

The Effects of Using Conventional and Self-Ligating Brackets on Oral Hygiene and Periodontal Health Status: A Rapid Review

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Abstract

Fixed orthodontic components frequently provide plaque retention area, hinder oral hygiene procedures, and impede self-cleaning action leading to an increase in plaque accumulation, particularly in the cervical regions of brackets near gingival margin. The archwire ligation method on brackets is another factor influencing plaque retention. Determining the type of bracket that has minimal impact on oral hygiene is essential. This study aims to identify the effects of using conventional (CB) and self-ligating brackets (SLB) on oral hygiene and periodontal health status in patients with mild to moderate crowding.

This rapid review was conducted according to the PICO framework and PRISMA flowchart. Electronic database searching and snowballing technique were performed. Risk of bias assessment was made using the original Cochrane risk of bias tool.

8 eligible experimental study articles were included. The studies from qualitatively analyzed articles showed that both CB and SLB could increase the values of measured clinical parameters for oral hygiene (PI) and periodontal health status (GI, bleeding index, PD). Most of the articles showed the increased parameter values were similar between the two bracket groups. PD values remained within the normal limits.

Generally, the effects of using CB and SLB were similar in increasing oral hygiene (PI) and periodontal health status (GI and bleeding index) in patients with mild to moderate crowding, although 3 articles revealed contradictive effects.

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Introduction

The incidence and prevalence of periodontal disease had been increasing in the past 3 decades.¹ Periodontal disease prevalence was reported to be approximately 20-50% worldwide both in developed and developing countries.^{2,3} Prevalence of the periodontal disease varies between regions of the world and Asian nations present higher prevalence and severity of periodontal disease.⁴ The highest burden of periodontal disease over the last 3 decades was recorded in Southeast Asia.¹ According to Basic Health Research (Riskesdas) in 2018, the prevalence of periodontitis in Indonesia was 74,1%.⁵ Periodontal disease is

one of the main reasons for tooth loss that can inhibit mastication, aesthetics, self-confidence, and quality of life.^{2,3}

Periodontal disease encompasses both gingival inflammation or gingivitis and inflammation accompanied by the loss of periodontal tissue as known as periodontitis.^{6,7} Gingivitis precedes periodontitis, but gingivitis doesn't always progress to periodontitis.⁷ Bacterial plaque is the primary etiologic factor that initiates either gingivitis or periodontitis.^{6,8} Predisposing factors for periodontal disease include tooth crowding and the use of fixed orthodontic appliances.^{6,9-12} Irregular alignment and crowding of teeth in malocclusion affect periodontal health by providing retentive-plaque area which further increases plaque accumulation, more difficult plaque control, and hamper the efficient oral hygiene procedure.¹³⁻¹⁵ There's an association between the severity of malocclusion and the presence of periodontal disease.¹⁴

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Fixed orthodontic appliances promote plaque accumulation, particularly in the most critical sites such as the cervical regions of brackets near gingival margin that lead to the development of gingivitis and underneath the orthodontic archwire.¹⁶⁻²² Brackets, bands, and archwires frequently create plaque retention areas, hinder oral hygiene procedures, and impede self-cleaning action on teeth and gingiva by saliva, tongue, cheeks, and lips.^{8,10,23,24}

Inadequate plaque removal will jeopardize periodontal health.²⁵ Two major categories of ligation methods are conventional ligation utilizing elastomer or stainless-steel ligature and self-ligation.²⁶ Self-ligating bracket (SLB) holds the archwire inside the bracket slot with an inbuilt locking mechanism such as clip that can be opened and closed.²⁷⁻²⁹

Despite the widespread use of fixed orthodontic appliances in society, the risk of using these appliances is frequently not realized especially in relation to oral hygiene.³⁰ The archwire ligation method on brackets is another factor influencing plaque retention.⁸ Determining the type of bracket that has minimal impact on oral hygiene is essential.²³ Good oral hygiene and patients' periodontal status before, during, and after orthodontic therapy influence the short- and long-term successful outcomes of orthodontic treatment.³¹⁻³³ Education, motivation, well-maintained oral hygiene, and regular periodontal care are important and should become the primary concern throughout fixed orthodontic treatment regardless of the bracket type used.^{27,34}

Self-ligating brackets have drawn a lot of attention in orthodontics over the past several years.¹⁹ Fewer plaque deposition is one of the claimed advantages of SLB which contributes in maintaining better oral hygiene.³⁵⁻³⁸ SLB can retain less or more bacterial plaque than conventional brackets (CB) is up to debate.²⁸ Reviews and clinical studies comparing different bracket types have also shown various contradictory findings when analyzing hygiene levels.³⁹ Comparisons of the two ligation systems have yielded varying results, presumably due to various brackets designs within each system which could affect the amount of plaque that was trapped and the response induced in the tissues.⁴⁰ Arnold et al. (2016)²⁷ and Yang et al. (2017)⁴¹ stated that additional high-quality randomized controlled trials (RCT) with low risk

of bias were deemed necessary to confirm that SLB does not have advantages over CB regarding oral hygiene maintenance and periodontal health in the previous systematic review and meta-analyses articles. Souper et al. (2021)³⁹ who evaluated oral hygiene also suggested that further studies were required to support this clinical relevance.

The most recent and available RCT literature were included and this rapid review had more specific crowding criteria by involving articles with mild to moderate crowding patients in their studies. The purpose of this study was to identify the effects of using conventional and self-ligating brackets on oral hygiene and periodontal health status in patients with mild to moderate crowding.

Materials and methods

The study design of this research was a rapid review following Cochrane guideline.⁴² Rapid review is a form of knowledge synthesis that accelerates the process of conducting a traditional systematic review through streamlining or omitting specific methods.⁴² PICO framework was followed to develop a specific research question as follows (P) Fixed orthodontic treatment patients with mild to moderate crowding (I) were given CB intervention (C) compared with patients treated using SLB (O) to determine the effects on oral hygiene and periodontal health status by measuring clinical parameters Plaque Index (PI), Gingival Index (GI), Bleeding Index, and Probing Depth (PD).

Articles with experimental study design that evaluated the effects of CB and SLB on oral hygiene and periodontal health status as seen through PI, GI, bleeding index, and PD measurements and involved patients with mild to moderate crowding were included. The included articles in this rapid review were published in English by Scopus-indexed journals from 2012 to 2022 and were available in full text. The following exclusion criteria were applied: experimental study with samples other than humans and research involving patients who already had periodontal disease, systemic disease, congenital abnormality, with special needs, and consuming medications that might interfere with clinical examination.

