Efficacy of Second Molar to Achieve Anchorage Control in Maximum Anchorage Cases

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Abstract

Background: The aim of the study was to assess the efficacy of inclusion of second molar in treatment at the outset to reinforce anchorage.

Methods: A comparative study comprising of 30 maximum anchorage cases to quantify anchorage loss in two situations was undertaken. Group I consisted of cases in which only first molars were banded and Group II consisted of cases where both first and second molars were banded. A total of seven landmarks were marked and six measurements were recorded on the pre-treatment and post-treatment lateral cephalogram.

Result: The difference in pre-treatment and post-treatment values of all the variables were statistically significant ($p < 0.05$) except maxillary central incisor vertical movement (U1 VER), implying a significant post-treatment change. Thus in both the treatment approaches U6 and U1 showed a considerable amount of movement in horizontal and vertical direction and there was rotation which brought about change in angular values.

Conclusion: The study has successfully quantified the anchorage loss and brought out the advantages of including second molar in treatment at the outset. Not only the anchorage loss is minimized but inclusion of second molar also helps to maximize incisor retraction and helps control angular movement of molar and incisor. Extra time required for second molar banding is well spent, as the benefits are overwhelming.

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Key Words : Anchorage loss; Second molar

Introduction

One of the foremost concerns of the specialty of Orthodontics has been the development of the techniques that could adequately control anchorage unit in the selective movement of individual teeth or groups of teeth. Angle stated, "The resistance of the anchorage must be greater than that offered by the teeth to be moved; otherwise, there will be a displacement of the anchorage and failure in the movement of teeth in the desired direction" [1]. The anchorage unit must be overwhelmingly more resistant than the teeth being moved and Mc Laughlin et al [2] advocated the use of holding arches or extra oral anchorage when holding arches are not used.

There are two generalized types of anchorage used in orthodontics: tooth anchorage and auxiliary anchorage. Auxiliary anchorage or auxiliary holding appliances are those adjunctive procedures (and appliances) that enhance anchorage e.g. headgear, palatal bar, lip bumper, lingual bar or banding second molars. Maximum anchorage cases are effectively treated with fiber reinforced composites placed in

posterior segment with the aim to increase the anchorage [3].

The reaction force should be dissipated over as many other teeth as possible to prevent mesial movement of the posterior segment in maximum anchorage cases. The anchorage value of a tooth is as much as its root surface area or periodontal ligament (PDL) area. The addition of 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 periodontal ligament area is likely to make the force that much more physiologic causing anchorage loss [4,5].

The aim of this study was to assess the efficacy of inclusion of second molar in treatment at the outset to reinforce anchorage, by quantifying the anchorage loss and effect on movement of molars and incisors in two different situations, firstly cases treated in whom only first molar is banded (Group I) and secondly cases treated in whom second molar is also banded at the outset (Group II). All the cases selected required

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extraction of first premolars in both maxillary and mandibular arch and were maximum anchorage cases.

Material and Methods

The study design was a randomized controlled trial (RCT) with one observation subsequent to the initial baseline observation. The sample consisted of 30 patients (10 males and 20 females) from the orthodontic outpatient department.

After obtaining the informed consent, the cases were allotted to each group by randomization. On the basis of the diagnosis of the presenting malocclusion, the extraction of first premolars and retraction of upper and lower anterior was indicated in all the patients combined with maximum anchorage in the maxillary arch in all subjects. Maximum anchorage was predicated on the need to restrict mesial movement of the maxillary first molars until crowding, overjet or bimaxillary protrusions were resolved. Patients were not included in the study if maximum anchorage in the maxillary arch would be detrimental to their treatment or if canines were allowed to drift after the extraction of maxillary first premolars.

After extraction of the maxillary first premolars, only the first molars were banded in Group I patients and first and second molar were banded in Group II. Roth 0.018" pre-adjusted edgewise appliance was used for all the patients. Pre and post-treatment records included study models, orthopantomograph, lateral cephalogram and photographs.

