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International Journal of Orthodontic Rehabilitation

ASSESSMENT OF PALATAL RUGAE CHARACTERISTICS IN DIFFERENT SKELETAL MALOCCLUSIONS – A SCOPING REVIEW

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How to cite this article: *Assessment Of Palatal Rugae Characteristics In Different Skeletal Malocclusions – A Scoping Review. Int J Orthod Rehabil 2023; 14 (2) 17-30.*

Doi: 10.56501/intjorthodrehabil.v14i2.611.

Received : 11-11-2022 *Accepted: 24-05-2023* *Web Published: 05-06-2023*

ABSTRACT

Aim: To systematically gather and assess the orthodontic literature on the characteristics of palatal rugae patterns in various skeletal malocclusions.

Materials And Methods: A search was conducted on Embase, PubMed, and Google Scholar databases till June 2022. The titles and abstracts were thoroughly reviewed to eliminate duplicates and irrelevant articles. The full-text articles were then screened using the inclusion criteria.

Results: Out of 16 included studies, 8 studies assessed the wavy and curved type of rugae, which were the most prevalent in all groups of malocclusions. Three studies assessed curvy patterns, two on straight patterns, and three assessed rugae orientation. Several studies have found that the palatal rugae do not significantly differ among different malocclusions. Few studies, however, indicate that palatal rugae are greater in number in class II malocclusion compared to class I and class III malocclusion.

Conclusion: This review demonstrates that there are distinct patterns of palatal rugae in Class I and Class III malocclusions, with Class II malocclusion having the most.

KEYWORDS – Palatal Rugae, Malocclusion**,** Skeletal Pattern, Rugoscopy**.**

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INTRODUCTION

The term "palatal rugae" refers to an array of anatomical folds that exist behind the incisive papilla on either side of the median palatal raphe on the anterior region of the palatal mucosa.[1] There are typically 4 to 6 rugae on each side of the palatal shelves. A great deal of the span of the palatal shelves is taken up by palatal rugae, which first appear in the third month at around 12 to 14 weeks of intrauterine life.[2] However, by the last phase of intrauterine life, their pattern becomes irregular, with those in the anterior becoming more prominent while the posteriors disappear. They have precise alignment with a characteristic orientation pattern at birth and will acquire the final shape whilst adolescence.[3] They may change in size as the palate grows, but the shape continues to be constant. They remain stable in their position and pattern throughout an individual's life upon adolescence.[4]

