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Original Research Article

Implementation of ERAS in kidney transplantation: a comprehensive approach

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ABSTRACT

Background: The implementation of enhanced recovery after surgery (ERAS) protocols in kidney transplantation represents a significant advancement in perioperative care, aiming to enhance patient outcomes and optimize resource utilization. Although ERAS protocols are well-documented in other surgical domains, their application in kidney transplantation remains relatively unexplored. Our study aims to explore the effectiveness of ERAS protocol in Kidney Transplantation, to assess the post-operative outcomes.
Methods: This comparative prospective analysis was conducted on 100 patients admitted for Kidney transplantation compared with 100 historic conventional kidney transplant patients.
Results: In this study conducted at Dr. B. L. Kapur Memorial Hospital and Research Centre, the application of an Enhanced Recovery After Surgery (ERAS) protocol in kidney transplantation demonstrated several positive outcomes. The ERAS group exhibited significantly lower pain scores, reduced post-operative nausea and vomiting, earlier return to regular diet, and shorter hospital stays (median 6 days vs. 7 days in the non-ERAS group). Notably, patients in the ERAS group had no narcotic usage after discharge, while 26% of non-ERAS patients required narcotic analgesics. Overall complications were comparable between the two groups.
Conclusions: ERAS in kidney transplantation improves pain management, mobility, and diet transition, leading to shorter hospital stays. Multidisciplinary collaboration is crucial during the transition.

Keywords: Enhanced recovery after surgery, Kidney transplantation, Perioperative care, Pain management, Postoperative outcomes

INTRODUCTION

Kidney transplantation is a critical intervention offering superior outcomes compared to dialysis, yet its growing demand presents significant resource challenges.[1] Enhanced Recovery After Surgery (ERAS) protocols, widely recognized for their efficacy in various surgical contexts, holds promise for optimizing postoperative care and reducing associated costs within kidney transplantation programs.[2] These protocols encompass preoperative counseling, nutritional management, intra-operative measures, standardized pain management strategies, and early mobilization initiatives.[3]

Despite initial investment requirements, the long-term financial benefits of ERAS implementation have been consistently demonstrated across surgical specialities.[2,4] As such, the successful integration of ERAS protocols into kidney transplantation represents a compelling avenue for enhancing patient outcomes while

simultaneously addressing the financial strains faced by transplant programs.[5-7]

The objective of the study was to evaluate the effectiveness of Enhanced Recovery After Surgery (ERAS) protocols in kidney transplantation, focusing on the improvement of post-operative outcomes, including pain management, recovery times, and overall patient well-being, compared to conventional kidney transplant procedures.

METHODS

The study at Dr. B L Kapur Memorial Hospital was conducted prospectively (Prospective observational study) from March 2021 to February 2023 conducted at B.L. Kapoor Max Hospital, New Delhi, focusing on patients admitted to the Department of Genito-Urinary Surgery. Only patients meeting specified criteria were included. Outcomes, including length of stay, were compared between 100 patients in the ERAS group and 100 historical conventional patients. All participants were fully informed and included only with their consent.

Inclusion and exclusion criteria

Patients aged 18-65 years with end-stage renal disease undergoing live donor kidney transplantation who provided informed consent and were deemed medically fit (ASA I–III) with optimized comorbidities were included in the study. Exclusions were patients under 18 or over 65, those receiving deceased donor or multi-organ transplants, emergency cases, or those with severe comorbidities, ASA IV or higher, contraindications to ERAS components, extensive prior abdominal surgery or non-compliance with the ERAS protocol.

ERAS protocol pathway

Pre-operatively

Preoperative counselling: renal transplant recipients underwent comprehensive counseling sessions regarding their condition, the surgical procedure, and the core components of ERAS, along with its benefits. Patients received clear instructions about expectations during their hospital stay, including early mobilization, feeding, and breathing exercises post-surgery. Counseling emphasizes the importance of active patient involvement in the recovery process.

