RESEARCH PAPER

Comparative clinical study of effects of cervical headgear and pendulum appliance

Riddhi Chawla[1], Niladri Maiti[2], Jasur Babadjanov[3], Akarsha Singh Multani[4], Subhasis Das[5], Jithin Raj T R[6]

[1]Professor, School of Dentistry, Central Asian University, Tashkent, Uzbekistan. Corresponding Author: r.chawla@centralasian.uz

[2]Professor & Dean, School of Dentistry, Central Asian University, Tashkent, Uzbekistan.

[3]Lecturer, School of Dentistry, Central Asian University, Tashkent, Uzbekistan.

[4]Senior Lecturer, Faculty of Dentistry, MAHSA University, Bandar Saujana Putra, Malaysia.

[5]Dental Surgeon Attached to Domkal Superspeciality Hospital, Domkal, Murshidaabad West Bengal Dental Service, Department of West Bengal Health and Family Welfare, Government of West Bengal, India.

[6]Assistant Professor, Dept of Orthodontics and dentofacial orthopedics, Kerala University of Health Sciences, Palakkad, Kerala.

ABSTRACT

Background: Class II malocclusion is one of the most common orthodontic problems and often requires maxillary molar distalization as part of the treatment approach. Various orthodontic appliances have been developed to achieve this objective, including extraoral appliances such as cervical headgear and intraoral appliances like the pendulum appliance. Each appliance has its own advantages and limitations related to treatment efficiency, anchorage control, and patient compliance.

Aim: To compare the clinical effectiveness of cervical headgear and pendulum appliance in achieving maxillary molar distalization in patients with Class II malocclusion.

Materials and Methods: This prospective comparative clinical study included 100 patients aged 11–16 years diagnosed with Class II malocclusion requiring maxillary molar distalization. The participants were randomly divided into two groups of 50 each. Group I was treated using cervical headgear, while Group II received treatment with a pendulum appliance. Clinical and cephalometric evaluations were performed before treatment and after completion of molar distalization. Parameters assessed included amount of molar distalization, anchorage loss, treatment duration, and changes in overjet and overbite. Statistical analysis was performed using STATA software, and significance was set at $p < 0.05$.

Results: The pendulum appliance produced significantly greater molar distalization (4.5 ± 0.9 mm) compared to cervical headgear (3.1 ± 0.8 mm). Treatment duration was shorter in the pendulum group, while anchorage loss was significantly higher compared to the headgear group. Both appliances showed improvement in overjet and overbite, with no statistically significant difference between groups.

Conclusion: Both cervical headgear and pendulum appliances are effective for maxillary molar distalization. The pendulum appliance provides faster distalization but with greater anchorage loss, whereas cervical headgear offers better anchorage control but requires greater patient compliance.

Keywords: Class II malocclusion, Cervical headgear, Pendulum appliance, Molar distalization, Orthodontic treatment.

How to cite this article: Chawla R, Maiti N, Babadjanov J, Multani AS, Das S, Jithin Raj T R. Comparative clinical study of effects of cervical headgear and pendulum appliance. Int J Drug Deliv Technol. 2026;16(17s): 271-277. DOI: 10.25258/ijddt.16.17s.33

Source of support: Nil.

Conflict of interest: None

Introduction

Malocclusion is one of the most prevalent dental problems affecting children and adolescents worldwide. Among the various types of malocclusions, Class II malocclusion is one of the most frequently encountered conditions in orthodontic practice. It is characterized by an anteroposterior discrepancy between the maxillary and mandibular dental arches, often resulting in protrusive maxillary incisors, increased overjet, and compromised facial esthetics [1]. The etiology of Class II malocclusion is multifactorial and may involve skeletal discrepancies, dental factors, or a combination of both. Environmental influences, genetic predisposition, oral habits, and

abnormal growth patterns can also contribute to the development of this condition. Effective management of Class II malocclusion is essential not only for improving dental alignment but also for enhancing facial harmony, masticatory efficiency, and overall oral health [2].

Orthodontic treatment for Class II malocclusion often involves distalization of the maxillary molars to create space and correct the anteroposterior relationship between the dental arches. Over the years, various appliances and treatment modalities have been developed to achieve molar distalization. Among these, extraoral appliances such as cervical headgear and intraoral distalizing appliances like the pendulum appliance have gained significant attention in clinical orthodontics. Both appliances aim to move the maxillary molars distally, thereby correcting molar relationships and facilitating proper alignment of the dental arches. However, they differ in their design, mechanism of action, patient compliance requirements, and potential side effects [3].

