



## Research Article

# A novel anterior approach that involves Retzius space development between the umbilical ligaments is associated with a lower incidence of postoperative inguinal hernia in robotic radical prostatectomy

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## ABSTRACT

**Background:** To facilitate robotic radical prostatectomy (RP), we developed a novel anterior approach that utilizes a peritoneal incision between the umbilical ligaments to develop the Retzius space without contacting the internal inguinal rings, followed by closure of this space prior to prostatectomy and vesicourethral anastomosis. This approach could decrease the incidence of postoperative inguinal hernia (IH), similar to a Retzius-sparing RP (RS-RP). We compared the incidence of IH following this novel approach with that following conventional anterior RP and RS-RP.

**Methods:** We retrospectively reviewed 532 patients who underwent robotic RP from September 2017 to August 2022. We compared the incidence of IH following novel anterior RP ( $n = 153$ ) to that following conventional anterior RP ( $n = 284$ ) and RS-RP ( $n = 95$ ). We also assessed the independent factors associated with postoperative IH using Cox hazard models.

**Results:** The 12- and 24-month cumulative incidences of postoperative IH following novel anterior RP were 1.3% and 1.3%, significantly lower than those associated with conventional anterior RP (8.0% and 12.6%,  $p = 0.009$ ) but not significantly different from those following RS-RP (1.1% and 2.1%,  $p = 0.782$ ). In multivariate analysis, use of the novel anterior RP approach, RS-RP, and body mass index were independent factors negatively associated with the occurrence of postoperative IH.

**Conclusions:** This novel anterior approach involves developing the Retzius space between the umbilical ligaments and closure of this space following prostatectomy and vesicourethral anastomosis. It can decrease the incidence of IH compared to the conventional anterior approach. Prospective comparative studies are necessary to confirm the benefits of this approach.

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## 1. Introduction

Radical prostatectomy (RP) is considered the gold standard for treating clinically localized prostate cancer (PC). Relatively common complications of RP, such as urinary incontinence and impotence, have been well described and studied. However, inguinal hernia (IH) is also recognized as a complication of RP. During the era of open prostatectomy, a wide range of IH incidences have been reported from 4.4% to 50% [1]. Recently, robotic surgery has increasingly been used to treat PC due to the inherent advantages of the minimally invasive procedure. Patients

undergoing robotic RP also have a higher incidence of IH compared to patients who do not undergo surgery, with an incidence of 5.8–19.4% [2].

To prevent IH, several techniques have been reported in open, laparoscopic, and robotic RP, such as blunt dissection with mobilization of the cord, vas, and vessels [3]; herniotomy and mobilization of the vas and testicular vessels [4]; and herniorrhaphy with onlay mesh [5–7]. Retzius-sparing RP (RS-RP) was developed by Galfano et al [8]. This surgery is associated with a lower occurrence of IH compared to that of conventional anterior RP (C-ARP) [9]. This technique does not dissect the Retzius space or damage the tissues

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around the internal inguinal rings (IIRs), which is considered to account for the lower IH incidence. The HOOD technique, first reported by Wagaskar [10] and used in PC patients without tumors of the anterior regions, preserves the detrusor apron, puboprostatic ligament complex, arcus tendineus, endopelvic fascia, and Douglas pouch and improves cases of incontinence. In this technique, the peritoneum is dissected between the umbilical ligaments with preservation of the Retzius space, after which the space is closed following prostatectomy and vesicourethral anastomosis, and therefore the tissues around the IIRs are not damaged. This technique is similar to RS-RP in that it avoids contact with the IIRs, which can decrease the incidence of IH. However, it remains undetermined whether the HOOD technique is associated with a decreased incidence of IH.

We developed a novel anterior approach, which is a hybrid of the HOOD technique and ARP (H-ARP). In this approach, similar to the HOOD technique, the peritoneum is dissected between the umbilical ligaments when the Retzius space is created, followed by undergoing prostatectomy and vesicourethral anastomosis as with C-ARP. This approach could potentially decrease the incidence of IH and could be used in all PC patients undergoing robotic RP. Herein, we compared the incidence of IH following H-ARP to that associated with C-ARP and RS-RP to assess its effectiveness.

## 2. Materials and methods

This retrospective observational study received approval from the institutional review board of Jichi Medical University Saitama Medical Center (RinS20–058). We retrospectively collected data from 583 patients who underwent robotic RP from September 2017 to August 2022. In all, 51 patients who had a history of surgery for IH or had experienced concurrent IH were excluded, leaving 532 patients to be analyzed in the present study.

