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Ilaser Submucous Destruction in the Treatment of Hemorrhoids

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Aim: to improve the results of treatment in patients with hemorrhoids of the 2nd and 3rd stages.
Materials and methods. The prospective study included 60 patients with hemorrhoids of the 2nd and 3rd stages. All patients underwent destruction of internal hemorrhoids with a fiber laser with a diode pump with a wavelength of 1940 nm. The technique is based on the effect of laser energy on the cavernous tissue of the internal hemorrhoidal node and on the terminal branches of the upper rectal artery. The efficiency of the destruction of internal hemorrhoids and the frequency of relapses of the disease were evaluated. The effectiveness of the proposed method was evaluated using anoscopy, measurement of the size of internal hemorrhoidal nodes, transrectal ultrasound with dopplerography. The analysis of the intensity of the pain syndrome, the consumption of nonsteroidal anti-inflammatory drugs and the assessment of the quality of life on the SF-36 scale was carried out. Sphincterometry was performed in all patients to determine the possible effect of laser radiation on the rectal locking apparatus. To assess the possible causes of complications, a single-factor analysis of the amount of energy transferred to each hemorrhoidal node and the total amount of energy spent on the operation was conducted.
Results. In all patients, by day 7 after surgery, the pain syndrome in 43 patients (75.4 %) corresponded to 0 points according to VAS. In 3 patients (5 %) intraoperative hemorrhage developed. In the early postoperative period, 5 patients (8.3 %) had 7 complications: 5 cases of thrombosis of the external hemorrhoidal node and 2 — of acute urinary retention. The conducted single-factor analysis showed the dependence of the development of complications on the energy transferred to each hemorrhoidal node and its total amount for the entire operation. In terms of up to 6 months, there were no signs of a return of the disease in any case (hemorrhoidal prolapse and blood discharge). The detected hemorrhoids before the operation, a month after the operation, were not visualized, which persisted after 6 months. The performed transrectal ultrasound examination with spectral-wave dopplerography for up to 6 months allowed to diagnose a persistent decrease in blood flow along the terminal branches of the upper rectal artery compared with preoperative values. When performed sphincterometry, there was no change in the parameters of the anal sphincter function compared to preoperative parameters.
Conclusion. The proposed method applying a fiber laser with a diode pump with a wavelength of 1940 nm makes it possible to affect transdermally the internal hemorrhoidal node without damaging the mucosa of the anal canal. The absence of postoperative wounds in the anal canal leads to a decrease in pain syndrome, and by day 7 there are no clinical manifestations of hemorrhoids. The method of laser destruction of internal hemorrhoids can be used in outpatient conditions and can improve the quality of life of patients in the early postoperative period.
Keywords: hemorrhoids, laser destruction, minimally invasive methods of hemorrhoid treatment, laser hemorrhoidoplasty, laser
Conflict of interest: the authors declare no conflict of interest.

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Лазерная субмукозная деструкция в лечении геморроя

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Цель исследования: улучшить результаты лечения пациентов с геморроем 2-й и 3-й стадий.
Материалы и методы. В проспективное исследование включены 60 пациентов с геморроем 2-й и 3-й стадий. Всем пациентам выполнена деструкция внутренних геморроидальных узлов волоконным лазером с диодной накачкой с длиной волны 1940 нм. Методика основана на воздействии лазерной энергии на ка-

вернозную ткань внутреннего геморроидального узла и на конечные ветви верхней прямокишечной артерии. Эффективность деструкции внутренних геморроидальных узлов оценивали с помощью аноскопии, измерения размеров внутренних геморроидальных узлов, трансректального ультразвукового исследования с допплерографией, также оценивалась частота развития рецидивов заболевания. Проведен анализ интенсивности послеоперационного болевого синдрома, оценка количества использованных нестероидных противовоспалительных препаратов в раннем послеоперационном периоде и качества жизни по шкале SF-36. С целью определения возможного воздействия лазерного излучения на запирательный аппарат прямой кишки всем пациентам выполнена сфинктерометрия. Для оценки возможных причин развития осложнений был выполнен однофакторный анализ количества энергии, переданной на каждый геморроидальный узел, и общего количества энергии, затраченной на операцию.

