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RESEARCH ARTICLE

DERMATOGLYPHICS – A GENETIC DECODER FOR DENTAL DISORDERS

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ABSTRACT

Dermatoglyphics is the scientific study of fingerprint pattern and are the dermal ridge configurations present on fingers, palms, toes and soles in humans and animals. On closer inspection of these ridges, they have a promising, simple, inexpensive means of information to determine whether a given patient could have a particular chromosomal defect. Finger prints analysis for identifying a person's individuality is well known. Dermatoglyphics is emerging as an inexpensive, non invasive tool in identifying the genetic disorders affecting the oral and para oral structure. It is observed that different diseases have different finger print pattern. Any deviation from the normal dermatoglyphic patterns indicates a genetic difference in suspected individuals. This review focuses on the different fingerprint patterns in various dental disorders and the various studies involving the dermatoglyphics in dentistry.

INTRODUCTION

Dermatoglyphics is that specialization of science, that pertains with the study of ridge patterns on the finger tips, palms, soles and toes (Blanka Schumann and Milton Alter, 1976). They are also found on palms, soles of feet and lips (Bhattacharjee, 1965 and Biswas, 1936). The skin on the palmar and plantar surfaces of human are not smooth. They tend to be grooved by curious ridges, forming myriad configurations. Fingerprints are extremely complex. Fingerprints are a reproduction of friction skin ridges found on the palm of the fingers and thumbs (Bansal, 1966). These ridge configuration have attracted the attention of laymen for millennia (Blanka Schumann and Milton Alter, 1976). Only in the last century, the fact that each individual's ridge confirmations are unique have been utilized as a means of personal identification particularly by law enforcement officials. Widespread medical interest in epidermal ridges developed only in the last few decades when it became apparent that many patients with chromosomal aberrations exhibited unusual ridge patterns. On closer inspection of these ridges, they had a promising, simple, inexpensive means of information to determine whether a given patient could have a particular chromosomal defect (Blanka Schumann and Milton Alter, 1976).

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Pattern configuration

It can be divided into palmar and finger print patterns

Palm is divided into various anatomical areas namely, thenar area, four interdigital areas and hypothenar area (Figure 1 and 2).

Types of finger print patterns

Two types of fingerprint characteristics are used in identification of individuals namely

1. Global features, are those characteristics which are visible to the naked eye.
2. Local features represents tiny characteristic of fingerprint ridges (Bhattacharjee, 1965 and Biswas, 1936).

Ridges are arranged in two dimensional, making them distinctive and are used for identification. Two or more individuals may have the possibility of having the similar global features. But still individuals have different and distinctive fingerprints because of the local features, that is, the uniqueness of two dimensional arrangement. Global features include (Chattopadhyay, 1966 and Das and Das, 1996) Pattern area, core area, type lines, delta ridge count, ridge pattern (Figure 2).

Pattern Area: Fingerprints are read and classified based on the information in the pattern area. Certain minutiae points that are used for final recognition might be outside the pattern area.

