Original Article

Dermatoglyphic findings in dental caries and their correlation with salivary levels of *Streptococcus mutans* and *Lactobacillus* in school-going children in and around Moradabad

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Abstract

Introduction: Dental caries is the disease of the calcified tissues of the teeth resulting from the action of microorganisms on carbohydrates characterized by a decalcification of inorganic portion of the tooth and accomplished or followed by disintegration of organic portion. Genetic susceptibility to dental caries is dependent on certain factors, which, if evaluated, can help in estimating disease situation prematurely. Dermatoglyphics are the genetically determined dermal ridge configurations on the digits, palms and soles, influenced by environmental forces that are operating before birth. Hence, the study was undertaken to establish a possible link between dental caries and dermatoglyphics and to determine whether specific dermatoglyphic patterns exist which help in predicting the occurrence of dental caries.

Subjects and Methods: The dermatoglyphics of 50 caries free (CF) and 50 individuals with dental caries (WDC) were taken and compared with the microbial levels of *Streptococcus mutans* and lactobacilli, and results were evaluated qualitatively and quantitatively.

Statistical Analysis: Analysis was done using *P* value, Chi-square test and Student's *t*-test.

Results and Conclusion: (1) Whorl pattern was more common in individuals WDC ($P < 0.0001$) as compared to the CF individuals who exhibited more loop pattern ($P = 0.002$). (2) Whorl pattern had significant association with the microbial counts of *S. mutans* ($P = 0.383$) and *Lactobacillus* ($P = 0.015$) with no such statistically significant correlation with loop pattern in the disease group. (3) ≤6 loops was a good predictor of caries. ≥4 whorls was a moderate predictor of caries.

Keywords: Dental caries, dermatoglyphics, *Lactobacillus*, *Streptococcus mutans*

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Received: 14.05.2018, **Accepted:** 05.09.2018

INTRODUCTION

Dental caries is the most common disease in the field of dentistry and is considered irreversible.[1,2] Globally, 32% of the 12-year-old children have more than three decayed teeth. In India, the prevalence of dental caries varies from 33.7% to 90% in children population and is increasing at

Access this article online

Quick Response Code:

Website: www.jomfp.in

DOI: 10.4103/jomfp.JOMFP_110_18

How to cite this article: Sharma R, Singh NN, Sreedhar G. Dermatoglyphic findings in dental caries and their correlation with salivary levels of *Streptococcus mutans* and *Lactobacillus* in school-going children in and around Moradabad. J Oral Maxillofac Pathol 2018;22:360-6.

an alarming rate.[2] Dental caries being multifactorial has a genetic component as well.[3,4]

Dermatoglyphics is the scientific study of fingerprints on the surfaces of hands and feet.[5,6] They are coincident with occurrence of other genetic conditions with anomalous changes.[7,8] This study correlates high dental caries experience with a change in the dermatoglyphics and salivary levels of *Streptococcus mutans* and *Lactobacillus*.

SUBJECTS AND METHODS

The study was conducted in local schools of Moradabad where a total of 1000 children aged 13–15 years were examined for decayed, missing and filled teeth (DMFT) by organizing dental camps.

Of all the children so examined, only 100 participants were selected for the present study out of which 50 participants were taken as controls and 50 participants as study samples after following certain inclusion and exclusion criteria.

The inclusion criteria of this study were as follows:
1. Children between 13–16 years of age
2. Children with either no caries (for control group) or with more than five carious teeth (for dental caries group)
3. Children with the same socioeconomic background, geographic and climatic zone.

The exclusion criteria of this study were as follows:
1. Children who were on antibiotics or had taken antibiotics for 1 month
2. Children with orthodontic appliances.

Determination of control and disease group

The participants having caries-free (CF) teeth (DMFT = 0) were considered in the control group (CF) and participants having a DMFT of >5 were considered to be in the dental caries group (with dental caries [WDC]).

