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Fast-track surgery and enhanced recovery after surgery concepts after their application in hernia repair

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ABSTRACT

The growing number of surgical interventions that occur worldwide, along with the increasing prevalence of general somatic pathology, keeps current the problem of preventing complications during surgery and in the postoperative period. An efficient solution to this problem is to determine the risk of surgery, directed preoperative preparation, taking into account the comorbidity, optimization of surgery and postoperative rehabilitation. Fast-track surgery and enhanced recovery after surgery programs have significant potential for improving outcomes of surgery. These programs are widely used in various fields of surgery, but their effectiveness in herniology, especially in the performing simultaneous surgeries, there are very few reports, and the results of individual studies are contradictory. The review provides an analysis of holistic strategies of fast-track surgery and enhanced recovery and individual measures to assess the effectiveness of their impact on the immediate results of surgical interventions.

Keywords: fast-track surgery, enhanced recovery after surgery, multimodal anesthesia, ventral hernia repair, immediate result

INTRODUCTION

Surgery for many diseases is a mandatory or optional method of treatment. According to a global study, the total number of surgeries in 2012 was 359.5 million, which is 38% more than in 2004 [1]. At the same time, even after elective surgeries, the frequency of complications reaches 16.8%, and postoperative mortality – 0.5% [2]. Postoperative complications are the cause of death, long-term or permanent deterioration of health and huge material losses of national health systems. Most publications on surgical topics are devoted to the prevention of early and late complications after various surgeries. Multiple measures of preoperative preparation, improvements in methods of surgical interventions, intraoperative and postoperative management of patients were offered. But a really revolutionary approach was the similar strategy of fast-track surgery (FTS) and enhanced recovery after surgery (ERAS).

COMPREHENSIVE STRATEGIES IN IMPROVING THE SURGICAL OUTCOMES

FTS and ERAS strategies are relatively new concepts of surgical care for patients based on an understanding of the pathophysiology of post-aggressive responses to surgery and other non-drug and drug interventions. The term fast-track surgery can be defined as a coordinated perioperative approach to the treatment of the patient, which aims to maximize the intensity of surgical stress

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and recovery of the patient as soon as possible after surgery [3]. The main principle of fast-track surgery is the treatment of the disease with minimal disruption of the patient's physiology using evidence-based strategies to accelerate recovery after surgery. The combination of the best surgical methods, modern anesthesia and pain control methods is aimed at reducing the perioperative response to stress and organ dysfunction, the frequency of postoperative complications, along with reducing the cost and duration of inpatient treatment [4,5]. ERAS strategy is focused mainly on optimizing of postoperative management of patients, but with the use of similar multimodal principles. This method is also used in the surgery of ventral hernias [6].

The consistent concept of fast-track surgery and enhanced recovery applies to all stages of perioperative care with a large number of different measures in the preoperative period, during surgery and in the postoperative period [4,7]. Preoperative assessment allows determining the risks and the possibility of stabilizing the comorbidity and optimizing the function of the organs before surgery. Comorbidity increases the risk of complications and mortality during abdominal wall reconstruction, so the protocols of enhanced recovery should take into account preoperative improvement of the condition [8]. Careful preoperative preparation of patients in whom hernioplasty is planned, allows preventing postoperative complications [9]. In addition, patients receive information about the planned course of postoperative tretment, analgesia, mobilization and activation program. Several studies have shown that such information can reduce anxiety, the need for narcotic analgesics, reduce or eliminate the side effects associated with their use, and length of hospital stay [10-12]. K. Slim and D. Standaert (2020) believe that in patients with postoperative ventral hernias (PVH), due to comorbidity, pre-rehabilitation with smoking cessation, treatment of obesity or excessive weight loss and diabetes mellitus (DM) is the most important in enhanced recovery programs. But the level of evidence in patients with PVH is not yet sufficient [13,14].

In most programs of enhanced recovery after surgery, when choosing the method of surgical intervention, minimally invasive methods are preferred, in particular, with the use of video laparoscopic techniques. Open hernioplasty is associated with a significant amount of surgical trauma, as well as a greater expectancy of systemic inflammatory response, significant stress on humoral mechanisms, greater manifestations of pain, greater need for analgesics [15-17].

