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Original Article

Effect of orange polarized light on post burn pediatric scar: a single blind randomized clinical trial

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Abstract. [Purpose] This study was carried out to investigate the effect of orange filtered polarized polychromatic light on post burn pediatric scar. [Participants and Methods] Thirty children with post burn scar in wrist and hands participated in this study. They were between 3 to 7 years old, having hypertrophic burn scar ≥2 months post healing, free from concomitant skin disease and keloids. They were randomly assigned into two groups. The control group (A) (n=15) received Scar Standard Management (SSM) protocol and the study group (B) (n=15) received SSM protocol along with 15 min/area polarized light with medical range filter followed by 15 min/area orange filtered polarized light. All children received the study protocol once a day, 3 times/week for one month. Scar assessment was done before and after the study protocol by using Vancouver Scar Scale (VSS). [Results] All participated children were analyzed. Comparison of post treatment results between groups revealed significant improvement of post burn scar for both groups with significant difference in favor to the study group. [Conclusion] Ultimately it was revealed that Orange filtered polarized light has a special and beneficial effect on decreasing post burn pediatric scar.
Key words: Burn, Pediatric scar, Orange polarized light, Vancouver Scar Scale

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INTRODUCTION

Burn is a devastating, common injury in children, affecting all the developmental stages of a child and consequently distressing his family[1]. The prevalence of child burn in low and middle-income countries is 90%. African region bears almost two-thirds of these injuries[2]. Considering the economic status of these countries, Burn management drains the health care systems resources[3].

In spite of the recent health improvement for burn victims, hypertrophic scars remain a common problem for any disturbed healing process[4]. This problem is major in pediatrics as their skin is thinner than adult in a way that even a minor burn can cause complications as hypertrophic scar and keloid formation[5, 6], threatening children future of productive lives[7].

Hypertrophic scars are characterized by their three Rs; Red, Rigid, and Raised. It is also characterized by clinical symptoms as pain and pruritus. Hypertrophic scar management ranges from range of motion exercises, massage, pressure therapy,

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and silicone applications. However, patient response to these modalities is variable and compliance is difficult to measure[8, 9].

Light has a stochastic nature; most natural light is non-polarized, as electric field direction changes in an unpredictable way. Predicting light direction makes it polarized, which may be done inside the source or after light emission stage[10].

Known with its photo-biostimulatory effect, polarized light has been used to accelerate wound healing. Although the exact mechanism of action is not clear, polarized light can enhance circulation, cell proliferation, and collagen synthesis. The Bioptron products are non-laser optical devices, produce polarized, non-coherent and polychromatic beams in a safe wavelength range that does not endanger DNA or produce burn[11–16].

Up to author knowledge, there is no study investigated the effect of orange filtered polarized polychromatic light on post burn pediatric scar. So, the purpose of this study was to evaluate the effect of orange filtered polarized polychromatic light on post burn pediatric scar.

PARTICIPANTS AND METHODS

The research design of this study was a prospective, randomized, single-blind, pre-post-test, controlled trial. Ethical approval was obtained from the institutional review board at Faculty of physical therapy, Cairo University before study, commencement with number P.T.REC/012/00440. The study followed the Guidelines of Declaration of Helsinki on conduction of human research. The study started August 2016 and ended October, 2017.

A convenient sample of thirty children (20 girls and 10 boys) was recruited from the outpatient clinic of surgery, Faculty of physical therapy, Cairo University. They were enrolled and assessed for their eligibility to participate in the study according to the following inclusion criteria: children with ages from 3 to 7 years, having a hypertrophic burn scar (≥2 months post healing) that has been clinically diagnosed by a burn care specialist. Children with concomitant skin disease (i.e. chronic skin conditions, herpes infection) and those with a history of keloid scarring were excluded from the study. Informed written consent was signed from each parent after explaining the nature, purpose, and benefits of the study, the right to refuse or withdraw, the confidentiality of the obtained information were also reported. Privacy was assured through coding of all data. Randomization was performed by using odd & even numbers for random allocation of the recruited children into two groups of 15 children each: The control group (group A) or the study group (group B) by a blinded and an independent research. All children received the study protocol once a day, 3 times/week for one month. They were all analyzed as no participants dropped out of the study after randomization.

