

Review Article

Forces generated with the use of intrusion arches in orthodontics – A review of literature

ABSTRACT

In routine orthodontic practice, Class II malocclusions are the most customary treated cases. The cardinal objective and radical challenge of Class II treatment is the correction of deep overbite. Correction of deep overbite should be carried out prior to retraction of teeth. Various treatment protocols are used for correction of deep overbite, in which intrusion arches are more elementary to use for correcting deep bite by true intrusion or by pseudo-intrusion. This review paper contains various intrusion arches and related studies along with the key functions which are sketched out in the form of table. Individual forces produced by intrusion arches on teeth for all tooth movements are also categorized and tabulated.

Keywords: Deep overbite, extrusion, incisors, intrusion, utility arch

INTRODUCTION

Deep overbite is one of the most prevalent malocclusions seen in children as well as in adults.^[1] It is one of the paramount challenges of Class II treatment, which is characterized by the vertical overlap in the anterior region.^[2,3] Deep overbite is recurrent in adult patients either by their growth pattern or by dental-related factors, such as loss of the posterior teeth.^[4,5] In most instances, the correction of overbite is produced by the extrusion of posterior teeth as with the greatest success seen in growing patients.^[2] Orthodontic mechanics to treat deep overbite can be performed by maxillary and mandibular tooth extrusion or intrusion, maxillary clockwise rotation, and curve of spee flattening,^[4,5] however, intrusion arch is the most commodious method.

TYPES OF DEEP OVERBITE CORRECTION

1. Intrusion of teeth – The movement of the geometric center of the root (centroid) is called intrusion, which is apical in respect to the occlusal plane or a plane based on the long axis of centroid. Labial tipping of an incisor

around its centroid produces pseudo-intrusion which is helpful in correction of Class II Division 2.^[1] Intrusion of both anterior and posterior teeth are possible

2. Extrusion of teeth – The correction of deep overbite is produced by the extrusion of posterior teeth, which is seen to be the greatest success in patients with mandibular growth^[2]
3. Combination – The correction of deep overbite is also by the combination of the above two.

STUTI RAJ, PRATIK CHANDRA¹, RAGNI TANDON¹, NIKHIL ASOK², ABHIMANYU VIKRAM SINGH³

Senior Lecturer, Department of Orthodontics, Bhojia Dental College, Buddh, Baddi, (Affiliated from- Himachal Pradesh University, Shimla) Himachal Pradesh, ¹Professor, Department of Orthodontics, Saraswati Dental College, Lucknow, ²Consultant orthodontist, Millennium Dental Clinic, Thrissur, Kerala, ³Assistant Professor, Department of Orthodontics, Babu Banarsi Das Dental College and University, Lucknow, Uttar Pradesh, India

Address for correspondence: Dr. Stuti Raj, Senior Lecturer, Department of Orthodontics, Bhojia Dental College, Buddh, Baddi (Affiliated from Himachal Pradesh University, Shimla) Himachal Pradesh, India.
E-mail: dr.stuti.raj@gmail.com

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MATERIALS AND METHODS

- We collected data according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis guidelines for reporting systematic reviews of health sciences interventions.^[6] One hundred and forty-one searched along with three intrusion arches from two books were included to find the intrusion arches to correct the deep overbite
- To identify all studies that examined the correction of deep overbite with the help of only intrusion arches, a literature survey was done from library and Google Scholar from the year 1977–2019 and used the Medical Subject Headings term “orthodontics” and was crossed with a combination of the following term: intrusion arches, intrusion arches for deep overbite correction, and forces produced by intrusion arches on tooth movements
- All articles which were written in English were included
- Data were collected from only original invention articles and books. The flow diagram of data search is shown in Figure 1].

