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Review Article

Orthodontic treatment modalities of intrusion: a review

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ABSTRACT

Orthodontic intrusion is a common treatment approach in managing orthodontic esthetic and functional problems. Intrusion often constitutes an integral part of orthodontic treatment in order to improve sagittal and vertical incisor relationships. In this article we are trying to review all the appliances in a manner of their evolution, beginning from removal appliances used initially, discussing role of functional appliances, head gears, intrusion arches, implants, magnets and surgical procedures etc. in treatment of intrusion.

Keywords: Intrusion, Esthetic, Intrusion arches, Implants

INTRODUCTION

Orthodontic intrusion is a common treatment approach in managing orthodontic esthetic and functional problems, including gummy smile and deep bite.[1] It has been proposed that curvature of the incisal edges of the upper anterior teeth and curvature of the upper border of the lower lip should be in harmony and this curvature is called as smile arc.[1,2]

Most orthodontist often come across cases with excessive incisor exposure and increased overbite in their clinical practice. These patients require a comprehensive treatment plan, which establishes how the incisor exposure should be reduced and deep overbite corrected, depending on the cause.[3-5]

Intrusion often constitutes an integral part of orthodontic treatment in order to improve sagittal and vertical incisor relationships, to correct interincisal angle and, consequently, gingival line and restore esthetics of smiling.[6-8]

Numerous methods have been described for incisor intrusion. In this article we are trying to review all the appliances in a manner of their evolution, beginning from removal appliances used initially, discussing role of functional appliances, head gears, intrusion arches, implants, magnets and surgical procedures etc. in treatment of intrusion.

TREATMENT MODALITIES

Intrusion with removable appliances

Sved bite plane

Sved modified the bite plate to attempt to obtain some depression of the maxillary anterior teeth as well as the mandibular anterior teeth. He has covered acrylic on the entire palatal and incisal surfaces and extended up one third of the labial surfaces of the anterior teeth. This makes the appliance tooth-borne rather than mostly tissue-borne. The acrylic covering on the palate may be flat or inclined. In Sved's appliance the more rigid acrylic provides increased resistance to labial movement of teeth.

The force applied to maxillary anterior teeth is more in an apical direction and less in a labial one. Sved's bite plane can also be used in conjunction with a lower one.[9,10]

Intrusion with acrylic bite plate and elastics

The appliance consists of an acrylic biteplate held firmly in place with clasps. Occlusal contact with the acrylic must be constant and well distributed to counteract any extrusive reaction produced by occlusion with the clasps. Two hooks, one buccal and one lingual, are embedded in the acrylic adjacent to the extruded molar. A 3/16", 5oz elastic is stretched between the hooks and across the molar. The appliance should be worn full-time, except for meals and oral hygiene, and the elastic should be changed daily. The intrusive force applied against the molar is directed vertically, close to the center of resistance of the tooth. Therefore, the movement is generally axial, with no lingual or buccal tipping.[10]

A lingual arch for intruding and up righting lower incisors

A simple lingual arch with elastomeric chain attached to lingual buttons on the incisors overcomes the problems of both sectional and full arches by creating equal downward force vectors that pass behind the centers of resistance of all four incisors. Appliance design A 0.036" lower lingual arch is soldered to first molar bands. Distal extension forms occlusal rest on the second molars to prevent distal tipping of the first molars as the incisors are intruded.[10]

INTRUSION WITH FUNCTIONAL APPLIANCE

Activator

The activator was originally used by Andresen in 1908.[9,10] It consists of a large acrylic splint with a large lingual flange to maintain the mandible downward and forward. The original appliance was retained loosely by means of a maxillary labial bow. The loose retention was intended because it was thought that the patient continually would be functioning or using, muscle activity to actively hold the appliance in position, accentuating the treatment effects.

Another type of activator resulted from modifications by Egil Harvold of Denmark and Donald Woodside of Canada, including an increased mandibular opening for improved retention and increased soft tissue stretch. In addition, posterior facets were replaced with interocclusal acrylic to prevent eruption of the maxillary posterior teeth and to leave space for mandibular posterior teeth as well as acrylic capping over the mandibular incisor edges. In deep overbite cases caused by supraocclusion of the incisors, the interocclusal space is usually small.

The activator should not be constructed with a high construction bite in these cases. Intrusion of incisors is possible to only a limited extent when an activator is being used. Any correction is attained by loading the incisal edges with acrylic cover. Depression is relative, rather than absolute, since the other teeth are free to erupt and to accomplish the predetermined growth pattern. In such cases a successful result requires a significant increment of growth in the vertical direction.

