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Research Article

Childhood Caries

A Study to Assess Dermatoglyphic Characterization and Salivary Ph in Early Childhood Caries

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Abstract: Dental caries detection at an early stage by applying dermatoglyphics and assessing the salivary pH levels can facilitate the initiation of preventive measures at a younger age. However, there are little data available to substantiate the utility of dermatoglyphics and salivary pH in studying the genetic basis of dental caries.Therefore,the present study was aimed to assess the correlation between dermatoglyphic patterns and salivary pH in children with and without Early Childhood Caries (ECC).This cross-sectional study was carried out in 156 children of randomly selected schools in Puducherry in the age group of 3-5 years. Children with decayed, extracted and filled (defs) score of = 5 for group 1 (children with ECC) and defs score of 0 for group 2 (children without ECC) were considered for the study. Their fingerprint patterns and salivary pH were recorded and analysed using Chi-square test and Spearman correlation tests.In children without ECC group, loop frequency 10 and 7 was the most observed category whereas in subjects with ECC group, whorl frequency 7 and 8 was the most observed category. Significant proportion of whorls was seen more in both males and females in ECC group($p<0.0001$). The mean salivary pH of subjects with ECC was 6.35±0.38 which was statistically significant ($p<0.0001$). Dermatoglyphic pattern and salivary pH can be used as predictive tool for diagnosis of ECC as there exists a definite variation in dermatoglyphic patterns and salivary pH in children with ECC and caries-free group. There are various methods to diagnose ECC but so far, there is no method to predict ECC using a dermatoglyphic pattern, salivary pH and ECC that may further facilitate initiation of preventive measures to avoid the progression of ECC at a younger age.

Keywords: Dental Caries, Dermatoglyphics, Salivary PH, Loop and Whorl

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1. INTRODUCTION

The term dermatoglyphics is derived from two Greek words (derma, skin, and glyphe, carve) and relates to epidermal skin ridge patterns found on the fingers, palms and soles. Harold Cummins coined this phrase in 1926. Finger and palm prints are known to form during the 6-7th week of the embryonic period and to be completed after 10-20 weeks of gestation. The genetic process of dermatoglyphic traits is complex and poorly understood. Their variable characteristics are not shared by other people, even monozygotic twins or the identical person from location to location. Defects in these areas are influenced by a mixture of environmental and hereditary factors, but only if the sum of the factors exceeds a certain threshold. Dermatoglyphics is a window of congenital abnormalities and are patterns of dermal ridges present on the fingers, palms, toes, and soles of human. It is one of the best available diagnostic tools for genetic disorders. Dermatoglyphics are patterns of dermal ridges found on fingers, palms, toes, and soles. Dermal ridges are primarily influenced by genetics, but they are susceptible to alteration when the blended genetic and environmental modifications exceed a certain cutoff point during the crucial phase of ridge differentiation. Dermatoglyphic patterns are also examined in order to forecast genetic disorders such as Down syndrome, Alzheimer's disease, multiple sclerosis, congenital spinal cord anomalies, and so on[1]. Dental caries is an infectious disease of multifactorial cause, with genetic susceptibility being one of the etiological factors. The American Academy of Paediatric Dentistry (AAPD) describes Early Childhood Caries (ECC), previously called "nursing bottle caries", "baby bottle tooth decay", as a major public health problem. AAPD describes ECC as the presence of one or more decayed (non – cavitated or cavitated lesions), missing (due to caries) or filled tooth surfaces in any primary tooth in a child of 71 months of age or younger. In children younger than three years of age, any sign of smooth-surface caries is indicative of severe early childhood caries (S-ECC). Early diagnosis of this condition helps to provide preventive oral health care at a younger age, provided the genetic basis of the disease can be determined [2]. The rationale behind the use of dermatoglyphic patterns as a genetic marker for dental caries is due to the fact that the epithelium of finger buds, primary palate, and the enamel (most susceptible tissue to dental caries) have an ectodermal origin, and all develop at the same time of intrauterine life. Thus, a tooth anomaly is expected when intrauterine dermal damage [3]. The enamel which is most susceptible to caries is also formed from ectoderm simultaneously during intrauterine life. Thus, the genetic abnormality at this stage is also reflected in the dermatoglyphics pattern [3,4]. The rate of salivary secretions and quality of saliva not only aids in demineralization or remineralization of tooth structure but is also essential for maintaining the integrity of the soft tissues as well. The plausible reasons for the change in the oral balance that causes demineralization may be answered by measuring salivary parameters such as salivary pH [5,6]. In the light of the above, this study was planned to determine the most frequently occurring dermatoglyphic patterns (whorl or loop) in children, with and without ECC, and to observe if there exist any correlation between dermatoglyphic patterns and salivary pH. The current study aimed to establish the use of dermatoglyphics dental caries prediction and to evaluate the variation of fingerprint patterns (whorl and loop) with respect to changes in salivary pH. This will help to recognize the genetic susceptibility of children to dental caries for early detection, planning rational strategies for the management, and better prevention of dental caries.

