Surgery 165 (2019) 393–397

Contents lists available at ScienceDirect

Surgery

journal homepage: www.elsevier.com/locate/surg

Hernia

Enhanced recovery after abdominal wall reconstruction reduces length of postoperative stay: An observational cohort study

Kristian Kiim Jensen, MD, PhD[a,*], Jannie Dressler, MD[a], Niklas Nygaard Baastrup, MD[a], Henrik Kehlet, MD, PhD, FACS (Hon)[b], Lars Nannestad Jørgensen, MD, DMSc, FACS[a]

[a] Digestive Disease Center, Bispebjerg Hospital, University of Copenhagen, Denmark
[b] Section of Surgical Pathophysiology, Rigshospitalet, University of Copenhagen, Denmark

ARTICLE INFO

Article history:
Accepted 27 July 2018
Available online 6 September 2018

ABSTRACT

Background: Enhanced recovery after surgery has been shown to lead to improved postoperative outcomes after several surgical procedures. However, only a few studies have examined the application of enhanced recovery after surgery after abdominal wall reconstruction. The aim of the current observational cohort study was to evaluate the outcomes of enhanced recovery after surgery after abdominal wall reconstruction in a large cohort.

Method: This was a retrospective cohort study comparing patients undergoing abdominal wall reconstruction in a standard care pathway (control group) with patients undergoing abdominal wall reconstruction in an enhanced recovery after surgery pathway. Registered outcomes included 30-day postoperative complications, length of stay, and readmission rate.

Results: A total of 190 patients undergoing abdominal wall reconstruction for large incisional hernias were included in the study, of which 96 were treated according to standard protocol, and 94 underwent enhanced recovery after surgery pathway. Length of stay was significantly reduced after the introduction of enhanced recovery after surgery (median 4, interquartile range 3–6 days vs. control 5, 4–7 days, $P < .001$). There was no difference between the cohorts in the incidence of postoperative complications requiring operative intervention (enhanced recovery after surgery 10.6% vs control 10.4%, $P = 1.0$) or the rate of readmissions (enhanced recovery after surgery 16.0% vs control 12.5%, $P = .635$).

Conclusion: Enhanced recovery after surgery is feasible after abdominal wall reconstruction, leading to reduced length of stay without increasing the rate of complications or readmissions. Enhanced recovery should be implemented as standard in centers performing abdominal wall reconstruction.

Introduction

Enhanced recovery after surgery (ERAS) is a multimodal evidence-based approach to improve the postoperative outcome after surgical procedures.[1] Using this approach, the rate of postoperative complications and length of postoperative stay has been reduced in almost every surgical specialty during the last 2 decades.[2,3] However, data from ERAS pathways for patients undergoing abdominal wall reconstruction (AWR) is sparse.[4,5]

At our center, ERAS was introduced in 2014 after initial results were published in a pilot study.[4] The pilot study was limited by a low number of included patients, leaving a high risk of type-II error. We hypothesized that in a large cohort, ERAS would lead to reduced length of stay (LOS) and lower complication rates without increasing the readmission rates. Thus, the aim of the current study was to evaluate the complication rates, length of hospital stay, and readmission rates in an ERAS pathway by comparing patients undergoing ERAS after AWR with those who underwent AWR before the introduction of the new pathway.

Methods

This was a retrospective cohort study based on a prospectively kept local database that included all patients undergoing AWR at a regional hernia center, which treated patients with complex abdominal wall defects in the Capital Region of Denmark and serviced 1.8 million inhabitants.

On December 1, 2014, an ERAS pathway was introduced after AWR and was subsequently applied to all patients undergoing AWR. From February 2016 to March 2018, a randomized controlled trial comparing preoperative high-dose glucocorticoid to placebo was conducted at our center, and to minimize bias, the 42 patients

* Corresponding author: Digestive Disease Center, Bispebjerg Hospital, University of Copenhagen, Bispebjerg Bakke 23, DK-2400 Copenhagen NV
E-mail address: mail@kristiankiim.dk (K.K. Jensen).

https://doi.org/10.1016/j.surg.2018.07.035
0039-6060/

included in the randomized controlled trial were excluded from the present analysis. All remaining patients undergoing AWR in the ERAS pathway were included in the study and compared with patients undergoing AWR before the introduction of ERAS. A total of 32 patients treated immediately before and after the introduction of the ERAS pathway were evaluated in a previously published pilot study.[4] These patients were also included in the current study. As a standard, all patients operated on for fascial defects >10 cm are offered open surgery at our center.

