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ORIGINAL ARTICLE

# Reduction in postoperative ileus rates utilizing lower pressure pneumoperitoneum in robotic-assisted radical prostatectomy

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**Abstract**
Robotic-assisted radical prostatectomy (RARP) is the most commonly performed surgery for prostate cancer. This is a study comparing differences in postoperative outcomes between pneumoperitoneum pressures of 15 mmHg and 12 mmHg. Retrospective chart review was performed on 400 patients undergoing RARP over a 5 year period. A combination of Fisher's exact test and ANOVA were utilized for statistical analysis. Age, BMI, Gleason score, positive margin rate, complication rates, blood loss, and operative times were similar in both groups. Length of stay and postoperative ileus rates were significantly less in the 12 mmHg group ($p < 0.05$). RARP can be safely performed utilizing a lower pressure pneumoperitoneum. Decreasing insufflation pressures from 15 to 12 mmHg can further lead to decreased rates of postoperative ileus.

**Keywords** Low-pressure pneumoperitoneum · Standard pressure pneumoperitoneum · Robotic-assisted radical prostatectomy · Postoperative ileus · Prostate cancer · Robotic surgery

**Abbreviations**

| | |
|---|---|
| LPP | Low-pressure pneumoperitoneum |
| SPP | Standard pressure pneumoperitoneum |
| RARP | Robotic-assisted radical prostatectomy |
| POI | Postoperative ileus |
| BMI | Body mass index |
| LOS | Length of stay |

## Introduction

Robotic-assisted radical prostatectomy (RARP) now represents over 85% of prostatectomies performed in the United States [1]. This technology embodies the current paradigm shift to minimally invasive urologic surgery, and has quickly surpassed open surgery as the standard of care for treatment of organ confined prostate cancer. While there are many advantages to minimally invasive surgery, the increased utilization of robotic technology and laparoscopy is not without drawbacks. The physiologic consequences associated with laparoscopy are well documented and can have significant effects on a patient's postoperative course. Specifically, pneumoperitoneum pressures lead to gaseous compression of the bowel and decreased mesenteric blood flow, possibly equating to prolonged return of bowel function [2].

Within the laparoscopic community, there has been increasing interest directed towards determining the optimal intra-abdominal pressure to allow for adequate visualization, while concurrently mitigating adverse physiologic effects of pneumoperitoneum. A recent retrospective review at our institution analyzed a small subset of patients undergoing RARP at a standard pressure pneumoperitoneum (SPP) of 15 mmHg versus a lower pressure pneumoperitoneum (LPP) of 12 mmHg [3]. This review found that LPP was noninferior to SPP in terms of postoperative outcomes. Interestingly, these data also showed a trend towards decreased rates of postoperative ileus (POI) in the LPP, though statistical significance was not reached due to small sample size.

The objective of this study is to evaluate postoperative outcomes in patients undergoing RARP at a lower pneumoperitoneum pressure of 12 mmHg compared to the standard pressure of 15 mmHg. In addition, this study aims to determine if LPP results in lower POI rates.

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## Methods

This study represents a retrospective review of RARPs performed between January 2012 and August 2016 by a single high-volume robotic surgeon (TJM). Inclusion criteria included patients that were over 18 years old who were diagnosed with prostatic adenocarcinoma on 12-core needle biopsy. Exclusion criteria included patients that had preoperative evidence of metastatic disease.

After 209 patients successfully underwent RARP at a pneumoperitoneum pressure of 15 mmHg, a pressure of 12 mmHg was implemented for the remaining 198 patients. With the exception of pneumoperitoneum pressure, all other preoperative, intraoperative, and postoperative parameters were standardized between the two groups. All patients were given a standard bowel prep the evening before surgery. All patients were given a preoperative antibiotic, which was continued for 24 h after surgery. During the initial $CO_2$ insufflation, the pneumoperitoneum was set at 15 mmHg for robotic port placement. Following port placement, patients were either placed at the SPP of 15 mmHg or the LPP of 12 mmHg. Airseal® iFS device was utilized during surgery to assist in maintenance of pneumoperitoneum. Sequential compression devices were placed prior to surgery and maintained until discharge. Postoperatively, patients were started on a clear liquid diet immediately after surgery; this was advanced to a general diet on postoperative day 1 as tolerated. Patients were encouraged to ambulate immediately postoperatively. Postoperative pain was managed with oral and IV narcotics for breakthrough pain control. Urethral catheters were removed in the office 1 week postoperatively. At the 1 week postoperative visit, patients were asked standardized questions regarding return of bowel function and the absence of ileus.