We began the H-ARP method in December 2020 and collected the data from a total of 153 patients who underwent this approach from December 2020 to August 2022. We compared the incidence of postoperative IH following H-ARP to that associated with C-ARP (surgeries performed between September 2017 and August 2022:  $n = 284$ ) and RS-RP (surgeries performed between September 2017 and August 2022:  $n = 95$ ). Nine surgeons with varying experience with robotic RP, ranging from novices to those who have handled >200 cases, performed robotic radical prostatectomies using either

the da Vinci Si® Surgical System or the Xi® Surgical System (Intuitive Surgical, Sunnyvale, CA, USA).

### 2.1. Surgical techniques used in the novel anterior approach

The surgical protocols for C-ARP and RS-RP used at our institute have previously been described [11]. Surgical techniques of the H-ARP are as follows (Fig. 1 and supplementary movie 1):

- *Posterior approach (same as the C-ARP)*

The parietal peritoneum on the anterior surface of the Douglas space is incised, after which the seminal vesicles and deferens vasa are isolated and sectioned.

- *Development of the Retzius space (same as in the HOOD technique)*

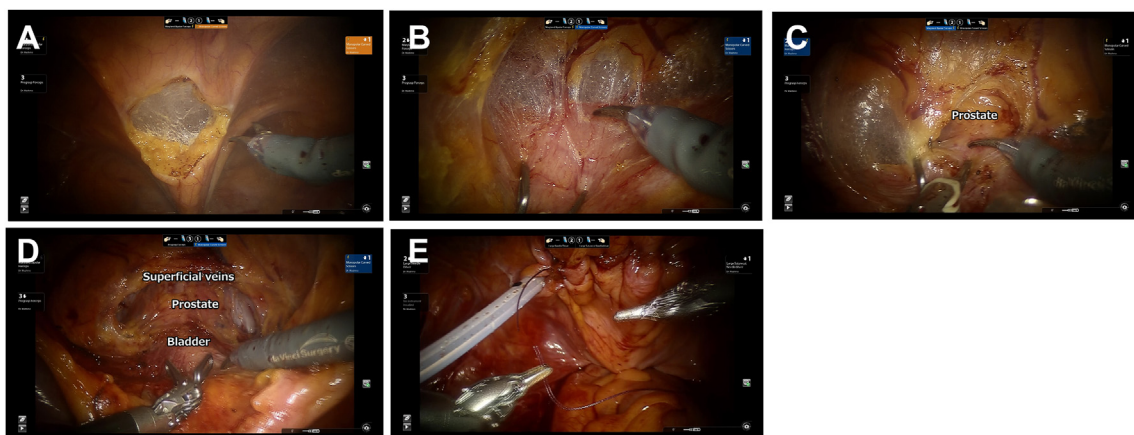
An inverted U-shaped incision is made on the parietal peritoneum between the umbilical ligaments to reveal the bladder (Fig. 1A). The layer just above the detrusor muscles is developed and the overlapping vessels including the superficial preprostatic vessels are preserved (Fig. 1B). The detrusor apron at the bladder neck is transected to expose the anterior surface of the prostate (Fig. 1C). The exposure of the anterior surface of the prostate is completed with preservation of the superficial preprostatic vessels (Fig. 1D).

- *Prostatectomy and vesicourethral anastomosis (same as with the C-ARP)*

Prostatectomy is performed using the same method as with C-ARP. Nerve-sparing is performed in patients with preserved preoperative sexual function when there is no tumor located in the posterior lesion of the relevant side on preoperative MRI or prostate biopsies. When the tumor is not in the anterior lesion, the detrusor apron can be preserved. Then vesicourethral anastomosis is achieved with continuous suturing.

- *Closure of the Retzius space (same as with the HOOD technique)*

A drainage tube is placed into the retropubic space and the parietal peritoneum between the umbilical ligaments is closed (Fig. 1E).



**Fig. 1.** Surgical procedures in H-ARP. (A) An inverted U-shaped incision is made on the parietal peritoneum between the umbilical ligaments to reveal the bladder. (B) The layer just above the detrusor muscles is developed. (C) The detrusor apron at the bladder neck is transected to expose the anterior surface of the prostate. (D) Exposure of the anterior prostate is completed with preservation of the superficial preprostatic vessels. (E) Parietal peritoneum between the umbilical ligaments is sutured to close the Retzius space.

