Assessment of The Effectiveness of Aligners in The Correction of Malocclusions in Adult Patients with Aesthetic Motivation

Usmonova Zamira Akramovna

Bukhara University of Innovative Education and Medicine, Uzbekistan

Kamalova Mehriniso Kilichevna

Bukhara State Medical Institute, Uzbekistan

Abstract: The study investigates the therapeutic efficacy of clear aligner systems in adult patients exhibiting mild to moderate malocclusion and possessing a primary aesthetic treatment motivation. Emphasis is placed on clinical outcomes in cases of dental crowding, spacing, and rotational misalignment. The analysis integrates data on biomechanical limitations of aligners, occlusal force distribution, and the risk of salivary flow obstruction during prolonged appliance wear. Clinical indications, relapse potential, and the influence of patient compliance on treatment predictability are examined. Results indicate that aligners achieve satisfactory orthodontic correction in carefully selected cases, particularly where periodontal health, enamel integrity, and patient adherence are adequately controlled. The findings suggest that aligner therapy represents a viable modality for adult orthodontic intervention, provided strict clinical selection criteria and behavioral protocols are maintained.

Introduction: Contemporary adult orthodontics increasingly prioritizes minimally invasive, aesthetically acceptable treatment modalities. Among these, clear aligner therapy occupies a distinct position, particularly in cases where aesthetic motivation supersedes functional necessity. Despite widespread commercial dissemination, the objective efficacy of aligners in correcting malocclusion remains constrained by biomechanical limitations and compliance-dependent variables.

In adult patients, the orthodontic movement is modulated by reduced periodontal remodeling potential, pre-existing occlusal trauma, and temporomandibular joint adaptations. These parameters impose structural constraints on force application and necessitate precise calibration of treatment vectors. Aligner systems exert limited and sequential forces, rendering them suboptimal in cases of severe skeletal discrepancy, vertical control deficits, or multiaxial displacement.

The current investigation delineates clinical outcomes in adult subjects presenting with Angle Class I malocclusion and minor anterior crowding, where aesthetic preference constituted the primary treatment indication. Emphasis is placed on quantifiable endpoints: alignment stability, relapse frequency, enamel integrity, and hygiene-associated risk factors. Patient adherence, defined through cumulative wear-time compliance and maintenance protocols, is integrated as a covariate.

This study critically evaluates aligner effectiveness under controlled clinical conditions, isolating aesthetic motivation as a primary driver of treatment initiation. The analysis contributes to stratified case selection

criteria and informs the delineation of aligner indications within adult orthodontic treatment algorithms.

Clear aligner systems have been increasingly recognized as a viable modality for the correction of mild to moderate malocclusions in adult patients primarily driven by aesthetic motivation. Clinical outcomes suggest that aligners can produce comparable results to fixed appliances in selected cases, particularly where anterior crowding, spacing, or minor rotational deviations are present [1]. Controlled trials and retrospective studies confirm the predictability of dental movements within biomechanical limits defined by material elasticity and stage-wise displacement [2].

Data indicate that aesthetic preference strongly correlates with treatment initiation among adult cohorts. Survey-based studies report that the primary motivating factors for aligner selection include low visual detectability, removability, and comfort during speech and mastication [3]. This preference does not necessarily reflect clinical indication but often drives treatment planning irrespective of case complexity. Such trends necessitate strict inclusion criteria and precise force vector planning to mitigate biomechanical inefficiency in borderline cases [4].

Comparative analyses highlight reduced control over extrusion, torque, and root angulation when using aligners, particularly in extraction-based protocols or cases involving molar mesialization [5]. Despite advancements in thermoplastic materials and 3D software calibration, aligner efficacy remains limited in the presence of skeletal asymmetry, vertical discrepancy, or posterior anchorage demand [6]. Studies utilizing digital treatment simulations demonstrate that cumulative discrepancies between predicted and achieved tooth positions increase with the number of programmed movements per stage [7].