Intrusion with headgears

Headgears are routinely used as a part of orthopedic phase of treatment The centre of resistance of the unit or units to be moved is the basic point of consideration for the arrangement of a force system. Applying a simple force through the centre of resistance will lead to a pure vector. Here no rotation will occur. If a force vector runs eccentrically to the centre of resistance, a combination of translatory and rotational movement will occur. The estimated position of centre of resistance of the dentition (i.e. when all teeth in front of first molar were included) is located between the apices of the premolars. According to observed clinical reactions, the centre of resistance of the maxilla is in the area of posterior aspect of zygomaticomaxillary suture. Initially the arches are well aligned and preferably, a stainless-steel wire should be placed in the upper arch so that when the headgear is applied to the maxillary arch, maxilla behaves as a single unit.[4,5]

Depending on the part from which anchorage is obtained, headgear can be classified as:[5,6] High pull headgear (anchorage obtained from the upper part of the head), combi pull headgear (line of traction is between high pull and straight pull) and cervical pull headgear (anchorage is obtained from the nape of the neck).

Another variable in the headgear is the outer bow of the face bow. The outer bow can be long, medium or short. The line of traction or direction can be changed by varying the length of outer bow or by varying the angulation of the outer and inner bow.

High pull headgear

In high pull headgear the effect on the dentition depends on the location of the centre of resistance relative to the line of action of force: When the direction of pull is placed behind the centre of resistance of the maxilla and the maxillary dentition, a clockwise rotation of maxilla and dentition is observed. The molars will show intrusion and the incisors will extrude. The net effect is clockwise rotation of the occlusal plane. When the pull is in the front of the centre of resistance of both maxilla and the maxillary dentition, an anti-clockwise rotation is observed. Molars tend to extrude and the incisors tend to intrude. The occlusal plane also rotates anti-clockwise. Thus, bite opening is facilitated. When the forces are passing through the centre of maxilla and the maxillary dentition, it does not produce any vertical or rotational effect. This is therefore ideal set-up for vertical control.

Cervical pull headgear

In cervical pull headgear when the inner and outer bows are in the same plane, there is clockwise rotation of both maxilla and the maxillary dentition. The incisor region will move inferiorly to a greater extent than the molar region. The occlusal plane will also rotate in the clockwise direction. The bite will actually deepen. If the outer is bent upwards so that the direction of traction is between the centre of the maxilla and the dentition, the maxilla will rotate in a clockwise direction. Hence the molars will experience a more downward influence than the incisors and the upper occlusal plane will rotate in an anti-clockwise direction and thus bite opening is facilitated.

Combi pull headgear

This type of headgear allows a distal force to pass straight through the centre of resistance of the dentition. In order to achieve this, the outer bow of the headgear is angled upwards about 15 degrees. This allows for more distalization of maxilla with minimal rotational effects.

'J-hook' occipital pull headgear

'J' hook headgear is two separate curved larger gauge wires that are formed on their ends into smaller hooks. Both of which attach directly to the anterior part of maxillary arch wire. This type of headgear is more commonly used for retraction of canines or incisors rather than orthopedic procedures. The J-hook headgear is limited to use only with maxillary fixed appliance with a continuous arch wire. It is preferable if all the maxillary teeth are incorporated in the fixed appliance, but a minimum requirement is inclusion of maxillary first molars and incisors. The intraoral point of attachment is directly to the maxillary arch wire, which usually is attached to all of the maxillary teeth.

Occipital pull with intraoral attachment between the canine and lateral incisor is used, for deep bite cases. With this point of attachment well above the occlusal plane, the extraoral force is directed superiorly and posteriorly. When this J-hook headgear with occipital pull is used, the force vector is further forward so that it tends to have an intrusive force to the maxillary incisors and may have an indirect extrusive force to the maxillary molars as a result of upward tipping of occlusal plane anteriorly. If the headgear is worn more than 16 hours/ day at force level below 400 gm, less skeletal effect and more tooth movement will occur.

CORRECTION OF DEEP BITE WITH COMBINED ACTIVATOR HEADGEAR ORTHOPEDICS

In Stackli and Teuscher started to combine activator treatment with a cervical headgear attached to upper molars. They attached the face bow directly to the activator and applied occipital traction to achieve better vertical and rotational control during orthopedic class II treatment.

