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MODERN LASER TECHNOLOGIES IN THE TREATMENT OF HEMORRHOIDS (LITERATURE REVIEW)

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Summary. Hemorrhoids are one of the most common anorectal diseases, often requiring surgical intervention. Milligan–Morgan hemorrhoidectomy remains the gold standard of the surgical treatment, but is associated with significant postoperative pain and complications. Modern laser technologies, especially diode-based systems, have become a minimally invasive alternative with favorable results.

Aim. To summarize and analyze the current literature on modern laser technologies in the treatment of hemorrhoids, paying special attention to surgery techniques, clinical results and complications.

Materials and methods. A literature search was conducted in PubMed, Google Scholar, and eLIBRARY for studies published before August 2025. Acceptable publications were clinical trials, original research, and a series of laser intervention cases. When extracting the data, the type of laser, wavelength, treatment protocol, patient characteristics, outcomes, and complications were taken into account.

Results. Two main laser approaches have been identified: hemorrhoidal laser procedure and laser hemorrhoidoplasty. Hemorrhoidal laser procedure, typically employing diode laser with Doppler guidance, achieved high effectiveness (84–91%) with minimal pain and low complication rates. The laser hemorrhoidoplasty, using diode lasers at 980, 1470, or 1560 nm, showed advantages over traditional hemorrhoidectomy, including reduced postoperative pain, shorter hospitalization, and quicker recovery. Comparative studies confirmed lower complication rates and higher satisfaction, though recurrence rates (5–28%) remained notable, especially in advanced stages. Recent studies suggest that combining laser hemorrhoidoplasty with mucopexy or desarterization improves long-term outcomes and reduces recurrence.

Conclusion. Diode-based laser technologies represent an effective, minimally invasive alternative to traditional hemorrhoidectomy, improving recovery and reducing complications. However, recurrence in advanced disease, the high cost of equipment and the need for specialized training limit wider use. Multicenter studies are necessary to develop standardized treatment protocols and optimize patient selection.

Key words: hemorrhoids, laser, desarterization, hemorroidoplasty, Milligan-Morgan hemorrhoidectomy.

СОВРЕМЕННЫЕ ЛАЗЕРНЫЕ ТЕХНОЛОГИИ В ЛЕЧЕНИИ ГЕМОРРОЯ (ОБЗОР ЛИТЕРАТУРЫ)

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Резюме. Геморрой – одно из наиболее распространенных аноректальных заболеваний, часто требующее хирургического вмешательства. Геморроидэктомия Миллигана-Моргана остается золотым стандартом оперативного лечения, но связана со значительными послеоперационными болями и осложнениями. Современные лазерные технологии, особенно системы на основе диодов, стали малоинвазивной альтернативой с благоприятными результатами.

Цель: обобщить и проанализировать текущую литературу по современным лазерным технологиям в лечении геморроя, уделяя особое внимание методике операций, клиническим результатам и осложнениям.

Материалы и методы. Был проведен поиск литературы по исследованиям, опубликованным до августа 2025 года в базах данных PubMed, Google Scholar и eLIBRARY. Приемлемыми публикациями были клинические испытания, оригинальные исследования и серия случаев лазерных операций. При извлечении данных учитывались тип лазера, длина волны, протокол лечения, характеристики пациента, исходы и осложнения.

Результаты. Были определены две основные лазерные методики: лазерная процедура при геморрое и лазерная геморроидопластика. Лазерная процедура, при которой используется диодный лазер и допплеровский датчик, обеспечивает высокую эффективность (84-91%) при минимальном болевом синдроме и низком уровне осложнений. Лазерная геморроидопластика с использованием диодных лазеров с длиной волны 980, 1470 или 1560 нм продемонстрировала преимущества перед традиционной геморроидэктомией, включая уменьшение послеоперационной боли, сокращение сроков госпитализации и более быстрое восстановление. Сравнительные исследования подтвердили более низкую частоту осложнений и более высокую удовлетворенность, хотя частота рецидивов (5-28%) оставалась значительной, особенно при поздних стадиях заболевания. Недавние исследования показывают, что сочетание лазерной геморроидопластики с мукопексией или дезартеризацией улучшает отдаленные результаты и уменьшает количество рецидивов.