2. MATERIALS AND METHODS

2.1 Study Design

This cross-sectional study was conducted in randomly selected schools of Puducherry in children of 3-5 years of age group, The Institutional ethical committee clearance (IGIDSIRB2014 NDP02PGKAPPD) as well as prior informed consent was obtained from parents/guardians of the children participating in the study. The exclusion criteria comprised children above six years of age, taking any medications, mentally retarded, medically compromised, a trauma in the finger buds, fingerprint pattern other than whorl or loops or those who whorls and loops as fingerprint pattern that was equal in number[7,8]

2.2 Caries Detection

A total of 220 children (both boys and girls) were checked for the presence or absence of dental caries. For this, the first teeth were cleansed with sterile cotton to remove any food debris. Dental caries was recorded with the help of blunt-ended right-angle probe (no.17), shepherd probe (no.23), and odontoscope (mouth mirror), under natural diffuse light defs' index.[9] Those children with 'defs' score of ≥ 5 were included in group 1 (children with ECC) and those with defs score of 0 were in group 2 (children without ECC). Children with defs score < 5 were excluded (59 children) from the study [9,10]. See figure 1

Fig 1 showing caries in children

2.3 *Data Collection*

2.3.1 *Dermatoglyphic Pattern Recording and Interpretation (Method of Recording Finger and Palm Prints:)*

Dermatoglyphic pattern of all 10 palmar digits of 161 children was recorded. Both hands of the children were cleaned with a cotton swab dabbed in disinfectant solution (savlon) to free them of dirt particles and were dried. The children were then guided to place each finger over the Secugen fingerprint reader without applying any undue pressure and the scanning was completed. Scanned images were then saved on the laptop under the appropriate groups (group 1- with ECC and group 2 without ECC).[11]

2.3.2 *Interpretation of Dermatoglyphic Patterns*

All the recorded 1610 fingerprints were analysed by a fingerprint expert from fingerprint Bureau, who was unaware of the hypothesis under investigation to minimize chances of observational bias. Those children with equal number of whorls or loops were excluded from the study. Thus, considering inclusion, exclusion criteria, and sample size, a total of 1560 dermatoglyphic patterns from 156 children were studied.[12]

2.4 *Salivary pH estimation*

Unstimulated saliva was collected from 156 children. They were advised not to drink or eat anything (except water) for 2 h before saliva collection. Saliva sample collection was done between 10 am to 12 noon in order to match with the normal circadian rhythm[13]. Children were recommended to avoid any heavy physical exercise before saliva collection. By using the spitting method, saliva was collected. The study participants were instructed to sit with their heads inclined forward so that saliva is collected anteriorly in the floor of the mouth [14]. Then they were asked to spit the pooled saliva into a tumbler. The saliva pH strip (GC India Dental Pvt Ltd) was dipped into the collected saliva sample for 10 sec. The colour change of the pH strip was compared with the colour chart indicating the salivary pH sample while the paper is still moist.

3. STATISTICAL ANALYSIS

Data was analyzed using R statistical software version 3.6.0. Continuous variables are represented by mean ± standard deviation, categorical variables are represented by frequency (count). The dependency between whorl and loop pattern was evaluated using Chi-square test, whereas the correlation between salivary pH and the dermatoglyphics pattern was done using Spearman's correlation test.

4. RESULTS

The mean age for children in group 1 (with ECC) was found to be 4.05±0.58 years and for group 2 (without ECC) was 4.37±0.74 years. The percentage of male and female participants in group 1 were 41(52.6%) and 37(47.4%) respectively. In group 2, 45(57.7%) were male and 33(42.3%) were females. In subjects without ECC group, loop frequency 10 and 7 was the most observed category (figure 1) whereas in subjects with ECC group, whorl frequency 7 and 8 was the most observed category (figure 2). Using Chi-square test, a strong association was observed between the groups and whorl or loop frequency which was found to be statistically significant (Cramer's V=0.8037126; p=0.0004998). *Group 1: with ECC; Group 2: without ECC; Spearman's correlation test used to obtain the correlation coefficient*

