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SYSTEMATIC REVIEW

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Change in clinical parameters after subgingival instrumentation for the treatment of periodontitis and timing of periodontal re-evaluation: A systematic review and meta-analysis

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Abstract

Aim: To evaluate the changes in periodontal parameters (reduction in probing pocket depth [PPD], gain in clinical attachment level [CAL] and reduction in full-mouth bleeding on probing [BoP]) after subgingival instrumentation of periodontal pockets at different time points in systemically healthy patients suffering from periodontitis.

Materials and Methods: Four databases were searched for RCTs that carried out subgingival instrumentation in periodontal pockets and evaluated PPD at a minimum of two consecutive time points other than baseline. The analysis was conducted for both all pocket depths and stratified for initially shallow (4–5 mm) and deep (≥6 mm) pockets and data were extracted for various time points, 1–2, 3–4 and 5–6 months. Weighted mean effects (WMEs) were calculated with 95% confidence interval (CI) and predictive intervals were calculated.

Results: Twenty-nine RCTs were identified, and all of them were included in the meta-analysis. The results showed that for both shallow and deep pockets there was a small though clinically meaningful change between 1- to 2-month and 3- to 4-month time points and between these and 5–6 months.

Conclusions: In systemically healthy patients, the greater part of reduction in PPD and gain in CAL occurs within the first 1–2 months after subgingival instrumentation. However, additional benefits in terms of pocket depth reduction occur beyond these early time points.

KEYWORDS

clinical attachment level gain, periodontal re-evaluation, periodontitis, probing pocket depth reduction, subgingival instrumentation

Clinical Relevance

Scientific rationale for study: Although a stepwise approach for the treatment of periodontal disease has been proposed in clinical guidelines, the best time point for re-evaluation after Steps 1 and 2 remains unclear.

Lucrezia Paternò Holtzman and Nicola Alberto Valente contributed equally to the realization of this study.

Principal findings: The majority of the probing pocket depth (PPD) reduction and clinical attachment level (CAL) gain can be observed within the first 2 months post-instrumentation, although clinically relevant changes occur at 3–4 and 5–6 months.
Practical implications: Based on the present data, the maximum effect of Step 2 therapy on PPD reduction is achieved after 1–2 months. Though re-evaluation could be performed at 1–2 months, most cases will benefit in waiting up to 3 months for a further 0.5–1 mm of PPD reduction. The impact of this additional reduction and its clinical significance will depend on the initial pocket depth.

1 | INTRODUCTION

The European Federation of Periodontology (EFP) recently published clinical practice guidelines aiming to provide recommendations for practitioners for the treatment of Stage I–III periodontitis (Sanz et al., 2020). These are based on a stepwise approach to therapy, which includes a sequence of interventions applied in an incremental fashion. While Step 1 aims to guide behavioural changes and assist the patient in supragingival biofilm control, Step 2 focuses on subgingival instrumentation. A recent systematic review (Suvan et al., 2020) evaluated the efficacy of Step 2 treatment and concluded that it is efficacious in achieving the clinical endpoints of periodontal therapy (probing depth reduction, reduction of inflammation and reduced number of diseased sites).

According to the EFP guidelines, the cumulative effect of the first and second steps of therapy (subgingival instrumentation) should be assessed at the moment of periodontal re-evaluation: if the endpoints of therapy (no periodontal pockets >4 mm with bleeding on probing [BoP] or no deep periodontal pockets [≥6 mm]) have not been achieved, the third step of the therapy (surgical treatment or repeated instrumentation) should be considered. On the other hand, if the clinical goals have been met, the patient is inserted into a supportive periodontal care programme, aimed to maintain periodontal stability (Sanz et al., 2020).

From clinical and histological standpoints, different time intervals after subgingival instrumentation have been proposed in the literature as appropriate to re-evaluate the periodontal condition (Segelnick & Weinberg, 2006).

The clinical practice guidelines clearly state the importance of periodontal re-evaluation, which should be performed 'once the periodontal tissues have healed' (Sanz et al., 2020). However, the exact moment in which this assessment should be carried out after Step 2 is not explicitly stated. The selection of an appropriate time point is of paramount importance. If Step 3 were to be performed before tissues have healed completely after Steps 1 and 2, this would imply an increase in treatment morbidity. By re-evaluating when the periodontal tissues have reached a complete maturation, it is more likely that the correct therapy is selected while reducing morbidity.

Therefore, the aim of the present systematic review was to investigate the variation of clinical parameters after subgingival instrumentation for the treatment of periodontitis and search for evidence regarding the best timing for periodontal re-evaluation in periodontitis patients treated with subgingival instrumentation.

2 | MATERIALS AND METHODS

This review has been registered at the National Institute for Health Research PROSPERO, International Prospective Register of Systematic Reviews and has been assigned the number CRD42020223552.

2.1 | PICO criteria definitions

Population: Patients with a diagnosis of periodontitis in need of mechanical supra- and subgingival instrumentation performed without adjunctive treatments (Steps 1 and 2).
Intervention: Re-evaluation performed after 1–2 months from treatment.
Comparison: Re-evaluation performed after 3–4 or 5–6 months from treatment.
Outcomes:
Primary outcome: Change in probing pocket depth (PPD) at 1–2, 3–4 and 5–6 months;
Secondary outcomes: Change in clinical attachment level (CAL), change in bleeding upon probing (BoP), change in gingival index (GI), change in pocket closure (%) at 1–2, 3–4 and 5–6 months.
Study type: Randomized controlled trials (RCTs).

2.2 | Focused question

In patients suffering from periodontitis treated with mechanical supra and subgingival instrumentation (Steps 1 and 2) and re-evaluated after 1–2 months, what is the change in clinical parameters (PPD, BoP, CAL, GI, pocket closure) after 3–4 and 5–6 months post-treatment?

2.3 | Primary outcome

PPD reduction at different time points (1–2, 3–4 and 5–6 months).

2.4 | Secondary outcomes

Changes in CAL, GI and BoP and rate of pocket closure at different time points (1–2, 3–4 and 5–6 months).

2.5 | Search strategy

Electronic search: The reporting of this systematic analysis adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021).

Relevant articles published up to December 1, 2022 were searched using the relevant keywords and respective Boolean logic operators (AND, OR, NOT) used in the following databases: PubMed, EMBASE, Ovid MEDLINE and Web of Science. The relevant keywords were combined as follows for the search: ((‘periodontitis’[All Fields]) AND ((‘therapy’[All Fields]) OR (‘non surgical therapy’[All Fields]) OR (‘ultrasonic’[All Fields]) OR (‘manual’[All Fields]) OR (‘mechanical’[All Fields]) OR (‘laser’[All Fields]) OR (‘antibiotics’[All Fields]) OR (‘antiseptic’[All Fields])) NOT ((‘endodontics’[All Fields]) OR (‘apical’[All Fields])) AND ((humans[Filter]) AND (alladult[Filter])) AND ((humans[Filter]) AND (english[Filter]) AND (alladult[Filter]))) Filters: Humans, English, Adult: 19+ years.

Manual search: A manual search was performed to identify additional relevant references. The bibliographies of included references were checked from the years 2012 until 2022 as well as the following journals: *Journal of Clinical Periodontology*, *Journal of Periodontology*, *International Journal of Periodontics and restorative Dentistry*, *Journal of Periodontal Research*.

Two independent reviewers (LPH and NAV) screened all of the titles, abstracts and then the full text of the studies according to the inclusion and exclusion criteria. Disagreements were resolved by discussion with a third reviewer (MC).

2.6 | Inclusion criteria

- Studies investigating subgingival instrumentation for treatment of periodontitis in otherwise healthy individuals (i.e. not suffering from systemic diseases that may affect gingival inflammation/metabolism or taking medications that may affect gingival inflammation/metabolism).
- Study groups (both test and control) that included patients treated without additional therapies (e.g. laser and antibiotics).
- Randomized controlled clinical trials (RCTs).
- Studies reporting on PPD and/or CAL at minimum two follow-up time points (aside from baseline) with a minimum initial follow-up of 1 month.
- At least 10 patients included per treatment group.
- Patient level analysis.
- Studies using a quadrant-wise or full-mouth delivery of subgingival therapy (Suvan et al., 2020).
- Studies employing mechanical or power-driven instruments, or a combination of both (Suvan et al., 2020).

2.7 | Exclusion criteria

- Periodontal non-surgical therapy for gingivitis, necrotizing periodontitis and periodontitis as manifestation of systemic diseases.
- Split mouth design.
- Subsequent articles reporting information on the same cohort of patients—in this case, only the most recent publication was included.
- Studies lacking a clear periodontal diagnosis.
- Studies in which patients received subgingival re-instrumentation after the initial session of therapy, for instance, during periodontal maintenance sessions.
- Studies including surgical therapy of periodontal defects.
- Additional therapy (local or systemic antimicrobials, laser, host modulators, laser or antimicrobial photodynamic therapy) combined with subgingival instrumentation.
- Studies with a single follow-up appointment.
- Studies focusing specifically on infrabony defects/furcation defects.

2.8 | Quality assessment

Two authors (GVO and LC) independently assessed the studies in terms of the inclusion, relevance, eligibility and risk of bias across studies following the Cochrane Collaboration RoB-2 tool (Sterne et al., 2019). Disagreements were resolved by discussion with a third reviewer (MC).

2.9 | Data extraction and collection process

Following the screening process, two reviewers (LPH and NAV) independently extracted the data of the selected articles using data extraction tables. Disagreements were resolved by discussion with a third reviewer (MC). The primary outcome (PPD reduction) and secondary outcomes (CAL, BoP changes) are reported in the table as mean and standard deviation according to time ranges (1–2 months, 3–4 months and 5–6 months) and baseline PPD, either as an absolute value or as a change between the different time points depending on how they were reported in the study.

2.10 | Statistical analysis

Data were organized into evidence tables, and a descriptive summary was performed to determine the data and study variations (i.e. study subjects, treatment and results). Following article selection, Cohen's kappa coefficient (*k*) was performed to assess inter-examiner agreement.

For continuous data (changes in PD and CAL), mean changes with standard deviation were calculated between the two reported different time points and analysed with weighted mean effect (WME) and 95% confidence intervals (CIs). When change values in periodontal parameters were reported with respect to baseline, but not between consecutive time points, the mean effect with standard deviation between them (1–2 months vs. 3–4 months, 3–4 months vs. 5–6 months) was calculated and analysed with weighted mean differences and 95% CIs. All these values were grouped according to the value of baseline PPD (all, shallow [4–5 mm] or deep [≥6 mm]).

Random-effects meta-analyses were performed using PPD and CAL WME with their associated 95% CIs for the variations between changes between baseline and 1–2 months, baseline and 3–4 months, 1–2 months and 3–4 months, 3–4 months and 5–6 months respectively. Statistical heterogeneity was explored. The significance of discrepancies in the estimates of the treatment effects from the different trials was assessed by means of Cochrane's Q statistic ($p < 0.05$) for heterogeneity and the I^2 index (Higgins, 2003). Forest plots were used to illustrate the outcomes of the different analyses.

Publication bias was evaluated through Funnel plots (function: metafunnel) and Egger's test for small-study effects (Egger et al., 1997). All analyses were performed with Stata (Stata Statistical Software: Release 15 C, StataCorp LLC, College Station, TX, USA).

3 | RESULTS

3.1 | Search results and selection of included studies

A total of 4467 references, published up to December 2022, were identified by the electronic search. Seven citations from the manual search and the grey literature search were identified. After creating a single list and removal of 82 duplicates, 4392 records remained for title-abstract screening; independent screening of titles and abstracts resulted in the elimination of 3924 articles with a good inter-reviewer agreement (kappa = 0.92); therefore, 468 articles remained for full-text evaluation (kappa = 0.91). After full-text screening, 439 references were discarded. The final number of articles included in the review was 29 (list of excluded references and reasons for exclusion can be found in Figure 1); a total of 34 treatment groups were included. All 29 references (Tables 1a and 1b) were consequently included in both qualitative analysis and meta-analysis.

3.2 | Characteristics of included studies

3.2.1 | Disease definition

In 25 studies, periodontitis was defined as chronic (or adult), ranging from mild generalized to severe generalized, while in 4 studies (Andere et al., 2017; do Vale et al., 2016; Emingil et al., 2012; Taiete et al., 2016), the authors included aggressive periodontitis.

None of the included studies claimed to include localized forms of periodontal disease. Although it was not specified, most likely all studies treated generalized forms of disease with varying extent.

