A Clinical Evaluation of Three Force Delivery Systems in Stage II of the Begg Technique

Vincy Antony Margaret, Prathapan Parayaruthottam, K Jyothindra Kumar

ABSTRACT

Introduction: Orthodontic treatment is presently dominated by two techniques, the Begg light wire differential force technique and the preadjusted edgewise technique. Orthodontic appliances at present commonly utilize sliding mechanics for extraction space closure with different types of force delivery systems.

Materials and methods: The present study was designed to compare the rates of retraction and anchorage loss between elastics, elastomeric chains and nickel-titanium (NiTi) closed coil springs, using a continuous archwire system with the Begg light wire differential force technique.

Results: The rate of canine retraction was faster by 0.6 mm per month with the NiTi closed coil spring compared to elastics and elastomeric chains. The NiTi closed coil springs produced more rapid rate of canine retraction but they also produced the greatest amount of anchorage loss.

Keywords: Anchorage loss, Nickel-titanium closed coil springs, Elastics, Elastomeric chains.

INTRODUCTION

Therapeutic extraction of teeth to gain space for the retraction of anteriors is an accepted procedure in orthodontic practice. The creation of space in the dental arch through extraction therapy requires effective mechanisms to close and consolidate this space to achieve the desired treatment objectives.

The Begg light wire differential force technique is one of the most versatile orthodontic treatment philosophies. The light wire technique is based on the concept of ‘differential force’. In this technique, tipping of the crown is effected first and then tipping of the root to translate the tooth. This produces an efficient and effective anchorage control system.

Traditionally, in pure Begg mechanics, the extraction space is closed with the help of light intramaxillary elastics in each quadrant. However, there are a variety of force delivery systems currently available that can produce optimum force levels to move teeth through the alveolar bone. These include coil springs, latex elastics, elastomeric chains and threads, sectional archwire auxiliaries and magnets.

The ideal force delivery system would meet the following criteria:

1. Provide optimal tooth moving forces that elicit the desired effect.
2. Be comfortable and hygienic for the patient.
3. Require minimum operator manipulation and chairtime.
4. Require minimal patient cooperation.
5. Be economical.

Thus, an optimal space closure system should result in the highest possible rate of desirable tooth movement without irreversible damage to the periodontal ligament, the alveolar bone or the dental tissues.

However, cephalometric studies have shown that the space gained by extraction is not completely utilized for the retraction of anteriors. There are a variety of anchorage situations met with in clinical practice:

1. The high anchorage situation—in which the majority of the space is to be utilized for anterior retraction.
2. The medium anchorage situation—where anchorage concerns demand a 50% utilization of space by molar protraction and incisor retraction.
3. The low anchorage situation—in which only 25% of the space need be used for anterior retraction and the remaining space closed by molar protraction.

Knowledge of the amount of space that can be utilized is important for proper treatment planning. But there are very few studies correlating the rate and amount of retraction with the different retraction modalities which will help us to appropriately use the particular modality for a particular anchorage situation. Therefore, there is a need to estimate the amount of incisor retraction that can be achieved by orthodontic...
procedures in extraction cases. As bimaxillary protrusion constitutes a major racial feature of Kerala population, determination of the amount of incisor retraction possible and the molar anchorage loss that occurs with different retraction modalities in the Begg technique will reveal the appropriateness and applicability to this population. It is in this context that the study is undertaken to identify and assess the use of a particular force delivery system for respective anchorage situations.

The aim of the present study is to evaluate cephalometrically and clinically the extent of molar anchor loss that has occurred in vivo following the extraction of first premolars, using three different retraction modalities applied in the second stage of Begg technique. The rate of retraction of anteriors was also studied. It was also intended to cephalometrically appraise the changes in axial inclinations of incisors and interincisal angle that have occurred during the treatment period with the different retraction modalities.

AIMS AND OBJECTIVES

1. To estimate the molar anchorage loss that occurs while retracting the anteriors in Stage II of the Begg technique.
2. To assess the effect on anchorage of three different force delivery systems:
   a. Latex elastics
   b. Elastomeric chains
   c. Nickel-titanium (NiTi) closed coil springs.
3. To compare the rate of retraction in Stage II of Begg technique using different anterior retraction mechanics.
4. To analyze the changes in axial inclination of incisors and interincisal angle brought about during treatment as a function of time and retraction modality.
5. To determine the nature of association, if there is any, between retraction modality, incisor retraction and molar protraction.

