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# IS THERE A RELATIONSHIP BETWEEN FINGER PRINT PATTERN AND MINERALS CONTENT OF THE PRIMARY TEETH ENAMEL?

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## *ABSTRACT*

**Objectives:** The present study aimed to evaluate the minerals content, calcium (Ca) and phosphorus (P) weight percent of primary teeth enamel in dependence to finger print pattern.

**Materials and methods:** Thirty primary teeth (10 for each finger print pattern: whorl, loop and arch group). Enamel slab from each tooth was obtained, embedded and scanned by Scanning Electron Microscope - Energy Dispersive Analytic X-ray. Then the minerals weight percent of Ca and P from three different enamel areas (outer, middle, and inner) as well as the minerals content of enamel in relation to the three finger print patterns were quantified. One-way ANOVA test was used to compare among the three finger print patterns and the three enamel areas. Post- Hoc Tukey test was used for multiple comparisons and p value $\leq 0.05$ was considered to be statistically significant.

**Results:** The loop pattern has statistically significant higher weight percent of Ca followed by arch then whrol pattern, the arch pattern has the highest weight percent of P followed by loop then whrol pattern and the differences were statistically significant ($p \leq 0.05$). The highest weight percent of minerals (Ca + P) was observed in outer enamel area of loop pattern while the lowest percent was found in middle area of whrol pattern ($53.860 \pm 0.686$ vs $51.600 \pm 1.442$). Regardless finger print pattern, there were no significant differences in Ca and P among the three enamel areas ($p > 0.05$).

**Conclusions:** There were dependent differences observed in the three finger print patterns, Ca weight percent was the highest in loop pattern while phosphorus was the highest in arch pattern. However, no area dependent differences were observed in the three enamel areas.

**KEY WORDS:** Dental caries, Finger print, Mineral content.

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## INTRODUCTION

Dermatoglyphic pattern is unique for each person, it is based on the genetic constitution of the individual, developed at birth and there after remain unchanged throughout life[1-3].

Basically, the pattern of the skin lines on the finger is formed during the second trimester of the intrauterine life and it does not change for any individual during the life. It has been reported that the epidermal ridges of the fingers, the palms and facial structures like lip, alveolus, palate and tooth bud are formed from the same embryonic tissue (ectomesenchyme) during the same embryonic period (6-9 weeks)[4]. The genetic constitution whether normal or abnormal is established during this period and is reflected by dermatoglyphics. Thus, with genetic information, the susceptibility for caries due to abnormality in the tooth structures like alterations in dental hard tissues like structure of dental enamel, tooth eruption and development may be reflected in the dermatoglyphics namely whorl and loop patterns[5,6].

Many previous studies[7-11] indicated a significant relationship between dermatoglyphics and dental caries. A previous study[12] performed on 200 Egyptian preschool children to evaluate dental caries in relation to dermatoglyphics found increased frequency of loops (63.2%) followed by whorls (33.2%) and arches (3.6%) among them. Also, the study found a significant association between fingerprint patterns and early childhood caries, increased whorl pattern among children who had dental caries while loop pattern was more prevalent among caries free children.

The dental caries is multifactorial disease but why it is more prevalent in some children than others is not clear. From the previous studies the dental caries in relation to dermatoglyphics was more prevalent with whorl pattern than loop and arch pattern but the cause is not clear. So, the expected cause may be due to differences in mineral content of enamel.

There are no previous studies carried out to investigate the relationship between finger print patterns and mineral content of enamel, so the present study was carried out to clarify such relationship. Primary teeth are an easily available biological material for research, and the analysis of their mineral composition may indicate why the dental caries risk is higher in whorl finger print than loop and arch conditions.

## AIM OF THE WORK

The aim of this study was to determine whether there are relationship between the mineral content of primary teeth enamel and their finger print pattern.

## MATERIALS AND METHODS

**Study design:** The present study was analytical comparative study. The sample consisted of 30 primary 2$^{nd}$ molars (5 upper and 5 lower primary molars for each finger print pattern)(Figure 1).