Articles searching, collection, and selection were conducted according to the

Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines 2009.⁴³

Electronic database searching was performed on PubMed, Taylor&Francis Online, and Cochrane Library using a combination of the following keywords (crowding) AND (conventional brackets) AND (self-ligating brackets) AND (oral hygiene) OR (dental plaque) OR (periodontal status) OR (periodontal health). Snowballing technique was also used from the reference lists of the retrieved relevant articles. This rapid review took place in Bandung, Indonesia from February to August 2022.

Qualitative data analysis was carried out by extracting data to obtain information related to the articles being studied. Risk of bias assessment then was made using the original Cochrane risk of bias tool for the included RCTs.⁴⁴ Seven domains were considered: 1) random sequence generation, 2) allocation concealment, 3) blinding of participants and personnel, 4) blinding of outcome assessment, 5) incomplete outcome data, 6) selective reporting, and 7) other bias. The overall risk of bias of each RCT was assessed as "high", "low", or "unclear".

Results

The flow of articles selection process according to the PRISMA guideline is shown in Figure 1. 1882 articles were initially identified from the electronic searching on 3 databases and 4 additional articles were selected through snowballing technique. A total of 1886 articles were identified at the searching phase and then 5 duplicates were removed. Titles and abstracts from 1881 articles were screened and 1866 were excluded because they were considered irrelevant and the full text were inaccessible.

Fifteen full-text articles were read to identify potentially eligible articles and 7 articles were discarded as the inclusion criteria were not met. In the end, 8 articles remained to be included in the qualitative analysis. Data extraction results of the included studies were summarized in Table 1.

Eight experimental studies were included in this rapid review, consisting of 7 RCTs and 1 non-randomized clinical trial. Risk of bias assessment was done on these eligible RCT articles and summarized in Figure 2. 4 of 7 RCT articles^{23,40,45,46} showed high risk of bias and the other 3 articles^{8,47,48} were rated as unclear risk of

bias since insufficient details were provided to allow the risk of bias judgment.

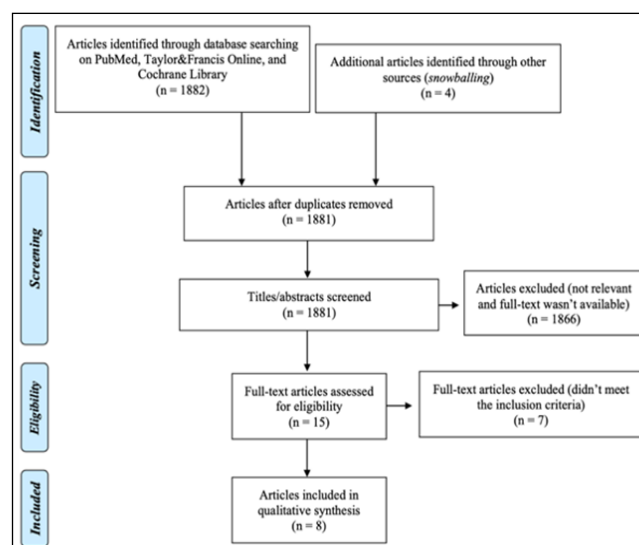


Figure 1. PRISMA flow diagram of the articles selection process.

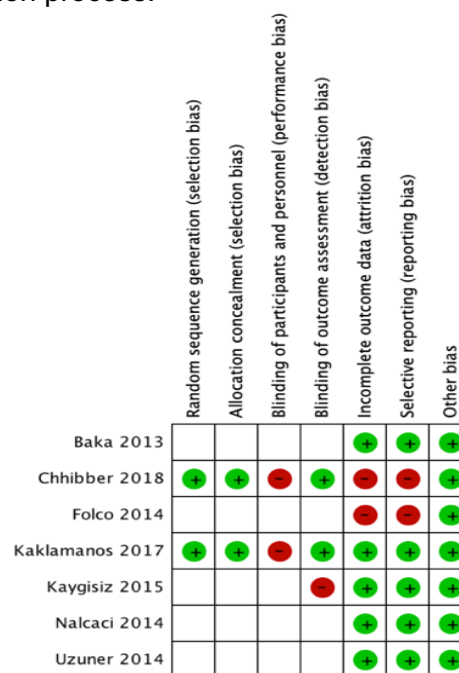


Figure 2. Risk of bias summary for included RCTs." because it is the second order figure in the manuscript.

The percentage of risk of bias assessment for each domain in all included RCT studies is presented in Figure 3. Blinding of participants and personnel domain had the worst assessment result out of all reviewed articles with approximately 25% at high risk of bias and around 75% showing unclear risk of bias. Other bias domain revealed the lowest risk of bias.

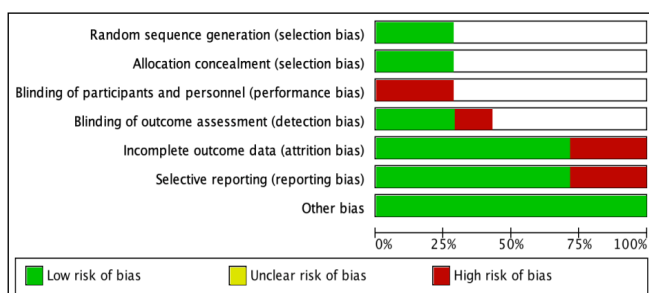


Figure 3. Risk of bias assessment in each domain.

Discussion

Poor oral hygiene is commonly happened and often characterized by inflammation. The early stage is the reversible inflammation of the gingiva or gingivitis initiated by dental plaque and the advantage stage manifests as periodontitis when permanent bone and tissue destruction has occurred.⁴⁹ Orthodontic appliances induce oral environment alteration.¹⁰ Fixed orthodontic components create retention sites for microbial plaque that is known to be the major etiologic factor in periodontal inflammation.⁴⁸ The homogeneity of oral hygiene condition and periodontal health status between the CB and SLB group was seen before the treatment started at the beginning of the studies.

Orthodontic appliances have detrimental effects on oral hygiene.⁸ The results of this rapid review indicate that plaque accumulation increases despite the type of brackets used in the fixed orthodontic treatment.^{8,10,23,40,45,47,48} Majority of the included articles reported both types of brackets have similar adverse effects on oral hygiene level as seen by the plaque accumulation.^{8,23,40,45,48} Chhibber et al.⁴⁵ reported similar increase in PI values between the CB group and the SLB group. This is in accordance with the previous studies by Baka et al.⁸, Folco et al.⁴⁰, Kaygisiz et al.²³, and Uzuner et al.⁴⁸ which didn't find any significant differences in the PI values increase among the two bracket groups throughout the study. Goldbecher stated that the bracket type itself is not the most crucial predisposing factor for the plaque accumulation. There are various factors between patients than between the bracket ligation systems.³⁷ Improved patient cooperation, oral hygiene level, and clinical indices will be achieved if dental care providers emphasize oral hygiene instructions and give the reinforcement at subsequent visits.⁴⁰

