

Postoperative inguinal hernia after robotic-assisted radical prostatectomy for prostate cancer: evaluation of risk factors and recommendation of a convenient prophylactic procedure

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Citation: Iwamoto H, Morizane S, Hikita K, Honda M, Takenaka A. Postoperative inguinal hernia after robotic-assisted radical prostatectomy for prostate cancer: evaluation of risk factors and recommendation of a convenient prophylactic procedure. Cent European J Urol. 2019; 72: 418-424.

Article history

Submitted: July 17, 2019
Accepted: Nov. 3, 2019
Published online: Dec. 6, 2019

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Introduction The aim of this article is to evaluate the risk factors and recommend a prophylactic procedure for preventing inguinal hernia (IH) after robotic assisted radical prostatectomy (RARP) without extra products and operative time.

Material and methods A total of 279 patients (558 groins) who underwent RARP at our institution from October 2010 to December 2015 were retrospectively reviewed. Age, body mass index, prostate-specific antigen, clinical T stage, prostate volume, console time and the dilatation of internal inguinal ring were evaluated as the risk factors of IH. We also investigated whether the different incision procedures of the peritoneum around the medial side of the internal inguinal ring, 'proximal incision' or 'distal incision', were related to the occurrence of IH.

Results Postoperative IH occurred in 39 (7.5%) of 558 groins. The dilatation of the internal inguinal ring was observed in 89 of 558 (15.9%) groins. The proximal and distal incision group included 296 groins (52.8%) and 262 groins (47.2%), respectively. Univariate and multivariate analyses revealed the right side ($P = 0.041$), the dilatation of internal inguinal ring ($P < 0.01$) and the distal incision ($P < 0.01$) were significant risk factors for postoperative IH. Furthermore, the proximal incision significantly reduced the risk of postoperative IH regardless of the dilatation of internal inguinal ring.

Conclusions The dilatation of the internal inguinal ring represents an important risk factor for IH after RARP. However, incising the peritoneum sufficiently close to the medial edge of the internal inguinal ring can prevent postoperative IH without extra products and time.

Key Words: postoperative inguinal hernia ↔ robotic assisted radical prostatectomy
↔ risk factors ↔ prophylactic procedure

INTRODUCTION

Postoperative inguinal hernia (IH) has been a well-known complication after radical prostatectomy (RP) since the days of open abdominal surgery. It has been reported that the incidence of IH after open RP ranges from 15% to 20% [1]. Although the precise mechanism of IH after RP is still unclear, some previous studies have reported the risk factors for IH after open RP as including old age, low

body mass index (BMI), subclinical inguinal hernia, previous history of major abdominal surgery, postoperative bladder neck contracture, and so on [2, 3]. Some prophylactic procedures during open RP were introduced, such as blunt dissection of the peritoneum at the internal inguinal ring and isolation of the spermatic cord from the peritoneum [4]. On the other hand, in the era of minimally invasive surgery, represented by robotic-assisted radical prostatectomy (RARP), the incidence of postoperative

IH has also been reported to range from 4% to 20% [5]. Even though RARP has improved the outcomes of urinary incontinence and erectile dysfunction compared to open RP, RARP has made little contribution to the reduction of the risk of postoperative IH. Moreover, relatively little data exist regarding the risk factors and prophylactic procedures for IH after RARP. Most of the prophylactic procedures introduced to date in RARP involve extra products and operative time [6, 7, 8].

The purpose of the present study was to evaluate the risk factors and recommend a convenient procedure for preventing IH after RARP without extra products and operative time.

MATERIAL AND METHODS

This study was approved by the Ethics Committee (no. 2567) of Tottori University, Japan. A total of 279 patients (558 groins) who underwent RARP at our institution from October 2010 to December 2015 and had at least 6 months of follow-up were retrospectively reviewed. Postoperative IH was diagnosed by one urologist in our institution when patients made regular outpatient visit as postoperative follow-up. Patients who underwent inguinal hernia repair before or during RARP were excluded from the present study. However, patients who had dilatation of the internal inguinal ring without symptoms were included.

RARPs were performed with the da Vinci robotic system (Intuitive Surgical, Sunnyvale, CA) by multiple surgeons and with six ports, as reported in a previous study [9]. Intraoperative pneumoperitoneum pressure was normally set in 8–10 mmHg,

which was raised to 12–15 mmHg depending on bleeding. Four types of nerve-sparing (NS) techniques, including intrafascial dissection, interfascial dissection, extrafascial dissection (partial NS), and wide dissection (non-NS), were used according to our treatment strategy. Intrafascial and interfascial dissection were defined as NS. Extended pelvic lymph node dissection (PLND) was performed in the lymphatic areas overlying the external iliac axis, those in the obturator fossa and around the internal iliac artery up to the ureter, and limited PLND was performed in only the obturator fossa area [10].

