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CONVENTIONAL DERMATOGLYPHICS –REVIVED CONCEPT: A REVIEW

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ABSTRACT

Over the past 150 years, Dermatoglyphics has been a useful tool in understanding basic questions in biology, medicine, genetics and evolution, in addition to being the best and most widely used method for personal identification .Dermatoglyphic analysis is now beginning to prove itself as an extremely useful tool for preliminary investigations into conditions with a suspected genetic basis. In many respects, it has been used as an adjunct to other disciplines, serving as a vehicle to resolve broader biomedical problems. Thus in biology, anthropology, genetics and medicine, dermatoglyphics serves as a tool to describe, compare and contrast, and at times predict occurrences and risks for biomedical events studied by these major disciplinary areas. This review focuses briefly on the spectrum of development underlying the traditional dermatoglyphics

KEYWORDS

Dermatoglyphics, Genetics, Biomedical, Review

HISTORY OF DERMATOGLYPHICS:

The scientific basis of friction ridge identification has evolved over many years, even centuries. *(1)* .The scientific study of papillary ridges of the hands and feet is credited as the beginning with the work of **Joannes Evangelista Purkinje in 1823.** *(2)* **William Herschel (1858)** was the first to experiment with fingerprints in India. *(3)* **.Sir Francis Galton (1892)** conducted extensive research on the significance of skin ridge patterns, not only to demonstrate their permanence but also their use as a means of identification. He demonstrated the hereditary significance of fingerprints and the biological variations of different finger print patterns amongst different racial groups *(4)*. **In 1892,** he published the book ***"Fingerprints"*** and in doing so, significantly advanced the science of fingerprint identification *(3)*.

Sir Edward Henry (1893) published the book *'The classification and uses of fingerprints"* which established the modern era of finger print identification, which is now the basis for most of the other classification systems *(3)*. **Harris Hawthorne Wilder (1902)** in the early 20th Century, pioneered comprehensive studies on the methodology, inheritance and racial variation of palmar and plantar papillary ridge patterns, as well as finger prints. *(2).*A British commissioner in India, **Sir William Herschel**, noticed the use of thumbprints as a form of signature amongst illiterate Indians and clearly established the fact that fingerprints did not change their form over time and therefore could be used as a reliable form of personal identification.

Cummins and Midlo (1926) were the first to coin the term **'Dermatoglyphics'** (from two Greek words- derma=skin, glyphe=carving). It is the science and art of the study of surface markings /patterns of ridges on the skin of the fingers, palm, toes and soles. *(5)*.The main thrust of their research was on Down's syndrome and the characteristic hand formations. They showed that the hand with significant dermatoglyphic configurations would assist the identification of Mongolism in the newborn child. *(5)*.**Charles Midlo M D (1929)** together with others published one of the most widely referred book ***"Fingerprints, Palms and soles", a bible in the field of Dermatoglyphics*** *(1)***. Penrose L S (1945),** inspired by the works of **Cummins and Midlo**, conducted his own dermatoglyphic investigations as a further aspect of his research into Down's syndrome and other congenital medical disorders *(1)*.

Galton Center (1965) contributed to the development of dermatoglyphics and formulated the measurement to establish the position of displaced axial tri radius in terms of atd angle, as well as establishing the inheritance of its position in the palm *(1)*. **Sarah Holt (1968)** published the book ***'The Genetics of dermal ridges'*** and summarized the statistical distributions of dermatoglyphic patterns of the fingers and the palm in various people, both normal and congenitally affected individuals. The research focused not only on the identification of those features of the palm, which would indicate the genetic likelihood of a mother giving birth to a Down's syndrome child, but also concentrated on the study of twins *(1)*.

Schaumann and Alter's (1976) published a book ***'Dermatoglyphics in Medical disorders'*** which summarizes the findings of dermatoglyphic patterns in various disease conditions *(1)*. **Engler et al (1982)** conducted a study on patients with breast cancer and *concluded that the presence of six or more whorls on the fingertips of a person provided a high risk for breast cancer (3).* The current state of medical dermatoglyphics is such, that the diagnosis of some illnesses can now be done on the basis of dermatoglyphic analysis alone and currently, several dermatoglyphic researches claim a very high degree of accuracy in their prognostic ability from the hand features.

