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REVIEW ARTICLE

Dermatoglyphics: A Brief Review

¹Archana Singh, ²Rakesh Gupta, ³SHH Zaidi, ⁴Arun Singh

ABSTRACT

Dermatoglyphics refers to epidermal ridges present on the palm, sole, fingers, and toes. These epidermal ridges are formed in the same intrauterine period when neuronal development takes place in the intrauterine life of a fetus. Thus, dermatoglyphics is correlated with genetic abnormalities and is useful in the diagnosis of congenital malformations and many other medical disorders. Each and every individual has unique fingerprints, even in twins. These fingerprints remain the same lifelong from their development unless they are damaged by dermal injuries. The different regions of our brain are reflected by fingerprints, palm prints and foot patterns present in the 10 fingers, 10 toes, palmar and plantar surfaces respectively and these dermatoglyphics represent the various regions of brain therefore can be used in dermatoglyphics mental intelligence test (DMIT) and now a day is being used globally.

Keywords: Dermatoglyphics, Dermatoglyphics mental intelligence test, Fingerprint.

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INTRODUCTION

Dermatoglyphics is the scientific study of fingerprints that started in 1892 when one of the most original biologists of his time, Sir Francis Galton, a cousin of Charles Darwin, published his now classic work on fingerprints. The study was later termed dermatoglyphics by Dr. Harold Cummins, the father of American fingerprint analysis. Dermatoglyphics is a Greek word, derma means skin and glyph means carving.¹

Dermatoglyphics is the process of taking the impression of papillary ridges of fingertips for analysis. Papillary ridges are confined to the palms and soles and flexure surfaces of the digits. These ridges form narrow parallel

or curved arrays separated by narrow furrow. The aperture of sweat ducts opens at regular intervals along the summit of each ridge.²

Fingerprint is unique for an individual because epidermal ridges are genetically determined and their pattern remains constant throughout life. So, this has a value in the diagnosis of hereditary disorders as well as identification of an individual.³ Dermal ridges begin to form around the 13th week of intrauterine life and development is completed by the end of the 21st week and then remains invariable. They follow a polygenic pattern of inheritance.^{4,5} Critical growth of various major organs also occurs during this time period of intrauterine life, especially neuronal development (structure derived from neural ectoderm). So, the ridge pattern can be affected by certain abnormalities of early development including genetic disorders, such as Down syndrome and skeleton malformation, such as polydactyly.

Fingerprint measuring parameters include (i) frequency of ridges in a particular pattern and (ii) disposition of triradii (junctional area where three sets of parallel ridges meet). Fingerprint ridge pattern can be separated into three major types, arches (5%), loops (70%), and whorls (25%). Arches have no triradii, loops have one triradii, and whorls have two or more triradii. Whorl pattern is more common on the right hand and males generally have more whorls and few arches than females. A similar pattern is seen in the toe.²

Fingerprint Pattern Configurations⁶

- *Arches (A):* These are parallel ridges that traverse the pattern area and form a curve that is concave proximally. The arch pattern is subdivided into two types: (a) Simple arch or plain arch composed of ridges that cross the fingertip from one side to the other without recurving. (b) Tented arch (TA) composed of ridges that meet at a point so that their smooth sweep is interrupted. (The point of confluence is called a triradius, because ridges usually radiate from this point in three different directions. In the TA, the triradius is located near the midline axis of the distal phalanx).
- *Loops (L):* A series of ridges enter the pattern area on one side of the digit, recurve abruptly, and leave the pattern area on the same side. If the ridge opens on the ulnar side, resulting loop is termed as ulnar loop (U, LU). If the ridge opens toward the radial margin, it is called a radial loop (R, LU).