MATERIALS AND METHODS

The samples for this study included 21 postpubertal patients who had Angle’s Class I malocclusion with bimaxillary dentoalveolar protrusion, the treatment of which required the extraction of all four first bicusps. All the objectives of Stage I was to be ensured before commencing Stage II of the Begg technique. These included molars in Angle’s Class I relationship and correction of all individual tooth malalignments.

The inclusion criteria for the selection of cases for this study were as follows:
1. A minimum dental age of 16 years.
2. All teeth inclusive of the second molars were to be fully erupted and in functional occlusion before commencement of the study.
3. Canine retraction of a minimum of 3.5 mm would be required to be effected in Stage II.
4. Cephalometrically, the patients were to have ANB angles of 2 to 4° and a normal growth pattern.

The samples in the three groups were tested to note if they were homogenous. The data revealed them to have no statistically significant difference in the linear and angular measurements tested. Thus, the samples were concluded to be homogenous.

The study had a sample size of 21 patients with seven patients in each group. Three different force delivery systems were evaluated. They were:
1. Latex elastics-5/16” Green, HP Elastics, HP Industries, Calicut, Kerala, India.

Based on the three force delivery systems used (Fig. 1), the samples were divided into three different groups:
- Group I—Elastics
- Group II—E-chain
- Group III—NiTi closed coil springs

The 21 patients were then allotted to each of the groups by the lottery method with each group comprising seven patients.

In the group using elastics for space closure, Class I intramaxillary elastics were placed for all four quadrants with initial force levels ranging from 3½ to 4 ounces (100-120 gm). Previous studies have shown that the initial force of the latex elastics was reduced in vivo by approximately 25 gm. Therefore, effective force delivered was found to be in the optimum range of 3 to 3½ ounces (80-100 gm). The patients were instructed to wear the elastics at all times except during brushing and to change them every alternate day.

The elastic chain used was the short spaced variety from the Ortho Organizers Company. Studies have revealed a force degradation of 50 to 75% in the first 24 hours. The force for the chains was measured and applied by the same operator, to be as close to the selected value and rechecking minimizing operator error.

The closed coil NiTi springs were Ormco’s 12 mm ‘medium force’ type with dimensions of 0.010” x 0.030”, being the wire size and internal coil diameter respectively. Studies have shown only 10% force decay for the springs. The closed coil springs were adjusted so as to deliver an equivalent amount of force as elastics and E-chains.

At each visit, the elastic chains were replaced whereas the springs were left in situ, and tightened as needed to maintain the force level. The force applied at each visit was recorded with a Dontrix gauge.

The amount of incisor retraction and molar protraction brought about by the force delivery systems in Groups I to III were evaluated from serial lateral cephalometric radiographs taken at the beginning of Stage II (T1) and at the end of Stage II (T2). All lateral cephalograms were traced by one investigator. Angular measurements were made to the nearest 0.5° and linear measurements to 0.5 mm (Figs 2 and 3).
anterior retraction at the completion of extraction space closure (Figs 4 to 6).

The rate of retraction was defined as the distance travelled in millimetres divided by the time required to complete space closure. Anchorage loss was recorded as the amount of movement in millimeters that occurred in the direction opposite to the direction of the applied force.

**STATISTICAL ANALYSIS**

All the measurements were tabulated and mean rates of space closure were calculated. Paired ‘t’-tests were performed independently for the difference of the rates and amount of retraction and anchorage loss. Mean values between the groups were compared using student ‘t’-test. A ‘p’-value of less than 0.05, was considered statistically significant.

**DISCUSSION**

Bimaxillary dentoalveolar protrusion is the most prevalent malocclusion seen in the Kerala population and is characterized by the increased axial inclination of the incisors and a reduced interincisal angle. Begg technique is considered superior in
A Clinical Evaluation of Three Force Delivery Systems in Stage II of the Begg Technique


Treating bimaxillary dentoalveolar protrusion because of minimal anchor loss and greater extraction space utilization compared to other techniques.

