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Long-Term Results of Laser Submucosal Destruction in the Treatment of Grade 2 – 3 Hemorrhoids

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Aim: improvement the results of treatment in patients with Grade 2–3 of hemorrhoids.
Materials and methods. A single-center prospective study included 90 patients with Grade 2–3 haemorrhoidal disease who met the inclusion criteria. All patients underwent transdermal laser submucosal destruction of internal hemorrhoids with a water-absorbed laser with a wavelength of 1940 nm according to the method proposed by us. In the course of the procedure the laser effect is applied both to the cavernous tissue of hemorrhoidal nodes and to the terminal branches of the superior rectal artery. The primary endpoints of the study were destruction of the cavernous tissue of internal hemorrhoidal nodes and the frequency of recurrence of the disease. The effectiveness of the technique was assessed using anoscopy, ultrasound examination with a rectal sensor with spectral-wave Dopplerography 1, 3, 6 and 12 months after surgery. At the same time, the quality of life and the severity of hemorrhoidal disease symptoms were assessed using the SF-36 scale and a point assessment of the clinical manifestations of hemorrhoids. In the first 7 days after surgery, the intensity of the pain syndrome was analyzed using the Visual Analog Scale (VAS). In order to determine the safety of the technique with respect to the effect on the locking apparatus of the rectum, sphincterometry was performed in all patients. Intra- and postoperative complications and recurrences of the disease within 1 year were also recorded, the causes of the return of clinical manifestations of hemorrhoidal disease were analyzed.
Results. The level of pain syndrome by day 7 after surgery corresponded to 0 points on the VAS in 52 (58 %) patients. Intraoperatively, bleeding occurred in 3 (3.3 %) patients and submucous hematoma formed in 15 (16.7 %) patients. In the early postoperative period, thrombosis of external hemorrhoids developed in 5 (5.6 %) patients, two of these patients developed acute urinary retention. Internal hemorrhoids determined before surgery were not visualized one month after surgery either by anoscopy or by ultrasound examination with a rectal sensor. According to the results of spectral wave Dopplerography, a persistent decrease in blood flow along the terminal branches of the superior rectal artery is noted for up to 12 months after the intervention. According to sphincterometry, no changes in the parameters of the anal sphincter function were noted compared with the preoperative parameters. 18 and 24 months after the operation, two patients were diagnosed with recurrence of hemorrhoidal disease. The analysis showed that the reason for the return of clinical manifestations of the disease was the supply of insufficient laser energy.
Conclusion. Laser submucosal destruction of internal hemorrhoids using a laser with a wavelength of 1940 nm is a minimally invasive method for treating Grade 2–3 of hemorrhoidal disease, which has demonstrated high efficiency (good results) in the late postoperative period. Thus, according to the results of our study, the return of clinical manifestations of hemorrhoidal disease was revealed only in 2 patients after 18 and 24 months. A repeated laser destruction procedure allowed us to achieve a good result in these patients.
Keywords: hemorrhoids, laser destruction, minimally invasive methods of hemorrhoid treatment, laser hemorrhoidoplasty, laser, relapse
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Отдаленные результаты лазерной подслизистой деструкции в лечении геморроя 2–3-й стадий

