ORIGINAL ARTICLE

Extraperitoneal vs. transperitoneal robot-assisted laparoscopic radical prostatectomy—analysis of perioperative outcomes, a single surgeon's experience

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Abstract

Robot-assisted laparoscopic radical prostatectomy (RRP) has traditionally been done using transperitoneal (TP) approach. This requires patients to be in the steep Trendelenburg position with antecedent risks of high intraoperative ventilatory pressure, post-operative confusion status, corneal and cerebral edema, deep vein thrombosis (DVT), predisposes risk of intestinal injury and slight delay in bowel recovery. Extraperitoneal (EP-RRP) approach circumvents the above given issues. Between July 2013 and October 2016, 57 patients underwent RRP for adenocarcinoma done by a single surgeon (NR). Salvage prostatectomies were excluded. RRP was performed using techniques TP ($n = 23$) and EP ($n = 34$). Patients were selected in a non-randomized fashion. Clinico-pathologic parameters and perioperative outcomes were compared in both groups using nonparametric tests. Patient demographics, clinico-pathological features, length of stay and total operative time were similar in both groups. Dock (Trendelenburgh) time was shorter in EP-RRP compared to TP-RRP [median (1st–3rd quartiles) (p value)] [180 (150–220) min vs. 220 (180–230) min ($p = 0.039$)]. Other significant differences includes EP-RRP vs. TPRRP, ventilatory pressures (cm of H_2O) [34 (32–34) vs. 40 (38–40) ($p = 0.000$)], ETCO2 (mm of Hg) [38 (36–40) vs. 32 (30–34) ($p = 0.000$)], ambulation (day) [0.00 (0–1) vs. 0.00 (0–2) ($p = 0.022$)], return of bowel activity (day) [1.0 (1.0–2.0) vs. 2.0 (2.0–2.0) ($p = 0.000$)] and opening of bowel (day) [2.0 (1.0–2.0) vs. 3.0 (3.0–3.0) ($p = 0.000$)]. EP-RRP offers similar clinical outcomes to TPRRP but with the advantages of shorter Trendelenburgh time, early recovery of bowel functions with avoidance of bowel injury and intraperitoneal urine leak. Overall, early recovery of patients who had undergone EP-RRP potentiates it to be performed as day care procedure.

Keywords Extraperitoneal · Perioperative outcomes · Robot · Radical prostatectomy · Transperitoneal

Introduction

Robot-assisted laparoscopic radical prostatectomy (RRP) has become the standard mode of treatment for organ-confined carcinoma of prostate [1]. RRP can be performed via either transperitoneal (TP) or extra-peritoneal (EP) approach.

RRP has traditionally done by TP approach since its inception and it is the most common technique used worldwide [2–4]. Its advantages include wide working space,

shorter duration of trocar positioning and preparation of working space; and its disadvantages are contact with bowel leading to delayed recovery with a small risk of inadvertent injury, steep Trendelenburg position with antecedent risks of high intraoperative ventilatory pressure, postoperative confusion status, corneal and cerebral edema, deep venous thrombosis (DVT) and intraperitoneal urine leak [5].

EP circumvents many of the above given issues. Its main advantages are recapitulation of open radical prostatectomy (its surgical principles and implications), containment of urine and blood in extraperitoneal space that allows tamponade, non-violation of peritoneal cavity preventing bowel injury and issues related to steep Trendelenburg position. However, its limitations include narrow working space, difficulty in gaining access; but these could be overcome by reasonable operative expertise [6–9].

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The main aim of the present study was to evaluate perioperative outcomes of TP–RRP and EP–RRP especially its relationship to bowel recovery, length of stay and issues related to steep Trendelenburg position.

Materials and methods

Study design and population

The present study was conducted in a non-randomized fashion of prospectively collected data to compare the perioperative outcomes of RRP performed by a single surgeon (NR) by EP or TP approach. Between July 2013 and October 2016, 57 RRP procedures were performed and data was documented prospectively into two groups—23 TP-RRP and 34 EP-RRP. Patients included were prostate cancer individuals diagnosed by transrectal ultrasound-guided biopsy because of a serum level of PSA > 4 ng/mL and/ or an abnormality on digital rectal examination with radiological proof (MRI/PET scan). The patients with localized and locally advanced disease were included in the study. Patient with bony metastasis were not offered RRP. Surgery was performed at least 4–6 weeks after prostate biopsy.