Результаты. К 7-му дню после операции болевой синдром по визуальной аналоговой шкале у 43 (75,4 %) пациентов соответствовал 0 баллов. У 3 (5 %) пациентов развились интраоперационные кровотечения. В раннем послеоперационном периоде у 5 (8,3 %) пациентов возникло 7 осложнений: 5 случаев тромбоза наружных геморроидальных узлов и 2 случая острой задержки мочеиспускания. Проведенный однофакторный анализ показал зависимость развития осложнений от количества энергии, переданной на каждый геморроидальный узел, и ее общего количества за всю операцию. В сроки до 6 месяцев ни в одном случае не было признаков рецидива заболевания (выпадение геморроидальных узлов и выделение крови). Выявляемые до операции геморроидальные узлы уже через месяц после операции не визуализировались, что сохранялось и через 6 месяцев. Выполненное трансректальное ультразвуковое исследование со спектрально-волновой допплерографией в сроки до 6 месяцев позволило диагностировать стойкое снижение показателей кровотока по конечным ветвям верхней прямокишечной артерии по сравнению с дооперационными величинами. При выполнении сфинктерометрии не отмечено изменения параметров функции анальных сфинктеров по сравнению с дооперационными показателями.

Заключение. Предложенный нами метод с использованием волоконного лазера с диодной накачкой с длиной волны 1940 нм дает возможность трансдермально воздействовать на внутренний геморроидальный узел без повреждения слизистой оболочки анального канала. Отсутствие послеоперационных ран в анальном канале приводит к снижению болевого синдрома и уже к 7-му дню после операции — к отсутствию клинических проявлений геморроидальной болезни. Метод лазерной деструкции внутренних геморроидальных узлов может быть использован в амбулаторных условиях и позволяет улучшить качество жизни пациентов в раннем послеоперационном периоде.

Ключевые слова: геморрой, лазерная деструкция, малоинвазивные методы лечения геморроя, лазерная геморроидопластика, лазер

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Introduction

Minimally invasive methods have become increasingly common in clinical practice. One of these methods is laser destruction of internal hemorrhoids. The history of the use of lasers in the treatment of hemorrhoids can be traced back to the mid-80s of the twentieth century, when CO_2 and YAG lasers were first used to perform excisional hemorrhoidectomy. However, this did not allow to achieve a decrease in the intensity of postoperative pain syndrome, to reduce the number of complications and the time of wound healing in comparison with the traditional Milligan — Morgan hemorrhoidectomy [1–6]. Due to high economic costs and lack of benefits, the use of lasers in the treatment of hemorrhoids was suspended.

The emergence of diode lasers for minimally invasive treatment of hemorrhoids has given a new round of laser technology implementation in coloproctology. n 2005, R. Salfi proposed the use of a laser with a wavelength of 980 nm to perform the HeLP procedure (Hemorroid Laser Procedure — laser desarterization of hemorrhoids), which consists in laser desarterization of the terminal branches of the superior rectal artery under the control of transrectal ultrasound with dopplerography. The effectiveness of the method was 91 % [7]. Another minimally invasive technique for the treatment of hemorrhoids, based on the destruction of internal hemorrhoids, was first used in 2006 by A.F. Karahaliloğlu by transdermal access, also using a 980 nm laser. The effectiveness of the technique reached 94.3 % [8]. In 2007 G. Weyand et al. presented the results of laser destruction of internal hemorrhoids by intranodal access using a diode laser with a wavelength of 1470 nm, demonstrating the effectiveness of the method in 86 % [9].

Currently, laser destruction of internal hemorrhoids is performed applying lasers of various wavelengths — 810 nm, 980 nm, 1470 nm. A unified approach to assess the optimal amount of energy acting on the cavernous tissue of the hemorrhoid to achieve effective and safe destruction has not been developed. These circumstances gave rise to a study of the effectiveness and safety of using a laser with a

wavelength of 1940 nm applying different amounts of energy on internal hemorrhoids.

Materials and methods

Ryzhikh National Medical Research Center of Coloproctology has accumulated experience in treating of 60 patients with hemorrhoids of stages 2 and 3. The study included patients with external and internal hemorrhoids of stages 2 and 3, 18 years and older, who gave informed consent to participate in the study and agreed with the proposed examination and treatment plan. The protocol was approved by the local ethics committee of Ryzhikh National Medical Research Center of Coloproctology on December 23, 2021. This work is a continuation of the previously published research [10].

The study included 20 patients (33.3 %) with stage 2 and 40 (66.7 %) — with stage 3 hemorrhoids. The average age was 38 (23–77) years. The majority of patients were males — 45 (75 %). The median duration of the disease history was 5 (0.3–20.0) years. Measuring the size of internal hemorrhoids in the projection of 3, 7 and 11 o'clock positions showed almost the same values: at 3 o'clock — 18 (11–28) mm, at 7 o'clock — 20 (10–27) mm, at 11 o'clock — 19 (10–27) mm.

