

Pattern self-repetition of fingerprints, lip prints, and palatal rugae among three generations of family: A forensic approach to identify family hierarchy


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Abstract

Context: The unique pattern and structural diversity of fingerprints, lip prints, palatal rugae, and their occurrence in different patterns among individuals make it questionable whether they are completely unique even in a family hierarchy? Do they have any repetition of the patterns among the generations? Or is this a mere chaos theory? **Aims:** The present study aims to assess the pattern self-repetition of fingerprints, lip prints, and palatal rugae among three generations of ten different families. **Settings and Design:** The present study was conducted at Rungta College of Dental Science and Research, Bhilai, India. Participants birth by origin of Chhattisgarh were only included in the study. **Subjects and Methods:** Thirty participants from three consecutive generations of ten different families were briefed about the purpose of the study, and their fingerprints, lip prints, and palatal rugae impression were recorded and analyzed for the pattern of self-repetition. **Statistical Analysis Used:** Multiple comparisons among the generations and one-way analysis of variance test were performed using SPSS 20 trial version. **Results:** Among the pattern of primary palatal rugae, 10% showed repetition in all the three generations. Thirty percent showed repetition of the pattern of thumb fingerprints in all the three generation. The pattern of lip prints in the middle 1/3rd of lower lip, 20% showed repetition in alternative generations. **Conclusions:** The evaluations of fingerprints, lip prints, and palatal rugae showed fractal dimensions, occurring variations in dimensions according to the complexity of each structure. Even though a minute self-repetition in the patterns of lip, thumb, and palate among the three consequent generations in a family was observed considering the sample size, these results need to be confirmed in a larger sample, either to establish the role of chaos theory in forensic science or identifying a particular pattern of the individual in his family hierarchy.

Key words: Chaos theory, family hierarchy, fingerprints, lip prints, palatal rugae, pattern self-repetition

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Introduction

The diversity in fingerprints, lip prints, and palatal rugae comprises the part of nonlinear geometry in human body. Other examples include the fractal distribution of intestinal villa, dynamic organization of the immune system, and projection of the dendrites of multipolar neurons. The brain anatomy, specifically the grooves, shows a pattern of self-similarity, comprising an extensive area of cerebral cortex in this portion.^[1]

The human fingerprint is a unique pattern that is, intrinsically linked to each individual. No two fingerprints are identical, which greatly assists in its role in forensic identification. Lip prints are similar to fingerprints where individual characteristics of grooves and furrows are used for identification. Lip prints are unique and do not change during the life of a person. "Palatal rugoscopy" which is the study of palatal rugae, has been equated with fingerprints and are unique to an individual.^[2] These are the irregular transverse ridges radiating outward from the palatine raphe in the anterior half of the hard palate.^[3]

No two fingerprints are identical. Identity is established or denied by the minutia of smaller detail. The ending ridges, bifurcations or forking of ridges, the islands or enclosures, the short ridges and dots that make up the patterns, and the surrounding friction skin area determine whether or not fingerprint as made by the same finger. It is not only the appearance of these details in the fingerprint but their relative position to each other is also a major factor in the identification procedural process.^[4] The design and structure of palatal rugae are unchanged and are not altered by chemicals, heat, disease, or trauma, or if they are destroyed, they are reproduced exactly on the same site they were located.^[5]

Establishing a person's identity can be a difficult and challenging process in forensic identification. Dental, fingerprints, and DNA comparison are most common techniques used.^[6] The dental identification represents the most useful scientific methods in mass disasters, success rate being 75%.^[5] The theory of uniqueness is a strong point used in the analysis of fingerprints and bite marks to convince the court of law. Likewise, even lip prints and palatal rugae patterns are considered to be unique to an individual, and hence, hold the potential for identification.^[6]

However, their unique pattern and structural diversity and their occurrence in different patterns among individuals make it questionable whether they are completely unique even in a family hierarchy. Do they have any repetition of the patterns among the generations or is this a mere chaos theory. The present study aims to assess the pattern self-repetition of fingerprints, lip prints, and palatal rugae among three consequent generations of ten

different families from the population of Central India (Chhattisgarh).

