



The Opportunity of Using Diode Laser with the Length of 1940 nm in the Treatment of Hemorrhoids

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Aim: to improve the results of treatment of patients with hemorrhoidal disease of the 2nd and 3rd stages by using a diode laser with a wavelength of 1940 nm.

Materials and methods. The study included 28 patients with hemorrhoids of the second or third stage. A new treatment method based on the use of a diode laser with a wavelength of 1940 nm was applied to all patients. This technique (laser hemorrhoidoplasty) provides for the thermal effect of laser radiation on the cavernous tissue of the internal hemorrhoid node and the terminal branches of the upper rectal artery. The intensity of postoperative pain syndrome was assessed and the clinical symptoms of hemorrhoidal disease manifestations were studied before and after surgery. To study the effectiveness of the proposed method and to assess the depth of thermal exposure to laser radiation, transrectal ultrasound with Dopplerography and pathomorphological examination were performed. The functional state of the rectal locking apparatus before surgery and in the postoperative period was assessed using sphincterometry. The quality of life of patients who underwent laser hemorrhoidoplasty was studied according to the SF 36 questionnaire.

Results. Surgical intervention was performed under both local and spinal anesthesia. Intraoperative complications in the form of hemorrhoidal node bleeding were noted in 3 patients. In the early postoperative period, inflammatory edema of external hemorrhoids was diagnosed in 4 patients. The intensity of the pain syndrome was assessed on the VAS scale and by day 7 in 93 % of patients it did not exceed 1 point. All 28 patients were followed up within 1 to 6 months after the operation. All had no complaints characteristic of hemorrhoidal disease, no relapse of the disease was detected in any observation. Transrectal ultrasound with Dopplerography was performed, which made it possible to diagnose a 2–3-fold decrease in blood flow along the terminal branches of the upper rectal artery, and internal hemorrhoids determined earlier, before surgery, were not visualized already 1 month after surgery. According to sphincterometry, no violations of anal retention function were detected in all 28 patients.

Conclusion. Surgical treatment of hemorrhoids of the 2nd and 3rd stages with the use of a diode laser with a wavelength of 1940 nm. with proper technical performance and the choice of optimal energy, it allows to achieve a good clinical effect. The proposed method of intervention ensures the absence of a pronounced pain syndrome, which does not lead to a significant decrease in the quality of life already in the early postoperative period and allows to shorten the period of labor rehabilitation. Laser hemorrhoidoplasty is a highly effective method of treating hemorrhoids at stages 2 and 3 of the disease and opens up the possibility of treatment on an outpatient basis.

Keywords: hemorrhoids, hemorrhoidal LASER procedure, laser

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Возможность применения диодного лазера с длиной волны 1940 нм в лечении геморроя

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Цель: улучшение результатов лечения пациентов с геморроидальной болезнью 2-й и 3-й стадии с помощью применения диодного лазера с длиной волны 1940 нм.

Материалы и методы. В исследование включены 28 пациентов с геморроем второй или третьей стадии. Всем пациентам был применен новый метод лечения, основанный на использовании диодного лазера с длиной волны 1940 нм. Данная методика (лазерная геморроидопластика) предусматривает термическое воздействие лазерного излучения на кавернозную ткань внутреннего геморроидального узла и конечные ветви верхней прямокишечной артерии. Проведена оценка интенсивности послеоперационного болевого синдрома по визуально-аналоговой шкале (ВАШ) и изучение клинической симптоматики проявлений геморроидальной болезни до и после операции. Для изучения эффективности предложенного метода и оценки глубины термического воздействия лазерного излучения выполнены трансректальное ультразвуковое исследование с доплерографией в импульсно-волновом и энергетическом режимах и патоморфологическое исследование. Функциональное состояние запирающего аппарата прямой кишки оценивали при помощи сфинктерометрии до операции и в послеоперационном периоде. Проведено изучение качества жизни пациентов, перенесших лазерную геморроидопластику, согласно опроснику SF 36.

