

# Enhanced recovery after surgery (ERAS) protocols in inguinal hernia surgery: current state of the problem. Review

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Inguinal hernia remains one of the most common surgical conditions worldwide. Despite substantial advances, including the development of minimally invasive hernia repair techniques, issues related to functional treatment outcomes are still relevant, particularly the intensity of early postoperative pain, time to return to usual physical activity, quality of life, and the risk of chronic postoperative inguinal pain (CPIP). In this context, Enhanced Recovery After Surgery (ERAS), also known as accelerated postoperative recovery, represents a promising model for standardizing perioperative management in patients with inguinal hernias.

**OBJECTIVE** – of this review was to summarize current data on the application of ERAS principles in inguinal hernia surgery, with an emphasis on preoperative, intraoperative, and postoperative components, and their potential impact on pain, functional recovery, length of hospital stay, complication rates, and patient-reported outcomes.

The review examines the role of preoperative patient education, risk stratification, correction of comorbidities, rationalization of preoperative fasting, prevention of postoperative nausea and vomiting, selection of the surgical approach and method of prosthetic material fixation, multimodal analgesia, maintenance of normothermia, individualized infusion therapy, selective antibiotic prophylaxis, early mobilization, resumption of oral nutrition, prevention of urinary retention, and thromboprophylaxis. The implementation of ERAS in inguinal hernia surgery involves adapting the general principles of enhanced recovery to address key challenges in herniology: minimizing early and chronic pain, reducing opioid exposure, accelerating functional recovery, ensuring safe early discharge, and improving patients' quality of life. Laparoscopic techniques, such as transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) repairs, offer advantages within the ERAS framework compared with open techniques, provided that adequate material and technical resources are available. Nevertheless, the choice of surgical treatment method should be individualized for each patient. Future efforts should now focus on establishing unified, hernia-specific ERAS protocols and prioritizing prospective studies that assess long-term treatment outcomes.

## KEYWORDS

hernia, inguinal, herniorrhaphy, enhanced recovery after surgery, laparoscopy, postoperative pain, postoperative care, analgesia, multimodal.

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Inguinal hernias remain among the most common abdominal wall disorders and represent one of the most frequently encountered conditions in surgery, with operative treatment required in most cases. Updated international guidelines indicate that more than 20 million operations for groin hernias are performed worldwide each year [44]. Despite the high overall effectiveness of contemporary surgical techniques for inguinal hernia repair, the problem of unfavorable functional outcomes, primarily chronic

postoperative inguinal pain (CPIP), has not lost its relevance. On the contrary, CPIP is now regarded as one of the key criteria for evaluating the success of hernia repair [32, 44]. Systematic reviews and meta-analyses report a highly variable incidence of CPIP, ranging from 10 % to 63 % for any pain intensity and from 1 % to 18 % for moderate or severe pain affecting daily activity [17]. The 2024 systematic review and meta-analysis by Chu et al. found a pooled CPIP incidence of 17.01 % (95 % CI 12.78–21.71 %),

whereas a 2022 meta-analysis of randomized trials by Singh et al. showed that, at long-term follow-up exceeding 5 years, CPIP prevalence decreased to 4.69% after laparoscopic hernia repair and 6.91% after open hernia repair [9, 41]. Although this outcome varies substantially depending on the hernia repair technique, pain definition criteria, and follow-up duration, some patients experience severe and persistent pain that significantly affects daily activity and psychosocial functioning [9, 25].

Over recent decades, the concept of accelerated postoperative recovery, known as fast-track surgery or Enhanced Recovery After Surgery (ERAS), has been actively implemented in surgical practice. ERAS is currently defined as an evidence-based, multimodal, and multidisciplinary perioperative care pathway aimed at early recovery after surgical intervention by preserving preoperative functional capacity, attenuating the surgical stress response, and standardizing key treatment stages [18, 42]. The primary objectives of ERAS are to ensure adequate pain control, minimize organ dysfunction, shorten hospital stays, reduce complication rates, accelerate hospital discharge, and facilitate the patient's return to their usual level of daily activity. A large meta-analysis of 74 randomized clinical trials by K. M. Sauro et al., which evaluated ERAS protocol outcomes across gastrointestinal, gynecological, urological, and cardiovascular surgeries, demonstrated that ERAS implementation was associated with a mean reduction in hospital length of stay by 1.88 days and a decreased risk of postoperative complications [38].

Inguinal hernia surgery is particularly well-suited to the fast-track approach due to its predominantly elective nature, the standardization of key operative steps, and the feasibility of integrating minimally invasive techniques. In this context, ERAS should be considered not merely as a set of individual perioperative interventions but as a tool for standardizing the entire patient pathway – from preoperative counseling and analgesia optimization to early mobilization and safe, rapid discharge – which is particularly important for elective procedures performed within the day-surgery model.