However, in many cases it is not possible to abandon open surgeries. Shyam D.C. and Rapsang A.G. (2013) reported that «open» surgeries can be used in patients of older age groups. Despite the fact that the use of «open» technology is associated with longer hospital stays, the mortality rate is zero, and the complication rate and recurrence rate is very low, even in those with concomitant diseases [18]. Nanavati A.J. and Prabhakar S. (2014) in the analysis of the frequency of use of "open" and laparoscopic techniques in fast-track surgery found that most clinical studies that examined the fast-track procedures involved the liberal use of laparoscopic methods. However, when the protocol of optimal perioperative care was used for open surgeries, no significant difference was found between the results of treatment [19]. It should also be noted that the use of laparoscopic technique is associated with certain complications, the probability of which is higher in elderly and senile patients and in the presence of serious comorbidity [20]. Patients with reduced cardiovascular and respiratory function, including chronic heart failure (CHF), chronic obstructive pulmonary disease (COPD), emphysema, and pneumosclerosis have an increased risk of hypoxemia during laparoscopic procedures [21].

The use of a combination of fast-track rehabilitation methods can affect the outcome more than the choice between laparoscopic technique and «open» surgery. The results of some studies indicate that within the emergency surgery program there is no difference between laparoscopic and open surgery in terms of postoperative recovery or duration of hospital stay [22, 23]. On the other hand, the results of the analysis of the effectiveness of enhanced recovery programs and their components showed that the improvement of results was associated with the most complete implementation of the protocol, and among the individual components had a significant impact only minimally invasive procedure (OR = 0.63; 95% CI – 0.4-0.9), which led to a decrease in the duration of hospitalization and the frequency of severe complications [24].

One of the reasons for the adverse consequences of surgical interventions is inadequate preoperative preparation. Traditional bowel preparation showed to be potentially harmful, increasing the risk of sepsis and worsening postoperative dehydration. Instead of long-term refusal from oral food and fluid intake, it is allowed to drink up to

150 ml orally 2 hours before surgery to quench thirst. Additional intravenous administration to patients for a night before the planned surgery, as well as one hour before the start of 5% glucose solution with electrolytes significantly increases the patient's comfort, relieving thirst, eliminating hunger and anxiety [25,26].

In the complex of emergency surgery, an important measure is to abandon the routine use of nasogastric tubes and drainage of the abdominal cavity. It was found that they rather increase the complications of the postoperative period and prolong the hospital stay [27,28]. Abdominal drainage does not prevent the development of complications but, on the contrary, is more often associated with the development of postoperative ileus [29-31].

Adequate postoperative nutrition is very important. The oral way of administration is traditionally limited in the postoperative period and involves a gradual transition from fluid intake to solid foods. However, several studies have shown that early eating is safe even after bowel resection because early enteral nutrition reduces intestinal permeability, which also reduces infection by reducing bacterial translocation. Rapid recovery of peristalsis is facilitated by epidural anesthesia, refusal or reduction of opioid dose, normalization of water-salt metabolism and targeted drug therapy [32-35]. In the last decade, in order to prevent disorders of motor-evacuatory function of the gastrointestinal tract, Alvimopan has been used, which is an antagonist of peripheral μ (mu)-opioid receptors and slows down the inhibitory effect of opioid analgesics on the gastrointestinal tract [36-38]. Another extremely "fashionable" way to solve the problem of postoperative ileus removal is the use of chewing gum by patients undergone surgery. Chewing gum promotes early recovery of intestinal function after abdominal surgery, which explains the increase in the concentration of gastrin, neurotensin neuropeptide, pancreatic polypeptides with increased secretion of the duodenum and increased myoelectric activity of the intestine [39-41].

Enhanced recovery of complete nutrition makes it possible to optimize fluid supply. Excessive parenteral hydration can lead to lung and heart dysfunction, impair wound healing due to edema and reduced tissue oxygenation. The accumulation of fluid in the intestinal interstitium leads to an increase in intra-abdominal pressure (IAP), helps to limit pulmonary ventilation, circulatory disorders in the intestinal wall and restricts renal blood flow. Therefore, the management of infusion therapy should be arranged for each patient [42,43].

Early mobilization of the patient is a universal component of any enhanced recovery protocols. Prolonged bed rest increases muscle loss, contributes to hypoventilation, lung dysfunction, infections and thromboembolic complications. Early mobilization of patients instead reduces fatigue, improves sleep, accelerates the return to leisure activities and significantly reduces the risk of the negative effects mentioned above [44-46].

