Optimization of Treatment Methods for Purulent-Destructive Soft Tissue Diseases through the use of Laser Treatment Methods

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Received: 31 October 2021 Accepted: 30 November 2021 Published: 10 December 2021

Abstract

Optimization of methods for the treatment of purulent-destructive diseases through the complex application of photodynamic therapy (PDT) and CO 2 laser.Materials and Methods: 360 patients with purulent-destructive soft tissue disease were examined and treated. Depending on the treatment carried out, the patients were conditionally divided into 3 groups: the 1st (control group) included 118 patients who underwent conventional traditional methods of treatment; in the 2nd group (main group I) there were 120 patients who, in combination with traditional methods of treatment, used PDT with a photosensitizer (PS) 0.05

Index terms— photodynamic therapy, photosensitizer, methylene blue, ??2 laser, laser surgery, microbe, planimetry.

Abstract-Purpose: Optimization of methods for the treatment of purulent-destructive diseases through the complex application of photodynamic therapy (PDT) and CO 2 laser.

Materials and Methods: 360 patients with purulent-destructive soft tissue disease were examined and treated. Depending on the treatment carried out, the patients were conditionally divided into 3 groups: the 1st (control group) included 118 patients who underwent conventional traditional methods of treatment; in the 2nd group (main group I) there were 120 patients who, in combination with traditional methods of treatment, used PDT with a photosensitizer (PS) 0.05% methylene blue buffer solution (MB); and the 3rd group (main group II) included 122 patients where PDT was used in combination with traditional methods of treatment (0.05% methylene blue buffer solution was used as PS) and a CO 2 laser. Clinical, microbiological, morphological and planimetric methods have been investigated to assess the effectiveness of the method.

Results: Photodynamic therapy with a light emitter ALT-Vostok-03 is a rather effective non-invasive and sparing method of treating purulent wounds and serves as a rationale for the application of the method of photodynamic therapy in clinical practice for the treatment of local acute purulent-inflammatory processes in combination with a CO 2 laser and traditional methods of treatment. In patients of the main group, the normalization of temperature and heart rate was observed at 3.0 ± 0.5 days, a decrease in LII indices to the normal level was observed at 7.0 ± 0.5 days after the treatment. Analysis of the dynamics of clinical manifestations showed that the treatment of purulent wounds using PDT with a photosensitizer of the blizzard blue leads to a rapid decrease in perifocal inflammatory manifestations. Hyperemia of the skin around purulent wounds and a decrease in perifocal inflammation persisted for 3.5 ± 0.5 days, a decrease in local edema was noted for 2.0 ± 0.5 days. The average length of hospital stays for patients in the main group averaged 5.0 ± 2.5 bed-days. After 3-5 sessions of PDT with a photosensitizer MS in the main group, the microbial contamination decreased to a critical level, and after 6-8 sessions, no microbial growth was observed.

1 Introduction

espite the achievements of recent years in the field of microbiology, immunology, intensive work on the development and implementation of new antibacterial drugs, improvement of surgical techniques, the problem of treating purulent-inflammatory diseases of soft tissues does not lose its relevance [4,8,32,36]. This problem is compounded by the growing number of pathogenic microorganisms resistant to both antibiotics and some antiseptics [25,31].

In the general structure of surgical diseases, surgical infection is observed in 35 -45% of patients. At the same time, up to 70-80% of these patients are admitted to hospitals for urgent indications. In the structure

of postoperative complications, surgical infection ranges from 32 to 75% [1,2,23,13,19,9,37,34,35,43]. These impressive figures convincingly indicate the relevance and unsolved problem of purulent infection in surgery, which is a very serious medical, social and economic problem that remains relevant today [29].

Despite the availability of various methods of treatment used in purulent surgery, it does not reduce the number of patients with surgical infection, which contributed to the introduction of a wide range of physical and physicochemical methods of local treatment of purulent soft tissue diseases [1,14,20,40].