Collection of data

The children were examined and data were collected on a case history sheet. The "DMFT" index was used for the permanent teeth and "dmft" index was used for deciduous teeth. Recording was done by a single calibrated examiner using mouth mirror and probe.

Dermatoglyphic analysis of fingers

The fingerprints of the individuals from whom the saliva was taken were also recorded using the stamp-pad ink method [Figure 1]. First of all, the participants were asked to wash their hands with an antiseptic handwash and were allowed to dry. The fingerprints were taken both from the control (CF) and dental caries group (WDC). The fingerprints taken were thereafter analyzed by an illuminating hand lens and were classified as under Galton's classification of finger patterns (1982) which classifies them as follows: whorls, loops and arches[9] [Figures 2-4]. Tabulation of data and comparison between the groups were done thereafter.

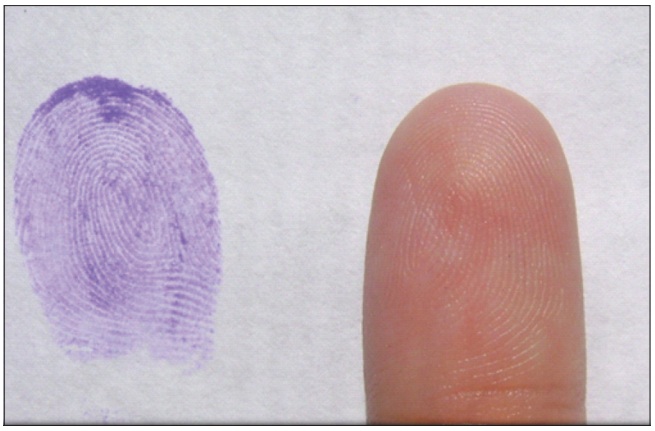

Figure 1: The loop pattern

Microbial analysis

Saliva was collected between 9.30 a.m. and 11.30 a.m. during the school hours from both the control group (CF) and dental caries group (WDC). The participants were asked to refrain from eating for 1 h before saliva collection. About 2 ml of the saliva was collected in a calibrated plastic cup. By means of sterile disposable syringe, 1 ml aliquot of saliva was transferred from the cup to the previously labeled sterile bottle containing 4 ml of transport media (Thioglycollate media) and transferred to laboratory for microbial estimation.[7]

Laboratory procedures

The salivary samples in the suitable transport media were streaked in duplicate on a preprepared suitable medium specific for *S. mutans* (Mitis Salivarius-Bacitracin Agar or Blood Agar Base) and *Lactobacillus* MRS Agar for *Lactobacillus* [Figure 5]. The streaking was done by streak plate method for the isolation of pure bacterial cultures both for *S. mutans* and *Lactobacillus*. Thereafter, the plates were incubated under aerobic conditions for the isolation of *S. mutans* for 48 h at 37°C and under anaerobic conditions for *Lactobacillus* species for 48 h at 37°C. Following incubation, species were identified with hand lens having specific morphologic characteristics for *S. mutans* and *Lactobacillus* on their specific culture media. Gram staining was also performed for the preliminary confirmation of the *Streptococcus* and *Lactobacillus* species[7] [Figures 6 and 7]. Colony count was done with magnifying

glass. Semi-quantitation was done by multiplying the actual number of colonies with 1×10^3 because of the fact that the saliva sample was diluted one thousand times (1:5 dilution).

