Color light therapy in the treatment of postoperative wounds

M.Yu. Gotovsky[1], N.T. Salia[2]
[1]Center of intelligent medical systems "IMEDIS" (Moscow),
[2]FSBI NMITs SSH named after A.N.Bakuleva MH RF "(Moscow)

Color therapy in treatment of postoperative wounds

M.Yu. Gotovskiy[1], NT Salia[2]
[1]Center of intellectual medical systems "IMEDIS" (Moscow, Russia),
[2]AN Bakoulev Medical Center for Cardiovascular Surgery (Moscow, Russia)

SUMMARY

Introduction. Stimulating the healing of intentional or unintentional wounds and prevention of the development of wound infection is an urgent problem of modern medicine.

Methods. Using electronic databases, a search was carried out for publications onthe use of color light therapy (optical radiation of the visible range) to accelerate wound healing and in the prevention of wound infections.

Results. It is shown that color light therapy in the visible region of the spectrum atlocal application has a positive effect on the wound process, promotes faster scarring and reduces the time for wound healing.

Conclusion. The use of color light therapy helps to speed up the processeswound healing and can significantly reduce the percentage of complications in the complex treatment of infected wounds.

Key words: phototherapy, color light therapy, wounds, postoperative wounds,wound healing, prevention of postoperative complications, optical incoherent radiation, LEDs.

RESUME

Background. Facilitation of healing of intentional or unintentional wounds and prevention of the development of wound infection is an urgent problem of modern medicine.

Methods. Using electronic databases, we searched for publications on the use of color light therapy (optical radiation in the visible range) to accelerate wound healing and in the prevention of wound infections.

Results. It has been shown that color light therapy in the visible region of the spectrum, when applied topically, has a positive effect on the wound process, promotes faster scarring and reduces the time for wound healing.

Conclusion. The use of color light therapy helps to accelerate wound healing processes and can significantly reduce the percentage of complications in the complex treatment of infected wounds.

Keywords: phototherapy, color light therapy, wounds, postoperative wounds, wound healing, prophylactics of postoperative complications, optical non-coherent emission, light emitting diodes.

INTRODUCTION

A wound, according to general concepts, is a mechanical violation of the integrity of the skin, mucous membranes with possible simultaneous damage to deep-lying tissues and / or internal organs with the development of local, regional and general disorders of vital activity [1]. Depending on the circumstances (reasons), the origin of the wound can be deliberate (surgical interventions, plastic surgery, aesthetic correction) and unintentional (injuries and traumatic injuries) [2, 3]. Surgical wounds are applied curatively and under aseptic conditions that minimize the risk of complications, while unintentional wounds and injuries are usually contaminated with microorganisms, and there is always a high probability

the occurrence of complications.

Currently, an urgent problem is the prevention of wound infections, the occurrence of which leads to a prolonged hospital stay, a longer recovery, and a decrease in the quality of life of patients [4, 5]. The use of new antibacterial drugs and the improvement of surgical techniques do not lead, as a rule, to a decrease in postoperative complications, the percentage of which has not only not decreased in recent years, but, on the contrary, has increased.

In recent years, to accelerate wound healing and to prevent the occurrence of wound infections, optical radiation of the visible range (color light therapy) has been used, which has a multicomponent effect: anti-inflammatory, immunostimulating, bactericidal and improving local hemodynamics [6, 7]. Modern studies have shown that as a result of the use of LEDs, due to the selective absorption of the components of incoherent radiation, the growth of granulations and epithelization in the area of the wound defect are stimulated, which contributes to the acceleration of the wound healing process [8]. According to studies, the use of LED radiation of the visible part of the spectrum as part of a complex antimicrobial therapy allows blocking the development of pyoinflammatory processes and preventing the formation of complications.

The development and practical use of new antibacterial drugs have led in recent years not only to a decrease in the percentage of complications of infected wounds, but to the emergence of new, more resistant strains of microorganisms. In this regard, the obtained results of a review of the use of blue and violet colors for inactivation of species of microorganisms with multiple antibiotic resistance and for the treatment of localized wound infections are relevant [10, 11].

METHODS

Electronic databases

The search for publications in the domestic and foreign press was carried out through the Internet resources (e.Library.ru, Medline.com, PubMed.com, EBSCO.com) for the period from 1991 to January 2021.