Surgical technique

Extraperitoneal approach

The skin incisions and the order of port placement are as marked (Fig. 1). Extraperitoneal space is approached using a transverse 1.3 cm incision just right and inferior to the umbilicus. The anterior rectus sheath is incised and the rectus muscle is split. The index finger is inserted along and in caudal direction opening up the extraperitoneal space. The pre-peritoneal balloon is used to create the space and 12 mm trocar is introduced. The technique is similar to the one described for laparoscopic extraperitoneal radical prostatectomy [10]. Subsequent to the camera trocar, four additional ports are placed (3–8 mm trocars and 1–10 mm trocar for assistant) as shown in the picture.

The lateral ports are placed initially after creating the extra-peritoneal space using camera as a dissecting tool. Placement of additional port allows usage of laparoscopic instruments which in turn helps in the port placement. Median ports are placed using camera in 10 mm trocar which allows the visualization of the peritoneal reflection.

Operative technique

RRP is performed using Leipzig–Bradford technique for radical prostatectomy [11]. In summary, the steps of the operation are consistently followed in this fashion; incisions on

endopelvic fascia and division of puboprostatic ligaments, paraurethral dissection of bladder neck, anterior opening of the bladder neck, securing the catheter with a trans-abdominal stitch which in turn allows elevation of the prostate, posterior bladder neck dissection, vas and seminal vesicles dissection, opening of Denonvillers fascia and separation of the neurovascular bundles, deep venous complex ligation, apical dissection and disconnection of prostate from urethra and finally urethero-vesical anastomosis. Extended pelvic lymph node dissection (EPLND) was done in appropriately indicated candidates before urethero-vesical anastomosis. A drain is placed in the pelvic cavity and the specimen is extracted through one of the 10 mm port incision.

Transperitoneal approach

Under general anesthesia, the patient was placed in the Trendelenburg position with legs apart. The skin was incised vertically just above the umbilicus. The anterior rectus sheath was incised vertically over 1 cm. Pneumoperitoneum was created with veress needle and 12-mm optic trocar was then introduced. After inspecting abdominal cavity, the first 8-mm robot trocar on the right side was placed under vision, about four fingers laterally to the supra-umbilical incision on the line joining the sub-umbilical incision and the right anterior iliac crest. Another 8-mm robot trocar was placed secularly to the first one on the left side. A third 8-mm robot trocar for the fourth robotic arm was placed 2–4 inches cranially to the left anterior iliac crest. The distance of this trocar to the iliac crest depends on the morphology of the patient. A 12- and 5 mm assistant trocar was placed on right side of patient. The robot was docked and bladder was dissected. Extraperitoneal space was created. Rests of steps were similar as described above.

Post-operative management

All patients followed specially formulated enhanced recovery protocol and accordingly they were ambulated and resumed on normal diet 6–8 h of surgery. The patients were discharged with Foley catheter and with/without drain, after return of bowel activity and when no major complications were observed. All patients were followed up in the outpatient clinic and Foley was removed on 10th postoperative day.

Preoperative, operative and postoperative data

Age, preoperative PSA value, Biopsy–Gleason Score, clinical and pathological stages, rate of unilateral/bilateral nerve sparing or wide excision, rate of extended pelvic lymphadenectomy with its yield, total console time, skin-to-skin operation time and total anesthesia time, intraoperative

ventilator pressures, end tidal CO_2 pressures, estimated blood loss, rates of major complications, time to beginning of ambulation and oral diet, time to return of bowel activity (bowel sounds) and opening of bowel (passage of flatus/stools), duration of hospitalization and oncological outcomes in terms of positive margin rates along with continence rate at 4 weeks and 3 months were recorded and evaluated.

Statistical analysis

All statistical analysis tests were carried out with SPSS for Windows version 22 (SPSS, Chicago, IL, USA). Student's two tailed *t* test was used to compare the categorical values between groups. The Mann–Whitney *U* test was used to compare the median values of two nonparametric continuous variables. Statistical significance was set at $p < 0.05$.

Results

57 RRP cases were performed in a non-randomized way and documented prospectively into two groups that are 23 TP-RRP and 34 EP-RRP.

