

Review

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Review of intracorporeal and extracorporeal continent urinary diversion - where do we stand in 2021?

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Abstract

Robot-assisted radical cystectomy has become widely accepted as a safe and minimally invasive procedure for the treatment of bladder cancer. The urinary diversion continues to be performed completely intracorporeally or extracorporeally. Over the past decade, there has been an increasing number of continent diversions being performed intracorporeally. We evaluated the most recent literature regarding intraoperative metrics and outcomes that compare the intracorporeal and extracorporeal approaches.

Keywords: Cystectomy, intracorporeal, extracorporeal, continent urinary diversion

INTRODUCTION

Robot-assisted radical cystectomy (RARC) has become widely accepted as a safe minimally invasive procedure with equivalent oncologic outcomes^[1,2]. The RAZOR trial showed RARC to have similar progression-free survival to open radical cystectomy^[3]. Urinary diversion has historically been performed exclusively as an extracorporeal procedure, however, was first described using an intracorporeal technique in 2003 with the ileal conduit^[4]. Since then, it has gained increasing popularity with recent data showing up to 97% of diversions being performed intracorporeally within some groups^[5]. We aim to discuss the current



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status of intracorporeal and extracorporeal continent urinary diversion in the setting of RARC. We evaluate the most contemporary data examining operative and postoperative metrics used to assess intracorporeal and extracorporeal approaches to continent diversions.

EXTRACORPOREAL DEFINITION

The definition of an extracorporeal diversion varies among surgeons. For many, this means making a laparotomy incision and performing the entirety of the procedure open. For others, a more hybrid approach is used that involves making a much smaller 5-7 cm incision and utilizing the robot to perform the urethral and/or ureteral anastomoses. This difference cannot be under-emphasized, as the hybrid approach allows for the possibility of less ureteral mobilization as well as a more precise urethral anastomosis for the orthotopic diversions. While the literature does not readily differentiate between the two, we will herein assume they are all the same for the purpose of this discussion.

LEARNING CURVE

The learning curve associated with intracorporeal continent urinary diversion should not be understated. There have been estimations of the learning curve for RARC and the agreement of 21-30 cases for this specific procedure has been reached to accomplish a lymph node yield of 20 as well as a positive surgical margin rate of 5% or lower^[6]. While this may not seem like a large number of cases, “high volume centers” are 4-6 cases per year while “very high volume” centers are 7+ RARC/year^[7]. This means that for a surgeon transitioning to intracorporeal diversions, it could take many years to cover the 30 cases required for the extirpative portion of the surgery alone.

Some groups have attempted to overcome this by having a clear mentor and mentee set-up with a set number of cases required to be performed together before operating independently^[8]. In addition to this, some also have a group of nurses and technicians that exclusively work robotic cases and are present for all their diversion cases. While this would indeed aid with the learning curve, this is not feasible in all institutions.

OPERATIVE TIME

As we continue to move forward in the robotic era, the ever-pressing question continues to arise, “why should we continue to perform extracorporeal diversions over intracorporeal?” One of the big arguments is shorter operative times. Operative times from experienced surgeons range from 265-760 min^[9] for intracorporeal neobladders, while extracorporeal are 285-401^[10,11]. Even in the most experienced hands, 58%-64% of patients experience a complication within the first 90 days after radical cystectomy regardless of how the diversion is performed^[12,13].

Zhang *et al.*^[14] recently published their data of 948 patients with 26 months of follow-up looking at intracorporeal diversions *vs.* RARC and open diversion *vs.* open radical cystectomy with open diversion. They found that the open radical cystectomy with open diversion had the shortest operative time. This intuitively makes sense and continues to be a motivating factor towards open diversions to attempt to minimize the operative time of an already long procedure. Novara *et al.*^[13] found similar outcomes with shorter operative times associated with the open cystectomy. Shim *et al.*^[15] looked specifically at intracorporeal diversions compared to extracorporeal and found the operative time to also be significantly longer with the intracorporeal urinary diversion. Lenfant *et al.*^[10] also found that surgeons were less likely to offer a patient with an ASA score ≥ 3 an intracorporeal urinary diversion given the potentially longer exposure to Trendelenburg position with pneumoperitoneum. This difference cannot be ignored when comparing these two surgical approaches and must remain a continued part of the conversation.

