European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 07, Issue 06, 2020

Low Level Laser Therapy In Dentistry: A Systematic Review

Dr. Lipika Gopal[1], Dr. Ashim Aggarwal[2]

[1]PhD Research Scholar,Department of Oral and Maxillofacial surgery, Faculty of Dental Sciences, Manav Rachna Dental College, MRIIRS
[2]Supervisor,Professor & HOD Department of Oral and Maxillofacial surgery Faculty of Dental Sciences, Manav Rachna Dental College, MRIIRS

Email id -[1] lipikagopal@yahoo.com, [2]viceprincipal.mrdc@mrei.ac.in

Abstract: Objectives: Systemic review to know the effectiveness of low level laser therapy (LLLT).
Material and Methods: Literature search was carried out from online databases including Medline, Web of Science, and Scopus between 2010 to 2019.
Results: Following screening, 10 publications were eligible for the review. A meta-analysis could not be performed due to the heterogeneity of the studies. The results from the studies indicate that use of maintained dose of LLLT post therapy had substantial beneficial effects.
Conclusions: The use of LLLT post operatively has certain positive effect. Evidence on accelerated wound healing and post-operative analgesia were profound but increased rate of bone formation were only limited to animal studies. Further research is warranted to reach absolute certainty.

1. INTRODUCTION

The thought of laser light as a remedial measure in providing analgesia, anti-inflammatory action and healing properties was given by several scientists. The first prototype of laser was developed by Maximan in 1960. The use of laser was first described by Mester et al in 1971[1]. In dentistry the first laser was marketed in the year 1989. A modified opthalmic Neodynium: Yttrium Aluminium Garnet (Nd:YAG) laser was put in dental use in 1989[2]. Since its first dental application, the procedures involving laser therapy has increased rapidly in last few decades. Laser dentistry has reached its zenith in research and clinical practice since last decade.
Light Amplification by Stimulated Emission of Radiation is commonly known as LASER[2]. It is an equipment that converts light of different frequencies into non-divergent beam of monochromatic light. This beam of light is considered to be collimated, intense and coherent generating electromagnetic radiation with a uniform wavelength, phase and polarisation. Lasers can be distinguished based on the tissue it acts on and based on the wavelengths. Regarding tissue interaction, lasers can be classified as soft and hard tissue lasers. Soft tissue laser includes holmium,Nd:YAG,argon,diode,CO2 lasers while hard tissue lasers comprises of Er: Yttrium Scandium-gallium-garnet (Er:YSGG) and Erbium:YAG (Er:YAG). The dosage of laser beam and wavelength affects the laser. The low dosage lasers are those with low-energy power of < 90mW. These lasers emit lowest energy level and is considered to be a type of intensive, focal light therapy. This is termed as Low Level Laser therapy (LLLT) which is indicated for biostimulation at low dosages in tissue. Hence LLLT involves application of phototherapy which is coherent and low power monochromatic light. Low level laser therapy is indicated for effects like collagen synthesis, fibroblast proliferation and ultimately

biostimulation of wound[3].Low level laser therapy (LLLT) is considered to be a noninvasive therapy. LLLT is characterised by wavelength ranging from 600-1100nm, an output power of 1-500mW and energy density of 0.04-50J/cm2[4]. It is preferred over the conventional lasers because of the high level of healing property and other therapeutic uses which include postoperative care, reduced edema, inflammation and pain.

2. MATERIAL AND METHODS

Search strategy and study selection
The literature search was carried out from online databases including Medline, Web of Science, Scopus. The references of each article were also taken into consideration. The bibliographic databases were searched from 2010 to 2019. The MesH terms taken into account were "laser therapy", "low level laser therapy", "photobiomodulation", "laser bio-stimulation" and "cold laser".
Inclusion criteria - Studies meeting following criteria were taken into consideration:-
1. Authors determining parameters of lasers such as power output and duration of treatment.
2. The condition treated was clearly stated.
3. The type of laser used and wavelength defined.
4. Primary studies/studies in which LLLT was compared with placebo/without laser irradiation taken as control.
Exclusion criteria
1. Studies reported in languages other than English.
2. Sources from Wikipedia without references.
3. In vitro studies involving tissues, cells and not whole animal.

