



# Tooth whitening in conventional orthodontic patients: a systematic review

*Blanqueamiento dental en pacientes con tratamiento ortodóncico: Revisión sistemática*

*Clareamento dental em pacientes com tratamento ortodôntico: revisão sistemática*

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## Abstract

This systematic review aimed to identify and critically evaluate the available evidence of the appropriate moment to perform tooth whitening in conventional orthodontic patients. A systematic review in MEDLINE and SciELO databases from inception to February 2021 was carried out by two independent reviewers. Randomized clinical trials, non-randomized clinical trials, case-control, cohort, cross-sectional, case-series and reviews that focused on the application of tooth whitening during or after orthodontic treatment were considered for inclusion. The primary outcome was defined as tooth whitening during/after orthodontic treatment. The secondary outcome included the time in days after bracket debonding in which tooth whitening was performed. Risk of bias analysis was performed for each study and the findings were synthesized in a narrative summary. A total of 4 randomized clinical trials, 1 non-randomized clinical trial and 3 reviews were included in the qualitative synthesis. One study performed tooth whitening during, and three studies after orthodontic treatment. One study compared tooth whitening during and after orthodontic treatment. The time after which tooth whitening was applied following bracket debonding ranged from 7 to 90 days with a mean value of 40.2 days. All studies reported satisfactory improvements in tooth color shade during or after orthodontic treatment independent of the protocol. Low quality evidence suggests that the appropriate moment to perform tooth whitening in conventional orthodontic patients is after brackets removal with a waiting period of at least 30 days. There is not adequate evidence to support tooth whitening during conventional orthodontic treatment.

**Keywords:** tooth whitening; tooth bleaching; orthodontic patients; systematic review.

## Resumen

Esta revisión sistemática tuvo como objetivo identificar y evaluar críticamente la evidencia disponible del momento adecuado para realizar el blanqueamiento dental en pacientes de ortodoncia convencional. Dos revisores independientes llevaron a cabo la revisión sistemática en las bases de datos MEDLINE y SciELO

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desde el inicio hasta febrero de 2021. Se consideraron para su inclusión ensayos clínicos aleatorizados, ensayos clínicos no aleatorizados, de casos y controles, de cohortes, transversales, de series de casos y revisiones que se centraran en la aplicación del blanqueamiento dental durante o después del tratamiento de ortodoncia. El resultado primario se definió como blanqueamiento dental durante/después del tratamiento de ortodoncia. El resultado secundario incluyó el tiempo en días después del desprendimiento del soporte en el que se realizó el blanqueamiento dental. Se realizó un análisis de riesgo de sesgo para cada estudio y los hallazgos se sintetizaron en un resumen narrativo. En la síntesis cualitativa se incluyeron un total de 4 ensayos clínicos aleatorizados, 1 ensayo clínico no aleatorizado y 3 revisiones. Un estudio realizó el blanqueamiento dental durante y tres estudios después del tratamiento de ortodoncia. Un estudio comparó el blanqueamiento dental durante y después del tratamiento de ortodoncia. El tiempo después del cual se aplicó el blanqueamiento dental después del desprendimiento de los brackets osciló entre 7 y 90 días con un valor medio de 40,2 días. Todos los estudios informaron mejoras satisfactorias en el tono del color de los dientes durante o después del tratamiento de ortodoncia, independientemente del protocolo. La evidencia de baja calidad sugiere que el momento adecuado para realizar el blanqueamiento dental en pacientes con ortodoncia convencional es después de la extracción de los brackets con un período de espera de al menos 30 días. No hay evidencia adecuada para respaldar el blanqueamiento dental durante el tratamiento de ortodoncia convencional.

