

**EFFECT OF LOW LEVEL LASER THERAPY (LLLT) ON THE SEVERITY OF POST-BURN IMMATURE SCARS: A RANDOMIZED CONTROL STUDY**

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**ABSTRACT**

**Background:** Immature scars are a major problem during post-burn rehabilitation phase. These scars are preventable and reversible. Conventional treatment of post-burn immature scars is pressure therapy, but it has a limitation of poor adherence. Many adjuvant therapies are existent for treatment of these scars; Low Level Laser Therapy (LLLT) being one of them. The effect of LLLT over post-burn scars is not supported by sufficient clinical evidence.

**Objective:** We conducted a randomized control study to compare the effect of conventional therapy and combined (LLLT + conventional) therapy on the severity of post-burn immature scars.

**Methods:** The study is a single blind, randomized control study conducted at a tertiary university hospital. Two groups are studied, the control group received conventional therapy and the study group received combined therapy, for 8 weeks. Total 41 subjects were included. One scar of each subject was included in each group. Outcome variables were recorded using Vancouver Scar Scale (VSS) score and itching. Inter-group and intra-group comparisons were made using paired t-tests.

**Results:** The mean age of patients was 24.1±16.9 years. There were 14 male and 27 female subjects. Groups were comparable. On intra-group analysis, there was a significant decrease in VSS score and itching of scars in both groups after 8 weeks of intervention. While on inter-group analysis, a decrease in scar vascularity of the study group was significantly more than that of control group. But the difference of scar height, pliability and VSS score between two groups remained non-significant post-intervention also. Study group scars have significantly more reduction in itching during the study period.

**Conclusion:** Conventional pressure therapy for post burn immature scar is effective. It is important to start scar therapy early in the natural course of post-burn immature scar. Although present study did not show a positive effect of LLLT on severity (VSS score) of post-burn immature scars, it has a role in hastening the process of reduction in vascularity and itching of these scars. LLLT can be used as an adjuvant to conventional scar therapy, especially during the first post-burn year.

**Study Registration:** This study is prospectively registered in Clinical Trial Registry of India (CTRI/2018/08/015147).

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**Keywords:** Post burn immature scars, Low Level Laser Therapy, randomized control study, Vancouver Scar Scale, itching

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**INTRODUCTION**

A burn is a major problem in low and middle-income countries, with an annual incidence of around 6-7 million per year in India.<sup>1</sup> Out of these around 0.15 million people require prolonged rehabilitation.<sup>1</sup> Post burn scars have significant physical, psychosocial and socioeconomic impact on a burn survivor.<sup>2</sup> Immature or hypertrophic scar is a major problem in the post burn patients. It is a red, itchy or painful and slightly elevated scar in the process of remodeling.<sup>3</sup> Post burn immature scars are reversible as well as preventable.<sup>3-5</sup> Pressure therapy is the conventional treatment of post burn scars.<sup>3-5</sup> Various other modalities exist as an adjuvant

to pressure therapy for immature scar management.<sup>6-9</sup> The effect of these adjuvant therapy modalities is not supported with sufficient evidence.

Low Level Laser Therapy (LLLT) is one of the proposed modalities to improve scar quality. LLLT is claimed to increase collagen synthesis, decrease inflammation and has a positive impact on scar remodeling.<sup>10-14</sup> LLLT is one of the standards and safe treatments for immature scars. It can be utilized to promote faster maturation of post burn scars as an adjuvant to conventional scar therapy.<sup>15</sup> In this article, we present results of a single-blind randomized control study to assess the effect of low level laser therapy

