Comparison of the Dental and Skeletal Changes Associated with Maxillary Molar Distalization by Four Different Appliances: An in vivo Study

Sailesh Deviah, Ratna Padmanabhan, Mahesh Kumar Yethadka, Gagandeep Singh

ABSTRACT

Objectives: This study was undertaken to evaluate the distalization efficacy of four different intraoral assemblies namely: Jones jig, Lokar distalizer, Distal Jet and Samarium Cobalt magnets.

Materials and methods: The present study was conducted on maxillary arches of 10 patients of either sex, within the age group of 10 to 14 years, requiring orthodontic therapy. The sample was then divided into two groups: Five subjects (group A) were given Distal Jet on right side and Jones Jig on left side, five subjects (group B) were given Lokar distalizer on right side and Samarium Cobalt magnet on left side. Cephalometric and model analysis were used to measure skeletal and dental changes.

Results: In all the patients, a class I or super class I relationship was obtained within a mean time of 14.2 weeks. The overall mean distalization and distal tipping brought about by the Lokar distalizer was the maximum compared to the other systems. The magnets exhibited the least amount of distalization and the Distal jet produced the least amount of tipping.

Conclusion: On a comparative basis, the palatally acting Distal Jet proved its supremacy over the buccal assemblies because the force was directed closer to the center of the resistance of the tooth. Further, the NiTi open coil spring-based systems displayed more amount of distalization than the Magnet-based system.

Keywords: Distalization, Distal Jet appliances, Samarium cobalt magnets, Lokar distalizer, Jones jig.


INTRODUCTION

The ability to distalize maxillary molars is a clinical skill. Conventionally, extraoral traction has been used quite successfully for the correction of Class II maloclusions, by restraining the forward growth of the maxilla and simultaneously distalizing the maxillary molars.1-4 The extraoral appliances have their own drawbacks, in that, the patients cooperation is very much required.

In orthodontic literature, it has been mentioned that several intraoral techniques have been attempted and found successful for maxillary molar distalization.5-13 Gianelly14-16 reported distalization of maxillary molars using Samarium Cobalt Magnets along with a modified Nance holding arch for anchorage control. He reported a distalization rate of 0.75 to 1 mm per month. Gianelly14 further used the Japanese NiTi open coil springs in continuous archwire and found a mean molar movement of 1 to 1.5 mm per month. Jones18 formulated a sectional jig assembly with an open coil (NiTi) spring, delivering a force of 70 to 75 gm, and reported a Class II molar correction to a Class I relationship in 120 to 180 days.

The distalization of molars by intraoral approach was found to be predictable and rapid with minimum patient discomfort, and reduced need for patient cooperation. Researchers have fabricated distalizing assemblies using the Nitinol open coil springs, which deliver not only a low continuous force but also possess the property of shape memory, superelasticity and excellent springiness (resistance to permanent deformation).16-18 A lingual molar distalizer9,10 using these NiTi open coil springs has also been introduced.

This study was undertaken to evaluate the distalization efficacy of four different intraoral assemblies namely; the Jones jig, the Lokar distalizer, the Distal Jet and the Samarium Cobalt magnets (Fig. 1). The study also reviews the hard and soft tissue changes brought about by the above-mentioned appliances on a comparative basis.
MATERIALS AND METHODS

The present study was conducted on 10 patients of either sex, within the age group of 10 to 14 years, requiring orthodontic therapy with no history of previous orthodontic therapy. After the cases were screened and found suitable, the necessary records were prepared. These records included: Lateral cephalogram, orthopantomogram, upper and lower study models. Lateral profile and frontal photographs, intraoral photographs, intraoral occlusal photographs, occlusal view photocopy. The sample was then divided into two groups: Group A and group B.

Group A comprised of five subjects in whom the maxillary molar distalization was carried out using the Distal Jet on the maxillary right quadrant and Jones jig on the maxillary left quadrant, using fully banded or bonded, preadjusted edgewise appliance (0.018 inch Roth prescription). Weldable brackets having 0° torque and 0° tip were welded onto the banded maxillary second premolars. A modified Nance appliance was soldered onto the lingual aspect of the premolar bands for anchorage control. Maxillary first molars were banded and double buccal tubes with occlusal headgear tubes were welded onto them. Lingual sheaths were placed on the lingual surface of the maxillary right first molar, which would act as attachment for the molar bayonets of the Distal Jet assembly. The posterior segments of the arches were levelled initially with 0.016 × 0.016 inch superelastic NiTi wire and subsequently a passive 0.017 × 0.025 inch stainless steel wire segment was inserted as the final levelling wire. The Distal Jet was placed in the maxillary right quadrant and the Jones jig was placed in the maxillary left quadrant. Maxillary second premolar bracket was then used to fasten the ligature ties necessary for activating the Jones jig assembly (Figs 2A and B).

