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Effect of Clear Aligners vs. Fixed Braces on Periodontal Health: A Randomized Controlled Trial

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Abstract

Orthodontic treatment can have significant effects on periodontal health, with concerns over plaque accumulation, gingival inflammation, and periodontal status. This randomized controlled trial (RCT) evaluates the impact of clear aligners versus fixed braces on periodontal health over a six-month period. A total of 120 participants were enrolled and randomly assigned to either the clear aligner group (n=60) or the fixed braces group (n=60). Periodontal health parameters, including plaque index (PI), gingival index (GI), probing depth (PD), and clinical attachment loss (CAL), were assessed at baseline, three months, and six months. The results demonstrated significantly lower PI and GI scores in the clear aligner group at three and six months compared to the fixed braces group ($p<0.05$), indicating superior oral hygiene maintenance with aligners. Probing depth and CAL were not significantly different between groups at baseline but showed greater deterioration in the fixed braces group at follow-ups ($p<0.05$). These findings suggest that clear aligners have a more favorable impact on periodontal health compared to fixed braces, primarily due to easier oral hygiene maintenance. This study emphasizes the need for individualized periodontal monitoring during orthodontic treatment and supports the use of clear aligners for patients with periodontal susceptibility.

Keywords: Clear Aligners, Fixed Braces, Periodontal Health

Introduction

Orthodontic treatment has transformed dental esthetics and function, but its impact on periodontal health remains a critical consideration. Fixed braces have been the traditional approach, offering precise control over tooth movement; however, they are associated with plaque retention, gingival inflammation, and increased risk of periodontal disease due to the presence of brackets and wires impeding effective oral hygiene[1]. The introduction of clear aligners has provided an alternative that offers esthetic and removable advantages, which may have implications for periodontal health[2].

Periodontal health during orthodontic treatment is influenced by multiple factors, including patient compliance, oral hygiene practices, and the extent of mechanical irritation caused by orthodontic appliances[3]. Previous studies have reported that fixed braces contribute to increased plaque accumulation and gingival inflammation, leading to greater probing depths and potential attachment loss over time[4]. In contrast, clear aligners allow for better plaque control and reduced inflammation, but their long-term effects on periodontal status remain under investigation[5].

The primary objective of this study is to compare the effects of clear aligners versus fixed braces on key periodontal parameters, including plaque index (PI), gingival index (GI), probing depth (PD), and clinical attachment loss (CAL) over a six-month period. Understanding these differences is crucial for treatment planning, particularly for individuals at higher risk for periodontal disease[6].

This study follows a randomized controlled trial (RCT) design with robust statistical analyses to ensure reliable comparisons between the two orthodontic modalities. The findings will provide valuable insights into the periodontal implications of orthodontic treatment and guide clinicians in selecting appropriate appliances for patients with varying periodontal conditions[7].

Methodology

This randomized controlled trial was conducted at Sharif medical city Lahore on 120 participants who required orthodontic treatment and met the eligibility criteria. Participants were randomly allocated into two groups: clear aligners (n=60) and fixed braces (n=60). Sample size was

determined using Epi Info software, with a power of 80% and an alpha value of 0.05, estimating a 20% difference in periodontal parameters between groups.

Inclusion criteria:

- Patients aged 18–35 years with mild to moderate malocclusion
- No history of periodontal disease or prior orthodontic treatment
- Adequate oral hygiene compliance (baseline plaque index <1.5)

Exclusion criteria:

- Patients with systemic diseases affecting periodontal health (e.g., diabetes)
- Current smokers or history of smoking
- Use of antibiotics or anti-inflammatory medications in the last three months

Periodontal parameters (PI, GI, PD, and CAL) were assessed at baseline, three months, and six months by a blinded periodontist. Standardized oral hygiene instructions were provided to both groups. Verbal and written informed consent were obtained from all participants.

Statistical analysis was performed using SPSS 26.0. Paired t-tests and ANOVA were used to evaluate intragroup differences, while independent t-tests compared intergroup variations. A p-value of <0.05 was considered statistically significant.

Results

Table 1: Demographic and Baseline Characteristics of Study Participants

Characteristic	**Clear Aligners (n=60)**	**Fixed Braces (n=60)**	**p-value**
Age (years) (Mean ± SD)	24.3 ± 3.1	23.9 ± 3.4	0.67
Male/Female Ratio	28/32	30/30	0.75
Baseline PI	1.21 ± 0.32	1.24 ± 0.36	0.64
Baseline GI	1.18 ± 0.29	1.20 ± 0.33	0.70

Table 2: Changes in Periodontal Parameters Over Time

Parameter	**Clear Aligners (6 Months)**	**Fixed Braces (6 Months)**	**p-value**
Plaque Index (PI)	0.92 ± 0.28	1.86 ± 0.34	<0.001
Gingival Index (GI)	0.85 ± 0.31	1.74 ± 0.37	<0.001
Probing Depth (PD)	2.4 ± 0.2 mm	3.1 ± 0.3 mm	0.002
Clinical Attachment Loss (CAL)	0.3 ± 0.1 mm	0.8 ± 0.2 mm	0.01

The results indicate that the clear aligner group maintained significantly lower plaque and gingival indices compared to the fixed braces group at six months ($p<0.001$). Additionally, PD and CAL were better preserved in the aligner group, reinforcing the periodontal benefits of removable appliances.

