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Systematic Review

The Effectiveness of Dental Bleaching during Orthodontic Treatment with Clear Aligners: A Systematic Review

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Abstract: The objective of this article was to systematically review the literature to determine how effective tooth whitening procedures are when carried out in tandem with orthodontic clear aligners. This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Online searches of PubMed, Medline via Ovid, Science Direct, the Cochrane database of systematic reviews via Ovid, Scopus, and Google Scholar as well as manual searches of the references of the selected articles were conducted. Clinical studies which assessed the efficacy of dental bleaching using orthodontic clear aligners were included in the present study. Data from the included studies were extracted and assessed for risk of bias using the Cochrane risk of bias tool. Three studies met the inclusion and exclusion criteria and were included in this study. One study compared the efficiency of tooth bleaching between clear aligners and conventional bleaching trays. One study evaluated the effectiveness of dental bleaching using clear aligners by comparing the tooth shade of those patients to a control group of patients who did not receive dental bleaching during orthodontic clear aligner treatment. One study evaluated the effectiveness of different concentrations of different bleaching agents using clear aligners. All the included studies showed an improved tooth shade when using clear aligners as bleaching trays.

Keywords: tooth whitening; dental bleaching; carbamide peroxide; clear aligners; Invisalign

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1. Introduction

Orthodontic treatment with clear aligners has become increasingly popular [1–7]. There are a number of companies which have introduced clear aligners including ClearCorrect, ClearPath, eCligner, K Line, and OrthoCaps (Figure 1) [3,8]. These technologies involve the application of sequential, custom-made, removable aligners which are designed and fabricated using computer-aided design and computer-aided manufacturing (CADD-CAM) [4–9] (Figure 2). The first clear aligner system was Invisalign, which was introduced by Align Technology in 1997 [4,9–14].

Figure 1. An example of maxillary clear aligner.

Figure 2. A 3Shape software used in this example to design a maxillary clear aligner.

Orthodontic treatment with clear aligners has shown advantages over traditional fixed appliances, such as aesthetic comfort and increased patient acceptance [7,15–17]. In addition, clear aligners are more convenient for eating and brushing since the aligners can be removed by the patients [12–14,18]. Furthermore, tooth bleaching is frequently requested by orthodontic patients. One study showed that 88% of orthodontic patients asked for tooth whitening during or after orthodontic treatment [19,20]. Another study reported higher patient satisfaction when dental bleaching was combined with orthodontic treatment when compared to orthodontic treatment only [21].

At-home tooth whitening (Figure 3) has been a common approach to whiten the teeth since its introduction in 1989 by Haywood and Heymann [22–24]. This is attributed to its efficiency, lower cost, feasibility, and reduced adverse effects such as tooth sensitivity and soft tissue burns [25–28].

Figure 3. Home bleaching kit with a tray which is worn at night until the desired tooth shade is achieved.

Before the introduction of clear aligners, tooth bleaching was delayed until after the orthodontic treatment with a fixed appliance. This is for many reasons, including that tooth alignment achieved after the orthodontic treatment facilitates achieving a uniform tooth whitening. Moreover, waiting two weeks after finishing the orthodontic treatment with a fixed appliance would allow some time for the gingivae to heal in case of gingivitis, which would worsen if the tooth whitening started during the orthodontic treatment while the gingivae are still inflamed [29,30].

With the emergence of clear aligners, it is now possible to have the teeth bleached during the clear aligner therapy by using the aligner as a bleaching tray at night. This is also possible as studies have shown that bleaching using non-scalloped and non-reservoir trays is safe and effective [31–34]. However, the question remains whether tooth bleaching performed using clear aligners during the orthodontic treatment is an effective treatment modality or whether dental bleaching should be postponed until after the completion of orthodontic treatment. Therefore, this systematic review aimed to evaluate the effectiveness of dental bleaching using orthodontic clear aligners for tooth shade improvement.

2. Materials and Methods

2.1. Protocol

This systematic review was reported according to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (Figure 4).