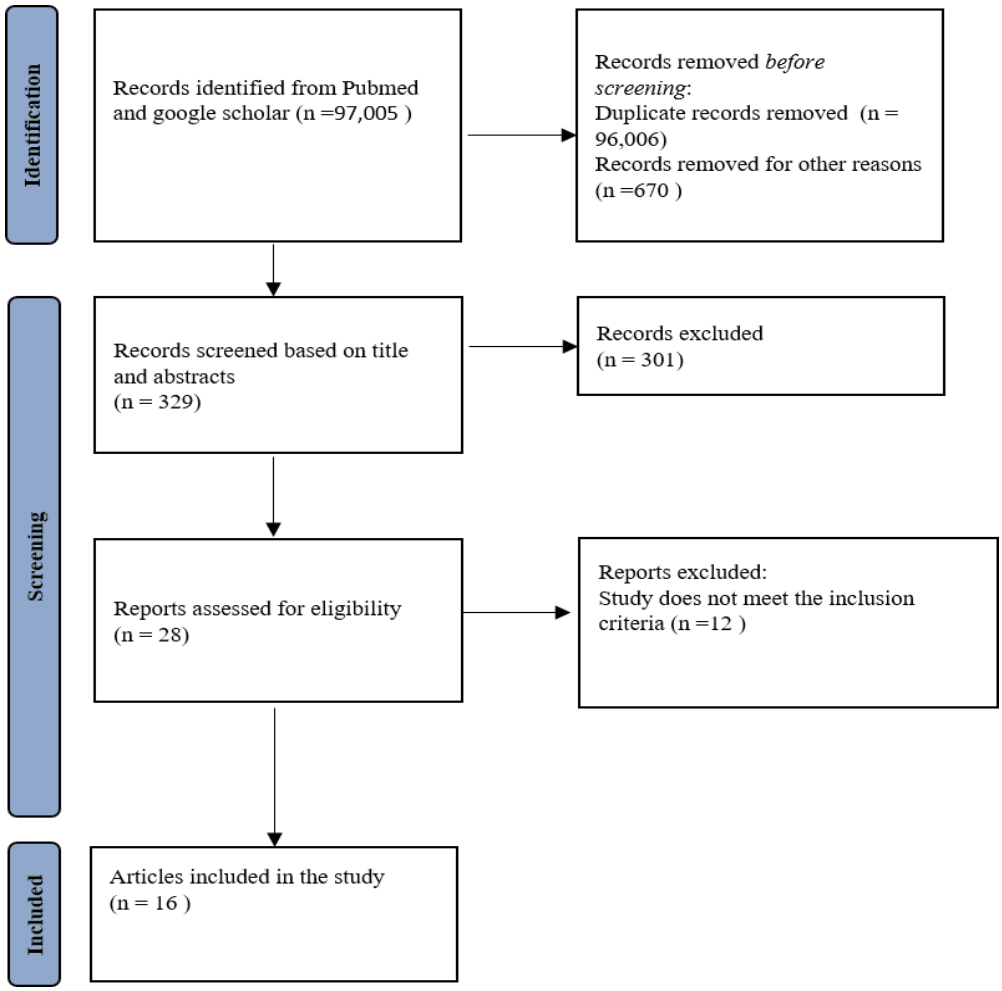
Many authors have tried to classify palatal rugae.[5] Among the various classifications, Thomas and Kotze's along with Kapali et al are the most widely accepted.[6] Rugae were classified by Thomas and Kotze based on their length as follows: those greater than 5mm were considered as the Primary rugae, Secondary rugae ranged between 3 to 5 mm, lesser than 3 mm were Fragmentary rugae, while those lesser than 2 mm were disregarded.[7] They are circular, wavy, straight, and curved in terms of shape. Rugae is also classified as unification if it has two arms and either a converging or diverging type, depending on the type of origin and termination.

The dorsal surface on the tongue's taste receptors are improved by the palatal rugae, which are also involved in swallowing and speech.[8] They are protected from high temperatures and trauma by the surrounding hard and soft tissues, including the lips, tongue, cheeks, teeth, and bone. They play an important role in forensics for medicolegal identification.[5]

The morphological features of palatal rugae are set up at an early age approximately at 10 years and are stable in their position as well as pattern throughout an individual's life, hence they are used as a reference landmark for superimposition on dental casts and evaluate the extent of tooth movement in orthodontics.[9] Nevertheless, certain circumstances, notably finger sucking as a child and orthodontic forces, might have contributed to variations in the morphology of palatal rugae. Likewise, extractions have been reported to have a local effect in the orientation of the Palatal rugae.[6] Though there are studies in literature associating palatal rugae patterns with malocclusion, there is no consensus regarding the association. Hence, the current study sought to determine whether there is a relationship between morphological features of palatal rugae and malocclusion through a scoping literature review.

MATERIALS AND METHODS

Embase, PubMed and Google Scholar, databases were searched from December 1980 and June 2022 with the following keywords “Palatal rugae OR plica palatine transversae OR rugoscopy” AND “Malocclusion OR sagittal malocclusion OR class I occlusion OR class II occlusion OR class III occlusion OR skeletal malocclusion OR orthodontic”.



INCLUSION CRITERIA

Observational studies assessing the relationship between palatal rugae, and malocclusion were included. Studies in English language and human subjects were included.

EXCLUSION CRITERIA

Animal studies were excluded in the review.

FOCUS QUESTION

What is the association between the type, orientation, direction of palatal rugae with different malocclusion?

DATA COLLECTION

A tailored data form was created with the author's name, year of publication, population, sample size, age, study design, classification, methodology, and inference. For purposes of preventing bias, two independent observers had been employed to review the articles and fill out the forms. The data are given in Table 1.

