Palatal Rugae Pattern Identification to Determine Family Lineage in Minangkabau, West Sumatera, Indonesia

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Abstract
This paper discusses the use of palatal rugae patterns and their contribution in the identification of individuals and the determination of family lineage in West Sumatera, Indonesia. Identifying an individual is a prerequisite for the issuance of the death certificate and for personal, social and legal reasons. The most common techniques used in this context are dental records, fingerprint and DNA comparisons. However, under certain circumstances, these cannot always be used. But interestingly palatal rugae patterns are preserved and can be used as alternatives. This paper argues that the study of palatal rugae (rugoscopy) can help reveal a person's identity and determine family lineage.

Objective:
The present study was carried out to ascertain whether there is any hereditary patterns in the palatal rugae patterns of the mother, father, and the offpring in one family.

Method:
This is a cross sectional study of 48 samples consisting of 12 families in *Luhak Nan Tigo*. The parents and offspring (son or daughter) of each family were randomly selected. Palatal rugae impression was recorded using alginate while palatal rugae patterns were noted and recorded. *One Way ANOVA* test (SPSS 17) was used as statistical anaysis method.

Result :
The study shows that there is a significant similarity in curved, wavy, and straight rugae patterns ($p > 0.05$) as well as in primary, secondary, and fragmented rugae based on the family tie between the father, mother, sons and daughters of the *Minangkabau* ethnic. Unilateral and circular rugae tests are insignificant ($p < 0.05$).

Conclussion :
This is a cross sectional study whose results are only based on 48 samples consisting of 12 families, therefore further studies are needed with a larger sample quantity. The results of this study indicate the role of factors in the patterns of palatal rugae.

Keyword: Palatal Rugae, Pattern Identification , *Minangkabau* Family Lineage.

Introduction

Many South-East Asia countries, including Indonesia, have been struck by several natural disasters in the past decades. In the last couple of years, Indonesia alone has dealt with more than 400 natural disasters of which floods, fires, typhoons and landslides are the most common. In addition to this, destructive disasters such as earthquakes, tsunamis and volcano eruptions also occur on a yearly basis.[17] In Indonesia, five provinces out of 10 have suffered the most catastrophic disasters. These provinces are: West Nusa Tenggara, South Sulawesi, North Sumatera, East Borneo and West Sumatera. As an area located around the coast of Sumatera, West Sumatera is one of the disaster-prone areas.[22] Natural disasters have caused the loss of the lives of ten of thousand of West Sumatran people. Sadly however, many of these victims had not been identified due to lack of financial or material means to conduct identification procedures. Identifying an individual is a prerequisite for the issuance of their death certificate and for personal, social and legal reasons. In forensic, the main methods of human identification used are the DNA test, retina, fingerprints and dental characteristics. DNA testing is the gold standard in forensic science but it is very costly and cannot be conducted by everybody. In many instances, one or all of these methods may not be totally effective or conclusive.[11] Hence the need for the study of palatal rugae as an alternative method for the scientific identification of individuals. Forensic odontology has played a key role in the identification of persons in mass disasters, in crime investigations, in ethnic studies, and in the identification of decomposed and disfigured bodies like that of drowned persons, fire victims, and victims of motor vehicle accidents.[18] The various methods employed in forensic odontology include rugoscopy, cheiloscopy, bite marks, tooth prints, radiographs, photographic study, and molecular methods.[9] When these methods of identification are unavailable, rugae may be considered as an alternative source of information facilatate the identification process.[11] There are several methods that help classifies palatal rugae. The most frequent used is the classification given by Thomas and Kotze,[10] which classifies Palatal rugaes in three categories based on their length: Primary rugae (more than 5 mm in length), secondary rugae (3-5 mm in length) and fragmented rugae (<2 mm in length). The patterns of the rugae are classified into curved, wavy, straight and circular types. Straight patterns have a direct course from the point of origin to their insertion in a straight line. Curved patterns have a crescent shaped pattern with a mild curvature. Wavy rugae are serpentine in shape. Rugae with specific continuous ring type morphology are classified as circular. Unified rugaes are united either in their origin or in their insertion giving a forked appearance. These are the patterns involved in this study conducted to assess the association of palatal rugae patterns among family members of the *Minangkabau*, a subgroup of the *Deutro Malay* ethnic, which consist of *Aceh, Malay*, *Minahasa, Bugis, Makasar*, *Sasak*, *Bali, Java*, and *Minangkabau*.[6]

