

Enhanced recovery after surgery in patients undergoing laparoscopic partial nephrectomy. Results from a real-world randomized controlled trial

Xiaoqiang Xue, Dong Wang, Zhigang Ji, Yi Xie

Department of Urology, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China

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Abstract

Introduction: Enhanced recovery after surgery (ERAS) is a set of perioperative interventions to alleviate patients' stress response and complications, and to promote rehabilitation. Data on its implementation in renal cell carcinoma treated by laparoscopic partial nephrectomy are lacking.

Aim: To evaluate the prospect of application of ERAS in laparoscopic partial nephrectomy based on real-world data.

Material and methods: Sixty patients with T1a staging renal cell carcinoma (RCC) were randomly classified as the ERAS group (31 patients) or traditional treatment group (29 patients). Relevant endpoints including postoperative length of stay, ambulation, fart, oral intake, pain at different movement and time points, postoperative nausea and vomiting, complications as well as hospitalization expenses in the two groups were analyzed and compared.

Results: The ERAS optimization group presented a shorter time of first-time ambulation ($p = 0.008$), less pain at rest and ankle movement ($p < 0.05$), and less feeling of nausea 2 and 4 h after surgery ($p = 0.006$ and 0.027 , respectively). (Although the differences in hospitalization expenses, postoperative length of stay, and complications were not reached in our study ($p > 0.05$), they were significantly lower than those reported in other literature.

Conclusions: The idea of ERAS has had an imperceptible influence on clinical strategy making for over 20 years. This study shows that it could alleviate postoperative pain both at rest and movement, enable earlier walking, and reduce postoperative nausea in patients who have undergone laparoscopic partial nephrectomy. However, its efficacy is sometimes over-extended when compared to extreme conservative. Also, specific ERAS protocols and large-sample clinical trials are needed.

Key words: enhanced recovery after surgery, laparoscopic partial nephrectomy, renal cell carcinoma, randomized controlled trial.

Introduction

In 1997, Kehlet summarized contemporary methods for controlling postoperative dysfunction and indicated that multimodal interventions might help in reducing undesirable surgical outcomes and costs, as well as promoting recovery [1, 2]. That is

now recognized as the very first description of the idea of enhanced recovery after surgery (ERAS). Based on it, ERAS was first adopted in colorectal cancer patients [3].

Despite its wide implementation in the fields of gastrointestinal surgery, hepatobiliary surgery, and

Address for correspondence

Yi Xie, Department of Urology, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, No. 1 Shuaifuyuan Rd., Dongcheng, Beijing 100730, China, phone: +86-10-6915-2521, e-mail: xieyi6262@163.com

cardiothoracic surgery [4], the application of ERAS in urology was late. While most studies focused on its effects on radical cystectomy [5–7], real-world trials on ERAS in renal cell carcinoma (RCC) were scarce.

Aim

The purpose of this study was to explore the feasibility and value of adopting ERAS in RCC patients treated with laparoscopic partial nephrectomy (LPN). Given that no consensus was reached on the ERAS protocol in the field of urology and variation of medical systems, the results might help deepen the understanding of ERAS in urology and provide some concrete evidence for better policymaking.

Material and methods

Ethics statement and patient selection

This randomized controlled trial was designed and conducted according to the principles of the Declaration of Helsinki and was approved by the Ethics Committee of the authors' institution (approval no. ZS-1559). The inclusion criteria were as follows: (I) patients with renal tumor who were about to receive laparoscopic partial nephrectomy as treatment; (II) 25–75 years old, regardless of gender; (III) no regional or distant metastasis; (IV) preoperative examinations showed no severe accompanying diseases or malnutrition. Exclusion criteria were: (I) those who did not meet the inclusion criteria; (II) other surgical methods or approach; (III) history of abdominal or retroperitoneal surgery; (IV) other situations assessed as factors interfering with the study. Data of postoperative length of stay (LOS), medical expenses, first-time water and food intake, return of anal exsufflation, postoperative nausea and vomiting (PONV), pain at different status and time, and postoperative complications were mainly analyzed.

