

**Arthroscopic laser technologies in the treatment of intraarticular  
pathology of the knee joint**

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**Abstract.** Intra-articular pathology of the knee joint is among the most common musculoskeletal disorders and is a leading cause of pain, limited mobility, and decreased quality of life. Improving minimally invasive surgical treatment methods remains a pressing area in modern traumatology and orthopedics. One promising approach is the use of laser technology in arthroscopic surgery.

The aim of the study was to investigate the possibilities of using arthroscopic laser technologies in the treatment of patients with intra-articular pathology of the knee joint.

**Materials and methods.** We analyzed the treatment outcomes of 74 patients with intra-articular pathology of the knee joint who underwent arthroscopic interventions using a 1470 nm diode laser. The average age of the patients was  $46.8 \pm 9.7$  years. Of the examined patients, 42 were men (56.8%) and 32 were women (43.2%). The main pathology types were meniscus damage, chondromalacia of articular cartilage, chronic synovitis, and combined intra-articular lesions. Treatment outcomes were assessed using the visual analogue pain scale (VAS), the Lysholm scale, range of motion in the knee joint, and the incidence of postoperative complications.

Results. Six months after the surgery, the pain intensity decreased from  $7.2 \pm 1.1$  to  $2.1 \pm 0.8$  points according to VAS ( $p < 0.001$ ). The functional state of the knee joint according to the Lysholm scale improved from  $54.6 \pm 8.7$  to  $87.9 \pm 6.5$  points ( $p < 0.001$ ). The average range of flexion increased from  $104.2 \pm 12.6^\circ$  to  $128.7 \pm 8.9^\circ$  ( $p < 0.001$ ), and the extension deficit decreased from  $8.4 \pm 3.2^\circ$  to  $1.9 \pm 1.1^\circ$  ( $p < 0.001$ ). Postoperative complications were observed in 3 (4.1%) patients and were transient. Excellent and good treatment results were achieved in 79.7% of the examined patients.

Conclusion. Arthroscopic laser technologies are a promising treatment for intra-articular pathology of the knee joint. Their use helps reduce pain, improve joint function, restore range of motion, and is characterized by a low rate of postoperative complications.

**Key words:** knee joint, arthroscopy, laser technologies, meniscus, chondromalacia, synovitis, surgical treatment, orthopedics.

**Relevance.** Knee joint pathology occupies a leading place in the structure of diseases and injuries of the musculoskeletal system and is one of the most common causes of limited motor activity in patients of working age. Among the most common intra-articular diseases of the knee joint are meniscal damage, chondral defects, chronic synovitis, and combined degenerative-dystrophic changes in the joint structures [2, pp. 15–22; 5, pp. 23–34; 8, pp. 1–12].

The development of arthroscopic surgery has significantly expanded the possibilities of minimally invasive treatment of intra-articular pathology of the knee joint. Modern arthroscopic interventions allow for precise visualization of intra-articular structures, performing therapeutic manipulations with minimal trauma to surrounding tissues, and ensuring early functional rehabilitation of patients [1, pp. 89–97; 3, pp. 512–520; 4, pp. 42–49; 6, p. e70932; 7, pp. 22–30].

In recent years, particular attention has been paid to the implementation of laser technology in arthroscopic surgery. The use of laser radiation ensures high precision in targeting pathologically altered tissues, enables coagulation of small

vessels, reduces intraoperative bleeding, and performs selective treatment of damaged areas of articular cartilage, menisci, and synovial membrane [10, pp. 354–360; 11, pp. 577–586].

