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OPTIMIZATION OF SURGICAL TREATMENT OF VARICOCELE BASED ON AN INDIVIDUALIZED APPROACH AND IMPLEMENTATION OF MINIMALLY INVASIVE TECHNOLOGIES

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Summary.

Varicocele is one of the most common causes of male infertility and is diagnosed in approximately 15% of the general male population and up to 35% of men with primary infertility. The search for effective and minimally traumatic surgical approaches remains a relevant problem in modern urology and andrology.

Objective. *To evaluate the clinical effectiveness and safety of modern minimally invasive surgical techniques for varicocele treatment using an individualized approach based on the hemodynamic type of venous reflux.*

Materials and Methods. *A retrospective study included 127 patients with left-sided varicocele who underwent surgical treatment between 2019 and 2024 at the Samarkand branch of the Republican Specialized Scientific and Practical Medical Center of Cardiology. Patients were divided into two groups depending on the surgical technique. The comparison group (n=59) underwent traditional operations (Ivanissevich or Palomo), while the main group (n=68) received minimally invasive treatment including endovascular laser ablation of the left testicular vein and microsurgical Marmaraa varicocelectomy. The study was carried out in compliance with the provisions of the World Medical Association's Declaration of Helsinki (2013). The study protocol was reviewed and approved by the local ethics committee of Samarkand State Medical University (No. 079, 2024). All patients were informed of the aims and methods of the study and signed a voluntary informed consent form to participate in the study and undergo surgical treatment. The confidentiality of patients' personal data was fully maintained at all stages of the study. Statistical analysis of the data was performed using methods of variational statistics, employing the SPSS Statistics software package (version 26.0) and Microsoft Excel. Quantitative indicators are presented as mean values (M) and standard deviation (±SD). This work was carried out as part of the research project «Improving methods of diagnosis and surgical treatment of diseases of the genitourinary system using modern minimally invasive technologies», conducted at the Department of Surgery, Endoscopy and Anaesthesiology-Resuscitation of the Faculty of Postgraduate Education at Samarkand State Medical University. Research project duration: 2022-2026.*

Results. *Implementation of minimally invasive technologies significantly reduced postoperative complications from 18.6% to 2.9% and recurrence rate from 19.0% to 3.6%. In addition, patients demonstrated improved clinical outcomes and shorter recovery time. The obtained results confirm that the integration of modern minimally invasive technologies with an individualized hemodynamic approach significantly improves the effectiveness of varicocele treatment. These findings support the feasibility of wider implementation of such methods in clinical practice for the management of varicocele in adolescents and young men.*

Conclusion. *Minimally invasive techniques combined with individualized surgical strategy based on hemodynamic reflux type significantly improve treatment outcomes and reduce recurrence of varicocele.*

Keywords: *Varicocele; Endovascular Laser Ablation; Marmaraa Technique; Minimally Invasive Surgery; Venous Reflux.*

Introduction

Varicocele is one of the leading causes of male infertility: according to international meta-analyses, varicocele is found in approximately 15% of healthy men and in up to 35% of men with primary infertility [1, 2]. It has been proven that surgical or endovascular treatment of varicocele can lead to a significant improvement in sperm analysis parameters and an increased likelihood of pregnancy [3, 4].

In the United States and other countries, minimally invasive approaches (microsurgical, embolization, laser) are highly valued because they are associated with fewer complications and a shorter recovery period, especially in patients with higher grades of varicocele [5, 6]. According to data from the American Urological Association and the American Society for Reproductive Medicine, microsurgical varicocelectomy remains the gold standard for the treatment of clinically significant varicocele associated with impaired spermatogenesis [7, 8].

In European countries, varicocele is also considered an important medical and social problem affecting male reproductive health. Large epidemiological studies conducted in Italy, Germany, and France demonstrate that the prevalence of varicocele among adolescents and young men ranges from 10% to 20%, with a significant association between varicocele severity and deterioration of semen parameters. European clinical guidelines emphasize the importance of early diagnosis and timely surgical correction to prevent progressive testicular damage and infertility [9, 10, 11].