Sample size

Recart *et al.* reported that the average LOS in their ERAS cohort was 41 ± 11 h while that in the routine group was 59 ± 11 h [8]. According to the bilateral test formula of two parallel groups:

$$Z = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \times (\sigma_1^2 + \sigma_2^2)}{\delta^2}$$

where N is the number of required cases, $Z_{\alpha/2}$ is the Z value corresponding to $\alpha = 0.05$ ($Z_{\alpha/2} = 1.96$), Z_{β} is

the Z value corresponding to the probability of type II error β ($\beta = 0.1$, $Z_{\beta} = 1.28$), δ is the difference of the means ($\delta = 18$), and σ is the standard deviation in each group ($\sigma_1 = \sigma_2 = 11$). Here, we could calculate that the sample size in each group should be no less than 8 patients.

Finally, 60 patients were included after preliminary eligibility screening, and were randomly allocated to two cohorts: 31 in the ERAS optimization group and the other 29 in the traditional treatment group. All patients were treated by the same surgeon and had given their written informed consent before the operations.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Baseline characteristics and homogeneity

The R.E.N.A.L. score [9] in the traditional group was 7.28 ± 1.62 (mean \pm SD), while that in the ERAS group was 7.10 ± 1.68 . Student's t -test showed that no difference in the tumor complexity was found between those two groups ($t = 0.42$, $p = 0.677$). Detailed baseline characteristics and homogeneity test results of the two groups can be seen in Table I. It could be interpreted that the demographic characteristics of the two groups, such as age, gender, and educational status, were comparable. Their preoperative clinical signs, laboratory tests, and physiological and biochemical indexes showed no difference as well. The conclusion could be drawn that the distribution of preoperative parameters in those two groups was balanced and comparable ($p > 0.05$).

Perioperative management methods

Owing to the lack of consensus, the perioperative ERAS optimization protocol was drafted by summarizing published experience and then modified under real-world circumstances in our medical center.

Note that the routine protocol in the control group varied considerably from hospital to hospital; for instance, postoperative patients were strictly confined to bed for 1–2 weeks after surgery in some other studies [10, 11], while they were routinely required to start ambulation on postoperative day (POD) 2 in our hospital since years ago, to say nothing of the removal of the ureter catheter or drainage tube. This

Table I. Baseline characteristics and homogeneity test results of the two groups

Category	Traditional group (mean \pm SD)	ERAS group (mean \pm SD)	χ^2/t value/Z	P-value
Age [years]	55.97 \pm 12.39	53.70 \pm 10.69	0.70	0.486
Gender:			0.01	0.919
Male	20	21		
Female	9	10		
BMI	25.24 \pm 3.28	26.63 \pm 3.84	-1.494	0.141
Body temperature [$^{\circ}$ C]	36.37 \pm 0.38	36.13 \pm 0.35	0.411	0.683
Heart rate [beats per minute]	80.14 \pm 10.41	76.77 \pm 9.32	1.312	0.195
Systolic pressure [mm Hg]	132.52 \pm 13.93	137.70 \pm 15.86	-1.332	0.188
Diastolic pressure [mm Hg]	80.24 \pm 7.71	78.70 \pm 11.05	0.621	0.537
Respiratory rate [beats per minute]	18.17 \pm 1.99	18.30 \pm 1.62	-0.381	0.705
Highest education level:			0.191	0.849*
Illiterate:	0	2		
Elementary school	3	2		
Junior high school	1	3		
Senior high school/equivalent	14	10		
Bachelor's degree	5	7		
Postgraduate or above	2	2		
Unknown	4	5		
Previous medical history:			0.098	0.754
None	12	14		
Mild illness	17	17		
Leukocyte:			N.A.	1.000**
Normal range	28	30		
Abnormal range	1	1		
Preoperative hemoglobin:			0.308	0.579
Normal range	29	30		
Abnormal range	0	1		
Preoperative creatinine:			N.A.	1.000**
Normal range	29	30		
Abnormal range	0	1		
Total bilirubin:			0.308	0.579
Normal range	26	29		
Abnormal range	3	2		
Activated partial thromboplastin time:			N.A.	1.000**
Normal range	28	29		
Abnormal range	1	2		
Prothrombin time:			0.001	0.975
Normal range	27	30		
Abnormal range	2	1		

ERAS – enhanced recovery after surgery, N.A. – not applicable, *Wilcoxon test, **results of Fisher's exact test.