Method

This research was conducted in *Luhak Nan Tigo* located at *Guguak*, *Situjuh*, and *Tanjung* Sub-districts in the District of *50 Kota*, *Tanjung Baru* subdistrict situated at the District of *Luhak Tanah Datar*, and in *Baso*, *Banuhampu*, and *Tanjung Raya* Subdistricts located at the District of *Luhak Agam*. The study was conducted from January to June 2017. A total of 489 palatal rugaes were observed in 48 palatal rugae models from 12 families. The study was conducted with the door to door system in each subdistrict. Prints of jaws of the respondents were obtained after the research was explained to them and informed consent was provided. The Commitee of the Research Ethics

of the Faculty of Medicine, Andalas University, with regard to the protection of human rights and welfare in medical health research has carefully reviewed the research protocol with Ethical Clearance number 073 / KEP / FK2017 on March 2nd 2017.

Figure 1 : Delineation of palatal rugae pattern on dental casts

Maxillary impression using irreversible hydrocolloid alginate. The impression were casted using dental stone type 3. The jaws were printed using irreversible hydrocolloid material i.e., alginat. The result of the jaw printing was casted using dental stone tipe 3. The maxillary cast analysis was performed single-blinded by two different observers to get accurate measurements and reliable results, then classified based on Thomas- Kotze and Sunita Kapali classification method. Observers are dentists of the Faculty of Dentistry University Andalas who have good eyesight, understanding and perception. The same procedure was used in length measurement and observation of palatal rugae patterns. The Result Measurement of each observer was tested using Technical Error of test Measurement (TEM) intra-observer and inter-observer. TEM test was performed on 20 samples of maxillary cast having primary rugae and secondary rugae. Based on the results of the research, it can be concluded that in *Deutro Melayu* descents, the dominant rugae patterns in region A are point-shaped, while the dominant rugae patterns in region B, C and D are wavy. In Chinese descents, the dominant rugae patterns in region A are point-shaped and those of region B are in the form of lines. While in region C and D, the dominant rugae patterns are wavy-shaped. There is a significant difference ($p < 0.05$) of the palatal rugae patterns between the descendants of *Deutro Malay* and Chinese descents only in the left B region (0.013). There is a significant difference ($p < 0.05$) of the rare palatal size between the descendants of *Deutro Malay* and Chinese descents in region B and C.

Results

This study was conducted to assess the similarity of palatal rugae patterns between family members, i.e., father, mother, sons and daughters of the *Minangkabau* ethnic. A total of 489 palatal rugaes were observed in 48 palatal rugae models from 12 families. *One Way Anova* test results of curved, wavy, and straight rugaes are $p > 0.05$, which indicates that there is a significant similarity in the shape patterns. The results of the unilateral and circular rugae form test are $p < 0.05$, which also

indicates that there is an insignificant similarity in the patterns of uniform and circular form. The results of the primary, secondary, and fragmented rugae test are p> 0.05, indicating a significant similarity in the palatal rugae patterns based on the family tie between the father, mother, sons and daughters of a *Minangkabau* family. The average number of palatal rugae and p value in this study are as follows:

Tabel 1: Average Amount of Palatal Rugae

Rugae Pattern		Mother	Father	Son	Daughter	P
Shape	Curve	2,92±1,67	4,08±1,92	3,08±1,78	2,92±1,37	0,28
	Wavy	2,92±1,67	3,42±1,92	4,05±2,19	4,75±2,52	0,11
	Straight	2,00±1,70	1,75±1,28	2,50±1,44	1,83±1,11	0,56
	Unified	1,50±1,16	0.50±0,90	1,08±0,99	0,50±0,67	0,03
	Circular	0	0	0,08±0,28	0,42±0,66	0,02
Size	Primary	7,25±1,81	7,83±1,26	8,33±1,07	8,17±1,26	0,24
	Secondary	1,67±1,37	1,83±1,40	2,17±1,74	1,75±1,13	0,83
	Fragmented	0,42±0,66	0,08±0,66	0,75±1,71	0,05±0,90	0,47