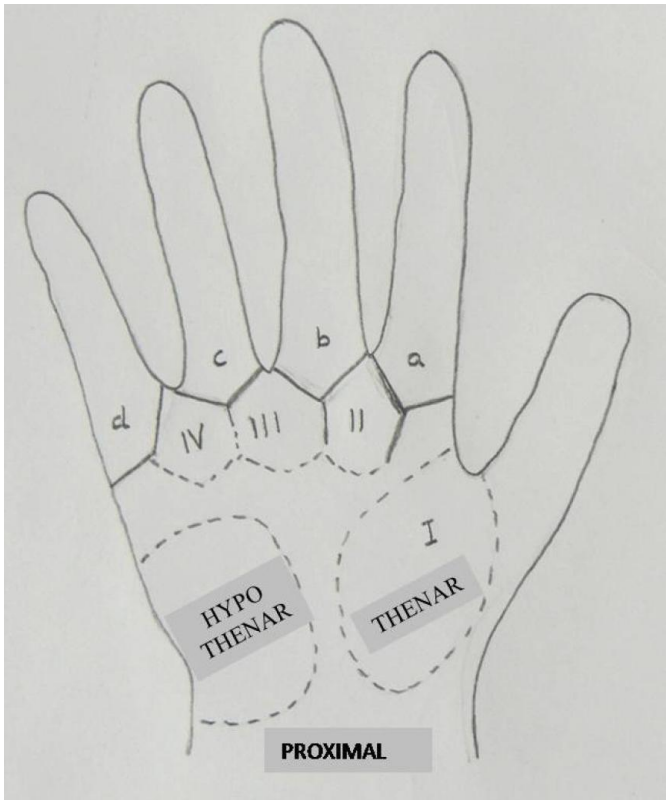

Figure 1. Palmar Landmarks for Dermatoglyphics or the Five Dermataoglyphic Area of the Palm

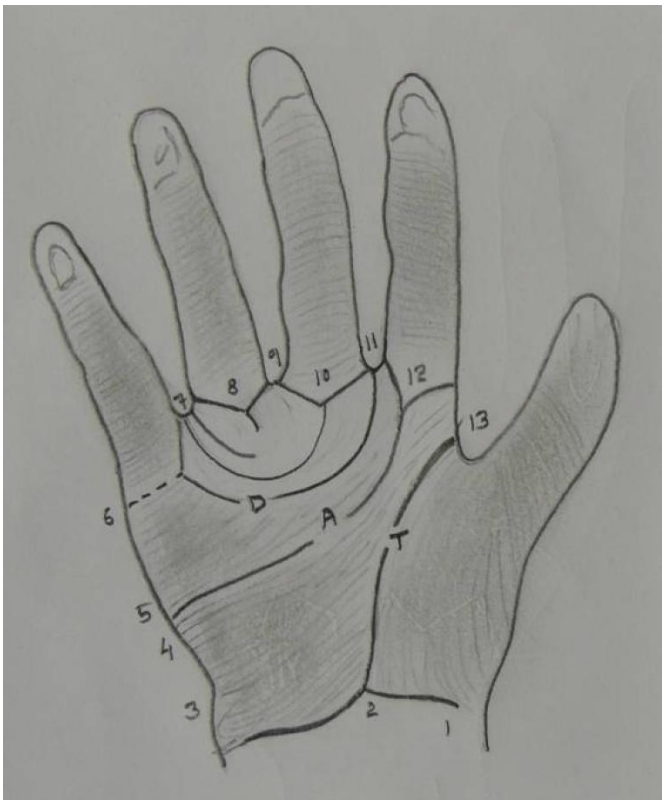

Figure 2. The Main Lines of the Palm and Scheme of Numbers for Formulating Palmar Main Lines

Core Point: is located at the approximate centre of the finger impression and is used as a starting reference point for reading and classifying the print.

Type Lines: are those two innermost ridges that originate parallel, diverge and surround or tend to surround the pattern area.

Delta: In all types of ridge patterns, an area occurs where two lines run side by side and diverge significantly. Recurving line passes in front of a structure which is triangular in shape and referred as delta or triradius.

Ridge Count: Refers to the number of ridges between the delta and the core. In order to establish the ridge count, an imaginary line is drawn from the delta to the core; after that each ridge that touches this line is counted (Book, 1957).

Ridge Patterns: Fingerprints have general ridge patterns for classification which are divided into three classes namely: Loops, Whorl and Arch.

Loops: loops constitute the most common type of fingerprint pattern. One or more ridges entering from one side of the print, recurring and exiting from the same side is a loop.

The loop that opens towards the little finger is termed as ulnar loop. The loop that opens from thumb is termed as the radial loop. All loops have one delta.

Whorl: They are of four distinct types namely:

1. The Plain Whorl,
2. The Central Pocket Loop,
3. The Double Loop, and
4. The Accidental.

All whorl patterns consists of type lines and a minimum of two deltas. Simple and central pocket whorls have at least one ridge that completes the circuit. Ridge may be spiral, oval or any variant of a circle (Malhotra, 1987 and Nakul Chandra Sarkar, 2004).

Arches: Arches may present basically as two patterns namely: simple and tented (Figure 3). They do not have type line, deltas or cores. Of the two types, by its name the simple arch is the simplest of all fingerprint patterns. It is constituted by ridges entering from one side of the print and exiting on the opposite side. These ridges tend to rise at the center of the pattern, thus forming a wave like structure. The tented arch is similar, but instead of rising smoothly at the centre, they rise as a sharp up thrust/spike, or the ridges meet at an angle less than 90 degree ($<90^0$).

