



Single-port robotic-assisted simple prostatectomy is associated with decreased post-operative narcotic use in a propensity score matched analysis

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Abstract

Robotic-assisted simple prostatectomy (RASP) has proven to be an effective minimally invasive option for benign prostatic enlargement (BPE) in recent years. Single-site surgery is theorized to reduce post-operative pain beyond traditional minimally invasive approaches. We sought to assess whether use of a single-port robotic platform decreases post-operative opioid use in patients undergoing robotic-assisted simple prostatectomy (RASP). A retrospective review was performed of all patients undergoing RASP our institution from November 2017 to July 2019. Demographic, intraoperative, and post-operative data, including morphine equivalent (ME) use, were collected. Patients were stratified by robotic platform utilized. Propensity score matching using nearest neighbor method was performed using prostate volume, Charlson comorbidity index (CCI), and post-op ketorolac use in 4:1 fashion. Chi-squared analysis and Kruskal–Wallis analyses were utilized. Two-hundred-and-seven men underwent RASP. After matching, 80 patients (64 multi-port, 16 single-port) were included in the analysis. Groups were comparable for age, body mass index, CCI, prostate volume, prior opioid use, and use of scheduled ketorolac post op. The single-port approach was associated with a reduction in MEs once admitted to the floor (5 vs. 11 mg, $p=0.025$) and an increase in the proportion of patients who did not require any narcotics post-operatively (44 vs. 19%, $p=0.036$). In a propensity matched cohort of patients undergoing RASP at a single institution, use of the single-port robotic system conferred a significant decrease in post-operative narcotic use by approximately 50%.

Keywords Robotics · Single port · Prostatectomy · Narcotic · Pain · Minimally invasive

Introduction

Lower urinary tract symptom (LUTS) related to benign prostatic enlargement (BPE) is common in men over 60 [1]. Patients with very large prostates (> 80 g) and LUTS who require surgery have traditionally been managed with open simple prostatectomy as transurethral inventions are often inadequate [2]. With advances in surgical technology, minimally invasive options for enucleation of the adenoma, including anatomic endoscopic enucleation of the prostate (AEEP), laparoscopic [3] and robotic-assisted [4] simple

prostatectomy (RASP), are now favored due to the reduction in blood transfusion rates, length of hospitalization, and post-operative pain [3, 5]. Both AEEP and RASP have demonstrated similar efficacy but AEEP is associated with shorter length of stay and catheter duration while RASP removes greater tissue volume, shorter operative time but increased bleeding [6].

Laparoendoscopic single-site surgery (LESS) has further been explored as a means of improving these outcomes by reducing the invasiveness of laparoscopy [7]. Similarly, robotic LESS [8], in which multi-port robotic systems are utilized in a reprogrammed, cross-armed fashion with novel curved instruments, has also been explored. Unfortunately, neither single-site modality gained widespread adoption due to the increased technical difficulty of the procedures. In 2018, a dedicated single-port robotic platform (DaVinci SP, Intuitive, Sunnyvale, CA, USA), was approved by the Food and Drug Administration (FDA). Since its market

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approval, it has been utilized for multiple urologic interventions [9–14] including RASP [15].

The primary theoretical benefit of single-site surgery is reduced post-operative pain and improved cosmesis. Urologic literature to support this assertion is limited, and is almost exclusively in surgery of the upper urinary tract, such as nephrectomy [16, 17] and pyeloplasty [18]. While limited in the urologic literature, there is extensive gynecologic literature demonstrating this advantage in pelvic surgery [19, 20]. The recent opioid epidemic in the United States, a result of liberalization of laws and subsequent overprescription [21], has led to a concerted effort minimizing the need for narcotics [22]. Additionally, opioid-naïve patients who undergo surgery are at risk of developing chronic opioid use, and elderly men at particularly high risk [23]. We sought to compare post-operative opioid use between single-port RASP and multi-port RASP in men who underwent surgery for symptomatic BPE at our institution.

