MR. WEI SHEN TAN (Orcid ID : 0000-0002-6119-4043)

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Intracorporeal robotic assisted radical cystectomy together with an enhanced recovery programme improves postoperative outcomes by aggregating marginal gains.

Wei Shen Tan[1,2], Mae-Yen Tan[3], Benjamin W Lamb[4], Ashwin Sridhar[1,2], Anna Mohammed[2], Hilary Baker[2], Senthil Nathan[1,2], Timothy Briggs[2], Melanie Tan[4], John D Kelly[1,2]

1. Division of Surgery and Interventional Science, University College London, London, UK
2. Department of Urology, University College London Hospital, London, UK
3. School of Medicine, University of Glasgow, Glasgow, Scotland, UK
4. Department of Urology, Peter MacCallum Cancer Centre, Melbourne, Australia
5. Department of Anaesthesia and Perioperative Medicine, University College London Hospital, London, UK

Corresponding author:

Wei Shen Tan
Division of Surgery & Interventional Science,
University College London,

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74 Huntley Street,
London WC1E 6AU,
UK
Tel: +44(0)20 7679 6182
Fax: +44(0)20 7679 6470
Email: wei.tan@ucl.ac.uk

Abstract

Objective

To assess the cumulative effect of an enhanced recovery after surgery (ERAS) pathway and a minimally invasive RARC with intracorporeal urinary diversion (iRARC) in comparison to open radical cystectomy (ORC) on hospital length of stay (LOS) and perioperative outcomes.

Materials & methods

Between Feb 2009 and Oct 2017, 304 radical cystectomy cases were performed at a single institution (54 ORC, 250 RARC). Data were prospectively collected. We identified 45 consecutive ORC cases performed without ERAS before the commencement of the RARC programme (Cohort A), 50 consecutive iRARC cases performed without ERAS (Cohort B) and 40 iRARC cases with ERAS (Cohort C). Primary outcome measure was hospital LOS while secondary outcome measures included perioperative 90-day complications and readmission rates. Complications were accessed using the Clavian-Dindo classification.

Results

Patients in all cohorts were evenly match in age, sex, body mass index (BMI), neoadjuvant treatment, tumour stage, lymph node yield, previous pelvic radiotherapy and surgery, perioperative anaemia as well as physiological state. iRARC with ERAS patients had a significantly higher ASA (III-IV) and were more likely to receive neobladder reconstruction. Median hospital LOS were shorter in iRARC with ERAS (7 days, IQR: 6-10) compared to iRARC without ERAS (11, 8-15) and ORC (17 (14-21). In a propensity score-matched cohort of iRARC patients, patients with ERAS has a significantly lower 90-day readmission rates. Additionally, implementing ERAS in an iRARC cohort resulted in a

significantly lower 90-day all (p<0.001) and GI related complications (p=0.001). the use of ERAS and younger patients were independently associated with a hospital LOS ≤10 days on multinomial logistic regression.

Conclusion

A comprehensive ERAS programme can significantly reduce hospital LOS in patients undergoing iRARC without increasing 90-day readmission rates. An ERAS programme can augment the benefits of iRARC in improving perioperative outcomes. In studies comparing ORC and RARC, the presence or absence of an ERAS programme will be a confounding factor and only level I evidence can be interpreted reliably.

Introduction

Radical cystectomy is the recommended treatment for muscle invasive bladder cancer and selected high risk non-muscle invasive bladder cancer as set out by international guidelines [1, 2]. Cystectomy is a morbid procedure and associated with a 3% 90-day mortality in high volume centers [3]. Risk of complication can be attributed to cardiovascular and respiratory comorbidity in an older population with a high prevalence of smoking history.

Efforts to minimise postoperative morbidity include the development of robotic assisted radical cystectomy with intracorporeal urinary diversion (iRARC) and its rapid adoption seeks to replicate the oncological principles of open surgery whilst promoting early return to normal activity. Early oncological outcomes for open radical cystectomy (ORC) and iRARC are similar [4], however a meta-analysis of randomised controlled trials (RCT) comparing open ORC and RARC has failed to show significant differences in overall perioperative outcomes [5]. Although RARC results in lower blood loss and lower wound related complications, there was no difference in 90-day complications nor hospital length of stay (LOS). Single institution observation data does suggest a benefit for RARC however by definition, reports are from early adopters in high volume centres and frequently have established perioperative enhanced recovery after surgery (ERAS) programs [6].

