# Maxillary molar distalization with MGBM-system in class II malocclusion

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## ABSTRACT

**Aims:** Objective of this retrospective study was to evaluate the treatment effects of the MGBM-System (G.B Maino, A. Giannelly, R. Bernard, P. Mura), a new intraoral device to treat Class II malocclusions with no patient cooperation by unilateral or bilateral molar distalization.
**Materials and Methods:** A retrospective study was conducted to compare the pre-distalization and post-distalization cephalograms and dental model casts of 30 patients (15 male, 15 female) with Class II malocclusion treated with MGBM-System. Mean age at the beginning of treatment was 13.3 years (standard deviation 3.3). Angular, horizontal and vertical measurements were recorded to monitor skeletal and dental-alveolar changes. Molar movements in horizontal plane were monitored by making dental measurements on dental model casts.
**Results:** The MGBM-System produced a rapid molar distalization and Class II relationship was corrected in 8 months ± 2.05, on average. The maxillary first molars were distalized of 4.14 (PTV-6 cemento-enamel junction), associated with a significant distal axis incline of 10. 5° referred to SN and a significant intrusion of 1.3 mm (PP). As for anchorage loss, the first premolar exhibited a significant mesial movement of 0.86 mm, associated with a significant mesial axis incline of 2.46°. No significative changes in either sagittal or vertical skeletal relationship were observed.
**Conclusion:** The results suggest that the MGBM-System is an efficient and reliable device for distalizing the maxillary permanent first and second molars.


**Key words:** Class II, molar distalization, MGBM-System, no compliance device, skeletal anchorage

## INTRODUCTION

Treatment of Class II malocclusion frequently requires distalization of the maxillary molars into a Class I relationship. Compliance-dependent appliances such as headgear[1] and removable appliance,[2] were traditionally used for upper molar distalization. The need for patient compliance in achieving Class II correction is often the most limiting factor in determining the duration and the success of these treatments. Several intraoral distalizing appliances have been described in last years to make treatment success independent of patient compliance. These devices, such as Distal Jet,[3,4] Jones and White,[5] Hilgers and Pendulum[6] and repelling magnets[7] allow molar distalization without cooperation, but they needed anchorage supplied from anterior teeth causing maxillary incisor protrusion and increased overjet and overbite. On average, the dental movement produced by the most common intraoral distalizing appliances was 71% molar distalization and 29% reciprocal anchorage loss.[8]

To avoid this negative effect, recent studies have been directed toward the use of dental implants,[9] miniplates,[10] miniscrews[11,12] as anchorage units in orthodontic patients. Many Authors[13,14] had successful results using intraosseus screws for maxillary molar distalization. In 2007, MGBM-System[15] was introduced as a no-cooperation based system for non-extraction treatment of Class II malocclusions that combines sliding mechanics with the use of miniscrews for anchorage control.

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The aim of this study was to investigate the efficacy and efficiently of MGBM-System.

## MATERIALS AND METHODS

A retrospective study was designed to evaluate the skeletal and dentoalveolar effects of molar distalization produced by MGBM-System. The sample comprised 30 patients (15 female, 15 male; mean age 13.3 years±3.3) with Class II malocclusion treated with MGBM-System. Gender differences were not considered a factor because of the short duration of MGBM-System treatment.

All subjects were consecutively treated with the same protocol in a single orthodontic practice.

All subjects met the following inclusion criteria:

- Bilateral Class II malocclusion.
- Non-extraction treatment plan.
- Absence of cross-bite and agenesy.
- Good quality diagnostic cephalometric radiographs with corresponding good visualization of landmarks taken at the beginning and immediately after the end of molar distalization.
- Good quality model dental model casts at the beginning and at the end of distalization.
- A history of good oral hygiene and no damage to the appliance.
- No other appliance was used other than MGBM-System during the distalization phase.

All patients and parents were informed about the surgical procedure and signed a consent form.

### MGBM-System

MGBM-System is a new device for the upper first and second molar distalization used to treat Class II malocclusions without cooperation[15]

The first phase of Class II treatment by MGBM-System involves the distalization of the maxillary molars to an overcorrected Class I relationship.

