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ORIGINAL ARTICLE

DERMATOGLYPHICS A METHOD OF SEX DIFFERENTIATION: A STUDY

Asis Kumar Ray[1], Rathin Kumar Duari[2], S. N. Gole[3]

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ABSTRACT: Digital dermatoglyphics has been found useful in forensic medicine and identification purposes. It is useful in medical diagnosis of genetically inherited diseases and in detection of crimes. Anthropometric studies of the digit, palm and feet provides data that reveal the relative distribution of dermal ridges among people in different geographical zones. Cross-sectional study was carried out using 100 males and 100 female healthy students of Kalinga Institute of Medical Sciences (KIMS) in Odisha State of India to establish their digital dermatoglyphics traits. This was done by counting and classifying their ridge pattern configurations of arches, loops and whorls and by counting their ridge densities/25mm.^{2} Plain arches were the most predominant digital pattern in females (31%) than in males (10%), followed by loops (38%) in males than (28.5%) in females. The sex differences between these patterns are significant. Sexual dimorphism was also evident with the males≤11/25mm^2 showing lower in finger ridge count than the females 12/25mm^2. This study has established on the normal dermatoglyphics patterns of medical students of KIMS in Orissa State of India.

KEYWORDS: Dermatoglyphics, Ridge density, Pattern frequency, Pattern intensity, Sex difference.

INTRODUCTION: Many human body features have been used to identify the sex of an individual. Due to their uniqueness and immutability, fingerprints are also one of the most commonly employed biometric features. Fingerprints of an individual have been used as one of the vital parts of identification in both civil and criminal cases because of their unique properties of absolute identity. Fingerprints have become increasingly popular for personal identification and verification in applications including banking security and physical access control. In addition to their value in criminal matters, fingerprints can ensure personal identification for humanitarian reasons, such as in cases of amnesia, missing persons, or unknown deceased. Fingerprints are invaluable in effecting identifications in tragedies such as fire, flood, and vehicle crashes. Digital dermatoglyphics has been found useful in forensic medicine and identification purposes. It is useful in medical diagnosis of genetically inherited diseases and in detection of crimes. Finger ridges and ridge patterns are highly heritable, durable, and age-independent human traits and have been studied as a model quantitative trait in humans for over the years. They develop between approximately the 13th and 18th weeks of gestation, and in the absence of trauma remain essentially unchanged throughout life. Despite many well developed fingerprint matching techniques and a wide range of biometric applications, a reliable fingerprint based sex determination method does not seem to be available.

AIMS AND OBJECTIVES OF THIS STUDY: Despite the fact that the differences in epidermal ridge density between men and women have been accepted for some time, they have only been thoroughly demonstrated in a small number of populations. The aim of this study is to determine whether such differences exist in a sample of the Indian population by counting epidermal ridges within three well-defined fingerprint areas. If significant differences do exist, then the likelihood of inferring sex from given ridge densities will be explored.

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MATERIALS AND METHODS: A total of 200 MBBS students of Kalinga Institute of Medical Sciences, Bhubaneswar, ODISSA, volunteered for the study. The study population consisted of 100 males and 100 females. Informed consent was taken from the study individuals. Institute Ethics committee guidelines relating to the use of human subjects for research purposes are duly followed.

The materials used for this study were printers black ink, glass plate, roller, horseshoe lens, transparent film strip, and pencil, measuring tape, bathroom scale, pin and Performa. The prints are taken with the fingers applied with regular & firm pressure on the Performa. In this way for each and every individual the entire prints of ten fingers are prepared. Only plain prints are taken (No roll prints). The parameters are analyzed including the pattern frequency, pattern intensity index and total finger ridge count with sex differentiation.

OBSERVATION: Total 200 nos. of students volunteered for this study, so 2000 fingers were analyzed for this purpose. It is observed that the frequency of the digital patterns and sex differentiation obtained from the study of 200 KIMS, MBBS student subjects. Loops were the most predominant pattern (33.25%) followed by whorls (28.75%), Plain arches (20.5%), and the least were the tented arch (3.25%). Plain arches were significantly greater in females than in males. (Table 1).

It is found that the ridge density ranges 3 to 10/25mm^2 are for the males & 12 to15/25mm^2 onwards is for the females. Only there is a very small overlapping at 11/25mm^2, where 6 males among 100 and 1 female among 100 females are matched. (Table 2).

DISCUSSION: Many studies have been conducted on ridge count but, mainly for race determination and genetic inheritance of ridge pattern. The present study is conducted to broaden the horizon of ridge count i.e. sex determination by finger print ridge density. The findings available in this study will be correlated to the findings of the studies carried out by various researchers in the different parts of the world. The statistical analysis and the favored odds show that a ridge count of ≤11 ridges/25mm^2 is more likely to be of male origin and a ridge count of ≥12/25mm^2 is more likely to be of female origin. A print showing a count of ≥10/25mm.sq.[2] will have a high probability to be that of male, while no female in this study was found to have 10 ridges. Similarly a ridge count of ≥13 ridges/25mm^2 will be more in favor of female, while there was no male found in this category.

