Review Article

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Skin Carvings: Predictive Diagnosis in Modern Era

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The science and art of markings of the skin especially hands and feet's is known as dermatoglyphics, where derma means skin and glyph mean carving. For centuries, the features of the hands have fascinated scholars, sages, theologians, doctors, and layman alike. In 1926 Cummins introduced the term "dermatoglyphics." "Samudra Shastra" was known as ridge pattern study in ancient India. The epidermal ridge patterns were classified into "Chakra, Shankya, and Padma" which corresponds with the whorl, loop, and arch system of modern classification. All individuals have unique fingerprints which remain unchanged over the lifetime. Multiple genes determine fingerprint configurations and the study of fingerprints reveal vital genetic and medical information about an individual. Dermatoglyphics is considered as the window of congenital abnormalities and is a sensitive indicator of intrauterine anomalies. For preliminary investigations in conditions with a suspected genetic basis dermatoglyphic analysis is now beginning to prove itself as an extremely useful tool. In dentistry, various studies have been published on the dermatoglyphics. Here in this present review, the dermatoglyphic patterns of the palms and soles, the methods to record the palm and sole prints and various studies conducted among the dental disorders has been highlighted.

Keywords: Dental disorders, Dentistry, Dermatoglyphics, Skin carvings

INTRODUCTION

Dermatoglyphics is the study of palmer and plantar dermal ridge carvings on hands and feet (Derma: Skin, Glyph: Carving). The terminology was coined by Cummins and Midlo in 1926 and Cummins is regarded as the "Father of Dermatoglyphics."[1] In ancient India, ridge pattern study was known as "Samudra Shastra." The epidermal ridge patterns were classified into "Chakra, Shankya and Padma" which corresponds with the whorl, loop, and Arch system of modern classification. Fingerprints are unique to all individuals and remain unchanged over the lifetime. Multiple genes determine the fingerprint configuration and the study of fingerprints reveal vital genetic and medical information about an individual.[2]

Abnormal dermatoglyphic patterns have been observed in several nonchromosomal genetic disorders and other diseases whose etiology may be influenced directly or indirectly by genetic inheritance. Dermatoglyphics are assumed to be genetically controlled although the exact mechanism of inheritance is still unknown.[1] In dentistry, the significance of dermatoglyphics has been investigated by several investigators. The study of the ridged skin can be used in predicting the genetic susceptibility of diseases through a cost effective means which can be used in field studies.

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HISTORY OF DERMATOGLYPHICS

- William Herschel (1858)was the first to experiment with fingerprints in India
- Sir Francis Galton (1892)with his extensive research demonstrated the hereditary significance of fingerprints and biological variations of different racial groups
- Sir Edward Henry (1893)published the book "the classification and uses of fingerprints," commencing a modern era of fingerprint identification
- Cummins and Midlo (1926)coined the term dermatoglyphics
- Penrose (1945)conducted dermatoglyphic investigation in down's syndrome and other congenital disorders
- Schaumann and Alter's (1976)published the book "dermatoglyphics in medical disorders."
- Dermatoglyphics today: The current state of medical dermatoglyphics is such that the diagnosis of some diseases can now be done on the basis of dermatoglyphics

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alone. Currently, several researchers claim very high degree of accuracy in their prognostic ability from the hand features.[2]

EMBRYOGENESIS

The ridge patterns are formed at the sites of a series of fetal mounds situated on the tips of the digits, in the four interdigital areas, in the thenar and hypothenar areas of the palm and sole, and in the calcar area of the sole. These mounds first appear as bulges at about the 6th week of embryonic development, when the hands and feet are relatively undifferentiated. During the next 4 weeks, the mounds become rounded and distinctly separated from each other. At about the 13th week, the mounds begin to regress slowly, their elevations are reduced, and their borders and boundaries become indefinite. At this time, the dermal ridges are being formed and the interplay of mound regression and ridge formation produces the various patterns. The embryogenesis of the dermatoglyphic patterning is the same for the hands and feet, although each step of the process occurs in the foot 2 or 3 weeks after it has taken place in the hand. The formation of the patterns is complete by about the 18th week and remains unchanged from that time on throughout life except for absolute growth. Although the dermal configurations may be said to be stable after the 4th month, disturbances of embryonic growth and development prior to this time may be reflected in abnormal pattern types or frequencies.[3]

CLASSIFICATION OF DERMATOGLYPHICS

Variability of patterns is sufficiently great so that no two individual's not even identical twins have identical ridge patterns. The patterns can be classified into various groups as follows.

