Lasers in Dental Science (2019) 3:91–98
https://doi.org/10.1007/s41547-019-00064-9

REVIEW ARTICLE

Effectiveness of periodontal treatment with Nd:YAG laser therapy adjunct to scaling and root planing: a systemic review and meta-analysis

Zaeem Arif Abbasi[1] · Ayesha Tariq Niaz[2] · Saima Akram Butt[1]

Received: 20 December 2018 / Accepted: 14 May 2019 / Published online: 27 May 2019

Abstract

Purpose To determine if management with neodymium-doped yttrium aluminum garnet (Nd:YAG) laser therapy as an adjunct to scaling and root planing (SRP) yields a better periodontal outcome in terms of reduction in periodontal probing depth (PPD) and interleukin 1-beta (IL-1β) level, as compared to SRP alone for the treatment of periodontitis.

Methods Searches were conducted on various online databases up to and including October 2018. Studies in which Nd:YAG laser therapy was used for the treatment of periodontitis were scrutinized procedurally, and studies fulfilling the inclusion criteria were retrieved and encompassed in the present study.

Result Five studies were included in this analysis, which used the combined approach of Nd:YAG laser therapy + SRP (test group) and SRP only (control group). The follow-up period ranged from 8 to 12 weeks. The Nd:YAG laser used in all of the studies had wavelengths, energy/pulse, and duration of irradiation of 1064 nm, 75–100 mJ, and 60–120 s, respectively. Meta-analysis showed significant PPD reduction (Q value = 75.4, DF = 3, P value < 0.0001, I^2 = 96.02%) and IL-1β reduction (Q value = 86.2, DF = 3, P value < 0.0001, I^2 = 96.52%) for the test group as compared to the control group at follow-up.

Conclusion It is still debatable and yet to be determined, whether Nd:YAG laser therapy + SRP yields better result when compared to SRP alone in reducing PPD and IL-1β level for treatment of periodontitis, given that there is lack of research related to it.

Keywords Laser therapy · Meta-analysis · Nd:YAG · Periodontitis · Scaling and root planing

Introduction

Periodontitis is an inflammatory disease affecting the periodontium (including gingivae, periodontal ligaments, cementum, and alveolar bone). The main etiological factor causing periodontitis is the plaque which contains bacterial pathogens that trigger the host immune system and cause breakdown of the hard and soft tissues of the periodontium, eventually resulting in tooth loss [1]. In recent times, treatment is not just restricted to reducing the bacterial load which restricted the eventual disease progression but also to regenerating the soft and hard periodontal tissues that were broken down during the disease process [2–5].

SRP remains to the cornerstone for non-surgical periodontal therapy, where the hand scalers or ultrasonic devices are used for debriding the root surface that facilitates the reattachment of periodontium [6]. Despite this therapy being demanding, there are severe physical limitations associated with it, mainly the incapability to debride the root surface in deep pockets and inaccessible furcation defects, inadequate removal of the pathogenic organisms, and henceforth the disease recurrence [7, 8]. Certain adjunctive therapies have been recommended to overcome these limitations, such as the systemic or local use of antimicrobial agents [9, 10], using a different laser, such as Er:YAG and Nd:YAG [11, 12], and surgical treatments [13, 14].

Various lasers have been introduced for the treatment of oral diseases, and their applications in dental clinics have

✉ Zaeem Arif Abbasi
zaeemarif@hotmail.com

[1] Department of Oral Pathology, Faculty of Dentistry, Ziauddin University, 4/B, Shahrah-e-Ghalib, Block 6, Clifton, Karachi, Sindh 7500, Pakistan

[2] Department of Oral Biology, Dow University of Health Sciences, Karachi, Pakistan

become a topic of much interest among practitioners. The use of lasers in dentistry has been much under debate due to its various advantages as well as certain associated risks [15]. Technological advances and improvements have increased the choices of the available laser systems for oral use. Among them, a recently developed Nd:YAG laser system possesses suitable characteristics for oral soft and hard tissue ablation [16]. The aim of this study is to evaluate whether treatment with Nd:YAG laser therapy as an adjunct to SRP yields a better periodontal outcome in terms of PPD and IL-1β as compared to SRP alone for the treatment of periodontitis.

Numerous studies have indicated that adjunctive Nd:YAG laser therapy for the treatment of periodontitis may improve clinical periodontal outcomes [17, 18]. However, some studies have mentioned the presence of a thermal effect on the surrounding tissue in addition to cracks on root surfaces, observed microscopically, weakening then the surrounding tissue [19, 20].

