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Case Report

The benefit of differential moment concept in managing posterior anchorage and avoiding bite deepening

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ABSTRACT

Background: *Anchorage is one of the major concerns in orthodontic space closure. Various methods have been proposed to enhance posterior anchorage in space closure such as headgear, Nance holding appliance, and micro implant as temporary anchorage devices. However, several issues such as patient's compliance, appliance effectiveness, and cost of the device become many clinicians concern. The differential moment concept in segmented arch is a technique that requires no patient compliance but can effectively manage posterior anchorage and avoid bite deepening by careful application of forces and moments.* ***Purpose:*** *The purpose of this case report is to show the use of differential moment concept in segmented arch technique to manage posterior anchorage and to avoid bite deepening.* ***Case:*** *A 21 years old female patient with protrusive teeth as her chief complaint was treated using fixed orthodontic appliance.* ***Case management:*** *The treatment included four first bicuspid extraction and space closure utilizing differential moment concept in segmented arch.* ***Conclusion:*** *It can be concluded that application of differential moment concept in segmented arch technique is a non invasive, compliance independent, effective, and cost efficient method to manage posterior anchorage and to avoid bite deepening.*

Key words: *Anchorage, bite deepening, differential moment, segmented arch*

ABSTRAK

Latar belakang: *Penjangkaran merupakan salah satu aspek yang sering kali menjadi masalah dalam penutupan ruang pada perawatan ortodonti. Berbagai metode disarankan untuk memperkuat penjangkaran posterior dalam penutupan ruang seperti headgear, piranti penahan Nance, dan implan mikro sebagai alat penjangkar sementara. Namun demikian, beberapa hal seperti kerjasama pasien, efektivitas piranti, dan biaya dari alat-alat tersebut sering menjadi perhatian/pertimbangan bagi klinisi. Konsep momen diferensial pada segmented arch adalah suatu cara yang efektif untuk memperkuat penjangkaran dan menghindari pendalaman gigitan tanpa memerlukan kerjasama pasien.* ***Tujuan:*** *Laporan kasus ini bertujuan untuk menunjukkan penggunaan konsep momen diferensial pada segmented arch untuk mengatasi masalah penjangkaran posterior dan pendalaman gigitan.* ***Kasus:*** *Seorang perempuan usia 21 tahun dengan keluhan utama gigi-gigi anterior protrusif dilakukan perawatan dengan alat ortodonti cekat.* ***Tatalaksana kasus:*** *Perawatan yang dilakukan meliputi pencabutan 4 premolar pertama dan penutupan ruang dengan konsep momen diferensial pada segmented arch.* ***Kesimpulan:*** *Dapat disimpulkan bahwa penggunaan konsep momen diferensial pada segmented arch efektif untuk mengatasi masalah penjangkaran posterior dan pendalaman gigitan.*

Kata kunci: *Penjangkaran, pendalaman gigitan, momen diferensial, segmented arch*

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INTRODUCTION

Orthodontic anchorage is the resistance to force provided by other teeth or by structures outside the mouth. Controlling anchorage is one of the most critical elements of orthodontic treatment.[1] Generally, there are two types of anchorage used in orthodontic: tooth anchorage and

auxiliary anchorage. Tooth anchorage may be defined as resistance to movement by using teeth as anchorage. Auxiliary anchorage are those adjunctive procedures or appliances that increase anchorage by incorporating adjacent soft and hard tissue components, i.e., headgear, Nance holding appliance, and temporary anchorage device.[2] Headgear, which used to control anchorage, is a device that has been used in orthodontic for at least 100 years. Unfortunately, the use of headgear depends on patient compliance for success. In recent years, with the introduction of temporary anchorage devices, a paradigm shift has occurred in the overall perspective toward patient compliance, preservation of anchorage and facilitation of treatment for various difficult malocclusions. However, temporary anchorage devices are invasive as well as expensive and are best reserved for problems that cannot be effectively managed with conventional mechanics.[3]