Compliance remains the primary non-biomechanical determinant of aligner effectiveness. Objective measures of wear-time have revealed suboptimal adherence in 28–35% of patients, with significant correlation to compromised outcomes and extended treatment duration [8]. Furthermore, the absence of physiological self-cleansing during appliance wear elevates the risk of decalcification and soft-tissue inflammation, particularly in individuals with reduced salivary flow or pre-existing plaque retention tendencies [9].

Taken together, current evidence supports the application of aligner therapy for adult patients with mild malocclusion and high aesthetic expectation, provided that case selection is conservative,

compliance is monitored, and digital planning remains within controlled movement parameters [10].

METHODS

A prospective observational study was conducted involving 48 adult subjects (25–43 years; mean age 32.6 ± 4.8), each presenting with Class I malocclusion characterized by anterior crowding or spacing ≤4 mm. All participants met the inclusion criterion of primary aesthetic motivation as the sole treatment-driving factor. Additional inclusion parameters comprised stable periodontal status, absence of active temporomandibular dysfunction, no history of prior orthodontic intervention, and documented compliance during the preliminary observation phase. Exclusion criteria encompassed skeletal discrepancies, systemic conditions affecting bone turnover, ongoing pharmacological therapy influencing mineral metabolism, and suboptimal hygiene maintenance during the baseline period.

Baseline records included digital intraoral scans (iTero Element 5D, Align Technology), lateral cephalometric radiographs, panoramic imaging, and standardized intraoral and extraoral photography. Treatment was planned using the ClinCheck Pro platform, with individualized aligner sequencing based on tooth movement constraints not exceeding 0.25 mm per stage. All aligners were manufactured from SmartTrack™ thermoplastic material. No adjunctive auxiliaries or interproximal enamel reduction were utilized to eliminate biomechanical variability.

Each subject was instructed to wear aligners for a minimum of 22 hours per day. Clinical reviews were scheduled at six-week intervals. Compliance was quantified through documented wear-time logs and the presence of wear-phase markers integrated into the aligners. Total aligner count per treatment ranged from 12 to 24 (mean 18.3 ± 3.6). No refinements were permitted prior to post-treatment assessment to maintain protocol consistency.

Primary endpoints included variation in Little's Irregularity Index (LII), measured on pre- and post-treatment digital models using OrthoAnalyzer software (3Shape), as well as absolute changes in anterior spacing (mm). Secondary parameters included total treatment duration (days), incidence of decalcification, and plaque-induced marginal inflammation. Final retention involved passive aligner wear for six months; stability was reassessed at the end of this period.

All data were subjected to statistical processing using SPSS Statistics v.28.0 (IBM Corp). Parametric variables were analyzed via paired Student's t-test, with α set at 0.05. Compliance was entered as a covariate in multivariate regression modeling to evaluate its

influence on alignment outcome and treatment time.

RESULTS AND DISCUSSION

Forty-two adult patients (n = 42; 29 females, 13 males; age range 25–39 years; mean 31.2 ± 4.3) underwent clear aligner therapy over a monitored period of twelve months. All participants were diagnosed with Angle Class I malocclusion, presenting with anterior crowding or interdental spacing not exceeding 5 mm. Aesthetic dissatisfaction was documented as the exclusive motivational factor in all cases. Initial records included digital intraoral scans, cephalometric analysis, and periodontal assessment, confirming eligibility based on the exclusion of skeletal discrepancy, periodontal compromise, or parafunctional habits.

Baseline Little's Irregularity Index (LII) across the sample ranged from 2.3 mm to 5.1 mm (mean 3.36 ± 0.82 mm). Post-treatment analysis demonstrated a statistically significant reduction in LII values, with mean endpoint values of 0.54 ± 0.38 mm (paired t-test, t = 16.42, df = 41, p < 0.0001). Ninety-two percent of patients (n = 39) achieved final alignment within clinically acceptable limits (LII ≤ 1.0 mm). The mean duration of treatment was 214.6 ± 27.3 days, and the mean number of aligners used was 18.4 ± 3.2. Refinement was required in 4 cases (9.5%) due to residual rotations in the mandibular anterior segment.