Co-morbidity optimization: patients underwent breathing exercises and interventions to quit smoking and alcohol consumption. Nutritional status was optimized, and other medical co-morbidities were managed to ensure fitness for surgery.

Starvation: ERAS patients scheduled for surgery observed a fasting period of six hours for solid meals and 2 hours of clear liquid meals pre-operatively.

Intra-operatively

Surgical approach and incision: non-muscle cutting incisions were utilized compared to conventional muscle cutting incisions.

Transverse abdominis plane (TAP) block analgesia: ERAS patients received TAP block analgesia preoperatively, involving the administration of a local anaesthetic solution to block spinal nerves. This approach effectively reduced the postoperative stress response and enhanced gut function.

Avoidance of postoperative drains: routine drain tubes were avoided, and if necessary, they were removed once drainage was minimal (<50 ml).

Postoperative nausea vomiting prophylaxis (PONV): strict PONV prophylaxis was administered to ERAS patients to prevent postoperative nausea and vomiting.

Hypothermia prevention: measures were taken to prevent intraoperative hypothermia, such as using warm air blankets, warm intravenous fluids, and active warming techniques. Preventing hypothermia reduced the risk of surgical site infections, coagulopathy, cardiac morbidity, and other complications associated with hypothermia.

Intraoperative fluid management: fluids were administered at a constant infusion rate to maintain adequate blood pressure, with continuous monitoring of metabolic parameters.

Postoperatively

Fluid management: patients received postoperative fluids according to blood pressure, urine output, weight gain, and electrolyte levels, with close monitoring of volume status.

Postoperative analgesia: ERAS patients received postoperative analgesia with injectable Fentanyl initially, followed by IV paracetamol infusion and tramadol for breakthrough pain.

Early postoperative diet: early nutrition commenced shortly after surgery, progressing from clear oral liquids to a full diet over several days.

Early postoperative mobilization: patients were encouraged to ambulate early post-surgery, with daily monitoring of vital signs, fluid balance, and laboratory parameters. Doppler assessment was conducted for anastomosis and blood flow, and wound care was provided as needed.

Postoperatively, graft doppler was done for assessment of anastomosis, blood flow, and perinephric collection on POD 4. Wound dressings were done on POD-4. Patients with surgical site infections were managed with wound

dressings and antibiotics according to culture and sensitivity. All patients were followed up for outcomes like complications (Table 2), graft survival and readmissions.[8] Postoperative antibiotics and immunosuppression were continued as per nephrology advice.

Table 1: ERAS protocols vs conventional methods.[3]

	ERAS protocols	Conventional methods
Preoperative recommendations	Starvation period of 6 hrs for solids and 2 hrs for clear liquids.	Starvation period of 8 hrs
	2 hours before surgery, administration of: IV 100 ml of 25% dextrose and 500 ml of 0.9% NaCl	No carbohydrate loading
Operative	General anesthesia with TAP block	General anaesthesia
	Non-Muscle cutting incision	Muscle cutting incision
Postoperative	Low molecular weight heparin on POD-1 and POD-2	Low molecular weight heparin up to POD-6
	Fluid therapy according to, Mean arterial pressure, urine output weight gain per day (<3kg /day) until POD -3	Fluid therapy according to urine output, heart rate, and BP.
	Elective use of abdominal drains	Routine use of abdominal drains
	Early nutrition from 6 hrs after surgery (POD-0) with clear oral liquids, full liquid on POD-1 Soft diet on POD -2. Full diet on POD -3	Nutrition from POD-1 (Clear liquid), POD-2 (full liquid) Soft diet on POD -3. Full diet on POD -4.
	Early removal of Foley's catheter on day 5	Removal of Foley's catheter on POD-7
	Inj. Fentanyl analgesia after Transverse abdominis plane block till POD-1 Then an injection of Paracetamol 100m iv 8 hourly till POD-3 and then SOS for breakthrough pain.	Inj. Fentanyl analgesia till POD-3 then Inj. Tramadol 50 mg IV 8 hourly
	Mobilisation on POD -2	Mobilisation on POD -3
	PONV prophylaxis: Inj. Ondansetron	NO PONV prophylaxis
Expected duration of stay	On POD-5	On POD-7
Post-discharge	Early follow-up by Phone calls at 48hrs and SOS Clinical visit on 4th day Twice/week for 2 weeks. Once /week for 2 weeks Once monthly	Patient follow-up after 1 week in clinic. Then thrice /week for 2 weeks Twice/week for 2 weeks. Once /week for 1 month Once monthly.