Sequence of mechanotherapy was as follows

- Leveling and alignment
- Retraction of canines by sliding mechanics
- Retraction of anterior by loop mechanics
- Finishing

Once alignment was achieved with 0.016" heat activated nickel titanium (HANT) wire and leveling with 0.016" NiTi Reverse Curve of Spee. The average leveling and alignment period was 08 months. The canines were retracted on 0.016" x 0.022" stainless steel arch wire with nickel titanium coil springs generating forces of 150 to 200 gm, acting reciprocally on the canine and molar. If one canine was completely retracted before the other canine, the nickel titanium coil spring was removed and the canine was laced with a 0.010-inch stainless steel ligature tie to the first molar and second premolar in Group I and second molar, first molar and second premolar in Group II. Once the canines were retracted and laced back to

the anchorage unit the anterior segment was retracted by 0.017" x 0.025" TMA teardrop wire formed out of straight lengths.

Tracings and super imposition of the lateral cephalometric radiographs was patterned after study by Lisa et al [6]. Pre-treatment and post-treatment tracings were done by two different orthodontist and superimpositions done by third orthodontist to rule out any bias. Tracings included the anterior and posterior images of the zygomatic process of the maxilla, pterygomaxillary fissure, palate, internal structures of the palate, maxillary central incisor and maxillary first permanent molar. The maxillary superimposition was performed "blind" with a maxillary tracing which had no teeth. The teeth were added to the tracing once the maxillae were superimposed. The two fiducial points from the pretreatment tracing were then transferred to the post retraction tracing.

The following landmarks were marked (Fig. 1)

1. Anterior Fiduciary Point (AFP): Located approximately 5 mm anterior to anterior nasal spine.
2. Posterior Fiduciary Point (PFP): Located approximately 5 mm posterior-to-posterior nasal spine. PFP combined with AFP are representative of the palatal plane.
3. Mesial Molar Point (MMP): The most anterior point of the mesial outline of the maxillary first molar crown.
4. Molar Root Point (MRP): The root apex of the mesiobuccal root of the maxillary first molar.
5. Molar Occlusal Point (MOP): The mesiobuccal cusp tip of the maxillary first molar.
6. Incisor Point (IP): The most incisal point of the crown of the maxillary central incisor.
7. Incisor Root Point (IRP): The root apex of the maxillary central incisor.

Following measurements were recorded to 0.5 mm/degree of accuracy (Fig. 2)

1. Maxillary first molar horizontal movement (U6 HOR).
2. Maxillary first molar vertical movement (U6 VER).
3. Maxillary first molar angular movement (U6 ANG).
4. Maxillary central incisor horizontal movement (U1 HOR).
5. Maxillary central incisor vertical movement (U1 VER).
6. Maxillary central incisor angular movement (U1 ANG).

A database was created in Microsoft Access and Statistical

Fig. 1 : Cephalometric landmarks.

Fig. 2 : Cephalometric measurements.

Package for the Social Sciences (SPSS) version 13 was used for statistical analysis. Appropriate tests of statistical significance like chi square, Fisher's exact and 't' test (paired and unpaired) were used wherever required. Statistical significance was taken at $p < 0.05$. The study had 80% power at $\alpha = 0.05$ (two sided) to detect a difference of 0.9 or more in the means between the groups or within the groups.

Results

The treatment as per the mechanics described was completed for 30 patients. Out of these 16 were in Group I and 14 in Group II. The mean age and standard deviation was 16.2 ± 2.4 years for Group I and 16.8 ± 2.1 years for Group II. There was no statistically significant difference between the groups regarding age distribution ($p = 0.475$, chi square). The gender distribution between the groups also did not have a statistically significant difference ($p = 0.122$, Fisher's exact).

The mean values and standard deviations were calculated for each variable for pretreatment readings (Table 1) and for post-treatment readings (Table 2) for both the groups. To rule out any bias, all the pre and post-treatment variables were subjected to statistical analysis. Pre and post-treatment

values of each variable were compared between the groups (Tables 1,2) and the differences were not statistically significant.

