A REVIEW OF BIOMECHANICAL IMPLICATIONS OF ANTERIOR INTRUSION ARCHES IN ORTHODONTICS

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Abstract

Orthodontic intrusion is a popular method of treating gummy smiles and deep bites, among other orthodontic aesthetic and functional issues. Described in the article are the biomechanics of intrusion in orthodontic treatment and many approaches to successfully move teeth during intrusion without harming the tooth. Along with the sorts of intrusion, it also lists their benefits and drawbacks. The article discusses and evaluates the use of various fixed appliances and how they might be modified to achieve intrusion mechanics.

I. Introduction:

While some authors believe it is possible to achieve intrusion, others claim it is impossible to achieve true intrusion. For the orthodontist, intrusion has always been a challenge. (1)

Charles J.Burstone defined intrusion as " The Apical development of the geometric focal point of the root (centroid) in appreciation to the occlusal plane or plane dependent on the long pivot of the tooth"(2)

Intrusion, as defined by Marcotte, is the "tooth movement that occurs in an axial (apical) direction and whose centre of rotation lies at infinity. It is an axial type of translation"(3)

Kinds of Intrusion Arches
1. Relative Intrusion (Leveling by expulsion)
2. Absolute Intrusion

II. BIOMECHANICS OF INTRUSION:

When an intrusive force is directed through the anterior teeth's centre of resistance, true intrusion results. Unfortunately, this is challenging to do because the labiolingual inclination of the upper incisors affects the spatial relationship between the centre of resistance (CR) and the point of force application (P.F.A). Normally, intrusive force is used on the incisors' labial surface.(4)
This causes a moment that often causes the crowns to flare and the roots to migrate lingually. In situations where the incisors are clearly proclined, an intrusive force creates a large moment. Before beginning intrusive mechanics in these situations, the incisors should be retracted in order to shift their axial inclination. Thus, light continuous force aimed at the root apex of incisors is essential for a successful intrusion.(4,5)

Common consideration during anterior intrusion

1. Force levels: The apex of the loading diagram for intrusive force is where it is most concentrated. Because of this, very little forces are required to provide the ideal pressure the during intrusion in the periodontal ligament.
   Burstone recommended 25 gm for each upper incisor and 50 gm for each cuspid as optimum force. Forces needed in lower are nearly half of these. Nanda recommended slightly lower force values: 12-15 gm for upper central incisors, 8- 10 gm for upper lateral as well as lower centrals whereas 25gm forces for all the cuspids(5)
2. Anchorage considerations: There is always some amount of extrusive force on the posteriors while applying intrusive forces on the anterior. This is considered “loss of vertical anchorage”. Such extrusion can be prevented with the help of:
   a. Headgear
   b. Low-lying TPA (tongue pressing on it would counter the forces of extrusion)
   c. Posterior acrylic bite blocks
   d. Micro-implants

3. Line of force application: the C. Res being palatal to the line of force application there is a tendency to cause crown labial and root lingual rotation or flaring of the incisors. This would be beneficial if the incisors are retroclined but not if normally inclined or proclined.

Methods to control flaring:

a. Bending the arch wire ends to resist flaring.
b. Using class I force from molars to anteriors.
c. Using Class II force to control flaring (posterior extrusive component present)
d. Connecting the anterior teeth with a rigid sectional wire so the C. Res shift distally to the location depending on the number of teeth in the segment. Then tying the intrusion arch to the rigid sectional wire directs the force close to the C. Res.
e. Reciprocal extrusive force in the posterior acts buccal to the C. Res leading to rolling in of the molar. A TPA would be very effective in preventing the rolling.

Bypass Arches:

They engage molars on one end and act on incisors at the other end, without engaging the teeth in between. Steps are made in order to bypass cuspids and premolars.They provide satisfactory true intrusion as compared to continuous arch intrusion.
E.g., Utility Arch, Burstone’s intrusion arch.

III. DESIGNS OF INTRUSION ARCHES

Types of designs for an intrusion arch:
1. Continuous arch
2. Segmental intrusion arch

The Intrusion arches are reviewed in this discussion are as follows:

INTRUSION UTILITY ARCH(Fig 1) :

Robert M. Ricketts created the utility arch in the early 1950s, and it has become a staple of bioprogressive therapy.
Whether loops are present or not, utility arches all share a similar design.which include,

1. Molar segments
2. Posterior vertical segment
3. Vestibular segment
4. Anterior vertical segment

5. Incisal segment.

Utility arches are made from chrome-cobalt wires, as suggested by Ricketts. In contrast to stainless steel wire, chrome-cobalt wire is simple to work with and makes for easy loop formation.