In Ukraine, the problem of varicocele remains highly relevant in pediatric and adolescent surgery. According to national clinical observations, varicocele is one of the most common surgical diseases among adolescent boys

and is diagnosed in approximately 12-18% of cases during preventive examinations [12, 13]. Ukrainian specialists note that late diagnosis and the use of traditional surgical approaches are often associated with recurrence and postoperative complications, which necessitates the introduction of modern minimally invasive treatment technologies [14, 15].

In China, numerous clinical and epidemiological studies have confirmed the high prevalence of varicocele among young men, particularly among patients seeking treatment for infertility [16]. Chinese researchers report that the incidence of varicocele in infertile men may reach 40%, highlighting the need for effective treatment strategies and improved diagnostic methods [17]. In recent years, Chinese surgical centers have increasingly adopted minimally invasive approaches, including microsurgical techniques and endovascular interventions, demonstrating favorable clinical outcomes and lower recurrence rates [18, 19].

In Uzbekistan, varicocele also represents a significant reproductive health problem for adolescents and young men. Surveys and studies in Samarkand indicate that the incidence of varicocele among adolescents is approximately 15% of men over the age of 11, with the condition being particularly common in the 14-16 age group [20]. Furthermore, experience shows that traditional surgical treatment methods in some cases fail to provide satisfactory radical treatment and are accompanied by a relatively high rate of recurrence and complications [21].

Given the large number of young patients and the potential impact on fertility and psychological well-being, the search for modern, safe, and effective methods for varicocele treatment in Uzbekistan is of great practical value [22]. Reducing complications and recurrence, as well as improving sperm quality, remain pressing issues, particularly when comparing traditional surgical procedures with innovative minimally invasive techniques such as endovascular laser ablation of the testicular vein.

The aim of this study was to evaluate the effectiveness of minimally invasive surgical methods for varicocele treatment and to substantiate the feasibility of an individualized approach based on hemodynamic reflux type.

Materials and methods of research

The study was based on the results of surgical treatment of 127 patients with left-sided varicocele admitted to the surgical department of the Samarkand branch of the Republican Specialized Scientific and Practical Medical Center of Cardiology between 2019 and 2024.

The study was conducted in accordance with the principles of the Declaration of Helsinki. The research protocol was approved by the local Ethics Committee of Samarkand State Medical University (protocol № 13, year 2024). Written informed consent was obtained from all participants.

Patients were divided into two groups based on the surgical technique. From 2019 to 2021, 59 (46.4%) patients underwent conventional surgical procedures-the Ivanissevich procedure or the Palomo procedure-constituting the comparison group. From 2022 to 2024, 68 (53.5%) patients underwent minimally invasive procedures, such as endovascular laser ablation of the left testicular vein (EVLA LTV) and the Marmaraa procedure. These patients were assigned to the study group.

The degree of varicocele in patients was assessed in accordance with the classification of the World Health Organization (WHO 1993, 1997), which is an internationally recognized standard for stratifying the severity of the disease (Table 1).

Table 1

Distribution of patients by varicocele grade (WHO classification).

Degree of varicocele	Study groups								Total			
	Comparison group				Main group							
	initially		relapse		initially		relapse		initially		relapse	
	abs.	%	abs.	%	abs.	%	abs.	%	abs.	%	abs.	%
I	1	1.9	-	-	2	3.5	-	-	3	2.7	-	-
II	13	24.5	1	16.7	14	24.6	2	18.2	27	24.5	3	17.6
III	39	73.6	5	83.3	41	71.9	9	81.8	80	72.7	14	82.3
Total	53	100	6	100	57	100	11	100	110	100	17	100

All patients admitted with a confirmed diagnosis of varicocele were required to undergo a comprehensive set of clinical, laboratory, and instrumental studies aimed at a comprehensive assessment of the anatomical and functional state of the venous system of the scrotum, the identification of concomitant pathologies, as well as clarification of the severity of the disease and the possible impact on reproductive function.