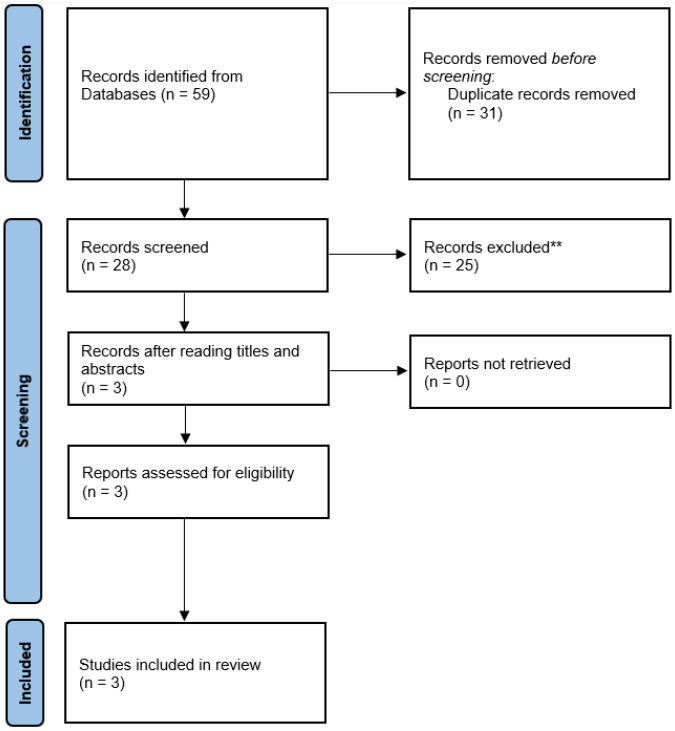

Figure 4. Flow diagram of the selected studies. (** Excluded records after peer review).

2.2. Search Strategy

A literature search was carried out using the following databases: PubMed, Medline via Ovid, Science Direct, the Cochrane database of systematic reviews via Ovid, and Scopus. This search used MeSH terms and keywords in different combinations, as described in the following paragraph. In addition, a manual search of the bibliographies of all full-text articles and related reviews selected from the electronic search was conducted. Finally, a manual search of Google Scholar using the same combinations was also performed.

The search used the following MeSH terms: "tooth bleaching", "tooth bleaching agents", "orthodontic appliance, removable", and "treatment outcome", along with keyword searches. The search also used the following keywords: "Dental bleaching", "tooth whitening", "tooth discoloration", "hydrogen peroxide", "carbamide peroxide", "clear aligners", "clear aligner appliance*", "clear dental brace*", "Invisalign", "treatment effectiveness", "clinical efficacy", "patient-relevant outcome", "orthodontic treatment", "orthodontic tooth movement", and "dental procedure". The following searches and search terms were applied: ("dental bleaching" OR "tooth bleaching" OR "tooth discoloration") AND ("orthodontic appliance removable" OR "clear dental brace*" OR "clear aligner*"), ("tooth bleaching") AND ("clear aligner appliance*" OR "Invisalign"), ("dental bleaching") AND ("orthodontic appliance removable" OR "clear aligner appliance") AND ("clinical efficacy"), ("tooth bleaching agents" OR "carbamide peroxide" OR "hydrogen peroxide") AND ("Invisalign" OR "clear aligner appliance" OR "orthodontic appliance removable"), ("tooth bleaching" OR "dental bleaching" OR "tooth whitening" OR "tooth bleaching agents") AND ("orthodontic appliance removable" OR "clear aligners" OR "clear aligner appliance*" OR "clear dental brace*" OR "Invisalign") AND ("treatment outcome" OR "clinical efficacy" OR "clinical effectiveness") AND ("orthodontic treatment" OR "dental procedure"), ("tooth bleaching" OR "tooth bleaching agents" OR "carbamide peroxide"

OR "hydrogen peroxide") AND ("orthodontic appliance removable" OR "clear aligners" OR "clear aligner appliance*" OR "clear dental brace*" OR "Invisalign") AND ("treatment outcome" OR "clinical efficacy" OR "treatment effectiveness"), ("tooth discoloration" OR "dental bleaching agents" OR "tooth whitening") AND ("orthodontic appliance removable" OR "clear dental brace") AND ("treatment outcome" OR "patient-relevant outcome"). Where * includes singular and plural forms of the keyword.

