https://ijmsphr.com

DOI: - 10.37547/ijmsphr/Volume07Issue04-09

Open Access Research Paper

INTERNATIONAL JOURNAL OF MEDICAL SCIENCE AND PUBLIC HEALTH RESEARCH

Vol. 07, No. 04, April 2026, 44-49

eISSN 2767-3774

Optimization of Treatment Strategy in Patients with Mild Acute Pancreatitis Based on The Inclusion of Low-Intensity Laser Irradiation

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Article Received: 19/03/2026, Article Accepted: 03/04/2026, Article Published: 29/04/2026

Abstract

To evaluate the effectiveness of including low-intensity laser irradiation (LILI) in the complex therapy of mild acute pancreatitis, with emphasis on pain relief, surgical strategy, and long-term treatment outcomes. Materials and Methods. A total of 60 patients with mild acute pancreatitis were examined and randomized into two groups: the main group (n=30), which received standard treatment combined with LILI, and the control group (n=30), which received standard treatment only. Treatment effectiveness was assessed based on the dynamics of pain syndrome using the visual analogue scale (VAS), the frequency of surgical interventions, length of hospital stay, and recurrence rate during 12 months of follow-up. Results. Patients in the main group demonstrated a more rapid decrease in pain intensity: the median VAS score by day 3 was 2.1 points versus 3.8 points in the control group ($p<0.01$). The frequency of sanitation laparoscopy was lower in the main group (10% versus 33.3%; $p<0.05$), as was the need for emergency cholecystectomy and ERCP. The mean length of hospital stay was reduced in the main group (3.8±0.3 versus 4.6±0.3 days; $p<0.05$). During one-year follow-up, recurrence of acute pancreatitis was observed in 6.7% of patients in the main group compared with 23.3% in the control group ($p<0.05$). The developed management algorithm allowed optimization of treatment strategy by reducing repeated hospitalizations and the number of surgical interventions. Conclusion. The inclusion of LILI in the treatment of acute pancreatitis provides faster pain relief, reduces the frequency of surgical interventions, shortens the duration of hospitalization, and decreases the risk of disease recurrence. This method may be considered a pathogenetically justified and clinically effective supplement to standard treatment protocols.

Keywords: Acute pancreatitis; pain; low-intensity laser irradiation; surgical strategy; long-term outcomes.

Introduction

Acute pancreatitis (AP) is one of the most relevant problems in abdominal surgery and intensive care. It is characterized by pronounced pain syndrome, a high risk of complications, and significant socioeconomic losses. Despite the introduction of modern diagnostic and therapeutic algorithms, the frequency of complicated forms of the disease and the need for surgical interventions remain high [1]. The pathogenesis of AP includes early activation of proteolytic enzymes, development of a systemic inflammatory response, and microcirculatory impairment, which determine the severity of the clinical

picture and influence disease outcomes [1].

Current clinical guidelines, including ACG, IAP/APA, and Canadian guidelines, emphasize the need for a comprehensive approach that includes adequate pain management, optimization of surgical strategy, and monitoring of long-term treatment outcomes [2, 3]. An important direction is the use of adjunctive technologies capable of accelerating pain relief, reducing the frequency of surgical interventions, and decreasing recurrence rates. Among such methods, low-intensity laser irradiation (LILI) is considered promising due to its analgesic, anti-inflammatory, and microcirculatory effects [4].

Clinical and experimental studies have shown that the use of LILI contributes not only to relief of pain syndrome but also to functional recovery, a reduction in repeated hospitalizations, and improvement in patients' quality of life [5, 6]. In this regard, investigation of the role of LILI in the complex therapy of AP, with emphasis on pain syndrome, surgical outcomes, and long-term results, appears to be a justified and relevant scientific direction.

Objective of the study. To evaluate the effectiveness of including low-intensity laser irradiation (LILI) in the complex therapy of mild acute pancreatitis, with emphasis on pain relief, surgical strategy, and long-term treatment outcomes.