ERAS was initially piloted and evolved for colorectal surgery and has led to the reduction in hospital LOS and complications without compromising patient safety [7]. More recently, ERAS has been implemented for radical cystectomy with reports of reduced perioperative complications rates and LOS to as low as four days [8-10]. ERAS represent a multi-modal perioperative care pathway designed to expedite postoperative recovery and improve morbidity by minimising organ dysfunction and reducing the metabolic stress response secondary to surgery.

In this study, we assess the impact of iRARC as well as cumulative effect of ERAS and iRARC on the perioperative outcomes of patients undergoing radical cystectomy.

Patient and methods

Patient population

Between March 2009 and November 2016, 304 radical cystectomy cases were performed at a single institution (54 ORC, 250 RARC). Data were prospectively collected using an institutional approved database. iRARC has been the default approach to radical cystectomy from 2014, with 98% of cystectomy cases performed by this approach. A structured ERAS pathway was adopted in May 2016. We identified 45 consecutive ORC cases without ERAS during which there was no iRARC performed (Cohort A), 50 consecutive iRARC cases before the implementation of an ERAS pathway (Cohort B) and 50 consecutive iRARC cases which were performed following the adoption of ERAS (Cohort C). All cases were performed by one of two surgeons. Fifty cases were excluded during the transition period from ORC to iRARC to account for iRARC learning curve and a further 75 cases were excluded when the current ERAS pathway was gradually implemented (Figure 1). This study was part of a quality assurance programme and registered with our intuitional department (Urology2015.2).

Surgical technique

All patients either received ileal conduit or neobladder reconstruction which was dependent on patient choice provided there were no absolute contraindications. A standard approach for ORC and iRARC has been previously described [11, 12]. A Studer neobladder was performed for ORC cases. Briefly, iRARC was performed using a standard 6-port transperitoneal approach with 20° Trendelenburg. A standard lymph node dissection template with the following boundaries were used for both open and iRARC cases: genitofemoral nerve laterally, ureteric crossing at the common iliac vessels proximally, the circumflex iliac vein and node of Cloquet anteriorly and the hypogastric vessels posteriorly. Following RARC and construction of urinary diversion, the specimen and dissected nodes were placed in an Endo Catch bag (Covidien, Dublin, Ireland) and removed. For patients receiving ileal conduit, a 15 cm segment of ileum 15 cm from the ileal-cecal valve was isolated using a 60 mm Endo-GIA laparoscopic intestinal stapler (Covidien, Dublin, Ireland). Intracorporeal neobladder construction was performed using 50 cm of terminal ileum, which was detubularised and cross-folded to form the Pyramid pouch, which is without an afferent limb [11]. A suprapubic and urethral catheter was placed for neobladder patients. Uretero-ileal anastomosis was performed using either Bricker or Wallace anastomosis depending on surgeon's preference over 6 Fr infant feeding tubes. The tubes were externalised and sutured using 3-0 undyed polyglactin 910 sutures (Ethicon, Somerville, New Jersey, USA), which breaks down after 10 days and allows the stents to fall out. A pelvic drain was placed and removed when output is <50 ml/ 24 hours. At six weeks, a cystogram was performed for neobladder patients prior to removal of urethral and suprapubic catheter if there was no urinary leak.

Non-ERAS pathway

All patients received best of care practice with no standardisation of preoperative and postoperative care. Patients abstained from food and only had clear fluids for 12 hours, up until two hours before surgery. Bowel preparation was avoided prior to surgery. Intraoperatively, 3000 ml of intravenous (IV) fluids were typically prescribed intraoperatively. All patients received epidural analgesia. Postoperative analgesia

comprised of fentanyl patient controlled analgesia (PCA) stepping down onto an oral regime consistent with the World Health Organisation (WHO) analgesic stepladder. The ORC cohort had their nasogastric (NG) tube removed 1-2 days postoperatively provided they were tolerating oral intake. iRARC cohort had their NG tube removed following surgery. Patients were commenced on a soft diet from day two if tolerated. Patient mobilisation was dependent on the motivation of individual patients.

