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IMPROVEMENT OF THE TECHNOLOGY OF LASER INFLUENCE IN THE PREVENTION OF ANASTOMOSITS AND INSUFFICIENCY OF SUTURES OF COLONIC ANASTOMOSIS

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Abstract. The method of percutaneous low-energy infrared laser exposure proposed by the authors is simple to perform, which eliminates the need for intra-intestinal use of fiber optics. Sequential irradiation at the projected points makes it possible to achieve the required therapeutic dose in the area of the colonic anastomosis, providing an increase in local microcirculation and tissue repair.

The authors, as a result of the inclusion of low-energy laser therapy in the complex of postoperative management of patients with resection interventions on the colon, made it possible to accelerate the rehabilitation processes, reduce the time for regression of inflammation markers, restore active peristalsis and also provided a decrease in the proportion of uncomplicated course. Stimulation of local microcirculation and reparative processes through the use of laser therapy sessions made it possible to reduce the incidence of specific anastomotic complications from 19.1% to 3.2%, reduce the mortality rate from 8.5% to 3.2 %, as well as the duration of the hospital postoperative period from 11.5±0.4 to 8.8±0.4 days ($p<0.001$).

Keywords: high-energy lasers, low-energy lasers, infrared lasers, anastomotic leakage, colonic anastomosis, large bowel, prevention.

Introduction

Colorectal surgery has now undergone significant progress with minimizing the incidence of early postoperative complications and low in-hospital mortality. Nevertheless, further optimization of the tactical aspects of perioperative management of patients is necessary in relation to reducing the risk of postoperative complications such as colonic anastomotic leakage (CAL) and abdominal sepsis. The analysis of the literature indicates that the incidence of CAL in colorectal surgery remains high, and the prevention of this complication is a huge problem. [1; 4; 6].

Currently, most authors argue that CAL entails a number of fatal postoperative complications and requires accurate preoperative risk assessment, and individualized surgical tactics, which in turn become significant points that have a potential decisive role in improving postoperative outcomes and patients' quality of life [5; 7-10].

In this regard, targeted research is needed to find, develop and introduce into clinical practice more reliable and effective methods for the prevention and treatment of CAL, aimed at enhancing regeneration processes in the fistula zone. At the same time, the search and development of new methods for stimulating healing processes in the anastomosis zone using laser exposure is a highly significant direction for improving the results of resection operations on the colon. [1; 2; 3].

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Purpose of the study

Improving the results of surgical treatment during resection of the colon by improving the technology of laser exposure in the prevention of anastomositis and colonic anastomotic leakage.

Materials and methods

The clinical part of the study presents the experience of treating 78 patients who underwent resection interventions on the large intestine for intestinal obstruction of benign and tumor pathology. To solve the tasks, all patients were divided into two groups. Indications for surgery in most cases in both study groups were adhesive intestinal obstruction and tumor of the colon. In the distribution of patients according to the severity of the condition upon admission to the hospital, in most cases, the average severity was determined. In most cases, both in the comparison group and in the main group, a thin resection was performed with the imposition of ileotransverse anastomosis.

To achieve the goal of the study and solve the tasks set, the following methods were used: general clinical, instrumental, laboratory, histomorphological, special and statistical research methods.

As an apparatus for laser treatment, a serially produced and certified in our country medical laser "Vostok-1" was used - a pulsed low-energy laser in the infrared range.

Distinctive aspects and technical advantages of the proposed method are: the use of a semiconductor laser emitter with a wavelength of 850-890 nm, as in other cases, emitters with a wavelength of 600-640 nm were mainly used; laser exposure is carried out by means of transcutaneous irradiation, which does not require the use of fiber optics introduced into the lumen of the colon for local therapy; to expand the irradiation zone and increase the effectiveness of laser therapy, exposure in the infrared (IR) range is carried out at three points with a treatment duration of 2 minutes. Pulse power of 1500-3000 Hz contributes to the maximum stimulation of microcirculation in tissues. Under conditions of transition from denser tissues to air ones (which takes place in the abdominal cavity), the laser exposure is enhanced.

