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Improved Outcomes Utilizing a Valveless-Trocar System during Robot-assisted Radical Prostatectomy (RARP)

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ABSTRACT

Introduction: To evaluate the effect of valveless trocar system (VTS) on intra-operative parameters, peri-operative outcomes, and 30-day postoperative complications in patients undergoing robotic-assisted laparoscopic prostatectomy.

Methods: A total of 200 consecutive patients undergoing Robot-assisted radical prostatectomy by a single surgeon were prospectively evaluated using either the valveless trocar (n = 100) or standard trocars (n = 100). Patient demographics, intra-operative parameters, length of stay, presence or absence of postoperative nausea and vomiting, analog pain score at 0–6 hours, 6–12 hours, 12–18 hours, and >24 hours, and 30-day postoperative complications were analyzed.

Results: There were no significant differences in estimated blood loss, intra-operative urine output, length of stay, or 30-day complication rates between the two groups. While the VTS group had higher Body Mass Index (BMI) (28.45 vs. 27.23; $P = 0.049$), the operative time was significantly shorter in the VTS group (146 minutes vs. 167 minutes; $P < .005$). The VTS group experienced fewer episodes of nausea (2% vs. 10%; $P = 0.0172$). The VTS group had less pain intensity compared to the control in the first 18 hours: 0–6 hours (1.9 vs. 2.5; $P = 0.034$), 6–12 hours (2.8 vs. 3.6; $P = 0.044$), and 12–18 hours (2.2 vs. 3.1; $P = 0.049$), respectively.

Conclusion: The use of a valveless trocar system during robot-assisted robotic prostatectomy may shorten operative times, and reduce postoperative pain scores and nausea episodes without increasing the 30-day complication rate. Further prospective randomized trials should be performed to validate these findings.

Key Words: Valveless trocar, Prostate cancer, Robotic prostatectomy, Outcomes.

INTRODUCTION

Since Palmer's original publication on laparoscopy in 1947, numerous advances, including enhanced visualization, instrumentation improvements, and the recent substantial advancement of robot-assisted laparoscopic surgery, have occurred that improve both operative and postoperative outcomes.^{1,2} Of these many advancements, peritoneal insufflation and regulation have remained relatively unchanged.

The valve-less trocar system (VTS), AirSeal Intelligent Flow System™ (ConMed; Utica, New York, USA) is an integrated three-lumen insufflation system that provides high flow insufflation, stable pneumoperitoneum, valveless trocar access, and constant smoke evacuation (Figure 1). This is accomplished without the use of the standard trap door valve within the trocar, which allows the passage of instruments with minimal intra-abdominal pressure loss. The system is composed of the specialized valveless trocar, three-lumen tubing, and specialized insufflator. By eliminating the mechanical valve, issues that previously increased operative time are reduced or eliminated. These issues include the transfer of condensation on the valve to the camera, difficulty removing intact specimens, and the risk of losing needles during passage or retrieval. Elimination of a mechanical seal is accomplished by creating a static pressure zone of a "curtain" of opposing airflow within the trocar. The design incorporates a system of small nozzles located within the proximal trocar that supplies pressurized high-flow CO₂, which is opposed, and neutralized, by the intrabdominal gas flowing outward. Airflow, and thus the desired intrabdominal pressure, is regulated at this curtain by proximally located CO₂ pressure sensors. Any excess CO₂ that interrupts the

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Figure 1. AirSeal Intelligent Flow System™ (ConMed; Utica, New York, USA) is an integrated system with specialized valveless trocar, three lumen tubing, and specialized insufflator.⁸

stability of the “curtain” is evacuated and recirculated back to the pump where it is recompressed and recycled. A third lumen evacuates the smoke, which is filtered, compressed, and recycled with the CO₂. The recycling process decreases overall consumption of insufflation gas used in each procedure, and it has shown to be associated with a decrease in the operative time.^{3,4} Herein, we sought to assess the effect of using AirSeal on intra-operative parameters, peri-operative outcomes, and 30-day postoperative complications.