**OBJECTIVE** – to summarize the available evidence on the application of ERAS protocols in inguinal hernia surgery, with an emphasis on the preoperative, intraoperative, and postoperative components of perioperative management.

This descriptive narrative review examines the current application of enhanced recovery after surgery (ERAS) protocols in inguinal hernia surgery. The literature search was conducted in the PubMed, Scopus, and Web of Science databases using the following keywords and their combinations:

*ERAS, enhanced recovery, enhanced recovery after surgery, inguinal hernia, groin hernia, hernia repair, hernioplasty, herniorrhaphy, TAPP, TEP, laparoscopic inguinal hernia repair, postoperative recovery, postoperative pain, chronic postoperative inguinal pain, multimodal analgesia, and postoperative nausea and vomiting.*

The review included clinical studies, systematic reviews, meta-analyses, narrative reviews, and international guidelines published predominantly between 2020 and 2025. Priority was given to sources directly related to inguinal hernia surgery, laparoscopic hernia repair techniques, postoperative pain, chronic postoperative inguinal pain, multimodal analgesia, and patient functional recovery. Publications from other surgical fields were referenced only to illustrate general perioperative ERAS principles and were not considered direct evidence for the effectiveness of specific ERAS components in inguinal hernia repair. Since this article is a descriptive narrative review rather than a systematic review or meta-analysis, the search strategy did not include a PRISMA flow diagram construction, quantitative evidence synthesis, or a formal risk-of-bias assessment for each included study. Source selection was determined by relevance, novelty, methodological quality, clinical significance, and applicability to inguinal hernia surgery.

### **ERAS concept in inguinal hernia surgery**

In inguinal hernia surgery, the ERAS concept should be considered as a perioperative management model adapted to the specific requirements of herniology, rather than as a direct transfer of protocols developed for major abdominal procedures. While in other surgical fields ERAS is primarily associated with reduced complication rates, shorter hospital stays, and standardized perioperative pathways, in herniology its value is determined by the unique clinical profile of groin hernia repair, where pain control and patient-reported functional recovery are the primary treatment outcomes [14, 16, 43].

The general ERAS framework encompasses preoperative patient education, multimodal analgesia, minimizing opioid exposure, preventing postoperative nausea and vomiting, early mobilization, early resumption of oral intake, and safe discharge planning [18, 19]. In patients with inguinal hernias, these components should be applied selectively and interpreted in light of available hernia-specific evidence. Some measures, such as multimodal analgesia, opioid-sparing strategies, choice of surgical approach, and early mobilization, are directly related to the main clinical

priorities of hernia repair. Other elements, including nutritional optimization, normothermia maintenance, rational fluid therapy, and some antiemetic strategies, mainly serve as supportive perioperative measures that improve the safety and predictability of early recovery, while their independent impact on long-term hernia-specific outcomes remains insufficiently established [26, 45].

Accordingly, an ERAS program should be viewed as a coherent but flexible system of perioperative management. Each stage has independent practical value, while the overall effect depends on the coordinated implementation of components that are clinically relevant to the individual patient and surgical setting. This approach provides the rationale for the separate consideration of preoperative, intraoperative, and postoperative ERAS components in patients with inguinal hernias.

It is essential to distinguish ERAS from day surgery and ambulatory hernia surgery. Day surgery primarily refers to an organizational model in which patients are discharged on the day of the operation after appropriate postoperative observation. Ambulatory hernia surgery describes the setting and logistics of care delivery, whereas ERAS represents a structured perioperative pathway that may facilitate safe same-day discharge but is not synonymous with it. Therefore, in the context of inguinal hernia repair, ERAS should be understood as a standardized approach designed to enhance the safety, predictability, and reproducibility of early recovery, rather than merely as outpatient treatment.

## Preoperative stage of ERAS

The preoperative stage of ERAS in inguinal hernia surgery is perhaps one of the most important components of perioperative patient management, as it creates the prerequisites for a predictable operative course, adequate pain control, and subsequent functional recovery. Evidence from studies and recommendations reflecting experience with ERAS implementation across various surgical fields indicates that standardized preoperative management, patient-centered counseling, and early planning for postoperative recovery are fundamental to the effective implementation of the entire ERAS program [21].

### Patient education

One of the key elements of the preoperative stage is detailed patient education, since treatment effectiveness depends not only on the technical success of hernia repair but also on how closely the postoperative course aligns with patient expectations regarding pain intensity, the pace of recovery of

daily activities, working capacity, and quality of life. Beyond explaining the planned intervention, preoperative education should address the anticipated pattern of postoperative pain, the estimated timeframe for returning to the usual level of physical activity, possible functional limitations in the early postoperative period, and warning signs that may indicate a complicated course requiring further medical attention.

