ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 3, Issue – 2, March - 2020, Page No. : 435 - 443

Comparision of the Treatment Efficiency between Labial and Lingual Fixed Mechanotherapy – A Prospective Clinical Study

[1]Dr.Vagdevi Hosur Kantharaju, MDS, Specialist Orthodontist, Private Practitioner, Mysore, India.

[2]Dr. Mala Ram Manohar, MDS, HOD, Dept of orthodontics and dentofacial orthopaedics, College of Dental Sciences, Davangere, India.

[3]Dr. G Shivaprakash, MDS, HOD, Dept of orthodontics and dentofacial orthopaedics, College of Dental Sciences, Davangere, India.

Correspondence Author: Dr.Vagdevi Hosur Kantharaju, MDS, Specialist Orthodontist, Private Practitioner, 3rd cross, 4th main, Vijayanagara 1st stage, , Mysore, Karnataka, India.

Citation of this Article: Dr.Vagdevi Hosur Kantharaju, Dr. Mala Ram Manohar, Dr. G Shivaprakash, "Comparision of the Treatment Efficiency between Labial and Lingual Fixed Mechanotherapy – A Prospective Clinical Study", IJDSIR- March - 2020, Vol. – 3, Issue -2, P. No. 435 – 443.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Lingual orthodontic appliances are a viable alternative to labial appliances for those esthetically conscious patients. At the same time these patients also demand a high level of comfort, greater treatment efficiency, better esthetic results and faster treatment. This study was undertaken to compare the efficiency of labial and lingual appliance in terms of torque changes, arch width and form changes. Twenty patients requiring first premolar extraction were selected, 10 patients were treated with the Lingual Appliance and 10 with the Labial Appliance. Pre and Post Lateral cephalograms and dental study models of each patient were taken. Torque, arch form and width changes were recorded. The post treatment torque comparison showed significant difference in upper incisor inclination between the labial and the lingual group. U1-NA & U1-SN showed statistically significant lower torque values in the lingual group but U1-PP values were not statistically significant. Arch width ratio in the labial and lingual appliance group significantly increased in both the maxillary and mandibular arches. The lingual group however showed a highly significant decrease Arch form ratio in both the arches. This study revealed that Lingual Appliance patients finished with significantly reduced torque expression of the upper incisors compared to the labial group, an increase in squareness of both the arches and a more constricted arch form especially in the molar region.

Keywords: Dental Arches, Treatment Efficacy, Torque.

Introduction

Adult orthodontics is increasing in popularity and the possibility of "invisible braces" is an idea that could be appealing to many patients who refused treatment with conventional labial appliances. During the past 10 years, various designs of lingual brackets have been used and frequently modified in an attempt to provide patient comfort, mechanical efficiency, and precise tooth positioning. [1]

The use of lingual appliances is a commonly used alternative, but compared to labial appliances, these are thought to result in different clinical outcomes, such as ‘‘bite opening,’’ [1]decreased axial inclination of the maxillary incisors, [2]and reduced torque control.[3] The short interbracket distance in lingual appliances is also problematic, especially during detailing. [4]

Past studies [1, 5] have mainly used cephalometric analysis to evaluate the clinical outcome of lingual appliances, but arch form and width changes have never been assessed.

Thus, the purpose of this study is to test for specific treatment differences like torque, arch width and form changes between patients treated with lingual and labial fixed appliances.

Materials and Methods

In this prospective clinical study the patients were selected from the Department of Orthodontics and Dentofacial Orthopedics, CODS, Ethical clearance was obtained from the Institutional Ethical Committee before the commencement of the study (Ref: CODS/2427/2018-19).

Twenty patients who met the inclusion criteria were selected. The main variables within these groups were age, sex, and severity of malocclusion was selected. All eligible patients (ie, those who met the inclusion criteria and provided informed consent for their participation) were included in the analysis. The criteria for case selection were as follows:

Inclusion criteria

1) Patients requiring therapeutic extraction of first pre molars;

2) Angle Class II malocclusion;

3) Patients with aesthetic concern;

4) No history of previous orthodontic treatment; and

5) Patients who will not undergo any lateral expansion of dental arches.

The labial group comprised two men and eight women with an average (± standard deviation [SD]) age of 16.20 ± 2.1 years. The lingual group consisted of 10 women with an average age of 19.60 ± 1.8 years.

