Horizontal and vertical changes in anchor molars after extractions in bimaxillary protrusion cases

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Abstract

Objective: To evaluate changes in the anchor molar position (horizontal, vertical) after retraction in bimaxillary protrusion maximum anchorage cases. **Materials and Methods:** Thirty patients requiring maximum anchorage after extraction of the first premolars were selected for this study. The second molars were banded in both arches along with trans-palatal arch in the maxillary arch and lingual arch in the mandibular arch. En mass retraction was done using sliding mechanics. Horizontal and vertical positions of the anchor first molars were evaluated cephalometrically before and after orthodontic retraction. **Results:** In the horizontal plane, maxillary first molars showed net mesial movement of 1.72 mm, and there was a statistical difference between the pre- and post-values ($P < 0.001$). The mandibular molars showed a net horizontal movement of 2.26 mm, and there was a statistically significant difference between the pre- and post-values ($P < 0.001$). In the vertical plane, there was vertical movement of the maxillary anchor molars by a net value of 0.95 mm which was statistically significant ($P < 0.001$). The mandibular anchor molars moved vertically by a net value of 0.45 mm. This difference was statistically not significant. **Conclusion:** There was anchorage loss seen in both the planes (horizontal, vertical) of the maxillary anchor molars. In the mandibular anchor molars, there was anchorage loss seen only in the horizontal plane. No anchorage loss was seen in the vertical plane.

Key words: Anchorage loss, bimaxillary protrusion, en mass retraction

INTRODUCTION

Anchorage control plays a pivotal role in the effective management of orthodontic patients for obtaining both structural and facial esthetics. Anchorage is defined as the resistance to unwanted tooth movement or as the desired reaction of posterior teeth to space closure mechanotherapy.[1,2] Depending on the requirement, it can be classified as minimum, medium, or maximum anchorage.[3] Obtaining maximum or absolute anchorage has always been an arduous goal for the practicing orthodontist often resulting in a condition, dreaded by most, called anchorage loss. Anchorage loss is the reciprocal reaction of the anchor unit that can obstruct the success of orthodontic treatment by complicating anteroposterior correction. Anchorage control is critical in patients if maximum anterior tooth retraction is desired. Extra oral appliances such as headgears have been effective in molar anchorage control; however, their effectiveness depends on patient compliance.[4-6] The use of multiple teeth at the anchorage segment to form a large counterbalancing unit

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and the application of differential moments have also been described as methods to stabilize the molar position.[3,7,8]

Factors such as malocclusion, type and extent of tooth movement (bodily/tipping), root angulation and length, missing teeth, intraoral/extraoral mechanics, patient compliance, crowding, overjet, extraction site, alveolar bone contour, inter-arch inter-digitation, skeletal pattern, third molars, and pathology (ankylosis, periodontitis) affect anchorage loss.[9-13] The anchorage value of a tooth is as much as its root surface area or periodontal ligament (PDL) area. The addition of the second molar would change the ratio of root surface area, so the PDL of anterior teeth would experience relatively more pressure producing relatively more retraction of the anterior teeth. However, the distribution of force over a wider PDL area is likely to make the force that much more physiologic causing anchorage loss.[7,14] Mesial tipping of the maxillary molars is a common observation during orthodontic treatment. For patients requiring maximal anchorage, mesial tipping of the maxillary molars means anchorage/space loss, which often leads to occlusal plane changes and bad treatment results. In contrast, distal tipping of the maxillary molars seems to be beneficial.[15,16] The purpose of this study was to evaluate the anchorage loss in maximum anchorage bimaxillary protrusion cases after orthodontic retraction.

MATERIALS AND METHODS

This study was conducted on 30 subjects (male – 18, female – 12) chosen from Department of Orthodontics and Dentofacial Orthopaedics, Saraswati Dental College, Lucknow, after getting approval from the Institutional Review Board, Ethical Committee and an informed patients consent.

Inclusion criteria

- Bimaxillary dentoalveolar protrusion where extraction of maxillary and mandibular first premolars was involved
- Angles Class I molar relation
- Full complement of permanent teeth (with or without third molars)
- Moderate to critical anchorage cases requiring 75–100% retraction of anterior teeth.

Exclusion criteria

- Moderate to severe crowding, deep bite, 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.

