

ORIGINAL ARTICLE

The utilization of nonthermal blue (405–425 nm) and near infrared (850–890 nm) light in aesthetic dermatology and surgery—a multicenter study

GARY LASK¹, NATHALIE FOURNIER², MARIO TRELLES³, MONICA ELMAN⁴,
MICHAEL SCHEFLAN⁵, MICHAEL SLATKINE⁶, JENNY NAIMARK⁶ & YORAM HARTH⁷

¹UCLA Medical School, Los Angeles, CA, USA, ²CLDP, Calpiers, France, ³Vilafortuny Medical Institute, Cambrils, Spain, ⁴Laser Aesthetic Dermatology Center, Tel Aviv, Israel, ⁵Atidim Laser Center, Tel Aviv, Israel, ⁶Curelight Ltd, Mendham, NJ, USA, and ⁷Nordau Medical Center, Haifa, Israel

Abstract

Background: A major cause of skin aging is a chronic micro-inflammation triggered by UV radiation and external pollutants. It has been demonstrated that blue light diminishes inflammatory conditions and near infrared light enhances circulation. **Objectives:** To assess the effectiveness of a non thermal dual wavelength - blue (405 – 420 nm) and near infrared (850 – 900 nm) - light source in skin rejuvenation, in the reduction of the duration of post skin resurfacing erythema and in the acceleration of healing of post surgical conditions (face lift and breast augmentation).

Methods: We have utilized a non contact, hand free dual wavelength light source (iClearXL and Clear100XL, Curelight Ltd) to treat over 60 patients and perform three controlled studies in four centers. Follow up duration was three months. Control group for photorejuvenation consisted of patients treated with Glycolic peeling and daily appliance of vitamin C Control group for post skin resurfacing erythema duration consisted of patients untreated by the light source and control group for post surgical healing consisted of patients untreated by the light source or treated by the light source on one side only.

Results: Post skin resurfacing erythema duration is reduced by 90%. The healing of post surgical conditions is substantially accelerated and discomfort is reduced. The anti aging effect of the light source includes: reduction of pore size in 90% of patients with stable results at three months follow up, enhanced skin radiance in 90% of patients with stable results at three months follow up and smoothing of fine wrinkles in 45% of patients with stable results at three months follow up. The control group showed poor results which were stable for a duration of less than one month.

Conclusions: A non thermal, non contact / hand free light source emitting at 405–420 nm and 850–900 nm considerably enhances aesthetic and surgical aesthetic procedures without consuming user time.

Key words: anti-ageing, anti-inflammatory, blue light, face lift, near infrared light, photorejuvenation, pores, skin resurfacing, wounds healing, wrinkles

Introduction

The utilization of near infrared light at 850–890 nm for the accelerated healing of ischemic wounds is well documented. Significant results have been obtained with the treatment of nonhealing chronic ischemic leg wounds (1). Near infrared light was found to enhance blood and lymphatic flow in the wound tissue through the release of nitric oxide from the blood causing relaxation and dilatation of vessels walls. Nitric oxide serves as a neurotransmitter which relaxes the muscles and dilates vessels (1). The enhancement of blood flow in dermal and subdermal tissue oxygenizes the wound tissue, thereby enhancing metabolism and speed of healing

process. The increase in lymphatic drainage removes toxins from wound area and decreases edema and pain. The penetration depth of near infrared light in tissue is as deep as 5–7 mm. Danno et al. have recently demonstrated the role of near infrared light in wound repair (2). The ability of near infrared light to partially protect the skin from solar radiation has been demonstrated by Frank et al. (3).

A recent study by Shalita et al. (4) has demonstrated that blue light at 405–425 nm has a strong anti-inflammatory effect on the skin. Skin inflammation as a response to adverse external conditions (such as created by pollution or UV radiation) is triggered by pro-inflammatory cytokines released by keratinocytes and mast cells. Shalita et al. have grown human

keratinocytes in two separated dishes which were illuminated with UVB light and measured the concentration of inflammation markers IL1-a and ICAM-1 in both dishes. While illuminating one of the dishes with blue light at 405–425 nm and not illuminating the second control dish, the concentration of the inflammation markers in the blue light illuminated dish fell dramatically thereby demonstrating that blue light inhibits the production of pro-inflammatory cytokines. The penetration depth of blue light into the skin is about 0.5–1 mm.