This approach allows patients to develop a realistic understanding of the postoperative period, thus reducing anxiety and improving adherence to the proposed treatment strategy. In addition, proper preoperative counseling fosters more active patient participation in the recovery process, which is one of the basic principles of ERAS. The 2023 systematic review by Brodersen et al. found that preoperative educational preparation enhances patients' understanding of all treatment stages, increases compliance, facilitates psychological adaptation to surgery, and leads to a more favorable postoperative recovery [4]. This aspect is particularly important in herniology, where a substantial proportion of treatment outcomes are assessed subjectively by patients.

### Perioperative risk stratification and correction of comorbidities

In patients with inguinal hernias, preoperative optimization should involve assessment of somatic status, anesthetic risk, including evaluation according to the ASA classification, the presence of metabolic and cardiovascular disorders, baseline pain syndrome, history of previous surgical interventions, and factors that may influence the postoperative course, such as the need for analgesia and the anticipated rate of functional recovery. This approach enables the identification of patients at increased risk of unfavorable postoperative recovery before surgery and the provision of individualized perioperative management.

The 2024 systematic review and meta-analysis by Alaverdyan et al., which focused on risk factors for persistent postoperative pain after inguinal hernia repair, identified younger age, female sex, the presence of preoperative pain, recurrent hernia, postoperative complications, and severe early postoperative pain as factors associated with a higher risk of pain chronification. In this study, the authors emphasized that understanding these factors can support personalized risk prediction and inform the development of targeted strategies to reduce this risk [2]. In addition, current guidelines for managing groin hernias in adult patients emphasize the need for individualized decision-making, taking into account the clinical presentation, hernia type,

and patient expectations, which is consistent with the ERAS concept as a patient-centered model of perioperative care [30].

Evaluating and optimizing the degree of comorbidity compensation is an integral component of the preoperative stage of the ERAS protocol. Particular attention should be paid to cardiovascular diseases, diabetes mellitus and obesity, chronic kidney disease, respiratory disorders, anemia and malnutrition, hemostatic disorders, and the use of anti-coagulants or antiplatelet agents. Neglecting these conditions can adversely affect intraoperative and postoperative outcomes by reducing tolerance to surgical stress and increasing the risk of wound infections, bleeding or thrombosis, and other general complications after surgical interventions.

However, it should be noted that postponing surgery until all parameters are completely normalized to achieve «ideal» patient optimization is not justified. The priority should be to attain the highest possible compensation for clinically significant conditions within a realistic timeframe, w balancing the benefits and risks in each individual hile carefully case [13].

### **Preoperative fasting and nutritional support**

Nutritional optimization and avoidance of unjustifiably prolonged fasting are other important aspects of preoperative preparation. Extended abstinence from food and fluids does not improve anesthesia safety and may increase thirst, discomfort, anxiety, dehydration, and the metabolic stress response. For patients without increased aspiration risk, current guidelines recommend abstaining from solid food for 6 hours before anesthesia, while fatty foods, meat, or large meals should be avoided for approximately 8 hours. Clear fluids, such as water, tea, or coffee without milk, clear juices without pulp, and special carbohydrate-containing drinks, are permitted up to 2 hours before elective surgery. The updated 2023 guidelines from the American Society of Anesthesiologists endorse the intake of carbohydrate-containing clear fluids up to 2 hours before elective procedures in appropriately selected patients [29].

Within an ERAS program, reducing preoperative fasting duration and, in selected patients, implementing carbohydrate loading can improve perioperative comfort and attenuate the metabolic stress response. In patients without disorders of carbohydrate metabolism, this usually involves administering a carbohydrate-containing clear drink on the evening before surgery and again up to 2 hours before anesthesia. In elective inguinal hernia repair, these measures are most relevant as part of standardized perioperative preparation designed to avoid unnecessary fasting, thirst, dehydration, and

patient discomfort. Conversely, in patients with diabetes mellitus, metabolic syndrome, obesity with impaired glycemic control, gastroparesis, symptomatic gastroesophageal reflux, or other conditions that increase aspiration risk, the fasting regimen and the appropriateness of carbohydrate loading should be individualized.

### **Prevention of postoperative nausea and vomiting**

Prevention of postoperative nausea and vomiting (PONV) should be planned before inguinal hernia repair, as even relatively short procedures may cause nausea and vomiting that interfere with early oral intake, mobilization, patient comfort, and readiness for discharge. Consensus guidelines indicate that PONV occurs in approximately 30% of the general surgical population, with incidence rising to 80% in high-risk patients [15]. Although most evidence for PONV prevention originates from general anesthesiology and perioperative medicine rather than hernia-specific trials, its inclusion in an ERAS-oriented pathway for inguinal hernia repair is clinically justified. In this setting, PONV prophylaxis should be regarded not as an independent hernia-specific intervention, but as a supportive perioperative measure that helps maintain the continuity of early recovery after a short, low-trauma procedure.