Bergamo et al.¹⁰ and Nalcaci et al.⁴⁷ showed contrast findings as there were significant differences in the increased plaque accumulation between the CB group and the SLB group hence one of the bracket groups showed worse oral hygiene condition. These findings are associated with the bracket type or design, size, and the proximity of the brackets to the gingival margin which may influence the plaque accumulation.^{10,47,48}

The passive SLB used in the study of Bergamo et al.¹⁰ have larger size compared to the other bracket designs thus the enamel surface and the distance between the brackets and gingiva were reduced leading to the deterioration of oral hygiene and impaired cleanability. Assessing plaque score is essential as an oral hygiene evaluation of people wearing fixed orthodontic appliances.³⁰ Participants in the CB and SLB groups at the end of the studies demonstrated grade 1 to 2 plaque accumulation.^{45,50} Oral hygiene plays a very important role in orthodontics and has a great impact on oral health as well as the outcome of orthodontic treatment.^{32,51}

Pathologic changes including gingivitis, gingival bleeding, gingival enlargement, and increased periodontal pocket depth occur during fixed orthodontic treatment.⁸ Similar results were also observed in the severity of gingival inflammation because GI values increased during the treatment with CB and SLB.^{10,23,40,45-48} Most articles demonstrated no differences in the increase of GI values among the two types of bracket hence both CB and SLB have unfavorable effects on periodontal health status as indicated by the gingival inflammation.^{10,23,40,45,46} Similar GI values increase between the CB and SLB group in fixed orthodontic treatment was revealed by Chhibber et al.⁴⁵ and Kaklamanos et al.⁴⁶ and this finding corresponds with the previous studies by Bergamo et al.¹⁰, Folco et al.⁴⁰, and Kaygisiz et al.²³ Moderate gingival inflammation developed in both groups by the end of the majority of the studies.^{10,40,45,46,50} Contrary to this condition, Lang and Bartold defined periodontal health as a state free from clinically detected inflammatory periodontal disease.⁵² Periodontal tissues play a critical role in orthodontic tooth movement because this treatment necessitates bone turnover to permit the tooth movement within the bone.⁵³ Professional treatment and patient

cooperation seem to be more essential in preserving periodontal health.⁴⁰ On the other hand, Nalcaci et al.⁴⁷ and Uzuner et al.⁴⁸ reported contradictive results since one of the bracket groups showed higher gingival index score increase compared to the other group therefore the severity of gingival inflammation was worse in one bracket group.

The health of periodontal tissues can be evaluated through bleeding criteria which is a sensitive early sign of gingivitis.^{54,55} The absence of bleeding on probing at repeated assessments depicted periodontal health and was considered as a very reliable indicator for periodontal stability.⁵² This rapid review found the increase in bleeding index values was mostly experienced by both bracket groups throughout the studies.^{8,45,47} Consistent with our result, Mazin et al.²² proved that participants who were wearing fixed orthodontic appliances exhibited an increase in bleeding site percentage. On the contrary, reduction of bleeding index values in the CB and SLB groups was found by Bergamo et al.¹⁰ and Kaygisiz et al.²³ in their studies. This finding was associated with the influence of oral hygiene supplements given before the treatment, oral hygiene instructions, and the patient's motivation. In addition, it's also attributed to the behavioral changes due to the Hawthorne effect or participant's awareness to be observed and evaluated.^{10,23,45} Most articles that reported bleeding index values elevation showed similar increases in this parameter between the two bracket types.^{8,45} This indicates that both types of brackets have similar adverse effects on periodontal health status based on bleeding that occurs when probing.^{8,45} Conflicting result was revealed in a study conducted by Nalcaci et al.⁴⁷ who stated higher increase in bleeding index value of the CB group than SLB group implying there was difference in the bleeding index increase among the bracket groups. Better parameter values in the SLB group could have been related to the different type of SLB used, study population, age, and statistical analyses from other studies.⁴⁷

PD was measured as the distance from the gingival margin to the most apical region of the sulcus.^{23,48} The result of this rapid review showed that generally, the PD values have increased in both bracket groups.^{8,40,48} In contrast, Kaygisiz et al.²³ discovered that PD values decreased in the SLB group and the PD values in

the CB group tended to remain constant. The study of Uzuner et al.⁴⁸ reported the increased PD values were significantly higher in the SLB group compared to the CB group. SLB used in that study were larger than the CB therefore the proximity of the brackets to the gingival margin impeded the oral hygiene procedures.⁴⁸ The majority of the articles^{8,23,40} found no differences in the effects of CB and SLB on periodontal health status measured by probing depth considering the PD scores in both groups of all articles^{8,23,40,48} were within the normal values⁵⁶ throughout the studies. Gingival alterations during the orthodontic treatment are temporary without causing permanent damage to the periodontal tissues.⁵⁵ PD measurement result must be considered in conjunction with another important clinical parameter such as BOP and should not be used alone to determine a healthy gingival state or the presence of gingival disease.⁵²

Plaque control is important for preserving the gingival-periodontal health status of patients undergoing orthodontic treatment.^{40,57} Plaque control measures with mechanical and chemical techniques have been found to be effective in reducing plaque.⁵⁸ Chemical plaque removal serves as a complement to mechanical methods considering there is evidence that regular toothbrushing and flossing are insufficient to control bacterial contamination.⁵⁹ Orthodontic treatment should be carried out with a multidisciplinary approach requiring the participation of a periodontist.^{60,61} Instruct the orthodontic patients to have routine control visits to both orthodontist and periodontist.⁶¹ One of the main factors determining the outcome of orthodontic treatment is continuous monitoring of periodontal health with regular examination during the treatment.⁶¹ Comprehensive oral hygiene instructions with or without professional prophylaxis will succeed the efficient control of plaque accumulation and gingival health improvement in orthodontic patients.⁶² Sebbar et al.⁶¹ believed that orthodontic treatment combined with the patient's compliance and absence of periodontal inflammation can lead to satisfying treatment results without causing irreversible damage to periodontal tissue.

The risk of bias in 4 studies of Chhibber et al.⁴⁵, Folco et al.⁴⁰, Kaklamanos et al.⁴⁶, and Kaygisiz et al.²³ was high as they clearly stated that it was not possible to blind the participants,

personnel, and outcome assessors; reported loss to follow-up and drop out; and found selective reporting of the results. Blinding couldn't be made due to the nature of the interventions given and this is in accordance with the bias judgment of blinding of participants and personnel domain which had the worst result. Unclear risk of bias in 3 studies by Baka et al.⁸, Nalcaci et al.⁴⁷, and Uzuner et al.⁴⁸ owing to the lack of available information to do risk of bias assessment.