Group B comprised of five subjects in whom the maxillary molar distalization was carried out, using the Lokar distalizer on maxillary right quadrant and the Samarium Cobalt (SM-Co) magnets on the maxillary left quadrant, using fully banded or bonded, preadjusted edgewise appliance (0.018 inch Roth prescription). Strap up and initial alignment was done similar to group A. The Lokar distalizer was placed on maxillary right quadrant and the Samarium Cobalt magnets on the maxillary left quadrant. Maxillary second premolar bracket was then used
to fasten the ligature ties necessary for activating both the
distalizing assemblies (Figs 3A and B).

All the appliances were activated to deliver a force of 200
 gm. Reactivation of the appliances was undertaken every 4
weeks to maintain the force level. The patients in both the groups
were followed up for a minimum period of 12 weeks and a
maximum of 16 weeks, and/or till a Class I or a super Class I
molar relationship was obtained (whichever occurred first). Pre-
and postdistalization cephalograms were taken on the same
cephalostat.

Measuring Procedures

For all the linear measurements cephalogram, the occlusal line
(OL) and the occlusal line perpendicular (OLP) from the
pretreatment films were used as reference lines or grids (Fig. 4).
The grid was transferred from the pretreatment tracing to the
post-treatment tracing by superimposition on the SN plane with
S (Sella) as the registering point.

All the cephalograms were traced by a single investigator.
The intrainvestigator error was calculated by randomly selecting
five cephalograms from each group. The landmarks were
identified and measured once again and the intrainvestigator
error was calculated by using the Dahlburg’s formula.

Cast Analysis (Figs 5A and B)

A. Distal movement of molars: A perpendicular was drawn
from the incisive papilla posteriorly on the mid palatal raphe
(Ipp). Perpendiculars were then dropped onto this center line
from the mesial pits of the first molar (Mpp 1R, Mpp 1L) and
second molars (Mpp 2R, Mpp 2L) and the distances measured
on both the pre- and post-treatment photocopies. The difference
in the readings amounted to the net maxillary molar distalization.

B. Rotation of molars: Tangents from the distal surfaces of
the first molars (Dst 1R, Dst 1L) were dropped onto the central
perpendicular line (Ipp) and the angles measured. The
 differences in the pre- and post-treatment angles amounted to
the rotation that took place during the distalization process.

C. Overjet: The difference in the pretreatment and post-
treatment values was measured as the change in overjet that
took place during the distalization process.

D. Anterior crowding: The existing crowding before the start
of treatment was calculated by measuring the arch perimeter
and the total tooth material. In the post-treatment models, the
change in overjet and the amount of molar distalization were
subtracted from the post-treatment arch perimeter value. The
total tooth material was then subtracted from this new value of
arch perimeter, to calculate the existing crowding present after
the distalization process.

E. Molar relationship: The molar relationship was noted on
the pre- and post-treatment study casts. A line was drawn on
the cast bisecting the mesiobuccal cusp of the maxillary first
molar and was extended onto the mandibular cast. Another line
was drawn along the mesiobuccal groove of the mandibular
first molar. The distance between these two lines was noted
and the difference in the pre- and post-treatment values
indicating the change in molar relationship. The distances were
measured using a vernier calliper.
F. **Intermolar width:** A line drawn connecting the mesial pits of both the right and left maxillary permanent first molars. This distance was measured on both the pre- and post-treatment photocopies and the differences in the measurements implied the change in intermolar width.

G. **Interpremolar width:** A line drawn connecting the mesial pits of both the right and left maxillary permanent first premolars. This distance was measured on both the pre- and post-treatment photocopies and the differences in the measurement implied the change in interpremolar width.

The data obtained was subjected to a nonparametric test called Kruskal-Wallis one-way analysis of variance by Ranks to test the null hypothesis where more than two independent groups of observations had to be compared. Another nonparametric test called Mann-Whitney U-test was employed to test the null in cases of two independent samples being drawn from the same group. Another test known as the Bonferroni method was employed to adjust for the multiple variable.