Colonies were calculated by the following formula:

$$\text{Number of colonies} = n \times \text{Dilution factor} = \_\_\_\_ \text{CFU/mL of saliva}$$

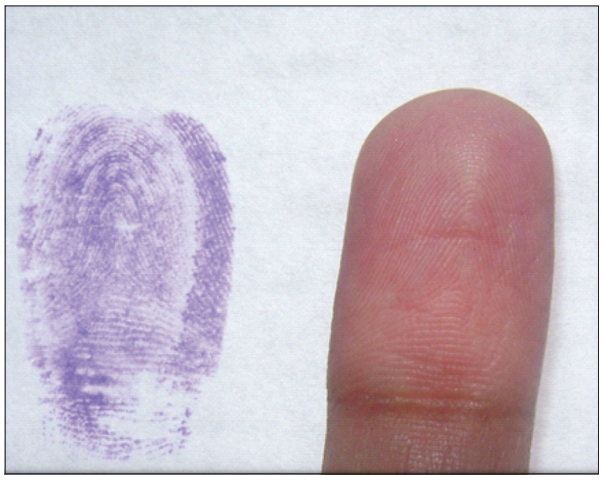

Figure 2: The arch pattern

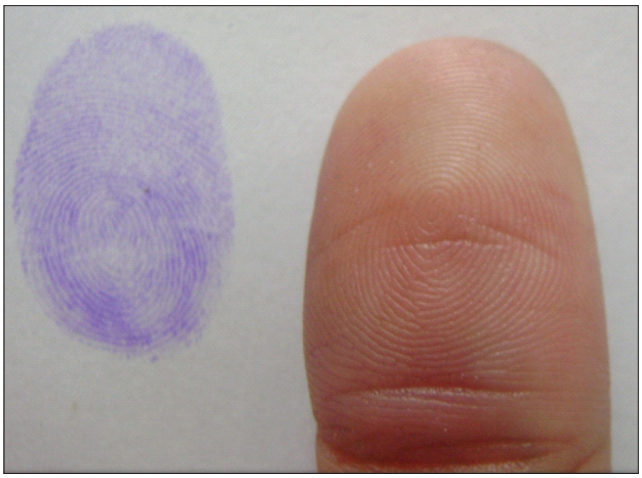

Figure 3: The whorl pattern

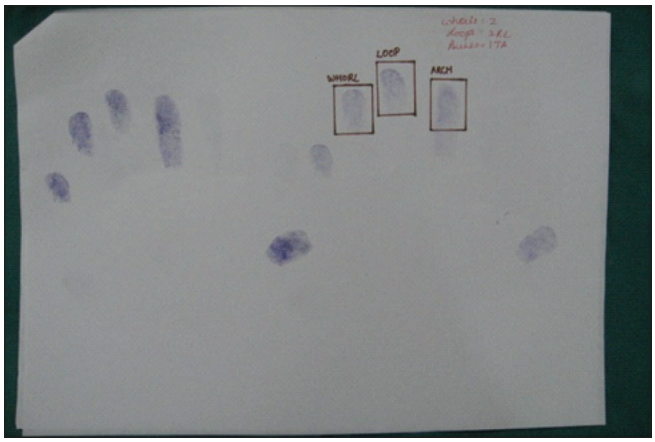

Figure 4: Fingerprint record on an A4-sized paper showing three dermatoglyphic patterns: whorl, loop and arch