MATERIALS AND METHODS

All data were prospectively collected into an Institutional Review Board (IRB)-approved registry database. Between March 2014 and June 2015, a total of 200 consecutive non-randomized patients undergoing robot-assisted robotic prostatectomy (RARP) were equally assigned to VTS group and control group (1:1). The VTS group utilized the complete Airseal Intelligent Flow System™, and the control group utilized a standard 12-mm Covidien Versaport (Covidien, Dublin, Ireland) bladeless optical trocar connected to a standard insufflator (Stryker, Kalamazoo, Michigan, USA). A standard insufflation pressure of 15 mm Hg was utilized in both arms.

Intraperitoneal insufflation was achieved via the Veress needle. Once the pneumoperitoneum was established, the camera trocar was placed cranial to the umbilicus in the midline. The remaining 8-mm robotic trocars were placed in a standardized fashion under direct vision across the lower abdomen in addition to a 5-mm assistant port in the left upper quadrant. Either the 12-mm VTS or Covidien Versaport were placed in the left lower quadrant. Lymph-node dissection and nerve-sparing quantity were based on perioperative clinical findings and surgeon discretion (DL). A local anesthetic via intraperitoneal transversus abdominus block was performed at the conclusion of the case with 5 mL of bupivacaine bilaterally for a total of 10 mL.⁵ Each patient received postoperative pain control medications based on our pathway protocol, which included 15 mg ketorolac given immediately postoperatively and every 6 hours as an inpatient. A

total of 14 patients did not receive ketorolac, seven patients from each group, due to allergies or compromised renal function. Breakthrough pain was managed using acetaminophen and opioid-based medications.

Total operative time; estimated blood loss; intra-operative urine output; length of stay; presence or absence of postoperative nausea and vomiting (PONV) documented in the nursing notes; analog pain score at 0–6 hours, 6–12 hours, 12–18 hours, and >24 hours; and 30-day postoperative complications were abstracted from the database.

Statistical Analysis

Mean and standard deviation were reported for continuous variables. Frequencies and proportions were reported for categorical variables. χ^2 and Mann-Whitney *U* tests were used to compare outcomes between the VTS group and Control group. Statistical analyses were performed with SPSS (IBM, SPSS Statistics for Windows, Version 24, Chicago, Illinois, USA).

RESULTS

There were no significant differences in estimated blood loss, intra-operative urine output, and length of stay between the two groups. While the VTS group had higher Body Mass Index (BMI) (28.45 vs. 27.23 kg/m²; *P* = 0.049), the operative time was significantly shorter in the VTS group (146 minutes vs. 167 minutes; *P* < 0.005). The control group had shorter times to ambulation (9 hours vs. 10.9 hours; *P* = 0.015). Table 1 summarizes patients' demographics, intra-operative parameters, and postoperative outcomes.

The VTS group experienced fewer episodes of nausea (2% vs. 10%; *P* = 0.0172), but this difference did not affect vomiting episodes (VTS, 1% vs. control, 0%; *P* = 0.316). The VTS group had less pain intensity compared to the control in the first 18 hours: 0–6 hours (1.9 vs. 2.5; *P* = 0.034), 6–12 hours (2.8 vs. 3.6; *P* = .044), and 12–18 hours (2.2 vs. 3.1; *P* = 0.049), respectively. This difference in pain intensity favored the VTS group at 18–24 hours and >24 hours; however, it was not statistically significant (Table 2). The overall 30-day complications rate in this cohort was 4.5%. Table 3 summarizes the 30-day complications in both groups.

DISCUSSION

In this study we have demonstrated that using Airseal during RARP was associated with shorter operative time, less postoperative nausea and pain in the first 18 hours after surgery, and was not associated with an increase in overall compli-

Table 1.

Demographics and Perioperative Outcomes for Patients Undergoing RARP with Either the Valveless or Standard Trocar

	Valveless Trocar Group	Control Group	P Value
Age, mean ± SD	62 ± 7	62 ± 7	0.823
BMI (kg/m ²), mean ± SD	28.45 ± 4.20	27.23 ± 4.47	0.0495
Operation time (minutes), mean ± SD	146 ± 35	167 ± 25	<0.05
Nerve sparing			
Right side	86%	90%	0.38
Left side	87%	91%	0.36
Pelvic lymphadenectomy	97.2%	100%	
Length of stay (days), mean ± SD	1 ± 1	1 ± 0	0.285
Intra-operative blood loss (mL), mean ± SD	133 ± 66	144 ± 58	0.254
Intra-operative urine output (mL), mean ± SD	360 ± 267	273 ± 158	0.2416
Time to ambulation (hours), mean ± SD	10.9 ± 5.9	9.0 ± 4.4	0.015

BMI, ; RARP, robotic-assisted radical prostatectomy.