Результаты: хирургическое вмешательство выполняли как под местной, так и под спинальной анестезией. Интраоперационные осложнения в виде кровотечения из геморроидального узла отмечены у 3 больных. В раннем послеоперационном периоде у 4 пациентов диагностирован воспалительный отек наружных геморроидальных узлов. Интенсивность болевого синдрома по ВАШ уже к 7-му дню у 93 % пациентов не превышала 1 балл. В сроки от 1 до 6 месяцев после операции прослежены все 28 пациентов. У всех отсутствовали жалобы, характерные для геморроидальной болезни, ни в одном наблюдении не было выявлено рецидива заболевания. Трансректальное ультразвуковое исследование с доплерографией в импульсно-волновом и энергетическом режимах установило снижение скоростных показателей кровотока по конечным ветвям верхней прямокишечной артерии в 2–3 раза, а внутренние геморроидальные узлы, определяемые до операции, не визуализировались уже через 1 месяц после ее проведения. По данным сфинктерометрии не выявлено нарушений функции анального держания у всех 28 пациентов.

Заключение: хирургическое лечение геморроя 2-й и 3-й стадии с применением диодного лазера с длиной волны 1940 нм при правильном техническом выполнении и выборе оптимальной энергии позволяет добиться хорошего клинического эффекта. Предложенный метод вмешательства обеспечивает отсутствие выраженного болевого синдрома, поддержание качества жизни уже в раннем послеоперационном периоде и позволяет сократить период трудовой реабилитации. Лазерная геморроидопластика является высокоэффективным методом лечения геморроя при 2-й и 3-й стадии заболевания и открывает возможности проведения лечения в амбулаторных условиях.

Ключевые слова: геморрой, лазерная геморроидопластика, лазер

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Introduction

Until the present time, the most common method of treating stage 3rd hemorrhoids is hemorrhoidectomy, which is a radical method of treatment. The disadvantages of this intervention include severe postoperative pain syndrome, long healing periods of postoperative wounds and a long period of disability. In the long-term period, there are such serious complications as stricture of the anal canal (2–9 %), insufficiency of the anal sphincter (4–52 %) and long-term non-healing wounds (2–18 %) [1–8]. Recently, minimally invasive techniques (sclerosing of internal hemorrhoids, desarterization of hemorrhoids, and mucopexy) have been relevant in the treatment of the 2nd – 3rd stages of hemorrhoidal disease, allowing to reduce the intensity of pain syndrome, reduce the rehabilitation of the patient. Their effectiveness sometimes reaches high values, so at stage 2nd of hemorrhoidal disease, the effectiveness of sclerotherapy ranges from 69.8 % to 81.8 %, and at stage 3 from 31.3 % to 76.2 % [9–12], the effectiveness of desarterization at stage 3rd is 85 %, and in combination with mucopexy from 61.4 % to 93.6 % [13–20].

Currently, the development of high technologies for the introduction of lasers has found its successful application in various fields of surgery, including in the treatment of hemorrhoidal disease. The application of a diode laser with a wavelength of 980 nm in patients with stage 3rd hemorrhoidal disease allows 82.3 % of patients to stop its clinical manifestations. With an increase in the wavelength of the laser used, greater efficiency and a decrease in the number of undesirable complications are noted. The application of a diode laser with a wavelength of 1470 nm in patients with stage 3rd hemorrhoidal disease for up to 8.6 months makes

it possible to achieve the absence of relapses of the disease [21]. The application of lasers with a wavelength of 810 nm in the treatment of hemorrhoids is effective in 60.4 % of patients, but burn lesions in the surgical area (in 26.6 %) and edema of external hemorrhoids (in 33.3 %) were quite frequent complications, which is associated with the traumatic nature of the hemoglobin laser [22].

Nevertheless, to date there is no single method of using laser energy in the treatment of this disease, there is no clear data on the optimal power of the applied energy and the duration of the pulse of exposure to the cavernous tissue of the internal hemorrhoid node.

