Original Article

Comparative evaluation of sagittal anchorage loss in lingual and labial appliances during space closure: A pilot study

Shivanand Venkatesh, Joe Rozario[1], Sanjay V. Ganeshkar[2], Shreya Ajmera[2]

Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Sciences, M S Ramaiah University of Applied Sciences, [1]Department of Orthodontics and Dentofacial Orthopedics, Shyamala Reddy Dental College, Bengaluru, [2]Department of Orthodontics and Dentofacial Orthopedics, SDM College of Dental Sciences, Sattur, Dharwad, Karnataka, India

Abstract

Aim: The purpose of this investigation was to assess and compare the anchorage loss between labial and lingual appliance systems during space closure. **Materials and Methods:** Twenty subjects were part of the study among which 10 subjects (mean age 21 ± 3.6 years) were treated using lingual appliance system (0.018" slot-STb™) and 10 subjects (mean age 19 ± 6.1 years) were treated using labial preadjusted edgewise appliance system (0.018" slot-MBT™). First premolar extractions were performed to enable retraction of anterior teeth. Lateral cephalometric radiographs were taken at two intervals, before starting space closure and after space closure that were connoted as T0 and T1 and were analyzed using the method described by Pancherz to measure anchorage loss. Intraclass correlation coefficient (ICC) was used to evaluate intraexaminer reliability of the measurements. Student's *t*-test was performed to verify any statistical significant correlation between the labial and lingual appliance systems. Statistical differences were determined at the 95% confidence level ($P < 0.05$). **Results:** The results showed that all ICC for lingual and labial group were ≥0.90 showing good repeatability of the measurements. Mean anchorage loss of 1.238 ± 0.17 mm in lingual appliance system and an anchorage loss of 2.06 ± 0.39 mm occurred with the labial appliance system. On the comparison between the two appliance systems, lingual appliance demonstrated a significantly lesser anchorage loss than did the labial appliance. **Interpretation and Conclusion:** This prospective study concludes with the fact that lingual appliance provided better anchorage control than labial appliance during space closure. Use of lingual appliance could be considered in critical anchorage cases when compared with labial appliance.

Key words: Anchorage loss, labial appliance, lingual appliance

INTRODUCTION

In orthodontic treatment, anchorage loss is a potential side-effect of orthodontic mechanotherapy and one of the major causes of unsuccessful results. The cause for anchorage loss has been described as a multifactorial response in relation to the appliance type, the extraction site, age, crowding and overjet.[1] With the extraction site, there has been a wide belief that anchorage loss is more with second premolars than first premolars due to faster mesial movement of the molar. In labial appliance, various studies have quoted better anchorage control with first premolar extraction than second premolar extractions.[2-4] However, Geron *et al.* reported that the amount of anchorage loss with second premolar extraction in lingual technique is comparable to first premolar extraction situations (only a difference of 0.5 mm between the techniques was observed) and concluded that location of the premolar

Access this article online	
Quick Response Code:	Website: www.apospublications.com
	DOI: 10.4103/2321-1407.148027

Address for Correspondence:
Dr. Shivanand Venkatesh, Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Sciences, M S Ramaiah University of Applied Sciences , MSR Nagar, Bengaluru - 560 054, Karnataka, India. E-mail: shivanand85@gmail.com

extraction site could not be considered as significant anchorage loss factor.[1]

Takemoto suggested that the anchorage value of posterior teeth is higher in lingual appliance and the direction of forces applied during space closure brings about buccal root torque and hence enhances anchorage.[5] Geron also reported several factors responsible for better anchorage control in lingual appliances and proposed six anchorage keys to enhancing the anchorage further.[6] Although it has been postulated that the lingual appliance has theoretically lesser anchorage loss compared with the labial appliance, there are very few studies evaluating the same. To the best of our knowledge, only one study compared the anchorage loss between labial and lingual appliances, but it was retrospective in nature.[1] Since it has been widely believed that lingual appliance provides better anchorage control, it was decided to perform a prospective evaluation to best test the hypothesis. Therefore, a pilot study to compare the anchorage loss between labial and lingual orthodontics would provide a better knowledge on the controversy. Hence, this pilot study was designed to assess and compare the anchorage loss between labial and lingual appliance systems during space closure.