Minutiae (Loesch, 1973): On careful examination of the palms epidermal ridges seem to be parallel lines. These parallel lines reveal different types of patterns which can be collectively known as minutiae. These are highly polymorphic and their number, type, patterns being unique to the particular person, hence it is reliable marker for personal identification. Variations of the aforesaid are seen among different races, countries and even different regions within a country .Within India the range of minutiae is from 6-12, while in other countries it is from 6-17.

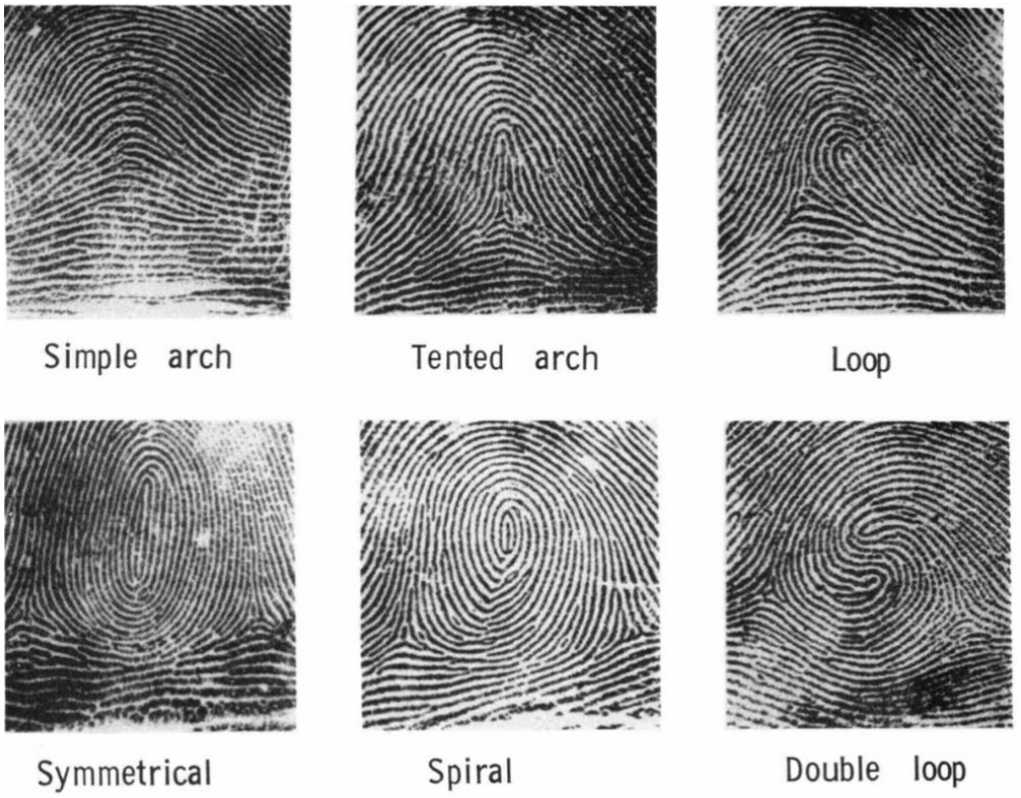

Figure 3. Finger Print Patterns for Dermatoglyphics

Classification of the Minutiae (Figure 4): As there is no universally accepted classification of minutiae, many classification have been made by various scientist like Steffens (1965), Loesch (1973), Penrose (1968), Cummins and Midlo (1961). Some of the minutiae are:

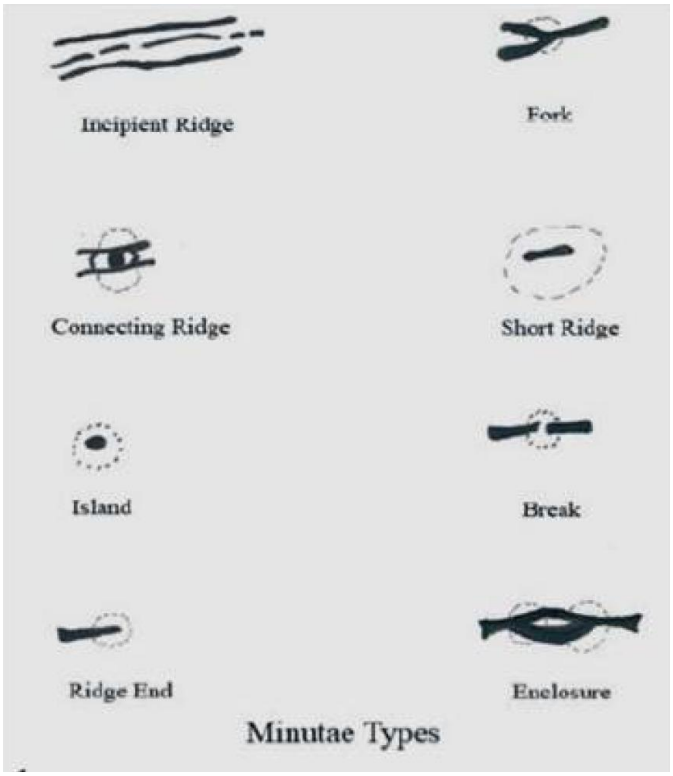

Figure 4. Minutiae Types

Interstitial lines: They rarely contain sweat pore, and referred as subsidiary ridges because of their position at a lower level than the ridges. Alternatively called an incipient vestigial rudimentary, secondary or nascent ridges.

Break: A joint or gap about one ridge unit in length between two ridges ends first starts.

Short ridge: A small ridge of two to five sebaceous gland pores.

Connecting ridge: A short ridge presenting itself perpendicular to one another. They may or may not contain sweat gland

Fork/'y' shaped ridge: formed by the Bifurcation of the ridges.

Island/point: It is small ridge approximately a dot size having a circular outline, and has only a sweat gland.

End: An abrupt termination of ridges.

Comb: A formation of five or more parallel ridges joined to another ridge almost at a right angle to direction.

Enclosure: Continuous ridge that encircles a furrow. Composed of two minutiae namely –fork facing each other.

atd angle (Verbov, 1970)

The classification of the patterns formed by the digital triradii is not classified exactly in the same way as the fingertip

patterns, although loops and less common whorls can be recognized. Another triradius is usually found at the base of the palm (near the base of the fourth metacarpal) and is termed as the axial triradius (t) (Figure 5); the position of this triradius is determined genetically. At times, two or even three axial triradii may be present. When an axial triradius occurs near the centre of the palm it is called t" (Figure 5), while one situated in an intermediate position between t and t" is referred to as t'. The atd angle formed by the axial triradius and the triradii at the bases of the index (a) and little fingers (d), is of utmost importance; frequently it has a value of around 45°. The maximal atd angle is a useful measurement for quantifying the position of the most distal axial triradius.