Publication search algorithm

The search was carried out using the keywords: phototherapy, color light therapy, wounds, wound healing, optical radiation of the visible range and LEDs in combination with each other.

Selection criteria for articles

The selection criteria for articles were as follows: original articles published in peer-reviewed scientific journals, randomized controlled trials comparing color light therapy using different wavelengths (colors) of visible optical radiation, intensities, times, zones and exposure points with the results of control studies (placebo). In the case of finding articles identical in content by the same authors in the process of processing the resulting data set, the results were combined.

RESULTS OF THE GENERALIZED ANALYSIS OF PUBLICATIONSA comparative

study of the effect of laser and LED radiation on the processes of wound healing in the sternum in patients after sternotomy was carried out using cytomorphological studies and registration of microcirculation [12]. Irradiation

was carried out from the device "Mustang 017-MCS-PC" and from LED matrices "Barva-Flex / SIK" in blue (wavelength - 470 nm) and IR radiation (wavelength - 940 nm) and "Barva-Flex / ZIK" green color (wavelength - 525 nm) and infrared radiation (wavelength - 940 nm) during dressings 1-2 times a day. The results showed that 3-5 sessions of color therapy led to the elimination of the appearance of suppuration in the suture zone, and significantly accelerated the healing of the sternum. In this case, the effects of the influence of laser and LED radiation were comparable. Thus, exposure to laser and LED radiation is an effective way to stimulate reparative processes in the sternum after sternotomy and prevent complications.

The effect of color light therapy on wound healing and pain after sternotomy was studied in patients within 6 months after coronary artery bypass grafting [13]. The study was conducted with the participation of 90 patients, who were randomly divided equally into three groups - the main, placebo and control. In the main group, during hospitalization of patients, the wound area was irradiated in red with a wavelength of 640 ± 20 nm at an average energy density of 1.2 J / cm^2... The results of color therapy in the main group were assessed according to subjective criteria, pain when coughing, wound healing according to clinical indicators and interpretation of photographs, which were compared with the placebo and control groups. In the group of patients receiving color therapy, there was a significant decrease in pain on days 6 and 8 after discharge from the hospital compared to the other two groups, and the complete disappearance of pain occurred a month after the operation. An independent analysis of photographs of wounds showed that after color therapy, less pronounced hyperemia was noted, and accelerated healing of postoperative wounds was also observed. Thus, the use of color light therapy with a wavelength of 640 nm in patients after coronary artery bypass grafting had a significant analgesic effect,

The effect of coherent (laser) and incoherent (LED) irradiation on the nature of healing of longitudinal sternotomy incisions in patients after coronary artery bypass grafting with normal and elevated blood glucose levels before surgery was analyzed [14]. The study included 120 patients who were randomly assigned to four equal groups: laser therapy group (orange color, wavelength 620 nm), LED therapy group (red color, wavelength 640 nm), placebo group and control group. ... Color light therapy (laser and LED) was carried out with the same average energy density of 6 J / cm^2 2–8 days after the operation, and the analysis of photographs was used to assess hyperemia and wound healing. The results showed a similar decrease in hyperemia, bleeding and no differences in wound healing after laser and LED therapy, as in the groups with normoglycemic and hyperglycemic patients. It is assumed that the use of both coherent and incoherent light with the used parameters in color light therapy is effective for accelerating wound healing after sternotomy, which manifests itself on the eighth day after surgery.

Clinical evaluation of the use of color light therapy to accelerate wound healing after safenectomy was performed in patients who underwent coronary artery bypass grafting with extracorporeal circulation [15]. All patients (40 men and women) were divided into the main group, in which red color therapy was carried out (wavelength - 640 ± 20 nm) with an average energy density of 6 J / cm^2 and a placebo group. The dynamics of tissue repair after safenectomy was analyzed using digital photogrammetry and quantified on the first and fifth days after surgery. The results showed that the group with color therapy had fewer bleeding areas, as well as decreased area of hematomas and areas of redness compared to the placebo group. The use of color light therapy after safenectomy thus facilitates tissue repair processes, can prevent complications and shorten hospitalization time after surgery.