Material and methods

Review registration and focused PICO question

The present review was registered at the "PROSPERO International Prospective Register of Systematic Reviews" (registration number CRD42018110159). Guidelines from the "Preferred Reporting Items for Systematic Review and Meta-Analysis" (PRISMA) were taken to design this review [21]. The "PICO principle (i.e., "Patients," adults with periodontitis; "Interventions," Nd:YAG laser plus SRP; "Comparisons," SRP alone; "Outcomes," PPD and IL-1β level reduction)" was utilized for the development and addressing the following research question: "Does Nd:YAG laser as an adjunct to SRP yield better outcomes in terms of PPD and IL-1β than SRP alone in treating periodontitis?"

Literature search

Literature searching was done through multiple databases (Google Scholar, PubMed, MEDLINE, EMBASE, Science Direct, SCOPUS, etc.) up to and including October 2018 for articles focusing on the research question. For the PubMed library, the following combinations of free textual words and MeSH (Medical Subject Headings) words were used: (*Nd:YAG laser OR lasers*) AND (*chronic periodontitis OR periodontitis*, *adult OR aggressive periodontitis*) OR (*scaling, dental AND root planing*) OR (*scaling OR periodontal debridement*) AND (*interleukin 1 beta OR interleukin 1*).

Selection criteria

Two reviewers (ZA and AN) independently conducted the selection and analysis of articles. Any dissension among the authors regarding study inclusion or exclusion was resolved through discussion and/or by referring a third reviewer (SB). The following eligibility criteria were entailed for the inclusion of studies:

(1) Study design: Randomized control trials (RCTs) and clinical trials (split-mouth, controlled, or comparative) were included.

(2) Study participants: Diagnosed periodontitis patients (aged ≥ 18 years) including both genders.

(3) Study groups: Patients treated with Nd:YAG laser therapy + SRP (test group) compared to those treated with SRP only (control group) with at a minimum of 10 patients in each group.

(4) Outcome: Periodontal probing depth (PPD) reduction (primary outcome) and IL-1β (secondary outcomes).

In vitro and animal studies, laser treatments other than Nd:YAG laser therapy, combination of laser therapies, case series and reports, and review articles were excluded.

Screening and selection

Two reviewers (ZA and AH) autonomously screened titles and abstracts for research articles based upon the eligibility criteria. Interobserver's agreement was evaluated by means of kappa scores. If data relevant to the eligibility criteria was not obtainable in the abstract, or if the title was appropriate but the abstract was not obtainable, then the paper was selected for a full reading of the text. Articles that fulfilled the eligibility criteria were included in this review and were then processed for data extraction. Figure 1 describes the screening process according to the PRISMA guidelines [21].

Data extraction

Data related to participant's demographic characteristics, study groups, study design, follow-up period, features of laser equipment, and study outcomes were systematized from the included studies. Information gathered depended on the focused query outlined for the current systematic review. The reviewers crosschecked all of the data obtained. Any discrepancy was resolved by discussing among all the reviewers until there was an agreement.

Data synthesis

Meta-analyses were done separately, for each of the primary (PPD) and secondary outcomes (IL-1β). The I^2 and Q-statistics were used to assess the heterogeneity among the studies included in this analysis [22]. Forest plots were figured to report the weighted mean difference (WMD) of outcomes and 95% confidence intervals (CI). If the p value was < 0.05, then the pooled effect was considered statistically significant. For the purpose of interpreting the values obtained on