Purpose of research: to study the possibility of treating patients with hemorrhoidal disease of stage 2nd–3rd applying laser exposure to the cavernous tissue of the internal hemorrhoidal node and the terminal branches of the upper rectal artery.

Materials and methods of research

From February 2021 to present, a study based on the use of a laser for the treatment of hemorrhoids is being conducted at the Federal State Budgetary Institution “NMRC of Coloproctology named after A.N. Ryzhikh” of the Ministry of Health of the Russian Federation. In our study, a diode-pumped fiber laser doped with thulium ions with a wavelength of 1940 nm of domestic production by NTO IRE-Polyus LLC with an end light guide was used.

Hemorrhoidoplasty is performed due to the thermal effect of laser radiation with a wavelength of 1940 nm on the cavernous tissue of the internal hemorrhoidal node and on the terminal branches of the upper rectal artery. The main estimated indicator is the frequency of recurrence of hemorrhoidal disease.

Table. Distribution of chronic hemorrhoid symptoms by points

Symptom	Frequency of occurrence	Points
Feeling of humidity		1
Itching, burning, discomfort		2
Feeling of a foreign body		3
Blood on toilet paper	A) 1–3 times a week	4
	B) More than 3 times a week	5
Blood is released in drops	A) 1–3 times a week	6
	B) More than 3 times a week	7
The drop-down nodes are adjusted manually		8
The drop-down nodes are adjusted independently		9
Blood is released in a trickle	A) 1–3 times a week	10
	B) More than 3 times a week	11

The study included 28 patients; 10 (35.7 %) with the stage 2nd and 18 (64.3 %) with the stage 3rd hemorrhoidal disease who had not previously operated on the anal canal. All patients signed a voluntary informed consent. The majority of patients were males 23 (82.1 %), women were 5 (17.9 %), the median age of patients was 37 (25-59) years. The duration of the disease in 21 (75 %) patients ranged from 2 to 10 years. The criteria for non-inclusion were acute hemorrhoids, the presence of inflammatory bowel diseases in the patient, concomitant diseases of the rectum and anal canal, the presence of severe somatic diseases in the decompensation stage and mental illnesses.

Intervention technique. Under local or spinal anesthesia, the final anoscope is inserted, which is positioned so that the internal hemorrhoid node is determined in the lumen of the anoscope, then internal hemorrhoids are measured using a special ruler to determine the laser energy supplied and further analyze possible complications. After that, sequentially using a laser tool in the projection of internal hemorrhoids at a distance of 1 cm from the edge of the anus, a puncture of the perianal skin 1–2 mm long is performed, passing through it an end light guide into the internal hemorrhoid node to its proximal border: its correct location is evaluated by a pilot beam at the end of the light guide. After that, laser energy is supplied in a pulsed mode with a power of 7 Watts, the pulse duration is 500 ms, the pause time is 700 ms. When analyzing the effect of laser radiation on the cavernous tissue of the internal hemorrhoidal node, the median of the transmitted energy was 55.7 (48.1;82.8) J per 1 cm of cavernous tissue.

In the postoperative period, in the period from day 1st to day 7th, patients had pain syndrome assessed according to VAS, quality of life – according to the SF 36 questionnaire on day 7th and 30th. The assessment of clinical manifestations of hemorrhoidal disease was carried out according to a point system for the convenience of analyzing the effectiveness of treatment and statistical processing of the data obtained in the form of numerical values (Table 1) [9].

Anoscopy was performed in all patients after 1st, 3rd and 6th months.

In order to assess the blood flow along the terminal branches of the upper rectal artery and the area of internal hemorrhoids before and after surgery in terms of 1st, 3rd and 6th months, patients underwent transrectal ultrasound with Dopplerography in pulse-wave and energy modes using a biplane rectal sensor with a frequency of 5–10 MHz on a Hi Vision Preirus device (Hitachi, Japan). At the same time, the velocity parameters of blood flow were evaluated: Vp – peak systolic velocity; Vd – final

diastolic velocity; Vm – average velocity; RI – resistance index $(Vp - Vd)/Vp$; PI – pulsation index $(Vp - Vd)/Vm$.

