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Intrusion Arches and its Effect on Incisors – Review

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Abstract

In the 21st century, there has been a significant rise in the demand for esthetic dental treatments, including correction of gummy smiles, deep bites, and overall smile design. alongside cosmetic concerns, functional issues and various malocclusions remain prevalent. Deep curve of spee and conditions such as increased lower anterior facial height and elongated ramal length, which often contribute to deep bites, are effectively managed through orthodontic intrusion of anterior teeth. The key to successful intrusion is light continuous force directed toward the tooth apex. Burstone (1977) suggested 50 grams to 200 grams of intrusive force are required for intrusion in the upper anterior teeth.

Not all patients with deep overbite should be treated with the same mechanics. Some patients require intrusion of the anterior teeth, while others require primarily extrusion. Deep bite can be corrected in a number of ways, depending on the individual needs of the patient and the nature of the problem. There are two major mechanisms in biomechanics of intrusion: continuous and segmental. various intrusion arches are Rickett's utility arch, Tipback springs (intrusion springs), Burstone's continuous intrusion arch, Burstone's three-piece intrusion arch, k-sir, Connecticut intrusion arch, Poul gessing retraction spring, Translation arch, Lingual arch for intruding and Uprighting lower incisor and Tooth intrusion, carried out with fixed appliances and a round arch wire. In this review, the various incisor intrusion arches, types of intrusion, indications for intrusion, correction of deep curve of spee by intrusion, effects on periodontium and comparison with other intrusion arches and other orthodontic appliance are discussed.

Background

Introduction

Charles J. Burstone is characterized 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 [1].

Correction of deep overbite in conjunction with a Class II molar relationship may be accomplished by anterior intrusion, posterior extrusion, or a combination of both and decision is based on the ideal incisor position, considering lip-to-tooth relationships and the lower vertical dimension [2]. The incisal edges of upper anterior teeth and curvature of the upper border of the lower lip should be in harmony, which can be disrupted by hav-

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ing a vertical maxillary excess or in cases of deep bite where the incisor show could be more than the normal.

Marcotte defines intrusion as the "tooth movement that occurs in an axial (apical) direction and whose center of rotation lies at infinity. It is an axial type of translation". Deep bite, is known to be one of the most common and deleterious malocclusion, affecting the future health of the masticatory apparatus and the dental units. Coined by Edward Angle, it is basically an incorrect relation between the teeth of the two dental arches when they approach each other as the jaws close [3].

Optimal Force for Intrusion An optimal force is one that produces a rapid rate of tooth movements, without discomfort to the patient or any tissue damage. Burstone (1977) suggested 50 grams of intrusive force for upper central incisors, 100 grams for central and laterals and 200 grams for six upper anteriors. He advocated use of 40 grams for four lower incisors and 160 grams for all six lower anteriors [4].

True molar intrusion appears to be achievable in the maxillary arch, although the amount of evidence is minimal. The clinical significance of the magnitude of the true intrusion reported is questionable as the sole treatment option to correct open-bite malocclusions [5]. the correction of the deep overbite is done with the help of second-order bends (type back bend) applied to the molars [6].

Recent clinical evidence has shown that orthodontic intrusion can be effectively performed with proper care, ensuring that the forces applied are closely regulated in terms of both intensity and direction [7]. hat intrusion with low forces can be effective in reducing overbite while causing only a negligible amount of apical root resorption [8]. TADs can be used as orthodontic anchorage to effectively intrude the incisors without the need for patient cooperation [9]. Combined ortho-periodontal treatment showed that orthodontic intrusion on a reduced but healthy periodontium can be considered a beneficial treatment for the periodontium, provided that potential adverse effects are carefully monitored [10].

Molar intrusion has always been a complex and difficult treatment modality. It can be approached for treating open bite patients or over erupted molar tooth/teeth [11]. It was obvious that intrusion was best performed when

- Forces were low (5 to 15 gm per tooth) with the line of action of the force passing through or close to the center of resistance,
- The gingiva status was healthy, and
- No interference with perioral function was present [12].

Stress is concentrated at the PDL apex region, irrespective of the point of orthodontic force application [13].

Six principles must be considered in incisor or canine intrusion [1]:

a. The use of optimal magnitudes of force and the delivery of this force constantly with low-load-deflection springs;

b. The use of a single point contact in the anterior region;

c. The careful selection of the point of force application with respect to the center of resistance of the teeth to be intruded;

d. Selective intrusion based on anterior tooth geometry;

e. Control over the reactive units by formation of a posterior anchorage unit; and

f. Inhibition of eruption of the posterior teeth and avoidance of undesirable eruptive mechanics.

