Research Protocol

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Dentistry Section

Evaluation of Rate of Intrusion, Retraction and Amount of Periapical Root Resorption with Jayade's Intrusion Arch versus Modified Three-piece Intrusion Arch using CBCT: A Research Protocol

BULBUL MANOJ BAID[1], RANJIT HARIDAS KAMBLE[2], VIKRANT JADHAV[3], RUCHIKA PANDEY[4]

ABSTRACT

Introduction: Deep bite, a common orthodontic malocclusion, necessitates timely intervention to prevent potential side-effects. If left untreated, a deep bite can lead to increased tooth wear, dental injuries, and Temporomandibular Joint (TMJ) disorders. Various treatment modalities, such as anterior teeth intrusion and posterior teeth extrusion, are employed to correct deep bite. However, selecting the optimal approach requires careful consideration of patient-specific factors and treatment objectives. While anterior teeth intrusion is effective for mild to moderate cases, posterior teeth extrusion may be preferred in severe deep bite scenarios. There are various treatment modalities for deep bite correction such as intrusion arches and mini screw implants. Jayade's intrusion arch, detailed by A.V. Jayade in "Refined Begg for Modern Times" (2001), is an orthodontic appliance designed to correct vertical dental misalignments by intruding over-erupted anterior teeth. The modified three-piece intrusion arch is an advancement of the traditional intrusion arch technique. It incorporates three distinct segments: two lateral segments and a central segment. This design allows for greater precision and control over the intrusion forces applied to specific teeth or groups of teeth.

Need of the Study: Simultaneous intrusion and retraction mechanics in orthodontic treatment are very challenging, and there is a paucity of data regarding the best modalities for achieving these with minimal root resorption.

Aim: Comparative evaluation of the rate of intrusion, retraction and amount of periapical root resorption with Jayade's intrusion arch and the modified three-piece intrusion arch using Cone Beam Computed Tomography (CBCT).

Materials and Methods: The present prospective, two-arm parallel interventional study will be conducted in the Department of Orthodontics and Dentofacial Orthopaedics Outpatient Department, Sharad Pawar Dental College, Sawangi (Meghe), Wardha, Maharashtra, India, from September 2024 to February 2026. Study will involve the recruitment of 20 patients and all these patients will be divided into two groups for comparative analysis. The intervention will entail the use of the McLaughlin, Bennett and Trevisi (MBT) bracket system equipped with triple tubes on maxillary teeth, characterised by a slot dimension of 0.022 inches by 0.028 inches, as the standardised starting point for all cases. After initial alignment and leveling, and extractions as per the case, the intrusion arch will be applied. Jayade's intrusion arch will be given in group A, while the modified three-piece intrusion arch will be given in group B. The assessment of intrusion rate, retraction rate and amount of root resorption will be conducted both prior to the initiation of intrusive and retractive forces, as well as, at intervals of two, four and six months following the application of the intrusion arches.

Keywords: Anchorage, Cone beam computed tomography, Deep bite, Extraction, Lateral cephalogram

INTRODUCTION

A deep bite is characterised by an increased vertical overlap between the upper and lower incisors. Within a standard occlusion, the optimal overbite typically ranges from 2-4 mm, which equates to 5-25% of the lower incisor's total crown height [1]. Nonetheless, an overbite range of 25-40% may also be considered normal, provided it does not induce functional challenges during various TMJ movements. However, an overlap exceeding 40% of the lower incisor crown height qualifies as a deep bite [2].

Neglected deep bite concerns can escalate, giving rise to various complications, including increased tooth wear, dental injuries, periodontal issues, challenges in occlusion and mastication, headaches, TMJ disorders and ultimately, tooth loss. Overbite presentations may be categorised as skeletal, dental, or a combination thereof. Dental deep overbite can be addressed through anterior teeth intrusion, posterior teeth extrusion, or a hybrid approach that amalgamates both methodologies [3].