Subjects and Methods

The present study was conducted at Rungta College of Dental Science and Research, Bhilai, India. The study participants included three consecutive generations of ten different families. Participants birth by origin of Chhattisgarh were only included in the study. Participants with any inflammation, trauma, congenital deformity, or any other disease of the lips, skin, and palate and with any known hypersensitivity to the lipstick, Indian ink, and alginate impression material were excluded from the study. The research protocol was initially submitted to the institutional ethical committee and review board of Rungta College of Dental Science and Research, Bhilai. The ethical clearance was obtained before commencing the study.

All the participants were briefed about the purpose of the study, and their fingerprints, lip prints, and palatal rugae impression were recorded with their due verbal and written consent. The materials used in the study were Indian ink, nonglossy lipstick of a dark color (Lakme Enrich, Hindustan Lever Ltd., India), scissors, white bond paper, transparent cellophane tape, magnifying lens, alginate impression material, and impression trays [Figure 1].

Fingerprint recording procedure

The collection of fingerprints was performed by impression of the right thumb and left thumb on paper using the blue pigment ink.

The fingerprints were categorized according to the classification of Vucetich^[7] (Vucetich, 1904), which divides the fingerprints into four main groups: (1) arch; (2) internal clip; (3) external clip; and (4) verticil [Figure 2].



Figure 1: Materials used in the study were Indian ink, nonglossy lipstick of a dark color (Lakme enrich, Hindustan Lever Ltd., India), scissors, white bond paper, transparent cellophane tape, magnifying lens, alginate impression material, and impression trays

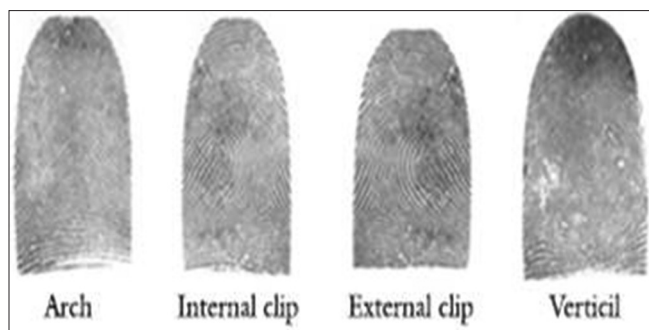


Figure 2: Vucetich classification of fingerprints

Lip print recording procedure

Participant's lips were cleaned with sterile gauze before application of lipstick. The participant was asked to open the mouth and lipstick was applied in a single motion on both the lips. The participant was asked to gently rub his/her lips together to spread the lipstick evenly on the both lips. A cellophane tape measuring about 5 cm × 5 cm is applied evenly on the participant's lips. After application of even pressure, the cellophane tape is removed and is pasted on white bond paper. The lip prints were studied carefully using a magnifying glass in bright light to identify and classify. The middle part of the lower lip was considered for classification as this fragment is usually visible in any trace and most frequently found at the crime scene. The classification scheme proposed by Tsuchihashi (1974) was used to analyze the lip prints.

- Type I: Clear-cut vertical grooves that run across the entire lips
- Type II: Branched grooves
- Type III: Intersected grooves
- Type IV: Reticular grooves
- Type V: Grooves do not fall into any of the above categories and cannot be differentiated morphologically (undetermined).

Palatal rugae recording procedure

Alginate impression of maxillary arch was made and the study models were prepared in dental stone for interpretation. The rugae were delineated using a sharp graphite pencil and recorded according to the classification given by Thomas and Kotze (1983). The shapes of individual primary rugae were classified into four major types: curved, wavy, straight, and bifurcated [Figure 3]. Straight type of palatal rugae was present as straight line from their origin to insertion. The curved type had a crescent shape with a gentle curve. Wavy rugae were serpentine in shape and rugae that showed definite branching were bifurcated type. In addition, nonspecific rugae pattern was observed, which did not fall in any of the mentioned classes.