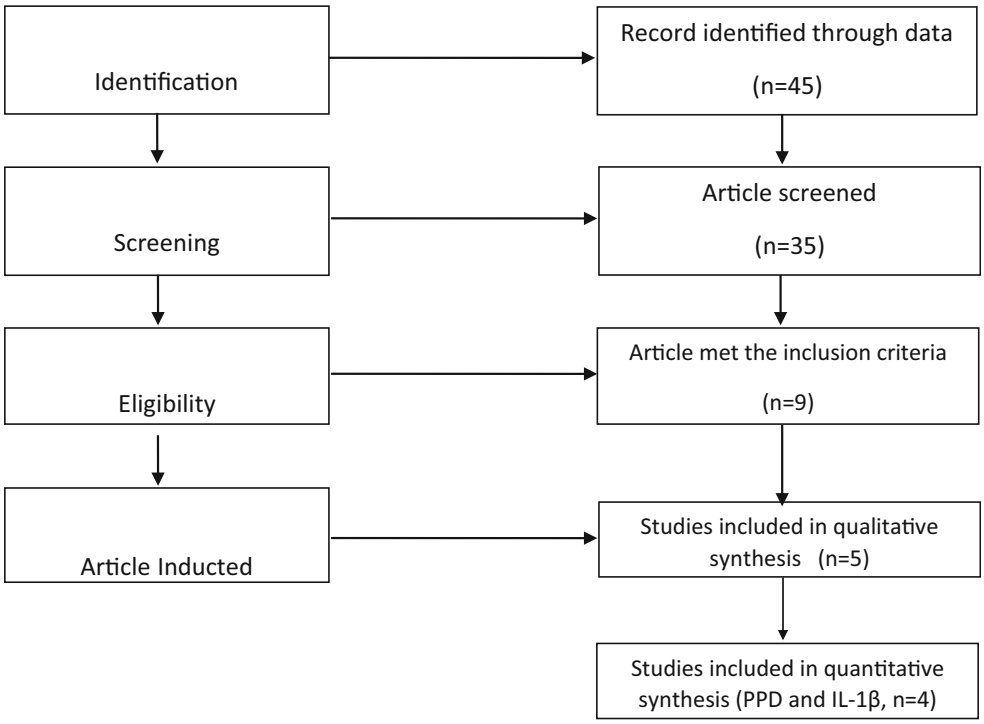

Fig. 1 Flow diagram according to PRISMA guidelines

a fixed/random model, Cohen's rule of thumb was applied which states that a value of 0.2 reflects a small effect, 0.5 a medium effect, and value greater than 0.8 a large effect. For determining the level of heterogeneity supposition, Cochrane Q was determined. The I^2 statistic was applied to quantify inter-study variability having a range of 0 to 100%, with 0% indicating no heterogeneity whereas the increased values indicate a higher level of heterogeneity. Statistical software (MedCalc) was used for the analyses.

Results

Study selection

A total of 49 study titles and abstracts were initially identified in the following databases: MEDLINE ($n = 3$), PubMed ($n = 24$), EMBASE ($n = 7$), Science Direct ($n = 14$), and SCOPUS ($n = 1$). After removal of the duplicates, 45 articles were identified. Thirty-six records were excluded as irrelevant to the focus question. Out of the total 9 papers that were selected for full-text reading, 4 research papers were further excluded. Five studies [23–27] were finally selected and processed for data extraction. Figure 1 shows the flow chart of study selection according to PRISMA [21].

Characteristics of included studies

Five studies were included in this review [23–27]. The studies were carried out in Saudi Arabia [23, 27], Spain [24], Turkey [25], and Sweden [26]. In all studies, the individuals had mean age ranging between 46.1 and 57.9 years. All five studies included subjects with chronic periodontitis with PPD ≥ 4 mm [23–27]. All studies [23–27] used the combined approach SRP + Nd:YAG laser in the test group and SRP alone in the control group. In four studies [23, 25–27], the follow-up was 3 months, whereas in one study [24], the follow-up was 8 weeks.

Quality of the clinical studies

All the five studies included in this analysis were RCTs and were appropriately randomized with an adequate sample size, statistical analysis, and report of losses. A pre-submitted checklist based on the recommended revisions of the Consolidated Standards of Reporting Trials was used to conduct the present analysis [28]. The risk of bias was estimated for each selected RCT based on the "Cochrane Handbook for Systematic Reviews of Interventions" [29]: (1) low risk of bias (when all criteria were met); (2) high risk of bias (when ≥ 1 criterion was not met); and (3) unclear (when ≥ 1 criterion was partially met) (Table 4).

Test for heterogeneity

The Q test and I^2 test were calculated to identify the level of heterogeneity, as the values of level of inconsistency were within 95% of CI. Random-effects model was used for assessing the pool effects (Table 1, Tables 2, 3 4).

Table 1 Pooled effects of SRP + Nd:YAG laser therapy on periodontal probing depth (A) and interleukin-1β (B) in terms of standardized mean difference (SMD)

Study	Experimental group	Control group	Total	SMD	SE	95% CI	*T*	*P*	Weight (%)	
									Fixed	Random
(A)										
Talat Qadri (2010)	30	30	60	− 0.817	0.27	− 1.349 to − 0.286			31.93	25.28
Eltas (2011)	20	20	40	− 0.615	0.32	− 1.296 to − 0.0068			22.21	24.94
Clara Gomez (2011) [25]	30	30	60	1.165	0.28	0.612 to 1.718			29.53	25.22
Abdul Jabbar (2017) [24]	28	28	56	− 2.770	0.37	− 3.514 to − 2.025			16.32	24.56
Total (fixed effects)	108	108	216	− 0.514	0.15	− 0.810 to − 0.218	− 3.424	0.001	100.00	100.00
Total (random effects)	108	108	216	− 0.755	0.76	− 2.254 to 0.744	− 0.993	0.322	100.00	100.00
	Test for heterogeneity: Q value = 75.4, DF = 3, P value < 0.0001, I^2 = 96.02%									
(B)										
Talat Qadri (2010) [27]	30	30	60	− 0.107	0.26	− 0.617 to 0.404			37.32	25.86
Eltas (2011) [26]	20	20	40	− 0.216	0.31	− 0.845 to 0.413			25.12	25.59
Clara Gomez (2011) [25]	30	30	60	− 1.091	0.27	− 1.639 to − 0.543			32.42	25.78
Abdul Jabbar (2017) [24]	28	28	56	− 6.718	0.69	− 8.096 to − 5.340			5.14	22.76
Total (fixed effects)	108	108	216	− 0.793	0.16	− 1.100 to − 0.486	−5.090	< 0.001	100.00	100.00
Total (random effects)	108	108	216	− 1.893	0.88	− 3.627 to − 0.160	−2.153	0.032	100.00	100.00
	Test for heterogeneity: Q value = 86.2, DF = 3, P value < 0.0001, I^2 = 96.52%									