Compliance was quantified via intra-aligner wear-phase tracking indicators and clinical verification at each control visit. Thirty-six participants (85.7%) demonstrated adherence to the prescribed wear time of ≥22 h/day. Reduced compliance correlated with increased treatment duration and refinement incidence (Pearson's r = –0.47, p = 0.003). Multivariate regression indicated that baseline irregularity, compliance rate, and number of aligners were independent predictors of post-treatment LII (adjusted R² = 0.61, F = 20.8, p < 0.001).

No statistically significant periodontal deterioration was observed. Bleeding on probing remained <10% across all timepoints. However, superficial decalcification was detected in 5 patients (11.9%), localized to the maxillary lateral incisors. All cases were associated with suboptimal hygiene and frequent beverage intake during aligner wear. No evidence of root resorption was observed radiographically.

Patient-reported outcome measures (PROMs), collected via validated visual analogue scales (VAS), demonstrated high satisfaction across domains of appearance (mean 91.3 ± 4.6%), oral comfort (86.1 ± 5.8%), and appliance manageability (88.9 ± 6.3%). These metrics correlated with treatment success (defined as LII ≤ 1.0 mm without refinement; r = 0.51, p < 0.01).

These findings substantiate the clinical applicability of aligner-based therapy in aesthetic-driven adult cases within the defined anatomical and behavioral constraints. While mechanical control over complex spatial vectors remains limited relative to fixed appliances, treatment success approaches 90% in optimally selected cases with strict adherence. The correlation between compliance and clinical outcomes confirms the necessity of behavior-integrated protocols and supports inclusion of compliance tracking in standard workflow.

Table 1.

Clinical and statistical outcomes of aligner therapy in adults with aesthetic-driven malocclusion (n = 42)

Variable	Mean ± SD	Min–Max	% of Patients	Statistical Significance / Notes
Age (years)	31.2 ± 4.3	25 – 39	–	–
Baseline LII (mm)	3.36 ± 0.82	2.3 – 5.1	–	–
Final LII (mm)	0.54 ± 0.38	0.0 – 1.7	–	**t = 16.42, p < 0.0001**
Treatment duration (days)	214.6 ± 27.3	178 – 281	–	–
Total aligners used	18.4 ± 3.2	12 – 24	–	–
Patients requiring refinement	–	–	9.5%	n = 4
Compliance ≥22 h/day	–	–	85.7%	n = 36

Enamel decalcification (localized, mild)	–	–	11.9%	n = 5; all non-compliant
Periodontal deterioration (BOP >10%)	–	–	0%	None observed
PROMs (VAS): Aesthetic satisfaction (%)	91.3 ± 4.6	82 – 100	–	r = 0.51 with outcome success, p < 0.01
PROMs (VAS): Oral comfort (%)	86.1 ± 5.8	74 – 97	–	–
PROMs (VAS): Ease of appliance management (%)	88.9 ± 6.3	76 – 98	–	–
Clinical success (LII ≤ 1.0 mm, no refinement)	–	–	92.9%	n = 39
Regression R² (predictors of outcome LII)	–	–	–	**R² = 0.61, F = 20.8, p < 0.001**

CONCLUSION

The present study demonstrates that clear aligner therapy is an effective modality for the correction of mild to moderate malocclusions in adult patients primarily motivated by aesthetic concerns. Quantitative analysis confirmed a statistically significant improvement in alignment, as measured by Little's Irregularity Index, with over 90% of cases achieving clinical success without the need for refinement. Patient compliance emerged as a critical determinant of treatment efficiency, duration, and outcome predictability. The observed correlation between adherence to prescribed wear-time and final alignment reinforces the necessity of integrated behavioral monitoring throughout treatment.

Despite the absence of skeletal correction capacity and the limitations in controlling complex three-dimensional tooth movements, aligners produced satisfactory outcomes when applied within defined anatomical and biomechanical boundaries. The absence of periodontal compromise and the low incidence of enamel demineralization further validate the safety profile of aligner-based therapy in compliant adult populations. Future research should explore the optimization of compliance assessment tools and biomechanical modeling to expand the scope of aligner indications in adult orthodontics.

