Upper Incisor Changes Due to Modifying the Point of Application of Forces during Space Closure in MBT Technique

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Statement of Problem: A recent technique (MBT) has been introduced for easy and efficient orthodontic treatment by means of straight wire fixed appliances. Although this technique has many advantages, in space closure stage causes up righting problem in upper incisors, which should be adjusted by applying additional torque in anterior region.
Purpose: The purpose of this clinical trial was to determine whether there is a significant difference in final incisor inclination (torque) of two groups one treated with MBT technique and the other by changing the point of application of the closing force (in anterior region).
Materials and Methods: Twelve patients (8 girls, 4 boys) with Cl I malocclusion and crowding, whom were candidate for first premolars extraction, were selected.
For space closure, 6 anterior teeth (canine to canine) in upper and lower jaws ligated and the applied force was from the hooks on canines to hooks on the first molars.
After space closure the results compared with the results of a previous study which treatment plan was according to original MBT technique (anterior hooks soldered to arch wire). Forces applied randomly among quadrants by NiTi coil spring (American Orthodontics Co.) or active tie backs with elastic modules (Dentaurum Co.)
Results: The results showed a statistically significant difference between final torques of two techniques (P=0.0001). Also, the rate of space closure with NiTi coils was significantly greater than active tie back (P=0.0001).
Conclusion: Anchorage loss in two groups compared and the results indicated significantly lower anchorage loss in NiTi coil spring group (P=0.035).

Key words: Straight wire; MBT; Incisor torque; Space; Closure; NiTi; Coil Spring

Journal of Dentistry, Tehran University of Medical Sciences, Tehran, Iran (2004; Vol. 1, No. 2)

Straight wire Appliances was introduced for the first time in 1972. With the help of the information gathered from the analysis of 120 normal cases that had not been treated with orthodontic appliances, Andrews designed and presented a new bracket.(1) These brackets so-called preadjusted appliances are still with heavy ongoing forces. By considering clinical uses and previous experiences, Andrews modified the brackets and specified them for a wider range of cases.(2) After awhile, it was known that in extraction cases, preparations such as Anti-Tip, Anti-Rotation and power arms, were needed to exercise an accurate

control at the space closing stage. Also to achieve a better control, three types of brackets were designed for Incisors.[3] The limitations of Andrew's system were explained by Roth after a few years.[4] Due to difficulties in the use of vast range of brackets, Roth invented a system which by small alteration can be applied in both extraction and non-extraction cases and this in fact paved the way for the emergence of the second generation of readjusted appliances. [5] Andrew's and Roth's prescriptions were on the basis of preliminary limited clinical experiences with preadjusted appliances.

After 20 years of experience, since Andrews Straight Wire Appliances has been introduced, the third generation of preadjusted appliances have been presented by three investigator, McLaughlin, Bennett and Trevisi (MBT).[4]

The MBT system is a kind of preadjusted appliance, which is suitable for applying the light and continuous force, lace back, and bends back and is designed to be compatible with sliding mechanics.[4] But one of the most serious problem in this system occurs at phase II of treatment, where the lingualization of upper incisors create the undertorqued incisors during the space closure [6,7]. Many methods have been proposed to solve this problem. The MBT designers suggested the technique, which was placing additional torque on the straight arch at the space closure phase. This suggestion can cause additional problems and also put the MBT philosophy under question.

This study tried to solve this problem (under torque incisors) by changing the point of force application and aimed at investigating the applied torque at the space closure phase and at the end of treatment.

Materials and Methods

In this clinical trial the results from upper incisors' torque are compared with the findings of another study conducted with MBT standard method (as a control group). In this study the mean value of canine and molar angular differences were compared at the space closure phase. Also the rate of anchorage loss and the amount of retraction of anterior teeth were compared in two methods (Active Tie Back and NiTi Coil Spring).

Regard to the pilot study and by considering a and ß equal to 0.05, calculation showed that the test group should be consisted of at least 8 patients. Finally twelve patients, 8 girls and 4 boys, were entered in this study. They were between 11 to 17 years old with mean value of 13 and standard deviation of 2.24. Because of ethics consideration, the results of similar study were used as control.[8] All cases had mild skeletal class II with no sever problems in vertical or horizontal planes. Molar relation of all cases in study group was class I and moderate crowding was observed and extraction of first premolar was in their treatment plan.

The 0.022? slot straight wire system brackets (Roth) were used and molars were banded on the basis of MBT method. After phase one of treatment, which is aligning and levelling, the 0.021?×0.25? stainless steel markers were made and placed in the slot of one of central incisor, canines and in the molar tube of both sides. The markers were made in different shapes so can distinguish in Radiographies. Then a lateral cephalometric Radiography was obtained. An alginate impression was obtained and a stone cast was made before the start of space closing phase. The spaces were closed by two methods; active tie back and coil spring. Both of these methods were randomly used in each patient in the right and left quadrants. Instead of using soldered hooks to 0.19?×0.25? stainless steel arch wires, after wire ligation of six anterior teeth the force was directly applied to hooks of canine brackets.