Table II. Perioperative management protocols for patients who have undergone laparoscopic partial nephrectomy

Management	Routine group in other report (9)	Traditional group	ERAS group
Preoperative patient education	Routine preoperative medical knowledge related education	Regular medical knowledge conveyed in a question-and-answer way, no further discussion if not required	Multimedia education on the background of ERAS, plans were thoroughly explained and suggestions for promoting recovery were made
Preoperative fasting	Fasting starts from 12 h before surgery, water deprivation starts 4 h before surgery	Preoperative fasting starting from 12 h before surgery, preoperative water deprivation starting from 6 h before surgery	Semi-fluid food was accessible 6 h before surgery, water deprivation starting from 2 h before surgery. 400 ml of carbohydrate liquid (12.5%) was given to those without diabetes 2 h before surgery
Bowel preparation	With soap and water	Polyethylene glycol solution as laxatives	No enema
Pre-anesthesia medication	Not mentioned	Given as needed	Avoid long-acting sedative drugs
General anesthesia plan	Not mentioned	Intravenous anesthesia	Intravenous anesthesia plus nerve block
Standard anesthesia protocol	Not mentioned	Intraoperative intravenous opioids for pain control, using low-tidal volume and high-frequency ventilation	Using short-acting opioids, preventing hypoxemia and hypothermia, controlling intraoperative blood glucose and blood pressure, infusing blood products in time, using low-tidal volume and high-frequency ventilation
Postoperative pain control	Postoperative on-demand analgesia	No preventive analgesia Intraoperative: intravenous injection of fentanyl Postoperative: PCA pump	Preventive analgesia: flurbiprofen axetil injection Intraoperative: regional block and incision infiltration, fentanyl Postoperative: flurbiprofen axetil injection, morphine PCA pump for salvage analgesia
Ileus prevention	Not mentioned	Not stressed	Gum chewing, early ambulation, controlled rehydration, and fewer opioids
Nausea and emesis prevention	Not mentioned	On-demand	Using ondansetron in patients with risk factors such as female gender, history of motion sickness, and non-smoker, if there were more than 2 risk factors, multimodal antiemetic therapy was used
Postoperative mobilization	Strictly stay in bed for about 7 days after the operation, or even longer	In the premise of safety, they were encouraged to start walking once they were physically prepared, usually on postoperative day 3–4	Encouraging patients to mobilize limbs and ankles early, when there are no risks of bleeding, they were required to start walking on postoperative day 2
Urinary catheter removal	3–5 days after surgery	2–3 days after surgery	As soon as the patients could walk to the restroom
Drainage tube management	5–6 days after surgery	3–4 days after surgery	Under the premise of safety, no perirenal drainage tube was placed
Postoperative fluid infusion	2500–3000 ml is routinely used for 3–4 days after the operation	2,500–3,000 ml fluid given daily after surgery, lasting for 3–4 days	Controlled infusion, resume a normal diet as soon as possible

Table II. Cont.

Management	Routine group in other report (9)	Traditional group	ERAS group
Postoperative feeding	Drinking after exhausting, then gradual transition from liquid to general food	Food and water are forbidden until anal exsufflation	Liquids were allowed 6 h after surgery, semi-fluid food started on postoperative day 1

PCA – patient-controlled analgesia; postoperative day 1 means the day after the operation day, and so on.

difference might explain our less favorable negative results in hospitalization expenses, postoperative LOS, and complications. Further exploration is presented in the Discussion section. Detailed perioperative management protocols of LPN patients are presented in Table II.

Quality control and statistical analysis

The software of EpiData version 3.1 (The EpiData Association) was used to input and manage the data. After the database was verified to be correct, a blind audit was conducted to determine the modification and confirmation of the statistical analysis plan, then the data were exported in the data format required by the statistical software. When data were output, a query table was generated for data range and logic check. Measurement data were described as mean \pm standard deviation (mean \pm SD), median, maximum, minimum, and quartile. Enumeration data were described as a percentage or constituent ratio. The independent-sample *t*-test was used to compare the measurement data with normal distribution and homogeneous variance; the independent-sample *t*-test was used to compare the measurement data with normal distribution but uneven variance; the Wilcoxon test (rank-sum test) was used to compare the measurement data with non-normal distribution or ordered enumeration data; the χ^2 test in a contingency table was used to compare the non-ordered enumeration data. All statistical tests were performed in a two-sided test, and *p*-value < 0.05 was considered to be statistically significant. Statistical Product and Service Solutions version 24.0 (SPSS, IBM Corp.) was used to complete the statistical analysis.

