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Comparative analysis of Ameloglyphics, dermatoglyphics and Blood groups

[1]Singroha K, MDS PhD Scholar, Department of Smart Health Care, AIIMS Jodhpur, India.

[2]Saxena M, Department of Prosthodontics & Oral Implantology, Consultant Prosthodontist, GDC Hyderabad, Dr. Knruhs, Hyderabad, India.

[3]Kamath VV, Department of Oral Pathology, Principal, Professor and Head, SGR Dental College, Bengaluru, India.

[4]Jahagirdar D, BDS, GDC Hyderabad, Dr. Knruhs, Hyderabad, India.

[5]Sharma M, Department of Smart Health Care, BDS, Post graduate trainee, AIIMS-IIT, Jodhpur, India.

[6]Singh K, MDS, Department of Prosthodontics, Medical officer Dental, CHC Lohwat Jodhpur, India.

Corresponding Author: Saxena M, Department of Prosthodontics & Oral Implantology, Consultant Prosthodontist, GDC Hyderabad, Dr. Knruhs, Hyderabad, India.

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Abstract

Background: Tooth enamel being highly mineralized resists degradation to the maximum compared to other human tissues. Ameloglyphics is the science of recording and analyzing the teeth prints. Teeth prints are external manifestations of enamel rod ends, with a distinct pattern. These patterns can be recorded and analyzed like finger print patterns.

Aim: Identification of uniqueness, reproducibility and authenticity of enamel patterns and to analyze correlation between Ameloglyphics, dermatoglyphics and blood groups.

Materials and methods: Enamel patterns were registered in a standard procedure by ink transfer on a cellophane tape from etched tooth enamel surface. These prints were then subjected to Rapid Sizer® (sketched outline image software) to obtain a pattern. Finger prints and blood groups of the same individuals were then done following standard protocols.

Results: Enamel patterns were found to be organized into three broad groups; long prisms, short prisms and a combination of the two. Long prism pattern was seen in 55% of the subjects, 32.5% exhibited short prism and 12.5% long prism short prism pattern. Enamel patterns and finger prints showed a positive relationship (Pearson's correlation, +0.034). Comparison between enamel pattern-finger prints and enamel pattern-blood groups were statistically non-significant. There was more than 98% reproduction and specificity in the Ameloglyphics procedure. Manual Pattern sketching proved to be reliable and reproducible similar to those used in dermatoglyphics.

Conclusion: Ameloglyphics is easy, reliable and reproducible technique. Its use in forensic odontology in subject identification cannot be understated and may be used as a stand-alone tool.

Keywords: Ameloglyphics, blood groups, dermatoglyphics, enamel prints, forensic odontology.

Introduction

Advances in the study of disaster incidents have led us to optimize the development of more sound tools from sturdy substrates for disaster victim identification. Even though, DNA analysis is the most reliable method of identification, the feasibility of these methods is reduced when bodies are burned or decomposed severely.[1] Dermatoglyphics too can't be always counted upon due to its dependency on soft tissues that are easily friable.[2] Teeth are the most durable human tissues that can withstand thermal and physical insults to the maximum when compared to any other human tissue in a disaster scene. Enamel is a decorously designed natural bio-composite that acts as an outer cover of teeth structure, is the hardest, stiffest and one of the most durable load-bearing tissues of the human body[3]. Teeth contain a microscopic record of their growth below their surface and recite their growth story which is very individualistic of every tooth in a person through the pattern of enamel rods, analogous to tree rings. Bundles of crystallites known as prisms are fundamental units of enamel.[4]

The structural complexity is related to arrangement of these crystals. There exists a variation in crystal orientation which is a reflection of variation in the topography of the secretory surfaces of ameloblasts. Enamel surface carvings have been manifested by prism decussations. The undulation of prisms from side to side in a sinusoidal and helicoidal fashion is described as prism decussation.[5] Ameloglyphics is the science of recording and analyzing the teeth prints, manifested by the arrangement of prisms.[6] Dermatoglyphics is study of pattern of fine ridges on fingers, palms and soles. The type of finger print is unique and is based on genetic characters of each individual. Finger prints are regarded as the most reliable tool for personal identification. [7]

The present study aims to compare and analyze enamel prints (Ameloglyphics) with finger prints (dermatoglyphics) and blood groups of individuals. Correlations clinically and statistically are sought to be defined to predict the feasibility of utilization of any of the three investigative techniques in identification. Such an exercise would greatly augment existing techniques in forensic science and help in better identification of the individuals involved.

Materials and Methods

The sample size comprised of 40 randomly selected consenting adults. The study also satisfied the criteria laid by the Institutional Ethical Review Board. The study was carried out following the infection control protocol.

