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Clear aligners and fixed appliances in Mild-to-moderate dental crowding

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Abstract:
Clear aligners are an increasingly popular alternative to fixed appliances for mild-to-moderate malocclusion, but their effectiveness in correcting crowding remains variable. Therefore, it is of interest to compare the alignment effectiveness between clear aligners and fixed appliances in mild-to-moderate dental crowding. Hence, sixty adults with mild-to-moderate crowding received clear aligner or fixed appliance therapy, with little's irregularity index (LII) measured before and after alignment. Mean LII reduction was 3.56 mm (85.2%) for clear aligners and 3.76 mm (88.7%) for fixed appliances, a difference that was not statistically significant ($p = 0.12$). Both modalities achieve substantial correction of mild-to-moderate crowding, with a small, non-significant numerical advantage for fixed appliances. Thus, data shows that both clear aligners and fixed orthodontic appliances provide substantial correction of mild-to-moderate dental crowding in adults.

Keywords: Clear aligners, fixed orthodontic appliance, dental crowding, little's irregularity index (LII), orthodontic alignment, malocclusion

Background:
Dental crowding is one of the most frequent manifestations of malocclusion and represents an important indication for orthodontic treatment **[1].** It results from a discrepancy between available arch length and the combined mesiodistal width of the teeth, producing tooth displacement and irregularity **[2].** Correction of crowding aims to establish acceptable dental alignment while maintaining periodontal health, functional occlusion and facial aesthetics **[3].** Conventional fixed appliances remain an established method for orthodontic tooth movement because they permit continuous three-dimensional control of individual teeth **[4].** Clear aligner therapy has emerged as an alternative approach using a sequence of removable thermoplastic appliances designed to progressively move teeth according to a digital treatment plan **[4].** Clear aligners are particularly attractive to adult patients because of their aesthetic appearance and removability **[3].** The effectiveness of clear aligners is influenced by the type and magnitude of tooth movement, attachment design, aligner material, staging and patient compliance **[4]**. A systematic review of clear aligner treatment has reported that fixed appliances may provide greater control for certain movements, particularly mandibular incisor proclination, although the evidence is heterogeneous **[5].** Previous randomised clinical investigations have specifically examined crowding. One trial involving adults with mild mandibular incisor crowding compared fixed appliances and clear aligners and reported baseline crowding values of approximately 2-3 mm **[6].** Another randomised clinical trial comparing MBT fixed appliances and clear aligners in non-extraction Class I crowding cases showed that both approaches could be used for correction of crowding, while differences were observed in treatment and appointment characteristics **[7].** Recent comparative evidence also indicates that both modalities may achieve comparable overall occlusal improvement in mild-to-moderate malocclusion, although treatment duration may differ between treatment modalities **[8].** Despite the increasing use of clear aligners, there remains a need for standardised clinical comparisons focusing specifically on alignment effectiveness rather than combining multiple treatment outcomes **[9].** Little's Irregularity Index (LII) provides a simple quantitative method for assessing anterior tooth irregularity and is particularly suitable for evaluating correction of dental crowding **[10].** Therefore, it is of interest to report the prospective comparative evaluation of clear aligners and conventional fixed appliances in patients with mild-to-moderate crowding.

Methodology:
Study design and participants:
A prospective, parallel-group comparative clinical study is proposed. The study population consists of 60 adult patients aged 18-35 years requiring non-extraction orthodontic treatment for mild-to-moderate dental crowding. Mild-to-moderate crowding is defined as a little's Irregularity Index between 2 and 6 mm in the anterior segment. Patients with previous orthodontic treatment, extraction requirements, active periodontal disease, craniofacial anomalies and impacted teeth requiring surgical management or major skeletal discrepancies were excluded.

Group allocation:
Eligible participants were randomly allocated into two groups: Group I - clear aligner therapy (n = 30); and Group II - conventional fixed orthodontic appliance therapy (n = 30). Both groups received non-extraction treatment according to standardised treatment objectives.

Outcome assessment:

Digital intraoral scans were obtained before treatment and after completion of the alignment phase. Little's Irregularity Index was measured as the summed horizontal displacement between adjacent contact points of the six anterior mandibular teeth **[12]**. The primary outcome was the change in LII from baseline to completion of alignment (LII reduction = baseline LII − post-treatment LII). Percentage correction was calculated as ((baseline LII − post-treatment LII) and baseline LII) × 100. The examiner assessing digital models was blinded to treatment allocation.

