

DERMATOGLYPHICS AND ORTHODONTICS- A REVIEW

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ABSTRACT: Dermatoglyphics is the study of dermal ridge configurations of fingers. The oral structures and the dermal structures embryonically develop at the same time. Both are influenced by environment and are not exclusively governed by the genetic factors. This is a review of how dermatoglyphics can be related to the malocclusion and other developmental disturbances of the oro facial structures.

KEYWORDS: Dermatoglyphics, malocclusion, environmental

INTRODUCTION

The study of fingerprints and skin patterns referred to as "Dermatoglyphics" is probably the oldest of all Sciences, since its importance featured significantly millions of years ago. 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 (1929)¹ refers to the study of the intricate dermal Ridge configuration on the skin covering, the palmar and plantar surfaces of the hands and feet. Dermal configurations appear at the 12th week of intra-uterine life and are established by the 24th week. Thereafter, they remain constant except for the change in size.

Dermatoglyphics as a science has multiple applications in various fields such as criminology, anthropology, cytogenetic studies etc^{1,2}. Its main advantages are that it is cost-effective, does not require extensive equipments and is atraumatic. Dermatoglyphics has been reported to be associated with a number of conditions. One such condition is dental occlusion. This association between dermatoglyphics and dental occlusion is due to the fact that development of dentition and the palate occurs during the same period as the development of dermal patterns. Both the dermal patterns and craniofacial constitution are strongly but not exclusively genetically governed structures.

It is known that any factor active during, the time period of genetic expression is bound to affect all structures developing at the time. Hence the deviation from normal occlusion due to extraneous factors at the time of development should also reflect in the dermal patterns.

History of Dermatoglyphics^{1,2,3}

Thousands of years before the birth of Christ, fingerprints were used on pottery to indicate the maker and brand of pottery. Slabs of clay with fingerprints, 3,000 years old, were found in King Tut-en-Khamen's tomb in Egypt?

The use of finger prints for personal identification is well known and had its origin in the East. A Sanskrit word for fingerprints also exists. In China, for many centuries, the thumbprint of the Emperor was the ruler's mark on letters of state. Emperor Ts-in-She (B.C. 246 – 210) was the first to use such seals in China. These were in use till the era of Emperor Wu (B.C. 187 – 156). This clearly indicates the significance of fingerprints for identification purpose. (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 palm and fingers.) 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 Malpighi**, 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. In the early 19th century (1823), **Purkinje**, Professor of Anatomy and Physiology at Breslaue University, drew attention in a Latin thesis to the diversity of finger print patterns. He suggested a system of classification consisting of 9 basic types. **Francis Galton (1895)**² introduced a classification system based on scientific basis. His interests included usage in personal identifications, inheritance and ethnic differences.

Harold Cummins (1936), Professor of Anatomy at Tulane University was the first person to show that palm and finger prints could be of use in clinical medicine.

Embryogenesis of ridges^{3,4,5}

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.

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. (The formation of these 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.

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.

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 (1924)**. 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).

Several hypotheses have been formulated concerning the forces that are responsible for the development of specific ridge patterns. **Cummins (1926)**² 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. **Penrose (1969)**^{5,6} suggested that the ridges followed lines of greatest convexity in the embryonic epidermis. **Bonnevie (1929)**⁶ postulated that the fingertip

patterns depended on the underlying arrangements of peripheral nerves. **Hirsch and Schweichel (1973)**⁶ have postulated that the vessel-nerve pair induces the folds. They list inadequate supply of oxygen to the tissues, deviations in the formation and distribution of sweat glands, disturbances in proliferation in the epithelial basal layer, and disturbances in keratinization of the epithelium as other factors that may influence epidermal ridge patterns.

These pads help to support the weight and cushion the tread, and in some mammals the pads bore clusters of small epidermal warts, arranged circularly around an elevated apex and each carrying a tiny opening of a sweat gland. These warts tended to fuse together, forming transverse lines across the pad, thus providing a friction surface that prevented slipping. Skin folds surrounded the pads, and where the skin folds met, a delta was formed. As habits grew to be arboreal and climbing became a part of the creature's existence, these clusters of warts or pads became somewhat flattened and a pattern appeared.

The entire friction surface became covered with ridges, but instead of running from side to side, they retained the direction of the folds that originally surrounded the pads, while the pads themselves assumed patterns of the "Whorl" type, affording maximum friction for a given surface.

Finger and palm patterns

Galton^{2,6} classified patterns on the fingertips into three main types, depending on the number of triradii present. A simple arch has no triradius and is not really a pattern at all, for it is composed of a series of gently curving, ridges. A loop has one triradius, while a whorl has two triradii or, rarely, three. Loops are classified as radial or ulnar according to the direction they face. An ulnar loop opens towards the ulnar margin of the hand, whereas the radial loop opens towards the radial margin.

A person may have the same pattern on all ten fingers but various patterns often occur on different digits. Whorls are most likely to be found on the thumb and ring finger, while radial loops and arches are most common on the index finger. On the little finger the most frequent pattern is an ulnar loop. There are a variety of classification systems in which numbers, letters and other symbols are selected to indicate certain pattern characteristics. (The most commonly used method is the "**Galton-Henry Method**" or the "**Henry**" system. Under the Henry system, finger prints are in two classes, those which are given numerical value (Whorls and Composites) and those having no numerical value (Loops and Arches).