Preoperative data

The patient demographics are listed in Table 1. The demographics (age, height and weight) were similar in the two groups. The clinico-pathological parameters (prior history of LUTS, pervious history of any treatment, clinical staging by DRE, PSA at diagnosis, Gleason Score, MRI staging) were also similar in both groups as shown in Table 2.

Operative data

The operative data are shown in Table 3. The total operative time was slightly longer with the TP approach at 240 (220–280) min than in the EP group at 230 (200–262.5) min. But the difference in operative times was not statistically significant ($p = 0.119$). Dock (Trendelenburg) time was shorter in EP-RRP compared to TP-RRP [median (1st–3rd

Table 1 Demographic table

Parameters [median (1st–3rd quartiles)]	EP-RRP (n = 34)	TP-RRP (n = 23)	p value
Age in years	65.5 (61–73)	66 (63–72)	0.89
Height in cms	166 (163.0–172.0)	165 (157.0–172.0)	0.153
Weight in kgs	66.9 (61.7–75.2)	70 (65.0–74.0)	0.585
PSA at diagnosis	10.63 (7.3–15.7)	15 (9.0–33.0)	0.058

Table 2 Preoperative parameters

Parameters	EP-RRP (n = 34)	TP-RRP (n = 23)	p value
Luts	28	19	0.98
Previous treatment	2	0	0.23
Gleason score			
6	13	11	0.557
7	14	10	
8	5	2	
9	2	0	
DRE			
Benign	0	1	0.203
T2	27	14	
T3	7	8	
Clinical T stage			
Benign	0	2	0.13
T2	24	12	
T3	10	9	

quartiles)] [180 (150–220) vs. 220 (180–230) min] and was statistically significant ($p = 0.039$). Ventilatory pressures (cm of H_2O) were lower in EP-RRP [34 (32–34) vs. 40 (38–40) ($p = 0.000$)] and $ETCO_2$ (mm of Hg) [38 (36–40) vs. 32 (30–34) ($p = 0.000$)] was higher in EP-RRP as compared to TP-RRP and both were statistically significant. The blood loss was minimal in both groups; only two patients who underwent RRP through TP approach required blood transfusion. No other major intraoperative complications were encountered in either group. No surgery required conversion to open. No patient of EP was converted to the TP approach.

Both groups were similar in terms of rate of extended pelvic lymphadenectomy (28 in EP-RRP vs. 16 in TP-RRP, $p = 0.25$). But the number of lymph nodes yield is significant higher in EP-RRP as compared to TP-RRP [8 (4.0–14.25) vs. 3 (0.0–8.0) ($p = 0.033$)].

Postoperative data

The patient who underwent EP approach were more willing to ambulate earlier as compared to TP [0.00 (0–1) vs. 0.00 (0–2) ($p = 0.022$)]. The return of bowel activity in days [1.0 (1.0–2.0) vs. 2.0 (2.0–2.0) ($p = 0.000$)] and opening of bowel movements (in days) [2.0 (1.0–2.0) vs. 3.0 (3.0–3.0) ($p = 0.000$)] were early in EP group and was statistically significant. The total length of stay was comparable in both groups and median day of discharge was Day 2. The details of postoperative data are shown in Table 4. Only one patient in TP group had post op ventilatory issue which required keeping him for longer duration in hospital (discharged on POD 7). No major postoperative complications were incurred in either group. The positive margin rates were as 3

Table 3 Intraoperative parameters

Parameters	EP–RRP (n = 34)	TP-RRP (n = 23)	p value
Median operative time in mins	230.0 (200.0–262.5)	240.0 (220–280.0)	0.119
Median dock time in mins	180.0 (150.0–220.0)	220 (180.0–230.0)	0.039*
Median ventilatory pressures	34.0 (32.0–34.0)	40.0 (38.0–40.0)	0.000*
Median ETCO$_2$	38.0 (36.0–40.0)	32.0 (30.0–34.0)	0.000*
Nerve sparing			
Bilaeral nerve sparing	5	0	0.013*
Unilateral nerve sparing	8	1	
Wide excision	21	22	
EPLND rate	28 (82.35%)	16 (69.56%)	0.25
Ventilatory issues			
No	34	21	0.08*
Yes	0	2	
Post op complications			
Nil	33	23	0.407
Infection	1	0	