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Цель: улучшение результатов лечения пациентов с геморроем 2–3-й стадий.
Материалы и методы. В одноцентровое проспективное исследование включены 90 пациентов с геморроидальной болезнью 2–3-й стадий, соответствующие критериям включения. Всем больным выполнялась трансдермальная лазерная подслизистая деструкция внутренних геморроидальных узлов водопоглощаемым лазером с длиной волны 1940 нм по предложенной нами методике. В ходе выполнения процедуры лазерное воздействие оказывается как на кавернозную ткань геморроидальных узлов, так и на конечные ветви верхней прямокишечной артерии. Первичными точками исследования являлись деструкция кавернозной ткани внутренних геморроидальных узлов и частота рецидивов заболевания. Оценка эффективности методики проводилась при помощи аноскопии, ультразвукового исследования ректальным датчиком со спектрально-волновой доплерографией через 1, 3, 6 и 12 месяцев после операции. В эти же сроки выполнялась оценка качества жизни и степени выраженности симптомов геморроидальной болезни по шкале SF-36 и балльной оценки клинических проявлений геморроя. В первые 7 дней после операции проводился анализ интенсивности болевого синдрома при помощи визуально-аналоговой шкалы боли (ВАШ). С целью определения безопасности методики относительно воздействия на запирательный аппарат прямой кишки всем пациентам выполнялась сфинктерометрия. Также были зарегистрированы интра- и послеоперационные осложнения и рецидивы заболевания в течение 1 года, проанализированы причины возникновения возврата клинических проявлений геморроидальной болезни.
Результаты. Уровень болевого синдрома к 7-му дню после операции соответствовал 0 баллов по ВАШ у 52 (57,8 %) больных. Интраоперационно у 3 (3,3 %) пациентов возникло кровотечение и у 15 (16,7 %) больных образовалась подслизистая гематома. В раннем послеоперационном периоде у 5 (5,6 %) пациентов развился тромбоз наружных геморроидальных узлов, у 2 (2,2 %) из этих больных возникла острая задержка мочеиспускания. Определяемые до операции внутренние геморроидальные узлы через месяц после вмешательства не визуализировались как при аноскопии, так и при выполнении ультразвукового исследования ректальным датчиком. По результатам спектрально-волновой доплерографии отмечалось стойкое снижение показателей кровотока по конечным ветвям верхней прямокишечной артерии в сроки до 12 месяцев после операции. По данным сфинктерометрии не отмечено изменения параметров функции анальных сфинктеров по сравнению с дооперационными показателями. Через 18 и 24 месяца после операции у 2 (2,2 %) пациентов диагностирован рецидив геморроидальной болезни. Проведенный анализ показал, что причиной возврата клинических проявлений заболевания являлась подача недостаточного количества лазерной энергии.
Заключение. Лазерная подслизистая деструкция внутренних геморроидальных узлов с использованием лазера с длиной волны 1940 нм является малоинвазивным методом лечения геморроя 2–3-й стадий, продемонстрировавшим высокую эффективность в отдаленные сроки после операции. По результатам проведенного исследования возврат клинических проявлений геморроидальной болезни выявлен у 2 (2,2 %) пациентов через 18 и 24 месяца. Повторная процедура лазерной деструкции позволила добиться хороших результатов у этих пациентов.
Ключевые слова: геморрой, лазерная деструкция, малоинвазивные методы лечения геморроя, лазерная геморроидопластика, лазер, рецидив
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Introduction

Hemorrhoids are one of the most common diseases of the rectum. Hemorrhoidectomy remains the most radical and effective method of treating Grade 4 hemorrhoidal disease [1, 2]. Patients of working age are often diagnosed with Grade 2–3 hemorrhoids. Currently, various minimally invasive methods are increasingly preferred in the treatment of hemorrhoidal disease, allowing patients to return to their usual work activities shortly after surgery. In addition, minimally invasive techniques have a number of other undeniable advantages, such as low levels of postoperative pain, reduced hospitalization time, and the possibility of performing the procedure on an outpatient basis or in a day hospital [3, 4].

Recently, with the development of medical technology and the emergence of new devices, laser-based methods have become increasingly popular in the treatment of hemorrhoids. These methods include laser dearterization, both independently (HeLP — hemorrhoid laser procedure) and in combination with mucopexy (HeLPexx — hemorrhoid laser procedure with suture-pexy), and laser hemorrhoidoplasty (LHP) [5–7]. For the first time, the method of laser hemorrhoidoplasty for the treatment of hemorrhoids of Grade 2–3 was proposed in 2006 by A.F. Karahaliloglu [8]. According to available literature data, this technique can be performed with lasers of various wavelengths (810, 980, 1470, and 1940 nm)

both transnodally and transdermally [8–10]. In connection with the appearance of publications demonstrating the advantages of long-wave water-absorbing lasers, our Research Center conducted a study on the use of a diode-pumped fiber laser with a wavelength of 1940 nm in the minimally invasive treatment of hemorrhoidal disease and evaluated the long-term results of treatment in patients with Grade 2–3 hemorrhoids [11].