The divergence of laser radiation at the output of the emitter is no more than 70°; the laser belongs to the 3rd class of laser safety and does not require the wearing of special glasses for medical personnel.

The main arguments in favor of the use of IR laser radiation:

- Associated with the properties of the laser radiation itself. The fact is that laser radiation, when interacting with tissues, has the ability to penetrate tissues, scatter, and reflect from the surface. The penetration ability depends on the wavelength. The IR spectrum has the greatest penetration depth, namely 890 nm-1 μm. Thus, the chosen laser with a wavelength of 890 nm contributes to a deeper penetration into the tissues, and also allows for a longer postoperative exposure to radiation through the skin.
- Pulsed laser radiation causes the least overheating of tissues and at the same time penetrates deeper into tissues. The scattering effect is achieved in the transition zone from a dense medium to an air one (which takes place in the intestine),

10.5281/zenodo.6350921
moreover, the biostimulation effect is enhanced due to the occurrence of resonant waves in the media separation zone.

- Since the model of intestinal suture insufficiency formation provided for the creation of an ischemia zone (most often occurs in emergency surgery), IR laser radiation stimulates microcirculation in tissues to a greater extent.
- In order to prevent the development of anastomosis and narrowing of the anastomosis zone, pulsed IR laser radiation has the ability to prevent excessive growth of scar tissue, and also accelerates repair processes in tissues.

The laser treatment method includes the following characteristics.

Total impact zones in the treatment of the patient - 3; laser exposure is carried out daily at the same time. Total treatment sessions for patients - up to 14 per 1 course of treatment; after the treatment session, the patient should be in the supine position for another 15 minutes; There were no side effects from laser treatment.

Determination of points for laser exposure is carried out as follows. As it passes through dense media, the power of exposure weakens, so it is necessary to increase the duration of exposure (at least 2 minutes), if necessary, you can increase the number of points for exposure (at least 3 points). The laser penetrates into the human body quite deeply (up to 15 cm), while the radiation absorption zone is intestinal loops filled with air. The planned points should be localized in the form of a triangle, the upper side of which is directed towards the epigastrium, and the center of the triangle should be projected onto the area of the colonic anastomosis. The length of the side of the triangle should be 5-10 cm, if the projected area is characterized by a large diameter, then it is recommended to project additional points in the form of a square or pentagon, etc., with centralization relative to the anastomosis area. Consistently, irradiation is carried out on all projected points. In the zone of intersection of the laser beams in the depths of the tissues, the required dose is reached. Laser radiation has an aftereffect, therefore, to improve microcirculation, sequential irradiation is carried out point by point.

Carrying out sequential irradiation at the projected points allows you to achieve the required therapeutic dose in the area of the colonic anastomosis, providing an increase in local microcirculation and tissue repair. The scheme of localization of points for percutaneous exposure in various types of resection of the colon is shown in Fig.1.