Anchorage is provided by a transpalatal bar, bonded on the occlusal surfaces, of the maxillary first premolars and connected to two palatal miniscrews (Spider Screw,[16] HDC, Sarcedo, Italy) inserted directly between the first molar and the second premolar.

To distalize the first molar before the eruption of the second molar, we use a sectional SS wire extended from the first premolar to the first molar and a compressed 200 g Sentalloy coil spring activated of 10 mm.

When the second molars are erupted, the simultaneous upper molar distalizing system was applied. It consists of two different distalizing components: One activated against the first molar as previously described and the other against the second molar.

A double tube is inserted onto the SS wire through the lower tube and positioned to abut the premolar bracket. The tube is blocked by the compressed coil against the premolar bracket. The second distalizing component is a shape memory. 018 × 025" SS Nickel Titanium wire 160 g of force featuring an excess of length and crimped mesial and distal stops extending from the second molar, looped vertically for 6 mm in the buccal fold and inserted into the upper tube of the double tube on the sectional wire.

As the wire assumes its normal horizontal orientation, it places the distal force on the second molars [Figure 1].

After attaining an overcorrected Class I molar relationship, the palatal miniscrews and the transpalatal bar are removed and 2 miniscrews are placed in the buccal site mesial to the first molars, perpendicular or oblique to the cortical bone to allow premolars, canine and incisors retraction by sliding mechanics with 150 g nickel titanium coil.

After the first premolars have attained a Class I position the last phase of treatment is the retraction of the incisors by means of sliding mechanics.

### Cephalometric Analysis

Lateral cephalograms and dental model casts were taken at the beginning of treatment with the MGBM-System (T0) and the end of molar distalization (T1).

The cephalograms were taken with two different X-ray equipments. Because the radiographic magnification factor was similar, no correction was necessary. Angular, horizontal and vertical changes were recorded to monitor skeletal and dental-alveolar changes. The soft-tissue and skeletal

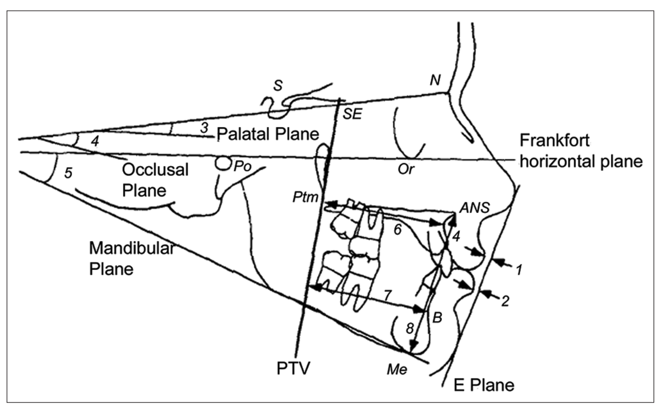


**Figure 1:** Cephalometric soft-tissue and skeletal measurements. (1) Upper lip to E-plane (mm); (2) Lower lip to E-plane (mm); (3) SN-palatal plane angle (°); (4) SN-anatomic occlusal plane angle (°); (5) Frankfort-mandibular plane angle (°); (6) PTV to A point (°); (7) PTV to B point; (°) (8) ANS to menton (mm)

measurements are shown in and dental measurements in Figure 2a and b. Centroid points were constructed for the crowns of the maxillary first and second molars and premolars as the midpoint between the greatest mesial and distal convexity of the crowns of these teeth as seen on the cephalometric radiograph.

Ghosh and Nanda[17] cephalometric analysis was used to assess dentoskeletal effects.

The main outcome measures to be assessed on cephalograms were:

- Distal movement and distal tipping of maxillary first permanent molars.
- Anchorage loss, i.e., anterior movement of maxillary central incisors.
- Dental changes of upper molars in the horizontal plane.

