Review Article

Applications of Dermatoglyphics in Dentistry: A Narrative Review

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ABSTRACT

The word 'dermatoglyphics' comes from two Greek words (derma, skin and glyphe, carve) and refers to the study of the epidermal skin ridge formations which appear on the fingers, palms of the hands and soles of the feet. There are numerous applications of dermatoglyphics in dentistry as lot of studies done on dental caries and dermatoglyphics show that there is a strong correlation of dermatoglyphic patterns to the prevalence of dental caries. Dermatoglyphics should be adopted by more dental professionals and researchers for oral cavity related studies, leading to new discoveries for an early diagnosis, prompt treatment and more effective prevention of many genetic disorders of the oral cavity and other diseases whose etiology may be influenced directly or indirectly by genetic inheritance. In the future, it may serve as an important tool that can predict the future health of a person.

Key words: Dentistry, Dermatoglyphics, Dental Caries, Oral diseases

For centuries, the features of hands have fascinated scholars, sages, theologians, doctors, laymen alike. The modern study of the hand is far removed from the popular image of the soothsaying hand reader uttering mysterious incantations in an arcane language. Rather, through decades of scientific research, the hand has come to be recognized as a powerful tool in the diagnosis of psychological, medical and genetic conditions [1].

The study of fingerprints and skin patterns, referred to as Dermatoglyphics, is one of the oldest sciences. However, the science of identification from fingerprints is even now a subject of mystery to the general public. The term Dermatoglyphics, as defined by Cummins and Midlo in 1925, refers to the study of the intricate dermal ridge configurations on the skin covering the palmar and plantar surfaces of the hands and feet [2].

Finger and palm prints are formed during the 6th-7th week of the embryonic period and are completed after 10 – 11 weeks of gestation [3]. Genetic process of dermatoglyphic traits is complex and is not perfectly known [4]. Their variable characteristics are not duplicated in other people, even in monozygotic twins, or even in the same person, from location to location [5]. Abnormalities in these areas are influenced by a combination of hereditary and environmental factors, but only when the combined factors exceed a certain level, can these abnormalities begin to appear [6].

Widespread medical interest in epidermal ridges developed only in the last few decades, when it became apparent that many patients with chromosomal aberrations had unusual ridge formations [7]. Thus, the study of dermatoglyphics is considered as a window of congenital abnormalities, and is a sensitive indicator of intrauterine anomalies as abnormal dermatoglyphic patterns have been observed in several non-chromosomal genetic disorders and other diseases whose etiology may be influenced directly or indirectly by genetic inheritance [8]. Early detection can aid the clinician to anticipate the health problems in children, and initiate preventive and protective health care measures at a very young age [9].

Over the past 150 years, dermatoglyphics has developed into 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 [10,11].

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HISTORY OF DERMATOGLYPHICS

Thousands of years before the birth of Christ, fingerprints were used on pottery to indicate the maker and brand of pottery [12]. 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 [13,14]. In China, the thumbprint of the Emperor was the ruler's mark on letters of state. This practice was in use from around 236 B.C. to 156 B.C.

Scientific interest was however not aroused until the later years of the 17th century. An English doctor, Nehemiah Grew, was the first person to describe the pores, ridges and arrangements on the palms and fingers [12]. The following year, a book on human anatomy by Bidloo was published in Amsterdam. This included a short account of the epidermal ridges on the thumb, in Latin. A year later, in 1686, Marcello Malphigi, an Italian physiologist, mentioned briefly, ridges on palms and fingers in *De Externo Tactus Organo*. During the 18th century, various accounts of epidermal ridges appeared in anatomical publications [15].

In 1822, Joannes Evangelista Purkinje, Professor of Anatomy and Physiology at Breslane University, drew attention in a Latin thesis to the diversity of fingerprint patterns [16]. William Herschel, in 1858, was the first to experiment with fingerprints in India [17]. Sir Francis Galton (1892) conducted extensive research on the significance of skin ridge patterns and demonstrated the hereditary significance of fingerprints and the biological variations of different fingerprint patterns amongst different racial groups. He published the book "Fingerprints" and in doing so, significantly advanced the science of fingerprint identification [15].