MATERIALS AND METHODS

The study was conducted on 20 subjects chosen from Department of Orthodontics and Dentofacial Orthopaedics, after getting an approval from the Institutional Review Board, Ethical Committee and an informed patients' consent. They were selected for the study based on the following criteria: Bimaxillary dentoalveolar protrusion where extraction of upper first premolars were involved, full complement of teeth from right first molar to left first molar and moderate to critical anchorage cases requiring 75-100% retraction of anterior teeth. All lingual cases had shallow bite, and bite blocks need not had to be placed for vertical disocclusion since they are known to affect the anchorage. For the purpose of enhancing anchorage, second molars were bonded, and archwire was passed. Patients with moderate to severe crowding, deep bite, systemic diseases, mutilated dentition, craniofacial or skeletal anomalies affecting the craniofacial region, skeletal and dental Angle's Class III and Class II malocclusions, high angle and low angle cases were excluded from the study.

Ten subjects between the age group 17 and 25 years (mean age 21 ± 3.6 years) were treated using lingual appliance system (0.018" slot Scuzzo Takemoto brackets-STb™ marketed by Ormco) and 10 subjects between the age group 14 and 23 years (mean age 19 ± 6.1 years) were treated using labial preadjusted edgewise appliance system (0.018" slot McLaughlin Bennett Trevisi brackets-MBT™ Victory series™ marketed by 3M Unitek). The lingual set up was performed on a Torque Angulation Device and Bracket Positioning Device (Precise Indirect Bodning System™, Thailand) to set the torque and angulation values for all the teeth. MBT prescription was followed for the lingual setup for the purpose of standardization with labial appliance. In the lingual appliance system, 0.012-inch Nitinol superelastic wire was the initial archwire used followed by 0.014-inch or 0.016-inch Nitinol superelastic wires. Leveling and alignment were completed using 0.016-inch or 0.018-inch stainless steel wires. 0.017 × 0.025-inch titanium molybdenum alloy or stainless steel wires were placed for torque expression for 3 months. Space closure by en masse retraction was carried out on a 0.017 × 0.025-inch stainless steel wires using sliding mechanics.[7] In the labial appliance, leveling and alignment were completed using 0.016-inch or 0.018-inch stainless steel archwires, followed by placement 0.017 × 0.025-inch stainless steel archwires placed for torque expression and space closure.[8] En masse retraction was carried using nickel titanium (NiTi) closed coil springs in the upper arch and E-chains in the lower arch with a force of approximately 150 g on each side. NiTi coil springs were not used in the upper arch in order to prevent any injury to the tongue.

Cephalometric radiographs were taken at two intervals during the study period: Before starting space closure and after space closure that were connoted as T0 and T1. The lateral cephalometric radiographs of all the selected subjects were taken in the Natural Head Position using Rotograph 230/Eur-4 X-ray machine (Villa system Medicali, Italy), exposed at 80 kV/8 mA for 0.8 s. The patients were positioned for taking lateral cephalograms as recommended by American standard cephalometric arrangement.[9] K-separators were placed between first permanent molar and second molar and in the second quadrant to differentiate between the right (mesial aspect) and left molars (distal aspect) on the lateral cephalogram.

All the tracings were made on 75 μm lacquered polyester acetate tracing papers (Garware Polyester Ltd., Mumbai, Maharashtra, India) using a 0.03 mm Staedtler™ lead pencil. All lateral cephalograms were traced, and linear measurements were performed to the nearest 0.001 mm using Mitutoyo Digital Caliper (Mitutoyo American Corporation™). All tracings were done by a single individual to eliminate the possibility of inter-operator error. Intra operator error was evaluated by randomly selecting 20 radiographs and repeating all the tracings after 3 weeks by the same operator.[10] The procedure for

measuring the sagittal anchorage loss was performed as described by Pancherz.[1,11] The linear distance from distal contact point of the maxillary first molar (M1) to a line perpendicular to the occlusal plane through Sella (OLp) was measured in millimetres on all the tracings [Figure 1]. The positive value obtained from the difference between the readings corresponded to the amount of mesial movement of the maxillary first molar in the sagittal plane. Anchorage loss for all the subjects was determined in the same fashion.