Materials and methods

At the National Medical Research Center for Coloproctology named after A.N. Ryzhikh we analyzed the long-term results of a study on the use of laser transdermal destruction in the treatment of hemorrhoidal disease. This study included 90 patients over the age of 18 with Grade 2–3 of hemorrhoids, all of whom signed a voluntary informed consent form and underwent surgery using the method we proposed, for which we received patent No. 2785255 on December 5, 2022 "Method for treating hemorrhoids using a fiber laser with a wavelength of 1940 nm".

It is worth noting that 56 (62.2 %) of the patients included in the study suffered from Grade 3 hemorrhoids, while the remaining 34 (37.8 %) were diagnosed with Grade 2 disease. The average age of the patients was 41 (19–78) years, with males significantly outnumbering females — 60 (66.7 %) people. The average duration of the disease was 5 (0.2–21) years, and the average body mass index was 24.8 (17.7–38.9) kg/m^2.

All patients underwent a comprehensive examination before surgery and at specific intervals after surgery. During the initial examination, anoscopy was performed, during which the length of the internal hemorrhoidal nodes was measured using a caliper-type ruler, which was subsequently correlated with the amount of laser energy in joules delivered to a specific hemorrhoidal node. All patients also underwent colonoscopy in the preoperative period to rule out concomitant intestinal diseases, sphincterometry, and ultrasound examination with a rectal sensor with spectral wave Doppler imaging. All patients were surveyed using SF-36 questionnaires and a scoring system for clinical manifestations of hemorrhoids, reflecting the quality of life of patients and the severity of disease symptoms.

After the above-described preoperative examination, all patients underwent transdermal laser submucosal destruction of internal hemorrhoidal nodes. Taking into account the preferences of the patients, this intervention was performed under local anesthesia in 49 (54.4 %) people and under spinal anesthesia in 41 (45.6 %) cases.

The destruction was performed using a diode-pumped fiber laser with a wavelength of 1940 nm (OOO NTO "IRE-Polus"), which has a medical device registration certificate No. RZN 2019/9361. The operation was performed according to the method we proposed, with laser energy delivered in a pulsed-periodic mode, the power of the delivered energy was 7 Watts, the pulse was 500 ms, and the pause was 750 ms [12].

The amount of energy required to treat an internal hemorrhoidal node with a laser, depending on its size, was estimated based on the results of our pilot study involving 28 people [13]. The median energy transferred was 55.7 (48.1–82.8) J per 1 cm of cavernous tissue [13]. When evaluating the long-term results, 2 (2.2 %) patients were diagnosed with a recurrence of the disease 12 and 18 months after the operation. Based on the results of our analysis, it was found that the above amount of laser energy is insufficient and causes the return of clinical manifestations of hemorrhoidal disease in these patients. Subsequently, taking into account these circumstances, as well as the analysis of ROC-curve for the probability of complications, we determined that 100 J of laser energy is required to treat 1 cm of cavernous tissue of an internal hemorrhoidal node with a 1940 nm wavelength laser in a pulsed-periodic mode with a power of 7 W. Thus, summarizing the data for all patients included in our study, we see that for a hemorrhoidal node at 3 o'clock with an average length of 18 (11–28) mm, we applied an average of 119 (56–245) J of laser energy. To treat cavernous tissue of an internal hemorrhoidal node at 7 o'clock with an average size of 21 (10–27) mm, 123 (60–236) J of energy was required, and for a hemorrhoidal node at 11 o'clock with a length of 19 (10–27) mm, 109 (60–243) J was required. Since the penetration depth of a laser with a wavelength of 1940 nm is 0.76 mm, there is minimal thermal impact on the surrounding tissues, which does not lead to damage to the mucous membrane above the internal hemorrhoidal node. Therefore, at the time of treatment of the cavernous tissue with this laser, no visual changes in the hemorrhoidal nodes occur. The final effect of the procedure develops gradually due to the gradual replacement of cavernous tissue with connective tissue, as well as the spread of fibrosis to the terminal branches of the superior rectal artery, thus providing an additional effect of dearterialization.