In order to assess the condition of the rectal locking apparatus and the possible effect of laser radiation on it, sphincterometry was performed before and 1 month after the operation.

Research results

3 patients (10.7 %) had intraoperative bleeding when the energy used was 300–370 J, which required hemorrhoidectomy with the exclusion of patients from the study. All the bleeding occurred at the stage of mastering the technique, 2 bleeding developed due to a violation of the integrity of the internal hemorrhoid node with a laser instrument, and in 1 patient we associate the development of this complication with an insufficient amount of transmitted energy.

In 8 cases (28.6 %), the energy used was 371-500 J. None of the patients in this group had intraoperative and early complications.

In 4 patients (14.3 %), inflammatory changes of external hemorrhoids occurred in the early postoperative period, in all cases the transferred energy was 501–600 J. 3 (10.7 %) of these patients developed edema of the external hemorrhoids, and 1 (3.6 %) – thrombosis of the external hemorrhoid, which required conservative therapy with a positive effect. We associate the development of these complications with a large amount of transferred energy.

In the early postoperative period, in the period from day 1st to day 7th, the intensity of the pain syndrome was assessed according to the VAS scale, while by 1-2 days after surgery in 24 (85.7 %) patients, the pain syndrome was 1–3 points, and by day 5th in 23 (82.1 %) patients, the pain syndrome corresponded to 0–1 point. The analysis of the severity of the pain syndrome was carried out on the background of the act of defecation, while we noted that already on the 3rd day after the operation, all patients had stools, while 23 (82.1 %) patients had pain syndrome according to VAS corresponded to 0–3 points.

When assessing the clinical manifestations of hemorrhoidal disease according to the point system in the preoperative period, the median was 18 points, while on the 7th day after surgery this value corresponded to 2 points, and by the 30th day 0 points, which indicates the high effectiveness of the technique used.

During anoscopy performed before the operation, enlarged internal hemorrhoids are visualized, and after the operation in terms of 1st, 3rd, 6th months they were not detected, the mucous membrane in this area is not changed.

