EVALUATION OF TWO ARCH DESIGNS FOR ORTHODONTIC INTRUSION AND RETRACTION OF TEETH

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Background: Simultaneous intrusion and retraction of the anterior teeth is desirable to achieve optimum treatment results for orthodontic patients with deep overbite and flared incisors. The present study evaluates two different designs of arches for orthodontic intrusion and retraction of teeth.

Methods: Thirty orthodontic patients, divided into two groups having an overbite more than 3 mm and requiring extraction of first premolars were included in the study. Model analysis and cephalometric analysis were carried out for each patient. 0.018" Roth prescription brackets were used. One group was treated using Three-piece intrusion arch. Kalra's Simultaneous intrusion retraction arch was used for the other group. On obtaining desired overbite/overjet, the intrusion arches were removed. On accomplishment of final finishing and detailing, the cases were placed on retention appliance.

Result: Chair side time required for fabrication of both intrusion arches was almost similar. Both groups achieved more than 1.9 mm intrusion with minimal effects on the buccal segments.

Conclusion: Both the designs of intrusion arch wires used in the present study allow the clinician to deliver a well-controlled force system with minimal chair side adjustments and with no additional deleterious effects on the buccal segments.

Key words: Orthodontics; Intrusion; Retraction.
INTRODUCTION

Overbite is the measure of the vertical relationship between the maxillary and mandibular incisors. A vertical relationship, which differs from the normal range, is a contributing factor in many malocclusions; correcting this discrepancy is of major concern to clinicians. Deep bite has been considered one of the most common malocclusions and the most difficult to treat successfully. The amount of vertical overlap often varies excessively and is one of the most common and early manifestations of a malocclusion. The common definition of overbite was developed by Strang [1] who defined it as "the overlapping of the upper anterior teeth over the lowers in the vertical plane."

The cause of deep bite may be lack of eruption of posterior teeth (true deep bite), over-eruption of the anterior teeth (pseudo deep bite) or a combination of both. The true deep bite should be treated by the extrusion of posterior teeth and pseudo deep bite by true intrusion.

During orthodontic therapy, correction of deep overbite in patients with flared incisors is a difficult biomechanical challenge, since uprighting of incisors often lengthens the crowns vertically and increases the overbite. Deep overbite may be accompanied by intraarch spacing associated with flared incisors or intraarch crowding requiring premolar extractions. In extraction cases, alignment of the anterior teeth does not correct their axial inclinations or the deep overbite. Simultaneous intrusion and retraction of the anterior teeth may be desirable to achieve optimum treatment results. During intrusion of the anterior teeth, control of their labio-lingual axial inclinations is critical for successful completion of treatment.

Intrusion is defined by Nicolai [2] as "a translational form of the tooth movement directed apically and parallel to the long axis", where as Burstone [3] defined it as "apical movement of the geometric center of the root in respect to the occlusal plane or a plane based on the long axis of the tooth." Labial tipping of an incisor around its center of resistance produces pseudo intrusion, which can also correct the deep bite.

MATERIALS AND METHODS

Thirty orthodontic patients with an overbite in excess of 3 mm were included for this study. Treatment was performed by one orthodontist only. Patients included in the sample were between 14 to 28 years of age. Patients requiring extraction of first premolars for correction of flared incisors or correction of crowded dentition were included in the study. Patients with periodontal disease were excluded from this study.

The patients were divided into two groups of fifteen subjects each (Table 1). A clinical case history, lateral cephalometric radiograph, study models, orthopantomogram, extraoral and intraoral photographs were obtained for each patient at the start of the orthodontic therapy and when intrusion of the four maxillary incisors was completed.

Prior to undertaking cases for orthodontic therapy, oral prophylaxis was carried out. Cases requiring restoration of teeth were also attended to.

The study models were analysed and lateral cephalograms were traced for cephalometric analysis.

Vertical movement of the anterior segment was determined by the perpendicular distance between the center of resistance of the maxillary central incisor (indicating the amount of intrusion) and the palatal plane. The center of resistance (Cres) of the maxillary incisors was selected as a measurement point instead of the center of resistance of the anterior segment because it is easy to locate & reproduce. Due to the rigidity of the anterior segment and the small sagittal distance from the Cres of the maxillary central incisor to the Cres of the anterior segment in this sample, the possibility of error created by using this measurement is small. The Cres of the maxillary central incisor was taken at one-third the root length apical of the alveolar crest. The vertical movement of the anterior segment was measured by subtracting the post treatment measurement from the corresponding pre-treatment values.

Vertical movement of the buccal segment was determined by the distance perpendicular between the center of resistance of the maxillary first molar and the palatal plane. The Cres of the maxillary first molar was selected as a measurement point instead of the center of resistance of the buccal segment because it is a more reliable location and easy to reproduce. The location of the center of resistance of the maxillary first molar was the trifurcation of its roots. The vertical movement of the posterior segment was measured by subtracting the post treatment measurement from the corresponding pretreatment values.