Postoperative parameters evaluated included length of stay (LOS), complications, and postoperative ileus. POI was defined using the standardized international consensus panel definition: "the occurrence of two or more symptoms on postoperative day 4 or after: nausea and vomiting, inability to tolerate diet, absence of flatus for 24 h, abdominal distention, or radiographic confirmation" [4]. POI analysis included patients that were unable to be discharged initially from the hospital, or patients that were readmitted for bowel-related sequelae.

Statistical analysis included the utilization of Fisher's exact test for statistical significance and ANOVA for analysis of mean variables using standard SAS software. The threshold for significance was $p < 0.05$ in each of the measured categories.

**Table 1** Patient demographics

| | 12 mmHg | 15 mmHg | *p* value |
|---|---|---|---|
| Number of patients | 198 | 209 | |
| Mean age (years) | 63.05 | 61.96 | 0.43 |
| Mean BMI (range) | 29.88 (20–46) | 29.66 (20–49) | 0.664 |
| Mean Gleason score | 6.76 | 6.62 | 0.148 |

**Table 2** Postoperative outcomes

| | 12 mmHg | 15 mmHg | *p* value |
|---|---|---|---|
| Blood loss (mL) | 172.01 | 173.28 | 0.68 |
| Length of operation (min) | 105.49 | 111.31 | 0.883 |
| Length of stay (days) | 1.49 | 1.76 | **0.022** |
| Postoperative ileus | 10 | 25 | **0.014** |
| Positive margin | 32 | 23 | 0.147 |
| Readmission | 10 | 9 | 0.7 |
| Hematoma | 2 | 1 | 0.66 |
| Fistula | 0 | 1 | 0.31 |

Bold—$p < 0.05$ was significant

## Results

### Patient demographics

A total of 407 patients were included in our analysis (Table 1). In the SPP group, there were 209 patients, and in the LPP group, there were 198 patients. The mean age was 63.5 in the LPP group and 61.9 in the SPP group ($p = 0.43$). Body mass index (BMI) was 29.9 in the LPP group and 29.66 in the SPP group ($p = 0.664$). Mean combined Gleason scores were 6.76 in the LPP group and 6.62 in the SPP group ($p = 0.148$). The most common stage for both groups was T2c, representing 58% in the LPP group and 62% in the SPP.

### Operative and postoperative parameters (Table 2)

Mean blood loss was 180.45 mL in the LPP group and 175.33 mL in the SPP group ($p = 0.68$). Mean operative time was 105.5 min in the LPP group and 111.3 min in the SPP group ($p = 0.883$). Hematomas were seen in two patients in the LPP group and one patient in the SPP group ($p = 0.66$). Positive margins were found in 16% of the LPP group and 11% of the SPP, although this was not statistically significant ($p = 0.147$).

LOS was significantly less in the LPP group (1.49 days vs 1.76 days, $p = 0.022$). POI rate was 5% (10/198 patients) in the LPP group and 12% (25/209 patients) in the SPP

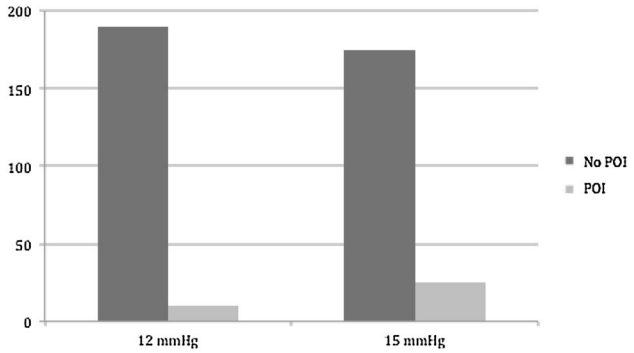


**Fig. 1** Postoperative ileus (POI) rates with respective pneumoperitoneum pressures

group (Fig. 1); this was statistically significant ($p = 0.014$). Readmission was 4% for the LPP group and 5% for the SPP group ($p = 0.7$).

## Discussion

Radical prostatectomy represents the gold standard for the treatment of organ confined prostatic adenocarcinoma. By improving techniques that allow the minimization of postoperative complications, urologists can better optimize patient convalescence. There has been a significant amount of research conducted in general surgery laparoscopic literature regarding pneumoperitoneum pressures; however, urologic literature is limited [5].