The limitation of this rapid review was the availability of access to use the latest Cochrane risk of bias tool. Insufficient information provided regarding research methods also became another problem in performing risk of bias assessment. It's deemed necessary for further studies to present a more detailed description of the research methodology because it's associated with the quality of the study to identify the effects of the bracket type used on oral hygiene and periodontal health status. RCT with more specific criteria of malocclusion is required in future research.

Conclusions

The findings from analyzed articles in this rapid review generally showed that the effects of using conventional and self-ligating brackets were similar in increasing oral hygiene (PI) and periodontal health status (GI and bleeding index) in patients with mild to moderate crowding, although 3 articles revealed contradictory effects.

One article reported higher increase in plaque accumulation (PI) and periodontal disease (GI and bleeding index) in the conventional bracket group. One article reported higher plaque accumulation (PI) increase in the self-ligating bracket group and another article reported higher periodontal disease (GI) increase in the self-ligating bracket group.

A multidisciplinary approach involving orthodontist and periodontist in treating orthodontic patients, regular control appointments, professional tooth cleaning, oral hygiene instructions along with reinforcements periodically, and the patients' awareness to comply and practice the oral hygiene instructions independently are needed in order to achieve favorable standards of patients' oral hygiene and health regardless the type of brackets.

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Declaration of Interest

The authors report no conflict of interest.

No	Author (year)	Study Design, Hypothesis, and Participant	Intervention	Parameter and Measurement Time	Study Results	Conclusion
1.	Baka et al. (2013) ⁸	<p>Design: RCT, split-mouth design, comparative study</p> <p>Hypothesis: SLB have an advantage in terms of the accumulation of plaque because of the absence of ligatures</p> <p>Participant: 20 male patients with mild or moderate crowding</p> <p>Mean Age (range): 14,2 ± 1,5 years (11-16,7 years)</p>	<p>No additional materials such as chains, coil springs, or figure-8 ligatures were used during the study period</p> <p>Group 1: SLB : in the maxillary right and mandibular left dentitions CB with SS ligature: in the maxillary left and mandibular right dentitions</p> <p>Group 2: CB with SS ligature: in the maxillary right and mandibular left dentitions SLB: in the maxillary left and mandibular right dentitions</p> <p>OH Procedures:</p> <ul style="list-style-type: none"> Supragingival scaling and polishing after the initial examination OHI Oral-care products were provided (standardized toothpastes and toothbrushes) The participants were asked not to use any other oral-care products during the study 	<p>Parameter: PI BOP PPD</p> <p>Measurement Time: Before bonding (T0) 1 week after bonding (T1) 3 months after bonding (T2)</p>	<p>PI:</p> <ul style="list-style-type: none"> - CB: 1,11 ± 0,25 to 2,48 ± 0,26 = 1,37 ± 0,34 - SLB: 1,11 ± 0,30 to 2,27 ± 0,34 = 1,16 ± 0,38 <p>- Intergroup comparison (P = 0,091) Not Significant</p> <p>BOP:</p> <ul style="list-style-type: none"> - CB: 51,83 ± 14,37 to 89,83 ± 7,05 = 38,00 ± 14,53 - SLB: 48,17 ± 16,31 to 86,00 ± 7,30 = 37,84 ± 15,87 <p>- Intergroup comparison (P = 0,871) Not significant</p> <p>PPD:</p> <ul style="list-style-type: none"> - CB: 2,02 ± 0,37 to 2,71 ± 0,48 = 0,68 ± 0,32 - SLB: 2,00 ± 0,43 to 2,73 ± 0,49 = 0,72 ± 0,31 <p>- Intergroup comparison (P = 0,882) Not significant</p>	<p>PI, BOP, and PPD values increased during the first 3 months of orthodontic treatment in both CB group and SLE group.</p> <p>SLB and CB with SS ligature exhibited similar changes in the increase of periodontal parameters (BOP and PPD).</p> <p>Hypothesis is rejected because SLB and CB ligated with SS ligature do not differ in terms of dental plaque retention.</p>