RICKETTS UTILITY ARCH

Late in the 1950's Robert Ricketts and others attempted to counteract the tipping that occurred in the buccal segments in extraction cases by utilizing the supposedly immutable lower incisors as an anchor unit to hold the lower second bicuspids and molars upright in the retraction process.[11] Round arch segments were laced from the lower molars and bicuspids to the lower incisors as the cuspids were retracted. It was noted that not only were the buccal segments maintained in an upright position, but that the lower incisors intruded with this light, continuous pressure. Later, there was a development of what is now classically described as the step-down base arch or Rickett's lower utility arch. Although the utility arch itself has not changed drastically in design from its early conception, understanding of its actions and reactions in the face of mechanics employed and growth response has been greatly enhanced.

Force used for intrusion with Ricketts utility arch

Utility arch mechanics used in the intrusion of lower incisors have shown clinically that the four lower incisors can be intruded very efficiently with forces of 15 to 20 gram per lower incisor or 60 to 80 gm for all four lower incisor teeth. The upper incisors have a root surface cross section that is almost twice as large as the lower incisors and, therefore the force required for their intrusions is twice as much as the lower arch, approximately 160 gram or 40 gm per each tooth. The mandibular utility arch is best fabricated from 0.016×0.016 Blue Elgiloy wire in order to create a lever system that will deliver a continuous force to the lower incisors. The design of the mandibular utility arch is dictated by the requirement that this light force be delivered in a continuous manner of a long lever arm from the molar to the incisors. The arch is stepped down at the molar, lies in the buccal vestibule, and is stepped back up at incisors to avoid interference from the forces of occlusion that would distort it. This buccal bridge section is flared slightly buccally to prevent tissue irritation opposing the vertical steps as the arch approaches the tissue and the incisor teeth are intruded.

The lower utility arch should have a form unlike any other arch placed in the bioprogressive therapy. Its anterior arch form is tightly contoured to the lower incisor teeth. This will allow the lower incisors, especially the lower lateral incisors, to intrude without advancing the crown. A 5^0 to 10^0 labial root torque will counteract the forward tipping action quite common with intrusive arches.

MAXILLARY INTRUSION UTILITY ARCH

Upper utility arch is made like the lower one. A 0.016×0.022" blue Elgiloy is used for upper utility arch.

It applies a light continuous pressure to effect intrusion of upper incisor teeth. Nitinol wire also can be used.

CONNECTICUT INTRUSION ARCH

Connecticut Intrusion arch introduced by Nanda is fabricated from nickel-titanium alloys as it is the material of choice for delivering continuous forces under large activation. These alloys have high memory and low load deflection rate producing small increments of deactivation over time and thus reducing the number of reactivation appointment.[12,15]

Appliance design

Connecticut intrusion arch incorporates the characteristics of utility arch as well as those of conventional intrusion arch. C.T.A is performed with the appropriate bends necessary for easy insertion and use. Two wire sizes are available 0.016"×0.22" and 0.017"×0.025" maxillary and mandibular versions have anterior dimensions of 34 mm and 28 mm respectively. The bypass, located distal to lateral incisors is available in two different lengths to accommodate for extraction, non-extraction and mixed dentition cases.

Mechanics

CTA's basic mechanism of force delivery is a V bend calibrated to deliver approximately 40-60 g of force. Upon insertion the V bend lies just anterior to the molar brackets. When arch is activated, a simple force system results consisting of vertical force in the anterior region and a moment in the posterior region.

Incisor intrusion

With proper diagnosis and treatment planning CTA can rapidly correct a deep bite and class II molar relationship, requiring a minimal number of appliance adjustment. A pure intrusion arch would have a point contact at the incisors. Insertion of wire into the incisor bracket however will tend to flare the incisors, which may not be desirable. During intrusion of flared incisors CTA's point of force application is anterior to center of resistance, which will flare the incisor seven more unless the length of wire between them and the molar is fixed. A tight inch back will prevent incisor flaring during intrusion and produce some retraction of incisors as well.

BURSTONE INTRUSION ARCH

In the 1950's Burstone developed the segmented arch technique, which had different cross-section of the wire within the same arch and wires that did not run continuously from one bracket to the adjacent bracket. Burstone concluded that one of the limitations of the continuous arch therapy is its inability to produce genuine intrusion.[13,16]

Basic mechanism of Burstone intrusion arch consists of-posterior anchorage unit, anterior segment and intrusive arch spring.

Posterior anchorage

To increase the stability of the posterior segment, wires that are 0.018"×0.025" or 0.021"×0.25" stainless steel can be placed, (depending upon whether it is 0.018 or 0.022 slot) following initial alignment and maintained in placed throughout treatment. When alignment is completed in the posterior segment, right and left buccal segments are joined together across the arch by means of trans-palatal arch in maxilla and low lingual arch in mandible.

