



CEPHALOMETRIC COMPARISON OF TREATMENT OUTCOMES WITH CLEAR ALIGNERS VERSUS FIXED APPLIANCES IN ANTERIOR DENTAL OPEN BITE PATIENTS-A RANDOMIZED CONTROLLED TRIAL

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Abstract: Background: **Objective:** To compare post-treatment mandibular plane angle between fixed appliances and clear aligners in patients having anterior open bite. **Materials and Methods:** A randomized controlled trial was conducted on 218 participants aged 15–25 years (109 fixed appliances, 109 aligners) at Akhtar Saeed Medical and Dental College from May to October 2025. Patients had anterior open bite with a normo-divergent skeletal pattern, fully erupted teeth, and healthy periodontium. Exclusion criteria included cleft conditions, craniofacial syndromes, prior orthodontic treatment, or need for orthognathic surgery or skeletal anchorage. Participants were randomly assigned to fixed or aligner groups. Mandibular plane angle was measured on pre- and post-treatment lateral cephalograms after nine months. Data were analyzed using independent t-tests, with stratification by age and gender; significance was set at $p < 0.05$. **Results:** Pre-treatment mandibular plane angles were similar between groups. After treatment, fixed appliances reduced the mandibular plane angle more than aligners ($42.83^\circ \pm 4.10$ vs $44.79^\circ \pm 5.21$; $p < 0.001$). Among females, the reduction was greater with fixed appliances ($42.60^\circ \pm 4.00$ vs $44.66^\circ \pm 4.99$; $p = 0.010$). In the 21–25-year age group, fixed appliances also produced a larger decrease than aligners ($42.55^\circ \pm 3.75$ vs $45.39^\circ \pm 5.34$; $p < 0.001$). No significant differences were observed in males or in the 15–20-year age group. **Conclusion:** Fixed appliances achieve stronger vertical control than clear aligners in anterior open bite patients, especially in females and older patients (21–25 years).

Keywords: Anterior open bite, Fixed appliances, Clear aligners, Mandibular plane angle

INTRODUCTION

Anterior dental open bite is one of the most difficult problems to treat in orthodontics due to its diagnosis and long-term retention of treated patients because of

its high tendency to relapse.¹ Over the past two decades, there has been a significant increase in the utilization of clear aligners as an alternative treatment for mild to moderate dental malalignment, in place of

fixed appliances.² This approach offers numerous advantages compared to traditional orthodontic treatment, such as enhanced aesthetics, reduced patient discomfort, easier periodontal care, and decreased time spent in dental chairs as well as fewer emergency visits for dentists.^{2, 3}

For many years, fixed orthodontic appliances have been considered the preferred choice. However, clear aligners have gained significant popularity due to the growing demand for improved aesthetics, prompting researchers to focus more on clear aligner therapy.^{4, 5} Furthermore, thermoplastic aligners offer enhanced comfort, easier maintenance of oral hygiene, and a reduction in root resorption compared to traditional fixed appliances.⁴

In more recent times, clinicians have started incorporating clear aligners to address the vertical dimension issue and prevent the development of posterior open bites at the end of clear aligner treatment. Since its introduction by Align Technology in 1999, the clear aligner system has gained popularity among adult patients as a preferred treatment option.⁶ This is mainly attributed to the improved aesthetics and comfort offered by removable clear aligners compared to traditional fixed appliances.⁷ Previous studies have highlighted the limitations of Invisalign treatment in managing complex malocclusions.⁸ However, with the introduction of various improvements (G7 series) in recent years, several clinical case reports have demonstrated successful vertical control using clear aligners. Some clinicians assert that the clear aligner system can effectively treat open bites in individuals with high mandibular plane angles without extruding posterior teeth.⁹ They achieve this by incorporating intrusive forces and utilizing the thickness of the plastic material between the teeth.