2.	Bergamo et al. (2016) ¹⁰	<p>Design: Clinical trial</p> <p>Hypothesis: -</p> <p>Participant: 20 patients (11 males and 9 females) with mild crowding</p> <p>Mean Age (range): 13,3 ± 1,03 years (11-15 years)</p>	<p>The brackets were bonded on the maxillary incisors and canines</p> <ul style="list-style-type: none"> - CB - Active SLB - Passive SLB <p>OH Procedures: The teeth were cleaned with non-fluoride extra-fine grain pumice and water slurry on a slow-rotating rubber cup after measurements OHI Oral-care products were provided (fluoridated toothpastes and toothbrushes)</p>	<p>Parameter: PI GI GBI</p> <p>Measurement Time: Before bonding 30 days after bonding 60 days after bonding</p>	<p>PI:</p> <p>1st Set (30 days)</p> <ul style="list-style-type: none"> - CB: 1,30 ± 0,733 to 1,45 ± 0,605 = 0,15 - Active SLB: 1,25 ± 0,716 to 1,45 ± 0,686 = 0,20 - Passive SLB: 1,45 ± 0,826 to 1,70 ± 0,733 = 0,25 - Intergroup comparison (P>0,05) Not significant <p>2nd Set (60 days)</p> <ul style="list-style-type: none"> - CB: 1,30 ± 0,657 to 1,55 ± 0,686 = 0,25 - Active SLB: 1,20 ± 0,616 to 1,45 ± 0,686 = 0,25 - Passive SLB: 1,15 ± 0,587 to 1,75 ± 0,786 = 0,60 - Intergroup comparison (P<0,05) Significant <p>GI:</p> <p>1st Set (30 days)</p> <ul style="list-style-type: none"> - CB: MB: 1,05 ± 0,39 to 1,15 ± 0,59 = 0,1 B: 1,05 ± 0,39 to 1,05 ± 0,51 = 0 DB: 1,10 ± 0,45 to 1,10 ± 0,55 = 0 - Active SLB: MB: 1,05 ± 0,39 to 1,20 ± 0,62 = 0,15 B: 1,05 ± 0,39 to 1,15 ± 0,59 = 0,1 DB: 1,05 ± 0,39 to 1,15 ± 0,59 = 0,1 - Passive SLB: MB: 1,05 ± 0,39 to 1,10 ± 0,55 = 0,05 B: 1,00 ± 0,32 to 1,05 ± 0,51 = 0,05 DB: 1,05 ± 0,39 to 1,10 ± 0,51 = 0,05 - Intergroup comparison (P>0,05) Not significant <p>2nd Set (60 days)</p> <ul style="list-style-type: none"> - CB: MB: 1,15 ± 0,49 to 1,20 ± 0,62 = 0,05 B: 1,10 ± 0,45 to 1,15 ± 0,59 = 0,05 DB: 1,15 ± 0,49 to 1,20 ± 0,62 = 0,05 - Active SLB: MB: 1,10 ± 0,45 to 1,20 ± 0,62 = 0,1 B: 1,10 ± 0,45 to 1,10 ± 0,55 = 0 DB: 1,15 ± 0,49 to 1,20 ± 0,62 = 0,05 - Passive SLB: MB: 1,20 ± 0,52 to 1,20 ± 0,62 = 0 B: 1,10 ± 0,45 to 1,15 ± 0,59 = 0,05 DB: 1,30 ± 0,57 to 1,20 ± 0,62 = 0,1 - Intergroup comparison (P>0,05) Not significant <p>GBI:</p> <p>1st Set (30 days)</p> <ul style="list-style-type: none"> - CB: 0,15 ± 0,49 to 0,10 ± 0,45 = 0,05 - Active SLB: 0,15 ± 0,49 to 0,10 ± 0,45 = 0,05 - Passive SLB: 0,25 ± 0,64 to 0,15 ± 0,49 = 0,10 - Intergroup comparison (P>0,05) Not significant <p>2nd Set (60 days)</p> <ul style="list-style-type: none"> - CB: 0,10 ± 0,31 to 0,10 ± 0,45 = 0 - Active SLB: 0,15 ± 0,37 to 0,10 ± 0,45 = 0,05 - Passive SLB: 0,10 ± 0,31 to 0,20 ± 0,52 = 0,10 - Intergroup comparison (P>0,05) Not significant 	<p>There was difference in the increase of PI values at 60 days after bonding with the highest score was observed in passive SLB group, indicating the influence of bracket design on clinical parameter changes in the initial stage of the orthodontic treatment.</p> <p>There was no differences in the GI and GBI score increase during the trial period regardless of the bracket design.</p>
3.	Chhibber et al. (2018) ⁴⁵	<p>Design: RCT, 3-arm parallel, single blinded</p> <p>Null Hypothesis: OH and periodontal health in orthodontic patients are not affected by the type of orthodontic appliance</p> <p>Participant: 71 patients (41 males and 30 females) with less than 5 mm of anterior crowding or spacing</p>	<p>CLA SLB CB with elastomer</p> <p>OH Procedures:</p> <ul style="list-style-type: none"> - OHI - Oral-care products were provided (toothbrush, toothpaste, interdental brush, dental floss) - Information brochure about OH maintenance was provided 	<p>Parameter: PI GI PBI</p> <p>Measurement Time: Before treatment or baseline (T0) After 9 months of treatment (T1) After 18 months of treatment or completion of treatment (T2)</p>	<p>PI:</p> <ul style="list-style-type: none"> - CLA: 0,50 ± 0,51 to 0,92 ± 0,58 = 0,42 - CB: 0,70 ± 0,73 to 1,32 ± 0,67 = 0,62 - SLB: 0,65 ± 0,49 to 1,07 ± 0,59 = 0,42 - Intergroup comparison SLB and ELB (P = 0,906) Not significant <p>GI:</p> <ul style="list-style-type: none"> - CLA: 0,42 ± 0,50 to 0,75 ± 0,53 = 0,33 - CB: 0,05 ± 0,22 to 1,32 ± 0,67 = 1,27 - SLB: 0,12 ± 0,33 to 1,00 ± 0,65 = 0,88 	<p>No evidence of significant difference in the OH level among subjects treated with CLA, SLB, and CB (elastomeric-ligated) after 18 months of active orthodontic treatment as seen from the increased PI values in all intervention groups.</p> <p>Overall, there was insufficient evidence to reject the null</p>