EMBRYOGENESIS OF DERMATOGLYPHICS

A proper understanding of dermatoglyphics in man can only be obtained "with knowledge of their phylogenetic and ontogenetic history". Unfortunately, there is a paucity of knowledge concerning the developmental mechanism that determines the ultimate epidermal ridge patterns but a relationship to the foetal volar pads clearly exists because ridge patterns form at the sites of these pads [18]. Foetal volar pads are mound-shaped elevations of mesenchymal tissue situated distal to the proximal end of the metacarpal bone of each finger, in each interdigital area, in the thenar and hypothenar areas of the palms and soles, and in the calcar area of the sole [18,19]. The stages in the embryogenesis of the ridge patterns are [20]:

1. Early limb development (4th - 6th week)
2. Pad reappearance (6½ - 8th week)
3. Pad regression (10th – 12th week)
4. Ridge formation (13th week)
5. Definite pattern (19th week)

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 [16].

The formation of the foetal volar pads is first visible on the fingertips during the 6th to 7th week of embryonic development. It has been established that the critical period of ridge formation begins i.e., about 3 months of age, when the volar pads are near or just beyond their peak development. The outer surface of the epidermis remains smooth whereas an undulation can be observed in the basal layer of the epidermis. This shallow epidermal proliferation is seen in the fourth month as distinct, clearly defined folds of the lower layer of the stratum germinativum growing downwards into the corium. The corium, in turn, forms papillae projecting upward into the epidermis. As growth continues, glandular folds divide at their tips and thus increase in number [18].

The epidermal ridge patterns are completed only after the sixth prenatal month, when the glandular folds are fully formed and after the sweat gland secretion and keratinization have begun. At this time, the configurations on the skin surface begin to reflect the underlying patterns [19].

It is believed that the presence of the volar pads as well as their size and position are, to a large extent, responsible for the configuration of papillary ridge patterns, as postulated by Bonnevie (1923), who 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". For example, small pads would result in a simple pattern (arch) whereas more prominent pads would tend to lead to the development of large and more complex systems of ridge configuration (loops and whorls) [20]. Bonnevie (1929) also speculated that fingerprint patterns were dependent upon the underlying arrangement of peripheral nerves [16].

Several hypotheses have been formulated concerning the forces that are responsible for the development of specific ridge patterns. Cummins (1935) speculated that the dermal ridge configurations were the result of physical and

topographic growth forces. It is believed that the tensions and pressures in the skin during early embryogenesis determine the directions of the epidermal ridges [15]. 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 [21].

DERMATOGLYPHIC LANDMARKS

The three basic Dermatoglyphic landmarks found on the fingertip patterns are Triradii, Cores and Radiant [22,23].

1. 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 1˚ 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.

2. 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.

3. Radiant: These are the ridges that emanate from the triradius and enclose the pattern area. These ridges constitute the 'skeletal' framework of the pattern area.

METHODS OF RECORDING DERMATOGLYPHICS

A number of methods for recording dermatoglyphics exist. Methods vary in their requirements for equipment, time and experience and in the quality of the prints obtained, although both quantitative and qualitative analyses can be acquired from most of the methods. Scanning by the eyes alone often gives sufficient data but prints are necessary for quantitative analyses [24]. The methods are:

1. **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 glazed surface [25].
2. **Faurot inkless method -** Commercially available patented solution and specially treated sensitized paper is used in this method [25].
3. **Transparent adhesive tape method –** In this 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 [1].
4. **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 [26].

DISCUSSION

The study of fingerprints and skin patterns, referred to as Dermatoglyphics, is one of the oldest sciences. However, the science of identification from fingerprints is even now a subject of mystery to the general public [2]. Widespread medical interest in epidermal ridges developed only in the last few decades, when it became apparent that many patients with chromosomal aberrations had unusual ridge formations [7]. Thus, the study of dermatoglyphics is considered as window of congenital abnormalities, and is a sensitive indicator of intrauterine anomalies as abnormal dermatoglyphic patterns have been observed in several non-chromosomal genetic disorders and other diseases whose etiology may be influenced directly or indirectly by genetic inheritance [8]. Early detection can aid the clinician to anticipate the health problems in children, and initiate preventive and protective health care measures at a very young age [9].

Recently, the recognition of irregular prints among patients with dental caries, periodontitis and certain other types of congenital anomalies like cleft lip and palate has drawn attention to the field of dental dermatoglyphics [11].