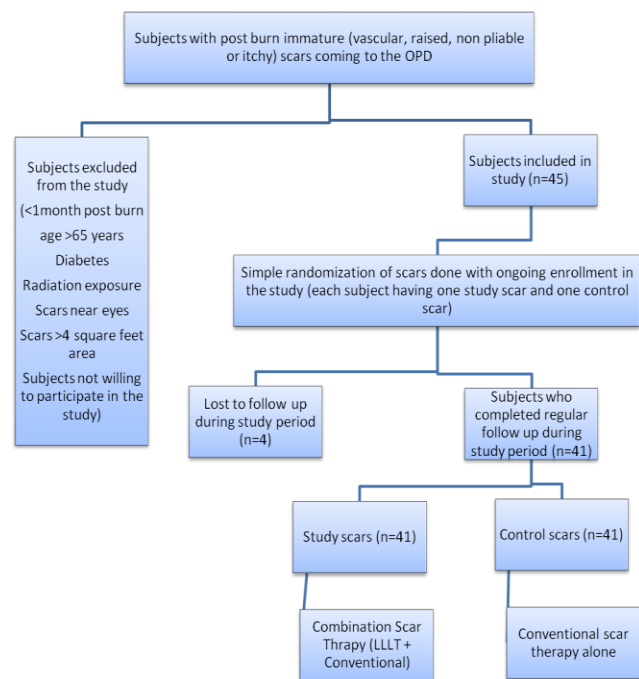
(LLLT) on the severity of post-burn immature scars.

## MATERIALS AND METHODS:

This study was performed at the tertiary burn care centre of our institute in India between August 2018 and October 2019. Ethical clearance for the study was obtained from the institute ethics committee. The study design is a single institute randomized control study. The sampling population included post burn patients attending the plastic surgery outpatient department of our institute. Subjects with post-burn immature (vascular, raised, non-pliable or itchy) scars were included. Exclusion criteria were following: (1) Subjects with acute burn wounds (<1month old), (2) subjects with age >65 years, (3) Subjects with diabetes/ radiation exposure, (4) Scars near eyes, (5) Scars >4 square feet area and (5) Subjects not willing to participate in the study.

Two groups were studied: (1) Group 1 (study group) was the scars treated with combination therapy (LLLT and conventional therapy); and (2) Group 2 (control group) was the scars treated with conventional therapy alone. After taking written informed consent, patient selection and scar selection for the study was done by the investigator based on

inclusion and exclusion criteria. In every subject two discrete patches of post-burn immature scar was elected. In each subject selected, scars were similar in area and VSS score ( $\pm 1$ ) at the time of presentation. One scar of each subject was included in study group and one in the control group. Thus each group was having the same number of scars and the same set of the subjects. Group was allotted to the scar using a simple randomization technique. The total number of scars studied was 41 in each group. (Figure-1)



**Figure 1: Study process flow diagram**

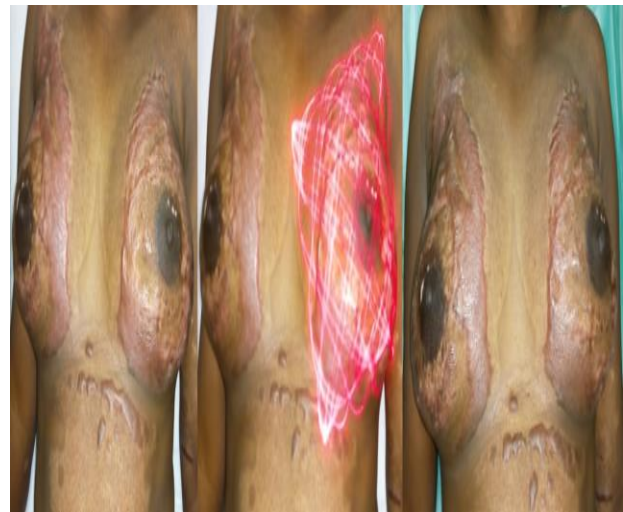
Low level laser used was Gallium Arsenide (GaAs) diode red laser of wavelength 650 nm, output power 100 mW, frequency 10 kHz, continuous beam, scanning mode, non contact delivery (60cm distance between laser source and scar) with an area of delivery adjustable according to the size of the scar. Laser therapy was given for duration of 125 sec every time. Therapy is given twice a week (not less than 3 days interval between two therapies) for 8 weeks. LLLT was given to the study scars on daycare basis, with all laser safety precautions in a dedicated laser room. (Figure-2)



**Figure 2: Low Level Laser Machine used for study**

Conventional scar therapy (including scar massage, pressure garments, elastic bandages, low stretch exercises, or orthotics) were continued in all scars of the subjects equally during the study period.

