"Dermatoglyphics"- The Science of Lines and Patterns and Its Implications in Dentistry

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ABSTRACT

Dermatoglyphics is the study of unique lines and patterns on the palms, fingers, soles and toes of an individual. They have been traditionally used for foretelling the future and in criminal investigations. Today, these patterns have found their way in the medical and dental field, and are being utilized as a preliminary diagnostic tool for conditions with a genetic base. These patterns are individually unique, permanent and remain unchanged from cradle to grave. These patterns are formed in early weeks of fetal life, after which they remain unaffected by genetic and environmental forces. Thus, they can help in assessment of intrauterine irregularities and prenatal detection of disorders. This branch is relatively recent, still in its infancy, and requires further research to validate its role in dental field. However, the studies done so far in this field prove that Dermatoglyphics holds great promise and is here to stay. This article aims to highlight the dermatoglyphic features and characteristics in some common clinical dental conditions, along with the method of registering prints, advantages and limitations of Dermatoglyphics.

Keywords: Dermatoglyphics, fingerprint patterns, palmar patterns, dentistry, genetic,diagnosis

INTRODUCTION

Thousands of years ago, Aristotle was so true in recognising the potential of the hand. He described hand as "the organ of all organs". The study of the hands dates back to several centuries. The features of the hands have fascinated people from all walks of life- be it scholars, sages, doctors or laymen. These lines and patterns have been deciphered by traditional palmists to predict the future and in forensics as a definitive tool for identification of criminals. Today the study of the hand has crossed its traditional realms and is being widely used as an adjunct in medical and dental fields to diagnose conditions with a suspected genetic base.

DERMATOGLYPHICS

The scientific study of intricate patterns and fingerprints from palms, fingers, soles and toes is referred to as " Dermatoglyphics". It was coined by Cummins and Midlo in 1926.[1-3] "Derma" means skin and "glyphic" means carvings.[1-3] These ridges are epidermal in origin and develop on the volar surfaces. The primary ridge formation is responsible for the dermatoglyphic pattern. Ridges are the areas which decompose the last after a person dies. These naturally occurring patterns are unique to an individual and remain unchanged from birth until death. The fingerprints are not even similar in monozygotic twins.[4]

The development of dermatoglyphic patterns begins with the appearance of fetal pads in the 6th week of gestation and ends with the appearance of finished patterns on the surface of the skin in the 24th week of gestation. These patterns once developed are unaffected by the environment, and this explains their unique role, as a marker for individual identification and study of specific traits in humans for detection of intrauterine abnormalities and defects in initial weeks of pregnancy.[5] Genetics and environmental forces, have a vital role in the genesis and development of an individual's fingerprints. The dermal ridges develop in the areas corresponding to the volar pads. These begin developing from around 6th week of gestation. This means that the normal or abnormal genome is already formed in this period and can be studied and reflected by Dermatoglyphics.[6,7] The ectoderm gives rise to teeth, and thus any damage during the intrauterine stage to this structure may be manifested as a tooth anomaly. Many studies done in medicine have found an association between fingerprint patterns and various medical conditions. Widespread dental interest arose only in the last few decades when it became apparent that patients with chromosomal aberrations had unusual ridge anatomy.

METHODS OF REGISTERING PRINTS

The study of dermatoglyphics requires good quality fingerprint and palmar prints. Several methods are available:

Transparent adhesive tape method: Dry colouring pigments like chalk, ink or graphite are applied on hands. The tape is used to lift the print. Prints are clear and can be preserved. However, recording entire hand can be cumbersome.

Photographic method: Polaroid camera is used to capture the magnified image that is formed based on the principles of total internal reflection It is expensive.

Numerical method: Algorithm of synthesis of images of fingerprints is used to create all possible arrangements of ridges called minutiae. The digital coding of the fingerprint helps in assessment and cataloguing all intricate patterns. However, needs professional expertise for print analysis.

Faurot inkless method: Commercially available patented solution is used to record prints on sensitised paper. Shortcoming is availability.

Biometrics method: Automatic separate machines for finger and palm scan the hand to record prints. It is expensive.

Inkpad method: The fingers are pressed on the stamp pad turn by turn and recorded on paper. The prints are usually smudged and the ink is difficult to remove, causing embarrassment to the patient.

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The ink and roller method: Reported by Cummins and Midlo, utilises printer's ink, commonly known as duplicating ink. The ink is spread on a sheet with a roller, and fingers and palm are pressed onto the sheet. The ink smeared hands are then transferred on paper. This is an inexpensive and rapid method to register clear, smudge free fingerprints. These prints get dried easily and can be preserved for future use. Also, the ink can be easily removed after the procedure. It is most commonly employed to record fingerprints.

