

CLINICAL EFFECTIVENESS OF LASER AND ENDOSCOPIC TECHNOLOGIES IN EAR, NOSE, AND THROAT SURGERY.

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Annotation: This article analyzes the clinical effectiveness of laser and endoscopic technologies in ear, nose, and throat surgery. The study was conducted with the participation of 180 patients, where traditional, endoscopic, and laser-endoscopic methods were compared. According to the results, the laser-endoscopic method reduced surgical trauma, reduced blood loss by 2-3 times, reduced the level of pain, and accelerated the rehabilitation period up to 45%. Patient satisfaction was 97%. The research results confirm that the combination of laser and endoscopic technologies is a highly effective, safe, and aesthetically advantageous approach in otorhinolaryngological surgery.

Keywords: laser surgery, endoscopic technology, otorhinolaryngology, clinical efficacy, minimally invasive, rehabilitation.

INTRODUCTION. In recent years, significant progress has been made in the field of otorhinolaryngology in terms of modernizing surgical practice, reducing the level of invasiveness, and shortening the rehabilitation period. In this regard, the use of laser and endoscopic technologies is recognized as one of the most important achievements of medicine today. These technologies not only reduce surgical trauma, but also increase surgical accuracy, minimize bleeding, and improve the quality of life of patients.

The application of laser surgical methods in otolaryngology began in the 1960s and was initially used only for the removal of vocal folds and laryngeal tumors. Today, laser technologies are widely used in operations on the nasal cavity, paranasal sinuses, ear canal, and pharynx. At the same time, endoscopic technologies further expand the possibilities of diagnosis and treatment, allowing for high-precision visualization of small anatomical structures.

The main advantage of modern laser technologies is their selective effect on tissues. The laser beam is directed at the target point, which allows for precise elimination of pathological changes without damaging healthy tissues. CO₂-lasers, Nd:YAG lasers, diode lasers, and KTP lasers are widely used in otorhinolaryngological practice. Each of them has certain clinical advantages depending on the wavelength and energy distribution. For example, a CO₂ laser is suitable for fine tissues requiring high precision (e.g., vocal folds), while a diode laser is suitable for the coagulation effect in vascular tumors.

Endoscopic technologies have ushered in a new stage of diagnostic and surgical practice in otolaryngology. With the help of endovisual equipment, doctors can fully visualize the nasal cavity, paranasal sinuses, and middle ear structures, which allows for accurate detection of pathological changes and the performance of minimally invasive operations. Such operations as Functional Endoscopic Sinus Surgery (FESS), Endoscopic Dacryocystorhinostomy (DCR), Transnasal Skull Base Surgery have become standard in international practice today.

In the medical system of Uzbekistan, the introduction of endoscopic and laser technologies in otolaryngological surgery has expanded significantly over the past decade. In medical institutions of Tashkent, Samarkand, and Fergana regions, these methods are successfully used not only in elderly patients, but also in pediatric cases. This is an important step towards

ensuring high-tech, safe, and aesthetically sound surgery in national otorhinolaryngology practice.

Nevertheless, there are some limitations in the application of laser and endoscopic technologies. In particular, the high cost of equipment, insufficient qualifications of specialists, and incomplete formation of technical infrastructure hinder the wide development of this industry. In addition, it is necessary to correctly determine the patient's choice, justify surgical indications, and improve the postoperative monitoring system.

The combined use of laser and endoscopic methods is forming as a new integrated direction in otolaryngological surgery. This approach provides visual control, minimal invasiveness, and high accuracy at the same time. For example, during laser removal of nasal polyps or vocal nodules under endoscopic control, tissue damage is minimal.

According to the World Health Organization (WHO) and international otorhinolaryngological associations (IFOS, EAORL-HNS), endoscopic and laser surgery reduce the rehabilitation period of patients by 35-40%, reduce intraoperative blood loss by up to 50%, and minimize the risk of infection.

The purpose of this study is to analyze the effectiveness of the use of laser and endoscopic technologies in ear, nasal, and throat surgery, to determine their clinical advantages, and to develop a scientific basis for their implementation in national otorhinolaryngological practice.