Outcome variables were recorded using Vancouver Scar Scale (VSS) score and relief in itching. The VSS score of the scar was objectively calculated as shown in Table-1. The presence of itching (pruritis) was asked to subjects. Outcome variables were recorded at the time of presentation and after 8 weeks (i.e. after completion of the intervention). The itching was recorded as present or absent. An observer who evaluates the VSS and itching was kept unaware of the fact that which scar has been treated with LLLT (single blind study). Figure 3 and 4 show clinical images of two scars.



**Figure 3: Clinical picture of a scar before, during and after the study (Right breast scar is control scar and left breast scar is study scar)**

Independent-t-tests were performed to ensure group similarities at baseline. Inter-group and intra-group comparisons were made

using paired t-tests. The correlation between post-burn injury duration and outcome variables was evaluated by Pearson's analysis. All the statistical analysis were carried out at a 5% level of significance and  $p < 0.05$  was considered as significant.



**Figure 4: Clinical picture of a scar before, during and after the study (Right side scar is control scar and left side scar is study scar)**

## RESULTS:

The mean age of patients was  $24.1 \pm 16.9$  (range, 3-62 years). There were 14(34.1%) male and 27(65.9%) female subjects. Two groups were statistically found comparable in terms of baseline VSS scores, itching and individual scar characteristics (Pigmentation, vascularity, pliability, and height).

Within the group, analysis showed that after 8 weeks of intervention there was a significant decrease in VSS score of scars in both groups. Scar vascularity and pliability decreased significantly while a decrease in scar height was not significant. Scar pigmentation remained unchanged. VSS score of control group scars decreases from  $7.4 \pm 1.8$  to  $7.1 \pm 2.0$  ( $p = 0.005$ ), and that of study group scars decreased from  $7.5 \pm 1.8$  to  $6.9 \pm 2.3$  ( $p = 0.000$ ).

The inter-group analysis showed that after 8 weeks of intervention decrease in scar vascularity of the study group was significantly more than that of the control group. But the difference of scar height, pliability and VSS score between two groups remained non-significant post-intervention also. There was no change in scar pigmentation in both groups. (Table-2)

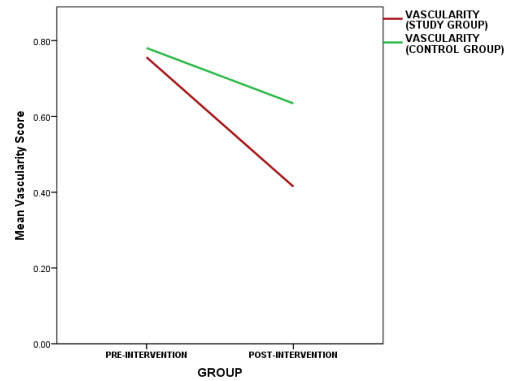
The magnitude of change in scar vascularity in study group [0.34 (95% CI, 0.19-0.5,  $P = 0.001$ )] was significantly better than that in control group [0.14 (95% CI, 0.03-0.26,  $P = 0.012$ )]. (Figure-5)

The magnitude of change in pliability, height and VSS score in study group [0.2 (95% CI, 0.07-0.32,  $P = 0.003$ ), 0.07 (95% CI, -0.01-0.15,  $P = 0.083$ ) and 0.60 (95% CI, 0.31-

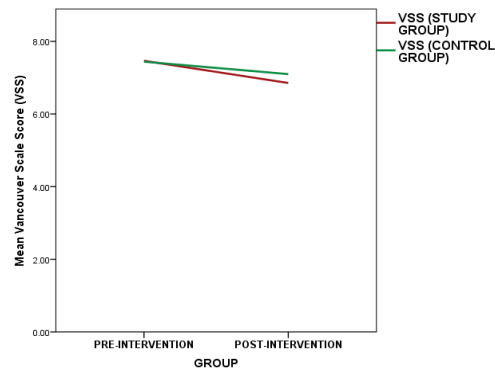
0.9,  $P=0.001$ ), respectively] was marginally better than that in control group [0.17 (95% CI, 0.05-0.29,  $P=0.007$ ), 0.024 (95% CI, -0.024-0.073) and 0.34 (95% CI, 0.11-0.57,  $P=0.005$ ), respectively]; but it was statistically not significant. (Figure-6)

