Original Article

JINPAFO Vol.13, Issue 1, Jan - Jun 2024

Stability of palatal rugae in cleft patients following palatal expansion: A Forensic odontology perspective

Anshul Chaudhry[1], Girish Chaudhary[2]

[1]Professor, Department of Orthodontics and Dentofacial Orthopaedics, Christian Dental College, CMC, Ludhiana-141008, Punjab, India

[2] Associate Professor, Department of Orthodontics and Dentofacial Orthopaedics, Baba Jaswant Singh Dental College and Hospital, Ludhiana-141010, Punjab, India

ABSTRACT-

Introduction:

Palatal rugae have been recognized for their role in forensic identification as they remain stable throughout an individual's growth and even after orthodontic treatments. This study evaluated the stability of palatal rugae after palatal expansion of cleft patients in the transverse dimension.

Material and method:

Sample size consisted of 10 patients where 6 patients were treated by rapid maxillary expansion and 4 were treated by slow maxillary expansion. On the pre and post expansion cast; first, second and third rugae were recorded. Digital caliper was used to assess the changes in the transverse position of rugae by measuring the inter medial and inter lateral rugae distances.

Results:

A statistically significant increase was seen in values between medial aspect of 2nd and 3rd rugae and lateral aspects of 1st , 2nd and 3rd rugae. Conclusion: The only stable reference mark was mesial aspect of first rugae.

Keywords: Dental Records, forensic dentistry, palatal rugae, cleft palate, Orthodontics

Introduction

Forensic Odontology is a specialized field within forensic science that focuses on the study of dental records and bite marks to aid in criminal investigations[1].Various dental records used for human body identification include dental casts, X-rays, and any dental work to match individuals with their unique dental profiles[1].In disaster victim identification, dental records can provide crucial information when traditional methods are not feasible[2].

Among the various dental methods used for forensic identification, the study of palatine rugae offers a promising alternative, especially when teeth are lost due to trauma or in conjunction with other identification criteria[3]. Palatine rugae, also known as "plicae palatinae," are anatomical folds or wrinkles found on the anterior third of the palate, just behind the incisive papilla. These rugae begin to form during the third month of fetal development from the hard connective tissue covering the bone. By the 12th to 14th week of prenatal life, the pattern and orientation of the rugae are established and remain relatively stable until the oral mucosa degenerates[4].

The stability and distinctiveness of palatal rugae make them valuable for forensic identification.

They can be utilized to monitor dental movements during orthodontic treatment, serving as key landmarks in various therapeutic approaches. Additionally, palatal rugae help in identifying submucosal clefts and evaluating the extent of anteroposterior tooth movement following treatment[5]. They also play a crucial role as reference points in the superimposition of dental casts for orthodontic purposes. Investigating both the qualitative and quantitative stability of palatine rugae during growth and orthodontic treatment holds significant potential for forensic applications[6].

A constricted maxillary arch is a frequent challenge encountered by orthodontists when treating the cleft

Address for Correspondence:
Dr. Anshul Chaudhry
Professor
Department of Orthodontics and Dentofacial Orthopaedics, Christian Dental College, Ludhiana-141008, Punjab
Email: dr.anshulchaudhry@gmail.com

How to cite this article: Chaudhry A, Chaudhry G. Stability of palatal rugae in cleft patients following palatal expansion: A Forensic odontology perspective. J Indo Pacific Acad Forensic Odontology. 2024 Jan-june; 13 (1): 20-24.

patients.Common methods for maxillary expansion include slow maxillary expansion, rapid maxillary expansion, and surgically assisted rapid palatal expansion (SARPE).

This pilot study aimed to assess whether transverse changes in palatine rugae occur following the application of orthodontic forces for midpalatal expansion in patients with maxillary cleft and constriction in the maxilla. Additionally, it sought to explore the potential use of palatine rugae in the forensic identification of these patients.

Material and method:

The study consisted of 10 patients who had unilateral cleft in the maxillary region and had a transverse deficiency.The inclusion criteria were

1. Patients with constricted maxillary arch
2. No prior history of orthodontic treatment
3. No history of any habit

Informed consent was obtained from the parents before participation in the study. Quad helix was used for the expansion in 6 patients and Banded HYRAX was used for 4 patients.

