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*Research Article*

# Robotic Assisted Radical Prostatectomy Performed Under Ultra Low Intraperitoneal Pressure: A Single Centre Experience.

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## Abstract

**Background:** Robotic-assisted radical prostatectomy (RARP) is the standard surgical option for localized prostate cancer. Ultra-low intraperitoneal pressure (ULP, ≤6 mmHg) has become a promising alternative, but there is still limited evidence of its safety, oncological outcomes and feasibility for use in routine clinical practice.

**Aim:** To assess the peri-operative, pathological and post-operative results of ULP in RALP at a single centre with a focus on operative efficiency, oncological safety, complications and feasibility of same day discharge.

**Methods:** A retrospective observational study from a single tertiary referral centre in the United Kingdom was done from January 2021 to April 2026 who underwent RARP. Baseline demographic, operative, pathological, and postoperative variables were analysed using descriptive statistics.

**Results:** 500 patients had RARP using ULP. The mean console time was 99.67 ± 47.42 minutes, and the mean estimated blood loss was 260.10 ± 131.61mLs. Pelvic lymph node dissection was done in 6.6% of patients and 37.0% were planned as day-case procedures. Bilateral nerve sparing was performed in 28.8% and unilateral nerve sparing in 50.6% of the cases. Negative surgical margins were obtained in 72.4% of patients. Post-operative complications were rare, the most common being wound infection (2.2%) and the other complications were seen in ≤1.2% of patients.

**Conclusion:** ULP in RALP is a feasible, safe, and reproducible technique with good peri- and oncological outcomes. Its low complication rate and successful implementation of same day discharge make it a good fit for enhanced recovery pathways.

**Keywords:** Robotic-assisted radical prostatectomy, Ultra-low pneumoperitoneum, Prostate cancer, Same-day discharge, Enhanced recovery after surgery.

## INTRODUCTION

Robotic-assisted radical prostatectomy (RARP) is the preferred surgical treatment for patients with localized and locally advanced prostate cancer.[1] Compared with conventional open and laparoscopic approaches, RARP offers enhanced three-dimensional visualization, superior instrument dexterity, reduced blood loss, shorter hospital stay, and faster postoperative recovery while maintaining excellent functional and oncological outcomes.[2] Typically, RARP is performed at pneumoperitoneum pressures of 12–15 mmHg to achieve adequate surgical exposure and working space; however, high intra-peritoneal pressures have been linked to negative intra and post operation physiological outcomes such as decreased venous return, increased systemic vascular resistance, increased airway pressures, decreased renal blood flow and delayed gastrointestinal recovery, especially in elderly patients and those with multiple co-morbidities.[3,4] Recent years have seen an increase in the interest in minimizing the physiological effects of pneumoperitoneum by using the technique of ultra-low intraperitoneal pressure (ULP), which is defined as an insufflation pressure of 6 mmHg or less.[5] With advancements in robotic optics, instrumentation and surgical skills, it has become increasingly possible to perform complex pelvic operations under low insufflation pressures without compromising the surgical view.[6] RCTs have shown that ULP during RARP is associated with reduced postoperative pain, decreased shoulder-tip discomfort, early return of bowel function and improved postoperative recovery while maintaining similar operative time, blood loss and perioperative safety when compared with standard-pressure pneumoperitoneum.[7,8]

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Alongside these developments, enhanced recovery after surgery (ERAS) pathways have allowed the same day discharge (SDD) after RARP to be implemented in several recent studies with low complication, emergency department and hospital readmission rates.[9] Both single centre and multicentre studies have shown high patient satisfaction and successful implementation of day cases RARP, and systematic reviews have confirmed the feasibility and safety of SDD when applied in appropriately selected patients.[10-12]

However, in clinical practice today, the use of ULP in RARP is still limited, despite these encouraging results. Questions remain about how to maintain adequate surgical exposure, technical reproducibility, surgical efficiency, and potential impact on oncological outcomes, especially when the surgery is technically challenging, such as when performing pelvic lymph node dissection or in patients with locally advanced disease. In addition, there is a lack of real-world evidence comparing ULP RARP in a large, consecutive series of patients, outside of a randomized clinical trial.