A previous study was conducted comparing aligners and fixed appliances for the treatment of anterior open bite in hyper divergent cases. The post-treatment mandibular plane angle in the aligner was 45.15 ± 5.310 and in fixed appliances was 43.26 ± 4.620 .¹⁰

Therefore, the purpose this study conducted in Akhtar Saeed Medical and dental college will compare the efficacy of aligners with fixed appliance treatment and allows better understand the treatment outcomes in patients with open bite which will greatly aid clinician in the management of these patients. It is generally considered that aligners have a bite plane and an intrusive effect, which may correct open bite. Therefore, a well-controlled clinical trial can answer this question. Furthermore, there have been no previous studies on this subject, and variations in outcomes can be expected due to compliance and genetic factors. This study aims to provide guidelines in this area.

The objective was to compare post treatment mandibular plane angle between fixed appliances vs

clear aligner therapy in patients with Anterior dental open bite.

MATERIALS AND METHODS

This randomized controlled trial (parallel) was conducted at Akhtar Saeed Medical and Dental College (Orthodontics Department) using a non-probability consecutive sampling technique. This research was conducted in a duration of Six months from 1st May 2025 to 30th October 2025 following the consent of the synopsis of the research by the College of Physicians and Surgeons Pakistan (CPSP). The study is conducted under the consent of the Institutional Review Board, Akhtar Saeed Medical and Dental College Lahore, with approval no: [Ref. No. AMDC/Dental/ Ortho/1696-B) date 08-June-2023, on 218 participants (109 treated with fixed appliances and 109 with aligners). This trial was not registered with any clinical trial registry.

The sample size was 218 participants (109 fixed appliances and 109 aligners), calculated using OpenEpi at a 95% confidence level and 80% power, based on the population mean mandibular plane angle (43 ± 4.620 in the fixed appliance group) and the anticipated population mean (45.15 ± 5.310 in the aligner group) from a previous study.¹⁰

The study included patients with anterior open bite, which was assessed clinically and considered positive in cases of lack of overlap or negative overbite, a normo-divergent skeletal pattern with a tendency toward high angle, proper use of aligners for 22 hours daily throughout treatment, age between 15 and 25 years, fully erupted teeth, and a healthy periodontium. Patients were excluded if they lacked cephalometric radiographs, had cleft conditions, craniofacial syndromes, required correction by orthognathic surgery for open bite greater than 8 mm, needed temporary anchorage devices for open bite greater than 6 mm, had previous orthodontic treatment, or were allergic to nickel or latex, as nickel is found in fixed appliances and latex in elastomeric ligatures.

The study was approved by the ethical board of Akhtar Saeed Medical and Dental College Hospital. Each participant received a full explanation of the study, and written informed consent was obtained. Participants were assured that their personal information would remain confidential. Those who met the inclusion criteria were randomly assigned to two groups—Group I (aligners) and Group II (fixed appliances)—using block randomization.

In Group I, the laboratory fabricated aligners according to the orthodontic consultant's treatment plan, and patients were instructed to wear each aligner for at least 22 hours per day. In Group II, metallic pre-adjusted fixed appliances were bonded using light-cure composite by a second-year FCPS trainee, a senior trainee, or a consultant. A single examiner, a second-year FCPS trainee, measured the mandibular

plane angle on pre- and post-treatment cephalograms after nine months of treatment. Age and gender were also recorded. Randomization and strict inclusion criteria helped control for bias and confounding factors.

Data analysis was conducted using R software version 4.3.3. For continuous data, such as age and pre- and post-treatment mandibular plane angle, the mean and standard deviation (and median with interquartile range, where appropriate) were calculated. Categorical data, such as gender, were analyzed by determining frequency and percentage. To compare

the outcome variable (post-treatment mandibular plane angle), an independent samples t-test was utilized. Stratification based on age group and gender was performed to observe any effect modifiers, and post-stratification independent samples t-tests were executed. The normality assumption of the outcome variables was assessed using the Shapiro-Wilk test. $p < 0.05$ was considered statistically significant.