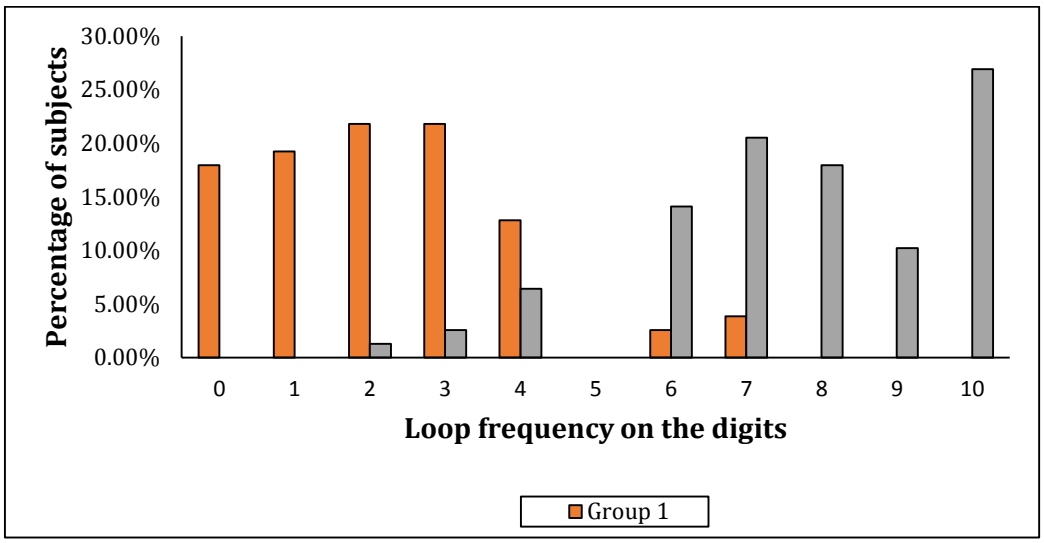

Fig 1: Distribution of loop frequency over groups.

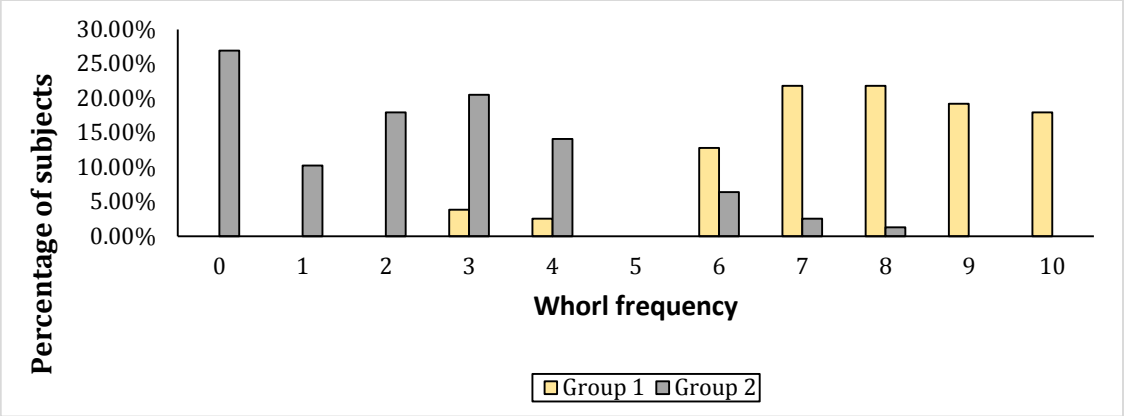

Fig 2: Distribution of whorl frequency over groups.

The proportion of whorls was significantly more in both males and females in ECC group p<0.0001) whereas the proportion of loops was observed to be more in males and females without ECC (p<0.0001) (table 1).

Table 1 – gender characteristics *p: proportion test, g: greater, l: lesser; ECC-early childhood caries*

Gender	Whorls (count)			Loop (count)		
	With ECC	Without ECC	p-value	With ECC	Without ECC	p-value
Male	41	3	<0.0001[p, g]	4	38	<0.0001[p, l]
Female	32	5	<0.0001[p, g]	1	31	<0.0001[p, l]

The frequency of whorl pattern was observed to be more on the ring finger of both the right (8.97%) and left hand (8.97%) in ECC group. However, loop frequency was seen more on the right-hand middle finger (9.23%) and left-hand little finger (9.49%) in subjects without ECC group (table 2).