The aim of the present study was to assess the perioperative, pathological and postoperative outcome of ULP RARP at one centre. The study evaluated the surgical margin status, complication profile, operative characteristics and feasibility of same day discharge in a large consecutive series of patients undergoing RARP, including patients requiring pelvic lymph node dissection (PLND).

## MATERIALS AND METHODS

This was a retrospective observational study using prospectively collected data from one medium volume tertiary referral centre in the United Kingdom. Consecutive patients who underwent RARP between January 2021 and April 2026 were included in the study. All operations were carried out by one consultant urological surgeon using the da Vinci X robotic surgical system (Intuitive Surgical, Sunnyvale, CA, USA).

Eligible patients were adult men with histologically confirmed localized or locally advanced prostate adenocarcinoma who underwent RARP, with or without PLND. Patients were recruited regardless of the intended type of admission, day case or in-patient.

Since this was a retrospective study of anonymized data obtained during routine clinical practice, with no direct patient contact or intervention, the institutional ethics committee and informed consent were waived as per local institutional policy.

All operations were conducted under general anaesthetic with a standardized transperitoneal robotic approach. The intra-abdominal insufflation pressure was considered ULP if it was ≤6 mmHg. At the start of the operation pneumoperitoneum was created by Versius insufflation technique and kept at this level whenever a good operative exposure was obtained. Temporary increase of the insufflation pressure was performed at the discretion of the operating surgeon and anaesthetist, if surgical visibility or technical difficulty was compromised, to ensure the safe completion of the operation. The decision on surgical approach (anterior or posterior), whether to perform pelvic lymph node dissection, whether or not to use a clipless technique, and whether or not to perform unilateral, bilateral or no nerve sparing was individualized based on the characteristics of the tumour, patient factors, and intraoperative findings. Some cases were undertaken as supervised training cases under the direct supervision of the consultant surgeon by a registrar.

Clinical, operative, pathological and post-operative information was obtained from the institutional surgical database, which was maintained prospectively. Demographic factors at baseline were patient age, body mass index (BMI), and American Society of Anaesthesiologists (ASA) physical status classification. The operative variables were console time, estimated blood loss, surgical approach, pelvic lymph node dissection, nerve sparing, planned day case surgery, clipless technique, training case status, and successful self-trial without catheter (TWOC). Pathological outcomes were pathological tumour stage, International Society of Urological Pathology (ISUP)/Gleason Grade Group and surgical margin status. Postoperative outcomes comprised procedure-related complications recorded at follow-up.

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA). The continuous variables were presented as mean ± standard deviation (SD) and categorical variables as frequencies and percentages.

## RESULTS

A total of 500 patients who underwent RARP using ULP were included in the study. The majority of patients were aged 61–70 years (58.0%), followed by 51–60 years (23.0%) and >70 years (17.2%), while only 1.8% were aged 40–50 years. Most patients were overweight, with 52.6% having a body mass index (BMI) of 25.0–29.9 kg/m², whereas 23.6% were obese (BMI 30.0–34.9 kg/m²), 20.4% had a normal BMI, and only 3.4% had a BMI of 35.0–39.9 kg/m². Most of the study population was ASA grade II (97.8%), with 0.6% ASA grade I and 1.6% ASA grade III, which means that majority of patients had mild systemic disease at the time of surgery (**Table 1**).

**Table 1.** Baseline Demographic and Clinical Characteristics of the Study Population (N = 500).

| Variable | Category | N (%) |
|---|---|---|
| Age (years) | 40–50 | 9 (1.8%) |
| | 51–60 | 115 (23.0%) |
| | 61–70 | 290 (58.0%) |
| | >70 | 86 (17.2%) |
| BMI (kg/m²) | 18.5–24.9 | 102 (20.4%) |
| | 25.0–29.9 | 263 (52.6%) |
| | 30.0–34.9 | 118 (23.6%) |
| | 35.0–39.9 | 17 (3.4%) |
| ASA Grade | I | 3 (0.6%) |
| | II | 489 (97.8%) |
| | III | 8 (1.6%) |

The mean console time was 99.67 ± 47.42 minutes, and the mean estimated blood loss was 260.10 ± 131.61 mL, indicating that RARP under ULP was conducted with acceptable console time and blood loss among all patients in the study (**Table 2**).