The differential moment concept is a mean of anchorage management that increases anchorage by a careful application of forces and moments. Differential moment offer many advantages in orthodontic treatment, including simultaneous correction overbite and overjet, arch length, and class II malocclusion.[4] The application of differential moment induces differential tooth movement due to differential stress in the periodontal ligament, which can aid the anchorage control. Moments applied to the anterior unit (alpha moment) must be sizeable enough to prevent labial movement of the roots (uncontrolled tipping movement); on the other hand, moment on the posterior unit (beta moment) must be of enough magnitude to induce bodily movement or even root movement. The clinical expression of tipping movements regularly occurs faster than root movement, so that the anterior teeth retract distally into the space before any mesial molar movement is seen.[5,6] The purpose of this case report is to demonstrate the ability of differential moment concept in segmented arch technique to manage posterior anchorage and to avoid bite deepening.

CASE

Patient was a 21 years 10 months old female who presented a protrusive teeth and crowding on lower front teeth as her chief complain. Past and present medical history was negligible. The conditions of dentition and other intra oral structure were unerupted lower right third molar, partially erupted lower left third molar, calculus on lower teeth and no other past dental history. The etiology was probably combination of genetic and environment factors.

Patient had symmetrical dolichofacial face and convex facial profile. Lips were strain upon closure. When smiling, the wide buccal corridors due to narrow dental arch became evidence and there was excessive gingival display. Facial and upper dental midlines were coincided. Patient was in permanent dentition stage. Molar along with canine relationships were bilaterally 25% and 50% class II, respectively. Overjet was 4 mm and overbite was 1.5 mm. The upper and lower dental midlines were almost coincided. The lower arch was moderately crowded (Figure 1).

Figure 1. Pre-treatment facial and intraoral photographs: a) Frontal; b) Frontal smiling; c) Lateral; d) Upper arch; e) Lower arch; f) Right; g) Front; h) Left.

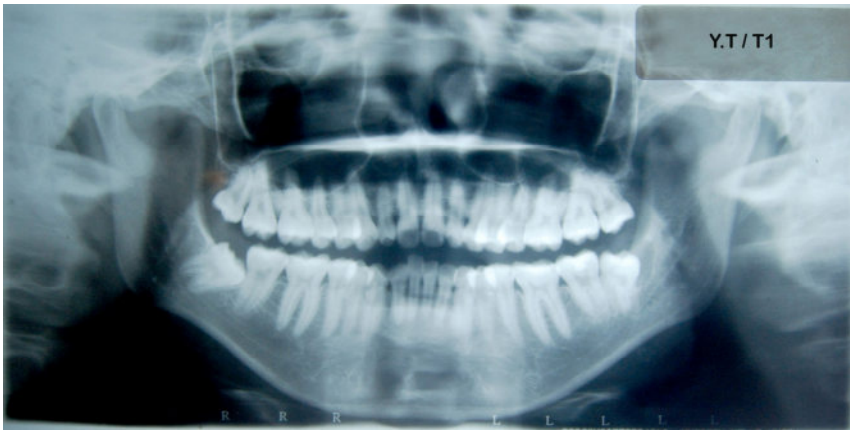

Figure 2. Pre-treatment panoramic radiograph.