Results

Clinical management and safety evaluation

All patients were treated by the same surgeon who was experienced in performing LRN. Student's

t-test indicated no statistically significant difference between the two groups in postoperative LOS, medical expenses, first-time drinking, return of anal exsufflation or fluid/semi-fluid food intake (*p* > 0.05). However, patients in the ERAS optimization group presented significantly earlier ambulation than those in the traditional treatment group (*t* = 2.743, *p* = 0.008). Detailed results are presented in Table III. Because most patients with renal cancers are older than 65 years old, we presented the subgroup analysis results of them in Table III as well (12 patients in the traditional group and 13 in the ERAS group). Note that patients over 65 presented a delayed return of normal function compared to their junior counterparts, while most data in the subgroup were comparable.

Outpatient clinic records showed that no patients reported incision bleeding, infection, poor healing, incontinence, thrombosis, cardiovascular events, or death 4 weeks after discharge.

Benefit evaluation

Results of pain degree at various status, nausea, vomiting at different time points were evaluated. The scoring system is presented in Table IV. It can be concluded the numeric rating scales (NRS) score of pain at rest and movement showed a tendency of changing with time (Figure 1); further analysis of variance of repeated measurements (R.M. ANOVA) indicated that the postoperative pain degree at rest within the first 12 h, postoperative pain at movement within the first 6 h and postoperative nausea within the first 4 h in the ERAS optimization group were significantly improved compared to those in the traditional treatment group (Table V). Although pain degree at in-bed turning over at the point of time of 12 h postoperatively in the ERAS group was significantly lower from that of the control group (*t* = 2.38, *p* = 0.018), the rest of the results did not show any significant difference.

Table III. Results of different clinical management of the two groups

Category	Traditional group (mean ± SD)	ERAS group (mean ± SD)	t value	P-value	Traditional group**	ERAS group**	t value**	P-value**
Postoperative length of stay [days]	5.65 ±1.14	5.61 ±1.17	0.141	0.889	6.17 ±1.08	6.08 ±1.24	0.182	0.785
Medical costs (converted to U.S. dollars*)	3477.94 ±576.66	3581.73 ±672.09	-0.64	0.525	3522.18 ±621.22	3710.12 ±581.26	0.117	0.657
First-time drinking [h]	28.52 ±17.26	28.15 ±17.10	0.175	0.862	29.75 ±11.33	29.15 ±13.20	0.225	0.982
Recovery of anal exsufflation [h]	35.36 ±17.36	34.43 ±21.26	0.187	0.852	37.42 ±13.36	38.15 ±16.94	0.219	0.789
First-time ambulation [h]	53.35 ±16.15	42.35 ±15.31	2.743	0.008	55.25 ±20.12	42.31 ±12.31	2.545	0.012
Time of first intake of fluid food [h]	41.17 ±16.39	38.57 ±18.19	0.581	0.563	42.17 ±18.17	39.92 ±16.26	0.651	0.612
Time of first intake of semi-fluid food [h]	53.14 ± 18.14	50.30 ±21.35	0.565	0.574	49.42 ±15.14	47.15 ±12.98	0.547	0.417

*The average exchange rate of U.S. dollar to local currency in November 2018 was adopted, 6.9351 Chinese Yuan equaled 1 U.S. dollar. **Groups only include patients over 65 years.

Discussion

Renal cell carcinoma accounts for over 80% of all primary renal neoplasms, and over 400,000 people are diagnosed with RCC worldwide annually [12]. For patients with localized RCC, radical nephrectomy shows no superiority to partial nephrectomy in terms of oncologic outcomes [13–15]. On the other hand, enhanced recovery after surgery, developed from the idea of fast-track surgery, has been widely adopted in the field of general surgery [1–3]. ERAS is, in essence, a treatment protocol that calls for multidisciplinary and comprehensive interventions. The kernel of ERAS is a patient-oriented approach, adjusting perioperative management dynamically to alleviate both physical and mental trauma caused by operations, to lighten the burden of hospitalization economically [4]. With the renewal of this concept, relevant factors including anesthesia, nursing, and social workers have also been added [16, 17].

Although the application of ERAS in patients undergoing radical cystectomy has been individually reported, its prospects in renal cancer, prostate cancer, and urinary calculi are still unexplored [18]. In our view, radical cystectomy, especially with in-

Table IV. Scoring system in pain, nausea, and vomiting evaluation

Category	Definition
Pain score:	
0	Painless
1–3	Mild pain that would not affect sleep
4–6	Moderate pain
7–9	Severe pain that leads to insomnia or sudden waking
10	Extreme, unbearable pain
Nausea score:	
0	None
1	Mild (none at rest, slight during exercise)
2	Moderate (occasionally occurs at rest)
3	Severe (persistent nausea at rest)
Vomiting score:	
0	None
1	Mild (1–2 times/day)
2	Moderate (3–5 times/day)
3	Severe (> 6 times/day)

