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The Impact of Flash-Free Adhesives in the Future of Orthodontic Brackets: A Systematic Review

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Abstract:- Flash-free adhesives, as an alternative to the process of Flash cleanup, which used to be a major part of conventional adhesive applications, apart from being an additive step, also tend to leave uneven clumps with the need for extreme technical expertise.To establish the status of Flash-free adhesives as an alternative to conventional adhesive systems for Orthodontic brackets. A literature search was performed using PubMed, Google scholar, Science direct, Lilacs and Grey literature using MeSH terms- Flash-free adhesives, Orthodontic brackets, fixed appliances. Out of 91 articles, 30 full-text articles were assessed for eligibility, and then four were taken for systematic review. This review was then reported according to the PRISMA guidelines. While compared to conventional adhesives, Flash-free adhesives are more effective in treating orthodontic brackets because of a reduction in the accumulation of plaque control and demineralization. The study concludes that it reduces the extent of accumulation of plaque control by eliminating excess adhesive and reducing bracket failures. The use of flash-free adhesives is more effective in the treatment of orthodontic brackets.

Keywords:- *Flash-free adhesives, Orthodontic Brackets, Conventional adhesives, Flashcleanup.*

I. INTRODUCTION

Successful orthodontic treatment ensures the patient's comfort throughout theduration of the treatment. As Kirk A Davis highlights the importance of chair time, being the King in orthodontics, he mentions how with the significant reduction of chair time, they were able to complete more cases and remove the painstakingly long bonding appointments from their schedule [1]. Application of orthodontic brackets forms a core part of most of its treatment territory [2]. An ideal procedure for the application of an orthodontic bracket involves the safety of providing minimal damage to the surface during debonding [3]. Thus, judging on the given scenario, it posed a challenge to how this specific process could be made simpler, paving the way to the world of flash free adhesives. As Kirk A Davis mentions, free adhesives show how exhausting flash removal is in the bonding process, highlighting its dependence on fine motor skills, constant concentration and visual focus[1]. Flash-free brackets significantly reduce the application time and provide notable retention, protecting the enamel from demineralisation during treatment.

Apart from the time factor, flash-based adhesives also show a high preference for white spot lesion formations. Greek et al. found that WSL occurred at least once post-fixed orthodontic treatment[4]. Other studies range an incidence range of around 2-96% [5,6]. The cause has been identified as the persistence of excess adhesive flash, which acts as gingival irritation, thus amplifying the chances [7] of bacterial colonisation, thus contributing to the increased incidence[8,9]. Conventionally, flash, the excessive adhesive that flows around the base of the bracket, forms a hotspot for plaque accumulation contributed by enamel demineralisation, making oral hygiene practices for the patient troublesome. When flash free adhesives placed on the tooth it decompresses at the base of the bracket[10]. When orthodontic treatment is completed, the removal of the attachments, as well as the residual adhesive, produces clouds of visible dust, aerosols formed by agglomeration or a chemical reaction of vapours, classified by the mass median aerodynamic diameter (MMAD) produced, which splatters into the air surrounding the patient as well as the operator[11].

When discussing bond failure, bond strength comes to play, and among the articles testing it, 3 of them show high bond strength using flash-free adhesives[12,13.14]. However, one must remove this adhesive from the tooth surface, which takes up the maximum chunk of time for both the clinician and the patient during an appointment. A significant reduction of time in the flash removal process was seen in three studies. [15,16]. The result of a flash-free adhesive is equal, whenattached at the final step of cleaning

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the enamel after the treatment[17]. Thus flash, free adhesives significantly reduce and ease the debonding procedure. Finally, this study is to establish the status of Flash-free adhesives as an alternative to conventional adhesive systems for Orthodontic brackets.

II. MATERIALS AND METHODS

A. *STUDY DESIGN:*

Systematic review of randomized controlled trials.

B. *ELIGIBILITY CRITERIA:*

a) Inclusion Criteria

- Randomised controlled study.
- Only available Full-text articles.
- Randomised controlled trials based on flash free adhesives highlighting its major qualities were included.

b) Exclusion Criteria

- Non-randomized studies
- Only abstract available studies.

C. *SEARCH STRATEGY*

Published literature on assessing the effectiveness of Flash- free adhesives on treatment of orthodontic brackets, including original articles and research papers in databases such as PubMed, Science Direct, Lilacs, grey literature Google scholar. A literature search to gather relevant data was performed using MeSH terms Flash-free adhesives, Orthodontic brackets, fixed appliances using AND, OR.