Ameloglyphics (Enamel Prints)

The study was carried out in vivo on intact labial surface of clinical crowns of maxillary permanent central incisors of randomly selected consenting subjects. Patients were subjected to oral prophylaxis before the enamel prints were registered. The labial surface of central incisor was then isolated, air dried and made saliva free with the help of cotton rolls. It was etched with 37% phosphoric acid for 45 seconds and rinsed with distilled water. The etched surface was then dried with 20% acetone carried on a cotton bud, applied for ten seconds.[8] Ink was impregnated on the marked area using pre-inked strips. Uniform pressure was applied to the ink strip by using cotton buds for 30 seconds. The print was lifted placing a cellophane tape, subjected to uniform pressure with cotton buds for 15 seconds. Tooth

mousse was then applied for 15 minutes. The print on cellophane tape was mounted on the slide. Microphotographs were taken at 10X magnification of an Olympus 20i microscope.

Pattern sketching

The image was then run through Rapid Sizer® image editing software to obtain a pattern (sketched outline image software). Rapid Sizer is a pattern sketching software identified from freeware's on the net. Permission was obtained from the developer prior to usage. This software outlined the prism images and created a sketch similar to that done by Veri finger for finger prints. The outlined patterns greatly enhanced the groupings of the enamel prints and its identification.

Testing reproducibility of prints

To ascertain accurate reproducibility of the print and authentication of the technique, three prints of the same tooth from each individual were taken by the author (KS) and compared. Three prints from the same tooth were lifted by the second author and the prints compared. To establish specificity and uniqueness in identification of the prints, multiple sets of A4 size copies of all the prints were taken on plain paper. A master set had the details of all the patients imprinted while the other sets had only coded numbers. The master set was spread on the table and random copies of the sets were given to all the departmental members for identification.

Dermatoglyphics (Finger Prints)

For taking the finger prints, Cummins ink method was used. Printer's ink was uniformly spread on a glass slab with the help of a roller. Left thumb prints were taken after washing the hands with soap water and after complete drying. The pattern of finger print, total and absolute ridge counts were observed with the help of hand lens. The finger print patterns were classified into loops, whorls and arches according to Henry's system of classification.[10]

Blood grouping

Blood groups were detected using standard protocols.[11]

Results

Analysis of Ameloglyphics

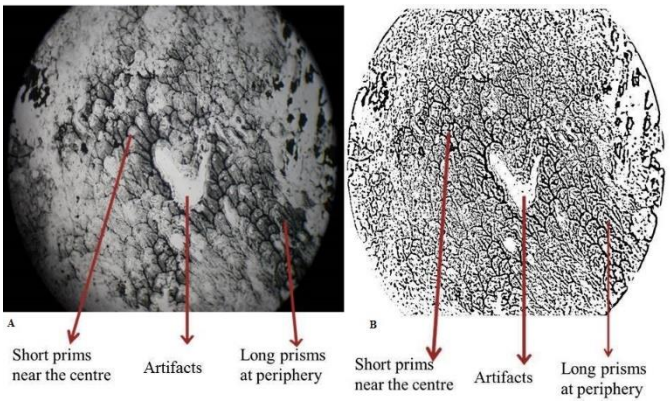

Fig. 1: The enamel prints resembled enamel prisms (A) Microphotograph of enamel print, (B) deduced pattern

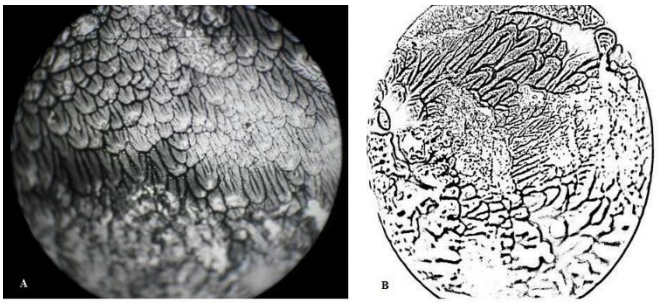

Fig. 2 (A): microphotograph of enamel print (LPP)

Fig. 2 (B): pattern showing long prism patterns (LPP)

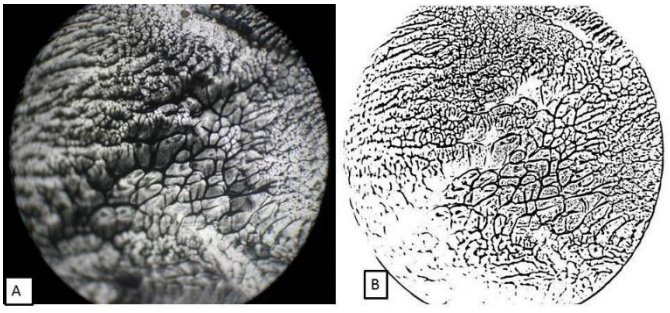

Fig. 3 (A): microphotograph of enamel print

Fig. 3 (B): pattern showing short prism pattern (SPP)

