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Our experience with ERAS program in children with Hirschsprung disease

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Keypoints

To evaluate the safety and efficacy of accelerated surgery (ERAS) combined with laparoscopy in the treatment of Hirschsprung disease in children

Abstract

Introduction

The ERAS program has only recently been applied to children, with the main obstacle being the complexity of pediatric surgeries. Children have their own unique physiological response to surgery, including being more vulnerable to dehydration and hypothermia, having a lower tolerance for intraoperative blood loss, and an increased risk of anesthesia complications. However, the use of ERAS has been limited in the pediatric population due to a clear lack of evidence. We have used components of ERAS in our pediatric patients undergoing surgery for Hirschsprung disease.

Purpose of the study: To evaluate the safety and efficacy of accelerated surgery (ERAS) combined with laparoscopy in the treatment of Hirschsprung disease in children.

Materials and Methods

The study was conducted on 76 children with Hirschsprung's disease who underwent elective surgery with bowel pull-down in the period from 2011 to 2024 in the surgical clinic and in the bases of the AMU. The patients were divided into two groups: the ERAS program combined with laparoscopy (study group, n=38) and the laparoscopic surgery with conventional perioperative management (control group, n=38). Postoperative bowel function recovery, hospital stay, hospital costs, complications were compared, and postoperative recovery was monitored for four weeks.

Results

There were no significant differences in intraoperative blood loss and operative time between the ERAS group and the control group (both P>0.05). Recovery of bowel movements occurred earlier in the ERAS group, but the difference was not statistically significant (P=0.062). Hospital stay was shorter [(5,77±0,8) days versus (14,2±2,8) days], and hospitalization costs were significantly lower in the study group than in the control group.

Conclusion

1. The ERAS protocol is applicable to pediatric Hirschsprung disease surgeries with shorter hospital stay and fewer complications, especially in the form of SSI. We recommend using the maximum number of components based on our experience to obtain optimal results.
2. Accelerated surgery combined with laparoscopy in the treatment of Hirschsprung's disease in children is safe and effective.

Keywords

ERAS, Hirschsprung disease, caudal block

Introduction

Enhanced recovery after surgery (ERAS) was first introduced by Henrik Kehlet in 1997, with the aim of optimizing perioperative care by reducing the physiological response to surgical stress. The ERAS (Enhanced Recovery After Surgery) program is an early rehabilitation program

after surgery based on pathophysiological principles, the main one of which is the limitation of perioperative trauma and the corresponding reduction of the body's stress response. Stress is a term that refers to a non-specific response of the body to external stimuli with subsequent changes in homeostasis necessary for adaptation to changing environmental conditions. As a result of studying the main pathophysiological features of the systemic stress response of the body to the induced trauma, three main methods of preventing or reducing the consequences of the stress response were identified: reducing the volume of surgical trauma, pain control, as well as adequate and timely correction of homeostatic and metabolic disorders through adequate infusion therapy. All surgical interventions are accompanied by pain, which can increase endocrine and metabolic reactions, autonomic reflexes, muscle spasms, nausea, postoperative intestinal paresis and thereby slow down the patient's recovery process. A more effective method of perioperative pain relief is the selective blockade of sensory afferent fibers of the spinal cord without affecting the motor and autonomic centers, which is achieved by using epidural anesthesia, which at the level of the thoracic spinal cord, compared with parenteral use of opioid analgesics, provides not only better postoperative analgesia, but also helps to reduce the period of postoperative intestinal paresis, which is clinically expressed in earlier restoration of peristalsis, regardless of the local anesthetic used. The maximum reduction of the volume of tissue damage without affecting the adequacy of the volume of surgical intervention was and remains the main principle of minimally invasive surgery, the concept of which is based on the concepts of primary and secondary damage during surgery. Primary injury is direct trauma to the anterior abdominal wall as a result of surgical access, as well as to the organs and tissues of the abdominal cavity as a result of surgical manipulations. Secondary injury is associated with pathophysiological changes caused by bleeding, artificial ventilation of the lungs, vasomotor disorders, manifestations of pain afferentation, position on the operating table, as well as intra-abdominal hypertension caused by carboxyperitoneum. Reducing the manifestations of damage during minimally invasive surgery is possible by minimizing neurohumoral stimulation due to the reduction of surgical access and the use of technical means that allow minimizing traumatic tissue damage during the main stage of the operation. Trauma to the anterior abdominal wall can be reduced by changing the orientation of the laparotomy approach. Laparoscopic approach makes it possible to significantly reduce trauma to the anterior abdominal wall. New promising areas for limiting trauma to the anterior abdominal wall in laparoscopic surgery are mini laparoscopy, SILS (Single incision laparoscopic surgery), NOTES (Natural Orifice Transluminal Extraction of Specimen) and hybrid laparo-endoscopic technologies – CELS (Combined Laparoscopic Endoscopic Surgery). It has been established with a high degree of evidence that laparoscopic surgical interventions are associated with less blood loss and the incidence of abdominal adhesive disease due to reduced trauma to the serous membrane of the abdominal organs and the parietal peritoneum. The ERAS program has only recently been applied to children, with the main obstacle being the complexity of pediatric surgeries. Children have their own unique physiological response to surgery, including being more vulnerable to dehydration and hypothermia, having a lower tolerance for intraoperative blood loss, and an increased risk of anesthesia complications. Thus, individual ERAS principles need to be evaluated before they can be widely adopted in children. Enhanced recovery after surgery (ERAS) is a multimodal perioperative pathway that has been shown to improve outcomes after surgery. They are also known as enhanced recovery pathways (ERPs) or expedited surgery in various studies. They consist of several evidence-based perioperative elements that have been shown to be beneficial individually but, when used together, have been shown to significantly improve outcomes. They were initially adopted in adult colorectal surgery and demonstrated shorter hospital stays and fewer complications. However,