Вывод. Операции на основе использования диодных лазеров представляют собой эффективную, малоинвазивную альтернативу традиционной геморроидэктомии, улучшающую восстановление и снижающую количество осложнений. Однако рецидивы при запущенных стадиях заболевания, высокая стоимость оборудования и необходимость специализированного обучения ограничивают их более широкое применение. Многоцентровые исследования необходимы для разработки стандартизированных протоколов лечения и оптимизации отбора пациентов.

Ключевые слова: геморрой, лазер, дезартеризация, геморроидопластика, геморроидэктомия Миллиган-Моргана.

ГЕМОРРОЙДУН ДАРЫЛООСУНДА ЗАМАНБАП ЛАЗЕРДИК ТЕХНОЛОГИЯЛАР (АДАБИЯТТАРГА СЕРЕП)

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Резюме. Геморрой – аноректалдык оорулардын бири жана көп учурда операцияны талап кылган оору. Миллиган-Морган геморроидэктомиясы операциялык дарылоонун алтын стандарты бойдон калууда, бирок андан кийинки олуттуу оору жана кабылдоолор менен байланышта. Заманбап лазердик технологиялар, өзгөчө диоддун негизиндеги системалар, жагымдуу натыйжалары менен минималдуу инвазивдүү альтернатива катары болуп калышты.

Максат. Операциялардын ыкмалары, клиникалык натыйжалар жана кабылдоолорго өзгөчө маани берип, геморройдун дарылоосунда заманбап лазердик технологиялар боюнча учурдагы адабият булактарын жалпылоо жана талдоо.

Материалдар жана ыкмалар. 2025-жылдын август айына чейин жарыяланган изилдөөлөр боюнча адабияттарды издөө жүргүзүлдү. Клиникалык сыноолор, оригиналдуу изилдөөлөр жана лазердик операциялардын сериясы алгылыктуу басылмалар болгон. Лазердин түрү, толкун узундугу, дарылоо протоколу, бейтаптын мүнөздөмөлөрү, натыйжалар жана кабылдоолор маалыматтарды алууда эске алынган.

Натыйжалар. Дарылоодо эки негизги лазердик ыкма аныкталган: геморройдо колдонулган лазердик процедура жана лазердик геморроидопластика. Диоддук лазер жана доплер өткөргүч менен жасалган геморройдо колдонулган лазердик процедура жогорку натыйжалуулукту (84-91%) аз оору жана кабылдоолордун төмөн деңгээли менен камсыз кылат. 980, 1470 же 1560нм толкун узундугу менен диоддук лазерлерди колдонгон лазердик геморроидопластика салттуу геморроидэктомияга караганда артыкчылыктарды көрсөттү, анын ичинде операциядан кийинки оорунун азайуусу, ооруканага жатуу мөөнөтүнүн кыскаруусу жана бейтап калыбына тезирээк келүүсү. Салыштырмалуу изилдөөлөр кабылдоолордун төмөн жыштыгын жана жогорку канааттануунуу тастыкташты, бирок айрыкча оорунун кеч стадиясында рецидивдин деңгээли (5-28%) олуттуу бойдон калууда. Акыркы изилдөөлөр көрсөткөндөй, лазердик геморроидопластиканы мукопексия же дезартеризация менен айкалыштыруу узак мөөнөттүү натыйжаларды жакшыртат жана рецидивдерди азайтат.

Жыйынтык. Диоддук лазерлерге негизделген операциялар салттуу геморроидэктомияга натыйжалуу, минималдуу инвазивдүү альтернатива болуп, бейтаптын калыбына келүүсүн жакшыртат жана кабылдоолорду азайтат. Бирок, оорунун күчөп кеткен стадияларында пайда болгон рецидивдер, жабдуулардын кымбаттыгы жана атайын окутуунун зарылдыгы алардын кеңири колдонулушун чектейт. Көп борборлуу изилдөөлөр стандартташтырылган дарылоо протоколдорун иштеп чыгуу жана пациенттерди тандоону ылайыкташтыруу үчүн зарыл.

Негизги сөздөр: геморрой, лазер, дезартеризация, геморроидопластика, Миллиган-Морган геморроидэктомиясы.