All therapeutic extractions of first premolars were carried out under local anaesthesia using 2% lignocaine with 1:80,000 adrenaline. 0.018" Roth prescription brackets were used. Preformed stainless steel transpalatal arches were used in all the cases to augment anchorage. Initial alignment was performed in segments. In Group A (Three-piece intrusion arch), the anterior segment extended from the right to left lateral incisor and the buccal segment from canine to first molar. In Group B (Kalra's Simultaneous Intrusion
and Retraction arch), the anterior segment extended from the right to left canine and the buccal segment from second premolar to first molar. On achieving optimum alignment, the intrusion arch was then placed with a force level of 60 grams in group A and 100 grams in group B.

Visits were scheduled every four weeks. When the incisors were intruded and retracted to the proper level, the intrusion arch was removed. A lateral cephalogram and impressions of the dental arches were recorded and study models were obtained.

In Group A the Three-Piece Intrusion Arch was used. It is a three-piece base arch used to intrude the anterior segment. The three-piece intrusion arch consists of the following parts: (i) The posterior anchorage unit (ii) The anterior segment with a posterior extension (iii) The intrusion cantilevers and (iv) Elastic chain.

The anterior segment was bent gingivally distal to the laterals, then bent horizontally, creating a step of approximately 3 mm. The distal part extended posteriorly to the distal end of the canine bracket, ending in the form of a hook. The anterior part was fabricated of a heavy stainless steel to prevent side-effects created by bending of the wire during force application.

The anterior segment allowed further distal placement of the intrusive force, which was desirable in case of flared incisors. The intrusion cantilevers were fabricated from 0.017" X 0.025" TMA. The wire was first bent gingivally mesial to molar tube and then a helix formed. On the mesial end of the cantilever, a hook was bent through which the intrusive force applied to the anterior segment. The cantilever was activated by making a bend mesial to the helix at the molar tube and then cinched back. An elastic chain was attached to the hook to facilitate simultaneous intrusion and retraction (Figure 1). A force of approximately 150 grams per side was used with the elastic chain for separate canine retraction. A force of approximately 200 grams per side was used with the elastic chain for retraction of incisors, once separate canine retraction was completed. All forces were measured with a Dontrix tension gauge.

In Group B the K-SIR (Kalra's Simultaneous Intrusion and Retraction) Arch was used. It is a continuous 0.017" X 0.025" TMA archwire with closed 7 mm X 2 mm U-loops at the extraction sites. To obtain bodily movement and prevent tipping of the teeth into the extraction spaces, a 90° V-bend was placed in the archwire at the level of each U-loop. A 60° V-bend located posterior to the center of the interbracket distance produced an increased clockwise moment on the first molar, which augmented molar anchorage as well as the intrusion of the anterior teeth.

To prevent the buccal segments from rolling mesiopalatally due to the force produced by the loop activation, a 20° antitrotation bend was placed in the archwire just distal to each U-loop.

A trial activation of the archwire was performed outside the mouth. This trial activation releases the stress built up from bending the wire and thus reduces the severity of the V-bends. However, the shape of the archwire should be maintained in subsequent activations of the loops. After the trial activation, the neutral position of the each loop is determined with the legs extended horizontally. In neutral position, the U-loop will be about 3.5 mm wide. The archwire is inserted into the auxiliary tubes of the first molars and engaged in the six anterior brackets (Figure 2).

It was activated about 3 mm, so that the mesial and distal legs of the loops were barely apart. The second premolars were bypassed to increase the interbracket distance between the two ends of attachment.

RESULTS

Thirty patients were included at the start of the present study. There were 18 females and 12 males (Table 2). Three patients from the present study were lost to follow up due to their permanent transfer. Two were from Group A and one from Group B. No major complication in patients of either group was observed.

A total of five patients (three from Group A and two from Group B) reported with ulceration in buccal mucosa secondary to irritation from ends of archwires, during the entire course of treatment. This problem was attended to by cutting/cinching the ends of the archwire.

The mean chair-side time for fabrication and ligation of the appliance is given in Table 3. In both groups, a clinically significant amount of incisor intrusion was achieved (Table 4). The extrusion of the buccal segments is given in Table 5.

DISCUSSION

In a study on the influence of force magnitude on intrusion of the maxillary segment using a three piece intrusion arch with force levels of 40 grams and 80 grams, Steenbergen [4] achieved a mean intrusion of 2 mm in both groups, comparable to the amount of intrusion achieved in the present study.
Weiland [5], using Burstone’s segmented arch technique achieved a mean intrusion of 1.5 mm of maxillary incisors. According to Ng [6], the segmented arch technique can produce 1.5 mm of incisor intrusion in the maxillary arch.

The mechanisms used for incisor retraction and intrusion for Group A in the present study employed the principles of the segmented arch technique [7]. Segmented arch mechanics uses different wire cross-sections in a given arch rather than continuous wires. The advantage of using such an approach is that it is possible to develop a precise and predictable force system between an anterior segment (incisors) and a posterior segment (premolar and molars) enabling pure intrusion of the anterior teeth and control of their axial inclinations. Movement of the posterior segment is also well controlled. The appliances used enabled the magnitude of the moments and forces delivered to be well controlled. Consequently, constant levels of force could be maintained and the moment to force ratio (M/F) at the centers of resistance easily regulated to produce the desired tooth movement.