10 patients were placed with Lingual and rest 10 with Labial fixed appliance respectively. All patients were treated with 0.018-inch slot brackets. Lingual cases were treated with STb lingual brackets (Ormco, Orange, Calif). [6] The wire sequence in all labial cases was 0.014- or 0.016-inch nickel-titanium (Ni-Ti), 0.016 × 0.022-inch Ni-Ti, 0.016 × 0.022-inch stainless steel (SS), and 0.017 × 0.022-inch SS. The wire sequence in all lingual cases was 0.014- or 0.016-inch Ni-Ti, 0.018- inch titanium molybdenum alloy (TMA) or 0.016-inch SS, 0.017 × 0.022-inch copper (Co)-Ni-Ti, 0.0175 × 0.0175-inch TMA or 0.016 × 0.016-inch SS, 0.016 × 0.022-inch SS or 0.017 × 0.022-inch SS. Anterior retraction was by en mass retraction using sliding mechanics in all cases. A transpalatal arch or Nance appliance was required in both groups. An over correction was incorporated into the lingual set up as recommended by Scuzzo and Takemoto. [7]

Lateral cephalograms and dental study models of each patient were taken before and after completion of the treatment for assessment of torque and arch form and width changes respectively. All cephalometric radiographs were traced and study models were measured by the same investigator.

Torque Changes: (Fig. 1)

The following angular measurements were taken on all subjects: The angle formed by upper central incisor long axis to NA line, SN Plane and Palatal Plane were measured on the lateral cephalogram of pre and post treatment cephalograms for assessing the torque changes.

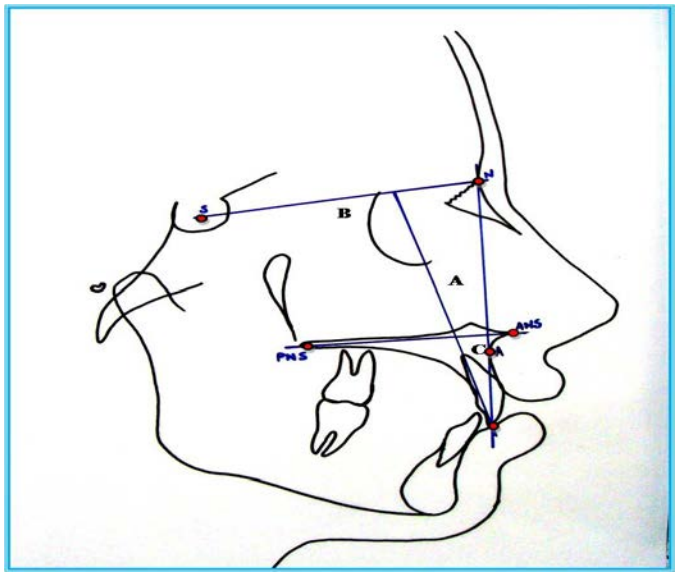

Fig. 1: Angular Measurements: U1-NA, U1-SN & U1-PP

Arch Form & Width Changes: (Fig. 2 & 3)

Dental study models were used to study Arch Width and Arch Form changes using linear measurements and ratios in pre and post treatment models. Linear measurements were made with sliding calipers. Two ratios were calculated to assess changes in arch shape and form. [8]

$$\text{Arch Width Ratio} = \frac{\text{Inter Canine Width}}{\text{Inter Molar Width}}$$

$$\text{Arch Form Ratio} = \frac{\text{Arch Chord}}{\text{Inter Molar Width}}$$

Intercanine width: It is measured as the maximum distance at the buccal surfaces of the canines.

Intermolar width: It is measured as the maximum distance at the buccal surfaces of the molars.

Arch chord: Linear distance from the interincisal midline at the labial interpapillary process to the distobuccal aspect of the first molar.

Fig. 2: Inter-Canine Width and Inter-Molar Width Measurements

Fig. 3: Arch chord Measurements

Statistical Analysis

All the data were analyzed with MINITAB version 13.1 & SPSS software's. Results are presented as mean ± SD. Student's unpaired t-test was used for inter-group comparison of changes between labial and lingual groups to assess age and torque changes, chi-sqaure test for assessing sex differences between labial and lingual group and Mann Whitney U-test was used for inter-group comparison of arch width and form changes. A p-value of 0.05 or less was considered for the results to be statistically significant.