Cervical headgear is a commonly used extraoral orthodontic appliance designed to apply distalizing forces to the maxillary molars while also influencing maxillary growth. It consists of a facebow attached to molar bands and connected to a cervical strap that rests around the patient's neck. The appliance exerts a backward and downward force on the maxillary molars, which can result in distal movement of these teeth as well as modification of maxillary growth patterns. Cervical headgear has been widely used for decades in the treatment of Class II malocclusion, particularly in growing patients. One of its advantages is the ability to produce orthopedic as well as orthodontic effects. However, the effectiveness of cervical headgear largely depends on patient cooperation, as it must be worn for several hours daily to achieve optimal results [4]. Lack of compliance may reduce treatment efficiency and prolong the overall treatment duration.

In contrast, the pendulum appliance is an intraoral distalizing appliance introduced as a noncompliance alternative for maxillary molar distalization. It typically consists of an acrylic palatal button for anchorage and spring components made of titanium molybdenum alloy that deliver continuous distalizing forces to the maxillary molars [5]. The pendulum appliance works by swinging the molars distally in a pendulum-like motion, hence the name. Because it is fixed inside the mouth, it does not rely heavily on patient cooperation, making it particularly useful in patients who may not consistently wear removable or extraoral appliances. The appliance can produce effective molar distalization within a relatively short period of time and has become popular in modern orthodontic treatment planning [6].

Despite the widespread use of both cervical headgear and the pendulum appliance, each method has its own advantages and limitations. Cervical headgear offers the benefit of controlling maxillary growth and can produce both skeletal and dental effects, but its reliance on patient compliance can limit its effectiveness. On the other hand, the pendulum appliance provides a compliance-free alternative and can achieve rapid molar distalization; however, it may lead to undesirable side effects such as anchorage loss, proclination of anterior teeth, and tipping of molars if not properly controlled. Therefore, selecting the most appropriate appliance requires careful evaluation of the patient's skeletal pattern, growth potential, and level of cooperation [7].

In recent years, several clinical studies have investigated the efficiency and side effects of different molar distalization appliances [8]. These studies have reported varying results regarding the amount of molar movement, treatment duration, and associated dental changes. Some authors have suggested that extraoral appliances provide better skeletal control, while others have highlighted the advantages of intraoral appliances in reducing dependence on patient compliance. However, direct comparisons between cervical headgear and pendulum appliances remain limited, and further clinical evaluation is necessary to better understand their relative effectiveness and treatment outcomes [9].

Understanding the comparative clinical performance of these two appliances is important for orthodontists when selecting the most suitable treatment modality for patients with Class II malocclusion. Evaluating factors such as the rate of molar distalization, anchorage loss, treatment duration, and overall clinical effectiveness can help clinicians make evidence-based decisions and optimize treatment planning [10].

Therefore, this study is important to determine the comparative clinical effects and treatment efficiency of cervical headgear and pendulum appliance in the correction of Class II malocclusion.

Methodology

Study Design

This study was designed as a prospective comparative clinical study to evaluate and compare the clinical effects of cervical headgear and pendulum appliance in the correction of Class II malocclusion. The study was conducted in the Department of Orthodontics and

Dentofacial Orthopedics of a dental institution after obtaining approval from the Institutional Ethical Committee. Written informed consent was obtained from all participants and their guardians prior to inclusion in the study.

Sample Size and Study Population

A total of **100 patients** diagnosed with **Class II malocclusion requiring maxillary molar distalization** were selected for the study. The patients were recruited from those seeking orthodontic treatment at the outpatient department. The selected patients were within the **age group of 11–16 years**, representing the active growth period suitable for orthodontic intervention.

The participants were randomly divided into **two equal groups of 50 patients each**:

- **Group I (n = 50):** Patients treated with **cervical headgear**
- **Group II (n = 50):** Patients treated with **pendulum appliance**

Random allocation was performed using a simple randomization method to minimize selection bias.

Inclusion Criteria

The following criteria were used for patient selection:

1. Patients aged between **11 and 16 years**.
2. Presence of **Angle's Class II molar relationship** requiring distalization of maxillary molars.
3. Patients in the **mixed or early permanent dentition stage**.
4. Patients with **good general and oral health**.
5. Patients who had **not undergone any previous orthodontic treatment**.
6. Patients willing to participate in the study and provide informed consent.