DERMATOGLYPHIC LANDMARKS

The curved lines in a fingerprint constitute the Ridge.
The approximate centre of a pattern is known as a Core.
The meeting point of three ridges that form angles of approximately 120 degrees with one another is known as the Triradial point/ Delta.
The numerous ridges that enclose the pattern constitute the skeletal framework of the pattern and are called Radiants.

1. FINGERTIP PATTERN CONFIGURATIONS

Many classifications have been proposed by several investigators to classify these patterns. The most commonly used classification today was given by Sir Francis Galton(1892), who classified fingertip pattern configurations on the distal phalanges into 3 broad groups[6]:

1) Arch: It is the simplest type of fingerprint that is formed by ridges entering from one side and exiting from the other with a distally bowed sweep. These ridges tend to rise in the centre of the pattern, forming a wave like pattern. Such arches are known as *Plain arches*. However, if the rise of the ridges at the centre is not smooth, but it is sharp like a spike, then it is known as a *Tented arch*. Arch does not have a delta.

2) Loop: In a loop, the ridges curve around only one extremity of the pattern and flow to the margin of the digit. The loop possesses only one delta/ triradial point. If the loop opens towards the ulna bone, it is known as *Ulnar loop* and if it opens towards the radial bone, it is known as *Radial loop*. Thus, the ulnar and radial loops differ in both the hands. For example, on the left hand, a loop that opens to the left would be an ulnar loop, while the one that opens to the right would be a radial loop.

3) Whorl: Ridge configurations with concentric circles encircling the core are designated as whorls. These configurations have two or more deltas, usually on both radial and ulnar sides of the patterns. However, complex configurations under whorl are referred to as "Composites". The simplest whorl has ridges commonly arranged as a succession of concentric rings or ellipses, and is known as a *Plain (Simple) whorl.* Configurations which are not entirely concentric but spiral around a core in either a clockwise or a counterclockwise direction are referred to as a *Double or a spiral whorl.* Whorls can also take the form of spiral, shell, circle, target or eye.
Complex patterns, not qualifying under any of these categories constitute *Accidental whorls*. Combination patterns, like patterns with a loop and whorl or other variable combinations fall under the category of Composites.
A *Central pocket loop/whorl* is a pattern containing a loop and a whorl, where a small whorl is enclosed by a loop. It can be ulnar or radial. However, the significance of separating these two varieties of loop whorls for medical diagnosis remains unproved. Therefore, they are ordinarily grouped together.

2. PALMAR PATTERN CONFIGURATION

The palm has been divided into several anatomically designed areas for dermatoglyphic analysis. These are:

i) Thenar (Th) and first inter-digital area (I_1): These two areas are considered as one due to close proximity anatomically. Patterns, when present, are most often loops.
ii) Second (I_2), third (I_3) and fourth (I_4) inter-digital area: Loops and whorls are mostly encountered.
iii) Hypothenar area (Hy): Most commonly encountered patterns are Whorls, loops and tented arches.

3. RIDGE COUNTING

Ridges are often counted between two digital triradii. a, b, c and d are alphabets ascribed to the triradial point located at the base of the index, middle, ring and little finger respectively. The ridge count most frequently obtained is between triradii a and b, and is referred to as the a-b ridge count.[5] Sometimes, ridge counting is done along a straight line between one tradial point to the core of the pattern. The ridges falling on the core and triradial point are not included in the count. This count is referred to as *Total Ridge Count(TRC).*

4. atd ANGLE

The angle formed by joining the lines from the digital triradius (a) to the axial triradius (t) and from axial triradius(t) again to the digital triradius (d) constitutes the atd angle. The more distal the position of 't', the larger the atd angle. Accessory 'a' or 'd' triradii may also be present occasionally.