Disease severity was described with a wide range of qualifying terms (e.g. 'early' 'mild', 'moderate', 'severe' and 'advanced') and periodontal parameters (e.g. CAL, PPD, GI and BoP).

3.2.2 | Study population/selected samples

Collectively, 633 patients were treated with Step 1 (supragingival plaque control) and Step 2 (subgingival instrumentation).

The mean age of participants ranged from 27.50 to 56.80 years, with a mean of 44.80 ± 16.71. In terms of tobacco use, 14 studies (Andere et al., 2017; Chopra et al., 2016; Cosyn et al., 2007; do Vale et al., 2016; Grover et al., 2016; Mohammad et al., 2005; Monzavi et al., 2016; Nogueira-Filho et al., 2010; Pera et al., 2012; Pradeep & Kathariya, 2011; Saglam et al., 2014; Taiete et al., 2016; Ustun et al., 2018; Zengin Celik et al., 2019) excluded smokers while 2 studies (Machion et al., 2004; Theodoro et al., 2018) included only smokers. In the remaining 13 studies (AlAhmari et al., 2019; Cosyn et al., 2006; Cosyn et al., 2013; Emingil et al., 2012; Fonseca et al., 2015; Gürkan et al., 2005; Ioannou et al., 2009; Jervøe-Storm et al., 2006; Oteo et al., 2010; Palmer et al., 1998; Sakellari et al., 2010; Sanz-Sánchez et al., 2015; Zanatta et al., 2006), both categories were represented with various proportions.

3.2.3 | Outcome assessment

All selected studies used a full-mouth approach to assess clinical outcome variables, either by evaluating all sites, or a group of sites according to a part of the mouth (e.g. a quadrant) or according to a clinical criterion (e.g. PPD > 4 mm). The clinical parameters were reported as follows: PPD and CAL in all 29 articles, BoP in 19 (AlAhmari et al., 2019; Andere et al., 2017; Chopra et al., 2016; Cosyn et al., 2013, 2007; Emingil et al., 2012; Fonseca et al., 2015; Jervøe-Storm et al., 2006; Machion et al., 2004; Mohammad et al., 2005; Oteo et al., 2010; Palmer et al., 1998; Pera et al., 2012; Saglam et al., 2014; Sakellari et al., 2010; Sanz-Sánchez et al., 2015; Theodoro et al., 2018; Ustun et al., 2018; Zengin Celik et al., 2019) and GI in 5 studies (Fonseca et al., 2015; Grover et al., 2016; Pradeep & Kathariya, 2011; Saglam et al., 2014; Ustun et al., 2018); the number of sites measured per tooth was 4–6 among all the selected publications. A total of 15 studies conducted follow-ups at 1 month, 1 at 45 days, 3 at 2 months, 28 at 3 months, 0 at 4 and 5 months and 22 at 6 months.

The outcome 'pocket closure', defined as PPD ≤ 4 mm with no BoP (Sanz et al., 2020), was not reported consistently among the

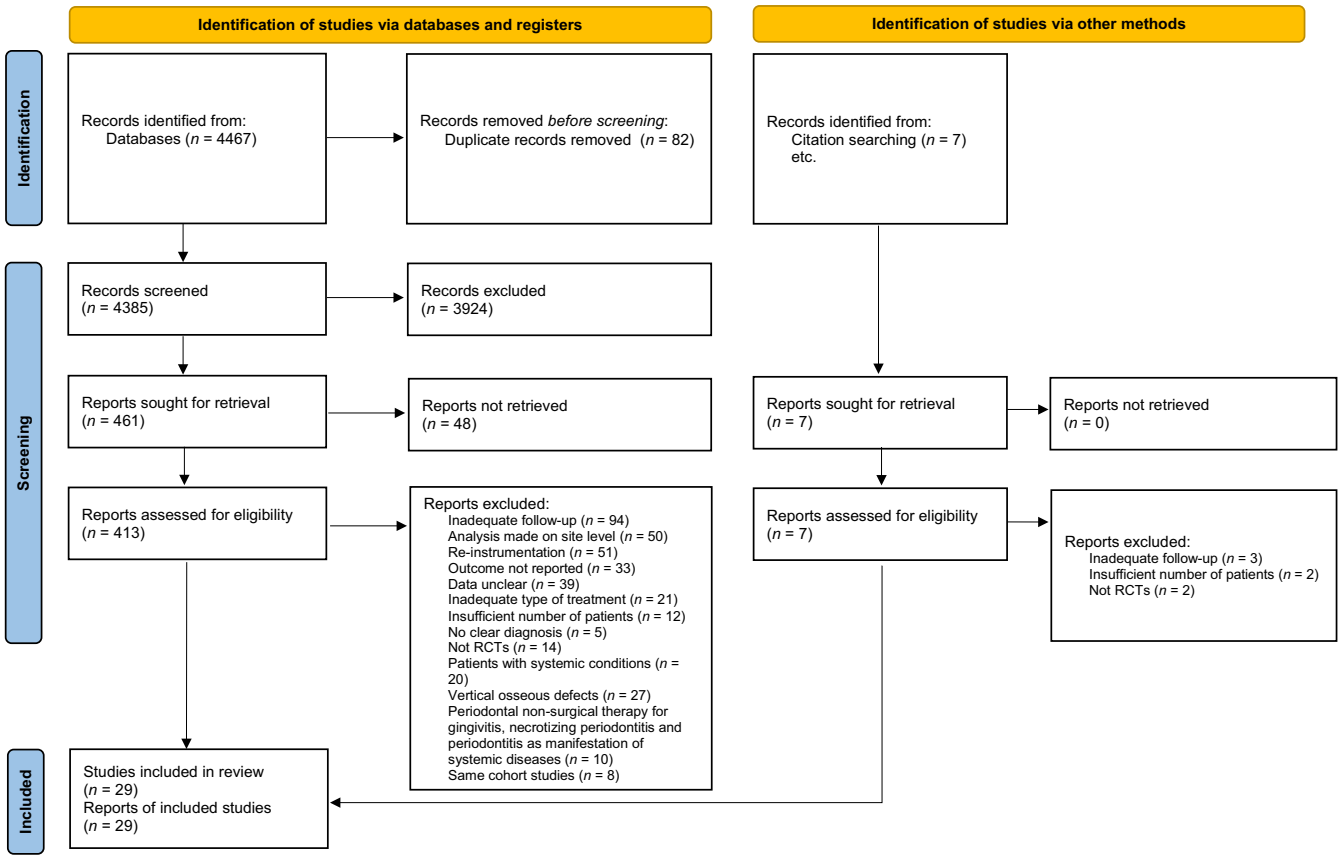

FIGURE 1 PRISMA flow chart.

included studies. It was therefore impossible to perform any kind of analysis on this parameter.

3.2.4 | Type of interventions: Non-surgical mechanical therapy

All included articles reported non-surgical mechanical instrumentation as the only active therapy in all patients. Different approaches with regard to both timing (quadrant-wise or various types of full-mouth approach) and instrumentation (power-driven or manual) were included.

In total, 12 treatment groups in 12 different studies performed a full-mouth approach (AlAhmari et al., 2019; Andere et al., 2017; Cosyn et al., 2007; do Vale et al., 2016; Fonseca et al., 2015; Jervøe-Storm et al., 2006; Nogueira-Filho et al., 2010; Pera et al., 2012; Saglam et al., 2014; Sakellari et al., 2010; Ustun et al., 2018; Zanatta et al., 2006), while 11 treatment groups in 10 studies carried out a quadrant-wise treatment (Cosyn et al., 2006; Emingil et al., 2012; Fonseca et al., 2015; Gürkan et al., 2005; Ioannou et al., 2009; Jervøe-Storm et al., 2006; Oteo et al., 2010; Palmer et al., 1998; Sanz-Sánchez et al., 2015; Zanatta et al., 2006). Finally, six studies (six treatment groups) did not specify the type of timing approach they selected for treatment (Machion et al., 2004; Mohammad et al., 2005; Monzavi et al., 2016; Pradeep & Kathariya, 2011; Taiete et al., 2016; Theodoro et al., 2018).

In terms of instrumentation, 10 treatment groups in 10 studies used only ultrasonic instrumentation (Andere et al., 2017; Cosyn et al., 2013; do Vale et al., 2016; Ioannou et al., 2009; Palmer et al., 1998; Pera et al., 2012; Pradeep & Kathariya, 2011; Sanz-Sánchez et al., 2015; Zanatta et al., 2006), while 13 studies for a total of 14 treatment groups preferred a combination of manual and ultrasonic instruments (Chopra et al., 2016; Cosyn et al., 2006; Cosyn et al., 2007; Grover et al., 2016; Jervøe-Storm et al., 2006; Monzavi et al., 2016; Oteo et al., 2010; Saglam et al., 2014; Sakellari et al., 2010; Taiete et al., 2016; Theodoro et al., 2018; Ustun et al., 2018; Zengin Celik et al., 2019). A total of six treatment groups in five studies used only manual instruments (AlAhmari et al., 2019; Fonseca et al., 2015; Ioannou et al., 2009, Zanatta et al., 2006, Gürkan et al., 2005); finally, in four treatment groups of four studies, the type of selected instrumentation was not specified (Emingil et al., 2012; Machion et al., 2004; Mohammad et al., 2005; Nogueira-Filho et al., 2010).

3.2.5 | Type of interventions: Supportive periodontal therapy phase

Among all studies, the vast majority (24 studies) enrolled subjects in a supportive periodontal therapy programme after performing subgingival instrumentation, while five studies (AlAhmari et al., 2019, Chopra et al., 2016, Fonseca et al., 2015; Grover et al., 2016; Jervøe-Storm

TABLE 1a Characteristics of included studies, study design, population and intervention.

Main author	Country	Settings	Sample size	Smoking habits	Mean age	Age range	% of women	Type of tooth	Diagnosis	Treatment (full mouth/ quadrant wise)	Instruments	Maintenance	Clinical parameters	# sites per tooth
AlAhmari et al. (2019)	Saudi Arabia	University	A. 22 B. 21	A. mixed B. none	A. 45.2 B. 44.2	N.R.	0	All	At least 30% sites with AL ≥ 3 mm and PD ≥ 3 mm	Full mouth	Manual	N.R.	PD, CAL, BoP, PI	6
Andere et al. (2017)	Brazil	University	20	None	31.25	N.R.	95	All	Presence of at least six sites presenting PD and CAL loss ≥5 mm with bleeding on probing (BoP) and at least two sites with PD ≥7 mm (including incisors and first molars, in addition to two other non-contiguous teeth between them)	Full mouth	Ultrasonic w/ subgingival tips	Supragingival + OHI	BoP, PD, CAL, REC	6
Zengin Celik et al. (2019)	Turkey	University	19	None	38.4	25–58	50	All	Had at least 16 teeth with at least 4 teeth in each quadrant, had a at least 4 periodontal pockets with a probing depth (PD) of ≥ 5 mm	Full mouth	Ultrasonic and manual Gracey curettes	Supragingival + OHI	PI, PD, CAL, BoP	6
Chopra et al. (2016)	India	University	59	None	36.70	N.R.	49.15	All	Clinical attachment loss of ≤5 mm	N.R.	Ultrasonic and manual Gracey curettes	N.R.	PD, CAL, BoP	6
Cosyn et al. (2006)	Belgium	University/ private	13	Mixed	51	N.R.	61.54	All	≥15% of all experimental sites exhibiting a probing depth (PD) of ≥ 7 mm, which bled upon probing (BoP), and radiographic evidence of extended bone loss (≥1/3 of root length).	Quadrant wise	Ultrasonic and manual Gracey curettes	Supragingival + OHI	SBI, PD, BoP, PI. CAL, REC	6

TABLE 1a (Continued)