Data Analysis
Demographic data and study design including application protocol, follow-up and main results were recorded from each article. (Table 1). Qualitative synthesis was conducted using evidence tables and written evidence summaries. Studies were summarized to minimize heterogeneity. Due to small sample sizes and significant heterogeneity among studies, no meta-analyses were performed. Risk of bias was assessed for each individual study. The Consort guidelines have been followed in selection and exemption of studies in this article. (Table 2).

Table 1: Categorical list of the studies used in the review

Author & Year	Country	Study design	Sample	No.of animals/subjects	Laser type	Application period	Results
Hamzah et al, 2019 [5]	Iraq	Randomised clinical trial	Clinically healthy patients	20	Diode laser, 940nm, 0.8W	Continuous mode with exposure time ranging from 15-60s	The pain score decreased zsignificantly only on 5th day postoperatively and also there was

							a significant decreased level of discomfort and bleeding levels in laser group.
Deynek et al, 2019 [6]	Turkey	Randomised Clinical trial	Wistar rats	80	Indium Gallium Arsenide Phosphide, 940nm, 0.1W	Continuous mode for 3 mins twice weekly after 1 week expansion period	Favourable effect on bone formation in orthopaedically expanded midpalatal suture of rats.There was higher level of osteoblasts and osteocytes.
Lingamaneni S et al, 2018 [7]	India	Randomised, double blind,split mouth clinical study	Systemically healthy individuals in which gingivectomy procedure was done	10 subjects	Diode laser, 810nm, 0.1W in continous mode for 5 min	3^{rd}, 7^{th}, 14^{th} day	Laser showed better surface epithelialisation resulting in improved wound healing significantly on the 14^{th} day post operatively
Noda et al, 2016 [8]	Japan	Split mouth	Healthy Sprague-Dawley rats	27 rats	High-frequency pulsed diode laser,	1 minute applica	Laser improved surface