Enhanced Recovery After Surgery (ERAS)

The ERAS protocol implemented has been previously described [12]. All patients are seen at a dedicated cystectomy preassessment clinic where they see a surgeon, anaesthetist, stoma care nurse and have cardioplumonary exercise test (CPET) performed. Patients are educated on the surgical pathway and patient's goals and expectations are set.

No bowel prep is utilised, instead patients are advised to adopt a low-residue diet for two days prior to surgery. All patients are provided with two high calorie carbohydrate drinks to consume before surgery: one at 22:00 hours the night before surgery, the second at 06:00 hours on the day of surgery. Spinal anaesthesia with 2 ml 0.5% heavy bupivacaine and 1 mg of diamorphine is used as a single shot neuroaxial block. A Transoesophageal Doppler is used for indirect monitoring of cardiac output to aid goal-directed fluid therapy.

Following surgery, the NG tube is removed in theatre and all patients were admitted to intensive care. A standard prescribing regime includes paracetamol, non-steroidal and oral morphine for breakthrough pain as well as regular pharmacological agents to promote bowel recovery; metoclopramide, magnesium sulphate and ranitidine. Subcutaneous low molecular weight heparin is administered six hours following surgery for four weeks postoperatively.

IV fluids are discontinued following surgery. Patients are commenced on oral clear fluids immediately postoperatively, and allowed free fluids orally as tolerated. Oral diet is started on the first postoperative day. Patients are instructed to start an incrementally increasing mobilisation regime starting with a minimum of 20 meters three times per day and increasing up to 60 meters three times per day immediately.

Surgical, anaesthetic, nursing and physiotherapy staff assist patients with initial mobilisation and all teams empower the patient to independently follow the mobilisation regime thereafter.

Data collected

Patient demographics and preoperative variables including CPET which measures anaerobic threshold (AT), peak oxygen consumption (VO_2) and minute ventilation/ carbon dioxide production (VE/VCO_2) as well as American Association of Anaesthetics (ASA) score, clinical and pathological characteristics, were recorded. Peri- and post-operative data including perioperative 90-day complications, hospital LOS, readmission rates and mortality were collected. Postoperative ileus was confirmed on CT scan following clinical suspicion. All patients were followed-up for a minimum of 90-days following surgery.

Study outcomes

The primary endpoint was hospital LOS while the secondary endpoints for the study were 90-day readmission rate, and perioperative complications. Complications were classified using Clavian-Dindo classification.

Statistics

All continuous data such as mean, median, interquartile range and 95% confidence interval were reported using descriptive statistics. Comparative statistics between categorical variables were reported using Chi-square test, while t-test or ANOVA were used for comparison of continuous variables. Multivariable logistic regression was performed to determine the interaction between variables.

To attempt to account for selection bias, propensity score-matched analysis was performed to adjust for differences in patient characteristics between iRARC treated patients with or without ERAS. The nearest neighbour propensity score-match was used to match iRARC patients with or without ERAS in a 1:1 ratio. Propensity score

was determined by modelling logistic regression with the following dependent variables: age, body mass index (BMI), gender, ASA score and neoadjuvant chemotherapy (NAC) use.

SPSS v.22 (IBM Corp, Armonk, New York, USA) was used to perform all statistical analysis. Statistical significance was set a p value <0.05.

Results

Patient demographics for 45 ORC patients (Cohort A), 50 iRARC patients (Cohort B) and 50 iRARC patients with ERAS (Cohort C) are presented in Table 1. Patients in each cohort were evenly matched in age, gender, BMI, NAC, tumour stage, lymph node yield, previous pelvic radiotherapy and surgery, perioperative anaemia as well as physiological state (Table 1). iRARC patients with ERAS (Cohort C) had a significantly higher ASA (III-IV) and were more likely to receive neobladder reconstruction (Table 1).

Table 2 presents data for hospital LOS, 90-day readmission rates, 90-day morbidity and mortality stratified by cohort. The overall 90-day readmission rate for all patients was 20%, and 90-day rate for all complication was 57.2% and 22.4% for major complications. GI related complications (37.9%) and infection (29.7%) were most common. Wound related complications were significantly less frequent in iRARC cases compared to ORC (5.0% vs 28.6%, p<0.001).