All patients underwent retro-muscular mesh placement a.m. Rives-Stoppa, aided by endoscopic anterior components separation or open transversus abdominis release, according to intraoperative assessment.[6,7] Transversus abdominis release was adopted at our center in 2015 and thus only performed in the ERAS group. During the study period, a total of 3 senior surgeons who specialized in hernia surgery performed the operations.

Registered outcomes

Preoperatively, registered data included age, sex, body mass index (BMI), comorbidities, glucocorticoid usage, fascial defect size, number of previous hernia repairs, smoking status, alcohol consumption, and American Society of Anesthesiologists (ASA) score, as well as the use of epidural catheter or transversus abdominis plane block for analgesia. Intraoperative variables included site of mesh placement, type of components separation, contamination grade, and type of mesh used. Postoperatively, all surgical and medical complications, reoperations, LOS, and readmissions within 30 days were registered. Complications were reported according to the Clavien-Dindo ranking score.[8] As a standard, all patients were seen by a hernia surgeon 30 days postoperatively.

The main outcome was complications during the first 30 days postoperatively. Second, postoperative LOS and readmission were analyzed.

ERAS pathway

Preoperative optimization of the patients included complete smoking cessation, weight loss if BMI > 35 kg/m^2, and a reduction in alcohol consumption, if this was excessive. If these demands could not be met and severe symptoms or repeated incarcerations were present, patients were nonetheless offered AWR. The ERAS pathway has been described in detail previously.[4]

At the time of planning of surgery, and again on the day of preoperative admission, patients were informed about the expected postoperative course, including early feeding and early mobilization. One hour before surgery (day 0), oral pain prophylaxis and low molecular weight heparin (tinzaparin) 3,500 IU was administered subcutaneously, and an epidural catheter was applied in the thoracic vertebral interspace 8 to 10, according to the hernia location. After the induction of anesthesia, intravenous methylprednisolone 125 mg was administered as a single shot.

At completion of surgery and before extubation an abdominal binder was applied, and patients were instructed to wear the binder until clinical follow-up 30 days postoperatively.

The epidural analgesia was discontinued at 9:00 PM on postoperative day 2, and the epidural catheter was subsequently removed the morning after. One hour before pausing epidural analgesia, morphine 10 mg was administered orally as analgesic bridging. Rescue analgesics consisted of either orally or intravenously administered morphine or oxycodone, administered on demand.

Subcutaneous drains were removed when the daily output was below 60 mL per drain. Patients were mobilized from the bed postoperatively as soon as possible, preferably upon returning from the recovery ward. Further details about the pathway are described in Table 1.

Although the postoperative discharge criteria were largely unchanged after the introduction of the ERAS protocol, daily assessments of these were made mandatory in patients undergoing ERAS, and the patient was discharged whenever these criteria were fulfilled (Table 2).

Statistics

Categorical variables were given as *n* (%) and compared across groups using the chi-square test. Numerical variables were given as mean (standard deviation [SD]) and compared across the 2 groups using Student *t*-test with the exception of LOS, which was reported as median (interquartile range [IQR]) and compared across groups using Mann Whitney U-test. Approval for this study was granted by the National Danish Data Protection Agency (BFH-2016-062, I-Suite: 04939) and the Regional Ethics Committee of Copenhagen (journal no. 16044045).