Impressions were taken for all the patients and casts were poured. Separators were placed for banding between premolar and molar in the maxilla. Bands were adapted and another impression was taken with bands and the poured cast was used as a working model.

Appliance was fabricated on the working model. Hyrax expansion screw was selected depending on the amount of expansion required. Hyrax was soldered to these bands, maintaining a gap of 2 mm away from the palate and the acrylic block was cemented with GIC on the occlusal surface of posterior teeth.19 gauge wire was used to make the Quad Helixand posterior arms were soldered to bands (Fig 1).

Appliance activation began one week after its insertion, following a protocol of screw activation every 12 hours, corresponding to a rate of 0.50 mm per day (2 turns/day; 0.25 mm per turn) for 3-4 weeks. Expansion was halted when the occlusal surface of the maxillary lingual cusp of the upper first molars made contact with the occlusal surface of the facial cusp of the mandibular lower first molars, with an additional 2-3 mm of overexpansion included to account for potential relapse.

Quad helix was activated by opening the helices where activation of anterior helices increased intermolar width and adjusting posterior helices caused lateral arm expansion which counteracted mesial rotation of anterior helices activation. The appliance was activated extraorally at each visit until the adequate expansion was obtained. After this, the appliance was worn for approximately three months before it was removed.

The expansion appliances were then removed from the arch, and new impressions were taken to create post-expansion casts. A removable retention appliance was given for an additional 6 months to maintain the expansion.

Following the classification system established by Kapali et all7. Pre and post expansion cast were traced with 0.3mm graphite at the same time (Fig 2 a,b).

Medial and lateral points were marked at the ends of the first, second, and third rugae and traced along the entire length of each primary rugae (Fig 3). The distances between the medial and lateral rugae were measured using Vernier calipers with 0.1 mm accuracy . Measurement points for the inter-medial and inter-lateral distances were marked , and the readings were recorded.

Stastical Analysis

Pre- and post-expansion measurements of the inter-medial and inter-lateral distances for the first, second, and third primary rugae were analyzed using SPSS software version 25. The Wilcoxon Signed Ranks test was used to evaluate the statistical significance of transverse changes in the rugae region after expansion.

Results

Tracing showed a consistent increase in all pre and post-expansion; inter-medial and inter-lateral distance values [Table 1 ,2]. The smallest increase was observed in the inter-medial distance of the first primary rugae (0.14 mm), while the largest increase occurred in the inter-lateral distance of