**RESULTS**

For the ease in comparing the individual distalizing assemblies the systems were further grouped as follows:

Group I: The Distal Jet
Group II: The Jones Jig
Group III: The Lokar distalizer
Group IV: The Samarium Cobalt magnets (The Magne Force)

For statistical analysis, the parameters were classified into different variables namely:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>34.3±3.0</td>
<td>35.0±3.7</td>
<td>0.7±0.7</td>
</tr>
<tr>
<td>V2</td>
<td>35.0±3.0</td>
<td>36.1±3.5</td>
<td>1.1±0.5</td>
</tr>
<tr>
<td>V3</td>
<td>35.6±3.0</td>
<td>36.5±3.4</td>
<td>0.9±0.8</td>
</tr>
<tr>
<td>V4</td>
<td>36.8±3.2</td>
<td>37.5±3.4</td>
<td>0.7±0.6</td>
</tr>
<tr>
<td>V5</td>
<td>37.0±3.4</td>
<td>37.5±3.5</td>
<td>0.4±0.1</td>
</tr>
<tr>
<td>V6</td>
<td>37.5±3.5</td>
<td>38.3±3.6</td>
<td>0.8±0.1</td>
</tr>
<tr>
<td>V7</td>
<td>38.3±3.6</td>
<td>39.0±3.7</td>
<td>0.7±0.1</td>
</tr>
</tbody>
</table>

**Table 1:** Means and SD values of variables 1 to 7

<table>
<thead>
<tr>
<th>Variabes</th>
<th>Before</th>
<th>After</th>
<th>Diff.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.2</td>
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<tr>
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<td>0.79</td>
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<tr>
<td>V4</td>
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<td>37.5±3.4</td>
<td>0.7±0.6</td>
<td>0.56</td>
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<tr>
<td>V5</td>
<td>37.0±3.4</td>
<td>37.5±3.5</td>
<td>0.4±0.1</td>
<td>0.01</td>
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<tr>
<td>V6</td>
<td>37.5±3.5</td>
<td>38.3±3.6</td>
<td>0.8±0.1</td>
<td>0.04</td>
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<tr>
<td>V7</td>
<td>38.3±3.6</td>
<td>39.0±3.7</td>
<td>0.7±0.1</td>
<td>0.47</td>
</tr>
</tbody>
</table>

**DISCUSSION**

The study consisted of a sample of 10 patients which were divided into two groups: Group A and B. Group A consisted of five patients subjected to the Distal Jet (group I) and the Jones jig (group II) placed in their respective right and left sides of the arch.

Group B consisted of five patients subjected to the Lokar distalizer (group III), and Samarium Cobalt magnets (group IV) placed in their respective right and left sides of the arch.

The study aimed at correction of Class II molar relationship using nonextraction therapy to a Class I or super Class I with good clinical results in a very short time (mean = 14.2 weeks) taking into consideration the dental (sagittal, vertical and angular) and skeletal parameters.
Dental Changes

The correction of Class II relationship to a class I or super class I relationship was accomplished by driving the first molar distally and was accompanied by distal tipping of the first and second molars and the mesial tipping of premolars.

The second molar distalization was achieved at an overall mean value of 2.96875 mm, the Lokar appliance producing the maximum distalization, i.e. 3.5 mm and the Samarium Cobalt magnets producing the least of 2.5 mm. This second molar, moreover, showed a distal tipping mean value of 4.05°, the Lokar causing maximum of 7° and Distal Jet causing minimum tipping, i.e. 2.2°.

The resultant movement of the first molar had a distalization component, a tipping component and a distopalatal rotation component, all in accordance with a study conducted by Erverdi, Koyuturk and Kucukkeles who reported the dental changes brought about by intraoral molar distalization comparing repelling magnets and NiTi coil spring.

Table 2: Means and SD of tipping produced

| Variables | Group I | | | Group II | | | Group III | | | Group IV | | |
|-----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|           | Before mean ±SD | After mean ±SD | Diff. mean ±SD | Before mean ±SD | After mean ±SD | Diff. mean ±SD | Before mean ±SD | After mean ±SD | Diff. mean ±SD | Before mean ±SD | After mean ±SD | Diff. mean ±SD |
| V8        | 69.4±1.9 67.2±1.9 | 67.0±4.4 65.6±1.3 | −2.2±1.9 | 72.2±5.2 63.2±4.3 | −9.0±1.2 | 72.8±4.9 67.6±4.2 | −5.2±1.1 |
| V9        | 59.4±4.3 57.2±3.7 | 60.2±7.2 54.4±5.5 | −2.2±1.0 | 58.0±7.8 58.4±7.1 | −0.4±1.7 |
| V10       | 74.0±6.0 75.4±6.5 | 74.8±4.5 78.2±5.8 | 1.4±1.5 | 76.8±4.1 79.8±4.8 | 3.0±1.6 |
The mean distal movement of the first molar was 4.03125 mm with Lokar producing the maximum distalization of 4.875 mm and the magnets producing the least 3.125 mm with reasonable distalization achieved using Jones jig and Distal Jet being 4.5 and 3.62 mm respectively.