Previously, we conducted a retrospective review, demonstrating that RARP can be safely performed at a lower pneumoperitoneum of 12 mmHg compared to the standard of 15 mmHg, without an increase in postoperative complications [3]. Interestingly, we further found a trend towards decreased POI rates in the LPP group, though statistical significance was not reached due to small sample size [3]. After this initial result, we were able to expand our cohort and confirm with statistical significance that POI rates were lower in the LPP group (5% vs 12%). These results represent the first identification that higher pneumoperitoneum pressures are a risk factor for POI development in the urologic literature.

Annually, POI is estimated to have a 1.5 billion dollar impact on healthcare costs in the United States [6]. In addition to increased resource allocation and patient dissatisfaction, objective measurements, such as POI, may have an impact on future quality metrics that evaluate hospitals and physicians [7]. Despite the vast amount of research directed at perfecting RARP outcomes, there is limited published data on factors that contribute to POI after RARP [8]. The incidence of POI is thought to range between 3–10% of urologic surgeries; however, it can be difficult to quantify, as multiple definitions have been proposed [9].

The standard definition of POI refers to obstipation and intolerance of oral intake as a result of disrupted normal coordinated propulsive motor activity of the gastrointestinal tract following surgical intervention [10]. When terming POI in our cohort, we used an international consensus panel definition, which defined POI as "the occurrence of two or more symptoms on postoperative day 4 or after: nausea and vomiting, inability to tolerate diet, absence of flatus for 24 h, abdominal distention, or radiographic confirmation." [4].

There are several proposed mechanisms of POI after laparoscopic surgery: inflammation, neural reflexes, and possibly ischemia. A study done by Schilling et al. [11] found a decrease in blood flow to the jejunum by 32% and colon by 44% after increasing pneumoperitoneum pressures from 10 to 15 mmHg. The clinical impact of these changes has been under debate; however, our series represents a large patient population which suggests that POI rates are decreased with lower pneumoperitoneum pressures. This finding is of substantial clinical significance as minimally invasive robotic-assisted laparoscopic surgery becomes increasingly utilized in the urologic community. As robotic surgery becomes more commonplace, increased numbers of patients will be exposed to prolonged periods of pneumoperitoneum, which can result in negative physiologic consequences. By lowering pneumoperitoneum pressures, we can decrease postoperative complications, such as POI, without sparing visualization or surgical outcomes.

This study is not without its limitations. First, the retrospective design lacks randomization and results in a subsequent decrease in reliability of the results. Our patients were not prospectively or randomly assigned pneumoperitoneum values, which could potentially limit the data's applicability. Despite this limitation, our cohorts were well matched and both groups showed similar characteristics regarding age, BMI, and pathological stage. In addition, the surgeries were completed after the primary surgeon (TJM) had completed over 1000 cases; this mitigates the possibility of a learning curve affecting the results. Second, POI can be difficult to quantify, because there are multiple different definitions. To mitigate this, we used an international consensus panel standardized definition of ileus. Next, we did not control or measure opioid usage. Opioids have a well-known relationship with decreased gastrointestinal motility and ileus. This could have potentially had an effect on our results. Finally, the AirSeal® iFS device was utilized for all patients in our study. This device assists with maintenance of a stable pneumoperitoneum and smoke evacuation during suctioning without rapid changes in intra-abdominal pressure. The use of this could potentially prohibit generalizability to surgeons that do not utilize this technology.

Further randomized and prospective studies are required to confirm the effect of lowering pneumoperitoneum pressures in the setting of RARP. An in-depth analysis of multiple pneumoperitoneum pressures could be performed to determine the optimal pneumoperitoneum pressure setting when performing RARP.

Despite these limitations, our study represents the first analysis of its kind in patients undergoing RARP at a lower pneumoperitoneum pressure, revealing a statistically and clinically significant reduction of POI in the setting of LPP.

## Conclusions

Robotic-assisted radical prostatectomy can safely be performed utilizing a lower pressure pneumoperitoneum of 12 mmHg. The data presented show no statistical difference in operative times, blood loss, positive surgical margins, or other postoperative complications. However, by decreasing insufflation pressures from 15 to 12 mmHg, the rate of postoperative ileus decreased from 12 to 5%.

### Compliance with ethical standards

**Conflict of interest** All authors declare that they have no conflicts of interest.

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