Dermatoglyphic Patterns in Children with Dental Caries: 
An In vivo Study

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Abstract

Background: Dental caries is the predominant cause of tooth loss in children and young adults. Mutans streptococci are the principal etiological agents of dental caries, of which Streptococcus mutans (SM) and Streptococcus sobrinus are most important in terms of human caries. Genetic factors also contribute to dental caries of which dermatoglyphics is one. Aim: The aim of the study was to explore the unique relationship between genetic component (dermatoglyphics) and dental components (dental caries, salivary pH, SM level) and to identify children at particular risk of dental decay. Settings and Design: One hundred children, 6–12 years of age, were selected and divided into two groups: Group 1 (children with dental caries, subject group) and Group 2 (children without dental caries, control group). Methods: Dermatoglyphic patterns were recorded using a digital scanner (CanoScan LiDE), and dental caries status was recorded with “decayed-extracted-filled teeth” index for primary teeth and “decayed-missing-filled teeth” index for permanent teeth. Salivary pH was determined using pH meter strips. SM level was estimated by microbial culture of collected saliva samples. Statistical Analysis: Mann–Whitney test, Wilcoxon test, and Z-test were applied. Results and Conclusion: (1) Subject group had a decreased frequency of loops, whereas control group had increased frequency of loop pattern on palmer digits (P < 0.001). (2) Subject group had a low salivary pH toward normal and control group had high salivary pH values toward normal (P < 0.001). (3) Subject group had high SM level as compared to control group (P < 0.001). Therefore, there exists a relationship between genetic component (dermatoglyphics) and dental component (dental caries, salivary pH, and SM level).

Keywords: Dental caries, dermatoglyphics, Streptococcus mutans

INTRODUCTION

Dermatoglyphics (in ancient Greek “derma - skin,” “glyphic – carving”) is the scientific study of naturally occurring patterns on the surface of hands and feet.[1] Dr. Harold Cummins coined the term in 1926 and is regarded as the “Father of Dermatoglyphics.”[2-4] Epidermal ridges on fingers, palms, toes, and soles begin to develop during the 3rd week of intrauterine life and development is complete by 19th week of gestation. Epithelium of primary palate, finger bud, and enamel (most susceptible tissue to dental caries) are ectodermal in origin and develop from the same site and the same time of intrauterine life. Therefore, genetic and environmental factors responsible for causing dental caries may also cause peculiarities in dermatoglyphic patterns.[3,4]

The present study explores the significance of dermatoglyphics in dental caries. We support by means of dermatoglyphics that hereditary plays an important role in dental caries.

METHODS

One hundred children in the age group of 6–12 years were selected for the study. They were divided into two groups:

- Group 1 (subject group) – 50 children with dental caries (≥4 carious teeth)
- Group 2 (control group) – 50 children without dental caries.

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For caries detection
Teeth were cleaned of any food debris present, with the help of sterile cotton or three-way syringe. “Decayed-extracted-filled teeth” index for primary teeth and “decayed-missing-filled teeth” index for permanent teeth were recorded with the help of blunt-ended right-angle probe (no. 17), shepherd crook probe (no. 23), and odontoscope (Mouth Mirror) under natural diffuse light.

For dermatoglyphic pattern recording and interpretation
Children’s right-hand digits followed by left-hand digits were cleaned with a cotton swab dabbed in disinfectant solution (savlon) and allowed to dry. They were then guided to place their right-hand digits followed by left-hand digits under the digital scanner lid (CanoScan LiDE) without applying any undue pressure and scanned. Thumbs were scanned separately to get a clear view. The scanned images obtained were then analyzed with the help of a computer software (Adobe Photostudio 5.5), and interpretation was done under the guidance of handwriting and fingerprint expert. Dermatoglyphic patterns were then interpreted as loop pattern (radial and ulnar) or any other pattern (whorl and arch) [Figure 1].

Salivary pH estimation
Unstimulated saliva was collected from the study population, at least 2 h after meals. pH meter strip was dipped into the collected saliva sample for 10 s. The color change of pH meter strip was compared with standard color chart, indicating the pH of saliva sample while the paper was still moist. pH reading >6 was considered basic and <6 as acidic.