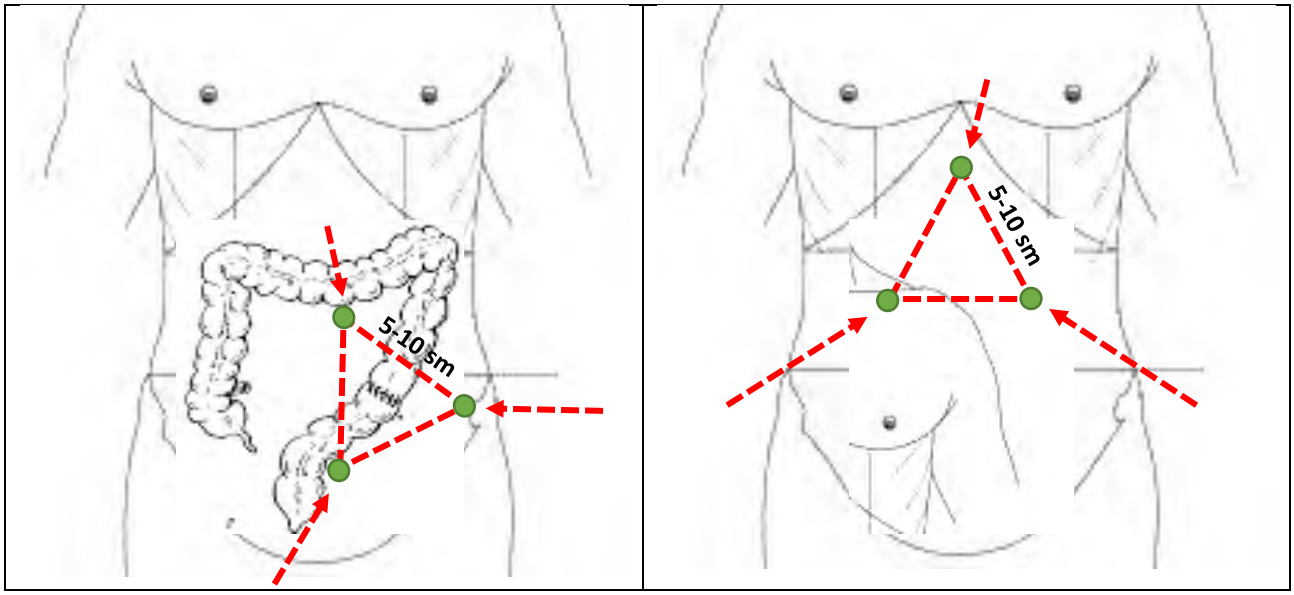


Fig. 1. Scheme of localization of points for percutaneous laser exposure in various types of colon resection.

Research results

We present a comparative analysis of the features of the postoperative course and rehabilitation of patients after resection interventions on the large intestine in the study groups.

In general, for a comparative analysis and evaluation of the effectiveness of the clinical results of the use of NELI for the prevention and treatment of insufficiency of sutures in the colon, such indicators of the early postoperative period as the timing of the appearance of active intestinal motility, independent stool and normalization of body temperature, as well as the timing of removal of drainage tubes were studied.

Active peristalsis was noted on day 2.6±0.07 in the comparison group, while in the main group it was observed on day 1.7±0.10, which had a statistically significant difference ($t=7.15$, $p<0.001$).

Independent stools could be observed within 4.3±0.15 days in the comparison group and 2.9±0.15 days in the main study group ($t=6.71$; $p<0.001$).

Normalization of temperature in the main group was noted on day 3.6±0.36, and in the comparison group - on day 4.7±0.32 ($t=2.23$; $p<0.05$). The terms of drain removal were 4.2±0.27 days in the main group versus 5.7±0.43 days in the comparison group ($t=3.11$; $p<0.01$).