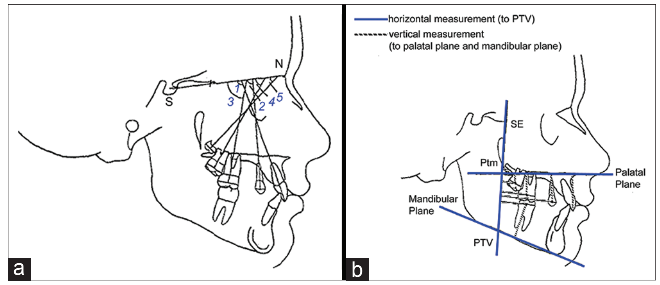


**Figure 2:** (a) Cephalometric angular dental measurements. (1) SN-maxillary incisor (°); (2) SN-maxillary first premolar (°); (3) SN-maxillary first molar (°); (4) SN-maxillary second molar (°); (5) SN-maxillary third molar (°) (b) Cephalometric linear dental measurements. (1) PTV-maxillary first premolar centroid; (2) PTV-maxillary first molar centroid; (3) PTV-maxillary second molar centroid; (4) PTV-mandibular first molar centroid; (5) PP-maxillary incisor; (6) PP-maxillary first premolar centroid; (7) PP-maxillary first molar centroid; (8) PP-maxillary second molar centroid; (9) Mandibular plane-mandibular first molar centroid

## Dental Model Casts Analysis

Molars movement in the horizontal plane was monitored by taking alginate impressions and making dental model casts both at the beginning of therapy (T0) and at the end of distalization phase (T1). Manual calipers were used to determine the changes in the molar region by measuring the pairs of dental model casts. The measurements were to identify in each patient any increase or decrease in transverse arch width in the region of the first, second molars and first premolars as well as the magnitude and mode of molar rotation achieved by the therapy. Figures 3 and 4 show the different measurements considered for each subject. The angles between the straight line transversing the mesiobuccal and distobuccal cusp tips and the raphe-median line were also measured.

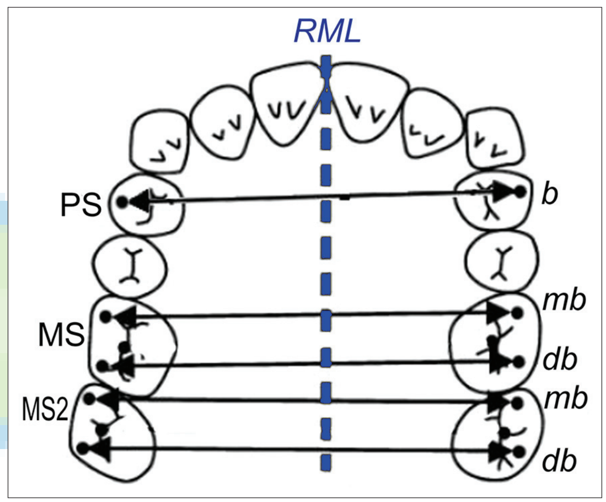


**Figure 3:** Dental model casts analysis. Transversal changes in the horizontal plane. Cast analysis. Transversal changes in the horizontal plane. (1) Measurement between maxillary first premolar; (2) Measurement between maxillary first premolar mesiobuccal cusp distobuccal cusp and (3) Measurement between maxillary second molars mesiobuccal cusp distobuccal cusp

## Statistical Method

Descriptive statistics (mean, standard deviation (SD)) were calculated for each cephalometric and dental model cast measurement at T0 and T1. The non-parametric Mann-Whitney Test was used to analyze the differences between paired pre-treatment and post-treatment variables (level of significance $P<0.05$).

To assess the error of location of the reference points all tracings were traced by an investigator (L.M.) and verified by another (G.M.) casual errors were assessed by using Dahlberg's[18] formula and systematic errors were ascertained by using paired t tests. No statistically significant error was detected for any cephalometric and dental casts measurement (Student paired *t*-test, level of significance $P<0.05$).

Statistical analysis was performed using MedCalc software version 11.1.1.0, Mariakerke, Belgium.