Thirty cases were selected which were started with straight wire appliance system (MBT 0.022 slot) (Victory series™ Low Profile, 3M Unitek). Extraction of maxillary and mandibular first premolars was done as maximum anchorage was indicated in all subjects. After initial leveling and alignment by NiTi archwires, 0.019 × 0.025 SS wire was ligated in all the subjects. Soldered trans-palatal arch (TPA) was given on the first molars and the second molars were also banded. En mass retraction was started using closed NiTi coil springs (9 mm length) with sliding mechanics [Figure 1].

All the cephalograms were recorded with the same exposure parameters (KvP - 80, mA - 10 exposure time 0.5 s) with the same magnification and the same machine (Kodak 8000C Digital and Panoramic System Cephalometer Rochester, NY, USA). The X-rays were printed using Fujifilm Medical Dry Imaging film (8 × 10 inches in size) and the Fujifilm Drypix Plus Printer. Pretreatment (T_1) and posttreatment (T_2) cephalogram tracings were done. All cephalograms were traced manually using lead acetate paper and 4B tracings pencils by the same operator. Various landmarks and planes were identified, and linear measurements were recorded [Figure 2]. The horizontal anchor molar position was determined by the distance between the distobuccal cusp of the anchor molars to a perpendicular drawn from the Frankfort horizontal plane through Xi point [Figures 3 and 4].[17] The vertical anchor molar position was measured by the distance between a perpendicular line drawn from the palatal plane and the mandibular to the distobuccal cusp of the maxillary and mandibular anchor molars, respectively. The palatal plane is drawn from anterior nasal spine to posterior nasal spine, whereas the mandibular plane is drawn from menton to gonion. Measurements were taken before treatment (T_1) and postretraction (T_2).

Statistical methods

A master file was created, and the data were statistically analyzed on a computer with SPSS software (Version 17 Chicago, IL, USA). A data file was created under dBase and converted into a microstat file. The data were subjected to descriptive analysis for mean, standard deviation, range, and 95% confidence interval. The *P* value of 0.05 was

Figure 1: En mass retraction using sliding mechanics

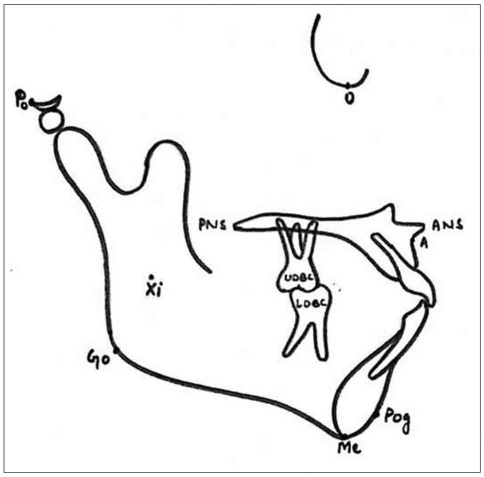

Figure 2: Cephalometric points and planes used in the study

considered statistically significant. The Shapiro–Wilks test for normality showed that not all variables were normally distributed. Therefore, the Mann–Whitney nonparametric statistical test was used to compare the starting forms and the changes between T1 and T2. To identify errors associated with radiographic measurements, 10 radiographs were selected randomly. Their tracings and measurements were repeated 8 weeks after the first measurements were taken. Same was done for postretraction radiographs. A paired sample *t*-test was applied to the first and second measurements, and the differences between measurements were insignificant.

RESULTS

The treatment as per the mechanics described was completed for 30 patients. The mean age and standard deviation were 16.2 ± 2.4 years for males and 16.8 ± 2.1 years for females. The mean values and standard deviations were calculated for each variable for pretreatment readings and for posttreatment readings [Table 1]. To rule out any bias, all the pre- and post-treatment variables were subjected to statistical analysis. There was a statistically significant difference between the readings of Xi point to U6 ($P < 0.001$), Xi point to L6 ($P < 0.001$) and Pp to U6 ($P < 0.001$). There was no statistical difference between MP and L6 ($P = 0.139$). The mean anchorage loss in the sagittal direction for U6 was 1.72 mm and 2.26 mm for the L6. The mean anchorage loss in the vertical direction for the U6 was 0.95 mm and 0.45 mm for the L6 which was statistically insignificant [Table 2]. Thus, considerable amount of movement in horizontal and vertical direction was seen for the anchor molars.