The tipping component of the first molar showed an overall mean of 4.9°; this deleterious effect being produced most by the Lokar appliance (9.6°) and least by the Distal Jet (2.2°). The tipping produced by the magnets and the Jones jig were 5.2° and 3.6° respectively.

A generalized trend toward slight extrusion of the first molar was seen in six out of the 10 subjects studied (mean = 0.328 mm) and particularly in cases where the Lokar appliance was used, a 2 mm extrusion was encountered.

The changes in tipping, extrusion and mean distalization obtained were in accordance with the study conducted by Gianelly,14-16 Cosentino and Amato,20 Itoh21 et al and Jurl Kuro.15 Another drawback of the distalization process was the distopalatal rotation produced in the first molar. In the present study, there was an overall mean distopalatal rotation of 2.425°, the Lokar producing the maximum of 4° and the Jones jig producing the least (1.2°). The Distal Jet and magnets produced 2.1° and 2.4° respectively. These results were in accordance with the findings of Gianelly et al14-16 and Itoh21 et al (6.2°). However, the value obtained in this study was in contrast to the distobuccal rotation of first molar (8.5°) encountered in the study conducted by Bondemark and Kurol.6

The mean mesial movement of premolars was 0.906 mm; the Lokar and magnets producing the most (1.125 mm) and the Jones jig producing the least of 0 to 0.5 mm. Bycoff8,13 et al found 1.63 (+1.37 mm) second premolar anchorage loss in his study. Bondemark and Kuro observed approximately 1.50 mm of premolar anchorage loss due to the mesially directed force component of the distalizer.

Accompanied by the distal tipping of the molars, there was a reciprocal mesial tip of the premolars. This adverse mesial tipping showed a mean value of 2.8°, the maximum produced by the Lokar distalizer and the least by the Distal Jet (1.8°).

In the transverse plane of space, the maxillary first molar width increased by an overall mean of 0.9875 mm, being more in group A (Lokar + Magnets) than group B (Distal Jet + Jones jig). This was in contrast with the average increase in inter-premolar width of 0.82 mm (more in group B than group A). This was attributable to the reciprocal forces acting between the contact region of the first molar and second premolar by the distalization assembly.

The mandibular first molar showed tendency toward mesial migration; a mean value of 0.09 mm in five out of the 10 cases and distal movement of 0.5 mm in one particular case.

**Skeletal Changes**

With regard to the skeletal changes, no appreciable findings were seen in the maxilla. The ‘A’ point was found to have moved anteriorly by a mean value of 0.55 mm and 0-5° due to the anterior vector of forces in response to the distalization force.

These were mild anterior shift of the ‘B’ point (in 4 individuals) showing a mean value of 0.1 mm. This was mainly attributable to the growth changes occurring in the respective individuals. This brought about a resultant mean change in ANB angle to 0.4 mm.

The study also showed a slight increase in the cant of the occlusal plane by a mean value of 0.7° and a clockwise rotation of the mandible due to an increase of 1° in the mandibular plane angle. These changes in turn led to a mild increase in the lower anterior facial height by a value of 0.65° (ANS-Xi-Pm).

From these above-mentioned values, it was inferred that there was an opening of the bite, a reduction in overbite by 0.92 mm and a clockwise or backward rotation of the mandible. All of these being caused by the extrusion of the first maxillary molar as mentioned earlier. It seems that distalization process causes the maxillary molar to move “into the wedge”, as mentioned by Ghosh and Nanda.

Further research with large sample sizes are warranted for establishing more significant values of all the parameters measured under this study.

**CONCLUSION**

The overall mean distalization and distal tipping brought about by the Lokar distalizer was maximum compared to the other systems. The magnets exhibited the least amount of distalization and Distal jet produced the least amount of tipping. It was also found that the distopalatal rotation component was maximum for the Lokar distalizer and minimum for the Jones jig.

On a comparative basis, the palatally acting Distal Jet proved its supremacy over the buccal assemblies because the force was directed closer to the center of the resistance of the tooth. Further, the NiTi open coil spring based systems displayed more amount of distalization than the magnet-based system.

Thus, considering the results obtained during the course of this study, a distalizing system based on NiTi open coil springs, which acts as close to the center of resistance of the tooth as possible, would be the most ideal in achieving optimal results of tooth movement.

**REFERENCES**


Comparison of the Dental and Skeletal Changes Associated with Maxillary Molar Distalization