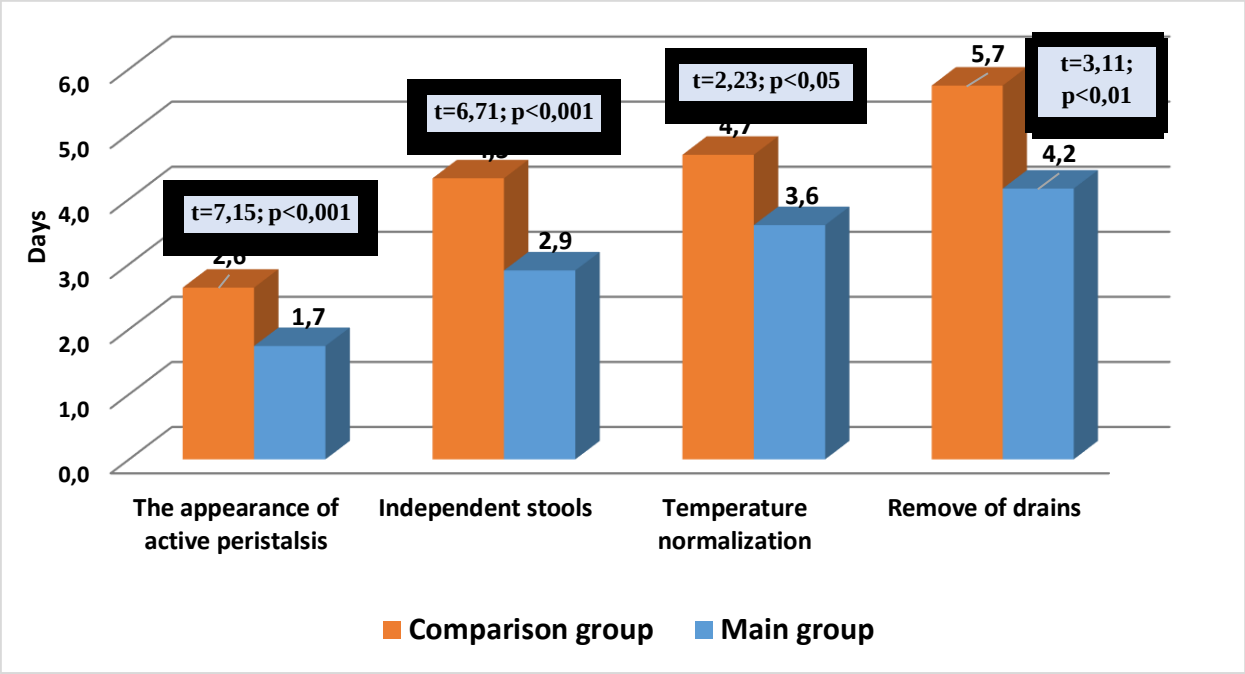


Fig. 2. Dynamics of the course of the early postoperative period (days).

A comparative analysis of the dynamics of changes in laboratory parameters against the background of the undertaken treatment tactics showed that leukocytosis noted on the 1st day both in the comparison group (12.1±0.28) and in the main group (11.7±0.25) was reduced to 10.4±0.32 and 9.5±0.29 in the comparison group and the main group, respectively ($t=2.08$; $p<0.05$). Subsequently, positive dynamics was observed in both study groups with a statistically significant difference in favor of the main group of patients.

The erythrocyte sedimentation rate, studied in the early postoperative period, tended to increase up to 5 days in both groups of patients, then decreased from 31.1±0.80 to 28.2±0.69 mm/h in the comparison group and from 28 .7±1.97 to 24.1±1.66 mm/h in the main group ($t=2.28$; $p<0.05$).

In turn, the leukocyte index of intoxication, starting from the 3rd day of the early postoperative period, tended to decrease both in the comparison group (2.9±0.07) and in the main group (2.3±0.08) with a significant statistical difference ($t=6.33$; $p<0.001$).

An analysis of the frequency of specific postoperative complications showed that in most cases in the comparison group (19.1%; 9 out of 47)) anastomosis was noted, while in the main group this complication was observed only in 3.2% (1 out of 31) cases (Table 1).

Table 1

The frequency of postoperative complications in study groups

Complications	Comparison group (n=47)		Main group (n=31)	
	abs	%	abs	%
Specific				

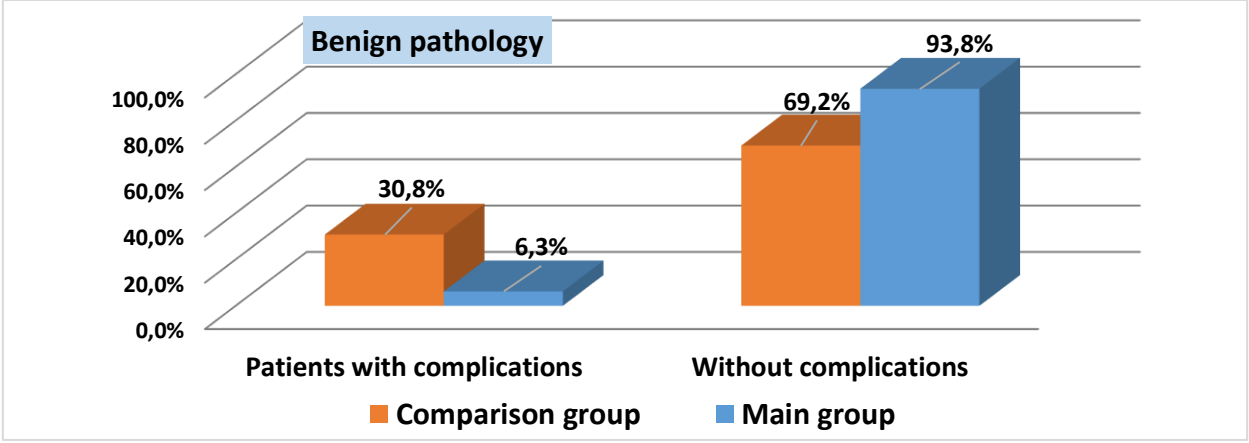
Anastomotic suture failure	3	6,4%	0	0,0%
Peritonitis	1	2,1%	0	0,0%
Abscess	2	4,3%	0	0,0%
Early adhesive intestinal obstruction	1	2,1%	0	0,0%
Anastomositis	9	19,1%	1	3,2%
Suppuration of the wound	7	14,9%	2	6,5%
Eventration	1	2,1%	0	0,0%
General				
Bronchopulmonary	8	17,0%	3	9,7%
Thromboembolic	2	4,3%	1	3,2%
Cardiovascular	4	8,5%	2	6,5%
Mortality	4	8,5%	1	3,2%