Itching reduced from 73.2% to 39% in the study group while same reduced from 73.2% to 58.5% in the control group. Study group scars have significantly more reduction in itching during the study period. (Figure-7) (Table-3)

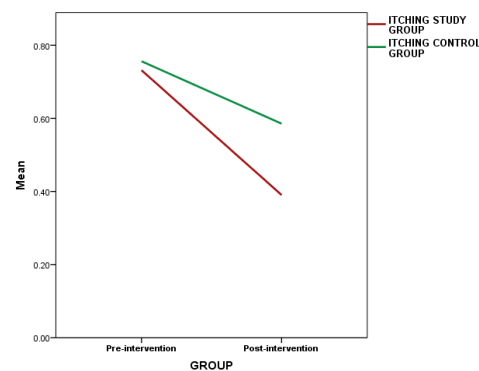
The mean duration of time since burn injury and initiation of therapy was  $15.8 \pm 13.5$  (range, 1-54 months). The correlation between time since burn and study variables has shown that itching is present in 95.5% scars presenting before 1 year, while it is present in only 47.4% scars presenting after 1 year. There was a significant and inverse correlation between vascularity and time since burn injury in both study and control groups. Remaining variables and VSS score have a direct relation with time since burn injury.



**Figure 5: Comparison of change in scar vascularity between study and control group**



**Figure 6: Comparison of change in VSS score of scars between study and control group**



**Figure 7: Comparison of change in itching in scars between study and control group**

**Table-1: Vancouver Scar Scale (VSS)**

<b>Pigmentation</b>	0	Normal
	1	Hypopigmentation
	2	Mixed pigmentation
	3	Hyperpigmentation
<b>Vascularity</b>	0	Normal
	1	Pink
	2	Red
	3	Purple
<b>Pliability</b>	0	Normal
	1	Supple
	2	Yielding
	3	Firm
	4	Banding
	5	Contracture
<b>Height</b>	0	Normal
	1	>0-1 mm
	2	>1-2 mm
	3	>2-4 mm
	4	>4 mm

**Table-2: Change in test variables**

VARIABLE	MEAN CHANGE STUDY GROUP	P-value	MEAN CHANGE CONTROL GROUP	p-Value
VASCULARITY	0.341(95% CI, 0.19-0.5)	<b>0.001</b>	0.14(95% CI, 0.03-0.26)	<b>0.012*</b>
ITCHING	0.34 (95% CI, 0.19-0.5)	<b>0.001</b>	0.17(95% CI, 0.05-0.3)	<b>0.007*</b>
VSS SCORE	0.60 (95%CI, 0.31-0.9)	<b>0.001</b>	0.34 (95% CI, 0.11-0.57)	<b>0.005*</b>
PLIABILITY	0.2(95% CI, 0.07-0.32)	<b>0.003</b>	0.17 (95% CI, 0.05-0.29)	<b>0.007*</b>
HEIGHT	0.07 (95% CI, -0.01-0.15)	0.083	0.024 (95% CI, -0.024-0.073)	0.323
PIGMENTATION	No Change		No Change	

- Statistically significant

**Table 3: Itching in study and control group**

Itching	Study Group		Control Group	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
No	11 (26.8%)	25 (61%)	11 (26.8%)	17 (41.5%)
Yes	30 (73.2%)	16 (39%)	30 (73.2%)	24 (58.5%)
Total	41	41	41	41

## Discussion

The present study shows that conventional therapy (pressure garments, scar massage, etc.) is effective in improving scar quality of post-burn immature scars. Its effects are evident in 8 weeks of therapy. It makes the scar less vascular and more pliable, reduces the itching. But it does not have any effect of scar pigmentation. Also, the height of the scar does not appear to improve with 8 weeks of

conventional therapy. Present results are in accordance with other studies.<sup>3, 6</sup> However, previous clinical studies showed a positive effect of pressure therapy on scar height also. Probably shorter duration of therapy is the reason for less improvement in scar height in the present study. At present, the use of pressure therapy is the clinically accepted treatment protocol for post burn immature scars and it should be continued to use.