All patients underwent minimally invasive treatment in the amount of laser destruction of internal hemorrhoids applying a laser with a wavelength of 1940 nm. This is a diode-pumped fiber laser doped with thulium ions (Scientific and Technical Organization "IRE-Polus"). Laser destruction was performed under local anesthesia in 27 patients (45 %), under spinal anesthesia — in 33 (55 %).

To perform laser destruction, an end light guide with a diameter of 0.55 mm with a conductor having an outer diameter of 1.47 mm was used in pulsed mode, the power of the supplied energy was 7 Watts, a pulse — 500 ms, a pause — 750 ms. Patent for invention No. 2785255 as of 05.12.2022 was obtained for the technique we used ("A method of treating hemorrhoids using a fiber laser with a wavelength of 1940 nm" by Kuzminov A.M., Frolov S.A., Vyshegorodtsev D.V., Korolik V.Yu., Bogormistrov I.S., Battalova A.M.).

Operative technique. In the patient's position for lithotomy, a terminal anoscope was inserted into the lumen of the anal canal, at a distance of 0.5–1.0 cm from the edge of the anus on the skin of the perianal area, a puncture was performed using a laser instrument, through which the end light guide was carried subcutaneously-submucosally into the internal hemorrhoidal node to its proximal edge. The correct location was determined by the pilot ray located at the end of the laser fiber. After that, laser energy was supplied, spreading it with pendulum-like movements, affecting the cavernous tissue of the internal hemorrhoidal node and the terminal branches of the upper rectal artery.

The control points of our study were the assessment of the destruction of internal hemorrhoids and the frequency of relapses. The analysis of the intensity of postoperative pain syndrome in the early postoperative period was carried out on a visual analog scale (VAS) from 0 to 10 points. The consumption of NSAIDs was taken into account: when a pronounced pain syndrome occurred, intramuscular injections of ketoprofen solution (50 mg/mL) were performed for the purpose of anesthesia.

The causes of postoperative complications were also assessed.

All patients underwent endoscopy before surgery and in 1, 3 and 6 months after surgery to visualize and measure internal hemorrhoids. To assess the velocity parameters of blood flow along the terminal branches of the upper rectal artery and the area of internal hemorrhoids, transrectal ultrasound with spectral-wave dopplerography in pulse-wave and energy modes was performed.

To determine the possible effect of laser radiation on the rectal locking apparatus, sphincterometry was performed on the WPM Solar complex (MMS, Netherlands) in all patients before the surgery and 30 day after with the use of a non-perfusion sensor of water filling and cutaneous electrodes. The method consisted in determining the manometric parameters of the tone of the anal sphincters at rest and the contractile ability of the external sphincter with volitional contraction.

For the convenience of analyzing the effectiveness of treatment and statistical processing of the data obtained in the form of numerical values, the clinical manifestations of hemorrhoidal disease were evaluated according to a point system (Table 1) [11].

The SF-36 questionnaire was used to analyze the quality of life of patients on days 7 and 30 after the surgery.

Results

Three patients (5 %) developed intraoperative bleeding from an internal hemorrhoid. In two cases, this complication was caused by the traumatization of the internal hemorrhoidal node with a laser instrument and its exit into the lumen of the intestine. The occurrence of another bleeding was most likely due to an insufficient amount of energy acting on the cavernous tissue of the hemorrhoidal node, however, given the little experience of using this technique, it is currently difficult to unambiguously judge the causes of the complication. Due to the occurrence of bleeding, patients underwent hemorrhoidectomy.

In 5 patients (8.8 %), thrombosis of external hemorrhoids occurred in the early postoperative period, which we associate with an excessive amount of transferred energy, which in these patients ranged from 501 to 600 J. Two of these patients (3.3 %) developed acute urinary retention. In all cases, conservative therapy with a positive effect was carried out.