In all study groups, patients underwent surgical treatment for varicocele. Since 2022, in our clinical practice, when choosing a surgical treatment strategy for varicocele, we have been using an individualized, differentiated approach based on careful consideration of the clinical course of the disease and the hemodynamic type of venous reflux in each patient. Specifically, in all patients in the main study group with primary varicocele characterized by renospermatic type I venous reflux (33 patients, or 76.7% of the group), as well as in patients with a combined type with a predominance of renospermatic reflux (type IIIA, 10 patients, or 23.2%), endovascular laser ablation of the left testicular vein (EVLA LTV) was used as the primary intervention (see Table 2). Moreover, among these patients, 1 case of recurrent varicocele type I was recorded, which is 2.3% of the number of those operated on.

Table 2

Distribution of patients undergoing endovascular laser ablation (EVLA LTV).

Degree of varicocele	Hemodynamic type				Total	
	Type I		III A type			
	abs.	%	abs.	%	abs.	%
1st degree	1	3.0	-	-	1	2.3
2nd degree	11	33.3	2	20.0	13	30.2
III degree	21	63.6	8	80.0	29	67.4
Total	33	100	10	100	43	100

Thus, the introduction of EVLA LTV into a complex of surgical procedures has significantly increased the effectiveness of treatment, reduced the invasiveness of the procedure and improved clinical outcomes in patients with various hemodynamic variants of varicocele.

The varicocele treatment method developed at our clinic-endovascular laser ablation of the left testicular vein and varicose veins of the left pampiniform plexus-is an innovative, minimally invasive technology based on a pathogenetic approach to correcting pathological venous reflux. This technique is aimed at selectively and effectively stopping abnormal blood flow in the testicular venous system, ensuring reliable elimination of the underlying cause of varicocele and significantly reducing the risk of postoperative complications and recurrence.

One of the key advantages of the proposed method is the high precision of local treatment of the left testicular vein, which avoids the left renal vein-a potential source of unwanted systemic and local effects-from the treatment area. This selective nature of the procedure ensures its high safety profile and minimal trauma, as well as shortens patient recovery time.

Endovascular laser ablation of the left testicular vein (EVLA LTV) was performed using a high-tech Biolitec LEONARDO MINI system with a 1470 nm wavelength and 12 watt power, manufactured in Germany (Fig. 1). This laser system ensured an optimal balance between ablation effectiveness and protection of surrounding tissue, thanks to the high absorption of laser radiation by water, which enabled uniform coagulative necrosis of the venous wall endothelium and subsequent stable closure of the affected vessel.

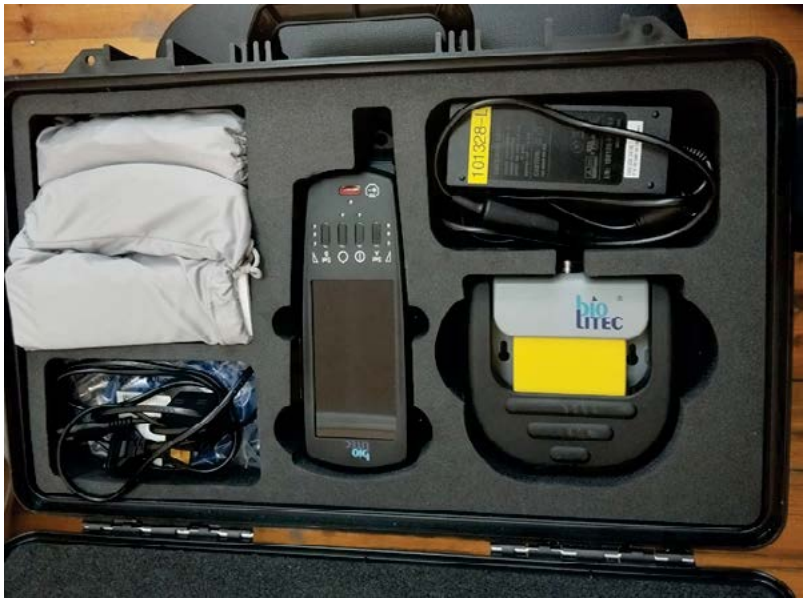

Fig. 1. Diode laser Biolitec LEONARDO MINI 1470 12 watt, Germany.