Loop pattern Whrol pattern Arch pattern

Fig. (1) Finger print pattern of the right thumb

**Sample selection:**

117 primary 2$^{nd}$ molars collected from children aged between 10 to 12 years old who attained Pediatric Dentistry and Dental Public Health Department, Faculty of Dentistry, Cairo University for extraction. Firstly, all children asked for finger print of the thumb to determine the finger print pattern after the child's parent signed informed

consent forms approved by the Ethics Committee of the Faculty, the right thumb was thoroughly cleaned, allowed to dry and guided by the researcher to the ink stamp pad and pressed firmly against the bond paper. The paper was stabilized on a hard smooth surface board. In this method, impressions were recorded 3-4 times, but third recording was satisfactory and readable. The finger print patterns were analyzed with the help of a magnifying glass (6 xs). All extracted sound primary molars were collected. The extracted teeth were cleaned thoroughly and stored in three containers containing 0.5% (w/v) thymol according to finger print pattern (74 Loop, 31 Whrol and 12 Arch). The collected molars were classified into upper (28 Loop, 15 Whrol and 5 Arch) and lower (46 Loop, 16 Whrol and 7 Arch), from each finger print group 10 teeth (5 upper and 5 lower) were randomly selected and subjected to preparation and analysis.

The present study did not include the children with syndromes as they may show a peculiar pattern of development of dermal ridges and may affect the mineral content of teeth.

## Preparation of the specimens

The teeth crowns were separated from the roots with diamond disc under continuous water cooling. Each tooth crown was sectioned into buccal and lingual halves, the enamel specimens were sectioned from buccal halves into the same size to ensure similar samples for all the teeth. Three reading for each sample of different areas in enamel of primary teeth (outer, middle and inner) were taken.

## Measurement and evaluation of mineral contents

The mineral analysis for enamel specimens was performed at National Research Center, Cairo, Egypt. The tooth sections were dried thoroughly under heat lamp, and mounted on brass rings using a non-conductor tape made of carbon; this was applied to the sections in the areas that did not need scanning, with the cut surface exposed to SEM-EDAX (Scanning Electron Microscope - Energy Dispersive Analytic X-ray) examination. SEM Model Quanta 250 FEG (Field Emission Gun) attached with EDAX Unit. The scanning parameters were set as follows: X-ray source, 20 kVp and 114 mA; integration time, 400 ms. All SEM and EDAX analyses were recorded for the outer, middle, and inner enamel areas (Figure 2).

## Statistical analysis of data

Statistical analysis was performed using SPSS version 22.0. One-way ANOVA was used to compare the total minerals, Ca and P weight percent amongst the three finger print patterns and the three enamel areas.  Post- Hoc Tukey test was used to compare minerals content, Ca and P weight percent for every

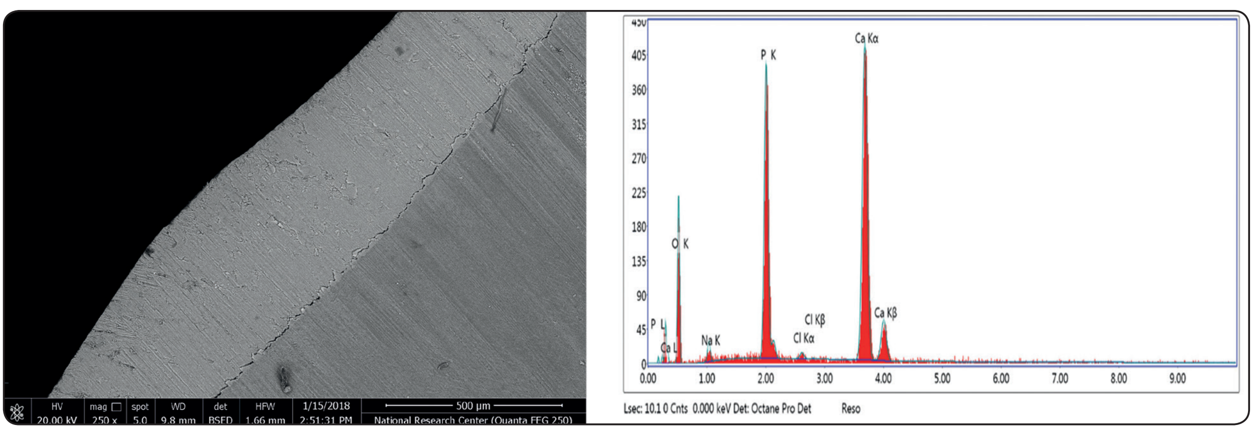


Fig. (2) Shows the EDAX pattern of calcium and phosphorus elements in enamel of primary tooth two patterns as well as every two enamel areas. A significance level of p≤ 0.05 was considered to be statistically significant.