**Palabras clave:** Blanqueamiento dental; aclaramiento dental; pacientes ortodóncicos; revisión sistemática.

### Resumo

Esta revisão sistemática teve como objetivo identificar e avaliar criticamente as evidências disponíveis do tempo adequado para a realização do clareamento dental em pacientes de ortodontia convencional. Dois revisores independentes realizaram a revisão sistemática nas bases de dados MEDLINE e SciELO desde o início até fevereiro de 2021. Foram considerados ensaios clínicos randomizados, não randomizados, de casos e controles, de coorte, transversais, de séries de casos e ensaios clínicos de revisão com foco na aplicação do clareamento dental durante ou após o tratamento ortodôntico. O resultado primário foi definido como clareamento dental durante/após o tratamento ortodôntico. O resultado secundário incluiu o tempo em dias após o desprendimento do suporte no qual o clareamento dos dentes foi realizado. Foi realizada uma análise de risco de viés para cada estudo e os achados foram sintetizados em um resumo narrativo. Um total de 4 ensaios clínicos randomizados, 1 ensaio clínico não randomizado e 3 revisões foram incluídos na síntese qualitativa. Um estudo realizou clareamento dental durante e três estudos após o tratamento ortodôntico. Um estudo comparou o clareamento dental durante e após o tratamento ortodôntico. O tempo depois do qual o clareamento dos dentes foi aplicado após o desprendimento do aparelho variou de 7 a 90 dias com um valor médio de 40,2 dias. Todos os estudos relataram melhorias satisfatórias no tom da cor dos dentes durante ou após o tratamento ortodôntico, independentemente do protocolo. Evidências de baixa qualidade sugerem que o tempo apropriado para realizar o clareamento dental em pessoas com ortodontia convencional é após a remoção do aparelho com um período de espera de pelo menos 30 dias. Não há evidências pertinentes para respaldar o clareamento dental durante o tratamento de ortodontia convencional.

**Palavras-chave:** Clareamento dental; branqueamento dental; pacientes ortodônticos; revisão sistemática.



## Introduction

External tooth whitening (TW) is nowadays a common cosmetic procedure which is designed to reduce the body color of the tooth (Tredwin *et al.* 2006). TW can be applied as in-office or at-home procedures with effective and satisfactory results in color improvement for patients. While both strategies have been considered safe, the effectiveness of at-home whitening protocols is uncertain and several adverse effects have been reported such as cervical resorption, soft tissue burns, increased dental porosity, dental hypersensitivity, pulp inflammation and even necrosis (Eachempati *et al.*, 2018; Alqahtani *et al.*, 2014; Costa *et al.*, 2010; Rodrigues *et al.* 2018).

An increased concern for whiter teeth in patients has also been reported by orthodontists. A survey in 1182 orthodontists reported that 88.8% of orthodontists had patients who requested tooth whitening, and 76.2% of orthodontists recommended whitening procedures (Slack *et al.*, 2013). The most frequent reason for the recommendation for in-office TW in orthodontic patients is the presence of white-spot lesions adjacent to brackets or after the debonding of brackets (Guzmán-Armstraog *et al.*, 2010). In addition, tooth color changes around brackets are frequent, resulting in a non-uniform tooth shade after bracket debonding (Kamber *et al.*, 2018). Hence, color changes during or after orthodontic treatment (OT) affects the aesthetic result. However, most suggestions for TW in orthodontic patients have been extrapolated from *in vitro* and few *in vivo* studies on the debonding effect on brackets after the application of whitening agents (Imani *et al.*, 2020; Mullins *et al.*, 2009). Consolaro *et al.* (2013) in a critical review suggested

that TW procedures should be best performed after brackets are removed to allow for the balance in the oral environment after orthodontic treatment. In addition, the authors recommended against TW during orthodontic treatment due to the limited penetration of the whitening agent under bracket surface. Nevertheless, there is no clear evidence-based recommendation for the use of TW during or after orthodontic treatment. Therefore, the objective of this systematic review was to identify and critically evaluate the available evidence of the appropriate moment to perform tooth whitening in conventional orthodontic patients.

## Methodology

*The protocol for this systematic review is in fulfillment with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines.*

### Research question

*What is the appropriate moment to perform tooth whitening in conventional orthodontic patients?*

### Search strategy and limits

*Two calibrated independent reviewers (SH, MFN) searched MEDLINE via PubMed and SciELO (gray literature) from inception to February 2021 using the medical subject heading (MeSH) terms and keywords: (((dental bleaching [Title/Abstract]) OR dental whitening [Title/Abstract]) OR tooth bleaching [Title/Abstract]) OR tooth whitening [Title/Abstract]) AND orthodontic treatment [Title/Abstract]. The reference list of potential articles was manually searched for additional results.*



Articles written in Spanish, English and Portuguese corresponding to randomized clinical trials (RCT), non-randomized clinical trials (non-RCT), case control, cohort, cross-sectional, case series and previous systematic and critical reviews that focused on the application of tooth whitening during or after orthodontic treatment were considered for inclusion. Case reports, *in vitro*, and animal studies were not considered in this systematic review.

#### *Population, intervention, and comparator*

Target population included patients under orthodontic treatment with no restriction of age.