The primary points of our study were the destruction of cavernous tissue of internal hemorrhoidal nodes, confirmed instrumentally, and the frequency of disease recurrence. To evaluate the results of the intervention, all patients were observed and examined at specific times after the

operation. In the first 7 days after the intervention, the level of pain syndrome was assessed using a visual analogue scale (VAS), and intra- and postoperative complications were recorded. To evaluate the primary endpoint, all patients underwent anoscopy and transrectal ultrasound with Doppler imaging 1, 3, 6, and 12 months after destruction. During these same periods, patients were asked to complete SF-36 questionnaires and clinical manifestations of hemorrhoidal disease scoring forms. One month after surgery, sphincterometry was performed to assess the safety of laser radiation exposure on the rectal sphincter.

Results

We analyzed intraoperative and postoperative complications. Thus, 3 (3.3 %) of 90 patients experienced intraoperative bleeding due to trauma to the internal hemorrhoidal node when the laser instrument was inserted into the cavernous tissue and its end entered the intestinal lumen. This complication required hemorrhoidectomy in all of these patients.

In 15 (16.7 %) patients, a submucosal hematoma formed intraoperatively. However, an ultrasound examination with a rectal sensor showed that only 3 (3.3 %) patients had a true hematoma, while in 12 (13.3 %) patients, the characteristic change in the internal hemorrhoidal node was due to explosive bubble boiling of the tissues as a result of laser radiation exposure. After analyzing the causes of these complications, we concluded that a true hematoma occurs as a result of the laser instrument entering the hemorrhoidal vein with a small amount of laser energy, and this condition persists for several days after the operation. A "false" hematoma (explosive bubble effect from the exposure of cavernous tissue to laser radiation) forms when a large amount of laser energy is applied to the hemorrhoidal vein, and no changes in the node are detected the next day. None of the 15 patients experienced intraoperative hematoma growth, so no additional treatment was required.

On the second day after surgery, 5 (5.6 %) patients developed thrombosis of the external hemorrhoidal nodes, which was treated with conservative therapy. This complication arose in the early stages of mastering the technique and, in our opinion, is associated with the transfer of laser energy to the tissue of the external hemorrhoidal node during the laser procedure. Also, 2 (2.2 %) of these patients developed acute urinary retention, requiring the placement of a urethral catheter with subsequent restoration of independent urination.

In the first 7 days after the intervention, we assessed the intensity of postoperative pain using a visual analogue scale (VAS), both during and without defecation. Thus, by the third day, the level of pain did not exceed 2 points in 85 (94.4 %) patients. Against the background of defecation, a decrease in the intensity of pain syndrome was also noted: by the third day, in 68 (75.6 %) patients, the pain syndrome decreased to 3 points, and by the seventh day, it corresponded to 0 points in 52 (57.8 %) patients. In our opinion, this trend is directly related to the absence of wounds in the anal canal.

To assess the effectiveness of the intervention, all patients underwent anoscopy in the postoperative period. Thus, one month after the operation, the previously identified internal hemorrhoidal nodes were no longer visible. This effect persisted in patients at 3, 6, and 12 months.

To instrumentally monitor the effectiveness of laser destruction during the same period, all patients underwent an ultrasound examination with a rectal sensor using spectral wave Doppler imaging. One month after the operation, we observed the absence of previously detected cavernous tissue, as well as a statistically significant reduction in blood flow velocity by at least 2–3 times, which indicated the effectiveness of the technique. These changes persisted in most patients 3, 6, and 12 months after the intervention.

One month after the operation, sphincterometry was performed in all patients to assess the safety of the technique, and the results showed no differences between pre- and postoperative indicators.