Therapeutic extraction of teeth to correct malocclusion is an accepted procedure in orthodontic practice. Traditionally in pure Begg mechanics, the extraction space is closed with the help of light intramaxillary elastics in each quadrant. But patient cooperation is a very important factor. Scientific advancements now enable us to choose from a variety of space closure systems. Furthermore, in treatment where the primary objective is to retract the anterior units into the extraction space using molars as anchorage units, the relative movements of these two units using the different modalities is important.

This investigation was done on 21 postpubertal patients with the samples being 14 females and seven males. The patients had undergone treatment for the correction of Class I bimaxillary dentoalveolar protrusion with the extraction of first premolars and using the Begg light wire appliance.

Notable weaknesses of other studies in this area included use of multiple operators and small sample size. This was a prospective study performed by a single operator thus eliminating interobserver variability. A preliminary report from a statistician indicated that a minimum of six patients per group should be studied in order to eliminate α-error at 0.05. Furthermore, this was also determined to be adequate to detect a difference of 0.25 mm/3 week interval in this study with 80% probability of detecting a difference between the space closure systems for the rate of retraction.

The study was done using cephalometric radiographs taken at the beginning and at the end of Stage II. Selection of cephalometric roentgenography as a means of investigation was done because of its scientific value and ability to produce accurate and reproducible results. In the present study, superimposition of the maxilla and mandible were done separately (Fig. 6 and Graphs 1 and 2). Maxillary superimposition was done along the palatal plane registered at the pterygomaxillary fissure. Mandibular superimposition was done by the Bjork’s method whereby the inner contour of the cortical plates at the inferior border of the symphysis and the inferior alveolar canal were used for superimposition. Further, the tooth movements were measured with respect to their initial position.

Rate of closure: The rate of tooth movement is defined as the displacement of the tooth per unit time. The mean rates of space closure were 1.00 mm, 1.25 mm and 1.44 mm/3 weeks in the upper arch and 0.68 mm, 1.06 mm and 1.27 mm/3 weeks in the lower arch for Groups I, II and III respectively (Table 1). Thus, the NiTi closed coil springs were found to have a significantly greater rate of closure of premolar extraction spaces compared to elastics and elastomeric chain in both maxilla and mandible (Graph 1). The paired t-test was done between the groups to test the difference noted in rate of space closure (Table 2). In this study, the NiTi closed coil springs produced nearly twice as rapid a rate of tooth movement as conventional elastics rated at about the same force level. This discrepancy is probably due to two factors: the ability of the springs to maintain a relatively constant force level compared to the elastics, and the elimination of the need for patient cooperation. Similar results were reported by Sonis (1994) and Samuels (1993, 1998) with the rate of space closure found to be twice that of elastics.

Molar anchorage loss: The present study attempted to compare the effect of the three different force delivery systems on the
amount of mesial movement of the upper and lower molars. It was done so with the aim of applying the results to different anchorage situations and thus we can manage the time and space problem appropriately. In the present study, the amount of mesial movement was greatest for NiTi springs (Graph 2) with a mean of 1.77 and 1.68 mm in the upper and lower arch respectively (Table 1). The paired t-test was done between the groups to test the difference noted in anchor loss (Table 4). It was found that there was a statistically significant change between the anchor loss noted in the groups with elastics and NiTi springs with the t-value significant at the 0.05 level. This may be explained due to the light constant force acting on both the anterior retraction unit as well as the reactionary unit as reported by Bennett and McLaughlin and Samuels (1998). The paired t-test done between the groups with elastomeric chains and elastics too showed a statistically significant difference at the 0.1 level. But there was no statistically significant difference in anchor loss between elastomeric chains and NiTi closed coil springs.

Parameters involving the changes in the axial inclination of incisors following retraction showed a significant change with respect to IMPA and interincisal angle (Table 3) after retraction with E chain and NiTi closed coil springs (Graphs 3 to 5).