An iRARC with ERAS (Cohort C) was associated with a reduced hospital LOS compared to ORC or iRARC alone (p<0.001) and with no associated increase in readmissions compared to Cohort A and B. Interestingly, the implementation of ERAS resulted in significantly lower 90-day all complications (p<0.001) and major complications (p=0.040). GI related complications were significantly lower in the ERAS patients treated with iRARC (18% vs 52%, p<0.001). The incidence of postoperative ileus was significantly lower in iRARC with ERAS patients (Cohort C) (16% vs 34%, p=0.021). There was no difference in 90-day infection and medical related complications. A box plot in Figure 2 shows the LOS distribution of the patient cohort.

Following propensity score-matching of iRARC patients to account for gender, age, BMI, ASA and neoadjuvant chemotherapy use, patients with ERAS were significantly associated with a lower 90-day admission rate (p=0.034) and all complications (p=0.006) and 30-day (p=0.017) and 90-day (p=0.002) GI related complications (Table 3). Patients with ERAS had a lower LOS (11.2 vs 14.0 days) although this was no significant.

Multivariable regression confirms that the implementation of an ERAS pathway and lower patient age were independently associated with patient LOS ≤ 10 days (OR: 0.2, 95% CI: 0.07-0.57, p=0.003) (Table 4). Additionally, multivariable regression show that ERAS was independently associated with associated with lower 90-day complications (OR: 0.17, 95% CI: 0.06-0.43, p<0.001) (Table 5).

Discussion

This study represents the first study to compare postoperative outcomes between patients who have undergone ORC and iRARC with or without an ERAS programme. We report that a structured ERAS protocol results in a decrease in hospital LOS in iRARC treated patients from a median of 11 to 7 days, without increasing 90-day readmission rates. In non-ERAS patients, there was a significantly shorter hospital LOS in iRARC compared to ORC, but it was the implementation of ERAS that augmented the benefits of iRARC and significantly improving perioperative outcomes. Furthermore, an ERAS protocol was independently associated with LOS < 10 days while a minimal invasive robotic approach was not.

Historic reports of ORC performed at high-volume institutions reported a 58- 64% 90-day complication rate following surgery, with a 13-22% major complication rate [13, 14]. Previously, we reported a 90-day all and major complication rate of 72% and 21% respectively with a median hospital LOS of 10.5 days in 134 consecutive iRARC cases {Tan, 2016 #159}. According to UK and USA population data, the mean LOS following cystectomy before the advent of ERAS was 19 and 11 days

respectively [16, 17]. Evidence from the implementation of ERAS protocols in ORC have resulted in shorter LOS while complication and readmission rates have remained constant [8]. In this study, we observed similar findings in our iRARC patient cohort.

Patient characteristics across our three patient cohorts were comparable. The only exception was that patients in Cohort C (iRARC with ERAS) where more likely to be ASA ≥III grade and undergo neobladder urinary diversion. Despite the potential disadvantage of increased anaesthetic risk, and more complex urinary diversion, patients in this cohort had a significantly lower hospital LOS compared to the non-ERAS cohort of ORC and iRARC, which is testament of the advantages of an ERAS programme. The mean AT of 10.5 suggests that most patients treated had a poor physiological reserve, and that all patients regardless of co-morbidity would benefit from the implementation of an ERAS programme.

In a propensity score-matched cohort of patients treated with iRARC adjusted for gender, age, BMI, ASA and NAC use, the introduction of ERAS reduced hospital LOS from a median of 11 to 7 days while significantly lowering the 90-day readmission rate suggests that patients were discharged home in a safe and timely manner. In addition, ERAS patients had a significantly lower rate of 90-day complications as well as a reduction in the incidence of ileus and subsequent GI related complications, which is recognised as a cause of prolonged hospital admission. The ERAS pathway, promotes early mobilisation, early introduction of oral intake, as well as the preference for non-steroidal analgesia over opiate based analgesia, all of which contribute towards early return to bowel function. As evidenced by data from an RCT, the adoption of spinal analgesia as part of an ERAS programme and avoiding epidural and PCA analgesia improves early mobilisation providing adequate pain control as well as the freedom from PCA pump attachment [18]. Epidural requires the continuous IV fluids which can lead to crystalloid overload resulting in oedematous bowel due to third spacing contributing to the developmental of ileus. Additionally, patients also mobilise less due to their attachment to IV lines. Not surprisingly ORC treated patients had significantly more wound complications compared to iRARC treated patients which is also consistent with data from meta-analysis [5].