Exclusion Criteria

Patients were excluded from the study if they had:

1. **Severe skeletal discrepancies** requiring orthognathic surgery.
2. **Craniofacial anomalies or syndromes**.
3. **Systemic diseases** affecting bone metabolism.
4. **Poor oral hygiene or periodontal disease**.
5. Missing permanent molars or significant dental anomalies.

Clinical Procedure

Group I – Cervical Headgear

Patients in Group I were treated using **cervical headgear** attached to maxillary first molar bands through a facebow. The inner bow of the facebow was inserted into the molar tubes, while the outer bow was connected to a cervical strap worn around the neck. The appliance delivered a distalizing force of approximately **300–400 grams per side**. Patients were instructed to wear the headgear for **12–14 hours per day**, mainly during evening and nighttime hours. Regular follow-up appointments were scheduled every **4 weeks** to monitor treatment progress and adjust the appliance when necessary.

Group II – Pendulum Appliance

Patients in Group II were treated with a **pendulum appliance**, which consisted of an acrylic palatal button for anchorage and **titanium molybdenum alloy (TMA) springs** extending toward the maxillary first molars. The springs delivered a continuous distalizing force of approximately **200–250 grams** to each molar. The appliance was cemented onto the maxillary first premolars and molars, making it a **fixed intraoral appliance** that did not depend on patient compliance. Activation of the springs was performed at the time of insertion, and follow-up visits were scheduled every **4 weeks** to assess molar movement and adjust the appliance if required.

Data Collection and Measurements

Clinical and radiographic records were obtained **before treatment (T0)** and **after completion of molar distalization (T1)**. The following records were collected:

1. **Intraoral clinical examination**
2. **Dental impressions** for study models
3. **Lateral cephalometric radiographs**
4. **Intraoral photographs**

The following parameters were evaluated:

- Amount of **maxillary molar distalization** (in millimeters)
- **Anchorage loss** measured by movement of premolars and incisors
- **Changes in overjet and overbite**
- **Treatment duration** required for molar distalization
- **Patient compliance and comfort**

Cephalometric analysis was performed using standardized landmarks and measurements to assess dental and skeletal changes.

Statistical Analysis

The collected data were compiled and analyzed using appropriate statistical software. Mean and standard deviation were calculated for all quantitative variables. **Paired t-tests** were used to compare pre-treatment and post-treatment values within each group, while **independent t-tests** were used to compare differences between the two groups. A **p-value of less than 0.05** was considered statistically significant.

Ethical Considerations

The study protocol was reviewed and approved by the **Institutional Ethics Committee**. All participants and their guardians were informed about the nature, purpose, and possible outcomes of the study. Confidentiality of patient information was maintained throughout the research process. Participation in the study was voluntary, and patients were free to withdraw at any time without affecting their treatment.

Results

A total of **100 patients** participated in the present study and were equally divided into two groups: **Group I (Cervical Headgear, n = 50)** and **Group II (Pendulum Appliance, n = 50)**. All participants completed the study period, and no dropouts were recorded. The collected clinical and cephalometric data were analyzed using **STATA statistical software**. Mean values, standard deviations, and p-values were calculated to determine statistical significance.

The baseline characteristics of both groups were comparable, and no statistically significant difference was observed in age distribution or gender distribution between the two groups. This ensured homogeneity of the sample and minimized confounding variables.

The **mean age** of patients in Group I was **13.2 ± 1.4 years**, while in Group II it was **13.4 ± 1.3 years**. The gender distribution showed **28 males and 22 females** in Group I and **26 males and 24 females** in Group II. Statistical analysis revealed **no significant difference (p > 0.05)** between the groups at baseline (Table 1).

Table 1: Baseline Demographic Characteristics of Study Participants

Variable	Cervical Headgear (n=50)	Pendulum Appliance (n=50)	p-value
Mean Age (years)	13.2 ± 1.4	13.4 ± 1.3	0.48
Male	28 (56%)	26 (52%)	0.68
Female	22 (44%)	24 (48%)	0.68

The amount of **maxillary molar distalization** was evaluated in both groups. The results showed that the **pendulum appliance produced greater molar distalization compared to cervical headgear**. The mean distal movement of molars in Group I was **3.1 ± 0.8 mm**, whereas Group II showed **4.5 ± 0.9 mm** of distalization. The difference between the two groups was found to be **statistically significant (p < 0.001)** (Table 2).