Main author	Country	Settings	Sample size	Smoking habits	Mean age	Age range	% of women	Type of tooth	Diagnosis	Treatment (full mouth/ quadrant wise)	Instruments	Maintenance	Clinical parameters	# sites per tooth
Cosyn et al. (2007)	Belgium	University	16	None	52	N.R.	56.25	All	At least one pocket per quadrant with a probing depth (PD) ≥6 mm, which bled upon probing; radiographic evidence of extended bone loss (≥1/3 of the root length)	Full mouth	Ultrasonic and manual Gracey curettes	Supragingival + OHI	PD, CAL, BoP, PI, SBI	6
Cosyn et al. (2013)	Belgium	University	18	Mixed	44	N.R.	44.44	All	PD ≥ 6 mm, which bled upon probing; radiographic evidence of extended bone loss (≥1/3 of the root length)	Quadrant wise	Ultrasonic	Supragingival + OHI	PI, BoP, PD, CAL	6
do Vale et al. (2016)	Brazil	University	14	None	28.57	N.R.	64.28	All	presence of ≥20 teeth, ≥8 teeth with (PD) ≥5 mm with (BoP) and at least 2 teeth with PD ≥7 mm	Full mouth	Ultrasonic	Supragingival + OHI	FMPS, BoP, PD, CAL, REC	6
Emingil et al. (2012)	Turkey	University	16	Mixed	29.56	N.R.	50	All	Aggressive (not further described)	Quadrant wise	N.R.	Supragingival + OHI	PD, CAL, BoP	6
Fonseca et al. (2015)	Brazil	University	A. 15 B. 13	Mixed	A. 44.6 B. 44.6	35–54	61.18	All	Mild to moderate Chronic (not further described)	A. Full mouth B. Quadrant wise	Manual (Gracey and McCall) curettes	N.R.	PD, CAL, PI, GI and BGI	6
Grover et al. (2016)	India	University	20	None	44.70	30–58	50	All	Chronic (not further described)	Quadrant wise	Ultrasonic and manual	N.R.	PD, PI, GI, mSBI and CAL	6, 4 for PI and GI
Zanatta et al. (2006)	Brazil	University	A. 15 B. 15	Mixed	A. 40 B. 41	A. 29–62 B. 27–59	N.R.	All	≥20 teeth without furcation involvement in both jaws, and ≥8 teeth with periodontal lesions characterized by a PD ≥ 5 mm and bleeding following pocket probing.	A. Quadrant wise B. Full mouth	A. Manual B. Ultrasonic	Supragingival + OHI	BoP, PD, CAL, REC, PI	6

(Continues)

TABLE 1a (Continued)

Main author	Country	Settings	Sample size	Smoking habits	Mean age	Age range	% of women	Type of tooth	Diagnosis	Treatment (full mouth/ quadrant wise)	Instruments	Maintenance	Clinical parameters	# sites per tooth
Gürkan et al. (2005)	Turkey	University	13	Mixed	46.77	35–59	30.8	All	>30% sites with ≥5 mm clinical attachment loss and having at least two sites with a PD ≥6 mm in each quadrant that bled on probing	Quadrant wise	Manual	Supragingival + OHI	PD, CAL, PBI and PI	6
Ioannou et al. (2009)	Greece	University	A. 20 B. 20	Mixed	A. 50.47 B. 49.62	N.R.	A. 70.6 B. 50	All	Four sites with PD ≥ 5 mm in at least two quadrants of each of the patients, demonstrating BoP	A. Quadrant wise B. Quadrant wise	A. Ultrasonic with A and P tips. B. Manual Gracey curettes	Supragingival + OHI	PI, PD, CAL, GBI	6, 4 for GBI and PI
Jervøe-Storm et al. (2006)	Germany	University	a. 10 b. 10	Mixed	A. 56.3 B. 49.1	N.R.	A. 50 B. 60	All	With at least two teeth per quadrant with a probing depth of ≥5 mm and BoP.	A. Full mouth B. Quadrant wise	Sonic and Manual instruments	N.R.	PD, CAL and BoP	6
Machion et al. (2004)	Brazil	University	23	All	40.45	N.R.	56	Anterior	Minimum of four periodontal pockets (probing depth of ≥5 mm and bleeding on probing) located on anterior teeth (canines and incisors)	N.R.	N.R	OHI	PI, BoP, PD, GR and RAL	6
Mohammad et al. (2005)	USA	University	12	None	83	77–90	92	N.R.	Baseline (CAL) 5–9 mm, (PD) 4–9 mm and (BoP) in at least two non-adjacent periodontal sites	N.R.	N.R	OHI	PD, BoP, CAL	6
Monzavi et al. (2016)	Iran	University	25	None	50.3	35–55	52	All	Presence of at ≥3 teeth exhibiting residual pocket depth of ≥5 mm with BoP	Full mouth	Ultrasonic and manual (Gracey curettes)	Supragingival + OHI	PI, PD, CAL, BoP	6
Nogueira-Filho et al. (2010)	Brazil	University	10	None	37.3	N.R.	66.7	All	≥30% sites with >5 mm PD and >4 mm CAL, BoP and calculus	Full mouth	N.R	Supragingival + OHI	PD, CAL, BoP, PI	N.R

TABLE 1a (Continued)

Main author	Country	Settings	Sample size	Smoking habits	Mean age	Age range	% of women	Type of tooth	Diagnosis	Treatment (full mouth/ quadrant wise)	Instruments	Maintenance	Clinical parameters	# sites per tooth
Oteo et al. (2010)	Spain	University	13	Mixed	46.9	37–65	38.5	All	Untreated moderate chronic periodontitis (Armitage, 1999) with radiographic evidence of generalized alveolar bone loss ≥30%, presence of at ≥pocket with PD ≥5 mm per quadrant with (BoP) and presence of ≥three teeth per quadrant	Full mouth	Ultrasonic and manual	OHI	PD, CAL, BoP	6
Palmer et al. (1998)	UK	University	27	Mixed	50.5	N.R.	N.R.	All	Moderate-advanced adult periodontitis (PD ≥ 5, CAL ≥ 2 and bone loss ≥4 mm	N.R.	Ultrasonic, not further defined	Supragingival + OHI	PII, BoP, PD, CAL	6
Pera et al. (2012)	Brazil	University	15	None	43.4	35–55	46.7	All	Generalized severe chronic (Armitage, 1999); ≥8 teeth presenting PD ≥5 mm with BoP and radio- graphic confirmation of bone loss; presence of ≥20 teeth	Full mouth	Ultrasonic scaler with subgingival tips	Supragingival + OHI	PD, CAL, BoP, PI	6
Pradeep and Kathariya (2011)	India	University	19	None	37.3	29–48	52.6	All	≥20 natural teeth with a PD of ≥5 mm and CAL of ≥3 mm in ≥30% sites were recruited	N.R.	Ultrasonic	OHI	PD, CAL, GI	N.R
Saglam et al. (2014)	Turkey	University	15	None	40.83	32–56	46.7	All	Chronic	Full mouth	Manual + ultrasonic	OHI	PD, CAL, BoP, PI, GI	
Sakellari et al. (2010)	Greece	University	29	Mixed	48.75	37–75	48	All	Generalized chronic periodontitis (Armitage, 1999) with ≥20 teeth	Full mouth	Ultrasonic and Gracey curettes	OHI	PD, CAL, BoP	6

(Continues)

TABLE 1a (Continued)

Main author	Country	Settings	Sample size	Smoking habits	Mean age	Age range	% of women	Type of tooth	Diagnosis	Treatment (full mouth/ quadrant wise)	Instruments	Maintenance	Clinical parameters	# sites per tooth
Sanz-Sánchez et al. (2015)	Spain	University	21	Mixed	56.8	39–71	78.19	All	Periodontitis based on the presence of ≥4 teeth per quadrant with PD ≥ 4.5 mm and 30% to 50% radiographic bone loss in ≥30% of teeth	Quadrant wise	Ultrasonic	Supragingival + OHI	BoP, PD, CAL, REC, PI	6
Taiete et al. (2016)	Brazil	University	18	None	27.5	N.R.	67	All	>20 teeth with PD ≥ 5 mm with at least two having PD > 7 mm	Full mouth	Ultrasonic scaler with subgingival tips and manual curettes	Supragingival + OHI	FMBS, FMPS, PD, GMP, CAL	N.R
Theodoro et al. (2018)	Brazil	University	17	All	46.2	N.R.	28.6	All	In≥3 teeth, including one or several sites with PD ≥ 5 mm; (CAL) ≥ 5 mm; ≥of 30% of the sites with PD and CAL ≥ 4 mm and (BoP)	Full mouth	Ultrasonic and manual curettes	OHI	PD, CAL, BoP	6
Ustun et al. (2018)	Turkey	University	20	None	45.80	35–58	40	All	At least two incisors or canines at two quadrants (mandible or maxilla) with PD 4–7 mm	Full mouth	Ultrasonic and hand instruments	Supragingival + OHI	CAL, PD, PI and GI	N.R

Abbreviations: BoP, bleeding on probing; CAL, clinical attachment level; GI, gingival index; mSBI, modified sulcus bleeding index; N.R, not reported; PBI, periodontal bleeding index; PD, probing depth; PI, plaque index; RAL, relative attachment level; REC, recession; SBI, sulcus bleeding index.

TABLE 1b Clinical outcomes.

Main author	Follow-up evaluations	PPD change all (mm) ± SD	PPD change 4–5 mm, (mm) ± SD	PPD change ≥6 mm, (mm) ± SD	CAL change all, (mm) ± SD	CAL change 4–5 mm, (mm) ± SD	CAL change ≥6 mm, (mm) ± SD	BoP change, (%) ± SD	GI change±SD
AlAhmari et al. (2019)	1, 3 months	A. 1 month = 0.7 ± 0.26 3 months = 0.6 ± 0.28 1–2 vs. 3–4 = −0.1 ± 0.35 B. 1 month = 2.2 ± 0.2 3 months = 2.5 ± 0.14 1–2 vs. 3–4 = 0.3 ± 0.21	N.R.	N.R.	A. 1 month = 0.8 ± 0.2 3 months = 1.1 ± 0.17 1–2 vs. 3–4 = 0.3 ± 0.15 B. 1 month = 2 ± 0.13 3 months = 2.3 ± 0.17 1–2 vs. 3–4 = 0.3 ± 0.15	N.R.	N.R.	A. 1 month = 4.7 ± 2 3 months = 2.6 ± 1.56 1–2 vs. 3–4 = −2.1 ± 1.46 B. 1 month = 43.9 ± 2.31 3 months = 40.9 ± 2.33 1–2 vs. 3–4 = −3 ± 1.42	N.R.
Andere et al., 2017	3, 6 months	3 months = 0.7 ± 0.17 6 months = 0.67 ± 0.4 3–4 vs. 5–6 = −0.03 ± 0.16	3 months = 1.92 ± 0.12 6 months = 1.84 ± 0.6 3–4 vs. 5–6 = −0.08 ± 0.18	3 months = 3.04 ± 0.25 6 months = 3.00 ± 1.3 3–4 vs. 5–6 = −0.04 ± 0.37	3 months = 0.63 ± 0.19 6 months = 0.60 ± 0.4 3–4 vs. 5–6 = −0.03 ± 0.17	3 months = 1.79 ± 0.17 6 months = 1.72 ± 0.6 3–4 vs. 5–6 = −0.07 ± 0.23	3 months = 2.97 ± 0.25 6 months =2.88 ± 14 3–4 vs. 5–6 = −0.09 ± 0.37	3 months = 36 ± 6.8 6 months = 36 ± 6.9 3–4 vs. 5–6 = 0 ± 2.02	N.R.
Zengin Celik et al. (2019)	3, 6 months	N.R.	3 months = 1.8 ± 0.4 6 months = 1.9 ± 0.4 1–2 vs. 3–4 = 0.1 ± 0.15	3 months = 2.4 ± 0.6 6 months = 2.7 ± 0.7 1–2 vs. 3–4 = 0.2 ± 0.29	N.R.	3 months = 1.8 ± 0.4 6 months = 1.8 ± 0.6 3–4 vs. 5–6 = 0.1 ± 0.21	3 months = 2.5 ± 0.8 6 months = 2.8 ± 0.8 3–4 vs. 5–6 = 0.35 ± 0.29	3 months = 46 ± 27 6 months = 45.7 ± 25 3–4 vs. 5–6 = −0.3 ± 8.2	N.R.
Chopra et al. (2016)	1, 3 months	1 month = 1.50 ± 0.48 3 months = 1.91 ± 0.55 1–2 vs. 3–4 = 0.41 ± 0.09	N.R.	N.R.	1 month = 1.21 ± 0.53 3 months = 1.60 ± 0.54 1–2 vs. 3–4 = 0.39 ± 0.1	N.R.	N.R.	1 month = 40.1 ± 2.24 3 months = 57.6 ± 1.52 1–2 vs. 3–4 = 17.5 ± 2.31	1 month = 0.67 ± 0.6 3 months = 0.92 ± 0.06 1–2 vs. 3–4 = 0.25 ± 0.06
Cosyn et al. (2006)	1, 3, 6 and 9 months	1 month = 1.18 ± 0.14 3 months = 1.27 ± 0.14 6 months = 1.22 ± 0.14 1–2 vs. 3–4 = 0.09 ± 0.15 3–4 vs. 5–6 = −0.05 ± 0.15	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.
Cosyn et al. (2007)	1, 3, 6 months	1 month = 0.79 ± 0.14 3 months = 0.95 ± 0.13 6 months = 0.96 ± 0.15 1–2 vs. 3–4 = 0.16 ± 0.1 3–4 vs. 5–6 = 0.01 ± 0.12	N.R.	N.R.	1 month = 0.08 ± 0.3 3 months = 0.26 ± 0.28 6 months = 0.39 ± 0.27 1–2 vs. 3–4 = 0.18 ± 0.31 3–4 vs. 5–6 = 0.13 ± 0.28	N.R.	N.R.	1 month = 30 ± 4.8 3 months = 28 ± 5.06 6 months = 30 ± 5.35 1–2 vs. 3–4 = −2 ± 3.55 3–4 vs. 5–6 = 2 ± 4.26	
Cosyn et al. (2013)	1 and 3 months	1 month = 0.96 ± 0.17 3 months = 1.02 ± 0.16 1–2 vs. 3–4 = 0.06 ± 0.13	N.R.	N.R.	1 month = 0.56 ± 0.2 3 months = 0.48 ± 0.23 1–2 vs. 3–4 = −0.08 ± 0.22	N.R.	N.R.	1 month = 32 ± 5.3 3 months = 32 ± 5.1 1–2 vs. 3–4 = 0 ± 3.68	N.R.
do Vale et al. (2016)	1, 3 and 6 months	1 month = 1.85 ± 0.18 3 months = 2.2 ± 0.18 6 months = 2.05 ± 0.2 1–2 vs. 3–4 = 0.35 ± 0.2	N.R.	N.R.	1 month = 1.15 ± 0.36 3 months = 1.33 ± 0.36 6 months = 1.18 ± 0.32 1–2 vs. 3–4 = 0.18 ± 0.38	N.R.	N.R.	N.R.	N.R.