Surgical technique. The first stage of the procedure involves an ultrasound examination using Color Doppler mapping (CDM), which allows visualization of the varicose veins of the pampiniform plexus, measurement of their diameter, and assessment of the presence and extent of retrograde blood flow. The patient is positioned supine or slightly rotated to the side opposite the testicular vein approach, ensuring optimal visualization and access to the anatomical structures.

After treating the skin of the groin area and lower abdomen with an antiseptic solution and applying sterile surgical linen, ultrasound control is again performed to accurately localize the testicular vein and determine the puncture zone (Fig. 2).

To provide local anesthesia, 10-15 ml of 0.5% novocaine solution is injected subcutaneously into the external inguinal ring. Next, under Doppler ultrasound guidance, a percutaneous puncture of the testicular vein is performed in the external inguinal ring, followed by insertion of a 5-6 Fr venous introducer (Fig. 3).

A laser light guide, typically a 1470 nm diode laser with a radial or annular emitting tip, is inserted through the introducer into the vein lumen. A solution consisting of 0.5% novocaine, isotonic sodium chloride solution, and adrenaline is infiltrated into the perivascular tissue surrounding the vein. The primary goals of this injection are adequate anesthesia, creation of a thermal cushion for the surrounding tissue, and induced vein constriction to ensure tight contact between the light guide and the venous wall.

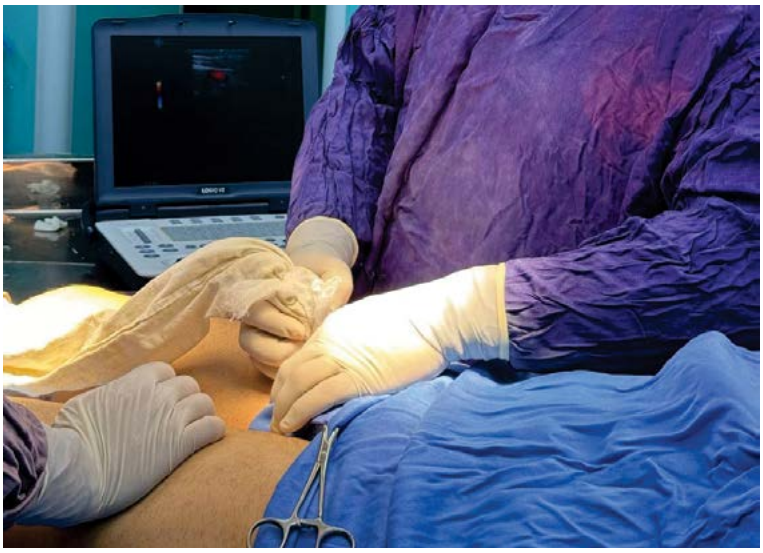

Fig. 2. Repeated Ultrasound control of the localization of the testicular vein and puncture site.