*Significant p value < 0.005

Table 4 Postoperative parameters

Parameters	EP-RRP (n = 34)	TP-RRP (n = 23)	p value
Median normal diet in days	0 (0.0–0.0)	0 (0.0–0.0)	0.411
Median ambulation in days	0 (0.0–1.0)	0 (0.0–2.0)	0.022*
Median return of bowel activity in days	1(1.0–2.0)	2 (2.0–3.0)	0.00*
Median bowel opening in days	2.0 (1.0–2.0)	3.0 (3.0–3.0)	0.00*
Median fit for discharge in days	2.0 (2.0–2.0)	2.0 (2.0–2.0)	0.676
pT			
T2	20	12	0.46
T3a	3	4	
T3b	11	6	
T4	0	1	
pN			
Negative	30	17	0.163
Positive	4	6	
Median nodes yield in number	8 (4.0–14.25)	3 (0.0–8.0)	0.033*
Gleason score			
6	10	9	0.34
7	19	9	
8	4	2	
9	1	3	
Margins			
Negative	31	14	0.006*
Positive	3	9	
Perineural invasion			
Absent	10	2	0.06*
Present	24	21	

*Significant p value < 0.005

out of 34 in EP-RRP and 9 out of 23 TP-RRP and it was statistically significant. The other histopathological parameters (pT, pN, Gleason score) were comparable in both groups.

The functional outcome in form of urinary continence (measured in terms of number pads used in day) at 4 weeks was compared in both groups, which showed EP-RRP

patients regained continence earlier then patients who undergone RP by TP approach; but at end of 3 months continence rates were similar (Table 5).

Discussion

The robot-assisted radical prostatectomy (RRP) has become an important treatment choice for non-metastatic prostate cancer [12]. In the era of open surgery this procedure was generally performed extraperitoneally. However, since inception of minimal invasive technique many surgeons prefer transperitoneal route in view of familiarity with the environment and large working space [3]. Across the world robot-assisted radical prostatectomy is done transperitoneally. Nonetheless, minimal invasive radical prostatectomy with extraperitoneal approach is equally feasible with added advantage of shorter bowel recovery and shorter surgical time compared to transperitoneal route [6–9].

Studies have been done comparing extraperitoneal and transperitoneal approach for robot-assisted radical prostatectomy [5, 13–15]. In this single surgeon series robotic radical prostatectomy was performed with both approaches—transperitoneal and extraperitoneal. The case selection was not randomized. The body habitus of patient especially lower abdomen, if found to be unsuitable for extraperitoneal route (as deemed by the operating surgeon) the patient was offered transperitoneal route. Unsuitable patient for extraperitoneal approach would be those who has a short stature (150 cm or less in height), or who had an umbilicus to pubic symphysis distance of less than 15 cm. This obviously carries a bias; however, the authors believe that this may not influence the outcome as procedure is performed by a single surgeon with single same technique.

The preoperative parameters (age, height, and weight, PSA, Clinical Stage and Gleason Score) were comparable in both groups. In our study, total operative and console times was more in TPRRP ($p = 0.119$ and $p = 0.039$ respectively) consistent with published literature perhaps related to

preparation of space of retzius, need to dissect bowel adhesions and bladder attachments [5, 15]. The extraperitoneal space creation is done in a patient in a supine position. Once the primary (periumbilical) port is inserted, the rest of the ports are inserted under vision. The patient is then given a Trendelenburg position of about 10 degrees (maximum, if needed less) and the robot is then docked. Head down and dock time is calculated from this point onwards in EP approach. In contrast, during TP approach, Trendelenburg happens as soon as ports are inserted and console time starts as robot is docked. This also explains the increased console and Trendelenburg time in TP-RRP.

TP patients are in steep Trendelenburg position for a longer period of time reflecting its potential effects; increase in ventilator pressures, cerebral and facial edema as observed in our study [ventilatory issues leads to longer hospital stay ($n = 1$), post-operative restlessness ($n = 2$) and subconjunctival edema ($n = 18$)]. We observed that ventilator pressure requirement was much significantly more in TP-RRP approach than in EP-RRP and $ETCO_2$ was significantly lower in TP-RRP.

The advantages of EP include creation of space of retizus in supine position, with a low need for inclination for the surgery (hence steep Trendelenburg-related side effects would not be an issue), peritoneum as a natural barrier to prevent bowels falling in the operating field, containment of blood and urine in the EP space. Earlier beginning of oral diet, earlier return of bowel activity and shorter hospitalization time was achievable in EP.