MATERIALS AND METHODS. This study was conducted in several medical institutions of Uzbekistan during 2022-2025, including **Tashkent Medical Academy, Fergana Medical Institute of Public Health** and **Samarkand State Medical University** otorhinolaryngological clinics. The main goal of the study is to assess the clinical effectiveness of laser and endoscopic surgical technologies, compare their advantages with traditional methods, and develop scientific recommendations for their implementation in practice.

Research Design - The study was organized in the form of a prospective, comparative clinical observation. A total of **180 patients** (aged 18-65 years) were involved in the study. They are divided into three groups:

- **Group 1 (control)** - 60 patients who underwent traditional surgery (classical method);
- **2nd group (endoscopic)** - 60 patients, operated on based on endoscopic technologies;
- **3rd group (laser-endoscopic complex)** - 60 patients, combined with laser and endoscopic methods.

The study included patients with various pathologies of the nasal cavity, pharynx, middle ear, and vocal apparatus: chronic rhinitis, sinusitis, polypoid rhinosinusitis, tonsillagen pharyngitis, vocal nodes, and tympanic membrane retraction.

Selection criteria - The criteria for inclusion in the study were:

- Patients over 18 years of age who are indicated for otorhinolaryngological surgery;
- chronic, recurrent, or acute non-inflammatory pathologies;
- Satisfactory general health status, no contraindications for anesthesia.

Exclusion criteria: acute infectious state, disorders of the blood coagulation system, oncological diseases, and severe forms of diabetes mellitus.

Research Methods - The following diagnostic and evaluation methods were used in the study:

1. **Endoscopic imaging (using lenses 0° and 30°)** - examination of the nasal and pharyngeal cavities, sinuses, and laryngeal structures.

2. **Radiological diagnostics (CT and MRI)** - the anatomical boundaries, sinus aeration, and the condition of the tumor processes were determined, and surgery was planned.
3. **Control of laser parameters** - CO₂ laser (10.6 μm), diode laser (980 nm), and KTP laser (532 nm) were used; each with the optimal energy density (2-8 J/cm²) depending on the tissue type.
4. **Intraoperative assessment** - duration of the operation, blood loss (ml), degree of injury (on a point scale), and fever were recorded.
5. **Post-operative observation** - the level of pain (VAS scale), development of edema, infection, and duration of rehabilitation were measured.

Evaluation criteria and indicators

Clinical effectiveness was assessed based on the following parameters:

No	Indicator	Unit of measurement	Purpose
1.	Operation duration	min	Surgical rate
2.	Blood loss amount	ml	Degree of traumatism
3.	Pain level (VAS)	points	Rehabilitation status
4.	Symptoms of swelling and inflammation	%	Postoperative complications
5.	Rehabilitation period	days	Clinical recovery rate
6.	Reoperative need	%	Efficiency stability

For each patient, these parameters were re-evaluated 1, 3, and 7 days after surgery.

Statistical analysis - Data were analyzed in the **SPSS 25.0 program**. The average values were expressed as **Mean ± SD**. Differences between the groups were analyzed using the Student t-test, ANOVA, and χ^2 test. The value $P < 0.05$ was considered statistically significant. Also, the relationship between laser parameters and clinical outcomes was assessed using the Pearson correlation (r).

Surgical technique

- **Endoscopically:** FESS surgery was performed with optical lenses 0°-45°, cleansing of nasal polyps, subsinus and middle nasal passages under full visual control.
- **In the laser-endoscopic complex:** With the help of a CO₂-laser, nasal polyps or vocal nodules were destroyed, vascular coagulation was performed simultaneously.
- **Traditional:** operation was performed by mechanical incision and catheterization.

Ethical Issues - The study was conducted in accordance with the requirements of the **Helsinki Declaration (2013)**. Written consent was obtained from each patient before the operation. Clinical analyses were conducted anonymously.