The control group (A) (n=15): each child was placed in sitting position while receiving the Scar Standard Management (SSM) protocol that includes: pulsed ultrasound waves (1.5 Watt/cm^2), deep friction massage and range of motion (ROM) exercises. Three sessions/week for 4 successive weeks were applied.

The study group (B) (n=15): Each child was placed in sitting position. Firstly, child received the SSM protocol as conducted for the control group, then received the polarized light therapy with medical color at a distance of 10 cm for 15 min/area. After that, the orange filter was applied to emit the orange colored polarized non-coherent light on the post burn scar of wrist and hand for 15 min. Three times week for successive 4 weeks were applied using Bioptron Pro I Light Therapy System (PAG-990) by (Bioptron AG, Switzerland) with the following technical characteristics: Wavelength 480–3,400 nm, degree of polarization>95% (590–1,550 nm), specific power density 40 mW/cm^2, light energy per minute 2.4 J/cm^2. Also, the orange filter was used to emit the orange colored polarized light.

All children with wrist and hand post burn scars were assessed by Vancouver Scar scoring (VSS) before and after starting the treatment program for both control and study groups. The VSS assesses four parameters, including vascularity, pigmentation, height/thickness and pliability, giving a range of 0–13 in the total score. Patient perception of his/her respective scars is not factored in to the overall score[17–19]. All interventions and assessments were applied with an expert physical therapist, who has 13 years of experience.

Statistical analysis was conducted using SPSS for windows, version 22 (SPSS, Inc., Chicago, IL, USA). The sample size (30 patients) was calculated to yield an 90% power and α=0.05. Prior to final analysis. The current study involved two independent variables. The first one was the tested group that had two levels (the control group A received SSM protocol and the study group B received SSM protocol along with colored polarized light with medical range filter for 15 min followed by orange filtered polarized light for 15 min). The second one was the treatment periods, which had two levels (pre and post). In addition, this study involved one tested dependent variable VSS score. Normality test of data using Shapiro-Wilk test was used, that reflect the data was normally distributed for VSS score, so parametric statistical tests in the form of (paired t-test) was used to compare between "pre" and "post" treatment for each group and "unpaired t-test" was conducted to compare VSS score between both groups in the "pre" and "post" treatment. The alpha level was set at (0.05).

RESULTS

There were no statistically significant differences ($p>0.05$) between participants in both groups concerning age. Also, χ^2 revealed there was no significant differences between both groups in gender distribution ($p>0.05$) (Table 1).

The mean ± SD values of pain level in the "pre" and "post" tests are presented in Table 2 for both groups. "Paired t-test" revealed that there was a significant reduction of VSS score ($p<0.05$) at post-treatment in compared to pre-treatment for both

Table 1. Demographic characteristics of both groups

	Group A	Group B	Comparison	
	Mean ± SD	Mean ± SD	t-value	p-value
Age (years)	5.26 ± 1.98	4.66 ± 1.63	0.905	0.373
Gender			χ^2	p-value
Female	9	11	0.6	0.439
Male	6	4		

*SD: standard deviation, p: probability, χ^2: Chi -Square.

Table 2. Descriptive statistics, t and p values of Vancouver Scar Scale VSS score pre and post treatment at both groups

VSS score	Means ± SD	Means ± SD	% of improvement
	Pre test	Post test	
Group A	10.66 ± 2.01	8.8 ± 1.61*	17.44
Group B	8.92 ± 2.36	4.93 ± 1.86*#	44.73

*Significant ($p<0.05$) difference between pre and post treatment within groups, #Significant ($p<0.05$) difference of post treatment between groups, SD: standard deviation.

groups. Considering the effect of the tested group (first independent variable) on VSS score, "unpaired t-test" revealed that the mean values of the "pre" test between both groups showed there was no significant differences ($p>0.05$). But, the mean values of the "post" test between both groups showed there was significant differences ($p<0.05$) and this significant reduction in favor to group B.

