Original Article

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STABILITY OF THE PALATINE RUGAE: AN ADJUNCT TO FORENSIC IDENTIFICATION

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ABSTRACT:

Introduction: The palatine rugae have a typical pattern and remain stable through a person's life. There is a controversy regarding the stability of the qualitative and quantitative characteristics of rugae after orthodontic treatment. In orthodontic treatment the tooth movement may cause the compression or alteration of rugae pattern.

Aims & Objectives: The following null hypothesis was investigated: that rugae are stable landmarks after orthodontic treatment done with or without extraction with the aid of three-dimensional blue light laser scanning technique and can be used for individual identification.

Materials & Method: The pre and post treatment casts of 50 patients in the age group of 16 to 25 years were selected. The sample was equally divided into 2 groups. Group 1 comprised of 25 patients who underwent treatment with extraction of maxillary 1st premolars and group 2 comprised of 25 patients who were treated without extraction. The pre post-treatment casts were scanned using Steinbichler COMET L3D Blue Light Laser Scanner and the measurement were made on the scanned images on the Seimens PLM software NX 8.5. The medio-lateral distance of the first, second and third rugae were measured, and the antero-posterior distances between first and second rugae as well as second and third rugae were measured at the lateral and medial ends respectively on the right and left sides.

Results: No statistically significant change was seen in the medio-lateral distance of the first, second and third rugae, and the antero-posterior linear distance between the rugae in extraction as well as non-extraction cases.

Conclusion: The rugae pattern does not show significant alteration after orthodontic therapy done with or without extraction, thus they can be used for the identification of an individual by forensic odontologists. They can be used as stable landmarks to measure quantitative changes in tooth movement after orthodontic therapy.

Keywords: Palatal rugae, Forensic odontology, Digital models, orthodontic treatment

INTRODUCTION:

Palatal rugae, also called plicae palatinae transversae or rugae palatina, refer to the ridges on the anterior part of the palatal mucosa behind the incisive papilla[1]. The rugae are permanent and their characteristic pattern does not change as a result of growth. They remain stable

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from the time of development until the oral mucosa degenerates at death[2]. In forensic dentistry lip prints and palatal rugae can be used as evidence for personal identification and criminal investigation[3].

Winslow[4] was the first to study the rugae pattern in 1732 and Santorini[5] made the first illustration of the rugae in 1775. The earliest study was done in 1889 by Allen to use palatal rugae as an alternate method for human identification in forensic science[6].

Several authors concluded in their study that the rugae are stable and can be used as reference landmarks[1,3-12] but Bailey et al[7] concluded, that in extraction cases the antero-posterior dimension showed significant changes between the first and second rugae. Shukla et al[8] also concluded that the lateral ends of first rugae are unstable in the transverse dimension.

Majority of the studies involving rugae[8-12] were done on plaster models. With the advancement in technology, the measurements on digital models were found to be valid and reproducible when comparison was made between 2-D and 3-D measurements[13,14]. Kim et al[15] compared mesio-distal width of teeth, maxillary and mandibular arch length and width and compared the same using plaster models, cone-beam computed tomography (CBCT) models, and laser-scanned models. They concluded that the laser-scanned models were highly accurate as compared to plaster models or CBCT scans.

Digital models are rapidly gaining popularity in many orthodontic practices, as they are relatively inexpensive, occupy less space and require less maintenance as compared to physical models. Furthermore, they provide more convenient access for diagnosis as study models[16].

Therefore, this study was undertaken on a three dimensional axes using blue light laser scanner to assess if any change(s) occurred in the rugae pattern post orthodontic therapy in the extraction or non-extraction modality in order to verify if the rugae as stable landmarks in order to rely on it for identification of a person in forensic science.

MATERIAL AND METHODS:

SUBJECTS: The sample consisted of pre and post treatment maxillary models of 50 patients in the age group of 16 to 25 years. The patients underwent orthodontic treatment in the Post Graduate clinic of Department of Orthodontics & Dentofacial Orthopedics at Subharti Dental College, Meerut.

The sample was divided into 2 groups on the basis of extraction and non-extraction treatment, each consisting of maxillary casts of 25 patients. The extraction group consisted of patients whose treatment included the extraction of two maxillary first premolars with subsequent retraction of anterior teeth in the extraction spaces. Both the groups were treated with fixed orthodontic therapy using 0.022 X 0.028 inch M.B.T pre-adjusted edgewise appliance.