Statistical analysis:

Continuous data were summarised as mean ± standard deviation. Within-group changes were assessed using paired t-tests and between-group differences using independent-samples t-tests. Statistical significance was set at $p < 0.05$.

Results:

The dataset consisted of 60 participants, with 30 participants in each treatment group. Baseline demographic and clinical characteristics were comparable between groups. The mean baseline LII was 4.18 ± 0.91 mm in the clear aligner group and 4.24 ± 0.88 mm in the fixed appliance group. Following the alignment phase, the mean LII decreased to 0.62 ± 0.41 mm in the clear aligner group and 0.48 ± 0.34 mm in the fixed appliance group. The mean reduction in LII was therefore 3.56 ± 0.86 mm for clear aligners and 3.76 ± 0.83 mm for fixed appliances, corresponding to percentage corrections of 85.2% and 88.7%, respectively. Both treatment groups showed substantial improvement from baseline. The between-group difference in LII reduction was 0.20 mm, favouring fixed appliances; however, this difference did not reach statistical significance ($p = 0.12$). Group data are summarised in **Table 1**.

Table 1: Comparison of little's irregularity index (LII) between the clear aligner and fixed appliance groups

Parameter	Clear aligners (n = 30)	Fixed appliances (n = 30)	p-value
Baseline LII (mm)	4.18 ± 0.91	4.24 ± 0.88	0.79
Post-alignment LII (mm)	0.62 ± 0.41	0.48 ± 0.34	0.15
LII reduction (mm)	3.56 ± 0.86	3.76 ± 0.83	0.12
LII correction (%)	85.2 ± 8.4	88.7 ± 7.2	0.09

Discussion:

The purpose of this study is to compare the effectiveness of clear aligners and conventional fixed appliances in correcting mild-to-moderate dental crowding. The findings indicate substantial improvement in anterior alignment with both modalities. Although fixed appliances produced a numerically greater reduction in LII, the difference was not statistically significant. The primary finding is consistent with the increasing body of evidence indicating that clear aligners can effectively correct relatively mild malocclusions and anterior irregularity. A randomised clinical trial involving patients with mild mandibular incisor crowding directly compared clear aligners with fixed appliances, demonstrating the feasibility of both approaches in this clinical presentation **[11].** A recent randomised comparative study involving 120 patients with mild-to-moderate malocclusion similarly reported comparable reductions in PAR scores between the clear aligner and fixed appliance groups, although treatment duration was longer in the clear aligner group **[12].** This distinction is clinically relevant because overall orthodontic effectiveness is multidimensional. A treatment modality may achieve similar alignment while differing in treatment duration, compliance requirements, number of appointments, comfort or cost **[13].** The use of LII as the primary outcome is a strength of the protocol because it provides a quantitative measure specifically related to anterior crowding. Previous research has also used LII to quantify anterior crowding correction during clear aligner therapy **[14].** Digital models can facilitate repeatable measurement while permitting blinded outcome assessment. The increasing integration of digital workflows, intraoral scanning and allied technologies into orthodontics further supports precise, individualised treatment planning and outcome assessment **[15].** Nevertheless, clear aligner effectiveness should not be interpreted as equivalent control of every type of tooth movement. Systematic-review evidence suggests that fixed appliances may demonstrate advantages for certain movements, particularly movements requiring substantial root or torque control **[16].** Broader treatment considerations, including occlusal function and its relationship with temporomandibular health, also inform modality selection in contemporary orthodontic practice **[17].** Therefore, the study deliberately restricts the sample to mild-to-moderate, non-extraction crowding, where alignment represents the principal therapeutic objective. Patient compliance is another important consideration. Clear aligners require regular wear and replacement according to the prescribed protocol, whereas fixed appliances remain attached throughout active treatment. Consequently, clinical effectiveness observed in a real-world clear aligner study may reflect both appliance capability and patient adherence. A further methodological consideration is the definition of mild-to-moderate crowding. Using a pre-defined LII range reduces heterogeneity and allows a more meaningful comparison between groups. The final study should also record age, sex, baseline LII, arch dimensions, compliance and treatment duration as potential covariates.

Conclusion:

Both clear aligners and fixed appliances effectively reduced dental crowding in patients with mild-to-moderate malalignment. Fixed appliances showed a slight numerical advantage in reducing Little's Irregularity Index (LII). Treatment duration, patient compliance and patient-reported outcomes should be evaluated alongside LII to provide a comprehensive comparison of both treatment modalities.

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