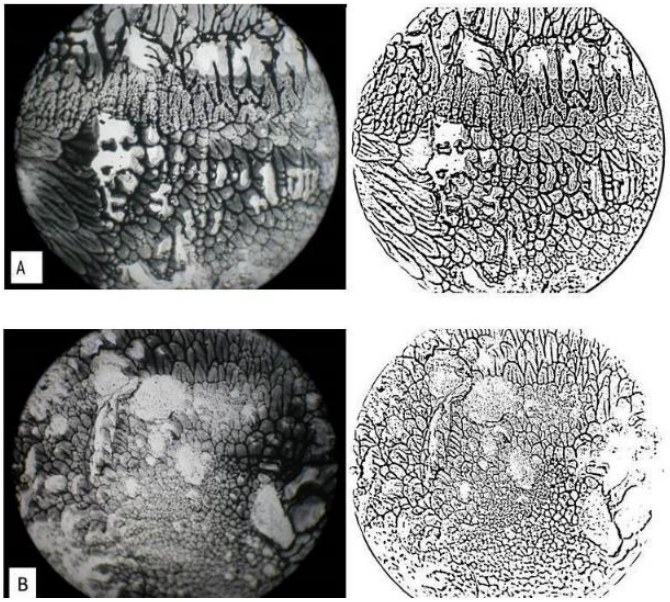

Fig. 4 (A): microphotograph of enamel print (LPSP)

Fig.4 (B): pattern showing long prism short prism patterns (LPSP).

The enamel prints resembled enamel prisms (Fig.1A and 1B) and were manually grouped into three categories.

1. Long prism patterns (LPP) (Fig.2A and 2B)
2. Short prism patterns (SPP) (Fig.3A and 3B)
3. Combination of the above (Long prism short prism (LPSP) (Fig.4A and 4B)

Long prism pattern was seen in 55% of the subjects, 32.5% exhibited short prism pattern and12.5% had a combination of long prism short prism pattern (Table I).

Upon comparison for reproducibility, feasibility and sensitivity of the above procedure, there was more than 98% reproduction, sameness and specificity amongst all the six prints of the same tooth.

Loop pattern was seen in 17 individuals, 13 individuals showed whorl pattern followed by 10 individuals with arch pattern. (Table II) A positive Pearson's correlation coefficient (r= + 0.034) was seen between enamel prints and finger prints. Pearson's chi-squared test (p=0.8) was observed to be statistically insignificant. (Table III)

14 individuals were recorded with O+ve and A+ve blood groups followed by 8 of them with B+ve and 3 individuals and 1 individual with AB+ve and A-ve respectively. (Table IV) Pearsons' coefficient correlation was recorded as -0.09 for the comparison between enamel pattern and blood groups. On application of Pearson's chi-squared test (p=0.5) was observed to be statistically insignificant. (Table V)

Table 1: Distribution of Enamel Patterns among the subjects. (Long Prism Pattern: LPP),
(Short Prism Pattern: SPP) (Combination of Long Prism Short Prism: LPSP)

Enamel pattern		
Type	No.	%
LPP	22	55
SPP	13	32.5
LPSP	5	12.5
Total	40	100

Table 2: Distribution of dermatoglyphics pattern in the subjects

Finger print pattern		
Type	No.	%
Whorl	13	32.5
Loop	17	42.5
Arch	10	25
Total	40	100

Discussion

Enamel is composed of 2.5 mm long enamel rods made of millions of hydroxyapatite crystals.[6] Ameloblasts surge in their course during the formative stage render a unique pattern to enamel specific to every species. Any alterations at the time of development are reflected as disturbance in the structure of enamel.[4, 5] Enamel prints cocooned in the teeth can serve as hard cognate to finger print patterns as in dermatoglyphics for forensic use.

In this study we found that it is possible to register prints from enamel similar to dermatoglyphics. Enamel structure is dictated by regulated gene expression,

thereby establishing a unique pattern for every individual.[12]

Table 3: Correlation between Finger print pattern and Enamel pattern.

		Enamel pattern				Pearson's R	P-value
		LPP	SPP	LPSP	Total		
Finger print pattern	Whorl	7	5	1	13	0.034	0.834
	Loop	10	4	3	17		
	Arc	5	4	1	10		
	Total	22	13	5	40		

Print patterns obtained in the present study too were very unique and specific to a particular individual.