DATA ANALYSIS

On the basis of the details gathered using customized data collection forms, the authors conducted a qualitative analysis. It was primarily focused on the relationship between malocclusion and the size, shape, and orientation of the palatal rugae.

S.NO	AUTHOR/ YEAR	POPULATION	SAMPLE SIZE	AGE	MALOCCLUSION STUDIED	CLASSIFICATION USED	STUDY DESIGN/ METHODS	INFERENCE
1	Gandikota et al 2012	India	24 maxillary dental cast	16-24 years	Sagittal malocclusion of Class II div 1 & Class I	Lysell (1955) Carrea classification (1955)	Invitro/ Manual drawing	Class II div 1 patients had shorter second and third palatal rugae compared to class I patients. Palatal rugae constriction was significantly greater in class II div I than in class I.
2	Kapoor et al 2015	India	66 maxillary dental cast	12-26 years	Sagittal malocclusion of Class I, Class II div 1, Class II div 2 & Class III malocclusions	Lysell 1955 Hauser	Invitro/ Manual drawing	Class II division 2 patients had the most primary, secondary, as well as fragmentary rugae. Primary rugae regardless of malocclusions exhibited prim arily a curvy pattern on the left side in contrast to the right side with a forking-diverging type. Rugae strength decreased from the first to the third primary rugae as a result of the pronounced & compressed intrauterine life. .
3	Ramakrishn a Juvva et al. 2016	India	105 maxillary dental cast	9-14 years	Sagittal malocclusion of Class I, Class II and, Class III	Nayak et al	Invitro/ Manual drawing	Wavy pattern predominated in all malocclusions, subsequently followed by the straight

								pattern. There existed not a significant association among the forms of palatal rugae with malocclusion.
4	Ekrem oral et al 2017	Turkey	105 maxillary dental cast	10-22 years	Sagittal malocclusion of Class I , Class II and Class III	Modified Thomas and Kotze classification	Invitro/ Digital photographs	1. Rugae patterns appeared distinct to each person. 2. Wavy and curved types of rugae were more common rugae patterns in all groups of malocclusion 3. There had been no substantial difference between subjects with different skeletal malocclusions.
5	Helena Alvarez-Solarte et al 2018	Colombia	264 maxillary dental cast	8-16 years	Based on Vertical malocclusion with Anterior open bite and normal overbite	Kapali et al Thomas and Kotze	Invitro/ Digital models	The most typical rugae shapes were curved & wavy, with a parallel and horizontal distribution. The maxillary length, depth and width of palatal rugae were decreased in the Anterior Open Bite group.
6	Alshahrani et al 2019	Saudi Arabia	481 maxillary dental cast	21-31 years	Sagittal malocclusion of Class I, Class II and Class III	Modified Brinon classification	Invitro/ Digital models	Smaller Palatal area will result in a smaller number of Palatal Rugae No significant relationship between the sagittal malocclusion of Class I, II & III malocclusion and the Inter canine distance, Intermolar

								distance, and Palatal height The number of straight & wav y rugae are inversely proportionate to the palatal area.
7	Farheen Fathima et al 2018	Pakistan	184 maxillary dental cast	12-30 years	Sagittal malocclusion of class I, class II div. 1, class II div. 2 & Class III	Kapali et al.	Invitro/ Manual drawing	The majority of palatal rugae on average were found in subjects in Class I. The first primary rugae were discovered to be more often posteriorly directed in Class II division 2 and to have substantial variation in orientation on the left side. There is a correlation between the Angle's malocclusions and the quantity and arrangement of palatal rugae. The primary palatal rugae's length and orientation, however, produced varying results.
8	Farheen Fatima et al 2019	Pakistan	165 maxillary dental cast	12-30 years	Sagittal malocclusion of Class I, Class II as well as Class III	Kapali et al.	Invitro/ Manual drawing	There is no discernible difference between the groups of sagittal skeletal malocclusion. Curved rugae were discovered to be the most common pattern in various malocclusion groups. First primary rugae that are posteriorly