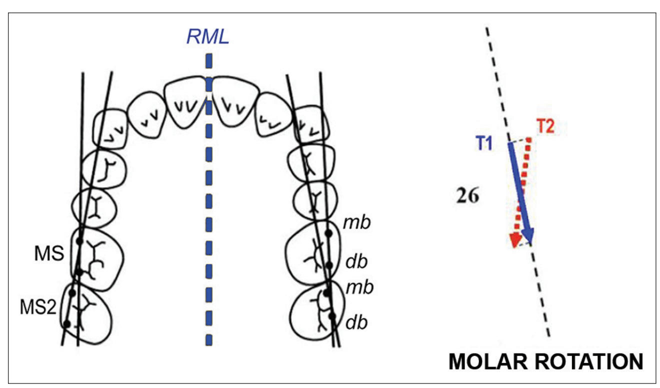


**Figure 4:** Dental model casts analysis. Molar rotation in the horizontal plane: Angle between midpalatal raphe and a line running through the mesiobuccal and distobuccal cusps of the molars. (1) Right first molars; (2) Left first molars, (3) Right second molars and (4) Left second molars

# RESULTS

Pre-treatment cephalometric values and dental model cast values are given in Tables 1 and 2 respectively.

Maxillary molars were distalized successfully to Class I relationships without patient cooperation in all cases in 8, 2 months time.

## Analysis of the Cephalograms Measurements

Cephalometric analysis showed no remarkable growth between the 2 measurement times.

**Table 1: Cephalometric pre-treatment values (t0)**

| Cephalometric values | t0 | |
|---|---|---|
| | Mean | SD |
| Soft-tissue values (mm) | | |
| Upper lip to E-plane | −1.8 | 1.5 |
| Lower lip to E-plane | −0.2 | 2.0 |
| Skeletal values | | |
| SN-palatal plane angle (°) | 8.7 | 5.7 |
| SN-occlusal plane angle (°) | 19.3 | 1.9 |
| FH-mandibular plane angle (°) ss | 21.7 | 2.1 |
| PTV-A point (mm) | 53.4 | 3.1 |
| PTV-B point (mm) | 60.2 | 3.3 |
| ANS-menton (mm) | 68.3 | 1.5 |
| Angular dental values (°) | | |
| SN-maxillary incisor | 103.8 | 6.9 |
| SN-maxillary first premolar | 84.6 | 6.3 |
| SN-maxillary first molar | 67.9 | 6.3 |
| SN-maxillary second molar | 64.1 | 6.0 |
| SN-maxillary third molar | 37.1 | 9.1 |
| Linear dental values (mm) | | |
| PTV-maxillary first premolar centroid | 39.7 | 5.8 |
| PTV-maxillary first molar centroid | 22.1 | 4.1 |
| PTV-maxillary second molar centroid | 12.4 | 4.3 |
| PTV-mandibular first molar centroid | 20.4 | 4.5 |
| PP-maxillary incisor | 30.4 | 2 |
| PP-maxillary first premolar centroid | 21.8 | 2.3 |
| PP-maxillary first molar centroid | 19 | 2 |
| PP-maxillary second molar centroid | 11.5 | 4.7 |
| Mandibular plane-mandibular first molar centroid | 29.6 | 6.5 |

SD – Standard deviation; SN – Scientific notation

**Table 2: Dental cast pre-treatment values (t0)**

| Dental cast values | t0 | | |
|---|---|---|---|
| | *N* | Mean | SD |
| Transverse values | | | |
| Between maxillary first premolar (mm) | 30 | 40.34 | 2.4 |
| Between maxillary first molars (mm) | | | |
| Mesiobuccal cusp | 30 | 49.37 | 2.93 |
| Distobuccal cusp | 30 | 51.72 | 3.12 |
| Between maxillary second molars (mm) | | | |
| Mesiobuccal cusp | 10 | 54.83 | 2.4 |
| Distobuccal cusp | 10 | 53.52 | 2.74 |
| Rotation values (°) | | | |
| Right first molars | 30 | −14.67 | 6.84 |
| Left first molars | 30 | −13.45 | 6.84 |
| Right second molars | 10 | 3.96 | 5.01 |
| Left second molars | 10 | 3.51 | 4.71 |

SD – Standard deviation

Mean values and SDs values of skeletal aesthetic and dental changes as shown by cephalometric analysis are given in Table 3.

Upper molar distalization was achieved in 8±2.05 months; showed significant mean values 4.14±2.8 mm (PTV-6 cemento-enamel junction (CEJ)). The distal movement of the second upper molar is similar to that of the first molar 4.0±2.4 mm (PTV-7 CEJ). The first maxillary molar crowns tipped distally average amounts of 10.5±6.2° (SN). Moreover, upper first molars also significantly extruded 1.3±0.9 mm referred to PP.