The exclusion criteria were as follows [Table 1]:

- Studies dealing with deep overbite correction by other methods
- Case reports on intrusion arches
- Clinical trials, comparative studies, reviews, and

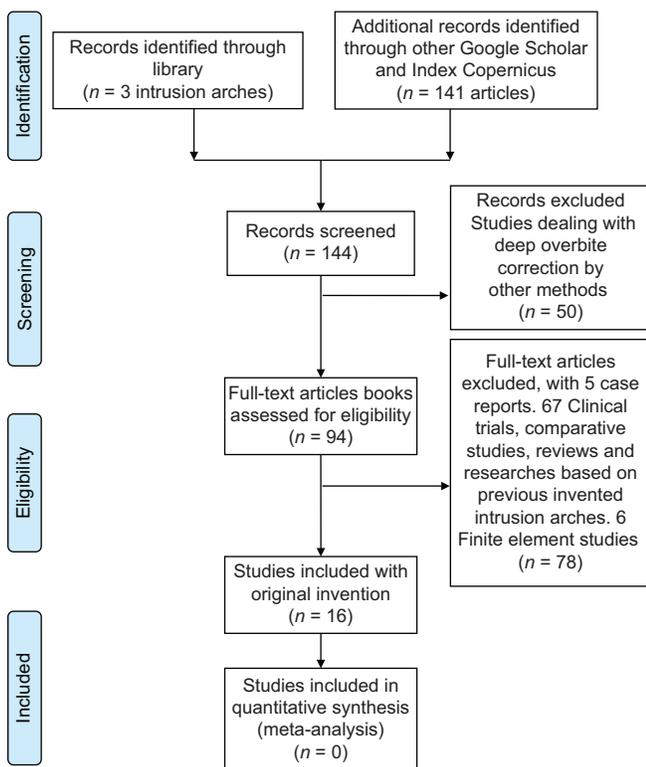


Figure 1: Flow diagram of data search according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis

- researches based on previously invented intrusion arches
- Finite element studies on intrusion arches.

To identify all the studies to find out the intrusion arches for deep overbite correction, a literature survey was done. The types of malocclusion were not restricted. To avoid multiple biases, we chose a table which represents articles on new appliance with independent study with different authors, under different titles, or in different journals and books.

Data were collected and included according to these headings:

- Author name, journal name
- Year of introduction
- Appliance introduced
- Functions
- Type of movement.

Sixteen intrusion arches were included in this review article for the correction of deep overbite^[2,7-15] [Table 2]. Forces generated by intrusion arches in all the three planes that are sagittal, transverse, and vertical are explained [Tables 3-5].

RESULTS

Correction of deep overbite can be accomplished by intrusion of anteriors, extrusion of posteriors, or by combination of both. Intrusion arches can intrude the incisors, extrude the molars by tip back, or can also perform both at the same time like in two-couple system. All intrusion arches are summarized along with their functions in Table 2. Out of all the intrusion arches, Burstone was first to introduce utility arch in the year 1977 for the correction of Class II deep overbites. He introduced intrusive utility arch for applying intrusive force on anteriors, selective intrusion and canine intrusion, and passive utility arches for passively holding the arch. Burstone also introduced retraction utility arch for retraction and intrusion of flared maxillary incisors and protraction utility arch for protrusion and flaring of maxillary incisors in Class II Division 2 cases.^[2] After this, Ricketts in

Table 1: The exclusion criteria and the number of articles excluded

The exclusion criteria	Number of articles excluded
Studies dealing with deep overbite correction by other methods	50
Case reports on intrusion arches	5
Clinical trials and comparative studies and reviews and researches based on previously invented intrusion arches	67
Finite element studies on intrusion arches	6
Total	128

