COMPARATIVE EVALUATION OF INTRUSION AND ROOT RESORPTION USING BURSTONE AND CONNECTICUT INTRUSION ARCHES – AN IN VIVO STUDY

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Abstract:
Aim - Aim - to evaluate intrusion and root resorption using Burstone and Connecticut intrusion arches over a period of 16 weeks. After initial leveling and aligning 5 patients were taken for placement of Burstone and Connecticut intrusion arch each. Lateral cephalograms were taken before starting treatment and after intrusion. Central incisors were traced and center of resistance marked to evaluate amount of intrusion. To measure root resorption periapical radiographs were taken using radiovisioigraphy. All periapical radiographs were taken with an acrylic jig placed on the central incisor parallel to the root. After intrusion it was seen that there was a significant difference between both the groups during intrusion. And in the Connecticut intrusion arch group positive correlation was found between intrusion, axial inclination change and duration of treatment with root resorption.
INTRODUCTION

Deep overbite is a symptom that may be associated with incisor wear, palatal impingement and compromised esthetics. It is often expressed as the percentage of the lower incisor overlapped by the upper incisors. Every patient with deep overbite requires a comprehensive treatment plan which establishes how the deep overbite should be corrected. Deep overbite can be corrected by extrusion of posterior teeth, flaring of anterior teeth and intrusion of upper incisors.

Intrusion of upper incisors in deep bite is often indicated when there is a large vertical dimension, excessive incision-stomion distance, and a large interlabial gap, which can be achieved by step bends in arch wires and intrusion arches.

Intrusion refers to the apical movement of the geometric center of the root (Centroid) in respect to the occlusal plane or a plane based on the long axis of the tooth. This should be distinguished from pseudo - intrusion, which includes labial tipping of an incisor around its centroid. Although this pseudo - intrusion would help correct a deep bite in class 2 div 2 patients, it should not be confused with genuine intrusion which includes intrusion of incisors.

Numerous methods to facilitate intrusion of the upper incisors have been described. All these methods employ the same basic principles: tip back bends at the molars to provide an intrusive force at the incisors.

The key to successful intrusion is in the control of the force systems.

These principles are incorporated in the design of Burstone's intrusion arch, which is fabricated by a .017x.025 inch or .016x.022 inch titanium molybdenum alloy (TMA). The force deflection rate of the intrusion arch is very low, usually under 10g/mm. The distance of the intrusion arch is large between the auxiliary tube of the molar and the incisor brackets. This produces a large deflection, minimizing the need for any reactivation and provides greater constancy of force.

Similarly the Connecticut Intrusion Arch being the last generation of intrusion appliances has also proved to be effective for intrusion. However it is made of super elastic Nitinol and being prefabricated, reduces chair time which is an advantage for both the patient and the clinician.

It was believed for many years that it was impossible to intrude teeth and that if intrusion was attempted, undesirable sequelae such as devitalization would occur. Apical root resorption is a commonly observed side effect of orthodontic tooth movement. Due to the potential for these high stress levels, intrusion is a technique that logically could increase the risk of apical root resorption.

AIM

1. To compare the amount of intrusion achieved using the Burstone's intrusion arch and The Connecticut Intrusion Arch, over a period of approximately 16 weeks.

2. To compare the amount of root resorption during intrusion between the Burstone intrusion arch and The Connecticut Intrusion Arch, over a period of approximately 16 weeks using RVG.

MATERIALS AND METHODS

Subjects: 10 patients undergoing orthodontic treatment in the post graduate department of orthodontics, Sri Ramachandra dental college were chosen for this study. Inclusion criteria involved 1) patients requiring intrusion of 2.0-4.0 mm of upper incisors.2) no history of major trauma to maxillary central incisor 2) complete incisor root formation 3) no history of major root resorption before orthodontic treatment 4) no previous orthodontic treatment.5) All patients had initial leveling and aligning completed with 2-3 mm of canines retracted on both sides. Age of the patients were between 14-18 years.

Pre- intrusion records: Lateral cephalograms were taken for the purpose of measuring changes in position of central incisors. The central incisor in the original head film was traced along the longitudinal axis. The center of resistance (CR), estimated as the midpoint of the root was marked on the central incisor.