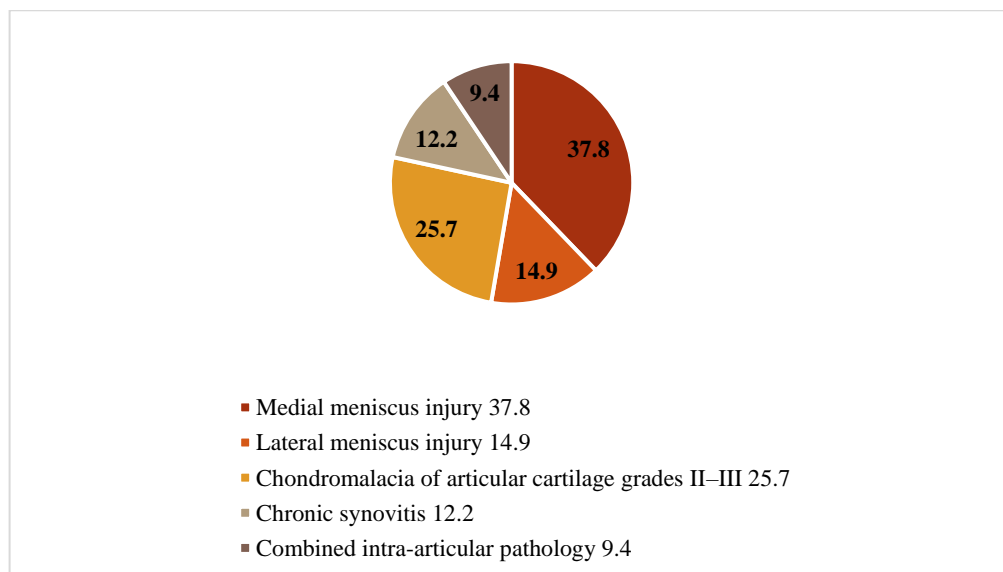
Despite the accumulated clinical experience of using laser technologies in orthopedics and traumatology, the issues of their use in various types of intra-articular pathology of the knee joint continue to be the subject of scientific debate. The characteristics of postoperative recovery of patients, the effect of laser exposure on the functional state of the joint and the possibilities of using these technologies in the complex treatment of degenerative and traumatic lesions of the knee joint have not been sufficiently studied [5, pp. 23–34; 6, p. e70932; 8, pp. 1–12; 9, Article 1493155].

In this regard, it seems relevant to study the results of the use of arthroscopic laser technologies in patients with various types of intra-articular pathology of the knee joint.

**The aim of the study was** to explore the potential of arthroscopic laser technologies in the treatment of patients with intra-articular pathology of the knee joint.

**Research materials and methods.** The study is based on an analysis of surgical treatment outcomes for 74 patients with intra-articular knee pathology who underwent arthroscopic procedures using laser technology between 2021 and 2025. All patients were examined and treated in a specialized trauma and orthopedic department. The study included 74 patients with intra-articular knee pathology who underwent arthroscopic treatment using laser technology. Among the examined patients, 42 (56.8%) were men, while 32 (43.2%) were women. The patients' age ranged from 28 to 67 years, with an average age of  $46.8 \pm 9.7$  years, indicating a predominance of individuals of working age. The average duration of the disease before surgery was  $3.4 \pm 1.8$  years, indicating a chronic course of the pathological process and the presence of persistent clinical manifestations requiring surgical treatment.

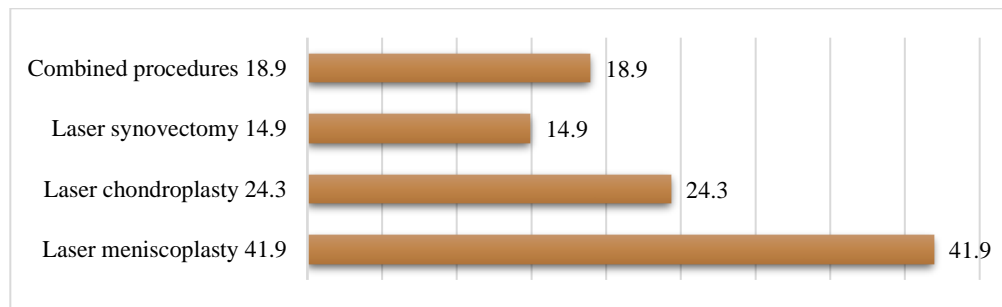
Inclusion criteria for the study included clinically and instrumentally confirmed intra-articular pathology of the knee joint, pain and functional impairment, and indications for arthroscopic surgery. The study excluded patients with severe degenerative-dystrophic changes in the knee joint corresponding to stage IV osteoarthritis, patients with systemic inflammatory connective tissue diseases, severe concomitant somatic pathology in the decompensation stage, and individuals who had previously undergone knee arthroplasty.