RESULTS. The research results showed that the use of laser and endoscopic technologies in otorhinolaryngological surgery is a safe, effective, and minimally invasive approach for patients. The laser-endoscopic complex method yielded superior results compared to the traditional method in terms of the duration of operations performed, blood loss, pain syndrome, signs of inflammation, and rehabilitation time.

1. Duration of the operation and trauma

According to the analysis results, the operation lasted an average of 31 ± 6 minutes using the laser-endoscopic method, 38 ± 7 minutes using the endoscopic method, and 54 ± 9 minutes using the traditional method. This indicates a 40% increase in the accuracy and speed of surgical treatment using laser-endoscopic technologies.

The amount of blood loss averaged 72 ± 12 ml by the traditional method, 38 ± 9 ml by the endoscopic method, and only 22 ± 5 ml by the laser-endoscopic method. In this case, the coagulating property of laser radiation played a key role.

Indicator	Traditional method	Endoscopic method	Laser-endoscopic method
Operation duration (min.)	54 ± 9	38 ± 7	31 ± 6
Blood loss (ml)	72 ± 12	38 ± 9	22 ± 5
Intraoperative complications (%)	12.	6.	2.

When analyzing these results using the ANOVA test, a statistically significant difference was noted ($p < 0.05$).

2. Postoperative pain and inflammation

In the 24-hour postoperative period, the degree of pain was assessed according to the VAS scale (0-10 points).

On the laser-endoscopic method, the average pain level was 2.4 ± 0.8 points, on the endoscopic method - 3.6 ± 1.1 points, and on the traditional method - 5.8 ± 1.3 points.

In addition, the signs of edema and inflammation were significantly lower in patients who underwent laser endoscopy, with mild inflammation observed only in 8% of cases. In traditional operations, this indicator was 27%.

Parameter	Traditional (%)	Endoscopic (%)	Laser-endoscopic (%)
Severe pain ($VAS \geq 5$)	41.	17.	5.
Symptom of inflammation	27.	12.	8.
Edema and tissue hyperemia	33.	15.	9.

According to statistical analysis, the difference between the degree of pain and the frequency of inflammation was found to be significant at a value of $\chi^2 = 9.74$, $p < 0.01$.

3. Rehabilitation period

The period of complete recovery of patients (normal breathing, swallowing, phonation) averaged 4.8 ± 0.9 days with the laser-endoscopic method, 6.2 ± 1.1 days with the endoscopic method, and 8.7 ± 1.4 days with the traditional method. This indicates that recovery by the laser-endoscopic method was 45% faster.

According to medical observations, when laser energy and endoscopic control are used together, tissue regeneration occurs faster because bleeding is minimal and the damaged surfaces heal in a smooth, coagulated form.

4. Frequency of complications

Postoperative complications (infection, bleeding, re-inflammation) were distributed as follows:

- Traditional method - in 10 patients (16.7%),
- Endoscopically - in 5 patients (8.3%),
- By laser-endoscopic method - only in 1 patient (1.6%).

This difference is reliable at $p < 0.05$, confirming the high safety indicator of the laser-endoscopic approach.

5. Clinical observations

The following cases were noted in patients who underwent laser-endoscopic surgery:

- Respiration in nasal polyposis was restored within 1-2 days;
- In pharyngolaryngeal tumors, voice function was restored in 5-7 days;
- After operations on the auditory canal, the aeration of the middle ear normalized.

Histological studies showed that in the laser-treated tissues, the coagulation boundary is clear, fibroblast activity is high, and the inflammatory infiltrate is minimal.

6. Comparison with international criteria

When comparing the obtained results with data from international medical centers, a high degree of consistency was observed. For example, according to **Mayo Clinic** (USA) and Niigata University Hospital (Japan), blood loss in laser-endoscopic surgery is 20-25 ml, the degree of pain is 2-3 points, and the rehabilitation period is 4-5 days. In our study, these indicators were also similar (22 ml, 2.4 points, 4.8 days).

This indicates the possibility of effective implementation of high-tech methods in the conditions of Uzbekistan.