The intervention considered for analysis was defined as external tooth whitening performed in-office by a clinician during or after conventional orthodontic treatment. In-office interventions may have been continued by the patients with at-home whitening agents as instructed by the clinician. Non-vital tooth whitening was not considered for analysis. Clinical studies which evaluated debonding force resistance of brackets after tooth whitening and tooth whitening during clear aligner orthodontics were also not considered.

This review examined interventions with comparators groups which included no intervention or intervention performed at different time intervals or with different whitening agent during or after orthodontic treatment.

#### *Outcomes*

This review aimed to identify, and critically assess the findings related to the most appropriate moment to perform tooth whitening in conventional orthodontics patients.

Therefore, the primary outcome was the application of tooth whitening during/after orthodontic treatment as a dichotomic result. A secondary outcome included the time in days after bracket debonding in which tooth whitening was performed.

#### *Data extraction*

Two independent reviewers (SH, MFN) extracted the information from studies that met the inclusion criteria in a pre-determined form which comprised: study identification, objective, age of participants, sex, number of participants, number of participants in intervention group, number of participants in comparison group, time (days) after bracket debonding in which tooth whitening was performed, tooth whitening during orthodontic treatment (yes/no), time of tooth whitening after bracket installation and conclusions. Any disagreement between the reviewers was discussed and resolved with a third reviewer (JEB).

#### *Risk of bias (quality) assessment*

RCTs were assessed using the Cochrane Risk of Bias version 2 (RoB 2). Each study was assessed, and each domain was judged as low risk of bias, some concerns or high risk of bias. An overall judgment of the study was determined as low risk of bias if all domains were low risk; some concerns if at least one domain raised some concerns but not be high risk; and high risk of bias if at least one domain was high risk.

Non-RCTs were assessed using the Cochrane Risk of Bias In Non-Randomized Studies of Interventions (ROBINS-I) tool. Each study was analyzed using the critical domains and judged as low, moderate, serious, and critical risk of bias. A study was judged as low risk of bias if all domains



were low risk; moderate risk of bias if all domains were low or moderate risk; serious risk of bias if at least one domain was at serious risk; critical risk of bias if at least one domain was at critical risk. Critical reviews were not quality assessed.

#### *Data synthesis and analysis*

Meta-analysis was not attempted since outcomes were recorded in a qualitative style. Consequently, the findings were synthesized with tabulation and figures, in addition to a narrative summary.

## Results

A systematic search in MEDLINE and SciELO yielded 41 potential results after duplicates were removed. The results were screened for the inclusion criteria and 11 were excluded. A total of 30 full-text articles were assessed for eligibility and 22 were further excluded, resulting in 8 articles included in the qualitative synthesis (Figure 1). Excluded records with reasons are presented in the supplementary material 1.