A specific question was formulated based on population, intervention, control, and outcome (PICO) criteria. According to these criteria, the population was patients treated with clear aligners, the intervention was tooth bleaching using clear aligners, the control was dental bleaching using conventional bleaching trays, and the outcome was the efficacy of tooth bleaching. The focused question of this systematic review was: "Is dental bleaching during orthodontic treatment with clear aligners as effective as dental bleaching using conventional bleaching trays?"

2.3. Inclusion Criteria

Clinical studies assessing the effectiveness of dental bleaching during orthodontic treatment with clear aligners were included in this study. Studies which were published up to December 2021 were included in this systematic review.

2.4. Exclusion Criteria

In vitro, non-human studies, literature reviews (although these were used to identify potential studies), and studies which assessed the efficiency of dental bleaching during fixed orthodontic treatment were excluded.

2.5. Study Selection

An electronic search of four databases (PubMed, Medline via Ovid, Science Direct, the Cochrane database of systematic reviews via Ovid, Scopus, and Google Scholar) as well as manual search of the studies derived from the electronic search were conducted. The titles and abstracts of the studies derived from the search were screened based on the inclusion criteria by one author (MK). If the title and abstract did not provide sufficient information to determine inclusion or exclusion, the full text article was read to make the final decision.

2.6. Data Extraction

The following data were extracted from the included studies: author(s), year of publication, study design, number of patients at baseline and at follow-up(s), type of clear aligner, type of dental bleaching materials used and their concentration, bleaching duration, evaluation criteria, follow-up period, and treatment outcome (Table 1).

2.7. Assessment of Methodological Quality

The risk of bias in the selected studies was assessed using the revised Cochrane risk of bias tool for randomised trials (RoB). In the Levrini et al. (2020) [35] study, the allocation sequence was not concealed as the same patients were enrolled in the control and testing groups; this was done by specifying the teeth to be bleached using the clear aligners and the teeth to be bleached using the conventional trays. Seleem and his colleagues (2021) [36] allocated patients to the 2 groups according to their next clinical appointment, which made the care providers know whether the patient was going to be enrolled in the control group or in the testing group. Moreover, the care providers and the outcome assessors in the same study were also not blinded, which put this study at high risk of bias. The risk of bias analysis is further detailed in the following table (Table 2). Oliverio et al. (2019) [37] mentioned that patients were randomly allocated to different groups, however, the process was not described. In the same study, it was not specified whether the care providers were blinded or not.

Table 1. Overview of the included studies.

Author & Year	Study Design	Sample Size and Tooth Shade at Baseline	Bleaching Agents and Groups	Type of Clear Aligner Used	Evaluation Criteria	Follow-Up Period	Treatment Outcome
Oliverio et al., 2019 [37]	Clinical study	38 patients	Group 1: 3% hydrogen peroxide, 9 h, on days 7–14 of aligner wear Group 2: 10% carbamide peroxide, 9 h, on days 7–14 of aligner wear Group 3: 16% carbamide peroxide, 9 h, on days 7–14 of aligner wear Group 4: 16% carbamide peroxide, 9 h, on days 1–14 of aligner wear	F22 aligners	Spectrophotometer and Vita Classical shade guide, three readings for each tooth of the six maxillary anterior teeth (incisal, middle, and cervical)	Re-evaluation was done at day 14 of aligner use; however, patients in groups 1–3 only received bleaching for one week compared to patients in group 4 who received two weeks of bleaching	Group 4 showed the greatest shade improvement; only patients in group 1 showed sites which had worsening in tooth shade
Levrini et al., 2020 [35]	Clinical study	10 patients	10% carbamide peroxide, 8 hrs, for 10 days; control teeth 41 and 32 received bleaching using bleaching trays while study teeth 31 and 42 received bleaching using Invisalign aligners	Invisalign	Spectrophotometer	Ten days	Both types of trays (bleaching trays, Invisalign aligners) were effective in bleaching without any significant differences between the types
Seleem et al., 2021 [36]	Clinical study	28 patients Baseline shade: 6.1	10% carbamide peroxide, two groups; control group where patients did not receive bleaching, study group where patients received bleaching using 10% carbamide peroxide for 8 hrs for 4 weeks	Invisalign	Vita Classical shade guide, middle third of maxillary and mandibular central and lateral incisors	At 2 and 4 weeks of dental bleaching and 2 weeks after bleaching termination (weeks 2, 4, and 6)	About half of the patients in the study group had a 3–6-shade improvement, while the remaining subjects showed an improvement of about 1–2 shades or more than 7 shades. Patients in the control group had a consistent shade average throughout the duration of the study

