


Minimally invasive surgery and enhanced recovery after surgery: The ideal combination?

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Enhanced recovery after surgery (ERAS) and minimally invasive surgery are both in the limelight due to their potential positive effects on surgical outcome. Large randomized trials and meta-analyses validated the use of both, laparoscopy and ERAS protocol, as individual measures. A synergistic effect of both entities might contribute to even better outcomes. This review hence assessed the literature upon up-to-date studies combining both methods.

KEYWORDS

colorectal surgery, enhanced recovery, laparoscopy, metabolic stress response

1 | INTRODUCTION

Over the past 2 decades, two game-changing developments have emerged in abdominal surgery: laparoscopy and enhanced recovery after surgery (ERAS) multimodal pathways. Although both modalities individually gained acceptance in the surgical community over the years based on convincing data, efforts were made to combine their advantages to provide best possible care to surgical patients. This review addresses the question why minimally invasive surgery should be embedded in enhanced recovery care protocols.

2 | MINIMALLY INVASIVE SURGERY—A SUCCESS STORY

The first laparoscopic cholecystectomy was performed 1985 by a German surgeon named Erich Mühe.¹ Several French surgeons started to perform this revolutionary procedure during the following years and in 1991, the first series of 20 laparoscopic colectomies was published.² Right and left colectomies for benign indications were performed with encouraging results: 80% of patients were able to tolerate liquid diet on the first postoperative day and 70% were discharged within 96 h.

Significant advantages of laparoscopy compared to open surgery were assessed by a randomized controlled trial a few years later with regards to perioperative blood loss, functional recovery, and overall morbidity.³ Over the years, the evidence was strengthened by several meta-analyses regarding short- (morbidity, return of bowel function, hospital stay)⁴ and long-term (equal oncological outcome)^{5,6} results,

which led to a wide adoption of this technique in developed countries.⁷ Despite initial scepticism, laparoscopic surgery offered numerous advantages beyond aesthetics compared to open surgery, and should nowadays be considered as standard of care when both approaches are suitable. Short-term benefits including reduced blood loss, less postoperative pain, accelerated functional recovery, and shorter length of stay (LOS) have been repeatedly demonstrated.^{4,8,9} Even discharge after 23 h has been achieved after laparoscopic colectomy in a selected cohort of young and fit patients.¹⁰ However, these advantages needed to be counter-balanced against oncological safety and long-term outcomes for cancer surgery. The COLOR II study¹¹ underlined the safety and completeness of oncological laparoscopic rectal surgery, and the follow-up study showed similar loco-regional recurrence rates in open and laparoscopic surgery.⁶ Even in earlier comparisons, lymph node harvest and remission rates were not compromised compared to open cancer surgery^{12,13} and continued to evolve with innovation and refinement of the technique,¹⁴ to offer a safe approach even to old and frail patients.^{15,16}

3 | ENHANCED RECOVERY AFTER SURGERY

In 1995, Kehlet and his team published for the first time a series of eight elderly high-risk patients undergoing colectomy within an enhanced recovery scheme.¹⁷ Epidural analgesia, early oral nutrition, mobilization, and laparoscopically assisted surgery were combined to provide “stress-free” colonic resection. Of nine consecutive patients, one had to be excluded due to conversion to open procedure. Effective pain relief and recovery led to a hospital stay of only 2 days.¹⁷ The results

represented a breakthrough in perioperative care, and it is remarkable that the first publication on enhanced recovery was combined with laparoscopy in an era when laparoscopic surgery was just emerging.

During the following years, efforts focused on improvement in pain management after open surgery.¹⁸ The specific role of combined spinal-epidural analgesia was evaluated in a cohort of patients averaging over 70 years and led to a median hospital stay of 2 days after open sigmoidectomy.¹⁹ Several further publications focused on similar care protocols in major open surgery, demonstrating favorable outcome and reduced LOS compared to traditional care pathways.^{20–22}

Today, evidence-based ERAS guidelines through different surgical specialities are available,^{23–25} and a recent meta-analysis confirmed a reduction of overall morbidity and shorter hospital stay without increasing mortality and readmission rate.²⁶

4 | PATHOPHYSIOLOGIC CONSIDERATIONS

The perioperative stress response associated with surgery consists of increased metabolic demand, catabolism, and other physiologic changes.²⁷ A clear understanding of how surgery impacts this stress response is a key to improve clinical outcomes, and to guide surgical and anesthesiologic practice.²⁸