Our results are consistent with other reported outcomes following implementation of an ERAS pathway for RARC [9, 10, 19]. The median LOS of 7-8 days is reported and avoidance of PCA has been highlighted as a major factor influencing LOS. Although our preference is for spinal analgesia, the use of oxycodone is described by others [9, 10, 19]. The European Association of Urology Robotic Section Scientific Working Group recently published consensus for enhanced recovery for RARC in efforts to guide the standardisation of postoperative care [20].

Previous studies have not reported 90-day complication rates, and instead report 30-day all and major complication rate, ranging from 31- 57%, and 9-18% respectively, with a 30-day readmission rate of 3-33% (Table 6) [9, 10, 19]. In this series, we report a 90-day all and major complication rate of 42% and 12%, with a 12% 90-day readmission. Our reported 30-day complication and readmission rates are comparable to other reported series.

We performed a multivariate analysis to identify factors which are associated with LOS ≤ 10 days. ASA ≥ III and elevated BMI as well as the technique of (open vs robotic) were not predictors of hospital LOS ≤ 10 days. In the iRARC + ERAS cohort, 24% of patients had LOS > 10 days and this was associated with the development of 30- and 90-day complications. We have previously reported that patients with significant risk factors such as preoperative anaemia, [21] and poor cardio-respiratory reserve [22] are not an increased risk of developing complications following an iRARC procedure. We identified that age and ERAS are independently associated with a reduction in LOS.

Within ERAS, there are multiple components which may influence the outcomes and can be considered as marginal gains representing small improvements in multiple areas that cumulatively result in significant benefit. As such, it is necessary to introduce the pathway as an all or nothing and our results suggest a significant gain. Similarly, the robotic approach has multiple components which collective can potentiate recovery however the impact of this alone has not been reported as level one evidence.

There are important limitations in this study. Firstly, patient cohort size was limited and represents an evolution of an optimised cystectomy programme. While outcomes of the iRARC patients in this cohort were prospectively recorded, the ORC

cohort represents a historic cohort which was before centralisation of cystectomy services and the data collected were retrospective. It is worth noting that while ERAS was associated with the significant gains seen, other factors such as centralisation of services and learning curve may account for the decrease in morbidity reported. The ORC cohort was performed pre-centralisation and while the Pasadena Consensus suggest that the learning curve for RARC is around 30 cases, despite excluding our first 50 iRARC cases, surgical technical ability may continue to improve beyond this [23]. Due to the retrospective nature of the data on ORC cases 30-day readmission rate may be under represented. Interestingly, 15.6% (7/45 patients) of ORC patients had a LOS ≥30 days, compared to 6% (3/50 patients) and 4% (2/50 patients) in the iRARC and iRARC with ERAS patient cohorts.

Conclusion

In conclusion, this data suggests that ERAS is an independent factor associated with hospital LOS ≤ 10 days and that the surgical approach (iRACR or ORC) was not. However, patients receiving ORC had a significantly longer hospital LOS compared to iRARC alone or iRARC with ERAS. These results suggest that the impact of ERAS can be a confounding factor when interpreting surgical outcome reports following robotic surgery. The type of perioperative care pathway is likely to influence the postoperative recovery outcome data and may explain the variability between single center series and RCT data is essential when evaluating new surgical technology. A trial to compare robotic assisted radical cystectomy with open radical cystectomy (iROC, clinicaltrials.gov: NCT03049410) where patients are randomised to iRARC or ORC with a comprehensive institutional ERAS pathway is currently underway and results will be eagerly awaited.

Conflicts of Interest

None

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Table 1: Patient characteristics