Methods

The study was conducted between 2020 and 2024 at the Republican Specialized Scientific and Practical Medical Center of Surgery named after Academician V. Vakhidov and Central Clinical Hospital No. 1 of the Main Medical Department. A total of 60 patients with mild acute pancreatitis, according to the Atlanta 2012 classification, who were admitted within the first 48 hours from disease onset, were included.

Study Design and Groups. Patients were randomized into two groups:

- Main group (n=30): standard treatment, including infusion therapy, analgesia, and secretion inhibitors, combined with low-intensity laser irradiation (LILI);

- Comparison group (n=30): standard treatment without LILI.

Inclusion Criteria. The inclusion criteria were as follows: age 18–75 years, confirmed diagnosis of mild acute pancreatitis, hospital admission no later than 48 hours from disease onset, and signed informed consent.

Exclusion Criteria. The exclusion criteria included organ failure according to the Marshall score ≥2, pancreatic necrosis, late hospitalization more than 72 hours after disease onset, severe concomitant diseases, pregnancy, and photosensitivity.

LILI Technique. Laser exposure was performed using "Mustang" or "Milta" devices. The wavelength was approximately 890 nm, output power was 5–10 mW, and modulation frequency was 1000 Hz. Sessions were performed 1–2 times per day, with a duration of 10–15 minutes each. The treatment course lasted 5 days.

Evaluation Criteria. The following parameters were used to assess treatment effectiveness:

1. Pain relief according to the visual analogue scale (VAS).

2. Surgical strategy, including the frequency of sanitation laparoscopy, emergency and elective laparoscopic cholecystectomy, and endoscopic interventions such as ERCP.

3. Hospital outcomes, including length of hospital stay and complication rate.

4. Long-term outcomes, including recurrence of acute pancreatitis and repeated hospitalizations during 12 months of follow-up.

5. Optimization of treatment strategy through development of a management algorithm for patients based on the effectiveness of LILI.

Statistical Analysis. Normality of distribution was assessed using the Shapiro–Wilk test. Quantitative data were analyzed using Student's t-test or the Mann–Whitney U test, depending on distribution characteristics. Categorical variables were analyzed using the χ^2 test or Fisher's exact test. Recurrence-free survival was assessed using the Kaplan–Meier method. Differences were considered statistically significant at $p<0.05$.

Results

The use of LILI in the main group made it possible to achieve more rapid relief of inflammation in mild acute pancreatitis. This was reflected in a decrease in the frequency of sanitation laparoscopy to 10% compared with 33.3% in the comparison group (p=0.029), an increase in the possibility of performing laparoscopic cholecystectomy electively from 13.3% to 40.0% in patients with biliary AP without worsening of disease course (p=0.020), and an overall reduction in the need for urgent surgical interventions while maintaining an equal frequency of ERCP in both groups (33.3%; p=0.785) (Table 1).

Table 1.

Comparative Analysis of the Need for Invasive Interventions in Patients with Mild Acute Pancreatitis

Intervention	Comparison group (n=30)	Main group (n=30)	χ^2	p

Sanitation laparoscopy	10 (33.3%)	3 (10.0%)	4.81	0.029
Laparoscopic cholecystectomy in biliary AP	4 (13.3%)	12 (40.0%)	5.5	0.020
ERCP	10 (33.3%)	10 (33.3%)	0.075	0.785

In the main group, the level of pain according to the VAS decreased from 7.8±0.5 to 3.1±0.4 points by the 3rd day of therapy. In the comparison group, the corresponding decrease was from 7.6±0.6 to 4.8±0.6 points. The between-group difference was statistically significant ($p<0.01$) (Figure 1).