In Germany, **Dr Alexander Rodewald in 2001** diagnosed many congenital abnormalities with 90% accuracy from the features of the hands alone *(1)*.**Dr. Stowens in 2003,** Chief of Pathology at St Luke's Hospital in New York, claims to diagnose schizophrenia and Leukemia with 90% accuracy from the patterns on the hands alone.

EMBRYOGENESIS OF DERMATOGLYPHIC PATTERNS

Earlier scientific studies related dermatological marking developments to the first four months of gestation. **Schaumann and Alter** described the process more accurately and in detail, as taking place early in fetal development and being genetically determined while being modified by environmental forces *(2)*.**Bonnevie (1924)** summarized the conclusions of the earlier investigators as 'A very intimate connection between pads and patterns with regard to the degree of elevation of the pads and the special configurations of their pattern". *(6)***Bonnevie (1929)** speculated that fingerprint patterns were dependent upon the underlying arrangement of peripheral nerves *(2)*.

Cummins (1935), observed the ridge configurations of congenitally malformed hands and proposed, that direction of epidermal ridges was determined by growth forces and contour of volar skin at the time of ridge formation. **Humphrey (1964)** studied the early function of the fetal hand and indicated that digital and palmar creases are secondary features, which are related to flexion movements in the developing hand between the seventh and fourteenth weeks of development *(7)*.

Gall and Associates (1966), stated, that the shape of volar pads determines fingertip patterns, the ridges covering the skin in the most economical way possible, according to strict topological principles (*6*). **Penrose (1968)** suggested that ridges are aligned at right angles to compression forces, take the shortest routes on the embryonic surfaces, and the abnormal configurations may be the result of alterations in the fluid balance at an early embryonic stage. *(6)* Therefore, ridge configuration is dependent on the shape of the volar pad at the time of initial primary ridge formation. A high volar pad would result in formation of a whorl, while a low pad would result in an arch and an intermediate pad height offset to one side of the digit would result in a loop formation (6).

Hirsch and J.V. Schweichel (1973) summarized that the arrangement of blood vessels and nerve pairs under the smooth epidermis exists shortly before glandular folds and speculated that the folds were induced by the blood vessel -nerve pairs. They concluded that the pattern of papillary ridges is set after the development of the glandular folds, after four months, although the growth pattern of the glandular folds is one of the three forces postulated to control the final highly arranged surface pattern. They also emphasized that the neuro-epithelium plays an important part in the development of the dermatoglyphic patterns and offered the following explanations (2). 1) Failure of nerves to grow into the epithelium may be expressed through dermatoglyphic aplasia ,2) Both qualitative and quantitative deviations of sub-epithelial nerve branches to form may be evidenced by dermatoglyphic dysplasia and 3) Where dermatoglyphics are distorted, there may be a disturbance of the spatial arrangement (2).

William. J. Babler (1976) indicated that the epidermal ridges first appear in the form of localized cell proliferations around the 10^{th} to 11^{th} week of gestation. These proliferations form shallow corrugations that project into the superficial layer of the dermis. The number of ridges continue to increase, being formed either between or adjacent to existing ridges. It is during this period of primary ridge formation, that the characteristic patterns are formed. At about 14 weeks, the primary ridge formation ceases and secondary ridges begin to form as sweat gland, and develop along the apices of the primary ridges at uniform intervals. At this time, the epidermal ridges first begin to appear on the volar surfaces. The dermal papillae are reported to develop in the valleys between the ridges on

the deep surface of the epidermis around the 24th week. Till then, the morphology of primary and secondary ridges appear as a smooth ridge of tissue and thereafter peg like structures, the dermal Papillae, characteristic of the definitive dermal ridges, are progressively formed (2).

Babler (1987) reported that there is a relationship between the volar pad shape and the epidermal ridge configuration; specifically narrow volar pads are related to whorl patterns. He also suggested the association between the shape of the distal phalanx and the pattern type. Significant correlations between the bony skeleton of the hand and the epidermal ridge dimensions and time of ossification may be a key factor in ridge patterning (2).

