RESEARCH PAPER

Comparative Evaluation of Mini-Implant Assisted Orthodontic Mechanics in the Correction of Class II Malocclusion: A Clinical Study

Dr Dharini M[1], Dr. Smriti Kumari[2], Dr Abhishek Gupta[3], Dr Mousami Kundu[4], Dr Swati Arun Dhone[5], Dr Nishigandha Satpathi[6], Dr Shyam Gopal Jayaswal[7*]

[1]Senior Lecturer, Department of Orthodontics and Dentofacial Orthopaedics, Dayananda Sagar College of Dental Sciences
[2]Assistant professor, Department of Orthodontics and Dentofacial Orthopaedics, Geetanjali dental and research institute, Udaipur, Rajasthan
[3]Professor, Department of Orthodontics and Dentofacial Orthopaedics, Hitkarini Dental College And Hospital, Jabalpur Madhya Pradesh Oral & Maxillofacial Surgeon, Awadh Dental College and Hospital
[4]Assistant Professor, Bharati Vidyapeeth (deemed to be University) Dental College and hospital, Navi Mumbai
[6]Senior Resident in Periodontology, Hitech Dental College and Hospital
[7]Dental Surgeon , FACULTY OF DENTAL SCIENCES IMS BHU*

Corresponding Author: Dr. Shyam Gopal Jayaswal
Email: shyamjayaswal1993@gmail.com

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ABSTRACT
Class II malocclusion is one of the most prevalent orthodontic discrepancies and often requires effective anchorage control for successful correction. Conventional anchorage methods are frequently associated with undesirable tooth movement and dependence on patient compliance. The introduction of orthodontic mini-implants, also known as temporary anchorage devices (TADs), has significantly improved anchorage management in clinical practice.
This clinical study aimed to comparatively evaluate the treatment outcomes of mini-implant assisted orthodontic mechanics versus conventional anchorage methods in the correction of Class II malocclusion.
A total of 40 patients diagnosed with Class II malocclusion were divided into two groups: Group A (conventional anchorage) and Group B (mini-implant assisted anchorage). Clinical and cephalometric parameters, including overjet, molar relationship, ANB angle, and treatment duration, were assessed before and after treatment.
The results showed that Group B demonstrated a significantly greater reduction in overjet, improved molar relationship, enhanced skeletal correction, and shorter treatment duration ($p < 0.05$) compared to Group A.
Conclusion: Mini-implant assisted orthodontic mechanics provide superior anchorage control and treatment efficiency in the correction of Class II malocclusion.

Keywords: Class II malocclusion, mini-implants, temporary anchorage devices (TADs), orthodontics, anchorage control, cephalometrics.
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1. INTRODUCTION

Class II malocclusion is one of the most common orthodontic discrepancies encountered in clinical practice and is characterized by an anteroposterior discrepancy between the maxillary and mandibular arches. It often presents with increased overjet, a convex facial profile, and, in some cases, functional and aesthetic concerns that can significantly impact a patient's quality of life. The management of Class II malocclusion depends on multiple factors, including the patient's age, growth potential, and severity of the skeletal and dental components. Treatment approaches may include growth modification in growing patients, dental camouflage

*Author for Correspondence: Dr. Shyam Gopal Jayaswal (shyamjayaswal1993@gmail.com)

in mild to moderate cases, or orthognathic surgery in severe skeletal discrepancies (Costa et al., 1998). A critical determinant of successful orthodontic treatment is effective anchorage control, which refers to the resistance to unwanted tooth movement. Conventional anchorage methods, such as extraoral appliances (headgear) and intraoral elastics, have been widely used for decades. However, these methods are highly dependent on patient compliance and are often associated with limitations such as anchorage loss, prolonged treatment duration, and unpredictable outcomes. Uncontrolled anchorage can compromise treatment objectives and reduce overall efficiency (Park et al., 2004). The introduction of temporary anchorage devices (TADs), particularly mini-implants, has significantly transformed orthodontic biomechanics. These devices provide absolute or near-absolute anchorage by being temporarily fixed into the bone, thereby eliminating the need for patient-dependent anchorage reinforcement. Mini-implants allow for precise, controlled, and efficient tooth movement without generating reciprocal forces on adjacent teeth. As a result, they enhance treatment predictability, minimize unwanted movements, and may reduce overall treatment time.

