



Original article

ACTA FAC. MED. NAISS. 2005; 22 (1): 29-35

Aleksandar Janković,
Milenko Stanojević,
Ivana Binić

Clinic of Dermatovenerology
Clinical Centre Niš

PHYSICAL THERAPY OF VENOUS ULCERS: EFFECTS OF ELECTROIONOTHERAPY AND POLARIZED LIGHT

SUMMARY

Venous ulcers are a common chronic disease requiring continuing therapeutic follow-up, significantly influencing patients' way of life. Moreover, the administered treatment is often unsuccessful and expensive. In dermatologic practice conservative treatment of venous ulcers is limited to medicamentous and physical therapy.

Our study included 45 patients with venous ulcers. The patients were treated with an apparatus which generates electroionic currents (15 patients), and an apparatus which generates polarized light (15 patients). There was also the control group of 15 patients. Our investigation focused on the control of the parameters changes important for ulcer healing (fibrin accumulations, exudation, granulation, epithelization), ulcer surroundings and associated symptoms. All the parameters were monitored clinically at the beginning, during and at the end of administered therapy, when the scores were determined. At the study end, on the basis of obtained result, the efficacy of therapeutic methods was assessed.

Comparing the findings of investigated parameters (statistically significant for all the parameters at the level $p < 0.05$ and $p < 0.01$) with the controls' ones, it was established that electroionizing radiation and polarized light accelerated ulcer healing. Electroionizing radiation leads to accelerated epithelization and more rapid healing of venous ulcers. Venous ulcers demonstrate epithelization sooner under the action of physical therapy, and electroionizing radiation alone demonstrates better effects compared to polarized light.

Key words: electroionization, polarized light, venous ulcer, epithelization

INTRODUCTION

Venous ulcers are a common chronic disease requiring continuing therapeutic surveillance, significantly influences quality of life of the affected due to associated edemas, eczema, superficial purulence and thrombophlebitis (1).

Also, the applied treatment is expensive, often without any effects. In dermatologic practice, in ad-

dition to medication, physical therapy is also commonly used with various success. Nowadays, extensive investigations are being conducted aiming at finding novel therapeutic methods in venous ulcer treatment. In severe, chronic, infected venous ulcers, there is a need for additional therapy, most commonly physical therapy (2). Recently, electroionotherapy has been very extensively used as a noninvasive approach and as a revolutionary inno-

vation in modern biomedical technology. Electroionization has been initially presented and applied in the field of sport medicine and in the treatment of simple cutaneous lesions, muscular traumas with tissue and intramuscular bleeding, for tendosynovitis and peritendinitis, entesopathy and osteohondritis, etc. (3,4). The field of action and indications in dermatology are vascular diseases and their clinical signs: severe pain associated with serious alterations of tissue microcirculation, insufficient and very slow scarring of venous, arterial, diabetic ulceration, neuropathies and cutaneous dystrophy correlated with vascular diseases. The method is also recommended when the infection is associated with vascular diseases (4, 5).

Favourable effects of polarized light are discovered in laser light studies. A group of physicians from Hungary discovered in 1981 the stimulation of defensive and reparatory functions with polarized light (6,7). These effects of bioptron-polarized light on human organism are conditioned by characteristics of this light: polarization, specific density force and constant energy. Depending on the exposure duration, polarized light penetrates into tissues to the depth of up to 2.5 cm (6,7). It clearly acts on vascularization and improves microcirculation. The mechanism is important regarding accelerated wound healing and epithelization, especially in case of infection (6–8).

AIMS

The aim of the study was to establish the effects of electroionizing radiation and polarized light on venous ulcer healing, as well as the degree of correlation with controls.

MATERIAL AND METHODS

The study was done at the Department for Peripheral Circulation Diseases and Section for Physical Therapy, Clinic of Dermatovenerology, Clinical Centre Niš.

The study included 45 patients, with various number of venous ulcers. The patients were randomized into 3 groups, with 15 patient each:

- group with electroionizing radiation treatment (ER)
- group with polarized light treatment (PL)
- control group (C)

Control group ulcers were not treated with physical therapy.