**Table 2.** Operative Characteristics of the Study Population (N = 500).

| Variable | Mean ± SD |
|---|---|
| Console time (minutes) | 99.67 ± 47.42 |
| Estimated blood loss (mL) | 260.10 ± 131.61 |

Thirty-three (33) patients (6.6%) underwent lymph node dissection. One hundred and eighty-five patients (37.0%) underwent planned day-case surgery. Most surgeries (94.0%) were performed by the anterior approach, and 6.0% by the posterior approach. Nerve sparing was done on the right side in 29.2% of patients, on the left side in 21.4%, bilaterally in 28.8%, and no nerve sparing was performed in 20.6% of patients. There were 37.0% training cases, and 56.8% of patients achieved successful TWOC (**Table 3**).

**Table 3.** Intraoperative and Surgical Characteristics (N = 500).

| Variable | Category | N (%) |
|---|---|---|
| Lymph Node Dissection | Yes | 33 (6.6%) |
| Planned DC | Yes | 185 (37.0%) |
| Surgical Approach | Anterior | 470 (94.0%) |
| | Posterior | 30 (6.0%) |
| Nerve Sparing | Right | 146 (29.2%) |
| | Left | 107 (21.4%) |
| | Bilateral | 144 (28.8%) |
| | None | 103 (20.6%) |
| Training Case | Yes | 185 (37.0%) |
| | No | 315 (63.0%) |
| Self TWOC | Yes | 284 (56.8%) |
| | No | 216 (43.2%) |

Pathological examination showed that T2c was the most common pathological stage (42.4%), followed by T3a (37.8%), T2a (10.4%), T3b (7.4%), and T2b (2.0%). The majority of tumours were ISUP/Gleason Grade Group 2 (75.2%), ISUP/Gleason Grade Group 3 (16.2%), ISUP/Gleason Grade Group 1 (4.6%), ISUP/Gleason Grade Group 5 (2.4%) and ISUP/Gleason Grade Group 4 (1.6%). In total, 72.4% had negative surgical margins while 138 patients (27.6%) had positive surgical margins. Of these, 49 were positive margins in training cases under consultant supervision and 81 were positive margins in pathological T3 cases, which shows that both the learning curve and advanced pathological stage had an impact on the margin positivity (**Table 4**).

**Table 4.** Tumor Characteristics (N = 500).

| Variable | Category | N (%) |
|---|---|---|
| Pathological Stage | T2a | 52 (10.4%) |
| | T2b | 10 (2.0%) |
| | T2c | 212 (42.4%) |
| | T3a | 189 (37.8%) |
| | T3b | 37 (7.4%) |
| ISUP/Gleason Grade Group | 1 | 23 (4.6%) |
| | 2 | 376 (75.2%) |
| | 3 | 81 (16.2%) |
| | 4 | 8 (1.6%) |
| | 5 | 12 (2.4%) |
| Surgical Margin Status | Clear | 362 (72.4%) |
| | Positive | 138 (27.6%) |

Seventy two percent utilized conventional clipping and since clipless approach was used starting in June 2025 most patient (27.4%) had a clipless surgical technique. Postoperative complications were rare, the most common being wound infection (2.2%), bladder neck stenosis (1.2%) and bladder tear (0.6%). The incidence of other complications such as jejunal perforation (during port insertion) (0.2%), small fluid collection, incisional hernia, pelvic haematoma, haematuria, urinary retention and lymphocele (0.2% each) was very low within this cohort, suggesting a low rate of postoperative complications (**Table 5**).

**Table 5.** Operative Technique and Postoperative Complications (N = 500).

| Variable | Category | N (%) |
|---|---|---|
| Clipless Technique | Yes | 137 (27.4%) |
| | No | 363 (72.6%) |
| Postoperative Complications | Wound infection | 11 (2.2%) |
| | Bladder neck stenosis | 6 (1.2%) |
| | Incontinence | 1 (0.2%) |
| | Small fluid collection | 1 (0.2%) |
| | Incisional hernia | 1 (0.2%) |
| | jejunal perforation (port insertion) | 1 (0.2%) |
| | Haematuria | 1 (0.2%) |
| | Lymphocele | 1 (0.2%) |

## DISCUSSION

The present study is one of the largest single centre UK experiences of RARP using ULP ≤6 mmHg. The results of this study show that ULP RARP can be performed safely and effectively with acceptable operative times, minimal estimated blood loss and low incidence of postoperative complications in a consecutive series of 500 patients. The mean console time of ~100 minutes and mean blood loss of 260 mL in our series are comparable to the contemporary literature on RARP using conventional pneumoperitoneum pressures, indicating that the use of ULP RARP did not negatively affect operative efficiency or surgical performance.[8,13] In addition, over a third of procedures were successfully planned as day case surgery, further emphasizing the practicality of incorporating ULP RARP into enhanced recovery pathways.

