Research Paper

Evaluating the Influence of Photobiomodulation in Wound Healing Following Intra-Alveolar Extraction of Tooth: A Double Blinded Split Mouth Study

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ABSTRACT

Aim and objective: The purpose of the study is to assess the efficacy of photobiomodulation (PBM) in wound healing following intra-alveolar extraction of tooth.

Patients and methods: This double blinded split mouth study included 62 patients undergoing bilateral extraction of tooth under local anaesthesia. The right arch was assigned as the study group to receive PBM therapy after extraction and the left arch was assigned as the control group. The study group received PBM therapy via a soft tissue diode laser set at wavelength of 980 nm with total exposure time of 90s at non contact mode for each extraction socket. Pain intensity using visual analogue scale and wound healing with laundry et al healing index was recorded at various intervals. Data was statistically analysed using SPSS version 22.

Results: In this study we found that there is decrease in pain after extraction following PBM therapy in comparison to the control group which is statistically significant (P = 0.001). The difference in wound healing between the study group and the control group did not show any statistical significance (P > 0.05).

Conclusion: Use of PBM therapy of 980 nm wavelength after an undisturbed intra-alveolar extraction of tooth reduces post operative pain with negligible impact on wound healing.

Keywords: PBM, extraction, post operative pain, wound healing, Socket healing.

INTRODUCTION

Extraction is a commonly performed procedure in dental practice. It is usually performed as a final resort for therapeutic or prophylactic reasons. Healing of an extraction socket is influenced by several factors like local, systemic, iatrogenic and environmental factors [1], and occurs by cellular responses to the histochemical changes occurring during extraction. Once the tooth is extracted, the socket fills up with blood forming a blood clot, which is eventually evacuated by the inflammatory cells leading to formation of new tissue. This is later on followed by fibroplasia and alveolar bone remodelling, the duration of which varies in each individual and may take up to several months [1,2].

Improper wound care and certain other systemic conditions lead to postoperative complications which are pain, haemorrhage, dry socket (Alveolar osteitis), delayed wound healing. The factors that contribute

to the complications can be local factors and systemic factors [3]. Systemic factors include anaemia, diabetes, advanced age [4]. Local factors include dislodgement of blood clot, infection, exposure of the alveolar bone like sharp bony margins and foreign body in the socket as a result of improper wound care and oral hygiene maintenance [4]. Routinely antibiotics, analgesics and Non – Steroidal anti-inflammatory drugs (NSAIDs) and rarely corticosteroids are used to control the incidence of postoperative complications [5,6]. Some additional methods include use of platelet rich fibrin (PRF), platelet rich plasma (PRP), vitamin C along with curettage and irrigation, topical application of hydrocortisone, low level laser therapy (LLLT), topical hemostatics, oxidised cellulose foam, and polylactic acid [4].

LASER Stands for Light Amplification and Stimulated Emission Radiation [7,8,9]. Low Level Laser Therapy (LLLT) or Photobiomodulation (PBM) is a non-surgical, non-thermal, non-ionising treatment modality which employs laser wavelength of 600 through 1000 nm [10]. PBM has substantial evidence that support its application in dentistry for management of temporomandibular joint pathology, chronic orofacial pain, aphthous stomatitis, neural and bone regeneration, dentinal hypersensitivity, and attenuating orthodontic pain [7,9,11-15]. The mechanism of action of PBM includes the primary effects being Biochemical, Bioelectric and Bioenergetic effects; the secondary effects being increase in blood flow and lymphatic drainage which interferes with natural inflammatory response and the general therapeutic effect being activation of the immune system [15,16].

Numerous studies indicate that the application of PBM both intraorally and extra orally may mitigate postoperative discomfort, oedema, and trismus following the surgical extraction of an impacted tooth. However, a uniform protocol of laser was not reported in these studies as an outcome of which there are debatable results.

There are limited literature reports regarding implication of PBM therapy following intra alveolar extraction of teeth. This study aims to evaluate the efficacy of photobiomodulation (PBM) in promoting wound healing after intra-alveolar extraction of teeth.

Aim and objective: The purpose of the study is to assess the efficacy of photobiomodulation (PBM) in wound healing following intra-alveolar extraction of tooth.

MATERIALS & METHODS

The double blinded split mouth study was carried out in the Department of Oral and Maxillofacial Surgery, SRM Kattankulathur Dental College and Hospital, for a period of 6 months on patients reporting to the out-patient department for extraction.

