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EFFECTIVENESS OF LASER AS AN ADJUNCT TO PERIODONTAL SURGICAL PROCEDURE A SYSTEMATIC REVIEW

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ABSTRACT :
BACKGROUND : Chronic periodontitis is an infectious disease resulting in inflammation within the supporting tissues of the teeth, loss of attachment, bone resorption and is characterized by pocket formation and/or gingival recession. Periodontal treatment/debridement carried out only with mechanical methods alone may fail to eliminate the tissue invasive pathogenic flora completely; therefore adjunctive antimicrobial therapy is equally important to achieve best results. Evidence has shown some benefits of using laser for non-surgical periodontal therapy. Improved clinical outcomes are due to its ablation or vaporization, hemostasis, field sterilization and morbidity reduction.
OBJECTIVE/AIM : The aim of this study was to investigate and compare the clinical and microbiological effects of adjunctive laser therapy along with conventional periodontal flap procedures versus conventional flap procedures alone for the treatment of generalized chronic periodontitis.
SEARCH METHOD : Three electronic databases PubMed, Cochrane Library and Google Scholar were searched for articles. Further articles were added using hand search. The search strategy was designed by the two authors. There were no date restrictions used in the search strategy. Reference lists of the selected articles were also searched.
SELECTION CRITERIA : only clinical trials were included in the current systematic review.
DATA COLLECTION AND ANALYSIS : Titles, abstracts and full texts of studies identified from the literature search were screened by two authors. Bias was analysed using Cochrane's Risk of bias tool.
RESULTS: The results of the systematic review emphasized that laser therapy used as an adjunct to conventional periodontal therapy significantly improves clinical and microbiological parameters also improves postoperative healing.
CONCLUSION : within the limits of this systematic review it can be concluded that laser used as an adjunct to conventional periodontal flap procedures is an effective method to ensure better outcomes. Further research is needed in the field to back the results of the article.

KEYWORDS : Periodontitis, Laser therapy, Flap surgery, Evidence based

INTRODUCTION :

Chronic periodontitis is one of the most prevalent oral conditions worldwide. It is an infectious disease resulting in inflammation within the supporting tissues of the teeth, loss of attachment bone loss and is characterized by pocket formation and/or gingival recession. Periodontal pockets act as an unique environment for colonising bacteria. It is known that periodontal disease requires the participation of a very limited number of the members of the anaerobic microbiota inhabiting the subgingival region, and results in the destruction of the supporting structures of the teeth. The current model for periodontitis includes microbial components, host inflammatory responses, and environmental factors. Ultimate goal of periodontal treatment is to eliminate these factors, regenerate the supporting tissues lost as a consequence of inflammatory periodontal disease and to restore function. Evidence says that non surgical periodontal therapy is insufficient in achieving complete elimination of these factors from deeper pockets the reason being limited access and difficulty to remove microbial pathogens that have penetrated into dentinal tubules and which are residing in lacunae and concavities[1]. Thus, surgical therapy is performed in cases with persistent inflammation, deeper pockets and class II & III furcation cases. Based on systematic review it is proven that long term effects of both surgical and non surgical treatment modalities are similar hence newer adjunctive therapies are need of the hour. An alternative (ecological) approach would be to alter the environment of the pocket to prevent the growth of the putative pathogens, as suggested by Marsh (ecological plaque hypothesis).

The limitations of SRP become more evident particularly if the disease has led to the formation of pockets deeper than 5 mm around the affected teeth[2–4].In the last decade, the use of lasers (light amplification by stimulated emission of radiation) has occupied part of the dialogue within periodontology and oral surgery due to several proposed advantages.[5–7] Recent years, the use of laser radiation has been expected to serve as an alternative or adjunctive treatment to conventional, mechanical periodontal therapy. Selective calculus ablation, bactericidal effect against periodontal pathogens, vaporization, pocket sterilization and morbidity reduction and improved postoperative healing hemostatic effect are some of the many characteristic advantages of the laser used as an adjunct to conventional treatment modalities [8,9]. In a clinical trial, Lobo and Pol et al reported that diode laser provided additional benefits to open flap debridement in terms of— decreased gingival index, implying a greater reduction in the gingival inflammation in the laser-treated test group. Less edema and post operative pain was seen post modified widman flap procedure in a study done by Sans-Moliner et al[10]. where a diode laser was used as an adjunct. In another clinical and microbiological study, bactericidal effect of DL was clearly marked by greater reduction of colony forming unit (CFU) of obligate anaerobes in the laser-treated test group than in the control group [8]. The lasers used in this arena include: carbon dioxide (CO2), neodymium doped: yttrium, aluminum and garnet (Nd-YAG), erbium yttrium, aluminum and garnet (ErYAG), erbium, chromium-doped:yttrium, scandium, gallium and garnet (Er,Cr:YSGG) and diode lasers. Erbium lasers have been reported to be most promising in treatment of periodontitis. Its ability to selectively ablate calculus harming the adjacent tissue is the key factor [11,12]. A part of the laser energy scatters and penetrates during irradiation into periodontal pockets. The attenuated laser at a low energy level might then stimulate the cells of surrounding tissue resulting in reduction of the inflammatory conditions [13]in cell proliferation[14] and in increased flow of lymph [15]improving the periodontal tissue attachment and possibly reducing postoperative pain.