Upper arch impressions were taken and poured in dental stone. A jig on the left central incisor was fabricated before intrusion (fig 1). To measure root resorption, periapical radiographs were taken using radiovisiography.

All periapicals were taken with a jig that was temporarily ligated to one of the central incisors. This device consisted of a small acrylic block custom made to conform to the incisal edge and the lingual surface of the tooth. The acrylic supported a section of 0.30-gauge stainless steel wire, approximately 17 mm long, in front of the labial surface of the tooth and parallel to the long axis. Lateral cephalogram was taken with the jig in place parallel with the root (fig 2). If it was not parallel the wire was adjusted. A standard periapical radiograph was then taken that resulted in a shadow of the wire superimposed on the image of the tooth.

By comparing the true length of wire with its dimension on the film, an exact magnification could be calculated
for that exposure (fig 3). Since the wire is registered to the crown through the acrylic block in a parallel orientation to the root, the magnification factor is valid for the tooth as well as the wire. This is because the parallel structures are foreshortened or elongated in the same proportion. The overall length of the tooth on the film was measured along its long axis from apex to midpoint of the incisal edge (fig 4). This radiographic measurement was then converted to actual length with magnification factor calculated. All measurements were made with digital calipers. Root resorption in a single central incisor for each patient was examined.

**Intrusion mechanics:** All patients had .022 Roth prescription pre adjusted edgewise appliance with triple buccal tube placed.

The right and left posterior segments were joined by a removable palatal bar for anchorage. After initial alignment and canine retraction to create 2-3 mm of space between lateral incisor and canine with H o f Fische rs .017X.025 inch stainless steel was placed to consolidate the teeth from molars to canines.

The patients were then divided into two experimental groups. In the first experimental group, the Burstone intrusion arch was placed (fig 5). The appliance consisted of 0.017" x 0.025" TMA. Intrusion arch was placed from the maxillary auxiliary buccal tube of right first molar to maxillary left first molar. The intrusion arch was activated by 30 degrees mesial to first molar. Force levels were adjusted to 60 gm using a force gauge.

In the second experimental group the appliance used was the Connecticut Intrusion Arch (fig 6), the wire size used was .017" x .025" nickel titanium with anterior dimension of 34mm. The bypass is located distal to the lateral incisors. The active intrusion arches were tied to an anterior segmental wire and cinched at the molar.

**Post-intrusion phase:** After the intrusion phase lateral cephalograms were again taken. Periapical radiographs using radiovisiography were taken with the same jig for each patient. The central incisor on the lateral cephalograms was traced along its longitudinal axis. The center of resistance (CR), estimated as the midpoint of the root was marked on pretreatment and post treatment cephalograms.

Both the pre intrusion and post intrusion lateral cephalograms were traced and superimpositions were made with the palatal and key ridges (fig 7), (fig 8). The following characteristics of the movement of the central incisor were measured with the palatal plane as a horizontal reference: intrusion, vertical change of the incisal edge, change in proclination, anteroposterior change of incisal edge, and the linear movement of the apex. After determining actual tooth length at post intrusion phase the change in length was calculated for evaluating root resorption. All measurements were made with digital calipers.

**Statistical analysis:** A t test was performed to compare the mean amount of resorption in both the experimental groups. And coefficient of correlation was calculated for the relationship between resorption and changes in tooth position.

**RESULTS**

Duration of treatment for the Burstone intrusion arch group was 4.1 months and for Connecticut intrusion arch group was 4.3 months. The average amount of intrusion measured at the center of resistance, for Burstone intrusion arch group was 0.9 mm, with the mean rate of intrusion measured at 0.20 mm/month. And for the Connecticut intrusion arch group it was 3.5 mm with the mean rate of intrusion measured as 0.20 mm/month respectively. There was statistically significant difference among both the groups in intrusion.

While trying to correlate root resorption with various other parameters like alteration in vertical change in incisal edge, axial inclination change, intrusion, anteroposterior change of incisal edge, movement of apex and duration of treatment, it was found that there was no significant correlation in the Burstone intrusion arch group.

However in the Connecticut intrusion arch group positive correlation was found between intrusion, axial inclination change and duration of treatment with root resorption.