This study was conducted after the approval from the institutional ethical committee. (Ethical Clearance No: SRMIEC- ST0724-1471)

SAMPLE SIZE ESTIMATION:

Using G Power statistics, A sample size was calculated having the power at alpha error 0.05, effect size 1.4, The minimum sample size required was 42 in each group. To account for possible attrition or withdrawal, the target sample size was increased to 62 in each group.

Studies conducted by Ansari Neelofar et al. were utilized for calculation of sample size [17].

PATIENT SELECTION PROTOCOL:

This study included 62 patients undergoing bilateral atraumatic intra-alveolar extraction of teeth. The participants recruited in the study were required to meet the necessary inclusion criteria i.e. patients of age 18 to 60 years requiring extraction of tooth from both sides of the dental arch and classified under ASA 1 and ASA 2. Patients with uncontrolled systemic disease and contraindications for laser therapy were excluded from the study.

All participants in the study received a detailed explanation of the procedure, after which an informed consent was obtained.

PATIENT ASSIGNMENT AND BLINDING:

The study was designed to be a split mouth study which included patients undergoing bilateral extraction, so that the same patient can serve as the laser and control group thereby eliminating any variation in individual's local and systemic conditions influencing wound healing and response to laser therapy. As a standard norm, the tooth extracted from the right arch (1st and 4th quadrant) were considered as a laser group and the tooth extracted from the left arch (2nd and 3rd quadrant) were considered as non-laser group or the control group. However, the patient and the outcome assessor is blinded to eliminate the possibility of bias, thus facilitating a double blinded study design.

SURGICAL PROCEDURE:

After a thorough clinical examination, under aseptic conditions, all patients were administered 2% Lignocaine hydrochloride solution with 1:80,000 Adrenaline to achieve local anaesthesia in relation to the surgical site. Once anaesthesia was achieved, atraumatic extraction of the target tooth was done and haemostasis was achieved following which laser was delivered to the right arch and the left arch served as the control. All extractions and laser delivery were carried out by the same dental surgeon to mitigate potential bias. All patients were given the regular post operative instructions and medications and were followed up on the 3rd and 7th post operative days.

LASER PROTOCOL:

After extraction, the right dental arch received PBM therapy from a soft tissue diode laser (Photon S 10 Laser unit). The laser unit was set at a wavelength of 980 nm continuous wave emission operated at an output power of 0.2W (Fig 1). The laser was delivered immediately after extraction at 3 target areas which included the occlusal, buccal, and the lingual/palatal surfaces of the extraction socket. The laser was delivered for 30 seconds at each of these target areas, cumulating into 90 seconds in total for each extraction socket, at non-contact mode (10 mm distance from the site).

Figure 1: Laser unit

ASSESSMENT PARAMETERS:

The following Assessment parameters were taken into consideration

1. Intensity of pain:

Pain was evaluated using a 10-level visual analogue scale (VAS). Pain was recorded after PBM therapy, post operative day 3 and post operative day 7.

2. Soft tissue healing:

Soft tissue healing was assessed using the healing index by Landry et al (Fig 2) on post operative day 3 and 7 by a physician qualified in the department of oral medicine, diagnosis and radiology (Fig. 3,4).

| Healing Grade	Clinical Criteria
Very poor 1	Tissue color: > 50% of gingivae red Response to palpation: bleeding Granulation tissue: present Incision margin: not epithelialized, with loss of epithelium beyond margins Suppuration: present
Poor 2	Tissue color: > 50% of gingivae red Response to palpation: bleeding Granulation tissue: present Incision margin: not epithelialized, with connective tissue exposed
Good 3	Tissue color: < 50% of gingivae red Response to palpation: no bleeding Granulation tissue: none Incision margin: no connective tissue exposed
Very good 4	Tissue color: < 25% of gingivae red Response to palpation: no bleeding Granulation tissue: none Incision margin: no connective tissue exposed
Excellent 5	Tissue color: all gingivae pink Response to palpation: no bleeding Granulation tissue: none Incision margin: no connective tissue exposed