In the course of the last 18 months we have studied the clinical efficacy of the combination of narrow blue (405–425 nm) and near infrared (850–890 nm) light bands in several centers for the treatment of common aesthetic skin conditions. The use of this specific combination of wavelengths was tested as a major part of an anti-aging program, as well as for enhanced healing after aesthetic surgical procedures: skin resurfacing, face-lifting and breast augmentation.

The wound nature of treated conditions

Post skin resurfacing or peeling

Medium depth skin resurfacing involves the removal of skin down to the papillary dermis, normally resulting in a large surface wound (the entire face) which is approximately 100 micron deep. This necrotic layer of ~100 micron depth has to naturally slough as part of the healing process. Although inflammation is a necessary path in any healing process, severe inflammation results in edema and deprived blood flow which normally slows the healing process. In most skin resurfacing procedures, the average erythema duration is over three weeks (5). By reducing the inflammation to an optimal level with the blue light and enhancing circulation with the near infrared light we expect to accelerate the healing process and decrease the erythema duration.

Postsurgical healing (face-lifting and post breast-augmentation)

A variety of conditions can compromise healing after rhytidectomy. The mechanical tension as well as extensive skin undermining frequently restrict blood circulation and lymphatic drainage resulting in ischemia and inadequate healing. These conditions are further emphasized in patients who smoke. Implants in breast augmentation are followed by inflammation and edema which also slow healing and are the source of pain and discomfort.

We expect the combination of blue and near infrared light to accelerate the postsurgical healing process and reduce the risks of capsule contracture.

Aging skin

Chronic micro-inflammation was recently identified as one of the major causes of coronary atherosclerosis (6). Giacomoni et al. (7) and Bosset et al. (8) identified a similar mechanism in the dermis and hypothesize that chronic micro-inflammation is a major factor in the destruction of collagen fibers in the aging skin. This continuous micro-inflammation is caused by permanent attack of cellular structure by outside environmental factors inducing formation of free radicals.

Permanent micro-inflammation is the cause of a permanent micro-edema, resulting in reduced micro-circulation and reduced oxygenation of cells such as fibroblasts as well as reduced lymphatic drainage.

A second major factor implicated as a cause for aging skin is a constant decrease in dermal blood circulation reducing metabolism and vitality of cutaneous structure.

We expect that the combination of blue and near infrared light will stop that permanent aging process and restore skin vitality and proper activity of fibroblasts.

Material and methods

Multicenter study

A novel blue (405–425 nm)/near infrared (850–890 nm) light source was tested in five dermatological/plastic surgery laser centers (USA, France, Spain, Israel). The current article reports on results obtained with 62 patients: 10 post face-lift including one half face control, 12 post skin resurfacing and removal of skin lesions (6 controls), 10 post breast augmentation (5 controls), and 30 anti-aging/skin rejuvenation (pores, fine wrinkles and skin radiance) —9 controls. In addition to the clear benefits in each



Figure 1. Treatment of a post breast augmentation patient with the blue/near infrared light source operated in a patient lying position.