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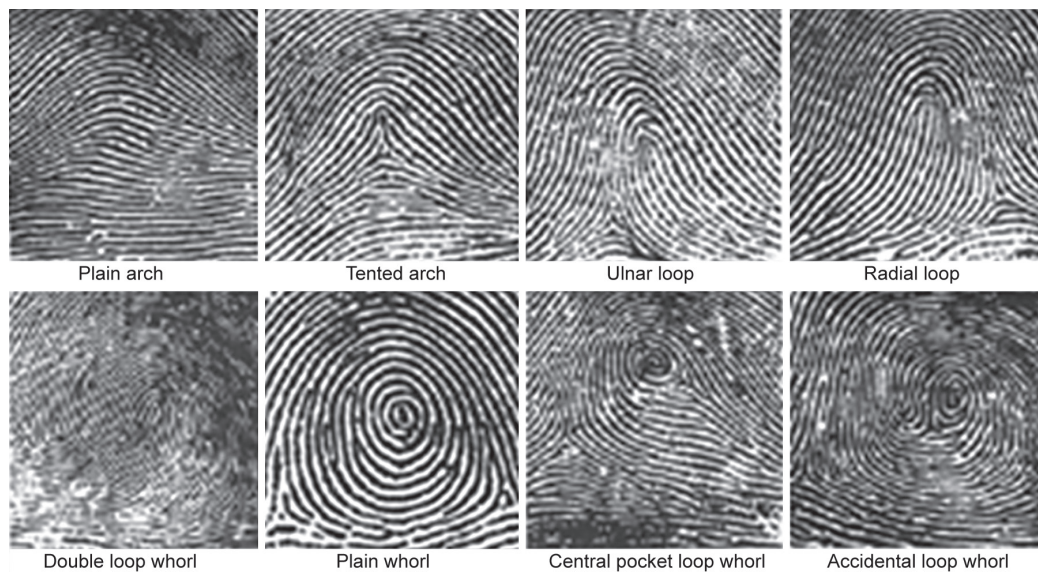


Fig. 1: Fingerprint patterns and classifications

Source: Above fingerprint images from *The Science of Fingerprints-Classifications and Uses*. By the FBI Identification Division 1957⁷

- **Whorls (W):** Whorls are configurations having ridges that actually encircle a core. The ridges in a plain (simple) whorl are commonly arranged as a succession of concentric rings or ellipses known as concentric whorls. If ridges spiral around the core in either a clockwise or a counterclockwise direction, it is known as double or a spiral whorl. A central pocket loop/whorl contains a loop within which a smaller whorl is located. Complex patterns, which cannot be classified as one of the above patterns, are called accidentals.
- Some represent a combination of two or more configurations, such as a loop and a whorl, triple loops, and other unusual formations. They are classified as arch with loop and arch with whorl (Fig. 1).

The three basic dermatoglyphic landmarks found on the fingertip patterns are as follows:⁶

1. **Triradius:** It is formed by the confluence of three ridge systems that form angles of approximately 120° with one another.
2. **Core:** Core is in the approximate center of the pattern. The core may be of different shapes. In a loop pattern, the core is usually represented by a straight, rod-like ridge or a series of two or more such parallel ridges. In a whorl, the core can appear as a dot or a short ridge (either straight or bent) or it can be shaped as a circle or an ellipse in the center of the pattern.
3. **Radiants:** These are the ridges that emanate from the triradius and enclose the pattern area. These ridges constitute the “skeletal” framework of the pattern.

Palmar Pattern Configuration^{6,8}

In order to carry out dermatoglyphic analyses that can be compared in different individuals, the palm has been

divided into several anatomically designed areas. It includes thenar areas; 1st, 2nd, 3rd, and 4th interdigital areas; and hypothenar area.

- **Ridge counting:** Ridges are often counted between two digital triradii. The ridge count most frequently obtained is between triradii a and b and is referred to as the a–b ridge count.
- **atd angle:** This angle is formed by lines drawn from the digital triradius (a) to the axial triradius (t) and from this triradius to the digital triradius (d). The more distal the position of “t,” the larger the atd angle. Sometimes, accessory “a” or “d” triradii are present on the palm (Fig. 2).