Table 2. Evaluation of the risk of bias in the included studies.

	Oliverio et al., 2019 [37]	Levrini et al., 2020 [35]	Seleem et al., 2021 [36]
Random sequence generation (selection bias)			
Allocation concealment (selection bias)			
Blinding of participants and personnel (performance bias)			
Blinding of outcome assessment (detection bias)			
Incomplete outcome data (attrition bias)			
Selective reporting (reporting bias)			
Other bias			

Low Risk Some concerns High Risk.

3. Results

The initial database searches revealed 59 studies; after removal of the duplicates ($n = 31$), 28 studies remained. After reading the titles and the abstracts, three articles were selected for full-text screening based on the inclusion criteria, and were ultimately included in the present study. No additional articles were identified using bibliographic or manual searches. Among the included studies, two studies evaluated the effectiveness of using 10% carbamide peroxide using Invisalign [35,36]; in both studies, patients were asked to bleach their teeth for 8 h. However, the duration differed from 10 days in one study [35] to 4 weeks in the other [36]. On the other hand, the third study [37] assessed the effectiveness of tooth bleaching using F22 clear aligners. In this study [37], different concentrations of carbamide and hydrogen peroxides, as well as different durations of bleaching (1 or 2 weeks), were assessed.

Levrini et al. (2020) evaluated the treatment outcome after bleaching using 10% carbamide peroxide when performed during orthodontic treatment with clear aligners [35]. In this study, 10 patients were asked to apply the bleaching agent in the areas of teeth 32, 31, 41, and 42 for 8 h per day for 10 days. Bleaching trays with reservoirs were used for teeth 41 and 32, while teeth 31 and 42 received bleaching using Invisalign aligners. The CIE L*, a*, b* system was used to evaluate tooth shade and to represent changes in tooth shade (ΔE) using the following equation: $\Delta E = \sqrt{(\Delta a)^2 + (\Delta L)^2 + (\Delta b)^2}$. Both bleaching protocols, with and without reservoir (Invisalign), resulted in significant reductions in tooth shade and comparable whitening effects. This was demonstrated by the average values of ΔE, which were 4.0 and 3.5 for bleaching trays with and without reservoir, respectively. These results might be attributed to the use of a higher volume of the bleaching agent in the reservoir trays, about 4 mm, compared to 2 mm applied in the non-reservoir trays (Invisalign aligners). These results showed a shade improvement that was greater by 0.5 shades when bleaching was performed using conventional bleaching trays rather than orthodontic Invisalign aligners, however, the difference was not statistically significant. The authors reported hypersensitivity and dysgeusia in some cases even though the bleaching material which was used in the study already contained potassium nitrate, which would decrease the risk of dentine hypersensitivity. However, these side effects did not require treatment interruption and recovered spontaneously. Furthermore, the authors reported that placement of 2 mm^3 of the bleaching material in the centre of the teeth within the aligners resulted in a homogenous distribution of the gel in the tray and preventing harmful damage to the gum, while placement of the same volume near the gum line of the tooth in

the tray provided the worst scenario and the highest risk for inhomogeneous distribution and injury to the gingival tissues.