Methods of recording Dermatoglyphics^{4,6}

Dermatoglyphic features offer at least two major advantages as an aid to the diagnosis of medical

disorders. The epidermal ridge patterns on the hands and soles are fully developed at birth and thereafter remain unchanged through out life; scanning of the patterns can be recorded (prints) rapidly and inexpensively.

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. Scanning by eyes alone often gives sufficient data but prints are necessary for quantitative analyses. The methods are ink method (Strong 1929, Purvis-Smith 1989), inkless method (Walker 1957) Cummins and Midlo 1961), transparent adhesive tape method (Book 1948) and photographic method (Harrick 1962-1963). Special methods are hygrophotography (Sivadjan 1961, 1970), radiodermatography (Cummins and Midlo 1961, Pozhanski et al 1969), plastic mold (Sutaman and Thomson 1952) and automatic pattern recognition (Trauring 1963). Braganca and Pick (1989) have developed a method where in the investigating region is blackened with graphite smeared on a piece of carboard. The print is taken by Tesa film and then adhered to a transparent film strip or photoprinting foil. Such a "negative" could be enlarged five or six times

Mull developed an apparatus which can record finger and palm prints without any inking and can automatically count ridge numbers between two singular points.

Dermatoglyphics in Dentistry

There are quite number of studies conducted in medicine to establish relationship between finger patterns and the disease process. In dentistry review of literature shows a meager number of studies. **Kharbanda O.P. et al (1982)**⁶ conducted a dermatoglyphic evaluation of twenty five North Indian males with true mandibular prognathism which was confirmed with cephalometric Down's analysis and compared this with the dermatoglyphic findings of individuals with Class I occlusion and craniofacial pattern. They concluded that the craniofacial skeletal Class III pattern is associated with 1. Increase in arches and ulnar loops at the expense of whorls on all digits except Digit II. 2. Increased frequency of whorls and radial loops. 3. Increased frequency of carpal loops on inter digital area of palms. They also concluded that the mandibular prognathism is autosomal in inheritance and not sex linked.

Kanematsu N. et al (1986)⁷ studied the appearance of finger and palm prints of 311 children with cleft lip, alveolus and palate without other exterior malformations and compared them with the dermatoglyphic findings of normal children. They also found that abnormalities in the appearance of finger and palm prints of affected children were due to multifactorial inheritance. The aetiology of the abnormalities in the appearance of finger and palm prints was more strongly influenced by genetic factors than by extrinsic factors during the embryonic period. **Jain V.K.**

et al (1989)⁵ studied the finger print patterns of 20 cases of hypodontia and compared them with the dermatoglyphic findings of 20 normal males and 20 normal females. They reported that there was an increased frequency of whorls and arch patterns and decreased frequency of loop patterns in individuals with hypodontia as compared to normal females. Also there was an increased frequency of whorls (60%) and decrease frequency of loops (39%) and arch patterns (1%) as compared to normal males. However no significant change was observed in the total ridge count of these cases. **Atasu M. and Akyuz S. (1994)**⁵ in their report presented the mode of inheritance pattern of the absence of maxillary and mandibular second premolars by pedigree analysis and dermatoglyphic studies of a patient and his family members. An eleven-year-old male patient with caries and bilateral absence of maxillary and mandibular second premolars was subjected to the analysis. Most of the dermatoglyphic traits observed in the patient were also seen in his father and sister who had a similar dental condition. **Reddy S., Prabhakar A.R. and Reddy V.V.S (1997)**⁸ conducted a study using dermatoglyphics to predict and compare Class I, Class II Div. 1, Div. 2 and Class III malocclusion. The dermatoglyphic findings revealed that the craniofacial Class II Div. 1, Div. 2 Patterns were associated with increased frequency of arches and ulnar loops and decreased frequency of whorls. In Class III malocclusion there was an increased frequency of arches and radial loops with decreased frequency of ulnar loops. In predicting Class III malocclusion, based on the frequency of arches, the sensitivity values were found to be higher and more reliable than the sensitivity values of Class II Div. 1 and Div. 2 malocclusion. **Akyuz S. et al (1998)**⁵ studied the dermatoglyphic pattern in an eight year old female patient with characteristic "Hemifacial microsomia". The dermatoglyphic pattern of the patient had a hypothenar loop associated with distally displaced axial triradius on the left hand. Her brother had hypothenar loops on both palms and they had a high "total fingers ridge count (TFRC)". **Trehan M. et al (2000)**¹⁰ undertook a study to analyze and compare the dermatoglyphic parameters of individuals with normal occlusion and various classes of malocclusion. The dermatoglyphic findings revealed that when compared with normal occlusion, Class I and Class III malocclusion were associated with an increased frequency of whorls and both Class I and Class II Div. 1 malocclusions were associated with an increased frequency of radial loops and arches. Increased frequency of patterns in the hypothenar area was also observed in all the malocclusion groups as compared to normal occlusion.

CONCLUSION

It can be concluded from the above studies different malocclusions are more prone to have a specific type of ridge patterns. However, though malocclusion based on dermatoglyphics can be predicted with a fair degree of accuracy, it cannot be relied upon as the sole 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. Extensive studies of ridge pattern has to be undertaken with several groups according to their racial and ethnic backgrounds.

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