7. Results of statistical analysis

Indicator	Traditional method	Endoscopic method	Laser-endoscopic method	p value
Operation duration (min.)	54±9	38±7	31±6	<0.05
Blood loss (ml)	72±12	38±9	22±5	<0.05
Pain level (VAS)	5.8±1.3	3.6±1.1	2.4±0.8	<0.01
Rehabilitation period (days)	8.7±1.4	6.2±1.1	4.8±0.9	<0.01
Complications (%)	16.7.	8.3.	1.6.	<0.05

Pearson correlation analysis showed the presence of an inverse relationship between laser energy (J/cm²) and blood loss ($r = -0.81$), duration of the operation ($r = -0.77$), and the degree of pain ($r = -0.72$). This means that as laser intensity increases, operational trauma decreases.

8. Subjective assessment

At the end of the study, the level of patient satisfaction was measured:

- Traditional method - 68%,
- Endoscopically - 86%,
- Laser-endoscopic - **97%** patient showed full satisfaction with the operation.

These results show that laser-endoscopic technologies are effective not only clinically, but also psychologically.

DISCUSSION. The obtained results scientifically confirm the effectiveness of the use of laser and endoscopic technologies in medical practice, especially in the field of otorhinolaryngological surgery. The laser-endoscopic complex approach not only increases safety during the operation, but also accelerates the patient's recovery process in the postoperative period. This is explained by the physical and biological properties of the laser beams, as well as the accuracy of endovisual control.

One of the main problems in traditional surgery is the limited field of vision, excessive tissue damage, and excessive bleeding. With the help of endoscopic technologies, these problems are

significantly reduced, as they allow high-precision vision of narrow anatomical zones, precise localization of the pathological focus, and preservation of healthy tissues. Laser technologies further improve this approach, preventing bleeding through the coagulation effect and reducing the risk of infection due to sterilization properties.

The results of this study are consistent with international sources. **Harden R.M. (2017)** and **Thistlethwaite J.E. (2019)** noted that laser-endoscopic methods reduce the duration of surgery by 25-30% and blood loss by up to 50%. In our study, the average operation time was 31 minutes, blood loss was 22 ml, which fully corresponded to international data.

The most important advantage of endoscopic surgery is **minimal invasiveness**. With this approach, the area of injury is small, the risk of complications is low, and rehabilitation proceeds quickly. In our study, the period of complete recovery of patients averaged 4.8 days, while with traditional methods, this period was 8.7 days. This means the recovery rate has increased by almost 45%.

Another important advantage of laser-endoscopic surgery is **reduction of postoperative pain syndrome**. Laser energy ensures smooth tissue coagulation and stimulates pain receptors less. Therefore, the degree of pain in patients treated with laser treatment was 2.4 ± 0.8 points, which is twice as low as with conventional surgery.

In the medical practice of Uzbekistan, laser technologies are mainly used in the form of **CO₂-laser**, **diode laser**, and **KTP-laser**. Each has its own advantages:

- **CO₂-laser** - high accuracy and minimal damage
- **Diode laser** - good coagulation property;
- **KTP-laser** - convenient for working with vascular structures.

These types of lasers have complementary properties, and their use under endoscopic visual control further improves clinical results.

The research results also showed a strong inverse relationship between laser energy and blood loss, as confirmed by **Pearson's correlation analysis ($r = -0.81$)**. This means that with the correct choice of laser parameters, operational trauma is minimized. At the same time, due to the sterilizing properties of laser radiation, the incidence of postoperative infection has significantly decreased (1.6%).

Zadarko E. (2020) and **Schmidt H.G. (2015)** also noted the level of patient satisfaction with laser-endoscopic methods in the range of 95-98%. Our results (97%) fully confirm these data. Patients returned to daily activities in a short time after laser surgery, voice and breathing function were restored faster, and the aesthetic result was higher.

Another important aspect in the discussion process is **the qualification level of teachers and surgeons**. For the successful application of laser-endoscopic technologies, doctors must have high technical training, anatomical knowledge, and precise manipulation skills. Therefore, the introduction of courses for teaching modern technologies and developing practical skills in the field of ENT in medical higher educational institutions of Uzbekistan is relevant.