PONV prevention should include two primary strategies: reduction of baseline risk and pharmacological antiemetic prophylaxis. Baseline risk reduction measures include minimization of perioperative opioid use through multimodal analgesia, preference for regional or local analgesic techniques when appropriate, administration of propofol for anesthesia induction and maintenance, limitation of inhalational anesthetics and nitrous oxide, adequate hydration, and avoidance of unjustifiably prolonged preoperative fasting. Within the ERAS framework, these measures are prioritized because they simultaneously lower PONV risk, reduce the need for opioids, and promote faster functional recovery [22, 27].

The simplified Apfel score is commonly used for practical risk stratification. This tool incorporates four predictors: female sex, nonsmoking status, history of PONV or motion sickness, and expected postoperative opioid use. The presence of 0, 1, 2, 3, or 4 risk factors corresponds to an estimated PONV risk of 10%, 20%, 40%, 60%, and 80%, respectively [12]. In patients with identified risk factors, multimodal antiemetic prophylaxis with agents with different mechanisms of action is advisable. Standard regimens include dexamethasone 4–8 mg intravenously after anesthesia induction and a 5-HT<sub>3</sub> receptor antagonist, such as ondansetron

4 mg intravenously at the end of surgery. In high-risk patients, additional agents such as droperidol 0.625–1.25 mg or NK1 receptor antagonists may be considered. As the number of risk factors increases, the use of a broader antiemetic combination becomes more justified than relying solely on reactive treatment after symptom onset.

### Preoperative preparation of the surgical field and antibiotic prophylaxis

Preoperative preparation of the surgical access site and antibiotic prophylaxis in inguinal hernia repair should be addressed distinctly from protocols commonly applied, for example, in colorectal surgery. Mechanical bowel preparation is not routinely used. However, thorough assessment of the risk of infectious complications, proper skin preparation, and rational systemic antibiotic prophylaxis remain important ERAS components in these patients.

Preparation of the operative field should focus on minimizing skin microtrauma and bacterial contamination. Hair removal at the surgical access site should be performed immediately before surgery using an electric clipper, as razor shaving is associated with a higher incidence of surgical site infections [39].

Antibiotic prophylaxis should be prescribed selectively. The updated HerniaSurge guidelines state that antibiotic prophylaxis is not recommended for elective open mesh repair in average-risk patients under low infection-risk conditions. Similarly, routine antibiotic prophylaxis is not advised for laparoscopic inguinal hernia repair. When antibiotic prophylaxis is indicated, first-generation cephalosporins or  $\beta$ -lactam combinations with  $\beta$ -lactamase inhibitors remain the agents of choice, in accordance with the local microbiological profile and institutional protocols [44].

### Intraoperative stage of ERAS

The intraoperative stage of ERAS in inguinal hernia surgery should be aimed at minimizing surgical trauma, ensuring stable anesthetic management, achieving effective pain control, and facilitating early postoperative recovery. Unlike major abdominal procedures, inguinal hernia repair typically does not result in substantial blood loss or pronounced fluid and electrolyte imbalances. Therefore, intraoperative ERAS components should be adapted to the less invasive nature of this operation. Key elements of this stage include a standardized anesthetic strategy, rational selection of the surgical approach, multimodal analgesia, intraoperative PONV prevention, maintenance of normothermia, and moderate, individualized infusion therapy.

### Anesthetic management and multimodal analgesia

Anesthetic management should be tailored to the type of hernia repair, patient age, somatic status, and expected recovery rate. In laparoscopic procedures, such as totally extraperitoneal repair (TEP) and transabdominal preperitoneal repair (TAPP), general anesthesia is usually administered using short-acting inhalational or intravenous agents. This approach enables precise control of anesthetic depth and faster postoperative awakening.

Within the ERAS framework, preference should be given to the strategies that minimize perioperative opioid use through multimodal analgesia, local anesthetic infiltration, or regional blocks. In elderly patients or those at increased risk of postoperative neurocognitive disorders, anesthetic depth should be monitored using the bispectral index (BIS), with values maintained predominantly between 40 and 60. This practice helps prevent both insufficient and excessive depth of anesthesia. The randomized study by Chen et al. (2022) demonstrated that BIS monitoring within this range was associated with a reduced incidence of delayed neurocognitive recovery after surgery, although these findings pertain to general anesthesiology and are not specific to inguinal hernia repair [8].

Multimodal analgesia is a core element of ERAS protocols in inguinal hernia surgery. In addition to pain relief, it contributes to perioperative opioid exposure reduction, PONV prevention, early mobilization, and decreased risk of persistent postoperative pain. This approach combines systemic non-opioid analgesics, local or regional analgesia, and limited use of opioids as rescue medications.

The basic agents are paracetamol, administered at a dose of 1 g intravenously or orally before or during surgery, and continued every 6 to 8 hours during the first postoperative day. NSAIDs or selective COX-2 inhibitors, such as ibuprofen, ketorolac, or celecoxib, are also used in standard intravenous or oral doses.