Intrusive spring

Intrusive arch consists of an 0.018"×0.022" or 0.018"×0.025" wire with a 3 mm helix wound 2½ times placed mesial to the auxiliary tube. Curvature in placed in the intrusive arch, so that the incisal portion lies gingival to the central incisors. When the arch is tied to the level of the incisors, an intrusive force is developed. In order that the arch does not increase its length during the activation, a gentle curvature should be placed with the amount of curvature increasing as one approaches the helix. In this way the activated arch wire will appear relatively straight, and as it works out during intrusion arch length will decrease and no anterior flaring is produced.

TIP-BACK SPRINGS (INTRUSION SPRINGS)

Originally proposed by Burstone, these springs are made of 0.017"×0.025" inch TMA wire. The upper and lower arches have to be leveled and aligned and rigid stainless-steel wire, preferably of 0.017×0.025-inch dimension should be engaged.[16]

These springs are indicated in cases requiring true intrusion of incisors and can be used in the following conditions. Growing patients with forward growth rotation, for a very deep curve of spee in the lower arch, cases with deep overbite due to extrusion of incisors and for a steep natural plane of occlusion.

THREE PIECE INTRUSION ARCH

The three-piece intrusion arch consists of the following parts-The anterior segment with posterior extension, posterior anchorage unit and intrusion cantilevers.[14,15]

POSTERIOR ANCHORAGE UNIT

After satisfactory alignment of the pre-molars and molars, passive segmented wire (0.017×0.025") stainless steel) are placed in the right and left posterior teeth for stabilization. A precision stainless steel trans-palatal arch (0.032×0.032) placed passively between first maxillary molars consolidates posterior unit now consisting of right

and left posterior units. Canines may be retracted separately and incorporated into buccal segment.

Anterior segment

The anterior segment is bent gingivally distal to the laterals and then bent horizontally creating a step of approximately 3 mm. The distal part extends posteriorly to the distal end of the canine bracket where it is formed into a hook. The anterior segment should be made of (0.017×0.025i-nch SS or larger) to prevent side effects created by bending of wire during force application.

Intrusion cantilever

The intrusion cantilever is fabricated from 0.017×0.025-inch T.M.A. The wire is bent gingivally mesial to the molar tube and a helix is formed. The mesial end of the cantilever is bend into a hook. The cantilever is then activated by making a bend mesial to the helix at the molar tube, such that the anterior end with the hook lies passively in the vestibule. This is then brought down and engaged onto the horizontal portion of anterior segment. This allows further distal placement of intrusive forces that is lateral to lateral incisor, so that resultant forces are made to pass through the center of resistance of anterior teeth. An elastic chain can be attached to the hook to facilitate simultaneous intrusion and retraction/to redirect the forces more parallel to the long axis of incisors. However, to achieve true intrusion of anterior teeth it is always necessary to balance effective force of intrusion

MULLIGANS INTRUSIVE ARCH

Introduced by Mulligan, intrusion arch is made from 0.016 SS round arch wire in a 0.018/0.022 slot. Both the upper molars are banded and the four incisors are bonded that is why it is called a 2×4 appliance. Intrusive force is created by an asymmetrical V bend which is intrusive at the incisors and extrusive at the molars. Arch wire is cinched back tightly at the molars. Mulligans intrusive arch finds its major application in the mixed dentition stage, where it can be used not only to intrude but also to retract and upright the molars.[16]

KALRA SIMULTANEOUS INTRUSION RETRACTION

The K-SIR arch wire is a modification of segmented loop mechanics of Nanda and Burstone. It is a continuous 0.019"×0.025" TMA arch wire with closed 7×2 mm U loop at the extraction site.[15] To obtain bodily movement and prevent tipping of teeth into the extraction space a 90° V bend is placed in the arch wire at the level of U-loop. This V-bend, when centered between the 1st molar and the canine during space closure, produces two equal and opposite moments to counter the moments caused by activation force of closing loop. An off centered 60° V bend located posterior to the inter-bracket distance produces an increased posterior clockwise moment on the 1st molar which augments the molar anchorage as well as intrusion of anterior teeth. To prevent the buccal segment from rolling mesiolingually due to force produced by loop activation, a 20° anti-rotation bend is placed in the arch wire just distal to each U-loop.[17]

INTRUSION WITH MAGNETS

Dellinger with his active vertical corrector, which is a simple removable or fixed orthodontic appliance could intrude the posterior teeth on both maxilla and mandible by reciprocal forces of the magnets.[18,19] This has provided the potent and rapid tool for actual depression of over erupted buccal segments, with long term stability and minimal untowards effects. The additional benefits of allowing, upward and forward rotation of the mandible in class II problems in to a more favourable sagittal apical base relationship, particularly in high angle cases, but reduce the need for orthognathic surgical procedures. according to Mc Namara, one of the less desirable effects of repelling magnets however is the shearing effect of the lateral component of forces as the magnets approach each other. However Dellinger has modified the vertical corrector appliance by adding lateral flanges, which largely eliminates this unwanted effect.