Statistical analysis

The statistics were performed using Statistical Package for Social Sciences software (SPSS 15.0, Chicago, IL, USA). The means, standard deviations, and minimum and maximum values were calculated. All the tracings were repeated after 3 weeks to evaluate the intraexaminer reliability using intraclass correlation coefficient (ICC). ICC values equal to 0 represented agreements, which are equivalent to that expected by chance, while 1 represented perfect agreement. An inter group comparison between the labial and lingual appliance group was done for determining anchorage loss during the time (T0 and T1) periods with paired-samples *t*-test. The level of statistical significance was established at $P < 0.05$.

RESULTS

The results showed that all ICC for lingual and labial group were >0.90 showing good repeatability of the measurements [Table 1]. Anchorage loss during space closure was 1.2380 ± 0.1705 mm for lingual appliance group and 2.0620 ± 0.3916 mm for the labial appliance group [Table 2]. Thus, the results suggested more anchorage loss with labial appliance compared with lingual appliance.

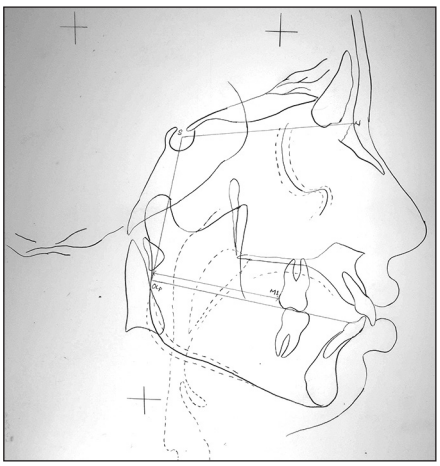

Figure 1: Lateral cephalometric tracing showing measurement of anchorage loss using Pancherz method

DISCUSSION

One of the major concerns of the specialty of orthodontics has been the development of techniques that could adequately control anchorage units in the selective movement of individual teeth or groups of teeth. In the light of this, orthodontists have developed a variety of strategies and techniques to maintain the anchorage by applying many methods to inhibit or prevent movement of the anchor teeth. Some of them are headgear by Kingsley,[12] second molar inclusion, Class II elastics, anchor bends by Begg, transpalatal arch by Goshgarian,[13] alpha-beta bends by Kuhlberg and Burstone[14] or the recent era of mini-implants.

Lingual appliance has been proven to have better anchorage control than labial appliance.[1,5] Hence, this study was performed in order to evaluate and compare the anchorage loss between the labial appliance and lingual appliance. For the present study, bimaxillary dentoalveolar protrusion cases were selected with minimal crowding and hence that good amount of space is available for retraction of the anterior teeth and to evaluate anchorage loss. With moderate to severe crowding cases most of the spaces will be utilized in leveling and aligning with little space available for retraction. Also, all the patients had shallow bite and hence did not require the use of bite raisers, so the negative effect of disocclusion on anchorage was potentially eliminated.[15]

Scuzzo Takemoto (STb™) brackets were used because they are low profile and hence it increases the interbracket distance when compared to the other lingual brackets. Also since reduced interbracket distance is known to affect the anchorage in lingual appliance and hence can induce bias in the study.[16] In order to standardize the mechanics between both the appliances, the slot was selected as 0.018-inch slot size. Indirect lingual bonding setup was performed using Torque Angulation and Bracket Positioning Device. Standard MBT™ torque and tip values were incorporated for standardization and also to prevent any effects of the same on the results.