Horstmann et al. showed in their study that EP-RRP had a significant difference in terms of the time to open bowel and the need for analgesic [16]. Consistent with their data, we also observed significantly shorter time for beginning of oral diet and return of bowel activity in the EP-RRP group. However, Chung et al. found no difference for the mean duration to a normal diet [14]. We did not find a statistically significant difference for hospitalization duration between TP and EP-RRP (2.21 vs. 2.05 days, respectively); this is consistent with literature that EP-RRP had a shorter duration of hospitalization without any significant difference [13, 14, 16]. But patients undergone RRP by EP approach had early and comfortable ambulation. No major complication rates (Clavein Grade III–V) were observed in both groups.

The first systematic review and meta-analysis carried out by Lee et al. concluded that EP-RRP and TP-RRP have similar oncological and functional outcomes, whereas EP-RRP has shorter total operation time despite its longer trocar insertion time, which is weighed by the shorter console time [17]. In the same meta-analysis, EP-RRP was found to be advantageous for grade I complications, whereas no difference was found for grade 2 or higher complications.

In our observational study, EP approach did not pose any difficulty in performing the extended pelvic lymph

Table 5 Follow-up parameters

Parameters	EP-RRP (n = 34)	TP-RRP (n = 23)	p value
Continence at 4 weeks			
Pad free	7	4	0.041*
≤1 pad a day	20	7	
≥2 pads a day	7	12	
Continence at 3 months			
Pad free	22	11	0.378
≤1 pad a day	9	9	
≥2 pads a day	3	1	

Fig. 1 The positions of port placements in extraperitoneal robotic radical prostatectomy
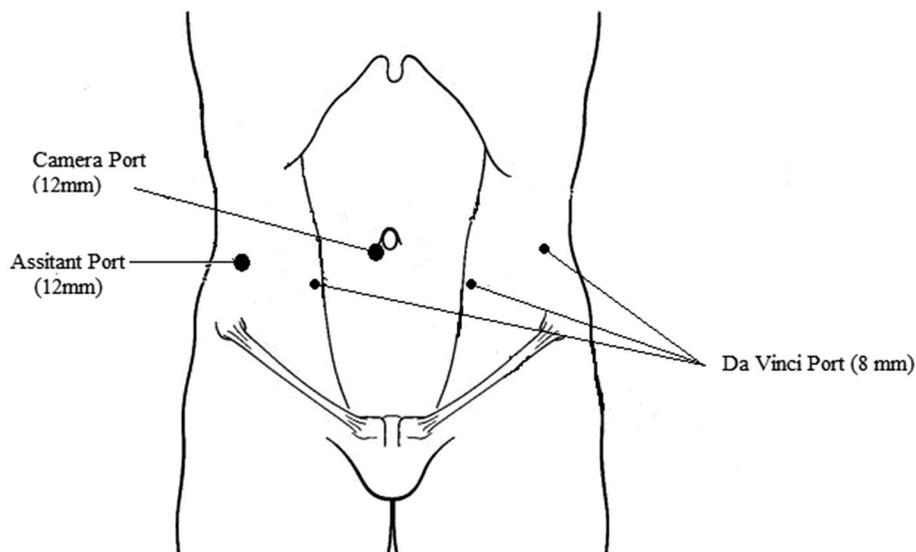
node dissection, in spite of perceiving that EP approach compromises LN yield due to lack of space and the ability to approach common iliac bifurcation and beyond. The way ports are inserted (Fig. 1) allows the primary author to approach node packets comfortably up to common iliac chain.

This study is non-randomized with its innate bias; therefore, a prospective large randomized trial done in multicentric fashion would be more appropriate to assess the perceived superiority of extraperitoneal approach for robot-assisted radical prostatectomy.

Conclusion

This study demonstrates that RRP can be done feasibly with EP approach with results compared to TP approach with added advantage in console time, ventilatory issues, return of bowel activity and early regain of continence. These outcomes aid the efforts to broaden the acquisition of extraperitoneal access to RRP and also ensure its potential to be performed even as outpatient surgery.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all patients for being included in the study.

Informed consent Informed consent was obtained from all individual participants included in the study.

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