Synthesized findings

The overall synthesized finding of four studies [23, 25–27] included was found to be in favor of the experimental group, in which the PPD decreased more as compared to the control group. One study [24], however, did not show positive results in the experimental group in terms of PPD. In terms of IL-1β levels, all the studies [23–27] were in favor of the experimental group that is there was a decrease in IL-1β levels after treatment. The pool effects of Cobb angle in terms of standardized mean difference of PPD as obtained in a random-effects model showed an impact of 0.49 in favor of the experimental group that according to a Cohen's rule of thumb depicts a near to moderate effect of SRP + Nd:YAG laser treatment (Fig. 2a). The standardized mean difference of IL-1β as obtained in a random-effects models showed, however, an impact of 1.8 in favor of the experimental group that according to a Cohen's rule of thumb depicts a large or greater effect of SRP + Nd:YAG laser treatment as compared to SRP only (Fig. 2b).

Four studies [23–26] had necessary data that was required for the meta-analysis considering the effects of SRP and Nd:YAG laser on PPD and IL-1β levels; one study [27] expressed the results of PPD in terms of % of teeth with ≥ 4 mm, whereas all other studies have expressed mean PPD in mm. Hence, it was excluded from the meta-analysis. Considering the effects of SRP + laser, as compared to SRP, a high degree of heterogeneity for PPD and IL-1β levels [*Q*

Table 2 Laser parameters of included studies

Study	Type of laser	Wave length (nm)	Energy/pulse (mJ)	Average output (W)	Duration of irradiation (s)	Pulse repetition rate (Hz)	Laser energy/tooth (J)	Optic fiber diameter (μm)
Talat Qadri (2010) [27]	Nd:YAG	1064	80	4	60–120	50	240–480	600
Eltas (2011) [26]	Nd:YAG	1064	100	1	120	10	N/A	200
Clara Gomez (2011) [25]	Nd:YAG	1064	75	N/A	60	10	N/A	200
Fawad Javed (2016) [28]	Nd:YAG	1064	80	4	60–120	50	240–480	600
Abdul Jabbar (2017) [24]	Nd:YAG	1064	80	4	60–120	50	240 to 480	N/A

nm, nanometer; mJ, millijoule; W, watts; s, seconds; Hz, Hertz; J, joule; μm, micrometer; N/A, not available

Table 3 Periodontal probing depth and interleukin-1β levels of the included studies

Study	PPD		IL-1β (pg/μl)	
	SRP + Nd:YAG	SRP only	SRP + Nd:YAG	SRP only
Talat Qadri (2010) [27]	Baseline: 4.59 (0.44) mm	Baseline: 4.41 (0.27) mm	Baseline: 0.46 (0.44)	Baseline: 0.32 (0.89)
	Follow-up: 3.12 (0.60) mm	Follow-up: 3.57 (0.48) mm	Follow-up: 0.12 (0.71)	Follow-up: 0.18 (0.33)
Eltas (2011) [26]	Baseline: 5.11 (1.18) mm	Baseline: 5.05 (1.33) mm	Baseline: 9.96 (5.17)	Baseline: 10.20 (3.60)
	Follow-up: 3.19 (1.27) mm	Follow-up: 4.11 (1.49) mm	Follow-up: 7.17 (2.62)	Follow-up: 7.70 (2.17)
Clara Gomez (2011) [25]	Baseline: 4.72 (0.26) mm	Baseline: 4.46 (0.29) mm	Baseline:0.069 (0.025)	Baseline: 0.074 (0.026)
	Follow-up: 3.56 (0.31) mm	Follow-up: 3.09 (0.47) mm	Follow-up: 0.086 (0.019)	Follow-up: 0.065 (0.019)
Fawad Javed (2016) [28]	Baseline: 39.7 (0.97) (% of sites having PPD ≥ 4 mm)	Baseline: 36.5 (1.77) (% of sites having PPD ≥ 4 mm)	Baseline: 0.027 (0.002)	Baseline: 0.031 (0.003)
	Follow-up: 1.9 (0.11) (% of sites having PPD ≥ 4 mm)	Follow-up: 14.7 (0.86) (% of sites having PPD ≥ 4 mm)	Follow-up: 0.004 (0.001)	Follow-up: 0.014 (0.009)
Abdul Jabbar (2017) [24]	Baseline: 6.6 (1.6) mm	Baseline: 6.4 (1.8) mm	Baseline: 0.448 (0.0216)	Baseline: 0.448 (0.0216)
	Follow-up: 2 (0.5) mm	Follow-up: 4.4 (1.1) mm	Follow-up: 0.102 (0.0182)	Follow-up: 0.012 (0.0034)