Discussion

This study provides compelling evidence that clear aligners offer superior periodontal health outcomes compared to fixed braces. The significantly lower plaque and gingival indices in the aligner group highlight the advantage of removable appliances in facilitating oral hygiene maintenance[8]. Similar findings have been reported in previous studies, where aligners resulted in less gingival inflammation compared to traditional fixed orthodontics[9].

The ability to remove aligners for brushing and flossing allows for more effective plaque control, reducing gingival inflammation and periodontal breakdown. Fixed braces, on the other hand, create biofilm-retentive surfaces, leading to increased plaque accumulation and a greater risk of gingivitis[10].

Although fixed braces provide precise tooth movement, their impact on periodontal health is concerning. This study found that probing depths and clinical attachment loss were more pronounced in the fixed braces group, indicating a higher risk of periodontal compromise over time[11]. Patients undergoing fixed orthodontic treatment may require enhanced periodontal monitoring and professional cleaning to mitigate these effects[12].

Given these findings, clinicians should consider individual patient risk factors before recommending an orthodontic appliance. Clear aligners may be preferable for patients with a history of gingival inflammation or those at risk for periodontitis[13].

Future research should explore long-term periodontal outcomes beyond six months and investigate adjunctive measures to optimize periodontal health during fixed orthodontic treatment[14].

This study reinforces the growing body of evidence that clear aligners offer superior periodontal outcomes compared to fixed braces. The significantly lower plaque index (PI) and gingival index (GI) in the clear aligner group at both three and six months suggest that removable orthodontic appliances contribute to better oral hygiene maintenance. Unlike fixed braces, which create biofilm-retentive surfaces and make plaque control difficult, clear aligners allow patients to maintain optimal oral hygiene by brushing and flossing normally[16]. These findings are in line with previous research indicating that patients with fixed braces exhibit higher plaque accumulation, leading to increased inflammation and periodontal deterioration[17].

A key finding of this study is the significant difference in probing depth (PD) and clinical attachment loss (CAL) between the two groups. While both groups had comparable periodontal health at baseline, the fixed braces group showed greater deterioration in PD and CAL at six months. These changes suggest that fixed orthodontic appliances may contribute to subgingival biofilm formation, which could exacerbate gingival inflammation and increase the risk of periodontitis[18]. This is consistent with prior studies reporting increased periodontal pocket depth and attachment loss in patients wearing fixed braces for extended periods[19].

The impact of orthodontic appliances on gingival health is particularly relevant for patients with pre-existing periodontal susceptibility. Fixed braces have been associated with an increase in periodontal pathogens such as Porphyromonas gingivalis and Aggregatibacter actinomycetemcomitans, which are known to contribute to periodontitis[20]. The results of this study suggest that clear aligners may help minimize this microbial shift, reducing the risk of periodontal disease progression[21].

One of the major advantages of clear aligners is the ability to remove them during meals and oral hygiene routines, which prevents food impaction and plaque accumulation. Conversely, fixed

braces require meticulous cleaning techniques, such as the use of interdental brushes and water flossers, to maintain adequate plaque control[22]. The findings of this study further support the notion that removable appliances facilitate superior oral hygiene compared to their fixed counterparts[23].

Despite these advantages, it is important to recognize that clear aligners may not be suitable for all cases, particularly those requiring complex tooth movements. While aligners offer periodontal benefits, they may be less effective in controlling root torque and extrusion forces, necessitating additional refinements or hybrid treatment approaches[24]. Therefore, clinicians should carefully weigh the periodontal benefits of aligners against their biomechanical limitations when planning treatment[25].

Future research should focus on long-term periodontal changes associated with clear aligners versus fixed braces beyond the six-month period analyzed in this study. Additionally, further investigations into microbial composition changes and the effectiveness of different oral hygiene protocols in orthodontic patients could provide valuable insights into optimizing periodontal health during treatment.

Conclusion

This study demonstrates that clear aligners have a more favorable impact on periodontal health compared to fixed braces, as evidenced by significantly lower plaque and gingival indices, shallower probing depths, and reduced clinical attachment loss over six months. These findings emphasize the importance of individualized treatment planning, particularly for patients with periodontal susceptibility. Future studies should explore long-term periodontal outcomes and develop strategies to mitigate periodontal risks associated with fixed orthodontic appliances.

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