The next most common in the comparison group was wound suppuration (14.9%; 7 out of 47), which in the main group was observed in only 6.5% (2 out of 31) of cases. Also in the comparison group, anastomosis suture failure (6.4%), peritonitis (2.1%), abscess (4.3%), early adhesive obstruction (2.1%) and eventration (2.1%) were registered, which were not observed in the main study group (Table 1).

Among the common complications in the early postoperative period, bronchopulmonary prevailed (17.0% in the comparison group and 9.7% in the main group).

The results of treatment showed that mortality was reduced from 8.5% in the comparison group to 3.2% in the main group (Table 1).

When distributing complications per patient, it was noted that the early postoperative period proceeded without complications in 70.2% (33 out of 47) cases in the comparison group and 87.1% (27 out of 31) in the main group. It should be noted that 3 or more complications with a significant difference were noted in patients in the comparison group - 14.9% versus 3.2% in the main group.



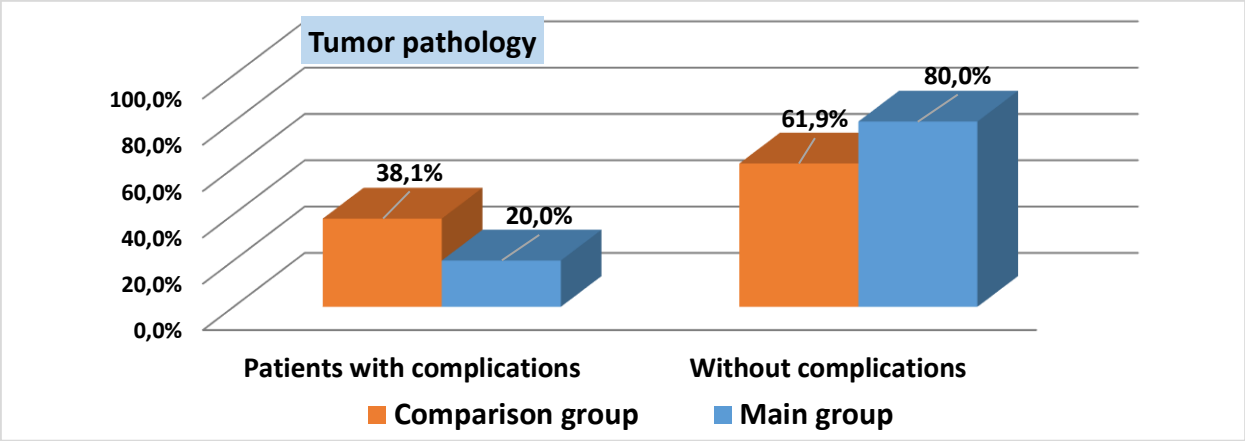


Fig. 3. The frequency of complicated postoperative course depending on the type of pathology.