A subjective assessment of the effectiveness of our intervention was performed using a scoring scale for clinical manifestations of hemorrhoids. Thus, the median score before surgery was 18 (2–40) points, and by day 7 after the intervention, it was 3 (0–16) points. One month after the procedure and in the subsequent periods, the median score was 0.

We used the SF-36 questionnaire to assess the quality of life of the patients included in the study. We observed a statistically significant improvement in physical functioning (PF) and mental health (MH) after surgery. Thus, before the intervention, the average PF and MH scores were 84.3 and 60.7 points, respectively, and by day 30 after the procedure, these indicators increased to 90.6 and 75.4 points ($p < 0.001$).

During the study period, 2 (2.2 %) patients experienced a recurrence of clinical manifestations of hemorrhoidal disease at 18 and 24 months. The first patient was diagnosed with Grade 3 hemorrhoidal disease at the initial visit. The patient complained of prolapse of hemorrhoidal nodes, which could only be corrected manually, as well

as droplets of blood from the anal canal. This clinical picture corresponded to 18 points on the clinical manifestations of hemorrhoids scoring scale. During anoscopy at 3, 7, and 11 o'clock on the conditional dial, enlarged internal hemorrhoids with a length of 21, 18, and 16 mm, respectively, were visualized. According to transrectal ultrasound examination, the area of cavernous tissue of internal hemorrhoidal nodes corresponded to 1.05, 1.08, and 0.64 cm^2. Preoperative blood flow velocity indicators were also recorded based on the results of spectral wave Doppler imaging (Table 1). The patient underwent transdermal laser submucosal destruction of internal hemorrhoidal nodes using our technique, with the amount of energy transferred corresponding to 180, 105, and 100 J to the hemorrhoidal nodes at 3, 7, and 11 o'clock, respectively. One month after the treatment, the main complaints reported by the patient before the intervention disappeared. Anoscopy did not reveal any internal hemorrhoidal nodes, which was also confirmed by transrectal ultrasound data. Dopplerography showed a threefold decrease in blood flow velocity in the terminal branches of the superior rectal artery (from 22.1 to 6.8 cm/s) (Table 1). The score on the clinical manifestations of hemorrhoids rating scale was 1 point. These results were maintained during follow-up examinations throughout the year. Eighteen months after the operation, the

Table 1. Analysis of the causes of hemorrhoid recurrence after laser submucosal destruction (Patient 1)

Таблица 1. Анализ причин развития рецидива геморроя после лазерной подслизистой деструкции (Пациент 1)

Hemorrhoidal node at 7 o'clock point ***Геморроидальный узел на 7 часах***	**Anoscopy** ***Аноскопия***	**Transrectal ultrasound** ***ТРУЗИ***	**Doppler flow imaging and spectral analysis, cm/s** ***Спектрально-волновая доплерография, см/с***	**Total score on the scoring scale** ***Сумма баллов по шкале балльной оценки***	**Amount of energy transmitted** ***Количество переданной энергии***
Before surgery *До операции*	Hemorrhoidal node with a length of 18 mm *Геморроидальный узел протяженностью 18 мм*	Cavernous tissue area 1.08 cm^2 *Площадь кавернозной ткани 1,08 $см^2$*	*Vp* = 22,1 *Vd* = 2,3 *Vm* = 9,3	18	105 J *105 Дж*
In 1 month *Через 1 месяц*	Cavernous tissue not identified *Кавернозная ткань не определяется*	Cavernous tissue not identified *Кавернозная ткань не определяется*	*Vp* = 6,9 *Vd* = 0,5 *Vm* = 3,64	1	
In 3 months *Через 3 месяца*	Cavernous tissue not identified *Кавернозная ткань не определяется*	Cavernous tissue not identified *Кавернозная ткань не определяется*	*Vp* = 6,8 *Vd* = 0,3 *Vm* = 3,55	1	
In 6 months *Через 6 месяцев*	Cavernous tissue not identified *Кавернозная ткань не определяется*	Cavernous tissue not identified *Кавернозная ткань не определяется*	*Vp* = 6,8 *Vd* = 0,3 *Vm* = 3,55	1	
In 12 months *Через 12 месяцев*	Cavernous tissue not identified *Кавернозная ткань не определяется*	Cavernous tissue not identified *Кавернозная ткань не определяется*	*Vp* = 6,8 *Vd* = 0,3 *Vm* = 3,55	1	
In 18 months *Через 18 месяцев*	An area of residual cavernous tissue measuring 6 mm in length *Островок остаточной кавернозной ткани протяженностью 6 мм*	Cavernous tissue area 0.24 cm^2 *Площадь кавернозной ткани 0,24 $см^2$*	*Vp* = 12,3 *Vd* = 0,8 *Vm* = 6,4	15	