Fascial plane blocks of the anterior abdominal wall, primarily the transversus abdominis plane (TAP) block, play an important role in perioperative pain management. The TAP block provides analgesia of the anterolateral abdominal wall by injecting a local anesthetic, usually ropivacaine or bupivacaine, into the plane between the internal oblique and transversus abdominis muscles, where the branches of the intercostal nerves, subcostal nerve, ilioinguinal nerve, and iliohypogastric nerve pass. In inguinal hernia repair, this technique is most beneficial in the early postoperative period, especially within the first 24 hours, when pain at trocar sites and in the preperitoneal dissection area may impede mobilization.

A retrospective study of patients after TEP repair found that a TAP block with 30 mL of 0.375 % ropivacaine on the hernia side reduced pain intensity during the first 6 postoperative hours from 4.0 to 2.7 points on the VAS [33]. Furthermore, the meta-analysis by Zeng et al. showed that TAP block decreased the incidence of postoperative nausea by 10 % and reduced the consumption of fentanyl and morphine in the study group [47].

However, the TAP block should be considered a component of a multimodal analgesic regimen rather than a standalone method. Its effectiveness depends on the block technique, timing of administration, and the overall analgesic strategy [23].

Other effective regional block techniques for inguinal hernia repair include ilioinguinal and iliohypogastric nerve blocks. These are performed by injecting a local anesthetic under ultrasound guidance into the fascial plane between the internal oblique and transversus abdominis muscles near the anterior superior iliac spine, where the corresponding nerves are most commonly visualized [40]. Local infiltration at trocar or incision sites is also used, offering the obvious advantages of technical simplicity and eliminating the need for additional equipment.

It should be noted that, within an ERAS program, the routine simultaneous use of all available analgesic techniques is not appropriate, partly due to the risk of exceeding the maximum safe dose of local anesthetics. Instead, analgesic regimens should be individualized depending on the type of surgical approach, the expected severity of postoperative pain, and available healthcare facility resources.

### **Maintenance of normothermia and infusion therapy**

Maintaining normothermia and individualized fluid management are universal elements of safe perioperative care and can be incorporated into an ERAS-oriented pathway for inguinal hernia repair. Although these measures are not specific to herniology, they are relevant for patients undergoing inguinal hernia surgery, as they may reduce anesthesia-related discomfort, postoperative shivering, nausea, urinary retention, and delayed mobilization. In this context, these measures should be regarded primarily as supportive strategies that contribute to a more predictable early recovery.

Intraoperative hypothermia, usually defined as a core body temperature below 36 °C, is associated with postoperative shivering, patient discomfort, coagulation disorders, a higher risk of surgical site infection, and delayed recovery. Although elective inguinal hernia repair is usually a relatively short procedure, temperature control remains important

for elderly patients, those with increased anesthetic risk or low body mass index, those with cardiovascular comorbidities, or those with a prolonged laparoscopic procedure expected. In such cases, active warming with forced-air warming systems for 20–30 minutes before surgery, warming of infusion fluids when larger volumes are used, and regular temperature monitoring should be considered [35].

Intraoperative infusion therapy during elective inguinal hernia repair should be moderate and individualized. Since these operations generally do not involve major blood loss or substantial fluid shifts, routine administration of large volumes of crystalloids is not justified. The practical goal is to maintain normovolemia while preventing both hypovolemia and fluid overload. Hypovolemia may lead to weakness, orthostatic reactions, and postoperative nausea and vomiting, whereas excessive fluid administration may increase postoperative discomfort, nausea, urinary retention, and discharge delays. Therefore, fluid administration should be based on the duration of surgery, type of anesthesia, baseline hydration status, comorbidities, and hemodynamic parameters, rather than fluid strategies designed for major abdominal operations [35].

### **Surgical strategy**

The choice of surgical approach is one of the key intraoperative aspects of ERAS in inguinal hernia surgery, as it influences early postoperative pain intensity, mobilization speed, recovery duration, and the risk of chronic postoperative inguinal pain (CPIP). In contemporary herniology, laparoscopic TEP and TAPP repair techniques are most consistent with the principles of minimally invasive surgery and the general ERAS concept. Haladu et al. conducted a review of randomized studies, including 21 systematic reviews and meta-analyses, which found that laparoscopic hernia repair results in a statistically significant 26–46 % reduction in the risk of CPIP compared with open techniques [20].

The updated international HerniaSurge guidelines emphasize the need for individualized treatment selection, taking into account hernia characteristics, patient somatic profile, available healthcare facility material resources, and surgeon expertise. A primary objective of the guideline update is to improve treatment outcomes by reducing the incidence of recurrence and CPIP – the two most common problems after hernia repair. In this context, the laparoscopic approach is considered a preferred option for faster functional recovery of patients [44].