A significant mesial movement of the first premolars (anchorage loss) of 1.0 mm associated with a significant mesial axial incline of 1.1° was recorded. In the anterior region the maxillay incisors tipped mesially average amounts of 0.5±1.1° (PP).

Distalization of maxillary molars with MGBM-System yielded also a clockwise rotation of the occlusal and mandibular planes. No statistically significant changes occurred in the soft-tissue measurements during distalization therapy.

## Analysis of Dental Cast Measurements

Dental changes in the horizontal plane shown by dental model casts measurements are given in Table 4.

The gain in transverse arch width in the first molar region between the mesiobuccal cusp tips and the distobuccal cusp tips (mean values of 2,65 mm±1.87 mm, −0.23±1.96 mm, respectively) proves both expansion and mesiobuccal rotation occurred in the first molar region. The mean mesio-buccal rotations of the first molars were 17.81±3.19° and 18.93±3.72°, respectively.

The second molars are also significant rotated at the end of distalization ($P$<0.001).

## CLINICAL CASE

A 13-year-old boy presented for treatment in the permanent dentition stage [Figure 5a-g]. Patient showed a bilateral Class II molar relationship. There was no transverse discrepancy. No signs or symptoms of temporomandibular joint problems were observed. There was a significant crowding in the upper arch with a severe irregularity index.

Panoramic radiographs showed the presence of all of the teeth included the lower and upper wisdom teeth.

Patient had an SNA angle of 81°, an SNB angle of 78° and an ANB angle of 3°. The mandibular plane (Sn-GoMe) angle was 35°, the lower incisors had a 92° angle relative to the mandibular plane and the upper incisors had a 105° angle relative to the palatal plane.

molars. We used MGBM-System as described above.

In the initial phase of distalization, we applied light forces that do not interfere with the stabilization of the palatal miniscrews. We started the simultaneous distalization with a 160 g Neo Sentalloy wire and a superelastic coil of 100 g. After 2 months, the coil was replaced with one of 200 g.

**Table 3: Mean values and standard deviations values of skeletal aesthetic and dental changes after molars distalization (t1-t0)**

| Cephalometric values | t1-t0 | | |
|---|---|---|---|
| | Mean | SD | *P* value |
| Soft tissue values (mm) | | | |
| Upper lip to E-plane | 0.7 | 0.9 | NS |
| Lower lip to E-plane | 0.5 | 1.3 | NS |
| Skeletal values | | | |
| SN-palatal plane angle (°) | 0.5 | 1.1 | ** |
| SN-occlusal plane angle (°) | 1.6 | 1.5 | ** |
| FH-mandibular plane angle (°) | 1.2 | 0.9 | *** |
| PTV-A point (mm) | 1 | 1.5 | NS |
| PTV-B point (mm) | −0.1 | 2 | *** |
| ANS-menton (mm) | 2.0 | 1.5 | NS |
| Angular dental values (°) | | | |
| SN-maxillary incisor | 1.4 | 2.5 | * |
| SN-maxillary first premolar | 2.46 | 4.3 | *** |
| SN-maxillary first molar | −10.5 | 6.2 | *** |
| SN-maxillary second molar | −10.1 | 9.7 | **** |
| SN-maxillary third molar | −8.2 | 9.6 | *** |
| Linear dental values | | | |
| PTV-maxillary first premolar centroid (mm) | 1.0 | 1.8 | *** |
| PTV-maxillary first molar centroid (mm) | −4.14 | 2.8 | *** |
| PTV-maxillary second molar centroid (mm) | −4.0 | 2.4 | *** |
| PTV-mandibular first molar centroid (mm) | 0.86 | 1.9 | ** |
| PP-maxillary incisor (°) | 0.5 | 1.1 | * |
| PP-maxillary first premolar centroid (°) | 1.1 | 1.9 | *** |
| PP-maxillary first molar centroid (°) | 1.3 | 0.9 | *** |
| PP-maxillary second molar centroid (°) | −0.9 | 2.1 | *** |
| Mandibular plane-mandibular first molar centroid (°) | 1.2 | 0.9 | *** |