Table 2: Clavien Dindo classification.[8]

Grade	Descriptions
1	Any deviation from the normal postoperative course without the need for pharmacologic treatment or surgical, endoscopic, and radiologic interventions.
2	Complications requiring pharmacologic treatment with drugs other than those allowed for Grade 1 complications. Blood transfusions, total parenteral infusions (IV fluids), and higher antibiotics for acute kidney injury managed.
3	Complications requiring ancillary surgical, endoscopic, or radiologic intervention.
3a	Intervention is not under general anesthesia.
3b	Intervention under general anesthesia.
4	Life-threatening complications (including central nervous system complications) requiring intensive care unit stay.
4a	Single-organ dysfunction (including dialysis) such as neighbouring organ injury, and myocardial infarction.
4b	Multiorgan dysfunction such as urosepsis.
5	Death of the patient.

Statistical analysis

To calculate the number of participants needed for this study, the significance level was set at 95% (α=0.05), and the power of the test was set at 80% with a type II error (β) of 0.20.

A previous study (B. H Dias et al found that the median length of stay for patients on ERAS protocol was 5 days and 7 days for patients in the conventional group.[9]

The sample size calculated is >35 to detect a difference in length of stay between the two groups; and number of patients admitted for renal transplant in our hospital is approximately 6 per month, so we took a sample size of 100 patients in our study.

The formula for the calculated sample size is given below

$$n = \frac{(\sigma_1^2 + \sigma_2^2)\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2}{(M_1 - M_2)^2}$$

$$n = \frac{(3^2 + 3^2)(1.96 + 0.842)^2}{2^2}$$

$$= \frac{(9 + 9) \times 7.85}{4}$$

$$= 35.33$$

where Zα/2 is the critical value of the Normal distribution at α/2 (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96), Zβ is the critical value of the Normal distribution at β (e.g. for a power of 80%, β is 0.2 and its critical value is 1.282) and σ 1 and σ 2 are the Standard deviations of the two groups and M1 and M2 are the means of two group

Statistical methods

Categorical and continuous variables will be presented as frequency (percentage) and mean±SD. Descriptive statistics will be used to summarize all demographic and other clinical characteristics of the patients. The Shaipro Wilk test will be used to test for normality. The relationship between two quantitative variables will be examined using Pearson's or Spearman's rank correlation coefficients. Associations between two or more qualitative variables will be assessed using chi-square or Fisher's exact tests, as appropriate. Quantitative data mean values between the two independent groups will be analyzed using unpaired t and Mann–Whitney U-tests, as appropriate. P<0.05 will be considered statistically significant.

RESULTS

This study conducted at Dr. B L Kapur Memorial Hospital and Research Centre in New Delhi investigated the application of an Enhanced Recovery After Surgery (ERAS) protocol in 100 cases of renal engraftment for chronic kidney disease between March 2021 and February 2023. The results were compared with similar patients retrospectively with non-ERAS traditional standard-of-care patients (as listed in the table). ERAS protocols aim to improve surgical outcomes and expedite recovery by implementing specific interventions before, during, and after surgery. There was no significant statistical difference between the two groups with regard to mean age, gender & BMI (Table 3). Also, there was no statistical difference noted with respect to the status of comorbidities. All transplants performed in both groups were live donor transplants.No statistical difference was found in graft function pre-op creatinine levels or creatinine drops on post-operative day 1 and 30. The overall pain scores were significantly lower with the ERAS group with no associated narcotic usage in the same group. Post-operative nausea and vomiting were also considerably lower in the ERAS group. ERAS protocol patients had earlier flatus passage and earlier bowel movements. In the ERAS group, patients tolerated a regular diet significantly earlier (within two days) compared to the traditional group (where it occurred on the third day postoperatively). The median length of stay in the hospital was 6 days for the ERAS group which is 1 day less than for non-ERAS group (i.e. 7 days). The patients from the ERAS group had no narcotic usage after discharge, however, 26% of patients in the non-ERAS group needed to use narcotic analgesics after discharge. The overall complications encountered in both groups were comparable.