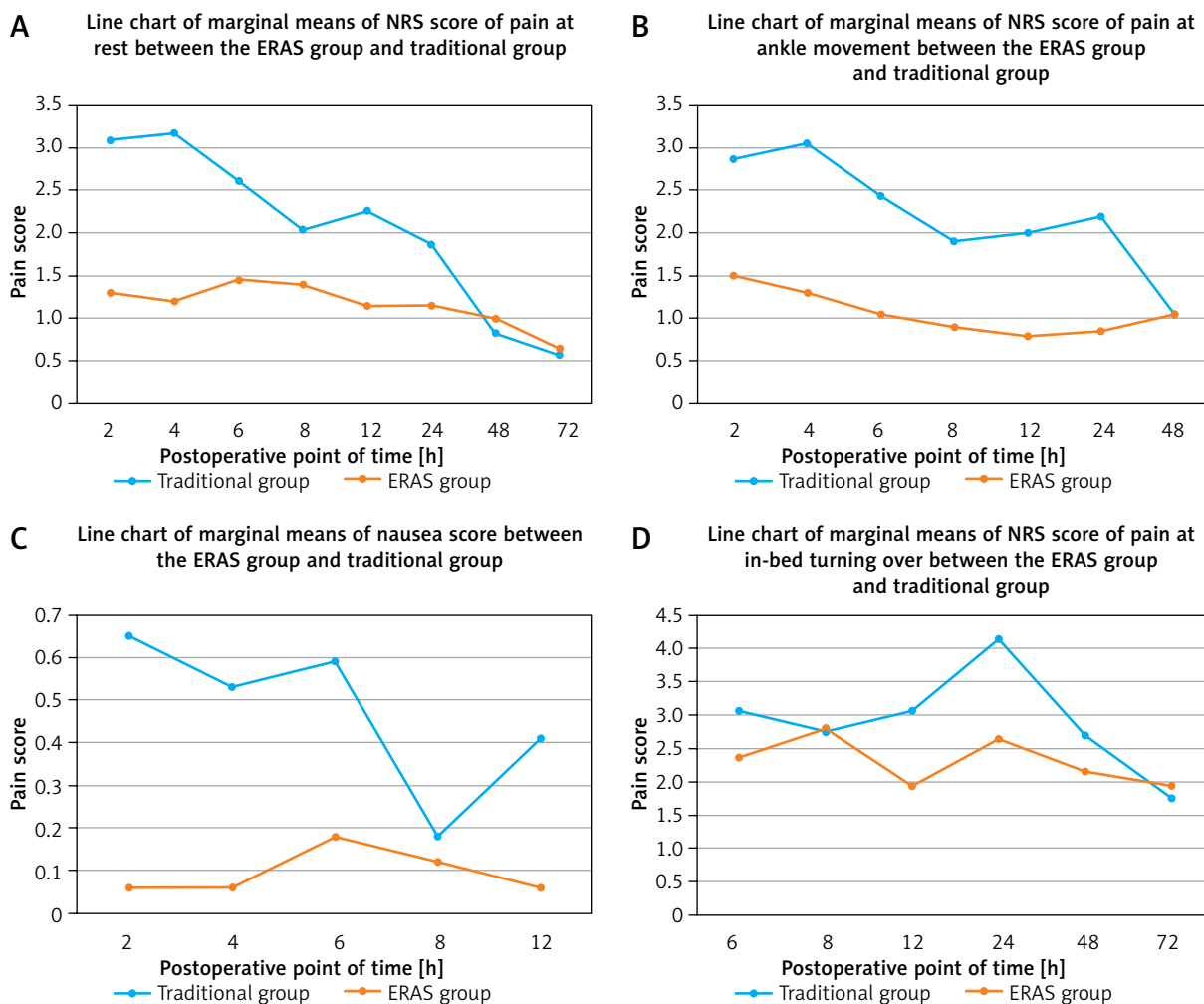


Figure 1. Line charts of marginal means of NRS score of pain and nausea between ERAS group and traditional group. The above line charts indicate the NRS score of pain at rest and ankle movement, as well as postoperative nausea, showing a tendency of changing with time

testine-related urinary reconstructions, would often bring greater surgical impacts and thereafter raise more interest from a range of disciplines, while treatment such as LPN is more urologist-dominant and less cross-disciplinary. However, one cannot conclude that ERAS in the field of urology is less important just because there is little research on it.