**Figure 1. Structure of intra-articular pathology of the knee joint**

All patients underwent diagnostic and therapeutic knee arthroscopy using a diode laser with a wavelength of 1470 nm and a power output of 8 to 12 watts. Laser therapy was used to ablate pathologically altered tissue, coagulate the synovial membrane, and treat damaged areas of the meniscus and cartilaginous structures of the joint.

Depending on the nature and location of the identified intra-articular changes, the extent of surgical intervention was determined individually for each patient (Fig. 2). Laser meniscoplasty was the most frequently performed procedure, performed in 31 (41.9%) patients. This high frequency is due to the significant prevalence of meniscus injuries among the patients examined.



**Figure 2. Types of arthroscopic interventions performed, %**

Laser chondroplasty was performed in 18 patients (24.3%) with degenerative changes in articular cartilage and localized cartilaginous defects. This procedure was aimed at treating damaged areas of cartilage and improving the intra-articular environment. Laser synovectomy was performed in 11 patients (14.9%) with signs of chronic synovitis and synovial hyperplasia. The use of laser irradiation allowed for precise coagulation of pathologically altered tissue with minimal trauma to surrounding structures. Combined intra-articular pathology was detected in 14 patients (18.9%), therefore, combined arthroscopic interventions were performed, including various laser treatment options for the menisci, articular cartilage, and synovial membrane.

To evaluate treatment outcomes, patients underwent a comprehensive clinical and functional examination preoperatively and six months after surgery. The following parameters were assessed: pain intensity using the visual analogue scale (VAS), knee joint function using the Lysholm Knee Score, knee range of motion, length of hospital stay, and the presence of postoperative complications.

Statistical processing of the study results was performed using the SPSS Statistics 26.0 software package. The distribution of quantitative variables was tested using the Shapiro–Wilk test. Data are presented as the mean and standard deviation ( $M \pm SD$ ). A paired Student's t-test was used to assess the significance of differences. Differences were considered statistically significant at  $p < 0.05$ .

**Study Results.** Analysis of the initial clinical and functional status of patients revealed that by the time of hospitalization, most subjects had a long-standing disease course and significant impairment of knee joint function. The

average duration of clinical manifestations was  $3.4\pm 1.8$  years, indicating the chronic nature of intra-articular pathology and the insufficient effectiveness of previous conservative treatment measures. Before surgery, all patients complained of pain of varying severity. The average visual analogue pain scale score was  $7.2\pm 1.1$  points, indicating severe pain intensity and significantly limiting the patients' daily motor activity. The functional state of the knee joint preoperatively, according to the Lysholm knee joint functional assessment scale, averaged  $54.6\pm 8.7$  points. The obtained results indicated the presence of moderate and severe functional impairments, accompanied by limited physical activity, decreased joint stability, and a deterioration in the patients' quality of life. A range of motion study revealed that the average knee flexion range was  $104.2\pm 12.6^\circ$ , which was below physiological limits. Furthermore, most patients exhibited an extension deficit, with an average range of  $8.4\pm 3.2^\circ$ . This limited range of motion was due to pain, inflammatory changes, and dysfunction of the intra-articular structures.

Analysis of treatment results showed positive dynamics of clinical and functional indicators in the majority of patients after arthroscopic interventions using laser technologies.