In addition to longer operative times, performing extracorporeal diversions allows the surgeon to keep all diversion options available to patients. For example, if a surgeon is most comfortable with only the intracorporeal ileal conduit, they may be reticent to discuss a continent diversion option, orthotopic or cutaneous. This is critically important when discussing open and robotic diversions. Given the steep learning curve of robotic diversions, it is not unreasonable to think that many surgeons are prone to perform the procedure they are more comfortable and adept at rather than what may be best for the patient.

COMPLICATIONS

Ureteroenteric stricture formation

Stricture formation at the site of the anastomosis from the ureter to the bowel is a potentially catastrophic complication. These patients frequently require surgical intervention including invasive anastomotic revisions. Rates of ureteroenteric anastomotic stricture (UEAS) are reported to occur in 2.6%-13% of cases depending on the definition used^[16]. Goh *et al.*^[17] evaluated stricture formation between RARC and open radical cystectomy. They found that there was a higher stricture rate in the RARC group, however, this also related to the hospital volume, yet again emphasizing the steepness of the learning curve associated with these procedures. Of note, 84% of their diversions were incontinent diversions that were all performed extracorporeally.

Ericson *et al.*^[18] evaluated UEAS rates in open radical cystectomy, RARC with extracorporeal diversion, and RARC with intracorporeal diversion. Their cohort of an impressive 968 patients reported an overall 11.3% stricture rate. Their subsets were broken down to a 9%, 11.3%, and 13% rate for open, extracorporeal, and intracorporeal respectively with a statistically significant difference. What must be noted, however, is that the intracorporeal rate decreased from 17.5% to 4.9% after 75 cases; which again emphasizes the steep and long learning curve associated with these procedures. Also important to note in this cohort is that only 13% of their diversions were continent for the intracorporeal subset compared to 27% of their extracorporeal subset.

Ahmadi *et al.*^[18] looked at UEAS rates in intracorporeal diversions with and without the use of indocyanine green (ICG) for perfusion evaluation of the distal ureter. What they found was that not only was there a much greater amount of distal ureter excised before anastomosis (> 5 cm in some cases) but that the ICG group had a 0% stricture formation at 12 months of follow up compared to the 10.6% per patient rate in the non-ICG group. Shen *et al.*^[19] evaluated the stricture rate with extracorporeal diversions utilizing ICG with SPY fluorescence to evaluate for distal perfusion. They found the stricture rate again to be 0% in the ICG group *vs.* 7.5% in the non-ICG group. They also reported a longer excision of the distal ureter as well with 3.8 cm in the ICG group *vs.* 2.2 cm in the non-ICG group. These studies lead us to believe that perhaps the rate of UEAS is not dependent on the method of diversion creation, but rather distal ureteral perfusion^[19].

Gastrointestinal complications

Gastrointestinal complications continue to be a major cause of morbidity in the cystectomy patient. Patient's hospital stays are prolonged with ileus, jaundice, and hematochezia as well as readmissions for similar issues. Shim *et al.*^[15] looked at complications between intracorporeal urinary diversion and extracorporeal urinary diversion in 362 patients. They found that gastrointestinal complications were significantly higher in the extracorporeal urinary diversion group. Zhang *et al.*^[14] also found a significantly lower gastrointestinal complication rate with the intracorporeal urinary diversion compared to both the extracorporeal urinary diversion and the open cystectomy. They found that the TPN requirement was highest for open cases. Hussein *et al.*^[5], however, found no significant difference in gastrointestinal complications between the intracorporeal urinary diversion and extracorporeal urinary diversion group,

looking at 972 patients. Feng *et al.*^[20] found fewer gastrointestinal complications with intracorporeal urinary diversions with 60% being continent diversions. Ahmed *et al.*^[21] found that 10% of intracorporeal diversions had gastrointestinal complications compared to 23% of those who underwent extracorporeal diversion.