INCLUSION CRITERIA

- Maxillary casts with no missing teeth till the second permanent molars.
- Dental casts with clearly visible rugae pattern.

EXCLUSION CRITERIA

- Poor quality of dental casts
- History of previous orthognathic surgery
- Dental patient's cast with congenital malformation/ anomalies
- Deformity/ scar on palatine rugae area

CAST ANALYSIS: The cast was scanned three dimensionally by Steinbichler COMET L3D Blue Light Laser Scanner, USA. The measurements were made on the scanned images on the Seimens PLM software NX 8.5, USA (Figure 1). The evaluation was done of the lengths of the palatine rugae and the inter rugae distance before and after treatment in both the treatment groups. All the measurements were made in millimeters (mm) to the nearest 0.01 mm precision and recorded by locating necessary landmarks using the software's intrinsic linear measurement function.

MEASUREMENTS

- The medio-lateral distance of first, second and third rugae were denoted as R1, R2 and R3 respectively on the right as well as left side (Figure 2).
- Distance between 1st and 2nd rugae was denoted as D1 and the distance between 2nd and 3rd rugae was denoted as D2 on the right and left side respectively (Figure 2)

STASTICAL ANALYSIS: Mean, standard deviation and T-test were performed within each group to evaluate the measurement changes at a level of significance denoted by p value <0.05

RESULTS:

In the non-extraction cases, when the medio-lateral distance of the rugae were compared between the pre-treatment and the post-treatment casts, no significant changes were seen (Table 1). Neither the antero-posterior distance on the right side showed any significant change (Graph 1), nor the change was significant in the distances between the first, second and third rugae respectively on the left side. (Graph 2), when the comparison was done in the pre and post-treatment laser scanned study models images of the non-extraction group

On analyzing the measurements of medio-lateral distance of first, second and third rugae in the extraction cases, it was inferred that no significant change(s) occurred after orthodontic treatment (Table 2). Again it was seen that no significant change occurred in the antero-posterior distance at the lateral or the medial ends between the first, second and third rugae respectively on the right side in the pre-treatment and post-treatment laser scanned dental cast images of the

group treated with extractions (Graph 3). On the left side of the laser scanned images of the study model the change in the antero-posterior distance between the first, second and third rugae was insignificant post orthodontic therapy in the extraction cases (Graph 4).

DISCUSSION:

This study was undertaken to assess and evaluate changes in the palatine rugae pattern in the pre and post-treatment casts of patients treated with extraction and non-extraction modalities of orthodontic treatment with the aid of three-dimensional blue light laser scanner using its advantage of accuracy and reproducibility. Although studies have shown that the rugae may experience minor changes in their size due to growth of the palate, but their shape was maintained after growth completion[17], and therefore the age group of patients selected for this study was chosen from 16 to 25 years.

A study done by Lim et al[18] concluded that digital models and CBCT images can be used for model analysis. The rapid adoption of the 3D model scanners in dental offices have lead to the introduction of new scanners and software products by different manufacturers with new technologic improvements and features, such as the capability to integrate scanned digital models with CBCT scans. Hence the present study involved the aid of blue light laser scanner for studying the stability of palatal rugae three-dimensionally.

It has been stated that some events can contribute to changes in rugae pattern like trauma, extreme finger sucking in infancy, and persistent pressure with orthodontic treatment[17]. Almeida et al [19] and Abdel-Aziz et al[20] noticed in their respective studies that tooth movement many lead to the change in the position of the rugae points. Therefore, in our study the comparisons were made between the pre and post-treatment casts of the extraction and non-extraction cases, to assess if the compression of the rugae mucosa caused any change in the pattern of the rugae during space closure.

The results of our study confirmed that no significant change occurred in the medio-lateral distance of the first, second and third rugae respectively. Also the antero-posterior linear distance at medial points and lateral points respectively between the first and second rugae, as well as second and third rugae showed no significant change(s) on the right and left sides of the pre and post-treatment casts in extraction and non-extraction cases. Since no alteration took place after orthodontic treatment, rugae may be used as stable landmarks.

Bailey et al[7] had also made a comparison between extraction and non-extraction cases to assess the stability of the rugae and they concluded that the extraction of two premolars creates space for distal retraction of the maxillary anterior teeth, which could lead to the changes in the antero-posterior distance between the rugae.