Table 3: Demographic and baseline recipient characteristics (n=100).

Characteristics		ERAS (n=100)	Non-ERAS (n=100)	P value
Age (years)	Mean	38 ± 13.5	36.48 ± 12.69	0.413
Gender				
Male		80 (80%)	70 (70%)	0.102
Female		20 (20%)	30 (30%)	
BMI	Mean ± SD	30.15 ± 5.13	31.05 ± 4.11	0.316
Comorbidities				
Diabetes		42 (42%)	55 (55%)	0.089
Hypertension		51 (51%)	46 (46%)	0.571

Table 4: Comparison of post-op variables ERAS vs non-ERAS.

Variables	ERAS	Non-ERAS	P value
Pre-op Creatinine	7.332 (4.11-12.53)	6.681 (3.53-13.15)	0.411
Creatinine - POD1	3.14 (2.16-7.78)	3.53 (2.75-8.96)	0.618
Creatinine - POD30	1.05 (0.63-1.68)	1.38 (0.54-2.46)	0.0588
Pain Score POD1 (Median)	1 (0-4)	4 (2-8)	0.0001
IV narcotic use	No	Yes: IV PCA (on POD 1 -2)	-
Median Peak Pain score	4 (1-6)	9 (5-10)	0.0001
PONV	1%	70%	0.001
Flatus passage (POD - median)	1	2	0.0001
First bowel movement (POD-Median)	2 (1-4)	4(3-6)	0.001
Narcotic use after discharge (Percent)	0	26	0.0001
Length of stay (Median, days)	6 (6-7)	7 (7-8)	<0.001
Overall complication	11 (11%)	13 (13%)	0.827
Clavien 1 and 2	5 (5%)	6 (6%)	0.756
Clavien >2	6 (6%)	7 (7%)	0.774

DISCUSSION

ERAS pathway is well practiced & followed in the field of general surgery & colorectal surgery.[2,10] With continuing practice, applications of ERAS protocol are being accepted in various surgical disciplines.[11,12] Few recent articles shed light on this less-practiced path.[3,13] Overall, the ERAS protocol aims to improve the perioperative period of the patient's entire surgical experience. We have started practicing ERAS protocol full-time in other surgeries like Laparoscopic and Robotic-assisted simple/radical nephrectomy, Radical prostatectomies, and other surgeries in urology. The experience with ERAS protocol in Kidney transplantation is sparse.[1,3] With this article, we seem to share our experience with ERAS protocols in Kidney transplantation recipient patients. Various factors add on to the post-operative morbidity in a patient of uncomplicated kidney transplantation.[14,15] These factors include-excessive IV fluids, parenteral opioid analgesia and bed rest.[3,16-18] Our study and assessment indicate that patients in the ERAS group have a mean hospital stay that is 1 day shorter (6 days) compared to those following conventional protocols (7 days). Elsabbagh et al reported a median stay of 2 days post-kidney transplant with the ERAS protocol.[3] Dias et al found a median stay of 5 days; while Espino et al noted a median stay of 4 days for patients under the ERAS protocol.[9,6]

ERAS includes key elements like preoperative consumption of carbohydrate-rich clear liquids and reduced fasting, offering significant benefits. Unlike traditional fasting, which may not affect gastric secretion or pH, we followed guidelines allowing clear liquids until 2 hours before anesthesia, improving patient comfort without raising pulmonary aspiration risk. Renal transplant patients often experience prolonged fasting and dehydration from dialysis. Carbohydrate-rich liquids help decrease insulin resistance and catabolism, aiding glucose control and muscle preservation during surgery.[3,19]