Discussion

Sumatra, located on the westernmost extremity of Indonesia, is the second biggest island in Indonesia and the sixth biggest in the world. Its Western side largely corresponds with the cultural sphere of the *Minangkabau* people. Geographically speaking, it comprises of an inland region called *Darek* and two coastal regions that lie on the Indian Ocean called *Rantau* and *Pasisir.* The inland region is the birthplace of the *Minangkabau* culture, and still forms the core region in which traditional culture is passed down. *Luhak Nan Tigo –Luhak Agam, Luihak Tanah Datar and Luhak Lima Puluh* are areas where the traditions of the *Minangkabau* people were handed down on a large scale in the inland region of West Sumatra.[13] This is the reason why the research was conduted at these locations. Palatal rugaes are irregular, asymmetric ridges of mucous membrane extending lateral from the incisive papilla and the anterior part of the median palatal raphe, which is just behind the maxillary central incisor teeth.[20] The use of palatal rugae as a method of personal identification was first suggested by Harrison Allen in 1889. The term “Palatal rugoscopy” was proposed in 1932, by a Spanish investigator named Trobo Hermosa.[11] The palatal rugae appear towards the third month of intrauterine life, from the covering connective tissue in the palatine process of maxillary bone, and its development and Growth is mutually controlled by epithelial-mesenchymal interactions, where specific extracellular matrix molecules are spatiotemporally expressed during development.[20] Palatal rugae patterns are unique. The proposed individuality of palatal rugae patterns may facilitate their use in postmortem identification. This is reinforced by the fact that palatal rugae can resist postmortem decomposition changes for up to 7 days after death and can withstand massive thermal insults like third degree burns. Palatal rugae can also resist other forms of massive trauma because their location is protected by the tongue, dentition, and cheeks.[13] The identification of a person through DNA examination has limitations such as contamination and

high cost. While the use of palatal rugae can provide ideal parameters because of its uniqueness, stability, resistance, and simple and inexpensive method. The potential use of palatal rugae in forensic identification has advantages because it is sufficiently able to discriminate between individuals as no two palatal rugae configurations are alike. This finding is in congruity with the results obtained in previous similar studies.[7] In this study , curved, wavy , and straight patterns show signifficant similarity (p> 0.05). It can therefore be concluded that certain rugae shapes are specific to a particular population and may also have utility in population differentiation.[7] Observing the rugae shapes, Selvamani et al found that wavy patterns are common in males and females, followed by curved and straight patterns. Circular patterns are very few in number but significant (P = 0.05).[19] The study of Abdelatif et al on palatal rugae in Egyptians and Saudi children revealed that Egyptian children have few circular rugae and unified. They also found that cross-link rugaes exist in Egyptians children but are absent in Saudi children.[1] Population differences pose the question as to how much is attributable to genetic differences and how much is the result of environmental effects. Some scientists claim that environmental factors are unlikely to affect the formation of rugae and believe that the shape of a rugae is determined by genes. It is plausible that, certain, but unidentified, genes influence the orientation of the collagen fibers during embryogenesis and govern rugae patterns in different populations.[1] Observing the length of rugae, primary rugae appeared to be most prevalent than secondary and fragmented rugae.[20] Examining the types and origins of palatal rugae according to the Lysell classifications, the study of Beatrice's (2013) showed that the palatal rugae of males is different from that of females. Primaryand Secondary rugae are all found in males compared to females, whereas fragmented rugaes are more common in females than males. Primary rugae derived from raphae are found in males, whereas medial origin is found in many women, the study concludes.

Moreover, the results of the research conducted by Aflanie and Madina (2017) on *Dayak Bukit* and *Banjar Hulu* tribes found that wavy patterns are dominant in the palatal rugae of the latter whereas divergent patterns prevails in the former. The result of the research was analyzed by Chi Square test and found that p = 0.0001 (p <0,05), which indicates that there were differences of palatal rugae characteristics between *Dayak Bukit*, *Banjar Hulu* and *Dayak Ngaju* tribes. In further test, it was found that *Dayak Bukit* tribe and *Banjar Hulu* tribe showed the possibility of kinship because there were no differences of characteristic of rugae patterns compared to *Dayak Ngaju*.