Extrusion of posterior teeth stands as one of the widely favoured approaches for addressing deep bite concerns in adolescent and adult populations. The intrusion of upper and/or lower incisors is often advantageous for mitigating deep bite conditions in many patients. Mild to moderate deep bites may benefit from incisor proclination. In adolescent patients, relative intrusion holds precedence as a treatment modality. Conversely, for non growing individuals, particularly those experiencing a deep bite and excessive gingival display due to maxillary incisor supraeruption, maxillary incisor intrusion emerges as the preferred therapeutic approach [4].

Factors such as the positioning of the incisor teeth, bracket-to-tooth relationships, and the lower vertical dimension are crucial determinants in the decision-making process. In a trial conducted by Nanda et al., it was asserted that the intrusion arch, when not directly engaged with the incisal brackets, exerts force in a notably distinct manner. When properly designed, this arch not only induces tipping of the molars in a posterior direction but also facilitates simultaneous incisor intrusion. Furthermore, a singular design is

capable of addressing multiple issues without necessitating wire alterations and with minimal or no adjustments to the appliances [3]. Important variables in the decision-making process include the lower vertical dimension, bracket-to-tooth linkages and the location of the incisor teeth [3].

Various appliances and methodologies exist for addressing deep bite orthodontic conditions. J-hook headgear, Ricketts' utility arch, Kalra Simultaneous Intrusion and Retraction (K-SIR) loop, Jayade's intrusion arch, Connecticut intrusion arches, and segmental intrusion arches like Burstone intrusion arch, as well as, mini-screws, are utilised as Temporary Anchorage Devices (TADs) [5].

The purpose of Jayade's intrusion arch and the modified three-piece design is to retain adequate anchoring while enabling the coordinated intrusion and retraction of proclined anterior teeth, correcting their axial inclinations.

The force application was founded on the idea that if intrusion along the tooth's long axis is necessary, it can be diverted lingually by applying a slight distal force. Only an intrusive force causes proclination. A slight distal force, combined with an intrusive force, also causes the anterior section to retract. Given the absence of substantiated evidence regarding the rate of intrusion, retraction, and the amount of periapical root resorption associated with the use of Jayade's intrusion arch and the modified three-piece intrusion arch, employing CBCT will help address this knowledge gap. The aim of the current study is to determine which of the two treatment procedures results in less harm to the surrounding structures and roots, as well as to better understand how successful both modalities are in treating deep bite.

Objectives:

- To evaluate the rate of intrusion and retraction using Jayade's and the modified three-piece intrusion arch at two, four, and six months after the application of intrusive and retractive forces.
- To compare the rate of intrusion and retraction caused by both intrusion arches at two, four, and six months after the application of intrusive and retractive forces.
- To evaluate the amount of root resorption of upper anterior teeth using Jayade's and the modified three-piece intrusion arch before the application of intrusive and retractive forces and at six months after the application of these forces.
- To compare the amount of root resorption of upper anterior teeth with both intrusion arches before the application of intrusive and retractive forces and at six months after the application of these forces.
- To evaluate the amount of anchorage loss of upper molars with both intrusion arches after the application of intrusive and retractive forces.
- To compare the amount of anchorage loss of upper molars with both intrusion arches after the application of intrusive and retractive forces.

Null hypothesis: There is no significant difference in the rates of intrusion, retraction, or the amount of periapical root resorption between Jayade's intrusion arch and the modified three-piece intrusion arch, as measured using CBCT.

Alternative hypothesis: There is a significant difference in the rates of intrusion and retraction, as well as in the amount of periapical root resorption, between Jayade's intrusion arch and the modified three-piece intrusion arch, as measured using CBCT.

REVIEW OF LITERATURE

The research primarily aims to evaluate which intrusion arch serves as the better treatment modality for simultaneous intrusion and retraction while minimising root resorption. Correcting a deep bite is of utmost importance and can lead to various complications. Goel P et al., assessed and compared the rates of intrusion and root resorption of maxillary incisors using three distinct intrusion techniques: Rickett's utility arch, Kalra's Simultaneous Intrusion and Retraction (K-SIR) arch, and the arch with a reverse curve of Spee. Based on the intrusion method employed, the patients were evenly divided into three groups: group I comprised subjects treated with the Rickett's utility arch, group II consisted of those treated with the K-SIR arch, and group III included individuals treated with the Reverse Curve of Spee (RCS) arch. The degree of intrusion and root resorption occurring during the intrusion phase was quantified for each participant. The study concluded that utility arches had higher rates of intrusion and root resorption, whereas K-SIR arches demonstrated substantially lower rates of root resorption, even when the rates of intrusion were almost equal [6].