Fingertip Patterns

These may be divided into arches, loops and whorls. Important landmarks used to classify fingertip patterns are the type lines, the triradius, and the core. The type lines are the innermost ridges which surround the pattern area. The triradius is located at the point where the type line diverges after running parallel to each other for at least a short distance. A dot, a ridge, or even the meeting of two ridges may constitute a triradius, but a bifurcation of ridge forming a type line is not considered a triradius. The core is the approximate center of the pattern area and is usually located where a rod-like ridge touches the innermost recurving ridge.[4]

In arch pattern, ridges enter from one side and flow to the other side, in some arch configuration a ridge just distally at approximately right angles from another ridge. The overlying ridges tent over this area producing a tented arch pattern. The arch pattern has no triradius.[4]

The three features required to form a loop include a triradius, at least one recurving ridge and a ridge count of at least one across a recurving ridge. If any one of these features is lacking the pattern is classified as tented arch and not a loop. The ridges of a loop enter on one side, recurve and exit on the same side of the finger. If the ridges enter and leave from the ulnar side, an ulnar loop is formed; if from the radial side, a radial loop results.[4]

Whorls are the most complex type of pattern and have at least triradii. A simple whorl consists of spiral or ellipse in the pattern area. Two interlocking loops form the double loop whorl pattern. A central pocket loop whorl may be recognized by the fact that a line connecting the two triradii fails to cut across any part of central pattern. An accidental whorl is formed by two or more different pattern types in the same pattern area. These may be an arch and a loop, a loop, and a whorl, etc. (Figure 1a and b).[4]

Finger Ridge Count

A ridge count is made by counting the ridges crossed by a line from triradius to the core. The count begins on the ridge lying immediately beyond the first white space after the triradius. The ridge forming the core is not counted. For whorl patterns, ridge counts are made from both triradii but only the larger of two counts is used in making the total finger ridge count (TRFC) (Figure 2).[4]

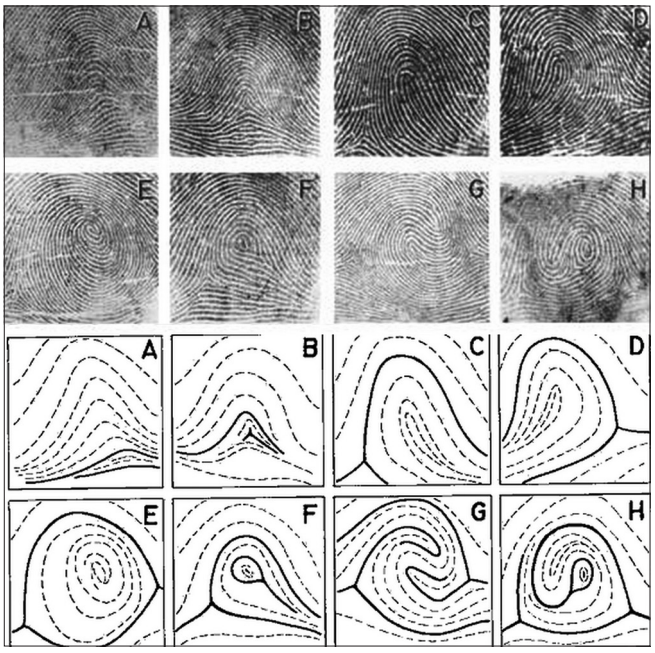

Figure 1: (a and b) A: Simple arch, B: Tented arch, C: Ulnar loop, D: Radial loop, E: Simple whorl, F: Central pocket, G: Double loop whorl, H: Accidental whorl

Palmar Patterns and Landmarks

The palmar area is divided into various zones within which a pattern may or may not be present. These areas include the hypothenar, the thenar, and the interdigital areas. There are four interdigital areas designated I_1, I_2, I_3, I_4 from the radial to the ulnar side. Triradii are found normally beneath each finger and the axial line of the palm. The distal triradii are called a, b, c, d from index to little finger. Hypothenar patterns includes several types, the most common configuration is the arch ulnar pattern also called the open pattern. Other arch configurations include the arch radial and the arch carpal. A whorl may be present in the hypothenar area. An S configuration is also classified as whorl. Loop configuration may be present and open towards the radial, the ulnar or the carpal regions (Figure 3). An angle drawn with apex at t and arm ending at a and d describes an Atd angle. If two or more axial t's are present the most distal t is selected in defining the angle. The number of ridges crossed by a line connecting the a and b triradii constitutes the a-b ridge count (Figure 4).[4]