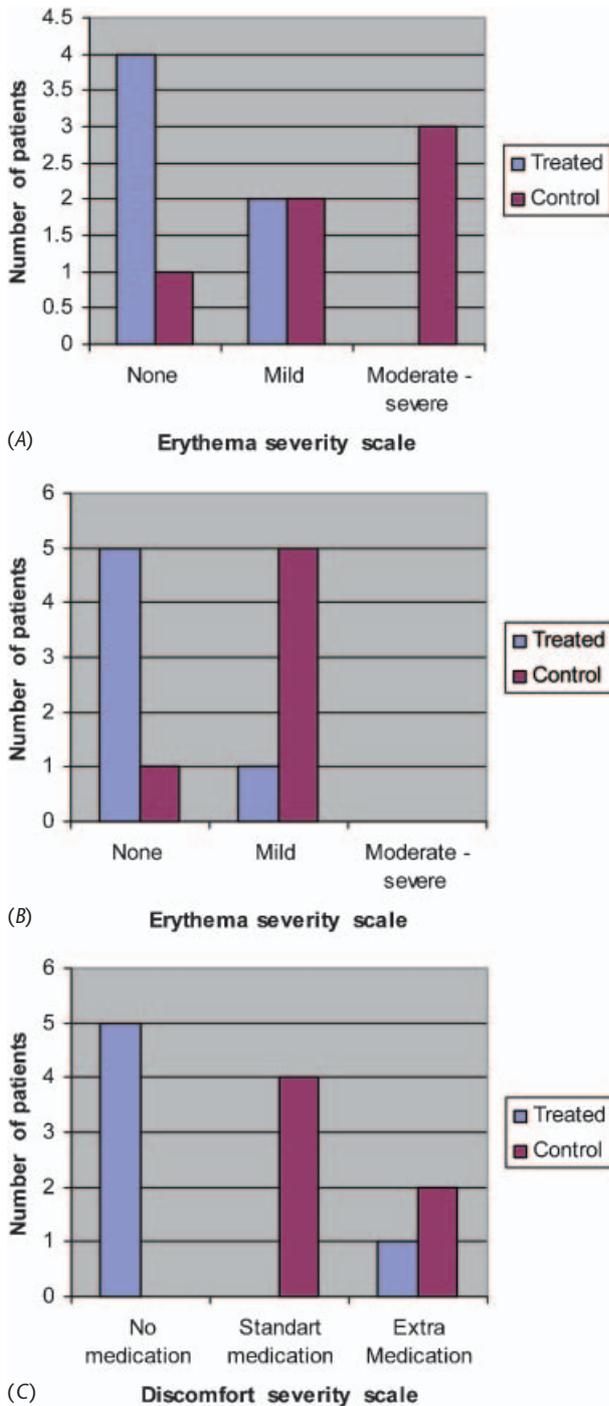


Figure 2. A: Reduction of post-skin-resurfacing erythema 12 days after skin resurfacing. B: Reduction of post-skin-resurfacing erythema 2 months after skin resurfacing. C: Discomfort assessment 12 days after skin resurfacing.

of the tested applications (some will be published separately), the studies revealed basic common physiological features of the light-based system which will be summarized in this report.

The light source

We have utilized two blue (405–425 nm)/infrared (850–890 nm) metal halide light sources (iClearXL



Figure 3. Skin resurfacing patient immediately after treatment (A) and 1 week later (B). Patient got a daily 20-minute treatment for five consecutive days.

with one light source, total illumination area 30 × 30 cm; Clear100XL with two light sources, illumination area 60 cm × 30 cm, Curelight Ltd). The treated power densities on the skin were 50 mW/cm² in the 850–890 nm band and 50 mW/cm² in the blue 405–425 nm band. The lamp is positioned at a distance of 20 cm from the target (usually the face or the breast). The patient is treated either in a sitting position (iClearXL) or a lying position (iClearXL, ClearLightXL). The device is turned on for 15–20 minutes and the operator leaves the patient unattended for the duration of the treatment.

Figure 1 shows the treatment light source and the patient in a lying position.

Treatment protocols

Reduction of erythema duration following skin resurfacing

Skin resurfacing was performed with an Er/CO₂ laser (Derma K, Lumenis) and a CO₂ laser (Luxar). Resurfacing patients were treated with a prophylac-

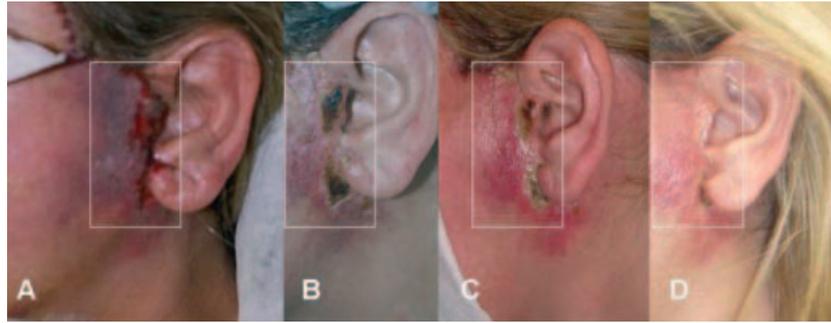


Figure 4. Accelerated healing of an ischemic suture line. A: Before blue/near infrared light treatment, five days after a face lifting procedure. B: After five days ($\times 3$ blue/near infrared light treatments). C: After 13 days ($\times 6$ light treatments). D: After additional two weeks follow-up (no additional treatments).