Table 2: Digit wise comparison of fingerprint patterns between children with and without ECC

	Group	
	Group 1 780 (%)	**Group 2 780 (%)**
Loop Pattern	**173 (22.18)**	**600 (76.92)**
Right hand	**86 (11.03)**	**311 (39.87)**
Thumb	22 (2.82)	50 (6.41)
Index	11 (1.41)	64 (8.21)
Middle	20 (2.56)	72 (9.23)
Ring	8 (1.03)	54 (6.92)
Little	25 (3.21)	71 (9.1)
Left hand	**87 (11.15)**	**289 (37.05)**
Thumb	19 (2.44)	48 (6.15)
Index	13 (1.67)	55 (7.05)
Middle	17 (2.18)	60 (7.69)
Ring	8 (1.03)	52 (6.67)
Little	30 (3.85)	74 (9.49)
Whorl Pattern	**607 (77.82)**	**180 (23.08)**
Right hand	**304 (38.97)**	**79 (10.13)**
Thumb	56 (7.18)	28 (3.59)
Index	67 (8.59)	14 (1.79)
Middle	58 (7.44)	6 (0.77)
Ring	70 (8.97)	24 (3.08)
Little	53 (6.79)	7 (0.9)
Left hand	**303 (38.85)**	**101 (12.95)**
Thumb	59 (7.56)	30 (3.85)
Index	65 (8.33)	23 (2.95)
Middle	61 (7.82)	18 (2.31)
Ring	70 (8.97)	26 (3.33)
Little	48 (6.15)	4 (0.51)

Group 1: with ECC; Group 2: without ECC; ECC-Early childhood caries; *significant p<0.0001

Mean salivary pH in children with ECC was less than those children without ECC which was statistically significant (P<0.0001) (table 3).

Table 3- Mean of Salivary pH in group 1 (children with ECC) and group 2 (children without ECC)

	Mean± Sd	Minimum	Maximum	Median	P value
Group 1	6.35±0.38	5.8	6.8	6.4	**<0.0001**
Group 2	7.1±0.18	6.4	7.4	7.2	

Group 1: with ECC; Group 2: without ECC

There was a statistically insignificant negative correlation observed between whorl frequency and salivary pH, that is with the increase in frequency of whorl pattern the salivary pH decreases in both the groups and vice versa. Similarly, a statistically insignificant positive correlation was noted between frequency of loop pattern and salivary pH in both the groups, depicting that salivary pH increases with the increase in frequency of loop pattern and vice versa. (table 4).

Table 4: Correlation between pattern (loop and whorl) and salivary pH in children with (group 1) and without (group 2) ECC

	Loop pattern	
	Correlation coefficient	p-value
Group 1	0.002146	0.9851
Group 2	0.131862	0.2498
	Whorl pattern	
Group 1	-0.00214	0.9851
Group 2	-0.131862	0.2498

Group 1: with ECC; Group 2: without ECC; Spearman's correlation test used to obtain the correlation coefficient