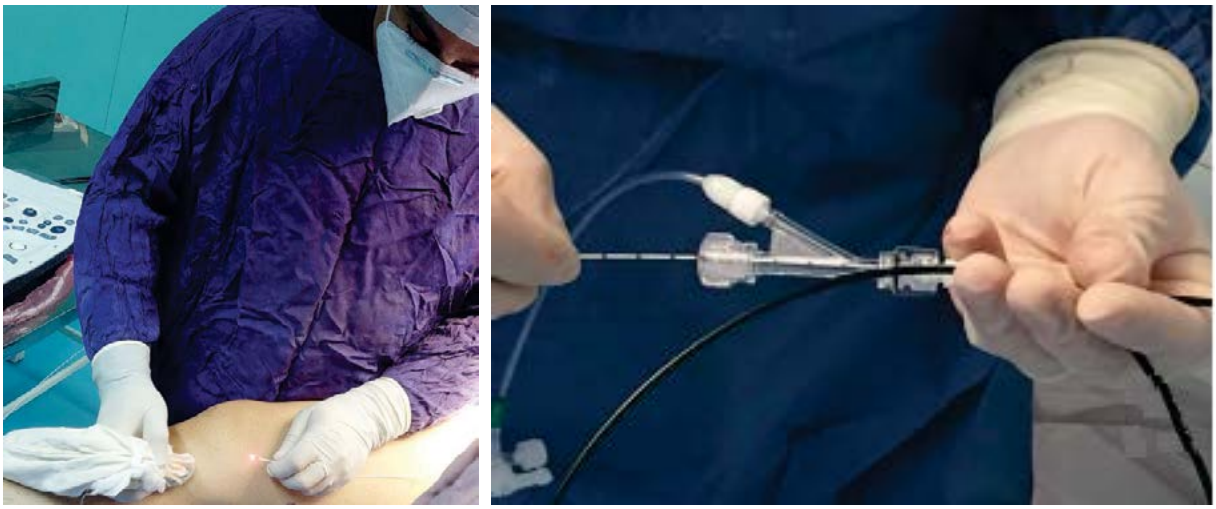

Fig. 3. A laser light guide is inserted into the lumen of the vein.

Under continuous ultrasound guidance, the fiber optic cable is slowly withdrawn retrogradely while laser energy is applied. The traction speed is typically 1-2 mm/s. The energy generation protocol includes the following parameters: wavelength – 1470 nm, energy density – 60-100 J/cm. Laser radiation induces coagulative necrosis of the endothelium, resulting in aseptic obliterative adhesion of the venous walls and cessation of pathological blood flow.

Upon completion of the procedure, the fiber optic cable and introducer are removed, the puncture channel is compressed, and a sterile aseptic dressing is applied. The final step is a follow-up ultrasound examination to confirm successful obliteration of the testicular vein, the absence of residual blood flow, and to rule out complications (hematomas, deep vein thrombosis, etc.).

The early recovery period is generally uneventful. The patient is observed for 1-2 hours and then discharged the same day.

The use of EVLA LTV for varicoceles, compared to traditional methods (such as open varicocelectomy according to Ivanisevich or Palomo), demonstrates a number of significant clinical and technical advantages. Among the most significant are: less invasiveness of the procedure, no need for laparoscopic or microscopic equipment, and minimized risk of damage to the testicular artery and lymphatic vessels.

In the main group of patients, 25 patients (36.8%) suffered from iliotesticular (type II) and mixed pathological venous reflux with a predominance of the ileotestesticular hemodynamic variant (type IIIB). In this category of patients, subinguinal selective microsurgical varicocelectomy was performed using the Marmaraa technique (see Table 3). The choice of this procedure was based on hemodynamic characteristics: during endovascular laser ablation of the left testicular vein (EVLA LTV), branches of the pampiniform plexus, which flow directly into the iliac vein, remained unaffected by the laser beam. Among the patients operated on using this method, 10 patients (40.0%) had a recurrent form of varicocele, which also predetermined the need for a microsurgical technique.

At this stage of the surgical intervention, magnifying optical systems with a magnification factor of 3.5 and 4.5 times were actively used, which ensured high accuracy and detail in the visualization of anatomical structures.

Table 3

Distribution of patients treated with Marmaraa microsurgical varicocelectomy.

Degree of varicocele	Hemodynamic type								Total	
	Primary				Varicocele recurrence					
	Type II		III B type		Type II		III B type			
	abs.	%	abs.	%	abs.	%	abs.	%	abs.	%
1st degree	-	-	1	16.7	-	-	-	-	1	4.0
2nd degree	1	11.1	1	16.7	1	33.3	-	-	3	12.0
III degree	8	88.9	4	66.7	2	66.7	7	100	21	84.0
Total	9	100	6	100	3	100	7	100	25	100

The study was conducted in accordance with the fundamental principles of bioethics and international ethical standards for medical research involving human subjects. The study was carried out in compliance with the provisions of the World Medical Association's Declaration of Helsinki (2013). The study protocol was reviewed and approved by the local ethics committee of Samarkand State Medical University (No. 079, 2024). All patients were informed of the aims and methods of the study and signed a voluntary informed consent form to participate in the study and undergo surgical treatment. The confidentiality of patients' personal data was fully maintained at all stages of the study.