One of the promising areas of modern medicine in solving this problem is the use of laser treatment methods. Photodynamic therapy (PDT) is a unique medical technology: highly effective, sparing, organpreserving, providing good cosmetic and functional results [26]. PDT is a relatively new method of treatment based on the use of drugs -photosensitizers (substances that are sensitive to light) and laser radiation with a certain wavelength corresponding to the absorption peak of the photosensitizer [17,24].

2 II.

3 Research Purpose

Improvement of the results of treatment of patients with purulent-destructive diseases of soft tissues with the help of local complex application of PDT and CO 2 laser.

4 III.

5 Materials and Methods

The study is based on the results of a comprehensive examination and treatment of 360 patients with purulent wounds of soft tissues who were treated in the department of purulent surgery of the 1city clinical hospital on the basis of the Department of Surgical Diseases of the TMA from 2014 to 2019. Depending on the treatment carried out, the patients were conditionally divided into 3 groups: the 1st (control group) included 118 patients who underwent conventional traditional methods of treatment; in the 2nd group (main group I) there were 120 patients who, in combination with traditional methods of treatment, used PDT with a photosensitizer (PS) 0.05% buffer solution of methylene blue (MS); and the 3rd group (main group II) included 122 patients where PDT was used in combination with traditional methods of treatment (0.05% methylene blue buffer solution was used as PS) and a CO2 laser. According to our data, the distribution of patients by age and sex is presented in table 1. Among the examined patients, there were 189 (52.5%) women, 171 (47.5%) men, the age of the patients varied from 18 to 82 years. The main contingent of patients was of working age from 18 to 60 years -277 patients (63%). Analyzing table 3 on the location of a purulent wound, it can be noted that most often purulent wounds were localized in the body area 98 (27.3%) and lower limbs -73 (20.3%). The time from the onset of the disease to treatment and hospitalization in the hospital averaged 7.2 $\pm$ 3.5 days. The analysis of concomitant diseases in the comparative groups shows that in the control group in 83.9%, in the main group I in 87.5%, and in the main group II in 86.0% of patients, one or more concomitant diseases were revealed. At the same time, arterial hypertension (21.4%), ischemic heart disease (14.2%), diabetes mellitus (13.0%) and varicose veins of the lower extremities with signs of varying severity of CVI (12.0%) prevailed.

6 Device characteristics

For photodynamic therapy, an ALT-Vostok model 03 light emitter was used, corresponding to the technical specifications TSh 64-15302652-002: 2010, Manufacturer LLC "NAF", Uzbekistan. With the following main technical characteristics: 1) Radiation range 660-670nm with a power density of 200 mW / cm^2; 2) Exit area of the emitting terminal 4 cm 2 .

The distance from the end of the radiator to the wound surface was 2-5 cm in the absence of thermal discomfort in the patient. The total irradiation time depended on the area of the wound surface and ranged from 15 to 30 minutes.

For the session of the CO2 laser, the apparatus "JZ-3A" was used. Laser wavelength: 10.6. Output Power: 1 ~15w. Exit mode: Focus, defocus.

In all studied groups, after the start of treatment, we studied general clinical parameters, morphology, microbiology and planimetry of purulent wounds in dynamics. After opening the abscess, all patients had bandaging on the next day after the operation, where the condition of the wound was assessed -resolution of hyperemia, swelling, pain and infiltration of the walls, the nature and amount of discharge from a purulent wound, the presence of non-viable, necrotic tissues and detritus was determined, as well as the timing of the appearance granulation and the beginning of epithelialization. The prints were taken from the walls of wounds for 3,7,10 days for cytological studies, as well as for dynamic control of changes in the microbial flora and its sensitivity to antibiotics.

After the surgical treatment of purulent foci, the dynamics of the course of the wound process in patients of the control and main groups were different, depending on the treatment.