Photodynamic therapy (PDT) is becoming an effective method of antibacterial treatment. It may be used as adjunct therapy for the treatment of severe periodontitis (de Oliveira et al., 2007a). Photo dynamic therapy (PDT) has been evaluated in in vitro and in vivo studies [16–20]. CO2 lasers have been successfully used as an adjunctive tool to de-epithelialize the mucoperiosteal flap during traditional flap surgery.[21] Laser treatment alone or in combination with mechanical (SRP) has produced positive clinical outcome with respect to gain CAL, decreasing in PD and bleeding on probing (BOP).[12,22,23]

Evidence shows effectiveness of lasers as an adjunct in non surgical management of periodontitis but its role as an adjunct to surgical management of periodontitis remains unclear. Hence the purpose of the present systematic review is to assess effectiveness of various types of laser used as an adjunct to periodontal surgical procedures.

AIM :

1. Aim of the systematic review is to assess effectiveness of various types of laser used as an adjunct to periodontal surgical procedures.

STRUCTURED QUESTION : Is laser an effective adjunct to surgical periodontal therapy to achieve better clinical outcome than conventional surgical periodontal treatment ?

PICO ANALYSIS :
Population : Individuals with chronic periodontitis.
Intervention : Laser used as adjunct to periodontal surgical procedure.
Comparison : Conventional periodontal surgical procedure.
Outcome : Clinical and microbiological parameters. (CAL, PPD, PI, GI, Microbiological parameters)

MATERIALS AND METHODS

Protocol Registration

This systematic review followed the Preferred Reporting Items for Systematic Reviews and MetaAnalyses (PRISMA) statement. The review protocol was registered under the PROSPERO database.

Search Strategy

Three electronic databases PubMed, Cochrane Library and Google Scholar were searched for articles. Further articles were added using hand search. The search strategy was designed by the two authors. There were no date restrictions used in the search strategy. Reference lists of the selected articles were also searched.

Selection Of Studies

INCLUSION CRITERIA :

- Studies using lasers as an adjunct to conventional surgical procedures.
- Clinical trials.
- Studies where surgical procedures were performed.
- Studies which compared laser group with conventional surgical procedures.

EXCLUSION CRITERIA :

- In vitro studies.
- Animal trials.
- Studies in other languages than english.
- Studies not having a control group.
- Studies available only in abstract form were excluded.

SEARCH RESULTS:

After removing duplicate studies and adding articles by hand search 342 articles were shortlisted. 12 articles were included for full text reading out of which 2 were excluded based on irrelevance after reading the entire article. The remaining 10 articles were analyzed and all relevant observations were recorded in this systematic review.

RESULTS:

Results are mentioned in the tables 1 and 2. Table 1 describes the general information of the articles included in the systematic review. Table 2 depicts the summary of findings of the variables of the interest in the included articles.

Table 1 : General information about articles included in the study.