In another study carried out by Shukla et al[8] it was concluded that the rugae points were unstable in the transverse dimension due to the changes in the lateral points of first rugae. The study was done to establish the reliability of the rugae pattern in identifying an individual after orthodontic treatment. The number of extraction cases in their study was comparatively more (40). This along with the type of orthodontic mechanotherapy not mentioned specifically by Shukla et al might have attributed to the difference in results as compared to the present study.

The results in the present study have a similarity as that of Pateria et al[9] who had also concluded that no change occurred in the rugae pattern after orthodontic treatment. Brent R. Hoggan and Cyril Sadowsky[21] assessed the antero-posterior tooth movements using the palatal rugae and concluded that the medial end of the third palatal rugae were suitable landmarks for serial model analysis of molars and incisors.

Numerous studies done by Lysell[1], Peavy & Kendrick[2], Kapali et al[17], English et al on the palatal rugae to verify its stability and individuality claimed that the pattern and orientation of rugae is typical for a person, which remains stable through out life.

Hence, as an orthodontist one can use rugae as reference points to measure the tooth movement and more importantly as a forensic odontologist one can use the rugae as stable landmarks for individual identification of a deceased person. Rugae palatina of an individual may also be used for maintaining criminal records in forensics as they have the reliability and individuality similar to that of fingerprints.

CONCLUSION:

The palatine rugae proved to be stable landmarks with no significant changes in the medio-lateral distance as well as the antero-posterior linear distance between first, second and third respectively rugae in both non-extraction and extraction cases.

The stable palatal rugae pattern can be a useful tool in forensic sciences to establish the identity of a person.

The rugae can be used as landmarks to superimpose pre and post-treatment study models in order to assess anchorage loss and/or tooth movement during/after orthodontic therapy.

REFERENCES:

1. Lysell L. Plicae palatinae transversae and papilla incisive in man: A morphologic and genetic study. Acta Odont Scand 1955; 13:1-137
2. Peavy DC Jr, Kendrick GS. The effects of tooth movement on

the palatine rugae. J Prosthet Dent 1967; 18:536-42.
3. Raghav P, Kumar N, Singh S, Ahuja NK, Ghalaut P. Lip Prints: The barcode of skeletal malocclusion. J Forensic Dent Sci 2013; 5:110-5
4. Winslow JB. Exposition Anatomique de la structure du corps humain. 1732. Cited by: Lysell L. Plicae palatinae transversae and papilla incisiva in man. Acta Odontol Scand 1955;13:(suppl 18):5-137.
5. Santorini JD. Septemdecim Tabulae. 1775. Cited by: Lysell L. Plicae palatinae transversae and papilla incisiva in man. Acta Odontol Scand 1955;13(suppl 18):5-137.
6. Harrison A. The palatal rugae in man. Proc Acad Nat Soc 1889; 6:245.
7. 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.
8. 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(1):20-9
9. Pateria A.H, Thakkar K, Palatal rugae a stable landmark-A comparison between pre and post orthodontic patients International Journal Of Dental Clinics 2011:3(4): 9-12
10. Kamala R, Gupta N, Bansal A, Sinha A. Palatal Rugae Pattern as an Aid for Personal Identification: A Forensic Study. Journal of Indian Academy of Oral Medicine and Radiology, July-September 2011; 23(3): 173-178
11. Bansode SC, Kulkarni MM. Importance of palatal rugae in individual identification. J Forensic Dent Sci 2009; 1:2.
12. Gandikota C, Venkata YP, Challa P, Juvvadi SR, Mathur A. Comparative study of palatal rugae pattern in class II div 1 and class I individuals. J Pharm Bioallied Sci. 2012; 4(Suppl 2): S358-63
13. Zilberman O, Huggare JAV, Parikakis KA. Evaluation of the validity of tooth size and arch width measurements using conventional and three-dimensional virtual orthodontic models. Angle Orthod. 2003; 73(3): 301-6.
14. Quimby ML, Vig KWL, Rashid RG, Firestone AR. The accuracy and reliability of measurements made on computer- based digital models. Angle Orthod. 2004; 74:298–303.
15. Kim J; Heo G, Lagrave`re M.O. Accuracy of laser-scanned models compared to plaster models and cone-beam computed tomography Angle Orthod. 2014; 84:443–450.
16. Leifert MF, Leifert MM, Efstratiadis SS, Cangialosi TJ. Comparison of space analysis evaluations with digital models and plaster dental casts. Am J Orthod Dentofacial Orthop. 2009;136:16.e1–4
17. Kapali S, Townsend G, Richards L, Parish T. Palatal rugae patterns in Australian aborigines and