Physiological effects of low pneumoperitoneum pressures during minimally invasive surgery have been demonstrated. New developments in the visualization and instrumentation of the robot have allowed surgeons to safely operate at much lower insufflation pressures, which do not seem to have a detrimental effect on cardiovascular, pulmonary, renal, or splanchnic physiology.[14] A recent systematic review and meta-analysis concluded that low-pressure pneumoperitoneum during RARP reduces postoperative pain and facilitates earlier recovery without increasing operative time, blood loss, or perioperative complications.[8] Similarly, Ferroni and Abaza demonstrated that ULP RARP at 6 mmHg was technically feasible while providing perioperative outcomes comparable with standard-pressure surgery.[13] Our results corroborate these findings, and indicate that in the hands of experienced surgeons, the use of ultra-low insufflation pressures does not compromise surgical exposure, but rather provides a similar peri-operative

outcome compared to standard pressure.

When changes are made to well-established surgical techniques, oncological safety is also crucial. Despite a relatively high pathological T3 rate (45.2%), negative surgical margins were obtained in 72.4% of patients in the present study. Of the 138 patients with positive surgical margins, 81 had pathological T3 disease, which is known to be associated with increase possibilities of positive margins. Furthermore, 49 positive margins were found in supervised registrar training cases, indicating that the surgical learning curve rather than insufflation pressure alone was a factor. Importantly, the margin rate observed was negative in the vast majority of cases, which is similar to that reported in contemporary RARP series using standard pneumoperitoneum.[15,16] Similarly, almost 80% of patients underwent unilateral or bilateral nerve-sparing surgery, which shows that the preservation of neurovascular structures remains technically feasible in the ULP environment.

An important strength of our programme is the incorporation of a comprehensive ERAS pathway. Preoperative weight optimisation is encouraged through a specific RARP education programme, patients are given regular pelvic floor muscle training prior to surgery and early mobilisation is commenced within 4 hours of surgery. These measures combined with ULP can help to improve the recovery time after surgery and help with same-day discharge. Increasing evidence supports day case RARP in appropriately selected patients, with reported same-day discharge success rates exceeding 90% and low rates of readmission and postoperative complications accounting for 3.4 and 4.6 respectively.[9-12,17] In addition to our experience with ULP RARP, we have also recently applied this pathway to selected patients undergoing pelvic lymph node dissection with a success rate for same day discharge of greater than 90%, with very low readmission and postoperative complication rates, further highlighting the potential of combining ULP with modern ERAS protocols.

The present study has a number of limitations. It is retrospective, single centre and may not be generalisable to other centres. Functional outcomes, such as postoperative pain, recovery of continence, erectile function, quality of life, and patient-reported recovery measures were not systematically assessed and could not be correlated with the use of ULP. Furthermore, no comparison with a contemporary cohort of normal pressure was done. However, the large, consecutive patient cohort, the single experienced surgeon performing the same procedure, and the prospectively maintained database allow for a good estimation of real-world clinical practice. As robotic surgery advances, future prospective multicentre studies and randomized controlled trials are required to further elucidate the effects of ultra-low pneumoperitoneum on perioperative recovery, long-term functional and oncological outcomes, health care costs, and surgeon ergonomics.

## CONCLUSION

RARP performed with ULP is a feasible, safe and reproducible surgical procedure, with acceptable operative times, low blood loss, SDD implantation, good oncological outcomes and low rates of postoperative complications, as demonstrated in this large single-centre experience.

These findings indicate that lower pneumoperitoneum pressure does not compromise surgical performance and could provide an opportunity to enhance surgical recovery and resource optimization. These findings could be backed by additional prospective multicentre studies with comparative standard-pressure cohorts and further evaluation of functional, oncological and patient-reported outcomes to confirm these results and establish the role of ULP pneumoperitoneum as a standard approach in robotic prostatectomy.

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