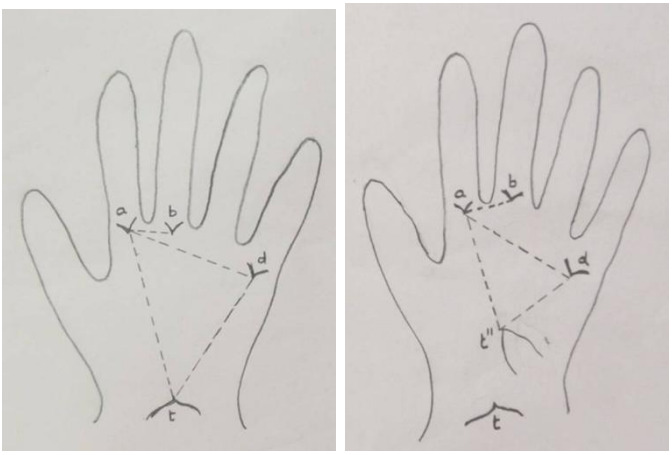

Figure 5. atd Angle

Dermatoglyphics in medical disorders

Abnormalities in the growth process which are liable to distort the alignment of dermal ridges may result from the abnormal expression of the genes, chromosomal aberrations, or even from drug poisoning or viral infection. In some cases the cause remains unknown (Holt and Penrose, 1968). (Ziegler *et al*., 1993) investigated dermatoglyphics in Type 1 diabetes mellitus. Quantitative characteristics of fingers and palms (ridge count and main line indices) as well as qualitative parameters such as digital and interdigital patterns, the position of the palmar axial triradii and main line courses were analysed. A lower third finger ridge count and a-b ridge count and higher transversality of the main lines as indicated by the main line index value or the ending of the main line A in a specific sector 5, 5', and 5" was observed in Type 1 diabetic patients compared with controls. In addition, increased frequency of palmar axial t' and t" triradii and a decreased frequency of 'true' patterns in the fourth interdigital and thenar area was noted in diabetic patients in comparison to control group. A significant increase in true palmar pattern on all palmar areas except interdigital areas in males and thenar areas in females was observed in autoimmune disease. The distal displacement of axial triradii was increased in both the sexes. The total finger ridge counts increased significantly in both the sexes (Singh *et al.,* 1987). Whorls are highly significant statistically in both generations of Bronchial Asthma patients as compared to control (Gupta and Prakash S. Dermatoglyphics, 2003). Characteristic dermatoglyphic changes rank high in frequency among the variable stigmata which go to make up the syndrome of mongolism. Although they are not diagnostic alone, it is however believed that these objectives are measurable and unchanging evidences of mongolism seen in hand prints should be useful in establishing diagnosis at an early stage (Cummins *et al.,* 1950). Higher frequency of low endings of line A on both hands, and–on the left hand–significantly more patterns in the fourth interdigital area and fewer patterns in the third interdigital area (Cummins *et al*., 1950). There was no significant association between the dermatoglyphic features and the HLA antigens (B8 and DRw3) which occurred most frequently in SLE patients (Vormittag *et al.,* 1981). Increased frequency of whorls and a decreased frequency of ulnar loops in the dermatoglyphic pattern in celiac disease (Tahan *et al.,* 1997). One study showed that the arch type fingerprint is significantly increased approximately by 2 times in patients with Myocardial infarction (MI) in comparison to control group (7.2% vs 3.7%). A significant difference in increasing the rate of arch type fingerprint on left thumb finger, left ring finger, and left fore finger. In addition, the arch type fingerprint was significantly increased among non-Q-wave type of MI and on the location of MI at Ant-septal and Ext-Ant in contrast to control group. Thus dermatoglyphic analysis of these subjects can help in early detection of patients with susceptibility to myocardial infarction in those individuals with absence of major risk factors such as hypertension, increasing of cholesterol level, overweight, diabetes mellitus, and smoking (Jalali and Hajian-Tilaki, 2002).

Dermatoglyphics in dentistry

In dentistry, dermatoglyphics has been studied in cleft lip and palate, hereditary gingival fibromatosis, periodontal diseases, dental caries, dental malocclusions and potentially malignant disorders (oral sub mucous fibrosis, leukoplakia, oral cancer), malignant disorders and aphthous ulcer of the oral cavity (Mathew *et al*., 2005; Reddy *et al*., 1997; Škrinjarić and Bačić, 1989; Atasu, 2005 and Sharma and Somani, 2009). Genetic or chromosomal abnormalities might be reflected as alterations in dermal ridges, they can be readily used as an accessible tool in the study of genetically influenced diseases (Tikare*et al*., 2010).

Cleft lip and Palate CL(P)

Saxena *et al*. (2012), concluded that Increased frequency of loops and arches and low mean total ridge count was observed in cleft subjects. Increased frequency of loops and arches with decreased frequency of whorls, mean total ridge count and atd angle of right hand was found in parents of cleft group as compared with the parents of the controls. Increased radial and ulnar loops were observed in Cleft lip and palate patients and increased wider atd angle (more than 30^0) in cleft patients was observed by Balgir *et al*. (2006).

Hereditary Gingival Fibromatosis

IIiJaŠkrinjarić, MiljenkoBačić (1989) conducted a study which showed the presence of patterns in IV interdigital areas in all patients. The fathers of 2 probands had double loops in the IV interdigital area. The frequency (0.6%) of occurrence of these are rare in general population. The position of the axial

triradius was moderately distal (t′) in 1, and markedly distal (t″) in another, and in 4 it was borderline (tb). An increase in Total finger ridge count was observed, suggesting increased size of the volar embryonal pads.