No.	Author/ Year	Type of study	Sample size	Smoking	Mean age (Years)	Other systematic conditions (yes/no)	Follow up (months)	Type of laser used	Study groups	No. of participants/samples per group
	Sculean et al. 2004	RCT	23	N	ND	N	6	Er:YAG laser	T::Laser+OFD C:OFD	T:12 C:11

	Crespi et al.2011	RCT	25	N	45	N	180	CO2 laser	T:OFD C:Laser	T:100 C:100
	Gokhale et al. 2012	RCT	30	N	30-50	N	3	CO2 laser	T:MWF +Laser C:MWF	T:30 C:30
	Gaspirc and Skaleric 2007	RCT	25	N	46.3±9.2	N	60	Er:YAG laser	T:Kirkland+laser C:Kirkland flap	T:73 C:73
	Janani Karthikeyan 2018	RCT	20	N	ND	N	6	Diode laser	T:OFD +laser C:OFD	T:20 C:20
	Sérgio H. L. Martins	RCT	20	N	ND	N	5	Diode laser	T:MWF+Laser C:MWF	T:20 C:20
	Javier D. Sanz-Moliner	RCT (PILOT STUDY)	13	Y (7/13)	48±8.5	N	1	Diode laser		T:13 C:13
	Snehal A. Dalvi et al 2019	RCT	20	N	ND	N	3	Diode laser	T:OFD +Laser C:OFD	T:20 C:20
	Bharathi Devi Jonnalagadda et al 2018	RCT	23	N	40.56±12.22	N	6	Diode laser	T:OFD +Laser C:OFD	T:23 C:23
	Tanya Marguerite Lobo et al 2015	RCT	30	N	ND	N	6	Diode laser	T:OFD +Laser C:OFD	T:30 C:30

Table 2 : Summary of findings of variables of interest

No.	Author / Year	Study groups	Mean PD(baseline)	Mean PD(final)	Mean CAL (baseline)	Mean CAL(final)	Plaque index(baseline)	Plaque index(final)	Gingival index (baseline)	Gingival index(final)	Micro biological parameter (YES/ NO)
3.	Sculean et al. 2004	T::Laser+OFD C:OFD	T:7.8± 1.3 C:7.8± 0.8	T:4.1± 1.3 C:4.6± 1.6	T:9.8± 2.9 C:9.2± 1.2	T:7.2± 2.5 C:7.7± 1.6	T:ND C:ND	T:ND C:ND	T:ND C:ND	T:ND C:ND	N
	Crespi et al.2011	T:OFD C:Laser	T:7.91 ±0.81 C:7.17 ±0.33	T:4.00 ±0.38 C:4.80 ±0.45	T:8.71 ±0.34 C;8.63 ±0.22	T: 3.61±1. 11 C:8.23 ±0.63	T:ND C:ND	T:ND C:ND	T:ND C:ND	T:ND C:ND	N
	Gokhale et al. 2012	T:OFD C:Laser	T:6.03 (1.22) C:5.80 (1.19)	T:2.97 (0.72) C:3.00 (0.95)	T:11.07 (1.57) C:11.5 (	T:9.70 (1.62) C:9.80 (1.77)	T:0.54 (0.45) C:0.55 (0.46)	T:0.29 (0.43) C:0.30 (0.44)	T:1.09 (0.75) C:1.07 (0.77)	T:0.30 (0.47) C:0.56 (0.62)	Y
	Gaspirc and Skalerič 2007	T:MWF +Laser C:MWF	T:5.63 ±0.95 C:5.78 ±0.82	T:2.84 ±0.43 C:2.91 ±0.55	T:6.14 +1.80 C:6.36 ±2.00	T:3.97 ±0.89 C:4.05 ±0.89	T:ND C:ND	T:ND C:ND	T:ND C:ND	T:ND C:ND	N
	Janani Karthikeyan 2018	T:Kirkland+laser C:Kirkland flap	T:6.451±0.846 C:6.131±0.805	T: 1.727 ±0.390 C:3.016±0.470	T: 6.744 ±0.937 C:6.501±0.942	T: 2.054 ±0.524 C:3.354±0.728	T:2.546 ±0.196 C:2.576 ±0.22	T:1.039 ±0.069 C:1.392 ±0.170	T:ND C:ND	T:ND C:ND	Y
	Sérgio H. L. Martins	T:OFD +laser C:OFD	T:5.63 ±0.45 C:5.70 ±0.50	T:2.70 ±0.3 C:3.40 ±0.50	T:6.05 ±0.82 C:6.18 ±0.74	T:3.70 ±0.8 C:4.18 ±0.66	T:ND C:ND	T:ND C:ND	T:ND C:ND	T:ND C:ND	N