SD – Standard deviation; NS – Not significant. *$P<0.05$; **$P<0.01$; ***$P<0.001$; SN – Scientific notation

**Table 4: Mean values and standard deviations values of dental changes in horizontal plane after molars distalization (t1-t0). Positive values: Mesiobuccal and distopalatal rotation; negative values: Mesiopalatal or distobuccal rotation**

| Dental cast values | t1-t0 | | | |
|---|---|---|---|---|
| | *N* | Mean | SD | *P* value |
| Between maxillary first premolar (mm) | 30 | 1.65 | 0.86 | ** |
| Between maxillary first molars (mm) | | | | |
| Mesiobuccal cusp | 30 | 2.65 | 1.87 | ** |
| Distobuccal cusp | 30 | −0.23 | 1.96 | NS |
| Between maxillary second molars (mm) | | | | |
| Mesiobuccal cusp | 10 | 2.22 | 1.22 | ** |
| Distobuccal cusp | 10 | −1.22 | 1.34 | NS |
| Rotation values (°) | | | | |
| Right first molars | 30 | 17.81 | 3.19 | *** |
| Left first molars | 30 | 18.93 | 3.72 | *** |
| Right second molars | 10 | 15.5 | 5.01 | *** |
| Left second molars | 10 | 14.1 | 4.71 | *** |

**$P<0.01$; ***$P<0.001$. NS – Not significant; SD – Standard deviation

After a treatment period of 5 months, the first and second maxillary molars had been moved 5 mm distally and at the end of distalization phase we achieved an overcorrected bilateral Class I molar relationship [Figure 6a-c].

The palatal miniscrews and the transpalatal bar were removed and 2 miniscrews (K1, 10 mm) are placed in the buccal site mesial to the first molars, perpendicular to the cortical bone [Figure 7a-c].

The miniscrews were placed low in the attached gingival because was not necessary to intrude the incisor segment.

We immediately applied 50-100 g using elastic stretched from the miniscrews to retract the premolars and canines at the same time.

After the first 2 months, during which time we could judge the trustworthiness of the miniscrews, we increased the elastic force. After the first premolars and canines have attained a Class I position, the retraction of the incisors by means of sliding mechanics started [Figures 8a-c].

At the end of the treatment an ideal Class I molar and canine relationship, an ideal overbite, and an ideal overjet were all achieved [Figure 9a-g].

## DISCUSSION

MGBM-system is an orthodontic device reinforced with temporary skeletal anchorage recently proposed for the upper first and second molars distalization.

This retrospective study reported the results of 30 patients with Class II bilateral malocclusion treated with MGBM-System. Maxillary molars were distalized successfully to Class I relationships without patient cooperation in all cases.

In each patient, upper molars have been overcorrected because molar anchorage loss invariably occurs during retraction of the premolars, the canines and especially the incisors.[19]

The amounts of molar distalization were 4.9 mm with MGBM-System after 8 months.

These results agree with those of Fudaley's and Antoszewska[20] review about orthodontic distalizers reinforced with TAD's, which reported values ranged from 3.5 to 6.4 mm.

Ideal distalization appliances should provide a bodily distal displacement of the molar. Depending on the device used, the amount of molar tipping shows a great variability: Antonarakis

Patient and his family choose the non-extraction alternative and a distal movement of the upper first and second molar was planned. The treatment objectives included achieving a Class I molar relationship with distalization of both upper first and second