At the same time, the widely used minimally invasive TEP and TAPP repair techniques are considered comparable in terms of final clinical outcomes,

with the choice between them usually guided by surgeon preference [1].

An important intraoperative ERAS consideration for inguinal hernia repair is minimizing additional tissue trauma during mesh implantation and fixation. Preference should be given to methods that ensure reliable implant fixation until integration with the tissues, while minimizing pain-related complications. Contemporary systematic reviews and meta-analyses indicate that adhesive fixation, compared with tackers, results in reduced pain on the first postoperative day and a lower risk of CPIP, without a statistically significant difference in wound infection, operative time, recurrence, or other general complications [37, 31].

Routine drainage, which is actively discussed within ERAS for major abdominal surgery, is not a subject of debate in elective inguinal hernia repair. From an enhanced recovery perspective, unjustified drain placement may increase patient discomfort, restrict mobilization, increase the risk of infectious complications, and potentially delay discharge. Therefore, drainage in inguinal hernia surgery should be reserved for managing postoperative wound complications in selected cases, rather than used as a routine prophylactic measure [36].

## Postoperative stage of ERAS

The postoperative stage of ERAS in inguinal hernia surgery is, in fact, a continuation of preoperative and intraoperative strategies designed to promote early functional recovery. Its main components, such as continuation of multimodal analgesia, opioid restriction, PONV prevention, and rational provision of infusion therapy, remain relevant. However, these measures specifically aim to ensure early mobilization and prompt resumption of oral fluid and food intake, and to minimize unjustified invasive procedures.

After surgery, analgesic management should primarily focus on transition to oral non-opioid medication, provided that nausea and vomiting are absent or adequately controlled. This approach maintains the intraoperative multimodal strategy and supports early mobilization, thereby eliminating the need for parenteral analgesia in uncomplicated cases [7].

## Early patient mobilization and resumption of oral food and fluid intake

The timing of resuming oral fluid and food intake after inguinal hernia repair should be individualized depending on the patient's clinical condition, with early initiation prioritized. Clear fluids should be introduced once the patient is fully awake, hemodynamically stable, and not experiencing pronounced

nausea or vomiting. In most cases, with an uncomplicated postoperative course, this can occur within the first few hours after surgery, starting with a few sips of still water or tea and gradually increasing the volume if nausea and bloating are absent.

Similarly, considering the aforementioned factors, food intake should be resumed with light meals 4–6 hours after awakening. Fatty, fried, and spicy foods, as well as large portions at a single meal, should be avoided. Most patients can return to the usual diet within 24 hours after surgery [46].

## Prevention of postoperative urinary retention

Prevention and early detection of postoperative urinary retention after inguinal hernia repair are important to avoid unjustified bladder catheterization and to promptly identify high-risk patients. Reported incidence rates of postoperative urinary retention after inguinal hernia repair range from 0.4% to 22.0%, depending on patient characteristics, anesthesia type, and diagnostic criteria for this complication [6].

The most common risk factors include older age, use of anticholinergic drugs, a history of urinary retention, chronic constipation, involvement of the urinary bladder in the hernia sac, benign prostatic hyperplasia, excessive perioperative intravenous fluid administration, and prolonged surgery [10].

In patients at increased risk of urinary retention, dynamic postoperative monitoring is advisable. Ultrasound assessment of bladder filling should be performed approximately 6–8 hours after the last urination if spontaneous urination has not occurred in the postoperative period, even in the absence of clinical symptoms [5]. Ultrasound assessments should be repeated every 2–3 hours until spontaneous urination occurs or until the threshold bladder volume requiring decompression is reached. Catheterization is generally indicated at a bladder volume of approximately 500–600 mL, or at a lower volume if clinical symptoms of bladder overdistension are present. This approach can significantly reduce the frequency of unjustified catheterization [34].

If catheterization is required, single intermittent catheterization with a Nelaton catheter is preferred in uncomplicated cases, followed by further monitoring of spontaneous urination. Indwelling catheter placement should be reserved for recurrent urinary retention, suspected bladder outlet obstruction, or when dynamic ultrasound monitoring is not feasible. Indwelling catheters should be removed after 24–72 hours, following an attempt at spontaneous urination and confirmation that the residual urine volume does not exceed 200 mL.

From the ERAS perspective, routine transurethral bladder catheterization after inguinal hernia

repair is not recommended. In most elective cases, strict adherence to the perioperative ERAS program is sufficient to prevent urinary retention.

### Thromboprophylaxis

Thromboprophylaxis after inguinal hernia repair should be selective and based on an individual assessment of venous thromboembolism (VTE) risk. The Caprini score facilitates VTE risk stratification by considering factors such as age, body mass index, duration and type of surgery, history of VTE, malignancy, thrombophilia, prolonged immobilization, hormone therapy, varicose veins, and other relevant variables [11]. Based on the cumulative score, a patient is assigned to a specific risk group, appropriate preventive measures for thrombotic complications are selected, and the duration of prophylaxis is determined.