Lekhadia DR and Hegde G treated a Class II Division 1 Subdivision case using a Modified Three-piece Base Arch for en masse retraction and intrusion. En masse retraction was accomplished in six months. They concluded that the shorter retraction time was attributed to a single step of retraction, in contrast to the Burstone three-piece incisor base arch, which retracts each canine separately before retracting the incisors [7].

Japneet et al., assessed the rate of intrusion and the amount of periapical root resorption in the adult population using temporary anchorage devices and the Connecticut Intrusion Arch (CIA). For this study, a sample of 20 patients will be divided into two groups. group A consisted of patients with bilateral TAD implants, while group B received the CIA to facilitate front tooth intrusion. Cone Beam Computed Tomography (CBCT) records were collected at the following time points: prior to implementing the intrusion mechanisms (T0), one month after implementation (T1), three months after implementation (T2) and six months after implementation (T3). The rate of intrusion and the volume of root resorption were evaluated and compared between these time periods [3].

MATERIALS AND METHODS

The present prospective, two-arm parallel interventional study will be conducted in the Outpatient Department, Department of Orthodontics and Dentofacial Orthopaedics, Sharad Pawar Dental College, Sawangi (Meghe), Wardha, Maharashtra, India, from September 2024 to February 2026. The Institutional Ethics Committee (IEC) of Datta Meghe Institute of Medical Sciences, Deemed to be University, has approved the current study (DMIHER(DU)/IEC/2024/248).

Inclusion criteria:

- Patients with a significant overbite (i.e., ≥5 mm).
- Patients of post-pubertal age.
- Patients with Class I or Class II overbite cases requiring extraction.

Exclusion criteria:

- Individuals with chronic or recurring periodontal conditions.
- Individuals who exhibit any systemic illnesses.
- Individuals who have previously received orthodontic treatment.
- Individuals with malformed bones.
- Individuals with deformed roots.

Sample size calculation:

$$n_1=\frac{(\sigma_1^2+\sigma_2^2/\kappa)(Z_{1-\alpha/2}+Z_{1-\beta})2}{\Delta^2}$$

Sample size formula for difference between two means:

Mean root resorption in Group-I=1.56

Mean root resorption in Group-II=1.08 [6]

σ1=SD of root resorption in Group-I=0.36

σ2=SD of root resorption in Group-II=0.41 [6]

For detecting mean difference of 0.48 i.e., Δ=1.56-1.08=0.48

K=1

N=(0.36*0.36 + 0.41*0.41) (1.96+0.84)2

0.48*0.48

=10.13=10

=10 patients needed in each group

Study Procedure

Individuals will be chosen at random from those attending the Orthodontics Outpatient Department (OPD) according to predetermined inclusion criteria. Treatment modalities will then be assigned to each patient using a randomised approach, including chits and a lucky draw system. For the study, a sample of twenty patients will be divided into two groups. Group A will receive Jayade's intrusion arch, while group B will receive a modified three-piece intrusion arch to allow for the retraction and intrusion of the anterior teeth. Eligible patients will provide informed consent, and the Institutional Ethics Committee (IEC) will approve the study before acquiring thorough case histories and study records for both participant groups.

All cases will start with the McLaughlin, Bennett and Trevisi (MBT) bracket system, which has three tubes on the upper teeth and a slot size of 0.022″×0.028″. After initial alignment and leveling, and extraction as determined by the case, the intrusion arch will be placed.

In group A:

- Jayade's intrusion arch will be provided. The Jayade's intrusion arch will be constructed with 0.016 AJ Wilcock wire [8].

