

Single-Port Robotic Prostatectomy is Associated with Decreased Hospitalization: Evidence from the NSQIP Database

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Abstract

Purpose:

Same-day discharge (SDD) after robotic prostatectomy is an increasingly common paradigm for carefully selected patients. The single-port (SP) robotic platform offers potential advantages over traditional multiport (MP) systems in supporting reduced length of stay (LOS). We assessed the association of SP versus MP during radical and simple prostatectomies with perioperative outcomes in a multi-institutional, nationally validated risk-adjusted registry.

Methods:

The 2022–2023 NSQIP database was queried for patients undergoing radical or simple prostatectomy. Outcomes included LOS, SDD, and 30-day complication rates. Multivariable negative binomial regression analysis identified predictors of LOS, while logistic regression analyses identified predictors of SDD and complications.

Results:

12,504 radical (12,337 MP, 167 SP) and 519 simple prostatectomies (492 MP, 27 SP) met inclusion criteria. SP was associated with significantly reduced LOS in both radical (IRR = 0.59 [0.49–0.72], $p < 0.05$) and simple prostatectomy (IRR = 0.65 [0.42–0.99], $p < 0.05$) compared with MP. Use of SP was additionally associated with increased SDD in radical prostatectomy (OR = 5.25 [3.68–7.48], $p < 0.05$), but not simple (OR = 2.86 [0.38–14.4], $p = 0.2$). There were no significant differences in 30-day complications between SP and MP for either radical or simple prostatectomies.

Conclusion:

In this multi-institutional NSQIP study, SP-radical prostatectomy was associated with markedly higher SDD rates. Additionally, both SP-radical and SP-simple prostatectomies showed significant reduction in hospital stay compared with MP without significantly increased 30-day complications. These findings support the potential role of the SP platform in facilitating same-day discharge in robotic prostatectomy, though the contribution of platform-specific versus practice-level factors requires further study.

INTRODUCTION

Robotic-assisted surgery has fundamentally transformed the management of localized prostate cancer and symptomatic benign prostatic hyperplasia, driving significant reductions in complication rates and enhancing perioperative outcomes [1, 2]. Currently, a multiport (MP) approach is the standard of care for robotic urologic surgery [3], however single-port (SP) approaches have been increasingly introduced and adopted to minimize surgical morbidity and expedite patient recovery [4–7]. By limiting access to a single incision and more easily facilitating an extraperitoneal or transvesical approach, the SP system is thought to minimize abdominal wall trauma and reduce peritoneal irritation during prostatectomy [5, 6]. While this approach theoretically facilitates reduced operative time and postoperative pain for robotic-assisted radical prostatectomy, current evidence on

these points is mixed [6–8]. Regardless, large cohort studies consistently show reduced lengths of stay (LOS) and similar functional and oncologic outcomes for SP-radical prostatectomy as compared to MP [6, 8, 9]. For robotic-assisted simple prostatectomy, SP-simple prostatectomy has demonstrated lower estimated blood loss, shorter LOS, reduced opioid use, shorter catheter duration, and lower rates of de novo urge incontinence in some studies [10–14], though these results have not uniformly held up on pooled analysis [9].

Same-day discharge (SDD) is an increasingly common paradigm in robotic surgery for select patients due to refinements in postoperative pathways and system-level pressures from the COVID-19 pandemic [4, 15–18]. Single-center studies have shown higher SDD rates with an SP approach for radical prostatectomy, but whether this association persists across diverse practice settings has not been assessed [6, 15–17, 19, 20]. For simple prostatectomy, use of the SP approach was shown to increase SDD likelihood and decrease LOS as compared to MP in a multi-institutional study from several academic, high-volume SP centers, though a subsequent meta-analysis showed no difference in LOS on pooled analysis and did not assess for SDD [9, 12].

In an effort to validate these findings on a contemporary national scale, we conducted a retrospective study to compare SDD, LOS, and 30-day complication rates between SP and MP approaches for robotic-assisted radical and simple prostatectomies using a diverse, multi-institutional registry of academic medical centers and community-based hospitals.

MATERIALS AND METHODS

The 2022–2023 American College of Surgeons National Surgical Quality Improvement Program (NSQIP) general and targeted procedure public use data files were queried for patients undergoing robotic radical or simple prostatectomy. These databases provide prospectively collected, de-identified patient-level demographic, perioperative, and 30-day outcomes data for patients undergoing surgery in the United States from 656 centers. This study was exempted from informed patient consent and Institutional Review Board approval due to its de-identified nature.