								directed have a higher prevalence across all skeletal patterns, according to the evaluation of rugae orientation.
9	Lalitya et al 2019	India	90 maxillary dental cast	13–18 years	Sagittal malocclusion of class I, class II & class III	Thomas & Kotze classification	Invitro/ Manual drawing	The overall number of rugae on either sides of the mid palatine raphe was significantly different in the female population with class II skeletal malocclusion. No specific sagittal skeletal jaw relation could be related to an unique rugae print pattern.
10	Swapna et al 2019	Malaysia	70 maxillary dental cast	19-23 years	Sagittal malocclusion of Class I, Class II & Class III	Kapali et al.	Invitro/ Manual drawing	When juxtaposed with Class I and Class III malocclusion, Class II malocclusion had the most primary, secondary, and fragmentary rugae. Comparing Class I malocclusion to the other two types, all the parameters displayed a similar bilateral orientation. All malocclusions' primary rugae displayed solel y a wavy pattern.
11	Goutham et al 2020	India	37 maxillary dental cast	Not specifie d	Sagittal malocclusion of class I	Kapali et al.	Invitro/ Manual drawing	Wavy rugae pattern was observed in class I malocclusion.

12	Crystal Runa Soans et al 2020	India	105 maxillary dental cast	18-25 years	Sagittal malocclusion of Class I, Class II, Class III	Modified Thomas and Kotze	Invitro/ Manual drawing	Particularly in skeletal Classes II and III, primary rugae were far more distributed on the right side of the palate than the left. All skeletal malocclusion groups showed a wavy or curved pattern of rugae, and skeletal Class III had the greatest number of straight rugae. Various skeletal dysplasia groups were identified with droplet-shaped incisive papilla's and horizontally aligned rugae.
13	Naila Rizwan et al 2020	Pakistan	384 maxillary dental cast	13 to 30 years	Sagittal malocclusion of Class I, Class II, Class III	Kapali et al.	Invitro/ Manual drawing	The most common rugae shapes in all skeletal malocclusions were circular and curved. The primary palatal rugae pattern differed significantly between the three skeletal malocclusion groups.
14	Heydari et al 2021	Iran	135 dental casts	18-25 years.	Sagittal malocclusion of class I, class II & class III	Kapali et al.	Invitro/ Manual drawing	When compared to other groups, Class III malocclusion had a lesser number of palatal rugae. Rugae were most commonly wavy and straight in all skeletal groups. Class I had a particularly straight pattern

								than the other classes. Rugae are oriented more anteriorly in Class II malocclusion. Class III had more horizontally di rected rugae than the other groups.
15	Sudhakar et al 2021	India	120 maxillary dental casts	15-30 years	Based on vertical growth pattern	Thomas and Kotze classification	Invitro/ Manual drawing	Wavy rugae are more common in horizontal as well as average growth patterns. In vertical and average growth patterns, curved-type rugae were more common. Diverging patterns were mostly observed in vertical growth patterns. PR exhibits sexual dimorphism as well. The association is clinically noteworthy because it will allow for the early identification of facial vertical growth patterns.
16	Maria Saadeh et al 2022	Lebanon	243 maxillary dental casts	25-32 years	Sagittal malocclusion of class I, class II divisions 1 as well as 2, class III & vertical pattern	Thomas and Kotze classification	Invitro/ Digital models	PR measurements differed in statistical terms among malocclusions, particularly in vertical patterns. Class II division 2 subjects had the most transverse & anteroposter ior rugae measurements. In hypodivergent groups, PR

								appeared more anteriorly directed in comparison to hyperdivergent groups.

TABLE 1: CHARACTERISTIC FEATURE OF THE INCLUDED STUDIES IN THE REVIEW

RESULTS

SEARCH OUTCOMES

Embase, PubMed, and Google Scholar yielded a combined total of 329 studies. 301 articles were removed for duplicity after being reviewed by two independent investigators. Following abstract screening, 28 studies were determined to be eligible for full-text assessment. After excluding articles that were irrelevant to the current research, the study included 16 articles.

DESCRIPTION OF STUDIES

METHODS TO ASSESS PALATAL RUGAE

Various methods for assessing palatal rugae on dental cast have been explained in the literature. All studies in the review used manual drawing in dental cast except in a study by ekrem where they had used digital photographs, Alsharani et al, Saadeh et al used digital scanning and software for measurements of palatal rugae.[10,11]Most of the studies were done by using the methods of classification given by Silva, Carrea, Modified Brinton, Lysell, Nayak, Thomas, Kotz, and Kapali.