5. DISCUSSION

The current study evaluates the importance of dermatoglyphics and salivary pH in the early identification of ECC. Although there are three fingerprint patterns commonly visible in the fingertips such as whorls, loops, and arches, as mentioned in various studies whorl and loop patterns were most associated with dental caries and no correlation was seen with arch patterns [14,15] Thus, only whorl and loop patterns were considered in the present study. There are numerous ways of recording fingerprint patterns such as ink method, lip stick method, photographic method, and transparent adhesive tape method; however, this study uses electronic method of fingerprint recording using Secugen Hamster fingerprint reader method due to its various benefits such as ease of recording and saving the fingerprint patterns for further referral. It also gives an added advantage of facilitating and comparing dermatoglyphic pattern between individuals. Scanning of fingerprints is easier in children as they are comfortable with that and dermatoglyphic records can be accomplished readily without causing any injury to the individual[14,15]. Children in the age group of 3-5 years were selected for the study with mean age being 4.05±0.58 years of children with ECC. According to the American Academy of Paediatric Dentistry (AAPD) children in the age group of 3 -5, have one or more cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled score of ≥4 (age 3), ≥5 (age 4), or ≥6 (age 5) surfaces constitutes severe-ECC. Therefore, children with extreme scores(def≥5) were included in the study to assess caries susceptibility. Our study results reveal that loop pattern frequency was less unlike the frequency of whorl pattern that was predominantly observed in children with ECC which is not in accordance to a study conducted by Chinmaya et al. to who stated that study participants with loop pattern depicted a higher prevalence of ECC [14]. However, there appears to be no specific reason for the variations in the findings. A study conducted by Sengupta et al. concluded that male study participants with ECC had a significant decrease in the whorl pattern percentage (Z = 1.94, p<0.05) and female study participants with ECC revealed a reverse trend with a significantly higher percentage of whorl pattern (Z = 4.12, p<0.001) [15] However, these findings were in contradiction with current study that depicted a significantly higher proportion of whorls in both males and females in ECC group. Although there was a predominance of whorl pattern in children with ECC, on individual finger analysis in the present study, it was observed to be more prominent on the right and left ring finger which was not in accordance with the study by Madan et al. who concluded that although the maximum occurrence of whorls was seen in the ECC group, 3rd digit of both hands had a statistically significant higher incidence[16] Thakkar et al. have found that those with high ECC were associated with increased incidence of whorls in the 2nd digit of both hands and were found to be statistically significant [17] .In contrast, Navit et al. in their study on individual finger analysis observed that the occurrence of whorls on the right-hand index finger (2nd digit) suggested a lower chance for caries[18] .The reason for these stark variations could be a fact that children with ECC did not exhibit a significant predilection for any specific dermal ridge pattern. The present study shows contrasting results when compared with various studies reported in literature. The plausible reason for this could be variations in age range and the method used in evaluating the finger print pattern as various studies reported used Midlo and Cummins method[16,17] of recording palm prints using Indiana Ink (stamp pad), roller and printing papers unlike the present study that used Secugen Hamster fingerprint reader method. The pH of saliva is crucial to preserve the integrity of oral cavity. Normal salivary pH is 6.2-7.6, with an average of 6.7. In the present study, the mean value for salivary pH in ECC group was observed to be lower. These findings were further substantiated by the study done by Kaur et al who revealed that mean value of salivary pH is more in children without caries (6.382 ± 0.41) than in children with caries (5.866 ± 0.22) [19]. Bordoni et al. concluded from their study that salivary pH

is one of the strongest components adding to the incidence of ECC [20] which is in concordance with the findings of the present study that showed a statistically significant decrease in the salivary pH levels in children with ECC. Thus, emphasizing the fact that with the decrease in salivary pH, an individual's susceptibility as well as exposure to dental caries increases. A study conducted by Sharma et al. observed a negative correlation of whorl pattern with salivary pH and a positive correlation of loop pattern with salivary pH that was statistically significant(p=0.0001) [21] which was somewhat in concordance to the results obtained from the present study, thus substantiating the fact that dermatoglyphic pattern(loop and whorl) and salivary pH are correlated. There are various methods to diagnose ECC but so far, there is no method to predict ECC. And because there is not much available literature depicting the correlation of dermatoglyphic pattern, salivary pH, and ECC, the results obtained from the current study, shedding light on the existing lacunae, add novelty to the study. The findings observed in this study may further facilitate the initiation of preventive measures to avoid the progression of ECC at a younger age using dermatoglyphics and salivary pH level. However, the current study has a few potential limitations as well. Firstly, only school children from Puducherry were included, however, a study in a larger population will be more informative in this aspect. Also, dermatoglyphic patterns of monozygotic twins and parents should be included in future studies for more conclusive results. It is difficult to distinguish whether genetic or environmental factors play a more dominant role in causing dental caries. Dermatoglyphic patterns are unique to each person and do not change once formed. As a result, it is used as a biometric analyzer for individual identification as well as for recognising specific diseases/syndromes in preventive medicine. In a country like India that's still developing, use of dermatoglyphics and salivary pH levels in predicting and diagnosing ECC at an early stage might gain popularity as a non-invasive, less expensive, and useful tool. Extensive research and large-scale studies are further needed to confirm our findings before applying dermatoglyphics to predict individuals prone to dental caries in clinical practice as dermatoglyphics is still not fully explored to date.

6. CONCLUSION

Children with ECC have a higher whorl pattern and a lower salivary pH than children without ECC. The study emphasizes the role that digital dermatoglyphics may play in the future in risk stratification of dental caries, allowing for earlier therapy to be implemented. This study also provides evidence that specific fingerprint patterns and salivary pH levels may be used as a potential non-invasive anatomical tool that will not only aid in the early screening and detection of dental caries in the future, but may also introduce us to more preventive, early diagnosis, and effective treatment strategies in patients with dental caries.

7. AUTHOR CONTRIBUTION STATEMENT

Annamary Kattakayam – data collection, Prathima G.S, - manuscript preparation and supervision, SajeevR, Kayalvizhi G, - concept and design

8. CONFLICT OF INTEREST

Conflict of interest declared none.

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