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 – 7, Issue – 2, April – 2024, Page No. : 16 - 23

Comparison of Rate of En Masse Retraction in Conventional Labial Appliance with Labial and Lingual Force Using Buccal and Palatal Miniscrews: A Clinical Study

[1]Dr Jainav Thakkar, Post Graduate Student, Department of Orthodontics and Dentofacial Orthopaedics, Manubhai Patel Dental College and Hospital and ORI, Vadodara, Gujarat, India

[2]Dr Kalpesh Patel, Professor and Head, Department of Orthodontics and Dentofacial Orthopaedics, Manubhai Patel Dental College and Hospital and ORI, Vadodara, Gujarat, India

[3]Dr Udita Thakkar, Associate Professor, Department of Orthodontics and Dentofacial Orthopaedics, Manubhai Patel Dental College and Hospital and ORI, Vadodara, Gujarat, India

Corresponding Author: Dr Jainav Thakkar, Post Graduate Student, Department of Orthodontics and Dentofacial Orthopaedics, Manubhai Patel Dental College and Hospital and ORI, Vadodara, Gujarat, India.

Citation of this Article: Dr Jainav Thakkar, Dr Kalpesh Patel, Dr Udita Thakkar, "Comparison of Rate of En Masse Retraction in Conventional Labial Appliance with Labial and Lingual Force Using Buccal and Palatal Miniscrews: A Clinical Study", IJDSIR- April – 2024, Volume –7, Issue - 2, P. No. 16 – 23.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction: To compare incisor inclination change and rate of en masse retraction between labial and lingual forces using buccal and palatal miniscrews respectively, with labial appliance.

Materials andMethod: 18 patients undergoing orthodontic treatment, requiring premolar extraction and miniscrew placement for anchorage were included in the study. Patients who fulfilled the inclusion criteria were allocated randomly into groups A and B. 9 patients were allocated to group A and were treated with buccal miniscrew and labial force and 9 patients were allocated to group B and were treated with palatal miniscrew and lingual force. Lateral cephalograms and cast were taken post-extraction (T1) and 3 months after retraction (T2). Hand tracing was done to measure the change in incisor inclination and a vernier caliper was used to measure the rate of retraction on the cast.

Results: The independent sample t test was done to check the significant difference in incisor inclination and rate of retraction between the two groups. Findings showed that the change in incisor inclination is higher in Group A (Labial force group) with a t value of 2.055 and is statistically non-significant with a p value of 0.05. The rate of retraction (mm/month) is higher in Group B (Lingual force group) with a t value of -3.021 and is statistically significant with a p value of 0.006.

Conclusion: The use of lingual force along with labial appliance was effective in maintaining the incisor inclination, although the difference was not statistically

significant. The rate of en masse retraction was higher in the lingual force group with palatal mini-screw compared to the labial force group with buccal mini-screw at the end of 3 months.

Keywords: Miniscrew, Rate of Retraction, Buccal Miniscrew, Palatal Miniscrew, Buccal Force, Lingual Force

Introduction

Dentoalveolar protrusion in the maxilla is one of the chief complaints in adult orthodontic patients. The premolars are commonly extracted to correct dentoalveolar protrusion and provide space for anterior retraction.[1] Where maxillary premolar extraction is indicated for class II or class I malocclusion, the technique must be designed to maximize the retraction of the anterior tooth and minimize the mesial movement of the upper molars until the crowding and protrusion is corrected.[2]

Maximum anchorage is usually needed for patients with severe protrusion. A variable anchor loss was reported with a conventional retraction by sliding mechanics in cases with extraction.[3,4] Extraoral attachments are a common method for reinforcing anchorage in the first molars of the maxillary arch, but this headgear is not popular in patients and is often not worn as prescribed, leading to poor treatment results.[5]

For reinforcing the orthodontic anchorage, the use of the miniscrew has become more and more popular recently, especially for closing the space with maximum anchorage. [6-8]

In protrusion cases, many authors have used maxillary buccal miniscrews and infra zygomatic crest implants for maximal retraction.[9]For achieving the direction of force vector towards the centre of resistance (Cres) of posterior teeth with retraction and intrusion of anterior teeth, position of miniscrew is preferred in apical portion, between 2nd premolar and 1st molar or 1st and 2nd molars, near Cres of posterior segment.[8]

Labial orthodontics and lingual orthodontics differ considerably in their biomechanics. Lingual orthodontics provides evidence of superior anchorage values and faster rate of retraction due to its positional biomechanical advantage. Unlike the labial appliances, the applied force in the lingual appliance passes close to the center of resistance of the tooth.[10]

Considering these references and the advantages of lingual biomechanics, the biomechanical principles of lingual orthodontics in labial orthodontics were used in this study to compare the rate of retraction and anchorage loss between conventional labial orthodontics and lingual force with labial orthodontics.