Note: *Vp — peak systolic velocity; Vd — end diastolic velocity; Vm — mean velocity.*

Примечание: *ТРУЗИ — трансректальное ультразвуковое исследование; Vp — пиковая систолическая скорость; Vd — конечная диастолическая скорость; Vm — средняя скорость.*

patient complained of bleeding from the anus and prolapse of a hemorrhoidal node during defecation, followed by spontaneous reduction. The patient was diagnosed with Grade 2 hemorrhoids, with a score of 15 points on the scoring scale. During anoscopy, we found an island of residual cavernous tissue up to 6 mm long in the 7 o'clock position on the conventional dial, which was also confirmed by the results of a transrectal ultrasound examination; the area of residual hemorrhoidal tissue was 0.24 cm^2. According to spectral wave Doppler ultrasound, an increase in blood flow velocity was noted in the 7 o'clock projection compared to the data obtained 3, 6, and 12 months after the operation. Thus, 12 months after the intervention, the peak systolic velocity (*Vp*) was 6.8 cm/s; the end-diastolic velocity (*Vd*) was 0.3 cm/s; and the mean velocity (*Vm*) was 3.55 cm/s. After 18 months, these indicators were 12.3, 0.8, and 6.4 cm/s, respectively. When analyzing the causes of recurrence, we concluded that an insufficient amount of laser energy (105 J) was applied to this hemorrhoidal node, located at 7 o'clock on the conditional dial, with a length of 18 mm.

A similar situation was observed in the second patient, who experienced a recurrence of clinical manifestations of the disease 24 months after surgery. Initially, the patient was diagnosed with Grade 2 hemorrhoids, with a total score of 16 points on the clinical manifestation rating scale. According to anoscopy data, the length of the internal hemorrhoidal nodes at 3, 7, and 11 o'clock was 14, 13, and 19 mm, respectively. According to transrectal ultrasound results, the area of cavernous tissue of the above nodes was 0.84, 0.65, and 1.33 cm^2. Spectral wave Doppler imaging was used to record blood flow velocity indicators before the operation (Table 2). The patient underwent transdermal laser submucosal destruction of internal hemorrhoidal nodes, with the amount of energy transferred corresponding to 110, 95, and 150 J to the internal hemorrhoidal nodes at 3, 7, and 11 o'clock, respectively. During a follow-up examination one month after surgery, the patient reported no previous complaints, and the score on the rating scale was 0. According to the results of anoscopy and transrectal ultrasound examination, the cavernous tissue of the internal hemorrhoidal nodes was not visualized. Spectral wave Doppler imaging showed that vascular loci with blood flow were not detected at 3, 7, and 11 o'clock (Table 2). Three, six, and twelve months after the operation, the results of follow-up examinations remained stable. However, 24 months after the intervention, the patient returned to us with new complaints of blood discharge from the anal canal during defecation, corresponding to a score of 6 on the scoring scale. During anoscopy at 11 o'clock, an island of residual cavernous tissue 4 mm long was visualized. According to transrectal ultrasound, the area of hemorrhoidal tissue was 0.12 cm^2. Spectral wave Doppler imaging also recorded the appearance of a vascular locus with the following blood flow velocity indicators: peak systolic velocity (*Vp*) — 5.4 cm/s; end-diastolic velocity (*Vd*) — 0.2 cm/s; mean velocity (*Vm*) — 2.3 cm/s. After analyzing the causes of recurrence, we also concluded that insufficient laser energy (150 J) was applied to this hemorrhoidal node, located at 11 o'clock on the conditional dial, with a length of 19 mm. These two patients underwent a repeat transdermal laser submucosal destruction procedure, followed by the disappearance of hemorrhoid symptoms.