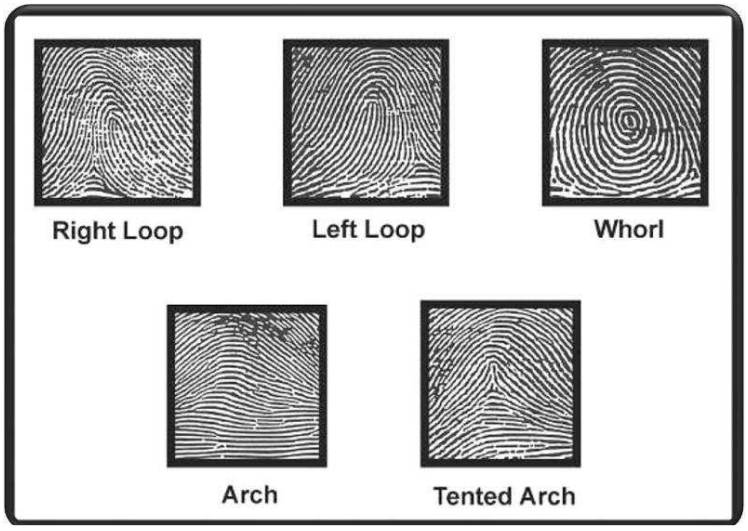
PATTERN CONFIGURATIONS

I) FINGERS:

Fingertip pattern configurations:

Galton (1892) divided the ridge patterns on the distal phalanges of the fingertips into three groups. **(Figure 1)** namely Arches **,** Loops and Whorls. Although numerous sub-classifications have been subsequently offered, this simple classification is still recognized and used by majority of investigators today(5).

Figure 1



1) Arches (A):

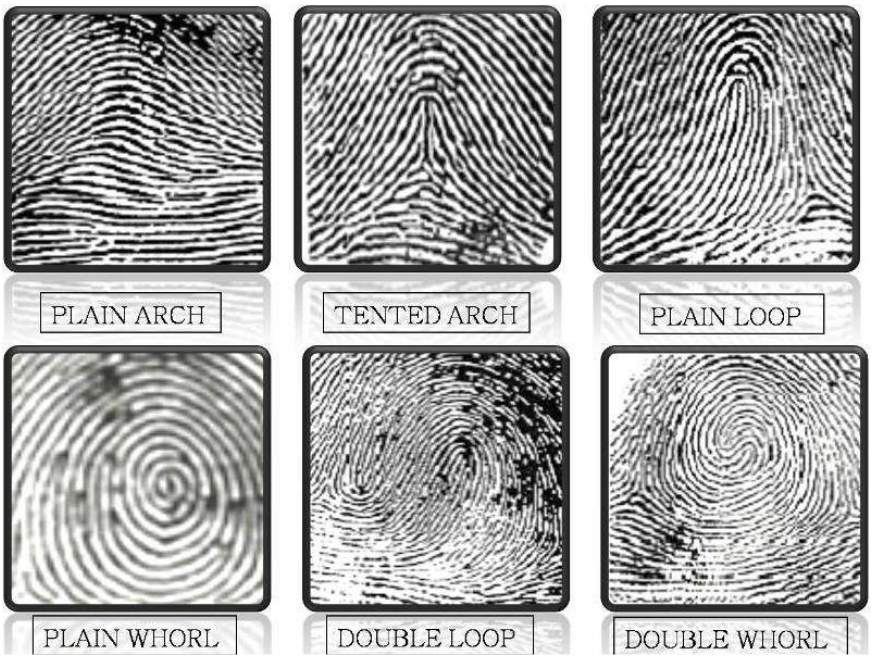
It is the simplest pattern found on fingertips. It is formed by succession of more or less parallel ridges, which traverse the pattern area and form a curve that is concave proximally. Sometimes, the curve is gentle; at other times it swings more sharply so that it may also be designated as a low or high arch respectively(5). The arch pattern is subdivided into two types.**1) Simple arch or plain arch (PA),** composed of ridges, that cross the fingertip from one side to the other without recurving. **2) 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 tri-radius, because ridges usually radiate from this point in three different directions. In the tented arch, the triradius is located near the midline axis of the distal phalanx. The distal radiant of the triradius usually points vertically toward the apex of the fingertip. Ridges passing over this radiant are abruptly elevated and form a tent like pattern and are designated as 'tented arch'.

(2) Loops (L):

It is the most common pattern on the fingertip. 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,L^U).
If the ridge opens toward the radial margin, it is called a radial loop. (R, Lr).A loop has a single triradius or confluence point of ridges. The triradius is usually located laterally on the fingertip and always on the side where the loop is closed. Loops may vary considerably in shape and size. They may be large or small, tailor short, vertically or horizontally oriented, **Plain Loop (PL) OR Double Loop (DL). (Figure 2)** Occasionally, 'Transitional' loops can be found which resemble whorls or complex patterns (5).