Figure 2: Landry et al Healing Index
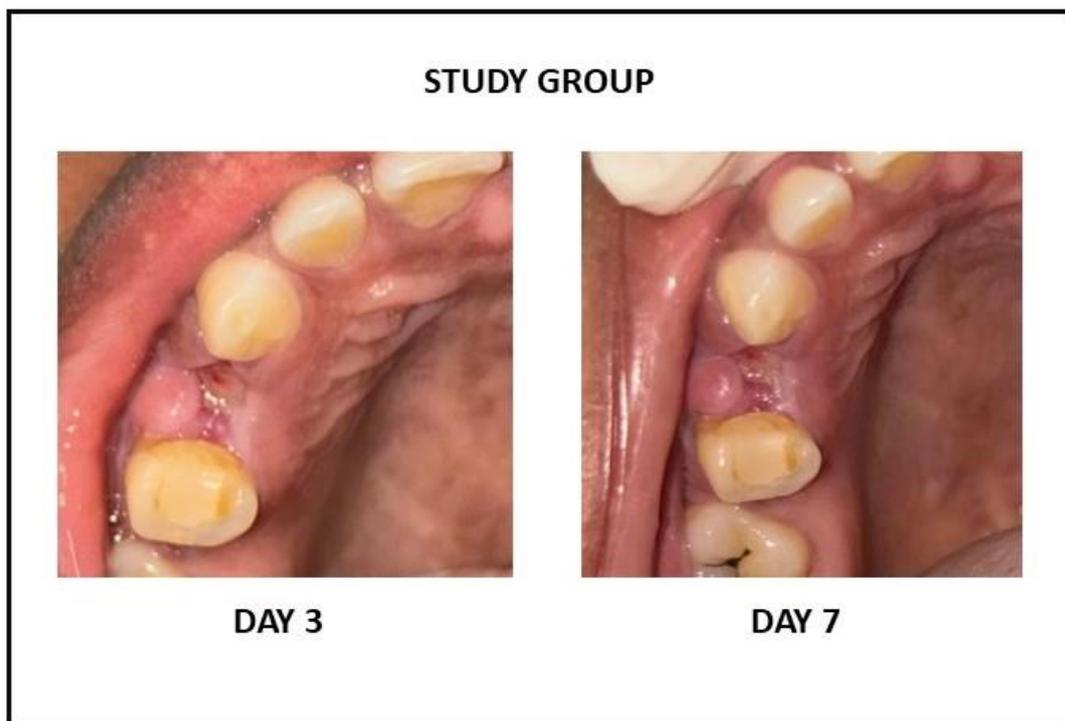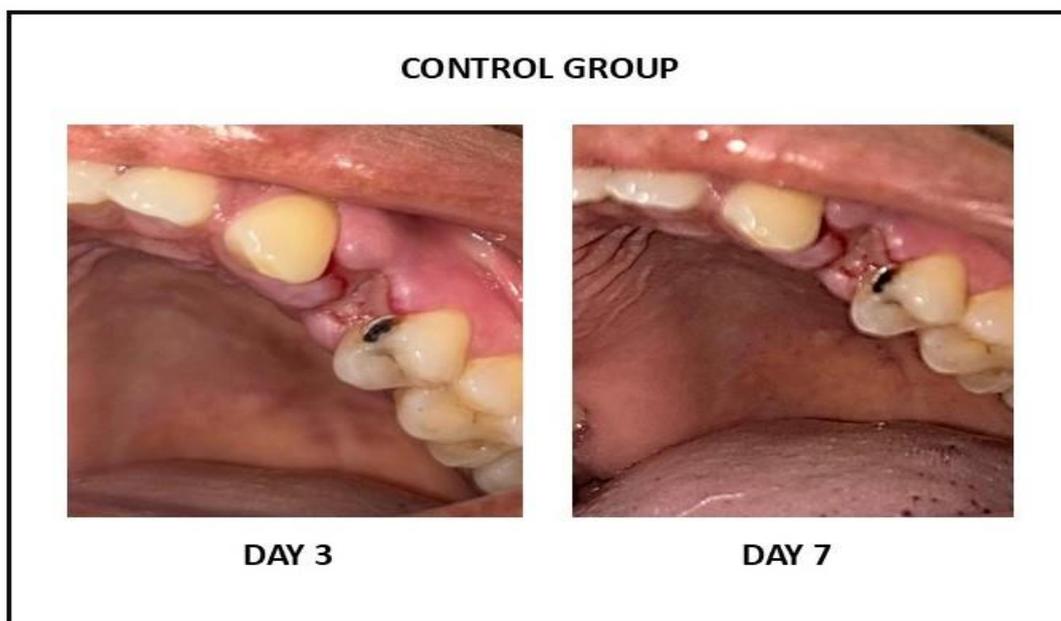

Figure 3:Study group healing

Figure 4: Control group healing

STATISTICAL ANALYSIS

Data was compiled in Microsoft Excel and then transferred to SPSS software version 22. Both descriptive and inferential statistics were applied. Since the data did not follow a normal distribution, non-parametric analysis was conducted. The Mann-Whitney U test was used to compare mean between the study and control groups for pain and wound healing, while Friedman's test was used to compare mean across time intervals within both groups for pain. Additionally, the Mann-Whitney U test was used for subgroup comparisons based on arch, assessing healing on postoperative days 3 and 7 between the study and control groups. Post hoc comparison was done within time intervals among study group and control group using Wilcoxon rank sum test for both pain and healing.