(Continues)

TABLE 1b (Continued)

Main author	Follow-up evaluations	PPD change all (mm) ± SD	PPD change 4–5 mm, (mm) ± SD	PPD change ≥6 mm, (mm) ± SD	CAL change all, (mm) ± SD	CAL change 4–5 mm, (mm) ± SD	CAL change ≥6 mm, (mm) ± SD	BoP change, (%) ± SD	GI change±SD
		3–4 vs. 5–6 = −0.15 ± 0.22			3–4 vs. 5–6 = −0.15 ± 0.35				
Emingil et al. (2012)	1, 3, 6 months	1 month = 1.47 ± 1.25 3 months = 1.54 ± 1.24 6 months = 1.68 ± 1.22 1–2 vs. 3–4 = 0.07 ± 0.88 3–4 vs. 5–6 = 0.14 ± 0.84	1 month = 2.04 ± 1.38 3 months = 2.35 ± 1.35 6 months = 2.51 ± 1.33 1–2 vs. 3–4 = 0.31 ± 0.89 3–4 vs. 5–6 = 0.16 ± 0.82	1 month = 4.1 ± 2.1 3 months = 4.4 ± 2.02 6 months = 4.76 ± 2.01 1–2 vs. 3–4 = 0.3 ± 1.17 3–4 vs. 5–6 = 0.36 ± 1.04	1 month = 1.39 ± 1.72 3 months = 1.53 ± 1.70 6 months = 1.58 ± 1.69 1–2 vs. 3–4 = 0.14 ± 1.4 3–4 vs. 5–6 = 0.05 ± 1.37	N.R.	N.R.	1 month = 47.23 ± 20.87 3 months = 48.73 ± 20.9 6 months = 49.7 ± 20.67 1–2 vs. 3–4 = 1.5 ± 8.98 3–4 vs. 5–6 = 0.97 ± 8.53	N.R.
Fonseca et al. (2015)	3 and 6 months	A. 3 months = 0.18 ± 0.2 6 months = 0.19 ± 0.2 3–4 vs. 5–6 = 0.01 ± 0.19 B. 3 months = 0.22 ± 0.21 6 months = 0.27 ± 0.2 3–4 vs. 5–6 = 0.05 ± 0.2	A. 3 months = 1.12 ± 0.24 6 months = 1.22 ± 0.24 3–4 vs. 5–6 = 0.01 ± 0.3 B. 3 months = 1.12 ± 0.28 6 months = 1.22 ± 0.27 3–4 vs. 5–6 = 0.1 ± 0.36	A. 3 months = 1.84 ± 0.4 6 months = 2.13 ± 0.32 3–4 vs. 5–6 = 0.29 ± 0.49 B. 3 months = 1.62 ± 0.6 6 months = 3.07 ± 0.63 3–4 vs. 5–6 = 1.45 ± 0.75	A. 3 months = 0.22 ± 0.32 6 months = 0.19 ± 0.32 3–4 vs. 5–6 = −0.03 ± 0.28 B. 3 months = 0.14 ± 0.45 6 months = 0.19 ± 0.44 3–4 vs. 5–6 = 0.05 ± 0.42	A. 3 months = 0.35 ± 0.11 6 months = 0.33 ± 0.1 3–4 vs. 5–6 = −0.02 ± 0.15 B. 3 months = 0.33 ± 0.17 6 months = 0.36 ± 0.16 3–4 vs. 5–6 = 0.03 ± 0.23	A. 3 months = 1.11 ± 0.32 6 months = 1.13 ± 0.31 3–4 vs. 5–6 = 0.02 ± 0.39 B. 3 months = 0.95 ± 0.39 6 months = 1.18 ± 0.34 3–4 vs. 5–6 = 0.23 ± 0.43	A. 3 months = 20.77 ± 7.02 6 months = 20.75 ± 7.01 3–4 vs. 5–6 = −0.02 ± 5.18 B. 3 months = 18.56 ± 6.21 6 months = 29.8 ± 4.85 3–4 vs. 5–6 = 11.24 ± 4.02	N.R.
Grover et al. (2016)	2 and 3 months	2 months = 0.6 ± 0.6 3 months = 0.81 ± 0.33 1–2 vs. 3–4 = 0.21 ± 0.52	N.R.	N.R.	2 months = 079 ± 0.99 3 months = 1.03 ± 0.49 1–2 vs. 3–4 = 0.23 ± 0.89	N.R.	N.R.	N.R.	2 months = 1 ± 0.13 3 months = 1.19 ± 0.3 1–2 vs. 3–4 = 0.19 ± 0.22
Zanatta et al. (2006)	1 and 3 months	A. 1 month = 1.83 ± 0.76 3 months = 2.51 ± 0.52 1–2 vs. 3–4 = 0.68 ± 0.16 B. 1 month = 2.16 ± 0.55 3 months = 2.58 ± 0.6 1–2 vs. 3–4 = 0.41 ± 0.13	A. 1 month = 1.65 ± 0.62 3 months = 2.20 ± 0.38 1–2 vs. 3–4 = 0.55 ± 0.13 B. 1 month = 1.98 ± 0.38 3 months = 2.19 ± 0.41 1–2 vs. 3–4 = 0.21 ± 0.12	A. 1 month = 2.61 ± 1.55 3 months = 4.37 ± 0.73 1–2 vs. 3–4 = 1.76 ± 0.42 B. 1 month = 3.51 ± 0.58 3 months =4.36 ± 0.54 1–2 vs. 3–4 = 0.85 ± 0.21	A. 1 month = 1.41 ± 0.67 3 months = 1.87 ± 0.56 1–2 vs. 3–4 = 0.46 ± 0.17 B. 1 month = 1.62 ± 0.73 3 months = 1.99 ± 0.92 1–2 vs. 3–4 = 0.37 ± 0.35	A. 1 month = 1.32 ± 0.52 3 months = 1.61 ± 0.41 1–2 vs. 3–4 = 0.29 ± 0.17 B. 1 month = 1.57 ± 0.53 3 months = 1.74 ± 0.55 1–2 vs. 3–4 = 0.17 ± 0.2	A. 1 month = 1.92 ± 1.23 3 months = 3.01 ± 1.08 1–2 vs. 3–4 = 1.09 ± 0.4 B. 1 month = 2.95 ± 0.59 3 months = 3.19 ± 0.81 1–2 vs. 3–4 = 0.24 ± 0.4	A. N.R. B. N.R.	A. N.R. B. N.R.
Gürkan et al. (2005)	3, 6 months	N.R.	3 months = 1.53 ± 0.04 6 months = 1.46 ± 0.05 3–4 vs. 5–6 = −0.07 ± 0.05	3 months = 2.78 ± 0.05 6 months = 2.57 ± 0.07 3–4 vs. 5–6 = −0.21 ± 0.08	N.R.	3 months = 1.01 ± 0.11 6 months = 0.78 ± 0.12 3–4 vs. 5–6 = −0.23 ± 0.12	3 months = 2.1 ± 0.61 6 months = 2.7 ± 0.57 3–4 vs. 5–6 = 0.6 ± 0.67	1 month = 55 ± 3.01 3 months = 67 ± 2.88 6 months = 52 ± 4.03 1–2 vs. 3–4 = 12 ± 2.02 3–4 vs. 5–6 = −15 ± 3.36	N.R.

TABLE 1b (Continued)

Main author	Follow-up evaluations	PPD change all (mm) ± SD	PPD change 4–5 mm, (mm) ± SD	PPD change ≥6 mm, (mm) ± SD	CAL change all, (mm) ± SD	CAL change 4–5 mm, (mm) ± SD	CAL change ≥6 mm, (mm) ± SD	BoP change, (%) ± SD	GI change±SD
Ioannou et al. (2009)	3, 6 months	A. 3 months = 0.53 ± 0.04 6 months = 0.44 ± 0.04 3–4 vs. 5–6 = −0.09 ± 0.04 B. 3 months = 0.88 ± 0.05 6 months = 0.88 ± 0.06 vs. 5–6 = 0 ± 0.05	A. 3 months = 1.23 ± 0.03 6 months = 1.28 ± 0.04 3–4 vs. 5–6 = 0.05 ± 0.05 B. 3 months = 1.55 ± 0.03 6 months = 1.53 ± 0.05 3–4 vs. 5–6 = −0.02 ± 0.05	A. 3 months = 2.16 ± 0.05 6 months = 2.28 ± 0.08 3–4 vs. 5–6 = 0.12 ± 0.09 B. 3 months = 2.71 ± 0.07 6 months = 3.14 ± 0.09 vs. 5–6 = 0.43 ± 0.08	A. 3 months = −0.38 ± 0.11 6 months = −0.29 ± 0.11 3–4 vs. 5–6 = 0.09 ± 0.12 B. 3 months = 1.14 ± 0.11 6 months = 1.05 ± 0.1 3–4 vs. 5–6 = −0.09 ± 0.07	A. 3 months = 0.79 ± 0.08 6 months = 0.75 ± 0.07 3–4 vs. 5–6 = −0.04 ± 0.08 B. 3 months = 1.25 ± 0.09 6 months = 1.25 ± 0.1 vs. 5–6 = 0 ± 0.1	A. 3 months = 1.89 ± 0.08 6 months = 1.96 ± 0.09 3–4 vs. 5–6 = 0.07 ± 0.1 B. 3 months = 2.06 ± 0.1 6 months = 2.55 ± 0.12 vs. 5–6 = 0.49 ± 0.12	N.R.	N.R.
Jerve-Størm et al. (2006)	3 and 6 months	N.R.	A. 3 months = 1.5 ± 0.77 6 months = 1.6 ± 0.56 3–4 vs. 5–6 = 0.2 ± 0.29 B. 3 months = 1.7 ± 0.48 6 months = 1.8 ± 0.54 3–4 vs. 5–6 = 0.2 ± 0.23	A. 3 months = 2.6 ± 1.17 6 months = 1.7 ± 1.69 3–4 vs. 5–6 = −0.9 ± 0.7 B. 3 months = 2.2 ± 0.99 6 months = 2.1 ± 1.35 3–4 vs. 5–6 = 0 ± 0.45	N.R.	A. 3 months = 0.9 ± 0.83 6 months = 1.1 ± 0.61 3–4 vs. 5–6 = 0.2 ± 0.32 B. 3 months = 1 ± 0.57 6 months = 0.9 ± 0.7 3–4 vs. 5–6 = −0.1 ± 0.4	A. 3 months = 1.6 ± 1.05 6 months = 0.7 ± 0.99 3–4 vs. 5–6 = −0.9 ± 0.57 B. 3 months = 1.6 ± 1.18 6 months = 1.4 ± 1.69 3–4 vs. 5–6 = −0.2 ± 0.44	A. 3 months = 55.6 ± 20 6 months = 43.2 ± 19 3–4 vs. 5–6 = −8.3 ± 6.12 B. 3 months = 34.9 ± 20 6 months = 49.3 ± 22 3–4 vs. 5–6 = −6.4 ± 5.05	
Machion et al. (2004)	45 days, 3 and 6 months	45 days = 1.5 ± 0.55 3 months = 1.62 ± 0.45 6 months = 1.76 ± 0.63 1–2 vs. 3–4 = 0.12 ± 0.15 3–4 vs. 5–6 = 0.14 ± 0.16	N.R.	N.R.	45 days = 1.07 ± 0.8 3 months = 1.11 ± 0.65 6 months = 1.04 ± 0.71 1–2 vs. 3–4 = 0.04 ± 0.21 3–4 vs. 5–6 = −0.07 ± 0.2	N.R.	N.R.	45 days = 28 ± 26 3 months = 35 ± 29 6 months = 36 ± 33 1–2 vs. 3–4 = 7 ± 8.12 3–4 vs. 5–6 = 1 ± 9.16	N.R.
Mohammad et al. (2005)	3, 6, 9 months	N.R.	3 months = 0.63 ± 0.1 6 months = 0.67 ± 0.14 3–4 vs. 5–6 = 0.04 ± 0.05	3 months = 0.75 ± 0.32 6 months = 0.81 ± 0.29 3–4 vs. 5–6 = 0.06 ± 0.12	N.R.	3 months = 0.33 ± 0.25 6 months = 0.33 ± 0.28 3–4 vs. 5–6 = 0 ± 0.11	3 months = 0.20 ± 0.59 6 months = 0.23 ± 0.56 3–4 vs. 5–6 = 0.03 ± 0.23	3 months = 13.7 ± 13.52 6 months = −5.9 ± 12.1	
Monzavi et al. (2016)	1 and 3 months	1 month = 0.42 ± 0.19 3 months = 0.63 ± 0.19 1–2 vs. 3–4 = 0.21 ± 0.2	N.R.	N.R.	1 month = 0.93 ± 0.24 3 months = 1.55 ± 0.24 1–2 vs. 3–4 = 0.62 ± 0.23	N.R.	N.R.	N.R.	N.R.
Nogueira-Filho et al. (2010)	7, 15, 30, 60 and 90 days	1 month = 1.07 ± 0.88 3 months = 1.1 ± 0.83 6 months = 0.57 ± 0.76	N.R.	N.R.	1 month = 1.07 ± 0.81 3 months = 1.3 ± 0.84 1–2 vs. 3–4 = 0.03 ± 0.63	N.R.	N.R.	N.R.	N.R.