Table 1: Dental linear changes (T_1 to T_2) measured on the cephalometric radiographs

Variables (*n*=30)	Mean±SD		Significance of chance	
	T_1	T_2	*t*	*P*
Maxillary arch (mm)				
Xi point - U6	44.43±4.32	46.15±4.33	13.86	<0.001
Palatal plane - U6	25.07±3.20	26.02±2.84	5.885	<0.001
Mandibular arch (mm)				
Xi point - L6	44.62±4.62	46.88±4.32	4.077	<0.001
Mandibular plane - L6	30.47±2.77	30.92±2.92	1.521	0.139

P=0.05 value of significance. T_1 – Pretreatment readings; T_2 – Posttreatment readings; SD – Standard deviation; U6 – Maxillary first molar; L6 – Mandibular first molar

Table 2: Mean anchorage loss

Variables (*n*=30)	Mean±SD	
	Change (T_2 to T_1)	Percentage change (T_2 to T_1)
Maxillary arch (mm)		
Xi point - U6	1.72±0.68	3.91±1.67
Palatal plane - U6	0.95±0.88	4.09±4.05
Mandibular arch (mm)		
Xi point - L6	2.26±3.04	5.43±8.45
Mandibular plane - L6	0.45±1.62	1.58±5.32

T_1 – Pretreatment readings; T_2 – Posttreatment readings; SD – Standard deviation; U6 – Maxillary first molar; L6 – Mandibular first molar

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,[18] second molar inclusion, Class II elastics, anchor bends by Begg, TPA by Goshgarian,[19] alpha-beta bends by Kuhlberg and Burstone[20] or the recent era of mini-implants. The inclusion of the second molar is a simple method to enhance anchorage in day to day orthodontic practice. It is simple and cost effective in the public health care delivery system as it does not require any extra armamentarium or clinical training. Severe bimaxillary proclination needing all first premolar extraction is common. During orthodontic treatment involving extraction of teeth, there is often need to close extraction space, after the initial de-crowding and alignment. The closure of the extraction space can be achieved by two techniques, friction (sliding) mechanics or frictionless (loop) mechanics. After quantifying the anchorage loss, the change in position of the maxillary and mandibular anchor molars after retraction was ascertained.

The analysis of pre- and post-treatment values revealed that a significant change in all the variables. The maxillary first molar did not remain stable through the retraction phase. Net mesial movement of 1.72 mm and net vertical movement of 0.95 mm were noted, this was statistically

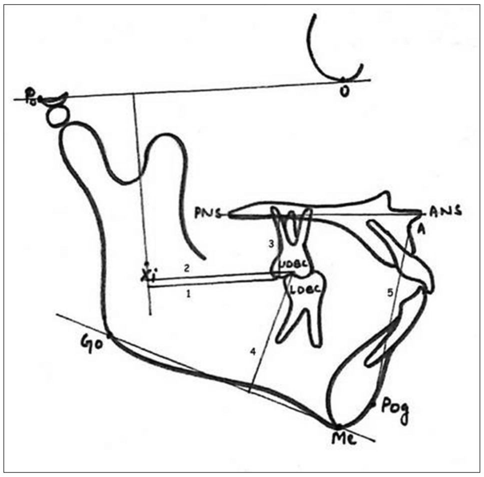

Figure 3: Cephalometric linear measurements used in the study

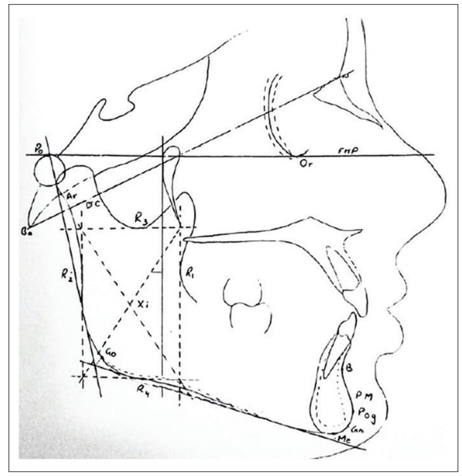

Figure 4: Xi point construction

significant. Similar results of maxillary molar anchorage loss were reported recently.[21] The mandibular anchor molars showed the net mesial movement of 2.26 mm accompanied by net vertical movement of 0.45 mm; the net mesial movement value was statistically significant while the net vertical value was not statistically significant. More mesial movement of the anchor molar was seen in the mandibular arch. This may be due to the force exerted by the developing or erupting third molar, as it erupts in a forward direction. In the vertical plane, the maxillary anchor molar extruded more than the mandibular molar. This may be due to gravitational force and porous maxillary bone structure. There is less literature which supports these facts. Previous reports noted 1.6–4 mm of mesial movement of molars while retracting only the canines with traditional mechanics.[9,22,23] With adjuncts for anchor preservation, up to 2.4 mm of anchor loss was observed.[24,25] Headgear, banding of second molars and second premolars, TPAs, and Nance appliances have routinely been used as adjuncts to enhance the anchorage of the first molars. Headgear has been the most preferred appliance in this regard.[10,26-28] However, its effect depends mainly on patient cooperation.[29]

