Original Article

Macroscopic effect of blue light cure on wound healing in NMRI mice NMRI

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Abstract

Background: Wound healing is a complex process and has been an ongoing challenge all over the world. Some studies have suggested light cure as a modality to accelerate wound repair. It can induce fibroblast proliferation, increase collagen synthesis and activate cellular processes involved in expression of procollagen type I and III mRNA. This study was designed to assess the macroscopic effect of halogen dental curing blue light on full-thickness open wound healing in NMRI mice.

Materials and Methods: Forty male NMRI mice were divided into control and treatment groups. A full-thickness wound of 6 mm in diameter was induced on the lower back of all mice under general anesthesia and sterile conditions. The mice of the treatment group received a 5-min exposure of halogen light Coltolux II (QHL), 420-500 nm, daily for 7 days. The diameter of the wound was measured in both the treatment and the control groups every second day up to Day 14. Data were analyzed by SPSS version 12 software using Student's *t*-test. A significance level of $P \leq 0.05$ was considered for each comparison.

Results: There was a significant difference in wound diameter between the control and the treatment groups at all measurements after Day 3 ($P \leq 0/05$).

Conclusion: The results of this study suggest improvement of full-thickness wound healing by daily irradiation of halogen dental curing blue light of 420-500 nm for 7 days.

Key Words: Light cure, NMRI mice, wound healing

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INTRODUCTION

There are several studies on the effect of laser therapy and wound healing suggesting wound healing speed-up following different laser protocols while still more studies are needed to determine the optimum parameters for this situation.[1] The wound-healing process involves a series of complex responses that

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are affected by different factors like etiologic basis of the wound, type of the tissue and general systemic condition of the patients.[2] Besides pharmacotherapy, other modalities such as stem cell therapy,[3] hyperbaric oxygen,[4,5] phototherapy and laser[6-8] have been suggested to improve wound healing. Whinfield and Aitkenhead have shown in their review that phototherapy may have positive effects in promoting wound healing *in vitro* and animal studies, but there was no established efficacy in clinical trials, and further studies are required to determine the role of phototherapy in wound care.[9]

Two meta-analyses of the efficacy of low-level laser in wound repair have revealed the efficacy of laser therapy for promoting wound healing[10,11] and pain relief.[11] A subgroup analysis of data showed a significant effect on collagen synthesis, rate of healing, tensile strength, wound size, time to wound closure, tensile stress, number and rate of degranulation of mast cells and flap survival.[12,13] Halogen dental cure emitting blue light of 420-500 nm is being used to cure dental composites for years. This is an innovative use of this device as an easy access affordable device for improvement of wound healing, and the following study was designed to test this idea.

MATERIALS AND METHODS

Forty male NMRI mice, weighing 20-25 g, were used for performing this experiment. Mice were provided from the Tehran Science and Research Azad University and all the experiments were performed in the Professor Torabinejad Research Center in Isfahan. This trial was approved by the ethical committee of the Tehran Science and Research Azad University on 14 September 2008. Animals were housed in cages on a 12 h:12 h light/dark cycle at 20-25°C with free access to food and water. After shaving the fur, a full-thickness circular wound of 6 mm in diameter was induced by a punch on the back of the mice (area above the tail) under ether anesthesia in all mice. All animals received an intramuscular injection of penicillin-gentamycin to prevent wound infection. Animals of the treatment group were subjected to 5-min blue light irradiation (Coltolux II [QHL], Coltene, Switzerland) from Days 1 to 7. Wound diameter was measured using a millimeter scaled paper on Days 1, 3, 5, 7, 10 and 13 after injury in both groups.

Data were analyzed by SPSS version 12 software using Student's *t*-test. A significance level of $P \leq 0.05$ was considered for each comparison.

RESULTS

Data of wound diameter in the control and treatment groups is shown in Table 1 and Figure 1. Except for Day 1, the wound diameter was significantly less in the treatment group compared with the control group at all measurements ($P \leq 0.01$).