One of the main criteria for assessing treatment effectiveness was pain intensity measured on a visual analogue scale (VAS). Before surgery, the average VAS score was  $7.2\pm 1.1$  points, indicating severe pain. Six months after surgery, a significant reduction in pain intensity was noted, reaching  $2.1\pm 0.8$  points ( $p < 0.001$ ), representing a 70.8% reduction in pain.

An analysis of treatment results revealed significant improvements in all clinical and functional parameters studied 6 months after arthroscopic intervention using laser technology (Table 1). The most significant changes were noted in pain. The average visual analogue pain scale score decreased from  $7.2\pm 1.1$  to  $2.1\pm 0.8$  points ( $p < 0.001$ ), indicating a significant reduction in pain intensity and improvement in patients' daily activities.

Table 1

**Dynamics of clinical and functional indicators in patients after arthroscopic treatment using laser technologies**

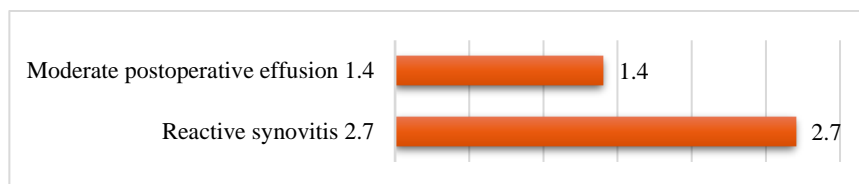
| <b>Indicator</b>   | <b>Before surgery</b> | <b>In 6 months</b> | <b>p</b> |
|--|-----------------------|--------------------|----------|
| Pain intensity according to VAS, points  | 7.2±1.1               | 2.1±0.8            | <0.001   |
| Functional assessment of the knee joint according to the Lysholm scale, points | 54.6±8.7              | 87.9±6.5           | <0.001   |
| Knee flexion, °  | 104.2±12.6            | 128.7±8.9          | <0.001   |
| Extension deficit, °   | 8.4±3.2               | 1.9±1.1            | <0.001   |

At the same time, a significant improvement in the functional state of the knee joint was noted. The average score on the Lysholm knee joint functional assessment scale increased from 54.6±8.7 to 87.9±6.5 points (  $p < 0.001$ ), indicating restoration of the supporting and motor function of the joint. Positive dynamics were also revealed when assessing the range of motion. The average flexion range increased from 104.2±12.6° to 128.7±8.9° (  $p < 0.001$ ), and the extension deficit decreased more than fourfold - from 8.4±3.2° to 1.9±1.1° (  $p < 0.001$ ). The results obtained indicate restoration of knee joint mobility and improvement of its biomechanical characteristics. The average duration of inpatient treatment was 3.8±1.2 bed-days. Most patients were mobilized within the first day after surgery, which helped reduce hospitalization times and speed up rehabilitation.

Postoperative complications were observed in 3 patients (4.1%) and were temporary. No infectious complications, repeat surgeries, or deterioration in knee joint function were recorded during the observation period.

An analysis of postoperative complications showed that the use of arthroscopic laser technologies was characterized by high safety and a low incidence of adverse outcomes. Complications were reported in only 3 (4.1%) of 74 patients and were temporary and reversible.

Reactive synovitis was the most common complication, occurring in two (2.7%) patients. This complication manifested as a moderate inflammatory reaction of the synovial membrane and was successfully managed with conservative anti-inflammatory therapy (Fig. 3).



**Figure 3. Structure of postoperative complications, %**

One patient (1.4%) experienced a moderate effusion in the knee joint in the early postoperative period. This effusion did not require repeat surgery and resolved with standard postoperative care. No infectious complications, cases of severe inflammation, or the need for repeat surgeries were reported in the study group. The absence of serious complications indicates the low invasiveness of the technique used and the high safety of laser technology in arthroscopic knee procedures. The use of arthroscopic laser technology is associated with a low rate of postoperative complications and ensures a favorable postoperative course in most patients.