	Javier D. Sanz-Moliner	T:MWF+Laser C:MWF	T:ND C:ND	T:ND C:ND	T:ND C:ND	T:ND C:ND	T:ND C:ND	T:ND C:ND	T:ND C:ND	T:ND C:ND	N
	Snehal A. Dalvi et al 2019	T:OFD +Laser C:OFD	T:5.42 ± 0.28 C:5.48 ± 0.26	T: 2.24 ± 0.39 C:2.38 ± 0.42	T:8.25 ± 0.36 C:8.24 ± 0.41	T:5.42 ± 0.55 C:5.48 ± 0.53	T:2.14 ± 0.39 C:2.10 ± 0.38	T:0.68 ± 0.25 C:0.73 ± 0.32	T:2.2 ± 0.32 C:2.2 ± 0.34	T:0.5 ± 0.2 C:0.89 ± 0.34	N
	Bharathi Devi Jonnalagadda et al 2018	T:OFD +Laser C:OFD	T:4.43 ± 1.03 C:4.48 ± 0.81	T:1.84 ± 0.43 C:1.81 ± 0.31	T:9.08 ± 1.43 C:9.23 ± 1.38	T:7.24 ± 1.20 C:7.24 ± 0.64	T:0.65 ± 0.46 C:0.73 ± 0.46	T:0.58 ± 0.42 C:0.67 ± 0.46	T:0.75 ± 0.44 C:0.83 ± 0.61	T:0.44 ± 0.34 C:0.43 ± 0.32	N
	Tanya Marguerite Lobo et al 2015	T:OFD +Laser C:OFD	T:6.02 ± 0.81 C:6.08 ± 0.91	T:2.35 ± 0.50 C:2.56 ± 0.49	T:6.83 ± 1.09 C:6.64 ± 0.84	T:5.18 ± 0.78 C:4.75 ± 0.47	T:2.35 ± 0.44 C:2.29 ± 0.42	T:0.99 ± 0.35 C:0.95 ± 0.29	T:2.07 ± 0.34 C:206 ± 0.34	T:0.60 ± 0.23 C:0.83 ± 0.22	N

Where T is test group and C denotes the control group.

RISK OF BIAS ASSESSMENT

Inherent risk of bias was assessed for each included study.following parameters were analysed to assess the bias. Random sequence allocation (selection bias), allocation concealment (selection bias), blinding of patients and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), selective reporting (reporting bias) and other bias.. An assessment of risk of bias (high, unclear, low) was made for each included trial by using the Cochrane risk of bias tool that was adapted to the current systematic review.

Table 3 : Level of evidence table for included articles.

SR NO	AUTHOR AND YEAR STUDY	DESIGN	LEVEL OF EVIDENCE
1	Sculean et al. 2004	RCT	Level 2
2	Crespi et al.2011	RCT	Level 2
3	Gokhale et al. 2012	RCT	Level 2
4	Gaspirc and Skaleric 2007	RCT	Level 2

5	Janani Karthikeyan 2018	RCT	Level 2
6	Sérgio H. L. Martins et al. 2017	RCT	Level 2
7	Javier D. Sanz-Molineret al. 2012	RCT (PILOT STUDY)	Level 2
8	Snehal A. Dalvi et al 2019	RCT	Level 2
9	Bharathi Devi Jonnalagadda et al 2018	RCT	Level 2
10	Tanya Marguerite Lobo et al 2015	RCT	Level 2

OXFORD CENTRE FOR EVIDENCE-BASED MEDICINE – LEVELS OF EVIDENCE

Level I- Systematic review of randomised trials or n-of-1 trials
Level II- Randomised trial or observational study with dramatic effect
Level III- Non-randomised controlled cohort/ follow-up study
Level IV- Case series, case-control or historically controlled studies
Level V- Mechanism-based reasoning (expert opinion, based on physiology, animal or laboratory studies)

DISCUSSION :

All the articles included in the study are randomised controlled trials which are level II evidence according to Oxford level of evidence. The purpose of the article is to put forward cumulative results and to find any lacunae if present in the included studies by critically analysing the included studies. All the articles have done adequate randomisation although some articles fail to clearly mention the risk of bias assessment questionnaire clearly.

Higher effectiveness of lasers over the conventional treatment modalities is due its theoretical advantages (i.e. ablation or vaporization, hemostasis, sterilization effect and morbidity reduction). Application of lasers to get better outcomes clinically as well and microbiologically is a highly controversial topic currently in clinical periodontics. Lasers are effective in the treatment of chronic and aggressive periodontitis and peri-implantitis, and even in treatment maintenance at follow-up session [24–27].