The following parameters were controlled:

- ulcer (number, surface, depth, volume, borders, fibrin deposits, exudation, granulation, epithelization),

- ulcer vicinity (erythema, edema, maceration, desquamation, scleroatrophy),
- associated symptoms (pain and pruritus).

Assessment of all clinical parameters, ulcer status and cutaneous alterations in the vicinity was performed in control examinations after I, III, V and VII week of the treatment.

Epithelization and granulation of venous ulcers were evaluated on the 0–3 scale (0 – prominent; 1 – moderate; 2 – slight; 3 – absent). For evaluation of other parameters, such as fibrin deposits, exudation, edema, erythema, maceration, desquamation, scleroatrophy, pain and itching. The 0-3 scale was also used (0 – absent; 1 – slight; 2 – moderate; 3 – prominent). In each check-up of the treatment effect the total score was determined for ulcer 0–12 which was separately calculated with ulcer volume; for ulcer vicinity 0–15, for symptoms 0–6 and for total score as a sum of scores of all parameters. At the end of the investigation, the total score reduction related to the initial score was determined. Also, on the basis of the established difference the efficacy of each treatment modality was determined. Epithelization degree was determined on the basis of the ulcer surface in mm² (measuring the half-diameter and calculating the surface according to the formula for a circle and ellipse, since most ulcers can be reduced to the circle or ellipse) at the treatment onset and control examinations.

Appropriate care, washing and bandaging of ulcerations were performed every day. Utilization of topical antibiotics was based on the biogram and antibiogram results or based on the therapeutic range, similar to the use of antiexudative, anti-inflammatory and disinfectant bandages. In cases of eczematization and other symptoms standard official glucocorticoids were administered to all groups.

On admission to the hospital, similar principles of local treatment were used in order for the investigation to be conducted under the same conditions in all groups and the treatment effects to be appropriately assessed.

Physical therapy in the ER group was administered with a medical apparatus for electroionic radiation indicated for venous ulcer and other vascular diseases treatments. Physical therapy with electroionic currents and radiation of venous ulcers was administered with medical apparatus manufactured by the Italian firm BIO-EJT SRL, *Bioejt*, model BE 10, composed of double control of electrical current amount, analogue instruments for separate display of positive and negative current, the intensities of which can be adjusted, a probe for current return between the patient and operator, special quick-connecting system containing patient cuffs and a stopwatch to determine treatment duration. The apparatus has the power of 60 W, with fusion

power of 2F 630 mA and 250 V, maximal power 40 kV and 10 μ A. It is constructed in a way to sustain cold sterilization and it should not be used in the presence of flammable substances/mixtures containing air, oxygen or nitric oxides. Patients with pacemaker should not be treated with electroionizing radiation. Treatment duration for all ulcerations measured in minutes is also determined by an automatic stopwatch. One treatment (10-minute duration) was conducted daily. The surfaces of clean ulcers (without deposits or fatty remnants) were irradiated. Physical therapy with polarized light in the PL group was conducted using the apparatus manufactured by Zepter-Bioptron (Swiss), Bioptron mark, model 2, indicated for venous ulcer treatment. The apparatus is devised for professional applications and it complies with the international medical/technical norms. The field of light emission is 15x15 cm. The light source is a halogen lamp (100 W power). It is applied from the distance of 10-15 cm, under the right angle, since then the apparatus has constant power density of 40 mW/cm² and constant energy of 2.4 J/cm²/min.

Treatment duration for all ulcers was set to be measured in minutes. One treatment (10-minute duration) was conducted daily. Ulcerations were first cleansed up from the fatty deposits and remnants and then directly irradiated. The results of the investigation were systematized, statistically processed and displayed in tables and graphs.