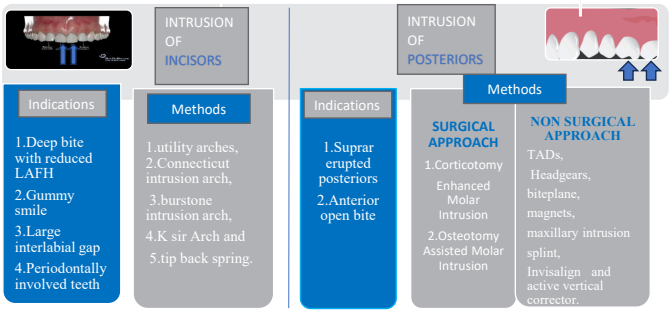
Point of force application

For an anterior segment comprising of two central incisors, center of resistance was located on a projection line parallel to mid saggital plane on a point situated at distal half of the canine. For an anterior segment that included the four incisors, center of resistance was situated on a projection line, perpendicular to occlusal plane between canines and 1st premolar [14].

Main text

Indications and methods used for intrusion of teeth are as mentioned below table 1.

Table 1: For methods and indications of intrusion arches.



Intrusion arch for the correction of deep curve of spee

a) Absolute intrusion

b) Relative intrusion, achieved by preventing eruption of the incisors while growth provides vertical space into which the posterior teeth erupt; and

c) Extrusion of posterior teeth, which causes the mandible to rotate down and back in the absence of growth

The difference between (B) and (C) is whether the mandible rotates downward & is determined by growth of ramus while the tooth movement is occurring, not by the orthodontic mechanics.

Levelling by intrusion with a fixed appliance requires a mechanical arrangement other than a continuous arch wire attached to each tooth. The key to successful intrusion is light continuous force directed toward the tooth apex. It is necessary to avoid pitting intrusion of one tooth against extrusion of its neighbour because in that circumstance extrusion will dominate. This can be accomplished in three ways:

with continuous archwires that bypass the premolar (and frequently the canine) teeth,

with segmented archwires (so that there is no connection along the arch between the anterior and posterior segments) and an auxiliary depressing arch, and

with aligners that have attachments on the posterior teeth so that when an upward force is placed on the anterior teeth, the aligner does not slide down posteriorly [15].

Periodontium of teeth and movement of teeth while intrusion is given in figure 1. [16]

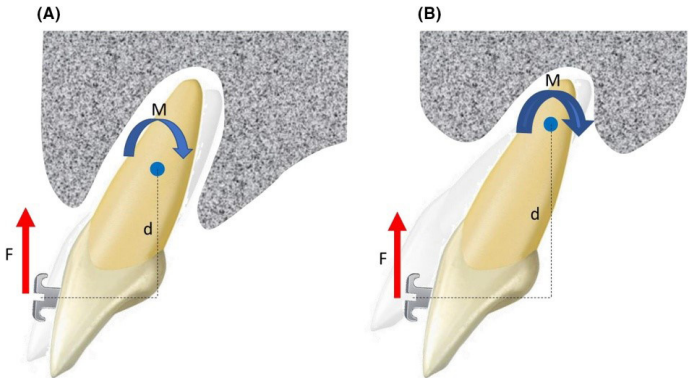


Figure 1: (A) in a patient with a normal periodontium is accompanied by a moment around the center of resistance of the tooth in question (F = force, M = moment, d = distance between the force application and the center of resistance);
Figure 1: (B) in a patient with reduced periodontium and bone loss leads to an apical displacement of the center of resistance in teeth with reduced periodontal support. When the alveolar bone level is reduced, the distance between the applied force and the center of resistance is increased, leading to a moment of greater [16].

Force of 1.0 N is too high for space closure of flared front teeth in periodontally damaged dentition, as extreme strains may occur. En masse retraction using cantilever mechanics with lower forces showed a uniform intrusion and retraction movement and thus proved to be a better option for treating patients with a periodontally compromised dentition [17]. Intrusion also results in root resorption, which will further affect the periodontium.

