Stability of Palatal Rugae after Rapid Maxillary Expansion

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Abstract

Introduction: Palatal rugae or plicae palatine are uneven ridges made of connective tissue situated beneath the incisive papilla. DNA analysis, finger prints analysis, are the most common techniques used for establishing person's identity but in situation where using these techniques are difficult palatal rugae can be used as a second source of identification. However, some habits like prolonged thumb sucking and orthodontic treatment for long duration could affect the rugae pattern. Hence, this study aims to evaluate the changes in transverse dimensions of palatal rugae in subjects treated with rapid maxillary expansion

Material and Methods: The palatal rugae patterns were measured and compared to evaluate the morphometric changes between pre-treatment cast (30 Pre-RME) and its post-treatment (30 Post-RME) counterpart. All pre-and post-expansion dental casts were traced and the intermedial and interlateral dimensions of first, second and third rugae were measured. The statistical analysis was done using paired t test.

Conclusion: The medial aspect of first primary rugae can be considered as a stable reference landmark while the lateral and medial aspects of the 2nd and 3rd rugae are liable to changes in transverse dimension. Hence, for forensic identification the stability of palatal rugae in patients who had undergone rapid maxillary expansion still remains questionable

Keywords: *Rapid Maxillary Expansion, Palatal rugae, Transverse dimension*

Introduction

Forensic dentistry or forensic odontology has large number of applications to forensic science. Even though DNA analysis, finger prints analysis, are the most common techniques used for establishing person's identity but in situation where using these techniques are difficult palatal rugae can be used as a second source of identification [1].

Palatal rugae or plicae palatine are uneven ridges made of connective tissue situated beneath the incisive papilla. Rugae starts from the anterior part of the hard palate to the mesial aspect of the first molars and never crosses the mid palatal raphae.[2.] They consist of keratinised stratified squamous epithelium with high density of merkael cells and develop by the third month of intrauterine life. Rugae aids in proper tongue placement during deglutition and mastication[3]. Once formed, their shape is maintained but due to palatal growth there can be changes in their size and acquires a unique pattern during puberty and stabilizes as the individual matures[4,5]. The rugae is protected by extraoral environmental factors, external temperature rise, trauma, palatal infections, chemical burns, and tooth exfoliation or eruption as these are anatomically located on the internal aspect of the oral cavity and hence it remains as a stable landmark.[6,7] However, some habits like prolonged thumb sucking and orthodontic treatment for long duration could alter the patterns of rugae, while in cleft patients surgical repair might lead to reduction in the number of rugae [8,9,10]

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People seek orthodontic treatment for improving facial aesthetics and function as the orofacial region is the main source of verbal communication and personal interaction, and is of significant concern. Transverse malocclusion can lead to facial asymmetry and subsequent aesthetic and functional problem. Irregularities in tooth position and jaws exerts significant impact on quality of life. Rapid maxillary expansion (RME) is a predictable evidence-based method for the correction of dentofacial abnormalities in transverse plane by expanding the maxillary arch [11,12,13]. RME leads to morphological recontouring of the maxilla and hard palate in the transverse dimension resulting in splitting of the mid palatal suture and separation of the two maxillary halves[11, 14]. However there is not much evidence with regards to other palatal changes, like structural alterations of the palatal rugae , changes in antero-posterior dimension, volumetric and surface palatal changes [15,16]. Many studies have focused on changes in sagittal or antero-posterior plane of palatal rugae related to non-extraction orthodontic treatment planning or maxillary first premolar extraction or even functional and orthopaedic appliances.[8,17,18,19] However, not many studies have compared the transverse dimension changes of the palatal rugae after rapid maxillary expansion which can have a significant effect on the palatal rugae

Hence, this study aims to evaluate the changes in transverse dimensions of palatal rugae in subjects treated with rapid maxillary expansion

Materials & Methods

· This retrospective study was conducted in Department of Orthodontics, Amrita School of Dentistry after the approval of the Institutional Research Ethics Committee Amrita Institute of Medical Science, Kochi.

· The study sample consist of records of adolescent subjects (10 ± 2.5years) with transverse maxillary constriction having posterior crossbite, without any habits like tongue trusting or thumb sucking and without any previous history of orthodontic treatment. Subjects with history of severe palatal trauma, syndromic patients, and patients with cleft palate or any surgical procedures performed on the hard palate were excluded from our study.