Unimodal measures are not sufficient to face this perioperative deterioration, and thus already 20 years ago, a multimodal approach was suggested.²⁹ Evidence-based items were combined to develop a standardized treatment schedule. Thromboembolic and antibiotic prophylaxis, already accepted risk-reducing tools by that time, were combined with new evidence on pain management and regional anesthesia, minimally invasive surgery and numerous postoperative items including early enteral nutrition.³⁰ In contrast, invasive measures like drains, nasogastric tubes, urinary catheters, and bowel preparation were challenged and mostly excluded from the multimodal care pathways.

To understand the benefits of these measures, their effects have to be observed from a pathophysiologic point of view. Minimally invasive surgery was shown to decrease the inflammatory response to surgery, as pictured by a less significant Interleukin-6 peak compared to open surgery.³⁰ This is probably best illustrated by a recent randomized controlled trial.³¹ Patients with colon cancer were randomized to laparoscopic or open colectomy, either within enhanced recovery or standard care. Different blood samples including systemic HLA-DR expression, C-reactive protein, and Interleukin-6 were analyzed at different time points following surgery. Interestingly, HLA-DR expression as surrogate parameter for immune function in patients undergoing laparoscopic surgery embedded in enhanced recovery care remained highest. The authors attributed this finding to the type of surgery rather than to the care pathway. Similar observations were made with Interleukin-6 and C-reactive protein as inflammatory parameter, measured until the 3rd-postoperative day. Interleukin-6 increase was less pronounced after laparoscopy within standard care than after open surgery within enhanced recovery care (Figure 1). Taken together, these findings suggest that laparoscopy adds benefits in decreasing the surgical stress response even if applied within enhanced recovery care.

5 | EFFECT DUE TO LAPAROSCOPY OR ENHANCED RECOVERY?

Due to the rising evidence and acceptance of both, ERAS and minimally invasive surgery, the question remained whether a combination of the two suits best for perioperative care. Confirming what was previously described, a recent meta-analysis showed that laparoscopy might represent a key factor rather than enhanced recovery care alone, as laparoscopy by itself offered independent advantages beyond ERAS care.³² The study observed a significant reduction in major morbidity in favor of laparoscopy compared to open surgery within ERAS care while there was no difference in complications between conventional care and ERAS in the laparoscopic group. Thus, the authors concluded that laparoscopy had a major additional effect.

The ultimate proof derived from the LAFA-study group, which compared four different care strategies in a prospective four-arm multicenter trial. Patients undergoing colectomy were randomized to laparoscopic versus open colectomy within either fast-track or standard care.³³ Discharge criteria were defined as adequate pain control, ability to tolerate solid food, absence of nausea, passage of flatus, and same mobilization as preoperatively. The authors declared that the most challenging issue was achievement of blinding of patients and caregivers. Hospital stay, which was the primary outcome, was shortest in the laparoscopic enhanced recovery group. Postoperative morbidity was comparable between the four groups. Interestingly, laparoscopy was found to be the only significant independent factor to reduce hospital stay and morbidity. It is important to mention that standard care initially already included 6 out of 15 predefined enhanced recovery items, hence labeled modern standard care. Further, the authors emphasized that an automatic adoption of the protocol among “standard” caregivers cannot be excluded. This “contagious” effect

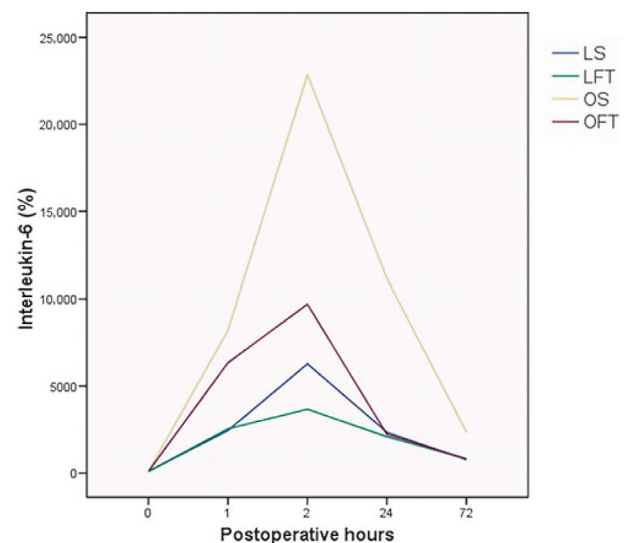


FIGURE 1 Postoperative Interleukin-6 levels according to care pathway. Interleukin-6 levels in percentage with baseline set at 100%. Reproduced from Veenhof AA et al with permission.³¹ LS, laparoscopy and standard care; LFT, laparoscopy and fast track care; OS, open surgery and standard care; OFT, open surgery and fast track care