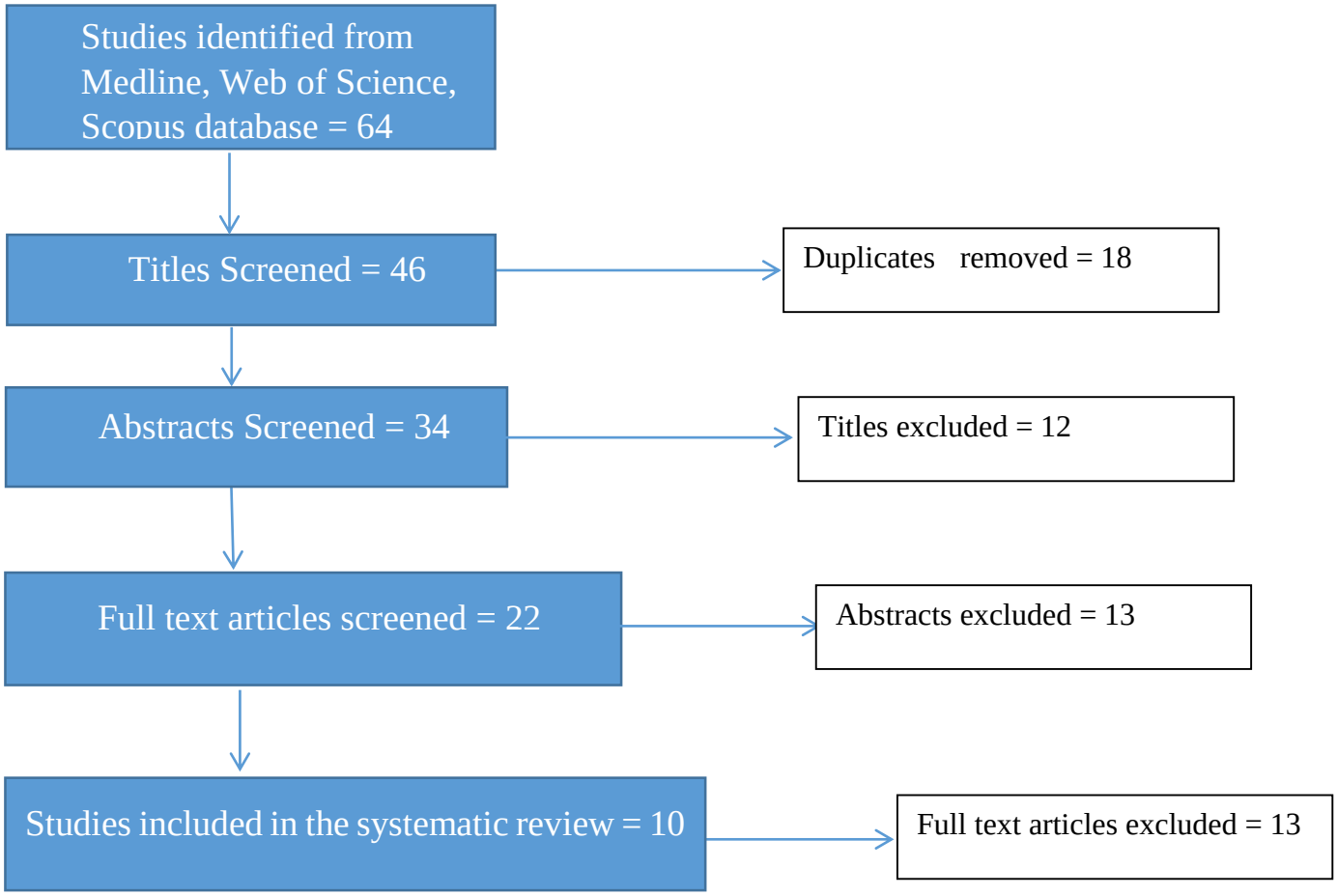
					650nm,0.28W	tion immed iately after tooth extracti on and daily for 7days	epithelial isation and also the bone mineral content, bone mineral density and bone volume significa ntly increased and showed a high osteocalc in and mRNA expressio n values and PCNA-p ositive cell numbers.
Alan et al, 2016 [9]	Turk ey	Rando mised clinical trial	Patients with asymptoma tic bilateral impacted mandibular 3rd molars	15	Gallium-Alumini um-Arsenide diode laser, 810nm at 300mW	40seco nds immed iately after the surgery and 2nd day after surgery .	Statistica lly significa nt decrease in pain intensity on 7th day, less facial swelling in laser group but no statistical ly significa nt differenc e betwen 2 groups, greater degree of

							oral opening on 2nd and 7th day after surgery but no statistically significant difference.
Hamad et al, 2016 [10]	Iraq	Randomised clinical trial	Male rabbits	20	Gallium-AluminiunArsenide diode laser, 808nm,0.9W	Continuous mode for 5 min immediately after extraction and then every 72hrs for next 12 days.	Laser treated sockets showed early formed new bone with faster maturation of primary bone to secondary bone. Also statistically significant increase in the density and volume of trabecular bone was noted.
Halon et al, 2015 [11]	Poland	Randomised control trial, split mouth	HIV infected subjects immediately after tooth extraction	27 subjects	Diode laser, 820nm,200mW, 6J/cm^2	Daily for 5 days	Laser therapy accelerated wound healing

Vallone et al, 2014 [12]	Italy	Randomised clinical trial	Healthy subjects	50	Galium-Aluminium-Arsenide diode, 980nm, 20W	Continuous mode thrice weekly and followed by daily schedule for 3 weeks	Decrease in back pain at the end of 3 week period in laser group
Maia ML de Moraes et al, 2014 [13]	Brazil	Randomised blind clinical trial	Systemicallyhealthy subjects	21	Low level laser therapy, 808nm, 100mW	Application for 19seconds 2 times per week for 4 weeks	Increase in pressure pain threshold and improvement of masticatory performance and lesser pain intensity of masticatory muscles in laser group.
Santos Junior et al, 2012 [14]	Brazil	Clinical controlled trial, split mouth	Healthy subjects	8	Diode GaAlAs laser, 780-980nm,10-40 mW	10 seconds of application immediately after tooth extraction and after 1 and 2 days.	Laser promoted postoperative analgesia but no difference between laser and controlled group was observed with respect to bone

							repair, wound healing and swelling.