Increased periodontal stresses resulting from severe attachment loss should be seriously considered by careful planning of the orthodontic mechanics and reduction of the applied forces is suggested. The presented cantilever mechanics seems to be an appropriate means for en masse retraction of periodontally compromised extruded front teeth. Gingival and alveolar bone remodelling were unable to keep pace with the maxillary anterior intrusion. Maximum stress was found in the cortical bone and in the PDL. Nature of the stress changed from compressive to tensile from cervical area to root apex, concentrating mainly at the apical area. Amongst the modalities compared, the best controlled tooth movements for anterior intrusion to treat anterior deep bite malocclusions, was for mini-implants placed distal to lateral incisors [3].

Types of intrusion arches

1. Rickett's utility arch
2. Connecticut intrusion arch
3. Burstone's three-piece intrusion arch
4. Tipback springs (intrusion springs)
5. Burstone's intrusion arch
6. K-sir (kalra simultaneous intrusion and retraction)
7. Intrusion arch of quiros
8. Lingual arch for intruding and uprighting lower incisor.
9. Pg retraction spring
10. Tads

Utility arch

Utility arch was designed by Robert M. Ricketts in the early 1950's and has been popularized as an integral part of bio progressive therapy. The utility arch is a two-couple intrusion arch wire used for control of anterior deep overbite [18]. It originally was developed to provide a method of leveling the curve of Spee in the mandible, but it has been adapted to perform many more functions than just lower incisor intrusion. Regardless of the presence or absence of loops, all utility arches have a common design [19], which consist of

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

The four types of utility arches are:

a) Passive Utility Arch

b) Intrusion Utility Arch

c) Retraction Utility Arch

d) Protraction utility Arch5

As advocated by Ricketts, utility arches are fabricated from chrome – cobalt wires. In contrast to stainless steel wire: chrome – cobalt wire is manipulated easily and loops can be formed in the wire with little difficulty. Generally rectangular wire is preferable to round wire to control torque and prevent unwanted tipping of incisor [20].

Unlike with utility arches, true maxillary incisor intrusion can be achieved by application of intrusive forces close to the center of resistance by using miniscrews with no counteractive movements in the molars [21].

The amount of intrusion is significantly higher in Skeletal anchorage device. Although vertical molar positional change was higher in Connecticut intrusion arh group than the Skeletal anchorage device., it was not changed significantly in both treatment modalities. Skeletal anchorage device overall had better results and was easier in handling during intrusion [22].

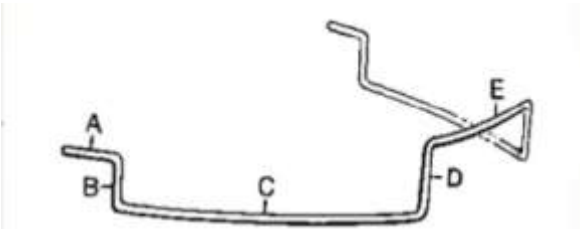


Figure 2: Utility Arch.

Figure 3: Connecticut intrusion arches.

Connecticut intrusion arch (CTA)

The present article will describe the nickel titanium (CTA). Although its most common use is for absolute intrusion of anterior teeth (Figure 3), it has many other applications, including molar tip back for Class II correction, preparation of posterior anchorage, incisor flaring, correction of minor open bites, levelling of anterior occlusal cants, and finishing [2].

The fundamental force delivery mechanism of the CTA involves a V-bend designed to deliver around 40-60g of force. Upon placement, the V-bend sits slightly in front of the molar brackets. Mini-implants were found to be superior to the Connecticut intrusion arch with respect to the amount of maxillary incisor intrusion and overbite correction [23].

Three-piece base arch intrusion mechanism

Deep overbite correction and space closure can be simultaneously achieved with the three-piece base arch intrusion mechanism in patients with flared incisors (Figure 4). The force system delivered on the anterior segment depends on the point of application of the intrusive force and its direction. This segmented approach to intrusion and retraction is clinically advantageous because it allows simultaneous control of tooth movement in the vertical and anteroposterior planes [24].