Similarly, based on Trobo classification, Akbar and Santoso (2014) concluded in their study that in the *Deutro Malay* race, the dominant rugea patterns in the right and left rugea region are point-shaped, whereas the right and left rugea region B, C and D, are wave-shaped. The study goes on to claim that in the Arabic race, the dominant rugea patterns in the left right A region is point-shaped, the dominant rugea patterns in the left and right of region B and C are line-shaped. While in the left and right of the rugea region D, line-shaped patterns and wave-shaped patterns are relatively equal in number. Significant differences in the palatal rugae patterns between the *Deutro Malay* and the Arabic races on the right A, left A, right C, left C regions was found. By using the classification of Caldas, it was found that the palatal rugae size in both left and right rugea region B and C of the *Deutro Malay* race is significantly different from that of the Arabic race.

Urthermore, based on the results of the study of Anggraini (2013), it can be concluded that in *Deutro Malay* descents, the dominant rugea patterns in region A are point-shaped, while the dominant rugea patterns in region B, C and D are wavy. In Chinese descents, the dominant rugea patterns in region A are point-shaped while the dominant rugae patterns in region B are line-shaped. The dominant rugea patterns in regions Cand D are wavy. There is a significant difference (p <0.05) of palatal rugae patterns between the descendants of *Deutro Malay* and Chinese descents only in the

left B region (0.013). There is also a significant difference ($p < 0.05$) of the palatal rugae size between the descendants of *Deutro Malay* and Chinese descents in region B and region C. This study has the same results as that of Suhartono et al (2016) which showed that 83%of the line, sinuous, and curve types of rugae as the predominant patterns represents the Indonesian population. The rugae patterns of all recorded individuals is unique, i.e., no similar patterns were found for two individuals. The results are consistent with slow rugae loss at an average rate of one rugae in about 15 (±2) years after early adulthood.

Additionally, a study on 30 patients conducted at the Narsinhbhai dental college and hospital revealed, after comparing each palatal rugae pattern of the 30 indviduals with the corresponding palatal rugae patterns of their respective parents, that there is a strong correlation of palatal rugae patterns between the 30 offsprings and their respective parents.[12]

Another study carried out by Patel to assess whether there is any hereditary pattern in palatal rugae patterns between the offspring and their parents. The study showed that there is a positive correlation of palatal rugae patterns between the offspring and either of their parents.[15] It was sensible that the rugae patterns of the offpring of 29 families out of 30 matched with those of either of their parents.

Finally, a study by Indira suggests that the comparison of palatal rugae patterns among family members also shows different patterns. Although in one family few forms were similar, the rugae patterns are not identical. This means that the role of heredity is uncertain in determining the orientation of rugae patterns.[7]

It can be concluded from the above discussion that there is a hereditary role in rugae palatal patterns, which makes it an important tool in the identification of a person and the determination one's family lineage.

Conclusion

The patterns of palatal rugae in *Minangkabau* family has the same number of rugae based on the significant shapes i.e., curved, wavy, and straight, and based on the significant length i.e., primary, secondary and fragmented. Because the results of this study are rather patial as they rely on a data consisting of only 48 individuals from 12 families, a more detailed follow-up study is needed with a larger sample size to reach an ultimate conclusion. The results of this study indicate that there are hereditary factors in the rugae patterns, whch makes them very useful for the identification of individuals. Chemical , disease, heat , and trauma cannot alter palatal rugae patterns. Cheeks , lips, tongue, buccal pad of fat , teeth and bones protect palatal rugae from trauma and high temperature. Although we acknowledge that the limited number of families studied does not allow us to reach a final deduction, it is important to note that rugae patterns may be used as genetic markers for further research. We hope this research is a contribution of data in the field of forensic odontology on individuals, especially the *Minangkabau* and the *Deutro Melayu*.

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