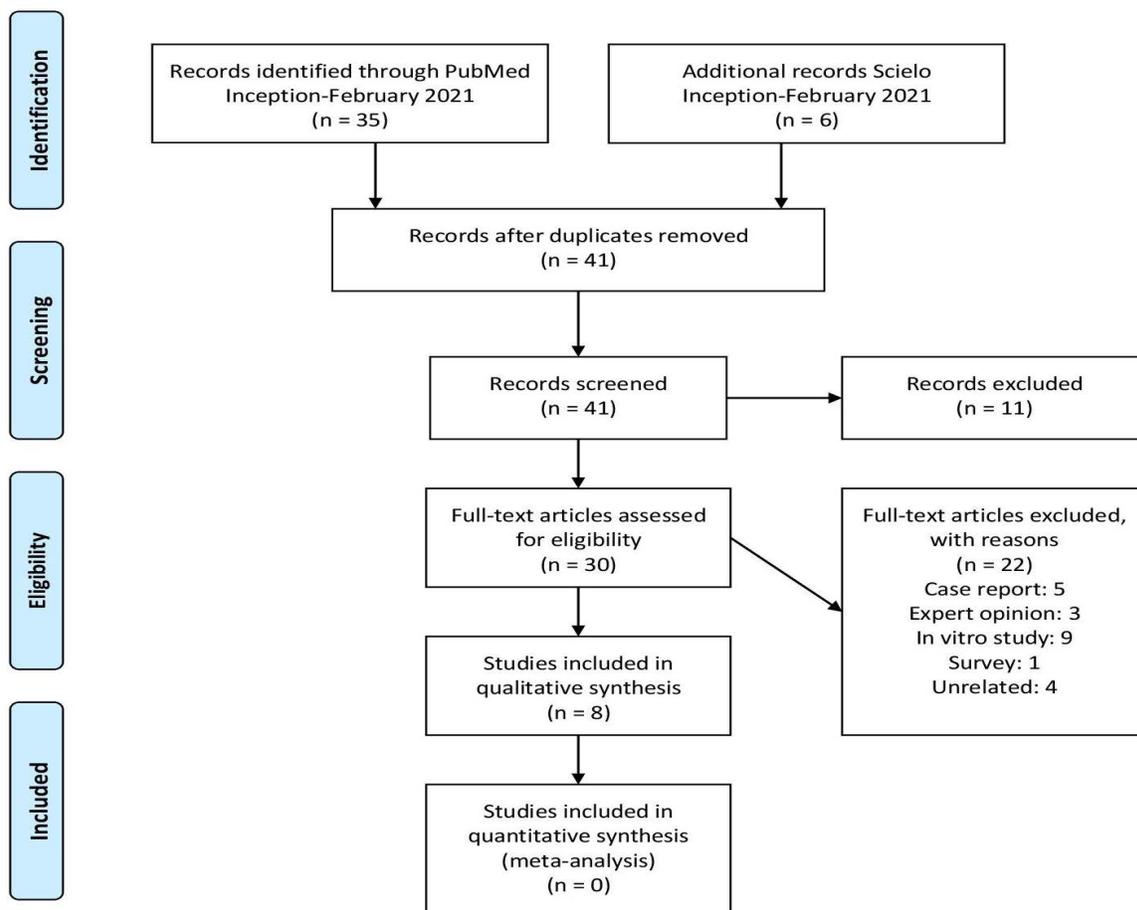


Figure 1. *Flowchart of study selection.*



Tables 1, 2 and 3 depict the characteristics and variables of the 8 included studies and reviews. Four studies were RCTs (Knösel *et al.*, 2007; Krug and Green, 2008; Montenegro-Arana *et al.*, 2016; Ahrari *et al.*, 2020) and one a non-RCT (Jadad *et al.*, 2011). Three results were critical reviews (Consolaro *et al.*, 2013; Márquez *et al.*, 2012; Freire *et al.*, 2018). The age of

participants ranged from 14 to 40 years old and were mostly women (table 1).

All clinical studies were small-sample size which comprised 19-71 participants and only one study (Montenegro-Arana *et al.*, 2016) provided information about sample size calculation (table 2). Three studies (Knösel *et al.*, 2007; Krug and Green, 2008; Ahrari *et al.*, 2020) performed tooth

Table 1  
*Characteristics of the included clinical studies*

Study	Design	Objective	Age of participants	Sex	Conclusions
Knösel <i>et al.</i> 2007	RCT	To evaluate the effect of external bleaching on the color and luminosity of inactive white-spot lesions present after fixed orthodontic appliance treatment.	≥ 14	NR	TW satisfactorily camouflaged white spot-lesions after OT. Slight DH was reported.
Krug and Green 2008	RCT	To compare two TW protocols after orthodontic therapy.	18.4	43F; 28M	Both TW protocols presented significant color shade improvement as compared to control. DH was not reported.
Jadad <i>et al.</i> 2011	Non- RCT	To assess the effectiveness of a new bleaching agent (8% hydrogen peroxide) used in patients wearing fixed orthodontic appliances.	18-40	NR	TW was achieved with and without brackets. No differences in color change were observed between the with and without brackets groups. DH was not reported.
Montenegro-Arana <i>et al.</i> 2016	RCT	To evaluate tooth sensitivity and the effectiveness of two types of bleaching agents when used in patients wearing orthodontic appliances.	24.4	23F; 17M	Both protocols resulted in significant and satisfactory improvement in tooth color shade. Slight DH was reported.
Ahrari <i>et al.</i> 2020	RCT	To compare the efficacy and complications of a home-applied and in-office bleaching protocols (LATW, PATW, CTW) after orthodontic treatment	21.6 ± 0.8	31F; 29M	All methods were effective for tooth whitening. In-office laser assisted tooth whitening produced the best results with less complications and less exposure time. DH was reported for all protocols but was less for laser assisted protocols. DH was highest in patients who received conventional in-office TW.