RESULTS

In the ER group there were 15 patients, out of which 8 men (53.33%) and 7 women (46.66%). Average age of the patients was 68.93 years, and average duration of venous ulcers 12.4 years. After 7 days of ER treatment reduction of ulcer surface was 6.60%, of depth 21.95%, of volume 28.94%; after III week, surface reduction was 38.97%, depth reduction 53.56%, volume reduction 73.52%; after V week, surface reduction was 58.70%, depth reduction 77.56% and volume reduction 87.03%. At the end of the treatment, after seven weeks, the total surface reduction was 68.48%, depth reduction 93.17% and volume reduction 96.89%. Surface reduction values in the V week and at the treatment end were statistically significant $p < 0.05$; for depth, $p < 0.05$ after the 7-day treatment, and $p < 0.01$ in III week; volume reduction was also statistically significant in III week.

Improvement of the total ulcer score, after the 7-day treatment, was 25.0%, after III week 58.46%, after the V week 84.67%. At the end of the treatment, after seven weeks, ulcer score was improved, with maximal value of 98.38%. Score improvement for ulcer vicinity after the 7-day treatment was

8.27%, after III week 37.59%, in the V week 62.40%, and at the end of the treatment 76.31%. Score improvement for the disease symptoms after the 7-day treatment was 21.05%, with the highest value of 92.10% in VII week (ie., at the end of the treatment). Improvement of the total score after the 7-day treatment was 16.94%, and at the end of the treatment 87.62%. According to results, the efficacy of administered treatment approach was assessed. Out of the total number of venous ulcers, 6 ulcers were assessed as excellent for surface reduction (40.0%), 14 ulcers for depth reduction (93.33%) and all 15 ulcers were assessed as excellent for volume reduction. Nine ulcers (60%) were assessed as very good for surface reduction and 1 ulcer (6.60%) for depth reduction. There were 15 patients in the PL experimental group, out of which 7 men (46.66%) and 8 women (53.33%). Average age of the patients was 70.13 years, and average ulcer duration 14.2 years. After the 7-day therapy with polarized light and topical antibiotics, surface reduction was 16.72%, depth reduction 20.77%, volume reduction 30.52%; after three weeks, surface reduction was 34.63%, depth reduction 50.15%, volume reduction 59.81%; after five weeks, surface reduction was 50.22%, depth reduction 70.07% and volume reduction 81.05%, and at the end of the treatment (after VII week), surface reduction was 59.83%, depth reduction 85.72% and volume reduction 92.3%. Values of surface reduction at the end of treatment were statistically significant, $p < 0.05$, for depth reduction statistical significance was $p < 0.05$ in III week, and in V and VII week $p < 0.001$; volume reduction was statistically significant in the III week, $p < 0.05$, and $p < 0.01$ in VII week. After the 7-day treatment average score was reduced, and the improvement was 24.55%; after three weeks of treatment score reduction was even greater – 65.62%, after V week 92.41% and after VII week ulcer score was improved with maximal value of 100%.

Score improvement for the changes in ulcer vicinity after the 7-day treatment was 19.76%, in III week 44.11%, the V week 77.64%, and at the end of the treatment 80.03%. The proportion of score improvement for symptoms after the 7-day treatment was 9.03%, with the highest value of 96.12% in VII week (treatment end). The percentage of improvement of the total score after the 7-day treatment was 20.19%, with the highest value at the end of the treatment – 93.39%. On the basis of these results, the efficacy of administered treatment approaches was determined. Out of the total number of venous ulcers in the PS group, 7 ulcers (46.66%) were assessed as excellent for surface reduction, as well as all 15 venous ulcers for depth and volume reduction. Six ulcers (40.0%) were assessed as very good for surface reduction, and 2 ulcers (13.33%) were assessed as good.

In group C there were 15 patients in total, out of which 2 men (13.33%) and 13 women (86.66%). Average age of these was 70.46 years, and average ulcer duration was 17 years. After the 7-day treatment with only topical antibiotics, surface reduction in C group was 2.55%, depth reduction 13.33%, volume reduction 36.55%; after III week, surface reduction was 24.95%, depth reduction 46.66%, volume reduction 80.20%; after V week surface reduction was 36.54%, depth reduction 63.11% and volume reduction 88.63%, and at the end of the treatment (seven weeks) surface reduction was 46.85%, depth reduction 70.66% and volume reduction 91.60%. Surface reduction during the treatment was not statistically significant. As for depth reduction, statistical significance was $p < 0.05$ after V week and $p < 0.01$ after VII week. Surface reduction was statistically significant in the III week of the treatment at the level of $p < 0.05$, and $p < 0.01$ in V week. After the 7-days treatment, ulcer average score was reduced, with the improvement of 10.78%; after the treatment in III week score reduction is even greater, with the improvement of 35.38%; after the treatment in V week the improvement was 54.61%, and at the end of the treatment 73.84%. Score improvement for the ulcer vicinity after the 7-day treatment was 13.88%, after III week 27.70%, after V week 37.03%, and after VII week 60.18%. Score improvement percentage for symptoms after the 7-day treatment was 12.50%, with the highest value of 62.50% after VII. Overall score improvement after the 7-day treatment was 9.92%, and after VII week 71.18%. Out