Palmar Creases

Normally, two deep transverse creases are present on the palm but occasionally only one is found and transitional types also occur. A single palmar flexion crease is called as simian line and a single phalangeal flexion crease may also be present in certain clinical disorders (Figure 5).[4]

FOOT PATTERNS

The various topographical areas and the triradii of the roles are similar to those in the palms. The occurrence of patterns in the calcar area is extremely rare. Loops of various forms may occur in the interdigital areas. In the hallucal area, the most common patterns are whorls or large distal loops (Figure 6).[3]

METHODS OF RECORDING DERMATOGLYPHICS

The methods used for palm and sole printing are inexpensive and rapid.

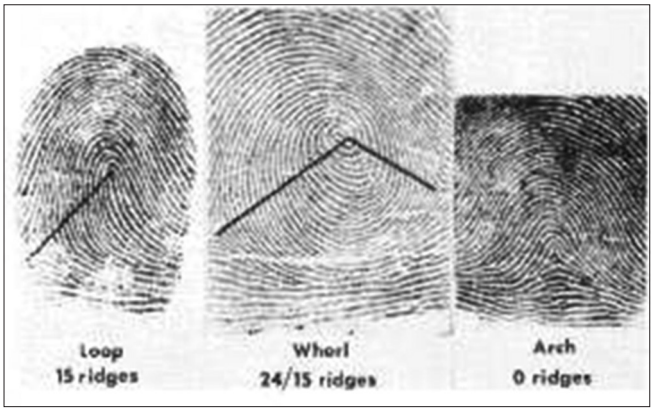

Figure 2: Finger ridge count

Ink Method

One of the most widely used method. The necessary equipment consists of printer's ink, a roller, a glass or metal inking slab, a sponge rubber, and good quality paper preferably with a slightly glazed surface.[2]

Faurot Inkless Method

Commercially available patented solution and specially treated sensitized paper is used in this method.[2]

Transparent Adhesive Tape Method

The print is produced by applying a dry coloring pigment to the skin, and lifting it off with the transparent adhesive tape. The coloring agent may be colored chalk, dust, India ink, standard ink, carbon paper, graphite stick or powdered graphite, common oil pastel crayon, etc. Advantage is prints are clear and not smudged and can be preserved for an indefinite period of time.[2]

Photographic Method

It is based on the principles of total internal reflection which occurs when an object is pressed against a prism. The magnified image is photographed by a Polaroid camera.[2]