(Continues)

TABLE 1b (Continued)

Main author	Follow-up evaluations	PPD change all (mm) ± SD	PPD change 4–5 mm, (mm) ± SD	PPD change ≥6 mm, (mm) ± SD	CAL change all, (mm) ± SD	CAL change 4–5 mm, (mm) ± SD	CAL change ≥6 mm, (mm) ± SD	BoP change, (%) ± SD	GI change±SD
		1–2 vs. 3–4 = 0.03 ± 0.56 3–4 vs. 5–6 = 5.5 ± 0.36							
Oteo et al. (2010)	1, 3, 6 months	1 month = 0.22 ± 0.21 3 months = 0.42 ± 0.22 6 months = 0.27 ± 0.21 1–2 vs. 3–4 = 0.2 ± 0.08 3–4 vs. 5–6 = −0.15 ± 0.08	N.R.	N.R.	1 month = 0.03 ± 0.45 3 months = 0.65 ± 0.48 6 months = 0.24 ± 0.45 1–2 vs. 3–4 = 0.62 ± 0.18 3–4 vs. 5–6 = −0.41 ± 0.18	N.R.	N.R.	1 month = 22.08 ± 3.65 3 months = 21.88 ± 3.75 6 months = 18.31 ± 3.65 1–2 vs. 3–4 = −0.2 ± 1–45 3–4 vs. 5–6 = −3.57 ± 1.45	N.R.
Palmer et al. (1998)	2 months, 6 months	N.R.	N.R.	N.R.	2 months = 0.36 ± 0.35 6 months = 0.51 ± 0.43	N.R.	N.R.	N.R.	N.R.
Pera et al. (2012)	3, 6 months	3 months = 1.7 ± 0.12 6 months = 2.2 ± 0.12 3–4 vs. 5–6 = 0.5 ± 0.15	3 months = 1.8 ± 0.14 6 months = 2.2 ± 0.14 3–4 vs. 5–6 = 0.4 ± 0.18	3 months = 2.7 ± 0.23 6 months = 3.7 ± 0.23 3–4 vs. 5–6 = 1 ± 0.29	3 months = 1.4 ± 0.27 6 months = 1.6 ± 0.29 3–4 vs. 5–6 = 0.2 ± 0.35	3 months = 1.4 ± 0.25 6 months = 1.7 ± 0.28 3–4 vs. 5–6 = 0.3 ± 0.35	3 months = 2.1 ± 0.61 6 months = 2.7 ± 0.57 3–4 vs. 5–6 = 0.6 ± 0.66	3–4 vs. 5–6 = 6.3 ± 2	N.R.
Pradeep and Kathariya (2011)	1, 3, 6, 9 months	1 month = 0.69 ± 0.29 3 months = 1.16 ± 0.33 6 months = 1 ± 0.31 1–2 vs. 3–4 = 0.47 ± 0.1 3–4 vs. 5–6 = −0.16 ± 0.1	N.R.	N.R.	1 month = 0.51 ± 0.16 3 months = 0.93 ± 0.22 6 months = 0.86 ± 0.23 1–2 vs. 3–4 = 0.42 ± 0.06 3–4 vs. 5–6 = −0.07 ± 0.07	N.R.	N.R.	N.R.	1 month = 1.71 ± 0.27 3 months = 1.72 ± 0.32 6 months = 1.5 ± 0.29 1–2 vs. 3–4 = 0.01 ± 0.1 3–4 vs. 5–6 = −0.22 ± 0.07
Saglam et al. (2014)	1, 3 and 6 months	1 month = 0.7 ± 0.14 3 months = 0.8 ± 0.14 6 months = 0.8 ± 0.14 1–2 vs. 3–4 = 0.1 ± 0.07 3–4 vs. 5–6 = 0 ± 0.07	N.R.	N.R.	1 month = 0.7 ± 0.19 3 months = 0.8 ± 0.19 6 months = 0.9 ± 0.19 1–2 vs. 3–4 = 0.1 ± 0.15 3–4 vs. 5–6 = 0.1 ± 0.15	N.R.	N.R.	1 month = 55 ± 3 3 months = 67 ± 2.89 6 months = 52 ± 4.03 1–2 vs. 3–4 = 12 ± 2.02 3–4 vs. 5–6 = −15 ± 3.37	1 month = 0.6 ± 0.06 3 months = 0.8 ± 0.06 6 months = 0.8 ± 0.06 1–2 vs. 3–4 = 0.2 ± 0.37 3–4 vs. 5–6 = −0.2 ± 0.04
Sakellari et al. (2010)	3, 6 months	3 months = 1.89 ± 0.23 6 months = 2.05 ± 0.19 3–4 vs. 5–6 = 0.16 ± 0.24	N.R.	N.R.	3 months = 1.23 ± 0.33 6 months = 1.4 ± 0.32 3–4 vs. 5–6 = 0.17 ± 0.37	N.R.	N.R.	3 months = 0.41 ± 0.07 6 months = 0.33 ± 0.08 3–4 vs. 5–6 = −0.08 ± 0.08	N.R.
Sanz-Sánchez et al. (2015)	3, 6 months	3 months = −0.41 ± 0.32 6 months = −0.45 ± 0.37 3–4 vs. 5–6 = 0.04 ± 0.1	N.R.	N.R.	3 months = 0.32 ± 0.32 6 months = −0.29 ± 0.37 3–4 vs. 5–6 = −0.03 ± 0.17	N.R.	N.R.	3 months = −24 ± 12 6 months = −30 ± 11	N.R.
Taiete et al. (2016)	3 and 6 months	3 months = 2.2 ± 0.6 6 months = 2.1 ± 0.7 3–4 vs. 5–6 = −0.1 ± 0.22	3 months = 1.6 ± 0.8 6 months = 1.5 ± 1 3–4 vs. 5–6 = −0.1 ± 0.3	3 months = 2.9 ± 0.9 6 months = 3 ± 0.9 3–4 vs. 5–6 = 0.1 ± 0.3	3 months = 1.4 ± 0.8 6 months = 1.5 ± 0.9 3–4 vs. 5–6 = 0.1 ± 0.2	3 months = 1 ± 0.9 6 months = 0.9 ± 1 3–4 vs. 5–6 = −0.1 ± 0.32	3 months = 2 ± 1 6 months = 2.2 ± 1 3–4 vs. 5–6 = 0.2 ± 0.33	N.R.	N.R.

TABLE 1b (Continued)

Main author	Follow-up evaluations	PPD change all (mm) ± SD	PPD change 4–5 mm, (mm) ± SD	PPD change ≥6 mm, (mm) ± SD	CAL change all, (mm) ± SD	CAL change 4–5 mm, (mm) ± SD	CAL change ≥6 mm, (mm) ± SD	BoP change, (%) ± SD	GI change±SD
Theodoro et al. (2018)	3, 6 months	3 months = −0.65 ± 0.26 6 months = 0.34 ± 0.27 3–4 vs. 5–6 = 0.99 ± 0.23	3 months = 0.66 ± 0.46 6 months = 0.68 ± 0.49 3–4 vs. 5–6 = 0.02 ± 0.16	3 months = 2.04 ± 1.12 6 months = 2.40 ± 1.14 3–4 vs. 5–6 = 0.36 ± 0.39	3 months = 0.17 ± 0.3 6 months = 0.21 ± 0.3 3–4 vs. 5–6 = 0.04 ± 0.27	3 months = 0.52 ± 0.7 6 months = 0.68 ± 0.61 3–4 vs. 5–6 = 0.16 ± 0.23	3 months = 2.19 ± 1.95 6 months = 2.38 ± 1.91 3–4 vs. 5–6 = 0.19 ± 0.66	3 months = 7.36 ± 7.24 6 months = 7.56 ± 7.67 3–4 vs. 5–6 = 0.23 ± 7.12	N.R.
Ustun et al. (2018)	1, 3 and 6 months	1 month = 1.09 ± 0.2 3 months = 1.76 ± 0.2 6 months = 1.94 ± 0.23 1–2 vs. 3–4 = 0.67 ± 0.17 3–4 vs. 5–6 = 0.18 ± 0.20	N.R.	N.R.	1 month = 0.70 ± 0.18 3 months = 0.88 ± 0.21 6 months = 1.12 ± 0.18 1–2 vs. 3–4 = 0.18 ± 0.21 3–4 vs. 5–6 = 0.23 ± 0.21	N.R.	N.R.	1 month = 27.2 ± 2.6 3 months = 36.25 ± 2.76 6 months = 44.6 ± 2.4 1–2 vs. 3–4 = 9.05 ± 2.93 3–4 vs. 5–6 = 8.35 ± 2.75	1 month = 0.58 ± 0.068 3 months = 0.73 ± 0.068 6 months = 0.76 ± 0.067 1–2 vs. 3–4 = 0.15 ± 0.04 3–4 vs. 5–6 = 0.03 ± 0.04

Abbreviations: N.R, not reported; vs., versus.

et al., 2006) reported no details on the type of maintenance they provided. Supportive periodontal treatment consisted of supragingival debridement and oral hygiene instructions (17 studies) (Andere et al., 2017; Cosyn et al., 2006; Cosyn et al., 2007, 2013; do Vale et al., 2016; Emingil et al., 2012; Gürkan et al., 2005; Ioannou et al., 2009; Monzavi et al., 2016; Nogueira-Filho et al., 2010; Palmer et al., 1998; Pera et al., 2012; Sanz-Sánchez et al., 2015; Ustun et al., 2018; Zanatta et al., 2006; Zengin Celik et al., 2019) or only oral hygiene instructions (7 studies) (Machion et al., 2004; Mohammad et al., 2005; Oteo et al., 2010; Pradeep & Kathariya, 2011; Saglam et al., 2014; Sakellari et al., 2010; Theodoro et al., 2018).

3.2.6 | Risk of bias quality assessment

Summarized results of the assessment of risk of bias are illustrated in Table S1a,b.