Figure 5: Colony growth on blood agar plate

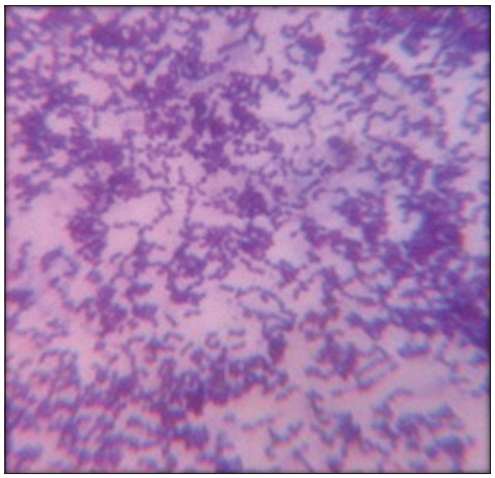

Figure 6: Gram-stained smear of Streptococci under × 100

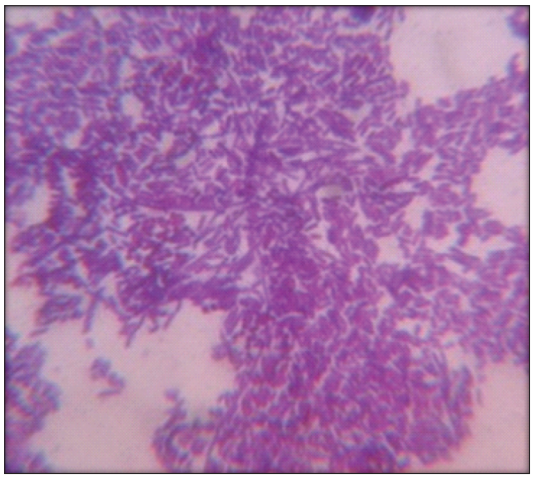

Figure 7: Gram-stained smear of lactobacilli under × 100

Where, *n* = Count of the morphologically identified colonies on the growth medium and dilution factor = Measure of the sample by the transport medium.

Identification of *S. mutans* was later confirmed by biochemical tests such as mannitol and sorbitol fermentation and catalase tests.

The results were statistically analyzed using the Statistical Package for the Social Sciences Version 15.0 (SPSS for Windows, Chicago, SPSS Inc., USA) statistical analysis software. The values were represented in number (%) and mean ± standard deviation. The statistical formulas used were mean, standard deviation, Chi-square test, Student's *t*-test and level of significance "p."

RESULTS

The present study was carried out to investigate the role of dermatoglyphics as an indicator of dental caries by comparing it with salivary levels of *S. mutans* and *Lactobacillus*.

Mean dermatoglyphic pattern in two groups

In CF group participants, the number of loops was significantly higher as compared to WDC group ($P = 0.002$), while the number of whorls was significantly higher in WDC group as compared to that in CF group ($P < 0.001$) [Table 1].

Mean microbial colony count in two groups

Mean number of colony of *S. mutans* and *Lactobacillus* was found to be increased in WDC group, while it was less in the CF group. On statistical evaluation, the difference between two groups was found to be statistically significant ($P < 0.001$) [Table 2].

Biochemical test positivity

All the three biochemical tests were found to be positive in 2 (4%) CF group specimens and 39 (78%) WDC group specimens, thus showing a statistically significant difference between the two groups [Table 3].

Association of dermatoglyphics and microbial colony count

A statistically significant difference in number of colonies was seen ($P = 0.018$) with the participants having >4 whorls showing higher number of colonies as compared to those having <4 whorl, while a statistically significant difference in number of colonies was seen ($P = 0.001$) with the participants having <6 loops showing higher number of colonies as compared to those having >6 loops [Tables 4 and 5].

Table 1: Mean dermatoglyphic pattern in two groups

Pattern	Mean±SD		Statistical significance	
	Control (*n*=50) (CF)	Study (*n*=50) (WDC)	*t*	*P*
Loops	6.40±2.52	4.80±2.49	3.191	0.002
Whorls	2.66±2.20	4.54±2.72	3.794	<0.001
Arches	0.88±1.88	0.66±1.84	0.592	0.555

SD: Standard deviation, CF: Caries free, WDC: With dental caries

Table 2: Mean microbial colony count in two groups

Species	Mean±SD		Statistical significance	
	Control (*n*=50) (CF)	Study (*n*=50) (WDC)	*t*	*P*
Streptococcus mutans	43.90±64.24	122.70±83.53	5.288	<0.001
Lactobacillus	15.80±51.31	64.80±67.01	4.105	<0.001

SD: Standard deviation, CF: Caries free, WDC: With dental caries

Table 3: Biochemical test positivity

Test	Control (*n*=50) (CF), *n* (%)	Study (*n*=50) (WDC), *n* (%)	Statistical significance	
			χ^2	*P*
Coagulase	2 (4)	39 (78)	56.594	<0.001
Catalase	2 (4)	39 (78)	56.594	<0.001
Mannitol	2 (4)	39 (78)	56.594	<0.001

CF: Caries free, WDC: With dental caries

In case of arches, statistically, there was no significant difference between the two groups ($P = 0.476$).