Methodology

The aim of the study was to compare en masse retraction between labial and lingual forces using buccal and palatal miniscrews respectively, with labial appliance.

Objective

1. To measure the rate of space closure and assess change in incisor inclination using lingual force for en masse retraction with palatal miniscrews.
2. To measure the rate of space closure and assess change in incisor inclination using labial force for en masse retraction with buccal miniscrews.
3. To compare the rate of space closure and assess change in incisor inclination using lingual and labial forces for en masse retraction with palatal and buccal miniscrews respectively.

Study Population

Patients who were undergoing fixed orthodontic treatment and whose treatment plan required extraction of upper first premolars, were considered for this study.

Materials

1. Vernier caliper
2. Lateral cephalograms
3. Temporary anchorage device (miniscrews) (For palatal 1.5mm diameter, 10mm length and for buccal 1.5mm diameter, 8mm length)
4. 0.022 slot MBT brackets.
5. 0.019 x 0.025 SS archwire

Sample size

Assuming a mean difference of 0.1mm in the rate of retraction between two groups with a standard deviation (SD) of 0.07mm, a minimum of 36 sites (18 sites in each group) was taken to achieve 90% power and 99% confidence.

Inclusion Criteria

1. Patients with age group 18-40 years.
2. Patients whose treatment plan includes extraction of upper first premolars.
3. Patients undergoing fixed orthodontic treatment.
4. Patients with an acceptable periodontal condition.
5. Patients with no medical or dental history compromising miniscrew placement.
6. No congenitally missing teeth except third molars.

Exclusion Criteria

1. Patients with poor periodontal conditions.
2. Patients having craniofacial asymmetry.
3. Patients with diminished crown height due to excessive wear, trauma or restorative work.
4. Patient who does not fill out the consent form.

Methodology

Standard orthodontic diagnostic records comprising of study models, lateral cephalograms, orthopantomogram, and photographs were taken for all patients. Patients were bonded with 022 slot MBT bracket prescription. After levelling and aligning, 019x025 SS wire was placed for retraction with sliding mechanics.

Those who fulfill the inclusion criteria and agree to take part were allocated randomly to:

Group A – en masse retraction using labial forces with buccal miniscrews. Two miniscrews were placed in the maxillary arch, one on left and one on the right side, between 2nd Premolar and 1st Molar (Figure 1), 350gm of force on each side was applied using elastomeric chains.

Group B – en masse retraction using lingual forces with palatal miniscrews. Miniscrews were placed in between the 2nd Premolar and 1st Molar on palatal slopes of the alveolus, on the left and the right side (Figure 2). Lingual button was bonded on the palatal surface of canines. Using elastomeric chains lingually 350gm of forces on each side was delivered from palatal miniscrew to lingual button. No forces on the buccal side of the arches were applied.

Figure 1: Buccal TAD

Figure 2: Palatal TAD

Lateral cephalograms and dental casts were taken postextraction (T1) and after 3 months of maxillary anterior retraction (T2). (Table 1)

Vernier caliper was used to measure the distance between the cusp tip of maxillary canine and the mesiobuccal cusp of maxillary first molar on study models to assess the space closure at T1 and T2. These values indicated the rate of space closure. (Figure 3)

Figure 3: Measurement on study model

Change in incisor inclination was measured from the manual tracing of lateral cephalogram by measuring angle between the long axis of maxillary incisors to palatal plane at T1 and T2. (Figure 4)