PPD, periodontal probing depth; IL-1β, interleukin 1-beta; SRP, scaling and root planing; Nd:YAG, neodymium-doped yttrium aluminum garnet laser

value = 41 (PPD) (Table 1) and 86.2 (IL-1β) (Table 2), P value < 0.0001 (PPD and IL-1β), $I^2 = 92.6\%$ (PPD) (Table 1) and 96.5% (IL-1β) (Table 2)] was noticed.

Publication bias

Asymmetrical funnel plot for PPD proposed significant publication bias regarding a reduction in PPD at the time of follow-up. The funnel plot of IL-1β reduction at the time of follow-up showed that most of the studies were in or very near to confidence area and showed certain symmetry (Fig. 3a,b).

Complications/adverse effects associated with Nd:YAG laser therapy

No complications or adverse effects in the Nd:YAG laser-treated group were reported in any of the studies.

Discussion

This systemic review was based on the hypothesis that Nd:YAG laser therapy as an adjunct to SRP will show better results in the treatment of periodontitis, as compared to SRP alone. All the studies [23–27] included in the present review showed that Nd:YAG laser therapy + SRP improved the clinical outcome that is PPD and decreased the IL-1β levels as well, as compared to SRP treatment alone.

There were several inconsistencies observed among the included studies [23–27], such as different mediums taken for IL-1β analysis and variation in the follow-up time. Four studies [23–26] took GCF as a medium for IL-1β analysis, whereas only one study [27] took serum as a medium for analysis. A study [30] showed that IL-1β levels in patients with periodontitis are lower in serum as compared to GCF, as IL-1β is released and acts locally on the periodontium. Only one study [24] had a follow-up time of 8 weeks, whereas all other studies [23, 25–27] included in this review had a follow-

Table 4 Evaluation of bias risk in the included studies

Studies	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting
Talat Qadri 2010 [27]	*2*	1	1	1	1	1
Eltas 2011 [26]	1	2	1	1	2	1
Clara Gomez 2011 [25]	1	1	1	1	1	1
Fawad Javed 2016 [28]	1	1	2	1	2	2
Abdul Jabbar 2017 [24]	1	1	1	1	1	2