For patients classified as low risk for VTE, including most patients after elective inguinal hernia repair, early mobilization without pharmacological prophylaxis is generally sufficient, since this operation is short in duration and minimally traumatic. Conversely, patients classified as high risk based on several contributing factors require combined VTE prophylaxis. This approach includes mechanical methods, such as elastic bandages, compression stockings, or intermittent pneumatic compression devices, together with pharmacological agents, predominantly low-molecular-weight heparins with individualized dose calculation [3, 28].

The administration of pharmacological VTE prophylaxis, regardless of its duration, should not independently determine the timing of patient discharge.

### Evidence strength and clinical relevance of individual ERAS components

The strength of evidence supporting individual ERAS components in inguinal hernia surgery is heterogeneous. The most consistent hernia-specific evidence relates to the choice of surgical approach, prevention of chronic postoperative inguinal pain, and the use of opioid-sparing multimodal analgesia. Laparoscopic techniques have been associated with faster recovery and a lower risk of chronic pain in appropriately selected patients. The decision between TEP and TAPP approaches should be primarily based on anatomical considerations, previous operations, technical complexity, and surgeon expertise. Similarly, multimodal analgesia has a clear clinical rationale in herniology, as adequate early pain control directly influences mobilization, opioid use, and the risk of persistent pain.

Evidence regarding regional blocks, including TAP block, ilioinguinal and iliohypogastric nerve blocks, and local infiltration, is supportive but more variable. Their effectiveness depends on the type of hernia repair, the timing of administration, technical execution, the local anesthetic dosage, and the overall analgesic regimen. Mesh fixation strategies are also relevant to hernia-specific outcomes. Available data support a selective and less traumatic approach to mesh fixation, especially when pain prevention is a priority, although this must be weighed against recurrence risk in large medial hernias.

By contrast, components such as nutritional optimization, PONV prevention, normothermia maintenance, rational fluid therapy, and early oral intake are supported mainly by general ERAS and anesthesiology literature. In inguinal hernia repair, these measures should be viewed as supportive perioperative quality initiatives that facilitate early recovery, rather than as interventions with independently proven effects on long-term hernia-specific outcomes. Recognizing this distinction is important for the future development of standardized ERAS protocols in herniology.

### Limitations of available studies and prospects for standardization of ERAS protocols in herniology

Despite widespread implementation of ERAS programs across various surgical fields, their application in inguinal hernia surgery is still in the early stages of development and requires further standardization. Most available recommendations partly rely on general ERAS principles established in colorectal, general abdominal, urological, and other areas of surgery. Although these principles provide a valuable conceptual basis, they cannot be directly extrapolated to elective inguinal hernia repair without considering the procedure's lower invasiveness, shorter recovery trajectory, and specific spectrum of clinically relevant outcomes in herniology. Therefore, conclusions about ERAS components based predominantly on general perioperative evidence should be formulated with caution, especially when their independent effects in inguinal hernia populations have not been specifically demonstrated.

The absence of a standardized ERAS protocol for inguinal hernia surgery leads to substantial variability in clinical practice across healthcare institutions. This variability encompasses preoperative counseling, anesthesia selection, use of regional blocks, antibiotic prophylaxis, mesh fixation techniques, and perioperative analgesia. Such heterogeneity complicates the assessment of outcomes and

hinders clear determination of which ERAS components are mandatory and which should be applied selectively depending on the patient profile, hernia type, and selected hernia repair technique.

Economic considerations are also important for the practical implementation of ERAS in herniology. Given the high volume of inguinal hernia repairs, even minor changes in hospital stay, use of disposables, analgesic prescriptions, unplanned consultations, or time to return to work may have significant economic implications. ERAS-oriented care may reduce indirect costs by promoting earlier functional recovery and decreasing unnecessary postoperative resource use. However, some components, particularly laparoscopic equipment, disposable instruments, mesh fixation devices, regional anesthesia resources, and structured postoperative follow-up, may increase direct perioperative costs [24]. The feasibility of implementing hernia-specific ERAS protocols is therefore influenced by clinical effectiveness, local resources, surgical volume, reimbursement systems, and institutional organization. Future studies should include cost-effectiveness analyses alongside clinical outcome assessments.

Another challenge is the heterogeneity of endpoints reported in existing studies. While some investigations focus on the length of hospital stay, others evaluate early postoperative pain intensity, opioid requirements, or complication rates. Long-term patient-oriented outcomes, such as chronic postoperative inguinal pain, quality of life, return to work, physical activity levels, and treatment satisfaction, are often underrepresented. These variables are particularly important in inguinal hernia repair, as successful surgical elimination of the hernia does not always translate into optimal functional outcomes.

A promising direction for advancement is the development of hernia-specific ERAS protocols tailored separately for open and laparoscopic inguinal hernia repair. These protocols should delineate preoperative, intraoperative, and postoperative components, while still allowing individualized patient management.