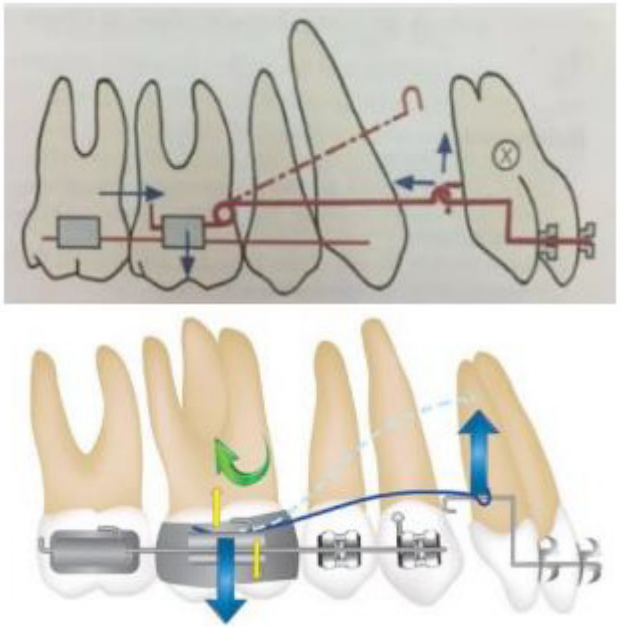


Figure 4: Connecticut intrusion arches.

Tip back springs

It is made of 0.017×0.025 TMA wire, Upper and lower curves must be levelled and adjusted and unbending tempered steel wire of 0.017×0.025 inch measurement (Figure 5). TMA wire without helix and SS wire of same measurement with helix can be utilized to give ideal power to intrusion. Grapple molar is strengthened with transpalatal curve in upper and lingual curve in the lower. A helix is shaped gingivally mesial to the molar tube and the mesial end of spring is twist into a snare and connected with distal to parallel incisor which as indicated by burstone is the focal point of opposition of four incisors [26].

Burstone intrusion arch

Burstone 0.017×0.025' TMA intrusion arch exerted the lowest forces/moments on posterior teeth (Figure 6). The highest forces were generated by the 0.016×0.016-inch Blue Elgiloy® utility arch and the highest moments by the lower 0.017×0.025-inch TMA® utility arch [27]. An increase in archwire diameter from 0·016 to 0·018 inch increased intrusive forces by 64 per cent for stainless steel and 58 per cent for nickel-titanium. Increasing anchor bend or reverse curve of Spee produced considerable force increases across the range of specimens [28].

Incisor intrusion in adults moves the dentogingival complex apically and is a valuable adjunct to [26] restorative treatment. Potential iatrogenic consequences of alveolar bone loss and root resorption are minimal and comparable with the consequences of other orthodontic tooth movements [29].

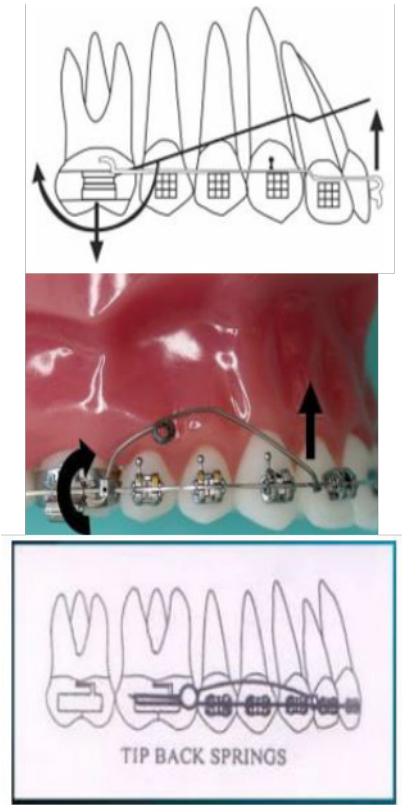


Figure 5: Tip back springs by incorporation of helix from molar connected to incisors for intrusion [7].

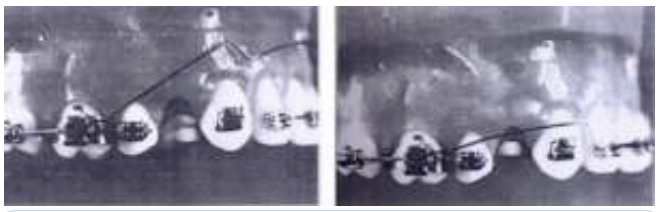


Figure 6: Burstone intrusion arch [25].

K-SIR (Kalra Simultaneous Intrusion and Retraction)

In this 0.019×0.025 TMA gives adequate solidarity to oppose bending, and adequate solidness to produce the required minutes. TMA wire and curve wire configuration consolidate to create relative low powers, low burden redirection rate and a scope of enactment that enable the machine to close spaces (Figure 7). TMA can be initiated twice as much as SS without experiencing perpetual twisting. K Sir curve result in intrusion just as just as withdrawal of foremost teeth in the meantime, this abbreviates the treatment time contrasted with regular edgewise mechanics.

