A COMPREHENSIVE ANALYSIS OF FINGERPRINTS

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Abstract: Dermatoglyphics is the science of fingerprints. It has been fascinating area of research for the geneticists, clinicians, researchers and plays an important role in the field of Forensic science too. These fingerprints usually develop during the third month of fetal life. The influence of environmental and biological factors are evident from the differential patterns in both hands of an individuals and the dissimilarities between the identical twins. Hence, is an interesting noninvasive method for studying the disease associations and also to determine the involvement of genetic factors through population studies. The present study aims to study the different fingerprints patterns like Arches, Whorls and Loops in a random sample obtained from our college students.

Keywords: Anthropology, Dermatoglyphics, Ridges, Relative Risk, Teratogen.

Introduction: The word "Dermatoglyphic" means a 'skin carving'. The study of epidermal ridges and the patterns formed by them is known as Dermatoglyphics. The ridges are a normal characteristic of the volar skin in man, apes and monkeys and are particularly prominent over the palmar surface of the hand and the plantar surface of the foot. Ridges act as an anti device and are thought to improve the sense of touch[1].The first systematic study of the whole subject, however, was carried out by Galton around the year 1890. His early interest was in the value of fingerprints for personal identification, for they persist throughout the life. He was the first to study dermal patterns in families and racial groups[2]. It was further elaborated and improved by Sir Edward Richard Henry of Scotland Yard for identifying criminals[3]. It was realized that uniqueness of fingerprints can serve as valuable indexes of human variation, and they are increasingly used in anthropology, medicine, and genetics. Dermatoglyphics, as Harold Cummins of Tulane University, named the study of epidermal ridges in 1926, cuts across all these disciplines[3].

The fingerprints develop by the 3rd month of fetal life and environmental fetal influences are evident from the differential patterns in both hands of an individual and the dissimilarities between the identical twins, environmental modifications can also be indeed by teratogenic substances. Mulvihill and Smith hypothesized that dermal ridge patterns are largely determined by the growth and topography of the fetal hand when ridges are forming[4]. Epidermal ridges are formed between 1124 weeks of gestation and after this period epidermal ridges do not change[5]. Since skin and brain develop

from same ectoderm, dermatoglyphic variations are informative for early developmental brain disturbances[6].

Anthropological variations in dermatology do not concern only anthropologists and geneticist but also physicians who have to compare peculiarities in a patient in the normal control subjects of the same sex and ethnic group. Cummins and Midlo classified various patterns on fingertips as Arch, Loop, Whorl and Composites. Arch is described as a ridges pass from one margin of the digit to the other with a gentle, distally bowed sweep. There is no triradius. Loop possesses only one triradius. The ridges curve around only one extremity of the pattern, forming the head of the loop. Whorl is distinguished by concentric design. The majority of the ridges make circuits around the core. True whorls typically possess two triradii. (Fig 1)

Fig 1. Fingerprint Patterns

Prenatal disturbance of ridge pattern is found in Down's syndrome in which there is a retardation of growth affecting most parts of the body[7].The earliest description of epidermal ridges was published at the end of 17th century, but the study of the finger patterns and their use for personal identification was begun by Francis Galton 1892. The pattern of ridge formation constitute a wholly distinctive set for every individual and remain unchanged throughout life, they allow investigation of identity. Dermatoglyphic studies have been done with respect to a number of genetic disorders and diseases. Studies of dermatoglyphics in cancer patients, psoriasis, medical diagnosis, and congenital heart malformations are well documented[8]. This an inexpensive and non aggressive genetic method that can be used in the evaluation of the relative risk in family members with positive disease history. Some diseases showing association with dermatoglyphics include mental retardation [9], leukemia[1], cancers of the oral cavity[10], essential hypertension[6], diabetes mellitus[11] and turner's syndrome.

Hereditary influence has been demonstrated by analysis of family members using correlation coefficients. Due to the stability of the finger patterns after birth as they are not influenced by external factors geographical, economical or other hieroglyphics are useful for studying the basic relation among different populations[12]. A study in India on 125 families with 376 children from Velanadu Brahmin and 100 families with 286 children from Telangana Brahmin caste showed the occurrence of an arch on atleast one of the ten finger tip to be aggregated in families. Dermatoglyphics has been accepted as a useful tool in the differentiation between monozygotic and dizygotic twins. With the rapid development of human cytogenetics and the discovery of chromosomal aberrations in man, the value of dermatoglyphics in clinical medicine has been proved.

Objectives: The present study was undertaken with an objective to study the interesting parameter of fingerprinitng by the undergraduate students. Our aim was to look into the different fingerprint patterns mainly Arches, loops and whorls.The first objective was to check the association between the fingerprints of left and right hand among the subjects. The second objective was to find a unique fingerprint pattern not reported so far, if any. The third objective was to draw an inference about the data so obtained.