In our experience, preoperative education is the key to ERAS. Thorough preoperative education could help patients understand the treatment process better, reduce their psychological pressure and improve their compliance. In different groups, we adopted different preoperative education strategies; namely, education was given to patients in the traditional treatment group orally in a guidance-compliance model,

while a cooperative education model was established using multimedia platforms in the ERAS optimization group. Although we did not design a specific scale for evaluating preoperative education, it was obvious that patients in the ERAS group showed a better understanding of the postoperative rehabilitation process and a higher degree of compliance than those in the traditional treatment group; for instance, patients in the ERAS group showed more care about ambulation and nutrition than their counterparts. Note that there was no difference in educational background.

Traditionally, preoperative long-term fasting was regarded as protection in avoiding emesis and mis-inhalation during anesthesia, however, more and more supportive studies showed that preop-

Table V. Evaluations of pain at rest and ankle movement, nausea scores in both ERAS and traditional groups

Time Group [h]	Pain at rest				Pain at ankle movement				Nausea				
	Multiple comparisons		R.M. ANOVA		Multiple comparisons		R.M. ANOVA		Multiple comparisons		R.M. ANOVA		
	Score	t	P-value	Results	Score	t	P-value	Results	Score	t	P-value	Results	
2	Trad	3.09 ±2.83	3.44	0.001	F _{group} = 5.25 P _{group} = 0.0272 F _{time} = 8.31	2.86 ±2.85	2.43	0.016	F _{group} = 5.92 P _{group} = 0.020 F _{time} = 6.67	0.65 ±1.12	2.82	0.006	F _{group} = 3.92 P _{group} = 0.057 F _{time} = 1.88
	ERAS	1.30 ±1.38				1.50 ±1.61				0.06 ±0.24			
4	Trad	3.17 ±2.98	3.63	< 0.001	P _{time} < 0.0001 F _{group} = 3.74 P _{group*time} < 0.0007	3.05 ±2.92	3.10	0.002	P _{time} < 0.001 F _{group} = 2.42 P _{group*time} = 0.07	0.53 ±0.87	2.24	0.027	P _{time} = 0.140 F _{group} = 2.06 P _{group*time} = 0.112
	ERAS	1.20 ±1.47				1.30 ±1.46				0.06 ±0.24			
6	Trad	2.61 ±2.19	2.08	0.038		2.43 ±2.13	2.28	0.024		0.59 ±0.87	1.96	0.052	
	ERAS	1.45 ±1.50				1.05 ±1.36				0.18 ±0.53			
8	Trad	2.04 ±1.77	1.29	0.198		1.90 ±1.76	1.35	0.178		0.18 ±0.39	0.39	0.697	
	ERAS	1.40 ±1.57				0.90 ±1.07				0.12 ±0.49			
12	Trad	2.26 ±1.89	2.20	0.029		2.00 ±1.76	1.93	0.055		0.41 ±0.87	1.78	0.007	
	ERAS	1.15 ±1.09				0.80 ±0.95				0.06 ±0.24			
24	Trad	1.87 ±1.98	0.70	0.483		2.19 ±2.48	1.98	0.049					
	ERAS	1.15 ±1.23				0.85 ±1.09							
48	Trad	0.83 ±0.98	-0.47	0.639		1.05 ±1.53	< 0.01	0.997					
	ERAS	1.00 ±1.21				1.05 ±1.15							
72	Trad	0.57 ±1.21	-0.50	0.620									
	ERAS	0.65 ±1.18											

Trad – traditional group, ERAS – ERAS group, R.M. ANOVA – analysis of variance of repeated measurements.

erative shorter-term fasting and oral carbohydrate liquid intake would not increase the incidence of intraoperative mis-inhalation [4, 16]. Moreover, it could help reduce perioperative fluid load and stabilize blood glucose. In this study, patients in the ERAS group with normal bowel function would not receive mechanic bowel preparation as the operation was performed in the retroperitoneal space. Analysis showed that there was no significant difference in the recovery of anal exsufflation. We assumed that this was because when anesthesia, surgical time, and other elements were similar, the only variable, polyethylene glycol solution, was mild and its effect on the intestinal tract was not significant. Hence, the conclusion that bowel preparation could be modified to be less intensive in general cases might be drawn, and therefore clinicians could improve patients' satisfaction and safety.

