



## The Comparison of the Bonding Performance between the new Flash-free Orthodontic Bracket Bonding System and the Traditional Bracket Bonding System: A Systematic Review and Meta-analysis

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### ABSTRACT

**Background and aim:** The purpose of this study was the comparison of the bonding performance between the new flash-free Orthodontic bracket bonding system and the traditional bracket bonding system.

**Material and methods:** The present study is a systematic review and meta-analysis based on PRISMA 2020 Checklist. Databases of PubMed, Scopus, Web of Science, EBSCO, ISI Web of knowledge, and Embase were searched for systematic literature until 23 October 2022. 95% confidence interval for mean differences with fixed effect model and Inverse-variance method were calculated. Meta-analysis was performed using Stata/MP v.17 software.

**Results:** In the initial review, duplicate studies were eliminated, and abstracts of 281 studies were reviewed. Two authors reviewed the full text of 49 studies, and five studies were selected. The bond failure rates risk ratio between the flash-free and control groups was 0.41 (RR, 0.41 95% CI -0.48, -1.29; p=0.37). The mean difference in bonding time between the flash-free and control groups was -1.68 (MD, -1.68 95% CI -1.81, -1.56; p=0.00).

**Conclusions:** Based on the present meta-analysis, no significant difference in terms of failure rate and adhesive remnant index score when comparing the flash-free Orthodontic bracket bonding system and the traditional bracket bonding system groups.

### 1. Introduction

Among the most common problems related to teeth is Malocclusion, the treatment solution of which is mainly orthodontics; Orthodontics with the fixed appliance is one of the most efficient treatments so far.<sup>[1]</sup> During orthodontic treatment, brackets play a very important role; they are usually attached to the teeth with glue, which remains during the treatment. Various adhesives have been introduced in orthodontics; optical adhesives take less time to bond brackets compared to chemically cured adhesives.<sup>[2]</sup> An adhesive precoated bonding system was introduced in 1991; However, one of the main problems in orthodontics is the remaining excess glue around the brackets (flash).<sup>[3]</sup> It takes time to remove it. The presence of flash during the treatment causes plaque accumulation, periodontal inflammation, and white spot lesions, which positively affect the teeth' beauty.<sup>[4]</sup> In 2013, flash-free technology was introduced to solve these problems, and its advantages were

the reduction of link failure rate and the convenience of flash cleaning.<sup>[5, 6]</sup> Studies have investigated the performance of non-flash and conventional adhesives, but the results are contradictory, and there are disagreements about clinical performance.<sup>[4, 5, 7]</sup> Therefore, conducting a study that comprehensively examines and compares the results of the studies is very important; In the present study, the clinical performance of flash-free bonding systems was investigated compared to the conventional method. The purpose of this study was the comparison of the bonding performance between the new flash-free Orthodontic bracket bonding system and the traditional bracket bonding system.

### 2. Material and methods

Search strategy

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The present study is a systematic review and meta-analysis based on the PRISMA 2020 Checklist.<sup>[8]</sup> All international databases, PubMed, Scopus, Science Direct, ISI, Web of Knowledge, and Embase, using keywords related to the objectives of the study until 23 October 2022 were reviewed. Google Scholar search engine was also used to find related articles.

MeSh keywords:

("Orthodontic Brackets"[Mesh] OR "Orthodontic Appliances"[Mesh] OR "Orthodontic Appliances, Fixed"[Mesh]) AND "Dental Bonding"[Mesh].

Search keywords:

" Orthodontic " OR " Orthodontic Brackets " OR " Orthodontic Appliances" AND " Dental Bonding" AND "flash-free" OR " flash free " AND " operator coated " OR " adhesive precoated."

**Data items, data collection, and selection process**

Using a checklist that included the author's name, year of publication, the number of patients, study design, control group, Duration of the study, and intervention group were extracted and reported in Table 3. Also, the data required for meta-analysis, including clinical outcome, bonding time, and adhesive remnant index score, were extracted from the studies. All articles were selected based on the inclusion criteria, two reviewers independently screened each record, and each report was retrieved.

**Eligibility criteria**

**Inclusion criteria:** Inclusion criteria were a response to PICO, as reported in Table 1. No language restrictions and Randomized controlled clinical trial studies.