The lower gastrointestinal complication rates associated with intracorporeal diversions are thought to be due to less bowel manipulation, exposure and mobilization^[21]. Shim *et al.*^[15] defined gastrointestinal complications to include ileus, jaundice and hematochezia. Zhang *et al.*^[14] by contrast defined gastrointestinal complications as ileus, diarrhea, gastrointestinal bleeding, gastritis and/or *Clostridium difficile*. These subtle differences in inclusion criteria and definitions of what constitutes a gastrointestinal complication may begin to explain why these results are inconsistent across so many different studies.

POSTOPERATIVE PARAMETERS

Postoperative parameters including length of stay, infections, and overall complications are consistent metrics evaluated when discussing the benefits of robotic surgery. With ERAS protocols integrated into most systems now, the time to discharge has significantly decreased after large abdominal procedures including radical cystectomy^[22]. Hussein *et al.*^[5] evaluated intracorporeal vs. extracorporeal diversion after RARC outcome parameters in 972 patients and found that the intracorporeal diversion had more complications and readmissions, however, these were not high-grade complications. They also noted that there were more infectious complications associated with the intracorporeal diversions. There was also a 1 day longer admission with the intracorporeal diversion subset.

Shim *et al.*^[15] also examined the outcomes of intracorporeal urinary diversion vs. extracorporeal urinary diversion. They found that the intracorporeal urinary diversion group had significantly shorter recovery parameters including time to passage of flatus, the start of oral intake, and length of hospital stay. Mazzone *et al.*^[23] did not find any difference in length of stay between intracorporeal urinary diversion and extracorporeal urinary diversion. Lenfant *et al.*^[10] also found that there was no difference in length of stay between the two groups. The data regarding length of hospital stay remains highly variable and inconclusive. Tables 1 and 2 show intraoperative and post-operative parameters between intracorporeal and extracorporeal urinary diversions.

FUNCTIONAL OUTCOMES

There continues to be limited data on functional outcomes for intracorporeal urinary diversion. Functional outcomes are influenced by many factors including patient age, mental status, reservoir volume, and urethral length. Tyrizis *et al.*^[9] had a cohort of 70 patients with an 88% daytime continence rate with an orthotopic Studer neobladder performed intracorporeally. Of this group, 88.6% were men. At their one-year follow-up, 46 men and 2 out of 3 females were defined as the continent with < 1 pad per day. One of the females had hypercontinence requiring clean intermittent catheterization. Canda *et al.*^[29] reported daytime continence in 11 out of 17 patients who underwent intracorporeal urinary diversion with an orthotopic neobladder.

Obrecht *et al.*^[24] recently published their one-year data of intracorporeal orthotopic neobladder creation looking primarily at functional outcomes. They had a 100% “social continence” rate, defined as < 1 pad per day as well as post-void residual of 0 with a median pouch capacity of 404 cc^[24]. It is important to note, however, that this is a small sample of 12 patients that were all male. It is difficult to be able to extrapolate this data over larger, more diverse populations. In addition to this, continence definitions vary widely across studies with terms such as “daytime continence” and “social continence” sometimes being used interchangeably without having a consistent clear definition.

Table 1. Robotic radical cystectomy with intracorporeal urinary diversion operative and post-operative characteristics