Results

Comparision of pre and post treatment torque between labial and lingual groups:

The mean, SD and mean difference for pre treatment torque value as measured with U1-NA, U1-SN and U1-PP which were statistically non significant as presented in Table 1.

	Labial cases		Lingual cases			
Parameter	Mean (Degrees)	SD	Mean (Degrees)	SD	Mean difference (Degrees)	P Value
U1-NA(°)	32.6	5.5	30.9	4.0	1.7	0.43 *
U1-SN(°)	115.2	6.9	115.8	3.3	0.6	0.80 *
U1-PP(°)	59.3	7.9	57.8	4.1	1.5	0.60 *

Table 1: Descriptive Statistics of Torque changes between Pre treatment Labial and Lingual Cases.

[*P >0.05 *(Student's unpaired t-test)*]

The mean, SD and mean difference for post treatment torque value as measured with U1-NA and U1-SN showed differences in mean scores which were statistically significant and statistically non significant for U1-PP as presented in Table 2.

	Labial cases		Lingual cases			
Parameter	Mean (Degrees)	SD	Mean (Degrees)	SD	Mean difference (Degrees)	P Value
U1-NA(°)	25.3	4.8	20.5	5.1	4.8	0.045 **
U1-SN(°)	109.9	4.7	103.2	5.2	6.7	0.007 **
U1-PP(°)	66.0	6.5	69.6	5.0	3.6	0.18 *

Table 2: Descriptive Statistics of Torque changes between Post treatment Labial and Lingual Cases.

*P >0.05, **P <0.05

Comparision of pre and post treatment arch form and width between labial and lingual groups

Mann–Whitney U-test applied for comparison between pre treatment labial and lingual group are as depicted in Table 3.

Intercanine width were statistically non significant. Intermolar width for mandibular arch showed a mean decrease of 2.85 mm which was statistically significant. Arch chord measurement decreased in the pre treatment lingual group when compared with that of pre treatment labial group for the maxilla which was statistically significant and in mandible it was statistically highly significant.

Arch width ratio increased in the pre treatment lingual group when compared with that of pre treatment labial group. Arch width in maxilla and mandible showed statistically significant change of p- 0.06 and 0.001 respectively.

Arch shape ratios decreased in the post treatment labial group compared to the pre treatment group for the maxilla and increased in mandible, both these changes were statistically non significant.

	Pre treatment labial		Pre treatment lingual			
Parameter	Mean (mm)	SD	Mean (mm)	SD	Mean difference (mm)	P Value
Max 3-3	34.05	2.74	34.60	2.83	0.55	0.48 *
Max 6-6	50.80	3.00	48.30	3.90	2.50	0.07 *
Arch chord	43.85	3.84	38.70	1.67	5.15	0.001**
Arch Width Ratio	0.67	0.03	0.73	0.08	0.06	0.06 **
Arch Shape Ratio	0.86	0.06	0.82	0.09	0.04	0.26 *
Mand 3-3	25.25	2.88	26.35	1.76	1.10	0.14 *
Mand 6-6	42.50	2.94	39.65	2.44	2.85	0.01 **
Arch chord	39.40	2.08	34.40	1.61	5.00	<0.001***
Arch Width Ratio	0.59	0.05	0.67	0.03	0.08	0.001 **
Arch Shape Ratio	0.73	0.39	0.87	0.03	0.14	0.3 *

Table 3: Descriptive Statistics of arch form and width changes between Pre treatment Labial and Lingual Cases.

*P >0.05(Non significant), **P <0.05(Significant) and ***P <0.001(Highly significant)

Mann–Whitney U-test applied for comparison between pre treatment labial and lingual group are as depicted in Table 4.