Despite the growing popularity and clinical application of mini-implants, there remains a need for comparative clinical evaluation of their effectiveness relative to conventional anchorage systems, particularly in the management of Class II malocclusion (Park et al., 2006). Therefore, the present study aims to compare the treatment outcomes of conventional anchorage systems with mini-implant assisted orthodontic mechanics (Papadopoulos, 2008). The comparison focuses on key clinical and cephalometric parameters, including overjet reduction, molar relationship correction, skeletal changes, and treatment duration, to determine the relative efficiency and effectiveness of these two approaches.

2. MATERIALS AND METHODS

2.1 Study Design

This study was designed as a prospective comparative clinical study conducted over a period of 12–18 months.

2.2 Ethical Considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to the commencement of treatment.

2.3 Sample Size

A total of 40 patients were included in the study. The age of the participants ranged from 15 to 25 years.

2.4 Inclusion Criteria

Patients were included in the study based on the following criteria:

- Presence of skeletal or dental Class II malocclusion
- Overjet ≥ 5 mm
- Fully erupted permanent dentition

2.5 Exclusion Criteria

Patients were excluded if they met any of the following conditions:

- History of previous orthodontic treatment
- Presence of craniofacial anomalies
- Systemic conditions affecting bone metabolism

2.6 Group Allocation

Group	Treatment Approach
Group A	Conventional anchorage (elastics/headgear)
Group B	Mini-implant assisted anchorage

2.7 Treatment Protocol

Group A (Conventional Anchorage):

Patients were treated using fixed orthodontic appliances with MBT prescription. Class II elastics were employed to achieve correction.

Group B (Mini-Implant Assisted Anchorage):

Mini-implants were placed in the posterior maxilla to provide anchorage. En-masse retraction was performed using sliding mechanics, with controlled force application ranging between 150–200 grams.

2.8 Outcome Measures

Clinical Parameters:

- Reduction in overjet
- Correction of molar relationship

Cephalometric Parameters:

- SNA, SNB, and ANB angles
- Incisor inclination (U1-SN, IMPA)

Treatment Duration:

- Total treatment time was recorded for each patient

2.9 Statistical Analysis

Statistical analysis was performed using SPSS software. The following tests were applied:

- Paired t-test for within-group comparisons
- Independent t-test for between-group comparisons

The level of statistical significance was set at $p < 0.05$.

3. RESULTS

3.1 Overjet Reduction

Group	Pre-treatment (mm)	Post-treatment (mm)
Group A	7.5 ± 1.2	3.2 ± 0.8
Group B	7.6 ± 1.1	2.1 ± 0.6

A greater reduction in overjet was observed in Group B compared to Group A, and the difference was statistically significant ($p < 0.05$).

3.2 ANB Angle Change

Group	Pre-treatment (°)	Post-treatment (°)
Group A	5.8	3.9
Group B	5.9	2.8

Group B demonstrated a more pronounced reduction in ANB angle, indicating better skeletal correction compared to Group A ($p < 0.05$).

3.3 Treatment Duration

Group	Duration (months)
Group A	18 ± 2
Group B	14 ± 1.5

The overall treatment duration was shorter in Group B than in Group A, and this difference was statistically significant ($p < 0.05$).

4. DISCUSSION

The present study demonstrates that mini-implant assisted orthodontic mechanics provide superior clinical and skeletal outcomes compared to conventional anchorage methods in the correction of Class II malocclusion (Upadhyay et al., 2008). The findings revealed greater reduction in overjet, improved molar relationships, enhanced skeletal correction, and shorter treatment duration in the mini-implant group. These results highlight the effectiveness of temporary anchorage devices (TADs) in improving treatment efficiency and predictability.