Study	N	Length of surgery (min) (median/mean)	Length of stay (mean/median days)	Complication rate Clavien 1-2 90d/30d (%)	Complication rate Clavien 3-5 90d/30d (%)	GI complications (%)	Overall complication rate 90d/30d (%)	Continence (0-1 pad/d) (day %/night %)
Hussein <i>et al.</i> ^[11] 2020	486	355/-	-/9	-	14/12	23	52/47	-
Mazzone <i>et al.</i> ^[23] 2021	162	350/-	-/11.5	-	-/35.2	-	-	-
Lenfant <i>et al.</i> ^[10] 2018	74	320/-	-/14	6.7/38	12.2/9.5	-	18.9/47.3	-
Zhang <i>et al.</i> ^[14] 2020	301	390/-	6/-	-	16.9/10	23.3	44.2/37.5	-
Shim <i>et al.</i> ^[15] 2020	84	-/566	16.6/-	26.7/-	14.7	4.8	41.7/-	-
Obrecht <i>et al.</i> ^[24] 2020	12	575/-	-	-	-	-	-	100/75
Tyritzis <i>et al.</i> ^[9] 2013	70	420/-	-/9	17/-	37.1/-	21.4	51.2/48.4	68.5/57.4
Mistretta <i>et al.</i> ^[25] 2021	57	-	-	-	-	-	-	89.4/87.1
Balbay <i>et al.</i> ^[26] 2020	22	-/552	10.5/-	13.6/92	18.2/9	13.6	-	82.3/47.1
Tuderti <i>et al.</i> ^[27] 2020	167	420/-	-	-	-	-	-	70-90

Grimm *et al.*^[30], by contrast to the intracorporeal orthotopic neobladder, had 178 patients who underwent creation of orthotopic neobladder in an extracorporeal manner with 48.5% daytime continence and 34.9% nighttime continence. This group, however, does not specify which of these patients underwent RARC as opposed to open radical cystectomy^[30]. Mistretta *et al.*^[25] also compared continence rates of RARC with intracorporeal and extracorporeal orthotopic neobladders with no statistically significant difference in functional outcomes [Tables 1 and 2]. Lin *et al.*^[28] use a hybrid approach by performing a RARC, extracorporeal creation of the neobladder, and laparoscopic urethra-neobladder anastomosis with 90% daytime and 82% nighttime continence [Table 2]. Despite this, there is a paucity of data on the functional outcomes for extracorporeal urinary diversion after RARC, however, daytime rates in the larger open studies range from 54%-99% daytime continence 36%-84.6% nighttime continence^[12,31-35].

Limitations

Overall experience with intracorporeal and extracorporeal urinary diversion has grown immensely over the past 20 years. This report presents the most recent and robust studies to address the important questions to consider when deciding between the two techniques. While we can make see emerging themes within

Table 2. Robotic radical cystectomy with extracorporeal urinary diversion operative and post-operative characteristics

Study	N	Length of surgery (min) (median/mean)	Length of stay (mean/median days)	Complication rate Clavien 1-2 90d/30d (%)	Complication rate Clavien 3-5 90d/30d (%)	GI complications (%)	Overall complication rate 90d/30d (%)	Continence (0-1 pad/d) (day %/night %)
Hussein <i>et al.</i> ^[51] 2018	486	401/-	-/8	-	12/10	20	35/28	-
Mazzone <i>et al.</i> ^[23] 2021	105	350/-	-/13	-	-/42.9	-	-	-
Lenfant <i>et al.</i> ^[10] 2018	34	285/-	-/12	11.7/32.4	17.6/5.9	-	29.4/38.2	-
Zhang <i>et al.</i> ^[14] 2020	375	421/-	7/-	-	24.8/17.9	29.3	48.3/43.2	-
Shim <i>et al.</i> ^[15] 2020	278	-/510	22.4/-	41/-	20.5/-	12.9	61.5/-	-
Mistretta <i>et al.</i> ^[25] 2021	44	-	-	-	-	-	-	63.8/51.6
Lin <i>et al.</i> ^[28] 2008	108	-/330	-	-	-	-	18.5	90.7/82.6

this growing body of evidence, the paucity of level one evidence limits our ability to draw definitive conclusions.

CONCLUSIONS

RARC has taken over as the treatment of choice in most cases in the treatment of muscle-invasive bladder cancer. As intracorporeal urinary diversion continues to gain popularity, we need to continue to challenge the data and evaluate if we are making the right decision for our patients. After looking across the data provided worldwide, there continues to be a reason to pause with the sweeping adoption of the intracorporeal urinary diversion with continued varied data of the superiority of outcomes.

DECLARATIONS

Authors' contributions

Balzano FL and Chan KG contributed equally to all components of the manuscript.

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Conflicts of interest

Both authors declare that there are no conflicts of interest.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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