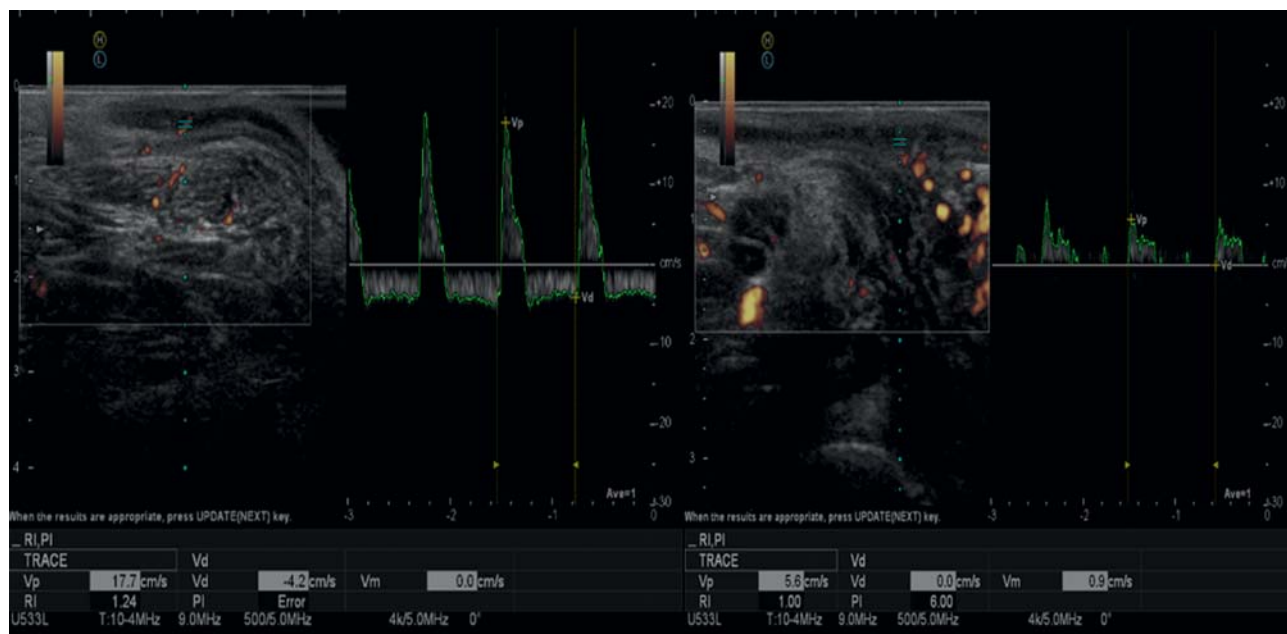
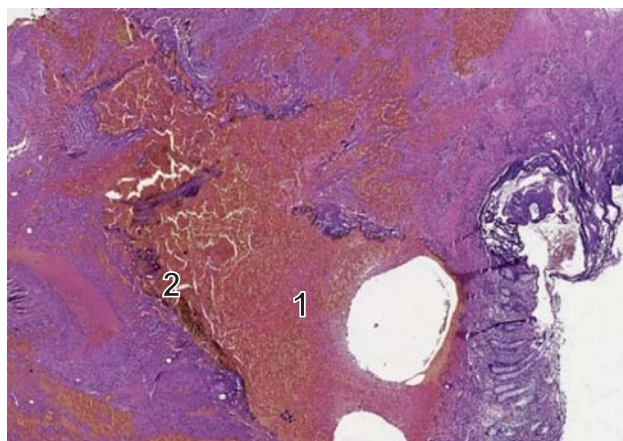
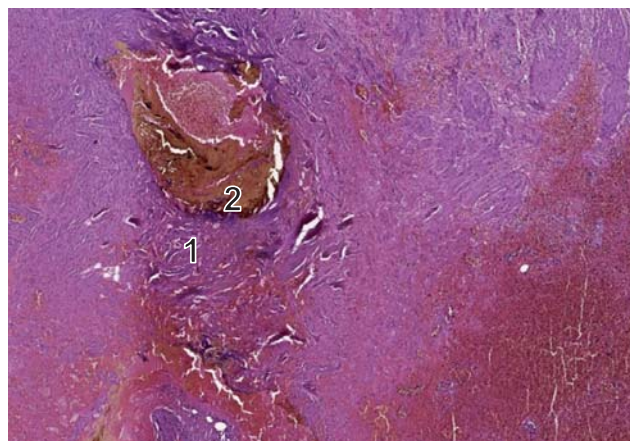


Fig. 1. Transrectal doppler ultrasound. A — before surgery, B — after surgery in a month (decrease of blood flow velocity indicators Vp, Vd and Vm)

Рис. 1. Трансректальное ультразвуковое исследование с доплерографией. А — до операции, В — через 1 месяц после операции (снижение скоростных показателей кровотока Vp, Vd и Vm)



A



B

Fig. 2. Remote internal hemorrhoidal node. $\times 40$, stained with hematoxylin and eosin. A — cochlear vein (1) with partial coagulation effect (2), B — vessel wall (1) with vessel wall thrombosis (2)

Рис. 2. Удаленный внутренний геморроидальный узел. Микропрепарат, $\times 40$, окраска гематоксилином и эозином. А — улитковая вена (1) с частичным коагуляционным воздействием (2), В — стенка сосуда (1) с пристеночным тромбом (2)

Transrectal ultrasound examination with Dopplerography in pulse-wave and energy modes made it possible to evaluate the effectiveness of laser energy on blood flow along the terminal branches of the upper rectal artery (Fig. 1).