DISCUSSION

This is the first study on using dental blue light cure for improvement of wound healing. The results of this study showed efficacy of 5-min 1-week irradiation by this blue light in improvement of full-thickness wound healing in NMRI mice. Considering more accessibility of this device for the patients compared with LED or other laser-emitting systems, it could be an attracting option for in-home use by patients with chronic ulcer.

Demidova-Rice *et al*. have reported significant improvement of wound healing in BALB/c and SKH1 hairless mice with 635 nm light.[14] There was no difference in the efficacy of the same wavelength from a lamp or He-Ne laser source. Da Silva 2010 reviewed studies on the use of laser therapy in the tissue repair process with a focus on the different lasers and applied parameters.[1] The closest wavelength to blue light dental cure is helium neon laser (He-Ne laser, 632.8 nm). Based on the available studies, several mechanisms could be suggested for improvement of wound healing by this laser. Significant increase in proliferation and differentiation of human osteoblasts, promoting migration, cell proliferation and viability of injured fibroblasts, and stimulating mitochondrial activity are reported in *in vitro* studies.[1] It could increase the percentage of collagen in skin injuries and reduce the severity of inflammation of skin injuries in both diabetic and non-diabetic rats treated with this laser.[1] Using the He-Ne laser in 2nd degree burn in rats has been associated with a significant increase in mast cells followed by a decreased number of mast cells during inflammatory and remodeling phases of wound healing.[9] Similar mechanisms may be involved in wound healing improvement induced by dental light

Table 1: Comparison of the mean wound diameter at Days 1, 3, 5, 7, 10 and 13 in both the control and the treatment groups

Follow-up (day)	1	3	5	7	10	13	*P* value**
Wound diameter							
Control	6±0	5.8±0.039	4.17±0.01	4.30±1.10	3.9±1.20	3±1.01	0.000
Treatment	6±0	5.45±0.06	4.42±1.14	4.19±1.08	3.65±1.08	2.7±1.20	0.000
P-value*	1.00	0.000	0.289	0.242	0.114	0.091	

Data are shown=Mean+SD (mm),*Used the Mann-Whitney test,**Used the Friedman test

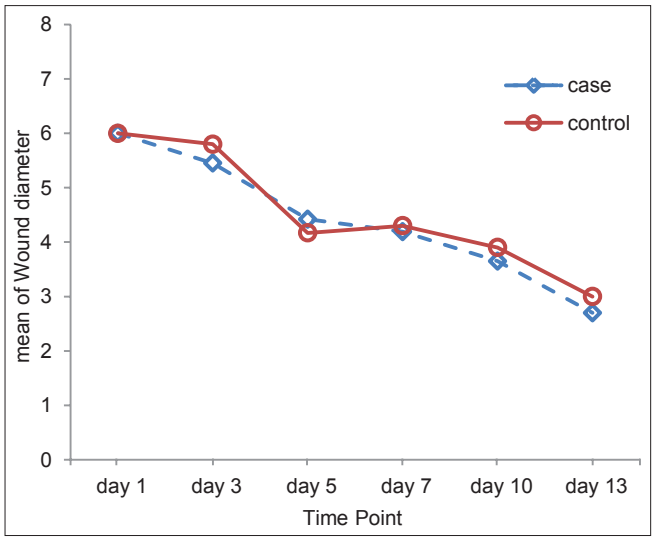

Figure 1: Line chart of the mean wound diameter at Days 1, 3, 5, 7, 10 and 13 based on the groups

cure. Low doses of blue light phototherapy destroy hospital- and community-acquired methicillin-resistant *S. aureus* (HA-MRSA). This antimicrobial effect may be involved in positive effects of blue light on wound repair.[11,15,16] A recent report of increased nitric oxide concentration in endothelial cell culture may also be involved in the observed positive effect of blue light on wound healing.[17]

More detailed studies are needed to assess the safety and mechanism of action of blue light therapy for this indication before introducing it for any clinical trial.

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