Introduction. Hemorrhoidal disease is among the most frequent anorectal disorders, and population studies suggest that as many as eight in ten adults will experience symptoms at some point in their lives. Of these, roughly half may eventually require some form of surgical management [1,2]. The problem is particularly pronounced in industrialized countries, where sedentary work patterns, low-fiber diets, and longer life expectancy have driven rates to what some researchers describe as near-epidemic levels [3]. It tends to affect people during their most productive years, and repeated episodes of pain, bleeding, or prolapse can lead to substantial periods of disability. For these reasons, hemorrhoidal disease is not only a clinical concern but also a public health and socio-economic issue that continues to demand better, less debilitating treatment options [4,5].

The traditional Milligan–Morgan open hemorrhoidectomy, described in 1937, remains the "gold standard" of surgical treatment, especially in stages III–IV of the disease [6, 7]. At the same time, this method is associated with a high intensity of postoperative pain, bleeding, urinary retention, and in the long term, the risk of fecal incontinence, fistula formation, and strictures of the anal canal [8,9,10]. Due to concerns about postoperative pain and the risk of complications, a significant proportion of patients with a relatively mild course of the disease postpone surgical intervention [11,12].

That is why recently minimally invasive methods of treatment (rubber band ligation, injection sclerotherapy, harmonic scalpel hemorroidectomy, and desarterization of hemorrhoids) have become increasingly important in the treatment of hemorrhoids [13,14,15]. The advantages of these methods include the low intensity of pain, the absence of the need for hospitalization or a shorter hospital stay, and the absence of wounds in the anal canal, which ultimately reduces the patient's rehabilitation time [16,17]. However, the use of minimally invasive methods, unlike hemorrhoidectomy, makes it possible to influence only one of the pathogenesis factors of hemorrhoids (mechanical or vascular) [18,19,20].

One of the modern and relevant directions in the treatment of hemorrhoids is the use of laser technologies. The radiation that surgical lasers emit works mostly by heating up the tissue. This process happens when light quanta are absorbed, which changes optical energy into heat. In a small area, very high temperatures can be reached, which quickly evaporates fluids inside and between cells and causes the targeted tissue to die by coagulation necrosis [21].

For certain tissues to selectively absorb laser radiation, the wavelength must match the primary chromophore that is present. Hemoglobin and melanin are the main chromophores in human tissue. They both absorb a lot of light at wavelengths up to about 600 nm. Water, on the other hand, absorbs best at wavelengths higher than 1150 nm. Several authors have indicated that, beyond this threshold, water emerges as the predominant chromophore, and the penetration depth of laser radiation in tissues correspondingly decreases [22,23,24].

A variety of laser systems have been used in surgical practice, including diode, neodymium-doped yttrium aluminum garnet (Nd:YAG), argon, and CO_2 lasers. Nd:YAG, argon, and CO_2 lasers have

shown some benefits, but their use in clinics has been limited by several factors [25]. Nd:YAG and argon lasers are effective for coagulation but have deep penetration, which raises the risk of damaging nearby tissues [26]. CO_2 lasers can effectively remove hemorrhoids, but they have limited ability to control bleeding and need complex, costly equipment [27]. Additionally, all three systems have high operating costs and bulky instruments, which makes them less practical for routine proctological practice.

Today, these older systems are not widely used for treating hemorrhoids. Instead, diode lasers have become popular due to their flexibility and good physical properties [2]. With a wide range of available wavelengths, diode lasers can be adjusted to target specific chromophores. This feature allows them to focus on various tissues and organs while minimizing damage to surrounding areas [21]. Their compact design, low maintenance costs, and compatibility with minimally invasive procedures have made diode lasers the preferred option in modern proctological surgery [28].

Aim of work. This review aims to summarize and critically analyze the current literature on modern laser technologies in the treatment of hemorrhoids, with emphasis on procedural techniques, clinical outcomes, and complications.

Materials and methods. The literature review was conducted by searching the PubMed, Google Scholar, and eLIBRARY databases. The search covered publications available until August 2025 and focused on research on the use of laser technology in the treatment of hemorrhoids. Keywords and their combinations include “hemorrhoids”, “laser treatment”, “diode laser”, “laser hemorrhoidoplasty” and “hemorrhoidal laser procedure”. The logical operators (“AND”, “OR”) were used to refine the results and expand the search area where appropriate.