Materials and methods

After institutional review board approval was obtained, we performed a retrospective chart review of all patients who underwent RASP for symptomatic BPE from November 2017 to July 2019 at our institution. Prostate size was determined pre-operatively by either transrectal ultrasound or magnetic resonance imaging. All procedures were performed through a transvesical approach. Multi-port procedures were performed through a transperitoneal approach and utilized a total of 5 ports (3 × 8 mm robotic ports and 2 × 12 mm ports). Single-port procedures were performed in an extraperitoneal fashion, as has been previously described [15], and utilized 2 ports (1 × 2.54 cm robotic port and 1, 8 mm assistant port).

Patient demographic (including age, race, body mass index (BMI), Charlson Comorbidity Index (CCI), prior opioid use), serologic (creatinine), intraoperative (operative duration, estimated blood loss, grams of tissue removed) and post-operative (narcotic utilization, blood transfusion, complications, length of stay) data were collected. Prior opioid use was defined as any opioid use for 1 month or longer prior to surgery. Narcotic utilization in the post-anesthesia care unit and inpatient units was collected and morphine equivalents (MEs) calculated. Narcotic utilization was converted into equivalent oral morphine by online converter (<https://www.oregonpainguidance.org/opioidmedcalculator/>).

Statistical analysis

Patients were stratified by robotic platforms: multi-port (Da Vinci Si or Xi) or single port (Da Vinci SP). Continuous variables were compared between the two groups using the

Kruskal–Wallis test and category variables were compared using chi-squared test. Based on significant differences noted between the groups, propensity score matching using the nearest neighbor method was performed in a 4:1 fashion. Propensity was estimated using multinomial logistic regression with robotic platform (multi-port or single port) as the outcome and age, Charlson comorbidity index, prostate volume, and use of ketorolac post-operatively as covariates. Categorical variables were then compared using Chi-squared analysis and continuous variables were compared using the Kruskal–Wallis test.

Results

After excluding those with incomplete data, a total of 222 patient who underwent RASP were included in the study, of which 16 patients underwent single-port RASP. Prior to matching, patients who underwent multi-port RASP had higher Charlson comorbidity indices (4 vs. 3, $p = 0.01$), higher prostate volume (125 vs. 105 cc, $p = 0.01$) and were more likely to receive scheduled ketorolac post-operatively (69 vs. 25%, $p < 0.001$) as compared to the patients who underwent single-port RASP (Table 1). Following 4:1 matching by propensity score, the 16 patients in the single-port RASP were matched to 64 patients in the multi-port group. The baseline covariates between the two groups were adequately matched with no significant differences in CCI, prostate volume, or use of ketorolac (Table 2).

Post-operative narcotic use

Median narcotic use in the PACU was not statistically different between the two groups (8 vs. 6 mg, $p = 0.65$). From admission to the hospital floor to time of hospital discharge, the mean morphine equivalents consumed was significantly more in the multi-port group (11 mg) as compared to the single-port group (5 mg, $p = 0.025$). Further, a significantly greater proportion of patients in the single-port group did not require any narcotics as an inpatient post-operatively compared to the multi-port group (44 vs. 19%, $p = 0.036$).

Peri-operative outcomes

Patients undergoing single-port RASP tended to have longer operative times (176 vs. 135 min, $p = 0.001$), but lower estimated blood loss (100 vs. 200 cc, $p = 0.001$). The 30-day complication rate did not differ between groups (6.2 vs. 12.5%, $p = 0.48$) and there was no difference in the transfusion rate (0 vs. 0%, $p = 1$).