The pre-treatment and post-treatment values of all the variables were subjected to statistical analysis within the group (Table 3). All the values are statistically significant for all the variables, which imply significant post-treatment changes. Thus in both the treatment approaches U6 and U1 showed a considerable amount of movement in horizontal and vertical direction and there was rotation which brought about change in angular values. After ascertaining the significance of all the pairs within and between the groups, another set of variables was obtained by subtracting the pre treatment value from the post-treatment value. Thus, a positive value indicates a larger post-treatment value and a negative value indicates a lesser post-treatment value. The difference was positive in both the groups for U6 HOR, U6 VER, and U1 VER whereas it was negative in both the groups for U6 ANG, U1 HOR and U1 ANG. The difference thus obtained was further tested for statistical significance between the groups. It was found to be statistically significant for all the variables except U1 VER (Table 4).

Table 1

Group statistics pre-treatment

	Group	N	Mean	Std. deviation	p* (unpaired t test)
U6 HOR	I	16	31.2500	3.21455	0.851
	II	14	30.5357	3.51625	
U6 VER	I	16	23.97	2.194	0.337
	II	14	23.50	3.541	
U6 ANG	I	16	88.9063	6.95753	0.868
	II	14	89.8214	8.25229	
U1 HOR	I	16	64.2188	4.18716	0.803
	II	14	64.2857	3.84665	
U1 VER	I	16	28.5000	2.71416	0.478
	II	14	29.3214	4.26798	
U1 ANG	I	16	122.5625	6.49070	0.133
	II	14	118.8929	5.82494	

*Statistical significance taken at $p < 0.05$.

Table 2

Group statistics post-treatment

	Group	N	Mean	Std. deviation	p* (unpaired t test)
U6 HORP	I	16	33.88	3.003	0.083
	II	14	31.49	3.321	
U6 VERP	I	16	25.72	2.575	0.211
	II	14	24.61	3.622	
U6 ANGP	I	16	87.16	6.434	0.356
	II	14	89.92	7.563	
U1 HORP	I	16	59.53	3.922	0.588
	II	14	58.29	3.274	
U1 VERP	I	16	30.97	2.754	0.203
	II	14	32.64	4.111	
U1 ANGP	I	16	103.66	7.648	0.338
	II	14	105.93	5.196	

*Statistical significance taken at $p < 0.05$.

Discussion

Various methods have been used to maximize the anchorage in clinical orthodontics from headgears to temporary anchorage devices. The inclusion of second

Table 3

Comparison within group I & group II : pre and post-treatment

Group		N	Mean	Std. deviation	p* (unpaired t test)
I	U6 HORP*	16	31.2500	3.21455	0.000
	U6 HOR	16	33.88	3.003	
I	U6 VERP	16	23.97	2.194	0.000
	U6 VER	16	25.72	2.575	
I	U6 ANGP	16	88.9063	6.95753	0.001
	U6 ANG	16	87.16	6.434	
I	U1 HORP	16	64.2188	4.18716	0.000
	U1 HOR	16	59.53	3.922	
I	U1 VERP	16	28.5000	2.71416	0.001
	U1 VER	16	30.97	2.754	
I	U1 ANGP	16	122.5625	6.49070	0.000
	U1 ANG	16	103.66	7.648	
II	U6 HORP	14	30.5357	3.51625	0.001
	U6 HOR	14	31.49	3.321	
II	U6 VERP	14	23.50	3.541	0.003
	U6 VER	14	24.61	3.622	
II	U6 ANGP	14	89.8214	8.25229	0.012
	U6 ANG	14	89.92	7.563	
II	U1 HORP	14	64.2857	3.84665	0.000
	U1 HOR	14	58.29	3.274	
II	U1 VERP	14	29.3214	4.26798	0.000
	U1 VER	14	32.64	4.111	
II	U1 ANGP	14	118.8929	5.82494	0.000
	U1 ANG	14	105.93	5.196	

*All variables with suffix P are pre-treatment values.