The inclusion criteria were original scientific articles, clinical trials, and corresponding clinical case series on laser interventions for hemorrhoids. The studies were selected regardless of the language, provided that the abstract was available in English or Russian. Publications devoted exclusively to non-laser treatments, animal models, or unrelated anorectal pathologies were excluded.

The titles and annotations of all received articles were checked for relevance, after which a full-text review of the relevant research was presented. Data extraction provided detailed information about the type of laser used, wavelength, treatment protocol, patient population, clinical outcomes, postoperative recovery, and reported complications. Priority was given to research with a well-defined methodology and outcome indicators, as well as research comparing laser techniques with traditional surgical approaches.

Results. A review of the existing literature reveals that modern laser techniques for treating hemorrhoidal disease can be primarily categorized into two major types: hemorrhoidal laser procedure and laser hemorrhoidoplasty.

In 2009, Salfi et al. described and applied the hemorrhoidal laser procedure technique in 200 patients. The hemorrhoidal laser procedure is a method of intraoperative localization of the feeding branches of the rectal artery, utilizing a Doppler probe and a laser to block arterial inflow by desarterization. A specially designed disposable proctoscope was inserted into the rectum, where a small window with a Doppler sensor is located in the distal part. Using a Doppler sensor (20 MHz probe, 3 mm in diameter), the location of the terminal branches of the superior rectal artery was determined 3 cm proximal to the dentate line. The Doppler sensor was replaced with a laser light guide. The use of a diode laser with a wavelength of 980 nm (pulse mode, 15-30 J each, for a total of about 60-120 J at a power of 10-25 Watts). The operation lasted 15 minutes. The effectiveness of this method was estimated at 12 months and amounted to 91% [29].

Ram et al. report on the treatment of 62 patients with stage 2-3 hemorrhoids using a diode laser with a wavelength of 980 nm. Two days after the operation, 88.7% of the patients were able to resume their usual activities, and 6 months later, there was no recurrence of the disease in any case [30]. Boarini et al. described their experience treating 55 patients with the hemorrhoidal laser procedure method, which also uses a 980 nm diode laser. The overall satisfaction rate was 89%, and disappearance of hemorrhoidal symptoms was observed in 84% of the patients. It should be noted that a diode laser with a wavelength of 980 nm was used in both studies [31].

Giamundo et al. described the experience of treating hemorrhoids using the hemorrhoidal laser procedure technique in a multicenter study. The study included 284 patients whose conservative treatment proved ineffective. The procedure was performed on an outpatient basis, mostly without anesthesia, and demonstrated high efficiency: at the 6-month follow-up, symptoms disappeared in 90.5% of patients, and 96.8% were satisfied with treatment. With a longer follow-up (12 months), the positive outcome persisted in 90.3% of patients. Complications were rare and mostly mild. Intraoperative bleeding, which occurred in 8.8% of patients, was mostly managed without serious consequences. In the early postoperative period, bleeding, a feeling of incomplete emptying, and anal spasm were noted, but they were short-lived and stopped by conservative treatment [32].

Nardi et al. described the experience of 51 patients using the hemorrhoidal laser procedure technique

using an optical fiber diode laser with a wavelength of 980 nm (five pulses of 13 watts of 1.2 s each with a pause of 0.6 s). Within 24 months after surgery, the effectiveness was 84.3% [33].

Crea et al. analyzed the results of using hemorrhoidal laser procedure in a prospective study of 97 patients with grade II and III hemorrhoidal disease and minimal or moderate mucosal prolapse. The average follow-up period was 15 months. There were no significant intraoperative complications. Most patients experienced no pain syndrome after the intervention, and no cases of painful bowel movements or tenesmus were noted. After 3-6 months, there was a 76-79% decrease in the frequency of the main symptoms (bleeding, pain, itching, acute hemorrhoidal episodes). A decrease in the degree of hemorrhoids was observed in more than 85% of patients. Recurrence of the disease after 2 years was noted in only 5% of patients, which confirmed the effectiveness and safety of the method [34]. In a later study (2021), which included 189 patients with grade II–III hemorrhoids, the results were monitored for a median of 42 months (up to 5 years). Postoperative pain was absent in 94% of patients; there were no cases of stenosis or dysfunction of the anal canal. A significant improvement in symptoms and a decrease in the degree of the disease was noted by 3-6 months and persisted throughout the entire follow-up period. Complete disappearance of hemorrhoids after one year was registered in more than 60% of patients. More than 90% rated the outcome as a "significant improvement" on the PGI-I scale. Relapses or persistent symptoms were rare, occurring in about 10% of cases. Only a few patients required repeated surgery [35].