	Post treatment labial		Post treatment lingual			
Parameter	Mean (mm)	SD	Mean (mm)	SD	Mean difference (mm)	P Value
Max 3-3	36.15	1.36	35.45	1.26	0.70	0.07 *
Max 6-6	52.25	1.78	49.40	1.65	2.85	<0.001 ***
Arch chord	44.20	1.55	38.05	1.09	6.15	<0.001 ***
Arch Width Ratio	0.69	0.03	0.72	0.04	0.03	0.003 **
Arch Shape Ratio	0.85	0.04	0.77	0.03	0.08	<0.001 ***
Mand 3-3	27.10	1.52	27.30	0.71	0.20	0.67 *
Mand 6-6	44.45	2.10	42.70	2.59	1.75	0.14 *
Arch chord	38.85	1.87	33.50	1.49	5.35	<0.001 ***
Arch Width Ratio	0.61	0.04	0.65	0.02	0.04	0.002 **
Arch Shape Ratio	0.87	0.03	0.80	0.03	0.07	<0.001 ***

Table 4: Descriptive Statistics of archform and width changes between Post treatment Labial and Lingual Cases. *P >0.05(Non significant), **P <0.05(Significant) and ***P <0.001(Highly significant)

Intercanine width were statistically non significant. Intermolar width for mandible showed a mean decrease of 2.85 mm which was statistically significant. Intermolar width between 2 group the values for maxilla were statistically highly significant (p<0.001 HS). Arch chord measurement decreased in the post treatment lingual group when compared with that of post treatment labial group which were statistically highly significant (p-<0.001 HS).

Arch width ratio increased in the post treatment lingual group when compared with that of post treatment labial group. Arch width in maxilla and mandible showed statistically significant change of p-0.003 and 0.002 respectively.

Arch shape ratios decreased in the post treatment lingual group compared to the post treatment labial group for maxilla and mandible both these changes were statistically highly significant (p- <0.001 HS).

Discussion

The lingual appliance therapy has its own set of unique problems by virtue of appliance having to be placed on the highly variable and inclined lingual anatomy. The reduced arch perimeter on the lingual aspect resulted in diminished inter bracket space and increased wire stiffness which makes the lingual appliance a very challenging treatment modality. [4]

Very few studies in the literature have comprehensively mentioned about the efficiency of lingual appliance system and compared it to the labial appliance system.[1,9,10] Hence this study was undertaken to analyse mainly the torque changes, arch form and width changes.

Torque changes

Placement of the appliance and the force application on the lingual directly affects the biomechanics of the maxillary anterior tooth movement. The point of force application is lingual to the center of resistance of the tooth being moved. The retraction mechanics in the lingual technique, by virtue of its point of force application itself, places a clockwise moment on the maxillary anteriors, resulting in labial root torque and lingual crown torque. Additionally, the vertical bowing effect of the retraction mechanics also tends to have a torque reducing effect on the maxillary incisors. An over correction of 10^0 - 12^0 of extra anterior labial crown torque was incorporated into the lingual set up of the cases in the present study as recommended by Scuzzo and Takemoto. [7]

In this study torque changes were analysed in lingual and labial technique cases to determine the effects of lingual biomechanics on the post treatment torque expression. There was no significant difference in the pretreatment torque between the two groups, showing that patients in both the groups had comparable incisor proclination at the start of the treatment. The post treatment torque comparison however showed significant difference in

upper incisor inclination between the labial and the lingual group. U1-NA & U1-SN showed statistically significant lower torque values in the lingual group but U1-PP values were not statistically significant. This could be attributed to the variation in the inclination of the palatal plane. The lingual patients finished with more upright incisors than the labial patients in this study.

Fulmer and Kuftinec[1] examined both extraction and non extraction labial and lingual cases and found that the lingual extraction group had slightly more upright maxillary incisors, but stated that the torque control of the appliance was adequate.

John R Smith [10] presented two extraction cases and found insufficient anterior torque control during space closure and suggested that, this could have been prevented with adequate size wires and with the use of an anterior high pull headgear would have added to the torque control.

Silvia Geron[11] said that even with perfect bracket placement, full-size straight wires cannot deliver teeth to the straight wire torque prescription, because of force diminution and the play between the archwire and bracket slot. In addition, much more torque is required in extraction cases treated with the lingual technique than with labial brackets, since the retraction force is applied lingual to the center of resistance of the anterior teeth, creating a tendency for these teeth to be retro lined during space closure. Therefore, extra torque is built into the Lingual Bracket Jig, based on the Bios prescription.

Liang .et.al [12] believed that thorough understanding of incisor torque control during labial and lingual treatment is critical for best results. They concluded that loss of torque was more likely with lingual technique and the clinician should increase lingual root torque when using the lingual technique. Hee Moon kyun.et.al [13] also recognized torque loss potential of the lingual mechanics and advised using a headgear with a removable Anterior Root Torquing Jig to help control the torque of maxillary incisors. Lingual brackets act as a tongue crib or spur, the tongue usually avoids the anterior brackets, thus reducing the anchorage loss normally associated with retraction of the anterior teeth. The buccinators muscle presses the lips continuously against the teeth during lingual treatment, further reinforcing anterior anchorage. Paige [14] used Auxillary root torturing springs to control the torque of anterior teeth.