Leveling and aligning for labial appliance was achieved in 3-6 months whereas for the lingual appliance it was achieved in 5-9 months. Once levelling and aligning were completed, rigid 0.017 × 0.025-inch stainless

Table 1: Intra examiner repeatability for tracings between lingual and labial orthodontics

Group	Difference (mean ± SD)	Corelation coefficient
Lingual	−0.09±1.1	0.92
Labial	−0.21±0.85	0.97

SD – Standard deviation

Table 2: Descriptive statistics and statistical comparison of T0 and T1 (mm) between lingual and labial orthodontics using paired-samples *t*-test

Group	*n*	Age	T0 (mm)	T1 (mm)	Difference	*P*
Lingual	10	21±3.6 years	48.2190±6.4616	49.4570±6.4465	1.2380±0.1705	0.001
Labial	10	19±6.1 years	41.9330±6.5591	43.9830±6.7660	2.0620±0.3916	

steel archwires were placed in both labial and lingual appliances. In the labial appliance, 0.017 × 0.025-inch stainless steel archwire was left for 1 month for torque expression, whereas in the lingual appliance, the wire was tied to the brackets with double over ties for effective torqueing and was left for 2-3 months for complete torque expression before starting space closure. Before starting space closure compensating curves of 5-10° were placed in the archwires to prevent bite deepening and maintenance of torque during space closure. Retraction hooks were placed on the same archwires, and space closure was started with sliding mechanics using NiTi coil springs applying a force of 150 g of each side. Space closure for labial appliance was achieved in 8-10 months whereas for the lingual appliance it was achieved in 9-13 months.

Although cephalometric radiographs have several limitations it is still a valuable time tested tool in evaluating anchorage loss and also since it is routinely taken as a part of the treatment hence no additional exposure to radiation to the patient.[1,17-19] With the availability of cone beam computed tomography, anchorage loss could be evaluated with better accuracy but with increased radiation exposure to the patient. Several studies have utilised dental models for evaluating anchorage loss, but the difficulty in locating stable landmarks and its reliability precludes its use from evaluating anchorage loss.[20,21] The Pancherz method of assessing anchorage loss is one of the most followed and accepted methods and hence it was used for the study.

This was the first prospective study conducted to compare the anchorage loss between labial and lingual appliances. The results of the present study suggested that anchorage loss was more in labial appliance when compared to lingual appliance [Table 2]. This goes in accordance with studies done by Geron *et al.*[1] and Takemoto.[5] The anchorage loss difference of 0.83 mm between lingual and labial appliances showed statistical significance in the present study. In a study performed by Geron, the anchorage loss difference was slightly more (1.16 mm) when compared to our study. This can be attributed to the use of bidimensional slot in their study hence enhancing anchorage in lingual appliance. Also, their study was retrospective in nature. Takemoto's unpublished data showed similar findings compared to the present study, but retraction in lingual appliance was carried out with Loop mechanics in his study hence better anchorage control was obtained in their study.[5]

As Scuzzo and Takemoto suggest, the lingual brackets are closer to the centre of resistance of the posterior teeth, hence the anchorage provided by them might be better when compared to labial appliance. Further, they quote that the lingual appliance has vectors of orthodontic forces that are applied to the anterior teeth and are directed lingually to the centre of rotation of each tooth in the horizontal plane. Hence, it provides the anterior teeth with a lingual crown torque. As a result, distally uprighting forces are applied to the posterior teeth through the archwire that makes the posterior teeth more resistant to anchorage loss.[22] Also, the use of 0.018" slot lingual brackets in the present study greatly increased the rigidity of the archwires, therefore, enhancing anchorage.

Since the present study supports the widespread belief about lingual appliance being better in anchorage control, it could be used in cases of moderate to critical anchorage cases. Also, first premolars may be preferred because of esthetic reasons since it has a long and sharp buccal cusp.[23]

CONCLUSION

This prospective pilot study concludes with the fact that lingual appliance provided better anchorage control than labial appliance during space closure. Use of lingual appliance could be considered in critical anchorage cases when compared with labial appliance.