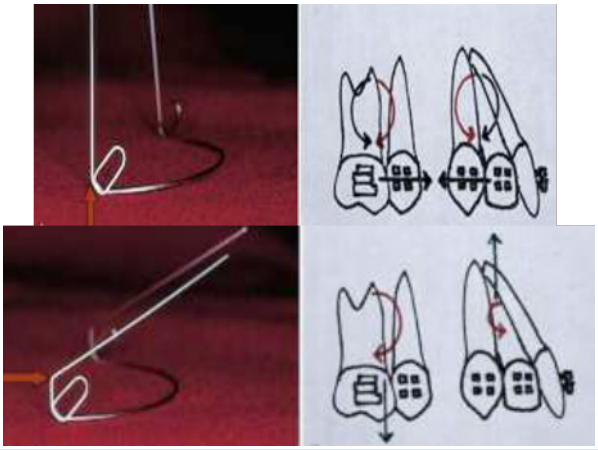


Figure 7: 90° bends placed at level of U- loops Archwire with off center 60° V-bend placed about distal of U- loop [25].

Intrusion arch of quiros [30]

It was designed by Oscar Quiros. It is fabricated with 0.017" ×0.025" stainless steel wire or 0.016"×0.022" TMA wire. The arch is made with anterior segment placed more gingivally than posterior segment which will make the intrusion of anterior teeth possible (Figure 8). The difference in level of anterior and posterior segment will be established by the amount of intrusion needed. Due to its design, it acts like a very elastic spring that will physiologically intrude the anterior teeth.

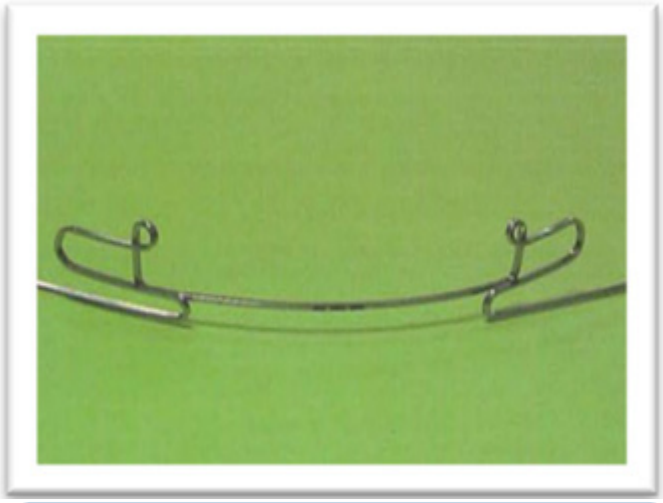


Figure 8: (30) S.S wire to design it and placed more gingivally for intrusion.

Figure 9: S.S archwire & lingual button and elastics to intrude incisors [30].

Lingual arch [30]

It was designed by Winston Senior. It is fabricated with 0.036" stainless steel wire. Lower lingual arch is soldered to first molar bands. Four elastic chains are attached to the anterior bridge of lingual arch. After cementation of the arch, the elastics are stretched to four lingual buttons on lower incisors. (Figure 9) These buttons should be bonded as far as possible from the gingival margin to facilitate intrusion.

Temporary anchorage devices

Anterior Intrusion with TADS, As per Nanda, the optimal position for inserting Temporary Anchorage Devices (TADs) for anterior intrusion is between the roots of the canine and lateral incisors (Figure 10).

Figure 10: Usage of TADS in intrusion of incisors [10].

Comparing Among Different Intrusion Arches and with Other Orthodontic Appliance and in Different Malocclusion

Treatment of Class II Division 2 malocclusion using temporary skeletal anchorage devices and an auxiliary intrusion arch after premolar extractions. This case report describes the successful treatment effectively achieved palatal root torque movement, controlled retraction, and intrusion of the maxillary incisors, resulting in a stable occlusion, improved facial profile, and enhanced smile esthetics. During space closure, root resorption and palatal bone loss were observed [31].

upper incisors were intruded and protruded, upper first molars were extruded, and lower incisors were protruded in Utility arch & Connecticut Intrusion Arch [32]. Nonsurgical orthodontic treatment using two mini-implants placed in the maxillary midpalatal molar region and an Aichi-Gakuin palatal bar successfully induced retraction and intrusion of the maxillary anterior teeth, resulting in the improvement of a gummy smile comparable to that achievable with surgical orthodontic treatment [33].