4.1 Anchorage Control

Anchorage control is a fundamental aspect of orthodontic treatment planning and execution. In the present study, mini-implants provided absolute anchorage, thereby minimizing undesirable tooth movements commonly observed with conventional methods. Unlike traditional anchorage systems, which depend on patient compliance and may result in anchorage loss, mini-implants offer a stable and reliable source of anchorage (Kuroda et al., 2007). This allows for precise tooth movement without reciprocal forces acting on adjacent teeth. Consequently, the use of mini-implants reduces treatment variability and enhances overall biomechanical control.

4.2 Treatment Efficiency

A significant reduction in treatment duration was observed in the mini-implant group compared to the conventional anchorage group. This improvement in efficiency can be attributed to the direct application of orthodontic forces and the elimination of anchorage loss. Mini-implants facilitate en-masse tooth movement without the need for additional anchorage reinforcement, thereby streamlining the treatment process. In contrast, conventional methods often require longer treatment time due to reliance on patient cooperation and the potential need for correction of unintended tooth movements.

4.3 Skeletal vs Dental Effects

The greater reduction in ANB angle observed in the mini-implant group suggests improved control over dentoalveolar compensation and a more favorable skeletal response. This indicates that mini-implant assisted mechanics not only enhance dental correction but also contribute to better skeletal outcomes in Class II malocclusion treatment (Papageorgiou et al., 2012). The ability to control both dental and skeletal components is essential for achieving stable and aesthetically pleasing results.

Previous studies have also reported enhanced treatment outcomes with TAD-supported orthodontic mechanics in Class II correction. The findings of the present study are consistent with existing literature, further supporting the clinical reliability and effectiveness of mini-implants as an alternative to conventional anchorage systems.

5. LIMITATIONS

The present study has certain limitations that should be considered while interpreting the results. First, the sample size was relatively moderate, which may limit the generalizability of the findings to a larger population (Chen et al., 2007). Second, the study did not include a long-term follow-up period; therefore, the stability of the treatment outcomes could not be assessed over time. Third, the procedures involved in mini-implant placement and orthodontic mechanics are operator-dependent, which may introduce variability in treatment outcomes.

6. CONCLUSION

Within the limitations of the present study, it can be concluded that mini-implant assisted orthodontic

mechanics offer significant advantages over conventional anchorage methods in the management of Class II malocclusion. The use of mini-implants provides superior anchorage control, thereby minimizing unwanted tooth movement and enhancing the precision of orthodontic force application (Wilmes & Drescher, 2011). This results in more efficient treatment mechanics and improved overall outcomes.

The findings of this study demonstrated a greater reduction in overjet, improved molar relationships, and enhanced skeletal correction, as evidenced by favorable changes in cephalometric parameters such as the ANB angle. In addition, the treatment duration was significantly reduced in patients treated with mini-implant supported mechanics, highlighting their role in improving treatment efficiency and reducing overall treatment time.

Clinical Implication: Mini-implants can be considered a reliable and effective alternative to conventional anchorage systems in the correction of Class II malocclusion. Their ability to provide stable anchorage, reduce dependence on patient compliance, and enhance treatment predictability makes them a valuable tool in contemporary orthodontic practice.

7. FUTURE RECOMMENDATIONS

Although the present study provides encouraging results, further research is necessary to validate and expand these findings. Long-term clinical studies are required to assess the stability and retention of treatment outcomes achieved with mini-implant assisted orthodontic mechanics. Additionally, comparative studies evaluating mini-implants against other treatment modalities, such as functional appliances and skeletal anchorage systems, would provide a broader understanding of their relative effectiveness (Ludwig et al., 2011).

Furthermore, large-scale multicenter clinical trials involving diverse patient populations are recommended to improve the generalizability of the results. Future studies should also focus on evaluating patient-centered outcomes, cost-effectiveness, and potential complications associated with mini-implant use to provide a more comprehensive assessment of their clinical applicability.

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