· Sample size was calculated based on results of a previous study[20]. With an effect size of 0.65 and 80% power, the minimum sample size was estimated to be 30 in each group.

· 30 Dental cast models of patients satisfying the inclusion criteria were selected from the Dept of Orthodontics. Bonded hyrax appliance was used for all 30 subjects. The appliance was activated 1 week after insertion with a protocol of 2 turns per day for 3-4 weeks activation was stopped once the maxillary palatal cusp of the upper first molars contacted the buccal cusp of the mandibular lower first molars allowing 2-3 mm of overexpansion to compensate for relapse. [figure 1]

· The palatal rugae patterns were measured and compared between pre-treatment cast (30 Pre RME) and its post-treatment (30 Post RME) counterpart for the evaluation of any morphometric changes. As this is a retrospective study there were no untreated control group.

Cast Analysis

· All pre-expansion and post-expansion dental casts were traced and analysed by two investigators independently to determine inter examiner reliability. Dental casts were drawn with a 0.3-mm graphite pencil (Faber Castell) according to Kapali et al classification of palatal rugae[21]

· The lateral and medial points of rugae were identified and marked on the lateral and medial ends of first, second, third rugae simultaneously on both pre and post cast and then traced (fig1&2).

· The line connecting the right and left medial rugae points is the intermedial dimension and the line connecting the right and left distal rugae points is considered as the interlateral dimension.

· The intermedial and interlateral dimensions of rugae were measured with the help of Vernier calipers with accuracy of 0.1mm and the readings were recorded.

Statistical Analysis

Statistical analysis comparing pre and post-expansion measurements of inter-medial and inter-lateral distances for first, second and third primary rugae was done using paired t test using SPSS software version 20. The inter

examiner reliability was assessed using Cronbach's alpha. First rugae showed Cronbach's alpha value of 1, second and third rugae 0.9 suggesting good agreement between the examiners.

Results

The study reveals an increase in inter medial and inter lateral values in all the post-expansion models. Minimum increase in values was recorded in the inter-medial distance of first primary rugae (0.29mm) and the maximum increase recorded in the inter-lateral distance of third primary rugae (2.58mm). A marked increase was also seen in the inter-medial distance of third primary rugae (1.27mm). Interlateral distance of second primary rugae was also increased(2.21mm). Statistical significance was calculated using paired t test. There was statistically significant($p<0.05$) increase in the intermedial and interlateral distance of second and third rugae whereas increase in the intermedial distance of first rugae was not statistically significant. Increase in the transverse changes was recorded maximum for third rugae and minimum for first rugae [table 1].

TABLE 1- Pre-expansion and post-expansion values of inter-medial and inter-lateral distances of first, second and third rugae

Rugae Number	Rugae Characteristic	Timepoint	N	Mean	Std. Deviation	P value
First rugae	Inter-medial	Pre-expansion	30	3.267	.5168	0.052
		Post-expansion	30	3.557	.6101	
	Inter-lateral	Pre-expansion	30	9.733	1.0273	0.008*
		Post-expansion	30	10.483	1.0716	
Second rugae	Inter-medial	Pre-expansion	30	5.247	.7736	0.000*
		Post-expansion	30	6.550	.9641	
	Inter-lateral	Pre-expansion	30	16.287	2.1770	0.000*
		Post-expansion	30	18.497	2.2986	
Third rugae	Inter-medial	Pre-expansion	30	9.080	1.2386	0.007*
		Post-expansion	30	10.357	2.1612	
	Inter-lateral	Pre-expansion	30	19.393	1.8857	0.000*
		Post-expansion	30	21.973	1.7352	

