

Palatal Rugae in Gender Discrimination: Auxiliary or Hindrance? A Systematic Review

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Abstract

Background and Aim: Uniqueness of rugae can be utilized similar to finger prints when compared with other methods in identification of a person, even with the presence of discrepancies in the patterns obtained in different populations. Nonetheless, it still cannot be used as a potential tool in gender discrimination. This study explored the debatable way of the use of palatal rugae for gender discrimination.

Materials and Methods: Key words including "palatal rugae" and "sex determination" were used for searching of the following databases: PubMed Central, EMBASE, EBSCOhost and Cochrane from the earliest available date to January 2019. Out of 296 articles, 257 were excluded after abstract analysis. Only 8 articles were finally included.

Results: A total of 1,152 subjects participated in this study, among them, 577 were females and 575 were males. Significant differences were observed in the number, length, and shape of the rugae patterns in both genders from one study to another.

Conclusion: In this analysis, we observed that females and males showed varied patterns of rugae on the palate, but males predominantly showed a particular pattern compared with females. Palatal rugae cannot be used as the only tool for gender discrimination.

Key Words: Palate; Forensic Dentistry; Sexism; Female; Male

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Introduction

Palatal rugae are the transverse folds that are asymmetric, and irregular elevations seen on the anterior third of the palate behind the incisive papilla. Anatomically, the rugae consist of around 3-7 dense ridges that radiate tangentially from the incisive papilla [1,2]. Among various methods, assessment of palatal rugae is recognized as a tool for personal identification when other methods (like fingerprints, DNA analysis, comparison of ante mortem and post mortem records) are unavailable like when the body is burnt or

decomposed and also in edentulous conditions [2,3].

The rugae pattern is considered as a unique pattern in every individual, as they are stable throughout life and remain unchanged except in their length during puberty. Their uniqueness and post mortem resistance makes palatal rugae an ideal forensic identification parameter [3,4]. Application of palatal rugae for identification purpose was first suggested by Allen in 1889. Since then, various studies were conducted in this respect. According to the literature, certain studies reported that males show a particular pattern more

predominantly than females, while some other studies mentioned that males and females have a varied pattern and unification, which conflicts with the usage of palatal rugae in sex determination in forensic odontology [5-7].

With this background, we conducted a systematic review with the main objective to assess the role of palatal rugae for gender discrimination for the purpose of identification in forensic odontology.

Materials and Methods

Search terms “palatal rugae” and “sex determination” were used for searching of the following databases: PubMed Central, EMBASE, EBSCOHOST and Cochrane from the earliest available date to January 2019. Relevant studies on reference lists of retrieved articles were also assessed.

Eligibility Criteria:

Inclusion criteria: Studies on healthy individuals over 15 years of age, who had no congenital or palatal abnormality, history of trauma, inflammation, orthodontic treatment, denture use, or surgical procedures in the rugae area were included.

Exclusion criteria: Comparative studies on

palatal rugae, comparison between cheiloscopy (study of lip prints) and rugoscopy for sex determination, digital methods of analysis of the palatal rugae pattern, systematic reviews, editorials, opinions, studies not published in a peer reviewed journal, studies available only as abstracts, studies published in other languages, and comparative observations of palatal rugae were excluded.

Article selection: Figure 1 shows the flow diagram of article selection.

Results

Summary of evidence and limitations:

The studies conducted on palatal rugae revealed that males and females showed varied patterns of wavy, curvy, circular, and straight rugae in different proportions according to the Thomas and Kotze classification. There were significant discrepancies observed based on the number, length and shape of the rugae patterns in both males and females from one study to another. On the contrary, certain studies conducted revealed the rugae patterns to be similar in both males and females. Eight articles were included in the study. Each article is summarized in Table 1 [1,6,7,8-12].