of the total number of venous ulcers in group C, 2 ulcers (13.33%) were assessed as poor for surface reduction, 6 ulcers (40.0%) were good, 5 (33.33%) were very good, and 2 (13.33%) were excellent. As for depth reduction, 2 ulcers (13.33%) were assessed as good, 6 ulcers (40.0%) were very good, and 7 ulcers (46.66%) were excellent. As far as volume reduction is concerned, 2 ulcers (13.33%) were assessed as very good and 13 ulcers (86.66%) were excellent.

Comparative results for all investigated parameters at the end of the study are shown in Table 1.

Table 1. Total reduction of the ulcer parameters at the end of the study

PARAMETERS	PL	ER	C
	%	%	%
Surface	60,87	68,48	46,85
Depth	85,72	93,17	70,66
Volume	92,47	96,89	91,60
Sc. ulcer	100	98,38	73,84
Sc. vicinity	80,03	76,31	60,18
Sc. symptoms	96,13	92,10	62,5
Total score:	90,39	87,62	67,17

Therapy efficacy grades are demonstrated for all groups in Table 2.

Table 2. Comparative efficacy assessment grades of ulcer physical therapies at the end of the study

Parameters	Numb. of patient.	EFFICACY GRADE							
		Poor		Good		Very good		Excellent	
		br.	%	br.	%	br.	%	br.	%
P	ER	-	-	-	-	9	60,00	6	40,00
	PL	-	-	2	13,33	6	40,00	7	46,66
	C	2	13,33	6	40,00	5	33,33	2	13,33
D	ER	-	-	-	-	1	6,66	14	93,33
	PL	-	-	-	-	-	-	15	100,0
	C	-	-	2	13,33	6	40,0	7	46,66
V	ER	-	-	-	-	-	-	15	100,0
	PL	-	-	-	-	-	-	15	100,0
	C	-	-	-	-	2	13,33	13	86,66

Figure 1 and 2 demonstrate comparative values of all studied parameters at the end of the study.

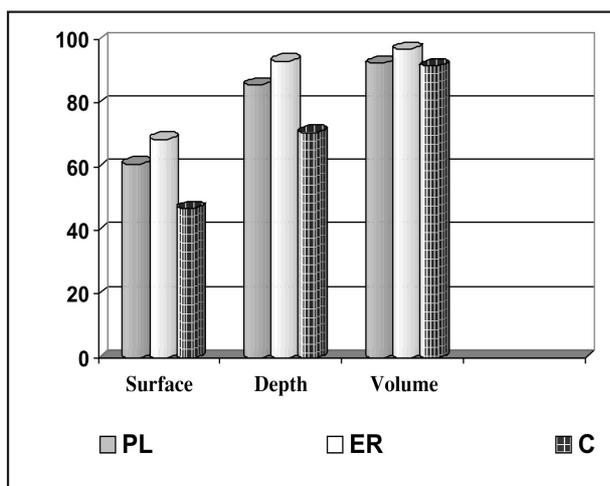


Figure 1. Final values of surface, depth and volume improvements in studied groups