The active tie back was set to apply a force of 450-500 grams on the basis of MBT method and the coil spring force was estimated to be approximately 200 grams. The patients were controlled every 4 weeks and in every visit active tiebacks were changed and only a gauge

controlled the force of coils. In this study any anchorage preparation such as headgear; palatal bar or intermaxillary elastics were not used (the two upper jaw cases treated with headgear were excluded from this study).

One session before completion of space closing, the arch wires were removed and final alginate impressions were obtained. Then the markers were placed again and another radiography was obtained by the same method in the same patient's position as the first radiography. Pancherz method was used to analyse the linear measurements. Angular changes in upper and lower jaws were calculated with SN and palatal plan (PP) and mandibular plan (MP) respectively.

In the present study, the speed of space closing and movement of anterior and posterior segments were compared between Active Tie Back (AT) and NiTi coil groups. Also linear and angular changes in canines and molars were measured in each quadrant. After evaluating radiographies and casts, the required data were extracted. t-test was used to analyse the data. For comparing molars and canines retraction between two groups (NiTi and AT) independent sample- t-test was employed.

Results

As explained before, the results of this study was compared to the results obtained from the similar study as control group in which, MBT method had been used.

Table I shows the incisors torque in present study and control groups. The results can be enumerated as follows:

- The inclination of upper incisors (torque) showed significant differences ($P<0.001$) in two groups (Table I).
- The mean value of space closing rate in AT group compared to NiTi coil showed significant differences (Table II).
- In AT group, the mean protraction of the first molars (%49.4) and retraction of canine (%50.6), movement of anterior and posterior segments, did not show any significant differences ($P=0.843$) (Table III and IV).
- In the NiTi coil group the mean protraction of the first molar (%38.2) and retraction of canine (%61.7) showed significant differences ($P<0.05$) (Table III and IV).
- By comparing the mean value of protraction of posterior segment between AT and coil groups significant differences has been shown ($P=0.007$) (Table III).
- Comparison of the mean retraction of anterior segment between two groups of AT and coil showed significant differences ($P=0.007$) (Table III)
- In AT group, the mean protraction of posteriors and the retraction of anteriors did not show any significant differences in the maxilla and in the mandible and P-values were 0.816 and 0.738 respectively (Table V).
- In the coil group comparison of the mean protraction of posteriors and the retraction of anteriors was significantly different in the lower jaw ($P=0.01$), however it was not significantly different in the upper jaw ($P=0.10$) (Table VI).
- The comparison between space closing of the posterior segment movement in AT and coil methods, did not showed any significant differences ($P=0.154$) (Table VII).
- Comparing the mean value of closed space by anterior and posterior movement in maxilla showed a significant different between AT and NiTi coil methods ($P=0.635$).
- The angular changes in posterior teeth (canines and molars) were not statistically significant ($P>0.05$) except in 3 cases (Table VII).

Discussion

After 20 years since straight wire appliances have been introduced and because of their considerable advantages, these appliances were gradually substituted the standard edgewise appliances.[1,2] The preadjusted appliances have been drastically changed during their development in the aspect of technique and appliance prescription.[3,4]

The latest development has been encouraged by three researchers, Maclaughin Bennet and Trevisi, first in terms of techniques and treatment philosophy and recently in appliance prescription (MBT technique). In view of the fact that this technique is new and owing to the existence of some problems in this method, precise clinical and paraclinical studies are of crucial importance.

Table I- Comparison of maxillary central torque in study and control groups at the end of space closing stage

Group / Case	1 (Torque)° Study	1 (Torque)° Control
1	11.0	5.0
2	10.0	5.5
3	12.0	3.0
4	9.0	7.0
5	10.5	6.0
6	11.5	3.5
7	9.5	10.0
8	8.5	2.0
9	7.0	3.0
10	7.5	4.5
11	10.0	5.0
12	10.5	4.0
Average	9.79	4.87
SD	1.544	2.144
SE	0.446	0.620

Table II- Comparison of means in the movement of canine and first molar teeth between AT and Coil methods

Variable	Group	N	Mean	SD	SE	P value
Movement of first molar tooth	AT Coil	21 23	2.2252 1.6996	.8606 .7839	.1878 .1635	.040
Movement of canine	AT Coil	21 23	2.1881 2.6491	.5098 .7718	.1112 .1609	.26

Table III- Comparison of percentage and speed of movement of canine and first molar tooth between AT and Coil methods

Variable	Group	N	Mean	SD	SE	P value
Speed	AT Coil	21 23	.7345 1.4248	.1889 9.168E-03	4.122E-02 1.912E-03	.000
Percentage of space closure in first molar teeth	AT Coil	21 23	49.9355 38.2554	13.8131 12.1116	3.0143 2.5046	.007
Percentage of space closure in canine teeth	At Coil	21 23	50.6045 61.7446	13.8131 12.0116	3.0143 2.5046	.007

Table IV- Comparison of differential movement of anterior and posterior segments between AT and Coil methods

The difference in	Group	Mean	SD	SE	P value
Percentage of space closure in molar and canine teeth	AT Coil	-1.2089 -23.4892	27.6262 24.02332	6.0285. 5.0092	.843 .000

One of these problems is the incisor torque control in phase II of the treatment (obviously the incisors have become lingualized).[6,7]

In this research, instead of using the soldered hooks in the MBT technique, the hook on canine brackets were used and six anterior teeth were tied with ligature wire (Table VII).