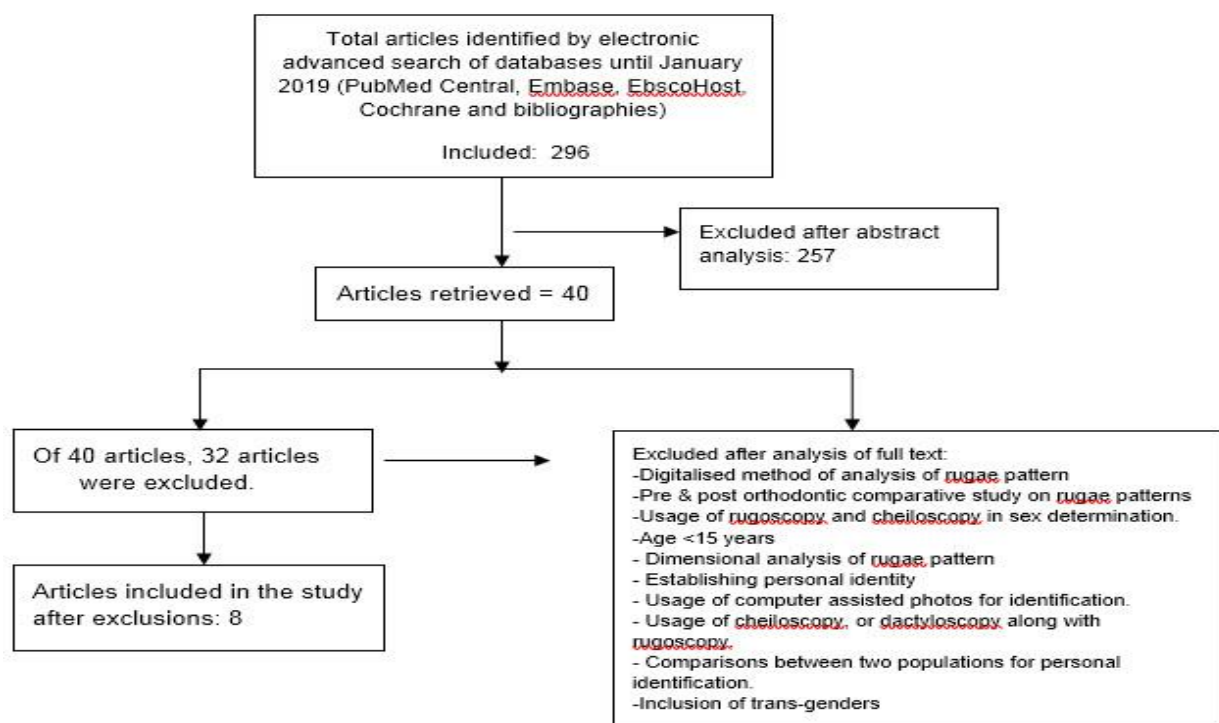


Figure 1. Flow diagram of article selection

Table 1. Characteristics of included studies

Author and Year	Study design	Study sample	Age group	Classification system used	Inclusion and exclusion criteria	Methodology	Results	Conclusion	Summary
Surekha et al., 2012 [8]	Cross sectional study	60 maxillary study models inclusive of 30 males & 30 females.	17-23 years	Thomas and Kotze.	Subjects belonging to North East (Manipur) and South West of India (Kerala).	Palatal rugae were analyzed based on right & left sides for total number, length & shape.	SHAPE: wavy>curved>straight>circular NUMBER: Females>males left>right side	Manipuri population showed predominantly curved shaped rugae. Kerala population showed predominantly wavy shaped rugae	Palatal rugae are distinctive to an individual and can be therefore used as an aid to identification.
Chandra et al., 2016 [9]	Cross sectional study	200 maxillary study models inclusive of 100 males & 100 females.	15-30 years	Thomas and Kotze.	Healthy individuals from Patna & Ranchi free from congenital & palatal abnormalities, trauma, inflammation, and orthodontic treatment, not wearing a denture, and no history of surgery	Palatal rugae were analyzed based on total number, length & shape.	SHAPE: curved>wavy>straight>divergent>circular. NUMBER: Females >males LENGTH: Primary rugae>secondary rugae in both males & females.	No significant gender discrimination was observed based on length while the predominant shape observed was the wavy pattern.	Pattern of rugae is extremely unique to humans as the fingerprints but it showed no significant gender discrimination based on the length of rugae pattern.
Paliwal et al., 2010 [10]	Cross sectional study	60 maxillary study models inclusive of 30 males & 30 females.	17-23 years	Thomas and Kotze.	The population of Madhya Pradesh and Kerala were analyzed.	Palatal rugae were analyzed based on total number, length & shape.	SHAPE: Wavy>curved>straight>unification>circular. NUMBER: Right side>left side	Straight type was predominant in Madhya Pradesh population while wavy type was predominant in Kerala population in males and females.	A subtle association in the rugae shape existed between the 2 populations. This requires further extensive study for establishing its significance in personal and racial identification.