Table 2: List of intrusion Arches

Author and book/journal	Year of introduction	Appliance introduced	Function	Type of movement
Burstone. Am J Orthod ^[2]	1977	Intrusive utility arch	Selective intrusion and canine intrusion	Intrusion
Burstone. Am J Orthod ^[2]	1977	Passive utility arch	For stabilization and space holding	Passive movement
Burstone. Am J Orthod ^[2]	1977	Retraction utility arch	For retracting and intruding incisors in cases of maxillary incisor flaring	Intrusion and retraction
Burstone. Am J Orthod ^[2]	1977	Protrusion utility arch	Used for flaring and intruding incisors in cases of Class II malocclusion	Intrusion and protraction
Ricketts et al. Bioprogressive Therapy Book ^[7]	1979	Ricketts utility arch	This was used as the starting appliance in deep bites or with crowded mandibular anterior conditions	Intrusion
Ricketts et al. Bioprogressive Therapy Book ^[7]	1979	Contraction utility arch	Retract mandibular incisors optimally with very light forces	Intrusion
Mulligan. J Clin Orthod ^[8]	1980	Mulligan utility arch	Cuspid intrusion takes place and molar extrusion	Combination
McNamara. J Clin Orthod ^[9]	1986	Intrusion utility arch	Intrusion and possible torquing of the lower incisors as well as a tipping back of the lower molars	Intrusion
McNamara. J Clin Orthod ^[9]	1986	Retrusion utility arch	Used in cases of dentoalveolar anterior crossbite in which there was slight proclination and spacing of the lower incisors. Retraction and intrusion both were possible	Intrusion
McNamara. J Clin Orthod ^[9]	1986	Protrusion utility arch	This can be used during the mixed-dentition period prior to functional jaw orthopedic appliance therapy for intruding and protracting molars	Intrusion
Marcott. Biomechanics in Orthodontics. Toronto ^[10]	1990	Marcotte intrusion arch	Intrusion of anteriors and extrusion of posterior teeth	Combination
Shroff et al. Am J Orthod Dentofacial Orthop ^[11]	1997	Three-piece intrusion arch	Intrusion of incisors and extrusion of molars	Combination
Kalra. J Clin Orthod ^[12]	1998	Simultaneous intrusion and retraction arch	Retraction and intrusion of anterior teeth	Intrusion
Nanda et al. J Clin Orthod ^[13]	1998	Connecticut Intrusion Arch	Intrusion of anterior teeth	Intrusion
Nanda and Kuhlberg. Biomechanics and Esthetic Strategies in Clinical Orthodontics Book ^[14]	2005	Connecticut New Intrusion Arch	Intrusion of anterior teeth	Intrusion
Ranjitbhai et al. Int J Orthod Rehabil ^[15]	2017	Modified three-piece intrusion arch	En masse retraction and intrusion	Intrusion

Table 3: Forces in anteroposterior movements (mesiobuccal surface of buccal segment and labiolingual surface of anteriors)

	6	5	4	3	2	1	Equivalent
Maxillary teeth							
Root surface area (cm ²)	1.20	0.55	0.75	0.75	0.40	0.50	4.15
Forces (g/cm ²)							
200	240	110	150	150	80	100	830
150	180	85	110	115	60	75	625
100	120	55	75	75	40	50	415
Mandibular teeth							
Root surface area (cm ²)	1.10	0.60	0.60	0.75	0.25	0.25	3.55
Forces (g/cm ²)							
200	220	120	120	150	50	50	710
150	175	90	90	115	40	40	550
100	110	60	60	75	25	25	355

1979 introduced utility arch which was used as starting appliance for deep overbite correction and for intrusion of mandibular incisors in crowding cases. He also introduced

contraction utility arch to retract mandibular incisors with light continuous force.^[7] Mulligan again in the year 1979 introduced Mulligan utility arch which focuses on intrusion of extruded canines and extrusion of molars.^[8] In the year 1986, McNamara introduced intrusion, retrusion, and protrusion utility arches. McNamara intrusion utility arches also have the property of torquing mandibular incisors and tipping mandibular molars apart from intrusion. Retrusion utility arch was used for correction of dentoalveolar anterior crossbite in which there was proclination and spacing in the lower anteriors. Protrusion utility arch was used in mixed-dentition period prior to functional jaw orthopedic appliance therapy for intruding and protracting molars.^[9] Marcotte introduced Marcotte intrusion arch (1990)^[10] and Bhavna Shroff introduced three-piece intrusion arch (1997),^[11] both were used for intrusion of anteriors and extrusion of posteriors. Three-piece intrusion arch with a good anchorage control used for correction of flared incisors and their axial inclinations. Simultaneous intrusion and retraction arch was designed by Varun Kalra in 1998 to perform both the