Statistical analysis of the data was performed using methods of variational statistics, employing the SPSS Statistics software package (version 26.0) and Microsoft Excel. Quantitative indicators are presented as mean values (M) and standard deviation (±SD). The Student's t-test was used to compare quantitative indicators between groups. Qualitative indicators were analysed using the chi-square (χ^2) test. Differences between indicators were considered statistically significant at a significance level of $p < 0.05$.

This work was carried out as part of the research project «Improving methods of diagnosis and surgical treatment of diseases of the genitourinary system using modern minimally invasive technologies», conducted at the Department of Surgery, Endoscopy and Anaesthesiology-Resuscitation of the Faculty of Postgraduate Education at Samarkand State Medical University. Research project duration: 2022-2026.

Research results and discussion

Improved tactical approaches to surgical treatment of varicocele, optimized surgical techniques, and reduced procedural invasiveness have had a significant positive impact on the immediate clinical outcomes of this patient population. Specifically, compared to the period 2019-2021, a significant reduction in the incidence of postoperative complications was observed-from 18.6% to 2.9% (Table 4). Among the reported complications, pain and discomfort in the scrotum were significantly less frequent (a 2-fold decrease), as were testicular hypotrophy and hydrocele (a 5-fold decrease). Serious complications such as postoperative bleeding and surgical wound infection were completely absent.

Table 4

Frequency of postoperative complications in patients after varicocelectomy.

Type of complication	Group of patients								Total, n=127	
	Comparison group				Main group					
	Ivanissevich operation (n=41)		Operation Palomo (n=18)		EVLA LTV (n=43)		Operation Marmara (n=25)			
	abs.	%	abs.	%	abs.	%	abs.	%	abs.	%
Pain and discomfort in the scrotum area	1	2.4	1	5.5	1	2.3*	1	4.0*	4	3.1
Testicular hypotrophy	1	2.4	1	5.5	-	-	-	-	2	1.6
Hydrocele	2	4.9	1	5.5	-	-	-	-	3	2.4
Bleeding	1	2.4	-	-	-	-	-	-	1	0.8
Suppuration of a postoperative wound	1	2.4	1	5.5	-	-	-	-	2	1.6
Temperature increase	1	2.4	-	-	-	-	-	-	1	0.8
Total complications	7	17.1	4	11.5	1	2.3*	1	4.0*	13	10.2
Number of patients with complications	4	9.7	3	16.7	1	2.3	1	4.0	9	7.1
Total complications in the study groups	11		18.6		2		2.9			

*Note: * – differences relative to the comparison group data are significant (* – P<0.05, * – P<0.001).*

The long-term outcomes of surgical treatment for varicocele were analyzed in 98 of 127 patients (77.2%) who underwent surgery. One of the key criteria for assessing long-term outcomes was the varicocele recurrence rate, as this indicator directly reflects the surgical completeness and effectiveness of the intervention. During the recurrence analysis, special attention was paid to the hemodynamic characteristics of pathological venous reflux, classified

according to Coolsaet (1980), to identify a possible correlation between the type of reflux and the risk of recurrence.

True varicocele recurrence was diagnosed in 10 of 98 patients (10.2%) followed up in the late postoperative period. Notably, in the cohort of patients operated on between 2019 and 2021, the recurrence rate was 19.0%. This may be due to the technical peculiarities of the procedures performed at this stage and the lack of a personalized approach to choosing treatment strategies.

A reduction in the recurrence rate to 3.6% in the subsequent observation period was made possible by the introduction of a set of preventive measures, including mandatory preoperative determination of the hemodynamic type of varicocele, a more precise selection of surgical tactics, as well as the introduction of innovative technologies such as endovascular laser ablation (EVLA) of the testicular vein and varicose veins of the pampiniform plexus.

An analysis of the obtained results allows us to draw the important conclusion that endovascular laser ablation of the testicular vein offers several significant advantages over traditional techniques, including laparoscopic varicocelectomy and the Palomo approach. The advantages of EVLA include, first and foremost, a significantly lower recurrence rate, high precision in targeting pathologically altered vessels, minimal invasiveness, and low trauma. This method ensures selective vein obliteration while preserving intact vessels and lymphatic structures, significantly reducing the risk of complications such as hydrocele and arterial damage.