Pelvic lymph node dissection (PLND) was performed only in patients whose MRI or CT scans indicated lymph node swelling in the pelvis.

We evaluated the cumulative incidence of postoperative IH following H-ARP vs. C-ARP vs. RS-RP, and the factors associated with postoperative IH.

Supplementary video related to this article can be found at <https://doi.org/10.1016/j.pnrl.2023.12.003>.

## 2.2. Statistical analysis

Data are presented as median and interquartile range (IQR) unless otherwise specified. Fisher's exact test,  $\chi^2$  test and one-way ANOVA with Tukey's multiple comparisons test were used to compare variables. Cumulative incidences of postoperative IH were computed using the Kaplan-Meier curve and contrasted with the log-rank test. Cox hazard mode was performed to assess the factors related to postoperative IH. Hazard ratios (HRs) and 95% confidence intervals (CIs) were calculated. A  $p < 0.05$  was considered to indicate statistical significance. All statistical evaluations were conducted using GraphPad Prism software version 9.5 (GraphPad Software, La Jolla, CA, USA).

## 3. Results

### 3.1. Patients' background (Table 1)

The median age and prostate-specific antigen (PSA) levels were 71 (67–74) and 7.75 (5.47–12.0) ng/mL, respectively. Patients' background factors including age, PSA levels, body mass index, and National Comprehensive Cancer Network (NCCN) risk, and the surgeon's experience did not significantly differ among the three groups. The median follow-up period was 17.8 (12.1–23.9), 41.8 (30.1–50.6), and 47.9 (31.3–58.1) months following H-ARP, C-ARP, and RS-RP, respectively.

### 3.2. Surgical preference and outcomes

C-ARP and RS-RP were mainly performed between 2017 and 2020 while H-ARP was performed for 91.5% and 98.5% of robotic RPs in 2021 and 2022, respectively (Supplementary Fig. 1). Nerve-sparing and pelvic lymph node dissection were performed in 61 (39.9%) and 1 (0.7%) patient in the H-ARP, 32 (11.2%) and 16 (5.6%) in the C-ARP, and 77 (80.2%) and 1 (1.0%) patient in the RS-RP. Blood loss did not significantly differ among the three groups whereas console time was significantly longer in the H-ARP compared to the others (Supplementary Table 1). Complications of any grade occurred in 7.2% of patients undergoing H-ARP, compared to 11.2% for C-ARP and 19.8% for RS-RP.

### 3.3. Cumulative incidences of postoperative IH

The 12- and 24-month cumulative incidences of postoperative IH in patients undergoing H-ARP were 1.3% and 1.3%, respectively, significantly lower than those who underwent C-ARP (8.0% and 12.6%,  $p = 0.0009$ ) but not significantly different from those observed following RS-RP (1.1% and 2.1%,  $p = 0.782$ ) (Fig. 2). In total, 47 patients (2 in H-ARP, 42 in C-ARP, and 3 in RS-RP) experienced IH postoperatively, in which 27, 9, and 11 cases occurred in the right, left, and bilateral sides, respectively. Of 58 IH cases, 49 cases were indirect and 4 cases were direct, while 5 were unknown (Table 2). Hernia size was  $<1.5$  cm in 9, 1.5–3.0 cm in 30,  $>3.0$  cm in 14, and unknown in 5 cases. Overall, 55 cases underwent anterior repair with mesh and a plug while the technique was unknown in three cases.

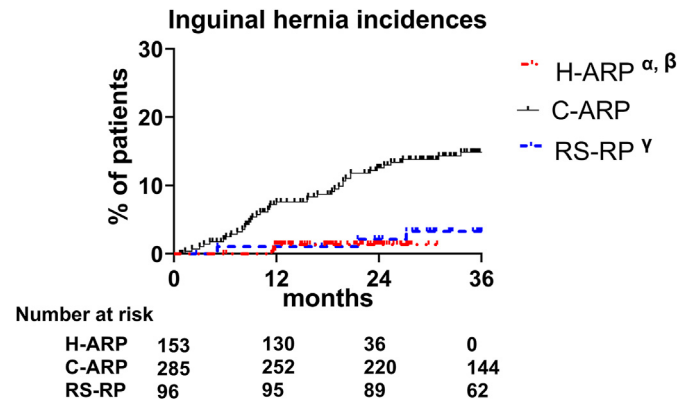


Fig. 2. Cumulative incidences of IH in H-ARP, C-ARP, and RS-RP. The red-dashed, black, and blue-dashed lines indicate H-ARP, C-ARP, and RS-RP, respectively.  $\alpha$ :  $p = 0.0009$  vs. C-ARP,  $\beta$ :  $p = 0.782$  vs. RS-RP,  $\gamma$ :  $p = 0.0018$  vs. C-ARP. C-ARP, conventional anterior robotic prostatectomy; H-ARP, the novel anterior robotic prostatectomy approach combining HOOD and C-ARP; RS-RP, Retzius sparing robotic prostatectomy.