	Cohort A ORC (n=45)	Cohort B iRARC (n=50)	Cohort C iRARC+ERAS (n=50)	P value
Mean age, years (range)	65.0 (34.7-80.5)	62.8 (41.8-83.9)	66.2 (31.5-84.7)	0.327
Sex, male (%)	32 (71.1)	36 (72.0)	40 (80.0)	0.467
Mean body mass index (kg/m^2) (range)	29.7 (18.0-46.3)	27.0 (16.6-38.3)	27.4 (19.1-38.0)	0.370
ASA score: I-II III-IV	 39 (86.7) 6 (13.3)	 31 (62.0) 19 (38.0)	 27 (54.0) 23 (46.0)	0.001
Neoadjuvant treatment (%): Chemotherapy Immunotherapy	 10 (22.2) 0	 17 (34.0) 0	 16 (32.0) 3 (6.0)	0.145
Preoperative anaemia (%)	24 (53.3)	24 (48.0)	24 (48.0)	0.838
Prior pelvic radiotherapy (%)	1 (2.2)	2 (4.0)	1 (2.0)	0.936
Prior pelvic surgery (%)	2 (4.4)	3 (6.0)	3 (6.0)	0.912
CPET: Mean AT (range)		 10.5 (7-18)	 10.5 (6-19)	 0.924
Mean VO2Max (range)		16.6 (8-43)	15.4 (9-34)	0.348
Mean VE/VCO2AT (range)		35.1 (27-49)	34.7 (26-51)	0.727
Tumour stage (%): ≤pT2 ≥pT3	 30 (66.7) 15 (33.3)	 27 (54.0) 23 (46.0)	 32 (64.0) 18 (36.0)	 0.402
Mean lymph node yield (range)	14 (0-48)	13 (0-35)	12 (0-26)	0.518
Nodal metastasis (%)	6 (13.3)	12 (24.0)	5 (15.2)	0.356
Diversion type (%) Ileal conduit Neobladder	 38 (84.4) 7 (15.6)	 41 (82.0) 9 (18.0)	 39 (78.0) 11 (22.0)	 0.002

Table 2: Details of patient length of stay, morbidity and mortality stratified according to patient cohort.

	ORC (n=45)	iRARC (n=50)	iRARC+ERAS (n=50)	P value
Length of stay: Mean, days (range)	20.1 (8-78)	13.6 (5-50)	10.9 (4-81)	<0.001
Median, days (IQR)	17 (13.5, 21)	11 (7.8, 15.3)	7 (6-10.3)	
90-day mortality	3 (7.0)	3 (6.0)	1 (2.0)	0.502
Postoperative ileus	14 (31.1)	19 (47.5)	8 (16.0)	0.047
30-day readmission (%)	3 (6.7)	7 (14.0)	6 (12.0)	0.504
90-day readmission (%)	10 (22.2)	13 (26.0)	6 (12.0)	0.107
30-day all complications (%)	32 (74.4)	32 (64.0)	19 (38.0)	0.001
30-day major complications (%)	11 (23.9)	11 (22.0)	6 (12.0)	0.354
30-day GI complications (%)	19 (44.2)	23 (46.0)	11 (22.0)	0.023
30-day infection complications (%)	17 (38.6)	13 (26.0)	11 (22.0)	0.182
30-day wound complications (%)	10 (23.3)	0 (0)	1 (2.0)	<0.001
30-day medical complications (%)	14 (31.1)	10 (20.0)	7 (14.0)	0.064
90-day all complications (%)	37 (86.0)	39 (78.0)	21 (42.0)	<0.001
90-day major complications (%)	13 (30.2)	13 (26.0)	6 (12.0)	0.040
90-day GI complications (%)	20 (47.6)	26 (52.0)	9 (18.0)	0.001
90-day infection complications (%)	16 (37.2)	17 (34.0)	10 (20.0)	0.148
90-day wound complications (%)	12 (28.6)	3 (6.0)	2 (4.0)	<0.001
90-day medical complications (%)	11 (26.2)	12 (24.0)	6 (12.2)	0.197

Table 3: Details of patient length of stay, morbidity and mortality following propensity score matching to account for gender, age, BMI, ASA score and neoadjuvant chemotherapy use.

	iRARC (n=40)	iRARC+ERAS (n=40)	P value
Length of stay: Mean, days (range)	14.0 (5-50)	11.2 (4-81)	0.31
Median, days (IQR)	10.5 (7.3-15)	7 (6-10)	
90-day mortality	1 (2.5)	1 (2.5)	0.986
Postoperative ileus	14 (35.0)	7 (17.5)	0.075
30-day readmission (%)	5 (12.5)	4 (10.0)	0.723
90-day readmission (%)	10 (25.0)	3 (7.5)	0.034
30-day all complications (%)	24 (60.0)	17 (42.5)	0.117
30-day major complications (%)	7 (17.5)	6 (15.0)	0.762
30-day GI complications (%)	18 (45.0)	8 (20.0)	0.017
30-day infection complications (%)	11 (28.5)	10 (25.0)	0.799
30-day wound complications (%)	0 (0)	1 (2.5)	0.314
30-day medical complications (%)	6 (15.0)	7 (17.5)	0.762
90-day all complications (%)	30 (75.0)	18 (45.0)	0.006
90-day major complications (%)	8 (20.0)	5 (12.5)	0.363
90-day GI complications (%)	20 (50.0)	7 (17.5)	0.002
90-day infection complications (%)	15 (37.5)	9 (22.5)	0.143
90-day wound complications (%)	3 (7.5)	2 (5.0)	0.644
90-day medical complications (%)	8 (20.0)	6 (15.4)	0.591