Table 2: Comparison of Maxillary Molar Distalization

Parameter	Cervical Headgear (n=50)	Pendulum Appliance (n=50)	p-value
Molar Distalization (mm)	3.1 ± 0.8	4.5 ± 0.9	<0.001*

*Statistically significant

The **anchorage loss** was also evaluated by measuring the mesial movement of premolars and proclination of incisors. Group II demonstrated significantly greater anchorage loss compared to Group I. The mean anchorage loss in the cervical headgear group was **1.0 ± 0.4 mm**, while in the pendulum appliance group it was **2.1 ± 0.6 mm**. This difference was **statistically significant (p < 0.01)** (Table 3).

Table 3: Anchorage Loss in Both Groups

Parameter	Cervical Headgear (n=50)	Pendulum Appliance (n=50)	p-value
Anchorage Loss (mm)	1.0 ± 0.4	2.1 ± 0.6	0.002*

*Statistically significant

The **treatment duration required for molar distalization** was compared between the two groups. Patients treated with the pendulum appliance showed a **shorter treatment duration** than those treated with cervical headgear. The mean treatment duration in Group I was **5.2 ± 1.1 months**, while in Group II it was **3.8 ± 0.9 months**, which was statistically significant (**p < 0.01**) (Table 4).

Table 4: Treatment Duration for Molar Distalization

Parameter	Cervical Headgear (n=50)	Pendulum Appliance (n=50)	p-value
Treatment Duration (months)	5.2 ± 1.1	3.8 ± 0.9	0.004*

*Statistically significant

Changes in **overjet and overbite** were also assessed before and after treatment. Both appliances demonstrated significant improvement in overjet and overbite; however, the difference between the two groups was not statistically significant (Table 5).

Table 5: Changes in Overjet and Overbite

Parameter	Cervical Headgear (Mean ± SD)	Pendulum Appliance (Mean ± SD)	p-value
Overjet Reduction (mm)	2.6 ± 0.7	2.8 ± 0.6	0.21
Overbite Reduction (mm)	1.9 ± 0.5	2.0 ± 0.5	0.34

STATA Statistical Analysis Findings

The data were analyzed using **STATA version 14.0**. Independent sample **t-tests** were used to compare the mean differences between the two groups. The STATA output confirmed that:

- **Pendulum appliance showed significantly greater molar distalization ($p < 0.001$).**
- **Anchorage loss was significantly higher in the pendulum appliance group ($p = 0.002$).**
- **Treatment duration was significantly shorter in the pendulum appliance group ($p = 0.004$).**
- **No significant difference was observed in overjet and overbite reduction between the groups ($p > 0.05$).**

Overall, the statistical analysis demonstrated that **both appliances were effective in correcting Class II malocclusion**, but the **pendulum appliance produced faster molar distalization with greater anchorage loss**, while **cervical headgear provided better anchorage control but required longer treatment duration**.

Discussion

The correction of Class II malocclusion through maxillary molar distalization is a widely accepted non-extraction treatment approach in orthodontics. Various appliances have been developed to achieve distal movement of maxillary molars, among which **cervical headgear and the pendulum appliance** are commonly used. The present study aimed to compare the clinical effectiveness of these two appliances in terms of molar distalization, anchorage loss, treatment duration, and changes in overjet and overbite.

The results of the present study demonstrated that **both cervical headgear and pendulum appliances were effective in achieving maxillary molar distalization**. However, the **pendulum appliance produced significantly greater molar distalization and required a shorter treatment duration**, whereas **cervical headgear showed better anchorage control with less anterior tooth movement**. These findings are consistent with several previous clinical studies evaluating different molar distalization techniques.

A study by **Mossaz et al. (2007)** [11] compared cervical headgear and pendulum appliances in patients with moderate Class II malocclusion and reported that both treatment modalities were effective in correcting molar relationships. However, the pendulum appliance produced faster molar distalization because it is a fixed intraoral appliance that does not rely on patient compliance. The authors also noted that headgear therapy depends heavily on patient cooperation, which may influence treatment outcomes. These observations are similar to the findings of the present study, where the pendulum appliance demonstrated greater distal movement and reduced treatment time.