RESULT

Out of the 62 study patients, 8 were males and 54 were female patients with a mean age of 41.5 yrs. Quadrant wise segregation shows 34 cases in maxilla and 28 cases in mandible.

Mean comparison done for pain between study group and the control group using Mann U Whitney test shows statistically significant difference in pain at post operative day 0 (P = 0.001) and postoperative day 3 (P=0.001). However, there was no statistically significant difference between both the groups for pain at post operative day 7 (Table 1, Fig.5)

TABLE 1: MEAN COMPARISON BETWEEN GROUPS USING MANN WHITNEY U TEST.

	GROUP	Mean	Std. D.	Minimum	Maximum	Mean Rank	Sum of Ranks	Z	P value
Pain POD 0	1	0.55	0.50	0.00	1.00	39.73	2463	-7.713	0.001
	2	1.55	0.56	1.00	3.00	85.27	5287		
Pain POD 3	1	0.77	0.42	0.00	1.00	51.21	3175	-4.025	0.001
	2	1.23	0.71	0.00	2.00	73.79	4575		
Pain POD 7	1	0.65	0.55	0.00	2.00	66.73	4137	-1.478	0.139
	2	0.52	0.62	0.00	2.00	58.27	3613		
Healing POD 3	1	2.81	0.60	2.00	4.00	61.66	3823	-0.283	0.777
	2	2.87	0.80	2.00	4.00	63.34	3927		
Healing POD 7	1	3.52	0.81	2.00	5.00	64.21	3981	-0.571	0.568
	2	3.48	0.84	2.00	5.00	60.79	3769		

(POD – Postoperative Day; Group 1 - Study group; Group 2 - control group)
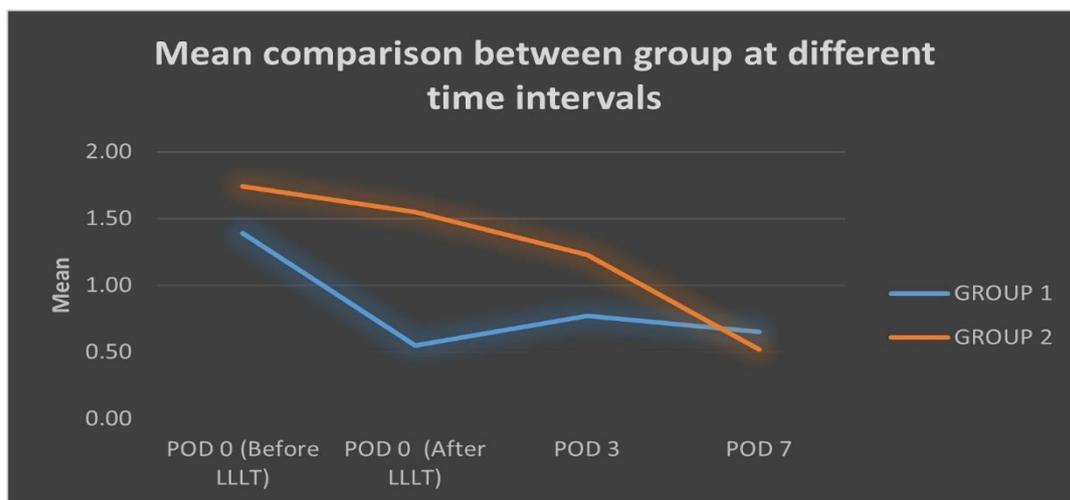
Figure 5:Mean comparison for pain