RESULTS

The groups were comparable at baseline. Mean age was similar between aligner (20.97 ± 2.92 years) and fixed appliance patients (20.44 ± 3.00 years; $p = 0.19$). Gender distribution did not differ (female: 59.6% vs 60.6%; $p = 0.89$). Age categories were also comparable, with no significant differences between groups ($p = 0.13$). (Table 1)

Pre-treatment mandibular plane angles were similar between the aligner and fixed appliance groups ($44.43^\circ \pm 4.91$ vs $44.87^\circ \pm 5.21$; $p = 0.52$). After treatment, the fixed appliance group showed a significantly lower mandibular plane angle compared with the aligner group ($42.83^\circ \pm 4.10$ vs $44.79^\circ \pm 5.21$; $p < 0.001$). (Table 2)

Among females, pre-treatment mandibular plane angles were similar between aligner and fixed appliance users ($45.11^\circ \pm 4.56$ vs $44.50^\circ \pm 5.10$; $p = 0.50$). However, after treatment, females in the fixed group showed a significantly lower mandibular plane angle compared with those in the aligner group ($42.60^\circ \pm 4.00$ vs $44.66^\circ \pm 4.99$; $p = 0.010$). Among males, pre-treatment angles did not differ significantly between groups ($43.42^\circ \pm 5.29$ vs $45.44^\circ \pm 5.40$; $p = 0.082$), and post-treatment angles also showed no significant difference ($44.97^\circ \pm 5.58$ vs $43.18^\circ \pm 4.27$; $p = 0.10$). (Table 3)

In the 15–20-year age group, pre-treatment mandibular plane angles were similar between aligner and fixed appliance patients ($44.46^\circ \pm 4.60$ vs $45.91^\circ \pm 5.03$; $p = 0.14$), and post-treatment angles did not differ significantly ($43.87^\circ \pm 4.93$ vs $43.11^\circ \pm 4.44$; $p = 0.40$). In the 21–25-year age group, pre-treatment angles were comparable ($44.41^\circ \pm 5.14$ vs $43.85^\circ \pm 5.24$; $p = 0.60$), but post-treatment mandibular plane angle was significantly higher in the aligner group compared with the fixed group ($45.39^\circ \pm 5.34$ vs $42.55^\circ \pm 3.75$; $p < 0.001$). (Table 4)

Table 1. Baseline characteristics of patients treated with aligners and fixed appliances

Characteristic	Aligner (n = 109)	Fixed (n = 109)	p value
Age, years (Mean $\pm$ SD)	20.97 ± 2.92	20.44 ± 3.00	0.19 ¹
Gender			0.89 ²
• Female	65 (59.6%)	66 (60.6%)	
• Male	44 (40.4%)	43 (39.4%)	
Age category			0.13 ²
• 15–20 years	43 (39.5%)	54 (49.5%)	
• 21–25 years	66 (60.5%)		

¹Independent two-samples *t*-test, ²Pearson's chi-squared test

Table 2. Comparison of mandibular plane angle between aligner and fixed appliance groups

Characteristic	Aligner (n = 109)	Fixed (n = 109)	p value
Pre-treatment mandibular plane angle, ° (Mean $\pm$ SD)	44.43 ± 4.91	44.87 ± 5.21	0.52 ¹
Post-treatment mandibular plane angle, ° (Mean $\pm$ SD)	44.79 ± 5.21	42.83 ± 4.10	<0.001 ¹

¹Independent two-samples *t*-test

Table 3. Comparison of mandibular plane angle by gender in aligner and fixed appliance groups

Characteristic	Female		p value	Male		p value
	Aligner (n = 65)	Fixed (n = 66)		Aligner (n = 44)	Fixed (n = 43)	
Pre-treatment mandibular plane angle, ° (Mean $\pm$ SD)	45.11 ± 4.56	44.50 ± 5.10	0.50 ²	43.42 ± 5.29	45.44 ± 5.40	0.082 ²

Post-treatment mandibular plane angle, ° (Mean ± SD)	44.66 ± 4.99	42.60 ± 4.00	0.010 ²	44.97 ± 5.58	43.18 ± 4.27	0.10 ²
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¹Mean (SD), ² two-sample *t*-test.