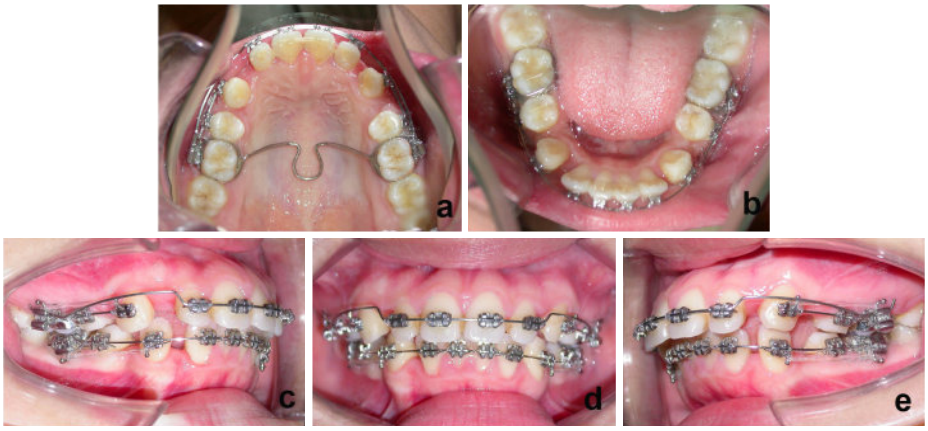

Figure 3. Three-piece segmented arches and intrusion arch were used on the upper arch to simultaneously retract canines, prevent bite deepening and enhance posterior anchorage by tipping molar distally. On the lower arch, canine retraction and posterior protraction were done to achieve class I occlusion. a) Upper arch; b) Lower arch; c) Right; d) Front; e) Left.

The cephalometric analysis revealed that patient had class II skeletal relationship and high mandibular plane angle. Lower incisors were protruded with normal inclination, upper incisors were protruded and proclined. Interincisal and nasolabial angle were acute. Lower and upper lips were protruded relative to E-line.

The panoramic confirmed that there was unerupted lower right third molar and no other pathology existed (Figure 2). This patient was diagnosed as class II skeletal malocclusion with bimaxillary dental protrusion.

CASE MANAGEMENT

The treatment objectives were established to masked skeletal discrepancy via dental movement, reduce upper incisors protrusion and proclination, reduce lower incisors protrusion, achieve adequate overbite and overjet, achieve class I occlusion of buccal segment, and improve facial profile.

The treatment plan was determined as follows: (1) extraction of upper and lower first bicuspids; (2) leveling and aligning upper and lower dental arch; (3) closing the extraction space with group A and B anchorage for upper and lower arch, respectively; (4) retraction of upper and lower anterior teeth with controlled tipping and bodily movement, respectively; (5) retention to maintain the treatment result. The fixed appliances used were 0.018 slot Roth prescription brackets, molar band with auxiliary tube, and transpalatal arch.

After extraction of first bicuspids, leveling and aligning were started using 0.014 and 0.016 superelastic nickel titanium archwire, respectively. Once alignment was achieved in the upper arch, three-piece segmented arches (0.016×0.022 SS) were put on posterior and anterior segment, and then the upper canines were retracted using module chain. Intrusion arch (0.016×0.022 CNA) was included to prevent bite deepening and increase posterior anchorage by tipping molar distally (Figure 3). In lower teeth, canines were retracted and posterior teeth were slightly protracted to achieve class I occlusion on continuous arch (0.016×0.022 SS).

Once the canine retraction had been completed, the anterior segment was retracted. Differential moment

mechanic was used to retract the upper and lower incisors. In order to do this mechanic, T-loops were pre-activated, off-centered gable bend were placed on distal legs. Pre-activation of the T-loops achieve the necessary moment to force ratio. This pre-activation started by carefully separating the legs of both T-loops by approximately 3 mm. Because of the posterior anchorage was the objective, the loops were offset to the posterior and additional gable bends were placed distal to the T-loops to increase anchorage moment. To take the advantage of the positional effects, the loops were directly engaged to the molar auxiliary tube bypassing the second premolars. The archwire was ready to be activated approximately 4 mm; 3 mm of pre activation plus 1 mm of additional activation (Figure 4). It is not necessary to be very far off center to obtain an adequate moment differential, with most cases requiring only 1–2 mm off-centering.

When the space closed, the finishing phase could be started. This phase of treatment involved the use of coordinated 0.017×0.025 CNA wire. Minor bends were placed in these beta titanium wires for finishing details. Retention consisted of an upper and lower circumferential retainer.

Figure 4. T-loop was used to retract four incisors on upper and lower arch. Pre-activated, off-centered position and gable bend on distal of T- loop would create differential moment. The differential moment concept would preserve posterior anchorage through differential tooth movement. a) Upper arch; b) Lower arch; c) Right; d) Front; e) Left.

Figure 5. Post-treatment facial and intraoral photographs. a) Frontal; b) Frontal smiling; c) Lateral; d) Upper arch; e) Lower arch; f) Right; g) Front; h) Left.