**Exclusion criteria:** Case studies, case reports, and review papers. Studies without full-text access.

**Table 1. PICO strategy.**

PICO Strategy	Description
P	Population: Patients undergoing orthodontic treatment with fixed appliances
I	Intervention: Flash-free
C	Comparison: Traditional bracket bonding system
O	Outcome: Clinical outcome, bonding time, the adhesive remnant index score

**Study risk of bias assessment**

The quality of the randomized control trial studies included was assessed using the Cochrane Collaboration's tool.<sup>[15]</sup> The scale scores for low risk and High or unclear were 1 and 0, respectively. Scale scores range from 0 to 6. A higher score means higher quality.

**Data analysis**

Data analysis was performed using STATA/MP. V17 software. 95% confidence interval for mean differences with the fixed effect model and Inverse-variance method and risk ratio with the fixed effect model and Mantel–Haenszel were calculated. Random effects were used, and I2 showed heterogeneity to deal with potential heterogeneity. I<sup>2</sup> values less than 50% indicate low heterogeneity, and above 50% indicate moderate to high heterogeneity.

**3. Results**

**Study selection**

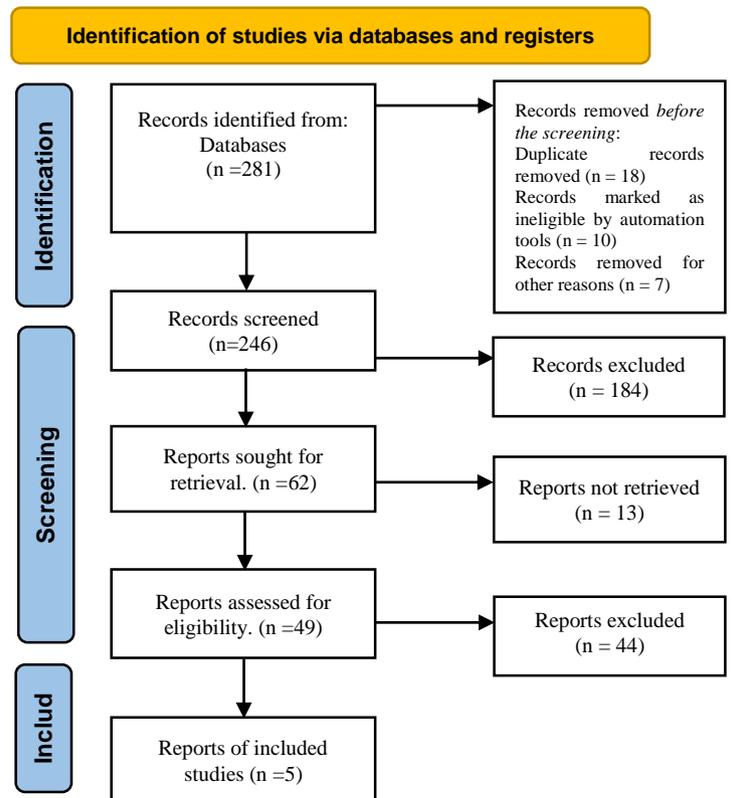
In the initial search, 281 articles related to the keywords were found. Of these, 18 studies were Duplicate records, 10 articles were removed due to Records marked as ineligible by automation tools, and 7 articles were records removed for other reasons. In the next step, abstracts of 246 articles were reviewed, and 184 articles were excluded from the research according to the exclusion criteria. The full text of 49 articles was reviewed, and according to the inclusion criteria, 44 studies were excluded, and five studies were selected (Fig. 1).

**Risk of bias in studies**

According to the risk of the bias assessment tool, four studies had a low risk of bias; one study had a moderate risk of bias (Table 3).

**Study characteristics**

A total of 167 patients under fixed orthodontics appliances were examined; The data extracted from the studies are reported in Table 2.



**Fig. 1. PRISMA 2020 Checklist.**

**Table 2. Data extracted from selected studies.**

Study. Years	Study Design	Number of Patients		Age Mean (SD)	Total of Brackets	Control Group	Study Duration (Month)
		Male	Female				
Tan et al., 2020 <sup>[9]</sup>	A split-mouth RCT	30		15.1	600	Conventional ceramic brackets	6
		10	20				
Yetkiner et al., 2019 <sup>[10]</sup>	A split-mouth RCT	20		14.23±0.15	NR	APC	1
Tümoğlu et al., 2019 <sup>[11]</sup>	A split-mouth RCT	33		17.2±3.6	660	Adhesive precoated bracket systems	6
		7	26				
Grünheid et al., 2019 <sup>[12]</sup>	A split-mouth RCT	42		19.7±9.3	420	APC	32
		22	20				
Grünheid et al., 2018 <sup>[13]</sup>	A split-mouth RCT	42		19.7±9.3	422	APC	12
		22	20				