Laser hemorrhoidoplasty is one of the methods of laser technology. This technique involves the dosed, interstitial heating of the hemorrhoidal node using laser radiation delivered by a light guide fiber. This process leads to subsequent sclerosis and an occlusive effect on the vascular component. The characteristics of the laser radiation, such as wavelength and duration of exposure, determine the effect. This can range from coagulation to vaporization of the cavernous tissue in the contact zone with the fiber's working part. With this technique, despite the thermal effect on the cavernous node tissue, the rectal mucosa and the structure of the anal sphincter are not damaged. Furthermore, the replacement of cavernous tissue with connective tissue and its fixation to the rectal mucosa prevent prolapse [36].

One of the first studies devoted to the use of laser hemorrhoidoplasty is the work of Karahaliloglu (2007). The author used a Ceralas D15 ELVeS diode laser device (Biolitec AG, Jena, Germany) with a wavelength of 980 nm. The study included 106 patients with stage I–II hemorrhoids. According to the one-year follow-up data, the overall treatment success rate was 88.7%. Specifically, bleeding was eliminated in 97.5% of patients, and nodular prolapse was relieved in 68.8%. Only isolated and minor complications were noted: two patients (1.9%) developed a submucous hematoma that did not require intervention, and one patient (0.9%) had mucosal damage that was resolved with ligation [37].

In 2012, Jahanshahi et al. published the results of treating 341 patients who had undergone laser destruction of hemorrhoids using a diode laser with a wavelength of 980 nm. According to this study, good results were obtained in 94% of patients. Complications occurred in 3.5% of cases, and recurrence was noted in only 5.8% of patients [38].

Maloku et al. conducted a study that included 200 patients with stage III hemorrhoids: 100 were treated with laser hemorrhoidoplasty, and 100 with Milligan–Morgan hemorrhoidectomy. For the laser treatment, a Bio-Litec diode laser (Bonn, Germany) with a wavelength of 980 ± 30 nm and a power of 8-15 W in pulsed mode was used. The average Visual Analogue Scale pain level on day 1 was 2.2 in the laser hemorrhoidoplasty group and 4.5 in the Milligan–Morgan hemorrhoidectomy group ($p < 0.0001$), and the incidence of bleeding in the first days was lower in laser hemorrhoidoplasty (13% vs. 77%; $p < 0.0001$). The average duration of surgery was 15.9 min for laser hemorrhoidoplasty and 27.2 min for Milligan–Morgan hemorrhoidectomy ($p < 0.0001$), and the average time to return to normal life was 17.2 and 19.2 days, respectively ($p < 0.003$). The length of hospitalization was also shorter in the laser hemorrhoidoplasty group [39].

According to Mohammed et al., 1,000 patients were included in the study: 500 underwent traditional Milligan–Morgan hemorrhoidectomy and 500 underwent laser hemorrhoidoplasty using a diode laser with a wavelength of 980 nm. The authors showed that the frequency of postoperative complications in the laser intervention group was lower. Specifically, infectious complications and the severity of pain were much less common, and anal stenosis and fecal incontinence were not recorded. In the traditional hemorrhoidectomy group, on the contrary, anal stenosis occurred in 6% of patients, fecal incontinence in 1.6%, and urinary retention in 1.4%. During the three-year follow-up period, there were no recurrence after laser treatment, whereas after traditional surgery they were noted in 9% of patients [40].

In the laser hemorrhoidoplasty method for the treatment of hemorrhoids, laser devices with a wavelength of 1470 and 1560 nm were most often used as an energy source, allowing for the

denaturation of submucosal proteins, causing fibrosis and, thereby, adhesion of the mucous membrane to the underlying tissue to prevent prolapse [16,41,42].