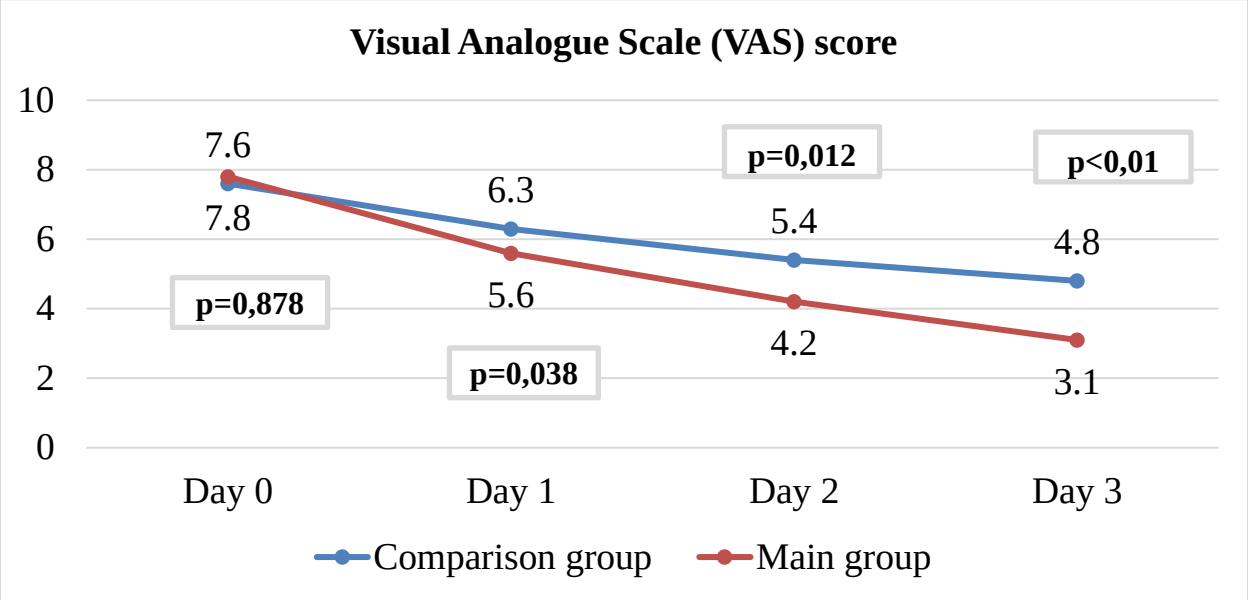

Figure 1. Dynamics of Pain Severity in Acute Pancreatitis

In the long-term perspective, analysis of freedom from recurrence of AP, presented in Figure 2, demonstrated a significant advantage in the main group.