In patients of the control group who received traditional treatment, temperature normalized on day 4.0 $\pm$ 0.5, heart rate normalized on day 4.5 $\pm$ 0.5, and a decrease in leucocyte index of intoxication -on day 8.5 $\pm$ 0.5 after

treatment. A decrease in perifocal edema in the area of purulent wounds was observed in patients for 4.5 ± 0.5 days. Hyperemia of the skin around the purulent wounds persisted for 5.0 ± 0.3 days, and infiltration of the edges and walls of the wounds -8.5 ± 0.5 days. Table **??**.

In the main group I, temperature normalized on the 3.0 ± 0.8th days, the heart rate decreased to normal values by 3.5 ± 0.7 days, a decrease in leucocyte index of intoxication to the normal level was observed on the 8.0 ± 0.5th days after carrying out medical measures. Analysis of the dynamics of clinical manifestations showed that the treatment of purulent wounds using photodynamic therapy with a photosensitizer blizzard blue leads to a rapid decrease in perifocal inflammatory manifestations. Hyperemia of the skin around purulent wounds and a decrease in perifocal inflammation persisted for 4.0 ± 0.5 days, and infiltration of the edges and walls of wounds -6.5 ± 0.5 days. Table **??**.

In the main group II, temperature normalized on the 3.0 ± 0.5th days, the heart rate decreased to normal values by 3.0 ± 0.5 days, and a decrease in leucocyte index of intoxication to the normal level was observed on days 7.0 ± 0.5 after therapeutic measures. Analysis of the dynamics of clinical manifestations showed that the treatment of purulent wounds using photodynamic therapy with a photosensitizer blizzard blue leads to a rapid decrease in perifocal inflammatory manifestations. Hyperemia of the skin around purulent wounds and a decrease in perifocal inflammation persisted for 3.5 ± 0.5 days, and infiltration of the edges and walls of wounds -5.5 ± 0.5 days. Table 8. There is no Fibrinous purulent exudate, there are signs of granulation on the wound.

Observation of the course of purulent wounds in dynamics showed that the cleansing of wounds from purulent-necrotic masses during the traditional treatment occurred on the days 7.0 ± 0.5 (on the 4.5 ± 0.5 th day in the main group I and 3,8±0,5 in the main group II), the appearance of granulations was noted on 7.5 ± 0.7th days (on the 5.0 ± 0.6 th day in the main group I and 4,0±0,5 in the main group II), and marginal epithelization was detected on 8.0 ± 0.7th days (on the 6, 5 ± 0.5 th day in the main group I and 5,5±0,5 in the main group II) after surgical treatment of a purulent focus -table 8. The average length of hospital stay for patients in the control group averaged 9.5 ± 3.5 beddays (7.5 ± 3.0 in the main group I and 6,0±2,5 in the main group II) -after a PDT session and a CO 2 laser, the terms decreased in the main group II. The staged planimetric studies carried out showed that in the main groups of patients, where PDT and CO 2 laser were used for treatment, the area of purulent wounds decreased faster than in the control group -Table 14. Thus, in patients of main group II, the area of purulent wounds decreased by 10th days by 72.7%, in patients in the main group this indicator is 69.5%, while with traditional treatment the area of purulent wounds decreased by 59.9% ($p < 0.05$). Studying the planimetric parameters obtained, we can conclude that the average daily rate of decrease in the area of purulent wounds in the control group was -5.99% in 10 days, in the main group I, with the combined use of photodynamic therapy with photosensitizer methylene blue, the rate of shortening of the wound surface was -6.9 %, and in the main group II, with the combined use of photodynamic therapy and a CO2 laser, the rate of shortening of the wound surface was higher and amounted to -7.2%.

In the course of monitoring the patients of the main group during the year, none of the patients showed the formation of keloid or gross hypertrophic scars. The scar tissue did not protrude above the skin level, was smooth, did not deform the skin and subcutaneous tissue, and was not adhered to the underlying tissues.