Seleem et al. (2021) assessed the effectiveness of tooth bleaching using the gold standard 10% carbamide peroxide using Invisalign [36]. In this study, 28 patients who were already undergoing orthodontic treatment with Invisalign were randomly allocated into two groups. Patients in the first group received tooth bleaching using 10% carbamide peroxide for 8 h a day for 4 weeks while patients in the second group did not receive dental bleaching. Tooth shade, gingival index (GI), and plaque index (PI) were evaluated at baseline, and at two-week intervals for 6 weeks using the VITA classical shade guide, the Turesky Modification of the Quigley–Hein Index, and the Löe and Silness gingival index, respectively. The authors reported a significant change in tooth shade in the study group over the two- and four-week periods, as well as a reduction in gingival and plaque indices. This is shown by the reduction in tooth shade from 6.1 at baseline to 2.6 at 2 weeks and 1.6 at 4 weeks. Overall, 44% of the patients in the study group showed an improvement of 3–6 shades, 28% showed an improvement of 1–2 shades, while another 28% showed an improvement of more than 7 shades, with an average shade improvement of 3.5 shades after 2 weeks. In contrast, the patients in the control group maintained a consistent shade average of 6.43 to 6.46 during the study. The authors reported dental sensitivity in one subject in the experimental group, which was attributed to a pre-existing gingival recession and was resolved by reducing the exposure time to carbamide peroxide for less than 8 h, despite the fact that all patients were asked to use a toothpaste containing potassium nitrate to reduce the risk of dentine hypersensitivity. Moreover, the authors reported that the use of carbamide peroxide, which decomposed into urea and hydrogen peroxide, resulted in an increased plaque and saliva pH which in turn reduced caries and gingival inflammation. This is shown by the significant decrease in the PI from 1.8 at T0 to 1.2 at T2 and to 1.11 at T4, as well as the significant decrease in the GI in the experimental group from 0.53 at T0 to 0.08 and 0.05 at T4 and T6, respectively. In addition, the presence of the highly reactive hydroxyl radicals, which reacted with the bacterial membrane lipids and DNA, resulted in bacterial cell death. Furthermore, evaluation of the teeth at the sixth week revealed that the teeth maintained the shade improvement and gingival health 2 weeks after bleaching termination. Limitations of the study included the small sample size and the fact that the examiners were not blinded to the intervention.

Oliverio et al. (2019) evaluated the efficacy of different home bleaching methods during orthodontic treatment with F22 aligners [37]. Thirty-eight patients were allocated into four different groups; patients in group 1 received home bleaching using 3% hydrogen peroxide for nine hours per day over days 7–14 of aligner use, patients in group 2 received home bleaching using 10% carbamide peroxide for nine hours per day over days 7–14 of aligner use, patients in group 3 received home bleaching using 16% carbamide peroxide for nine hours per day over days 7–14 of aligner use, while patients in group 4 received home bleaching using 16% carbamide peroxide for nine hours per day over days 1–14 of aligner use. The shade of the six maxillary anterior teeth was evaluated before treatment (baseline, T1) using a VITA Easyshade V compact in three areas per tooth (incisal, middle, and cervical), in which every value on the scale was given a numerical equivalent. A Kruskal-Wallis H test was used to compare the median shades for each site on the six upper teeth before whitening and showed that there were no statistically significant differences among the patients in the four different groups, meaning that the patients in the four groups belonged to the same population. This protocol was repeated after two weeks (T2) for colour analysis after application of the bleaching agents for nine hours by the patients. The authors reported the shade improvements for groups 1, 2, 3, and 4 as 51.0%, 57.0%, 60.4%, and 73.0%, respectively, when comparing the mean shade values at T1 to those at T2. The mean shade variation was also measured as being 28.6%, 27.5%, 31.7%, and 45.9% for groups 1, 2, 3, and 4, respectively. Furthermore, a worsening in tooth shade was reported in patients in group 1 only at a rate of 2.7%, while group 4 patients achieved a significantly greater shade improvement than patients in group 1 ($p = 0.02$), group 2 ($p = 0.01$), and group 3