the use of ERAS has been limited in the pediatric population due to a clear lack of evidence. We have used components of ERAS in our pediatric patients undergoing surgery for Hirschsprung disease.

Purpose of the study: To evaluate the safety and efficacy of accelerated surgery (ERAS) combined with laparoscopy in the treatment of Hirschsprung disease in children.

Material and Methods

The study was conducted on 76 children with Hirschsprung's disease who underwent elective surgery with bowel pull-down in the period from 2011 to 2024 in the surgical clinic and in the bases of the AMU. The age of the patients ranged from 6 months to 14 years. The patients were divided into two groups: the ERAS program combined with laparoscopy (study group, n=38) and the laparoscopic surgery with conventional perioperative management (control group, n=38). Postoperative bowel function recovery, hospital stay, hospital costs, complications were compared, and postoperative recovery was monitored for four weeks. The following components of the ERAS program were used and modified in the study (Table 1).

Preoperative period	Intraoperative period	Postoperative period
Detailed preoperative consultation	Maintaining normothermia	Non-opioid analgesia
No MBP	Avoiding electrolyte and water overload	Prevention of nausea and vomiting
No prolonged fasting (oral intake of clear liquids 3 hours before surgery)	Enhancement of regional anesthesia (caudal block)	Early oral feeding
Antibiotic prophylaxis	Minimal bowel processing	Early mobilization
	No drains or urinary catheters	Compliance audit and results

Table 1. ERAS program applied to children

Results

There were no significant differences in intraoperative blood loss and operative time between the ERAS group and the control group (both P>0.05). Recovery of bowel movements occurred earlier in the ERAS group, but the difference was not statistically significant (P=0.062). Hospital stay was shorter [(5,77±0,8) days versus (14,2±2,8) days], and hospitalization costs were significantly lower in the study group than in the control group (P<0.01). Postoperative complications and recovery conditions during 4 weeks of observation were similar between the two groups. All personnel involved in the child's care, including parents, were trained in the ERAS protocol. Two gentle micro enemas with saline were the only bowel preparation before surgery. Patients were given multimodal anesthesia based on regional anesthesia in the form of a caudal epidural block with a reduced dose of general anesthesia. Nasogastric tubes were removed the morning after surgery with the start of feeding. This included starting with clear liquid or breast milk, depending on the age of the child. Antiemetics were used judiciously if vomiting occurred. Repeated vomiting or abdominal distension were criteria for stopping feeding once started. Discharge was performed after a soft solid diet was established. The ERAS program was used in all patients in the main group. The outcomes studied were length of hospital stay after surgery and complications, including readmissions up to 1 year after surgery. Complications after surgery included prolonged bowel obstruction, anastomotic leak, surgical site infection (SSI)/sepsis, and adhesive obstruction. The need for antiemetics and opioid analgesia was noted.