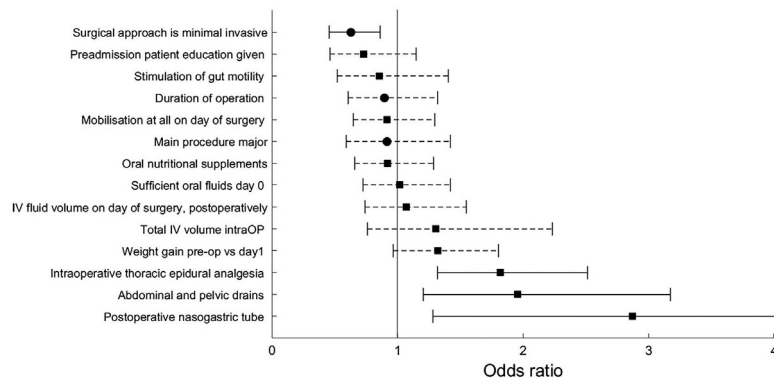


FIGURE 2 Individual impact of ERAS items on postoperative outcome. Adjusted risk factors for overall complications. Reproduced from Jurt J et al with permission.⁴¹ IV, intravenous; vs, versus; day 0, day of surgery. Odds ratios are shown with 95% confidence interval. An OR of more than 1 increases overall complications risk. Significant variables appear as full lines

has previously been described: implementation of an ERAS protocol in colorectal surgery induced a positive impact on patients undergoing non-ERAS-liver surgery on the same ward.³⁴

Several further prospective trials confirmed the superiority of a laparoscopic approach compared to open colorectal cancer surgery within enhanced recovery pathways in terms of recovery and LOS. The EnRoL study,³⁵ a multicenter collaboration of 12 British Institutions, showed similar post-operative physical fatigue scores for both randomized groups. However, median LOS was significantly shorter with 5 days in the laparoscopic group, compared to 7 days in the open group. The multicenter study of Esteban³⁶ compared a prospective cohort of 300 patients with a retrospective cohort treated by traditional care. The combination of fast track and laparoscopy led to a significant reduction in LOS, overall and surgical complications.³⁶ Finally, Tiefenthal³⁷ compared both surgical settings for right-sided cancer of the colon within fully implemented enhanced recovery care, to show earlier pain control and shorter LOS in the laparoscopic group after correction of selection bias.

Interestingly, an earlier comparison failed to demonstrate evident benefits by comparing laparoscopy and open colorectal surgery, while the fast-track prehabilitation program allowed fast discharge at 48 h in both groups.³⁸

The synergistic beneficial effect of combining laparoscopy and ERAS was further demonstrated by several systematic reviews.^{32,39,40}

6 | ENHANCED RECOVERY PROTOCOLS—COMPLIANCE IS THE KEY!

The impact of the individual items of the ERAS protocol on postoperative outcome has been studied recently.^{41,42} Eleven ERAS items and five confounding factors, including type of surgery, were analyzed and led to three main findings:

1. Higher adherence to the intended ERAS pathway was correlated to better clinical outcomes. This has also been shown by Gustafsson, who demonstrated best results with highest compliance,⁴² and in laparoscopic cancer surgery.⁴³
2. A minimal overall compliance of 70% was the threshold to achieve improved postsurgical results.

3. Last, the only independent protective factor for decreased postoperative complications was minimal invasive surgery (Figure 2), underlining the important potential of laparoscopy to contribute to better outcomes even when embedded in ERAS care.

7 | CONCLUSION

A synergistic beneficial effect of minimally invasive surgery and ERAS was repeatedly proven. Thus, laparoscopic surgery should be regarded as key element of modern ERAS care protocols.

CONFLICTS OF INTEREST

All authors have no conflicts of interest to declare.

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