In the present study, it is observed that combining LLLT does not reduce the efficacy of conventional therapy on the severity of post-burn immature scars. It gives either similar or better results. The present study shows that combination therapy improves scar vascularity and itching better than conventional therapy alone. This indicates that LLL has a positive effect on particularly these two characteristics of the post-burn immature scars. However the present study also showed that LLLT, when combined with conventional therapy, does not have an additive effect on pliability, height and total VSS score of post-burn immature scars.

Our findings do not match with a similar study done by Gaida et al in 2004.<sup>15</sup> Possible reasons for this difference may be following: 1) In the study of Gaida et al control group of scars did not receive any treatment while study group scars were treated with LLLT alone; and 2) Laser machine specifications are also slightly different in two studies.

On correlating scar characteristics with the time since burn injury we found that post-burn immature scars worsen with time if remains untreated. Their vascularity decreases with time and pliability remains almost the same. However, they become more

hypertrophic (raised height) and pigmented with time. Initially, almost all of the post-burn immature scars have itching, which decreases with time. All scars included in the present study showed either improvement or no change in VSS score after starting therapy in both conventional and combined therapy groups. Thus it is important to intervene early in the natural course of post-burn scar to avoid its complications which increases with time.

Studies have shown that conventional scar therapy (pressure therapy) can prevent post burn immature scar from becoming more hypertrophic and rigid.<sup>3, 6</sup> Thus it is important to start pressure therapy early to avoid hypertrophy of these scars. In the present study, LLLT has shown positive effect on vascularity and itching of the scars. Both these characteristics are shown to be more problematic during the first year of a scar. Thus, it can be said that combining LLLT with conventional therapy is expected to have better results if used during the early phase (first year) of the post-burn scar.

We did not find any local or systemic side effects of LLLT. None of the scars got worsened during study period. LLLT is a safe laser, considered to be a non-heat producing laser. It is classified as a laser safety class IIIb. For the scar treatment with LLLT patient has

to come twice a week to OPD, which was found to be problematic for some patients. There is no standard set parameter of LLLT for post-burn scar treatment. This makes the comparison between studies difficult. We found the problem of poor compliance with conventional scar therapy (pressure therapy). A possible reason for it is discomfort in wearing pressure garments for long periods.

Shortcomings of the present study are that we did not consider the categorization of scars based on the location of the scar, the extent of original burn injury, previous operative wound management, and presence of skin graft over the scars. These may be confounding factors contributing to errors. We used a scanning mode laser machine, which has the advantage of covering a large surface area in one sweep. The problem with scanning mode is it decreases the power density of the laser due to the scattering effect. Also, the power density is variable based on the area covered. The present study is a short-term study with 8 weeks of the intervention period. Results may be different on long term follow up of the subjects.

VSS is a validated tool for the measurement of severity of post-burn scars.<sup>16</sup> However use of individual scar characteristics (vascularity, pliability, pigmentation, and

height) as outcome parameter has questionable validity. VSS is a clinical tool and its sensitivity is low for detecting subtle changes in the scar. Itching is a subjective measure of scar quality, thus not an ideal outcome parameter. Finding of a positive effect of LLLT over scar vascularity and itching in the present study is promising; however, it needs further research with well designed clinical study with specific outcome measures.

## Conclusion

Conventional pressure therapy for post-burn immature scar is effective. It is important to start scar therapy early in the natural course of post-burn immature scar. It is important to ensure patient compliance with scar therapy. Combining low level laser (LLL) with conventional scar therapy does not alter its effectiveness.

Although the present study did not show a positive effect of LLLT on severity (VSS score) of post-burn immature scars, it has a role in hastening the process of reduction in vascularity and itching of these scars. LLLT can be used as an adjuvant to conventional scar therapy, especially during first post-burn year.

**LIST OF ABBREVIATIONS:**

CI = Confidence Interval  
 GaAs = Gallium Arsenide  
 LLLT = Low Level Laser Therapy  
 OPD = Out Patient Department  
 VSS = Vancouver Scar Scale

**DECLARATIONS:**

**Ethics approval-** This study was approved by Institute Ethics Committee (Human Studies), JIPMER, Puducherry. (Reference number: JIP/IEC/2017/0393)

**Consent-** Informed consent was taken from the participants (or their parents in case of minors) for participation in the study and publication of the data.