Results

Ten families included all the three generations comprised thirty participants of which 25 were males and five were

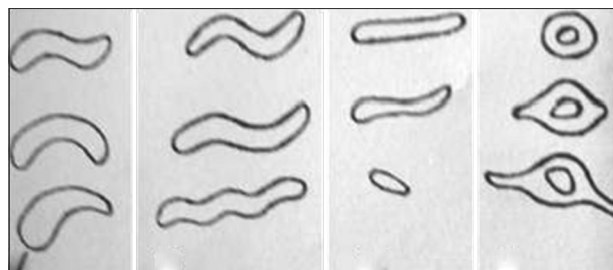


Figure 3: The shapes of individual primary rugae were classified into 4 major types: Curved, wavy, straight, and bifurcated

females. The first-generation participants' age group ranged from 65 to 80 years, second generation participants' age group ranged from 35 to 56 years, and third generation participants' ranged from 7 to 19 years. Among these families, 30% showed repetition of the pattern of thumb fingerprints in all the three generations. Fifty percent showed repetition in two consecutive generations. Ten percent showed repetition in alternative generations and 10% showed no repetition in any generation. The pattern of lip prints in the middle 1/3rd of lower lip, 20% showed repetition in alternative generations, and 40% showed repetition in consecutive generations while 40% showed no similarity in any generation. Among the pattern of primary palatal rugae, 10% showed repetition in all the three generations, 20% showed repetition in two consecutive generations, 10% showed repetition in alternative generations, and 60% showed no repetition in any generation at all.

Multiple comparisons within the group and analysis of variance test between the groups were done using IBM SPSS statistics for windows (Armonk, NY: IBM Corp.), 20 trial version. Multiple comparisons of thumb prints within the group, the 95% confidence interval lower bound and upper bound were 0.2758 and 1.2785 and the sum of squares between groups of thumbprint was 1.667, $P = 0.327$; lower lip print was 2.600, $P = 0.183$; palatal rugae was 8.067, $P = 0.106$, which were not significant ($P > 0.005$) owing to the insufficient sample size [Figures 4-7].

Discussion

Chaos theory concerns deterministic systems whose behavior can be predicted. Chaotic systems are predictable for a while and then "appear" to become random. Chaos theory remains unexplored when it comes to forensic science. This study is first of its kind where the individual patterns of fingerprint, lip print, and palatal rugae are evaluated in three consecutive generations of different families. Each of the structure is unique in its own way with varying dimensions and complexity making it the characteristic identification feature of an individual.

The fingerprint patterns recorded in our study were arch, external clip, internal clip, and verticil. Among these patterns,

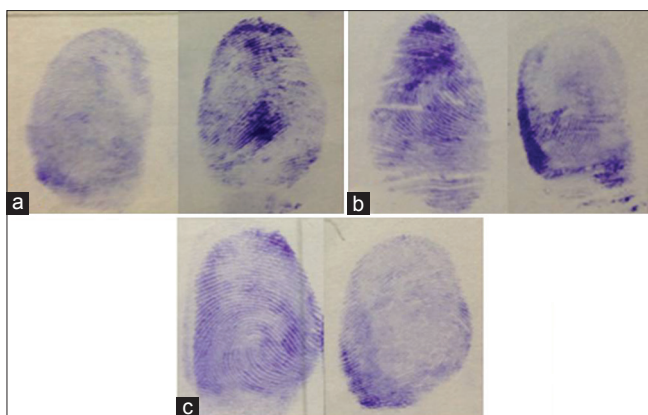


Figure 4: Thumb prints of three consecutive generations of a family. (a) Grandfather, (b) father, (c) son



Figure 6: Palate impressions of three consecutive generations of a family. (a) Grandfather, (b) father, (c) son

the external clip and internal clip showed maximum self-repetition in the three generations. Thirty percent showed repetition of the pattern of thumb fingerprints in all the three generations. Fifty percent showed repetition in two consecutive generations. Ten percent showed repetition in alternative generations and 10% showed no repetition in any generation.