<p>Bharath et al., 2011 [1]</p>	<p>Cross sectional study</p>	<p>100 maxillary study models inclusive of 50 males & 50 females.</p>	<p>15-30 years</p>	<p>Thomas and Kotze.</p>	<p>Healthy individuals free from congenital abnormalities, inflammation, trauma & orthodontic treatment were included.</p>	<p>Palatal rugae were analyzed based on total number, length & shape.</p>	<p>Total number of the rugae was not significantly different between the sexes. Association between rugae length and shape with sex determination was computed using discriminant analysis which enabled sex differentiation in this population with an accuracy of 78%.</p>	<p>Difference in unification pattern was statistically significant between genders. The total number was not significantly different</p> <p>Palatal rugae revealed a specific pattern in unification among males and females of the coastal Andhra population. Discriminant function analysis enabled sex determination of individuals.</p>
<p>Dwivedi and Nagarajappa 2016 [7]</p>	<p>Cross sectional study on Central Indian population.</p>	<p>500 maxillary study models inclusive of 250 males & 250 females.</p>	<p>17-25 years</p>	<p>Thomas and Kotze &</p>	<p>Subjects with any palatal abnormalities, soft tissue protrusions, trauma, and orthodontic treatment were excluded.</p>	<p>Palatal rugae were analyzed based on primary rugae, number, direction & pattern</p>	<p>NUMBER: Males > females</p> <p>PATTERN: In Males: Wavy>straight>curved>circular</p> <p>In Females: Straight>wavy>curved>circular</p>	<p>This study showed that there was a significant relationship between palatoscopy, human identification and sex determination.</p> <p>In this study, males had more rugae than females.</p>
<p>Harchandani et al., 2015 [6]</p>	<p>Cross sectional study</p>	<p>100 maxillary study models. 50 each from the populations in west & north India.</p>	<p>18-30 years</p>	<p>Thomas and Kotze & Kapali classification for shape of the rugae.</p>	<p>Completely dentulous, domicile by birth, absence of intraoral lesions, absence of congenital abnormalities, non-orthodontic participants were included.</p>	<p>Palatal rugae were analyzed based on number, type & pattern.</p>	<p>NUMBER: Males > females</p> <p>PATTERN: Wavy pattern was more common in males of west & north India. Females had straight rugae in western India while curved in North.</p>	<p>The uniqueness of palatal rugae pattern can be utilized when combined with other methods for forensic identification.</p> <p>The palatal rugae patterns and the number of rugae on the palate differed in both the Western and north Indian populations.</p>

<p>Balgi et al, 2014 [11]</p>	<p>Cross sectional study</p>	<p>50 maxillary study models inclusive of 25 males & 25 females</p>	<p>30-50 years</p>	<p>Thomas and Kotze.</p>	<p>Individuals free from congenital abnormalities, inflammation, trauma & orthodontic treatment were included.</p>	<p>Palatal rugae were analyzed based on length, number, and shape.</p>	<p>LENGTH: Males > females PATTERN: Straight pattern was predominant in females than males. NUMBER: Males > females</p>	<p>Most commonly seen rugae pattern in both males and females was of the straight variety and males showed more rugae in length and in number than females. As the analysis showed a significant difference of with length and shape of rugae patterns in males and females, rugoscopy, could be used as a tool for identification.</p>
<p>Alani et al, 2016 [12]</p>	<p>Cross sectional study</p>	<p>82 maxillary study models inclusive of 40 males & 42 females</p>	<p>16-25 years</p>	<p>Thomas and Kotze.</p>	<p>Individuals with congenital abnormalities, inflammation, trauma and orthodontic treatment were excluded.</p>	<p>Palatal rugae were analyzed based on the pattern and length.</p>	<p>PATTERN: Males – curved Females – straight LENGTH: Males > females</p>	<p>There was no significant statistical difference between genders in relation to the rugae pattern although there was predominance of the curved pattern in males and straight pattern in females. Despite the controversy about the stability of the characteristics of rugae and the extent of differences between genders, palatal rugae have been recognized as a potential source of identity.</p>

Discussion

Palatal rugae are unique to every individual due to their position in the oral cavity; but in spite of which, palatal rugae cannot be considered as a reliable marker for gender discrimination due to variations observed in the values obtained from different populations and also due to the insufficient means of methods available to differentiate the palatal rugae between males and females [13,14].

The anatomical position of the rugae inside the oral cavity is surrounded by the cheeks, lips, tongue, buccal fat pad, teeth, and bone which keep the rugae protected. According to a study by Jacob and Shalla [15], when rugae were considered as a criterion for identification, 79% accuracy with equivocation was demonstrated. They found that the low level of identification was caused by rugae obliteration in denture fabrication. Palatal rugae tracings derived from dentures do not give the desired accuracy required for forensic analysis [15]. Besides, orthodontic movement, cleft palate surgery, and forced eruption of impacted canines have an influence on rugae pattern. According to a study by Jain and Chowdhary [16], thumb sucking and extractions can produce a local effect on the direction of palatal rugae. It is also possible to consider the possibility of falsification of the rugae pattern in toothless cases [16]. Almeida et al. [17] observed that medial rugae were stable but lateral rugae showed significant changes. Thus, we observed varied levels of discrepancies between one study to another and therefore, conflict with the idea of usage of palatal rugae as a reliable marker for gender discrimination.

In this review, a total 8 articles were included after considering the inclusion criteria; all the findings from the studies were summarized, and the authors came to the conclusion that palatal rugae can only be

used as an adjuvant and not as primary tool in gender determination

Conclusion

Certain studies have stated that palatal rugae can be used as a minimal aid in the field of forensics for sex determination. But, with a varied range of discrepancies observed from population to population, we conclude that palatal rugae cannot be considered as an accurate auxiliary means for gender discrimination.

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