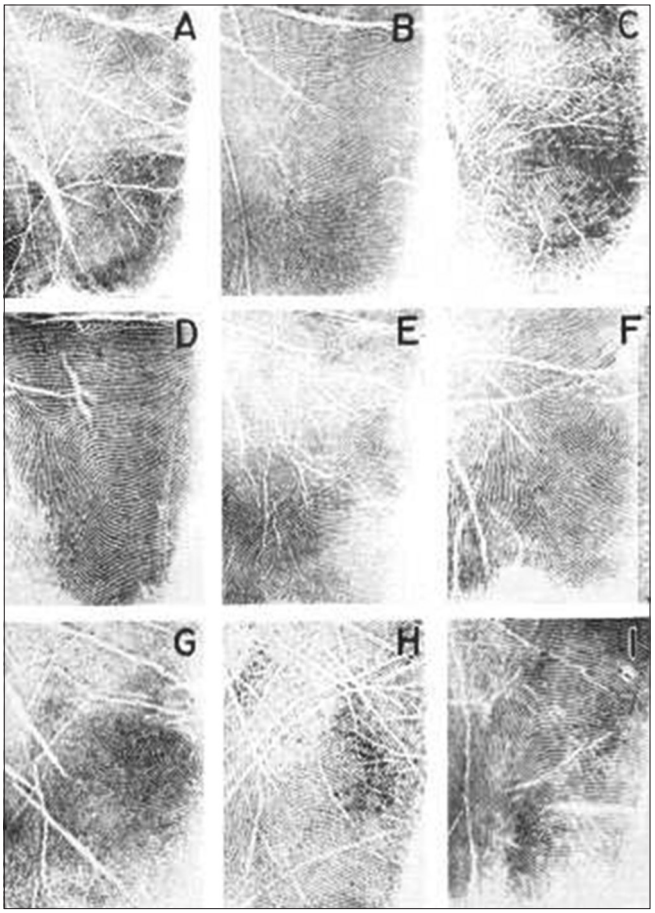

Figure 3: Hypothenar patterns

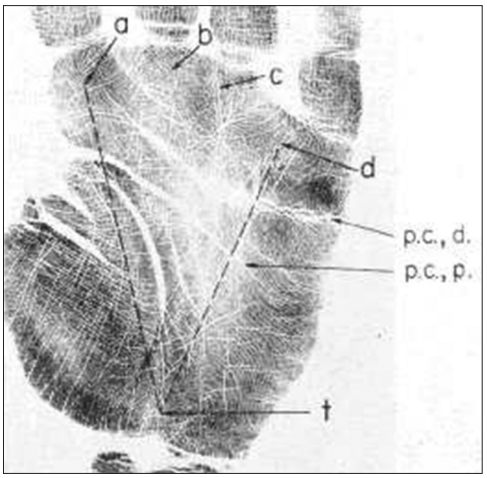

Figure 4: a, b, c, d: Digital triradii, t: Axial triradius

Figure 5: Simian line

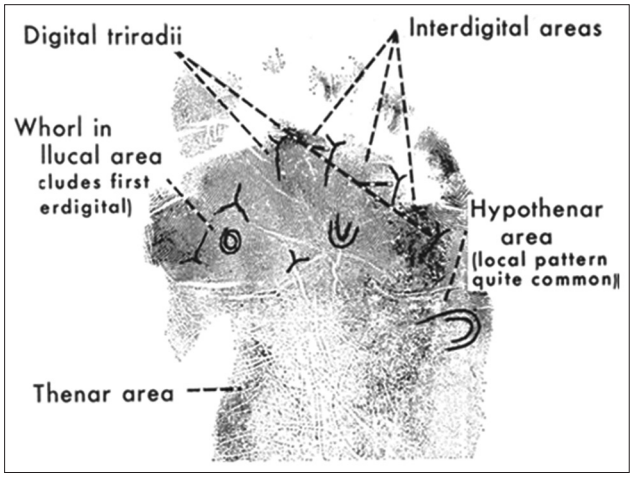

Figure 6: Sole print showing main topographical area

Special Methods

It allows the study of the correlation between the epidermal patterns and the underlying bone structures (radiodermatography), study of sweat pores (hygrophotography), or study of the spatial shape of the ridged skin areas, for example in primates (plastic mold method). In most individuals, other than newborns, the dermal patterning can be observed directly without magnification or with the aid of a simple hand lens and good lighting.[2]

DERMATOGLYPHIC STUDIES IN DENTISTRY

Syndromic Patients

High frequency of simian crease, ulnar loops on fingers and radial loop on digit 4 and 5 are seen in downs syndrome patients, short fifth finger, Atd ≥ 120, Ab ridge count ≥ 105, bilateral hypothenar pattern, and A - line in the thenar crease in Turner's syndrome, slightly increase in height of axial triradius in hypothenar areas, and decrease in thenar pattern in case of Klinefelter's syndrome, Short broad bands, high axial triradius and increased arch patterns in pseudohyperparathyroidism. and Bilateral I_2 and I_3 and four or more arches in the fingertips in Rubinstein-Tyabi syndrome (Preus and Fraser 1972)[5] Scott *et al*. in 2005 conducted a study to investigate dermatoglyphic patterns in non-syndromic. Filipino subjects with non-syndromic cleft lip (CL)with or without cleft palate (CP)and their unaffected relatives. They observed that the frequency of arches and ulnar loops were significantly increased, and whorls decreased in the affected group compared with the unaffected group.[6]