Table 4**Difference between pre and post-treatment**

	Group	N	Mean	Std. deviation	p* (unpaired t test)
U6 HOR diff	I	16	2.6250	0.74162	0.000
	II	14	0.9571	0.61608	
U6 VER diff	I	16	1.7500	0.75277	0.041
	II	14	1.1071	1.00343	
U6 ANG diff	I	16	-1.7500	1.27802	0.005
	II	14	-0.7308	1.80987	
U1 HOR diff	I	16	-4.6875	1.12361	0.028
	II	14	-6.0000	2.36155	
U1 VER diff	I	16	2.4688	1.14701	0.599
	II	14	3.3214	2.50850	
U1 ANG diff	I	16	-18.9063	5.53841	0.002
	II	14	-12.9643	2.87873	

*Statistical significance taken at $p < 0.05$.

molar is a simple method to enhance anchorage in day to day orthodontic practice. It is simple and cost effective in public health care delivery system as it does not require any extra armamentarium or clinical training.

After quantifying the anchorage loss, the effect on movement of molars and incisors after inclusion of second molar was ascertained. The analysis of pre and post-treatment values within the group revealed that both the methodologies brought about a significant change in all the variables. The difference in the pre and post-treatment values was statistically significant for all the variables except U1 VER. This means that inclusion of second molar has affected the horizontal, vertical and angular movement of molar and horizontal and angular movement of incisors.

U6 HOR movement was statistically significant in both the groups (Table 3). U6 HOR difference was 2.6250 mm in Group I and 0.9571 mm in Group II (Table 4). Hart et al [4] found 0.6mm and 3.25 mm of mesial molar movement in maximum and moderate/minimum anchorage cases respectively, at the completion of treatment. Whereas the group I value of 2.6250 mm in the current study is more than their findings in maximum anchorage cases, it is less than in moderate/minimum anchorage cases. The group II value of 0.9571 mm is closer to their maximum anchorage cases. When adjunctive appliances are not used while retracting canines with traditional mechanics, 0.7 to 4.0 mm of mesial molar movement has been reported [6-8], where as a range of the complete absence of molar movement and up to 2.4 mm of mesial molar movement has been reported while retracting canines combined with the use of adjunctive appliances to control anchorage [9,10]. All these studies have quantified the anchorage loss while retracting canines, whereas the current work has quantified and compared the anchorage loss at the

completion of treatment between control and treatment groups. The variation in the values between the current study and the studies reported could be due to different treatment mechanics and the stage at which the anchorage loss is recorded. U6 HOR movement difference was statistically significant between the groups implying that the inclusion of second molar helps to enhance anchorage and the movement of molar is controlled to the desired extent.

Mean horizontal movement of upper incisors was statistically significant within the groups (Table 3). The difference was -4.6875 mm in Group I and -6.000 mm in treatment Group II (Table 4) and was significant too. Hart et al [4] reported 5.35mm incisor retraction in maximum anchorage cases, which is lesser than current group II and more than group I, where as their moderate/minimum anchorage cases recorded a value of 1.87mm, which is considerably smaller. Both the modalities in the current study brought about significant incisor retraction but it was better in Group II. This could be attributed to lesser mesial molar movement due to better control as second molar also formed the part of anchor unit and that made more space available for incisor retraction. When the mean differences of U6 HOR and U1 HOR are compared between the groups, it is seen that in Group I molar has moved 1.6 mm more where as incisors have moved 1.4 mm less. Matching values explain less incisor retraction in Group I. This results matches with the study by Quinn et al [11].

Mean angular movement of molar was -1.7500° in Group I and -0.7308° for Group II. The U6 ANG movement was statistically significant for both the groups and the difference was also statistically significant meaning that though the molar experienced angular movement or tipping it was better controlled in Group II. This finding is contrary to Lisa et al [6] who have reported insignificant U6 ANG movement after canine retraction.