Sculean et al. included patients each of whom exhibited one deep intrabony defect were randomly treated with either access flap surgery followed by root surface and defect debridement using an Er:YAG laser (KEY3s) (160 mJ, 10 Hz) (test), or with access flap surgery followed by root surface and defect debridement using hand and ultrasonic instruments (control), at 6 months he found significant improvements of the investigated clinical parameters. [9]

Janani Karthikeyan, MDS, Rajaram Vijayalakshmi et al.conducted a study where : A total of 20 patients with generalized chronic periodontitis with probing pocket depth ‡5 mm after phase I therapy were included in this split-mouth study. Two contralateral quadrants of each patient were randomly assigned to either test or control group. Control group was treated with Kirkland flap surgery alone, whereas test group was treated with DL as an adjunct to Kirkland flap surgery. Results with baseline, both treatments showed an improvement in periodontal parameters at the third and sixth month. However, test group produced a significant improvement in plaque index (1.039 – 0.069 vs. 1.392 – 0.17, $p < 0.001$), bleeding on probing (16.512 – 5.982 vs. 37.051 – 7.459, $p < 0.001$), probing pocket depth (1.727 – 0.39 vs. 3.016 – 0.47, $p < 0.001$), and clinical attachment level (2.054 – 0.524 vs. 3.354 – 0.728, $p < 0.001$) at third and sixth month compared with the control group. Also the bacterial load of red complex bacteria was reduced in the laser group post treatment.[28]

Javier D. Sanz-Moliner included 13 patients with generalized severe chronic periodontitis completed the study. Control sites were randomly selected to receive an MWF and the contralateral test sites an MWF in conjunction with a DL. statistically significant results seen for tissue edema , pain medication consumption and intra-operative pain.[10]
Sneha R. Gokhale et al included 30 patients with generalized chronic periodontitis with probing depth > 5 mm after phase I therapy were included in the study. Diode laser was used as an adjunct to open flap debridement (test) as compared with conventional flap surgery (control) in a split-mouth study design. No significant difference was found in parameters in test and control groups, However, there was a statistically significant reduction in colony forming units (CFU) of obligate anaerobes in the test group as compared with the control group.[8]
Snehal A. Dalvi et al. carried out study on 20 individuals who were divided into 2 groups. 1 group underwent conventional OFD whereas group 2 OFD + aPDT. significant improvement in RAL, RGML and GI in the test group was seen.[29]

In contrast to cumulative results of the current article a study done by Crespi et al.2011 showed that in deep pockets (PD≥7mm), coronally advanced flap combined with CO2 laser provided greater PD reduction compared to modified Widman flap procedure[30] similar trend was noticed in CAL parameters. It can be safely said that CO2 lasers have beneficial effects in treatment of deep pockets. These findings have been partially attributed to CO2 laser ability of removing smear layer and eliminating bacterial cells from the diseased root surfaces [30,31]. Nonetheless the study was performed with 2 different surgical procedures also no damage to the root surface morphology was observed/mentioned in the study which is in contrast to previous literature [31–34]. Other studies are in the favour of the results of the current article [8,35,36]. Study done by Gokhale et al. [8] where he used diode laser as adjunct to mechanical debridement was compared with conventional therapy no significant results were found intergroup with regards to main clinical parameters. However a significant difference in pre and post surgical values of microbial colonies was evident in the treatment group[8].
Lasers disrupt the protective mechanism of the microbes and also denature the cellular wall proteins which results in cell lysis [37–39]. Lasers are found to decrease bone loss and reduce periodontal signs of redness and bleeding on probing after periodontal treatment [40–42].
Many of the key periodontal pathogens are suppressed in significant levels by laser exposure. The list includes Porphyromonas gingivalis, Aggregatibacter actinomycetemcomitans (previously Actinobacillus actinomycetemcomitans), Fusobacterium nucleatum, Prevotella intermedia and Streptococcus sanguis.
Dental lasers have also been studied in the field of regenerative periodontal surgeries [43–45]. In cases where low level laser was used as adjunct to GTR statistically better results were seen with respect to PD and CAL at 6 months. Also significant improvement in gingival bleeding index was seen favouring the laser group. Similar findings were seen in studies where LLLT was use as adjunct to GTR hence in can be stated that LLLT used as adjunct to regenerative procedure yields better short term results [45–48]. Lasers have also been used for root surface biomodification prior to GTR and regenerative procedures which shows favourable results [48–52]. In vitro studies conducted to assess responsiveness of the fibroblasts and collagen to the laser irradiation [47,53]. Less collagen breakdown following laser irradiation is described by plasminogen activator plasmin proteolytic system inhibition with the use of laser [52,53].