(p = 0.01). The authors concluded that the greatest shade improvement was achieved by the application of 16% carbamide peroxide for nine hours per day for 14 days in group 4, which corresponded to the highest concentration of the bleaching agent and the longest period of time. Moreover, no gingival inflammation or dental sensitivity were detected in any patients. In addition to evaluating the shade improvement, the effect of the dental bleaching agents on the surface texture and light transmission of the clear aligners was also assessed. For this purpose, six aligners were tested for microstructural changes: one new, one used for 14 days (T1), and one used aligner from each whitening group. Scanning Electron Microscopy (SEM) at different magnifications (250×, 1000×, or 5000×) revealed no microstructural changes. This finding was attributed to the presence of an organic layer covering the microfilamentous structure of the aligners, which was deposited during normal wear. In addition, examination of nine randomly selected aligners showed maintenance of transparency after the application of different bleaching agents when tested after 14 days using a double-beam spectrophotometer with an accuracy of 2 nm.

4. Discussion

At-home bleaching is becoming more popular for tooth bleaching since its introduction in 1989 by Haywood and Heymann [18,22]. In the past, home bleaching was performed with trays that have reservoirs for the bleaching agent. Nowadays, no evidence supports that bleaching using reservoir trays is superior to that using non-reservoir bleaching trays [36,38–40]. This would suggest that using clear aligners for tooth bleaching would effectively improve tooth shade when clear aligners are used as bleaching trays during the orthodontic treatment. In addition, tooth bleaching using clear aligners as bleaching trays has many advantages [35–37]. These include reducing the cost for the patient by eliminating the process required to make the bleaching trays, which involves taking new impressions for fabricating new trays. Additional advantages include reductions in the overall chairside time and improvements in the patient's oral hygiene [18,30].

Sword and Haywood (2020) used an Invisalign aligner as a bleaching tray in two patients. They aimed to assess the feasibility of having bleaching performed at the same time as orthodontic treatment without having non-whitened spots in the areas where the attachment buttons are located [18]. They suggested that home bleaching using 10% carbamide peroxide could be performed concurrently with Invisalign orthodontic treatment because the bleaching material had small-molecular-size particles that were able to penetrate the dentine of the areas adjacent to the attachment buttons without the need for direct contact between the bleaching material and tooth surface to achieve efficient bleaching for these areas [18]. Another study suggested the use of lingual attachments to overcome the issue of obtaining a homogenous tooth whitening, although if the clinician's planned movements required anterior labial attachments, tooth whitening was suggested to be postponed to the end of the treatment by using the final aligner during finishing or using a post-treatment retainer [37]. Furthermore, Levrini et al. (2020) suggested that the use of bleaching agents with aligners at the beginning of orthodontic treatment was not recommended as the crowding of the teeth would affect the fit of the tray and the final result of tooth whitening [35]. From the authors' perspective, tooth bleaching during orthodontic treatment with clear aligners can be effectively performed and achieve a homogenous tooth shade and an absence of non-whitened spots. This is because of the ability of the small-molecular-size particles of the bleaching agent to penetrate the areas adjacent to the attachments. However, in the presence of severe crowding, tooth bleaching can be postponed until after the alignment of the teeth during the finishing step.

Moreover, the effect of tooth bleaching on enamel mineral content has been evaluated by several studies, with some studies suggesting that bleaching materials could increase the enamel susceptibility to demineralisation [41,42]. However, no macroscopic changes in the enamel were reported in the literature, and another study suggested that only high concentrations of carbamide peroxide and hydrogen peroxide were associated with increased enamel susceptibility to demineralisation [43,44]. In addition, several studies

showed that using demineralising agents could increase the microhardness of bleached enamel [45–47]. For example, Kamath et al. (2013) reported that using Remin Pro resulted in remineralisation and increased the microhardness of bleached enamel [45]. However, from the authors' perspective, tooth bleaching is still considered a conservative option for patients requesting white teeth compared to indirect restorations, including veneers or crowns.