Patients were included for study if they were ≥ 18 years and underwent robotic MP- or SP-radical prostatectomy (CPT codes 55840, 55842, 55845, 55866) or robotic MP- or SP-simple prostatectomy (CPT codes 55821, 55831, 55867) with ICD10 diagnosis codes for prostate cancer and benign prostatic hyperplasia, respectively (**Supplementary Tables**). MP and SP cases were identified via the “operative approach” NSQIP variable, which differentiates “MIS through Single incision” from “laparoscopic robotic” cases. Surgical cases with secondary procedural CPT codes not related to standard of care prostatectomies (**Supplementary Tables**), concurrent procedures performed by non-urologists, or unplanned conversions to open were excluded.

Baseline variables included age at surgery, American Society of Anesthesiologists (ASA) class, diabetes, congestive heart failure (CHF), bleeding disorders, immunosuppression, prior pelvic surgery, and prior pelvic radiation. Perioperative variables included antibiotic use, operative time, and drain placement. The primary outcomes of interest were postoperative LOS and SDD rates. SDD was defined as a LOS of zero. Secondary outcomes encompassed 30-day rates of blood transfusions, lymphoceles, urine leaks, urinary tract infections, sepsis, readmissions, or return trips to the OR.

Statistical comparisons of baseline and perioperative variables were accomplished using t-test for continuous variables and chi-squared or Fisher’s exact test for categorical variables. Multivariable negative binomial

regression was used to determine the adjusted association of single-port use with expected LOS, which produces an Incidence Rate Ratio (IRR) that represents the ratio of expected mean length of stay between comparison groups. Additionally, multivariable logistic regressions were used to determine the adjusted odds of single-port use with SDD and with each secondary outcome. All analyses were performed in R (4.5.1).

RESULTS

A total of 12,504 radical (12,337 MP, 167 SP) and 519 simple (492 MP, 27 SP) prostatectomies met inclusion criteria for 2022–2023. For radical prostatectomies, patients undergoing SP surgery were more immunosuppressed, had fewer drains placed, more extended-term antibiotic use, and shorter operative times than patients undergoing MP surgery (Table 1). For simple prostatectomies, patients undergoing SP surgery had a greater history of pelvic surgery, had fewer drains placed, and more extended-term antibiotic use than patients undergoing MP surgery (Table 1). From an outcomes standpoint, almost 50% of SP-radical prostatectomy patients were discharged same-day, while the SDD rates for all other prostatectomy patients were ~ 10% or less (Table 2). Complications within 30 days of surgery were low in all groups (Table 2).

Table 1
Baseline characteristics of prostatectomy patients

Characteristic (%)	Radical		p	Simple		p
	Multiport (12,337)	Single-port (167)		Multiport (492)	Single-port (27)	
Age (mean [SD])	63.9 (6.9)	64.5 (7.3)	0.3	69.5 (7.0)	69.4 (8.2)	0.9
ASA class			0.1			0.1
1	157 (1.3)	2 (1.2)		4 (0.8)	0 (0.0)	
2	5823 (47.2)	60 (35.9)		244 (49.6)	14 (51.9)	
3	6177 (50.1)	102 (61.1)		238 (48.4)	11 (40.7)	
4	160 (1.3)	3 (1.8)		6 (1.2)	2 (7.4)	
None assigned	20 (0.2)	0 (0.0)		0 (0.0)	0 (0.0)	
Diabetes			0.5			0.5
No	10496 (85.1)	139 (83.2)		387 (78.7)	22 (81.5)	
Yes; no insulin	1506 (12.2)	21 (12.6)		84 (17.1)	5 (18.5)	
Yes; insulin	335 (2.7)	7 (4.2)		21 (4.3)	0 (0.0)	
CHF	131 (1.1)	3 (1.8)	0.6	13 (2.6)	1 (3.7)	1
Bleeding disorder	177 (1.4)	1 (0.6)	0.6	8 (1.6)	2 (7.4)	0.2
Immunosuppressed	249 (2.0)	8 (4.8)	< 0.05	8 (1.6)	0 (0.0)	1
Prior pelvic surgery	1957 (15.9)	36 (21.6)	0.1	94 (19.1)	11 (40.7)	< 0.05
Prior pelvic radiation	92 (0.7)	3 (1.8)	0.3	1 (0.2)	0 (0.0)	1
Drain placed	5079 (41.2)	24 (14.4)	< 0.05	247 (50.2)	1 (3.7)	< 0.05
Perioperative antibiotic use			< 0.05			< 0.05
No antibiotics	89 (0.7)	1 (0.6)		4 (0.8)	0 (0.0)	
< 24 hrs	11054 (89.6)	112 (67.1)		445 (90.4)	14 (51.9)	
24–72 hrs	884 (7.2)	6 (3.6)		33 (6.7)	2 (7.4)	
> 72 hrs	310 (2.5)	48 (28.7)		10 (2.0)	11 (40.7)	
Operative time (mean [SD])	209 (68)	172 (66)	< 0.05	174 (56)	157 (58)	0.1