Efficiency of using red color light therapy (wavelength - 633 ± 3 nm, average energy density - 96 J / cm2) for wound healing after correction of involutional changes in the facial skin (blepharoplasty and laser ablative resurfacing) was studied in a study involving two men and eight women aged 44 to 59 years [16]. Immediately after the operation, 48 hours later, and twice within the next week, one half of the face was irradiated for 20 minutes from an LED source, while the other half was an unirradiated control and was covered during the procedure with an opaque screen. Patients' subjective assessments of pain and discomfort were taken into account after 24 and 48 hours, then after 7; 10 days and after 2; 3 and 6 weeks after surgery. The presence and development of complications (erythema, edema, bruising) and the time to wound healing were assessed independently of clinical photography. As the results showed,

In the postoperative period after plastic surgery on the face (circular facelift, rhinoplasty, liposuction), the use of blue color therapy (wavelength - 405–420 nm) and IR radiation (wavelength - 850–900 nm) made it possible to eliminate the negative consequences of surgery in shorter terms [17]. After plastic surgeries in the facial area, 89 patients were under observation, of which 36
- after circular facelift, 32 - after rhinoplasty and 21 - after liposuction. In the postoperative period, the patients showed swelling of the soft tissues of the face, the presence of hematomas, muscle hypertonia, pain and decreased skin sensitivity. Color therapy was carried out 2–4 days after the operation, the course of treatment consisted of 6 daily procedures with a duration of 30 minutes. As a result of the course of treatment, almost all patients showed significant positive dynamics. There was a decrease in edema after the 1st procedure, and after the 2nd procedure there was a decrease in the severity of hematomas, a decrease in pain and an increase in skin sensitivity. After the end of the course of treatment, there was a complete regression of edema, hematomas, disappearance of pain and restoration of skin sensitivity, moreover, the most pronounced positive changes were observed in patients after rhinoplasty and liposuction and less pronounced - after a circular facelift. The results indicate the high efficiency of the use of color therapy with blue and IR radiation in patients after plastic surgery on the face, which makes it possible to recommend the inclusion of color light therapy in postoperative rehabilitation measures.

Table 1

Clinical Results of Color Light Therapy
to accelerate the healing of postoperative wounds

No. p / p	Wounds	Author (s)	Options impact (length waves, nm; area and time of exposure)	results	Lite-ratura
1.	Healing after sternotomy	Butaev A.Kh., Akhmedov U.B., Sabirov S.K., Khujamberdiev A.U.	Laser and LED radiation blue (470nm) and green (525nm) color, IR radiation (940nm) 1-2 times a day, 3-5 sessions	Accelerated healing and elimination of the appearance suppuration in the seam area, the influence of laser and LED radiation was comparable.	[12]

2.	Healing after sternotomy	de Oliveira RA, Fernandes GA, Lima AC, Tajra Filho AD, de Barros Araújo R. Jr, Nicolau RA	Red color (640 ± 20 nm), 1.2 J / cm2	Reduction of pain on the 6th and 8th day after discharge, disappearance of pain one month after surgery, less pronounced hyperemia and accelerated healing of wounds.	[13]
3.	Healing after sternotomy	Lima AC, Fernandes GA, Gonzaga IC, de Barros Araújo R., de Oliveria RA, Nicolau RA	Laser (Orange color, 620 nm), 6 J / cm2 and LED (red, 640 nm) 6 J / cm2 radiation, 2-8 days after operations	Laser and LED irradiation equally effective to reduce hyperemia, bleeding and accelerate healing wounds in normo- and hyperglycemic sick.	[fourteen]
4.	Healing after safenectomy	Júnior RDBA, Gonzaga ICA, Fernandes GA, Lima ACG, Cortelazzi PST, de Oliveira RA, Nicolau RA	Red color (640 ± 20 nm), 6 J / cm2, 1 and 5 days after operations	Reducing the number of zones bleeding reduction in area hematomas and areas hyperemia.	[15]
5.	Healing after bluff-roplasty and ablative laser grinding	Trelles MA, Allones I.	Red color (633 ± 3 nm), 96 J / cm2, 20 minutes directly after operation, after 48 hours and twice within next week	Shortening time healing wounds and side effects from half to one thirds.	[16]
6.	Healing after plastic face surgeries (circular facelift, rhinoplasty, liposuction)	Andreeva I.N., Bastrykina L.N.	Blue color (405-420 nm) and infrared radiation (850-900 nm) radiation, 2-4 days after operations, 30 min daily, 6 procedures per course	After the 1st procedure reduction of edema, after the 2nd - reduction of hematomas, pain, increased cutaneous sensitivity, by the end of the course treatment - complete disappearance negative consequences.	[17]
7.	Healing after abdominoplasty	Ramos RM, Burland M., Silva JB, Burman LM, Gelain MS, Debom LM, Bec JM, Alirezai M.,	Green (520 nm), orange (590 nm), red (645 nm) color, 15 min, at a distance of 5 cm, 10 J / cm2	Improvement of the condition scarring after 6 months and no difference between postoperative and intact side.	[eighteen]