In group B:

- A three-piece modified intrusion arch will be supplied.

The anterior segment of the modified three-piece intrusion arch will be constructed using a 0.021″×0.025″ stainless steel wire, while the two bilateral tip-back springs will be made of 0.017″×0.025″ TMA. For bilateral consolidation of the posterior segments, from the first premolar to the second molar, a passive stabilising wire of the same material will be employed. Additionally, an elastic chain will be stretched bilaterally from the molar hooks to the hooks of the anterior section [7].

Primary outcomes:

- Rate of intrusion and retraction of upper anterior teeth using Jayade's intrusion arch and the modified three-piece intrusion arch.
- Comparison of Jayade's intrusion arch and the modified three-piece intrusion arch in terms of the rate of intrusion and retraction.

Secondary outcomes:

- Amount of periapical root resorption of upper anterior teeth using Jayade's intrusion arch and the modified three-piece intrusion arch.
- Anchorage loss of upper molars using Jayade's intrusion arch and the modified three-piece intrusion arch.
- Comparison of Jayade's intrusion arch and the modified three-piece intrusion arch in terms of the amount of root resorption and anchorage loss.

At four predetermined intervals, all measurements will be taken using dental casts, which are made from putty or alginate impressions and cast in dental stone:

- T0: Before the initiation of intrusive and retractive forces
- T1: Two months subsequent to the commencement of intrusive and retractive forces
- T2: Four months subsequent to the commencement of intrusive and retractive forces
- T3: Six months subsequent to the commencement of intrusive and retractive forces

Additionally, lateral cephalograms and CBCT scans will be obtained at T0 and T3.

Intrusion analysis: This will be done by evaluating overbite correction at T0, T1, T2, and T3. The vertical distance between the upper central incisor and the lower central incisor will be directly assessed on plaster casts, measured from the center of their respective incisal edges. To facilitate precision, a pencil mark denoting the upper incisor edge will be inscribed on the buccal surface of the lower incisor [9]. On the lateral cephalogram, this will be measured from the nasal floor to the upper incisal edge (Burstone analysis) [10].

Retraction analysis: The distance between the apex of the upper canine and the medial extremity of the third palatal rugae will be measured to ascertain the anterior-posterior displacement of canines. The third rugae are regarded as stable landmarks, providing reliable references for assessing tooth movement [11]. On the lateral cephalogram, this will be measured from the PTM to the incisal edge [12].

Root resorption analysis: CBCT records will be obtained at:

- T0
- T3

The amount of root resorption will be evaluated and compared on CBCT scans at the T0 and T3 intervals [3].

Anchorage loss: The distance between the distal surface of the maxillary first molar and the medial extremity of the third palatal rugae will be measured to ascertain the anterior-posterior displacement of the molar.

The rates of intrusion and retraction, as well as, the amount of root resorption, will be evaluated and compared over specified time intervals. CBCT is a widely used technology in dental practice, known for its accuracy in predicting root volume and serving as the standard for distinguishing root anatomy. This precision primarily arises from its 3D imaging capabilities, as CBCT voxels exhibit isotropic characteristics [3].

STATISTICAL ANALYSIS

Statistical analysis will be conducted using descriptive and inferential statistics, including the Chi-square test and Student's paired and unpaired t-tests. The analysis will be performed using Statistical Package for Social Sciences (SPSS) software version 27.0 and GraphPad Prism version 7.0, with a significance level set at p-value <0.05.

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PARTICULARS OF CONTRIBUTORS:
1. Junior Resident, Department of Orthodontics and Dentofacial Orthopaedics, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.
2. Professor and Head, Department of Orthodontics and Dentofacial Orthopaedics, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.
3. Professor, Department of Orthodontics and Dentofacial Orthopaedics, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.
4. Junior Resident, Department of Orthodontics and Dentofacial Orthopaedics, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Bulbul Manoj Baid,
Junior Resident, Department of Orthodontics and Dentofacial Orthopaedics, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Higher Education and Research, Wardha-442001, Maharashtra, India.
E-mail: baidbulbul17@gmail.com

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