*Note:* Derived from research. RCT: randomized clinical trial. Non-RCT: non-randomized clinical trial. NR: not reported. F: female. M: male. TW: tooth whitening. OT: orthodontic treatment. DH: dental hypersensitivity. LATW: laser assisted tooth whitening. PATW: plasma arc tooth whitening. CTW: conventional tooth whitening.



whitening (TW) after orthodontic treatment (OT) was finalized (table 2). One study (Montenegro-Arana *et al.*, 2016) performed TW during OT immediately after bracket installation. One study (Jadad *et al.*, 2011) compared TW during OT immediately after bracket installation and TW after brackets debonding (table 2). The time in days after which TW was applied following bracket debonding ranged from 7 to 90 days with a mean value of 40.2 days (Knösel *et al.*, 2007; Krug and Green, 2008; Ahrari *et al.*,

2020) and one study (Jadad *et al.*, 2011) performed TW immediately after bracket debonding (table 2). Studies that applied TW during or immediately (Montenegro-Arana *et al.*, 2016; Jadad *et al.*, 2011) after bracket debonding used lower whitening agent concentration (8-10%). In contrast, studies that performed TW 90 days after bracket debonding (Knösel *et al.*, 2007; Ahrari *et al.*, 2020) used concentrations between 30-46% of the whitening agent (table 2).

Table 2  
*Variables of the included clinical studies*

Study	N participants	N intervention	N comparison	N participants after OT	Time of TW after brackets removal*	TW during OT	Time of TW after bracket installation**
Knösel <i>et al.</i> 2007	19	10 in-office 30% hydrogen peroxide x 60 minutes; 2 week later, at-home 15% hydrogen peroxide x 1-hour x 14 days	9 no intervention	10	90	No	NA
Krug and Green 2008	71	24 in-office	23 home kit TW; 24 controls (no TW)	47	7	No	NA
Jadad <i>et al.</i> 2011	40	20 with brackets. 8% hydrogen peroxide x 45 minutes x 10 days	20 after bracket removal. 8% hydrogen peroxide x 45 minutes x 10 days	20	Immediate	Yes	Immediate
Montenegro-Arana <i>et al.</i> 2016	40	20 8% hydrogen peroxide x 45 minutes x 10 days	20 10% hydrogen peroxide x 45 minutes x 10 days	NA	NA	Yes	Immediate
Ahrari <i>et al.</i> 2020	60	15 LATW 46% hydrogen peroxide. 15 PATW 35% hydrogen peroxide. 15 CTW 40% hydrogen peroxide	15; 20% carbamide peroxide x 2-4 hours x 14 days	60	90	No	NA

Note: Derived from research. NA: not applicable. TW: tooth whitening. OT: orthodontic treatment. LATW: laser assisted tooth whitening. PATW: plasma arc tooth whitening. CTW: conventional tooth whitening. \*Days after brackets removal. \*\*Days after brackets installation.



All studies reported satisfactory improvements in tooth color shade during or after OT independent of the protocol used with no significant differences among them (Knösel *et al.*, 2007; Krug and Green, 2008; Montenegro-Arana *et al.*, 2016; Ahrari *et al.*, 2020; Jadad *et al.*, 2011) However, the two studies (Montenegro-Arana *et al.*, 2016; Jadad *et al.*, 2011) that performed TW during OT are from the same group of researchers with the same protocol and therefore the external validity remains inconclusive.

Risk of bias for clinical studies is presented in figures 2 and 3. Three studies were judged to have high risk of bias (Knösel *et al.*, 2007; Krug and Green, 2008; Jadad *et al.*, 2011), one study (Montenegro-Arana *et al.*, 2016) had some concerns that may have introduced bias and one study presented low risk of bias (Ahrari *et al.*, 2020). Concerns about introducing bias in the studies were due to inadequate sample calculation, unclear randomization and concealment and

not sufficient description about blinding. In general, the evidence was judged low quality due to the inclusion of RCTs with great uncertainty and methodological issues.

Observations from the included reviews are presented in table 3. Two reviews (Consolaro *et al.*, 2013; Márquez *et al.*, 2013) considered TW during and after OT and one review (Freire *et al.*, 2018) during OT. Regarding the time after bracket debonding in which TW can be applied, the authors recommend a 14–30-day period (Consolaro *et al.*, 2013; Márquez *et al.*, 2012). All three reviews (Consolaro *et al.*, 2013; Márquez *et al.*, 2012; Freire *et al.*, 2018) did not recommend TW during conventional OT. The lack of diffusion of the whitening agent under the brackets which may result in non-uniform color changes and possible enamel cracks during debonding are variables to consider (Consolaro *et al.*, 2013).