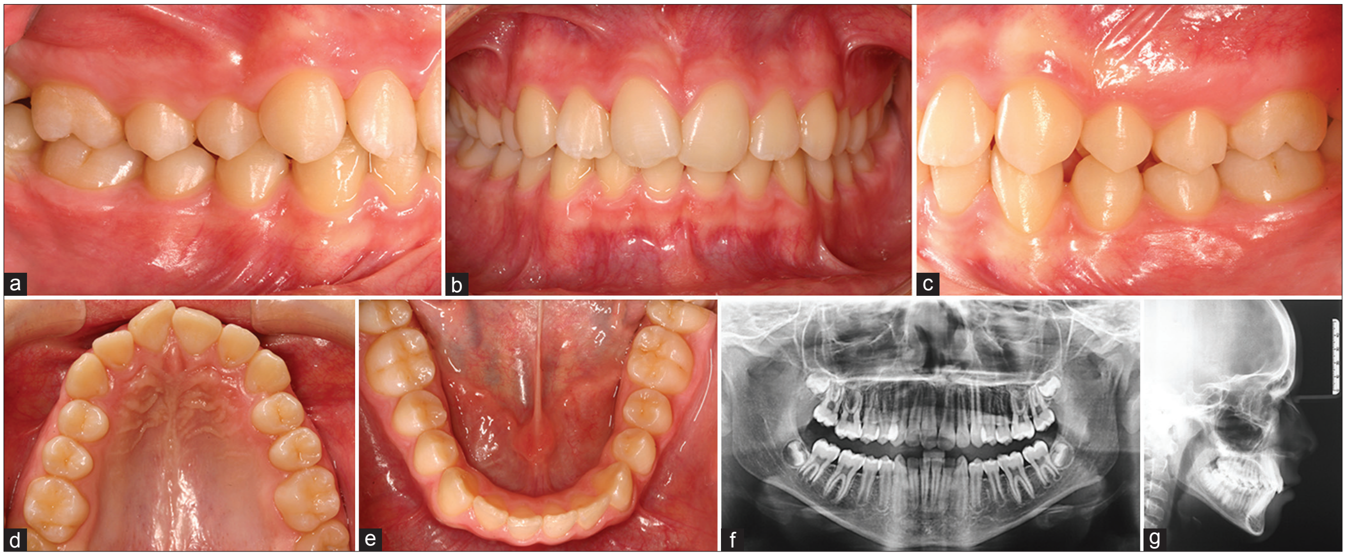

**Figure 5:** (a-g) Pre-treatment records

**Figure 6:** (a-c) Simultaneous distalization of the first and the second upper molars

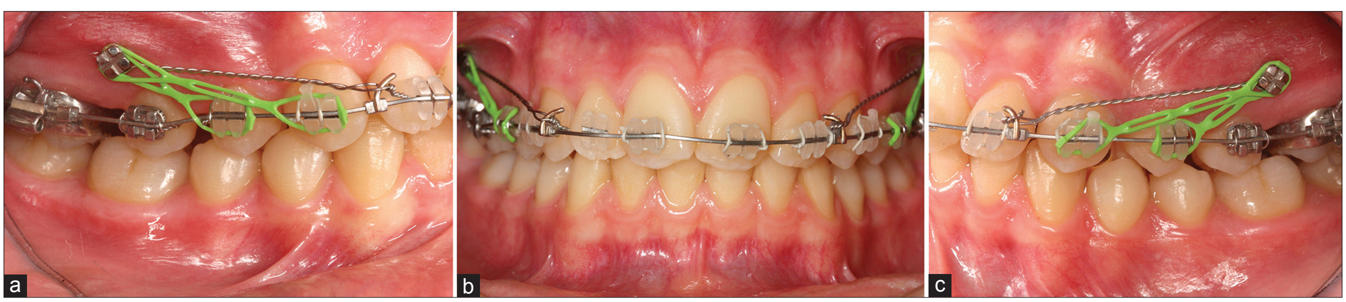

**Figure 7:** (a-c) Miniscrew placed in the buccal side for canines and premolars simultaneous retraction

**Figure 8:** (a-c) Incisors retraction

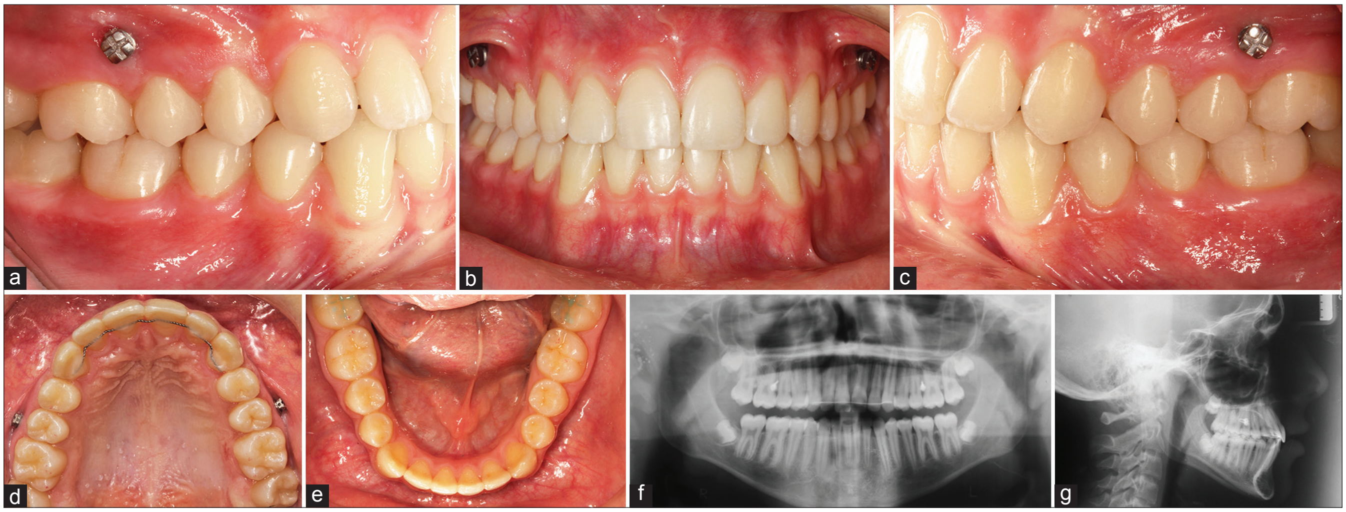

**Figure 9:** (a-g) Post-treatment records

and Kiliaridis[21] reported values of distal tipping of 8.3° for devices with vestibular application of force versus 3.6° of the devices with palatal force application system. In our study, the maxillary first molars were tipped distally 10.5 (SD 6.2)°.

In MGBM-System patients distal and reaction force vectors are located lower in respect to the molar center of resistance and consequently the distal movement of molars occurs with a distal tipping of the teeth. Furthermore, the germinating stage of the second molar can influence the molar tipping. According to Kinzinger *et al.*[22] in this study, 20 on 30 patients presented second molars erupting and this could explain the quite hight range of molar tipping.

The skeletal anchorage of MGBM protocol does not completely eliminate the loss of anterior anchorage. A clinical light but statistically significant anchorage loss caused by maxillary molar distalization is found expressed by the mesial movement of the premolar-incisor segment.