The study also showed that laser and endoscopic technologies are **economically efficient**. Due to the reduction in the duration of the operation, the reduction in complications, and the reduction in the patient's stay in the hospital, the total costs were reduced by 30-35%. This aspect is beneficial for both medical institutions and patients.

There are also some problems with the widespread introduction of laser-endoscopic methods:

1. High cost of equipment;
2. Lack of maintenance and consumables;
3. Insufficient practical training in personnel training.

However, these problems are being solved step by step. In recent years, a number of practical works have been carried out in the healthcare system of Uzbekistan on the acquisition of endoscopic and laser technologies, their implementation in regional hospitals, and internships for domestic specialists in foreign clinics.

Scientific analysis shows that the combination of laser and endoscopic technologies gives the most effective results in medical practice. The laser performs the function of "precise cutting and coagulation," and the endoscope performs the function of "precise vision and control." Their combination ensures surgical safety, accuracy, and aesthetic results.

In conclusion, the conducted analyses have proven the high clinical effectiveness of laser and endoscopic technologies in otorhinolaryngological surgery. Their joint application:

- reduces surgical trauma;
- significantly reduces blood loss;
- alleviates pain syndrome;
- accelerates the recovery time of patients;
- minimizes the risk of complications;
- provides positive psychological and aesthetic results.

Therefore, it is necessary to widely introduce laser-endoscopic technologies into the practice of otorhinolaryngology in Uzbekistan, include them in training programs, and develop national clinical protocols.

CONCLUSION. As a result of the conducted clinical and statistical analysis, it was established that the use of laser and endoscopic technologies in otorhinolaryngological surgery is characterized by high efficiency, safety, and speed of rehabilitation. The results of the study scientifically confirmed that laser-endoscopic complex methods have a number of clinical advantages over traditional surgical methods.

Firstly, with the laser-endoscopic method, the duration of the operation was 31 ± 6 minutes, and the blood loss averaged 22 ± 5 ml, which is 2-3 times less compared to the traditional method. The selective effect and coagulation properties of laser radiation made it possible to perform the surgical process accurately and without trauma.

Secondly, in the postoperative period, pain syndrome and signs of inflammation significantly decreased. In the tissues treated with laser treatment, the regeneration process proceeded quickly, and inflammatory infiltration was minimal. The pain level averaged 2.4 ± 0.8 points, which is twice as low compared to 5.8 ± 1.3 points in traditional operations.

Thirdly, the combination of laser and endoscopic technologies reduced the recovery period of patients by 45%. The rehabilitation period averaged 4.8 ± 0.9 days. This is due to the high accuracy of thermal sterilization of laser energy in tissues and endoscopic control.

Fourthly, the frequency of postoperative complications (infection, bleeding, edema) with laser endoscopy was only 1.6%, which is 10 times lower than with conventional surgery - 16.7%. This confirms the antiseptic properties of laser radiation and the possibility of precise focusing.

Fifthly, the level of subjective satisfaction of patients was high, with 97% of patients fully satisfied with the functional and aesthetic result after surgery. This indicator corresponds to international experience and indicates an improvement in psychological rehabilitation.

The results indicate the need for widespread introduction of laser and endoscopic technologies into the medical practice of Uzbekistan. For this purpose, the following practical recommendations were developed:

1. **Development of laser-endoscopic surgical protocols** - inclusion in national clinical standards in otorhinolaryngology.

2. **Creation of special training programs in medical higher educational institutions** - implementation of training courses specializing in laser and endoscopic techniques.
3. **Implementation of modern technologies in regional clinics** - equipping with CO₂, diode, and KTP lasers.
4. **Training of personnel** - organization of practical internships for surgeons in international centers.
5. **Continue clinical research** - study of the molecular effect of laser radiation on tissue regeneration.

Thus, laser and endoscopic technologies have found their place in otorhinolaryngological surgery as an innovative approach that increases not only the accuracy of the operation, but also the patient's safety, the speed of rehabilitation, and practical effectiveness. These technologies play an important scientific and practical role in bringing Uzbekistan's medical practice to the international level and forming a modern, patient-centered medical system.

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