Figure 2 : Consort diagram for study selection in this systematic review



4. RESULTS

Search Results

A total of 64 studies were identified based on search criteria, 18 duplicates were removed and 46 remaining titles were screened. A title review was then done and 12 studies were excluded, reason for exclusion was that they were non-english studies and remaining 34 studies were then again screened based on their abstracts

During the abstract review 13 studies were excluded as they did not include whole animal or human subjects and description of the type of laser was not mentioned. The full text of the remaining studies was assessed and 13 articles were excluded from the study as the correct intervention was not done or the study included only the abstracts or the frequency of the laser used was not correct.

A total of 10 studies were included in the systematic review, Studies by Lingamaneni et al., [7] Halon et al., [11] Santos Junior et al.,[14] Alan et al.,[9] Hamzah et al.,[5] Vallone et al.,[12] and Moraes et al.,[13] used human subjects, while Noda et al.[8] and Deynek et al.,[6] used rats for their respective studies ,Hammad et al.,[10] used male rabbits. Out of the studies that used human subjects the study by halon et al.,[11] had HIV infected patients.
Different type of lasers studied were Gallium-Aluminium-Arsenide diode laser, Indium Gallium Arsenide Phosphide diode laser, High-frequency pulsed diode laser with wavelength ranging from 650nm-980nm.The applications were done post-surgery at various time intervals and the follow up duration ranged from 5days to 4 weeks.

5. DISCUSSION

Lasers have inexplicably become an imminent part of our treatment protocols; this review has imminently found through various articles the beneficial effect of application of LLLT post-surgical procedures. The studies used included both animal and human studies hence it had a plethora of diversified subjects.
Surface epithelisation and keratinization results in wound healing, and acceleration in surface epithelisation or keratinisation accelerates the wound healing process.[15] Lingamaneni et al.,[7] in his study found that application of LLLT post gingivectomy procedures in systemically healthy subjects had better surface epithelisation. Halon et al., [11] too found accelerated wound healing post tooth extraction in HIV infected patients due to application of LLLT after tooth extraction. Noda et al., [8] found similar results albeit in Sprague-Dawley rats, who had shown better surface epithelisation post application of LLLT after tooth extraction.
Post-operative pain which is not properly managed has led to treatment complications hence importance for proper analgesia post any treatment is of utmost importance [16]. Santos Junior et al [14] in his study had found that LLLT promotes postoperative analgesia when applied for 10 seconds after tooth extraction similarly Alan et al found reduced swelling and pain intensity when LLLT was applied 40 s after surgery. Maia ML de Moraes [13] et al too found that LLLT on application in systemically healthy subject post post surgery increases in pressure pain threshold as well as reduces the pain in masticatory muscles. Hamzah et al., [5] too complemented this finding with his study wherein he found similar results
Bone formation post extraction takes places minimally at 3 months, but accelerated bone formation can occur if bone enhancing activity occurs at molecular level. Noda et al.,[8] in his study in rats showed that accelerated bone formation takes place which was indicated by increased bone mineral content and increased osteocalcin levels. Deynek et al., [6] too found favourable effect on bone formation in rats with increased levels of osteoblast.Hamad et al., in his study in rabbits found that LLLT used in post extraction sockets showed faster maturation of primary to secondary bone. Although there was no human studies that showed this beneficial effect in this review but the rate of increased formation of bone post LLLT therapy in post-operative cases in the above mentioned studies gives us suitable evidence to presume that a proper controlled human study would give a similar result.
This review emphasizes the beneficial effect of LLLT which are increased wound healing, Post-operative analgesia and increased bone formation. Additionally the ease of use of this therapy, patient convenience, Haemostatic effect and less traumatic effect although has not been detailed in the studies explored in this review but these beneficial effects of LLLT cannot be undermined. These benefits generate interests among clinicians to gain more knowledge and better understanding of its use and applications. Therefore, further research needs to be done with further emphasis on various application protocol to establish a proper treatment and follow up for each situation so as to improve patient comfort, services and treatment outcomes.