Furthermore, Levrini and his colleagues (2020) suggested that the application of 2 mm^3 of bleaching gel in the center of the Invisalign aligner provided the optimal gel distribution for efficient tooth whitening without gingival irritation [35]. In fact, in this study, the authors showed that there was no effect of pressure applied to the tray on the gel distribution. Instead, the gel distribution was affected by the chemical and physical properties of the gel, gel volume, gel thickness, and the point of application. Moreover, Oliverio et al. (2019) showed a uniform distribution of blue-dyed whitening sprays across the maxillary anterior tooth surfaces of F22 clear aligners (Sweden & Martina SpA, Due Carrare, Italy) when the whitening spray was sprayed onto the internal labial surface of the aligner, with one spray at the central incisors and one spray in each of the canine regions [37]. In the same study, the authors emphasised that there was no effect of using a reservoir tray on tooth whitening effectiveness [37]. Furthermore, other studies which used aligners for dental bleaching showed no adverse effects on the gingiva or on tooth sensitivity that would result in disruption of treatment [36,37]. Therefore, it can be concluded that tooth bleaching using clear aligners can be a safe treatment modality that would result in no harm to the gingivae when performed under professional supervision.

Moreover, Oliverio et al. (2019) evaluated the effect of tooth whitening on the microstructural properties and the translucency of F22 clear aligners. After assessment with a scanning electron microscope (SEM) and double-beam spectrophotometer, the authors suggested that different concentrations of different bleaching agents had no effect on the microstructural properties and translucency of F22 clear aligners [37]. The authors only reported the presence of striations which were the result of normal cleaning and the presence of some surface irregularities associated with the heat used for gliding the aligners rather than being a chemical degradation. Even though only a few studies evaluated the effect of the bleaching materials on the clear aligner material, the current evidence suggests that tooth bleaching can be performed effectively using clear aligners without adversely affecting the physical properties of the clear aligner and the goals of orthodontic therapy.

The present systematic review was conducted to evaluate the effectiveness of home bleaching using clear aligners and to compare this treatment protocol to tooth bleaching using conventional bleaching trays. Three studies assessed the effectiveness of bleaching using clear aligners, only one of them compared the bleaching using clear aligners to that using standard bleaching trays [35]. In this study, patients in both groups showed improvements in tooth shade with no statistically significant differences in tooth shade between the two groups. The other two studies also showed improvements in tooth shade in patients receiving dental bleaching using clear aligners, however, they did not have a control group in which patients received bleaching using standard bleaching trays for comparison [36,37]. Furthermore, there were some limitations in the included studies which respect to the clarity of the randomization process, the allocation sequence concealment, as well as the blindness of the treatment providers and outcome assessors. This puts the available evidence at "some concerns" to "high risk" of bias when evaluated using the Cochrane risk of bias tool. However, based on the available evidence it can be concluded that home bleaching during orthodontic treatment with clear aligners is a valid treatment option that can reduce overall treatment cost and time.

The limitations of the present study include the low number of evaluated studies, which already had a small sample size and had some inaccuracies in the randomisation process. Therefore, further clinical studies with larger sample sizes, more precise protocols for randomisation, and a longer follow-up period evaluating the efficiency of bleaching during clear aligner treatment are required to confirm the validity of using clear aligners for tooth bleaching alongside orthodontic treatment.

5. Conclusions

Based on the available evidence, it can be concluded that tooth bleaching using carbamide or hydrogen peroxides can effectively improve tooth shade when clear aligners are used as bleaching trays during orthodontic treatment. However, future randomised clinical trials with more extended follow-up periods evaluating the efficacy of using clear aligners as bleaching trays for home bleaching are required to evaluate the efficacy of this treatment modality.

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