STUDIES ON RUGAE PATTERN

Seven studies had mentioned on the form of wavy and curved pattern of Palatal rugae [10,12-17], one study by Naila Rizwan et al on the circular pattern[18] and one study by Heydari et al on the straight pattern.[19]

STUDIES ON ORIENTATION OF PALATAL RUGAE

Studies by Fathima et al reported on the orientation of rugae in all skeletal pattern.[15,16]

STUDIES ON DIRECTION OF PALATAL RUGAE

Studies by Solarte et al , Crystal Runa et al , Heydari et al described horizontal rugae with parallel distribution.[14, 19-20]

STUDIES ON SAGITTAL DIMENSION

15 articles had attempted to identify an association between palatal rugae and sagittal malocclusions. One study that compared class II division I with class I rugae pattern was by Gandikota et al.[12]

STUDIES ON VERTICAL DIMENSION

Solarte et al, Sudhakar et al, Maria E. Saadeh et al are three studies which compared the relationship between palatal rugae & vertical dimension.[11,14,24]

DISCUSSION

The palatal rugae, once formed, do not undergo any transformation and remain in the same position throughout an individual's life time. Individuals have distinct palatal rugae characteristics and may differ in their pattern and orientation. However, the review noticed conflicting evidences among multiple populations. Given that, there exists a gap in the scoping and systematic review, we intended to systematically collect and assess the orthodontic literature on the relationship of palatal rugae patterns with various malocclusions.

SAGITTAL ASPECT

With regard to the pattern of rugae, wavy and curved rugae were more prevalent in all malocclusions. The orientation of the rugae were found to be directed in the posterior direction in Class II Malocclusion than in others when viewed sagitally.[15,20] The Class II division 2 malocclusion has increased the length of rugae due to environmental factors.[20] There were contradictory results found with regards to the association between sagittal malocclusion and rugae patterns and found no statistically significant difference among different malocclusion about rugae pattern[12,14-15,20-21]whereas few studies reported that the primary, secondary as well as the fragmentary rugae were greater in class II malocclusion and has significant difference in rugae pattern with class II malocclusion than class I and class III.[13, 18-19, 24] One study that compared rugae pattern in class I and class II division I, where the length of second and third rugae were used and found that the length of rugae was shorter in class II division 1 than class I and concluded that there was a notable constriction of rugae observed in class II division I than in class I.[11]

VERTICAL ASPECT

With regard to the direction, rugae were horizontally oriented with parallel distribution among skeletal open bite cases. Solarte et al compared the relationship of palatal rugae in anterior open bite individuals as well as normal vertical overbite; concluded that the length, depth, and height of rugae were lower in anterior open bite than normal overbite cases.[14]

On comparing vertical growth pattern with palatal rugae, Sudhakar et al observed that the wavy type of rugae were prevalent in horizontal as well as in average growth patten, whereas the curved type was more common in vertical and average growth pattern, Diverging type was only seen in vertical pattern.[24]

SAGITTAL AND VERTICAL ASPECT

Comparing the sagittal malocclusion with vertical, Saadeh et.al found that primary rugae measurements were different among malocclusion, where transverse and anteroposterior measurements were greater in class II malocclusion than class I and class III. Palatal rugae were anteriorly directed in hypodivergent than hyperdivergent individuals.[11]

CONCLUSION

This review revealed that the wavy and curved patterns of rugae were more prevalent when compared with the straight pattern in all classes of occlusion. Class II malocclusions had a greater number of rugae and were constricted in length due to the narrow arch width. Palatal rugae length, depth, and height were all found to be decreased in open bite cases. But none of this could be significantly stated since there were contradictory reports as well. A considerable number of well-designed prospective studies are required to determine the precise association of palatal rugae with malocclusion.

SOURCE OF FUNDING

Nil in terms of financial assistance or sponsorship.

CONFLICT OF INTEREST

No conflicts of interest exist.

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