Dental Caries

Frequency of whorls was increased, TRFC was higher, high frequency of arches and radial loops in the nar and interdigital areas was seen and Atd angle was observed to be 45-56°. Ahmed *et al*. (2010),[7] increased TRFCand absolute finger ridge count on fingers, representing pattern size and types were observed. ab count and tr count were significantly lower in male and female caries sample group compared with the control group Sengupta *et al*. (2013).[8]

Sharma and Somani in 2009 conducted a study to determine if there is any significant correlation between salivary bacteria interactions, dermatoglyphics, and dental caries and found there was significant correlation.[9]

Bhat *et al*. in 2011 conducted a study to evaluate dermatoglyphic peculiarities and caries experience of deaf and mute children. They observed that the frequency of whorls was more in caries group and the frequency of the loop was more in caries-free group.[10]

Madan *et al*. in 2011 conducted a study to determine the genetic aspect involved in the occurrence of dental caries through a cost-effective means. They observed that Handprints of caries-free children, especially females,

showed maximum ulnar loops. The caries group showed maximum occurrence of whorls which were more prevalent in females on the left hand 3rd digit than in males where the whorls were found on the right-hand 3rd digit, and also low total ridge count, especially in males.[1]

CL and CP

Matew *et al*. in 2005 conducted a study to determine the dermatoglyphic peculiarities in children with oral clefts and observed that there was increase in triradii count, rare patterns on thenar eminence in hands, significantly high frequency of arches and radial loops and ulnar loops and also increased asymmetry of Atd angles.[11]

Potentially Malignant Disorders and Oral Carcinomas

Polat *et al*. in 2004 conducted a study to evaluate the dermatoglyphic patterns of finger and palm prints of patients with oral tumors. They observed increased frequency of arches, reduced frequency of Atd angle, increased frequency of axial triradii, reduced, increased frequency of the mainline a termination in sector 5.[12]

Veena in 2006 conducted a cross-sectional study on palmar dermatoglyphics among gutkha chewers with and without oral submucous fibrosis and observed that there was increase in frequency of arches, decrease in frequency of simple whorls, decreased Atd angle, and increase in pattern frequency in thenar/I_1 area.[13] Similarly, highly significant decrease in simple whorl pattern on left little finger, increase in composite whorl pattern on left little finger, decrease in composite whorl pattern of right index finger, increase in simple whorl pattern on right thumb, and composite whorl pattern on left thumb, decrease in radial loop on left index finger in oral submucous fibrosis (OSMF) patients compared to patients without OSMF Tamgire *et al*. in 2013.[14]

Venkatesh in 2006 carried out a study to determine whether specific dermatoglyphic patterns exists which can help in predicting the occurrence of oral squamous cell carcinoma and oral leukoplakia and his results showed that arches and loops were more frequent in cases when compared to the controls whereas whorls were more frequent in the control group. Similarly, loops were at higher frequency in the interdigital areas in cases when compared to the control.[15]

Periodontal Diseases

Atasu *et al*. in 2005 conducted a study to evaluate the Ab ridge count in periodontal diseases and when the fingertip patterns of the patients were compared to with those of periodontally healthy individuals there was decreased frequency of twinned and transversal ulnar loops on all fingers, and increased frequency of t' triradii on the palms of patients with juvenile periodontitis, decreased frequency of double loops on all fingers and increased frequency of radial loops on the right second digits and increased frequencies of IV and H loops and tb triradii on the palms of rapidly progressive periodontitis, increased frequency of concentric whorls and transversal ulnar loops on all fingers of patients with adult periodontitis.[16]

Bruxism and Malocclusion

Among bruxism patients dermatoglyphic patterns combined with other clinical features can serve to strengthen a diagnostic impression Polat *et al*. 2012[17] Dermatoglyphics parameters of individuals with malocclusions showed statistically significant increase in twinned loops in Class II malocclusion Reddy *et al*. 2013.[18] whereas Tikare *et al*. in 2010[19] showed not significant association.

CONCLUSION

Dermatoglyphics can prove to be useful and cost-effective tool for preliminary investigations for the conditions with a suspected genetic base and can serve to strengthen the diagnostic impression of the diseases right from an early age. Preventive oral measures can be taken in some of the conditions like dental caries and among the gutkha chewers of osmf where forecasting is possible with dermatoglyphics. This review brings out the importance of dermatoglyphic studies in dentistry. Although dermatoglyphic examination is technique sensitive but once applied can be a reliable parameter for dental science.

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