Table 4. Comparison of mandibular plane angle by age category in aligner and fixed appliance groups

Characteristic	15–20 years		p value	21–25 years		p value
	Aligner (n = 43)	Fixed (n = 54)		Aligner (n = 66)	Fixed (n = 55)	
Pre-treatment mandibular plane angle, ° (Mean ± SD)	44.46 ± 4.60	45.91 ± 5.03	0.14 ²	44.41 ± 5.14	43.85 ± 5.24	0.60 ¹
Post-treatment mandibular plane angle, ° (Mean ± SD)	43.87 ± 4.93	43.11 ± 4.44	0.40 ²	45.39 ± 5.34	42.55 ± 3.75	<0.001 ¹

¹two-sample *t*-test.

DISCUSSION

The current study showed that fixed appliances provide significantly greater reduction in mandibular plane angle than clear aligners over the course of treatment in anterior open bite patients. This difference particularly among females and in the older age group (21–25 years). While pre treatment vertical skeletal parameters such as mandibular plane angle were equivalent in both groups which shows that our pretreatment groups were not confounded.

A plausible explanation for this finding lies in the mechanics of the two treatment modalities. Fixed appliances apply continuous forces. They can use auxiliaries, such as intermaxillary elastics or vertical mechanics, and sometimes skeletal anchorage. These factors promote molar intrusion or differential extrusion and lead to counterclockwise mandibular rotation. Clear aligners rely on programmed tooth movements planned in software, like ClinCheck. They cover posterior teeth and act as a posterior bite plane, which can aid in bite opening. However, they usually close open bites by retroclining or extruding incisors.^{11, 12} The forces are intermittent, root control is limited, and skeletal effects are less predictable. These factors may limit vertical skeletal changes compared to fixed appliances.¹³

Our findings are consistent with previous studies. Garnett et al.¹⁰ studied hyperdivergent adults with anterior open bite. They found no significant difference in mandibular plane angle change between fixed appliances and clear aligners, both groups controlled vertical dimension mainly by retroclining incisors rather than changing molar position. Their study had a small sample, 17 fixed and 36 aligner patients, and did not analyze differences by sex or age. Another study by Haileet al.¹⁴ showed similar moderate vertical changes, suggesting aligners do not automatically give better vertical control. In adult non-extraction Class I cases, a longitudinal study found clear aligners did not do better than fixed appliances in keeping vertical dimension.

A multicenter study comparing Invisalign with fixed appliances combined with miniplaque-supported

posterior intrusion (MSPI) found that MSPI produced greater molar intrusion (1.5 mm) and a larger reduction in mandibular plane angle (–1.95°) than Invisalign. In contrast, Invisalign correction relied more on incisor movement. This aligns with our findings, suggesting that fixed mechanics, particularly with skeletal anchorage, can achieve stronger vertical skeletal effects.¹⁵ Conversely, a study on clear aligner treatment without skeletal anchorage reported only modest molar intrusion (~0.36 mm), with overbite correction mainly through incisor movement. This supports the idea that aligners control vertical dimension mostly through dental changes rather than skeletal modification.¹⁶

Evidence indicates that clear aligners can, in some cases, produce mild upper molar intrusion (around 0.3 mm on average) even without specific intrusion planning, possibly due to a “bite block” effect. However, these changes are generally small and do not lead to strong counterclockwise rotation of the mandible, which aligns with our finding that aligners reduced mandibular plane angle less than fixed appliances.¹⁷ Overall, our results provide high-quality (randomized) evidence confirming and quantifying the superior vertical control achievable with fixed appliances, particularly in subgroups such as females and older patients who may respond differently to open bite treatment.

CONCLUSION

This study shows that fixed appliances reduce the mandibular plane angle more than clear aligners in patients with anterior open bite. The effect is especially noticeable in females and in the older age group (21–25 years), highlighting the stronger vertical control achievable with fixed appliances.

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