		Uebel CO, Valmier J			

A comparative clinical study aimed at assessing the effect of color therapy on the wound healing process was carried out on 17 women with an average age of 35.7 years (18 to 55 years) who underwent symmetric abdominoplasty [18]. Postoperative scars on the right side were exposed to green (520 nm wavelength), orange (590 nm wavelength) and red (645 nm wavelength) colors, while left side scars received no additional treatment and were used as controls. The exposure was carried out for 15 minutes from an LED source located at a distance of 5 cm from the surface of the scar with an average energy density of 10 J / cm2... Clinical evaluation of postoperative scars was performed after 1; 6 and 12 months after surgery and the results of the condition of the scars on the right and left side were compared. At 6 months after surgery, there was a significant improvement in scarring on the right (light-irradiated) side compared to the unirradiated left side according to the Vancouver Scar Rating Scale (Vancouver scar scale). After one year of observation, the patients themselves did notnoted differences in the state of postoperative scars between the parties after color therapy and without the use of therapeutic effects. The studies performed statistically confirm the positive effect of color light therapy on the process of wound healing, reduction of the stage of scarring at the first stages of the postoperative process. It should be noted that, unfortunately, this publication does not provide an analysis of the results of the condition of the scars depending on the wavelength of the optical radiation used for the therapeutic effect during color light therapy.

CONCLUSION AND FUTURE PERSPECTIVES

The problem of complex treatment of wounds of various origins remains one of the most important in modern medicine and is an urgent and priority task for practical health care, since the outcome of the wound process and the patient's further work ability depend on the effectiveness of its resolution. The problem of wound treatment has recently acquired particular importance in connection with the increase in the number of man-made and natural disasters, as well as military conflicts and terrorist acts. Despite the active introduction of new methods into clinical practice, the problem of prevention and treatment of wounds is still relevant, and a high percentage of complications transfers this problem from the medical section to the socio-economic category.

The use of irradiation with visible optical radiation of various wavelengths for the treatment of wounds, as shown by the studies, leads to an acceleration of the healing process, which in the most favorable situations approaches the primary one. Comparison of laser (orange, wavelength - 620 nm) and LED (red, wavelength - 640 nm) radiation showed the same effectiveness for reducing hyperemia, bleeding and accelerating wound healing. Red LED sources in the wavelength range from 620 to 640 nm were most effective in shortening wound healing time, reducing bleeding, hyperemia and the occurrence of postoperative side effects. The use of laser and LED radiation in combination with IR radiation in the range of 850-940 nm made it possible to eliminate suppuration and accelerate the stages of scarring in the postoperative period. It should be emphasized that color light therapy and medical treatment of wounds are not competing methods, they can be considered as complementary components of complex therapy, contributing to the speedy recovery of the patient. Thus, the use of color light therapy can significantly reduce the time of wound healing, contributes to the formation of a less pronounced scar on the skin and a decrease in proliferative processes at the site of the inner suture, which is especially important in wound healing. they can be viewed as complementary components of complex therapy, contributing to the speedy recovery of the patient. Thus, the use of color light therapy can significantly reduce the time of wound healing, contributes to the formation of a less pronounced scar on the skin and a decrease in proliferative processes at the site of the inner suture, which is especially important in wound healing. they can be viewed as complementary components of complex therapy, contributing to the speedy recovery of the patient. Thus, the use of color light therapy can significantly reduce the time of wound healing, contributes to the formation of a less pronounced scar on the skin and a decrease in proliferative processes at the site of the inner suture, which is especially important in wound healing.

LITERATURE

1. Kuzin, M.I. Wounds and wound infection:a guide for doctors / M.I. Kuzin, B.M. Kostyuchenok; 2nd ed., Rev. and add. -M .: Medicine, 1990. - 591 s.

2. Minchenko, A.N. Wounds. Treatment and prevention of complications / A.N. Minchenko. - SPb: Publishing house in "SpetsLit", 2003. - 244 p.