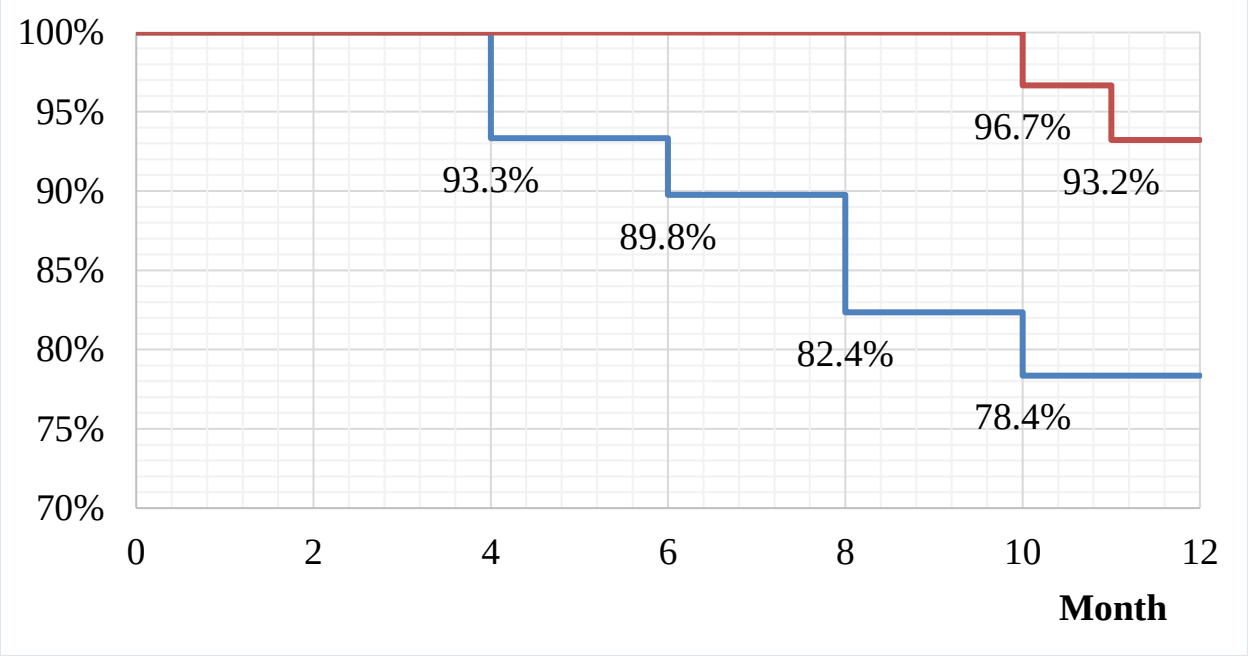

Figure 2. Curve of Freedom from Recurrence of AP Symptoms During 12 Months

During 12 months after therapy, the recurrence-free course rate was 93.2% in the main group (95% CI: 0.76–0.99), whereas in the comparison group it decreased to 78.4% (95% CI: 0.61–0.92). Notably, no recurrence episodes were recorded in the main group during the first 8 months, whereas in the comparison group the decrease in recurrence-free survival began as early as the 4th month.

Thus, the obtained data demonstrate that inclusion of low-intensity laser therapy in the complex treatment of mild acute pancreatitis contributes to faster relief of clinical and laboratory manifestations of the disease, accelerates regression of inflammation, and improves long-term outcomes by reducing the risk of recurrence.

Optimization of Treatment Strategy in Patients with Mild Acute Pancreatitis

Thus, LILI has a selective and physiological effect: it stimulates microcirculation without inducing hyperfunction, supports the integrity of the endocrine apparatus of the pancreas, and does not cause irritation or necrotic changes when used at an appropriate dose.

LILI should be prescribed as early as possible, within the first 1–3 hours after diagnosis. This approach allows minimization of interstitial edema, vascular congestion, and leukocytic infiltration already by days 1–2. According to experimental data, edema decreased from 3.0 to 1.2 points ($p<0.001$), while infiltration decreased from 2.8 to 1.0 points ($p<0.001$).

Preference should be given to course-based, repeated application of LILI to improve completeness of tissue recovery. According to experimental results, by day 5 the morphological state of pancreatic tissue approached normal values, with an integral score of 0.4±0.1 versus 9.2±0.4 in the untreated group ($p<0.001$).