Table 2
Length of stay, same-day discharge rates, and 30-day complications of prostatectomy patients

Characteristic (%)	Radical	Simple		
	Multiport (12,337)	Single-port (167)	Multiport (492)	Single-port (27)
LOS (median [IQR])	1 [1, 1]	1 [0,1]	1 [1, 2]	1 [1, 1]
SDD	1317 (10.7)	78 (46.7)	14 (2.8)	2 (7.4)
Readmission	389 (3.2)	7 (4.2)	22 (4.5)	0 (0.0)
Return to OR	65 (0.5)	0 (0.0)	6 (1.2)	0 (0.0)
UTI	364 (3.0)	2 (1.2)	35 (7.1)	2 (7.4)
Urine leak	170 (1.4)	1 (0.6)	3 (0.6)	0 (0.0)
Lymphocele	293 (2.4)	3 (1.8)	5 (1.0)	0 (0.0)
Sepsis	69 (0.6)	0 (0.0)	2 (0.4)	0 (0.0)
Blood transfusion	89 (0.7)	0 (0.0)	12 (2.4)	0 (0.0)

On multivariable analysis, use of SP was associated with significantly reduced expected LOS in both radical (IRR = 0.59 [0.49–0.72], $p < 0.05$) and simple prostatectomies (IRR = 0.65 [0.42–0.99], $p < 0.05$) as compared to MP (Table 3). Use of SP was additionally associated with increased SDD in radical prostatectomy (OR = 5.25 [3.68–7.48], $p < 0.05$), but not simple prostatectomy (OR = 2.86 [0.38–14.4], $p = 0.2$) as compared to MP. There was no difference in 30-day readmissions, return trips to the OR, UTIs, urine leaks, lymphoceles, sepsis, or blood transfusions between SP and MP for either radical or simple prostatectomy.

Table 3
Adjusted negative binomial assessing role of SP on LOS in prostatectomy

Variable	Radical	Simple		
	IRR (CI)	p	IRR (CI)	p
Age (per 10-year increase)	1.04 (1.01, 1.06)	< 0.05	1.13 (1.02, 1.26)	< 0.05
ASA class (compared to 1)				
2	1.08 (0.92, 1.26)	0.3	0.75 (0.33, 1.73)	0.5
3	1.15 (0.98, 1.34)	0.1	0.78 (0.34, 1.80)	0.6
4	1.41 (1.15, 1.72)	< 0.05	0.93 (0.35, 2.43)	0.9
None assigned	0.90 (0.55, 1.47)	0.7	n/a	n/a
Diabetes (compared to insulin dependent)				
No	0.93 (0.85, 1.02)	0.1	0.64 (0.48, 0.86)	< 0.05
Yes; no insulin	1.00 (0.91, 1.11)	0.9	0.57 (0.41, 0.80)	< 0.05
CHF	1.36 (1.19, 1.55)	< 0.05	1.13 (0.73, 1.73)	0.6
Bleeding disorder	0.98 (0.85, 1.12)	0.8	1.44 (0.91, 2.29)	0.1
Immunosuppressed	1.02 (0.91, 1.14)	0.7	0.70 (0.36, 1.37)	0.3
Prior pelvic surgery	1.04 (0.99, 1.08)	0.1	1.00 (0.83, 1.20)	0.9
Prior pelvic radiation	1.11 (0.94, 1.32)	0.2	1.30 (0.31, 5.50)	0.7
Drain placed	1.26 (1.22, 1.30)	< 0.05	1.12 (0.97, 1.30)	0.1
Perioperative antibiotic use (> 72 hours)				
No antibiotics	0.78 (0.63, 0.97)	< 0.05	0.39 (0.14, 1.14)	0.1
< 24 hrs or intraop use only	0.83 (0.76, 0.91)	< 0.05	0.66 (0.45, 0.96)	< 0.05
24–72 hrs	1.00 (0.89, 1.11)	0.9	0.80 (0.51, 1.25)	0.3
Operative time (per 30-minute increase)	1.04 (1.03, 1.05)	< 0.05	1.07 (1.03, 1.11)	< 0.05
Use of single port	0.59 (0.49, 0.72)	< 0.05	0.65 (0.42, 0.99)	< 0.05

DISCUSSION

In this multi-institutional, nationally validated analysis, we found that SP-radical prostatectomy was associated with markedly higher SDD rates and a significant reduction in LOS compared to the MP approach. For simple prostatectomy, our multivariable analysis similarly demonstrated that the SP approach led to a significantly reduced LOS, though it was not associated with significantly different SDD rates. Importantly, these reductions in hospitalization did not come at the cost of patient safety, as no significant differences in 30-day complication rates were detected for either surgery.