In a family fingerprint project conducted by Gaye 1970, similar results were obtained. He recorded the fingerprints of all the fingers of both hands from the participants belonging to first to fourth generation. He found that specific patterns were fixed to certain fingers. Index fingers contain a combination of whorl and radial loops while whorl and ulnar loops in thumb and middle finger. All the fingerprints were recorded and examined to discover instances in which there were minute areas which have been repeated. There were no similarities between any two fingerprints between any two family members but found a few self-repetition of patterns, for example, whorl pattern in little finger of first generation to repeat in second generation member 5.^[4] In our study also, the thumb print patterns were found to be repeated either in all the three generations, in first and second, or second and third and first or third.

Devi et al. 2007 conducted a study of inheritance analysis and evaluation of lip prints in 300 individuals (25 families).



Figure 5: Lip prints of three consecutive generations of a family. (a) Grandfather, (b) father, (c) son

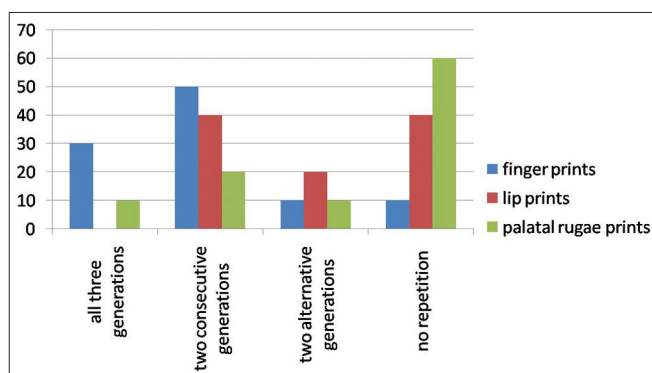


Figure 7: Graph showing pattern self-repetition of fingerprints, lip prints, and palatal rugae among three generations of family hierarchy

The determination of pattern in each segment of lip was based on the numerical superiority of properties of lines on the fragment. They found the presence of hereditary resemblance between parent and offsprings was 37.66%.^[8] In our study, the lip print patterns recorded were Type I, Type II, Type III, and Type IV among which 20% showed self-repetition in alternative generations and 40% showed repetition in alternative generations.

Studies of the inheritance of palatal rugae show varying results. Twin and family studies by Ritter (1943), Nilles (1950, 1952), Klenke (1951), and Lysell (1955) suggest an appreciable hereditary component, but this varies in extent in the different investigations and also from feature to feature.^[9] However, in our study, the shape of the primary palatal rugae was selected and analyzed for the self-repetition among the three generations, only 10% showed repetition in all the three generations, 20% showed repetition in two consecutive generations, 10% showed repetition in alternative generations, and 60% showed no repetition in any generation at all.

Many behaviors and structures of the human body behave unknown or not so well understood. Chaos theory could explain a wide range of events and justify the presence and morphology of certain structures in accordance with the need to survival of the human showing complexity,

dynamism, and adaptive capacity, that is, necessary to maintain a homeostatic condition by demonstrating that linearity is almost always associated with some condition that induced disease in humans.^[1]

This study summarizes the fact that despite the unique structure of fingerprints, lip prints, and palatal rugae there may be a particular pattern self-repetition in the family hierarchy which can help in identification of family hierarchy.

Conclusions

We can conclude that the evaluations of fingerprints, lip prints, and palatal rugae showed fractal dimensions according to the complexity of each structure. A minute self-repetition in the patterns of lip, thumb, and palate among the three consequent generations in a family was observed considering the sample size; these results need to be confirmed in a larger sample, either to establish the role of chaos theory in forensic science or identifying a particular pattern in family hierarchy.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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