There was only 1 patient who experienced emesis in our entire ERAS group of patients whereas Espino et al reported somewhat higher rate of emesis in ERAS patients compared with historic cohorts (15.8% vs 8.4%). Our ERAS group patients were administered post-op nausea vomiting (PONV) prophylaxis with pre-operative antiemetics, non-narcotic analgesics, optimized fluid and electrolytes, and early post-operative initiation of oral intake.

Goal-directed fluid therapy (GDFT) is a vital element of the ERAS pathway.[14,20,21] Chronic kidney disease patients are often prone to cardiovascular complications and hence it is essential to avoid excessive fluid administration in these recipient patients.[14] Excessive fluid is also associated with prolonged ileus, owing to bowel wall edema, weight gain, and hence leads to a delayed discharge from the hospital.[20] Postoperative opioids have risks, including delayed bowel function, dizziness, and impaired immunity.[22] Pain control in kidney transplants differs due to the nephrotoxicity of nonsteroidal anti-inflammatory drugs. ERAS pathway emphasizes multimodal pain control, including local anesthetics used comprehensively during surgery. We used 0.375% ROPIVACAINE for the TAP block. This was followed by the use of Fentanyl for 1st post-operative day; later Inj. Paracetamol 1 gm IV was used till 3rd post-operative day and then SOS for breakthrough pain.

Despite applying many efforts and taking specific written protocol steps, we decreased the hospital stay by a mere 1 day when compared for both groups. Various factors led to this much of hospital stay: Patients were unwilling get discharged on parenteral therapy or with per urethral

catheter in situ, and patients belonging to remote areas from the hospital.

Elsabbagh et al highlighted that postoperative length of stay can be reduced by up to 3 days if patients are discharged with a Foley catheter, which can be removed during their first clinic visit. Additionally, completion doses of immunosuppression medication can be administered during subsequent clinic follow-up visits if necessary. ERAS is not a one-size-fits-all approach; it should be adapted to the unique context of kidney transplant surgery. By combining precision and protocol, can optimize patient outcomes and enhance recovery after kidney transplantation.

The outline includes few simple steps that can be taken to improve the adoption of ERAS protocol: multidisciplinary collaboration: engage a diverse team, including surgeons, anaesthesiologists, nurses, physiotherapists and nutritionists, to ensure seamless implementation and adherence to ERAS principles. Customization: tailor the ERAS pathway to the specific needs of kidney transplant recipients, considering their unique characteristics and risk factors. Education and training: provide comprehensive training to healthcare professionals on ERAS components, emphasizing early ambulation, multimodal pain control, and early enteral feeding. Patient education: educate patients about ERAS, emphasizing the benefits of early mobilization, proper nutrition, and pain management. Address any concerns or misconceptions. Standardized protocols: develop clear, evidence-based ERAS protocols specific to kidney transplantation, focusing on preoperative, intraoperative, and postoperative phases. Outcome monitoring: regularly assess ERAS outcomes, including length of stay, complications, and patient satisfaction. Use this data to refine and improve the protocol. Quality improvement initiatives: continuously evaluate ERAS implementation, identify areas for improvement, and adapt protocols based on real-world experiences.

The study was limited by its design a retrospective, single-center cohort analysis of a small number of patients. However, the sample size was enough to show the difference between the two groups. Our study did not explore whether all ERAS components hold equal significance or identify the key components that determine clinical outcomes.

CONCLUSION

Implementing the ERAS pathway in kidney transplantation is feasible with necessary adjustments to accommodate the unique dynamics of the procedure. ERAS adoption is linked to better pain management, earlier mobility, quicker transition to a regular diet, and shorter hospital stays. When transitioning from a non-ERAS program to an ERAS program, a multidisciplinary approach is essential.

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