Overall, 19 studies (AlAhmari et al., 2019; Andere et al., 2017; Cosyn et al., 2007, 2013; do Vale et al., 2016; Emingil et al., 2012; Grover et al., 2016; Gürkan et al., 2005; Ioannou et al., 2009; Mohammad et al., 2005; Monzavi et al., 2016; Oteo et al., 2010; Palmer et al., 1998; Pera et al., 2012; Pradeep & Kathariya, 2011; Sanz-Sánchez et al., 2015; Taiete et al., 2016; Theodoro et al., 2018; Ustun et al., 2018) were judged to be at low risk, 1 at high risk (Saglam et al., 2014) and 9 presented with some concerns of bias (Chopra et al., 2016; Cosyn et al., 2006; Fonseca et al., 2015; Jervøe-Storm et al., 2006; Machion et al., 2004; Nogueira-Filho et al., 2010; Sakellari et al., 2010; Zengin Celik et al., 2019). Most of the concerns of bias were related to issues with the randomization process, allocation concealment or measurement of the outcome.

3.3 | Publication bias

Publication bias was identified when comparing changes in PPD from baseline to 3–4 months with those from 3–4 months to 5–6 months, both for 'all types PPD' ($p < .0005$, t = 4.39, 95% CI: 0.39; 1.11) and for 'shallow PPD' ($p < .0005$, t = 12.44, 95% CI = 1.15; 1.63) and 'deep PPD' ($p < .0005$, t = 13.30, 95% CI = 2.02; 2.81). No publication bias was found in all other cases where PPD parameters were analysed.

In the analysis of CAL, there was always publication bias, except when changes from baseline to 3–4 months were compared with those from 3–4 months to 5–6 months for all initial PPD ($p = .076$, $t = 1.89$, 95% CI = −0.068; 1.21). The limited numbers of studies included in specific categories of CAL (shallow and deep initial PPD for the comparison between baseline to 1–2 months and 1–2 months to 3–4 months) prevented the evaluation of the publication bias.

In the analysis of BoP and GI changes, no publication bias was found, except for BoP in the change from baseline to 1–2 months and 1–2 months to 3–4 months ($p = .042$, $t = 2.37$, 95% CI = 0.92; 38.98).

3.3.1 | Pocket closure

None of the 29 included studies reported pocket closure as a primary or secondary outcome.

3.4 | Quantitative synthesis

3.4.1 | Mean PPD reduction at different time points for all initial PPD values

Analysis of all treated pockets revealed a weighted mean PPD reduction of 1.16 mm within the first 1–2 months after treatment (16 studies, 18 treatment groups), and an additional reduction of 0.25 mm between 1–2 and 3–4 months (16 studies, 18 treatment groups). Weighted mean variation between the changes at the two time points (baseline to 1–2 months and 1–2 to 3–4 months) was 0.90 mm (SE = 0.13, CI 0.64; 1.15) (Figure S1, Table 2a,b).

The mean reduction in PPD within the first 3–4 months was 1.00 mm, and at the 5- to 6-month time point an additional reduction of 0.35 mm was registered. The delta among the reported changes had a weighted mean of 0.69 mm (SE = 0.13, CI 0.45; 0.94).

Heterogeneity was low for the first comparison ($I^2 = 2.56\%$ for comparison between 1–2 months and 3–4 months), but between 3–4 and 5–6 months, heterogeneity reached an I^2 value of 84.19%.

3.4.2 | Mean PPD reduction for initially shallow (PPD 4–5 mm) pockets

In the first 1–2 months after instrumentation, a weighted mean PPD reduction of 1.89 mm was achieved (2 studies, 3 treatment groups). An additional 0.36 mm of PPD reduction was observed between the first 1–2 months and the 3- to 4-month time point (two studies, three treatment groups). Weighted mean PPD reduction of the variation between the changes from baseline to 1–2 months and from 1–2 months to 3–4 months was 1.51 mm (SE 0.27, CI 0.99; 2.03) (Figure S2, Table 2a,b).

When considering the change occurring between baseline and the first 3–4 months, a mean PPD reduction of 1.46 mm was observed, with an additional reduction of 0.08 mm by the 5- to 6-month time point. Weighted mean PPD reduction of the variation between the changes from baseline to 3–4 months and from 3–4 months to 5–6 months was 1.35 mm (SE 0.10, CI 1.16; 1.54) (Figure S2).

Heterogeneity was low ($I^2 = 0$) for the comparison between baseline/1–2 months and 1-2 months/3–4 months, while it was higher ($I^2 = 35.43$) for the comparison between baseline/3–4 months and 3–4/5–6 months.

3.4.3 | Mean PPD reduction for initially deep (PPD > 6 mm) pockets

For initially deep (PPD ≥ 6 mm) sites, a weighted mean PPD reduction of 3.4 mm (CI 0.60; 4.09) was observed (two studies, three groups) within 1–2 months, with an additional reduction of 0.97 mm at the 3- to 4-month time point (two studies, three treatment groups) (Figure S3, Table 2a,b).

A weighted mean difference between the changes within the first 2 months and the changes between 1–2 and 3–4 months of 2.39 mm (SE = 0.71, CI 1.01; 3.78) was found, with an $I^2 = 29.28\%$.

Between baseline and 3–4 months, a PPD reduction of 2.44 mm was found, while an additional reduction of 0.23 mm in PPD occurred at 5–6 months. A weighted mean change between these variations was found to be 2.13 mm (SE = 0.16, CI 1.82; 2.45), (Figure S3). The heterogeneity for this comparison was high ($I^2 = 61.89$).

3.4.4 | Change in mean CAL gain at different time points for all pockets

Weighted mean CAL gain after 1–2 months post-therapy was 0.94 mm (15 studies, 17 treatment groups). There was an additional gain of 0.26 mm between the first 2 months and 3–4 months. The weighted mean change between the variations at baseline/1–2 months and 1–2/3–4 months was 0.66 mm (SE = 0.16, CI 0.35; 0.96) (Figure S4). The heterogeneity was low ($I^2 = 0$) (Table 3a,b).

Between the baseline and the first 3–4 months after treatment, a mean gain of 0.76 mm was observed. At 5–6 months, an additional mean gain was observed to be 0.02 mm, extracted from five studies (16 studies, 18 treatment groups). A weighted mean difference among the variations (baseline/3–4 months and 3–4/5–6 months) was 0.73 mm (SE = 0.17, CI 0.41; 1.06), (Figure S4). Heterogeneity was low ($I^2 = 0$).

3.4.5 | Change in mean CAL gain at different time points for initially shallow (PPD 4–5 mm) pockets

Within the first 1–2 months after treatment, the mean gain in attachment was 1.45 mm (2 treatment groups in the same study). After an additional 1–2 months (at the 3- to 4-month time point), there was a further gain of 0.23 mm. A weighted change between the aforementioned variations (baseline/1–2 months and 1–2/3–4 months) amounted to 1.21 mm (SE = 0.18, CI 0.85; 1.58) (Figure S5), with a low heterogeneity ($I^2 = 0$) (Table 3a,b).

After 3–4 months from baseline, an average CAL gain of 0.96 mm was found (13 treatment groups in 10 studies). Between 3–4 and 5–6 months, there was an additional gain of 0.02 mm. A weighted mean change between these comparisons (baseline/3–4 months and 3–4/5–6 months) amounted to 0.95 mm (SE = 0.12, CI 0.69; 1.20) (Figure S5). The heterogeneity was low ($I^2 = 22.40$).

3.4.6 | Change in mean CAL gain at different time points for initially deep (PPD > 6 mm) pockets

Within the first 1–2 months post-treatment, weighted mean CAL gain was 2.44 mm, based on two groups of the same study. After an additional 1–2 months (3- to 4-month time point), there was an additional

TABLE 2 (a, b) Differences at different time points and weighted mean change in probing depth (PPD), expressed in mm.

PPD								
2a	Δ baseline–1/2 months	WME (SE)	Δ 1/2–3/4 months	*p*	CI 95%	I^2	N. studies	N. treatment groups
All initial pockets	1.16	0.90 (0.13)	0.25	>.00005	0.64–1.15	2.56	16	18
Shallow initial pockets	1.89	1.51 (0.27)	0.36	>.00005	0.99–2.03	0	2	3
Deep initial pockets	3.4	2.39 (0.71)	0.97	.0007	1.01–3.78	29.28	2	3
2b	Δ baseline–3/4 months	WME (SE)	Δ 3/4–5/6 months	*p*	CI 95%	I^2	N. studies	N. treatment groups
All initial pockets	1.00	0.69 (0.13)	0.35	>.00005	0.45–0.94	84.19	16	19
Shallow initial pockets	1.46	1.35 (0.1)	0.08	>.00005	1.16–1.54	35.44	11	14
Deep initial pockets	2.44	2.13 (0.16)	0.23	>.00005	1.82–2.45	61.89	11	14

TABLE 3 (a, b) Differences at different time points and weighted mean change in clinical attachment level (CAL), expressed in mm.

CAL								
3a	Δ baseline–1/2 months	WME (SE)	Δ 1/2–3/4 months	*p*	CI 95%	I^2	N. studies	N. treatment groups
All initial pockets	0.94	0.66 (0.16)	0.26	>.00005	0.35–0.96	0	15	17
Shallow initial pockets	1.45	1.21 (0.18)	0.23	>.00005	0.85–1.58	0	1	2
Deep initial pockets	2.44	1.80 (0.94)	0.67	.0567	−0.051 to 3.63	0	1	2
3b	Δ baseline–3/4 months	WME (SE)	Δ 3/4–5/6 months	*p*	CI 95%	I^2	N. Studies	N. Treatment groups
All initial pockets	0.76	0.73 (0.17)	0.02	>.00005	0.41–1.06	0	16	18
Shallow initial pockets	0.96	0.95 (0.12)	0.02	>.00005	0.69–1.20	22.40	10	13
Deep initial pockets	1.76	1.65 (0.14)	0.08	>.00005	1.39–1.92	58.59	10	13

TABLE 4 (a, b) Differences at different time points and weighted mean change in bleeding on probing (BoP), expressed as %.

BoP								
4a	Δ baseline–1/2 months	WME (SE)	Δ 1/2–3/4 months	*p*	CI 95%	I^2	N. studies	N. treatment groups
All initial pockets	34.38	30.70 (4.8)	3.61	>.00005	21.29–40.12	0	10	11
4b	Δ baseline–3/4 months	WME (SE)	Δ 3/4–5/6 months	*p*	CI 95%	I^2	N. studies	N. treatment groups
All initial pockets	32.39	33.14 (7.56)	0.87	>.00005	18.32–47.95	0	13	16

gain of 0.67 mm on average (two treatment group in the same study). The weighted mean change between the variations among these time points (baseline/1–2 months and 1–2/3–4 months) amounted to 1.80 mm (SE = 0.94, CI −0.05; 3.63) (Figure S6). The heterogeneity was low ($I^2 = 0$) (Table 3a,b).

There was mean gain of CAL between baseline and 3–4 months post-therapy of 1.76 mm. Between 3–4 months and 5–6 months, there was an additional gain of 0.08 mm on average, (Figure S6).

The weighted mean change between the variations among these time points (baseline/3–4 months and 3–4/5–6 months) amounted to 1.65 mm (SE = 0.14, CI 1.39; 1.92). Heterogeneity was high ($I^2 = 58.59\%$) for this comparison.

3.4.7 | Mean BoP reduction (%) at different time points for all initial PPD values

Within the first 1–2 months after treatment, a mean reduction of BoP of 34.38% was observed. Between 1–2 months and 3–4 months, an additional average reduction of 3.61% could be calculated (10 studies with 11 treatment groups). The weighted mean variation among the changes in these time points (baseline/1–2 and 1–2/3–4 months) was 30.70% (SE = 4.8, CI 21.29; 40.12) (Figure S7). The heterogeneity was low ($I^2 = 0$) (Table 4a,b).

Between baseline and 3–4 months, there was a mean reduction of 32.39%, while between 3–4 and 5–6 months, there was an

TABLE 5 (a, b) Differences at different time points and weighted mean change in gingival index (GI), expressed as absolute value.

GI								
5a	Δ baseline–1/2 months	WME (SE)	Δ 1/2–3/4 months	*p*	CI 95%	I^2	N. studies	N. treatment groups
All initial pockets	0.91	0.73 (0.095)	0.16	>.00005	0.55–0.92	85.20	5	5
5b	Δ baseline–3/4 months	WME (SE)	Δ 3/4–5/6 months	*p*	CI 95%	I^2	N. studies	N. treatment groups
All initial pockets	1.09	1.20 (0.18)	0.13	>.00005	0.84–1.56	75.48	5	3

increase of 0.87% on average. The weighted mean variation among the changes in these time points (baseline/3–4 and 3–4/5–6 months) was 33.14% (SE = 7.56, CI 18.32; 47.96) (Figure S7). The heterogeneity was low ($I^2 = 0$).