Results

In the period from April 15, 2011 to March 31, 2018, a total of 232 patients underwent AWR. Of these, 42 were included in a randomized controlled trial of preoperative high-dose glucocorticoid versus placebo and excluded from the current study.[9] This left 190 patients for inclusion, of which 96 were treated according to the standard protocol, and 94 underwent the ERAS pathway. The 2 groups of patients were comparable in terms of sex distribution, BMI, and ASA classification, whereas patients in the ERAS group were older compared with the control group (63.7 ± 12.8 years vs 59.9 ± 12.7 years, $P = .035$, Table 3). There was no difference regarding the number of patients with excessive alcoholic intake, but there were fewer tobacco smokers in the ERAS group (4.4% vs 20.8%, $P = .006$). Further, there were no differences between the 2 groups in terms of fascial defect size, number of recurrence repairs, duration of surgery, or intraoperative contamination grade (Table 2). There was a significant difference in the type of components separation utilized, as transversus abdominis release was performed in 31.9% of patients in the ERAS group compared to 0% in the control group ($P < .001$). In total, 95.7% of the patients in the ERAS group received preoperative high-dose glucocorticoid and most patients in both groups had a thoracic epidural catheter placed preoperatively (control 87.4% vs ERAS 87.2%).

There was a higher incidence of wound-related events after the introduction of the ERAS pathway (12.5% vs 24.5%, $P = .033$, Table 4) but no difference in the incidence of wound-related events requiring operative intervention (7.1% vs. 6.9%, $P = .967$). In the control group, 1 patient developed postoperative small bowel obstruction. In addition, 2 patients in the control group and 1 patient in the ERAS group had early fascial dehiscence, including mesh displacement. Overall, there was no difference in the rates of reoperations between the 2 groups (ERAS 10.6% vs control 10.4%, $P = 1.0$). Moreover, the cohorts did not differ with regard to the incidence of pneumonia (ERAS 7.4% vs control 15.6%, $P = .125$) or renal failure requiring hemodialysis (ERAS 2.1% vs control 1.0%, $P = .619$). No patients in the cohort developed postoperative myocardial infarction or other thrombotic events. The LOS was significantly reduced in the ERAS group (ERAS median 4.0, IQR 3.0–6.0 days vs control 5.0, 4.0–7.0 days, $P < .001$) with no difference in the rate of 30-day readmissions (ERAS 16.0% vs control 12.5%, $P = .635$). Reasons for readmissions are shown in Table 4.

Discussion

In the current study, the introduction of an ERAS pathway resulted in a decreased LOS without increasing the rate of complications requiring intervention or readmissions.

Table 1
Perioperative care to patients undergoing abdominal wall reconstruction for large incisional hernia.

	Standard care	Enhanced recovery pathway
Preoperative information about expected discharge and discharge criteria	–	+
Oral analgesics preoperatively: paracetamol 1 g, ibuprofen 400 mg, gabapentin 600 mg	–	+
Preoperative high-dose glucocorticoid	–	+
Oral analgesics postoperatively: paracetamol 1 g × 4, ibuprofen 400 mg × 3	–	+
Required daily assessment of discharge criteria	–	+
Duration of epidural analgesia	3 days (or less)	2 days
Early oral feeding immediately postoperatively	+	+
Pulmonary physiotherapy immediately postoperatively	+	+
Supplemental oxygen	Only when supine first 48 hours postoperatively	Not defined
Postoperative chewing gum until bowel function	–	+
Urinary catheter removed 24 hours postoperatively	+	+
Enema 48 hours postoperatively if no bowel function	–	+
Drains removed when daily output in each drain less than	30 mL	60 mL

Table 2
Discharge criteria after abdominal wall reconstruction.

	Standard care	Enhanced recovery pathway
Ability to get dressed independently	+	+
Ability to get in and out of bed	+	+
Ability to sit and rise from a chair/toilet	+	+
Independence in personal care	+	+
Mobilization	+	+
Pain tolerated with oral analgesics (pain VAS score <5 during activity)	+	+
Sufficient oral intake of food and drinks	+	+
Acceptance of discharge	+	+
Transcutaneous oxygen saturation greater than 0.91 without supplementary oxygen	–	+

Table 3
Demographic and perioperative data on patients undergoing abdominal wall reconstruction before and after the introduction of an ERAS program.