D. *SEARCH ENGINE*

- PubMed
- Google Scholar
- Science direct
- Lilacs
- Grey literature

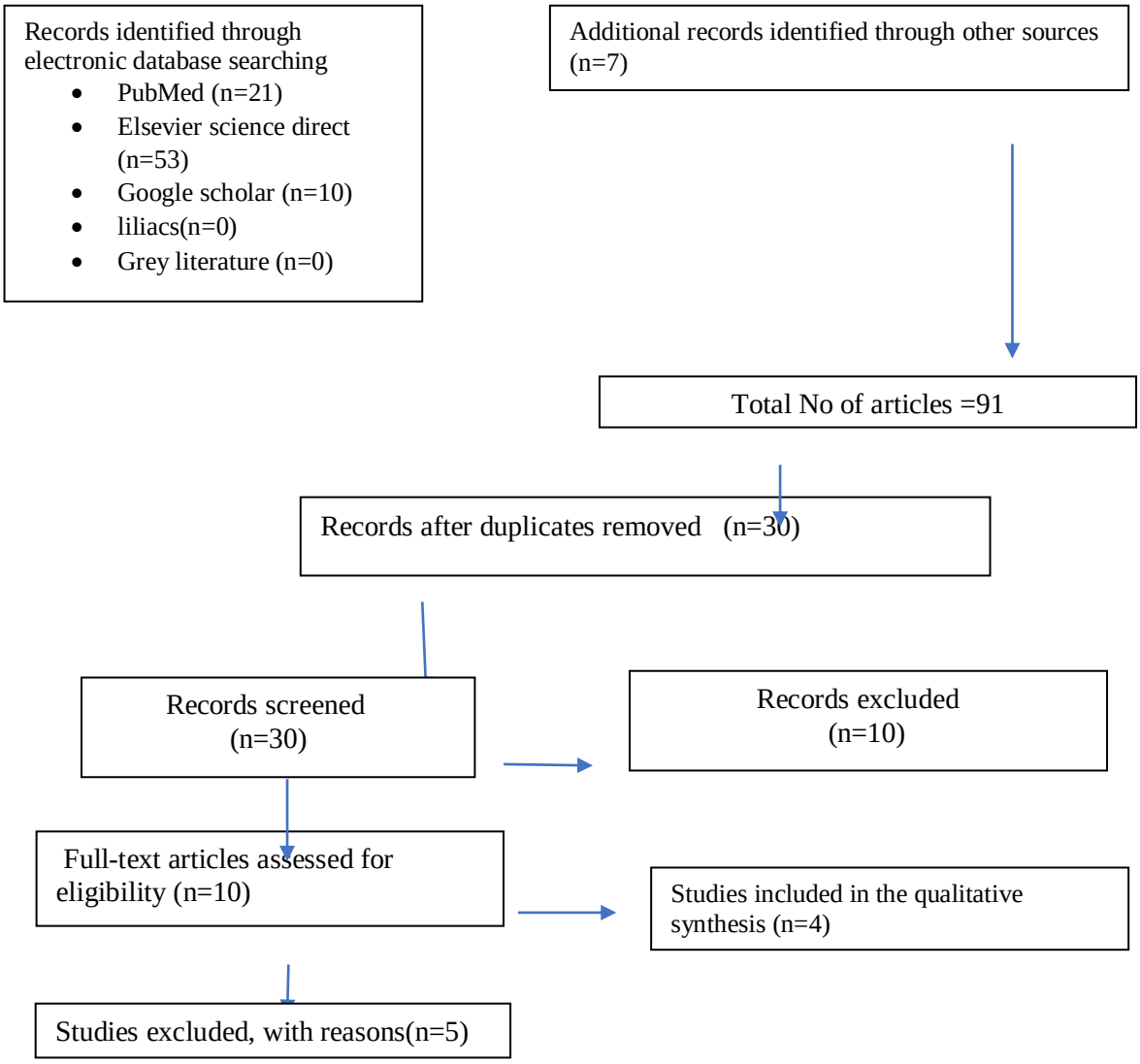

Fig. 1: Flow diagram showing the number of studies identified, screened, assessed for eligibility, excluded, and included in the

systematic review

The search provided 91 records, out of which 30 full-text articles were analyzed, and four articles were considered for the systematic review. Figure 1 depicts the flow chart of the reports that were found, duplicates removed, screened, excluded, and assessed for eligibility are included in the review.