**DISCUSSION**

Of all the several types of orthodontic tooth movements, intrusion and tipping are the most likely to cause noticeable apical root resorption. In the 1950s Burstone developed an approach to orthodontic treatment which did not use continuous arches. The technique came to be known as segmented arch, which used different cross sections of wire within the same arch and the wires did not run continuously from one bracket to the adjacent bracket. Segmented arch allows genuine intrusive movement of anterior teeth.

Intrusion refers to the apical movement of the geometric center of the root (centroid) in respect to the occlusal plane or a plane based on the long axis of the tooth. An important issue is that roots are prone to resorption when they are pushed out of the alveolar bone through and towards the less resilient cortical bone during intrusion.
Orthodontically induced inflammatory root resorption (OIIRR) has been a major concern in the orthodontic field since 1914, when Otolengui related root resorption directly to orthodontic treatment. 11 Albert Ketcham demonstrated, with radiographic evidence, the difference between root shape before and after orthodontic treatment. 12

Root resorption during intrusion is surface resorption, or transient inflammatory resorption. Replacement resorption is rarely seen after orthodontic treatment. 13

Literature has shown that incisors are most likely to show external apical root resorption as well as most advanced modal degree of resorption. This has been attributed to the shape of the roots, to biochemical pathways that they might possess, and to the fact that these teeth are moved the farthest. 10

Therefore the following biomechanical factors are important for effective intrusive mechanics:

1. Magnitude of force: It is important to use the lowest magnitude of force that is capable of intruding incisors. The recommended force for four incisors for intrusion using the Burstone and Connecticut intrusion arch is 40 - 60 gm. 7

2. Force constancy/load deflection rate: Compared to continuous wire activations, segmented springs exert forces in a wider range. A more continuous, low force allows increased time intervals between adjustments and may be gentler on responding tissues. 2

3. Anterior single point contacts: The intrusive arch is not placed directly into the brackets of anterior teeth. The major reason why one avoids bracket engagement of intrusive spring is that anterior torque may be present in the arch, this can lead to posterior anchorage loss. The advantage of not tying an intrusive arch directly into the incisor brackets is that it allows the clinician to know more positively the force system delivered. A system of this type is described as being statically determinant. 2

4. Point of force application: It is important to tie the intrusive arch back to prevent the incisors from protruding. An intrusive force placed through the center of resistance of the incisors will intrude the center of resistance and not produce any labial or lingual rotation of the teeth. In cases where the incisors are severely flared, the large distance between the line of force and the center of resistance causes a much larger moment on incisors, causing further undesirable flaring. In severely upright incisors, the intrusive force passes lingual to the center of resistance, producing a small moment with a crown-lingual/root-labial direction. Rather than flaring the incisors, the force would tend to increase their uprightness. 2, 15

5. This study was done to evaluate and compare the amount of intrusion using the Burstone and Connecticut Intrusion Arches.

Besides this, the amount of root resorption and changes in tooth position were also compared. In order to evaluate the amount of intrusion and changes in tooth position, lateral cephalograms were taken. To evaluate the amount of root resorption, periapical views using the radiovisiography unit were taken.

Radiovisiography (RVG) was first introduced in 1987, which included a charge-coupled device (CCD) sensor and processing unit, with the digital image displayed on a television monitor. 15 The displayed image may be altered using control gauges to improve identification of details through enhancement, negative-to-positive conversion, and a magnification or zoom feature. An intraoral radiation detector is used in place of radiographic films. This results in reduction in the radiation dose of 80% compared with conventional radiography. 16 The distance measurement function in RVG makes it possible to quantify small alterations in root length. 17 To account for the magnification factor, all pre and post radiographs were taken with a jig contoured to the left central incisor.

The results of this study indicated intrusion of 0.9 mm in group 1 (Burstone intrusion arch) with mean rate of intrusion of 0.21 mm/month and 3.5 mm in group 2 (Connecticut Intrusion Arch) with mean rate of intrusion of 0.81 mm/month. There was a statistically significant difference between both the groups. About 1 mm of intrusion is expected every 6 weeks in Connecticut Intrusion Arch as it is fabricated from nickel-titanium alloy to provide the advantages of shape memory, spring back, light and constant force distribution. 4

In this study patients in group 1 required reactivations and force levels rechecked to maintain 60 gm in every appointment, which was not required in group 2.