In the final analysis of the data, it may be stated that the group which used elastics was found to have the least anchorage loss. But on the other hand, it was also found to have the least rate of retraction of anteriors. The behavior of Group II was such that both the anchorage loss as well as the rate of retraction was much greater than Group I which used elastics. The NiTi closed coil springs were found to have the greatest rate of space closure but also showed the maximum loss of anchorage. The above observation could be explained as follows: it could be due to the sustained action of the NiTi coil springs which caused increased reactionary movement of the anchor unit as the retractive force is basically reciprocal in nature. In contrast, the intermittent force of the elastomers did not produce such a taxation of the anchorage unit. Thus, in low anchorage situations, NiTi coil springs would be ideal for extraction space
closure with its increased rate of tooth movement and high anchor loss. But in high anchorage situations, caution should be exercised when using NiTi springs and anchorage may need to be reinforced in the posterior segment either by including the second molars or by using adjuncts such as transpalatal arches or lingual arches to reinforce the anchorage. The different rates of space closure provided by the three different force delivery systems could be used to close different amounts of space on either side of the same arch. They also could be used to maintain or move the midline when used in the same arch with different space closure requirements on either side.

**CONCLUSION**

The present study attempted to evaluate cephalometrically the influence of three different retraction modalities—elastics, elastomeric chain and NiTi coil springs in Stage II of the Begg technique. The study had a sample size of 21 patients with seven patients in each group. The anchorage loss, rate of retraction and other skeletal and dental parameters were comparatively assessed. This was to identify and assess the use of a particular force delivery system for appropriate anchorage situations.

The following conclusions were obtained from the study:

1. Elastics were found to produce the least amount of retraction but they also produced the greatest anchorage loss and the rate of closure was also increased.
2. Elastomeric chains were found to produce greater anchorage loss and the rate of closure was also increased.
3. NiTi closed coil springs were found to have the maximum amount of retraction but they also produced the greatest amount of anchorage loss.

Hence, NiTi springs are found to be a valuable adjunct to the clinician, though its use has to be judicious and cautious. Future studies can be done by increasing the sample size and doing a similar study comparing the efficacy of retraction in the same appliance and the preadjusted edgewise appliance. The different retraction modalities can be used on the contralateral sides of the same patient in those studies. Parameters like patient discomfort, chairside time, root resorption for the different methods of retraction, rate of retraction with self-ligating brackets, can also be studied.

**REFERENCES**


<table>
<thead>
<tr>
<th>Table 3:</th>
<th>Mean and standard deviation of the difference in angular and linear parameters in Groups I to III at the beginning and end of Stage II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>Mean 7.79 4.41 11.93 3.87 19.36 9.43 12.36 4.99 0.64 0.5 0.8 0.81</td>
</tr>
<tr>
<td>SD</td>
<td>7.65 2.38 5.83 1.25 11.01 8.04 4.85 2.07 0.38 0.41 0.68 0.63</td>
</tr>
<tr>
<td>Group II</td>
<td>Mean 18.86 6.04 14.28 4.99 0.31 19.29 11.71 5.46 0.14 0.21 0.19 0.28</td>
</tr>
<tr>
<td>SD</td>
<td>4.62 1.65 4.85 2.09 8.18 5.83 4.71 2.18 0.24 0.39 0.95 1.15</td>
</tr>
<tr>
<td>Group III</td>
<td>Mean 15.21 5.46 13.07 5.24 27.36 11.57 13.71 4.17 0.71 0.57 0.057 0.114</td>
</tr>
<tr>
<td>SD</td>
<td>8.15 2.03 6.54 1.97 12.71 10.08 6.85 1.59 0.64 0.73 1.28 1.056</td>
</tr>
</tbody>
</table>

**Table 4: Paired t-test for anchorage loss between the three groups**

<table>
<thead>
<tr>
<th>Arch Test</th>
<th>Groups I and II</th>
<th>Groups I and III</th>
<th>Groups II and III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper t-test</td>
<td>2.03</td>
<td>2.71*</td>
<td>0.03</td>
</tr>
<tr>
<td>Lower t-test</td>
<td>2.37</td>
<td>3.13*</td>
<td>0.16</td>
</tr>
</tbody>
</table>

*Significant at 5% level (t = 2.447)