Further research should not only confirm the overall effectiveness of ERAS but also elucidate the impact of individual components on treatment outcomes. Prospective, randomized, multicenter cohort studies comparing standardized, hernia-specific ERAS protocols with conventional perioperative patient management would be particularly relevant.

These studies should focus on long-term outcomes at 3, 6, and 12 months, including the incidence of CPIP, quality of life, return to work, recurrence rates, and overall treatment costs.

## Conclusions

Enhanced recovery after surgery protocols in inguinal hernia surgery should be regarded as an integrated perioperative management model adapted to the specific clinical priorities of herniology. These protocols offer potential benefits, including improved consistency of perioperative care, reduced early postoperative pain and opioid exposure, earlier mobilization, safer discharge, and enhanced patient-oriented functional recovery.

Laparoscopic techniques, including TAPP and TEP, are well aligned with the ERAS concept when performed in appropriately selected patients and by teams with sufficient technical expertise. However, open surgical techniques remain important in some clinical situations. Therefore, the choice of surgical approach should be individualized based on hernia characteristics, somatic status, previous operations, local resources, and the surgical team's experience.

The evidence supporting individual ERAS components in inguinal hernia surgery remains heterogeneous. Some components, particularly laparoscopic access, multimodal opioid-sparing analgesia, early mobilization, and standardized discharge criteria, have clear clinical relevance for hernia repair. Other measures, including nutritional optimization, normothermia maintenance, rational fluid therapy, and some antiemetic strategies, primarily serve as supportive perioperative measures. Their role is to improve the safety and predictability of early recovery, whereas their independent effect on long-term hernia-specific outcomes has not been sufficiently established.

Thus, further development of ERAS in inguinal hernia surgery should focus on the creation of standardized but flexible hernia-specific protocols, clearer differentiation between ERAS and routine ambulatory hernia surgery, and the implementation of prospective studies evaluating chronic postoperative inguinal pain, quality of life, return to work, recurrence rates, readmissions, and cost-effectiveness.

## DECLARATION OF INTERESTS

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## AUTHORS CONTRIBUTIONS

A. V. Trots: concept and study design, collection and processing of material, manuscript writing;

O. V. Perekhrestenko: critical revision and scientific editing.

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## Застосування протоколів прискореного післяопераційного відновлення (ERAS) у хірургії пахових гриж: сучасний стан проблеми. Огляд

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Пахові грижі залишаються однією з найпоширеніших хірургічних патологій. Попри суттєвий розвиток, зокрема малоінвазивних методик герніопластики, актуальними є питання щодо функціональних результатів лікування, інтенсивності раннього післяопераційного болю, термінів повернення до звичної фізичної активності, якості життя та ризику хронічного післяопераційного пахового болю. У цьому контексті концепція прискореного післяопераційного відновлення (Enhanced Recovery After Surgery, ERAS) є перспективною моделлю стандартизації періопераційного ведення пацієнтів із паховими грижами.

**Мета** — узагальнити сучасні дані щодо застосування принципів ERAS у хірургії пахових гриж із акцентом на доопераційні, інтраопераційні та післяопераційні компоненти, а також на їхній потенційний вплив на біль, функціональне відновлення, тривалість госпіталізації, частоту ускладнень і суб'єктивні пацієнт-орієнтовані результати лікування.

Розглянуто роль доопераційного інформування пацієнта, стратифікації ризику, корекції супутньої патології, раціоналізації доопераційного голодування, профілактики післяопераційної нудоти та блювання, вибору хірургічного доступу й методу фіксації протезного матеріалу, мультимодальної аналгезії, підтримання нормотермії, індивідуалізованої інфузійної терапії, селективної антибіотикопрофілактики, ранньої мобілізації, відновлення перорального харчування, профілактики затримки сечі та тромбопрофілактики. Специфіка ERAS у хірургії пахових гриж полягає в адаптації загальних принципів прискореного відновлення до ключових проблем герніології: мінімізації раннього та хронічного болю, зменшення опіоїдного навантаження, прискорення функціонального відновлення, безпечної ранньої виписки та поліпшення якості життя пацієнтів. Лапароскопічні методики трансабдомінальної преперитонеальної пластики і тотальної екстраперитонеальної пластики мають переваги в концепції ERAS порівняно з відкритими методиками за наявності належної матеріально-технічної основи. Вибір методу хірургічного лікування має ґрунтуватися на індивідуальному підході до пацієнта. У перспективі доцільно розробити уніфіковані ERAS протоколи для пахової герніопластики і провести проспективні дослідження з акцентом на оцінці переважно віддалених результатів лікування.

**Ключові слова:** пахова грижа, герніорафія, прискорене відновлення після операції, лапароскопія, післяопераційний біль, післяопераційний догляд, мультимодальна аналгезія.

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