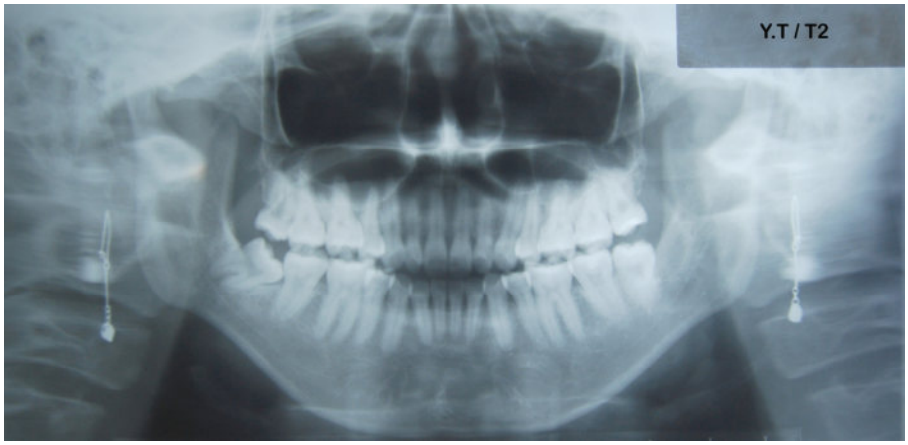

Figure 6. Post-treatment panoramic radiograph.

Table 1. Pre- and post-treatment cephalometric measurement

Analysis	Variables	Mean	Tracing 1	Tracing 2
Skeletal	SNA	84.6	83.5	82
	SNB	81	77.5	77
	Facial angle (FHP - N Pog)	87.8	86	87.5
	Convexity (A - N Pog)	3.8	8	6.5
	Mandibular Plane Angle (FHP - MP)	25	36.0	35
Dento-Skeletal	Lower Incisors - A Pog (mm)	3	12	9
	Lower Incisors - A Pog (degree)	23.2	30	27
	Upper Incisors - A Pog (mm)	5.5	17	13
	Upper Incisors - A Pog (degree)	34.8	45	32.5
Dental	Molar relationship	-3	-1	-3
	Overjet	2.5	4	3
	Overbite	2.5	1.5	2
	Interincisal Angle	121.9	106	121
Soft tissue	Nasolabial Angle	99.6	77	90
	Lower Lip - E Line	1.6	9	5
	Upper Lip - E Line	2	5	2

Facial profile and lips strain were improved. Patient had better smile appearance with broader dental arch. The bilateral class I molar and canine relationship were achieved as well as good overjet and overbite. The upper and lower dental midlines coincided with the facial midline. The buccal segments had good interdigitation. The upper and lower arch form were ovoid and symmetric (Figure 5).

The superimposed cephalometric tracing confirms the changes achieved with treatment. Overall superimposition showed backward reposition of point A and point B. Lips were retracted significantly. Maxillary superimposition showed upper incisors were retracted in control tipping movement approximately 14.5 degrees. Maxillary first molars moved mesially less than 0.5 mm in crown level. Maxilla was rotated in counter clockwise direction about 2 degrees relative to sella-nasion plane. Mandibular superimposition showed that mandibular incisors were retracted in bodily movement about 3 mm and intruded approximately 1 mm. Mandibular molars moved forward 2 mm in bodily fashion. Mandible was rotated in counter clockwise direction about 3 degree relative to sella-nasion plane. The post-treatment panoramic showed adequate root parallelism (Figure 6). Table 1 shows the comparison of cephalometric measurement between pre and post treatment.

DISCUSSION

Few studies have investigated the effectiveness of differential moment strategies for anchorage control. Well controlled clinical studies of orthodontic treatment strategies are difficult because of the great number of confounding

variables associated with orthodontic treatment. The differences among patients and the specific objectives of their treatment complicate the analysis of the effectiveness of particular treatment mechanisms. However, the studies that have been completed provide support for a differential moment concept for anchorage control.[7]