Salivary bacterial count estimation
Throat swab sample of children was taken [Figure 2] and transferred to the microbiology laboratory, where blood agar plates were prepared previously. Inoculation of throat swab sample on blood agar Petri plates was done in an inoculation chamber using streak culture method (right-angle streaking). The inoculated plates were then incubated in an incubator for 18–24 h at 37°C. After 18–24 h, the bacterial growth was appreciated [Figure 3]. The culture plates were then divided into four quadrants. Streptococcus mutans (SM) colonies were counted in each quadrant with the help of a digital colony counter.

Gram staining was done. SM colonies were seen microscopically [Figure 4]. Optochin test was done to differentiate between SM and Streptococcus pneumoniae since both show hemolysis on blood agar. Optochin test is positive for S. pneumoniae as S. pneumoniae show ≥14 mm inhibition zone around optochin disc.

Procedure followed was in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000.

Results
The subject group children had a low frequency of loop pattern (366, mean 7.40 ± 1.161) as compared to control group (473, mean 9.46 ± 0.676) [Tables 1 and 2].

Thirty-five (70%) subjects showed a pH value <6 and 15 (30%) showed a pH value >6 (mean 5.8660 ± 0.22279). In the

| Loop frequency | Number of subjects | Number of control |
|----------------|--------------------|-------------------|
| 0              | 0                  | 0                 |
| 1              | 0                  | 0                 |
| 2              | 0                  | 0                 |
| 3              | 0                  | 0                 |
| 4              | 1                  | 0                 |
| 5              | 0                  | 0                 |
| 6              | 7                  | 0                 |
| 7              | 16                 | 1                 |
| 8              | 18                 | 2                 |
| 9              | 6                  | 20                |
| 10             | 1                  | 27                |
| Total          | 366                | 473               |
control group, 12 (24%) had a pH value < 6 and 38 (76%) had a salivary pH > 6 (mean 6.3820 ± 0.41732). More numbers of children with pH value > 6 were seen in the control group as compared to the subject group [Tables 3 and 4].

Subject group children showed highly significant and significant growth types (mean 2.96 ± 0.832). The control group children showed less significant and moderately significant growth types (mean − 1.84 ± 0.976) [Tables 5 and 6].

Statistical analysis was done with Mann–Whitney test, Wilcoxon test, and Z-test.

Tests showed a high statistically significant difference between the loop frequency (P < 0.001), salivary pH (P < 0.001), and microbial growth (P < 0.001), among subject and control groups. Subject group had decreased frequency of loop pattern and less salivary pH value with increased microbial count. The control group had increased frequency of loops and more salivary pH value toward normal with decreased microbial count.

**DISCUSSION**

Individual susceptibility to dental caries varied from genetic factors and environmental influences.[5] Dermatoglyphics refers to the frictional ridge formation which appears on the palms of hand and soles of feet. The development of primary palate and lip is completed by the 7th week of intrauterine life and that of secondary palate by 12th week. The dermal ridges develop in relation to volar pads, which are formed by the 6th week of gestation, reach maximum size between 12th and 13th weeks, and are completely formed after 10–20 weeks of gestation.[2,4,6]

Tooth enamel (most susceptible to dental caries) and epithelium of finger bud are ectodermal in origin, same as that of palate and alveolar ridges and develop at the same time of intrauterine life. Therefore, abnormalities in these areas are influenced by a combination of hereditary and environmental factors, but only when the combined factors exceed a certain level, abnormalities are expected to appear. This threshold theory has been advanced by studies of Carter (1969) and Matsunga (1977) and is now well accepted.[6]
Dermatoglyphics is considered as a window of congenital abnormalities and is a sensitive indicator of intrauterine anomalies.[7] Dermatoglyphics is known to be one of the best available diagnostic tools in genetic disorders as dermatoglyphic patterns are genetically determined,[4,8] and once formed remain unchanged throughout the life of an individual except a change in size.

Fingerprints can be broadly classified as:[9]
- Manual fingerprints
- Electronic fingerprints.