Gorman and Smith [15] measured U1-SN in lingually treated cases and compared them to labial cases and found increased incisor torque control in lingual appliance cases. However difference was not statistically significant. Thier finding do not agree with the present study and a number of other studies as well. [1, 5, 11, 12, 13, 16]

Finding seen in our study were similar to the results shown by the above authors. [1, 5, 11, 12, 13, 16] The shorter distance between the brackets decreases the torque control and leads a more obtuse interincisal angle and more upright incisors in each arch, particularly in the extraction cases. [13] Also this could be due to the reason that retraction forces applied are occlusal and lingual to the center of resistance of anterior teeth. [10] This causes the teeth to tip during en-mass retraction of anterior teeth and the post treatment upper and lower incisors inclination was more upright on the average. Hence it is essential to incorporate sufficient amount of torque in the anterior segment to compensate for torque loss.

Arch Form and Width Changes

Maintenance of transverse dimensions and arch forms is extremely important during treatment. Especially in treatment of cases with extraction of teeth, arch form and arch width changes becomes extremely critical. Many clinicians and researchers believed that the mandibular arch form represents a state of structural and functional balance for the individual and that it should not be altered

in treatment.[17] However, some in the profession contend that the mandibular arch form can be successfully expanded to increase arch length availability for the dentition. [18] There is also the view that in extraction cases, intercanine distance will inevitably increase as the canines are retracted into a wider portion of the arch. [17]

The application of force on the lingual for space closure has an expansive effect on the dental arch due to the Transverse Bowing effect associated with sliding mechanics. [7] All the lingual cases in the present study were treated with en mass retraction using sliding mechanics. Hence it was sort to study whether lingual appliance caused any changes in arch form and width and whether arch form and width were maintained during treatment with both labial and lingual appliance.

The present study measured two absolute values i.e, inter canine width and intermolar width and two ratios i.e., Arch width ratio and Arch form ratio. Arch width ratio is a measure of the squareness of the arch and is derived by dividing inter canine width by inter molar width. Arch form ratio is the measure of shape of the arch and is derived by dividing arch chord by inter molar width.

The labial and lingual appliance cases in this study showed no significant change in inter canine width in both the maxilla and mandible with the treatment. Intercanine width was maintained rather efficiently with both the treatment modalities. Hence it can be inferred that the lingual appliance is as efficient as the labial appliance in promoting post treatment stability by maintaining inter canine width.

Inter molar width decreased in both the labial and lingual cases in both the arches, however the decrease in the lingual group was highly significant in the maxillary arch and in the labial group decrease was significant statistically in the mandibular arch. This finding supports the effect of the transverse bowing effect on the molar region.

Thus it can be inferred that the lingual treatment had a constricting effect on the molar region in both arches but the effect was more pronounced in the upper arch. This differential constriction in the two arches is in agreement with Scuzzo and Takemoto, who stated that the Transverse Bowing effect is frequently seen in the upper arch and rarely in the lower arch with its narrow alveolar bone, and presents as widening in the premolar region and constriction in the molar region. [7]

The lingual appliance cases finished with a more constricted arch form especially in the molar region. This could be avoided by stabilization of the first and second molar on the buccal aspect and by more careful arch wire fabrication with compensating bowing arch form to maintain the inter molar width.

Arch width ratio in both labial and lingual appliance group significantly increased in maxillary and mandibular arches. This implies that both the labial and lingual treatment resulted in increased in squareness of both the arches. In the both the treatment group this could be because of a greater decrease in intermolar width while the intercanine width remained almost constant.

In the labial group the arch form ratio showed a statistically non significant decrease in the maxillary arch and increase in the mandibular arch. The lingual group however showed a highly significant decrease in both the arches. Reduction of the arch form ratio is a logical expectation in both the labial and lingual groups since both the groups were treated with extraction mechanics. However the increased arch form ratio in the mandibular labial group could be attributed to correction of lower anterior crowding or proclination of the lower incisors causing the arch chord to increase. The highly significant reduction of arch form ratio in the lingual group reflects

the tendency of the lingual appliance to upright the anteriors, during retraction finishing with an increased inter incisal angle and under torqued incisors both in the maxillary and mandibular arches. [1] The bio mechanics of the lingual appliance supports this finding.