Table 2.

Pain Score Averaged at Different Time Interval for Patients Undergoing RARP with Either the Valveless or Standard Trocar

	Group	0-6 Hours	6-12 Hours	12-18 Hours	18-24 Hours	>24 Hours
VTS group pain score (average)	VTS	1.9	2.8	2.2	2.4	2.2
Control group pain score (average)	Control	2.5	3.6	3.1	2.9	3.4
	P Value	0.0339	0.0435	0.0468	0.2661	0.149

RARP, robotic-assisted radical prostatectomy; VTS, valveless trocar system.

cation rate. These findings add further insight into the potential benefits of utilizing VTS during RARP.

Our results are in line with the previous studies which have demonstrated that using VTS was associated with shorter operative time. This may be attributed to improved smoke evacuation, pneumoperitoneum stabilization, a decrease in frequency of camera cleans, trocars manipulations, unhindered removal of Hem-o-locks and needles, and preventing complete pneumoperitoneum loss in small and large leaks.^{3,6-9}

PONV is an overlooked patient outcome, and there is a paucity of the literature assessing PONV after RARP.¹⁰ PONV is a complex phenomenon, in which there are intricate interactions between multiple factors, such as age, gender, type of anesthesia, duration of anesthesia, and use of opioid, that can influence the severity and frequency of PONV.¹¹ We noted that the VTS group had fewer episodes of postoperative nausea compared to the control group. This can be explained by a shorter operative time and consequently anesthesia time. In addition,

the VTS group had less postoperative pain and therefore might have consumed fewer opioids.

Moreover, it has been postulated that intra-operative hypercarbia and steep Trendelenburg may be related to PONV by increasing intracranial pressure.^{12,13} Herati et al⁹ found that using VTS during renal surgery reduced CO₂ consumption and this may partially explain fewer nausea experiences by patients in the VTS group in this study. In this cohort, CO₂ absorption was not assessed.

Despite several strengths, our study has several limitations. First, although the data were prospectively collected, patients were not randomized between the two groups. Second, the number of events related to the loss of intra-abdominal pressure during the case was not noted. Opioid consumption postoperatively was not captured. Finally, no validated questionnaires were used to assess postoperative nausea. Despite these limitations, this is the first report on the effect of using VTS during RARP on postoperative pain, nausea, and 30-day complications.

Table 3.
Thirty-Day Complications for Patients Undergoing RARP with Either the Valveless or Standard Trocar

	Overall	Control Group	VTS Group	P Value
Overall peri-operative (<30 day) complications, n (%)				
No	181 (95.5)	96 (96)	95 (95)	0.7
Yes	9 (4.5)	4 (4)	5 (5)	
Clavien-Dindo classification, n (%)				1
Grade 1	0 (0)	0 (0)	0 (0)	
Grade 2	1 (11)	0 (0)	1 (25)	
Grade ≥ 3	8 (89)	4 (100)	4 (75)	
Type of complication (<30 day), n (%)				0.3
Urinary retention	3 (33)	3 (75)	0 (0)	
Adynamic ileus	1 (11)	1 (25)	0 (0)	
Pulmonary embolism	1 (11)	0	1 (20)	
Infected lymphocele	1 (11)	0	1 (20)	
Meatal stricture	1 (11)	0	1 (20)	
Diverticulitis	1 (11)	0	1 (20)	
Superficial phlebitis	1 (11)	0	1 (20)	

CONCLUSION

In conclusion, using the valveless trocar system during RARP may shorten operative times and reduce postoperative pain scores and nausea episodes without increasing the 30-day complication rate. Further prospective randomized trials should be performed to validate these findings.

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