	Standard care ($n=96$)	ERAS (n = 94)	P
Age [y], mean (SD)	59.9 (12.7)	63.7 (11.8)	.035
Male sex, *n* (%)	56 (58.3)	58 (61.7)	.745
ASA score, *n* (%)			.091
1	24 (25.0)	15 (16.0)	
2	56 (58.3)	69 (73.4)	
3	16 (16.7)	10 (10.6)	
BMI [kg/m^2], mean (SD)	28.0 (5.7)	28.3 (4.6)	.658
Tobacco smoking, *n* (%)	20 (20.8)	3 (4.4)	.006
Excessive alcoholic intake, *n* (%)	7 (7.3)	7 (10.4)	.672
Recurrent hernia, *n* (%)	21 (21.9)	23 (24.5)	.801
Duration of surgery [minutes], mean (SD)	235.0 (65.2)	245.8 (75.7)	.293
Horizontal fascial defect [cm], mean (SD)	12.0 (3.8)	11.1 (3.2)	.658
Vertical fascial defect [cm], mean (SD)	16.0 (5.4)	14.9 (5.8)	.154
Contamination grade, *n* (%)			.507
1	86 (89.6)	85 (90.4)	
2	8 (8.3)	9 (9.6)	
3	1 (1.0)	2 (2.1)	
4	1 (1.0)	0 (0)	
Preoperative glucocorticoid administration, *n* (%)	0 (0)	90 (95.7)	<.001
Lateral release procedures			
None	8 (8.3)	0 (0)	<.001
Endoscopic anterior component separation	88 (91.7)	64 (68.1)	
Transversus abdominis release	0 (0)	30 (31.9)	
Epidural analgesia, *n* (%)	83 (87.4)	82 (87.2)	.874

Two comparable cohort studies have previously reported on the outcomes of an ERAS pathway after AWR and reached different conclusions. Majumder et al, likewise, found decreased LOS from 6 to 4 days after the introduction of ERAS, whereas another cohort study reported a 5-day median LOS in both groups. However, the incidence of wound complications was significantly reduced from 32% in the control group to 11% in the ERAS group.[10,11] In both of these studies, and in the current study, the mean hernia dimensions were comparable, as were the rates of patient comorbidity. However, the mean BMI was higher in both studies than in the current study.

In the current study, the main analgesic treatment was an epidural catheter. This is in contrast to several reports from the United States, where transverse abdominis plane block using Exparel (Pacira Pharmaceuticals Inc., San Diego, California) has been implemented as the main analgesic treatment.[10,12] In a recent study from the Americas Hernia Society Quality Collaborative, it was found that epidural analgesia after AWR was associated with increased LOS and postoperative complications compared with patients without epidural analgesia. These reported differences could be due to confounding by indication.[13] The median LOS in the current study suggests that early discharge is indeed feasible

Table 4
Postoperative outcomes after abdominal wall reconstruction in 2 study cohorts: Standard care versus ERAS program.

	Standard care ($n = 96$)	ERAS ($n = 94$)	P
Wound-related complications, *n* (%)	12 (12.5)	23 (24.5)	.033
Surgical site infection	5 (5.2)	9 (9.6)	
Grade I	2	5	
Grade IIIb	3	4	
Seroma	2 (2.1)	6 (6.4)	
Grade I	2	6	
Skin dehiscence	4 (4.2)	3 (3.2)	
Grade I	1	2	
Grade IIIb	3	1	
Hematoma	1 (1.0)	4 (4.3)	
Grade I	0	1	
Grade II	0	1	
Grade IIIb	1	2	
Skin necrosis	0 (0.0)	1 (1.1)	
Grade I	0	1	
Fascial dehiscence, *n* (%)	2 (2.1)	1 (1.1)	1.00
Grade IIIb	2	0	
Grade IVb	0	1	
Pneumonia, *n* (%)	15 (15.6)	7 (7.4)	.125
Grade II	12	4	
Grade IVa	2	2	
Grade IVb	1	0	
LOS, median (IQR), days	5 (4–7)	4 (3–6)	<.001
30-day readmission, *n* (%)	12 (12.5)	15 (16.0)	.635
Complications requiring reoperation	7	7	
Complications treated conservatively	2	3	
Patient concern	3	4	
Pain	0	1	
30-day reoperation, *n* (%)	10 (10.4)	10 (10.6)	1.00
Hematoma	1	2	
Surgical site infection	3	4	
Fascial dehiscence	2	1	
Acalculous cholecystitis	1	0	
Skin dehiscence	3	1	
Small bowel obstruction	0	1	
Intra-abdominal hypertension	0	1	

after epidural analgesic treatment. It may be that one key element in reducing the LOS was the early discontinuation of the epidural analgesia. Whether or not transversus abdominis plane blocks are superior to epidural analgesia in this specific patient group remains to be examined.

