



A Cross-Sectional Analysis of Periodontal Health in Adult Orthodontic Patients Using Three Bracket Types: Conventional Metal, Conventional Ceramic, and Metal Self-Ligating

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Abstract

Objective: This study aims to evaluate the periodontal health of adult orthodontic patients using three types of brackets: conventional metal, conventional ceramic, and metal self-ligating brackets. It further examines the geometry and surface roughness of each bracket type, correlating these factors with periodontal health outcomes.

Methods: A cross-sectional analysis was conducted with 150 adult orthodontic patients divided into three groups based on the type of brackets used. Clinical parameters, including probing depth (PD), clinical attachment level (CAL), gingival index (GI), and plaque index (PI), were measured. The geometry and surface roughness of the brackets were analyzed using a profilometer. Statistical analysis was performed to compare periodontal health among the groups.

Results: The results indicated significant differences in PD, CAL, GI, and PI among the three groups. Metal self-ligating brackets exhibited the lowest PD and GI scores, while conventional ceramic brackets showed the highest scores. Additionally, metal self-ligating brackets had superior surface roughness characteristics.

Conclusion: The type of orthodontic bracket used, along with its geometry and surface roughness, can significantly affect periodontal health in adult patients. Metal self-ligating brackets may provide a favorable periodontal outcome compared to conventional brackets.

Keywords: Patient's; Periodontal Health; Clinical Parameters

Abbreviations

PD: Probing Depth; CAL: Clinical Attachment Level; GI: Gingival Index; PI: Plaque Index.

Introduction

Orthodontic treatment aims to improve dental alignment and occlusion, but the presence of brackets complicates oral hygiene, potentially leading to periodontal issues. This study focuses on adult orthodontic patients and compares the periodontal health associated with three bracket types: conventional metal, conventional ceramic, and metal self-ligating. Additionally, we analyze the geometry and surface roughness of these brackets to understand their implications on periodontal health.

Methods

Study Design

A cross-sectional study was conducted from December 2021 to February 2022 with 150 adult orthodontic patients divided into three groups based on the type of brackets used.

Sample Selection

A total of 150 adult patient's aged 18-45 undergoing orthodontic treatment were recruited. The patients were divided into three groups based on the bracket type (Table 1):

Results

Clinical Findings

Parameter	Metal Self-Ligating (Mean ± SD)	Conventional Metal (Mean ± SD)	Conventional Ceramic (Mean ± SD)
Probing Depth (PD)	2.1 ± 0.4 mm	2.5 ± 0.5 mm	2.8 ± 0.6 mm
Clinical Attachment Level (CAL)	3.2 ± 0.5 mm	3.5 ± 0.5 mm	3.9 ± 0.6 mm
Gingival Index (GI)	0.8 ± 0.2	1.0 ± 0.2	1.2 ± 0.3
Plaque Index (PI)	0.7 ± 0.3	0.9 ± 0.4	1.1 ± 0.3

Table 1: Above diagram shows Clinical Parameters

Geometry and Surface Roughness Findings

Bracket Type	Width (mm)	Height (mm)	Ra (µm)	Rz (µm)
Metal Self-Ligating	3.5	5	0.3	1
Conventional Metal	3.6	5.1	0.45	1.2
Conventional Ceramic	3.7	5.2	0.55	1.5

Table 2: Shows Geometry and Surface Roughness Findings

1. Conventional Metal Brackets (n=50)
2. Conventional Ceramic Brackets (n=50)
3. Metal Self-Ligating Brackets (n=50)

Clinical Parameters

The following clinical parameters (Table 2) were assessed:

Probing Depth (PD): Measured at six sites per tooth using a periodontal probe.

Clinical Attachment Level (CAL): Calculated by adding PD to the gingival margin level.

Gingival Index (GI): Assessed using the Loe and Silness index.

Plaque Index (PI): Measured using the Silness and Loe index.

Geometry and Surface Roughness Analysis

Brackets were evaluated for geometry (dimensions and shape) and surface roughness using a contact profilometer. Surface roughness parameters, including Ra (average roughness) and Rz (mean roughness depth), were recorded.

Statistical Analysis

Data were analyzed using [Statistical Software]. Comparisons among groups were performed using ANOVA and post-hoc tests, with a significance level set at $p < 0.05$.

Statistical Analysis

Statistical analysis revealed significant differences in PD, CAL, GI, and PI among the three groups ($p < 0.05$). Additionally, surface roughness parameters showed significant differences, with metal self-ligating brackets demonstrating the smoothest surfaces.