The results of the present study demonstrate that the use of minimally invasive technologies in the surgical treatment of varicocele significantly improves clinical outcomes compared with traditional open surgical techniques. The introduction of an individualized surgical strategy based on the hemodynamic type of venous reflux allowed for a rational selection of the most appropriate intervention method and contributed to a significant reduction in postoperative complications and recurrence rates [23, 24].

According to numerous international studies, microsurgical varicocelectomy and endovascular techniques are currently considered the most effective and safe methods for the treatment of varicocele. In particular, microsurgical subinguinal varicocelectomy according to the Marmara technique has been reported to demonstrate the lowest recurrence and complication rates due to improved visualization of the spermatic cord structures and preservation of lymphatic vessels and the testicular artery. Similar findings have been reported in several meta-analyses, which indicate that microsurgical approaches provide superior outcomes compared with traditional open procedures such as the Ivanissevich or Palomo operations [25].

The results obtained in our study are consistent with previously published data demonstrating the advantages of minimally invasive technologies. The incidence of postoperative complications in our cohort decreased from 18.6% in patients who underwent traditional surgical treatment to 2.9% after the introduction of minimally invasive techniques. Such a reduction may be explained by lower surgical trauma, better visualization of anatomical structures, and more precise correction of pathological venous reflux [26, 27].

Another important finding of the present study is the significant decrease in the recurrence rate of varicocele from 19.0% to 3.6% following the implementation of a differentiated treatment strategy. Previous studies have shown that recurrence of varicocele is often associated with incomplete ligation of venous collaterals or insufficient identification of the hemodynamic type of reflux. In this regard, the use of preoperative Doppler ultrasound examination and classification of reflux according to Coolsaet allows for more accurate planning of surgical tactics [28].

Endovascular laser ablation of the left testicular vein represents a relatively new minimally invasive technique that has demonstrated promising clinical outcomes. This method allows selective obliteration of the pathological venous segment while minimizing the risk of damage to surrounding anatomical structures. In addition, the procedure can be performed under local anesthesia and is associated with a shorter recovery period, which is particularly important for adolescents and young men [29].

Thus, the obtained results confirm that the integration of modern minimally invasive technologies with an individualized hemodynamic approach significantly improves the effectiveness of varicocele treatment. These findings support the feasibility of wider implementation of such methods in clinical practice for the management of varicocele in adolescents and young men.

Conclusions

1. The use of minimally invasive technologies such as endovascular laser ablation of the left testicular vein and microsurgical Marmara varicocelectomy allows an individualized surgical strategy based on the hemodynamic type of venous reflux.
2. The implementation of minimally invasive methods significantly reduced postoperative complications from 18.6% to 2.9%.
3. The recurrence rate decreased from 19.0% to 3.6%, indicating a higher effectiveness of modern surgical techniques.
4. Minimally invasive approaches improve clinical outcomes and shorten the postoperative rehabilitation period in patients with varicocele..

Prospects for further research. Further research should focus on expanding the clinical evaluation of minimally invasive techniques for the treatment of varicocele, particularly endovascular laser ablation of the testicular vein. Multicenter prospective studies with larger patient cohorts and longer follow-up periods are required to confirm the long-term effectiveness, safety, and reproducibility of this method in different clinical settings.

Another important direction for future investigations is the detailed assessment of reproductive outcomes after surgical treatment. Special attention should be paid to the dynamics of semen parameters, hormonal status, and fertility rates in patients undergoing different minimally invasive procedures. Comparative studies between

endovascular laser ablation, microsurgical varicocelectomy, and other modern endovascular techniques may help determine the optimal treatment strategy for various hemodynamic types of varicocele.

In addition, further studies should explore the potential role of advanced imaging technologies and intraoperative navigation methods for improving the accuracy of diagnosing venous reflux patterns and planning individualized surgical interventions. The integration of modern diagnostic tools with personalized surgical approaches may further reduce recurrence rates and postoperative complications, thereby improving long-term reproductive outcomes and quality of life in patients with varicocele.

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Conflict of interest. The authors declare no conflict of interest.