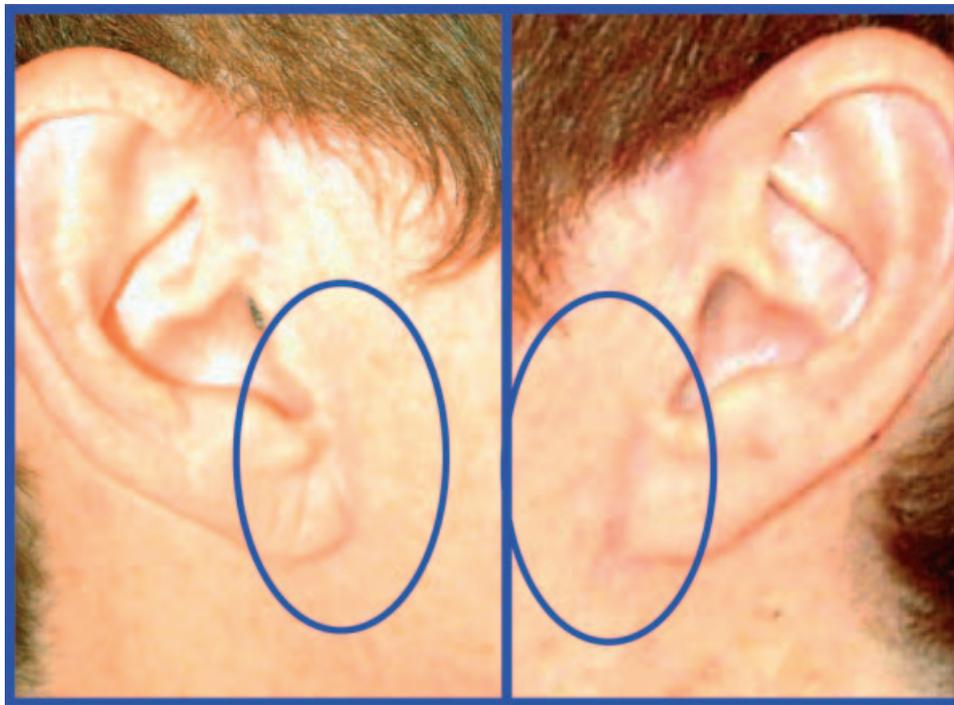


Figure 5. Accelerated healing of post face lifting suture line (after 6 weeks); split face controlled study. A: Right side treated with 405–420nm/850–890nm light, 6 treatments. B: Left side untreated (pink, depressed scar tissue).

tic oral acyclovir. Daily care schedule was started immediately after the skin resurfacing procedure and included twice daily water and soap facial wash followed by topical application of petrolatum mixed mupirocin. After five days, patients used an anti-burn BiafinTM cream twice a day for a duration of five days.

Blue/near infrared light was administered five to six times on a daily basis for 20 minutes from the front at a distance of 20 cm from the lamp, starting one day after skin resurfacing.

Twelve patients were treated with the light source and a control group of six patients were not treated with the light source.

Pictures were taken immediately after skin resurfacing and again a week later. Twelve days and two

months after the initial resurfacing treatment, patients were given questionnaires regarding pruritus, erythema, and postsurgical discomfort. Patients discomfort as well as pruritus and erythema were assessed using a 0–2 severity scale (none, mild, moderate to severe). Weighted average scores were calculated by totaling the patients' scores, then dividing by the number of patients in the respective group.