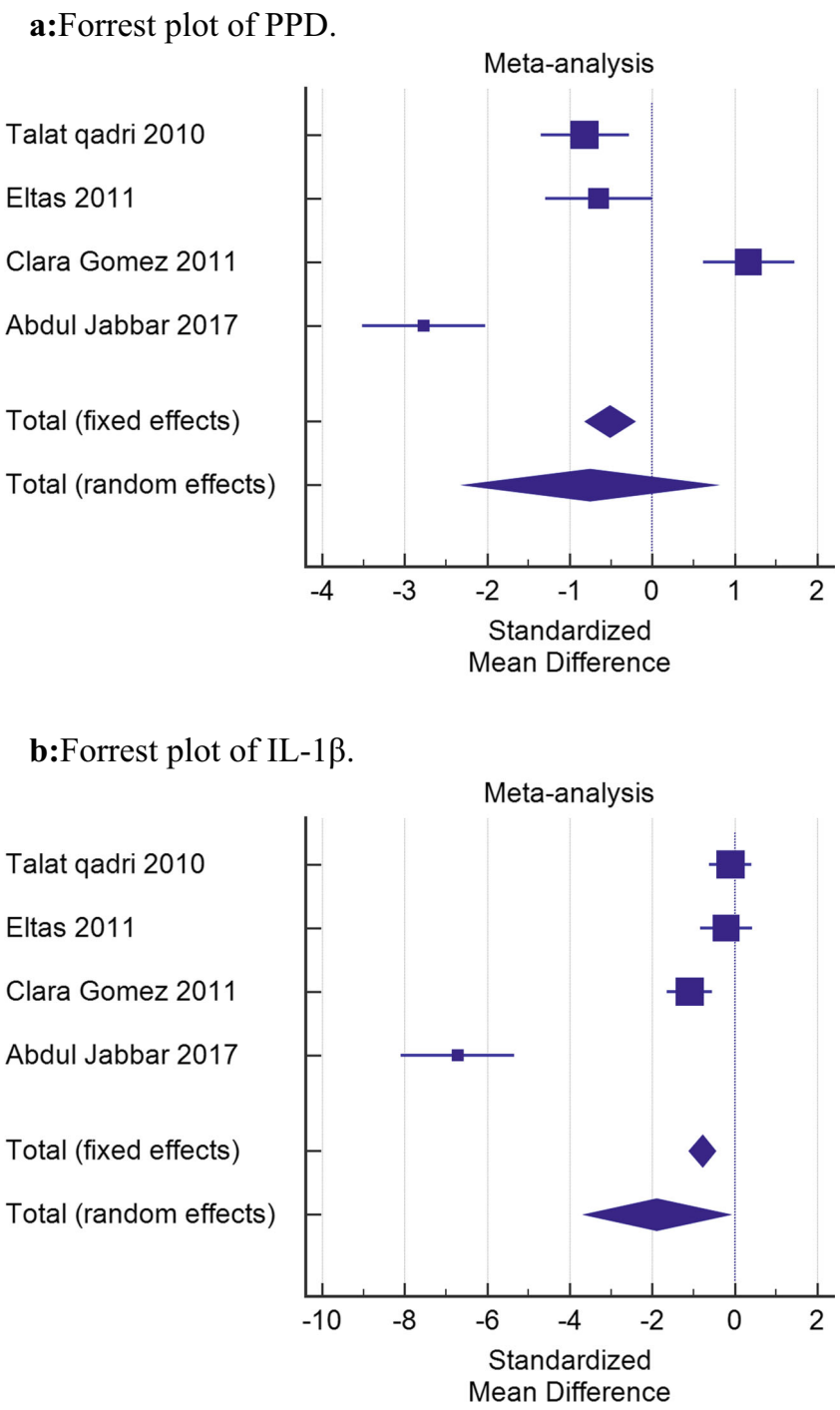

Fig. 2 **a** Funnel plot PPD reduction. **b** Funnel plot of IL-1β reduction

up time of 3 months. A shorter follow-up time would indicate that there would be less improvement in the PPD and IL-1β levels, as compared to those levels analyzed after 3 months of treatment.

It is important to mention that all the included studies had a lack of data related to laser parameters. Parameters such as energy/pulse, average output, duration of irradiation, pulse repetition rate, and optic fiber diameter either had diversity or were unreported in some studies (Table 2). These laser parameters could very well influence the outcome of the treatment. Therefore, further studies with standard laser parameters for the treatment of periodontitis are required to obtain a definitive conclusion in this matter.