Figure 2



(3) Whorls (W):

It is any ridge configuration with two or more triradii. One triradius is on radial and the other on the ulnar side *of* the pattern. **(Figure 2)** **Henry (1937)** limited the designation *of* the term 'Whorl' to those configurations having ridges that actually encircle a core. He named more complex patterns as **"Composites"** (5).

The ridges in a **Plain (Simple) whorl (PW)** are commonly arranged as a succession *of concentric rings or ellipses. Such patterns are described* ***as concentric whorls (W^c)*** (9). **(Figure 2) .**Another configuration spirals around the core in either a clockwise or a counterclockwise direction. This pattern is called a **Double (DW) or a spiral whorl (W^S). (Figure 2) .**Sometimes, both circles and ellipses or circles and spirals are present in the same pattern. The size *of* the whorl can vary considerably, and is determined by means *of* a ridge count (5).

A **central pocket loop/whorl (CPL) (W^{cp})** is a pattern containing a loop within which a smaller whorl is located. Central pockets are classified as ulnar or radial according to the side on which the outer loop opens. The significance *of* separating these two varieties of loop whorls for medical diagnosis remains unproved. Therefore, they are ordinarily grouped together as a **CPL.** Another type is composed *of* interlocking loops, which may form either a lateral pocket (W^{LP}), twin or twinned loop (w^t)

pattern. Each has two triradii and the two types *of* whorls are morphologically similar (5). Complex patterns, which cannot be classified as one *of* the above patterns, are called **Accidentals (A)/ (W^{aCC}).**

Some represent a combination *of* two or more configurations such as a loop and a whorl, triple loops and other unusual formations (5). They are classified as a) Arch with Loop (AWL) **(Figure 4),**b) Arch with Whorl (AWW) **(Figure 3)**

OTHER AREAS OF DERMATOGLYPHICS:

1. DERMATOGLYPHIC LANDMARKS

The three basic Dermatoglyphic landmarks found on the fingertip patterns are **Triradii** ,**Cores** and **Radiant**

Triradius:

It is formed by the confluence of three ridge systems. The geometric center of the triradius is designated as a triradial point. It is the meeting point of three ridges that form angles of approximately 120^0 with one another (5). The triradial point forms one terminus of the line along which ridges are counted. Sometimes, large patterns are extralimital in nature. These are commonly observed in the hypothenar areas of the palms and the hallucal areas of soles. (5)

Core:

It is in the approximate center of the pattern. The core may be of different shapes. A) 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, over which other recurving ridges pass. If a straight ridge is absent in the center of the loop, the innermost recurving ridge is designated as a core. B) 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 (5)

Radiants:

These are the ridges that emanate from the triradius and enclose the pattern area. These ridges constitute the 'skeletal' framework of the pattern area(5)

2. PALMS

PALMAR PATTERN CONFIGURATION

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,First, Second, third and fourth interdigital areas and Hypothenar area (5).

3. RIDGE COUNTING

It is used to indicate the pattern size. The counting is done along a straight line connecting the triradial point to the point of core. The ridges containing the point of core and triradial point are both excluded from the count. 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**.

4. 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. (5).

STUDIES IN DERMATOGLYPHICS

I) Dermatoglyphic studies on syndromes

Cummins (1939) demonstrated characteristic differences in frequency of dermal configurations between affected and normal children, long before chromosomal basis of diagnosis of Down's syndrome was established (8). **Walker (1957)** derived an estimate of the probability, that a child has Down's syndrome by a probability index. It was derived by multiplying the probabilities for each pattern or after conversion to logarithms, by adding them(8).**Lu (1968),** listed all possible combinations of finger patterns and their frequencies in a group of patients with Down's syndrome and controls and discriminated

(89%) of ab rid! those *from* without Down's syndrome (8). **Reed et al (1970),** in his study, constructed a nomogram using only four dermatoglyphic traits, chosen for their high discriminant values (8)**Borgaonkar et al (1971)** developed another method, using predictive discrimination by which 88% of patients with Down's syndrome and 92% of controls were discriminated (8).