## RESULTS

Comparison of enamel mineral content among the three finger print patterns revealed that, **regarding calcium**, totally, the loop pattern has the highest weight percent followed by arch pattern then whorl pattern and the difference was statistically significant (p≤ 0.05), there were statistically significant differences between loop pattern compared with whrol and arch patterns while there was no significant difference between whrol and arch patterns. Comparison among the different enamel areas indicated that, totally there were no statistically significant difference (p>0.05) among the three enamel areas regarding calcium (Table 1).

Comparison of each enamel area among the three different finger print patterns revealed that, there were significant differences among the calcium weight percent in the three enamel areas among the three finger print patterns (p≤ 0.05 for the three areas), the outer and middle enamel areas of loop pattern have the highest weight percent of calcium compared with those of whrol and arch patterns and the differences were statistically significant. On the other hand, calcium weight percent in inner area of whrol pattern was the lowest among the three patterns and the differences were significant compared to inner enamel areas of loop and arch patterns (Table 1 and Figure 3).

Comparison among the three enamel areas of each finger print patterns revealed that, in loop and arch finger print patterns, there were significant differences among the calcium weight percent in the three enamel areas (p≤ 0.05) while there was no significant difference among them in whrol pattern (p> 0.05). For loop pattern the highest calcium weight percent was in outer area and the difference was significant between outer and inner areas. For arch pattern the highest calcium weight percent was in inner area and the differences were significant between it compared to outer and middle areas (Table 1 and Figure 3).

TABLE (1) The weight percent of calcium in different enamel layers of deciduous teeth in relation to finger print pattern

| Pattern (No) / Layers (No) | Loop (10) Mean ± SD | Whrol (10) Mean ± SD | Arch (10) Mean ± SD | Total (30) Mean ± SD | p |
|---|---|---|---|---|---|
| Outer (10) | 33.445 ± 0.903 [a,A, B] | 31.845 ± 0.554 [A] | 31.316 ± 0.199 [b, B] | 32.202 ± 1.099 | p≤ 0.05 |
| Middle (10) | 33.215 ± 0.581 [C,D] | 31.547 ± 0.873 [C] | 31.286 ± 0.205 [c, D] | 32.014 ± 1.054 | p≤ 0.05 |
| Inner (10) | 32.615 ± 0.156 [a, E] | 31.540 ± 1.020 [E,F] | 32.656 ± 0.197 [b, c, F] | 32.270 ± 0.786 | p≤ 0.05 |
| Total (30) | 33.092 ± 0.701 [H,I] | 31.644 ± 0.822 [H] | 31.753 ± 0.677 [I] | | p≤ 0.05 |
| p | p≤ 0.05 | p> 0.05 | p≤ 0.05 | p> 0.05 | |

***(No) = Number of samples. p= The p value calculated by One way ANOVA test to compare the mineral weight percent among the three finger print patterns and the three enamel layers.***

***Similar capital letters mean statistical significant difference for calcium weight percent between every two corresponding finger print patterns. Similar small letters mean statistical significant difference for calcium weight percent between every two corresponding enamel layers (p ≤ 0.05) (Post-Hoc Tukey test).***

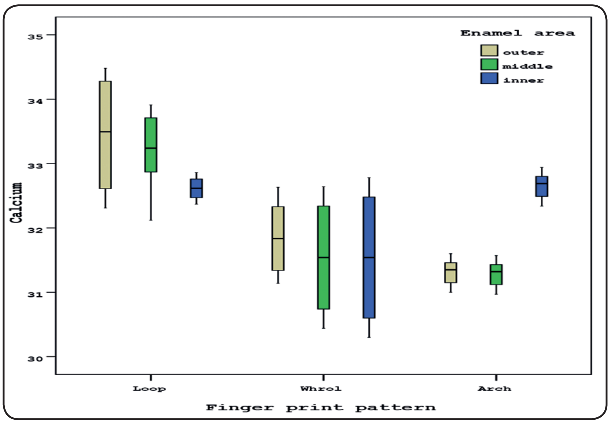


Fig. (3) Calcium weight percent of different enamel areas in relation to finger print pattern

**Regarding phosphorus**, totally the arch pattern has the highest weight percent among the three patterns followed by loop pattern then whrol pattern and the difference was statistically significant (p≤ 0.05), there were statistically significant differences between whrol compared with loop and arch patterns while there was no difference between loop and arch patterns. Comparison among the different enamel areas indicated that, totally there were no statistically significant difference among the three enamel areas regarding phosphorus (p> 0.05) (Table 2).

There were no significant differences in the phosphorus weight percent among the three finger print patterns in the outer and inner areas (p> 0.05) while in the middle enamel area there was significant difference among them (p≤ 0.05), the phosphorus weight percent was the lowest in whrol pattern compared to loop and arch patterns and the differences were statistically significant (Table 2 and Figure 4).