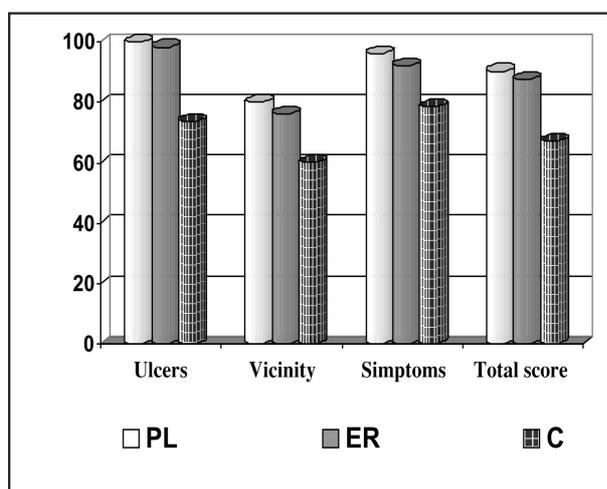


Figure 2. Final values of ulcer score improvements in studied groups

DISCUSSION

The aim of our study was adjusted to the actual circumstances in hospital care and general tendencies in venous ulcer treatment in our region. However, up to the present, we have not found investigations which would compare the effects of various kinds of physical treatments on venous ulcer healing. That was the reason why we have undertaken the comparative study in order to define which treatment modality is the most appropriate for venous ulcer treatment.

The study was conducted and controlled in hospital conditions, so that the obtained results could contribute to further investigations and definition of the most optimal modalities of topical treatment using new physical agents, physical therapy

and combined approaches. Duration of physical treatments was identical for all the patients and methods – 10 minutes – in order to assess the effects of different physical agents objectively.

The results of both ER and PL groups indicate positive effects of physical therapy, with markedly better values of all investigated parameters compared to group C. Ulcer surface and depth reduction in groups ER and PL demonstrate statistically significant difference in all check-up examinations and at the end of the treatment. Improvement of other parameters for ulcer vicinity, symptoms and general score is also statistically significant. Comparing our results with literature results (8,9) regarding polarized light action, we may observe similar values for surface, depth and volume reduction and for epithelization, as well as for score reduction (their percentual improvement).

From the literature data we may see that the effects of polarized light are conditioned by its polarization, specific density power and constant energy (8-10).

Physical therapy is generally mentioned as an accessory method with some physical agents, the use of which can be beneficial in venous ulcer treatment. However, there are only a few investigations with patient samples which can be valid to evaluate real effects of administered physical therapy (9,13,14). According to the studies published so far, it is very difficult to draw conclusions on its effects on venous ulcers.

In contact with the cell, polarized light leads to an increase of cell membrane energetic activity – regenerative processes are being enhanced, as well as the blood flow and cell number increase at the injury site. Capillaries start to proliferate as buds, penetrate the wound, make anastomoses and create a rich circulatory network in the granulation tissue (11,12). The influence of polarized light on microcirculatory bed is in the form of antiedematous, analgetic and anti-inflammatory action. Favourable healing of venous ulcers in our results can be explained by an anti-inflammatory effect, microcirculation improvement and stimulation of reparation processes. It enables its widespread use in dermatology and other fields of medicine. It should be emphasized that patients are very compliant regarding such kind of treatment.

In ER group, improvement of other parameters is clinically visible and the differences demonstrated for ulcer, its vicinity, symptoms and general score were statistically significant.

Venous ulcers demonstrate better epithelization under the action of electroionizing radiation. Comparing the differences and overall improvement of analyzed parameters, a difference was noted in electroionizing radiation and polarized light admin-

istration. Electroionizing radiation demonstrate better overall results in venous ulcer treatment and more rapid epithelization. The ulcer and ulcer vicinity score reduction is lower compared to PL group. At the end, we should emphasize that total efficacy grade is higher in ER group compared to PL group.

When interpreting the obtained results we should bear in mind the type and power of the applied physical agent, as well as the duration of venous ulcer treatment (9). During the ER treatment, a constant average radiation power was used during the whole of the treatment, despite the existing technical options for lower or higher power. Identical treatment duration should enable comparison of ER with PL effects.