Relationship of dermatoglyphics with decayed, missing and filled teeth status (study group [with dental caries] only)

There was no statistically significant association proven among CF and WDC group in regard to dermatoglyphics and DMFT status as shown in Table 6.

DISCUSSION

Multifactorial etiology works as a processing unit in the causation of dental caries in mineralized portions of human teeth.[9] *S. mutans* and lactobacilli have been linked to the etiology of dental caries.[10] Hence, the above two pathogenic bacteria have been included in the present study and their counts in CF and children WDC were considered.

In humans, the development of primary palate and the lip is completed by the 7th week of intrauterine life and that of secondary palate by the 12th week. The dermal ridges develop in relation to volar pads, which are formed by the 6th week of gestation and reach maximum size between 12th and 13th weeks. This means that genetic message contained in the genome normal or abnormal is deciphered during this period and is also reflected by dermatoglyphics. Moreover, tooth enamel is an ectodermal structure same as that of palate and alveolar ridges and is most susceptible to caries. The resulting ridge configurations

Table 4: Association of dermatoglyphics and *Streptococcus mutans* colony count

Group	Number of whorls <4		Number of whorls ≥4		Statistical significance		Number of loops ≤6		Number of loops >6		Statistical significance	
	n	Mean±SD	*n*	Mean±SD	*t*	*P*	*n*	Mean±SD	*n*	Mean±SD	*t*	*P*
Overall	42	60.1±74.9	58	100.1±86.9	2.40	0.018	55	107.285.9	45	54±72.5	3.3	0.001
Control group	27	51.3±79.3	23	35.22±40.1	0.88	0.383	15	43.33±47.2	35	44±71	−0.04	1
Study group	15	75±65.6	35	142.7±83.1	2.75	0.008	40	85.18±85.9	10	89±71	1.44	0.16

SD: Standard deviation

Table 5: Association of dermatoglyphics and *Lactobacillus* colony count

Group	Number of whorls <4		Number of whorls ≥4		Statistical significance		Number of loops ≤6		Number of loops >6		Statistical significance	
	n	Mean±SD	*n*	Mean±SD	*t*	*P*	*n*	Mean±SD	*n*	Mean±SD	*t*	*P*
Overall	42	22.14±58.7	58	53.5±65.4	2.46	0.015	55	53.64±65.10	45	24.00±60.1	2.35	0.021
Control group	27	20.37±62.4	23	10.4±34.7	0.68	0.501	15	6.00±20.63	35	20.00±59.7	−0.88	0.38
Study group	15	25.33±53.3	35	81.7±65.7	2.93	0.005	40	71.50±67.20	10	38.00±62	1.43	0.16

SD: Standard deviation

Table 6: Association of dermatoglyphics and decayed, missing and filled teeth

Number of loops	*n*	DMFT (mean±SD)	Number of whorls	*n*	DMFT (mean±SD)	Arch (es)	*n*	DMFT (mean±SD)
≤6	40	5.57±1.01	<4	15	5.27±0.46	Present	10	5.10±0.32
>6	10	5.30±0.48	≥4	35	5.63±1.06	Absent	40	5.63±1.00

DMFT: Decayed, missing and filled teeth, SD: Standard deviation

are genetically determined and are influenced or modified by environmental forces. This threshold theory advanced by studies of Carter (1969) and Matsunga (1977) is now generally accepted.[7]

Another important component of the present study is dermatoglyphics which have been shown to change in dental caries. According to Yamagata, Carter (1969) and Matsunga (1977), as the dermatoglyphics are genetically determined, any deviations in the dermatoglyphic features indicate a genetic difference between the controls and the abnormal population.[7,11]