The study of the microbiology of purulent wounds shows that those obtained from patients of three groups were contaminated with microorganisms, i.e. growth was observed in all samples (100%). From 105 examined patients, 124 strains of microbes were isolated, of which 86 (82%) were monocultures, 19 (18%) strains were found in an association of two types of microbes. In 9 (47.4%) cases, two types of staphylococci were sown; in 6 (31.5%) cultures hemolytic streptococci were associated with staphylococci and in 1 (5.3%) -E. coli. In one case, Candida fungi were excreted with E. coli, Proteus, and streptococci. The dominant pathogens of HVD were gram-positive microorganisms -124/112 (91.4%), among which the leading position was occupied by staphylococci 83%, represented, in most of the crops, by St. aureus (92%). Representatives of the gramnegative flora were: Proteusspp. (3 / 2.5%), Ps. aeruginosae (7/6%), E. coli (2 / 1.5%).

A comparative analysis of the data obtained from the three examined groups of patients showed that all the methods of treatment used had an effect to one degree or another on the causative agent of the purulent-inflammatory process. The differences between these groups were manifested in the timing of the elimination of the pathogen (Figure 23). Frequency and term of pathogen elimination the pathogen in the seeding on the 10th day of the study. In contrast, in group I of patients who received traditional treatment in combination with PDT, no growth of microbes was found. On the seventh day of examination in 12% of patients, and in the last study -in 59% of patients, which is 1.8 times more than in the control group. The best results were achieved in group II of the surveyed who received complex therapytraditional treatment + PDT + CO2 laser: elimination of the pathogen was observed on the seventh day in 36% of patients, which is 3 times higher than the indicators of group I patients. On the tenth day, the absence of growth was already in 67% of patients in this group, which is also higher than those of group I by 1.1 times, and in the control group of patients by 2 times. The data obtained allow us to conclude that the proposed method of treatment is highly effective. Morphological studies have shown that, before surgical treatment, during histological studies, the walls and bottom of the wound are represented by destructive necrotic tissues, abundantly infiltrated by polymorphonuclear leukocytes, the tissues are edematous having venous and capillary plethora, stasis, perivascular diapedetic and focal hemorrhages.

The study of the dynamics of acute purulentinflammatory diseases of soft tissues after traditional treatment showed that on the 3rd day, purulentdestructive and necrobiotic changes with infiltration of neutrophilic

leukocytes prevailed in almost all types of purulent diseases. By the 7th day of traditional treatment, infiltration of neutrophilic leukocytes is more often observed, the number of abscesses and foci of necrosis increases, and the destruction of specific tissue structures is observed. By the 10th day of the examination, the processes of edema and destruction in the purulent-inflamed tissue calmed down somewhat, certain boundaries appeared in the areas of neutrophilic infiltration, proliferative inflammation developed around the foci of abscesses and necrobiosis, and connective tissue was formed.

7 IV.

8 Discussion

Thus, the presented data convincingly prove the high clinical efficacy of antibacterial therapy based on a CO 2 laser and photodynamic effects caused by the simultaneous action of a physical and chemical factor on the pathogenic microflora.

According to the literature data, the effectiveness of methylene blue as a photosensitizer in PDT has also been proven. Methylene blue has no dark toxicity to living cells. The photosensitizer and white light alone do not have photodynamic antimicrobial activity. Methylene blue had the maximum antibacterial activity at a concentration of 50 uM (0.05%). Considering the above positive qualities, methylene blue makes it possible to widely recommend photodynamic therapy of purulent wounds in clinical medicine.

At the beginning of the twentieth century, the idea of a "magic bullet" was expressed by Paul Ehrlich, who suggested that incubation of bacteria with methylene blue dye should cause them to die when exposed to light. The effect of other photosensitizers was expressed to one degree or another, but the maximum effect with the minimum dose of laser radiation was achieved with the use of methylthioninium chloride (methylene blue) and zinc phthalocyanine [41].