Penrose and Loesch (1971), developed a dermatoglyphic discriminant *for* Trisomy 21, and *for* three other syndromes (D, E and 4P) using a new system of classification and laid more emphasis on sole patterns (8). **Marylin Preus et al in 1972** in his review article concluded that the hands and feet of a patient with trisomy 21 were generally short and broad. There was a high frequency of simian creases, incurved fifth digit (Clinodactyly) with or without a short or missing middle phalynx and a wide space between the first and second toe, with a deep plantar crease (8). Dermatoglyphic pattern showed an increase in the bilateral “t”, 10 ulnar loops on the fingers, radial loops in 4 or 5 fingers (8).

Rajangam S et al (1995) studied dermatoglyphic patterns of 235 cytogenetically confirmed patients of Down's syndrome. The data were correlated and compared with 230 controls. Patients' total finger ridge counts and 'atd' angles differed significantly from that of the controls. Mostly ulnar loop pattern was observed in the patients. Abnormal dermatoglyphic features such as simian crease, Sydney line and patterns in the hypothenar and interdigital areas have occurred more frequently in the patients. (9)

Katznelson MB et al (1999) carried out a study in order to evaluate the dermatoglyphic traits (DT) in males and females with Down's syndrome (DS). The aim of the study was to explore the possibility of using DT of the parents of DS patients to predict the likelihood of the disease appearing in the offspring. The samples were of DS patients (198 males and 140 females) and their parents (84 fathers and 153 mothers); all Israeli Jews. The prints were collected and interpretted. This included identification of patterns, ridge counts and the measurements of distances and angles in the palm of the hands; 79 DT for every individual: 28 continuous traits, 9 discrete traits, 11 indices of intraindividual diversity (Div), 15 indices of directional asymmetry were estimated. The results were compared between parents and control groups of women and men. The present study found proof of the existence of an additive genetic component in DT, while an increased ridge counts and arch patterns (ulnar and radial loops) was observed in parents of DS patients in comparison to control groups. The DT which is typical to DS patients was confirmed in parents also.

Thomas Fogle (2002) performed comparative Dermatoglyphic study between 180 Downs syndrome patient and 180 normal individuals. He concluded that ulnar loops and radial loops were mostly seen on index fingers and ring fingers respectively in Down syndrome compared to normal individuals. (10)**Sardool Singh (2005)** studied Dermatoglyphics of schizophrenics; patients with Down's syndrome and mentally retarded males were compared with those of normal Australian Europeans. It was noticed that the patients with Down's syndrome separated significantly from the rest of the groups. They showed a significant increase in the ulnar loop patterns compared to normal group. (11)

Matsuyama N, Ito Y (2006) studied each fingerprint type (arch, ulnar loop, radial loop, and whorl) of the parents of children with Trisomy 21 (Fathers: 71; Mothers: 128) born between 1965 and 1970 that was obtained from the Tokyo Medical and Dental University Hospital. Japanese controls were taken from dermatoglyphics data in Japan. Results from a statistical analysis based on the above data showed significant differences, more arches and fewer whorls in mothers of children with Trisomy 21. Among fathers of Trisomy 21 children, a

significant difference was found in there being fewer whorls and ulnar loops. Considering the mothers' fingerprints, they suspected that females with a higher frequency of arches and a lower frequency of whorls had a stronger possibility of bearing Trisomy 21 babies. (12)

b) 45, XO Turner's syndrome:

Marylin Preus et al (1972) in his review article concluded that individuals with XO Turner's syndrome often had a short fifth finger, dystrophic or hyper convex nails, shortening of the third to fifth metacarpals and lymphedema of the hands and *feet* in infancy. The A-line exists in the thenar area more frequently than in normal individuals with an increase in the atd angel greater than 120 and with an increase in the bilateral hypothenar area. (8)**Kobyliansky E et al (1997)** studied dermatoglyphic patterns among 57 Turner female patients and compared it with healthy individuals: 79 dermatoglyphic variables for every patient: 28 continuous traits, 9 discrete traits, 10 indices of arch patterns, 16 indices of directional asymmetry and 16 indices of fluctuating asymmetry were estimated. They found that there was significant increase in the ulnar loop patterns among these patients compared to control group. (13)

c) 47, XXY (Klinefelter's syndrome)