CONCLUSION :

Results of this systematic review fail to prove any statistically significant advantages of use of laser as adjunct over the conventional treatment procedures for pocket reduction or other surgical procedures. Lack of evidence, limited sample size and high heterogeneity amongst studies contribute to the non significant benefits of use of lasers as adjunct to conventional treatment. Similar studies with more sample size and added microbiological parameters have to be done to conclusively address the research question.

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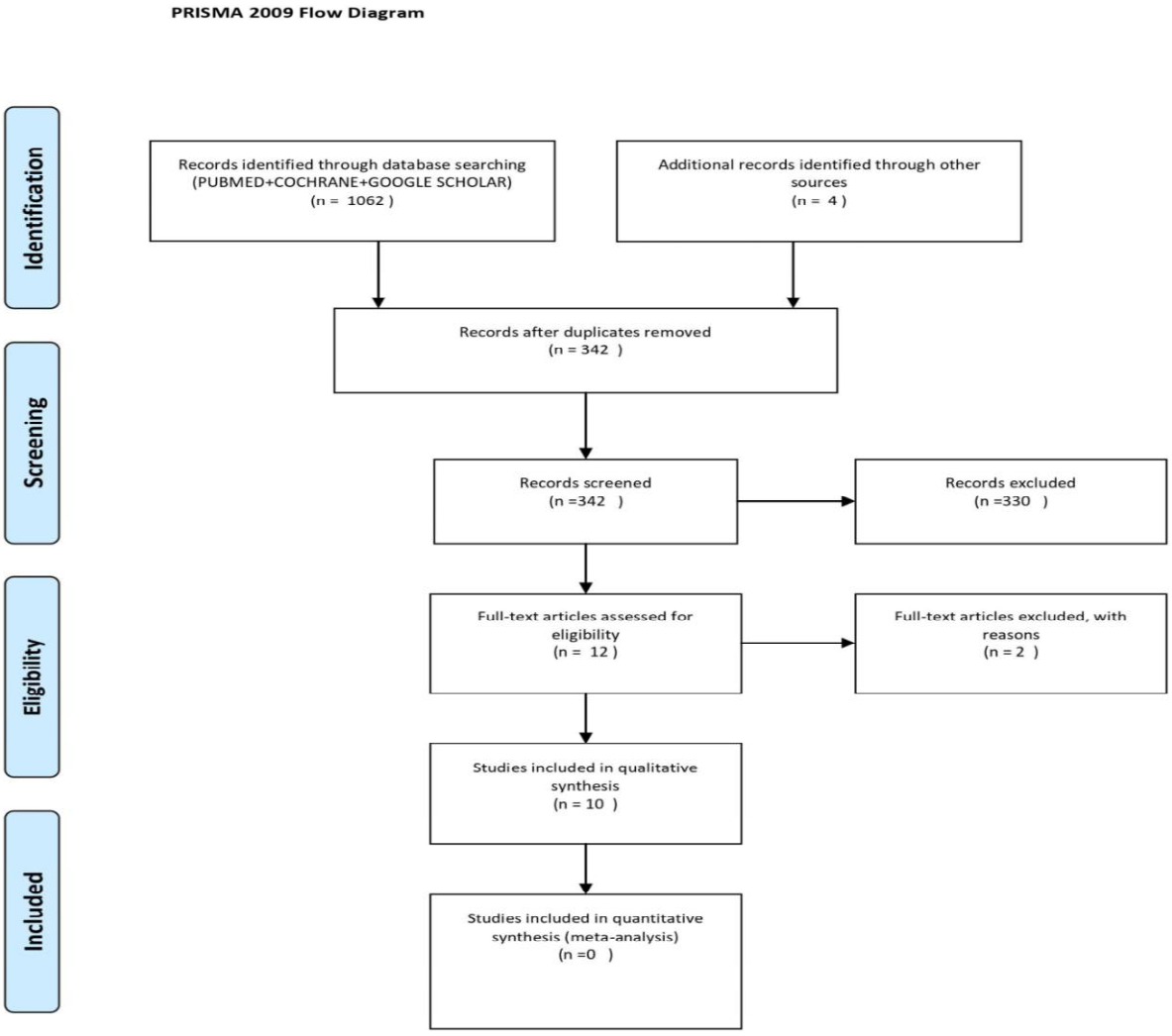

Figure 1 : PRISMA flow diagram for the included and excluded articles in the systematic review.