The European Laser Association in 1997 published the work of S.E. Milson et al. [41,42], which reported that H. pylori after incubation with methylene blue, toluidine blue and hematoporphyrin derivatives was successfully inactivated at doses of 50 and 100 J / cm2. The best photoinactivation effect was observed at a dose of 50 J / cm2 with methylene blue. The work noted that the dose of 50 J / cm2 is far beyond the damaging effect of laser radiation on the gastric mucosa [42].

The combined effect of PDT with methylene blue and a weak electric current (l mA) on E. coli in vitro in order to enhance the effect of PDT increases the efficiency of PDT [34]. The effect of preliminary laser irradiation of bacteria before incubation with a photosensitizer is interesting. In cases where APDT was applied to highly resistant bacteria such as the microbacterium tuberculosis, preliminary laser irradiation disrupted the structure of the cell wall in vitro and made the bacterium more susceptible to APDT [7].

PDT with methylene blue and irradiation with broadband white light (400-700 nm) at a dose of 10 J / cm2 inactivates Qb-bacteriophage RNA in vitro by linking it with plasma proteins [44].

The obtained clinical, histological, microbiological and immunological data indicate that photodynamic therapy with a laser and non-laser light source is a fairly effective non-invasive method for treating purulent wounds and serve as a rationale for the application of the method of photodynamic therapy in clinical practice for the treatment of local acute suppurative inflammation, in particular for the treatment of purulent proctological pathology [11].

The use of local photodynamic therapy in complex treatment with the use of laser radiation using the ALT "VOSTOK-03" apparatus and a photosensitizer of 0.05% methylene blue solution allows in a short time to achieve cleansing of wound surfaces from pathogenic microflora, to ensure the normalization of signs of intoxication in a shorter time compared to traditional treatment, to achieve a decrease in the number of progression of the pathological process on the foot from 31.5% to 6.7%, as well as a decrease in the number of deaths from 10.5% to 2.2% [29].

The optimal concentration of methylene blue in vitro, as well as the duration of laser radiation with a wavelength of 630-670 nm for photodynamic effects on Candida albicans, have been determined. A study (on rabbits) of the possibility of using photodynamic therapy (PDT) in fungal keratitis was carried out. At the next stage, the PDT method was introduced into clinical practice for the treatment of patients with fungal keratitis. PDT with 0.1% methylene blue is an effective method of treating fungal (C. albicans) keratitis, which is confirmed by microbiological and clinical studies [16].

Observation of the results of treatment of patients with purulent-destructive diseases of soft tissues shows that the use of laser methods of CO2 laser and subsequent PDT with the photosensitizer "Methylene blue" creates optimal conditions for cleansing the purulent focus from necrotic tissues and detritus, respectively, accelerating the reparative regenerative parameters. The method allows to achieve the fastest cleansing of the wound and reduce the duration of treatment in comparison with the control group of patients. The above results make it possible to evaluate the use of a CO2 laser and PDT with a photosensitizer "Methylene blue" in the treatment of purulent-destructive diseases and to recommend it for use in surgical practice.

V.

9 Conclusion

1. Selective use of a CO2 laser allows for early and bloodless necrosectomy, improvement of wound repair, as well as reduction of its microbial contamination. 2. Photodynamic therapy, when used in patients with

purulent-destructive diseases of soft tissues, allows at an earlier time to achieve cleansing of purulent wounds from pathogenic microbial flora, purulent exudate and accelerate its healing. 3. Photodynamic therapy is a fairly effective noninvasive and sparing method of treating purulent wounds and is a justified application of this method in clinical practice for the treatment of acute suppurative-inflammatory processes in combination with traditional methods. [1]

12

Figure 1: Pic 1 :Pic 2 :

23

Figure 2: Fig. 23 :

Figure 3:

1

Age of the patients	Control group Men	Women	Main group I Men	Women	Main g
From 18 to 44 years old	18	23	19	26	21
From 45 to 59 years old	15	17	16	18	19
From 60 to 74 years old	11	14	15	11	14
75 and elder	9	11	5	10	9
Total (%)	53(45%)	65(55%)	55(46%)	65(54%)	51,(

According to clinical entities in patients, (13.4%), phlegmon in 43 patients (11.
erysipelas prevailed in 63 patients (17.5%), carbuncle in postoperative suppuration of wounds
53 patients (14.8%), infected wounds in 48 patients localization in 34 patients (9.5%).