The recommended wire for the mandibular utility arch, in terms of choosing the right size for a 0.018" slot appliance, is either 0.016" x 0.022" or 0.016" x 0.016" wire.

With a 0.022" slot, 0.019" x 0.019" wire can be used in either arch, although 0.016" x 0.022" wire is advised for maxillary arches. To manage torque and avoid unintentional incisor tipping, rectangular wire generally outperforms round wire. The four different types of utility arches are passive, intrusion, retraction, and protraction.

The posterior vertical segments of the Intrusion Utility Arch do not touch the first molar bracket's auxillary tube. The arch is activated to intrude the anterior teeth. The optimal force level for mandibular incisor intrusion is 60–100 grammes of force produced by the utility arch on the mandibular incisors.(6)

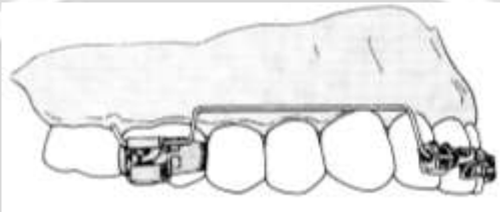

Fig 1. Intrusion Utility Arch

CONNECTICUT INTRUSION ARCH(Fig 2):

Nickel-Titanium alloys are used to create Ravindra Nanda's Connecticut Intrusion Arch (C.I.A.), as they are the ideal material for providing continuous forces with significant activation. Both utility arch's and traditional intrusion arch's qualities are incorporated into C.I.A. It is important to work C.I.A. on preformed wires with the proper bends for simple insertion and use. There are two wire sizes offered. The anterior dimensions of the 0.016" x 0.022" and 0.017" x 0.025" maxillary and mandibular versions are 34 mm and 28 mm, respectively. The bypass, which is distal to the lateral incisors, comes in two lengths to allow mixed dentition, non-extraction, and extraction.

The fundamental force delivery system used by C.I.A. is a V-bend that can exert between 40 and 60g of force. The V-bend is placed such that it is immediately in front of the molar brackets.
A basic force system is created when the arch is activated, consisting of a vertical force in the anterior region and a moment in the posterior region. To mitigate the impact on the molars, headgear may be used.(4,6)

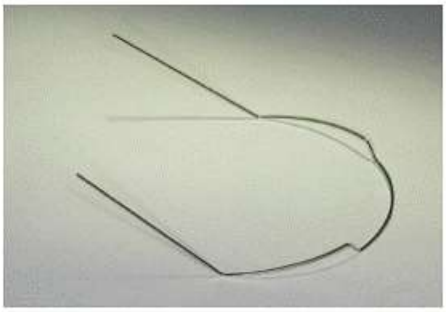

Fig 2. CONNECTICUT INTRUSION ARCH

BURSTONE INTRUSION ARCH(Fig. 3):

Burstone created the segmented arch technique in the 1950s, which used wires with various cross sections within the same arch and wires that did not run continuously from one bracket to the next. Burstone came to the conclusion that the continuous arch therapy's inability to create true intrusion is one of its drawbacks. The posterior anchorage unit, anterior section, and intrusive arch spring make up the fundamental components of the Burstone intrusion arch. After initial alignment, stainless steel wires that are either 0.018" x 0.025" or 0.021" x 0.25" (depending on whether it is a 0.018 or 0.022 slot) can be put to strengthen the stability of the posterior segment.

Right and left buccal segments are connected across the arch by a transpalatal arch in the maxilla and a low lingual arch in the mandible once alignment in the posterior segment is accomplished. The intrusive spring is not connected to the incisor bracket directly. The central incisor or four incisors are used as the anterior alignment arch or anterior segment, and the intrusive arch is secured to the wire either labially, incisally, or gingivally.(2)

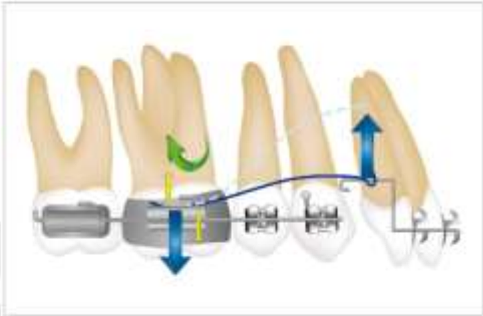

Fig. 3- BURSTONE INTRUSION ARCH

TIP BACK SPRINGS (INTRUSION SPRINGS)(Fig. 4)