*Statistically significant

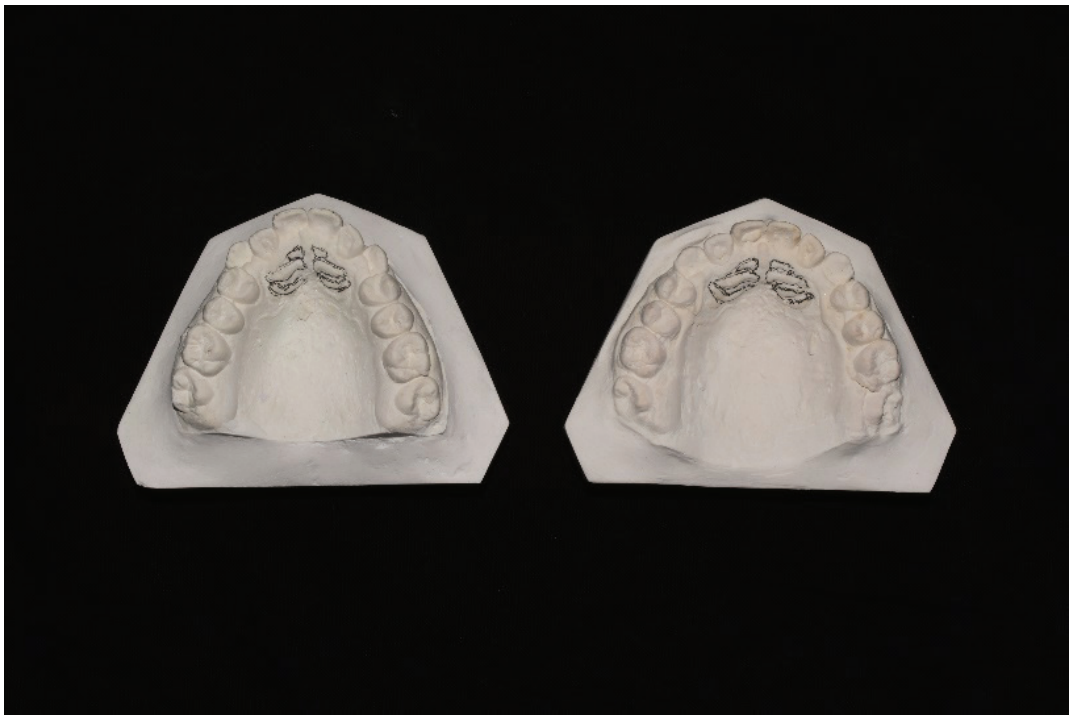

FIGURE 1 Pre and post expansion casts traced for first, second and third primary rugae with a 0.3 mm graphite pencil

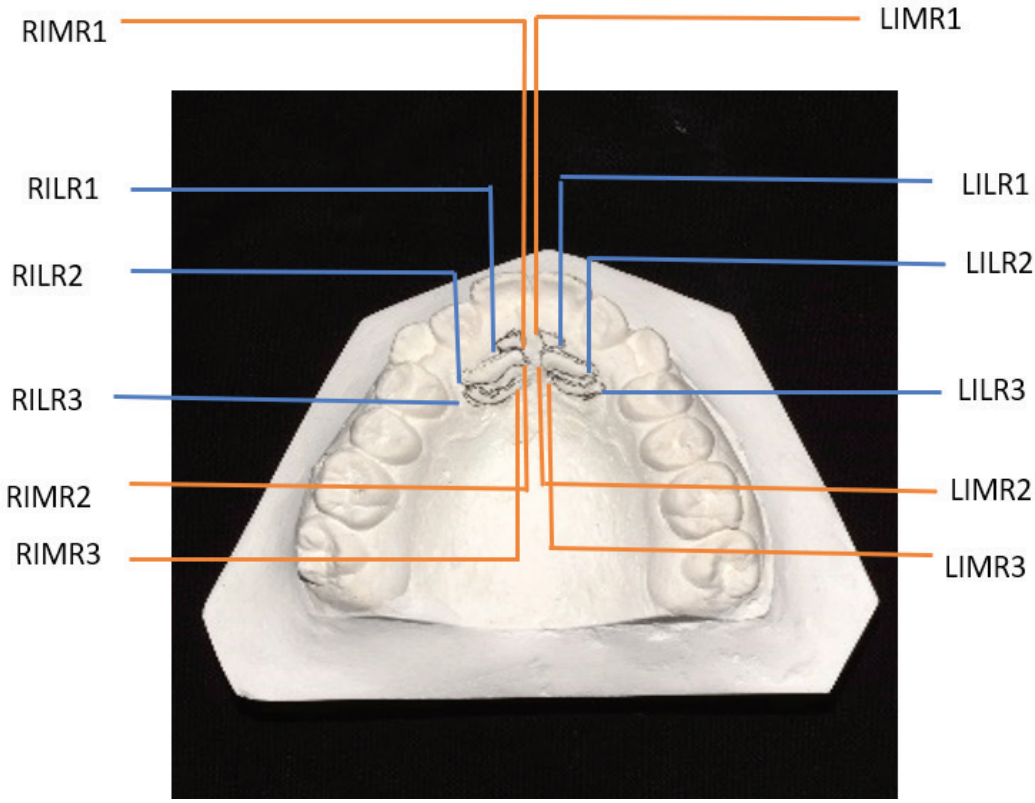

Figure 2 – Land marks for measuring of palatal rugae. RILR 1, RILR2, RILR 3- Right intermedial rugae points of first, second and third rugae. LILR1, LILR2, LILR3- Left interlateral rugae points of the first, second and third rugae. RIMR1, RIMR2, RIMR3- Right intermedial rugae points of the first, second and third rugae. LIMR1, LIMR2, LIMR3- Left intermedial rugae points of the first, second and third rugae