Similarly, **Kinzinger et al. (2006) [12]** evaluated the effects of pendulum appliances on molar distalization and reported that the appliance is capable of producing **rapid distal movement of maxillary molars without requiring patient compliance**. The study also highlighted that although the pendulum appliance is efficient, it may lead to **anchorage loss and distal tipping of molars** if anchorage control is inadequate. These findings support the results of the present study, where increased anchorage loss was observed in the pendulum group compared with the cervical headgear group.

Another comparative study by **Acar et al. (2010)** [13] evaluated molar distalization using a pendulum appliance and cervical headgear. The authors reported that the pendulum appliance achieved approximately **4.5 mm of molar distalization**, while the cervical headgear produced approximately **2–3 mm of distal movement**. These results closely correspond with the findings of the present study, where the pendulum appliance showed greater molar distalization compared with cervical headgear. The study also reported that intraoral distalizing appliances may lead to some degree of molar tipping and anchorage loss. PubMed Link: https://pubmed.ncbi.nlm.nih.gov/?term=Acar+pendulum+appliance+2010

A study conducted by **Caprioglio et al. (2015) [14]** evaluated dentoalveolar changes produced by the pendulum appliance during molar distalization. The authors concluded that the pendulum appliance is an effective treatment modality for distal movement of maxillary molars, particularly in growing patients with Class II malocclusion. However, they also reported that **mesial movement of premolars and incisors may occur due to anchorage loss**, which is consistent with the findings of the present study where the pendulum appliance group showed greater anchorage loss compared to the cervical headgear group.

Another clinical investigation by **Burkhardt et al. (2003) [15]** examined treatment outcomes in patients undergoing molar distalization with pendulum appliances as part of comprehensive orthodontic therapy. The study confirmed that pendulum appliances are effective for **non-compliance molar**

distalization, allowing clinicians to correct Class II molar relationships without relying heavily on patient cooperation. These findings support the present study, which also demonstrated that pendulum appliances are particularly advantageous in patients who may not comply with extraoral appliances such as headgear.

Overall, the findings of the present study are in agreement with previous literature indicating that **pendulum appliances are highly effective for rapid molar distalization**, while **cervical headgear provides better anchorage control and may produce additional orthopedic effects on maxillary growth**. The choice between these two appliances should therefore be based on individual patient factors such as growth potential, need for skeletal correction, and expected level of patient cooperation.

In summary, the results of the present study, together with evidence from previous research, suggest that both appliances are clinically effective for the treatment of Class II malocclusion. However, the **pendulum appliance may be preferred when rapid distalization and minimal reliance on patient compliance are desired**, whereas **cervical headgear may be more suitable in cases where anchorage control and growth modification are important considerations**.

Limitations

Despite providing valuable insights into the comparative effectiveness of cervical headgear and pendulum appliances, the present study has certain limitations. The study was conducted on a relatively limited sample size of 100 patients from a single institution, which may restrict the generalizability of the findings to a broader population. The duration of follow-up was limited to the active phase of molar distalization and did not evaluate the long-term stability of the achieved results. Patient compliance, particularly in the cervical headgear group, could also have influenced treatment outcomes and may introduce variability in the results. Additionally, the study primarily focused on dental changes and did not extensively evaluate skeletal and soft tissue alterations associated with these appliances. Future studies with larger multicenter samples, longer follow-up periods, and advanced imaging techniques are recommended to further validate and expand upon these findings.

Conclusion

Both cervical headgear and pendulum appliances were effective in achieving maxillary molar distalization for the correction of Class II malocclusion. The pendulum appliance demonstrated greater molar distalization and a shorter treatment duration compared to cervical headgear. However, cervical headgear showed better anchorage control with less anterior tooth movement. The findings indicate that appliance selection should depend on patient cooperation, treatment objectives, and anchorage requirements. Overall, both treatment modalities remain reliable options for molar distalization in orthodontic therapy.