Burstone suggested using 0.017" x 0.025" T.M.A wire springs.The upper and lower arches must be levelled and in alignment, and a firm stainless steel wire with a preferred diameter of 0.017 x 0.025 inches must be used. With a T.P.A. in the upper arch and a lingual holding arch in the lower arch, anchor molars should be strengthened. For the most effective force for intrusion, the intrusion springs are manufactured using 0.017" x 0.025" TMA wire without a helix or 0.017" x 0.025" stainless steel wire with a helix.

The wire is bent gingivally mesial to the molar tube to create a helix. The lateral incisor, which according to Burstone is about the centre of resistance of the four incisors, is engaged distally by the mesial end of the spring, which has been bent into a hook. The hook must be pulled down and engaged with the arch wire in order to activate the spring, which has a mesial end that is passively located at the height of the vestibular fold. (4)

Fig. 4-TIP BACK SPRINGS

5. THREE PIECE INTRUSION ARCH(Fig. 5):

The Three piece Intrusion arch consist of the following parts:
1. Posterior Anchorage unit
2. The anterior segment with posterior extension
3. Intrusion Cantilevers

The posterior anchorage unit: After the premolars and molars are properly aligned, the posterior anchorage unit is stabilised by inserting passive segmented wire (0.017 x 0.025" stainless steel) in the right and left posterior teeth. The posterior unit, which now consists of the right and left posterior units, is consolidated by a precision stainless steel trans-palatal arch (0.032 x 0.032 inch) passively positioned between the first maxillary molars. By pulling back just one, canines can be included into the buccal region.

The anterior segment: It bends gingivally distal to the laterals and then bends horizontally, resulting in a 3mm step. The distal portion creates a hook posterior to the canine bracket's distal end. To avoid negative consequences brought on by wire bending during force application, the anterior portion should be manufactured of (0.018 x0.025) or greater.(4,7)

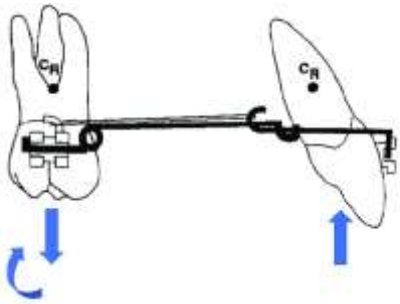

Fig. 5- THREE PIECE INTRUSION ARCH

INTRUSION CANTILEVER:

A helix is formed when 0.017 x 0.025 inch T.M.A. is bent gingivally, mesial to the molar tube, for the intrusion cantilever wire. The mesial cantilever's end has been bent into a hook. When the anterior end with the hook lies passively in the vestibule, the cantilever then activates by producing a bend mesial to the helix at the molar tube. This is subsequently brought down to interact with the anterior segment's horizontal section, causing the resulting forces to flow through the anterior teeth's centre of resistance. The hook can be connected to an elastic chain for simultaneous intrusion and retraction. However, it is always required to balance the effective force of intrusion to ensure real intrusion of anterior teeth.

6. KALRA SIMULTANEOUS INTRUSION RETRACTION (Fig. 6) :

The Nanda and Burstone segmented loop mechanisms have been modified to create the K-SIR archwire. It is a continuous TMA archwire measuring 0.019" x 0.025" with a closed U-loop measuring 7mm x 2mm at the extraction location. A 90° V bend is inserted into the arch wire at the level of the U-loop to facilitate movement and prevent teeth from tipping into the extraction space. This V-bend creates two equal and opposite moments to counter the moments brought on by the activation force of the closing loop when it is centred between the canine and the first molar during space closure.

An increased posterior clockwise moment on the first molar caused by an off-center 60° V-bend that is posterior to the inter-bracket distance enhances molar anchorage and prevents anterior teeth from erupting. A 20° anti-rotation bend is added to the arch wire just distal to each U loop to stop the buccal segment from rolling mesio-lingually as a result of the force generated by loop activation.

To relieve the stress from bending the arch wire, a trial activation of the wire is done outside the mouth. Following trial activation, each loop's neutral state is established with its legs stretched horizontally.