Periodontal diseases

Atasu *et al*. (2005) compared the finger-tip patterns of the periodontitis patients with periodontally healthy individuals, there was a decrease in frequencies of twinned and transversal ulnar loops on all fingers of the patients with Juvenile Periodontitis(JP), a decreased frequency of double loops on all fingers and an increased frequency of radial loops on the right second digits of the patients with Rapidly progressive periodontitis(RPP), and the increased frequencies of concentric whorls and transversal ulnar loops on all fingers of the patients with Adult Periodontitis, an increased frequency of t″ triradii on the palms of the patients with JP, the increased frequencies of IV and H loops and tbtriradii on the palms of the patients with RPP and an increased frequency of e triradii on the soles of the patients with JP were found.

Dental caries

A significant difference in loops between the subject (Caries) and control groups was observed by Sharma and Somani (2009) and also noticed significant difference between subject and control groups for microbial growth.

Occlusion and malocclusion

Mridula *et al*. (2001) concluded that, In normal occlusion, as the total finger ridge count increases, the space discrepancy decreases in the maxilla and as angle tab increases, the cumulative mesiodistal crown width decreases in both the maxilla and mandible. In class I malocclusion, as the total finger ridge count increases, the intermolar width decreases in the mandible and as the a-b ridge count increases in the right hand, the palatal vault also increases in height. As angle atd increases in the right hand, the arch length decreases in the maxilla and as angle atd increases in the left hand, the arch length decreases in the mandible. In class II div.1 maloclusion, as the total finger ridge count increases the cumulative mesiodistal crown width increases and the arch length and arch perimeter decreases in the mandible. As the a-b ridge count increases in the left hand, as angle tab increases, the intermolar width decreases in the mandible and as angle atd increases, the intercanine width also increases in the mandible. In class III malocclusion, as the a-b ridge count increases in the right hand, the height of palatal vault also increases in the right hand, the height of palatal vault also increases and the intermolar width decreases in the mandible. As the a-b ridge count increases in the left hand, the intercanine width and arch length also increase in the mandible. In the right hand, as angle atd increases, the intercanine width also increases in the maxilla and as angle tab increases, the intercanine and intermolar widths also decrease in the maxilla.

Oral Submucous Fibrosis (OSMF)

Veena, 2006 Significant findings in qualitative analyses of OSMF patients included increase in frequency of arches, decrease in frequency of simple whorls, increase in pattern frequency in thenar/II area in both hands. Quantitative analysis of OSMF patients showed a Significant findings which included decrease in atd angle in both right and left hands.

Cancer

One of the study has significantly found fewer ($P<0.05$) radial loop patterns on the first, second, third and fourth digits of the left hand, and the second digit of the right hand in squammous cell carcinoma of the head and neck cases (Atasu, 2005). Another study reported increased radial loops on the right hand of males and in females, an increased atd angle and a higher frequency of hypothenar patterns of the left palms in acutemyelogenous leukemia (Rosner, 1969). (Menser and Pervis-Smith, 1969) have reported an increase of arches and a decrease of ulnar loops in the fingertips of a group of patients with an acute blast cell leukemia.

Aphthous ulcers

Khasbage, (2012) found out an increase in percentage of loops in recurrent aphthous stomatitis. On comparing the two groups, Increased frequency of arches was observed in study group while composite whorl and the ulnar pattern were more frequent in control group. In addition to this, study group patients demonstrated higher frequency of total finger ridge Count. This study concluded that, there is a significant correlation between palmar dermatoglyphics and recurrent aphthous stomatitis, suggesting that genetics is one of the host risk factor associated with the latter, and could aid in early detection of the disease.

Conclusion

Dermatoglyphics deals with the study of the epidermal ridges and their configurations on the fingers, palms and soles. Epidermal ridge patterns form early in fetal development and remain unchanged throughout life and play a significant role in the diagnosis of many disorders with genetic background. It is observed that different diseases have different finger print pattern. Any deviation from the normal dermatoglyphic patterns indicates a genetic difference in suspected individuals. It could be concluded that the fingerprint pattern can be considered as a noninvasive diagnostic tool for prediction, early diagnosis and management of dental disorders.

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