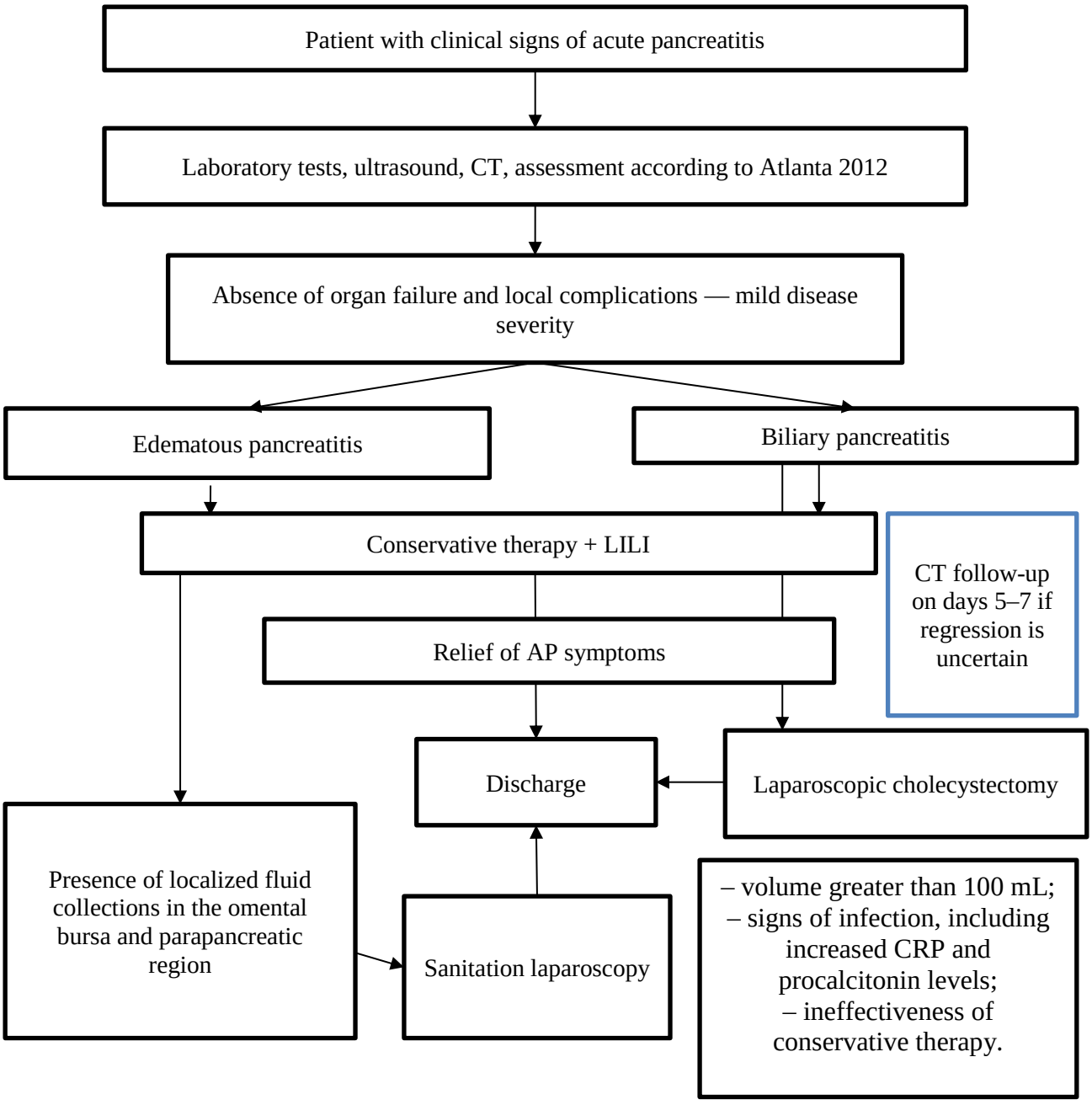

Figure 3. Algorithm for Diagnosis and Treatment of Mild Acute Pancreatitis

According to the algorithm (Figure 3), when mild AP is established, that is, in the absence of signs of organ failure and local complications, differentiation is performed between edematous and biliary pancreatitis. Patients in both categories receive conservative therapy, including infusion and analgesic support, secretion inhibitors, and LILI. A mandatory element of management is dynamic monitoring of clinical symptoms and laboratory parameters every 24–48 hours, as well as planned CT examination on days 5–7 if there is doubt regarding regression of the inflammatory process or suspicion of complications.

When AP symptoms are relieved and no signs of inflammatory progression are present, the patient may be discharged for outpatient follow-up. The discharge summary includes recommendations for repeated ultrasound or CT examination after 2–4 weeks, planned laparoscopic cholecystectomy in cases of biliary pancreatitis, diet therapy, and monitoring of pancreatic enzyme levels.