Table 1. Distribution of chronic hemorrhoids symptoms by points
Таблица 1. Распределение симптомов хронического геморроя по баллам

Symptom Симптом	Frequency of occurrence Частота появления	Points Баллы
Humidity feeling Чувство влажности		1
Itching, burning, discomfort Зуд, жжение, дискомфорт		2
Foreign body feeling Чувство инородного тела		3
Blood on toilet paper Кровь на туалетной бумаге	A — 1–3 times a week А — 1–3 раза в неделю	4
	B — > 3 times a week Б — более 3 раз в неделю	5
Blood released in drops Кровь выделяется каплями	A — 1–3 times a week А — 1–3 раза в неделю	6
	B — > 3 times a week Б — более 3 раз в неделю	7
Prolapse of nodes by a manual setting Выпадающие узлы вправляются при помощи ручного пособия		8
Prolapse of nodes, setting themselves Выпадающие узлы, вправляющиеся самостоятельно		9
Blood released in stream Кровь выделяется струйкой	A — 1–3 times a week А — 1–3 раза в неделю	10
	B — > 3 times a week Б — более 3 раз в неделю	11

To determine the possible causes of complications, a single-factor analysis was carried out, which took into account the stage of hemorrhoidal disease, the size of hemorrhoids, the amount of energy transferred to each node and the total amount of energy. The analysis showed that the development of complications is affected by the amount of energy transferred to individual nodes, as well as the total amount of energy (Table 2).

To determine the limits of the amount of laser energy used, at which the probability of complications increases, we conducted an analysis of ROC curves, which revealed cut-off points (Figure 1).

Based on the analysis of ROC curves, a single-factor analysis was carried out, which showed that with an increase in energy transfer in the projection at 3 o'clock above 165 J, at 7 o'clock — over 145 J, at 11 o'clock — over 140 J, total energy — over 420 J, the risk of postoperative complications increases (Table 3).

Postoperative pain syndrome was assessed by VAS (from 0 to 10 points), by day 2 after surgery, the pain syndrome in 53 patients (93 %) did not exceed 3 points, and by day 7 in 43 patients (75.4 %) it corresponded to 0 points. A decrease in the intensity of the pain syndrome was also observed during the act of defecation, so by day 3 in 42 patients (73.7 %) the pain syndrome did not exceed 3 points, and by day 7 in 32 patients (56.1 %) it was absent.

In the postoperative period, the consumption of NSAIDs was recorded, by day 2 after the operation, the consumption of drugs did not exceed 40 mg per day, and by day 7 after the operation, no patient needed anesthesia.

In order to determine the effectiveness of laser destruction in the postoperative period, anoscopy was performed to visualize internal hemorrhoids and their measurement using a ruler (according to the type of calipers), which showed that the internal hemorrhoids determined before the operation were not visualized a month after the operation, as well as in 3 and 6 months after the operation (Figure 2).

One, three and six months after the operation, transrectal ultrasound was performed with spectral-wave dopplerography in pulse-wave and energy modes. Already 1 month after the operation, hemorrhoids were not detected, which persisted by month 6 after the operation. Via dopplerography, a 2–3-fold decrease in blood flow rates was diagnosed.

The efficacy of laser destruction was evaluated using a scale of distribution of hemorrhoid symptoms by points. The median score by day 7 after the surgery was 3 (0–16) points, while before surgery it corresponded to 18 (2–40) points, and by first month after the surgery the median was 0 (0–10), which persisted 3 and 6 months after the surgery — 0 (0–5) and 0 (0–2) points correspondingly (Table 1).

Table 2. Single-factor analysis for determining the causes of complications of laser submucous destruction
Таблица 2. Однофакторный анализ определения причин осложнений лазерной субмукозной деструкции

Factors Факторы	OR (95% CI) ОШ (95% ДИ)	*p*
Hemorrhoid stage (3/2) Стадия геморроя 3/2	2.7 (0.3–25.0)	0.37
Total energy, J Общая энергия, Дж	1.02 (1.004–1.03)	0.01
Energy transmitted at 3 o'clock point, J Энергия, переданная на 3 часах, Дж	1.03 (1.004–1.05)	0.02
Energy transmitted at 7 o'clock point, J Энергия, переданная на 7 часах, Дж	1.02 (0.99–1.04)	0.15
Energy transmitted at 11 o'clock point, J Энергия, переданная на 11 часах, Дж	1.04 (1.014–1.07)	0.002
Size of the hemorrhoidal node at 3 o'clock point, cm Размер геморроидального узла на 3 часах, см	1.09 (0.9–1.3)	0.3
Size of the hemorrhoidal node at 7 o'clock point, cm Размер геморроидального узла на 7 часах, см	1.01 (0.9–1.2)	0.8
Size of the hemorrhoidal node at 11 o'clock point, cm Размер геморроидального узла на 11 часах, см	1.07 (0.9–1.3)	0.4

Note. OR — odds ratio; 95% CI — the 95 % confidence interval.
Примечание. ОШ — отношение шансов; 95% ДИ — 95%-ный доверительный интервал.