Manual fingerprint system includes Roscher manual system (developed in Germany and is implemented in Germany and Japan), Juan Vucetich system (developed in Argentina and is implemented in South America), and Henry classification system (developed in India and is implemented in English-speaking countries).

Electronic method records the fingerprints digitally on a glass plate, for example, live scan.

In the present study, electronic method (scanner, CanoScan LiDE) of recording and interpretation of dermatoglyphic pattern was adopted. The present method has several advantages over conventional methods such as (1) it is easy to record the patterns; (2) records can be saved for future referral and for comparisons with other person’s dermatoglyphic patterns, dermatoglyphic records can be accomplished immediately without any trauma to the patient; and (3) scanning and recording of fingerprints are better in children as they are fine in them.[7]

The fingerprints were classified on the basis of Cummins and Midlo Classification (published by Dr. Cummins and Midlo in year 1926) [Figure 2].

**Loop**

It consists of series of ridges that enter the pattern area on one side of the digit, recurve abruptly, and leave the pattern area on the same side. If the ridge opens on the ulnar side (away from the thumb), it is called as ulnar loop, and if opens toward the radial side (toward thumb), it is called as radial loop. A single triradius is present, which is located laterally on the fingertip, where the loop is closed.

**Whorl**

It has concentric or circular arrangement of ridges with two or more triradii.

**Arch**

It is the simplest ridge pattern formed by succession of one or more parallel ridges which cross the finger from one side to the other side without recurving. There is absence of triradii, except when the tented arch is present that will have a triradii point near its midline.

In the present study, the frequency of loop pattern in the subject and control groups was compared.

Dental caries is the predominant cause of tooth loss in children and young adults. The principal causative agents of dental caries are a group of streptococcal species collectively referred to as mutans streptococci, of which SM and *Streptococcus sobrinus* are the most important agents.[10-12] The first report of the involvement of streptococci in the etiology of dental caries was given by Clarke in 1924.[13,14]

Dermatoglyphics has been linked to dental caries,[2-5] cleft lip and palate,[10] hypohidrotic ectodermal dysplasia,[13] Ellis–Van Creveld syndrome,[16] bruxism,[17] malocclusion,[18] and other syndromes in orofacial region.[19]

In the present study, 100 children in the age group of 6–12 years were selected as it is the period of the second window of infectivity so that SM levels can be measured much confidently as incipient carious lesions transform into cavitation by 2–5 years,[13] in case of deciduous dentition rate being faster.

The standard value of pH is taken as 6, as the critical pH value of enamel and dentin is 5.5 and 6, respectively.[20]

SM is required for dental caries initiation, and it has been suggested that an SM count higher than 10^7 cfu/ml of saliva is related to higher caries risk.[21] The results of the present study show that individuals with a higher salivary SM count (i.e., subject group −2.96 ± 0.832) presented a higher caries outcome than those with a lower salivary SM count (i.e., control group −1.84 ± 0.976). The results are in accordance with the previous studies by Hegde S. K, 2005 and Leal S. C 2010.

Genetic and environmental factors have a significant role in the causation of dental caries. Genetic factors may modify caries development.[22,23] In the present study, control group (caries-free students) have increased frequency of loops (mean = 9.46, standard deviation [SD] = 0.676), decreased microbial count (1.84 ± 0.976), and increased salivary pH (6.3820 ± 0.41) as compared to the subject group (with dental caries) who have decreased loop frequency (mean = 7.40, SD = 1.161), increased microbial count (2.96 ± 0.382), and decreased salivary pH (5.8664 ± 0.22279). The difference is highly significant in controls and subjects in terms of frequency of loops (P < 0.001), microbial growth (P < 0.001), and salivary pH (P < 0.001).

Our findings support the previous study (Atasu M, 1998, Sharma A, Somani R 2008, Madan N, 2011).

Dermatoglyphics may be a genetic indicator for dental caries acquisition as we have SM levels for early childhood caries,
and it should be adopted by more dentists and researchers for oral cavity-related studies, leading to more early breakthroughs and new discoveries. This should aid in early diagnosis and prevention of many genetic related disorders of the mouth.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

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