		Mean Age: 15,6 ± 4,3 years			<p>Intergroup comparison SLB and ELB (P = 0,467) Not significant</p> <p>PBI:</p> <ul style="list-style-type: none"> - CLA: 0,50 ± 0,78 to 0,46 ± 0,72 = 0,04 - CB: 0,60 ± 0,75 to 0,84 ± 1,01 = 0,24 - SLB: 0,53 ± 0,72 to 0,73 ± 1,1 = 0,2 <p>Intergroup comparison SLB dan ELB (P = 0,667) Not significant</p>	hypothesis that the type of orthodontic appliance has no effect on periodontal health. CB and SLB groups presented similar increases in GI and PBI values when compared between the two groups. The choice of orthodontic appliance has little influence on the clinical periodontal parameters.
4.	Folco et al. (2014) ⁴⁰	<p>Design: RCT, comparative study</p> <p>Hypothesis: -</p> <p>Participant: 22 male and female patients with comparable relative crowding and cast discrepancy less than 7 mm</p> <p>Age Range: 16-30 years</p>	<p>Group A: SLB</p> <p>Group B: CB with elastomer which were replaced every 14 days</p> <p>OH Procedures:</p> <ul style="list-style-type: none"> - Basic periodontal treatment was provided if necessary - OHI - Participants were instructed to use Bass' technique - Participants were taught how to use interdental brush 	<p>Parameter: PI GI PD</p> <p>Measurement Time: Before bonding (baseline) 14 days after bonding 28 days after bonding 56 days after bonding</p>	<p>PI, GI, and PD: Intragroup comparison Fluctuating PI, GI, and PD values which tend to increase (P>0,05) in both bracket groups particularly in the SLB group on day 14. The indices approached values compatible with health for both groups at subsequent evaluations (day 28 and 56)</p> <p>Intergroup comparison (P>0,05) Not significant</p>	<p>Orthodontic treatment with either CB or SLB increased bacterial plaque and inflammatory gingival response.</p> <p>SLB and CB presented similar response regarding increased bacterial plaque indices and gingival clinical response.</p>
5.	Kaklamani et al. (2017) ⁴⁶	<p>Design: RCT, two-arm parallel, single-centre</p> <p>Hypothesis: -</p> <p>Participant: 22 patients with moderate crowding</p> <p>Age: -</p>	<p>CB SLB</p> <p>OH Procedures:</p> <ul style="list-style-type: none"> - OHI - Participants were advised to avoid antibiotics and antibacterial mouth rinses 	<p>Parameter: GI</p> <p>Measurement Time: The first measurement was performed immediately before bonding with follow-up every 3 months</p>	<p>GI:</p> <ul style="list-style-type: none"> - CB: 0,37 ± 0,12 to 1,53 ± 0,31 = 1,16 - SLB: 0,32 ± 0,11 to 1,48 ± 0,29 = 1,16 <p>Intergroup comparison (P>0,05) Not significant</p>	This study didn't reveal any differences between the compared group, CB and SLB, regarding the increased GI scores.
6.	Kaygisiz et al. (2015) ²³	<p>Design: RCT, comparative study</p> <p>Null Hypothesis: Bracket type has no effect on these measured parameters</p> <p>Participant: 60 patients (32 males and 28 females) with mild to moderate crowding</p> <p>Age: Mean age group 1 14,7 ± 1,39 years, group 2 14 ± 1,01 years, and group 3 14,4 ± 1,46 years Age range 12-18 years</p>	<p>Group 1: SLB</p> <p>Group 2: CB with SS ligature</p> <p>Group 3: Control group (the orthodontic treatment was started at the end of the study)</p> <p>OH Procedures:</p> <ul style="list-style-type: none"> - OHI - The method of brushing the teeth and tongue was shown with practices - Oral-care products were provided (fluoridated toothpastes and toothbrushes) - The participants were asked not to use any other oral-care products during the study 	<p>Parameter: PI GI BOP PD</p> <p>Measurement Time: 1 week before bonding (T1) Immediately before bonding (T2) 1 week after bonding (T3) 4 weeks after bonding (T4) 8 weeks after bonding (T5)</p>	<p>PI:</p> <ul style="list-style-type: none"> - CB: 0,45 ± 0,39 to 0,78 ± 0,52 = 0,33 - SLB: 0,43 ± 0,37 to 0,81 ± 0,43 = 0,38 - Control: 0,36 ± 0,30 to 0,63 ± 0,71 = 0,27 <p>Intergroup comparison (P = 0,406) Not significant</p> <p>GI:</p> <ul style="list-style-type: none"> - CB: 0,34 ± 0,41 to 0,38 ± 0,35 = 0,04 - SLB: 0,20 ± 0,18 to 0,58 ± 0,52 = 0,38 - Control: 0,29 ± 0,28 to 0,47 ± 0,51 = 0,18 <p>Intergroup comparison (P = 0,877) Not significant</p> <p>BOP:</p> <ul style="list-style-type: none"> - CB: 3,26 ± 2,29 to 2,11 ± 0,94 = 1,15 - SLB: 3,95 ± 2,61 to 2,34 ± 0,56 = 1,61 - Control: 3,03 ± 1,21 to 1,97 ± 0,73 = 1,06 <p>Intergroup comparison (P = 0,024) Significant</p> <p>PD:</p> <ul style="list-style-type: none"> - CB: 1,41 ± 0,28 to 1,42 ± 0,30 = 0,01 - SLB: 1,60 ± 0,48 to 1,46 ± 0,23 = 0,14 - Control: 0,15 ± 0,70 to 1,63 ± 0,54 = 1,48 <p>Intergroup comparison (P = 0,213) Not significant</p>	<p>The use of both SB and SLB caused increase in plaque accumulation.</p> <p>SLBs do not have an advantage over CB with respect to periodontal status.</p>
7.	Nalcaci et al. (2014) ⁴⁷	<p>Design: RCT, comparative study</p> <p>Null Hypothesis: Bracket type has no effect on these measured parameters</p> <p>Participant:</p>	<p>CB with elastomer SLB OHI</p>	<p>Parameter: PI GI BOP</p> <p>Measurement Time: Before bonding (T0) 1 week after bonding (T1)</p>	<p>PI:</p> <ul style="list-style-type: none"> - CB: 0,41 ± 0,05 to 0,94 ± 0,09 = 0,53 - SLB: 0,46 ± 0,06 to 0,66 ± 0,08 = 0,2 <p>Intergroup comparison (P = 0,030) Significant</p> <p>GI:</p> <ul style="list-style-type: none"> - CB: 0,36 ± 0,06 to 1,05 ± 0,10 = 0,69 - SLB: 0,36 ± 0,05 to 0,53 ± 0,07 = 0,17 	<p>SLB positively affected periodontal status.</p> <p>Bracket type has different adverse effect on periodontal status. SLB group showed better periodontal status compared to CB group.</p>

		46 patients (22 males and 24 females) with mild to moderate crowding		5 weeks after bonding (T2)	- Intergroup comparison (P = 0,001) Significant	SLB may be advised to increase the likelihood of better OH in course of orthodontic treatment.
		Age: Mean age SLB group 14,48 ± 1,27 years and CB group 13,30 ± 1,61 years Age range 11-16 years			BOP: - CB: 0,06 ± 0,006 to 0,21 ± 0,04 = 0,15 - SLB: 0,08 ± 0,007 to 0,13 ± 0,02 = 0,05 - Intergroup comparison (P = 0,039) Significant	
8.	Uzuner et al. (2014) ⁴⁸	Design: RCT, comparative study Null Hypothesis: Bracket type has no effect on these measured parameters Participant: 40 patients (11 males and 29 females) with mild crowding Age Range: 14-16 years	Group 1: CB with SS ligature Group 2: SLB OH Procedures: - OHI were given 1 week before the treatment started - Oral-care products were provided (fluoridated toothpastes and toothbrushes) - The participants were asked not to use any other oral-care products during the study	Parameter: PI GI PD Measurement Time: Before bonding (T1) 1 month after bonding (T2) which was the time for the appointment to change the first archwire	PI: - CB: 0,43 to 0,93 = 0,50 - SLB: 0,30 to 1,00 = 0,70 - Intergroup comparison (P = 0,069) Not significant GI: - CB: 0,48 to 0,61 = 0,13 - SLB: 0,16 to 1,02 = 0,86 - Intergroup comparison (P = 0,028) Significant PD: - CB: 1,77 to 2,20 = 0,43 - SLB: 1,35 to 3,00 = 1,65 - Intergroup comparison (P = 0,007) Significant	SLBs do not have an advantage over CB with respect to periodontal status. The expectation of better values for periodontal indices in the SLB group was not achieved. The two types of brackets have different adverse effects on periodontal health status because SLB group exhibited greater increase in GI and PD values than CB group.

Table 1. Data extraction of included articles.

RCT: randomized controlled trial, **CB:** conventional brackets, **SLB:** self-ligating brackets, **OH:** oral hygiene, **OHI:** oral hygiene instruction, **PI:** plaque index, **GI:** gingival index, **BOP:** bleeding on probing, **GBI:** gingival bleeding index, **PBI:** papillary bleeding index, **PD:** probing depth, **PPD:** periodontal probing depth, **MB:** mesiobuccal, **B:** buccal, **DB:** distobuccal, **CLA:** clear aligners, **SS:** stainless-steel.