Atasu M. [27] conducted one of the first studies to correlate dental caries and dermatoglyphics, and found an increased frequency of whorls on the fingers of those with dental caries, and increased frequency of ulnar loops on the fingers of caries free persons. Bhat et al, Abhilash et al, and Agravat et al. [28-30] corroborated these findings in later studies. Additionally, Madan et al. [31], Anitha C et al. [32] and Thakkar et al. [33] discovered that a low total ridge count was significantly associated with dental caries. Anitha C et al. [32] added that a low mean atd angle was frequently observed in children suffering from early childhood caries.

Bazmi et al. [14], however, reported an increased total finger ridge count and absolute finger ridge count on fingers, decreased ab ridge count and decreased triradii in caries afflicted individuals.

The findings of these studies establish a definite variation in the dermatoglyphics of caries affected and caries free group. Increased frequency of whorls, decreased frequency of loops and a low total ridge count can be used as markers for the screening of dental caries. Yilmaz S et al. [34] found a correlation between dermatoglyphics and periodontitis (early onset and adult periodontitis). Atasu et al. [27] elaborated on this and found Juvenile Periodontitis to be associated with decreased frequency of twinned and transversal ulnar loops and increased frequency of t" triradii. They reported a decreased frequency of double loops, increased frequency of radial loops, IV and H loops and tb triradii in patients with rapidly progressive periodontitis. There was an increased frequency of concentric whorls and transverse ulnar loops in patients with periodontitis. Kocchar et al. [35] observed a decreased frequency of loops in periodontitis.

It is clear that there exists a relationship between dermatoglyphics and periodontitis. But, further studies are required to substantiate these findings and strengthen the evidence. Venkatesh E et al. [36] investigated the relationship of dermatoglyphics with oral squamous cell carcinoma (OSCC) and leukoplakia and noticed an increased frequency of arches and loops in cases and increased frequency of whorls in unafflicted persons. Gupta A et al. [37] confirmed these findings and also added that there was decreased frequency of palmar accessory triradii in OSCC. Contrary to these studies, Ganvir et al. [38] observed an increased frequency of whorls in individuals with OSCC and oral submucous fibrosis (OSMF).

Gupta A et al. [37] reported an increased frequency of arches and ulnar loops and decreased frequency of simple whorls and palmar accessory triradii along with low mean atd angle in OSMF patients. Tamgire et al. [39] published similar findings adding that there was a decrease in total finger ridge count and increased pattern frequency in thenar areas in the OSMF patients. However, Kumar S et al. [40] found a decreased frequency of tented arches, ulnar and radial loops and an increased frequency of simple whorls in OSMF subjects.

Dermatoglyphic patterns may have a role in identifying susceptible or afflicted individuals when it comes to OSCC and premalignant conditions, but well-designed studies are necessary before considering these evidences as conclusive. Current literature describes an increased frequency of arches and ulnar loops in such individuals.

Reddy S et al. [41] revealed that Class II malocclusion was associated with increased frequency of arches and ulnar loops and decreased frequency of whorls and that in Class III malocclusion there was an increased frequency of arches and radial loops with decreased frequency of ulnar loops. These results were comparable to those obtained by Rajput S et al. [42] and Jindal G et al. [43]. In contrast to these results, Tikare S et al. [44] and Reddy BRM et al. [45] did not observe any statistical association between fingerprint patterns and malocclusion.

Fingertip whorls and patterns can be considered as a marker for development of malocclusion, while keeping in mind that future studies of ridge pattern are essential to elucidate a significant association between fingerprint patterns and malocclusion. Dermatoglyphics cannot be relied upon as the only factor. This is due to the fact that numerous other factors such as ethnic and racial variations, congenital, environmental and other local factors can also influence the development of malocclusion. The usage of dermatoglyphics in dentistry will benefit dentists as they can be analysers, enabling them to determine clefts, caries and submucous fibrosis by observing the various patterns of the patient's palms, and corroborating these with the oral findings.

CONCLUSION

Dermatoglyphics deals with the study of fine patterned dermal ridges on volar surfaces of soles, palms and ridges. In dentistry, Dermatoglyphics has drawn attention and has been used to unveil oral diseases like dental caries, oral cancer, bruxism, and malocclusion, anomalies of teeth, cleft lip, cleft palate, periodontal disease, dental fluorosis and also in unveiling truth with forensic odontology.

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