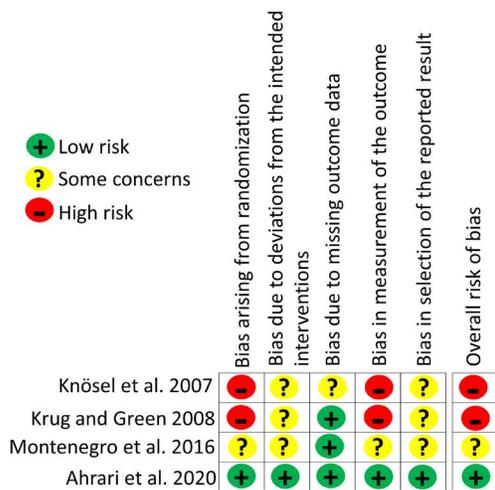


Figure 2. Risk of bias of randomized clinical trials.

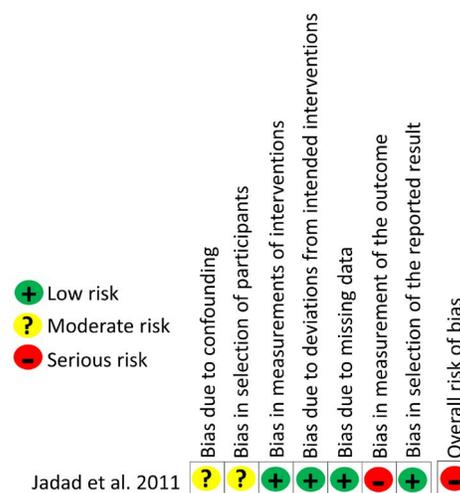


Figure 3. Risk of bias of non-randomized clinical trials.



Table 3  
*Data from reviews included in the analysis*

Study	Objective	Time of TW after brackets removal*	Time of TW after bracket installation**	DH	Observations
<a href="#">Márquez et al. 2012</a>	To review the current state of TW when applied during or after OT.	30	NR	No	TW can be performed 3-4 weeks after brackets removal. There is not enough objective evidence to recommend TW during OT. Pulp changes, DH and periodontal repair after brackets removal may justify the decision.
<a href="#">Consolaro et al. 2013</a>	To analyze the precautions, explanations and guidelines related to the best time to carry out TW.	14-28	NR	Yes	TW can be performed 2-4 weeks after brackets removal. TW during OT not recommended due to possible non-penetration of whitening agent under the brackets that may result in non-uniform color change. Possible risk of enamel cracks during bracket debonding.
<a href="#">Oliveira-Freire et al. 2019</a>	To review the currently available literature on TW during OT	NR	20 days before brackets removal	Yes	Not enough evidence to recommend TW during OT.

*Note:* Derived from research. NR: not reported. TW: tooth whitening. OT: orthodontic treatment. DH: dental hypersensitivity. \*Days after brackets removal. \*\*Days after brackets installation.

## Discussion

### *General issues*

Results from this systematic review were limited and meta-analysis was not attempted due to the nature of the data collected. In general, the clinical studies found were low quality with important methodological issues such as small-sample and no calculation of sample size. The inclusion of previous critical reviews offered some points of views based mainly on data from *in vitro* studies which need to be considered with caution when deciding about TW during or after OT. This narrative review synthesized the findings of quantitative studies which used diverse methodologies or with different conceptualizations to identify the appropriate moment to perform TW in conventional orthodontic patients. It is important to note that

all studies that were assessed reported satisfactory improvements in color, independent of the protocol used and therefore will not be subjected to discussion.

### *Tooth whitening during orthodontic treatment*

This systematic review found two studies from the same research group ([Montenegro-Arana et al., 2016](#); [Jadad et al., 2011](#)) which performed TW during OT with satisfactory results in color shade. However, the evidence is low quality and there seems to be a lack of rationality for this procedure with no external validity. Color changes of the tooth around brackets is a possible outcome but there is the concern that applying TW procedures with brackets in place would produce a non-uniform color change. Two *in vitro* studies using



bovine teeth demonstrated that the diffusion of the TW agent is impaired under the bracket resulting in significant difference in color between the center (area under bracket) and marginal areas of the tooth (Lunardi *et al.*, 2014; de Melo Oliveira *et al.*, 2021). In contrast, few case reports have obtained satisfactory results of TW used during clear aligner OT suggesting its feasibility with this technique in areas without bonded resin attachments (Oliverio *et al.*, 2019; Sword and Haywood, 2020). Nonetheless, controlled clinical studies are necessary to recommend this last strategy. The decision of TW during conventional OT appears to be based on clinical preference rather than on an evidence-based approach. Therefore, it is not possible to recommend TW during OT.

