Distribution of Control and Deaf Children

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

Pattern Type	Left Hand Fingertips					Right Hand Fingertips					All Digits
	I	II	III	IV	V	V	IV	III	II	I	
Ulnar loop											
Male control	40	22	30	25	27	29	22	33	22	48	3
Male deaf	43	29	40	30	41	42	27	42	26	15	4
Female control	38	14	26	19	26	28	23	32	26	31	2
Female deaf	29	14	16	10	14	22	14	22	18	21	6
Radial loop											
Male control	0	0	0	2	0	0	0	0	0	1	0
Male deaf	0	0	0	3	0	0	1	0	0	0	0
Female control	0	0	0	3	0	1	2	0	0	0	0
Female deaf	0	0	0	7	3	0	2	0	0	0	0
Arch											
Male control	1	2	4	9	4	1	10	4	3	3	0
Male deaf	0	3	8	9	2	4	8	7	3	2	0
Female control	4	3	8	8	4	2	3	7	0	1	0
Female deaf	0	4	5	6	3	5	8	5	4	4	0
Whorl											
Male control	14	26	15	14	19	20	18	13	25	48	3
Male deaf	13	34	17	23	22	19	29	16	35	47	0
Female control	9	28	16	22	23	19	23	12	25	31	2
Female deaf	8	17	14	10	10	8	9	7	11	20	3

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

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.

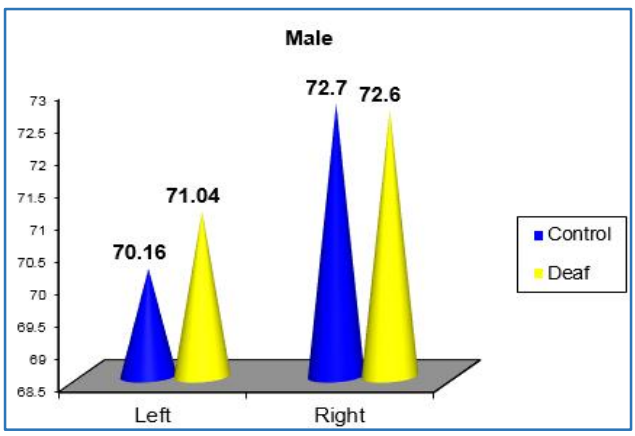
Female Children

Showed lower frequency of whorl pattern in all digits than female controls.

Study Group	Male		Female	
	Left	Right	Left	Right
Mean Control	51.2	53.0	47.9	52.4
S.D.	± 18.7	± 19.1	± 18.3	± 19.2
Mean Deaf	54.4	56.3	51.2	50.5
S.D.	± 17.4	± 18.5	± 24.1	± 22.9

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).



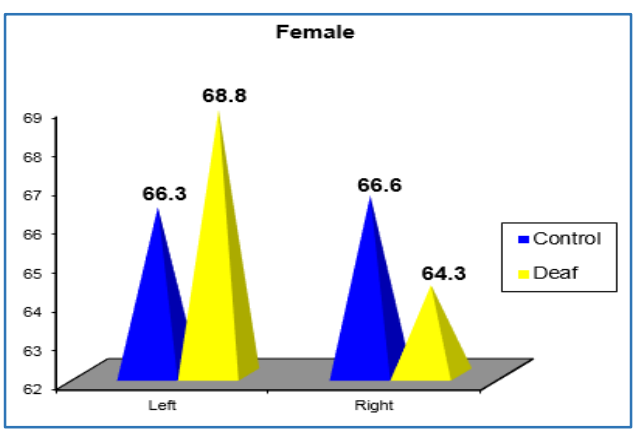
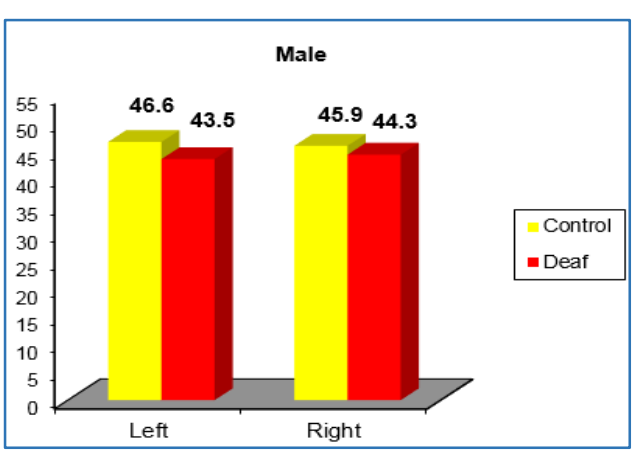


Fig. 4: AFRC of all Digits in the Study Group

AFRC is increased on left hands of female deaf children (Fig. 4).