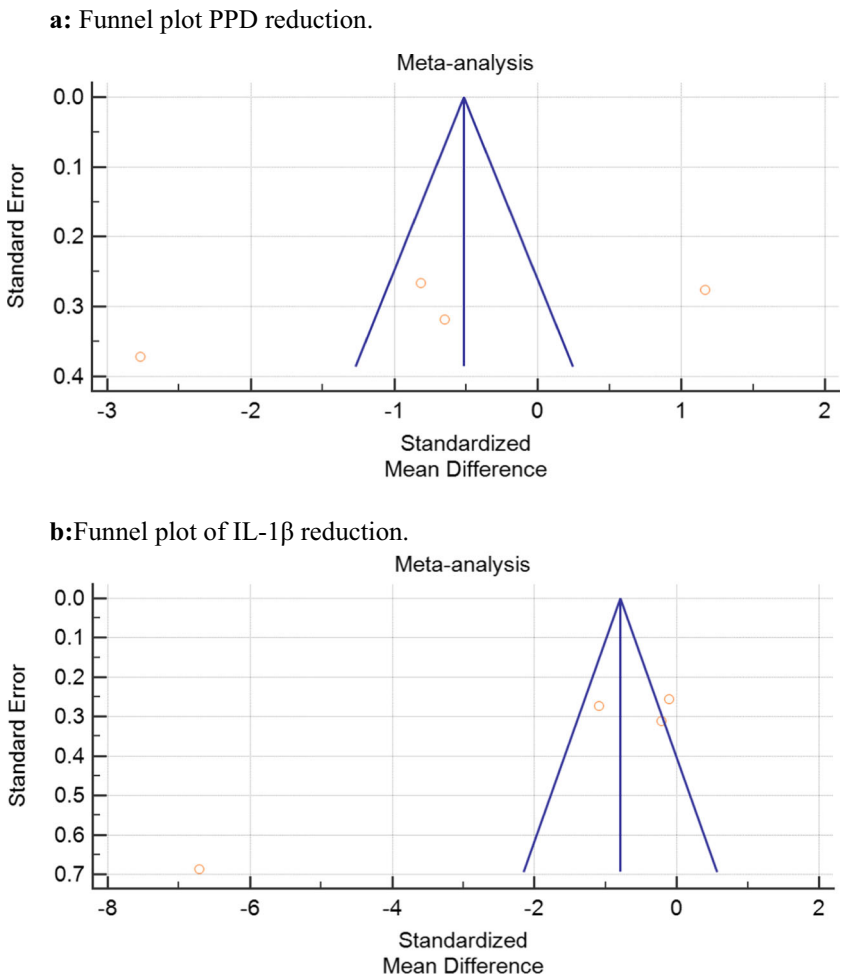

Fig. 3 **a** Funnel plot PPD reduction. **b** Funnel plot of IL-1β reduction

Interestingly, a higher reduction in IL-1β levels was observed in favor of SRP + Nd:YAG laser therapy. Given that IL-1β levels reflect the presence of inflammation in the periphery of the periodontium [31, 32], its reduction could confirm the capability of the Nd:YAG laser therapy to reduce inflammation.

Given the small number of studies that were included in the present meta-analysis, our findings are in agreement with those of previous systematic reviews [33, 34] that found insufficient evidence in the literature to support the adjunctive use of Nd:YAG laser therapy to SRP.

The main limitations of this analysis were the small number of included studies and only PPD was taken into account out of all other clinical periodontal parameters.

Conclusion

It is still questionable whether Nd:YAG laser therapy as an adjunct to SRP gives better clinical results in comparison to SRP alone, in the treatment of periodontitis, since the research evidence is insufficient. Another reason for these inconclusive results may be the high heterogeneities among the available studies. Thus, more clinical trials with longer follow-up periods utilizing standard laser parameters are required to obtain a stronger conclusive result.

Compliance with ethical standards

Conflict of interest All the authors have read and approved the final draft and declare that they have no conflict of interest.

References

*Indicate studies selected for this review

1. Pihlstrom BL, Michalowicz BS, Johnson NW (2005) Periodontal diseases. Lancet (London, England) 366(9499):1809–1820
2. Wang HL, Greenwell H, Fiorellini J, Giannobile W, Offenbacher S, Salkin L et al (2005) Periodontal regeneration. J Periodontol 76(9): 1601–1622
3. Schwarz F, Sculean A, Georg T, Reich E (2001) Periodontal treatment with an Er:YAG laser compared to scaling and root planing. A controlled clinical study. J Periodontol 72(3):361–367