USES OF DERMATOGLYPHICS

Identification of the Left-handed Uniqueness

Left handedness is developed genetically. Its determining factor is gene leucine rich repeat transmembrane neuronal (LRRTM1), which is a maternally suppressed gene present on chromosome 2p12. Left handers have a high risk of developing schizophrenia. Left handers have more radial loop, modified radial loop and TA, more number of peacock pattern, ulnar loop and single loop whorl and decreased central pocket whorl, double loop whorl, and simple arch when compared with right handers.¹⁰

Diagnosis of Medical Disorders

Genetic Disorders

Klinefelter syndrome: On digit 1 excess of arches, on digit 2 more ulnar loops, fewer whorls, lower ridge counts for

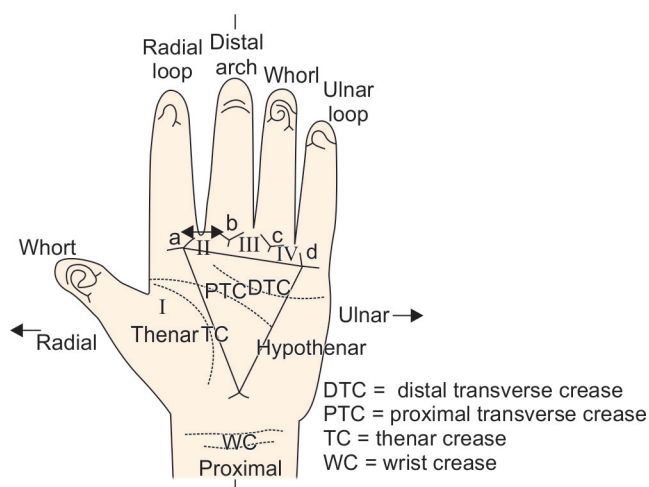


Fig. 2: Method of ascertaining the a-b ridge count with a single triradius "a"⁹

loops and whorls as compared with controls, and significant reduction of the total finger ridge count.¹¹

Cri du chat (5p-): In 90% excess of arches on fingertips and single transverse palmar creases.

Congenital blindness: Abnormal triradius¹² and excess of arches on fingertips.¹³

Noonan syndrome: Increased frequency of whorls on fingertips, and the axial triradius t, more often in position t' or t'' than in controls.¹⁴ Increased incidence of the single transverse palmar crease.

Trisomy 13 (Patau syndrome): In 60% excess of arches on fingertips and single transverse palmar creases.

Trisomy 18 (Edward's syndrome): Approximately 6 to 10 arches on fingertips and single transverse palmar creases in 30%.

Trisomy 21 (Down syndrome): Fingerprint pattern with mainly ulnar loops, a significantly different angle between the triradia a, t, and d (the "atd angle"), a single transverse palmar crease ("Simian line") (in 50%), patterns in the hypothenar and interdigital areas,¹⁵ and lower ridge counts along digital midlines, especially in little fingers, which correspond to finger shortening in those with Down syndrome.¹⁶ There is less variation in dermatoglyphic patterns between people with Down syndrome than between controls,¹⁷ and dermatoglyphic patterns can be used to determine correlations with congenital heart defects in individuals with Down syndrome by examining the left hand digit ridge count minus the right hand digit ridge count, and the number of ridges on the 5th digit of the left hand.¹⁸

Turner syndrome: Predominance of whorls.¹⁹

Rubinstein-Taybi syndrome: Preponderance of broad thumbs, low mean ridge count, and fingerprint patterns occurring on interdigital areas.²⁰

Schizophrenia: A-B ridge counts are generally lower than in controls.²¹

Medical Disorders

Dermatoglyphics in diabetes mellitus type II: It is a genetic disease, and so, dermatoglyphics plays a significant role in the diagnosis of diabetes mellitus. In type I diabetes, patients show characteristic reduction in loops and notable increase in whorls and arches.²²⁻²⁶ In type II diabetes, there is increase in the frequency of whorls and decrease in ulnar loops and no significant changes in radial loops in both hands irrespective of their sex. Males have significant reduction in arches in the right hand in comparison to females in the left hand.