Discussion

Recently, minimally invasive techniques using lasers with different wavelengths have become increasingly popular in the treatment of hemorrhoidal disease. These methods allow patients to return to their normal lives as quickly as possible without experiencing severe pain in the early postoperative period. It should not be forgotten that, along with this, the main goal of using minimally invasive techniques is the permanent elimination of the symptoms of hemorrhoidal disease.

Most researchers, when comparing radical surgery and minimally invasive methods of treating hemorrhoids, focus on pain syndrome, complications, the duration of the operation, and the length of hospitalization [14]. However, one of the important criteria for choosing a treatment method is its long-term effectiveness.

Currently, there are data in the literature on the long-term results of minimally invasive interventions using lasers with wavelengths of 980 and 1470 nm.

Thus, N. Crea et al. in their work evaluated the long-term results of surgery using the HeLP technique, performed with a diode laser with a wavelength of 1470 nm. According to the results of a 2-year follow-up of 97 patients who underwent surgery using this technique, 82 (85 %) experienced a partial disappearance of the clinical symptoms of hemorrhoidal disease. Overall, there was a 75 %, 78 %, and 71 % reduction in the frequency of symptoms such as bleeding from the anal canal, pain, and itching, respectively. Thus, 33 (72 %) of 46 patients with Grade 3 hemorrhoids were diagnosed with a reduction to Grade 2, and 39 (77 %) of 51 patients with Grade 2 disease were diagnosed with a reduction to Grade 1. The frequency of recurrence of hemorrhoidal disease over 2 years of observation was only 5 % [15].

Table 2. Analysis of the causes of hemorrhoid recurrence after laser submucosal destruction (Patient 2)

Таблица 2. Анализ причин развития рецидива геморроя после лазерной подслизистой деструкции (Пациент 2)

Hemorrhoidal node at 11 o'clock point ***Геморроидальный узел на 11 часах***	**Anoscopy** ***Аноскопия***	**Transrectal ultrasound** ***ТРУЗИ***	**Doppler flow imaging and spectral analysis, cm/s** ***Спектрально-волновая доплерография, см/с***	**Total score on the scoring scale** ***Сумма баллов по шкале балльной оценки***	**Amount of energy transmitted** ***Количество переданной энергии***
Before surgery *До операции*	Hemorrhoidal node with a length of 19 mm *Геморроидальный узел протяженностью 19 мм*	Cavernous tissue area 1.33 cm^2 *Площадь кавернозной ткани 1,33 $см^2$*	*Vp* = 11,4 *Vd* = 3,6 *Vm* = 6,1	18	105 J *105 Дж*
In 1 month *Через 1 месяц*	Cavernous tissue not identified *Кавернозная ткань не определяется*	Cavernous tissue not identified *Кавернозная ткань не определяется*	*Vp* = 0 *Vd* = 0 *Vm* = 0	0	
In 3 months *Через 3 месяца*	Cavernous tissue not identified *Кавернозная ткань не определяется*	Cavernous tissue not identified *Кавернозная ткань не определяется*	*Vp* = 0 *Vd* = 0 *Vm* = 0	0	
In 6 months *Через 6 месяцев*	Cavernous tissue not identified *Кавернозная ткань не определяется*	Cavernous tissue not identified *Кавернозная ткань не определяется*	*Vp* = 0 *Vd* = 0 *Vm* = 0	0	
In 12 months *Через 12 месяцев*	Cavernous tissue not identified *Кавернозная ткань не определяется*	Cavernous tissue not identified *Кавернозная ткань не определяется*	*Vp* = 0 *Vd* = 0 *Vm* = 0	0	
In 18 months *Через 18 месяцев*	An area of residual cavernous tissue measuring 4 mm in length *Остаточная кавернозная ткань протяженностью 4 мм*	Cavernous tissue area 0.12 cm^2 *Площадь кавернозной ткани 0,12 $см^2$*	*Vp* = 5,4 *Vd* = 0,2 *Vm* = 2,3	6	