A possible explanation of this side-effect could be the elasticity and reduced stiffness of the transpalatal bar and metal ligatures. Wire ligatures 0.012 "SS connecting the miniscrew to the transpalatal bar, are elastic and flexible as well as the transpalatal bar is flexible and deformable. Moreover, as reported by Kinzinger *et al.*[13] and Liou *et al.*,[23] palatal miniscrews may show small movements when stressed by orthodontic forces. These indesiderable movements would occur due to the absence of osseointegration and to the elasticity of the bone. Another cause of the unexpected loss of anterior anchorage could be the distance between the buccal force application and the tooth center of resistance. Antonarakis and Kiliaridis[21] in his review, showed that distalizer with palatal application of forces behaved less with anchorage loss and therefore a reduced anterior movement of the premolars (1.3 mm vs. 2 mm) compared to the vestibular system.

Analysis of the dental model casts reveals that a therapeutically desirable transversal expansion of the dental arch had occurred both in first and in second upper molars region. Moreover, the first molars developed a distal rotation of the buccal cusps during distal movement. This rotation is useful in the correction of mesially rotated molars. In fact most subjects with a Class II malocclusion show maxillary first molars rotated mesially around the palatal root.

## CONCLUSION

The results of this study have shown that the MGBM-System is an effective and efficient method for distalizing maxillary molars and this treatment requires minimal patient compliance. The use of transpalatal bar reinforced by two palatal miniscrews provides sufficient anchorage to distalize simultaneously first and second molars. A small amount of anchorage loss should be expected although the use of skeletal anchorage.

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