Intrusive forces on the upper anterior teeth can be used to tip back the posterior teeth while partially or completely correcting a Class II buccal relationship.

The main indication for the K-SIR archwire is for the retraction of anterior teeth in a first premolar extraction patient who has a deep overbite and excessive overjet and who requires both intrusion of the anterior teeth and maximum molar anchorage. However, the archwire can be modified to close extraction spaces in moderate and minimum anchorage situations with varying degrees of overbite.

A major advantage of the K-SIR appliance is its simplicity of design, with a minimal amount of wire in the loop configuration [8]. It is, therefore, easy to fabricate, comfortable for the patient and less likely to cause tissue impingement. The 0.017”x 0.025” TMA provides sufficient strength to resist distortion, as well as enough stiffness to generate the required moments. At the same time, the design of the archwire and the material properties of TMA combine to produce relatively low forces, a low load-deflection rate and a range of activation that allows the appliance to continue closing space over an eight-week period. TMA can be activated twice as much as stainless steel without undergoing permanent deformation and it produces half the force per unit activation.

Due to the frictionless mechanics used for space closure in this system and the presence of the off-center V-bend, which acts like an anchor bend, molar anchorage control is excellent, even without headgear. The clinician is thus less dependent on patient cooperation for a successful result in a maximum anchorage situation. As the intrusion of the six anterior teeth occurs at the same time as their retraction and because the canines and incisors are retracted as a unit, the K-SIR archwire shortens treatment time compared to conventional edgewise mechanics [8]. In addition, the en masse retraction of the six anterior teeth prevents the appearance of an unsightly space distal to the incisors, which occurs if the canines are retracted separately.

The use of intrusion arches to achieve orthodontic correction assures the attainment of a predictable and reproducible force system. Loss of anchorage is seldom observed because of the tip back moment of posterior teeth. Another advantage of intrusion mechanics is the control of vertical dimension. Both the designs of intrusion arch wires used in the present study allow the clinician to deliver a well-controlled force system with minimal chair side adjustments.

REFERENCES

### TABLE 1

**GROUPING OF SAMPLE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Group designation</th>
<th>Subject numbers</th>
<th>Subject size</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUP A</td>
<td>Burstone Group</td>
<td>A-1 to A-15</td>
<td>15</td>
</tr>
<tr>
<td>GROUP B</td>
<td>Kalra Group</td>
<td>B-1 to B-15</td>
<td>15</td>
</tr>
</tbody>
</table>

### TABLE 2

**MEAN AGE DISTRIBUTION OF SAMPLE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean age of females in years</th>
<th>Mean age of males in years</th>
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</thead>
<tbody>
<tr>
<td>GROUP A</td>
<td>14.6</td>
<td>18.8</td>
</tr>
<tr>
<td>GROUP B</td>
<td>15.1</td>
<td>18.3</td>
</tr>
</tbody>
</table>

### TABLE 3

**MEAN CHAIR SIDE TIME TAKEN FOR FABRICATION AND LIGATION OF INTRUSION ARCH IN SUBJECTS OF GROUP A AND GROUP B**

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean (minutes)</th>
<th>Standard deviation</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25.08</td>
<td>±2.47</td>
<td>0.19 (&gt;0.05) NS</td>
</tr>
<tr>
<td>B</td>
<td>24.07</td>
<td>±3.22</td>
<td></td>
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</tbody>
</table>

### TABLE 4

**MEAN DIFFERENCE OF MEASUREMENTS OF START AND FINISH VERTICAL MOVEMENT OF CENTRAL INCISORS IN GROUP A & GROUP B**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Mean difference (in - mm)</th>
<th>S.D.</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical movement of central incisors in Group A</td>
<td>2.03</td>
<td>±0.2689</td>
<td>0.077 (&gt; 0.05) NS</td>
</tr>
<tr>
<td>Vertical movement of central incisors in Group B</td>
<td>1.90</td>
<td>±0.188</td>
<td></td>
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</table>

S.D. = Standard deviation
N.S. = Non-significant.
TABLE 5

MEAN DIFFERENCE OF MEASUREMENTS OF START AND FINISH VERTICAL MOVEMENT OF BUCCAL SEGMENT IN GROUP A & GROUP B

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Mean difference (in + mm)</th>
<th>S.D.</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical movement of buccal segment in Group A</td>
<td>0.19</td>
<td>±0.034</td>
<td>2.5 (&gt;0.05) NS</td>
</tr>
<tr>
<td>Vertical movement of buccal segment in Group B</td>
<td>0.28</td>
<td>±0.027</td>
<td></td>
</tr>
</tbody>
</table>

S.D. = Standard deviation
N.S. = Non-significant.

Fig. 1: Lateral intra oral view of Three Piece Intrusion Arch

Fig. 2: Lateral intra oral view of Kalra's Simultaneous Intrusion and Retraction Arch