Previous studies had not discussed the role of analgesia in ERAS of LPN. Our study found that patients with the optimized analgesia protocol, namely prophylactic analgesia and short-acting opioids, reported less feeling of pain, both at rest and movement, and consequently an average of 11-hour earlier ambulation. Patient-controlled analgesia (PCA) is a kind of pain management technique in which anesthesiologists set the pain management program in advance according to the degree of pain and physical condition of patients, by which the patients could adjust and control the timing and dosage of receiving the painkiller according to their own needs. According to the different approaches of administration, PCA can be mainly divided into patient-controlled intravenous analgesia (PCIA) and patient-controlled epidural analgesia (PCEA). In this study, the technique of PCIA was adopted for postoperative analgesia because of the following reasons: (1) The block plane of PCEA in renal surgery should be around the 6th thoracic vertebral level; the high thoracic epidural block might have higher risks of hypotension and increase the difficulty of perioperative management; (2) PCEA should have higher possibility of urinary retention, which might affect the results of early urinary catheter removal; (3) PCIA would be easier for nursing; (4) cultural reasons. Pain and ambulation were regarded as two mutually reinforcing factors. For one thing, the decrease of pain would be conducive to faster ambulation. For another, earlier walking might help distract patients' attention, promote intestinal peristalsis, prevent the

occurrence of intestinal adhesions, and thereafter, lower the incidence of intestinal spasm. At the same time, earlier walking would contribute to the psychological recovery of patients.

The occurrence of postoperative nausea was reported to be up to 80% and vomiting was 30%, regarding surgery and anesthesia techniques, as well as predisposing patient status [19]. Postoperative nausea and vomiting (PONV) was sometimes omitted because of its mild symptoms and self-limited clinical features, yet it could be lethal in some extreme cases [20]. In this study, prophylactic anti-nausea drugs were provided to patients on a routine basis rather than the traditional demanding-prescription mode. The results indicated that the early incidence (postoperative 0–6 h) of nausea in the ERAS group was significantly lower, while the late incidence of PONV in the two groups showed no significant difference, which was consistent with previous studies [10]. We considered that these different results were partly because of the nature of retroperitoneal surgery; namely, the vasovagal reflex might be calmed in the first 6 h after surgery by anti-nausea drugs, while later with the return of patients' water intake and upcoming PONV pathophysiological climax (24 h postoperatively), cases of PONV occurred more often and intensively [19, 20]. For this reason, we might assume that our ERAS protocol was more effective in control of early nausea while more measures were needed for longer-term palliation in PONV.

Unlike other studies, this study revealed no difference in the costs and LOS between the two groups. We were initially surprised because the ERAS group should theoretically recover better and faster than the traditional group and therefore should have shorter postoperative LOS and lower hospital costs [4, 7]. Through an in-depth literature study, we found that the medical expenses in our medical center were much lower than those extracted from other studies in the same country, either in the traditional group or the ERAS group [10, 11]. Moreover, the LOS of both groups in our medical center was similar to that in the reported ERAS cohorts. Reasons for these situations might be that the control group in most ERAS studies was "idealized and traditionalized". For example, in some study designs [10, 11], patients with LPN in the control group were required to stay in bed for 1–2 weeks before they could walk for the first time, while in real-world circumstances

this is less likely to happen. For those patients, their hospitalization days and expenses would inevitably be different. Our view is that surgeons have more or less acquired the idea of ERAS in clinical practice and the management has been updated accordingly; hence, statistical difference on LOS and expenses might be less possible to be found. Besides, because the medical system varies from region to region, the LOS would differ as well. For instance, patients from the developed regions would have better access to the outpatient clinic for removal of their drainage tube or to the community hospital for further treatment. Consequently, instead of paying attention to positive results derived from old and abandoned settings, we suggest the importance of shortening the LOS and costs in ERAS studies should be less emphasized and a conclusion should be made based on the real-world status quo.

Despite its strengths, our study is not lacking in limitations. That is, its sample size limits the power to detect a differential result of the two groups. Moreover, the protocol of ERAS is not customized to match the characteristics of nephrectomy; therefore, some variables and parameters might be omitted. Finally, bias might occur during the transformation of some non-quantitative and subjective variables to quantitative values using scales.

Conclusions

ERAS has imperceptibly influenced surgeons' strategy making in the past 20 years. This real-world trial showed that the adoption of ERAS in laparoscopic partial nephrectomy could contribute to less pain at rest and movement, earlier postoperative walking, less early-stage nausea, and better satisfaction. Length of stay and expenses might not be the most important observation indices in large medical centers because of the variations of the medical system and clinical situations. However, larger-sample clinical trials are welcomed from all levels of hospitals, and a customized ERAS protocol in the field of urology is needed.