3.4.8 | Mean reduction in GI at different time points for all initial PPD values

In the first 2 months post-therapy, there was an average reduction in GI values of 0.91, while after an additional 1–2 months (at the 3- to 4-month time point), there was an additional reduction of 0.16 on average. The weighted mean average variation among the changes in these time points (baseline/1–2 and 1–2/3–4 months) was 0.73 (SE = 0.095, CI 0.55; 0.92) (5 studies) (Figure S8, Table 5a,b).

Heterogeneity for this comparison was high, with an $I^2 = 85.20\%$.

Within the first 3–4 months post-treatment, an average reduction in GI of 1.09 was found, while there was an increase of 0.13 on average between 3–4 and 5–6 months (three studies).

The weighted mean average variation among the changes in these time points (baseline/3–4 months and 3–4/5–6 months) was 1.20 (SE = 0.18, CI 0.84; 1.56), (Figure S8). Heterogeneity for this comparison was high ($I^2 = 75.48$).

4 | DISCUSSION

The results of the current systematic review highlight that the majority of the total PPD reduction in shallow pockets occurred within the first 1–2 months, with additional reduction—albeit of smaller entity—occurring up to 3–4 months post-treatment (more specifically, PPD further decreases by a weighted average of less than 0.5 mm after 3–4 months). The same trend could be observed for deeper pockets, where once again the majority of the PPD contraction was observed within the first 1–2 months, with approximately 1 mm reduction occurring up to 3–4 months after treatment. Both shallow and deeper pockets appear to follow a similar trend of PPD reduction, with a majority of contraction occurring within 1–2 months after treatment but clinically meaningful changes occurring after 3–4 and 5–6 months even without re-treatment.

Re-evaluation after Steps 1 and 2 is a critical moment in periodontal therapy, because it represents the opportunity for the clinician to determine whether the endpoints of periodontal treatment have been achieved, namely no periodontal pockets >4 mm with concomitant BoP or residual deep pockets ≥6 mm. Furthermore, re-evaluation is the moment in which the clinician decides whether the patient requires additional therapy (Step III) in order to control his/her periodontal condition.

As stated in the treatment guideline of Stage I–III periodontitis, after the first two steps, an adequate healing period should be allowed before the re-evaluation is performed. However, this 'adequate' period of time has not been quantified (Sanz et al., 2020).

The interpretation of these results suggests that the majority of PPD reduction after the treatment of Steps I and II may be observed after 1–2 months after treatment. However, waiting 3 months or longer may have a significant impact on a large proportion of sites, depending on the initial value of PPD. Indeed, the majority of shallow and many deep pockets would benefit from re-evaluation after at least 3 months from Steps 1 and 2. This in turn may decrease the number of sites that are considered in need of additional treatment, both non-surgical and surgical. The likelihood of a site no longer needing additional treatment depends on a series of factors, one of which is the baseline PPD. Sites with initially deeper PPD respond less favourably to non-surgical therapy (D'Aiuto et al., 2005; Tomasi et al., 2007). Hence, the timing of re-evaluation may also be tailored on the baseline PPD prior to instrumentation. Shallow pockets and the majority of deep pockets with PPD 6–8 mm may be re-evaluated after 3 months or more, but the likelihood of achieving pocket closure will decrease as baseline PPD increases. In such cases, waiting a longer time prior to re-evaluation may eliminate the need for additional treatment based on the current data.

Though data for changes in average PPD values have been presented, PPD changes stratified by initial PPD at baseline (shallow vs. deep sites) are much more clinically meaningful.

Various time points to re-evaluate the periodontium after supra- and subgingival instrumentation have been suggested in the literature (Segelnick & Weinberg, 2006). Proye et al. (1982) conducted a clinical study in which they reported changes in attachment levels and probing depths within 3 weeks after scaling and root planing (ScRP). Probing depths were stable after this time point, though the observation period ended after only 4 weeks. The authors reported that changes in the first week were due mainly to recession, while the following variations were due to gain in attachment levels; however, it was impossible to compare their

results with those of the present study because average probing depths were not provided and the authors generically included 'interproximal pockets greater than 3 mm'.

In a follow-up clinical study on the same population, Proye et al. (1982) observed that the results in terms of improvement of clinical parameters, obtained at 4 weeks were stable at 8 and 16 weeks after periodontal subgingival instrumentation (root planing). The authors included both shallow (4 mm) and deep (>4 mm) pockets but found no difference among the groups in terms of healing patterns.

Kaldahl et al. (1988) advocated a longer healing time, noting clinical changes up to 1 year after subgingival instrumentation (root planing) of sites with initial PPD of 5–6 mm or ≥7 mm. However, contrary to the studies included in the present systematic review, these sites were subgingivally re-instrumented every 3 months and observed clinical changes were on average of 0.5 mm.

From a histologic point of view, the timing of re-evaluation should be dictated by precise healing processes of the epithelial and connective tissue components of the dento-gingival junction (Waerhaug, 1978). According to Stahl et al. (1972), the junctional epithelium heals within 1–2 weeks. In the connective tissue compartment, formation of a new collagen matrix and its maturation is more variable, requires a longer time and was reported to last on average several months, as reported by Biagini et al. (1988). The authors performed histological analysis on tissue samples after performing manual and ultrasonic instrumentation. It would therefore appear logical to re-evaluate the periodontal condition after these events have taken place.

In the present study, in shallow pockets, there was a gain in CAL of 1.45 mm, with a clinically negligible increase (0.02 mm) at both the 3- to 4-month and 5- to 6-month time points. In deep pockets, CAL gain of 2.44 mm was found with an additional gain after 3–4 months (0.67 mm). From a histological standpoint, at 1–2 months, the newly formed collagen fibres are precisely oriented while oedema and inflammatory cells were absent, suggesting resolution of the inflammatory processes and maturation in the connective tissue compartment were underway (Biagini et al., 1988; Caton & Zander, 1979). However, complete maturation of connective tissue fibres appears to require much longer time frames.

In terms of BoP (%), the present article underlined once again that the most significant reduction was achieved within 1–2 months after treatment, with only minor changes thereafter (Cercek et al., 1983). This is understandable because gingival inflammation, hence bleeding, is expected to decrease as the inflammatory condition of the gingiva is resolved, PPD decreases and periodontal tissues heal.

Overall, the vast majority of the included studies were judged to be at a low risk of bias (19 studies out of 29), while nine studies presented some concerns. This underlines that the majority of the included studies are qualitatively sound. Only one RCT (Saglam et al., 2014) was considered as having a high risk of bias, mainly due to issues with randomization and allocation of participants into study groups and measurement of the outcome. A large proportion (nine studies) of studies had some concerns related to the randomization process and allocation concealment, but were considered to be at moderate risk of bias.

In the absence of prospective studies explicitly designed to address our research question and meeting our stringent inclusion criteria, we chose to limit our inclusion to RCTs. This decision was based on the belief that RCTs are generally more methodologically robust and feature a more rigorous study design compared with many prospective studies. Consequently, only patients belonging to groups that received treatment without adjunctive therapies were considered for inclusion. This criterion was applied regardless of whether these patients were part of the test or control group. In fact, it is worth noting that while some studies compared the use of additional methods to traditional mechanical therapy (such as manual or ultrasound), other studies involved group comparisons where no supplementary therapies were employed, but different approaches were examined (e.g. full-mouth vs. quadrant-wise treatment). So, in these latter cases, both the test and control groups were included.

The present systematic review has several limitations. Among the included studies, there was an inevitable degree of heterogeneity (severity of initial periodontal condition, risk factors and oral hygiene levels of included patients, treatment approaches, type and frequency of maintenance appointments to mention a few); however, the main shortcoming is the absence of data in the literature on the outcome 'pocket closure', which is the true endpoint of subgingival instrumentation (Sanz et al., 2020). Most comparisons are influenced by publication bias, as specified in Section 3. Furthermore, an obvious discrepancy between studies including 'chronic' ($N = 25$) and 'aggressive' ($N = 4$) forms of disease was present. Although the current classification system (Tonetti et al., 2018) does not differentiate between these forms of disease, they may be reflected in the case phenotype, which may in turn influence rate of disease progression, response to treatment and hence healing after Steps 1–2 therapy.

Additionally, our data only present information regarding pocket depth; however, the decision whether to perform periodontal surgery is not based on this parameter alone. Other complexity factors such as tooth type, presence of intra-bony defects, anatomical factors (i.e. root concavities), and degree of furcation involvement among others combined with patient factors come into play when deciding whether additional treatment should be performed in a given site.

The aforementioned shortcomings suggest that there is a need for prospective studies comparing sequential timings of periodontal re-evaluation and reporting closed pockets (%) at significant time points (1, 3 and 6 months).

5 | CONCLUSION

Within the limitations of the present review, a comprehensive search and analysis of the available literature based on RCTs investigating the change in clinical parameters after subgingival

instrumentation for the treatment of periodontitis in systemically healthy patients demonstrated that the majority of PPD reduction for all, shallow (4–5 mm) or deep (≥6 mm) pockets occurs within 1–2 months. However, there is an additional clinically significant decrease in PPD in both shallow and deep up to 3–4 months after therapy, which can decrease the number of sites that are considered in need of additional treatment.

Therefore according to the results of this systematic review and meta-analysis, waiting 3–4 months or longer prior to re-evaluation might be ideal after subgingival instrumentation for the treatment of periodontitis. However, these conclusions must be confirmed or refuted through appropriately designed and conducted clinical studies.

AUTHOR CONTRIBUTIONS

All authors contributed substantially to the interpretation of the data for the work and to drafting and critically revising the manuscript. They gave their final approval of the version to be published and agreed to be accountable for all aspects of the work. Additionally, Marco Clementini supervised, coordinated the research team and contributed to data interpretation. Lucrezia Paternò Holzman conceived the study and the research question and with Nicola Alberto Valente extracted the data and contributed to the final drafting of the manuscript, Luca Copes and Gianluca Vittorini Orgeas contributed to risk of bias analysis, and Nicola Discepoli analysed the data and contributed to data interpretation.

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None.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interests related to this study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

There were no external sources of funding to support the conduct of this review. The local ethical committee does not require ethical approval for systematic reviews.

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REFERENCES

AlAhmari, F., Ahmed, H. B., Al-Kheraif, A. A., Javed, F., & Akram, Z. (2019). Effectiveness of scaling and root planning with and without adjunct antimicrobial photodynamic therapy in the treatment of chronic periodontitis among cigarette-smokers and never-smokers: A randomized controlled clinical trial. *Photodiagnosis and Photodynamic Therapy*, *25*, 247–252.

Andere, N. M. R. B., Castro Dos Santos, N. C., Araujo, C. F., Mathias, I. F., Taiete, T., Casarin, R. C. V., Jardini, M. A. N., Shaddox, L. M., & Santamaria, M. P. (2017). Clarithromycin as an adjunct to one-stage full-mouth ultrasonic periodontal debridement in generalized aggressive periodontitis: A randomized controlled clinical trial. *Journal of Periodontology*, *88*(12), 1244–1252.

Armitage, G. C. (1999). Development of a classification system for periodontal diseases and conditions. *Annals of Periodontology*, *4*(1), 1–6. https://doi.org/10.1902/annals.1999.4.1.1

Biagini, G., Checchi, L., Miccoli, M. C., Vasi, V., & Castaldini, C. (1988). Root curettage and gingival repair in periodontics. *Journal of Periodontology*, *59*, 124–129.

Caton, J. G., & Zander, H. A. (1979). The attachment between tooth and gingival tissues after periodic root planing and soft tissue curettage. *Journal of Periodontology*, *50*, 462–466.

Cercek, J. F., Kiger, R. D., Garrett, S., & Egelberg, J. (1983). Relative effects of plaque control and instrumentation on the clinical parameters of human periodontal disease. *Journal of Clinical Periodontology*, *10*(1), 46–56.

Chopra, A., Thomas, B. S., Sivaraman, K., Prasad, H. K., & Kamath, S. U. (2016). Green tea intake as an adjunct to mechanical periodontal therapy for the management of mild to moderate chronic periodontitis: A randomized controlled clinical trial. *Oral Health & Preventive Dentistry*, *14*(4), 293–303.