Bobak *et al*.[30] reported that a TPA did not significantly modify the orthodontic anchorage. Furthermore, many consider palatal bars just a secondary method of anchorage support.[31] Investigations have looked into anchorage during treatment with Begg and Edgewise appliances.[10,32,33] More anchorage loss than that found in our study has been reported.[35-37] A study evaluating 32 patients with the extraction of 4 first premolars and Begg appliances found a mean mesial maxillary first molar movement of 2.7 mm.[32] The details described were vague, however, making any comparison with our study difficult. Another study of 4 first premolar extraction treatment with edge-wise appliances used the pitchfork analysis of Paquette *et al*.[34] to quantify molar movement; the 33 patients, however, had Class II Division 1 malocclusions. The mean mesial movements were 2.5 mm (3.1 mm bodily, 0.6 mm tipping) for the maxillary first molar and 3.3 mm (4.6 mm bodily, 1.3 mm tipping) for the mandibular first molar. The third study evaluating premolar extractions with edge-wise appliance was by Staggers[35] who examined only vertical changes after premolar extractions. Thirty-eight patients with Class I molar malocclusions and 4 first premolars removed were evaluated cephalometrically. For the maxillary first molar, the mean vertical change was 2.0 mm (standard deviation [SD], 2.0 mm). The mean vertical change for the mandibular first molar was 2.7 mm (SD, 2.0 mm). Our values for extrusion of the maxillary and mandibular first molars were lesser than those of Staggers. The results from this study are consistent with the findings of extraction studies in the literature [Table 3].

In addition, patients treated with the TPA as an auxiliary anchorage device did not show a significant difference from those treated with standard preadjusted appliances without additional anchorage.[37] Overjet did not change significantly from T_1 stage. The patients were bialveolar protrusive, suggesting that the extraction space was used mainly to correct protrusion. The mandibular incisors finished in an upright position, and the first molars remained in a Class I relationship. Maximum or absolute anchorage is indicated in many cases, anchorage devices capable of providing such support, such as implants or mini-screw implants are used to provide absolute anchorage.[38-41] Further studies are required to evaluate the anchorage loss seen in bimaxillary protrusion cases with various appliance systems.

CONCLUSION

- The results of this cephalometric investigation indicate that banding the second molar and using a trans-palatal,

Table 3: Comparison of mean anchorage loss reported in the literature

Author	Sample	Appliance	U6 horizontal (mm)	L6 horizontal (mm)	U6 vertical (mm)	L6 vertical (mm)
Allen[32]	32	Begg	2.7	NR	NR	NR
Saelens and De Smit[33]	30	Begg	4.4	5.7	NR	NR
Staggers *et al.*[35]	22	Edgewise	4.8	3.7	3.0	3.4
Paquette *et al.*[34]	33	Edgewise	2.5	3.3	NR	NR
Staggers[30]	38	Edgewise	NR	NR	2.0	2.7
Zablocki *et al.*[37]	30	Edgewise	4.5	3.0	1.8	2.9
Zablocki *et al.*[37]	30	Edgewise/TPA	4.1	2.6	1.4	3.2

U6 horizontal – Maxillary first molar horizontal; L6 horizontal – Mandibular first molar horizontal; U6 vertical – Maxillary first molar vertical; L6 vertical – Mandibular first molar vertical; NR – Not reported; TPA – Trans-palatal arch

lingual arch had no significant effect on either the anteroposterior or the vertical position of the maxillary and mandibular anchor molars in extraction cases after retraction

- Anchorage loss was seen in the horizontal (anteroposterior) and vertical direction in the maxillary anchor molars
- In the mandibular molars, anchorage loss was seen only in the horizontal plane. Vertical movement was also seen, but it was not significant
- This study does not suggest, however, that the trans-palatal, lingual arch should be considered as an unnecessary tool in the treatment of orthodontic patients, because of their other functions. Rather, the clinician should recognize their limitations in maintaining anchorage and seek alternative methods (e.g., microimplants) if the maximum or absolute anchorage is desired
- It is hoped that more investigations with larger samples will be forthcoming to further evaluate these maximum anchorage methods.

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Conflicts of interest

There are no conflicts of interest.

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