In the past many studies have been conducted on the finger print ridges with the idea of proving a gender difference in the finger print, but failed in the methodology. According to Reddy,[1] the mean ridge count for males is 13.41 and that of female is 12.04. These figures were exactly the opposite of Acree.[2] A similar study was done on males and females of American Negroes and Caucasian American by Plato et al.[3] Here again they found the mean ridge density in male is more than female. These results could be due to some defect in the counting method as there is no detail of the counting method. Cummins and Midlo[4] have established that females do have higher mean ridge count (23.4) than males (20.7). These values are higher than the present study. This may be because the number of subjects studied is less and due to geographical variation. Moore[5] also carried out a study on ridge to ridge distance and found that mean distance is more in male compared to female, but he studied only 10 males and 10 females. Okajima[6] also found that fork index is higher in females than in male in fingerprints. This again upholds the trend as in this present study.

The most prevalent digital ridge pattern type is loops (33.25%) followed by whorls(28.75%), plain arches (20.5%), ulnar loops (14.25%), and the least prevalent is tented arch (3.25%) according to this study and these values are not in conformity with the work of Boroffice,[7] which showed that

ulnar loops were the most predominant pattern (50.09%) and the least was the radial loops (1.13%) in the study of digital dermatoglyphic pattern in a sample of the Nigerian populations. Jaja and Igbigbi[8] in their work on the digital and palmar dermatoglyphics of the Ijaw of Southern Nigeria reported the ulnar loops as being the most prevalent digital ridge pattern type, followed by whorls, arches and the least being the radial loops.

In this study, loops were higher (38%) in males than females (28.5%). Sex differences in the distribution of the patterns are statistically significant along with the ridge density.

A cross sectional study of palmar and digital patterns randomly in Malawian subjects carried out by Igbigbi and Msamati[9] showed that the arches were the most predominant digital pattern in both sexes followed by radial loops in males and whorls in females. In the same study on Zimbabweans, ulnar loop were the most predominant digital pattern type in both sexes followed by whorls in males and arches in females. These disparities may be due to genetic as well as environmental factors and it has been reported that digital dermatoglyphics patterns are genetically determined and influenced by environmental, physical and topological factors.

CONCLUSION: Identification by finger prints is infallible and now with the help of this study it will be further helpful to the fingerprint experts to direct their search to a particular gender and eventually the investigating officers would save time in nabbing suspects.

The ridge density is a characteristic parameter to determine sex from fingerprints i.e., <12 (male) and >12 (female) .Pattern of fingerprint is most likely to be a specific parameter.

Table 1: Showing no. Of individuals per pattern with respect to their sex of 19 to 23 years age group. (Both Hands are taken into Account & Patterns are Analysed).

Digital Patterns	Males	Females	Row Total
Whorl	330(33%)	245(24.5%)	575(28.75%)
Ulnar Loop	155(15.5%)	130(13%)	285(14.25%)
Loop	380(38%)	285(28.5%)	665(33.25%)
Tented Arch	35(3.5%)	30(3.0%)	65(3.25%)
Plain Arch	100(10%)	310(31.0%)	410(20.5%)
Column Total	1000	1000	2000

Table 1

Table 2: Showing no. of individuals per specific ridge density ranges with respect to their sex of 19 to 23yrs of age group (Verrified & Analyzed).

Ridge density	Males	Females
3 to 6 /25 mm	27(27%)	0(0%)
6 to 10 /25 mm	66(66%)	0(0%)
11 /25 mm	6(6%)	1(1%)
12 to 15 /25 mm	1(1%)	71(71%)
15/25mm onwards	0(0%)	28(28%)

Table 2

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STATISTICS: There is no difference between the biometric measurements of ridges of males & females.

Total no of spots from which Biometric measure have been taken = 2000.

Degree of freedom in 2x3 table = (2-1) (3-1)=2

Expected frequencies for the above table.

Digital patterns	Male	Female	Total
Whorl Loops Archs	287.5	287.5	575
	475	475	950
	237.5	237.5	475
Total	**1000**	**1000**	**2000**

Table 3

$$X^2_{(\text{Chi-square})} = \sum \frac{(0-E)^2}{E}$$

$$\frac{(330-287.5)^2}{287.5} + \frac{(245-287.5)^2}{287.5} + \frac{(535-475)^2}{475} + \frac{415-475)}{475} + \frac{(135-237.5)^2}{237.5} + \frac{(340-237.5)^2}{237.5}$$

= 6.28+6.28+7.58+7.58+44.23+44.23=116.28

Value of $x^2$for 2df at 5% level of significance =5.991<116.28

Hence the test is highly significant and it implies that there is significant difference between the biometric measurements of ridges within males and females. P<.001.

P value < .001

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AUTHORS:

1. Asis Kumar Ray
2. Rathin Kumar Duari
3. S. N. Gole

PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Forensic Medicine & Toxicology, Kalinga Institute of Medical Sciences, Bhubaneswar.
2. Assistant Professor, Department of Forensic Medicine & Toxicology, Kalinga Institute of Medical Sciences, Bhubaneswar.
3. Post Graduate Student, Department of Forensic Medicine & Toxicology, Kalinga Institute of Medical Sciences, Bhubaneswar.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Asis Kumar Ray,
Plot 477, Saheed Nagar,
Bhubaneswar-751007,
Odisha.
E-mail: raydrasis@gmail.com

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