There were no significant differences among the phosphorus weight percent of the three enamel areas in loop and whrol patterns (p> 0.05) while in arch pattern there was significant difference among the three areas (p≤ 0.05) and the highest phosphorus weight percent was in middle areas compared to outer and inner areas and the differences were statistically significant (Table 2 and Figure 4).

**For total minerals (Ca + P)**, in general the loop pattern has the highest weight percent followed by arch pattern then whorl pattern and the difference was statistically significant (p≤ 0.05), there were statistically significant differences between loop pattern compared with whrol and arch patterns

TABLE (2) The weight percent of phosphorus in different enamel layers of deciduous teeth in relation to finger print pattern

| Pattern (No) / Layers (No) | Loop(10) Mean ± SD | Whrol(10) Mean ± SD | Arch(10) Mean ± SD | Total (30) Mean ± SD | p |
|---|---|---|---|---|---|
| Outer (10) | 20.415 ± 0.335 | 20.535 ± 0.262 | 20.510 ± 0.214 [a] | 20.487 ± 0.273 | p> 0.05 |
| Middle (10) | 20.570 ± 0.277 [A] | 20.060 ± 0.579 [A,B] | 20.980 ± 0.236 [a,b,B] | 20.537 ± 0.539 | p≤ 0.05 |
| Inner (10) | 20.655 ± 0.292 | 20.355 ± 0.499 | 20.710 ± 0.224 [b] | 20.567 ± 0.384 | p> 0.05 |
| Total (30) | 20.547 ± 0.309 [C] | 20.310 ± 0.492 [C,D] | 20.733 ± 0.292 [D] | | p≤ 0.05 |
| p | p> 0.05 | p> 0.05 | p≤ 0.05 | p> 0.05 | |

***(No) = Number of samples.*** ***p= The p value calculated by One way ANOVA test to compare the mineral weight percent among the three finger print patterns and the three enamel layers.***

***Similar capital letters mean statistical significant difference for phosphorus weight percent between every two corresponding finger print patterns. Similar small letters mean statistical significant difference for phosphorus weight percent between every two corresponding enamel layers (p ≤ 0.05) (Post-Hoc Tukey test).***

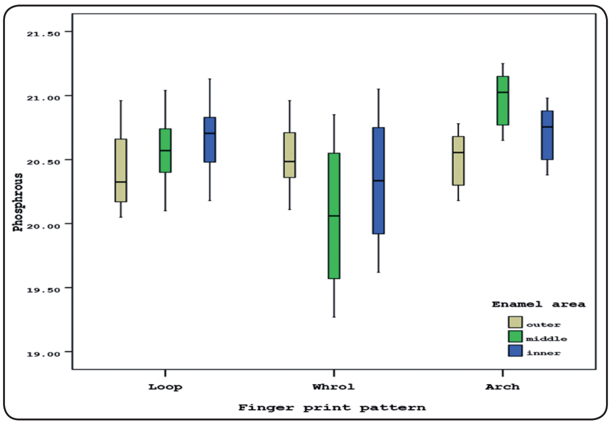


Fig. (4) Phosphorus weight percent of different enamel areas in relation to finger print pattern

while there was no significant difference between whrol and arch patterns. Comparison among the different enamel areas indicated that, totally there were no statistically significant difference among the three enamel areas regarding total minerals (Ca + P) (p> 0.05) (Table 3).

On comparison among the three finger print patterns, there were statistically significant differences among them for the three enamel areas (p≤ 0.05), the outer and middle enamel areas of loop pattern have the highest weight percent of (Ca + P) compared with those of whrol and arch patterns and the differences were statistically significant, on the other hand, (Ca + P) weight percent in inner area of whrol pattern was the lowest among the three patterns and the differences were statistically significant compared to loop and arch patterns (Table 3 and Figure 5).

Comparison among the three different enamel areas in each finger print pattern indicated that, there were no significant differences among the (Ca + P) weight percent among the three enamel areas of loop and whrol patterns (p> 0.05). On the other hand, there was significant difference among them in arch pattern (p≤ 0.05), the weight percent was the lowest in the outer area compared to middle and inner areas and the differences were statistically significant, also, the total minerals was significantly higher in inner layer than middle layer (Table 3 and Figure 5).