REFERENCES

1. Geron S, Shpack N, Kandos S, Davidovitch M, Vardimon AD. Anchorage loss — a multifactorial response. Angle Orthod 2003;73:730-7.
2. Williams R, Hosila FJ. The effect of different extraction sites upon incisor retraction. Am J Orthod 1976;69:388-410.
3. Creekmore TD. Where teeth should be positioned in the face and jaws and how to get them there. J Clin Orthod 1997;31:586-608.
4. Saelens NA, De Smit AA. Therapeutic changes in extraction versus non-extraction orthodontic treatment. Eur J Orthod 1998;20:225-36.
5. Takemoto K. Anchorage control in lingual orthodontics. In: Ramano R, editor. Lingual Orthodontics. Hamilton, Canada: BC Decker; 1998. p. 75-82.

6. Geron S, Vardimon A. Six anchorage keys in lingual orthodontic sliding mechanics. World J Orthod 2003;4:258-65.
7. McCrostie HS. Wire sequencing in lingual orthodontics. In: Ramano R, editor. Lingual Orthodontics. Hamilton, Canada: BC Decker; 1998. p. 63.
8. McLaughlin RP, Bennett JC, Trevisi HJ. Anchorage control and tooth levelling and aligning. In: McLaughlin RP, Bennett JC, Trevisi HJ, editors. Systemized Orthodontics Treatment Mechanics. Spain: Mosby; 2001. p. 93-113.
9. Proffit WR, Fields HW, Sarver DM. Contemporary Orthodontics. 4th ed. Canada: Mosby Elsevier; 2007. p. 202.
10. Richardson A. An investigation into the reproducibility of some points, planes, and lines used in cephalometric analysis. Am J Orthod 1966;52:637-51.
11. Pancherz H. A cephalometric analysis of skeletal and dental changes contributing to Class II correction in activator treatment. Am J Orthod 1984;85:125-34.
12. Roberts-Harry D, Sandy J. Orthodontics. Part 9: Anchorage control and distal movement. Br Dent J 2004;196:255-63.
13. Goshgarian RA. Orthodontic palatal arch wires. Alexandria, Virginia: United States Government Patent Office; 1972. Patent number 3792529.
14. Kuhlberg AJ, Burstone CJ. T-loop position and anchorage control. Am J Orthod Dentofacial Orthop 1997;112:12-8.
15. Alexander CM, Alexander RG, Gorman JC, Hilgers JJ, Kurz C, Scholz RP, *et al*. Lingual orthodontics: A status report. Part 5. Lingual mechanotherapy. J Clin Orthod 1983;17:99-115.
16. Kurz C, Bennett R. Extraction cases and the lingual appliance. J Am Ling Orthod Assoc 1988;3:10-13.
17. Urias D, Mustafa FI. Anchorage control in bioprogressive vs straight-wire treatment. Angle Orthod 2005;75:987-92.
18. Thiruvenkatachari B, Pavithranand A, Rajasigamani K, Kyung HM. Comparison and measurement of the amount of anchorage loss of the molars with and without the use of implant anchorage during canine retraction. Am J Orthod Dentofacial Orthop 2006;129:551-4.
19. Heo W, Nahm DS, Baek SH. En masse retraction and two-step retraction of maxillary anterior teeth in adult Class I women. A comparison of anchorage loss. Angle Orthod 2007;77:973-8.
20. 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.
21. 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.
22. Scuzzo G, Takemoto K. Invisible Orthodontics — Current Concepts and Solutions in Lingual Orthodontics. Germany: Quintessence Verlag; 2003. p. 63-4.
23. De Angelis V. The rationale for maxillary second premolar extractions in adult Class II treatment. J Clin Orthod 2007;41:445-50.

How to cite this article: Venkatesh S, Rozario J, Ganeshkar SV, Ajmera S. Comparative evaluation of sagittal anchorage loss in lingual and labial appliances during space closure: A pilot study. APOS Trends Orthod 2015;5:33-7.

Source of Support: Nil. **Conflict of Interest:** None declared.