Mean U1 ANG movement is -18.9063° in Group I and -12.9643° in Group II. This value is significant within the group and the difference is significant between the groups. This finding is baffling as it indicates either uncontrolled tipping or incomplete expression of torque in Group I. The only difference between the groups was of second molar being used to enhance anchorage in Group II. It appears that it controlled the U1 ANG movement in Group II in spite of the incisors being retracted to a slightly greater distance.

Mean vertical movement of molar was 1.7500 mm in Group I and 1.1071 mm in Group II molar showed considerably less vertical movement in Group II implying a better control. Mean vertical movement of incisors is 2.4688 mm in Group I and 3.3214 mm in Group II. The

values are statistically significant within the groups but the difference is insignificant. The inclusion of second molar did not have any beneficial effect on incisor vertical movement. Various investigators have used tip-back bends in such a manner as to produce differential torque and to achieve the goals of treatment satisfactorily with a minimum of patient cooperation and without the need for “reinforcing anchorage” with auxiliary appliances [12,13].

Inclusion of second molar at the outset does help in enhancing anchorage. It not only controls the mesial movement of molar but also helps to exercise control over angular and vertical movement of molars. Controlling these movements is an integral part of the orthodontic treatment strategy especially for those cases in which incisor retraction is necessary. However, the vertical movement of incisors remains unaffected with inclusion of second molar.

Conflicts of Interest

This study has been funded by research grants from the O/o DGAFMS, New Delhi.

Intellectual Contribution of Authors

Study Concept : Brig SM Londhe

Drafting & Manuscript Revision : Lt Col P Kumar, Brig SM Londhe, Col R Mitra

Statistical Analysis : Col A Kotwal, SM

Study Supervision : Brig SM Londhe, Lt Col P Kumar, Col R Mitra

References

1. Angle EH. Malocclusion of the teeth. 7th ed. Philadelphia: SS White Dental Manufacturing 1907.
2. Mc Laughlin RP, Bennett JC, Trivisi HJ. Anchorage balance during space closure. In: Mc Laughlin RP, Bennett JC, Trivisi HJ, editors. Systemized Orthodontic Treatment Mechanics. 3rd ed. Edinburgh: Mosby, 2001; 36 : 260-1.
3. Urbie F, Nanda R. Treatment of Bimaxillary protrusion using Fiber Reinforced Composite. J Clin Orthod 2007; 41: 27-32.
4. Hart A, Taft L, Greenberg SN. The effectiveness of differential moments in establishing and maintaining anchorage. Am J Orthod Dentofac Orthop 1992; 102: 434-42.
5. Proffit WR, Fields HW, Sarver DM. Contemporary Orthodontics. 4th ed, CV Mosby 2004; 345.
6. Lisa M, Rajrich M, Sadowsky C. Efficacy of intra arch mechanics using differential moments for achieving anchorage control in extraction cases, Am J Orthod Dentofac Orthop 1997; 112: 441- 8.
7. Andreasen GF, Zwanziger D. A clinical evaluation of the differential force concept as applied to the edgewise bracket. Am J Orthod 1980; 78: 25-40.
8. Dincer M, Iscan HN. The effects of different sectional arches in canine retraction. Eur J Orthod 1994; 16: 317-23.
9. Gjessing P. Biomechanical design and clinical evaluation of a new canine retraction spring. Am J Orthod Dentofac Orthop 1985; 87: 353-62.
10. Ziegler P, Ingervall B. A clinical study of maxillary canine retraction with a retraction spring and with sliding mechanics. Am J Orthod Dentofac Orthop 1989; 95: 99-106.
11. Quinn RS, Yoshikawa DK. A reassessment of force magnitude in orthodontics. Am J Orthod 1985; 88: 252-260.
12. Burstone CJ, Koenig HA. Creative wire bending, The force system from step and V bends. Am J Orthod Dentofac Orthop 1988; 93: 59-67.
13. Ronay F, Kleinert W, Melson B, Burstone CJ. Force system developed by V bends in an elastic orthodontic wire. Am J Orthod Dentofac Orthop 1989; 96: 295-301.

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