6. CONCLUSION

Evidences were found in this review that complemented the use of LLLT, although some the beneficial effects of LLLT were only seen in Animal studies. Evidences on accelerated wound healing and post-operative analgesia were profound but increased rate of bone formation were only limited to animal studies. Hence further research are needed to augment the beneficial effect of LLLT .The ease of use of LLLT in this increasing technology based world of research would give a new dimension in treatment option available for clinician.

CONFLICTS OF INTEREST : NONE
FUNDING : NONE

7. REFERENCES

[1] Mester E, Szende B, Spiry F, Sacher A. Effects of laserin wound healing. Lyon Chir 1971;67:416-9.
[2] Francis L, Pillai SB. Lasers in implant dentistry. J Dent Implant 2017;7:41-5.
[3] Del Fabbro M, Corbella S, Taschieri S, Francetti L, Weinstein R. Autologous platelet concentrate for post extraction socket healing:A systematic review. Eur J Oral Implantol 2014;7:333-44.
[4] Colaco AS. An update on the effect of low level laser therapy on growth factors involved in oral healing. J Dent Lasers 2018;12:46-9.
[5] Hamzah BF, Ibraheem NS. The effect of low-level laser therapy after simple tooth extraction.J Int Oral Health. 2019;11(4):181
[6] Tas Deynek G, Ramoglu SI. Effects of different settings for 940 nm diode laser on expanded suture in rats. Angle Orthod. 2019;89(3):446-54.
[7] Lingamaneni S, Mandadi LR, Pathakota KR. Assessment of healing following low-level laser irradiation after gingivectomy operations using a novel soft tissue healing index: A randomized, double-blind, split-mouth clinical pilot study. J Indian Soc Periodontol. 2019;23(1):53.
[8] Noda M, Aoki A, Mizutani K, Lin T, Komaki M, Shibata S, Izumi Y. High-frequency pulsed low-level diode laser therapy accelerates wound healing of tooth extraction socket: An in vivo study. Lasers Surg Med. 2016;48(10):955-64.
[9] Alan H, Yolcu Ü, Koparal M, Özgür C, Öztürk SA, Malkoç S. Evaluation of the effects of the low-level laser therapy on swelling, pain, and trismus after removal of impacted lower third molar. Head Face Med. 2016;12(1):25.
[10] Hamad SA, Naif JS, Abdullah MA. Effect of diode laser on healing of tooth extraction socket: an experimental study in rabbits J Oral Maxillofac Surg. 2016;15(3):308-14.
[11] Halon A, Donizy P, Dziegala M, Dobrakowski R, Simon K. Tissue laser biostimulation promotes post-extraction neoangiogenesis in HIV-infected patients Lasers Med. Sci. 2015;30(2):701-6.
[12] Vallone F, Benedicenti S, Sorrenti E, Schiavetti I, Angiero F. Effect of diode laser in the treatment of patients with nonspecific chronic low back pain: a randomized controlled trial. Photomed Laser Surg. 2014;32(9):490-4.
[13] de Moraes Maia ML, Ribeiro MA, Maia LG, Stuginski-Barbosa J, Costa YM, Porporatti AL, Conti PC, Bonjardim LR. Evaluation of low-level laser therapy effectiveness on the pain and masticatory performance of patients with myofascial pain. Lasers Med. Sci. 2014;29(1):29-35.

[14] da Guarda MG, Paraguassú GM, Cerqueira NS, Cury PR, Farias JG, Ramalho LM. Laser GaAlAs (λ860 nm) photobiomodulation for the treatment of bisphosphonate-induced osteonecrosis of the jaw. Photomed Laser Surg. 2012 1;30(5):293-7.
[15] Pastar I, Stojadinovic O, Yin NC, Ramirez H, Nusbaum AG, Sawaya A, Patel SB, Khalid L, Isseroff RR, Tomic-Canic M. Epithelialization in wound healing: a comprehensive review. Adv Wound Care. 2014;3(7):445-64.
[16] Garimella V, Cellini C. Postoperative pain control. Clin Colon Rectal Surg. 2013;26(3):191.