Table 1 Comparison of baseline variables between multi-port and single-port groups in the original and matched data sets

Characteristic	Unmatched			Matched		
	Multi-port (n = 206)	Single-port (n = 16)	P value ^a	Multi-port (n = 64)	Single-port (n = 16)	P value ^a
Age, years, median (IQR)	70 (65–74)	70 (66–72)	0.88	70 (64–74)	70 (66–72)	0.57
BMI, kg/m ² , median (IQR)	28 (25–31)	28.8 (24.8–32.1)	0.71	27.5 (24–31)	28.8 (24.8–32.1)	0.59
ASA, no. (%)			0.73			0.57
1	10 (5%)	0 (0%)		5 (6%)	0 (0%)	
2	119 (58%)	11 (69%)		54 (68%)	11 (69%)	
3	76 (37%)	5 (31%)		21 (26%)	5 (31%)	
4	1 (1%)	0 (0%)		0 (0%)	0 (%)	
CCI, median (IQR)	4 (3–5)	3 (2–3)	0.01	3 (2–4)	3 (2–3)	0.26
Prostate Volume (cm ³), median (IQR)	125 (104–153)	105 (97–121)	0.01	116 (100–132)	105 (97–121)	0.30
Yield (%), median (IQR)	65%(53–77%)	55%(53–70%)	0.33	66%(57–78)	55%(53–70)	0.17
Post-Op Ketorolac, no. (%)	143 (69%)	4 (25%)	< 0.001	35 (44%)	4 (25%)	0.16

CCI Charlson Comorbidity Index, EBL estimated blood loss, LOS length of stay, PACU Post anesthesia care unit, Yield tissue removed / total prostate volume

^aContinuous variables were compared using Kruskal–Wallis Test and categorical variables were compared using X² test

Table 2 Comparison of peri-operative outcomes between multi-port and single-port groups in the original and matched data sets

Characteristic	Matched		
	Multi-port (n = 64)	Single-port (n = 16)	P value ^a
Operative time, min, median (IQR)	135 (120–160)	176 (163–195)	0.001
EBL, mL, median (IQR)	200 (150–300)	100 (87–150)	0.001
LOS, days, median (IQR)	1 (1–1)	1 (1–1)	0.29
PACU opioid use ^b , mg	8 (3–15)	6 (3–11)	0.65
Floor opioid use ^b , mg	11 (5–20)	5 (0–8)	0.025
No-opioid post-op, no. (%)	12 (19%)	7 (44%)	0.036
Blood transfusion	0 (0%)	0 (0%)	1
30-day complication	8 (12.5%)	1 (6.2%)	0.48

CCI Charlson Comorbidity Index, EBL estimated blood loss, LOS length of stay, PACU Post anesthesia care unit

^aContinuous variables were compared using Kruskal–Wallis Test and categorical variables were compared using X² test

^bMeasured in morphine equivalents

Discussion

In this propensity matched cohort, we found that patients undergoing a single-port robotic simple prostatectomy, as compared to a multi-port approach, required significantly less inpatient narcotics during the post-operative admission. While operative times for single-port cases were significantly longer, the estimated blood loss during the case was less. To our knowledge, this is the first comparative study of single-port vs. multi-port RASP with regard to the benefit of decreased opioid use post-operatively.

Minimally invasive approaches to many types of urologic surgery continue to arise given the faster convalescence and improve peri-operative outcomes [24]. Single-site surgery has long been touted as the pinnacle of these advantages but has previously proved too technically demanding for widespread adoption [25]. The recent FDA approval of a dedicated single-port robotic platform has potentially made these procedures more feasible to a wider range of surgeons.

Only a limited number of studies have assessed pain after single-port robotic surgery to date. In a case-series Kaouk et al. reported low pain scores, rated 1–2 out of 10, at the

time of discharge after single-port laparoscopic and robotic partial nephrectomy [26]. Tsimoyiannis et al. evaluated pain scores after single-port laparoscopic cholecystectomy and demonstrated significantly lower pain scores and reduced analgesic requests, as compared to a multi-port approach [27]. More recently, in a study comparing single-port with multi-port robotic-assisted radical prostatectomy, the single-port approach was associated with a significantly greater number of patients being pain-free (0/10 pain) on post-operative day 1 as measured by visual analog scale [28]. However, this study did not demonstrate a reduction in ME. Similar to our findings, Lenfant and colleagues decreased opioid use in the hospital and at discharge in patients undergoing single-port robotic-assisted extraperitoneal prostatectomy [29]. Likewise Sawczyn and associated showed that the single-port prostatectomy was associated with increased odds of never receiving opioids [30]. In the present study, we identified both a reduction in pain scores and inpatient opiate use.