Mean comparison done for healing between groups using Mann U Whitney test shows considerable difference in healing between the study group and control group on post operative day 7 (Mean difference for study group 3.52±0.81 and control group 3.48±0.84). However, this difference was not statistically significant (Table 1, Fig.6).
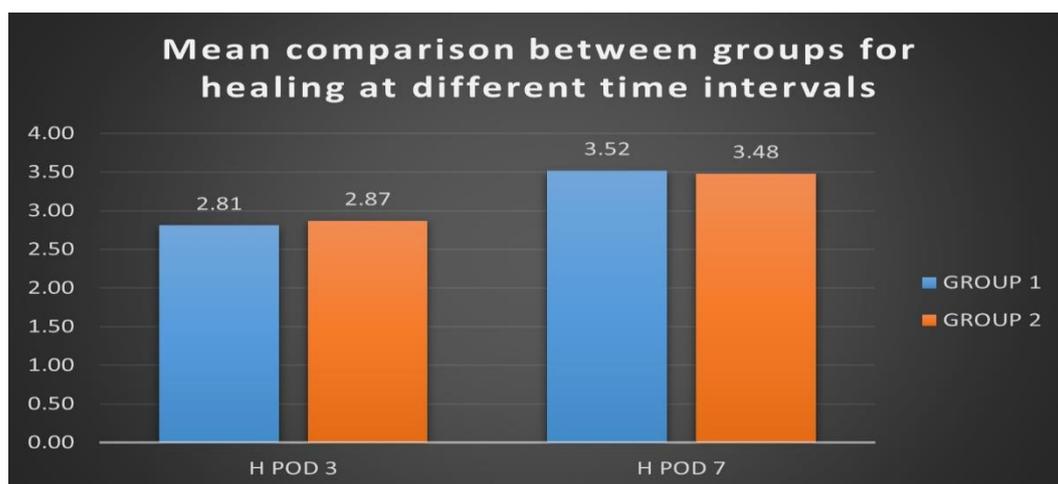

Figure 6:Mean comparison for healing

Friedman test was utilised for mean comparison of pain at all time interval among the study group and the control group, which shows that, within the study group and the control group there is a statistically significant difference in pain at all times i.e. postoperative day 0, postoperative day 3 and day 7 (P = 0.001) (Table 2)

TABLE 2: MEAN COMPARISON FOR PAIN WITHIN TIME INTERVALS AMONG GROUPS USING FRIEDMANS TEST.

GROUP	Time Intervals	Mean	Std. D.	Mean Rank	Chi-Square	P value
1	POD 0 (Before PBM)	1.39	0.75	3.42	86.04	0.001
	POD 0 (After PBM)	0.55	0.50	2.00		
	POD 3	0.77	0.42	2.40		
	POD 7	0.65	0.55	2.18		
2	POD 0 (Before PBM)	1.74	0.44	3.26	103.83	0.001
	POD 0 (After PBM)	1.55	0.56	2.94		
	POD 3	1.23	0.71	2.39		
	POD 7	0.52	0.62	1.42		

(POD – Postoperative Day, PBM - Photobiomodulation; Group 1 - Study group; Group 2 - control group)

Post hoc comparison of pain within time intervals using Wilcoxin rank sum test show a statistically significant difference in both study group (P = 0.001) as well as the control group (P = 0.001) at various time intervals (Table 3)

TABLE 3: POSTHOC COMPARISON FOR PAIN WITHIN TIME INTERVALS AMONG GROUPS USING WILCOXIN RANK SUM TEST.

Group	Comparison for pain within intervals		Z value	p value
1	POD 0	POD 3	-5.154	0.001
	POD 0	POD 7	-5.5	0.001
	POD 3	POD 7	-2.309	0.021
2				
	POD 0	POD 3	-3.78	0.001
	POD 0	POD 7	-6.216	0.001
	POD 3	POD 7	-5.562	0.001

(POD – Postoperative Day; Group 1 - Study group; Group 2 - control group)

Post hoc comparison of healing within time intervals using Wilcoxin rank sum test show a statistically significant difference in both study group (P = 0.001) as well as the control group (P = 0.001) (Table 4)

TABLE 4: POSTHOC COMPARISON FOR HEALING WITHIN TIME INTERVALS AMONG GROUPS USING WILCOXIN RANK SUM TEST.