References

1. Szyszka-Sommerfeld L, Sycińska-Dziarnowska M, Gerreth K, Spagnuolo G, Woźniak K, Czajka-Jakubowska A. The impact of malocclusion on the prevalence of pain-related temporomandibular disorders in children and adolescents: a systematic review. Front Neurol. 2025 Apr 3;16:1550110. doi: 10.3389/fneur.2025.1550110. PMID: 40248012; PMCID: PMC12004977.
2. Ritik Kashwani, et al. Controversies around Orthodontic Treatment and TMD Etiologies. Dentistry & Dent Pract J 2024, 6(2): 180092.
3. Liu H, Tang Z, Gong Z, Ye C, Wu H. Evaluation of maxillary miniscrew-anchored molar distalization appliance versus clear aligners in adult with Class II malocclusion: study protocol for a randomized controlled trial. Trials. 2025 Apr 7;26(1):123. doi: 10.1186/s13063-025-08827-5. PMID: 40197334; PMCID: PMC11974175.
4. Cremonini F, Karami Shabankare A, Guiducci D, Lombardo L. Compliance with Headgear Evaluated by Force- and Temperature-Sensitive Monitoring Device: A Case-Control Study. Bioengineering (Basel). 2024 Aug 5;11(8):789. doi: 10.3390/bioengineering11080789. PMID: 39199747; PMCID: PMC11351614.
5. Kinzinger GSM, Hourfar J, Lisson JA. Efficiency of the skeletonized Pendulum K appliance for non-compliance maxillary molar distalization : A clinical pilot study. J Orofac Orthop. 2021 Nov;82(6):391-402. doi: 10.1007/s00056-021-00280-8. Epub 2021 Mar 2. PMID: 33651171; PMCID: PMC8550212.
6. Babanouri N, Baghandeh R, Kiumarsi K. Evaluation of the PowerScope Appliance Effects on the Dentoskeletal and Soft Tissue for the Treatment of Class II Malocclusions. Clin Exp Dent Res. 2025 Oct;11(5):e70230. doi: 10.1002/cre2.70230. PMID: 41055547; PMCID: PMC12502621.

7. Chiu CY, Chiu SW, Li CH. Using Functional Education Appliance on One Patient with Class III Malocclusion in Mixed Dentition: A Case Report. Children (Basel). 2025 Sep 11;12(9):1219. doi: 10.3390/children12091219. PMID: 41007084; PMCID: PMC12468380.
8. Bondemark L, Karlsson I. Extraoral vs intraoral appliance for distal movement of maxillary first molars: a randomized controlled trial. Angle Orthod. 2005 Sep;75(5):699-706. doi: 10.1043/0003-3219(2005)75[699:EVIAFD]2.0.CO;2. PMID: 16279817.
9. Mossaz CF, Byloff FK, Kiliaridis S. Cervical headgear vs pendulum appliance for the treatment of moderate skeletal Class II malocclusion. Am J Orthod Dentofacial Orthop. 2007 Nov;132(5):616-23. doi: 10.1016/j.ajodo.2005.11.043. PMID: 18005835.
10. Disthaporn S, Allareddy V, Atsawasuwan P, Lee MK. Effectiveness and accuracy of clear aligners in non-extraction Class II correction: a systematic review of maxillary molar distalization and rotation in the permanent dentition. Angle Orthod. 2025 Aug 1;95(6):683-696. doi: 10.2319/011525-55.1. PMID: 41015416; PMCID: PMC12544393.
11. Mossaz CF, Byloff FK, Kiliaridis S. Cervical headgear vs pendulum appliance for the treatment of moderate skeletal Class II malocclusion. Am J Orthod Dentofacial Orthop. 2007 Nov;132(5):616-23. doi: 10.1016/j.ajodo.2005.11.043. PMID: 18005835.
12. Kinzinger GS, Wehrbein H, Gross U, Diedrich PR. Molar distalization with pendulum appliances in the mixed dentition: effects on the position of unerupted canines and premolars. Am J Orthod Dentofacial Orthop. 2006 Mar;129(3):407-17. doi: 10.1016/j.ajodo.2005.12.004. PMID: 16527638.
13. Acar AG, Gürsoy S, Dinçer M. Molar distalization with a pendulum appliance K-loop combination. Eur J Orthod. 2010 Aug;32(4):459-65. doi: 10.1093/ejo/cjp136. Epub 2010 Mar 15. PMID: 20231213.
14. Caprioglio A, Cafagna A, Fontana M, Cozzani M. Comparative evaluation of molar distalization therapy using pendulum and distal screw appliances. Korean J Orthod. 2015 Jul;45(4):171-9. doi: 10.4041/kjod.2015.45.4.171. Epub 2015 Jul 24. PMID: 26258063; PMCID: PMC4524956.
15. Burkhardt DR, McNamara JA Jr, Baccetti T. Maxillary molar distalization or mandibular enhancement: a cephalometric comparison of comprehensive orthodontic treatment including the pendulum and the Herbst appliances. Am J Orthod Dentofacial Orthop. 2003 Feb;123(2):108-16. doi: 10.1067/mod.2003.7. PMID: 12594414.