Throughout the literature we have not found any study of electroionizing radiation effects on venous ulcer healing. A few papers investigated the effects of electroionizing radiation in sports medicine for simple cutaneous lesions, muscular traumas with inter-tissue and intramuscular bleeding, in tendosynovitis and peritendinitis treatment, in entesopathies and osteochondritis treatment, strain treatment. In all these cases, it demonstrated its favourable action (3-5). Electroionizing radiation has some favourable features, such as analgesic effect, edema reduction, microcirculation improvement, angiogenesis stimulation etc. (5). All the investigations of ER point to direct or indirect favourable effects of electromagnetic fields on particular cells in a human body. Electrolyte exchange through the cell membrane alters electrolytic composition of the cell. Numerous enzymatic pathways are activated, cellular metabolism is remodelled and cellular and tissue regenerative processes are reactivated. Blood circulation is increased and accelerated, and edema and cyanosis reduced. Tissue and cellular vasomotor activity is maintained and defense mechanisms enhanced. Induced capillary neoangiogenesis accelerates granulation tissue creation (4,5). Electroionic radiation models the mechanism of wound healing in a non-thermal way (4, 5).

Due to insufficient practical knowledge on the beneficial effects of this kind of radiation further

work is required to establish the maximal effect of such physical agents. On the basis of the literature review on topical and physical therapy, positive action on these processes was established in venous ulcers. It is necessary to further investigate the effects of various power-levels of electroionic radiation for the given treatment durations and their possible combination, in order to establish the treatment protocol which would comprise the optimal power of radiation and its optimal duration, as a physical treatment which could be successfully used for venous ulcers. Objective improvements and absence of unfavourable effects during the treatment make patients very compliant.

During the treatment it is necessary to stick to the general topical treatment guidelines which could be adjusted to the ulcer healing phase (10,11,12).

Technical features of particular machines and pharmacologic characteristics of topical preparations for optimal venous ulcer epithelization are still a huge problem. Moreover, the price and potentials for widespread use of most investigated machines are also a problem (15-18).

CONCLUSION

Electroionizing radiation and polarized light accelerate ulcer healing. Electroionizing radiation leads to accelerated epithelization and more rapid healing of venous ulcers. Venous ulcers demonstrate epithelization sooner under the action of physical therapy, and electroionizing radiation alone demonstrate better effects compared to polarized light.

During the treatment it is necessary to stick to the general topical treatment guidelines which could be adjusted to the ulcer healing phase.

Technical features of particular machines and pharmacologic characteristics of topical preparations for optimal venous ulcer epithelization are still a huge problem.

REFERENCES

1. Valencia IC, Falabella A, Kirsner RS, Eagstein WH. Chronic venous insufficiency and venous leg ulceration. *J Am Acad Dermatol* 2001; 44: 401-21.
2. Junger M, Steins A, Zuder D, Klyszcz T. Physical therapy of venous diseases. *Vasa* 1998; 27: 73-9.
3. BIOEJT BE 101 Medical device for topical electroionotherapy. Expert Report 20/06/1997.
4. Palmeri F, Savojardo M, Pecorella G, Lo Coco L, Francavilla G. Valutazione sulla applicazione del BIO-EJT in traumatologia da sport. *Med Clin Term* 1998; 44-45: 139-151.
5. Ancona E. Valutazione dell'effetto dell'applicazione del BIOEJT sulle ulcere venose. Padova 1997.
6. Skrobić M. Bioptron fototerapija. Zepter internacional Yu, Beograd 1998.
7. Medenica Lj, Lens M. The use of polarised polychromatic non-coherent light alone as a therapy for venous leg ulceration. *J Wound Care* 2003; 12: 37-40.