Conflict of interest

The authors declare no conflict of interest.

References

1. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. *Br J Anaesth* 1997; 78: 606-17.
2. Kehlet H, Wilmore DW. Multimodal strategies to improve surgical outcome. *Am J Surg* 2002; 183: 630-41.
3. Fearon KC, Ljungqvist O, Von Meyenfeldt M, et al. Enhanced recovery after surgery: a consensus review of clinical care for patients undergoing colonic resection. *Clin Nutr* 2005; 24: 466-77.
4. Mortensen K, Nilsson M, Slim K, et al. Consensus guidelines for enhanced recovery after gastrectomy: Enhanced Recovery After Surgery (ERAS®) Society recommendations. *Br J Surg* 2014; 101: 1209-29.
5. Naito Y, Kanazawa H, Okada Y, et al. Adoption of enhanced recovery after surgery (ERAS) protocol for the management of patients undergoing radical cystectomy in Japan. *Nihon Hinyokika Gakkai Zasshi* 2020; 111: 9-15.
6. Sung LH, Yuk HD. Enhanced recovery after surgery of patients undergoing radical cystectomy for bladder cancer. *Transl Androl Urol* 2020; 9: 2986-96.
7. Zhang D, Sun K, Wang T, et al. Systematic review and meta-analysis of the efficacy and safety of enhanced recovery after surgery vs. conventional recovery after surgery on perioperative outcomes of radical cystectomy. *Front Oncol* 2020; 10: 541390.
8. Recart A, Duchene D, White PF, et al. Efficacy and safety of fast-track recovery strategy for patients undergoing laparoscopic nephrectomy. *J Endourol* 2005; 19: 1165-9.
9. Kutikov A, Uzzo RG. The R.E.N.A.L. nephrometry score: a comprehensive standardized system for quantitating renal tumor size, location and depth. *J Urol* 2009; 182: 844-53.
10. Miao C, Yu A, Yuan H, et al. Effect of enhanced recovery after surgery on postoperative recovery and quality of life in patients undergoing laparoscopic partial nephrectomy. *Front Oncol* 2020; 10: 513874.
11. Tang M, Dong H, Shao P, et al. The clinical application of enhanced recovery after surgery protocol in perioperative period of laparoscopic nephron sparing surgery. *Transl Androl Urol* 2020; 9: 1566-71.
12. Bray F, Ferlay J, Soerjomataram I, et al. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin* 2018; 68: 394-424.
13. Patard JJ, Shvarts O, Lam JS, et al. Safety and efficacy of partial nephrectomy for all T1 tumors based on an international multicenter experience. *J Urol* 2004; 171: 2181-5.
14. Crépel M, Jeldres C, Perrotta P, et al. Nephron-sparing surgery is equally effective to radical nephrectomy for T1BN0M0 renal cell carcinoma: a population-based assessment. *Urology* 2010; 75: 271-5.
15. Van Poppel H, da Pozzo L, Albrecht W, et al. A prospective, randomised EORTC intergroup phase 3 study comparing the oncologic outcome of elective nephron-sparing surgery and radical nephrectomy for low-stage renal cell carcinoma. *Eur Urol* 2011; 59: 543-52.
16. Pignot G, Brun C, Tourret M, et al. Essential elements of anaesthesia practice in ERAS programs. *World J Urol* 2020. doi: 10.1007/s00345-020-03410-w.
17. Cui XL, Li X, Li MN, et al. Ultrasound-guided transmuscular quadratus lumbus block reduces opioid consumption after laparoscopic partial nephrectomy. *Chin Med Sci J* 2020; 35: 289-96.

18. Saidian A, Nix JW. Enhanced recovery after surgery: urology. *Surg Clin North Am* 2018; 98: 1265-74.
19. Öbrink E, Jildenstål P, Oddby E, Jakobsson JG. Post-operative nausea and vomiting: update on predicting the probability and ways to minimize its occurrence, with focus on ambulatory surgery. *Int J Surg* 2015; 15: 100-6.
20. Weibel S, Rücker G, Eberhart LH, et al. Drugs for preventing postoperative nausea and vomiting in adults after general anaesthesia: a network meta-analysis. *Cochrane Database Syst Rev* 2020; 10: CD012859.

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