Figure 1: Quad helix in patient's mouth

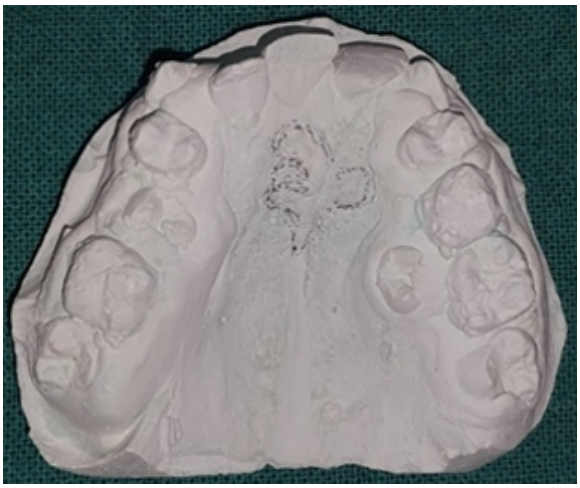

Figure 2 (a): Showing pre treatment cast with tracing of rugae

Figure 2(b) : Showing post treatment cast with tracings of rugae

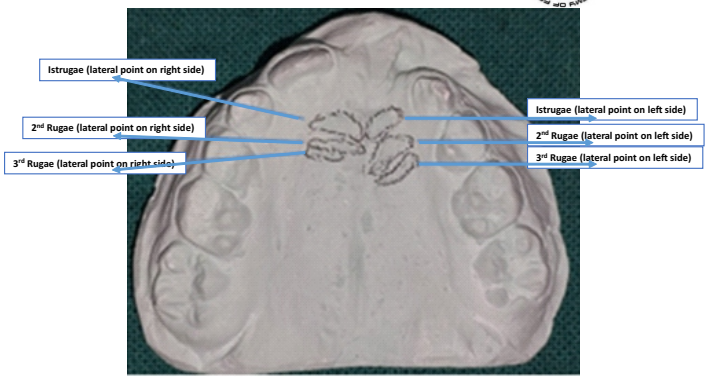

Figure 3: Demonstration of rugae on right and left side

Table 1: Pre Expansion

Rugae	Distance	N	Mean	Standard Deviation	P value
1st	IM	10	2.79	0.756	P >0.05
2nd	IM	10	6.54	1.162	P= 0.003
3rd	IM	10	15.23	2.198	P=0.007
1st	1L	10	5.12	1.208	P=0.016
2nd	1L	10	12.48	2.338	P= 0.008
3rd	1L	10	18.89	2.012	P=0.002

Table 2: Post Expansion

Rugae	Distance	N	Mean	Standard Deviation	P value
1st	IM	10	4.23	0.822	P >0.05
2nd	IM	10	7.62	1.572	P= 0.003
3rd	IM	10	18.23	2.178	P=0.006
1st	1L	10	6.21	1.674	P=0.15
2nd	1L	10	14.08	2.349	P= 0.008
3rd	1L	10	22.89	2.206	P=0.001

the third primary rugae (1.42 mm). A notable increase was also recorded in the inter-medial distance of the third primary rugae (0.93 mm). The statistical significance of these changes was assessed using the Wilcoxon Signed Ranks test.

The results showed a statistically significant increase ($p < 0.05$) for the inter medial distance of second ($p = 0.003$) and third rugae ($p = 0.007$). There was also a significant increase for inter lateral distance of first ($p = 0.016$), second ($p = 0.008$)and third rugae ($p = 0.002$).

Among these, the third rugae exhibited the greatest transverse changes, followed by the second, with the least change observed in the first rugae for both inter-lateral and inter-medial distances.

Discussion

The present study aimed to evaluate the stability of palatal rugae in the transverse dimension in patients with the cleft of maxilla who were given rapid and slow maxillary expansion appliances. The main goal of the study was to assess the viability of palatal rugae as a primary forensic identification criterion for these patients.

Our findings align well with existing evidence that indicates changes in the length and position of palatal rugae due to growth and orthodontic treatment.

Previous research has predominantly focused on transverse and anteroposterior changes in palatal rugae related to non-extraction orthodontic treatments[8], extraction of maxillary first premolars1, or the use of functional and headgear mechanics[9]. Notably, there has been little emphasis on the impact of maxillary midpalatal expansion in cleft patients, which directly affects the transverse dimension of palatal rugae by opening the palatal suture in a V-shaped manner[10], thereby significantly altering the anterior palatal vault and the connective tissue covering of palatal rugae. Consequently, further investigation is needed to determine whether palatal rugae can be considered stable reference landmarks for forensic identification in individuals who have undergone midpalatal expansion.

Our study found an increase in the transverse dimensions of

both intermedial and interlateral distances for the first, second, and third primary rugae, with the smallest changes observed in the intermedial distance of the first primary rugae which is consistent with the study by Almeida et al [11] , where they examined the stability of palatal rugae during growth in early Class II patients and the effects of headgear or functional appliance treatments on the position of rugae in a sample of 94 patients. Their results indicated no significant changes in the transverse offsets and linear distances between the medial points of the first rugae relative to the median palatal reference plane. This finding aligns with our study, which also found no significant change in the intermedial distance of the first palatal rugae.

Furthermore, Almeida et al[11]reported that none of the groups exhibited significant changes in the anteroposterior distances between the medial points of the second and third rugae, although the lateral offsets showed significant changes across all groups. This led to the conclusion that medial rugae are stable reference points. Our study supports this conclusion, as we observed significant changes in the lateral dimensions, with the third palatal rugae showing the greatest change, followed by the second, and the first showing the least. These changes were more pronounced in the lateral points compared to the medial points.