The U-loop is approximately 3.5mm broad in the neutral position, and the arch wire is placed into the auxiliary tube of the first molar and fastened to the six anterior brackets. It is engaged by the loop's mesial and distal legs, which are spaced about 3 mm apart. Second premolars are skipped in order to enhance the inter-bracket space between the ends of the attachment, which improves the effectiveness of the off-centered V bend. The tipping moments produced by the retraction force will be greater when the loops are first activated than the opposing moments produced by the V bend in the arch wire. The teeth will initially be carefully tipped into the extraction space as a result. The moment to force ratio will increase when the loops deactivate and the force drops, first causing bodily and then root movement . Therefore, until all the spaces have closed, the arch wire should only be activated every 6 to 8 weeks. An extrusive force on the molars will be produced by the anti-centered V-bend, which is typically unfavourable.

Keeping the reactive force to a minimum while applying the ideal amount of force on the teeth that need to be moved is one of the keys to preventing unfavourable side effects of an appliance.

The anterior part of the mouth is subjected to approximately 125g of intrusive force from the KSIR, and the two buccal segments—typically the first permanent molar and the second premolar, which are connected by segments of TMA wire—are subjected to an equal amount of extrusive force. By adding teeth to the anchoring unit and banding the second molar, you can increase anchorage in the antero-posterior direction while reducing reactive extrusive force on the buccal segment. The primary indication for K-SIR is for anterior tooth retraction in a patient undergoing first premolar extraction who has a deep overbite and an excessive overjet and who needs intrusion of anterior teeth and maximum molar anchorage because the intrusion of the six anterior teeth occurs concurrently with their retraction.K-SIR shortens the treatment time compared to conventional mechanics.(8,9)

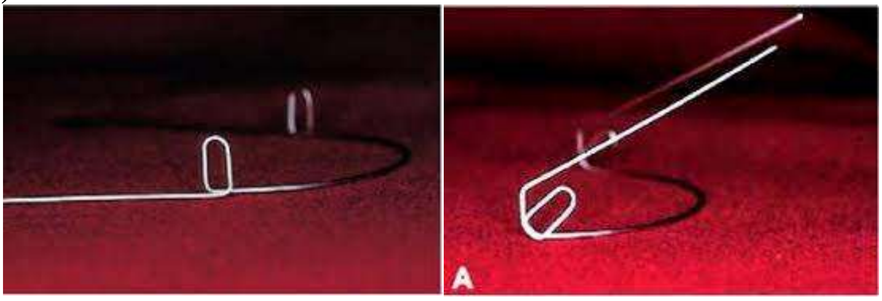

Fig 6 - KALRA SIMULTANEOUS INTRUSION RETRACTION

IV. Conclusion:

In order to produce successful orthodontic treatment outcomes that are more predictable and consistent, it is necessary to understand the fundamental biomechanical concepts involved in achieving regulated tooth movement. The variable elements can cause the device to deliver intraoral force of changing magnitude. These variables include various arch wire designs and various alloys of various dimensions. The tools and methods that practitioners utilise vary from person to person.
The fundamental forces and moments they produce, however, universal.

V. **References**:

1. Proffit WR, Fields HW, Larson B, Sarver DM. Contemporary Orthodontics - E-Book. Elsevier Health Sciences; 2018. 744 p.

2. Burstone CR. Deep overbite correction by intrusion. Am J Orthod. 1977 Jul;72(1):1–22.

3. Marcotte MR. Biomechanics in Orthodontics. Wiley-Blackwell; 1990. 200 p.

4. Nanda R. Biomechanics and Esthetic Strategies in Clinical Orthodontics. Saunders; 2005. 408 p.

5. van Steenbergen E, Burstone CJ, Prahl-Andersen B, Aartman IHA. The influence of force magnitude on intrusion of the maxillary segment. Angle Orthod. 2005 Sep;75(5):723–9.

6. McNamara JA, Brudon WL, Kokich VG. Orthodontics and Dentofacial Orthopedics. 2001. 576 p.

7. Shroff B, Yoon WM, Lindauer SJ, Burstone CJ. Simultaneous intrusion and retraction using a three-piece base arch. Angle Orthod. 1997;67(6):455–61; discussion 462.

8. Kharbanda. Orthodontics: Diagnosis and Management of Malocclusion and Dentofacial Deformities. Elsevier India; 2009. 428 p.

9. Kalra V. Simultaneous intrusion and retraction of the anterior teeth. J Clin Orthod. 1998 Sep;32(9):535–40.