### 3.4. Factors associated with postoperative IH

In multivariate analysis, undergoing the H-ARP (HR 0.137 [95% CI 0.022–0.465],  $p = 0.007$ ) or RS-RP [HR 0.220 [95% CI 0.052–0.632],  $p = 0.024$ ], and body mass index (HR 0.889 [95% CI 0.791–0.996],  $p = 0.046$ ), were independent factors negatively associated with the occurrence of postoperative IH (Table 3).

## 4. Discussion

We developed a novel anterior approach (H-ARP) that utilizes a peritoneal incision between the umbilical ligaments to develop the retroperitoneal space without contacting the IIR, followed by closure of this space prior to prostatectomy and vesicourethral anastomosis. It decreased the incidence of postoperative IH by 86% compared to C-ARP.

### 4.1. RP and IH

The incidences of IH following open RP, laparoscopic, and robotic RP have been reported to range from 12% to 38.7%, from 4.3% to 8.3%, and from 3% to 19.4%, respectively [12–15]. The incidence of IH following ARP (8.0% at 12 months and 12.6% at 24 months) in the present study was consistent with the results of these prior studies. Most postoperative IHs are indirect hernias. Low body mass index is associated with an increased risk for postoperative IH [9, 16, 17]. It is possible that an absence of peritoneal fat combined with increased intra-abdominal pressure can predispose patients with a low body mass index to IH. Furthermore, IH tends to be easier to detect in patients with a low BMI. In the present study, low body mass index was an independent factor for IH. Surgeon experience may also be a significant risk factor for IH [18] but in our study it was not.

### 4.2. Sparing the anatomy around the IIR could prevent IH

The RS-RP is associated with a lower incidence of IH [9]. The cumulative incidence of IH at 3 years following RS-RP is reported to be 5.8%, significantly lower than that of conventional ARP (28.4%). This approach spares vital myoepectineal structures around the IIR. HOOD technique and H-ARP methods are similar to the RS-RP in terms of avoiding contact with the IIR. The incidence of postoperative IH following H-ARP, 1.3% at 24 months, was 86% lower than that associated with C-ARP and comparable to that associated with RS-RP, suggesting that sparing the vital myoepectineal

**Table 1**  
Patients' background

	H-ARP (n = 153)	C-ARP (n = 285)	RS-RP (n = 96)	p-value
Age, median (IQR)	72 (68–75)	70 (67–74)	71 (66–75)	0.349
PSA, median (IQR)	8.80 (5.75–13.2)	6.52 (5.10–9.83)	7.45 (5.40–11.2)	0.157
Body mass index, median (IQR)	24.1 (22.1–26.1)	24.2 (22.3–26.3)	23.9 (22.1–25.1)	0.484
Prostate volume, median (IQR)	38.5 (29.9–50.0)	37.8 (30.0–51.4)	35.0 (27.2–43.1)	0.175
NCCN risk, n (%)	4 (3)	10 (4)	4 (4)	0.271
Low or less Intermediate	79 (52)	146 (51)	57 (59)	
High	48 (31)	79 (28)	28 (29)	
Very high	20 (13)	34 (12)	6 (6)	
Others	2 (1)	16 (6)	1 (1)	
Surgeon's experience				<0.0001
<40	59 (39)	125 (44)	11 (12)	
≥40	94 (61)	161 (56)	84 (88)	
Followup duration, months	17.8 (12.1–23.9)	41.8 (30.1–50.6)	47.9 (31.1–58.1)	<0.0001

C-ARP, conventional anterior robotic prostatectomy; H-ARP, the novel anterior robotic prostatectomy approach combining HOOD and C-ARP; IQR, interquartile range; NCCN, National Comprehensive Cancer Network; RS-RP, Retzius sparing robotic prostatectomy.