Note: *Vp — peak systolic velocity; Vd — end diastolic velocity; Vm — mean velocity.*

Примечание: *ТРУЗИ — трансректальное ультразвуковое исследование; Vp — пиковая систолическая скорость; Vd — конечная диастолическая скорость; Vm — средняя скорость.*

Similar results of the HeLP technique were described in a publication by P. Giamundo et al. This study also used a laser with a wavelength of 1470 nm. The overall effectiveness of the method was 93 % (158/170 patients) with an average follow-up period of 37 (12–76) months [5].

To perform laser hemorrhoidoplasty at the very beginning of the development of the LHP technique, a diode laser with a wavelength of 980 nm was used. The immediate and long-term results of surgery performed with this laser were described in a paper by A. Jahanshahi et al. Based on the results of observing 341 patients with Grade 2–3 hemorrhoids who underwent surgery using this technique, postoperative complications were noted in a total of 3.51 % of patients and included swelling of external hemorrhoidal nodes (8 patients; 2.34 %), bleeding (2 patients; 0.58 %), and abscess (2 patients; 0.58 %). During the 1-year observation period, no recurrences of the disease were noted [16].

L. Brusciano et al. suggested using a diode laser with a wavelength of 1470 nm for laser hemorrhoidoplasty, noting its advantages in terms of reducing the penetration capacity into surrounding tissues to 2 mm. The authors conducted

a study involving 50 patients with Grade 2–3 hemorrhoids, which showed that no one had any significant intraoperative complications or recurrence of the disease during the 8.6-month follow-up period [17].

M.F. Ferhatoglu et al. analyzed the treatment experience of 47 patients with Grade 2–3 hemorrhoids who underwent laser destruction using a diode laser with a wavelength of 1470 nm. One year after surgery, a recurrence of symptoms such as bleeding was noted in 14.9 % of patients and prolapse of hemorrhoidal nodes – in 21.3 % of patients [7].

According to the results of a randomized study by C. Gambardella, during an average observation period of 25 months, recurrence of hemorrhoidal disease was detected in 21.6 % of patients who underwent laser destruction of internal hemorrhoids using a diode laser with a wavelength of 1470 nm, compared with 8.1 % of patients who underwent Milligan – Morgan hemorrhoidectomy [18].

Recently, physicists have established that the use of short-wave lasers in high-power mode leads to a fairly high frequency of complications. Therefore, we conducted the first study in which we used a laser with a long wavelength of 1940 nm and a low power of 7 W to perform laser submucosal destruction.

Conclusion

Thus, laser submucosal destruction of internal hemorrhoidal nodes using a laser with a wavelength of 1940 nm is a minimally invasive method for treating Grade 2–3 hemorrhoidal disease, which has demonstrated high efficacy in the long term after surgery. According to the results of our study, the return of clinical manifestations of hemorrhoidal disease was detected in only 2 patients after 18 and 24 months. Initially, during the initial consultation, these patients were diagnosed with Grade 3 and Grade 2 disease, respectively. After the operation, the main complaints reported by the patients before the intervention disappeared. Eighteen and 24 months after laser destruction, the above patients noted a recurrence of clinical manifestations of hemorrhoidal disease, which was accompanied by a deterioration in the indicators during instrumental examination. The appearance of cavernous tissue islands and an increase in blood flow velocity in the terminal branches of the superior rectal artery were noted during with Doppler imaging. A repeat laser destruction procedure achieved good results in these patients. We also determined the optimal amount of laser energy required to achieve the maximum effect of the intervention and minimize the risk of complications.

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