The enamel prisms assume one of the three main patterns;

I: Prisms are circular,

II: Parallel alignment of prisms into rows and

III: Staggered rows of prisms with tail of prisms that lies between two heads in next row, rendering key hole appearance.[13]

The microphotographs of the prints correspond to the above patterns of enamel as seen under Electron Microscope, thereby establishing the authenticity of the technique used.[14] The enamel prints for teeth registered in the present study showed a similar combination of prism patterns which form the basis for identification. We have corroborated the expression of the pattern by SEM in a parallel study in the department.[23]

Table 4: Distribution of Blood Groups among the Subjects

Blood group		
Type	No.	%
O+	14	35
AB-	1	2.5
A+	14	35
B+	8	20
AB+	3	7.5
Total	40	100

The significant feature of this technique is the print pattern corresponds to the prism pattern of the enamel rods. The method employed is feasible and reproducible. When the master set was compared with random copies of the sets, a 100% recall and match of all the prints were obtained.

The present technique appears to be amenable to assessment by digital software. Photographs of the prints were digitized into image files at standard magnification and resolution using Adobe Photoshop v12.0. These images were then run through a pattern producing software Rapid Sizer which creates wavy patterns of the images. The patterns etched were highly descriptive, clear and outlined all variations captured in the ink-prints. The long and short prism pattern were then manually highlighted and classified for each sample. Double blind assessment of these patterns resulted in a 100% match and reproducibility. The present technique is similar to the Veri finger software used for identification of finger prints. Electronic-storage is thus possible by creating a database from images for identification. The only drawback in the present method is the lack of automated software for match from a database. The department is engaged in the creation of such software.

Analysis of correlation between dermatoglyphics and Ameloglyphics by Pearson's chi-squared test ($p=0.8$) was observed to be statistically insignificant, indicating that development of teeth print patterns and finger prints are not related.

Table 5: Correlation between Blood Group and Enamel pattern

		Enamel pattern				Pearson's R	P-value
		LPP	SPP	LPSP	Total		
Blood group	O+	8	4	2	14	-0.09	0.581
	AB-	1	0	0	1		
	A+	6	5	3	14		
	B+	4	4	0	8		
	AB+	3	0	0	3		
	Total	22	13	5	40		

Any organ in the human body is morphologically designed to accomplish the functions of that organ. Similarly, development of ridges and depressions on digits is believed to enhance grip and tactile sensation.[15, 16] Whereas in teeth the print pattern are rendered by enamel rods that serve to support and protect the underlying dental tissues. Such a presentation of ridges cannot be appreciated on teeth to serve as template for recording of minute, which are basic units in dermatoglyphics.[17]

There was no significant correlation obtained for Ameloglyphics and blood group as well, (p=0.5) on application of Pearson's chi-squared test.

Duplication of enamel rod end pattern can be obtained by various techniques such as using cellophane tape, rubber impression materials and cellulose acetate paper technique.[18] Use of cellophane technique is highly economical both in terms of procedure involved and storage. The cellophane tapes with prints captured on them can be mounted on the slides and stored for future use. The micro photographs of the same can also be used for electro storage.

When compared to cellophane technique, acetate peel technique is more technique sensitive and also the procurement of cellulose sheets is rather cumbersome. Moreover, the surface has to be reground each time a serial peel is needed unlike in cellophane technique where a one-time etch would suffice multiple collection of prints. In the cellophane tape technique prints are recorded by the virtue of ink transfer give a clear image at a scanner view (considered best to recognize patterns under light microscopy) unlike in peel technique where pattern is best visible only at higher magnification 40x (higher magnification limits the area of focus). Electronic storage is equally feasible with both the techniques both rely on captured images for pattern analysis.

Use of specialized tools such as biometrics to deduce patterns of the enamel rod arrangement have been listed in the literature. The microphotographs of the prints obtained using acetate peel technique were subjected to biometrics using Veri finger® software. Certain points called minute in the form of discontinuous lines, line endings or dots have been used by this software for identification and comparision.[19,20] Such tools have certain drawbacks, variations can occur in spite of standardization as inclusion and deletion of a single cluster of enamel rods will lead to variation in minute score.[21] The application of such a software for producing patterns in Ameloglyphics is questionable as it has been programed for a specific purpose that is to deduce pattern for finger prints, using minute present on ridges. The software does not process images captured as microphotographs instead it takes up images directly from the scanner for creating a data.[22] It would produce results in the same fashion for any kind of input as it does for finger prints.

Presence of automated software designed exclusively for Ameloglyphics would help in establishment of Ameloglyphics as a reliable tool in personal identification and maintaining identification records.

Ameloglyphics can be proved to be a potent tool in maintaining personal identification records as it is unique, non-intrusively acquired and can be stored as easily transmittable form of database.

Conclusion

Ameloglyphics is easy, reliable and reproducible technique. Its use in forensic odontology in subject identification cannot be understated and may be used as a stand-alone tool.

Acknowledgment

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