4. Moritz A, Schoop U, Goharkhay K, Schauer P, Doertbudak O, Wernisch J, Sperr W (1998) Treatment of periodontal pockets with a diode laser. Lasers Surg Med 22(5):302–311
5. Karlsson MR, Diogo Löfgren CI, Jansson HM (2008) The effect of laser therapy as an adjunct to non-surgical periodontal treatment in subjects with chronic periodontitis: a systematic review. J Periodontol 79(11):2021–2028
6. Cobb CM (2002) Clinical significance of non-surgical periodontal therapy: an evidence-based perspective of scaling and root planing. J Clin Periodontol 29(Suppl 2):6–16
7. Cugini MA, Haffajee AD, Smith C, Kent RL, Socransky SS (2000) The effect of scaling and root planing on the clinical and microbiological parameters of periodontal diseases: 12-month results. J Clin Periodontol 27(1):30–36
8. Sherman PR, Hutchens LH Jr, Jewson LG, Moriarty JM, Greco GW, WT MF Jr (1990) The effectiveness of subgingival scaling and root planning. I. Clinical detection of residual calculus. J Periodontol 61(1):3–8
9. Chambrone L, Vargas M, Arboleda S, Serna M, Guerrero M, de Sousa J, Lafaurie GI (2016) Efficacy of local and systemic antimicrobials in the non-surgical treatment of smokers with chronic periodontitis: a systematic review. J Periodontol 87(11):1320–1332
10. Rovai ES, Souto ML, Ganhito JA, Holzhausen M, Chambrone L, Pannuti CM (2016) Efficacy of local antimicrobials in the non-surgical treatment of patients with periodontitis and diabetes: a systematic review. J Periodontol 87(12):1406–1417
11. Chambrone L, Ramos UD, Reynolds MA (2018) Infrared lasers for the treatment of moderate to severe periodontitis: an American Academy of Periodontology best evidence review. J Periodontol 89(7):743–765
12. Mills MP, Rosen PS, Chambrone L, Greenwell H, Kao RT, Klokkevold PR, McAllister BS, Reynolds MA, Romanos GE, Wang HL (2018) American Academy of Periodontology best evidence consensus statement on the efficacy of laser therapy used alone or as an adjunct to non-surgical and surgical treatment of periodontitis and peri-implant diseases. J Periodontol 89(7):737–742
13. Deas DE, Moritz AJ, Sagun RS, Gruwell SF, Powell CA (2000. 2016) Scaling and root planing vs. conservative surgery in the treatment of chronic periodontitis. Periodontology 71(1):128–139
14. Cortellini P, Buti J, Pini Prato G, Tonetti MS (2017) Periodontal regeneration compared with access flap surgery in human intrabony defects 20-year follow-up of a randomized clinical trial: tooth retention, periodontitis recurrence and costs. J Clin Periodontol 44(1):58–66
15. Alwaeli HA, Al-Khateeb SN, Al-Sadi A (2015) Long-term clinical effect of adjunctive antimicrobial photodynamic therapy in periodontal treatment: a randomized clinical trial. Lasers Med Sci 30(2):801–807
16. Ishikawa I, Aoki A, Takasaki AA (2008) Clinical application of erbium: YAG laser in periodontology. J Int Acad Periodontol 10(1):22–30
17. Liu C-M, Hou L-T, Wong M-Y, Lan WH (1999) Comparison of Nd:YAG laser versus scaling and root planing in periodontal therapy. J Periodontol 70(11):1276–1282
18. Miyazaki A, Yamaguchi T, Nishikata J, Okuda K, Suda S, Orima K, Kobayashi T, Yamazaki K, Yoshikawa E, Yoshie H (2003) Effects of Nd:YAG and CO_2 laser treatment and ultrasonic scaling on periodontal pockets of chronic periodontitis patients. J Periodontol 74(2):175–180
19. Chanthaboury R, Irinakis T (2005) The use of lasers for periodontal debridement: marketing tool or proven therapy? Journal (Canadian Dental Association) 71(9):653–658
20. Cobb CM (2006) Lasers in periodontics: a review of the literature. J Periodontol 77(4):545–564
21. Moher D, Liberati A, Tetzlaff J, Altman DG (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med 151(4):264–269 **w64**
22. Higgins JP, Thompson SG, Deeks JJ, Altman DG (2003) Measuring inconsistency in meta-analyses. BMJ (Clinical research ed. 327(7414):557–560
23. Abduljabbar T, Vohra F, Kellesarian SV, Javed F (2017) Efficacy of scaling and root planning with and without adjunct Nd:YAG laser therapy on clinical periodontal parameters and gingival crevicular fluid interleukin 1-beta and tumor necrosis factor-alpha levels among patients with periodontal disease: a prospective randomized split-mouth clinical study. J Photochem Photobiol, B 169:70–74
24. Gomez C, Dominguez A, Garcia-Kass AI, Garcia-Nunez JA (2011) Adjunctive Nd:YAG laser application in chronic periodontitis: clinical, immunological, and microbiological aspects. Lasers Med Sci 26(4):453–463
25. Eltas A, Orbak R (2012) Effect of 1,064-nm Nd:YAG laser therapy on GCF IL-1beta and MMP-8 levels in patients with chronic periodontitis. Lasers Med Sci 27(3):543–550
26. Qadri T, Poddani P, Javed F, Tuner J, Gustafsson A (2010) A short-term evaluation of Nd:YAG laser as an adjunct to scaling and root planing in the treatment of periodontal inflammation. J Periodontol 81(8):1161–1166
27. Javed F, Kellesarian SV, Al-Kheraif AA, Ranna V, Qadri T, Yunker M et al (2016) Effect of Nd:YAG laser-assisted non-surgical periodontal therapy on clinical periodontal and serum biomarkers in patients with and without coronary artery disease: a short-term pilot study. Lasers Surg Med 48(10):929–935
28. Moher D, Hopewell S, Schulz KF, Montori V, Gotzsche PC, Devereaux PJ et al (2010) CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. J Clin Epidemiol 63(8):e1–e37
29. Higgins JPT, G S (2011) Cochrane handbook for systematic reviews of interventions version 5.1.0. The Cochrane Collaboration
30. Abdulkareem Hussain A, Ali B (2014) Evaluation of interleukin 1β levels in gingival crevicular fluid and serum of patients with gingivitis and chronic periodontitis, pp 70–75
31. Engebretson SP, Grbic JT, Singer R, Lamster IB (2002) GCF IL-1beta profiles in periodontal disease. J Clin Periodontol 29(1):48–53
32. Toker H, Poyraz O, Eren K (2008) Effect of periodontal treatment on IL-1beta, IL-1ra, and IL-10 levels in gingival crevicular fluid in patients with aggressive periodontitis. J Clin Periodontol 35(6):507–513
33. Slot DE, Kranendonk AA, Paraskevas S, Van der Weijden F (2009) The effect of a pulsed Nd:YAG laser in non-surgical periodontal therapy. J Periodontol 80(7):1041–1056
34. Schwarz F, Aoki A, Becker J, Sculean A (2008) Laser application in non-surgical periodontal therapy: a systematic review. J Clin Periodontol 35(8 **Suppl**):29–44