Caucasians. Aus Dent J 1997;42(2): 129-133.
18. Lim M.Y, Lim S. Comparison of model analysis measurements among plaster model, laser scan digital model, and cone beam CT image. Korean J Orthod 2009; 39(1):6-17.
19. 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.
20. Abdel-Aziz HM, Sabet NE. Palatal rugae area: A landmark for analysis of pre-and post-orthodontically treated adult Egyptian patients. East Mediterr Health J 2001;7:60-6.
21. 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.

TABLES:

TABLE-1: Length of 1st, 2nd & 3rd rugae on right and left side of pre and post-treatment casts in non-extraction cases

Rugae no.	**Length on left side** (mean±SD)		Probability of paired t-test	**Length on right side** (mean±SD)		Probability of paired t-test
	Pre Treatment	**Post Treatment**		**Pre Treatment**	**Post Treatment**	
R1	9.04±1.48	8.95±1.56	0.896	8.90±1.67	8.82±1.61	0.914
R2	9.41±2.92	9.31±2.90	0.939	9.32±3.14	9.26±3.09	0.966
R3	7.38±2.19	7.31±2.20	0.943	7.29±2.35	7.24±2.37	0.962

R1: first rugae R2: Second rugae R3: Third rugae p Value<0.05

TABLE-2: Length of 1st, 2nd & 3rd rugae on right and left side of pre and post-treatment casts in extraction cases

Rugae no.	**Length on left side** (mean±SD)		Probability of paired t-test	**Length on right side** (mean±SD)		Probability of paired t-test
	Pre Treatment	**Post Treatment**		**Pre Treatment**	**Post Treatment**	
R1	9.59±0.87	9.59±1.11	>0.99	9.97 ±1.37	10.0±1.28	0.907
R2	8.18±2.25	7.77±2.14	0.681	9.44±2.70	9.15±2.77	0.815
R3	8.40±2.35	8.35±2.28	0.962	10.45±2.5	9.91±2.55	0.638

R1: first rugae R2: Second rugae R3: Third rugae p Value<0.05

FIGURES:

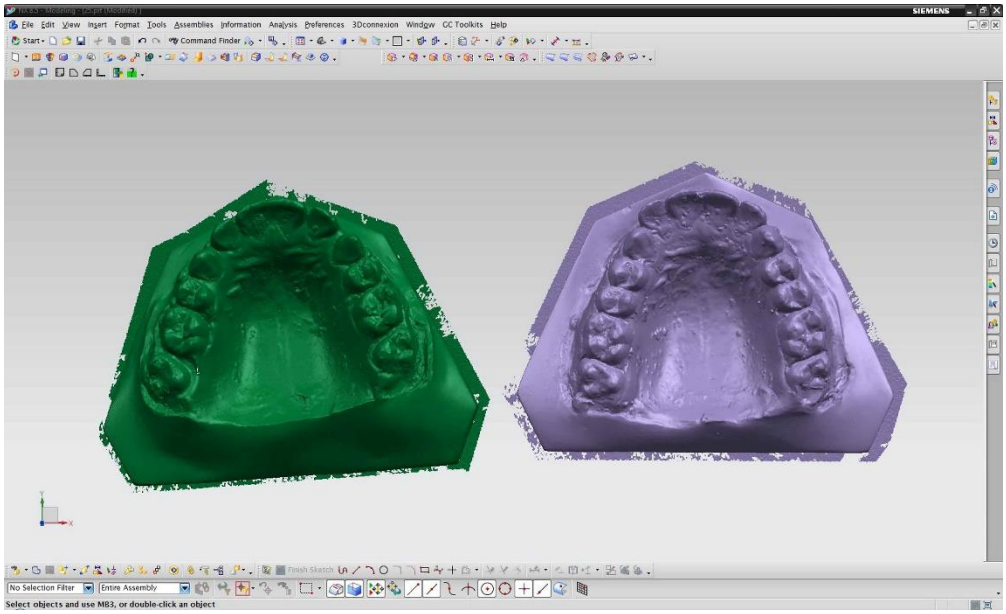


Figure 1: Seimens PLM software NX 8.5, USA

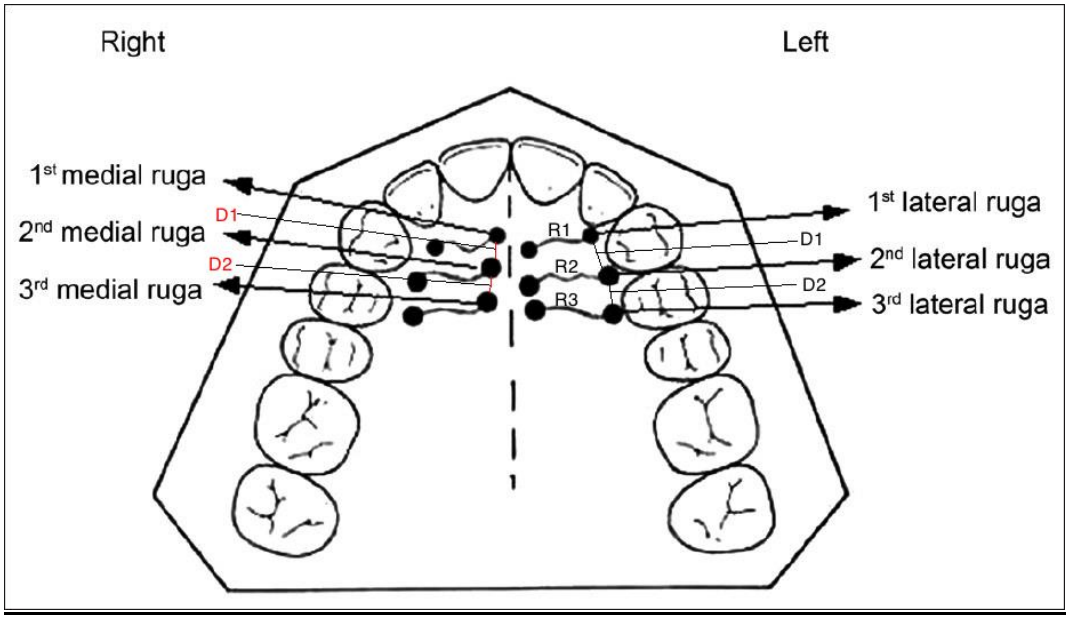
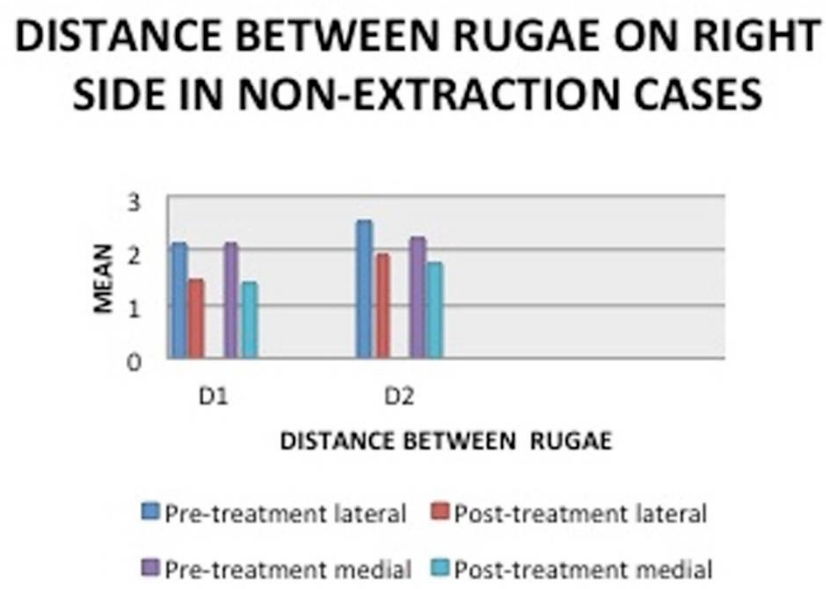
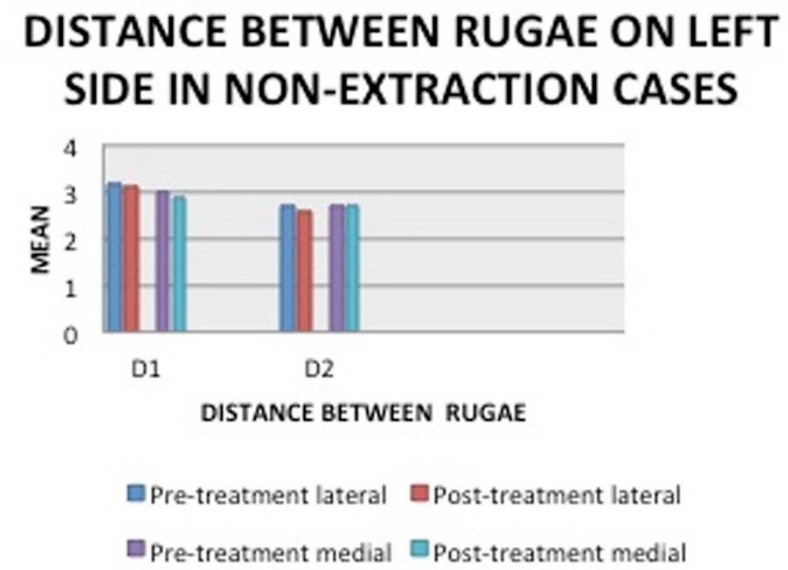