Material and Methods: The sample obtained was from the college students who were in the age group of 17- 20 years. A random sample of 100 students and their fingerprints were collected with prior consent from the subjects understudy. There were 72 females and 28 males. The sample includes students from

various regions of India, however most of them were from Southern parts of India preferably from Telangana. Our study also includes twins, there were seven twins and a triplet. The method in obtaining the fingerprints was using ink and paper method (Cummins and Midlo, 1961). Rolling the fingerprint from "nail edge to nail edge". For the fingers on the right hand, we shall be rolling from left to right and for the left hand fingers vice versa. Thumbs are rolled in the opposite direction as the fingers. Using the ink and paper method, roll the fingers on the ink pad so that the entire fingerprint pattern area is evenly covered with ink.The ink should cover from one edge of the nail to the other and from the crease of the first joint to the tip of the finger. Using the right amount of ink is of vital importance[13].

Results: In the total sample of 100, 8.0% were arches, 51.5% were loops and 40.5% were whorls. The maximum frequency of loops were observed, however the study did not differentiate between the subtypes of the fingerprint patterns. The females have 14% of arches, 51.2% of loops and 34.8% of whorls. The males showed 5.6% of arches, 48.8% of loops and 45.6% of whorls. The number of arches in females is 14% and in males is 5.6%. loops in females is 51.2% and males is 48.8% whereas Whorls in females is 45.6% and males is 34.6%. (Tab 1,2)

Comparison of fingerprints in males and females in the left hand reveals that the percentage of arches is significantly greater in females than the males with approximately 2:1 ratio, whereas in the right hand 5:1 ratio was observed. However, there is no significant difference in loops and whorls between males and females in both hands. Tab 2 The study revealed interesting fingerprint patterns in some of the individuals who demonstrated uniform single fingerprint patterns in all the fingers.(**Tab 4**) There were three individuals whose fingers had whorl pattern, two had loops and one had arches in all the fingers. Interestingly, this observation is unique to the females, as there were no males who showed this kind of an observation. (**Tab 3**) Apart from the random sample the study also included twins and triplets. The observations were interesting that none of the twins showed the presence of arches absolutely. There is a concordance of fingerprints among 50% in the right hand and only 25% in the left hand.(**Tab 5**)

Discussion: Fingerprints are complex traits involving the role of genetic and environmental factors. Studies suggest that many genes are involved in the inheritance of these finger patterns. They include small sample size and limited number of variables for study. Another limitation is that the study groups are not homogenous with respect to ethnicity. The heterogenous samples may to some extent distort as dermatoglyphic characteristics are usually ethnicity specific. The study conducted on random samples of size 100 consisted of maximum number of loops followed by whorls and the least being arches. However, this observation is in accordance with the most of the earlier studies. The study did not reveal any unusual The most interesting observation in the study was that some females in the random sample showed identical fingerprint patterns in all the fingers. Of these females, maximum were showing the whorl pattern followed by loops and then arches. Our finding showed the absence of arches in twins and triplets. Surprisingly, as expected the fingerprints patterns showed 100% concordance between the two hands of an individual even in the random sample, indicating the involvement of genetic component. Therefore, family studies might be effective to determine the role of genetic factors.

Tab 1: The distribution fingerprint as per our expectation

Tab 1: The distribution of fingerprint patterns in the random sample.

Pattern	Hands	Arch	%	Loop	%	Whorl	%	Total
Thumb	Right	8	0.8	54	5.4	38	3.8	100
	Left	6	0.6	52	5.1	42	4.2	100
Index Finger	Right	11	1.1	51	3.6	38	3.8	100
	Left	22	2.2	36	7.3	42	4.2	100
Middle finger	Right	7	0.7	73	6.2	20	2.0	100
	Left	8	0.8	62	6.2	30	3.0	100
Ring finger	Right	3	0.3	29	2.9	68	6.8	100
	Left	4	0.4	34	3.4	62	6.2	100
Little finger	Right	6	0.6	62	6.2	38	3.8	100
	Left	5	0.5	62	6.2	33	3.3	100
	Total	80	8.0	515	51.5	405	40.5	1000

Tab 2: Total distribution of fingerprints in both hands in males and females (n= 100)

Pattern	Female &Males	TOTAL
Loop	515	250
Arch	80	49
Whorl	405	201
Total	1000	500

Tab 3: The distribution of fingerprints in both hands in males and female

Pattern	Males	%	Females	%
Arch	14	5.6	49	4.9
Loop	122	48.8	250	25.0
Whorl	114	45.6	201	20.1
Total	250	50	500	50

Tab4: Unique Identica lfingerprin patterns in the random sample.

S No.	Pattern
F1	All Arches
F2	All whorls
F3	All Whorls
F4	All Whorls
F5	All Loops
F6	All Loops

Tab 5 : Fingerprint Patterns in Twin sample.

	Right hand			Left hand		
S.No	Arch	Loop	Whorl	Arch	Loop	Whorl
1a	0	1	4	1	1	3
b	0	1	4	0	2	3
2a	0	2	3	0	4	1
b	0	3	2	0	2	3
3a	0	0	5	0	1	4
b	0	1	4	0	1	4
4a	0	4	1	0	3	2
b	0	3	2	0	1	4
5a	0	3	2	0	3	2
b	0	3	2	0	5	0
c	0	4	1	0	5	0
6a	0	2	3	0	0	5
b	0	3	2	0	1	4
7a	0	1	4	0	1	4
b	0	1	4	0	2	3
8a	0	4	1	0	3	2
b	0	4	1	0	4	1
Total	0	40	45	1	39	45

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