The dermatoglyphic configuration of CF students and students WDC was significantly different from each other, particularly on the fingertips of the students which correlates well with the study carried out by Atasu in which he showed a relative preponderance of the whorl pattern in students WDC.[3]

According to Holt *et al*., the whorl pattern makes up 25%–35% of the patterns commonly encountered on the fingertips, while loop pattern constitutes 60%–70% of the fingerprint patterns, which explains the relative preponderance of the loop pattern in the CF individuals over whorl pattern in students WDC.[12,13]

Both dental caries and dermatoglyphics have been linked to heredity. Slayton *et al.,* worked on the hypothesis of Hunt *et al*., and proposed a heritable link to dental caries through animal studies and considered it to be a viable hypothesis.[14,15,16]

Selected children were between the age group 13 and 16 years in this study because of the following reasons:

1. By 13 years of age, all the permanent teeth erupt and stage of mixed dentition ends. As reported by Horowitz *et al*., a hereditary factor in dental caries experience cannot be readily measured until eruption of permanent teeth is essentially complete[17,18,19]
2. By this period, the second Window of infectivity of *S. mutans* would have been completed so that its levels can be measured much confidently.[10,12]

Hoolbrook stated that a number of lactobacilli decline as a number of open carious lesions decrease. This can explain the small number of lactobacilli as in the present study (0–150 × 10^6 CFU/ml of saliva) as compared to *S. mutans* (0–350 × 10^6 CFU/ml of saliva) and the fact that their count did not vary with respect to DMFT.[2,20]

Atasu said that proline-rich proteins present in saliva are inherited as autosomal dominant condition, manifested with dermatoglyphics and an increase in the microbial counts of cariogenic organisms.[3]

It was shown in the present study that as the number of loops increased, the counts of both *S. mutans* and

lactobacilli decreased, while as the whorls increased so do the counts of *S. mutans* and lactobacilli counts and *vice versa*.

The present study uses a cross-sectional study design which is has also been used by other authors to document the correlation of salivary microbial counts WDC. In such a kind of study, a single saliva/plaque sample is taken to record the count of microorganisms, which probably indicates the microbial count at a certain point of time, as dental caries develops over a considerable period during which bacterial counts would probably fluctuate in response to the changing oral environment. Tukia-Kulamala and Tenovuo reported that individual variation in salivary factors and microorganisms does exist with respect to time and that single-point measurement of salivary factors and microorganisms is unreliable for caries – diagnostic or predictive purposes.[21] Furthermore, Kristila *et al.* considered longitudinal analysis to be only way to determine the existence of any saliva–caries relationship with clinical significance, since cross-sectional data do not necessarily reflect the oral situation at the time when the disease process has started.[22]

The etiopathogenesis of dental caries has been an area of interest since a long time for the medical and dental personnel and several investigations have been carried out in this regard with appreciable success. Dermatoglyphics are a mirror of the genetic makeup of an individual and can serve as a potential diagnostic tool for various medical and dental diseases having genetic origin. Attempts have been made in the past to investigate the dermatoglyphic changes in diseases such as dental caries, but their numbers have not been enough to draw definitive conclusions.

The present study has investigated the dermatoglyphic changes in dental caries and associated salivary counts of *S. mutans* and lactobacilli. The conclusions drawn from the present study are as follows:

1. A positive correlation between dental caries and dermatoglyphics has been established. CF students had more ulnar loops on their fingertips and students with extensive caries had more whorls on their fingertips
2. A highly significant statistical correlation existed between *S. mutans* with respect to the DMFT. No significant relation was found between DMFT and counts of lactobacilli
3. As the number of loops increased, counts of both *S. mutans* and lactobacilli decreased while as the whorls increased so do the counts of *S. mutans* and lactobacilli.

CONCLUSION

Association of dermatoglyphics with variable microbial counts needs to be established through further longitudinal studies on similar grounds and added parameters with larger sample sizes. Furthermore, it has been established through the present study that dermatoglyphics apart from predicting future can also be used for predicting caries susceptibility.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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