Based on the results acquired from lateral cephalograms after space closing; it was revealed that the recent alterations at the point of application of force would significantly result in a better control on incisors' torque and its retention during phase II of treatment compared with MBT technique by hooks soldered to arch wire ($P<0.05$).[8]

The reason for such difference is the retained specification of 0.019? 0.025? stainless steel wire used in this method. Although the final torque has not been desirable yet, it simply could be compensated in the finishing phase. The only problem in this new method is possibly the presence of space between six anterior teeth after levelling and aligning phase, which should be closed before starting phase II of treatment. In fact, an extra session would be needed in these cases, but it is worth mentioning that the correction of undertorqued incisors at the end of phase II of treatment with MBT technique will demand more time.

In another part of this investigation, the manner of space closing with NiTi spring and active tie back were evaluated. The results showed that the space closing speed with NiTi spring was significantly more than AT system specially by comparing the elastic modulus the NiTi force applicated on anchorage unit was lower ($P<0.05$) which could be considered as a biomechanically more compatible (Table VII).

Table V- Comparison of differential movement of anterior and posterior movements in AT group between the upper and lower jaw

The difference in	Group	Mean	SD	SE	P value
Percentage of space closure in molar and canine teeth	Mandible	-5.0468	40.3644	14.2710	.734
	Maxilla	1.1528	17.4854	4.8496	.816

Table VI- Comparison of differential movement of anterior and posterior movement in Coil group between the upper and lower jaw

The difference in	Group	Mean	SD	SE	P value
Percentage of space closure in molar and canine teeth	Mandible	-23.8211	23.5927	5.7221	.001
	Maxilla	-22.5490	27.5084	11.2303	.101

Table VII- Angular change of canine and molar teeth

	N	Mean	SD	SE	P value
MP6R	12	.6250	.6077	.1754	.056
MP6L	12	.3333	.4924	.1421	.001
MP3R	12	1.0000	1.0000	.2887	1.000
MP3L	12	1.3333	.6914	.2775	.255
SN6R	12	.9583	.7217	.2083	.845
SN6L	12	1.1250	.9324	.2692	.651
PP6R	12	.8333	.6513	.1880	.394
PP6L	12	.8333	.8072	.2330	.489
SN3R	12	.6250	.4827	.1393	.021
SN3L	12	1.2083	1.0104	.2917	.490
PP3R	12	.5000	.4264	.1231	.002
PP3L	12	1.0833	.7930	.2289	.723

The ratio of space closing (the anterior segment to posterior segment) in the NiTi Coil was 60.40 when compared to AT group, which was 50.50, a better results in NiTi group was proven.

Obviously, the relative number of the coils used in the lower jaw was more than upper jaw, which might have affected the study outcomes because the movement of posterior segment in the lower jaw is more difficult compared to upper jaw. The angular changes of canines and molars in upper and lower jaws, didn't show significant differences except in the three cases (Table VII) which means, there were not any important angular changes during space closing phase and this proved that the applied forces did not make wire deflection. The anterior and posterior sections of the extracted teeth caused effective sliding without inducing friction of wire, which usually become ineffective due to tipping of adjacent teeth.

Moreover, any unwanted complications of the soft tissue such as accumulation of gum tissue on the extraction site and periodontal problems have not been discovered. Neither side effect like tipping and rotation or uncontrolled torque during the treatment nor any asymmetry in the arch after asymmetric use of NiTi Coil and AT have been seen. However, further studies would be required in this aspect. The asymmetric closing of spaces on both sides of arches would be useful in midline correction. Therefore the unequal rate of space closing could be used.

Conclusion

- The use of MBT method in the stage of space closing without making a bend to produce extra torque in wires will result in undertorque of the anterior teeth, which probably is due to losing the properties of the stainless wire at the time of ordinary soldering (annealing).
- The alteration in the point of force application to canine bracket hook could substantially prevent lingualization of the anterior teeth ($P<0.05$).
- The speed rate of space closure was significantly different in two methods (NiTi and Coil) whereby such differences could be used for anterior midline correction in one arch through the asymmetric application of AT and Coil.
- The Coil Method had lower anchorage loss than AT method, thus this method would be preferable.
- In comparison between coil and AT method for anterior and posterior segment movement, in the upper jaw, it showed significant differences. Although, in the lower jaw the mean values were different, the statistical difference was not significant ($P> 0.05$).
- The soft tissue problems such as the hyperplastic tissues were not found on the space closing sites. There was no significant tipping and rotational movement toward the extracted teeth area (which usually occurs when heavy forces are used) in both groups of AT and coil. Therefore, the 200 grams-force can be applied in space closing phase with the straight wire appliance as En Masse without any side effects or applying too much pressure on anchorage.

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