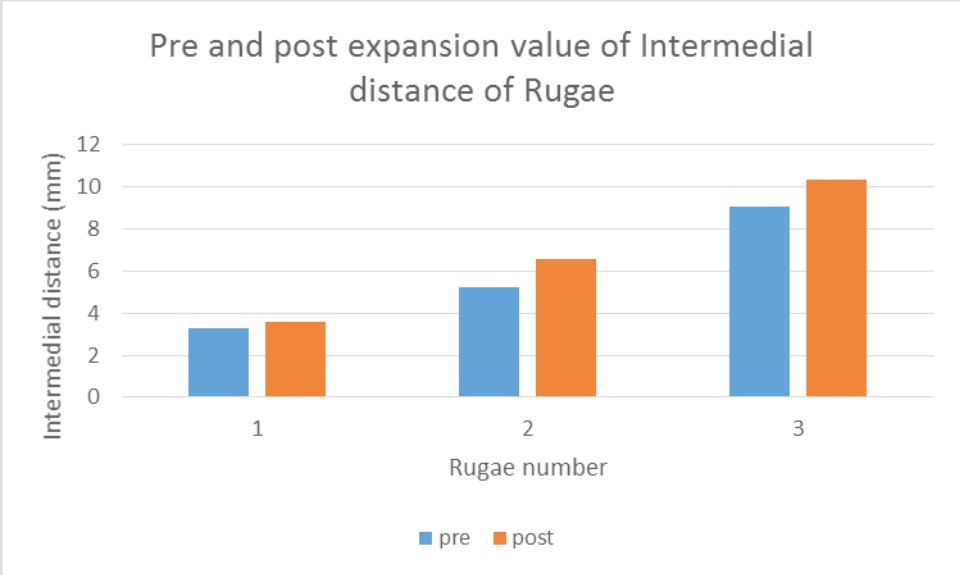

FIGURE 3- Pre and post expansion values of inter medial distance of Rugae

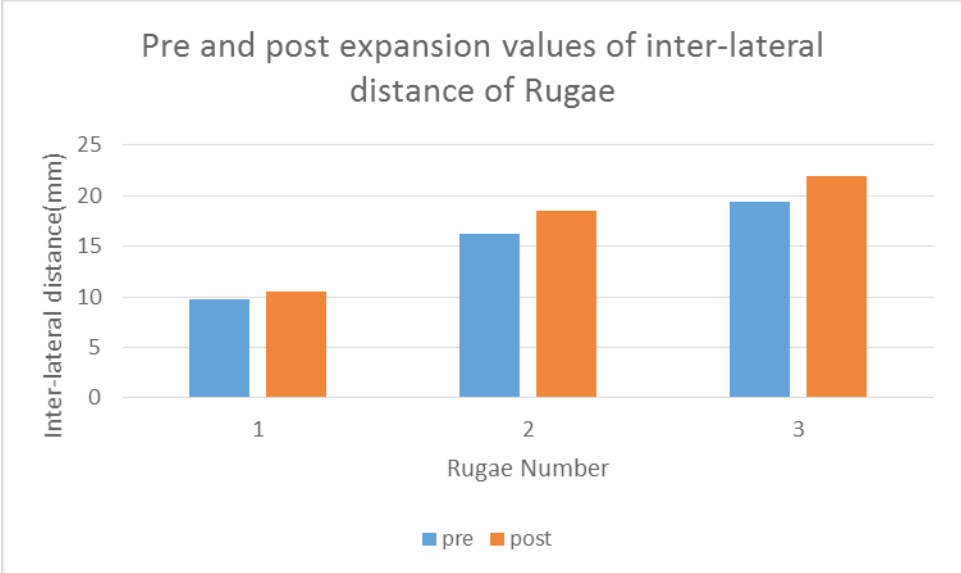

FIGURE 4-Pre and post expansion values of inter lateral distances of Rugae

Discussion

The palatal rugae are unique oral topographical structures of an individual, like his or her finger print and its characteristic pattern remains unchanged throughout life [22]. However, many studies have reported changes in the mean rugae count with age[23].The present study has been conducted to determine stability of palatal rugae in transverse dimension in adolescent patients subjected to rapid maxillary expansion and for the evaluation of stability of the palatal rugae for primary forensic identification criterion in these patients. Being a retrospective study there was no control group to monitor changes in palate due to growth in subjects who was not undertaking orthodontic treatment. Rapid maxillary palatal expansion can have a direct effect on palatal rugae as palatal expansion opens the mid palatal suture. This in turn will affect the connective tissue covering of palatal rugae and have an effect on the transverse dimension of palatal rugae.

Results of our study recorded an increase in transverse dimensions both in intermedial and interlateral distances of all first, second and third primary rugae, with least

changes shown by intermedial distance of first primary rugae (table 1).

Bailey et al[17] investigated on morphology of palatal rugae in non-extraction and extraction cases and concluded that the medial aspects of the 1st rugae remains stable in extraction and non-extraction group while the lateral and medial aspects of second rugae showed significant changes in extraction group .This is similar to the results of our study where the intermedial and interlateral distance of the first rugae did not show any significant changes while there were significant increase in the intermedial and interlateral dimension of the second and third rugae . This was also explained by Peavy et al [9] that "if the rugae are closer to the teeth, they are more prone to stretch in the direction related to the teeth movement".

Van der Linden [18] observed that medial point of the first rugae were not affected for the transverse values. However, in our study, intermedial distance of the first rugae

(0.29mm) were only minimally affected and it was statistically not significant.

Almeida et al [8] studied the stability of rugae during growth in class II patients and the effect of headgear or functional appliances treatment on position of rugae was studied and found that no significant change in transverse offsets and linear distances between medial points of the first rugae with respect to median palatal reference plane. Our study also supports this finding where the intermedial distance did not show any significant change in the context of first palatal rugae