III. RESULTS

Author Name	Year	Sample size	Patient Characteristics	Duration	Number(case/Control)
Thorsten Grünheid;Brent E. LarsonForty[35]	2018	45	Forty-five consecutive patients with requirement of fixed orthodontic treatment.	1 Year	Split Mouth study; APC Group 1:Flash free Group 2:Conventional Ceramics
ParaghVig, et al[36]	2019	18	18 patients with orthodontic irregularities undergoing fixed appliance therapy	5-8 weeks adjustments until treatment completes	Split Mouth study; APC Group 1:Flash free Group 2:Conventional Ceramics
Ayten Tan, SerpilCokakoglu[37]	2020	30	Adolescents,12 to 18 years, malocclusion patients were selected for this study	9-32 months	Split Mouth study; APC Group1:Flash free Group2:Conventional Ceramics
SerpilCokakoglu[38]	2020	30	Adolescents, (20 female, 10 male) aged 12 to 18 yearsundergoing orthodontic treatment	1 month after bonding(T1); 6 months after bonding(T2)	Split Mouth study; APC Group1:Flash free Group2:Conventional Ceramics

Table 1: Characteristics of Interventions in the included studies

Table 1 shows the characteristics of the intervention in the included studies. In all the above, the effectiveness of Flash-free adhesive was reviewed.

Author Name	Year	Effect Measure	Results
Thorsten Grünheid; Brent E. Larson Forty[35]	2018	Bonding time, Bracket Failure, Adhesive Remnant Index(ARI)	The bonding times were significantly shorter with the flash-free adhesive than with the conventional adhesive, both per tooth (P=0.001) and per quadrant (P=0.001). Compared with the conventional adhesive, the average bonding times per tooth and per quadrant with the flash-free adhesive were 37.3% and 32.9% shorter, respectively. The bracket failure rates at 1 year were 3.7% for the flash-free adhesive and 0.9% for the conventional adhesive. This was statistically equivalent. The average times to first-time failure of a bracket were 25 weeks for the flash-free adhesive and 11 weeks for the conventional adhesive. Although there were no significant differences in the adhesive remnant index scores upon failure (P .0.05), the flash- free adhesive tended to fail more often at the enamel-adhesive interface than did the conventionaladhesive.
ParaghVig et al[36]	2019	Quantitative (mg/m^3) and qualitative analysis of particulate production	In the clinical study, there was no statistically significant effect of bracket type on particulate concentration (P= 5 0.29). This was despite 3 patients with APC flash-free and 1 patient with conventional Clarity (with 1 bracket) having 1 or more ceramic bracket fracture at debonding requiring removal. No adverse eventsreported.
Ayten Tan, SerpilCokakoglu[37]	2020	Gingival and Plaque index	The assessment of demineralisation was reduced on a majority of the brackets in both groups. The conventional group show demineralization of enamel in contrast to flash-free brackets.Gingival and plaque index were seen after 6 months of treatment in both groups. Remarkable contrast in demineralisation or periodontal measurement were not seen in intergroup comparison at any given time points.
SerpilCokakoglu[38]	2020	Adhesive remnant index (ARI) ,Visual analogue scale (VAS)	Pain scores were generally higher for the conventional group than for the flash-free group. There were no differences in VAS scores across most tooth types during debonding. Overall, ARI results showed more adhesive remnants in the conventional bracket group (P < .001). Except for the right maxillary quadrant, the times required to remove the adhesive were significantly longer for the flash-free brackets than the conventional brackets (P ≤ .005).

Table 2: Outcome Data as reported in Included Studies

Table 2 shows the outcome of flash- free adhesives in the treatment of orthodontic brackets.

Author	Year	Random Sequence Generator	Allocation Concealment	Blinding of Outcome	Incomplet e Outcome Data	Blinding of Participant and personnel	Judgemental Bias	Selective Reporting
Thorsten Grünheid;Brent E. LarsonForty[35]	2018	+	+	+	-	-	+	-
ParaghVig et al[36]	2019	+	+	-	?	-	?	?
Ayten Tan, SerpenCokakoglu[37]	2020	+	?	+	?	+	-	-
Serpen Cokakoglu[38]	2020	+	-	+	-	+	-	?

Table 3: Bias assessment as included in the study

Table 3 shows the bias assessment of the involved studies. + = low risk of bias; - = high risk of bias; ?= unclear risk of bias.