If CT or ultrasound reveals localized fluid collections in the omental bursa or parapancreatic region, particularly with a volume greater than 100 ml, as well as in the presence of signs of infection such as increased CRP and procalcitonin levels or lack of response to conservative therapy, sanitation laparoscopy is indicated. This allows timely evacuation of pathological contents and prevention of progression of the infectious process.

Thus, the presented algorithm provides a staged and individualized management strategy for patients with mild AP, taking into account both the need for conservative therapy and functional support, as well as the conditions requiring timely surgical intervention in the presence of complications.

The LILI regimen used was as follows: device — infrared laser “Mustang” or “Milta”; wavelength — approximately 890 nm; power — 5–10 mW; modulation — 1000 Hz; session duration — 10–15 minutes; frequency — 1–2 times per day; treatment course — 5 days; technique — transcutaneous irradiation of the pancreatic projection area.

The therapeutic effect should be monitored based on clinical and laboratory parameters, including reduction of pain syndrome (VAS <3), positive dynamics of laboratory markers such as CRP, amylase, and bilirubin, restoration of intestinal peristalsis, and normalization of the ultrasound picture. Lack of effect within 48–72 hours requires reassessment of treatment strategy.

Against the background of a positive clinical and laboratory response, LILI creates conditions for safe performance of elective laparoscopic cholecystectomy on days 5–7. This makes it possible to eliminate the cause of the disease and reduce the risk of recurrence.

Discussion

The results of the present study demonstrate that inclusion of LILI in the complex therapy of patients with acute pancreatitis provides faster relief of pain syndrome and a significant reduction in the need for analgesics. These findings are consistent with the results of Urmantseva et al. (2019), who demonstrated a pronounced analgesic and anti-inflammatory effect of laser therapy in patients with chronic pancreatitis [4].

Surgical outcomes are of particular importance. According to Forsmark et al. (2016), the need for surgical interventions in AP is directly associated with the severity of inflammation and development of complications [1]. In our study, the frequency of sanitation laparoscopy and emergency interventions in the main group was substantially lower, indicating the possibility of using LILI as a factor optimizing surgical strategy. These conclusions are consistent with international guidelines by Banks and Freeman (2006) and Greenberg et al. (2016), which emphasize the importance of minimizing unjustified interventions [2, 3].

Analysis of long-term outcomes showed that recurrence of pancreatitis within 12 months occurred significantly less frequently in the group of patients who received LILI. Similar findings were previously reported by Meng et al. (2013), where the use of combined treatment methods led to a reduction in repeated hospitalizations and improved quality of life [6].

Finally, the obtained results allow LILI to be considered an element of optimization of treatment strategy in patients with acute pancreatitis. The use of this method does not contradict international standards, including IAP/APA 2013 and Tenner et al. 2013, but rather complements them by providing a pathogenetically oriented therapeutic effect [7, 8].

Thus, inclusion of low-intensity laser irradiation in the complex therapy of AP makes it possible to optimize treatment through faster pain relief, reduction in the frequency of surgical interventions, and decrease in the number of recurrences in the long-term period. These data confirm the need for further multicenter randomized studies to clarify exposure parameters and formalize the method in international clinical protocols.

Conclusion

The use of LILI in the complex therapy of mild acute pancreatitis demonstrated a significant advantage in terms of the dynamics of pain syndrome, timing of restoration of intestinal motor function, and relief of fever. It was associated with a decrease in the frequency of sanitation laparoscopy and an increase in the proportion of elective cholecystectomies in patients with biliary disease etiology. It also contributed to shorter hospital stay and a reduction in recurrence rate in the long-term period, confirming the pathogenetic validity and clinical feasibility of including this method in standardized management protocols for patients with mild acute pancreatitis.

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