Figure 4: Table 1 :

2

No.	Nosology	Control group	Main group I	Main group II	Total
1.	Erysipelas	23	29	11	63(17,5%)
2.	Carbuncle	17	11	25	53(14,8%)
3.	Infected wound	19	22	7	48(13,4%)
4.	Phlegmon	12	13	18	43(11,9%)
5.	Postoperative wound suppuration	10	9	15	34(9,5%)
6.	Abscessed furuncle	7	8	13	28(7,8%)
7.	Soft tissue abscess	8	4	10	22(6,1%)
8.	Postinjective abscess	7	8	6	21(5,8%)
9.	Acute suppurative mastitis	5	6	9	20(5,5%)
10.	Suppurative hematoma	7	5	4	16(4,4%)
11.	Other nosology	3	5	4	12(3,3%)
Total		118	120	122	360(100%)

Figure 5: Table 2 :

3

?	Body area	Control group	Main group I	Main group II	Total (abc and %)
1.	Body	34	28	36	98(27,3%)
2.	Lower limbs	21	33	19	73(20,3%)
3.	Neck	20	15	23	58(16,1%)
	Stomach	16	19	21	56(15,5%)
4.	Buttocks	14	15	16	45(12,5%)
5.	Upper limbs	13	10	7	30(8,3%)
	Total	118	120	122	360(100%)

Figure 6: Table 3 :

4

No.	Concomitant diseases	Control group (abc and %)	Main group I (abc and %)	Main group II (abc and %)	Total (abc and %)
1.	Hypertensive disease	26(22,0%)	29(24,1%)	22(18,0%)	77(21,4%)
2.	Coronary disease	18(15,2%)	14(11,7%)	19(15,5%)	51(14,2%)
3.	Diabetes mellitus	12(10,4%)	15(12,5%)	20(16,4%)	47(13,0%)
4.	Varicose of the lower extremities and CVI	13(11,0%)	19(16,0%)	11(9,0%)	43(12,0%)
5.	Respiratory diseases	11(9,3%)	7(5,8%)	8 (6,6%)	26(7,2%)
6.	Postinfarction cardiosclerosis	5(4,2%)	7(5,8%)	11 (9,0%)	23(6,4%)
7.	Diseases of the genitourinary system	5(4,2%)	7(5,8%)	9(7,4%)	21(5,8%)
8.	Arthropathy	9(7,6%)	7(5,8%)	5(4,1%)	21(5,8%)
9.	There was no concomitant pathology	19(16,1%)	15(12,5%)	17(14,0%)	51(14,2%)
		118	120	122	360(100%)

Figure 7: Table 4 :

8

Groups I ndicators			

Figure 8: Table 8 :

9

	Medium terms (days)		
Groups	Wound cleaning	Appearance of granulation	Onset of marginal epithelialization
Control group	7,0±0,5	7,5±0,6	8,0±0,7
Main group I	4,5±0,5	5,0±0,6	6,5±0,5
Main group II	3,8±0,5	4,0±0,6	5,5±0,5

Figure 9: Table 9 :

14

Group of patients	1 st day	Wound area (cm 2 and %) 3 rd day	7 th day	10 th day
Control group	147±6,0 cm 2 (100%)	133±5,0 (90,4%)	75±3,0 (51%)	59±5,5 (40,1%)
Main group I	141±8,0 cm 2 (100%)	119±5,0 (84,3%)	60±4,0 (42,5%)	43±2,5 (30,5%)
Main group II	143±5,0 cm 2 (100%)	111±5,0 (77,6%)	48±4,0 (33,5%)	39±2,0 (27,3%)

Figure 10: Table 14 :

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