Kanner's syndrome: It is the infantile autism caused by a wide range of neurological and psychological disorders. The onset of this syndrome is around 30 months of age; severe forms of manifestations include hearing loss, mental retardation with epilepsy, dyslexia, Martin bell syndrome, and rare cases of tuberous sclerosis. In digital dermatoglyphics, there is high frequency of arches and lower loops. Arches of the 1st, 4th, and 5th fingers of the left hand show higher frequency. There is prominent increase in ulnar loops. Palmer dermatoglyphic distortions are common in the left palm.²⁷⁻³⁰

Hypoparathyroidism: Decreased function of parathyroid hormone causes reduction in circulating parathyroid hormones, hypocalcemia, and hyperphosphatemia.⁵ It is characterized by short broad bands and increased arch patterns.³¹

Palmar Dermatoglyphics in Male Cationic Schizophrenia⁸

Schizophrenia is a neural disorder in which the patient has impairment in perception and thought processing.¹⁰ In this case, subjects were found to have more number of arches and loops and less whorls.³²

Dermatoglyphics in Dermatoglyphics Multiple Intelligence Test

Dermatoglyphics analysis is a quantitative analysis by the combination of new computer technology and science using Dermatoglyphics Multiple Intelligence Test (DMIT) software. By scanning and comparing the fingerprint patterns, nowadays, we are able to find out the inborn advantages and can give suggestions according to each person's own characteristics with no bias.³³

Theory of Multiple Intelligence (MI) was proposed by Prof. Howard Gardner of Harvard University (1983),^{34,35} defining the various kinds of mental intelligence like linguistic, musical, logical (mathematical), visual/spatial, bodily/kinesthetic, intrapersonal, interpersonal, and naturalistic, of which a child may stand out. Theory of MI^{34,35} of Howard Gardner made a strong impact on many

educators all over the world of providing opportunities for authentic learning based on the students' needs, interests, and talents. Many academic institutions are now restructuring their curriculum according to these intelligences.

Development of fingerprints of a person is directly associated with the development of the brain, and intelligence is too closely associated with the development of the brain. Therefore, by studying the fingerprints of a person, the forms and manifestation of various types of intelligences can be determined by DMIT.³³

Guidance and counseling offices of various academic institutions may use DMIT to critically assess the inherent acumen and aptitude of the students enrolled in their programs and to assist in the continual mapping of the growth and development of the students' talent, attitude, and skills along an educational gradient. Teachers may use the DMIT into guiding students with their innate learning style and study skills. Academic institutions may use DMIT to enhance their career guidance program. Dermatoglyphics mental intelligence test may be used as a measure for the student's goal-setting behavior and for their present and future lifestyles/expectations. It is needed to strengthen the self-confidence and self-esteem of students by identifying their innate abilities and guide them to a more happy and satisfied life. There is also a need to train teachers so that they serve as the best facilitators to nurture their students toward their life purpose. They would be able to guide them based on the innate findings of each student and create opportunities for them as well as treat each child differently based on their personality.³³

CONCLUSION

Cummins and Midloo³⁶ coined the term dermatoglyphics. Scientifically, it began with the publication of Purkinje's thesis (1823)³⁵ and Galton's classic book, *Fingerprints* (1892).³⁷ This review throws light on the importance of dermatoglyphic studies in various fields. In forensic sciences, it is important due to the feature that fingerprints are unchanged throughout life or even after death. Variations are present in patterns of fingerprints in different pathological conditions. Dermatoglyphics Multiple Intelligence Test is a remarkable offshoot of Howard Gardner's Theory of MI that helps remarkably in students opting the right field/career according to their intelligence.

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