#### *Tooth whitening after orthodontic treatment*

One of the main reasons for TW after OT is the development of white-spot lesions. However, the intervention that has shown moderate effectivity in treating these lesions is fluoride varnish application (Höchli *et al.*, 2017). In addition, the available evidence from a recent systematic review found no support for TW for the management of white-spot lesions after OT (Gizani *et al.*, 2020). On the other hand, extrinsic stains developed during OT can be successfully managed with TW strategies (Rodríguez-Martínez *et al.*, 2019). But the question is: ¿what is the appropriate time in days in which tooth whitening can be performed after bracket debonding? Several aspects are discussed based on the available evidence.

Important changes in pulp tissues occur during OT depending on the magnitude of the force and the type of movement. Pulp vitality is affected with moderate to severe intrusion forces due to vascular congestion

(Han *et al.*, 2013). Other researchers found in clinical studies that pulp volume and pulp blood flow are significantly decreased with orthodontic forces (Venkatesh *et al.*, 2014; Abu Alhaija *et al.*, 2019). Pulp blood flow was found to return to baseline values after one month, suggesting that waiting this time would be advisable after bracket removal to perform TW (Abu Alhaija *et al.*, 2019).

Debonding of brackets results in damage to the enamel, resin tags and increased sensitivity (Zaher *et al.*, 2012; Dumbryte *et al.*, 2017). A study found that sensitivity is higher immediately after bracket debonding and shows a decreased but still positive response after 7 days (Dumbryte *et al.*, 2017). Dental hypersensitivity was a frequent finding in this systematic review. In addition, polishing of the tooth surface with burs and discs after bracket debonding may also affect the enamel quality and result in damage (Faria-Júnior *et al.*, 2015; Vidor *et al.*, 2015). A recent experimental study showed that a remineralization layer can be formed 14 days after debonding when a toothpaste containing calcium sodium phosphosilicate (CSPS) was applied daily (Triwardhani *et al.*, 2019). Therefore, all these variables and possible consequences should be carefully assessed before deciding on performing TW after OT.

Periodontal changes are also associated with OT. Increased plaque accumulation and gingivitis is common in conventional orthodontic patients (Van Gastel *et al.*, 2007). Oral hygiene during OT is a major factor which influence the periodontal condition and successful achievement of treatment objectives (Talic, 2011). Additionally, it has been reported that the levels of plaque, bleeding on probing and gingivitis are significantly reduced 30 days after bracket debonding accompanied by prophylaxis



and oral hygiene instructions (Jadad *et al.*, 2011; Sallum *et al.*, 2004). Therefore, any TW procedure after OT would be best applied under proper oral hygiene and healthy periodontal conditions.

A final consideration is the concentration of the whitening agent. Tooth whitening agents, depending on the protocol used, must remain in contact with the tooth surface for extensive periods of time to produce its effects. Home whitening protocols used concentrations between 8-15% for 45 minutes to 1 hour. In contrast, in-office protocols used higher concentrations of the whitening agent (30-46%) for a short exposure time. It has been observed that patients overuse the at-home TW protocols that may result in important complications (Alqahatani *et al.*, 2014). An *in vitro* study showed that higher concentrations of carbamide peroxide (>10%) caused a reduction in the enamel microhardness. Furthermore, after a post-whitening recovery period in artificial saliva, the microhardness improved but did not reach baseline values (Basting *et al.*, 2003). This may indicate that the changes in the mineral composition and surface of the enamel produced by high concentration of whitening agents are permanent and therefore, could affect the previously altered tooth structure by the mechanical debonding of brackets.

Remineralization of the enamel is possible after orthodontic treatment and this phenomenon occurs naturally by saliva and with the use of fluorides or casein phosphopeptide-amorphous calcium phosphate products. Guzmán-Armstrong *et al.* (2010) reported that remineralization of white spot lesion is possible after bracket removal, but it depends on the severity of the lesions. Nonetheless, remineralization could take up to 6 months and therefore any treatment for

white spot lesion or stains should be delayed until the enamel has recovered. Therefore, TW after bracket debonding should be carefully considered as remineralization of the enamel is occurring and whitening agents could induce further damage to the tooth surface. In all cases, TW after OT must be closely monitored by the clinician in order to control the desired tooth color change and possible adverse effects.