Use of Artificial Intelligence. Artificial intelligence tools were used during the preparation of this manuscript to assist with linguistic editing, improvement of the English language, and structuring of the text. The use of AI was limited to language refinement and did not influence the scientific design of the study, data collection, statistical analysis, interpretation of results, or the conclusions of the research. All scientific content and final responsibility for the manuscript remain with the authors.

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ОПТИМІЗАЦІЯ ХІРУРГІЧНОГО ЛІКУВАННЯ ВАРИКОЗНОГО РОЗШИРЕННЯ НА ОСНОВІ ІНДИВІДУАЛЬНОГО ПІДХОДУ ТА ЗАСТОСУВАННЯ МІНІМАЛЬНО ІНВАЗИВНИХ ТЕХНОЛОГІЙ

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Резюме.

Варикозне розширення вен є однією з найпоширеніших причин чоловічого безпліддя та діагностується приблизно у 15% загальної чоловічої популяції та до 35% чоловіків з первинним безпліддям. Пошук ефективних та мінімально травматичних хірургічних підходів залишається актуальною проблемою в сучасній урології та андрології.

Мета. Оцінити клінічну ефективність та безпеку сучасних малоінвазивних хірургічних методик лікування варикозного розширення вен з використанням індивідуального підходу, заснованого на гемодинамічному типі венозного рефлюксу.

Матеріали та методи. Ретроспективне дослідження включало 127 пацієнтів з лівостороннім варикозним розширенням вен, які перенесли оперативне лікування в період з 2019 по 2024 рр. у Самаркандському відділенні Республіканського спеціалізованого науково-практичного медичного центру кардіології. Пацієнти були розділені на дві групи у залежності від техніки хірургічного втручання. Група порівняння (n=59) перенесла традиційні операції (Іваніссевича або Палома), тоді як основна група (n=68) отримала малоінвазивне лікування, що включало ендоваскулярну лазерну абляцію лівої яєчкової вени та мікрохірургічну варикозну вену Мармара. Дослідження проводилося відповідно до положень Гельсінської декларації Всесвітньої медичної асоціації (2013 р.). Протокол дослідження був розглянутий та схвалений місцевим етичним комітетом Самаркандського державного медичного університету (Протокол № 079, 2024). Всі пацієнти були проінформовані про цілі та методи дослідження та підписали добровільну інформовану згоду на участь у дослідженні та проходження хірургічного лікування. Конфіденційність персональних даних пацієнтів була повністю збережена на всіх етапах дослідження. Статистичний аналіз даних проводився методами варіаційної статистики з використанням пакету програм SPSS Statistics (версія 26.0) та Microsoft Excel. Кількісні показники представлені у вигляді середніх значень (M) та стандартного відхилення (±SD). Ця робота була виконана в рамках дослідницького проекту «Удосконалення методів діагностики та хірургічного лікування захворювань сечостатевої системи з використанням сучасних малоінвазивних технологій», що проводиться на кафедрі хірургії, ендоскопії та анестезіології-реаніматології факультету післядипломної освіти Самаркандського державного медичного університету, термін виконання 2022-2026 рр.

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Результати. Впровадження мінімально інвазивних технологій суттєво зменшило післяопераційні ускладнення з 18,6% до 2,9% і частоту рецидивів з 19,0% до 3,6%. Крім того, пацієнти продемонстрували покращення клінічних результатів і короткий час одужання. Отримані результати підтверджують, що інтеграція сучасних малоінвазивних технологій з індивідуалізованим гемодинамічним підходом значно покращує ефективність лікування варикозного розширення вен. Ці результати обгрунтовують доцільність ширшого впровадження таких методів у клінічну практику для лікування варикозного розширення вен у підлітків та молодих чоловіків.

Висновок. Мінімально інвазивні методи в поєднанні з індивідуальною хірургічною стратегією, заснованою на типі гемодинамічного рефлюксу, значно покращують результати лікування та зменшують рецидиви варисоселю.

Ключові слова: варикозне розширення вен; ендоваскулярна лазерна абляція; техніка Мармара; малоінвазивна хірургія; венозний рефлюкс.

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