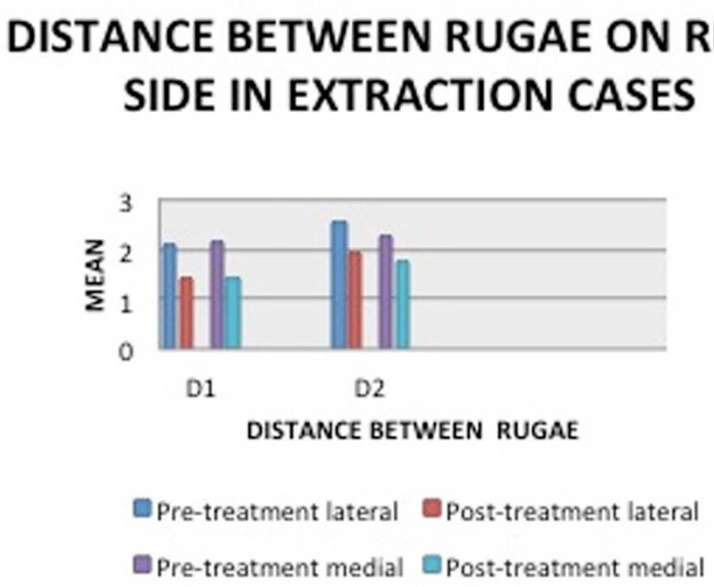
Figure 2: Measurements made on the study model



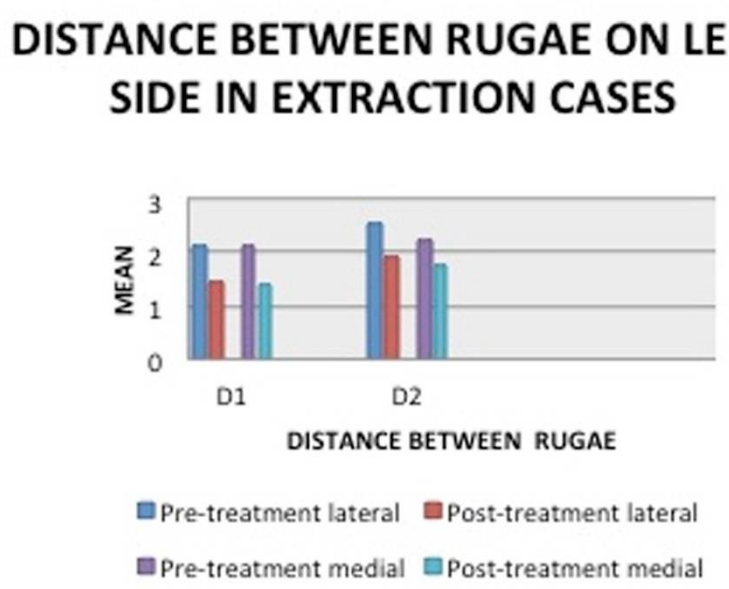
Graph 1: Antero-posterior distance in non-extraction cases on right side



Graph 2: Antero-posterior distance in non-extraction cases on left side



Graph 3: Antero-posterior distance in extraction cases on right side



Graph 4: Antero-posterior distance in extraction cases on left side