A 6-month postoperative assessment of long-term treatment results using the Lysholm knee functional assessment scale revealed predominantly favorable outcomes in the majority of patients (abl . 2). The largest group consisted of patients with excellent treatment results. A Lysholm score of over 90 points was recorded in 34 (45.9%) of the examined patients, indicating almost complete restoration of knee

function, the absence of significant complaints, and a return to their usual level of physical activity.

Table 2

### Evaluation of treatment results using the Lysholm scale after 6 months

| Result         | Lysholm points | n  | %    |
|----------------|----------------|----|------|
| Great          | >90            | 34 | 45.9 |
| Good           | 84–90          | 25 | 33.8 |
| Satisfactory   | 65–83          | 11 | 14.9 |
| Unsatisfactory | <65            | 4  | 5.4  |

Good results were achieved in 25 patients (33.8%). These patients experienced a significant reduction in pain, restoration of motor function, and minor residual functional limitations that did not significantly impact quality of life. Satisfactory results were recorded in 11 patients (14.9%). Despite the positive dynamics of clinical parameters, some patients continued to experience some functional impairment related to the initial severity of intra-articular changes and the duration of the disease. Unsatisfactory treatment results were observed in only 4 patients (5.4%). In these cases, complaints of intermittent pain, limited joint function, or insufficient restoration of motor activity persisted.

Overall, good and excellent results were achieved in 59 (79.7%) patients, which indicates the beneficial effect of arthroscopic laser technologies on the functional state of the knee joint and confirms the possibility of their use in the treatment of various types of intra-articular pathology.

**Discussion .** The obtained results indicate that the use of arthroscopic laser technologies can achieve significant improvements in the clinical and functional status of patients with intra-articular knee pathology. A reduction in pain, restoration of range of motion, and an increase in functional activity were observed already in the early postoperative period.

One of the most significant results of the study was a significant reduction in pain intensity on the VAS scale from  $7.2 \pm 1.1$  to  $2.1 \pm 0.8$  points 6 months after surgery. These findings demonstrate the pronounced anti-inflammatory and organ-preserving effects of laser treatment, which ensures gentle treatment of intra-articular structures with minimal trauma to surrounding tissues.

Improved knee joint function was accompanied by an increase in Lysholm scores from  $54.6 \pm 8.7$  to  $87.9 \pm 6.5$  points. A restoration of joint range of motion and a reduction in extension deficit were also noted. These changes suggest that laser technology facilitates more rapid restoration of intra-articular balance and improved knee biomechanics.

A key advantage of arthroscopic laser procedures is their minimally invasive nature. Laser radiation ensures highly precise treatment of pathologically altered tissues, effective hemostasis, and a reduction in the severity of reactive inflammatory changes. This reduces postoperative pain, shortens hospital stays, and accelerates functional recovery. The low rate of postoperative complications also confirms the safety of laser technology. The reported complications were temporary and did not require repeat surgeries. The absence of infectious complications indicates the minimally invasive nature of the technique used and good postoperative control.

The obtained results are consistent with current understanding of the advantages of minimally invasive arthroscopic surgery and confirm the potential of laser technology in the treatment of various types of intra-articular knee pathology. The use of laser equipment expands the capabilities of arthroscopic interventions and improves the quality of surgical treatment for patients with degenerative and traumatic joint lesions.

The use of arthroscopic laser technologies represents a modern approach to surgical treatment of intra-articular pathology of the knee joint, combining high precision of intervention, minimal trauma, and favorable functional results.