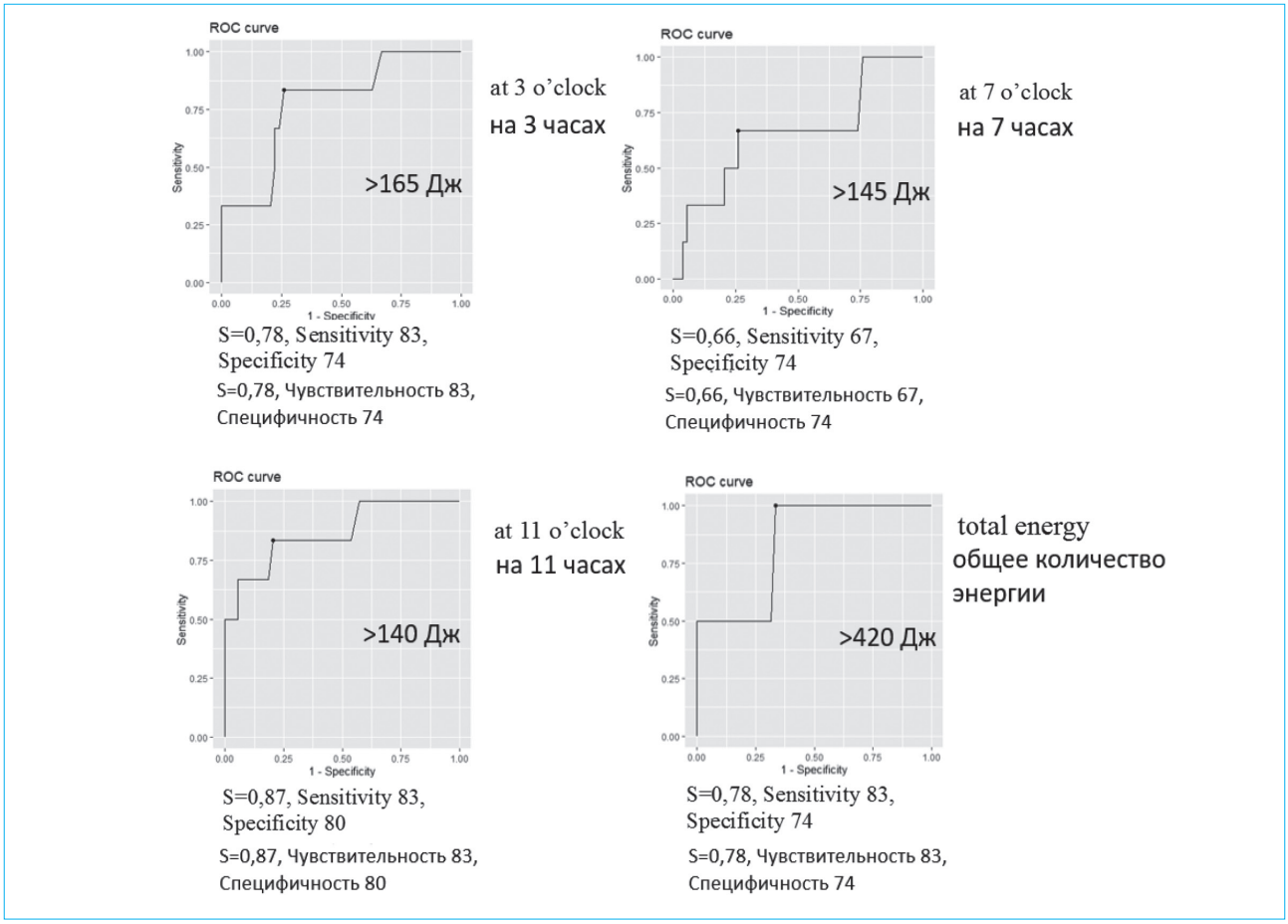

Fig. 1. ROC curves for determining the amount of energy used for the destruction of cavernous tissue of hemorrhoids in the projection at 3, 7 and 11 o'clock points and in total

Рис. 1. ROC-кривые определения количества энергии, используемой для деструкции кавернозной ткани геморроидальных узлов, в проекции 3, 7 и 11 часов и в общем

Table 3. Single-factor analysis of the amount of energy transferred to the hemorrhoidal node with an assessment of the chances of complications