The analysis of speed indicators in the projection of 3rd, 7th and 11th hours showed a decrease in param-

eters by 2–3 times, and the enlarged internal hemorrhoids determined before the operation were not visualized after the operation. This method demonstrated the efficient effect of the applied technique not only on the cavernous tissue of the internal hemorrhoidal node, but also on its blood supply carried out along the terminal branches of the upper rectal artery.

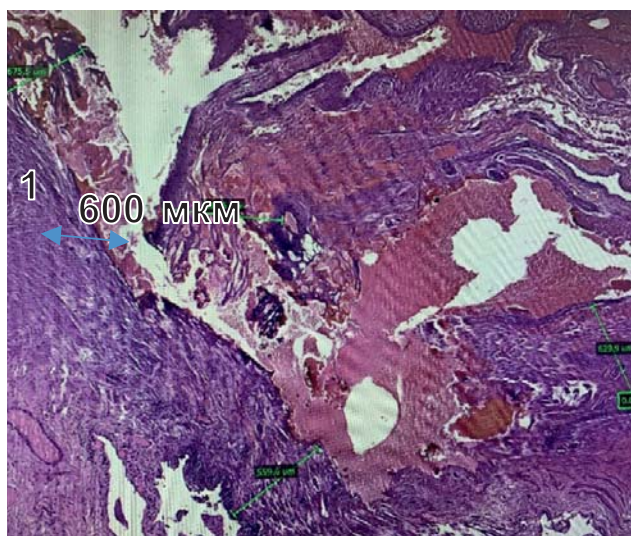


Fig. 3. Remote internal hemorrhoidal node. $\times 40$, stained with hematoxylin and eosin. Wound canal (1), depth of thermal effect (600 mcm)

Рис. 3. Удаленный внутренний геморроидальный узел. Микропрепарат, $\times 40$, окраска гематоксилином и эозином. Раневой канал (1), глубина термического воздействия (600 мкм)

Morphological examination showed cochlear veins with partial coagulation effect, vessels of smaller calibers with parietal thrombi (Fig. 2).

We were faced with the question of assessing the depth of thermal action of the laser we used with a wavelength of 1940 nm. Morphological examination showed the presence of a wound channel in the cavernous tissue, while the prevalence of exposure was about 600 microns. (Fig. 3).

All patients underwent sphincterometry. When analyzing the average pressure in the anal canal at rest and the maximum pressure during voluntary contraction, no statistically significant differences were obtained, respectively, $p = 0.6$ and $p = 0.09$, both before and in the postoperative period, which indicates the absence of laser energy effects on the structures of the anal pulp.

The quality of life of patients according to the SF 36 questionnaire already 7 days after surgery shows that the median of physical functioning was 90 points, and psychological health 72 points, which indicates that there is no negative impact on the main aspects of the quality of life of patients.

Up to date, we have tracked 28 patients who underwent laser hemorrhoidoplasty within a period of 1 to 6 months, no relapses of the disease have been detected in any patient.

Discussion

Analysis of the literature data indicates an ever-growing interest in the application of laser

technologies in the treatment of hemorrhoids. Almost all researchers note that the usage of a laser is quite easily tolerated by patients and continues the onset of minimally invasive technologies in the treatment of this disease. Currently, the most common technique that affects the cavernous tissue of the internal hemorrhoid node and the terminal branches of the upper rectal artery, which is possible in two variants: direct transnodal exposure through the lumen of the rectum and transdermal penetration into the internal hemorrhoid node. However, there is no consensus on the advantages of one or another way of penetration into the internal hemorrhoidal node.

When applying a laser with a wavelength of 1940 nm, postoperative pain syndrome by day 1st in 85.7 % of patients is 1–3 points on the VAS scale, early postoperative complications in the form of thrombosis of external hemorrhoids were diagnosed in 14.3 % who were stopped with conservative therapy. When assessing long-term results, no relapses of the disease were diagnosed in terms of up to 6 months.