Cosyn, J., Miremadi, S. R., Sabzevar, M. M., & De Bruyn, H. (2013). Clinical effects of an essential oil solution used as a coolant during ultrasonic root debridement. *International Journal of Dental Hygiene*, *11*(1), 62–68.

Cosyn, J., Wyn, I., De Rouck, T., & Sabzevar, M. M. (2006). Long-term clinical effects of a chlorhexidine varnish implemented treatment strategy for chronic periodontitis. *Journal of Periodontology*, *77*(3), 406–415.

Cosyn, J., Wyn, I., De Rouck, T., & Sabzevar, M. M. (2007). Subgingival chlorhexidine varnish administration as an adjunct to same-day full-mouth root planing. I. Clinical observations. *Journal of Periodontology*, *78*(3), 430–437.

D'Aiuto, F., Ready, D., Parkar, M., & Tonetti, M. S. (2005). Relative contribution of patient-, tooth-, and site- associated variability on the clinical outcomes of subgingival debridement. I. Probing depths. *Journal of Periodontology*, *76*(3), 398–405.

do Vale, H. F., Casarin, R. C., Taiete, T., Bovi Ambrosano, G. M., Ruiz, K. G., Nociti, F. H., Jr., Sallum, E. A., & Casati, M. Z. (2016). Full-mouth ultrasonic debridement associated with povidone iodine rinsing in GAgP treatment: A randomised clinical trial. *Clinical Oral Investigations*, *20*(1), 141–150.

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ*, *315*(7109), 629–634. https://doi.org/10.1136/bmj.315.7109.629

Emingil, G., Han, B., Ozdemir, G., Tervahartiala, T., Vural, C., Atilla, G., Baylas, H., & Sorsa, T. (2012). Effect of azithromycin, as an adjunct to nonsurgical periodontal treatment, on microbiological parameters and gingival crevicular fluid biomarkers in generalized aggressive periodontitis. *Journal of Periodontal Research*, *47*(6), 729–739.

Fonseca, D. C., Cortelli, J. R., Cortelli, S. C., Miranda Cota, L. O., Machado Costa, L. C., Moreira Castro, M. V., Oliveira Azevedo, A. M., & Costa, F. O. (2015). Clinical and microbiologic evaluation of scaling and root

planing per quadrant and one-stage full-mouth disinfection associated with azithromycin or chlorhexidine: A clinical randomized controlled trial. *Journal of Periodontology*, *86*(12), 1340–1351. https://doi.org/10.1902/jop.2015.150227

Grover, S., Tewari, S., Sharma, R. K., Singh, G., Yadav, A., & Naula, S. C. (2016). Effect of subgingivally delivered 10% emblica officinalis gel as an adjunct to scaling and root planing in the treatment of chronic periodontitis - a randomized placebo-controlled clinical trial. *Phytotherapy Research*, *30*(6), 956–962. https://doi.org/10.1002/ptr.5600

Gürkan, A., Çınarcık, S., & Hüseyinov, A. (2005). Adjunctive subantimicrobial dose doxycycline: Effect on clinical parameters and gingival crevicular fluid transforming growth factor-β1 levels in severe, generalized chronic periodontitis. *Journal of Clinical Periodontology*, *32*(3), 244–253. https://doi.org/10.1111/j.1600-051x.2005.00663.x

Higgins, J. P. T. (2003). Measuring inconsistency in meta-analyses. *BMJ*, *327*(7414), 557–560. https://doi.org/10.1136/bmj.327.7414.557

Ioannou, I., Dimitriadis, N., Papadimitriou, K., Sakellari, D., Vouros, I., & Konstantinidis, A. (2009). Hand instrumentation versus ultrasonic debridement in the treatment of chronic periodontitis: A randomized clinical and microbiological trial. *Journal of Clinical Periodontology*, *36*(2), 132–141.

Jervøe-Storm, P.-M., Semaan, E., AlAhdab, H., Engel, S., Fimmers, R., & Jepsen, S. (2006). Clinical outcomes of quadrant root planing versus full-mouth root planing. *Journal of Clinical Periodontology*, *33*(3), 209–215. https://doi.org/10.1111/j.1600-051x.2005.00890.x

Kaldahl, W. B., Kalkwarf, K. L., Patil, K. D., Dyer, J. K., & Bates, R. E., Jr. (1988). Evaluation of four modalities of periodontal therapy. Mean probing depth, probing attachment level and recession changes. *Journal of Periodontology*, *59*(12), 783–793.

Machion, L., Andia, D. C., Benatti, B. B., Carvalho, M. D., Nogueira-Filho, G. R., Casati, M. Z., Nociti, F. H., Jr., & Sallum, E. A. (2004). Locally delivered doxycycline as an adjunctive therapy to scaling and root planing in the treatment of smokers: A clinical study. *Journal of Periodontology*, *75*(3), 464–469. https://doi.org/10.1902/jop.2004.75.3.464

Mohammad, A. R., Preshaw, P. M., Bradshaw, M. H., Hefti, A. F., Powala, C. V., & Romanowicz, M. (2005). Adjunctive subantimicrobial dose doxycycline in the management of institutionalised geriatric patients with chronic periodontitis. *Gerodontology*, *22*(1), 37–43.

Monzavi, A., Chinipardaz, Z., Mousavi, M., Fekrazad, R., Moslemi, N., Azaripour, A., Bagherpasand, O., & Chiniforush, N. (2016). Antimicrobial photodynamic therapy using diode laser activated indocyanine green as an adjunct in the treatment of chronic periodontitis: A randomized clinical trial. *Photodiagnosis and Photodynamic Therapy*, *14*, 93–97.

Nogueira-Filho, G. R., Rosa, B. T., & David-Neto, J. R. (2010). Effects of hyperbaric oxygen therapy on the treatment of severe cases of periodontitis. *Undersea & Hyperbaric Medicine*, *37*(2), 107–114.

Oteo, A., Herrera, D., Figuero, E., O'Connor, A., González, I., & Sanz, M. (2010). Azithromycin as an adjunct to scaling and root planing in the treatment of *Porphyromonas gingivalis*-associated periodontitis: A pilot study. *Journal of Clinical Periodontology*, *37*(11), 1005–1015.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*, n71.

Palmer, R. M., Matthews, J. P., & Wilson, R. F. (1998). Adjunctive systemic and locally delivered metronidazole in the treatment of periodontitis: A controlled clinical study. *British Dental Journal*, *184*(11), 548–552.

Pera, C., Ueda, P., Casarin, R. C., Ribeiro, F. V., Pimentel, S. P., Casati, M. Z., & Cirano, F. R. (2012). Double-masked randomized clinical trial evaluating the effect of a triclosan/copolymer dentifrice on periodontal healing after one-stage full-mouth debridement. *Journal of Periodontology*, *83*(7), 909–916.

Pradeep, A. R., & Kathariya, R. (2011). Clarithromycin as an adjunct to non surgical periodontal therapy for chronic periodontitis: A double blinded, placebo controlled, randomized clinical trial. *Archives of Oral Biology*, *56*(10), 1112–1119. https://doi.org/10.1016/j.archoralbio.2011.03.021

Proye, M., Caton, J., & Polson, A. (1982). Initial healing of periodontal pockets after a single episode of root planing monitored by controlled probing forces. *Journal of Periodontology*, *53*(5), 296–301. https://doi.org/10.1902/jop.1982.53.5.296

Saglam, M., Kantarci, A., Dundar, N., & Hakki, S. S. (2014). Clinical and biochemical effects of diode laser as an adjunct to nonsurgical treatment of chronic periodontitis: A randomized, controlled clinical trial. *Lasers in Medical Science*, *29*(1), 37–46.

Sakellari, D., Ioannidis, I., Antoniadou, M., Slini, T., & Konstantinidis, A. (2010). Clinical and microbiological effects of adjunctive, locally delivered chlorhexidine on patients with chronic periodontitis. *Journal of the International Academy of Periodontology*, *12*(1), 20–26. Erratum in: J Int Acad Periodontol. 2010 Apr;12(2):62. Dimitra, Sakellari [corrected to Sakellari, Dimitra]; Ioannis, Ioannidis [corrected to Ioannidis, Ioannis]; Malama, Antoniadou [corrected to Antoniadou, Malama]; Theodora, Slini [corrected to Slini, Theodora]; Antonis, Konstantinidis [corrected to Konstant].

Sanz, M., Herrera, D., Kebshull, M., Chapple, I., Jepsen, S., Berglundh, T., Sculean, A., Tonetti, M. S., & EFP Workshop Participants and Methodological Consultants. (2020). Treatment of stage I-III periodontitis-the EFP S3 level clinical practice guideline. *Journal of Clinical Periodontology*, *47*(Suppl 22), 4–60.

Sanz-Sánchez, I., Ortiz-Vigón, A., Matos, R., Herrera, D., & Sanz, M. (2015). Clinical efficacy of subgingival debridement with adjunctive erbium: Yttrium-aluminum-garnet laser treatment in patients with chronic periodontitis: A randomized clinical trial. *Journal of Periodontology*, *86*(4), 527–535.

Segelnick, S., & Weinberg, M. (2006). Reevaluation of initial therapy: When is the appropriate time? *Journal of Periodontology*, *77*, 1598–1601.

Stahl, S. S., Slavkin, H. C., Yamada, L., & Levine, S. (1972). Speculations about gingival repair. *Journal of Periodontology*, *43*, 395–402.

Sterne, J. A. C., Savović, J., Page, M. J., Elbers, R. G., Blencowe, N. S., Boutron, I., Cates, C. J., Cheng, H.-Y., Corbett, M. S., Eldridge, S. M., Hernán, M. A., Hopewell, S., Hróbjartsson, A., Junqueira, D. R., Jüni, P., Kirkham, J. J., Lasserson, T., Li, T., McAleenan, A., … Higgins, J. P. T. (2019). RoB 2: A revised tool for assessing risk of bias in randomised trials. *BMJ*, *366*, l4898.

Suvan, J., Leira, Y., Moreno, F., Graziani, F., Derks, J., & Tomasi, C. (2020). Subgingival instrumentation for treatment of periodontitis. A systematic review. *Journal of Clinical Periodontology*, *47*(Suppl 22), 155–175.

Taiete, T., Casati, M. Z., Ribeiro Édel, P., Sallum, E. A., Nociti Júnior, F. H., & Casarin, R. C. (2016). Amoxicillin/metronidazole associated with nonsurgical therapy did not promote additional benefits in immunologic parameters in generalized aggressive periodontitis: A randomized controlled clinical trial. *Quintessence International*, *47*(4), 281–292.

Theodoro, L. H., Assem, N. Z., Longo, M., Alves, M. L. F., Duque, C., Stipp, R. N., Vizoto, N. L., & Garcia, V. G. (2018). Treatment of periodontitis in smokers with multiple sessions of antimicrobial photodynamic therapy or systemic antibiotics: A randomized clinical trial. *Photodiagnosis and Photodynamic Therapy*, *22*, 217–222.

Tomasi, C., Leyland, A. H., & Wennström, J. L. (2007). Factors influencing the outcome of non-surgical periodontal treatment: A multilevel approach. *Journal of Clinical Periodontology*, *34*(8), 682–690.

Tonetti, M. S., Greenwell, H., & Kornman, K. S. (2018). Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. *Journal of Periodontology*, *89*(S1). https://doi.org/10.1002/jper.18-0006

Ustun, K., Hatipoglu, M., Daltaban, O., Felek, R., & Firat, M. Z. (2018). Clinical and biochemical effects of erbium, chromium: Yttrium, scandium,

gallium, garnet laser treatment as a complement to periodontal treatment. *Nigerian Journal of Clinical Practice*, *21*(9), 1150–1157. https://doi.org/10.4103/njcp.njcp_51_18

Waerhaug, J. (1978). Healing of the dento-epithelial junction following subgingival plaque control. II: As observed on extracted teeth. *Journal of Periodontology*, *49*(3), 119–134.

Zanatta, G. M., Bittencourt, S., Nociti, F. H., Jr., Sallum, E. A., Sallum, A. W., & Casati, M. Z. (2006). Periodontal debridement with povidone-iodine in periodontal treatment: Short-term clinical and biochemical observations. *Journal of Periodontology*, *77*(3), 498–505.

Zengin Celik, T., Saglam, E., Ercan, C., Akbas, F., Nazaroglu, K., & Tunali, M. (2019). Clinical and microbiological effects of the use of erbium: Yttrium-aluminum-garnet laser on chronic periodontitis in addition to nonsurgical periodontal treatment: A randomized clinical Trial-6 months follow-up. *Photobiomodulation, Photomedicine, and Laser Surgery*, *37*(3), 182–190.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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