**Table 3. Risk of bias assessment (Collaboration’s tool).**

Study	Random sequence generation	Allocation Concealment	Blinding of Participants and Personnel	Blinding of Outcome Assessment	Incomplete Outcome Data	Selective Reporting	Total Score
Tan et al., 2020 <sup>[9]</sup>							3
Yetkiner et al., 2019 <sup>[10]</sup>							6
Tümoğlu et al., 2019 <sup>[11]</sup>							4
Grünheid et al., 2019 <sup>[12]</sup>							5
Grünheid et al., 2018 <sup>[13]</sup>							6

(Low (+), unclear (?), high (-))

**Clinical outcome**

The risk ratio of bond failure rate between the flash-free and control group was 0.41 (RR, 0.41 95% CI -0.48, -1.29; p=0.37) with moderate heterogeneity

(I<sup>2</sup>=68.39%; P =0.08). this result showed no statistically significant difference was observed between groups (p=0.37) (Fig. 2).

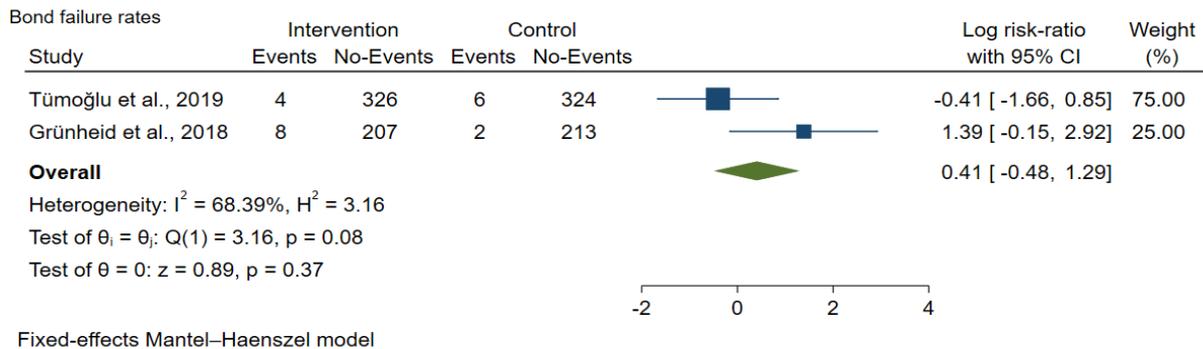


Fig. 2. Forest plot showed the bond failure rate risk ratio between the flash-free and control groups.

**Bonding time**

The mean difference in bonding time between the flash-free and control group was -1.68 (MD, -1.68 95% CI -1.81, -1.56;  $p=0.00$ ) with high heterogeneity ( $I^2=98.31\%$ ;  $P =0.00$ ). this result showed two groups have a statistically

significant difference so that the bonding time reduced in the flash-free group ( $p=0.00$ ) (Fig. 3).

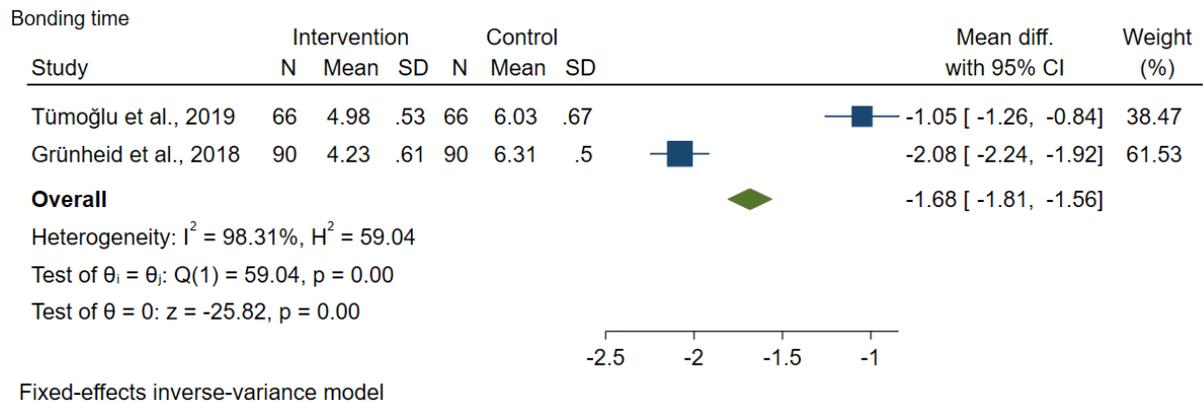


Fig. 3. Forest plot showed Mean differences in bonding time between flash-free and control groups.