DISCUSSION

After the recent advancement in burn management, the number of mortality has decreased and burn care directed to quality of life improvement. Burn survivors face recovery barriers in the form of long-term functional, emotional, and esthetic complication[20], caused mostly by hypertrophic scars, which is a challenge for patients, multidisciplinary team, and researchers especially for children, considered as the most population at risk.

This study investigated the effect of orange filtered polarized polychromatic light on post burn pediatric scars. The pre-treatment mean values of the measured variables of this study showed abnormal post-burn scar formation in both groups with higher score of VSS. This comes in agreement with Wang et al.[21] who stated that; injuries associated with prolonged immune responses, such in burns, are predisposed to developing abnormal scarring; characterized by misbalanced collagen types and non-linear collagen bundles orientation. Hypertrophic scar is common in children and its prevalence depends on burn cause, extent, and location[22].

VSS was first introduced in 1990 and extensively described in literature[20]. In this study, VSS was used to assess vascularity, pigmentation, thickness and pliability of hypertrophic post burn scar formation pre and post treatment to detect the difference between both groups. Despite the limitations of using scar scales as a subjective tool, the other used methods have varying degrees of reliability and validity and most of them are costly, time-consuming, highly technological, and often non-portable, making them clinically impractical[23, 24]. VSS is the first validated scar assessment scale and remains the most widely used scale within the clinical setting[23]. Furthermore, a previous study found that the VSS is adequate substitute to Cutometer, Mexameter, and DermaScan C, in discrimination of scar characteristics[17].

The study results revealed a significant difference post-treatment in favor of the study group compared to the control group; represented as vascularity and pigmentation improvement, changing scar color, scar height reduction, and increased pliability. VSS scores decreased in the study groups who received orange filtered polarized polychromatic light compared to the control group who received Scar Standard Management (SSM) protocol only.

These findings come in agreement with other studies[14, 25], reported that light is a form of energy used in healing long-time ago and that Biptron light therapy device stimulates the biological reactions in the body.

Our results might be attributed to the effect of orange filtered polarized light on mitochondrial respiratory chain activities particularly chytochrome C oxidase; accelerating adenosine tri-phosphate (ATP) production and stimulating various processes[16, 26]. It was reported in previous studies that that any polarized light has similar biostimulatory effects and that polarized light had some effects on cellular immunity[27]. The results might also be attributed to the interaction hypothesized between polarized light and the cell membrane. This interaction with the polar heads of the cell membrane leads to redistribution of the surface charges and lipid-protein connection modification influencing all the cellular processes connected to cell

membrane[28].

Light therapy can improve scars by reducing collagen synthesis and IL-6 mRNA levels[29]. Light therapy was also recommended in prevention or attenuation of hypertrophic scars or keloids development[26]. Red and near-infrared wavelengths phototherapy can suppress fibroblast proliferation[30]. Scars treated with light therapy (805 nm at 30 mW/cm2), for 30 days on daily base, showed no side effects and significant improvement in VSS score, skin topography, and clinical assessment of photographs[31].

Light therapy is not an ablative or thermal mechanism but rather a photochemical effect comparable to photosynthesis in plants. The effective tissue penetration of light and the specific wave-length of light absorbed by photoacceptors are two of the major parameters to be considered in light therapy[32] and the exact mechanism of action is still not adequately revealed.

Polarized colored light therapy contains several colors, all the colors possess unique frequencies and electromagnetic energies, and therefore different colors have different physiological effects[33], therefore, this study is limited to the orange filtered polarized polychromatic light. It is also limited on post burn pediatric scar using VSS as a method of assessment.

Further studies are recommended to evaluate the long lasting effect of polarized light though a follow-up assessment after several months' post-rehabilitation program. Other measured outcomes are also recommended for further studies; regarding the use of more objective tools of assessment and other variables such as, functional activity, and muscle strength. Extensive clinical research are needed to explain the exact physiological effect of phototherapy using various parameters.

It was concluded from the results of this clinical study that orange as a one color of filtered polarized polychromatic light hasa special and beneficial effect on decreasing post burn pediatric scar and improving its quality.

Conflict of interest

None.

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