Marylin Preus et al (1972) in his review article concluded that there is a slight increase in the height of the axial triradius in hypothenar patterns, and a decrease in thenar patterns . (8)

d) Pseudo hypoparathyroidism

Forbes (1967) reported an increase in patients with high axial triradius. An increase in arch patterns was noted, but the data was not presented in a form that can be evaluated for clinical use. (8).**Marylin Preus et al (1972)** in his review article concluded that these patients had short, broad hands and feet, with short metacarpals and metatarsals especially the fourth and fifth (8).

e) Rubinstein -Taybi syndrome (R-T Syndrome)

Marylin Preus et al (1972) in his review article concluded that one of the major diagnostic criteria for individuals with this syndrome were broad thumbs and great toes, a deep plantar crease, overlapping toes, and fifth finger clinodactyly or polydactyly. Dermatoglyphic features include an increase in the radial loop pattern, thenar pattern and bilateral I_3 pattern. (4)

II) Dermatoglyphic study in Breast Cancer

Marylin Preus et al (1972) in his review article concluded that Breast cancer is hereditary and earlier studies have revealed *two* genes BRCA and BRCA 2 on the q arm of chromosome 17 at the 36^{th} position. (8).**Engler et al (1982),** analyzed dermatoglyphic patterns in breast cancer patients, and concluded that the presence of six or *more* whorls on the fingertips of a person provides a high risk of obtaining breast cancer (3).**Huang C.M (1997)** studied Fingerprints of 570 breast cancer cases and the same number of matched controls from the population-based finger print file in Hawaii for studying the association between breast cancer and digital dermal patterns and ridge counts. The results showed that breast cancer patients had a significant excess of radial loops on the left hand. It was also found that the frequency of ulnar loops on the left hand was significantly elevated for premenopausal women with breast cancer, whereas an excess of radial loops on the left hand was observed for the postmenopausal women with breast cancer. (15)

Bierman et al (2003) studied Fingerprints of 200 women with histologically proven breast cancer (case group) and compared to fingerprints from 138 women with no history of any malignant disease (control group). Of the patterns analyzed, four were significantly associated with breast cancer: accidentals, transitionals, angled ulnar loops, and horizontal ulnar loops. Of 200 patients in the case group, 27 had one or more accidental prints, 58 had one or more transitionals, 34 had one or more horizontal ulnar loops, and 93 had one or more angled ulnar loop patterns. In 138 control subjects there

were 2 with accidental patterns, 21 with one or more transitionals, 6 with horizontal ulnar loops, and 16 with one or more angled ulnar loops. Thus the prints described will represent a noninvasive anatomical marker of breast cancer risk. (16)

Seltzer M.H (2005) studied Fingerprints and palm prints in 78 breast cancer patients, 391 patients at increased risk for developing breast cancer, and 64 control patients for the purpose of finding a pattern that would identify those women with breast cancer or those who are predisposed to its development. A pattern of 6 or more digital whorls was identified more frequently in women with breast cancer than in those without the disease. He concluded that digital dermatoglyphics may have a future role in identifying women either with or at increased risk for breast cancer such that either risk reduction measures or earlier therapy is administered. (17)

Chintamani et al (2007) conducted a study on 60 histo-pathologically confirmed breast cancer patients and their digital dermatoglyphic patterns were studied to assess their association with the type and onset of breast cancer. Simultaneously 60 age-matched controls were also selected that had no self or familial history of a diagnosed breast cancer and the observations were recorded. The differences of qualitative (dermatoglyphic patterns) data were tested for their significance using the chi-square test, and for quantitative (ridge counts and pattern intensity index) data using the t- test. It was observed that six or more whorls in the finger print pattern were statistically significant among the cancer patients as compared to controls. It was also seen that whorls in the right ring finger and right little finger were found increased among the cases as compared to controls. The differences between mean pattern intensity index of cases and controls were found to be statistically significant. Thus they concluded that the dermatoglyphic patterns may be utilized effectively to study the genetic basis of breast cancer and may also serve as a screening tool in the high-risk population.(18).

A recent study on a small group of breast cancer patients in Karnataka revealed that those with breast cancer disposition show an ulnar loop on the little finger *of* both hands and a ridge *count* of between 6 and 8. (19)

III) Dermatoglyphic studies in Psychological disorders.