**Table 2**  
Characteristics of IHs and the repair process

	H-ARP (n = 3 hernias)	C-ARP (n = 52 hernias)	RS-RP (n = 3 hernias)	Total (n = 58 hernia)
Hernia types, n (%)				
Indirect	1 (33)	45 (87)	3 (100)	49 (84)
Direct	1 (33)	3 (6)	0	4 (7)
Unknown	1 (33)	4 (8)	0	5 (9)
Hernia size, n (%)				
<1.5 cm	0	9 (17)	0	9 (16)
1.5–3.0 cm	0	28 (54)	2 (67)	30 (52)
>3.0 cm	3 (100)	11 (21)	0	14 (24)
Unknown	0	4 (8)	1 (33)	5 (9)
Repair methods, n (%)				
Mesh and plug	3 (100)	49 (94)	3 (100)	55 (95)
Unknown	0	3 (6)	0	3 (5)

C-ARP, conventional anterior robotic prostatectomy; H-ARP, the novel anterior robotic prostatectomy approach combining HOOD and C-ARP; RS-RP, Retzius sparing robotic prostatectomy.

structures around the IIR is critical to prevent IH. Likewise, perineal RP with preservation of the abovementioned anatomical structures yields a lower incidence of IH [19].

#### 4.3. Applicability of H-ARP

Our novel approach is a hybrid of the HOOD technique and conventional ARP, and most of the surgical techniques used are similar to those in conventional ARP. We believe that this H-ARP is likely to be more applicable compared to RS-RP and perineal RP, unlike being applied to all prostate cancer due to the difficulty of the surgical procedure and potentially high positive surgical

margins especially in anterior tumors [11, 20–22]. At our institute, more than 90% of robotic RPs have been performed using this technique since it was developed in December 2020 (Supplementary Fig. 1). Several IH-prevention techniques, such as herniorrhaphy with onlay mesh [5–7]; blunt dissection with mobilization of the cord, vas, and vessels [3]; and herniotomy with mobilization of the vas and testicular vessels [4] have been reported. However, these methods may use artificial agents or can be associated with delayed development of IH [23]. We believe that H-ARP is simpler and more reliable than these others. However, it may be associated with a longer console time than the C-ARP and RS-RP, due to the extra time required to close the Retzius space.

**Table 3**  
Factors associated with occurrence of IH

	Univariate analysis			Multivariate analysis		
	HR	95% CI	p-value	HR	95% CI	p-value
Age	1.003	0.956–1.06	0.896	1.004	0.950–1.07	0.897
Body mass index	0.897	0.804–0.996	0.045	0.889	0.791–0.996	0.046
Prostate volume	1.011	0.997–1.02	0.090	1.014	0.997–1.03	0.090
PSA	0.990	0.954–1.01	0.510	0.984	0.939–1.01	0.381
Console time	1.00	0.995–1.01	0.794	0.999	0.991–1.01	0.926
Surgical methods						
C-ARP	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
H-ARP	0.188	0.045–0.517	0.005	0.137	0.022–0.465	0.007
RS-RP	0.130	0.021–0.428	0.005	0.220	0.052–0.632	0.014
Surgeon's experience						
<40	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
≥40	0.635	0.358–1.13	0.120	0.685	0.323–1.43	0.315

C-ARP, conventional anterior robotic prostatectomy; CI, confidence interval; H-ARP, novel anterior robotic prostatectomy; HR, hazard ratio; PSA, prostate-specific antigen; Ref., reference; RS-RP, Retzius sparing robotic prostatectomy.



#### 4.4. Limitations

This study had some limitations. It was retrospective and observational and thus was subject to selection bias. The follow-up duration differed among the three surgical approaches and was particularly short for H-ARP; additionally, long-term results are missing. Several surgeons with varying degrees of expertise performed the robotic RP, which may have affected the results [24]. PLND was performed in very few patients in the present study and it remains undetermined whether adding PLND to H-ARP is associated with an increased incidence of IH.

In conclusion, we developed a novel anterior approach of robotic RP that involves a peritoneal incision between the umbilical ligaments to develop the Retzius space without contacting the IIR and closure of this space prior to prostatectomy and vesicourethral anastomosis. This novel approach is simple and easy to apply, and could dramatically decrease the incidence of IH compared to conventional ARP. Prospective comparative studies are needed to confirm the benefits of this approach.

#### Conflict of interest

None.

#### Acknowledgments

We would like to acknowledge Textcheck for editing our manuscript.

#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pnrl.2023.12.003>.

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