Almeida et al[11]also noted that orthopedic forces applied in the headgear group led to an increase in the distance between medial rugae points and the greatest magnitude of changes in lateral rugae points. This suggests that despite the stability of medial rugae, orthopedic forces can cause notable changes in both medial and lateral rugae distances, a correlation that our study also observed with changes in intermedial and interlateral distances due to orthodontic forces.

Kapoor et al[6]evaluated the stability of palatal rugae after maxillary expansion and concluded that the only stable reference landmark is the medial aspect of first primary rugae and the results of our study are also aligning well with their findings. Consistent findings were seen in the studies by different researchers[12,13,14,15] where they observed that rugae closer to the teeth are more prone to stretch in the direction of tooth movement. Associated buccal tipping of posterior teeth[16] ,in palatal expansion cases stretches the lateral rugae points outward, causing increase in the interlateral distances.

In the case of midpalatal expansion, the associated buccal tipping of posterior teeth[16]stretches the lateral rugae points outward, thus increasing the interlateral distances.

The position of lateral rugae points has also been affected in studies by van der Linden [17] and Almeida et al [11], both of which observed that none of the medial points of the first rugae were affected in terms of transverse values. In contrast, our study found that while the first medial rugae were minimally affected, the second and third rugae showed significant changes, with the third rugae exhibiting the greatest changes. Additionally, there was an increase in the interlateral distance for all three primary rugae. These findings can be attributed to the palate expanding in a fan-shaped manner at the midpalatal suture, which is more dental than skeletal in nature[10]. An increase in arch circumference may also contribute to the observed increases in both interlateral and intermedial distances.

Our results are partly supported by Hausser[18,19] who noted that a decrease in arch circumference affecting the anterior part of the palate resulted in no significant changes in transverse values for the medial and lateral points of the second and third rugae.

Bailey et al [14] observed greater transverse changes in medial rugae points in the non-extraction group and in lateral rugae points in the extraction group. This indicates that variations in orthodontic treatment mechanics significantly influence transverse changes in rugae.

Similarly, Shukla et al [20] found instability in lateral rugae points in a comparison of pre- and post-treatment casts of extraction and non-extraction orthodontic cases. Their study reported significant differences in the lateral points of the first and second rugae, corroborating our findings.

Despite our small sample size, the magnitude of changes observed in our study was significant. Adolescent patients, as opposed to adults, tend to exhibit greater changes, as supported by a longitudinal study by Christou et al [21], which measured vertical changes in rugae positions relative to the palatal plane over four years in a sample of 10 adults and 13 adolescents.

Highlights of Study:

This pilot study highlighted transverse changes in palatal rugae associated with midpalatal expansion using a small sample size, raising questions about the stability of palatal rugae as reference landmarks for forensic identification in these patients.

Drawbacks of Study:

The sample size was very small. To strengthen the findings, a larger-scale study should be conducted, including the monitoring for stability and retention till the growth phase gets over. Future research should also consider vertical and anteroposterior changes.

Establishing palatal rugae as a primary forensic identification tool, rather than an adjunct, depends on confirming their stability across all dimensions. Given the increasing incidence of mass disasters and situations where only minimal identifiable remnants remain, further research into the stability, uniqueness, and post-mortem resistance of palatal rugae is crucial for their potential forensic application.

Conclusion

The investigation into the stability of medial and lateral rugae points following midpalatal expansion reveals that only the medial aspect of the first primary rugae remains a stable reference landmark. In contrast, the medial and distal aspects of the second and third rugae are susceptible to changes in the transverse dimension. Therefore, the use of palatal rugae for forensic identification in individuals who have undergone midpalatal expansion remains questionable. Further research is needed to evaluate the stability of rugae across all dimensions and under various orthodontic treatments to establish their reliability for forensic applications.