References

- Nocini R, Lippi G, Mattiuzzi C. Periodontal disease: the portrait of an epidemic. *J Public Health Emerg.* 2020;4(10):1-6.
- Nazir M, Al-Ansari A, Al-Khalifa K, Alhareky M, Gaffar B, Almas K. Global Prevalence of Periodontal Disease and Lack of Its Surveillance. *The Scientific World Journal.* 2020;2020:1-8.
- Nazir MA. Prevalence of periodontal disease, its association with systemic diseases and prevention. *Int J Health Sci (Qassim).* 2017;1(2):72-80.
- Aviandiva M, Putri DS, Sulijaya B, Masulili SLC, Natalia, Lessang R. Clinical Periodontal Parameter of Smokers with Periodontitis in Asia Following Periodontal Therapy: An Update Systematic Review and Meta-Analysis. *Journal of International Dental and Medical Research.* 2022;15(2):926-34.
- Soulissa AG, Ummah SR, Lombardo B, Widyarman AS. Effectiveness of Pineapple (Ananas Comosus) Hump Extract in Inhibiting Periodontal Pathogens Biofilm Growth and Adhesion. *Journal of International Dental and Medical Research.* 2022;15(3):977-83.
- Madiba TK, Bhayat A. Periodontal disease - risk factors and treatment options. *South African Dental Journal.* 2018;73(9):571-5.
- Shaw L, Harjunmaa U, Doyle R, et al. Distinguishing the Signals of Gingivitis and Periodontitis in Supragingival Plaque: A Cross-Sectional Cohort Study in Malawi. *Appl Environ Microbiol.* 2016;82(19):6057-67.
- Baka ZM, Basciftci FA, Arslan U. Effects of 2 bracket and ligation types on plaque retention: A quantitative microbiologic analysis with real-time polymerase chain reaction. *American Journal of Orthodontics and Dentofacial Orthopedics.* 2013;144(2):260-7.
- Han JY. A comparative study of combined periodontal and orthodontic treatment with fixed appliances and clear aligners in patients with periodontitis. *J Periodontal Implant Sci.* 2015;45(6):193-204.
- Bergamo AZN, Nelson-Filho P, Romano FL, et al. Gingival crevicular fluid volume and periodontal parameters alterations after use of conventional and self-ligating brackets. *J Orthod.* 2016;43(4):260-7.
- Chongthanavanit P, Luppapornlarp S, Mamani NC, Sirisoontorn I. A Systematic Review of the Impact of Malocclusion on the Quality of Life among Young Adults. *Journal of International Dental and Medical Research.* 2022;15(1):358-64.
- Chongthanavanit P, Luppapornlarp S, Arunpraphan S, Sirisoontorn I. Relationship of Patients' Perception of Malocclusion Related Quality of Life and Orthodontic Treatment Need in Adults. *Journal of International Dental and Medical Research.* 2022;15(1):223-9.
- Hinrichs JE, Math VT. The Role of Dental Calculus and Other Local Predisposing Factors. In: Newman MG, Takei HH, Klokkevoeld PR, Carranza FA, eds. *Carranza's Clinical Periodontology.* 12th ed. Elsevier; 2015:116-31.
- Javali MA, Betsy J, Althobaiti RSS, Alshahrani RA, Alqahtani HAH. Relationship between Malocclusion and Periodontal Disease in Patients Seeking Orthodontic Treatment in Southwestern Saudi Arabia. *Saudi J Med Med Sci.* 2020;8(2):133-9.
- Salim NA, Alamouh RA, Al-Abdallah MM, Al-Asmar AA, Satterthwaite JD. Relationship between dental caries, oral hygiene and malocclusion among Syrian refugee children and adolescents: a cross-sectional study. *BMC Oral Health.* 2021;21(1):1-8.
- Guo J, Li L, Guan G, Bennani F, Mei L. Oral health knowledge and practice among orthodontic clients in China and New Zealand. *Canadian Journal of Dental Hygiene.* 2020;54(3):124-32.
- Cozzani M, Ragazzini G, Delucchi A, et al. Oral hygiene compliance in orthodontic patients: a randomized controlled study on the effects of a post-treatment communication. *Prog Orthod.* 2016;17(1):41.
- Papadimitriou A, Kouvelis G, Fanaropoulou T, et al. Effects of Self-ligating Orthodontic Appliances on the Periodontal Health of Adolescents: A Prospective Cohort Study. *Oral Health Prev Dent.* 2021;19(1):129-35.
- Cardoso M de A, Saraiva PP, Maltagliati LÁ, et al. Alterations in plaque accumulation and gingival inflammation promoted by treatment with self-ligating and conventional orthodontic brackets. *Dental Press J Orthod.* 2015;20(2):35-41.
- Alhajja ESA, Al-Saif EM, Taani DQ. Periodontal health knowledge and awareness among subjects with fixed orthodontic appliance. *Dental Press J Orthod.* 2018;23(5):40.e1-9.
- Mester A, Onisor F, Mesaros AS. Periodontal Health in Patients with Self-Ligating Brackets: A Systematic Review of Clinical Studies. *J Clin Med.* 2022;11(9):2570.
- Mazin H, Ali S, Salah R. The Effect of Fixed Orthodontic Appliances on Gingival Health. *IOSR Journal of Dental and*