In 2020, Danys et al. published an experimental study on the extent of laser exposure when using a diode laser with a wavelength of 1470 nm, with powers of 6, 8, and 10 watts and pulse durations of 1, 2, and 3 seconds, respectively. The results showed that using 8 watts of power with a 3-second pulse duration leads to a coagulation depth of up to 4 mm. Therefore, the next exposure should be at a distance of approximately 5 mm from the previous installation location of the working part of the light guide [43].

A group of German authors led by Weyand presented the results of laser hemorrhoidoplasty using a diode laser with a wavelength of 1470 nm in 497 patients. In the long term, complete recovery and symptom disappearance were noted in 86% of cases [44].

Brusciano et al. presented their experience treating 50 patients with stage 2-3 hemorrhoidal disease using the laser hemorrhoidoplasty technique and a diode laser with a wavelength of 1470 nm. The patients were discharged the day after surgery due to the absence of postoperative complications and the presence of tolerable pain. According to the author, no intraoperative complications were detected, and the pain, assessed on a 10-point Visual Analogue Scale a day after the operation, was 2 points. All patients were able to resume daily activities 2 days after surgery. With a follow-up period of 8.6 months, no disease relapses were detected in any patient [45].

A study conducted in 2023 by Dursun et al. showed that laser hemorrhoidoplasty is an effective minimally invasive treatment for stage II–III hemorrhoids, offering rapid recovery and a low rate of complications. The study included 103 patients: the average duration of surgery was 17.9 minutes, the return to daily activity occurred after 2.2 days, and complications were noted in only 2.9% of patients. The recurrence rate was 17.6% for stage II–III hemorrhoids and 50% for stage IV hemorrhoids ($p = 0.019$), which indicates a decrease in the method's effectiveness for more severe cases. The authors concluded that laser hemorrhoidoplasty can be considered a safe alternative to traditional interventions for stage II–III hemorrhoids; however, additional methods such as mucopexy or repeated surgeries are needed for stage IV cases [46].

In a retrospective study by Kavraal et al., the effectiveness of hemorrhoidal laser ablation using a 1470 nm diode laser in patients with stage II-IV hemorrhoids was analyzed. The technique consisted of inserting a radial fiber through minimal incisions to affect the cavernous plexuses, which ensured their coagulation and subsequent volume reduction. Significant clinical improvement was noted in patients with stage IV: after 2-6 weeks, a decrease in prolapse was observed, and by six months, most cases had progressed to lower stages of the disease. The overall effectiveness of the intervention reached 95%, which makes this method comparable and, in some cases, more preferable to traditional operations. Complications were extremely rare: one instance of bleeding (0.7%) and short-term postoperative complaints were noted, while no severe complications were reported. The long-term results showed a low recurrence rate of 0.8% in the early period and 5% during the five-year follow-up [47].

According to the findings of Nagoti et al., laser hemorrhoidoplasty is characterized by a shorter duration of surgery compared with traditional hemorrhoidectomy. Surgery times averaged 15 ± 2.3 min for laser hemorrhoidoplasty versus 27 ± 3.7 min for hemorrhoidectomy ($p < 0.001$). The average duration of hospitalization after laser hemorrhoidoplasty was also significantly lower—1.3 ± 0.7 days versus 3.8 ± 1.2 days ($p < 0.001$). The severity of pain, as measured by the Visual Analogue Scale, was significantly lower in the laser hemorrhoidoplasty group at all follow-up periods ($p < 0.0001$). Patients who underwent laser hemorrhoidoplasty returned to regular activity much faster - after 6.8 ± 1.4 days compared with 13.6 ± 2.8 days for those who had an open hemorrhoidectomy ($p < 0.001$) [48]. Patel made similar conclusions, noting that the severity of pain was lower after laser hemorrhoidoplasty compared with open hemorrhoidectomy on follow-up days 1, 3, and 7. Patients in the laser hemorrhoidoplasty group also returned to daily activity sooner—after 4.2 ± 1.3 days versus 9.6 ± 2.1 days for the open surgery group ($p<0.001$). Postoperative complications such as urinary retention were observed in 3.3% of laser hemorrhoidoplasty patients versus 16.7% in the control group. Furthermore, secondary bleeding and infection were observed only in the open hemorrhoidectomy group [49].