Children who underwent traditional preparation received chemical bowel preparation (polyethylene glycol) along with saline enemas, overnight fasting, use of drains, urinary catheters, prolonged retention of a nasogastric tube, feeding after documented stool, and opioid analgesia. There were some minor differences in the components of traditional preparation due to management by different surgeons. In both groups, vicryl was used as the suture

material. The type of intestinal anastomosis used in the main ERP as well as in the control was extramucosal single-layer. There was a significant difference in hospital stay between the two groups. Although complications were lower in the study group (6.6%) compared to the control group (22%), this did not reach statistical significance due to the small number. None of these cases required reoperation. Readmission was required in one case in the control group. In the ERP group, there was no need for opioid analgesics, either intra- or postoperatively. One child required one dose of antiemetic due to vomiting, which stopped immediately.

Statistical analysis the collected data were analyzed using SPSS version 24 software (IBM Corporation). Statistical analysis was performed using the nonparametric Mann–Whitney U test. $P < 0.05$ is considered statistically significant.

Discussion: ERAS is a perioperative program that reduces surgical stress, resulting in a faster return to baseline activity after major surgery. It has been used primarily in adults, but has also been reported in a few pediatric colorectal surgeries. The main components of ERAS used in our study are listed in Table 1. Although 19 components have been described in adults, in our study we used 14 elements that were applicable to children. Components such as premedication and stimulation of intestinal motility were not used in our study. Other components excluded from our study were smoking cessation and thromboprophylaxis, as they cannot be used in children. We used caudal epidural anesthesia rather than midthoracic epidural anesthesia, which appeared to provide adequate anesthesia for Hirschsprung's disease surgery. We will now look at each component in more detail.

Preoperative mechanical bowel preparation (MBP) used in control patients has been shown to be associated with an increased risk of wound infection (16.6%) and increased length of hospital stay, similar to the study by Gollin et al... MBP is used in colorectal surgeries to reduce contamination and thus reduce the incidence of complications such as anastomotic leakage and wound infection. In line with our study, other studies have shown that IPC is associated with an increased risk of anastomotic leakage, wound infection and extra-abdominal morbidity. This may be due to residual loose stool contaminating the surgical site, persistent bacterial load in the bowel despite reduced stool volume, significant loss of superficial mucus/epithelial cells and increased mural lymphocytes. The incidence of extra-abdominal morbidity in the ERAS group in our study was zero compared with 15% in the control group.

In our study, patients in the ERAS group received oral fluids 3 hours before surgery compared to overnight fasting in the control group. This prevents the catabolic effects of surgical stress. Prolonged fasting results in elevated cortisol levels, thereby increasing insulin resistance via inhibition of alpha-2-adrenergic receptors on pancreatic beta cells, hyperglycemia, poor wound healing, and increased risk of infection. Shortening the duration of fasting also reduces protein breakdown and improves muscle function. In addition, there was no evidence of aspiration with shortened fasting with fluid intake, which is similar to our experience.

General anesthesia was used during surgery along with a caudal epidural block using ropivacaine. Although this was used in both study groups, it was more focused in the ERAS group due to a detailed preoperative discussion among the teams about the need to avoid opioids postoperatively. Regional blocks have been shown to not only reduce postoperative pain and help avoid opioids, but also reduce bowel obstruction and maintain the perioperative nutritional profile.

A 2016 systematic review showed that normothermia reduces SSI. Normothermia in our study was maintained by optimal operating room temperature, use of heating pads, and warm fluids as needed. Hypothermia induces shivering and vasoconstriction, which triggers the stress response leading to increased SSI. Maintenance of euvolemia in the perioperative period has been shown to improve recovery after surgery. Our anesthesia team uses goal-directed fluid therapy by monitoring simple

physiological parameters such as heart rate, blood pressure, and urine output. Avoiding prolonged fasting and preoperative carbohydrate drinks also reduce intraoperative fluid requirements. Excessive fluid administration may be associated with increased cardiac demand, pulmonary edema, and intestinal edema, leading to bowel obstruction and hence delayed recovery. Maintenance of normothermia and euvolemia was similar in both study groups. Peritoneal drains and urinary catheters were completely avoided in the ERAS group. We empty the bladder using the Credé maneuver in cases where the bladder is full after induction. Postoperative urine output is measured by weighing diapers in young children. It is well known that urinary catheters increase the risk of urinary tract infections and also cause discomfort to the child. The use of peritoneal drainage does not facilitate early detection of anastomotic leakage, is associated with greater discomfort and an increased risk of wound infection. Nasogastric tubes were removed the day after surgery in the study group. Other studies in the adult literature have also reported removing the nasogastric tube immediately after surgery as it provides no additional benefit.