Table 4: Multinomial logistic regression for LOS ≤ 10 days

	P value	OR (95% CI)
ORC vs RARC	0.308	2.47 (0.43-14.12)
Ileal conduit vs Neobladder	0.996	1.00 (0.23-4.34)
Patient age (continuous)	0.014	1.1 (1.01-1.13)
BMI (continuous)	0.948	1.00 (0.91-1.09)
Preoperative anaemia (No vs Yes)	0.734	0.85 (0.32-2.24)
ASA (I-II vs III-IV)	0.374	0.63 (0.23-1.75)
ERAS (No vs Yes)	0.003	0.20 (0.07-0.57)

Table 5: Multinomial logistic regression for 90-day all complications for patients treated with iRARC

	90-day all complications	
	P value	OR (95% CI)
ORC vs RARC	0.369	0.16 (0.03-9.07)
Ileal conduit vs Neobladder	0.409	1.71 (0.48-6.19)
ASA (I-II vs III-IV)	0.141	2.07 (0.79-5.43)
ERAS (No vs Yes)	<0.001	0.17 (0.06-0.43)
NAC (No vs Yes)	0.446	1.45 (0.54-3.90)
Patient age (continuous)	0.356	1.02 (0.98-1.07)

Table 6: Comparison with other trails

	Current study	Koupparis et al. [10]	Miller et al. [9]	Collins et al. [19]
Number of ERAS cases and technique	50 iRARC	102 iRARC	114 e/iRARC	135 iRARC
Age, mean	66	68	67	70
ASA ≥III, %	46	26		48
Continent diversion, %	22	11	15	28
Median LOS, days	7	8	7	8
30-day complication, %	38	31	54	57
30-day major complication, %	12	9	18	19
30-day readmission, %	12	3	18	
90-day complication, %	42			
90-day major complication, %	12			
90-day readmission, %	12			
Key ERAS features				
No bowel prep	Yes	Yes	Yes	Yes
Carbohydrate loading	Yes	Not specified	Yes	Yes
Goal directed IV fluids	Yes	Not specified	Yes	Yes
Spinal anaesthesia	Yes	Epidural	Rectus sheath catheter +/- PCA	Yes
Remove NG tube immediately after surgery	Yes	Not specified	Yes	Yes
Drain use	Yes	Not specified	No	Yes
Prokinetic agents	Yes	Yes	Yes	Yes
Chewing gum	Yes	Not specified	Not specified	Yes
VTE prophylaxis	Yes	Yes	Yes	Yes
Early mobilisation	Yes	Yes	Yes	Yes
Removal of stents	Day 10	Not specified	Day 5	Day 10

Figure 1: Introduction of iRARC and ERAS

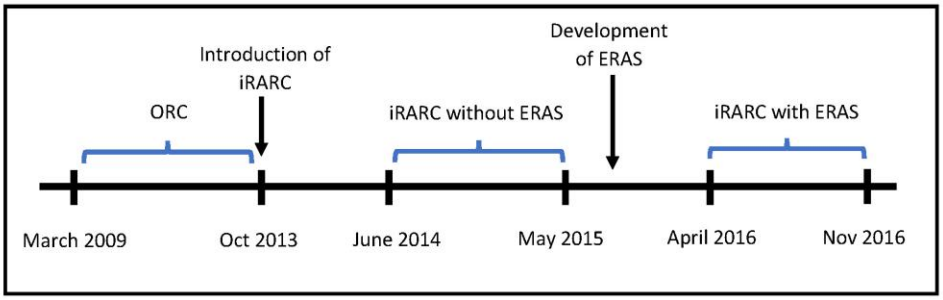

Figure 2: Box plot of median hospital length of stay according to patient cohort