Post surgery accelerated healing

Rhytidectomy. We have treated 10 patients after rhytidectomy. Each side of the face was illuminated for a duration of 15 minutes. The number of treatments ranged from six to eight,

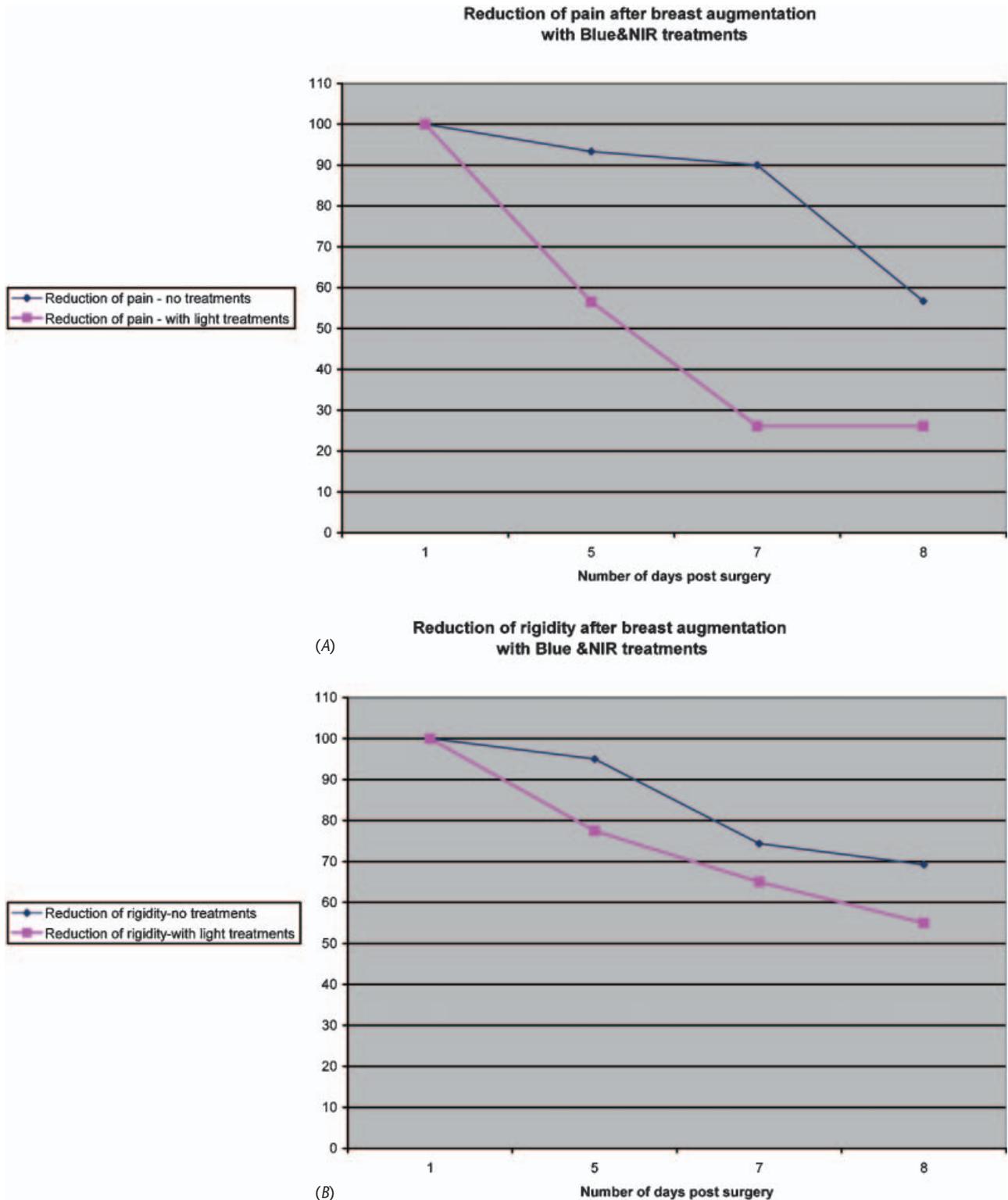


Figure 6. Pain (A) and rigidity reduction (B) after breast augmentation.

administered every two days, starting two days after surgery.

In one self control case, we have illuminated one side of the face with the blue/near infrared light source while leaving the other side of the face not illuminated.

We followed the suture line healing process for a duration of six weeks.

We have also treated patients who developed major complications (such as skin ischemia or post-hematoma fibrosis) in an effort to quickly resolve the problem.