Our findings corroborate prior meta-analyses of single-institution studies that have shown reduced LOS and increased SDD after SP-radical prostatectomy without increases in operative time or postoperative complications [21, 22]. By utilizing the broad NSQIP dataset, we demonstrate that the benefits of SP-radical prostatectomy are generalizable and not confined to high-volume academic centers. Interestingly, we observed shorter operative times for SP-radical prostatectomy as compared to MP, which may reflect a greater familiarity with the SP platform given the contemporary nature of our dataset and the known learning curve of SP [23].

While our study confirms many findings of the multi-institutional SPARC study on SP-simple prostatectomy, we did not find the same SDD benefit in our SP cohort, despite an overall reduction in LOS [12]. This difference may be explained by the propensity for more formalized SDD selection criteria and postoperative pathways at high-volume academic centers like those represented in SPARC, as opposed to the broader cross-section of clinical practices represented within NSQIP [17, 24, 25]. Furthermore, the largest meta-analysis to date comparing SP-simple prostatectomy and MP-simple prostatectomy included only three studies and identified reduced opioid consumption as the sole significant benefit of the SP approach [9]. While our SP-simple prostatectomy cohort is modestly sized, our multi-institutional risk-adjusted analysis demonstrates that the SP approach offers measurable perioperative benefits by reducing LOS.

The association between SP and expedited discharge may reflect a combination of platform-related and practice-related factors. The single incision minimizes abdominal wall trauma, while the extraperitoneal or transvesical approaches avoid peritoneal irritation, thereby reducing the postoperative pain, nausea, and ileus that often delay discharge [5, 6]. Additionally, the SP approach frequently allows for the omission of steep Trendelenburg positioning, further reducing postoperative nausea, which is a common driver of failed SDD [17, 26, 27]. Despite these potential advantages, the transition to SP requires navigating a distinct learning curve, even for highly experienced robotic surgeons [28, 29]. The restricted space and unique articulation mechanics of SP instruments can fundamentally alter pre-existing surgical gesture schema, often leading to increased operative times while surgical teams adapt to the new spatial dynamics and interface [6, 30]. Furthermore, surgeons and institutions that have adopted the SP platform may also be more likely to have implemented formalized SDD protocols and patient selection pathways, and NSQIP does not capture these practice-level variables. The observed SDD benefit therefore cannot be attributed solely to the SP platform itself.

Our study has several limitations inherent to the use of a large retrospective database. While NSQIP provides high-quality, audited data, it does not provide information on prostate volume, nerve-sparing techniques, and prior treatments for BPH that may influence operative complexity and discharge timing. Critically, the decision to attempt same-day discharge is influenced by institutional protocols and surgeon preference, which are not captured in the registry. As noted, the observed SDD association may partly reflect institutional selection bias rather than a direct platform effect. Although baseline comorbidities and ASA classification were comparable between the SP and MP cohorts, it is possible that selection for SP surgery and/or SDD was influenced by unmeasured factors, introducing a degree of confounding by indication. Despite being a national registry, our SP cohorts were significantly smaller than their MP counterparts, which may have limited our ability to detect small differences in SDD within the simple prostatectomy group, as well as meaningful differences in low-frequency complications such as sepsis, urine leak, and blood transfusion. The absence of statistically significant differences in 30-day complication rates should therefore be interpreted with caution, as the study was not powered to detect small but clinically relevant differences in these outcomes.

CONCLUSION

In a multi-institutional, nationally validated risk-adjusted registry, single-port radical prostatectomy was associated with markedly higher same-day discharge rates and reduced length of stay as compared to multiport without increased 30-day complications. Furthermore, the single-port approach significantly reduced hospital length of stay for simple prostatectomy. These findings demonstrate that SP prostatectomy is associated with favorable discharge metrics in a nationally representative cohort and support continued investigation into the role of the single-port platform within same-day discharge paradigms in robotic urologic surgery.

Declarations

The authors have no relevant financial or non-financial interests to disclose

Author Contribution

A.C. and B.W. conceived and designed the study. B.W. acquired the data. B.W. performed the statistical analysis. A.C., B.W., and D.D. analyzed and interpreted the data. B.W. and D.D. drafted the manuscript. A.C. provided administrative and technical support. All authors critically revised the manuscript and approved the final version.

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The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions drawn by the authors.

Data Availability

The data analyzed during the current study were obtained from the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) Participant Use Data File. Restrictions apply to the public redistribution of these data under the terms of the ACS NSQIP data use agreement. The data are available to qualified researchers directly from the American College of Surgeons via formal application at <https://www.facs.org/>.

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