Postoperatively, we used acetaminophen for pain relief in the control room, with a plan to administer nonsteroidal anti-inflammatory drugs (diclofenac, ketorolac, etc.) as needed. Our goal was to use non-opioid analgesia. Acetaminophen was given with diclofenac in the initial part of the study, but later acetaminophen was used as the sole analgesic. And in patients of the main group there was no need to use analgesics in the postoperative period, since during the caudal block we combined ropivacaine with dexmedetomidine. As a result, the duration of sensory blockade increased to 24 hours. More frequent use of regional anesthesia, relatively small incision, avoidance of drains and early feeding may be the reason for good pain tolerance in this protocol. It is well known that opioid use is associated with adverse effects such as postoperative nausea and vomiting (PONV), respiratory depression, bowel obstruction, urinary retention and potential for addiction. Therefore, multimodal non-opioid analgesia is encouraged in ERAS protocols.

PONV was observed in only one case in the study group, requiring two doses of antiemetic. This may be due to factors such as minimal bowel preparation preventing bowel obstruction and non-opioid analgesia. Therefore, we did not use prophylactic antiemetics as recommended in the ERAS protocol for adults. Feeding was initiated on day 1 postoperatively with clear juice or breast milk (for exclusively breastfed infants). Only one case in the ERAS group experienced ileus before day 2 postoperatively, indicating that all components of the protocol together reduce ileus. Although feeding was initiated at 4–5 days in the control group, two infants experienced ileus before day 7. Our experience is similar to that of others, which found that early feeding was well tolerated without increasing complication rates. This may be because digestion and absorption of food occurs predominantly in the small intestine (80–85%). Thus, any feed will be largely absorbed by the time it reaches the colon. Low-carbohydrate feedings do not cause stool to accumulate in the colon or high-pressure contractions. Early feeding has been recommended in small bowel anastomosis, also with similar results.

Early postoperative mobilization in the ERAS group was performed as soon as the child was comfortable. This was possible because we avoided tubes, drains, and continuous opioid infusions that limit mobility. Early mobilization promotes rapid recovery by several mechanisms. First, it minimizes muscle loss due to physical inactivity. It increases functional recovery by reducing intestinal obstruction through the prokinetic effect, and it reduces thromboembolic complications. The ERAS protocol recommends a 6-hour mobilization on the first postoperative day. We did not specifically follow this time interval, but we never limited the child in mobilization after surgery.

Our results show that ERAS is feasible in children undergoing surgery for Grsprung's disease with fewer complications and length of hospital stay. The results in our study are consistent with various ERAS studies. The

mean length of hospital stay after surgery in our study was 5.77 ± 0.8 days, which is similar to other studies. ERAS protocols have been repeatedly shown to reduce LOS. This translates into reduced costs and burden on healthcare facilities due to increased bed turnover. Complications were observed in only 5.6% of patients with ERAS, without SSI, which is lower than in the control group (21%), similar to the study by West et al … There were no rehospitalizations in the ERAS group during 1 year of follow-up, which is similar to other studies. All this confirms the cost-effectiveness of the ERAS protocol.

There is evidence from numerous studies that poor protocol adherence or implementation of only a few components of ERAS are not sufficient to achieve the full benefits of the ERAS program. Accordingly, there has been a recent focus on including more ERAS components in studies. We have implemented as many components as we can. For success, it is important that all people involved in the child's care are trained and adhere to the protocol. This includes members of the surgical team, anesthesiologists, nursing staff, and parents. Although our numbers in this study are small, we report our positive results to encourage wider and faster adoption of the ERAS protocol for the benefit of patients.

Conclusion

1. The ERAS protocol is applicable to pediatric Hirschsprung disease surgeries with shorter hospital stay and fewer complications, especially in the form of SSI. We recommend using the maximum number of components based on our experience to obtain optimal results.
2. Accelerated surgery combined with laparoscopy in the treatment of Hirschsprung's disease in children is safe and effective.

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