The inclusion of a preoperative single-shot, high-dose glucocorticoid as part of an ERAS program in patients undergoing AWR is novel. Aside from a small pilot study from our center, this treatment regimen has not been reported as standard in any other published material.[4] Glucocorticoid was originally included in the pathway because it inhibits the postoperative inflammatory response, leading to improved analgesia and, for some procedures, reduced rates of postoperative complications.[14,15] Although LOS was reduced in the current study, there was no statistical difference in the rate of postoperative complications requiring intervention after the introduction of ERAS, including single administration of preoperative glucocorticoid. It remains unknown if these findings can be specifically attributed to the anti-inflammatory effects of this drug, because the current study reports the results of the complete ERAS pathway.

The incidence of wound-related complication was significantly higher in the ERAS group. However, the incidence of wound-related complications requiring surgical intervention was comparable between the 2 groups, and the rate of postoperative pneumonia was insignificantly halved after the introduction of ERAS. The lack of improvement in complication rates may be due to the already low incidence in the control group, leaving little room for improvement in this outcome. Another reason for the similar complication rates across the 2 groups may be that the postoperative care for patients in the control group was originally derived from the colorectal postoperative pathway at our hospital, which contains some aspects of the ERAS principles—mainly early mobilization, early oral feeding, and regional anesthesia. The rate of postoperative pneumonia, however, was insignificantly decreased and may be related to improved analgesia by the administration of glucocorticoid. The higher prevalence of active tobacco smokers in the control group potentially offers another explanation for this finding. The higher incidence of wound-related complications in the ERAS group may be due to the slightly higher rate of comorbidity in this group, or a consequence of the reduced endoscopic approach to components separation after the introduction of transverse abdominis release during the period for inclusion of the ERAS group.[16]

The ERAS pathway reported in the current study did not include preoperative nutritional preparation. In the 2 previously published studies from other groups of ERAS for patients undergoing AWR, this was utilized in the form of immunonutrition drinks, which in several nonhernia studies has been found to reduce both the incidence of postoperative infections and LOS.[17,18] As a consequence, preoperative immunonutrition for all patients undergoing AWR has been recommended by some authors, although never examined specifically on this indication.[19] The lack of preoperative nutritional preparation in our ERAS program may also, in part, explain why no reduction in the rate of postoperative complications was found.

It has previously been shown that ERAS pathways reduce patient reported pain and the need for opioids.[20,21] For the current study, it was not possible to retrieve information about supplementary opioid usage. However, we hypothesize that the effects of ERAS on pain and opioid consumption reported in the literature also apply to patients undergoing AWR.

There are limitations to this study that must be acknowledged. Foremost among these is the use of a historical control group. The conclusions drawn from any study based on historical controls are inherently weaker than those reached from a randomized control study. There are other limitations as well. When the ERAS pathway was introduced, there may have been an expectation bias raised that played a role in the reduced LOS that was observed. In addition, the operative techniques may have improved over time, leading to the reduced LOS. We do not know what role, if any, glucocorticoids played in the outcomes reported here. The concurrent randomized study of glucocorticoid use may shed light on that question. The conclusions of this study must be interpreted with these weaknesses in mind.

In conclusion, the current study confirms that, for patients undergoing AWR, ERAS including administration of a high-dose preoperative glucocorticoid led to a reduction in postoperative LOS, with no difference in complications requiring intervention.

Conflicts of interest

The authors have indicated that they have no conflicts of interest regarding the content of this article.