**The adhesive remnant index score**

The mean difference in adhesive remnant index score between the flash-free and control group was -0.5 (MD, -0.5 95% CI -1.09, 0.09;  $p=0.10$ ) with low

heterogeneity ( $I^2=0\%$ ;  $P =1.00$ ). this result showed no statistically significant difference was observed between groups ( $p=0.10$ ) (Fig. 4).

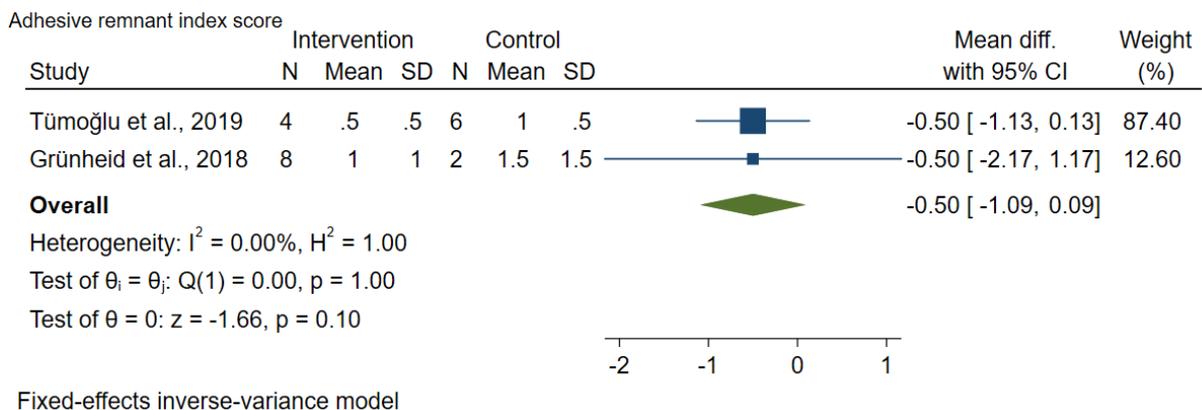


Fig. 4. Forest plot showed Mean differences of the adhesive remnant index score.

**4. Discussion**

One of the challenges in the orthodontic treatment process is the problem of flash, which takes time for orthodontists to remove, and the remaining flash

causes periodontal inflammation and plaque accumulation. Studies have shown that using a flash-free bonding system solves this problem.<sup>[14]</sup> In the present study, the flash-free bonding system was compared with traditional

methods, and meta-analysis showed that both groups were the same in terms of bond failure rate and adhesive remnant index score. While the bonding time was less in the flash-free bonding system group. Except for one study, four studies were of high quality; Also, a high heterogeneity between studies was observed in the examination of bonding time.

Moreover, these findings should be interpreted with caution, while there was little heterogeneity in the measurement of bond failure rate and adhesive remnant index score. The high heterogeneity of studies can be due to methodology. The lower bonding time in the flash-free bonding system group can be due to the removal of excess glue in this process, which saves time.<sup>[12]</sup> Also, this reduction in time leads to greater patient satisfaction during orthodontic treatment. In examining the failure rate, both groups were similar; However, reports indicate that the lower density of flash-free system cases can affect the strength of the band, which is suggested to be investigated in future studies.<sup>[7]</sup> Studies have also shown that in laboratory conditions, no significant difference was observed between the two groups in bond strength.<sup>[6, 15]</sup> Based on the available evidence, flash-free does not affect bond strength, and the rate of bond failure in the flash-free group is similar to traditional methods. The present study had limitations, firstly, the flash-free bonding system is a new adhesive, and this caused there to be fewer randomized clinical trial studies in this field. Meta-analysis was performed only in two studies because the study methodology needed to be aligned, and the outcome measurement was different. It is suggested that randomized clinical trial studies be conducted with higher sample sizes, high quality, and appropriate cognitive methodology.

## 5. Conclusion

The present meta-analysis showed no significant difference in failure rate and adhesive remnant index score when comparing the flash-free Orthodontic bracket bonding system and the traditional bracket bonding system groups, while the bonding time in the flash-free Orthodontic bracket bonding system group was less than the traditional one. It was a bracket bonding system. Therefore, a flash-free Orthodontic bracket bonding system is better than traditional methods.

## Conflict of Interest

The authors declared that there is no conflict of interest.

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