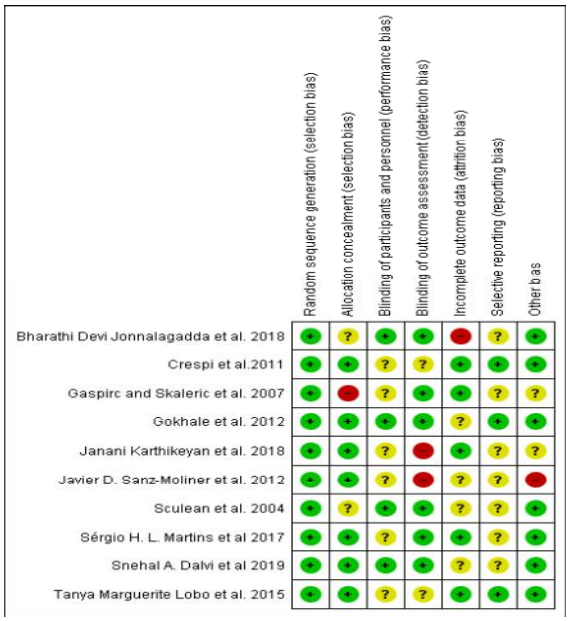

Figure 2 : Risk of bias assessment graph for all the included articles.

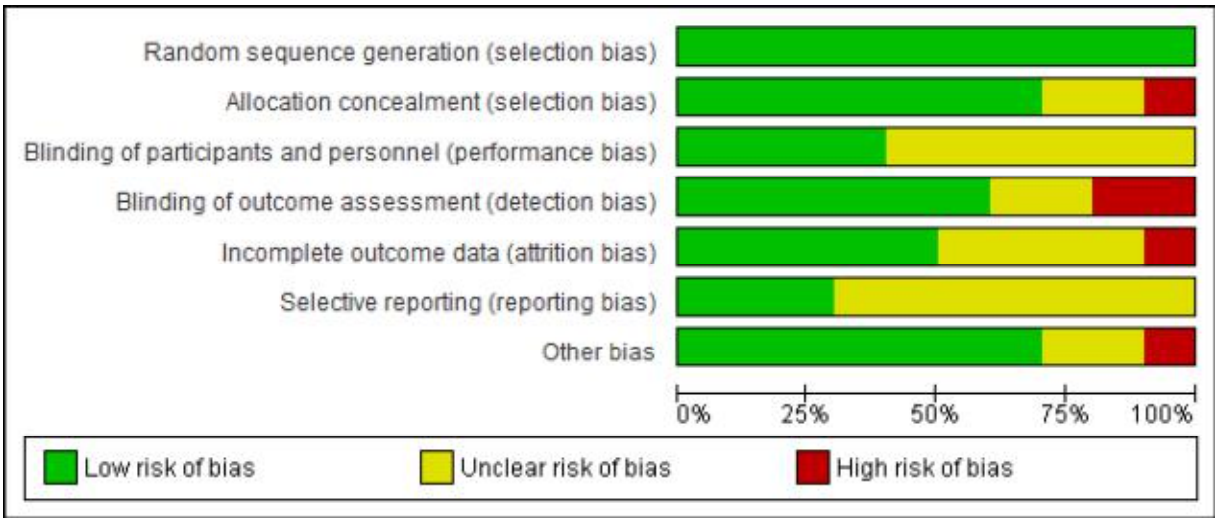

Figure 3 : Summary of risk of bias for the included studies in the systematic review.