**Availability of data and materials-** All data generated or analysed during this study are included in this published article and its supplementary information files.

**Funding-** This study was done at department of Plastic Surgery, JIPMER, Puducherry, India, which is a government institute. No extra funding was used for this project.

**Authors' contribution-** SG was the principle investigator. SG did recruitment of the subjects, randomization and group allotment to the scars. SG provided intervention to the scars. AA, CLR, PBM, SK and IP did blinded scar analysis and measurement of outcome parameters. SG analyzed and interpreted the patient data. Complete study was done under guidance of RKC. All authors contributed in writing the manuscript. All authors read and approved the final manuscript.

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**Conflict of Interest Statement-**

There is no conflict of interest.

**REFERENCES:**

1. Gupta JL, Makhija LK, Bajaj SP. National programme for prevention of burn injuries. Indian journal of plastic surgery. 2010 Sep;43(Suppl):S6.
2. Misra, et al. Facial burn scars- psychology and quality of life. Indian Journal of Burns. 2012 Dec; 20(1):57-61.
3. Serghiou MA, Ott S, Cowan A, Offenberg JK, Suman OE. Burn Rehabilitation Along the Continuum of Care. In: Herndon DN, editor. Total Burn Care. 5th ed. Edinburgh: Elsevier; 2018: 490-495.
4. Sarabhai S, Tiwari VK, Goel A, Gupta LC. Wound Healing in Burns. In: Sarabhai S, editor. Principles and Practice of Burn Care. Delhi: Jaypee. 2010: 51-68.
5. Kwan P, Desmouliere A, Tredget EE. Molecular and Cellular basis of Hypertrophic Scarring. In: Herndon DN, editor. Total Burn Care. 5th ed. Edinburgh: Elsevier; 2018: 455-465.
6. Steinstraesser L, Flak E, Witte B, et al. Pressure garment therapy alone and in combination with silicone for the prevention of hypertrophic scarring: randomized controlled trial with

- intraindividual comparison. *Plast Reconstr Surg.* 2011;128:306e-313e.
7. Nedelec B, Carter A, Forbes L, et al. Practice Guidelines for the application of Nonsilicone or silicone gels and gel sheets after burn injury. *J Burn Care Res.* 2015;36:345-374.
  8. McLaughlin, Branski LK, Norbury WB, Bache SE, et. al. Laser for Burn Scar Treatment. In: Herndon DN, editor. *Total Burn Care.* 5th ed. Edinburgh: Elsevier; 2018: 648-654.
  9. Parrett BM, Donelan MB. Pulsed dye laser in burn scars: current concepts and future directions. *Burns.* 2010;36:443-449.
  10. Chittoria R.K., Kumar S.H. (2018) Low-Level Laser Therapy (LLLT) in Wound Healing. In: . *Recent Clinical Techniques, Results, and Research in Wounds.* Springer; 2018, Cham.
  11. Mester E, Hazay L, Fenyo M, Kertész I, Toth N, Járányi Z et al. The biostimulating effect of laser beam. In: Waidelich W, editor. *Optoelectronics in Medicine.* Berlin: Springer; 1982: 146-152.
  12. Posten W, Wrone DA, Dover JS, Arndt KA, Silapunt S, Alam M. Low-level laser therapy for wound healing: mechanism and efficacy. *Dermatol Surg.* 2005 Mar; 31 (3):334–40.
  13. Farivar S, Malekshahabi T, Shiari R. Biological Effects of Low Level Laser Therapy. *J Lasers Med Sci.* 2014 spring;5(2):58-62.
  14. Andrade F, Rosana C, Manoel F. Effects of low-level laser therapy on wound healing. *Rev. Col. Bras. Cir.* 2014 Apr; 41(2):129-133.
  15. Gaida K, Koller R, Isler C, Aytekin O, Awami MA, Meissl G, Frey M. Low Level Laser Therapy—a conservative approach to the burn scar? *Burns.* 2004 Jun; 30(4):362–367.
  16. Baryza MJ, Baryza GA. The Vancouver Scar Scale: an administration tool and its interrater reliability. *J Burn Care Rehabil.* 1995 Seo-Oct; 16:535–8.