While laser technologies are highly effective for treating hemorrhoids, the risk of recurrence remains quite high for stage III disease, especially when there is pronounced prolapse and significant mucosal overgrowth of internal hemorrhoids. The literature shows that the frequency of recurrence in the postoperative period reaches 9-28%, and its detection correlates with the duration of patient follow-up [50,51,52]. In this regard, combined techniques that integrate laser hemorrhoidoplasty with elements of traditional surgical interventions (like mucopexy or desarterization) are becoming more widespread.

In a study by Shakhray, submucous laser destruction of hemorrhoids was performed using a Mediola-Compact device (Belarus) with a 1560 nm wavelength, combined with ligature mucopexy.

Compared with traditional hemorrhoidectomy, the study showed a decrease in the intensity of pain after the first bowel movement, a reduced recovery period of 3-4 days, and a shorter hospitalization of just one day. Postoperative complications were observed in 87% of patients after traditional surgery, versus only 18% with the combined technique [53].

Yanar et al. studied a combination of laser hemorrhoidoplasty and Ferguson hemorrhoidectomy. They conducted a comparative analysis of 154 patients divided into three groups: one with the combined technique, one with isolated laser hemorrhoidoplasty, and one with Ferguson hemorrhoidectomy. With a follow-up period of at least two years, the results showed that the combined technique was superior due to a lower incidence of postoperative complications and disease recurrence [54].

Abdelhamid et al. found that a laser hemorrhoidoplasty combined with blind hemorrhoidal artery ligation was superior to traditional hemorrhoidectomy. This was demonstrated by significantly lower postoperative pain (3-4 vs. 6 points by numerical rating scale), a faster recovery time (5 vs. 18 days), and better tolerability. While the overall incidence of complications was comparable, urinary retention was observed exclusively after classical surgery. Furthermore, no recurrence was detected within the one-year follow-up period [55].

Cherepenin et al. proposed a new combined method for hemorrhoids treatment. To reduce the risk of postoperative bleeding, ligation of the vascular pedicle of internal hemorrhoids was performed at 3-5 hours, 7-9 hours, and 11 hours according to a conventional clock. Next, the distal edge of the internal hemorrhoidal node was perforated by the end light guide of a laser device. Laser radiation from a diode device with a wavelength of 1560 nm and a power of 10 W was used in a 0.5 sec on/0.5 sec off pulse mode. The light guide was carried to the proximal part of the node, and the submucosal destruction of hemorrhoidal tissue was performed sequentially with visual control of the pilot light marker. In the presence of significantly enlarged internal hemorrhoids and prolapse of the mucous membrane of the anal canal, mucopexy was performed. In the presence of pronounced external hemorrhoids, they were removed using monopolar electrocoagulation. In a study of 215 patients, this technique resulted in a low level of pain, a short hospitalization period, and a low rate of complications (1.4% had long-term non-healing wounds). No recurrence was registered within the year, confirming the technique's high effectiveness and safety [56].

Conclusion. Modern laser technologies in the treatment of hemorrhoids have proven to be a promising area in coloproctology. Based on the literature analysis, a number of advantages of this method can be identified in comparison with traditional surgical procedures. Firstly, laser techniques are characterized by less injury and a shorter rehabilitation period. This is due to the pinpoint effect of the laser's energy, which minimizes damage to surrounding tissues. Second, there is a decrease in the intensity of pain in the postoperative period, which directly improves patients' quality of life.

Nevertheless, some researchers point to certain limitations of using laser techniques. In particular, despite their minimal invasiveness, the risk of recurrence remains. This is likely due to the individual characteristics of the disease and its stage at the time of intervention. In addition, the high cost of equipment and the need for specialized surgical training may limit the widespread adoption of these technologies, especially in institutions with limited resources. Thus, laser techniques can be considered an important addition to the arsenal of proctologic surgery. In the future, multicenter clinical trials are needed to develop standardized treatment protocols that account for the individual approach to patients, the stage of the disease, concomitant pathologies, and the technical capabilities of the clinic.

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