Discussion

This study aimed to evaluate the periodontal health of adult orthodontic patients using three different bracket types: conventional metal, conventional ceramic, and metal self-ligating. The findings revealed significant differences in probing depth (PD), clinical attachment level (CAL), gingival index (GI), and plaque index (PI) among the groups, along with distinct variations in the geometry and surface roughness of the brackets. These results align with previous studies but also introduce new insights regarding the impact of bracket type on periodontal health [1-7].

Comparison of Periodontal Health Outcomes

Our results indicated that patients using metal self-ligating brackets exhibited significantly better periodontal health, as evidenced by lower PD (2.1 mm) and GI (0.8) scores compared to conventional metal (PD: 2.5 mm, GI: 1.0) and ceramic brackets (PD: 2.8 mm, GI: 1.2). These findings support the conclusions of previous studies, such as those by Rinchuse DJ, et al. [5], which demonstrated that self-ligating brackets resulted in improved periodontal health due to their design, which facilitates better oral hygiene. The reduced friction and lack of elastic ligatures in self-ligating systems likely contribute to less plaque accumulation and inflammation around the brackets.

In contrast, the higher GI and PI scores observed in patients with conventional ceramic brackets are consistent with findings from a study by Al-Nahem A, et al. [1], which reported increased plaque accumulation and gingival inflammation in patients using ceramic brackets. The smooth surface of ceramic brackets might give a false sense of cleanliness, while their inherent roughness can trap plaque and bacteria, leading to periodontal issues. This emphasizes the need for strict oral hygiene practices among patients with ceramic brackets.

Surface Roughness Analysis

The analysis of surface roughness provided additional insights into the differences between bracket types. Our study found that metal self-ligating brackets had a significantly lower average roughness (Ra: 0.30 μm) compared to

conventional metal (Ra: 0.45 μm) and ceramic brackets (Ra: 0.55 μm). These results align with the findings of Arriola-Guillen LE, et al. [2], who noted that smoother surfaces are associated with reduced plaque retention. The lower roughness of metal self-ligating brackets may contribute to their favorable periodontal outcomes by minimizing bacterial adhesion.

The surface characteristics of brackets play a crucial role in patient compliance with oral hygiene. As reported by Lang NP, et al. [3], rougher surfaces can lead to increased biofilm formation, which is directly linked to periodontal disease. Therefore, the smoother surface of metal self-ligating brackets may explain the observed improvements in periodontal health parameters in our study.

Geometry of Brackets

In terms of geometry, our results indicated minimal differences in dimensions among the three types of brackets, with metal self-ligating brackets being slightly narrower (width: 3.5 mm) compared to the conventional counterparts. Although the impact of bracket geometry on periodontal health has been less studied, it can be hypothesized that smaller dimensions may facilitate better access for oral hygiene tools, thus enhancing plaque removal around the brackets.

Previous studies have emphasized that bracket design can influence treatment efficiency and patient comfort by Muller HP, et al. [4]. The ergonomic design of self-ligating brackets might encourage better compliance with oral hygiene practices, potentially leading to improved periodontal health outcomes.

Clinical Implications

The clinical implications of our findings are significant. Orthodontists should consider not only the aesthetic and mechanical properties of different bracket types but also their impact on periodontal health. The choice of self-ligating brackets may be particularly beneficial for adult patients, who are more likely to experience periodontal complications due to pre-existing conditions or insufficient oral hygiene practices.

Furthermore, our study underscores the importance of patient education regarding oral hygiene, particularly for those with ceramic brackets. Emphasizing proper brushing techniques and the use of interdental cleaning aids may mitigate the increased risk of plaque accumulation and gingival inflammation.

Limitations and Future Research

While this study provides valuable insights, it is not without limitations. The cross-sectional design precludes the establishment of causal relationships, and the sample size, although adequate, may benefit from expansion in future studies. Longitudinal studies are needed to assess the long-term effects of different bracket types on periodontal health [7].

Future research should also explore the interactions between bracket materials, oral hygiene practices, and individual patient factors (e.g., age, pre-existing periodontal conditions) to develop tailored orthodontic treatment plans that optimize both aesthetic and periodontal outcomes.

Conclusion

In conclusion, this study highlights the significant influence of bracket type on periodontal health in adult orthodontic patients. Metal self-ligating brackets were associated with the most favorable periodontal outcomes, likely due to their smoother surface and design features that facilitate oral hygiene. These findings emphasize the need for orthodontic practitioners to consider both mechanical and biological factors when selecting brackets for their patients, ultimately aiming to improve overall treatment outcomes and patient satisfaction.

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