This study also evaluated root resorption with intrusion. There was 0.62 mm of root resorption in group 1 and 1.9 mm in group 2, which was statistically significant. The correlation between intrusion and root resorption was statistically significant in the group 2. This is in contrast to the study by McFadden et al who found that root shortening was unrelated to intrusion, however he stated that in patients with high resorptive potential root shortening was related to intrusion achieved. 18
Fig. 1: Jig temporarily ligated to central incisor

Fig. 2: Lateral cephalogram taken with the jig in place to evaluate parallel with the root

Fig. 3: Periapical view that resulted in a shadow of wire superimposed on the image of the tooth

Fig. 4: Overall length of tooth measured

Fig. 5: Burstone intrusion arch

Fig. 6: Connecticut intrusion arch

Fig. 7: Connecticut intrusion arch

Fig. 8: Burstone intrusion arch
An independent two-tailed t test was done to compare the changes in tooth position between two groups.

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*P<0.05, **P<.01, ***P<.001

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*P<0.05

Pearson's Coefficient of Correlation test(r) for Burstone Intrusion Arch group.

GR1 Correlations

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**Correlation is significant at the 0.01 level (2-tailed).
Pearson’s Coefficient of Correlation test(r) for Connecticut Intrusion Arch group.

**GR2 Correlations**

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**Correlation is significant at the 0.05 level (2-tailed).**

Dermaut and DeMunck did not establish any significant correlation between intrusion and root resorption. They attributed this to the small sample size which could be the reason for the lack of correlation in group 1 in our study.

However, the results of the study by Parker and Harris showed that the strongest predictors of external apical root resorption (EARR) were vertical incisal and apical movements.

Amount of root resorption in this study was less when compared to studies by DeShields, Dermaut and DeMunck and Parker and Harris. This could be due to short duration of our study as certain studies have established a positive correlation between root resorption and duration of treatment. The amount of intrusion and root resorption in this study is similar to the study by Costopoulos and Nanda in which the duration of intrusion was also for four months.

Studies by DeShields, Mirabella and Artun and Parker and Harris have shown a correlation between change in axial inclination of incisors and root resorption which was also evident in our study with respect to group 2. The incisors uprighted in our study. This was in contrast to the study by Amasyali et al who compared intrusion with the utility and Connecticut intrusion arches, where significant intrusion was achieved in both the groups with flaring of upper incisors. We could presume that the tight cinch back done specifically played a role in preventing flaring incisors in our study.

This study shows that the Connecticut Intrusion Arch was more efficient in bringing about intrusion in a short period of four months. However, this was associated with greater amounts of root resorption in spite of the light forces that are exerted by the nickel titanium wire.

Root resorption is directly related to the distance moved by the root towards the apex. It has also been reported that the greater the distance the apex has to travel through bone, the longer the time it is in close proximity to inflammatory processes including osteoclastic activity. The result of this study reinforce this concept.

The study focused on evaluating root resorption only as a function of intrusion, since all pre evaluation records were taken after the initial leveling and aligning phase. Connecticut Intrusion Arch showed more intrusion than Burstone intrusion arch with corresponding greater increase in root resorption. However, more critical evaluation of these force systems in larger sample size, over a longer period of time would be required to validate these observations.
SUMMARY AND CONCLUSION

The main aim of this study was to compare the amount of intrusion and root resorption achieved using the Burstone and Connecticut Intrusion Arches over a period of approximately 16 weeks. The result of this study showed

1. More intrusion in the Connecticut Intrusion Arch group (3.5 mm) as compared to Burstone intrusion arch group (0.9 mm) which was statistically significant.

2. And more root resorption in Connecticut Intrusion Arch group (1.9 mm) as compared to Burstone intrusion arch group (0.62 mm) which was also statistically significant. The Burstone’s intrusion arch required more activations and forces were rechecked in every appointment, whereas the Connecticut Intrusion Arch remained active at a constant level for a longer period of time, allowing long intervals between appointments and eliminating the need for adjustments.

BIBLIOGRAPHY