Batool et al [19] investigated the stability of palatal rugae in expansion, extraction, non-extraction patients and found that the third rugae length was increased after RME which is similar to the results of our study where the intermedial and inter lateral distance of the third palatal rugae was increased and it was statistically significant($p<0.05$). Damstra et al[20] investigated the position of palatal rugae in antero-posterior and transverse dimension after rapid maxillary expansion and found significant change in transverse dimension of palatal rugae due to addition of RME to fixed appliance therapy .The third rugae showed significant increase in the transverse dimension, followed by the second rugae , and least for the first rugae which is identical to results of our study.

The RME could alter the position of palatal rugae because it increases the interpremolar and intermolar distance, and also affects the position of molar three dimensionally and can lead to elongation of palatal mucosa posteriorly. This was proved by Garrett et al[24] in their study, have shown total expansion at the level of 1st premolar was 55% (P1), at the level of 2nd premolar was 45% (P2), and at the level of 1st molar was 38% (M1). During expansion, Krebs et al[25]in his metallic implants study has proved the maxillary components rotates in the horizontal and frontal planes during expansion. The fulcrum of maxillary rotation during will be at the frontomaxillary as well as at the pterygopalatine suture during expansion. The increased intermedial and interlateral distance of palatal rugae proves that there is more of a skeletal expansion of the maxillary arch and at the mid palatal suture Moreover mid palatal expansion is associated with buccal tipping of posterior teeth which can stretch the lateral rugae points in outward direction, which in turn will increase the interlateral distance of the third rugae.

The mean transverse change between the third rugae (2.58) and second rugae (2.21) exceeds the 2.00 mm value considered to be significant statistically ($p<0.05$) and clinically. Therefore, the third and second rugae cannot be considered as stable anatomic marks for subjects undergone RME.

Conclusion

The quest for stability of medial and lateral rugae points following mid palatal expansion to be used as stable reference landmarks for forensic identification has led to the conclusion that only the medial aspect of first primary rugae can be considered as a stable reference landmark. While the medial and lateral aspects of the second and third rugae are liable to changes in transverse dimension. Hence, the ability of palatal rugae for forensic identification in patients who had undergone rapid maxillary expansion still remains questionable. However more studies with larger samples are required to confirm this finding.

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