Таблица 3. Однофакторный анализ количества энергии, переданной на геморроидальный узел, с оценкой шансов развития осложнений

Projection of the hemorrhoidal node Проекция геморроидального узла	Amount of energy, J Количество энергии, Дж	OR (95% CI) ОШ (95% ДИ)	*p*
3 o'clock 3 часа	> 165	14.0 (1.5–133.0)	0.020
7 o'clock 7 часов	> 145	5.7 (0.9–35.0)	0.050
11 o'clock 11 часов	> 140	20.0 (2.0–185.0)	0.001

Fig. 2. Anoscopy. Internal hemorrhoid node (arrow) before surgery — 24 mm; hemorrhoids are not visualized 1 and 6 months after the surgery

Рис. 2. Аноскопия. Внутренний геморроидальный узел (стрелка) до операции размером 24 мм; геморроидальные узлы не визуализируются через 1 и 6 мес после операции

According to the data of sphincterometry performed in 57 patients, none of the patients showed a decrease in indicators compared to preoperative values, which indicates that the technique used is not traumatic and there is no laser effect on the rectal locking apparatus.

According to the SF-36 scale before surgery, the average value of physical functioning (PF) and mental health (MH) scores was 85.1 and 61.8 points, and by day 30 after surgery, these indicators significantly increased (91.8 and 77.3 points; $p < 0.001$).

Discussion

Minimally invasive methods in the treatment of hemorrhoids are currently coming to the fore in the treatment of hemorrhoidal disease. One of such techniques is the use of laser energy. Most authors note the easy tolerability and high efficiency of using laser technologies in the treatment of hemorrhoids. However, lasers with different wavelengths from 810 to 1940 nm are currently used. The use of laser technologies is possible by two methods with the effect of laser energy directly on the internal hemorrhoidal node (transnodally) and transdermally affecting the cavernous tissue of the internal hemorrhoidal node and the terminal branches of the upper rectal artery. When using laser radiation with a wavelength of 1940 nm, the postoperative pain syndrome by day 2 in 93 % of patients does not exceed 3 points according to VAS, and early postoperative complications that occurred in 8.3 % of patients were stopped by conservative measures. When assessing the long-term results for up to 6 months, no relapses of the disease were detected.

L. Brusciano et al. presented the experience of treating 50 patients with stage 2–3 hemorrhoidal disease using the LHP (Laser HemorrhoidoPlasty) technique using a diode laser with a wavelength of 1470 nm. The patients were discharged the next day after surgery in the absence of postoperative complications and an insignificant level of postoperative

pain syndrome. According to the author, no intraoperative complications were detected, the pain syndrome assessed within a day after the operation on a 10-point scale was 2 points. All patients were able to start daily activity 2 days after surgery, with a follow-up period of 8.6 months, no relapse of the disease was detected in any patient [12].

In the research work of A.I. Nedozimovanyi et al., 65 patients with chronic hemorrhoids of stage 2 (20 %) and stage 3 (80 %) according to the Goligher classification were included. All patients underwent laser submucosal destruction of hemorrhoids using a diode laser with a wavelength of 1470 nm in pulsed mode (operating time — 150 ms, pause time — 50 ms); with radiation power of 7–8 Watts. In 54 patients (83 %), the postoperative period proceeded smoothly. Postoperative pain syndrome, on average, was 3 ± 0.2 points according to VAS. Complications were noted in 11 patients (16.9 %) in the early postoperative period. No relapses were recorded during the observation period [13].

Lakmali K. et al. analyzed data from 19 studies, which included 1937 patients who underwent laser destruction of hemorrhoids. Fourteen of those studies were prospective ones [14–25], four — randomized control studies [26–28] and one was a retrospective study [29]. Based on the analysis, the authors concluded that the use of laser in the treatment of hemorrhoids of stages 2 and 3 allows to reduce the level of pain syndrome and at the same time is accompanied by satisfactory long-term results.

Conclusion

Thus, the use of laser technologies in the treatment of hemorrhoids is minimally invasive, accompanied by minimal postoperative pain syndrome and allows achieving a good therapeutic effect. It is also possible to perform the technique under local anesthesia. However, the optimal amount of transmitted energy required to achieve an effective impact on the cavernous tissue of the internal hemorrhoidal node and the terminal branches of the upper rectal artery is currently insufficiently studied, which dictates the need for further research. This study is one of the first to indicate the possibility of using a diode laser with a wavelength of 1940 nm for the treatment of patients with hemorrhoids of stages 2 and 3.

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