References

1. Kehlet H, Wilmore DW. Evidence-based surgical care and the evolution of fast–track surgery. *Ann Surg*. 2008;248:189–198.
2. Varadhan KK, Neal KR, Dejong CHC, Fearon KCH, Ljungqvist O, Lobo DN. The enhanced recovery after surgery (ERAS) pathway for patients undergoing major elective open colorectal surgery: a meta-analysis of randomized controlled trials. *Clin Nutr*. 2010;29:434–440.
3. Lau CSM, Chamberlain RS. Enhanced recovery after surgery programs improve patient outcomes and recovery: a meta-analysis. *World J Surg*. 2017;41:899–913.
4. Jensen KK, Brondum TL, Harling H, Kehlet H, Jorgensen LN. Enhanced recovery after giant ventral hernia repair. *Hernia*. 2016;20:249–256.
5. Fayezizadeh M, Petro CC, Rosen MJ, Novitsky YW. Enhanced recovery after surgery pathway for abdominal wall reconstruction. *Plast Reconstr Surg*. 2014;134:151S–159S.
6. Köhler G, Fischer I, Kaltenböck R, Lechner M, Dauser B, Jorgensen LN. Evolution of endoscopic anterior component separation to a precostal access with a new cylindrical balloon trocar. *J Laparoendosc Adv Surg Tech A*. 2018;28:730–735.
7. Novitsky YW, Elliott HL, Orenstein SB, Rosen MJ. Transversus abdominis muscle release: a novel approach to posterior component separation during complex abdominal wall reconstruction. *Am J Surg*. 2012;204:709–716.
8. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg*. 2004;240:205–213.
9. Jensen KK, Brøndum TL, Belhage B, Hensler M, Arnesen RB, Kehlet H, et al. Preoperative steroid in abdominal wall reconstruction: protocol for a randomised trial. *Dan Med J*. 2016;63:A5260.
10. Majumder A, Fayezizadeh M, Neupane R, Elliott HL, Novitsky YW. Benefits of multimodal enhanced recovery pathway in patients undergoing open ventral hernia repair. *J Am Coll Surg*. 2016;222:1106–1115.
11. Stearns E, Plymale MA, Davenport DL, Totten C, Carmichael SP, Tancula CS, et al. Early outcomes of an enhanced recovery protocol for open repair of ventral hernia. *Surg Endosc*. 2018;32:2914–2922.
12. Doble J, Winder J, Witte S, Pauli E. 2018 International Hernia Congress. *Hernia*. 2018;22:51.
13. Prabhu AS, Krpata DM, Perez A, Phillips S, Huang L-C, Haskins IN, et al. Is it time to reconsider postoperative epidural analgesia in patients undergoing elective ventral hernia repair?: an AHSQC analysis. *Ann Surg*. 2018;267:971–976.
14. de la Motte L, Kehlet H, Vogt K, Nielsen CH, Groenvall JB, Nielsen HB, et al. Preoperative methylprednisolone enhances recovery after endovascular aortic repair: a randomized, double-blind, placebo-controlled clinical trial. *Ann Surg*. 2014;260:540–548.
15. Srinivasa S, Kahokehr AA, Yu T-C, Hill AG. Preoperative glucocorticoid use in major abdominal surgery. *Ann Surg*. 2011;254:183–191.
16. Jensen KK, Henriksen NA, Jorgensen LN. Endoscopic component separation for ventral hernia causes fewer wound complications compared to open components separation: a systematic review and meta-analysis. *Surg Endosc*. 2014;28:3046–3052.
17. Drover JW, Dhaliwal R, Weitzel L, Wischmeyer PE, Ochoa JB, Heyland DK. Perioperative use of arginine-supplemented diets: a systematic review of the evidence. *J Am Coll Surg*. 2011;212:385–399.
18. Awad S, Lobo DN. Metabolic conditioning to attenuate the adverse effects of perioperative fasting and improve patient outcomes. *Curr Opin Clin Nutr Metab Care*. 2012;15:194–200.
19. Liang MK, Holihan JL, Itani K, Alawadi ZM, Gonzalez JRF, Askenasy EP, et al. Ventral hernia management. *Ann Surg*. 2017;265:80–89.
20. Page AJ, Gani F, Crowley KT, Lee KHK, Grant MC, Zavadsky TL, et al. Patient outcomes and provider perceptions following implementation of a standardized perioperative care pathway for open liver resection. *Br J Surg*. 2016;103:564–571.
21. Sarin A, Litonius ES, Naidu R, Yost CS, Varma MG, Chen L-L. Successful implementation of an enhanced recovery after surgery program shortens length of stay and improves postoperative pain, and bowel and bladder function after colorectal surgery. *BMC Anesthesiol*. 2016;16:55.