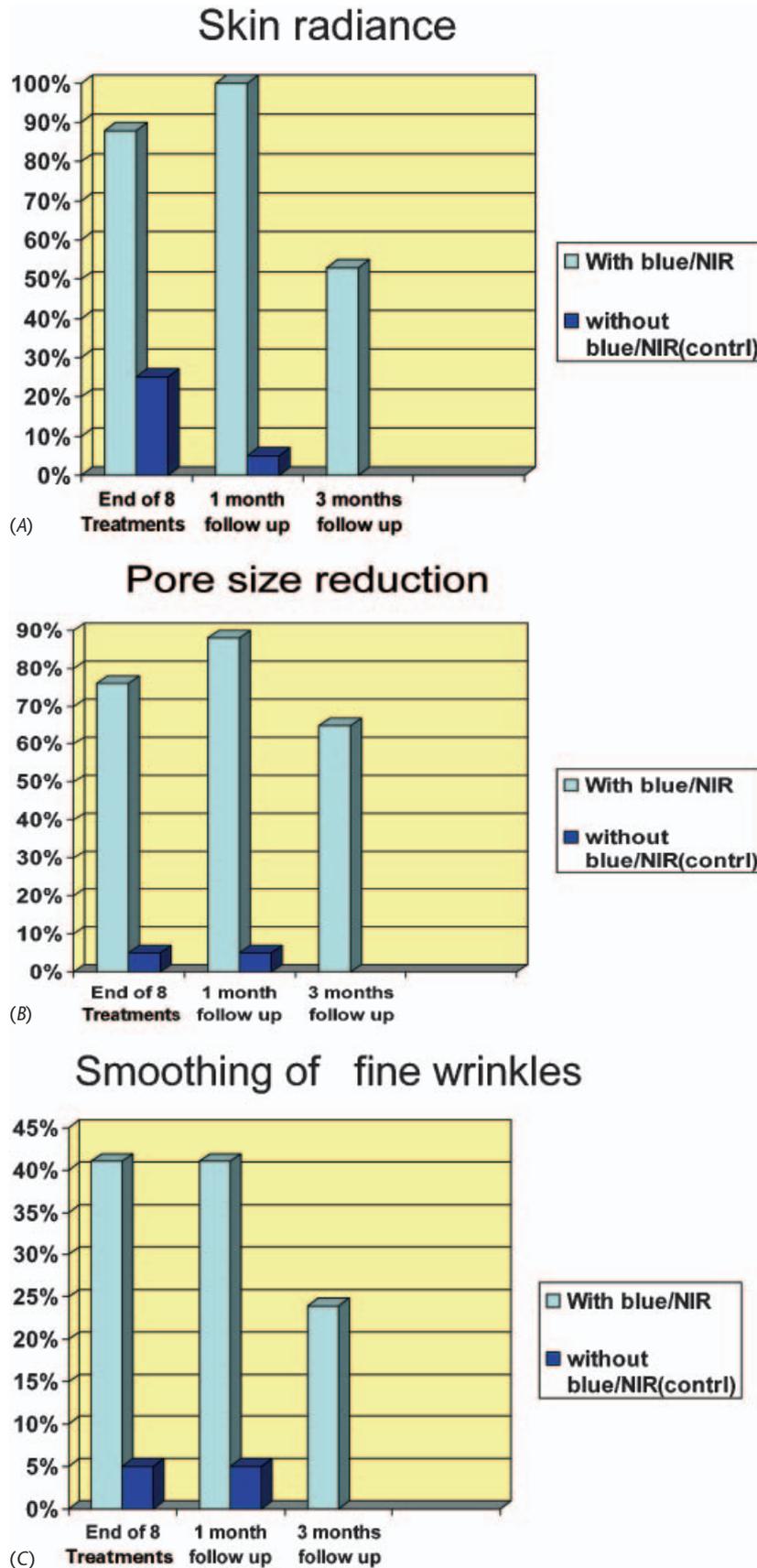


Figure 7. Three-month follow up of controlled anti-aging study. A: Improvement of skin radiance. B: Pore size reduction. C: Smoothing of fine wrinkles.



Figure 8. Photo rejuvenation with blue/near infrared light and vitamin C—pore size reduction. A: Before. B: One-month follow-up after $\times 8$ treatments.