Among patients with benign pathology of the large intestine, a complicated early postoperative period was noted in 30.8% (8 out of 26) of cases in the comparison group and in only 6.3% (1 out of 16) in the main group (Fig. 3). In turn, among patients with tumor pathology of the large intestine, a complicated early postoperative period was noted in 38.1% (8 out of 21) of cases in the comparison group and in only 20.0% (3 out of 15) in the main group (Fig. 4).

Among all patients in the comparison group, complications were noted in 34.0% (16 out of 47) of cases, and in the main group this figure was only 12.9% (4 out of 31) ($\chi 2=4.378$; Df=1; p=0.037).

Also, we studied the frequency of specific complications from the anastomosis, depending on the type of pathology. Statistical analysis showed that in the cohort of patients with benign colon pathology in the comparison group, specific complications were noted in 11.5% (3 out of 26) of cases, while in the main group this figure was 0%.

In the cohort of patients with malignant pathology of the colon, the frequency of specific anastomotic complications was 28.6% (6 out of 21) in the comparison group and only 6.7% (1 out of 15) in the main group.

In general, the pooled frequency of specific anastomotic complications with a significant statistical difference ($\chi 2=4.237$; Df=1; p=0.040) was lower in the main group - 3.2% (1 of 31) versus 19.1% (9 of 47) .

Comprehensive treatment of complications noted in the early postoperative period showed the following results: against the background of conservative tactics, mortality in the comparison group was 4.3% (2 out of 47), while no mortality was noted in the main group. In turn, mortality from complications against the background of surgical tactics in the comparison group was 2.1% (1 out of 47), and was not observed in the main group. In other cases, lethal cases were observed from general complications without local complications (2.1% in the comparison group and 3.2% in the main group).

The duration of the general hospital postoperative period of treatment was reduced from 11.5±0.4 (in the comparison group) to 8.8±0.4 days (in the main group) ($t=5.31$; $p<0.05$).

10.5281/zenodo.6350921

Discussion of research results

The inclusion of low-energy laser therapy in the complex of postoperative management of patients with resection interventions on the colon made it possible to accelerate the rehabilitation processes, reduce the time for regression of inflammation markers (leukocytes, LII; $p<0.05$), restore active peristalsis from 2.6 ± 0.07 to 1, 7±0.10 days ($t=7.15$; $p<0.001$), independent stool from 4.3±0.15 to 3.6±0.36 days ($t=6.71$; $p<0.001$). Against this background, there was a decrease in the frequency of anastomositis from 19.1% (in 9 out of 47 patients in the comparison group) to 3.2% (in 1 out of 31 patients in the main group), and the leveling of such specific complications as the failure of colonic sutures (from 6 .4%, in 3 patients in the comparison group), early adhesive intestinal obstruction (2.1%, in 1 patient). In general, the proportion of patients without a complicated course of the early postoperative period decreased from 34.0% (in 16 out of 47 patients in the comparison group) to 12.9% (in 4 out of 31 patients in the main group; $\chi2=4.378$; $Df=1$; $p=0.037$), and the incidence of complications from colon anastomoses decreased from 19.1% (in 9 patients in the comparison group) to 3.2% (in 1 patient in the main group; $\chi2=4.237$; $Df=1$; $p= 0.040$). Accordingly, the frequency of specific complications, the need for conservative resolution decreased from 12.8% (in 6 patients in the comparison group) to 3.2% (in 1 patient from the main group), the need for repeated surgical treatment was completely eliminated (from 6.4% , in 3 patients in the comparison group). In general, the treatment allowed to reduce the mortality rate from 8.5% (4 patients in the comparison group) to 3.2% (1 patient in the main group), as well as to reduce the duration of the hospital postoperative period from 11.5±0.4 to 8 .8±0.4 days ($t=5.31$; $p<0.001$).

Conclusions

Method of low-energy infrared laser exposure for the prevention and treatment of anastomositis and insufficiency of sutures of colonic anastomoses, provides increased local microcirculation and tissue repair, as well as reduced risk of scarring in the fistula zone.

The method of transcutaneous laser exposure eliminates the need for intra-intestinal use of fiber-optic optics and, through sequential irradiation at projected points, allows you to achieve the required therapeutic dose in the area of interest.

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