**Conclusions.** The study demonstrated that the use of arthroscopic laser technologies for intra-articular knee pathology significantly improves clinical and functional outcomes. The use of laser therapy during arthroscopic procedures significantly reduces pain, restores range of motion, and improves knee joint function. The obtained results demonstrate the high clinical value of laser technologies in the treatment of meniscus injuries, chondral lesions, and chronic inflammatory changes in intra-articular structures. The low rate of postoperative complications, the absence of infectious complications, and the absence of repeat surgeries confirm the safety and minimal invasiveness of the technique used. The 79.7% rate of good and excellent treatment results allows arthroscopic laser technologies to be considered a promising approach to minimally invasive knee surgery. This approach improves the quality of medical care, reduces rehabilitation time, and restores functional activity in patients with intra-articular knee pathology.

### **Bibliography**

1. Amiraslanov Yu.A., Kornilov N.N., Kulyaba T.A. Arthroscopic technologies in modern knee surgery // Traumatology and orthopedics of Russia. - 2021. - Vol. 27, No. 3. - P. 89–97.
2. Belenkiy I.G., Lasunskiy S.A., Korolev A.V. Modern approaches to arthroscopic treatment of knee meniscus injuries // Bulletin of Traumatology and Orthopedics named after N.N. Priorov. - 2020. - No. 2. - P. 15-22.
3. Borzunov D.Yu., Prudnikova O.G. Minimally invasive technologies in surgical treatment of knee joint diseases // Genius of Orthopedics. - 2022. - Vol. 28, No. 4. - P. 512–520.
4. Girshin S.G., Kornilov N.N. Arthroscopy of the knee joint: modern possibilities and development prospects // Practical medicine. - 2021. - Vol. 19, No. 6. - P. 42–49.

5. Kornilov N.N., Kulyaba T.A., Tikhilov R.M. Modern methods of surgical treatment of articular cartilage damage // *Traumatology and Orthopedics of Russia*. - 2023. - Vol. 29, No. 1. - P. 23–34.
6. Rathod V., Shrivastav S., Gharpinde MR Knee arthroscopy in the era of precision medicine: a comprehensive review of tailored approaches and emerging technologies // *Cureus*. — 2024. — Vol. 16, No. 10. - e70932.
7. Rao NN Recent advances and future trends in knee arthroscopy // *Journal of Arthroscopic Surgery and Sports Medicine*. — 2020. — Vol. 1, No. 1. - P. 22–30.
8. Turoń B., Wychowański M., Szymczak P. Impact of meniscus injury and chondromalacia on the patient-reported outcome after arthroscopic treatment // *Journal of Clinical Medicine*. — 2025. — Vol. 14. - P. 1–12.
9. Liang YY, Zhang X., Wang J. Research progress of knee fibrosis after anterior cruciate ligament reconstruction // *Frontiers in Pharmacology*. — 2024. — Vol. 15. - Article 1493155.
10. Tangsriwong K., Sakulsriprasert P., Bunprajun T. Effects of high-intensity laser therapy on knee pain and function in osteoarthritis patients // *Journal of Musculoskeletal Surgery and Research*. — 2025. — Vol. 9. - P. 354–360.
11. Schmolke S., Majewski M., Kuster M. The use of lasers in surgical orthopedics: a current review // *Unfallchirurg*. - 1997. - Vol. 100. - P. 577–586.
12. Wang M., Li Y., Zhang H. Surface electromyography and movement analysis in musculoskeletal rehabilitation: current applications and future directions // *Journal of Rehabilitation Medicine*. — 2019. — Vol. 51. - P. 561–569.
13. Stutzig N., Siebert T. Assessment of neuromuscular function using H-reflex and EMG techniques in sports medicine // *European Journal of Sport Science*. — 2017. — Vol. 17, No. 8. - P. 1012–1020.

14. Aagaard P., Simonsen EB, Andersen JL Neural adaptation to resistance training: changes in H-reflex and motor unit activation // *Journal of Applied Physiology*. - 2002. - Vol. 93. - P. 1318–1326.
15. Greenhaff PL, Timmons JA Skeletal muscle energy metabolism during high-intensity exercise // *Sports Medicine*. - 1998. - Vol. 25, No. 2. - P. 109–122.