IV. DISCUSSION

The studies suggest that the adhesives tested for the flash-free adhesives showed positive results when used in a clinical finding and did not have much variation compared to its laboratory performance. The bracket failure rates were much lesser than similar studies, which reported 2.7 to 9.5%[18,19]. Even though the flash free-adhesive showed a failure rate of 2%, which the manufacturers had deemed, it was well within the 10% that clinical usage mandates as admissible[20,21]. Although there might be mild differences in bracket failure rates when comparing two adhesives, it is minor and clinically insignificant. The benefits outweigh this difference: the elimination of the flash removal step, decreased time in bracket bonding procedure, and enhanced ability to target bracket positioning[22]. If an early failure occurs within three months, it is most likely due to the operator's inadequate enamel etching and poor moisture control while bonding[23]. If, however, it is beyond 12 months, other factors may be at play, such as long term exposure to the oral environment, like the temperature dynamics, which has been long proven to decrease bond strength of orthodontic adhesives tooth structure. On debonding, The flash-free adhesive left far more adhesive on the tooth structure comparatively, which agrees with in vitro studies that flash free failed more reliably at the bond interface. Nevertheless, the larger amount of adhesive which stays after the debonding procedure does not imply an increase in the time taken for debonding. Rotary instruments take a few seconds at most yet can add up when both arches are involved cumulatively. Therefore time-saving of more than 1/5th is significant. Total timings may amount to more than 3 minutes while debonding, partly explained by the lower filler content[24,25]. The nonwoven mesh at the bracket base, which has the flash-free material, provides the predetermined breaking point.

The second study revealed that pain scores show variability amongst different tooth types. This may be related to the debonding force, which is not standardised. Bishara et al. [26] noted that the debonding force during the removal of ceramic brackets was influenced by the method of debonding, composition, the mechanism of the bracket retention, as well as enamel conditioning procedure. Even though teeth were randomly selected during the removal of the brackets, there was significantly greater pain on the left side, in the upper and lower jaws. These differences maybe due to the non-standardised force of debonding and the thickness of the composite material. Flash-free adhesives have a uniform adhesive layer due to lower filler content. As Hama et al. [27] suggested, decreasing the thickness of the adhesive would reduce the strength taken to remove the adhesive and it, in turn, leads to less pain since the load applied would be lighter on the tooth. This is done in regards to the relationship between the removal force and thickness is tested in bovine teeth without brackets. In the debonding procedure, fractured parts of the ceramic brackets stayed as blinding was used in this study. As the literature suggests, ceramic remnants were taken out using a bur in a high-speed handpick before recording removal [28,29]. Pain scores were based on anatomic locations where they were significantly different only in the lower posterior region, which showed the left lower premolar had the highest VAS scores. These values were the cause of the significant differences. A higher score was recorded for the conventional brackets than the VAS scores between conventional and flash-free brackets for most tooth types. Pain levels were considered higher for conventional brackets due to excess flash being removed during bonding. This study also showed higher VAS scores in the anterior regions for all tooth types. which is explained by the increase in tactile sensory threshold, which increases from the anterior to the posterior region, as stated previously[30].

Due to the filler content of the flash-free adhesive being lesser than that in conventional adhesive, ARI scores showed a considerable difference. As the previous findings showed [31], adhesives with lower filler content showed lower scores of ARI for the flash-free group.

In contrast debonding at the bracket-adhesive interface led to higher ARI scores in the conventional group. None of the teeth in this investigation showed any enamel damage or had an ARI of 0. In one of the first clinical studies, Foersh et al. [26] reported that the average ARI for flash-free brackets was 2. This value was close to the current result, calculated as 2.3 for flash-free brackets, while the mean ARI was 2.8 for the conventional group. Hama et al. [27] indicated that a decreased adhesive thickness reduces the removal strength. If load applied by debonding pliers can be reduced, most of the remaining adhesive may be removed without pain. After removing the conventional brackets, the upper lateral and lower central incisor teeth had pronounced remnant adhesive in the right region.

The gingivitis changes showed a decline in the patients' oral hygiene motivation.

This study was a parted mouth clinical preliminary wherein every mediation was arbitrarily assigned to an alternate site in each subject's mouth[32]. This limits predisposition and eliminates a lot of between individual inconstancy, accordingly expanding the force of the review. Hindrances, for example, period effects and differences between mediation locales, were avoided[33].

Section disappointment rates at one year were 3.7% for the blaze free cement and 0.9% for customary cement. Proportionality testing showed factual equality of cements concerning section disappointment rates 90% certainty stretch, (0.004-0.049). Although there was no measurably critical contrast in ARI scores between the two types of cement, the dissemination of ARI scores shows that bond disappointments happened all the more frequently at the tooth-cement interface or inside the actual glue with the blaze freeglue[34].

V. CONCLUSION

Flash-free adhesives considerably increase the comfort and efficiency of orthodontic bracket treatment by significantly lowering the debonding time, and reduce debonding pain. However, flash-free adhesives currently lack scientific evidence for their effect on particulate concentration. Furthermore, it reduces the extent of demineralisation and plaque accumulation by eliminating excess adhesive, thereby also reducing bracket failures, thereby proving to have several advantages over the conventionally used orthodontic adhesives.

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Nil

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