The findings of the present study are particularly important given the cohort being treated. Patients undergoing a RASP are obviously all male and tend to be of a more advanced age. This population has specifically been identified as one at increased risk of long-term chronic opioid use after surgery [23]. There was increased incidence of chronic opioid use noted in the first post-operative year across all the surgical procedures with exception of cataract surgery and laparoscopic appendectomy. Being male (OR 1.34) or older than 50 years (OR 1.74) was additional risk factor in sensitivity analyses [23]. In the opioid epidemic era, all providers, including surgeons, are being called upon to be active participants in opioid stewardship, the single-port approach appears promising as a means to decreasing the need for opiates for post-operative pain control [31].

We offer a few possible explanations as to why a single-port RASP may lead to reduced pain. First, the cumulative incision size for a single-port RASP is less (25.4 mm robotic port + 8 mm assistant port = 33.4 mm) than a standard multi-port RASP (8 mm robotic \times 3 + 12 mm camera + 12 mm assistant = 48 mm). While the cumulative size of the incisions is less, the single-port robotic port is substantially larger than any other and some may surmise that this would lead to increase pain. That said, it is our hypothesis that placement of this trocar in the midline and thus, splitting the rectus muscle bellies, rather than traumatically traversing the musculature, ultimately leads to less pain. Further, pain is often related to imprecise placement of the remote center of the trocar at the fascial level. Having three additional ports makes this event more likely. This supposition that fewer ports alone has been shown to be associated with decreased post-operative pain is supported by the study of Poon et al. [32].

Finally, the reduced surgical footprint in single-port cases may also confer other benefits that can impact post-operative pain/discomfort, such as a reduced catheterization time. In performing a single-port RASP, the cystotomy required to complete the surgery is often approximately 3 cm. Anecdotally, we often need to enlarge our cystotomies to remove the adenoma after enucleation. After confirming a water tight closure, we have reported our excellent results when performing voiding trials the first day after surgery [15]. It is a common occurrence in our experience that patients will perseverate on their urethral catheter and catheter-related pain more than the minimal incisional pain. Thus, using the single-port robot to allow for early catheter removal, we can mitigate this contributor of post-operative morbidity.

As with all studies, there are a number of limitations. First, the retrospective nature of our study and non-randomized nature means that patient selection cannot be total controlled for leading to selection bias. Further, the smaller sample size of the single-port group limits the generalizability of our findings. Also, while significant differences in prostate size and Charlson comorbidity index were identified and controlled for using propensity score matching, other underlying factors not be measured may affect post-operative pain and narcotic use. Next, no standardized post-operative care pathway was utilized with regards to frequency of pain medication availability or type (e.g. hydromorphone vs. morphine). An unmeasured systematic difference (such as prescribing a medication every 6 h PRN vs. Every 8 h) in the post-operative pathway could ultimately lead to a difference in narcotic use. Though, this is felt to be unlikely given the same providers were involved in both single-port and multi-port surgery and the same post-operative order set was used for each patient. Finally, because the study was not blinded and the patients were aware they underwent a single-port surgery, it is possible they had an expectation or assumption of decreased post-operative pain that translated to decreased request for pain medication. Conversely, because the caregivers taking care of the patient knew they underwent single-port surgery they may have been less likely to provide pain medication. Finally, due to limited follow-up, we do not have evidence showing functional equivalency but using tissue removed as surrogate, we see little difference.

Conclusion

In this retrospective propensity matched study of patients undergoing multi-port vs. single-port robotic-assisted simple prostatectomy, the single-port approach was associated with almost a 50% decrease in the post-operative opioid use. The use of single-port approach appears promising in decreasing reliance on opioids for post-operative pain control and further dedicated study is warranted.

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Availability of data and material Available upon request.

Declarations

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

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