A C Bogle, T Reed & R J Rose (1994), published the replication of a study relating to the combined use of dermatoglyphics and the MMPI tests. The tests indicated that, identical twin subjects with asymmetric (dissimilar) patterns on their left and right hands were likely *to* suffer *from* environmental distresses, than identical twins who had symmetric patterns. Twins with asymmetric palmar patterns were considered *to* have poorer genetic buffering against environmental factors than those with symmetrical corresponding palmar patterns. These, with the asymmetrical patterns exhibited, heightened developmental sensitivity *to* extraneous environmental stress". Their findings suggested that such persons had poorer genetic buffering" and environmental sensitivity differences could be manifested in clinical correlative behaviors of anxiety or depression. (20)

IV) Dermatoglyphics in Obsessive-compulsive disorder

Balgir R S et al (2001) studied 50 patients with a predisposition to obsessive-compulsive disorder and compared with 50 healthy individuals. They concluded that the study group showed a significant increase in the ulnar loop with a ridge count of 2-3 on the forefinger or any other finger, and a proximal crease on the palm with a line running right cross compared to control group. (21)

V) Dermatoglyphics in Diabetes mellitus

Bets LV et al (1994) studied dermatoglyphic patterns among a group of Russian children with clinically diagnosed diabetes mellitus. Pattern asymmetry was

observed in children of both sexes compared to control group. The examined population was characterized by reduced incidence of loop patterns. (22)

Ravindranath R et al (1995) studied Total finger ridge count, absolute finger ridge count and finger print pattern in 150 maturity onset diabetes mellitus patients and compared to 120 controls. Significant findings were: in males, with both hands combined and separately (i) an increase in radial and ulnar loops and arches (ii) A decrease in whorls. (iii) In females, an increase in ulnar loops and a decrease in whorls in the left hand were observed. (23)

Vera M et al (1995) studied hand and palm dermatoglyphics in 158 insulin-dependent diabetic children. The findings in this group were compared with those in 400 control subjects, with a similar racial distribution. The main dermatoglyphic alterations found in diabetic patients were an increase in the number of t'-axial triradii and ulnar loops. (24)

R. S. Bali et al (2005) studied dermatoglyphic patterns of 108 male and 65 female patients diagnosed as diabetes mellitus. The control population consisted of 536 males and 234 females from the same population. Their results showed an increase in the ulnar loop patterns among diabetes mellitus patients compared to control population. (25)

Barta et al (2006) studied Dermatoglyphic features of 180 adults with diabetes mellitus. They found that the loop patterns and arch pattern was mostly seen on the thumb in diabetes mellitus patients compared to healthy individuals.(26)

VI) Dermatoglyphics in cleft lip and cleft palate.

Egle Zarakauskaite et al (2004), in their case control study, suggested that there are some significant dermatoglyphic peculiarities in persons with cleft lip and/or cleft palate (CLP) in comparison with control group. The patterns on thenar eminence in hands of those with CLP were six times rarer than in controls (p<O.O5). There was a significant difference (p<O.O5) between the control group and persons with CLP by count of all triradii (controls-98%, CLP-87.3%), the main line A ended more often in fields 5' and 5" in persons with CLP in comparison with their parents and there were significantly more arches, double loops and ulnar loops in with CLP than in control dermatograms. (21)

Scott NM et al (2005) studied dermatoglyphic prints from individuals with non-syndromic CL/P (n = 460) and their unaffected relatives (n = 254) from the Philippines and China. For both samples three raters designated the patterns as arch, ulnar loop, radial loop, and whorl. Chi-square analysis and standard ANOVA were used to investigate heterogeneity between subjects. The significant associations between particular pattern types and CL/P were not the same in both populations. An increased radial and ulnar loop were observed in Cleft lip and palate patients. (27)

Mathew L et al (2005) studied dermatoglyphic patterns of 100 children between age of 5-15 years with no difference between sexes of which 50 consisted of the study group (nonsyndromic children with oral clefts) and remaining 50 consisted of control group (healthy children without any anomalies). Bilateral finger prints were collected and analysed. It was observed that oral cleft individuals had an increased frequency of ulnar loops as the ridge configuration as compared to control group. (28)

Balgir R S (2006) studied dermatoglyphic characteristics of sixty nine cases of cleft lip with or without cleft palate and twenty eight isolated cleft palate cases. They were evaluated for finger patterns, digital patterns, interdigital patterns, types of C- and D-line. It showed variations in patients and controls. Wider 'atd' angle (more than 30 degrees) and dermatoglyphic asymmetry were noted in the patient groups. There was also a significant increase in the ulnar loop, arch patterns among the cleft palate patients. (19)

VII) Dermatoglyphics study in Myocardial Infarction patients.