Figure 4: Hand tracing

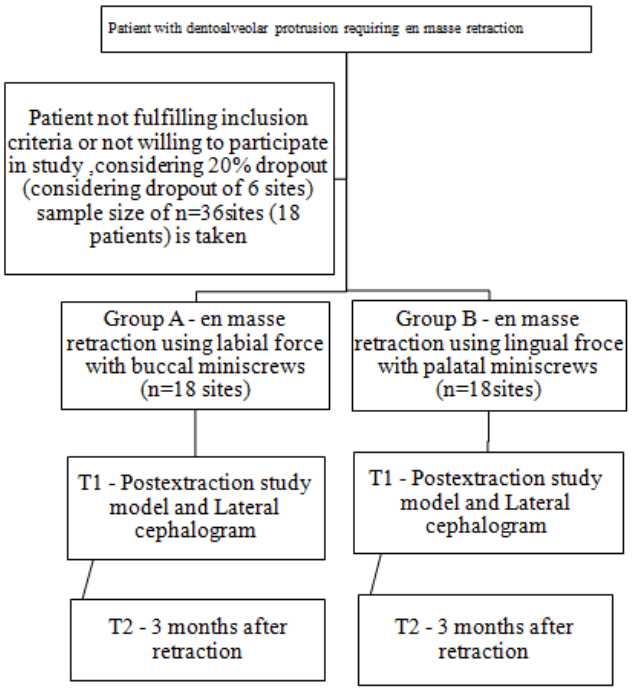

Table 1: Methodology Flowchart

Result

Comparison of pre-treatment change in incisor inclination, between the two groups shows that incisor inclination is higher in Group B (Lingual force group) with a t value of -1.724 and is statistically non significant with a p value of 0.097. (Table 2) (Figure 5)

Comparison of post-treatment change in incisor inclination, between the two groups shows that incisor inclination is higher in Group B (Lingual force group) with a t value of -2.55 and is statistically significant with a p value of 0.017. (Table 2) (Figure 5)

	Group A	Group B		
	Mean ± SD	Mean ± SD	t	P Value
Incisor Inclination (Degrees) Pre	115°±4.73°	117° ±3.64°	-1.724	0.097
Incisor Inclination (Degrees) Post	111° ±4.84°	115° ±3.85°	-2.55	0.017
Incisor Inclination (Degrees) Difference	4° ±2.25°	2.5° ±1.31°	2.055	0.05
Rate of retraction (mm/month)	0.75±0.23	1±0.2	-3.021	0.006

Table 2: Descriptive Statistics of Pre and Post-treatment change in incisor inclination and rate of retraction between Group A and Group B

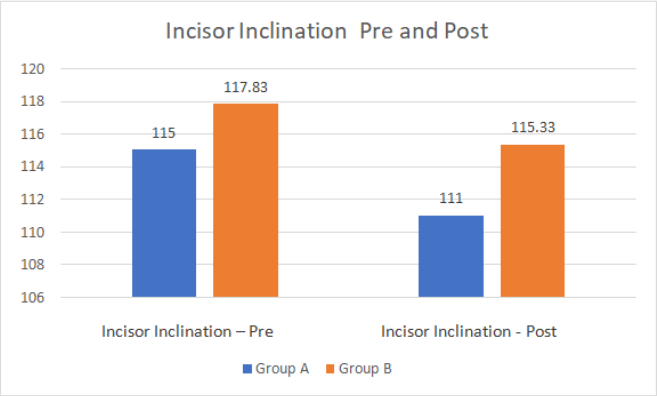

Figure 5: Incisor Inclination Pre and Post-treatment between Group A and Group B

As shown in Table 2, the change in incisor inclination is higher in Group A (Labial force group) with a t value of 2.055 and is statistically non significant with a p value of 0.05. (Figure 6)

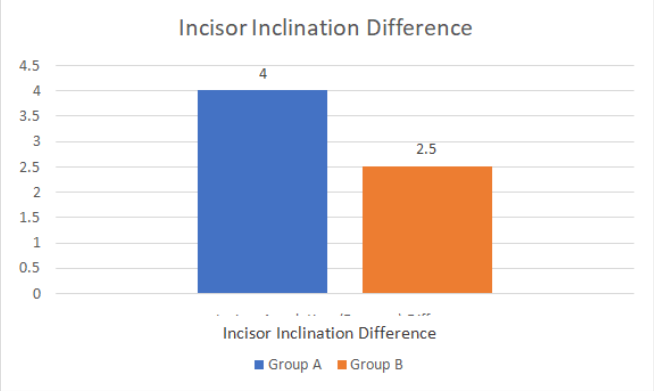

Figure 6: Incisor inclination difference between Group A and Group B

Comparison of the rate of retraction (mm/month) between the two groups shows that the rate of retraction (mm/month) is higher in Group B (Lingual force group) with a t value of -3.021 and is statistically significant with a p value of 0.006. (Table 2) (Figure 7)