Since no consensus regarding the number of days after bracket debonding in which TW can be safely applied and based on the available data, it seems rational to wait at least 30 days to avoid complications and to allow for the enamel, pulp and periodontal tissues to recover after OT. However, there may be cases in which an extended waiting period is appropriate depending on the clinical appearance of extrinsic stains, white spot lesions and quality of the enamel.

## Conclusions

Low quality evidence suggests that the appropriate moment to perform tooth whitening in conventional orthodontic patients is after brackets removal with a waiting period of at least 30 days. There is not adequate evidence to support tooth whitening during conventional orthodontic treatment.

## Conflict of Interest

The authors declare no competing interests.

## Author contribution statement

All the authors declare that the final version of this paper was read and approved. The total contribution percentage for the conceptualization, preparation, and



correction of this paper was as follows: S.H.V. 25%, M.F.N. 25%, J.E.B. 25% and F.A.R. 25%.

## Data availability statement

The data supporting the results of this study is available as “supplementary files” on the Uniciencia website.

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Tooth whitening in conventional orthodontic patients: a systematic review (Stefanía Hernández-Viana • Miguel Fernando Niño • Felipe Augusto Restrepo • Javier Enrique Botero) **Uniciencia** is protected by [Attribution-NonCommercial-NoDerivs 3.0 Unported \(CC BY-NC-ND 3.0\)](https://creativecommons.org/licenses/by-nc-nd/3.0/)



## Supplementary material 1

### List of excluded studies with reasons

Year	Authors	Title	Reason
1993	Bishara <i>et al.</i>	Effect of enamel bleaching on the bonding strength of orthodontic brackets	<i>In vitro</i> study
2001	Hintz <i>et al.</i>	Enamel colour changes following whitening with 10 percent carbamide peroxide: a comparison of orthodontically-bonded/debonded and untreated	<i>In vitro</i> study
2004	Staley RN, Vargas MA.	Bleaching during and after orthodontic treatment.	Expert opinion
2006	Schmidt and Tatum.	Cosmetic dentistry	Expert opinion
2007	Sundfeld <i>et al.</i>	Enamel Microabrasion Followed by Dental Bleaching for Patients after Orthodontic Treatment—Case Reports	Case report
2007	Türkkahraman <i>et al.</i>	Bleaching and desensitizer application effects on shear bond strengths of orthodontic brackets	<i>In vitro</i> study
2009	Thickett E, Cobourne MT.	New developments in tooth whitening. The current status of external bleaching in orthodontics	Expert opinion
2009	Mullins <i>et al.</i>	Tooth Whitening Effects on Bracket Bond Strength <i>In Vivo</i>	Unrelated
2009	Patusco <i>et al.</i>	Bond strength of metallic brackets after dental bleaching.	<i>In vitro</i> study
2011	Bidra and Uribe.	Successful Bleaching of Teeth with Dentinogenesis Imperfecta Discoloration: A Case Report	Case report
2012	Sundfeld <i>et al.</i>	Conservative reconstruction of the smile by orthodontic, bleaching, and restorative procedures	Case report
2012	Ray <i>et al.</i>	Are bleaching and desensitizing agents contraindication for patients seeking orthodontic treatment?	<i>In vitro</i> study
2013	Slack <i>et al.</i>	Tooth whitening in the orthodontic practice: A survey of orthodontists	Survey
2013	do Rego <i>et al.</i>	Evaluation of the influence of dental bleaching with 35% hydrogen peroxide in orthodontic bracket shear bond strength	<i>In vitro</i> study
2014	Lunardi <i>et al.</i>	Spectrophotometric evaluation of dental bleaching under orthodontic bracket in enamel and dentin	<i>In vitro</i> study
2015	Arboleda-Lopez <i>et al.</i>	Tooth whitening during orthodontic treatment: A six-month <i>in vitro</i> assessment of effectiveness and stability.	<i>In vitro</i> study
2017	Gomes <i>et al.</i>	In-Office Bleaching During Orthodontic Treatment	Case report
2019	Sardarian <i>et al.</i>	Bleaching during orthodontic treatment and its effect on bracket bond strength	<i>In vitro</i> study
2019	Oliverio <i>et al.</i>	Tooth Whitening in Association with Clear Aligner Treatment	Unrelated
2020	Levrini <i>et al.</i>	Dental bleaching during orthodontic treatment with aligners	Unrelated
2020	Sword RJ, Haywood VB.	Teeth Bleaching Efficacy During Clear Aligner Orthodontic Treatment.	Case report
2020	Gizani <i>et al.</i>	Is bleaching effective in the managing post-orthodontic white-spot lesions? A systematic review	Unrelated