Although simultaneous orthodontic intrusion of the 6 mandibular anterior teeth is not recommended, a few studies have evaluated individual canine intrusion. The rate of incisor intrusion in mini-implants was found to be 0.425 mm/month & Connecticut intrusion arch was 0.35 mm/month. The mean value of incisor intrusion obtained in Connecticut intrusion arch was 1.4 mm & in three-piece intrusion arch was 1.66 mm [34].

Class I malocclusion with proclined upper anterior teeth, crowding in upper and lower arches and an excessive gingival exposure. Fixed orthodontic therapy was initiated with first premolar extractions and the primary strategies after correcting of the crowding was the effective use of a 3-piece intrusion arch for simultaneous intrusion and retraction of proclined anterior teeth. Loss of anchorage is seldom observed because of the tip back moment on the posterior teeth. Another advantage of intrusion mechanics is the control of the vertical dimension [35].

The mean precision of true anterior intrusion with Invisalign clear aligners by using CBCT of a study by Al - balaa was 51.19%, and the mean amount of correction was 48.81% [36]. Mini implants can be considered superior to the conventional techniques (Connecticut intrusion arch and Burstone's three-piece intrusion arch) as it provides absolute anchorage which eliminates unwanted effects of incisor intrusion [37]. Mini-screws demonstrated the most effective maxillary incisor intrusion with minimal side effects compared to utility and Connecticut intrusion arches [17].

Biomechanical system called the posterior miniscrew-assisted lever arm, which is innovative in using existing posterior miniscrews to intrude the upper incisors and to control anterior overbite while simultaneously retracting the anterior teeth. But its efficiency in incisor intrusion has been proved with only 2 cases [38]. The likelihood of root resorption should be considered when frictionless mechanics are used for retraction of incisors [39].

The different intrusion arches are reviewed by chinki bansal et al [25], in the table 2.

Table 2: [25].

S. No	Intrusion arches	Year	Author	Material	Site of application
	Utility arches	1950s	Robert m Ricketts	0.016x 0.016 Blue elgiloy wire INCISORS	Incisors
	Connecticut intrusion arch	1998	Ravindra Nanda	0.016X0.022NiTi,0.017X 0.025 NiTi alloy Ni free β III CNA INCISORS	Incisors
	Burstone Intrusion Arch	1950s	Burstone	0.017x0.025-inch TMA wire INCISORS	Incisors
	Tip Back Springs (Intrusion Springs)		Burstone	0.017x0.025-inch TMA wire MOLARS Chinki	Molars
	Three Piece intrusion arch	1995	Shroff, lindauer, Burstone, Leiss	0.019x0.025 SS Posterior segment 0.017x 0.025 TMA Tip back spring Intrusion and retraction of Anterior segment flared anterior teeth	Intrusion & retraction of Flared anteriors
6.	K- Sir loop (frictionless mechanics)		Kalra	0.019x0.025 TMA Wire Intrusion and retraction of flared anterior teeth.	Intrusion & retraction of Flared anteriors

Conclusion

For a long time, dental intrusion was fraught with difficulties, often leading to various issues like damage to the supporting structures of the teeth and erosion of the tooth roots. However, recent clinical evidence has shown that orthodontic intrusion can be effectively performed with proper care, ensuring that the forces applied are closely regulated in terms of both intensity and direction. Burstone s TMA 0.017×0.025-inch intrusion arch exerted the lowest force on the incisors (0.99 N), followed by the TMA utility 0.017×0.025 inch (1.33 N) and the blue Elgiloy 0.016×0.016-inch utility (1.43 N) [40]. Understanding the basic biomechanical principles involved in producing controlled tooth movement enables to achieve successful orthodontic treatment outcomes which are more predictable and consistent. However, the fundamental forces and moments they produce are universal [30]. Hence, in this generation, smile correction and esthetics demands of the patient with deepbite, gummy smile and other malocclusions which require intrusion from single tooth to enmasse tooth movement can be best treated by orthodontic intrusion.

Author declarations

Ethics approval and consent to participate

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Availability of Materials

Not Applicable.

Competing interests

Not applicable.

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Author's Contributions

Concept and design: Dr. Ajith Kumar, Drafting of the manuscript: Dr. Ajith Kumar, Critical review of the manuscript: Dr. Ajith Kumar, Dr. Narendra Sharma. And guidance.

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