3. Broughton, G., 2nd... Wound healing: an overview / G. Broughton, 2nd, JE Janis, CE Attinger // Plast. Reconstr. Surg. - 2006. - Vol. 117, N.7 Suppl. - P.1e-S-32e-S.

4. Half a century of development of prevention of infectious complications in postoperative wounds / V.V. Parshikov, V.I. Loginov, A.B. Baburin, R.R. Kasimov // Medical Bulletin of Bashkortostan. - 2017. - Vol. 12, No. 1. - p.82-93.

5. Privolnev, V.V. Basic principles of local treatment of wounds and wound infections / V.V. Privolnev, E.V. Karakulina // Wedge. microbiol. antimicrobial. chemother. - 2011. - T. 13, no. 3. - C.214 -222.

6. Kuffer, DP Photobiomodulation in promoting wound healing: a review / DP Kuffer // Regen. Med. - 2016. - Vol.11, N.1. - P.107-122.

7. Barolet, D. Accelerating ablative fractional resurfacing wound healing recovery by photobiomodulation / D. Barolet // Curr. Dermatol. Rep. - 2016. - Vol.5, N.3. - P. 232-238.

8. Fryc, J. Diody elektroluminescencyjne LED w dermatologii-stymulacja gojenia ran / J. Fryc, I. Fryc // Przegl Dermatol. - 2016. - Vol. 103, No. 2. - P.169-175.

9. Karu, T. Is it time to consider photobiomodulation as a drug equivalent? / T. Karu // Photomed. Laser Surg. - 2013. - Vol.31, N.5. - P.189-191.

10. Enwemeka, CS Antimicrobial blue light: an emerging alternative to antibiotics / CS Enwemeka // Photomed. Laser Surg. - 2013. - Vol.31, N.11. - P.1-3.

11. Hamblin, MR Can light-based approaches overcome antimicrobial resistance? / MR Hamblin, H. Abrahamse // Drug. Dev. Res. - 2019. - Vol.80, N.1. - P.48-67.

12. The use of laser and LED exposure to stimulate reparative processes of the sternum during sternotomy / A.Kh. Butaev, U.B. Akhmedov, S.K. Sabirov, A.U. Khujamberdiev // Laser Medicine. - 2014. - T.18, No. 4. - p. 15.

13. The effects of LED emissions on sternotomy incision repair after myocardial revascularization: a randomized double-blind study with follow-up / RA de Oliveira, GA Fernandes, AC Lima [et al.] // Laser. Med. Sci. - 2014. - Vol.29, N.3. - P.1195-1202.

14 Low-level laser and light-emitting diode therapy for pain control in hyperglycemic and hormoglycemic patients who underwent coronary bypass surgery with internal mammary artery grafts: a randomized, double-blind study with follow-up / AC Lima, GA Fernandes, IC Gonzaga [et al.] // Photomed. Laser Surg. - 2016. - Vol.34, N.6. - P.244-251.

15. Low-intensity LED therapy (λ 640 ± 20 nm) on saphenectomy healing in patients who underwent coronary artery bypass graft: a randomized, double-blind study / RDBA Júnior, ICA Gonzaga, GA Fernandes [et al.] // Lasers Med. Sci. - 2018. - Vol.33, N.1. - P.103-109.

16. Trelles, MA Red light-emitting diode (LED) therapy accelerates wound healing post-blepharoplasty and periocular laser ablative resurfacing / MA Trelles, I. Allones // J. Cosmet. Laser Ther.- 2006. - Vol.8, N.1. - P.39-42.

17. Andreeva, I.N. The effectiveness of the use of photochromotherapy in the early postoperative period after plastic surgery on the face / I.N. Andreeva, L.N. Bastrykina // Modern scientific research and development / Mater. International Scientific and practical conference. - Prague, Czech Republic, 2017 .-- p. 490-494.

18. Photobiomodulation improved the first stages of wound healing process after abdominoplasty: an experimental, double-blinded, non-randomized clinical trial / RM Ramos, M. Burland, JB Silva [et al.] // Aesthetic Plast. Surg. - 2019. - Vol.43, N.1. - P.147-154.

Author's address
Ph.D. Gotovsky M.Yu., General Director of LLC "CIMS" IMEDIS "
info@imedis.ru

Gotovsky, M.Yu. Color light therapy in the treatment of postoperative wounds / M.Yu. Gotovsky, N.T. Salia // Traditional Medicine. - 2021. - No. 2 (65). - P.4-9.