References

1. Krishan K, Kanchan T, Garg AK. Dental evidence in forensic identification - An overview, methodology and present status. Open Dent J. 2015 Jul 31;9:250-6. doi: 10.2174/1874210601509010250.
2. Kolude B, Adeyemi BF, Taiwo JO, Sigbeku OF, Eze UO. The role of forensic dentist following mass disaster. Ann Ib Postgrad Med. 2010 Dec;8(2):111-7. doi: 10.4314/aipm.v8i2.71826.
3. Gupta AA, Kheur S, Alshehri A, Awadh W, Ahmed ZH, Feroz SMA, et al. Is palatal rugae pattern a reliable tool for personal identification following orthodontic treatment? A systematic review and meta-analysis. Diagnostics (Basel). 2022 Feb 6;12(2):418. doi: 10.3390/diagnostics12020418.
4. Patil MS, Patil SB, Acharya AB. Palatine rugae and their significance in clinical dentistry: A review of the literature. J Am Dent Assoc. 2008 Nov;139(11):1471-8. doi: 10.14219/jada.archive.2008.0072.
5. Chong JA, Mohamed AMFS, Pau A. Morphological patterns of the palatal rugae: A review. J Oral Biosci. 2020 Sep;62(3):249-259. doi: 10.1016/j.job.2020.06.003. Epub 2020 Jun 30.
6. Kapoor P, Miglani R. Transverse changes in lateral and medial aspects of palatal rugae after mid-palatal expansion: A pilot study. J Forensic Dent Sci. 2015 Jan-Apr;7(1):8-13. doi: 10.4103/0975-1475.150294.
7. Kapali S, Townsend G, Richards L, Parish T. Palatal rugae patterns in Australian aborigines and Caucasians. Aust Dent J. 1997;42:129-33.
8. Keiser-Neilsen S. Person Identification by Means of Teeth. Bristol: John Wright and Sons; 1980.
9. English WR, Robison SF, Summitt JB, Oesterle LJ, Brannon RB, Morlang WM. Individuality of human palatal rugae. J Forensic Sci. 1988;33:718-26.
10. Hass AJ. Rapid expansion of maxillary dental arch and nasal cavity by opening the mid-palatal suture. Angle Orthod. 1961;31:73-90.
11. Almeida MA, Phillips C, Kula K, Tulloch C. Stability of the palatal rugae as landmarks for analysis of dental casts. Angle Orthod. 1995;65:43-8.
12. Lysell L. Plicae palatinae transversae and papilla incisiva in man; a morphologic and genetic study. Acta Odontol Scand. 1955;13:5-137.
13. Peavy DC Jr, Kendrick GS. The effects of tooth movement on the palatine rugae. J Prosthet Dent. 1967;18:536-42.
14. Bailey LT, Esmailnejad A, Almeida MA. Stability of the palatal rugae as landmarks for analysis of dental casts in extraction and nonextraction cases. Angle Orthod. 1996;66:73-8.
15. Hoggan BR, Sadowsky C. The use of palatal rugae for the assessment of anteroposterior tooth movements. Am J Orthod Dentofacial Orthop. 2001;119:482-8.
16. Weissheimer A, de Menezes LM, Mezomo M, Dias DM, de Lima EM, Rizzatto SM. Immediate effects of rapid maxillary expansion with Haas-type and Hyrax-type expanders: A randomized clinical trial. Am J Orthod Dentofacial Orthop. 2011;140:366-76.
17. Van der Linden FP. Changes in the position of posterior teeth in relation to ruga points. Am J Orthod. 1978;74:142-61.
18. Hausser E. The palatal ridges in man; their significances and their modifications. Stoma (Heidelb). 1951;4:3-26.
19. Hausser E. Relation between the palatine ridges and the teeth. Dtsch Zahnarztl Z. 1950;5:879-84.
20. Shukla D, Chowdhry A, Bablani D, Jain P, Thapar R. Establishing the reliability of palatal rugae pattern in individual identification (following orthodontic treatment). J Forensic Odontostomatol. 2011;29:20-9.
21. Christou P, Kiliaridis S. Vertical growth-related changes in the positions of palatal rugae and maxillary incisors. Am J Orthod Dentofacial Orthop. 2008;133:81-6.