Breast augmentation. The protocol for post-breast-augmentation treatment was similar to the one used following face-lift. The effectiveness of the blue/near infrared light source was assessed by a questionnaire which described the pain, discomfort and stiffness of the breast on a daily basis. We have treated five patients with the light source and five control patients were not treated with the light source.

Anti-aging protocol

The photorejuvenation/skin anti-aging protocol consists of the following steps: 1) Superficial peeling with glycolic acid (20%–50%) every second treatment for the removal of the keratin layer; 2) Illumination of the skin with blue/near infrared light for a duration of 15 minutes on each side of the face; 3) The application of a vitamin C lotion (followed by daily application at home between treatments).

The treatment is performed twice a week for the duration of 4 weeks.

We have treated 20 patients with light source and 9 additional control patients without light (peeling and vitamin C only). We specifically looked for fine wrinkles, pores and skin radiance. Pictures were taken before the treatment, at the end of the treatment and one and three months after the last treatment.

Results

Skin temperature

The skin surface temperature was measured with a thermocouple for the duration of a 20-minute treatment and was found to rise by 2–3 degrees centigrade and stabilize at that temperature after 3

minutes. That results is in accordance with the pleasant feeling reported by all patients.

Reduction of erythema duration following skin resurfacing

Results show an average reduction of erythema duration following skin resurfacing by 50%, from 21 days to 10 days and a substantial reduction of post-treatment discomfort.

Figure 2A presents the reduction of post skin resurfacing erythema 12 days after skin resurfacing. Figure 2B presents the erythema level two months after skin resurfacing, and Figure 2C presents the discomfort assessment 12 days after skin resurfacing.

Figure 3 shows a patient who underwent skin resurfacing and was consequently treated with the blue/infrared light source. The first picture was taken immediately after the procedure and the second picture was taken six days after the procedure. The patient redness is almost gone.

Post surgery accelerated healing

Rhytidectomy. Figure 4 demonstrates the healing capability of the blue/near infrared light source. The patient in Figure 4 underwent a face-lift surgery and smoked before and after surgery in spite of clear instructions to avoid smoking. Healing was compromised and necrosis developed on one side, leading to a potentially major complication. The patient received six blue/near infrared light treatments for a duration of 20 minutes each time, starting five days after surgery when ischemic skin was observed. Treatment was administered every second day. Recovery was fast and no skin was lost to necrosis.

Figure 5 shows the suture line of both sides of a patient who underwent face-lift, six weeks after surgery.

One side was treated with blue/near infrared light after surgery, and the other, control side, was not treated with light. Figure 5A shows the treated side and Figure 5B shows the untreated side. The suture line of the untreated side is redder than the treated side.

Breast augmentation. Figures 6A and 6B provide a graphical summary of post-breast-augmentation comfort as function of time for the group treated with blue/near infrared light and for the non-treated control group. As can be seen from Figure 6A which is based on a four levels of comfort (pain, stiffness), the group which was treated with blue/near infrared light felt more comfortable after surgery. Pain was significantly reduced as compared to the control group and the return to softness was accelerated.

Photorejuvenation and anti-aging. Photorejuvenation and anti-aging showed very clear reduction of pore size and enhancement of skin vitality and radiance on 90% of patients. The results were stable for a duration of the three months post-treatment follow-up. This is in contrast to the control group who was treated with glycolic acid and vitamin C only and did not show any pore size reduction. Other control group parameters did not last over one month. The elimination of pores seems the most unique advantage of the light source. Figures 7A–C present the study results.

Figures 8A and 8B show a patient face before treatment and one month after treatment. The reduction of pore size is clearly visible.

Conclusions

The combined anti-inflammatory effect of narrow band (405–425nm) blue light and enhancement of

circulation by narrow band (850–890 nm) near infrared light provides an excellent means to enhance a wide range of aesthetic procedures in dermatologic or plastic surgery clinics. This includes enhancement of topical and surgical anti-aging treatments, reduction of the duration of post-skin-resurfacing erythema and accelerated healing after face-lift or breast augmentation. The treatment was totally free of side effects and very well accepted by the patients. The utilization of a single hands-free device which incorporates both wavelengths in a non-contact mode does not consume user time and enables him to treat other patients simultaneously.

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