5. FLUCTUATING ASYMMETRY(FA)

Fluctuating asymmetry describes random deviations from symmetry in normally bilaterally symmetric structures as reported by Van Valen in1962.[7,8] Dermatoglyphic asymmetry estimation helps to evaluate stability of intrauterine development. Since asymmetry is increased by situations of stress, it can constitute an indirect measure of the level of stability during growth. Increased instabilities during an organism's development can cause reduced buffering capacity to cope with such disturbances. Thus, these perturbations increase the levels of fluctuating asymmetry and thus indirectly help in estimating the degree of disturbance prevailing during the development.[8]
Fluctuating asymmetry is assessed by comparing the type of fingerprint pattern on same digit on the right and left hand. The fingerprint pattern type is checked whether they are identical for the same digit on right hand and left hands. If the pattern is similar on corresponding digits, they are considered as identical. If the patterns are different, they are considered dissimilar. The score is designated depending on the degree of discordance in between the corresponding fingers of left and right hand. Thus, the score has a maximum value of 5 and minimum value of 0.For example, if the pattern on both left and right index fingers is an arch, then they are identical.
Dermatoglyphics offers two major advantages:

1) The epidermal ridge patterns are fully developed at birth and thereafter, remain unchanged for life. They are individually unique.

2) The registration of prints can be accomplished rapidly, is economical, has good patient compliance and does not cause any trauma to the patient.

Limitations of Dermatoglyphics

1. Interpretation of dermatoglyphic traits require good quality prints. Ink should be dispensed in adequate quantities to prevent thick or thin prints.
2. Gross malformations of the limbs affect registration of prints.

Dermatoglyphic traits in some dental conditions:

Caries

Several authors have studied the corelation of dermatoglyphics and dental caries. Increased frequency of whorls has been observed in people with dental caries. Interestingly, increase in ulnar and radial loop pattern show decreased susceptibility to caries{Atasu[9], Madan[10], Abhilash[11],Bazmi[12], Agravat[13], Kocchar[14]}.

Yamunadevi[15] reported presence of whorl with double loop, whorl within a loop with high DMFT scores. Sharma[16] studied the relation between dermatoglyphics, caries and Streptococcus mutans level and found significant difference in dermatoglyphic patterns. Children with dental caries had decreased frequency of loops and a lower salivary pH toward normal. Caries free students had increased loops and there was a high significant difference in caries free and caries prone in terms of frequency of loops. Also increased number of loops was associated with low streptococcus mutans count.

Down Syndrome

Fogle[17], Balgir[6], Rajangam[18] and various investigators have conducted studies and reported increased number of ulnar loops, presence of a Simian crease and wider atd angles.

Periodontal disease

Atasu[19] conducted an elaborate study to determine dermatoglyphic patterns in different forms of periodontitis for the aim of finding a pattern type that would identify those patients. When the finger-tip patterns of the patients were compared with those of periodontally healthy individuals, patients with Juvenile Periodontitis showed decreased twinned and transverse loop patterns. Increased concentric whorls and transverse ulnar loops were seen in Aggressive Periodontitis patients. Patients with Rapidly Progressive Periodontitis showed increased frequency of radial loops and decreased double loops. Kocchar[14] reported decrease in loops and no significant relationship with whorls with increase in periodontal diseases.

Devishree G[20] reported increased frequency of ulnar loops and decreased frequency of whorls on all fingers of patients with Aggressive Periodontitis.

Bruxism

Polat[21] reported an increase in frequency of whorls and a decrease in frequency of ulnar loops in bruxism patients. There was lower frequency of atd angle, and no significant difference between the total finger ridge counts (TRC) and a-b ridge counts.

Cleft Lip/Palate

Various authors have conducted studies on cleft patients and have reported significant dermatoglyphic differences. Cleft patients report of increased radial and ulnar loops than arches or whorls. Also, there is more occurrence of unusual patterns