Table 4: Forces in transverse movements (buccolingual surface of buccal segment and mesiobuccal surface of anteriors)

	7	6	5	4	3	2	1
Maxillary teeth							
Root surface area (cm ²)	1.05	1.35	0.50	0.50	0.70	0.65	0.70
Forces (g/cm ²)							
150	155	205	75	75	105	100	105
100	105	135	50	50	70	65	70
Mandibular teeth							
Root surface area (cm ²)	0.95	1.05	0.60	0.60	0.70	0.50	0.50
Forces (g/cm ²)							
150	140	155	90	90	105	75	75
100	95	105	60	60	70	50	50

Table 5: Forces in intrusion and extrusion of teeth

	7	6	5	4	3	2	1
Maxillary teeth							
Root surface area (cm ²)	0.70	0.80	0.30	0.30	0.45	0.30	0.40
Forces (g/cm ²)							
150	105	120	45	45	65	45	60
100	70	80	30	30	45	30	40
Mandibular teeth							
Root surface area (cm ²)	0.75	0.85	0.30	0.30	0.35	0.20	0.20
Forces (g/cm ²)							
150	110	130	45	45	50	30	30
100	75	85	30	30	35	20	20

movements of anterior teeth simultaneously.^[12] Connecticut Intrusion Arch (1998)^[13] and Connecticut New Intrusion Arch (2005)^[14] both were introduced by Nanda *et al.* for intrusion of anterior teeth. There was also an introduction of modified three-piece intrusion arch in the year 2017 by Ranjitbhai *et al.* for en masse retraction and intrusion of anteriors.^[15]

DISCUSSION

Intrusion of teeth is based on mechanism which consists of three parts: (1) anchorage unit, (2) an anterior segment, and (3) an intrusive arch spring. The intrusion arch is placed in the auxiliary tube of the first molar attachment. It is important to use the lowest magnitude that is capable of intruding incisors. If the magnitudes of forces are too high, the rate of root resorption will increase not the rate of intrusion. An intrusive force placed through the center of resistance which is geometric center of the roots of the incisors to be intruded will intrude the teeth without producing any labial or lingual rotation of the teeth. Bench *et al.* in 1978 stated that utility arch should be activated for light continuous force of 60–100 g for the intrusion of mandibular incisors.^[2] The utility arch is a two-couple intrusion archwire which is usually made with rectangular wire, and is activated for incisor intrusion by a molar

tip-back bend.^[16] Utility arch can be designed differently for extraction and nonextraction cases. In extraction cases, the forces on molar are generated mesially and occlusally, with a distomolar bend preventing the molar from moving mesially.^[9]

Six principles must be pondered upon incisor or canine intrusion: (1) the use of optimal magnitudes of force and constantly delivering this force with low load-deflection springs; (2) in the anterior region, single-point contact should be used; (3) the point of force application with respect to the center of resistance of the teeth to be intruded should be selected cautiously; (4) the geometry of anterior tooth forms the basis of selective intrusion; (5) reactive units are controlled by formation of a posterior anchorage unit; and (6) the posterior teeth eruption should be inhibited and undesirable eruptive mechanics are avoided.^[2]

The optimum pressure for the tooth movement proposed by Brian Lee in his work is 200 g/cm² of enface root surface exposed to tooth movement. Pressure is defined as force per unit area. The magnitudes of force vary depending upon the planned direction of movement and size of the root surface involved. The forces per unit area are listed in all the three movements^[7] [Tables 3-5].

CONCLUSION

This paper enumerates all the types of intrusion arches and their function and types. The paper also differentiates forces on teeth in all movements which helps the clinician in application of precise force on the tooth movements. The list of intrusion arches helps the clinician to choose the suitable intrusion arch wherever required in a substantially reduced time and also helpful in research purposes.

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Conflicts of interest

There are no conflicts of interest.

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