The limitations of this study include a small sample size, and inter premolar width should have been considered so that transverse bowing effect could be more justifiable in lingual cases.

Conclusion

1. Lingual Appliance patients finished with significantly reduced torque expression of the upper incisors compared to the labial group.
2. The Lingual Appliance prescription requires additional torque incorporated in the maxillary incisor region.
3. The labial and lingual treatment resulted in increase squareness of both the arches.
4. The lingual appliance cases finished with a more constricted arch form especially in the molar region exhibiting the effect of Transverse bowing.
5. The lingual group showed highly significant decrease in arch form ratio in both the arches. This decrease in the lingual group reflects the under torque and upright incisors.

References

1. Fulmer D. T and Kuftinec M. M. Cephalometric appraisal of patients treated with fixed lingual orthodontic appliances: Historic review and analysis of cases. Am J Ortho 1989; 95(6): 514-520.
2. Geron S, Romano R, Brosh T. Vertical forces in labial and lingual orthodontics applied on maxillary incisors - a theoretical approach. Angle Orthod. 2004; 74:195 - 201.
3. Dianmond M. Critical aspects of lingual bracket placement. J Clin Orthod. 1983;17: 240–246.
4. Kurz C, Bennett R. Extraction cases and the lingual appliance. J Am Ling Orthod Assoc. 1988; 3:10–13.
5. Gorman J. Courtney and Smith J Richard. Comparison of treatment effects with labial and lingual fixed appliances. Am J Orthod Dentofac Orthop 1991: 99(3): 202-209.
6. Scuzzo G, Takemoto K, Takemoto Y, Takemoto A, Lombardo L. A new lingual straight-wire technique. J Clin Orthod. 2010; 44:114–123.
7. Giuseppe Scuzzo and Kyoto Takemoto. Invisible orthodontics: Current concepts and Solutions in Lingual Orthodontics. 1st Edition. Quintessenz, Germany 2003.
8. Harris EF. A longitudinal study of arch size and form in untreated adults. Am J Orthod Dentofac Orthop 1997; 111: 419-27.
9. Smith, J.R. Lingual Orthodontics: A Status Report Part 7B: Case Reports - Extraction. J Clin. Orthod 1983: 17(7): 464-473.
10. Gorman J. Courtney and Smith J Richard. Comparison of treatment effects with labial and lingual fixed appliances. Am J Orthod Dentofac Orthop 1991: 99(3): 202-209.
11. Silvia geron. Lingual Bracket J ig. J Clin. Orthod 1999:33(8):457-463.
12. Liang W, Rong Q, Lin J, Xu B. Torque control of the maxillary incisors in lingual and labial orthodontics: a 3-dimensional finite element analysis. Am J Orthod Dentofacial Orthop. 2009 Mar; 135(3):316-22.
13. Hee-Moon Kyung, Hyo-Sang Park, Jae-Hyun Sung. The Mushroom Bracket Positioner for Lingual Orthodontics. J Clin. Orthod 2002; 320-328.
14. Paige S.F. A lingual light-wire technique. J. Clin. Orthod. 16:534-544, 1982.

15. Gorman J.C, Hilgers J.J and Smith J.R. Lingual Orthodontics: A Status Report, Part 4: Diagnosis and Treatment Planning. J Clin. Orthod 1983: 17(1): 26-33.
16. Aldo Macchi, Angelo Tagliabue, Luca Levrini, Giorgio Trezzi. Philippe Self-Ligating lingual brackets. J Clin. Orthod 2002; 36(1): 42-45.
17. Burke SP, Sitveira AM, Goldsmith LJ, Yancey JM, Stewart AV, Scarfe WC. A meta-analysis of mandibular intercanine width in treatment and postretention. Angle orthod 1997; 68(1):53-60.
18. Fleming PS, DiBiase AT, Sarri G, Lee RT. Comparison of mandibular arch changes during alignment and leveling with 2 preadjusted edgewise appliances.Am J Orthod Dentofacial Orthop. 2009; 136(3):340-7.