The conventional canine retraction on light continuous wire will generate extrusive effect on incisors and bite deepening due to change in canines inclination.[8] To counteract this tendency, segmented arches and intrusion arch were used. The essence of the segmented arch is the establishment of well-defined units of teeth, so that anchorage and segments movement are clearly defined. The other advantage of segmented arch technique is force system can be defined as statically determinate instead of indeterminate. The meaning of statically determinate force systems is the moments and forces can readily be discerned, measured and evaluate.[1] The intrusion arch not only created vertical forces but also delivered a distal crown tip back moments on the molars to effectively control the anchorage loss often associated with sliding mechanic.[9] A frequently overlooked consideration in anchorage control is the first order side effect of space closure. The mesially directed, buccally located force on molar will tend to produce a mesially inward rotation. A transpalatal arch provides an excellent means for preventing this side effect.[10]

Many methods have been proposed to increase the anchorage. Those methods are ranged from traditional headgear to contemporary TADs (Temporary Anchorage Devices) but those methods have several shortcomings such as invasive procedures; patient compliance dependent; and additional treatment cost. However, differential moment concept is the method of choice because it is non invasive, independent of patient compliance, effective, and cost efficient. Differential moment concept is not without side effects. According to the principle of Static of Equilibrium, the unequal moments must be balanced by a third moment or couple. This couple is represented as a pair of vertical forces, intrusive to the anterior teeth and extrusive to the posterior teeth. The magnitudes of the forces are proportional to the moment differential. Fortunately, these vertical forces may be beneficial to correct of excessive overbite during space closure.[11,12]

The overall superimposition of cephalometric tracings showed that lips were retracted significantly due to maximum retraction of upper incisors and optimum retraction of lower incisors. Maxillary superimposition demonstrated minimum mesial movement of the upper molars and upper incisors were retracted in control tipping movement due to the proper application of alpha and beta moment. Mandibular superimposition showed that lower molars were protracted in bodily movement and lower incisors were bodily retracted to meet the treatment objective.

It can be concluded that application of differential moment concept in segmented arch is a non invasive, compliance independent, effective, and cost efficient method in managing posterior anchorage and avoiding bite deepening. It is recommended to provide more evidence in the efficacy of this treatment approach via well controlled clinical trials.

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REFERENCES

1. Proffit WR, Fields HW, Sarver DM. Contemporary Orthodontics. 4th ed. St. Louis: Mosby Co; 2007. p. 343, 383–92.
2. Langberg JB, Todd A. Treatment of a class I malocclusion with severe bimaxillary protrusion. Am J Orthod Dentofac Orthop 2004; 126(6): 739–46
3. Nanda R, Uribe FA. Temporary anchorage devices in orthodontics. St. Louis: Mosby Co; 2009. p. 3.
4. Mulligan TF. The advantages of differential moments. J Clin Orthod 2009; 43: 379–86.
5. Viecilli RF. Self-corrective T-loop design for differential space closure. Am J Orthod Dentofac Orthop 2006; 129(1): 48–53.
6. Martins RP, Buschang PH, Gandini LG. Group A T-loop for differential moment mechanics: An implant study. Am J Orthod Dentofac Orthop 2009; 135(2): 182–9.
7. Andrew JK, Priebe DN. Space closure and anchorage control. Semin Orthod 2001; 7(1): 42–9.
8. Uribe F, Nanda R. Treatment of class II, division 2 malocclusion in adult: Biomechanical considerations. J Clin Orthod 2003; 37: 599–606.
9. Şenişik EN, Türkkahraman H. Treatment effects of intrusion arches and mini-implant systems in deepbite patients. Am J Orthod Dentofac Orthop 2012; 141(6): 723–33.
10. Kuhlberg A. Segmented arch mechanics. In: Rakosi T, Graber TM †, editors. Orthodontic and dentofacial orthopedic treatment. Stuttgart: Thieme 2010. p. 222–34.
11. Nanda R, Andrew JK, Uribe F. Biomechanic basis of extraction space closure. In: Nanda R, editor. Biomechanics and Esthetic Strategies in Clinical Orthodontics. St. Louis: Elsevier Saunders 2005. p. 194–210.
12. Choi YJ, Chung JC, Choy KC, Kim KH. Absolute anchorage with universal t-loop mechanics for severe deepbite and maxillary anterior protrusion and its 10-year stability. Angle Orthod 2010; 80(4): 771–82.