INTRUSION WITH IMPLANTS

Extra dental intraoral anchorage system was introduced in 1997 as a method of overcoming the problem related to dental and extra oral anchorage. Three types of systems were developed viz. the osteointegrated implants on plant (Block and Hoffman and the zygomatic anchorage (Melson et al).[20,21]

Tooth intrusion is a desirable orthodontic movement limited principally by inadequate dental anchorage, when arch wire is designed to develop an intrusive dental force, it simultaneously generates a reactive extrusive force. These undesirable extrusive components of force are opposed mainly by occlusal forces. In some instances, for examples in high angle cases the occlusal forces may be inadequate and the reactive extrusive forces can lead to extrusion of molars and downward and backward rotation of the mandible resulting in unfavourable facial profile changes. A method of overcoming these undesirable changes is by the use of orthodontic mini-implants.

Endosseous implants became a major influence within the oral implant surgery due to the work of Branemark who achieved constant long term success rates with oral endosseous implants. In the early 1930's the introduction of stainless-steel metals and development of a cobalt chromium molybdenum alloy (Vitalium) gave new impetus to implant surgery.

Anterior intrusion mechanics in the mandibular arch

For intrusion of mandibular anterior teeth micro-implants can be placed between the roots of the lower incisors.

Again, force can be applied from the micro-implant directly to the main arch wire. One micro-implant placed between the lower central incisor roots usually is sufficient to allow intrusion of the entire mandibular anterior segment. However. if the occlusal plane is canted transversely, two micro-implants can be inserted between the central and lateral incisor roots bilaterally. Differential forces then can be applied for improvement of the canted occlusal plane during occlusion.[22]

INTRUSION WITH SURGICAL INTERVENTION

Combined treatments also exist, including surgery and orthodontic appliances. Corticotomy-facilitated orthodontic treatment allows reduced treatment time, and the adverse effects of the orthodontic treatment are limited.[23] Chung et al reported the use of corticotomy to help molar intrusion.[24,25] Araujo et al did a successful intrusion of molar in adult patient with the help of corticotomy.[25] Likewise, Kanno et al applied corticotomy and compression osteogenesis in the posterior maxilla to treat a severe anterior open bite case by 2-stage surgery.[26]

Newer treatment options for effective intrusion especially in adult cases include-Corticotomy-assisted orthodontics and Le fort 1 maxillary impaction.

Corticotomy-assisted orthodontic

Corticotomy has been used in difficult adult cases as an alternative to conventional orthodontic treatment or orthognathic surgery. Because the primary resistance to tooth movement is encountered in the cortical layer, corticotomy makes it possible to move teeth faster without undesirable side effects.[27]

Corticotomy-assisted posterior

Intrusion In cases with vertical problems and anterior open bite, there are many treatment approaches, depending on the severity of the problem: habit control, adenoidectomy, interarch vertical elastics, high-pull headgear, extraction of wedging teeth, MEAW arch wire, orthognathic surgery, and others. In mild-to-moderate adolescent cases, it is preferable to intrude the posterior teeth with high-pull headgear traction. Of course, in adult patients who have completed bone maturity, this approach will be ineffective, and a corticotomy-assisted technique should be considered.

Dental and skeletal evaluation

Occlusal equilibration should first be performed to decide whether corticotomy is indicated. The maxillary and mandibular casts are mounted on the articulator, and the posterior teeth on the maxillary cast are ground until a normal anterior overbite is achieved or the maxillary and mandibular canines are in contact.

If there is only a vertical discrepancy, a treatment involving corticotomy and orthopedic traction can be planned to intrude the posterior segment. If the vertical discrepancy is accompanied by a dental or transverse discrepancy, however, corticotomy is contraindicated. Because posterior impaction can occur at the corticotomy site between the palatal bone and the root tip of a buccal tooth, this procedure should be avoided in cases with short posterior alveolar height.

CONCLUSION

Over the years advancements in orthodontic technique and appliances have proved that diagnosis, treatment planning and application of precise appliance system can bring about the true intrusion of anterior and to some extend posterior units-with an application of optimum orthodontic and orthopedic force. There are number of appliances available till date and these can be used accordingly to patient requirement and clinician skill.

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