Multimodal analgesia during surgery and in the postoperative period is of particular importance in enhanced recovery programs. Postoperative pain exacerbates the surgical response to stress, organ dysfunction, and delays recovery. Severe stress and active use of opioids make it difficult to restore full gastrointestinal function and delay the activation of patients [47-49]. Therefore, multimodal analgesia is used in surgeries associated with subsequent intense pain. The principle of multimodal or balanced analgesia is to obtain additional effects from various forms of pain control while minimizing side effects, such as sedation, nausea, ileus and urinary retention. Multimodal analgesia combines several strategies. First of all, it is the rejection of opioids and the use of non-opioid drugs, which include nonsteroidal anti-inflammatory drugs (NSAIDs), glutamate antagonists (magnesium, ketamine), GABAergic measures (gabapentin), agonists of α2-adrenergic receptor as well as methods of regional anesthesia [50-52]. Due to the use of NSAIDs, a powerful anti-inflammatory effect is achieved, which after surgery provides a significant reduction in the severity of pain and significantly reduces its duration, which contributes to early motor activation of patients after surgery [53,54]. Reducing the need for opioids accelerates the restoration of cognitive functions, effective self-breathing, absorption capacity of the stomach and intestinal wall, provides a rapid reduction in IAP, and at the same time increases and accelerates blood flow in the intestinal wall and renal blood flow [22,55].

In addition, in many cases, attempts are made to limit the use of general anesthesia through the widespread use of regional anesthesia, including spinal and epidural anesthesia, transversus abdominis plane block (TAP-block) techniques, and blockade of nerve trunks and vaults prolonged catheterization [56]. In patients with inguinal hernias, paravertebral block, as the main method of anesthesia or as a supplement to general anesthesia, contributed to reduce the frequency and severity of urinary retention after hernioplasty and provided good anesthesia [57]. Blockade of the

transversus abdominis plane block (TAP) was proposed as an effective measure as part of multimodal analgesia in abdominal surgery, including PVH plastic surgery. The essence of this procedure is to introduce a local anesthetic into the space between the internal oblique and transverse muscles of the abdomen, where there are branches of sensitive thoracolumbar nerves that innervate the anterolateral parts of the anterior abdominal wall. Prolonged liposomal forms of local anesthetics (most often bupivacaine) or prolonged catheter administration are used to prolong the duration of the blockade [58]. To ensure the effectiveness of the TAP-block procedure, a clear positioning of the needle (or catheter) in the intermuscular space is required. To do this, the most commonly used needle insertion under the control of ultrasound [59]. But it is possible to do this under the control of direct visualization [60]. The use of TAP-block contributed to reduce the duration of inpatient treatment and decrease the dose of opioids in the 1st and 2nd postoperative days compared with patients who received epidural analgesia [61]. A meta-analysis of 10 controlled studies found that TAP-block was no less effective than epidural blockade in children and adults, but could lead to hypotension [62]. Instead of the TAP-block, ilio-inguinal-iliohypogastric block was also proposed, which proved to be even more effective in terms of the effectiveness of analgesia 6 and 8 hours after surgery [63]. This was confirmed by another study in which the procedures were performed under ultrasound control and use of 0.25% bupivacaine at a dosage of 0.3 ml/kg of body weight [64].

Reducing the severity of the systemic inflammatory response, both in «open» and laparoscopic interventions, contributes to intra-abdominal administration during surgery of drugs that can reduce the severity of post-traumatic inflammation. Attention is drawn to the possibility of its modeling by blocking peripheral glutamatergic receptors [65, 66]. The work of El-Gaby S.S. and Mohamed S.S. (2017) showed that intra-abdominal administration during laparoscopic intervention of ketamine, which has antagonism with respect to N-methyl-D-aspartate receptors, leads to a decrease in the severity of the systemic inflammatory response with a decrease in serum IL-6 in the postoperative period compared to the control group [67]. It should be noted that N-methyl-D-aspartate (glutamate) receptors are localized not only in the central nervous system, but are present in the smooth muscles of the stomach and intestines, so their block not only reduces pain, but also reduces the severity of inflammation [68].

In addition, the use of glucocorticoids has been shown to be an effective way to reduce the severity of systemic inflammatory reactions. In particular, a randomized double-blind clinical study found that a single administration of 125 mg of methylprednisolone immediately before surgery (during premedication) resulted in a significant reduction in C-reactive protein concentration, as well as a significant reduction in postoperative pain during activity and cough [69]. Another interesting method of reducing postoperative pain is the intra-abdominal administration of local anesthetics. H.M. Sultan et al. (2015) found a good effect of irrigation of the abdominal cavity with a solution of xylocaine and its introduction after surgery through a special port [70]. A similar result was obtained in another study [72]. N.W. Shady et al. (2018) used abdominal irrigation with a local anesthetic during laparoscopic surgery in patients with gynecological pathology [72]. Another promising way to increase the effectiveness of analgesia is patient-based protocols, which provide for the appointment of analgesics depending on the genetic characteristics of patients – the expression of genes that determine the effectiveness of narcotic and non-narcotic drugs [73].