GROUP	Time Intervals	Mean	Std. D.	Z value	P value
1	POD 3	2.81	0.60	-6.07	0.001
	POD 7	3.52	0.81		
2	POD 3	2.87	0.80	-5.856	0.001
	POD 7	3.48	0.84		

(POD – Postoperative Day; Group 1 - Study group; Group 2 - control group)

Subgroup comparison for healing was done for maxilla and mandible among the study group and the control group for post operative day 3 and post operative day 7 using Mann U Whitney test, which showed no statistically significant difference in healing for both maxilla and mandible between both groups at all times (P > 0.05) i.e. post operative day 3 and post operative day 7 (Table 5)

TABLE 5: SUBGROUP COMPARISON BASED ON ARCH BETWEEN GROUPS AMONG HEALING USING MANN U WHITNEY TEST

Arch	Group	N	Mean	Std. D.	Minimum	Maximum	Mean Rank	Z Value	P value
HEALING ON DAY 3									
1	1	34	2.82	0.71	2	4	36.32	-0.819	0.413
	2		2.71	0.83	2	4	32.68		
2	1	28	2.79	0.41	2	3	25.36	-1.697	0.09
	2		3.07	0.71	2	4	31.64		
HEALING ON DAY 7									
1	1	34	3.71	0.83	2	5	37.21	-1.196	0.232
	2		3.47	0.92	2	5	31.79		
2	1	28	3.29	0.71	2	4	27.36	-0.582	0.561
	2		3.5	0.74	3	5	29.64		

(Group 1 - Study group; Group 2 - control group; Arch 1 - Maxilla; Arch 2 - Mandible)

DISCUSSION

This split mouth study was aimed at evaluating the efficiency of PBM in reducing pain and promoting wound healing after a non-traumatic intra-alveolar extraction of tooth. Application of PBM after intra alveolar extraction has been explored in limited earlier studies with mixed outcomes. These variations can be attributed to differences in study design and

methodology, challenges in measuring variables related to postoperative sequelae, as well as variations in the types of lasers, handpieces, and irradiation techniques used [18].

In our study we had used a soft tissue laser of 980nm for 30s each on the buccal, lingual/palatal and the occlusal aspect cumulating to a 90s exposure time on each socket. The results of our study shows that there is a substantial decrease in postoperative pain on application of PBM therapy after extraction with negligible impact on socket healing.

In contrast to the study conducted by Farzaneh Ahrari et al, which concludes that PBM therapy of wavelength 660 nm and 810 nm or their combination has no greater effect then the placebo in reducing pain [2]; our study shows that PBM therapy of wavelength 980nm has a significant effect in reducing pain after extraction of tooth.

Based on a study conducted by Hilal Alan et al, there was a statistically significant difference in pain on day 7 [19]; our study shows striking statistical difference in pain on both postoperative day 0 and 3.

Meta analysis conducted by Daiane Domingos de Barros et al concludes that low level laser therapy was effective in relieving post operative pain following surgical extraction of lower third molar tooth [20], which is in accordance with the finding of this study i.e. PBM therapy can be used for pain control in an intra alveolar extraction

Use of PBM brings about alterations in cellular response which includes the primary Biochemical, Bioelectric and Bioenergetic effects which stimulate production of ATP and causes cellular mitotic acceleration; the secondary effects by increase in blood flow and lymphatic drainage which interferes with natural inflammatory response and the general therapeutic effect by activation of immune system [8,21].

The analgesic effects of PBM are attributed to its role in stimulating the production of endogenous endorphins (β-endorphins), reducing inflammatory cytokines and enzymes, modulating pain thresholds, inducing structural changes in neurons, decreasing mitochondrial membrane potential, and blocking fast axonal flow, which leads to neural conduction inhibition [8,9,21]. The anti-inflammatory effects of PBM are due to enhanced phagocytic activity, an increase in the number and diameter of lymphatic vessels, decreased blood vessel permeability, restored microcapillary circulation, and reduced oedema [7,9,13,22].

In contrast to study conducted by Farzaneh Ahrari et al concludes that LLLT of wavelength 660nm and 810 nm or their combination has no greater effect than the placebo in accelerating wound healing [2]; this study shows that there is a considerable difference in healing in the study group on postoperative day 7.

Mechanism by which PBM promotes wound healing is explained by the fact that photons emitted in the process of PBM is absorbed by mitochondrial chromophores causing two-fold increase in the mitochondrial respiratory chain leading to increased ATP production and release of nitrous oxide (NO), reactive oxygen species (ROS), and intracellular calcium which contribute to wound healing and prevent tissue necrosis [3,23]. Additionally, PBM reduces inflammation while concurrently increasing collagen synthesis and deposition, fibroblastic proliferation and angiogenesis – all of which has cumulative effects that enhance wound healing [7,22].

CONCLUSION

In conclusion, PBM therapy of wavelength 980nm has a significant role in reducing post operative pain with considerable effect on wound healing between the study and the control group. Extensive studies need to be conducted on a larger scale to substantiate the efficacy of PBM to promote wound healing.

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