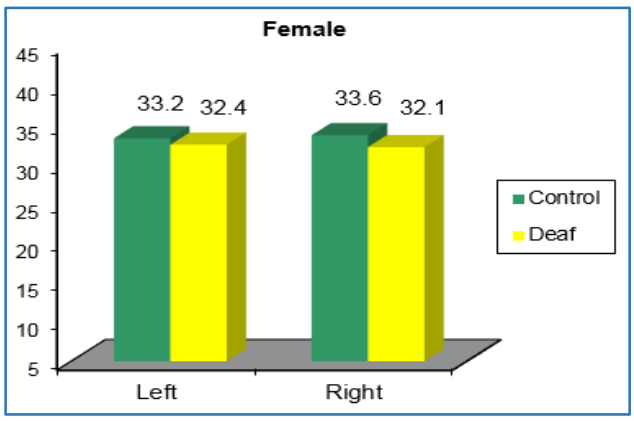
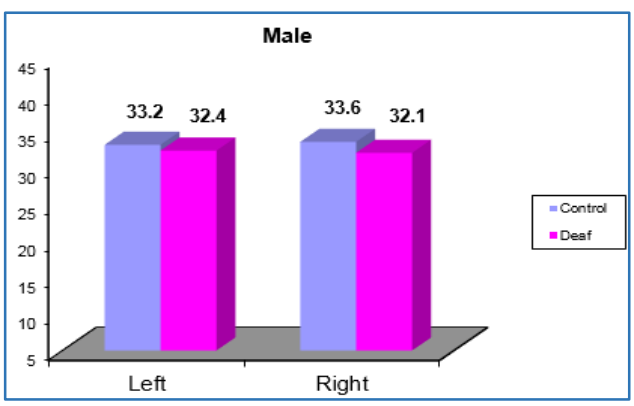


Fig. 5: Atd Angle

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



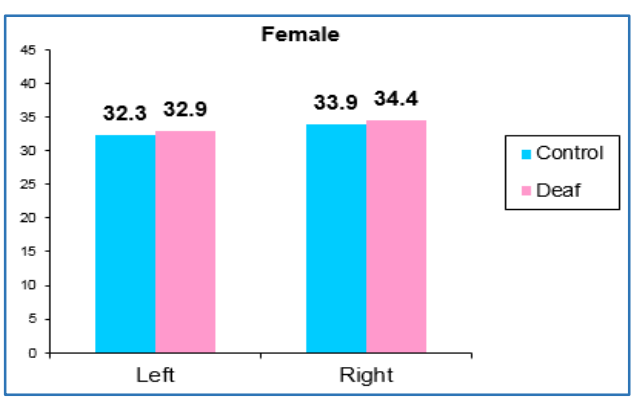


Fig. 6: A-B Ridge Count shows no Significant Change

Palmar Areas		Male		Female	
		Left	Right	Left	Right
Hypothenar	Control	12	18	14	6
	Deaf	21.53	29.2	14.28	8.57
Th/I_1	C	6	4	2	2
	D	6.15	6.15	5.71	5.71
I_2	C	8	4	10	16
	D	1.54	4.61	2.86	2.86
I_3	C	40	56	70	80
	D	36.92	44.61	17.14	22.86
I_4	C	62	44	48	42
	D	46.15	43.07	51.42	48.57

Table 4: Percentage of Palmar Pattern Configuration in Control and Deaf Children of both Sexes

Hypothenar and I_1 area showed increased frequency of patterns in left and right hands of both male and female deaf children (Table 4).

Pattern in I_2 was significantly lower in left hands of deaf male children, and in both hands of deaf female children. I_3 and I_4 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.[8,9] 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 mutes.[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 I_1 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 128-145.[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/I_1 area. In our study, 6.15% of deaf male children showed pattern. Loops in I_1 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 I_2 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 I_2 areas.[8] as in our study. I_3 and I_4 showed decreased frequency of pattern in both hands of deaf male and female children as compared to control. Percentage of I_4 pattern was more than other areas among deaf children. Loop pattern is more common in I_3 areas in deaf children whereas it is more in I_4.

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.

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