The results of many studies show that in conditions of multimodal analgesia, in addition to reducing the intensity of postoperative pain, the restoration of respiratory function, stabilization of central hemodynamics and normalization of IAP accelerate, renal vascular resistance decreases and renal blood flow increases [22,74,75]. The use of perioperative multimodal analgesia under the ERAS protocol has reduced opioid use on the day of surgery and on the 1st and 2nd postoperative day [76]. ERAS protocols have been recognized as effective in colorectal surgery, surgical hepatology, gastrectomy, pancreatic surgery, including in the elderly and senile, and in emergency surgery [77].

In recent years, there have been increasing reports of the effectiveness of individual measures or comprehensive accelerated recovery programs in the surgical treatment of ventral hernias. In the surgical treatment of PVH, these programs included preoperative prescription of glucocorticoids, daily evaluation of criteria for discharge and restoration of bowel function using chewing gum and cleansing enema on the second day after surgery [78], multimodal strategy of perioperative analgesia,

use of oral opioid receptor blockers and early enteral nutrition [79]. Multimodal analgesia, early mobilization, and accelerated recovery of bowel function with the use of alvimopan in the surgical treatment of ventral hernias have led to a reduction in the duration of inpatient treatment by 15% [39]. Another study found that enhanced recovery programs helped to restore bowel function earlier and reduce the incidence of wound complications [80].

The introduction of multimodal anesthesia with extensive use of ibuprofen and acetomiphene significantly reduced the need for opioids after ventricular hernia hernioplasty [53]. Significantly reduced the intensity of postoperative pain, accelerated the recovery of intestinal function and reduced the duration of hospitalization with alvimopan, early nutrition and multimodal analgesia with an emphasis on intraoperative nerve block long-acting anesthetic (Exparel) [36]. Some measures that correspond to emergency surgery programs were also proved to be effective. Thus, in the hernioplasty of giant PVH, the prescription of high doses of glucocorticoids before surgery helped to reduce the intensity and duration of pain, nausea and weakness. The duration of inpatient treatment decreased from 5.5 days to 3.0 days ($p = 0.003$), but the frequency of complications and re-hospitalizations did not change [81]. Similar results were obtained in patients undergone surgery for large PVH [82].

But the data obtained are far from unambiguous. Thus, a study C. Harryman et al. (2020) did not find a significant effect of the strategy of enhanced recovery on the duration of hospitalization and the cost of expanses in patients with open hernioplasty of ventral hernias, although the authors note a faster recovery of intestinal function and reducing the incidence of wound complications [83]. According to a study by J. Colvin et al. (2019), the introduction of the ERAS protocol of a patient with ventral hernia did not affect the duration of hospitalization, there was only a tendency to reduce the duration of the required analgesia [6]. Some studies found no benefit on the use of epidural anesthesia in surgical treatment. In contrast, in the group of patients who received epidural anesthesia, the duration of inpatient treatment of PVH was increased; there were complications of epidural anesthesia, and the intensity of postoperative pain was higher [84]. J. Jurt et al. (2017) found that along with the use of a nasogastric tube and drainage of the abdominal cavity, the frequency of complications was increased by intraoperative epidural anesthesia [24].

A recent systematic review and meta-analysis of 5 studies examining the results of the ERAS protocol in patients undergoing anterior abdominal wall reconstruction found no effect on recurrence rates and the incidence of wound complications, but a reduction in hospital stay duration [85]. According to the results of another systematic review and meta-analysis of 5 non-randomized studies, no other positive effect was found except for a reduction in the duration of hospitalization. Patients with enhanced recovery did not show a reduction in complications, bowel recovery time, opioid withdrawal time, urinary catheter removal time, restoration of normal nutrition, and readmission rates compared with controls [86].

CONCLUSIONS

The development and implementation of measures to prevent postoperative complications is a very important component of surgical treatment, especially in patients with extensive surgical interventions. Ventral hernia surgery, in particular large postoperative hernias, carries the risk of both systemic and local complications, which are the cause of long-term rehabilitation, recurrence of hernias and fatal consequences. In this aspect, the most promising are comprehensive FTS and ERAS strategies, which consist of various measures during the preparation for the surgery, during the surgery and in the postoperative period.

The results of research on the effectiveness of enhanced recovery programs in herniology are ambiguous. Issues remain about their feasibility depending on the location of the hernia, its size, method and scope of surgery, in the presence of comorbidity/or when performing simultaneous operations.

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