Table (3) The weight percent of minerals (Ca + P) in different enamel layers of primary teeth in relation to finger print pattern

| Pattern (No) / Layers (No) | Loop (10) Mean ± SD | Whrol (10) Mean ± SD | Arch (10) Mean ± SD | Total (30) Mean ± SD | p |
|---|---|---|---|---|---|
| Outer (10) | 53.860 ± 0.686 [A,B] | 52.380 ± 0.778 [A] | 51.826 ± 0.339 [a, b ,B] | 52.689 ± 1.063 | p≤ 0.05 |
| Middle (10) | 53.785 ± 0.548 [C,D] | 51.600 ± 1.442 [C] | 52.266 ± 0.337 [a, c, D] | 52.550 ± 1.280 | p≤ 0.05 |
| Inner (10) | 53.270 ± 0.375 [E] | 51.875 ± 1.507 [E,F] | 53.366 ± 0.333 [b, c, F] | 52.837 ± 1.124 | p≤ 0.05 |
| Total (30) | 53.638 ± 0.595 [G,H] | 51.952 ± 1.283 [G] | 52.486 ± 0.733 [H] | | p≤ 0.05 |
| p | p> 0.05 | p> 0.05 | p≤ 0.05 | p> 0.05 | |

***(No) = Number of samples.*** ***p= The p value calculated by One way ANOVA test to compare the mineral weight percent among the three finger print patterns and the three enamel layers.***

***Similar capital letters mean statistical significant difference for mineral weight percent between every two corresponding finger print patterns. Similar small letters mean statistical significant difference for mineral weight percent between every two corresponding enamel layers (p < 0.05) (Post-Hoc Tukey test).***

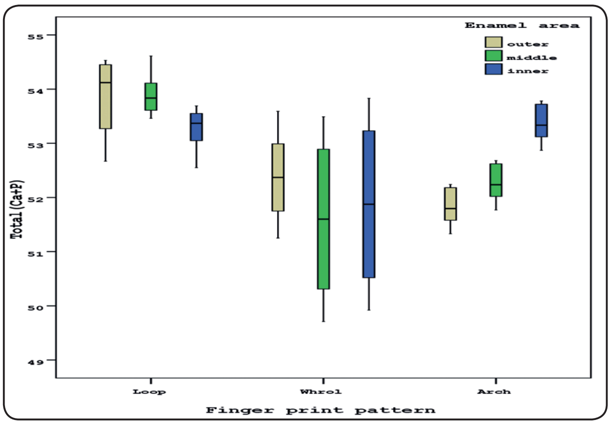


Fig. (5) Total (Ca + P) weight percent of different enamel areas in relation to finger print pattern

## DISCUSSION

The present study was designed to evaluate the minerals weight percent among different finger print patterns as the results of our previous study indicated that, the whrol pattern finger print children were at high caries risk than the children with loop or arch pattern[12]. Enamel specimens were used for comparing the minerals content of the different finger print pattern because the enamel has 95% mineral and 1% organic matter and 4-5% water by weight percentage[13]. Dental caries experience was more common among children who had enamel hypoplasia in their posterior teeth than among those with none[14-16].

SEM- EDAX was used in the present study for quantifying the mineral contents because it is a specific method to quantify the weight percent of chemical elements on substance surfaces and is largely used in engineering and chemistry and recently, it has been widely used in dental research to evaluate the elemental Ca and P content of teeth[17,18].

The present results demonstrated that minerals content varies substantially between the three finger print patterns and it was also observed that, the whrol enamel has the least minerals content followed by arch pattern and then loop pattern. These decreased minerals content may illustrate the previous results of increased caries risk among children with whrol finger print pattern[12,19]. Also the results of the present study support the previous studies which have been suggested that the lower minerals content may be translated into increased caries susceptibility and agreed with other studies which hypothesized that, minerals content may be a factor determining rate of demineralization/remineralization as well[20-22].

The results of the present study indicated that, the mineral content was higher in the outer enamel area of loop pattern than other areas in all patterns, this illustrate the more resistance of loop pattern to caries than the other patterns.

The present study is the first quantitative evaluation of mineral content (Ca and P) of the primary enamel teeth in relation to the different finger print patterns. This early identification of the individual with different finger print patterns as well as overall low mineralization of the enamel may be a valuable screening tool in determining a child with much higher than average caries risk, allowing intervention before development of caries.

## CONCLUSIONS

There was a relationship between finger print patterns and mineral content of enamel, enamel of whrol pattern finger print children exhibits the lowest mineralization content. The finger print pattern can be used as a non invasive anatomical marker for assessment of patient's susceptibility to developing caries, thus increasing the opportunity to prevent the dental caries before its initiation through different preventive programs.

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