Figure 4 : Electronic search results **PUBMED CENTRAL**

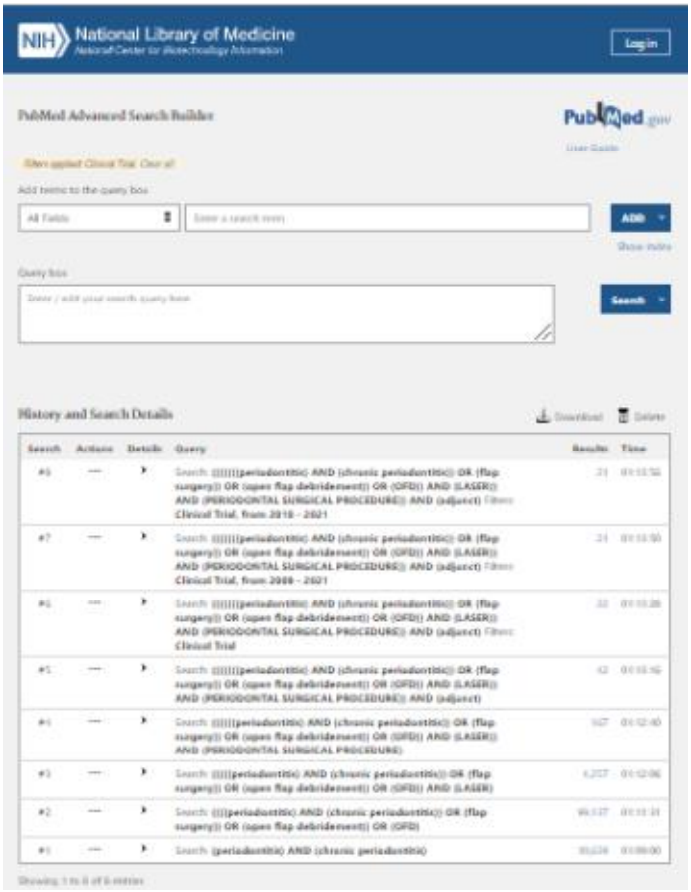

Figure 5 : Electronic search results **GOOGLE SCHOLAR**

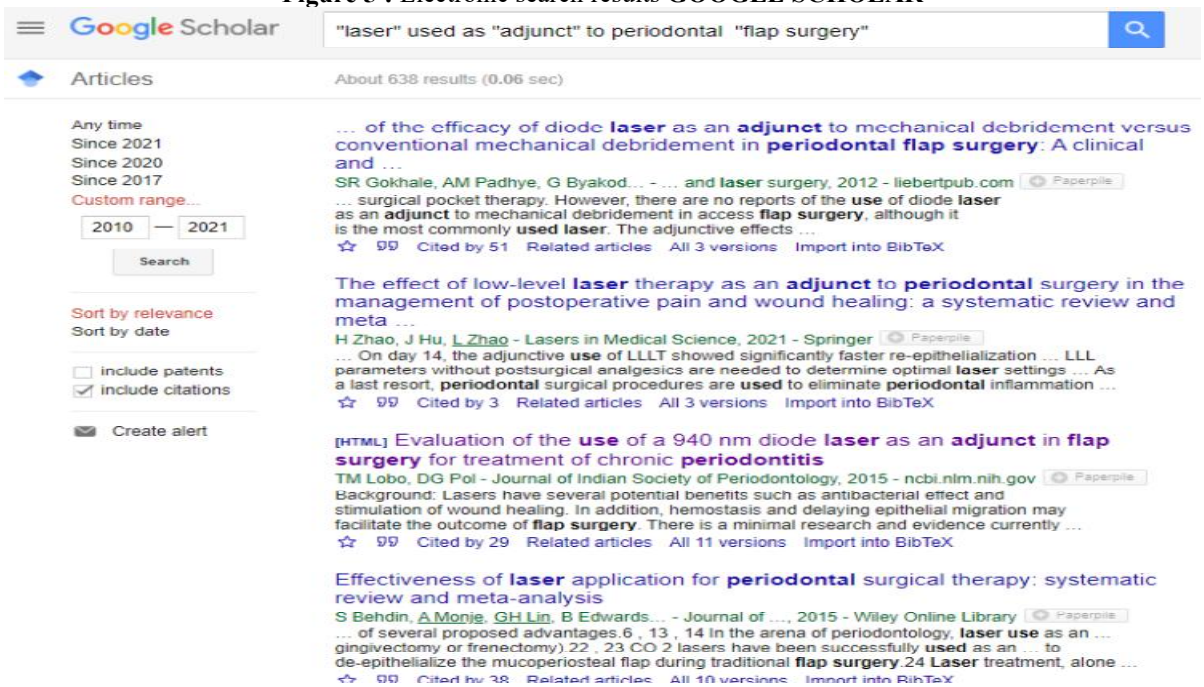

Figure 5 : Electronic search results **COCHRANE LIBRARY**