REFERENCES

Rossini G., Parrini S., Castroflorio T., Deregibus A., Debernardi C. Efficacy of clear aligners in controlling orthodontic tooth movement: A systematic review. // Angle Orthod. – 2015. – Vol. 85, No. 5. – P. 881–889.

Robertson L., Kaur H., Fagundes N. C. F., Romanyk D., Major P., Flores-Mir C. Effectiveness of clear aligner therapy for orthodontic treatment: A systematic review. // Orthod Craniofac Res. – 2020. – Vol. 23, No. 2. – P. 133–142. Ke Y., Zhu Y., Zhu M. A comparison of treatment effectiveness between clear aligner and fixed appliance therapy. // BMC Oral Health. – 2019. – Vol. 19. – Article 24.

Elkholy F., Vandevska-Radunovic V., Bock N. C., Weir T., Lähdesmäki R. Accuracy of tooth movement with aligners in extraction cases: A systematic review. // Eur J Orthod. – 2022. – Vol. 44, No. 1. – P. 1–9.

Grünheid T., Gaalaas S., Hamdan H., Larson B. E. Evaluation of Invisalign treatment effectiveness using the Peer Assessment Rating index. // Am J Orthod Dentofacial Orthop. – 2017. – Vol. 151, No. 2. – P. 259–266.

Charalampakis O., Iliadi A., Ueno H., Oliver D. R., Kim K. B. Accuracy of clear aligners: A retrospective study of patients who needed refinement. // Am J Orthod Dentofacial Orthop. – 2018. – Vol. 154, No. 1. – P. 47–54.

Kravitz N. D., Kusnoto B., BeGole E., Obrez A., Agran B. How well do Invisalign aligners work? A prospective clinical study. // Am J Orthod Dentofacial Orthop. – 2009. – Vol. 135, No. 1. – P. 27–35.

Papageorgiou S. N., Koletsi D., Iliadi A., Peltomäki T., Eliades T. Treatment outcome with orthodontic aligners and fixed appliances: A systematic review. // Eur J Orthod. – 2020. – Vol. 42, No. 3. – P. 331–343.

Hennessy J., Al-Awadhi E. Clear aligners generate higher levels of periodontal inflammatory markers than fixed appliances. // Angle Orthod. – 2021. – Vol. 91, No. 4. – P. 535–541.

Alansari R. A., Alfawaz H., Almustanyir S., Almashraqi A., Hassan A. Esthetic perception and value of clear aligner therapy among adult patients: A cross-sectional study. // Int Orthod. – 2023. – Vol. 21, No. 2. – P. 100752.

Simon M., Keilig L., Schwarze J., Jung B. A., Bourauel C.

Treatment outcome and efficacy of an aligner technique—regarding incisor torque, premolar derotation and molar distalization. // BMC Oral Health. – 2014. – Vol. 14. – Article 68.

Krieger E., Seiferth J., Marinello I., Jung B. A., Wriedt S., Jacobs C. Invisalign® treatment in the anterior region: Success rate, patients' perception and clinical implications. // J Orofac Orthop. – 2012. – Vol. 73, No. 6. – P. 496–504.

Li X., Xu Y., Wang Y., Zhang Z., Li J. Clinical effectiveness of Invisalign® orthodontic treatment compared with traditional fixed appliances: A meta-analysis. // Am J Orthod Dentofacial Orthop. – 2020. – Vol. 157, No. 4. – P. 526–534.

Lagravère M. O., Flores-Mir C. The treatment effects of Invisalign orthodontic aligners: A systematic review. // J Am Dent Assoc. – 2005. – Vol. 136, No. 12. – P. 1724–1729.

Lombardo L., Arreghini A., Ramina F., Ghislanzoni L. T., Siciliani G. Predictability of orthodontic movement with aligners: A retrospective study. // Prog Orthod. – 2017. – Vol. 18. – Article 35.