H. Palmer et al. conducted a study with 15 patients with hemorrhoids of stages 2nd and 3rd who underwent transnodal laser hemorrhoidoplasty. A laser with a wavelength of 810 nm, a power of 5 Watts, a frequency of 5 Hz, an energy density of 19 J per 1 cm² was used for the operation. The author notes a low level of pain intensity throughout the entire study period. Clinical examinations conducted 7th, 14th, 21st and 28th days after surgery showed the complete disappearance of hemorrhoids in 60.4 % of patients, a decrease in size in 33.3 % of patients, in 1 patient (6.6 %) treatment did not bring effect [22].

The greatest experience in the treatment of hemorrhoids with a diode laser with a power of 30 W and a wavelength of 980 nm is presented in a study of 341 patients with hemorrhoids of stages 2nd, 3rd, 4th, conducted by A. Jahanshahi et al. [23]. The average operation time was 10 minutes. The duration of hospitalization after surgery was about 18 hours. Follow-up was carried out on the 1st, 7th, 14th, 30th, 90th and 360th day after surgery. The need for anesthesia in the early postoperative period was low. Complications were noted in 12 (3.5 %) patients: in 8 patients (2.3 %) – edema of external hemorrhoids, in two (0.58 %) – bleeding and in two (0.58 %) – abscess. Two patients (0.58 %) required re-hospitalization due to the development of bleeding stopped by stitching bleeding areas. In the long-term period, strictures and relapses of the disease were not noted. Unfortunately, the author does not indicate the average energy required for one hemorrhoidal node.

S. Faes et al. evaluated the immediate (on day 1st, 30th, 60th) and long-term results (up to 5 years)

of laser hemorrhoidoplasty were evaluated in 50 patients with stage 2nd – 3rd hemorrhoidal disease applying a diode laser with a wavelength of 1470 nm [24]. The average energy used for surgical treatment was 486 J and 154 J per internal hemorrhoidal node. No intraoperative complications were observed. Postoperative pain was mild. However, postoperative complications occurred quite often – in 18 % (9/50) of patients: 2 – rectal fistula, 1 – urinary incontinence, 2 – external hemorrhoid thrombosis, 2 – perianal burns, 1 – bleeding, 1 – anal fissure. Good immediate results of treatment were achieved in 92 % of patients, but in the long term, a high frequency of relapse of the disease was found (34 %). The average follow-up period was 5.4 years, and the time to relapse was 21 months (from 0.2 to 6 years).

T. Poskus et al. compared the results of laser hemorrhoidoplasty, hemorrhoidectomy and suture mucopexy [25]. This was a randomized, double-blind, single-center prospective study in parallel groups, which included patients with the stage 2nd or stage 3rd hemorrhoids. Laser hemorrhoidoplasty was performed applying a diode laser with a wavelength of 1470 nm. Up to 250 J of energy per 1 hemorrhoid node. According to the results of the study, it was concluded that laser hemorrhoidoplasty is a safe, minimally invasive method of treating hemorrhoids, more effective than mucopexy and less effective than hemorrhoidectomy. Compared with hemorrhoidectomy, laser hemorrhoidoplasty and mucopexy resulted in a significant reduction in the level of postoperative pain during the first week. Patients after laser hemorrhoidoplasty returned to normal activity after 15 days. Strictures did not develop in any patient during the follow-up period. However, in the laser hemorrhoidoplasty group, recurrence of hemorrhoid symptoms in the form of bleeding was observed in 12.5 %, and recurrent prolapse of hemorrhoids occurred in 15 %.

Conclusions

Thus, the use of laser technologies in the treatment of hemorrhoidal disease is minimally invasive, can be performed under local anesthesia, is accompanied by minimal postoperative pain syndrome and allows achieving a good therapeutic effect. However, at present, the optimal amount of transmitted energy necessary to achieve an effective effect on the cavernous tissue of the internal hemorrhoid node has not been sufficiently studied. There are no studies indicating the possibility of using a diode laser with a wavelength of 1940 nm. These circumstances dictate the need for further research.

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