- Medical Sciences. 2016;15(11):82-8.
23. Kaygisiz E, Uzuner FD, Yuksel S, et al. Effects of self-ligating and conventional brackets on halitosis and periodontal conditions. *Angle Orthodontist*. 2015;85(3):468-73.
 24. Cerroni S, Pasquantonio G, Condò R, Cerroni L. Orthodontic Fixed Appliance and Periodontal Status: An Updated Systematic Review. *Open Dent J*. 2018;12(1):614-22.
 25. Aljohani SR, Alsaggaf DH. Adherence to Dietary Advice and Oral Hygiene Practices Among Orthodontic Patients. *Patient Prefer Adherence*. 2020;14:1991-2000.
 26. Buck T, Pellegrini P, Sauerwein R, et al. Elastomeric-ligated vs self-ligating appliances: A pilot study examining microbial colonization and white spot lesion formation after 1 year of orthodontic treatment. *Orthodontics (Chic)*. 2011;12(2):108-21.
 27. Arnold S, Koletsis D, Patcas R, Eliades T. The effect of bracket ligation on the periodontal status of adolescents undergoing orthodontic treatment. A systematic review and meta-analysis. *J Dent*. 2016;54:13-24.
 28. Bock F. The Development and History of Fixed Appliances. In: Ludwig B, Bister D, Baumgaertel S, eds. *Self-Ligating Brackets in Orthodontics: Current Concepts and Techniques*. Thieme; 2012:1-8.
 29. Ludwig B, Glasl B. Materials. In: Ludwig B, Bister D, Baumgaertel S, eds. *Self-Ligating Brackets in Orthodontics: Current Concepts and Techniques*. Thieme; 2012:9-32.
 30. Puspitasari Y, Aswar AA, Ilmianti. The relation between duration of fixed orthodontic treatment and oral hygiene status among students of Faculty of Dentistry Universitas Muslim Indonesia 2017. *Dentino Jurnal Kedokteran Gigi*. 2018;III(2):162-7.
 31. Lee JH, Abdullah AAA, Yahya NA. Oral Hygiene Practices among Fixed Orthodontic Patients in a University Dental Setting. *International Journal of Oral and Dental Health*. 2016;2(2):027.
 32. Buthelezi NL, Madiba TK. Oral hygiene habits and status of orthodontic patients attending the University of Pretoria, Oral and Dental Hospital. *South African Dental Journal*. 2021;76(3):130-5.
 33. Vanarsdall RL, Blasi I, Secchi AG. Periodontal-Orthodontic Interrelationships. In: Graber LW, Vanarsdall RL, Vig KWL, Huang GJ, eds. *Orthodontics: Current Principles and Techniques*. 6th ed. Elsevier; 2017:621-68.
 34. Vinod K, Reddy YG, Reddy VP, Nandan H, Sharma M. Orthodontic-periodontics interdisciplinary approach. *J Indian Soc Periodontol*. 2012;16(1):11-5.
 35. Al-Anezi SA. Dental plaque associated with self-ligating brackets during the initial phase of orthodontic treatment: A 3-month preliminary study. *J Orthod Sci*. 2014;3(1):7-11.
 36. Haradine NWT. Self-ligating brackets: where are we now? *J Orthod*. 2003;30(3):262-73.
 37. Goldbecher H. Bracket Systems. In: Ludwig B, Bister D, Baumgaertel S, eds. *Self-Ligating Brackets in Orthodontics: Current Concepts and Techniques*. Thieme; 2012:33-60.
 38. Ludwig B, Glasl B, Lietz T. Auxiliary Equipment and Techniques. In: Ludwig B, Bister D, Baumgaertel S, eds. *Self-Ligating Brackets in Orthodontics: Current Concepts and Techniques*. Thieme; 2012:172-213.
 39. Souper GH, Yaber MIS, Aguilar VV, Muñoz AD. Evidence-based comparison of self-ligating and conventional brackets. *Odontostomatologia*. 2021;23(38):1-14.
 40. Folco AA, Benítez-Rogé SC, Iglesias M, et al. Gingival response in orthodontic patients: Comparative study between self-ligating and conventional brackets. *Acta Odontol Latinoam*. 2014;27(3):120-4.
 41. Yang X, Su N, Shi Z, et al. Effects of self-ligating brackets on oral hygiene and discomfort: a systematic review and meta-analysis of randomized controlled clinical trials. *Int J Dent Hyg*. 2017;15(1):16-22.
 42. Garrity C, Gartlehner G, Nussbaumer-Streit B, et al. Cochrane Rapid Reviews Methods Group offers evidence-informed guidance to conduct rapid reviews. *J Clin Epidemiol*. 2021;130:13-22.
 43. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med*. 2009;6(7):e1000097.
 44. Higgins JPT, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ*. 2011;343:d5928.
 45. Chhibber A, Agarwal S, Yadav S, Kuo CL, Upadhyay M. Which orthodontic appliance is best for oral hygiene? A randomized clinical trial. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2018;153(2):175-83.
 46. Kaklamanos EG, Mavreas D, Tsalikis L, Karagiannis V, Athanasiou AE. Treatment duration and gingival inflammation in Angle's Class I malocclusion patients treated with the conventional straight-wire method and the Damon technique: a single-centre, randomised clinical trial. *J Orthod*. 2017;44(2):75-81.
 47. Nalçacı R, Özat Y, Çokakoğlu S, Türkkahraman H, Önal S, Kaya S. Effect of bracket type on halitosis, periodontal status, and microbial colonization. *Angle Orthodontist*. 2014;84(3):479-85.
 48. Uzuner FD, Kaygisiz E, Çankaya ZT. Effect of the bracket types on microbial colonization and periodontal status. *Angle Orthodontist*. 2014;84(6):1062-7.
 49. Zemedikun DT, Chandan JS, Raindi D, et al. Burden of chronic diseases associated with periodontal diseases: a retrospective cohort study using UK primary care data. *BMJ Open*. 2021;11(12):e0048296.
 50. Löe H. The Gingival Index, the Plaque Index and the Retention Index Systems. *J Periodontol*. 1967;38(6):610-6.
 51. Kozak U, Şekowska A, Chałas R. The Effect of Regime Oral-Hygiene Intervention on the Incidence of New White Spot Lesions in Teenagers Treated with Fixed Orthodontic Appliances. *Int J Environ Res Public Health*. 2020;17(24):9460.
 52. Lang NP, Bartold PM. Periodontal health. *J Periodontol*. 2018;89(Suppl. 1):S9-16.
 53. Mulla Issa FHK, Mulla Issa ZHK, Rabah AF, Hu L. Periodontal parameters in adult patients with clear aligners orthodontics treatment versus three other types of brackets: A cross-sectional study. *J Orthod Sci*. 2020;9(1):4.
 54. Halim H. The Relationship Between Orthodontic Treatment and Periodontal Health. *Asian Journal of Pharmaceutical and Clinical Research*. 2020;13(6):31-4.
 55. Zanatta FB, Ardenghi TM, Antoniazzi RP, Pinto TMP, Rösing CK. Association between gingivitis and anterior gingival enlargement in subjects undergoing fixed orthodontic treatment. *Dental Press J Orthod*. 2014;19(3):59-66.
 56. Fiorellini JP, Stathopoulou PG. Anatomy of the Periodontium. In: Newman MG, Takei HH, Klokkevid PR, Carranza FA, eds. *Carranza's Clinical Periodontology*. 12th ed. Elsevier; 2015:9-39.
 57. Moosa Y, Han LN, Safdar J, Sheikh OA, Pan YP. Periodontal status of Pakistani orthodontic patients. *Braz Oral Res*. 2015;29(1):1-5.
 58. Shekhar MG, Abraham S, Joy S, Mahabob N. Comparative Evaluation of Powered and Manual Toothbrushes in Reducing Plaque and Gingivitis in Institutionalized Orphan Children. *Journal of International Dental and Medical Research*. 2022;15(2):735-40.
 59. Cabrera VD, Pizarro MO, Peralta KYL, Estrada MAV, Álvarez CRM, Alarcón VS. Bacterial Adhesion and the Role of Mouthwashes in Orthodontics: A Literature Review. *Journal of International Dental and Medical Research*. 2022;15(2):850-7.
 60. Hânțoiu T, Monea A, Lazăr L, Hânțoiu L. Clinical evaluation of periodontal health during orthodontic treatment with fixed appliances. *Acta Med Marisiensis*. 2014;60(6):265-8.
 61. Sebbar M, Abidine Z, Laslami N, Bentahar Z. Periodontal Health and Orthodontics. In: Viridi MS, ed. *Emerging Trends in Oral Health Sciences and Dentistry*. IntechOpen; 2015:717-32.
 62. Singla S, Gupta P, Lehl G, Talwar M. Effects of Reinforced Oral Hygiene Instruction Program With and Without Professional Tooth Cleaning on Plaque Control and Gingival Health of Orthodontic Patients Wearing Multibracket Appliances. *Journal of Indian Orthodontic Society*. 2019;53(4):272-7.