8. Hass HL. The therapeutic activity of the BIOP-TRON- lamp in the treatment of disorders of wound healing. Diabetic gangrene. *Krankepf J* 1998; 36: 494–6.
9. Knajter I, Dostanić I, Ljuština M, Isakov B. Fizikalna terapija u dermatologiji i kozmetici, Medicina Jugoslavica, Beograd 1991.
10. Hass HL. Therapeutic potentials of the Bioptron light: treatment of disorders in wound healing. *Krankepf J* 1998; 36: 451–3.
11. Paravina M, Stanojević M, Poljački M, Ristić G, Jovanović D, Ljubenović M. Primena Bioptron polarizovane svetlosti u lečenju ulcus cruris. VI Beogradski dermatološki dani, Zbornik radova 1999; 148–49.
12. Ugrinović D, Stojisavljević M, Pejović T, Perišić S, Dostanić I. Primena polarizovane svetlosti Bioptron lampe u lečenju venskih ulceracija. VI Beogradski dermatološki dani, Zbornik radova 1999; 153–55.
13. Peschen M, Peter O, Vanscheidt W. Chronic venous insufficiency – from pathophysiology to therapy. Treatment of ulcus cruris – therapy guidelines. *Fortschr Med* 1999; 114: 395–7.
14. Junger M, Zuder D, Steins A, Hahn M, Klyszcz T. Treatment of venous ulcers with low frequency pulsed current (Dermapulse): effects on cutaneous microcirculation. *Hautarzt* 1997; 48: 897–903.
15. Franek A, Polak A, Kucharzewski M. Modern application of high voltage stimulation for enhanced healing of venous crural ulceration. *Med Eng Phys* 2000; 22: 647–55.
16. Gupta AK, Filonenko N, Salansky N, Sauder DN. The use of low energy photon therapy (LEPT) in venous leg ulcers: a double blind, placebo-controlled study. *Dermatol Surg* 1998; 24: 1383–6.
17. Flemming K, Cullum N. Therapeutic ultrasound for venous leg ulcers. *Cochrane database Syst Rev* 2000: CD0011180.
18. Gherardini G, Gurlek A, Evans GR, Milner SM, Matarasso A, Wassler M, Jernbeck J, Lunderberg T. Venous Ulcers: improved healing by iontophoretic administration of calcitonin gene-related peptide and vasoactive intestinal polypeptide. *Plast Reconstr Surg* 1998; 101: 90–3.

FIZIKALNA TERAPIJA VENSkih ULKUSA: EFEKTI ELEKTROJONSKE TERAPIJE I POLARIZOVANE SVETLOSTI

Aleksandar Janković, Milenko Stanojević, Ivana Binić

Klinika za dermatovenerologiju, Klinički centar Niš

SAŽETAK

Venski ulkusi su česti i onesposobljavaju bolesnika. Lečenje je skupo jer su ulkusi otporni na terapiju, zahtevaju stalni nadzor, većinom zbog pratećih edema, ekcema, površinskih gnojenja i tromboflebitisa. U dermatološkoj praksi, konzervativno lečenje venskih ulkusa ograničeno je na medikamentnu i fizikalnu terapiju.

Ispitivanjem je obuhvaćeno 45 bolesnika sa venskim ulkusima koji su lečeni upotrebom aparata koji generiše elektrojonske struje (15 bolesnika), upotrebom aparata koji proizvodi polarizovanu svetlost (15 bolesnika) i 15 bolesnika koji su činili kontrolnu grupu. Ispitivanjem je kontrolisana promena parametara koji su važni za zarastanje ulceracija, (fibrinske naslage, eksudacija, granulacija, epitelizacija), okolina ulceracije i prateći simptomi. Svi parametri su praćeni klinički, ocenjivanjem lokalnog statusa ulceracije na kontrolnim pregledima i na kraju lečenja. Na kraju ispitivanja, na osnovu postignutih rezultata, ocenjena je efikasnost terapijskih metoda.

Poredeći razlike i ukupno poboljšanje ispitivanih parametara na kraju ispitivanja (statistički značajne za sve parametre na nivou $p < 0,05$ i $p < 0,01$) u odnosu na kontrolnu grupu, primena elektrojonizujućeg zračenja i polarizovane svetlosti ubrzava zarastanje ulkusa. Elektrojonizujuće zračenje dovodi do bržeg zarastanja venskih ulkusa i brže epitelizacije. Polarizovana svetlost povoljnije utiče na neposrednu okolinu ulceracije.

Venski ulkusi pokazuju da brže epitelizuju pod dejstvom fizikalne terapije, a samo elektrojonizujuće zračenje pokazuje bolje efekte od polarizovane svetlosti.

Ključne reči: elektrojonizacija, polarizovana svetlost, venski ulkus, epitelizacija