F. Jalali et al (2002) studied the relation between the dermatoglyphic patterns of myocardial infarction patients. A multi-centre cross-sectional study was conducted among 900 patients diagnosed with myocardial infarction. The control group consisted of 900 subjects. In patients group, the distribution of dermatoglyphic pattern was 7.2 % arch type, 46.8 % loop type, and 46% whorl type of fingerprints. In contrast, in the control group, they were 3.7%, 50.7% and 45.5% respectively. This result showed a statistical significant increase in the rate of arch type fingerprints in patients with MI roughly two times. Also, in subgroup analysis, the percentage of arch type was significantly increased in left thumb, left forefinger and left ring finger among cases (P < 0. 0001).Their finding indicated that there is a significant relation between the arch types of fingerprint and the risk of MI. (29)

VIII) Dermatoglyphics in Genodermatosis.

Kuklin VT (2001) studied the ratios between dermatoglyphic patterns of different types in males and females with and without hereditary diseases of the skin. It was found that ridge patterns of fingers were determined by special polygenes. Patients with monogenic dermatoses (X-linked ichthyosis and autosomal recessive ichthyosiform erythroderma) exhibited a suppressed formation of the loop pattern compared to the control subjects. (30).**Blackwell D (2002)** studied palmar and fingerprints of 70 patients with Darier's disease and 409 normal controls. The dermatoglyphic characteristics of each group were determined and comparisons were made between them. Dermatoglyphic abnormalities were found. There was a significant increase in the ulnar loop pattern among the Darier's disease patients. (31)

Cusumano D (2003) studied fingertip dermatoglyphic patterns of forty-five patients with atopic dermatitis and compared them to those of sixty healthy individuals. The average number of whorl pattern detected was significantly higher in the atopic group than in the control group. However, atopic patients with hand dermatitis had, on the average, a greater number of whorl pattern than did the control patients have. (32)**Rodewald A (2005)** studied finger, palmar, and plantar prints of 8 males with X-linked hypohidrotic ectodermal dysplasia (HED), 8 carrier mothers, 7 sisters, and 1 carrier grandmother and compared them with data from 552 controls. The patients with HED and the carrier females had higher incidence of arches on the fingertips, of t" triradii, of hypothenar patterns (especially ulnar loops), and of transversal direction of the main lines on the palms than the control individuals had. The affected males were also characterized by severe hypoplasia and/or dysplasia of the dermal ridges ("ridge flattening"); the carrier females also showed ridge flattening and hypoplasia. (33)**Kargül B et al (2006)** studied dermatoglyphic patterns in 3 hypohidrotic ectodermal dysplasia (HED) patients and compared them with 45 controls. This clinical evaluation (intraoral and radiological), genetic findings, dermatoglyphic patterns were analysed. The HED patients had a higher incidence of ulnar loop patterns compared to the controls. (34).

IX) Dermatoglyphics in Dental caries.

Metin Atasu (1992) studied dermatoglyphic configurations in caries-free students and the students with extensive caries and found there was significant difference in dermatoglyphic patterns in these two groups. In other words caries free students had more ulnar loops on the fingertips and the students with extensive caries had more whorls on the finger tips. The role of heredity in dental caries has been shown in this study. (35)

A Sharma, R Somani studied to determine if there is any significant correlation between salivary bacteria interactions, dermatoglyphics, and dental caries. They found highly significant difference in loops between the subject (caries) and control groups , since the observed value (Z cal = 7.9762, 4.0248) was more than the

standard value (*Z* tab = 3.79) at *P* < 0.001 and also observed significant difference between subject and control groups for microbial growth since the observed value (*Z* cal = 2.43, 2.09, 2.29, 2.61) was more than the standard value (*Z* tab = 1.96) at *P* < 0.05.The results of the study inferred that there existed a statistically significant difference between subject and control groups for dermatoglyphics, and *S mutans* levels(36).

Dermatoglyphics in Malocclusion

S Tikare et al from their study observed that Dermatoglyphics might be an appropriate marker for malocclusion and further studies are required to elucidate an association between fingerprint patterns and malocclusion.(37)

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