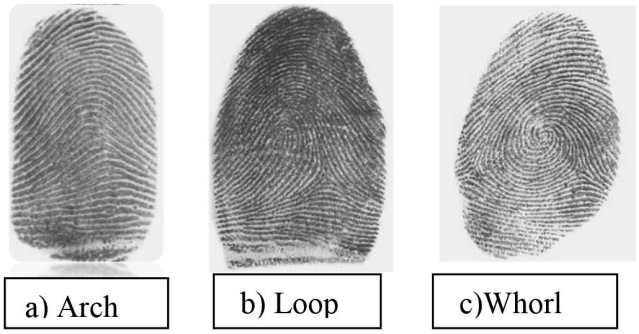

Figure-1: Basic fingerprint patterns

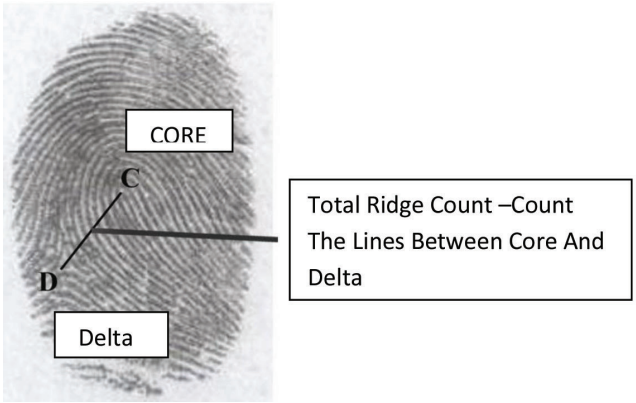

Figure-2: Core, delta and total ridge count determination

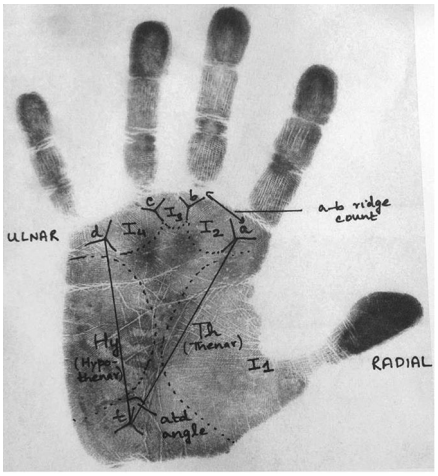

Figure-3: Palmar print with landmarks

like central pocket whorl and double loop. They report with wider atd angles and Simian crease on the palms (Balgir[6], Mathews[3], Jahanbin[22], Eslami[23]). Cleft patients show fluctuating asymmetry when compared to healthy subjects (Weinberg).[8] Interestingly, non affected parents who bear a cleft child also show different dermatoglyphic patterns as compared to parents who bear healthy babies (Eslami).[23] Cleft patients show elevated levels of FA with delayed development of pattern configurations. The parents of cleft children also show same features, but to a less degree when compared with their children. Unaffected parents of cleft patients have shown increased a-b ridge count. Therefore, a-b ridge count has been suggested as a sensitive indicator in people who have no family history but stand an increased chance of having a cleft child.[6] The increased tendency for retarded development in patterns and elevated

levels of FA indirectly indicate that the development in such patients is delayed.[24,25] This is significant because it can help in preliminary prenatal detection of disorders, and therefore appropriate referral and management.

Malocclusion

Jindal[26] found increased frequency of whorls in subjects having Class II malocclusion and increased frequency of plain arches in subjects having Class III malocclusion. TRC and atd angle showed significant differences in different classes of malocclusion. Asymmetry scores did not differ significantly. Ram Mohan Reddy[27] found increased twinned loops in class II malocclusions and absence of radial loops in class III malocclusions which was statistically significant. The parameters associated with palmar prints had no statistical significance. Tikare S[28] found a statistical association between whorl patterns and classes I and II malocclusion.

Reddy S[29] conducted a study to assess the relationship between malocclusion and dermatoglyphics. The dermatoglyphic findings showed increased frequency of arches and ulnar loops in Class II, div.1 and div. 2 patterns. There was decreased frequency of whorls. Class III malocclusion, however, showed increased frequency of arches and radial loops. Ulnar loop frequency was decreased. The predicted values based on the frequency of arches were more sensitive for Class III malocclusion than for ClassII, div.1 and div.2 malocclusion. The authors concluded from their study that dermatoglyphics might be an appropriate marker for malocclusion.

As fingerprints are formed during vital stages of fetal development, dermatoglyphic studies are in unique position to evaluate the effect of environment on early growth. Lesser time and cost requirements make Dermatoglyphics an easy alternative for much preferred but expensive DNA tests. Dermatoglyphic studies are reliable, non-invasive investigations which have good patient compliance. Dermatoglyphics is in a position to become the primary means of assessing complex genetic traits in the future. However, discrepancies in these traits suggest the need for further research in this regard to validate the use of dermatoglyphics as a diagnostic tool.[30]

CONCLUSION

Dermatoglyphics has bright future perspectives. It can be used as a useful adjunct to aid in preliminary medical diagnosis. Dermatoglyphics can help in prenatal detection of disorders which can help in detection of carriers of the disease. In such cases adequate education and counselling along with prenatal diagnosis for first affected fetuses can be offered. Such measures can also help the couple to seek appropriate medical care and services for affected children. It will help the parents to be better equipped with management of such children. Also, the early detection of inborn errors is crucial because it can used as a vital tool to counsel the couple about avoiding conception of further affected fetuses. They can also be used to study genetic etiology and as an educational tool for genetic counseling.

It's not the end but an opening to a new arena, where in near future detecting these diseases at an early stage will be possible using dermatoglyphics as a diagnostic tool.

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