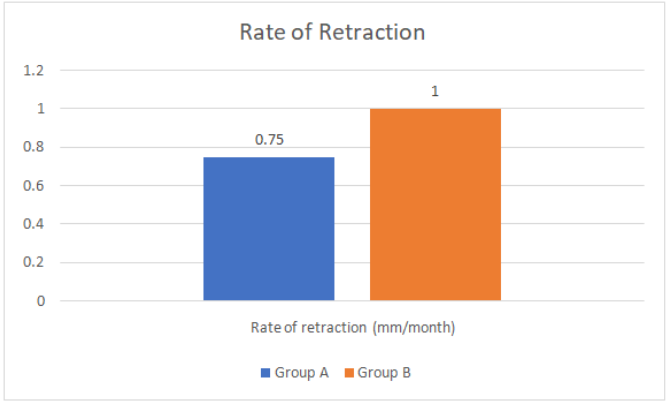

Figure 7: Rate of retraction between Group A and Group B

Discussion

Lingual orthodontics has different biomechanics than labial orthodontics. The point of force application in lingual orthodontics is on the lingual side, and this difference in the aspect of point of force application, as well as its varying distances from the center of resistance in both sagittal and vertical planes, are the main reasons why teeth respond differently to lingual technique. Because the appliance is on the lingual side, force vectors to the teeth are directed lingually to the center of rotation of each tooth, putting labial root torque on anterior teeth. As a result, torque control in lingual orthodontics is more difficult. This torque control issue in lingual orthodontics has been overcome by using a labial appliance with lingual force rather than a lingual appliance with lingual force.[11] The current study was designed to take advantage of the benefits of lingual biomechanics with the labial appliance to minimize treatment duration and get force vectors near to the center of resistance.

In extraction circumstances, variable anchor loss has been recorded with traditional retraction sliding mechanics. The most effective way to reinforce anchorage is with a miniscrew when sliding mechanics are used.[12]

Therefore in our study we have used miniscrews for anchorage purposes.

Rizk et al conducted a systematic review and meta-analysis, to compare the effectiveness of en masse versus two-step retraction. They concluded that en masse/miniscrew combination is superior to the two-step/conventional anchorage combination with regard to anchorage preservation and amount of retraction.13 Following the notion after leveling and aligning, en masse retraction was initiated with sliding mechanics in both groups.

In the current study, we have used E-chain for en masse retraction instead of NiTi coil spring. This was decided from the studies that showed the effectiveness of both methods being similar. One of the studies was by Bokas and Woods, where they did a split-mouth study in 12 patients for canine retraction with E chain and NiTi coil spring. They concluded that the rate of space closure and molar anchorage loss using either NiTi springs or elastomeric chains, if reactivated every 28 days, are likely to be similar. [14] Another study by Barsoum et al, concluded that the effectiveness of NiTi coil spring and E chain was not significantly different in 32 patients. [15]

Change in incisor inclination was studied by Ling W et al using lingual and labial biomechanics in a FEM study, where they found more torque loss in lingual than in labial force.[16] Contrary to this study, we found that change in incisor inclination was more evident in the labial force group i.e. 4 ± 2.25^{o} than in the lingual force group i.e. 2.5 ± 1.3^{o}. This can be due to the force vector passing closure to the center of resistance causing bodily movement rather than tipping. However, the finding in our study was not statistically significant ($p < 0.05$). This can be due to the use of the labial appliances in both groups which help to maintain the torque in both the groups.

Quraishi D et al and Kumar et al found in their study that, on application of force closure to the center of resistance i.e. through lingual force, rate of en masse retraction increased significantly.[11,17] The present study was an attempt to decrease the treatment time with faster rate of retraction utilizing lingual force in labial appliance. The rate of retraction at the end of 3 months for Group A (labial force group) was 0.74 ± 0.22 mm/month, while for Group B (lingual force group) it was 0.99 ± 0.20 mm/month. Thus, the comparison between the two groups shows that rate of en masse retraction is higher in Group B (lingual force group) with a t value of -3.021 and is statistically significant with a p value of 0.006.

Contrary to our findings, Ali SM et alfound the rate of retraction for individual canines was higher in the labial retraction group compared to the lingual retraction group.[18] In their study, they compared labial and lingual forces for the rate of canine retraction and three-dimensional control of the molar and canine using sliding mechanics. They found a better 3D molar control in lingual force and no significant difference in canine rotation, although the rate of retraction of canine was higher in labial force. However, in their study, individual canine retraction was compared which was not the case in our study.

The Limitation of this study was a limited period of 3 months. For future scope, a study with more treatment time of 6 months would give more benefit to the scientific society. Also, a similar study with a larger sample size would add more valuable data assets.

Conclusion

Use of lingual force along with labial appliance was effective in maintaining the incisor inclination, although the difference was not statistically significant.

Rate of en masse retraction was higher in lingual force group with palatal mini-screw compared to the labial force group with buccal mini-screw at the end of 3 month.

Thus, it can be concluded that using lingual force, closure to the centre of resistance with palatal mini-screw, the rate of retraction can be increased along with maintaining incisor inclination. Therefore, it can be an effective method to accelerate space closure.

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