Patient demographic data including age, BMI, pre-operative prostate-specific antigen (PSA), clinical T stage, prostate volume, prior abdominal surgery, console time, the nerve-sparing procedure, and the range of pelvic lymph node dissection were evaluated. Additionally, all video recordings of the target surgery were examined to identify intraoperative risk factors. Two hypotheses were generated: one was that dilatation of the internal inguinal ring (not synonymous with a patent processus vaginalis) and the other was that different procedures for peritoneal incision around the medial side of the internal inguinal ring were related to the occurrence of postoperative IH.

The different procedures for peritoneal incision around the medial side of the internal inguinal ring were defined as follows and are presented in Figure 1. When the peritoneum was incised at the lateral side of the medial umbilical ligament to expand the perivesical space, one procedure, described as ‘proximal incision’, was defined as incision of the peritoneum reached within 1 cm from the medial edge of the in-

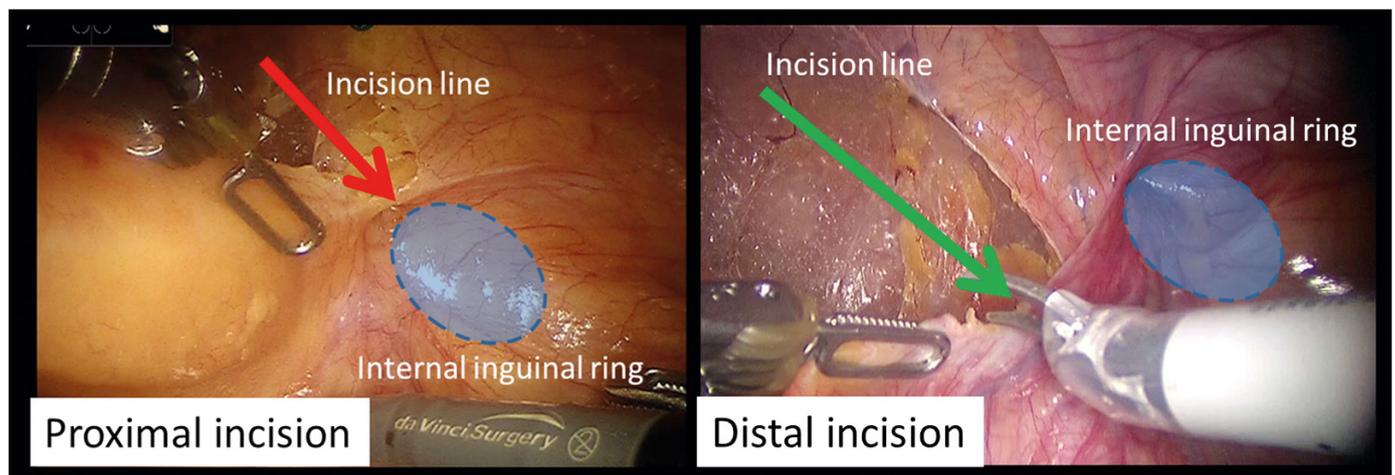


Figure 1. The different procedure of peritoneum incision around the medial side of the internal inguinal ring. ‘Proximal incision’ was the peritoneum incision reached within 1 cm from the medial edge of internal inguinal ring, while the other, ‘distal incision’ reached over 1 cm.

ternal inguinal ring, while the other, called 'distal incision', reached over 1 cm.

Statistical analysis

All statistical analyses were performed using PASW statistics 18 (SPSS, Chicago, IL). The chi-squared test was used for categorical variables, and Kaplan-Meier analysis was used to compare the incidence of postoperative IH between the two groups. A multivariate Cox regression analysis was done to evaluate the impact of each variable on postoperative IH. A P-value of <0.05 was considered significant.

RESULTS

Patients' demographics are shown in Table 1. Overall, 279 patients (558 groins) were included in this study. The median age of the patients was 66 years (range 48–76 years), median BMI was 23.6 kg/m² (range 18.0–35.4 kg/m²), median preoperative PSA was 8.25 ng/ml (range 1.2–50.5 ng/ml), median prostate volume was 28.3 ml (range 9.6–130.9 ml), and median console time of RARPs was 246 min (109–479 min). Regarding the distribution of clinical T stage, cT1c and cT2a accounted for approximately 65% of the total. Approximately 30% of all patients had a history of prior abdominal surgery, including appendectomy, gastrectomy, cholecystectomy, nephrectomy, and so on. NS was performed in 75 (26.9%) patients on the right side and 63 (22.6%) on the left side. Limited and extended PLND were performed in 174 (68.4%) and 88 (26.5%), respectively.

In terms of video findings of the target surgery, dilatation of the internal inguinal ring was confirmed in 58 (20.8%) patients on the right side and 31 (11.1%) on the left side. Proximal and distal incisions around the medial side of the internal inguinal ring were performed in 129 (46.2%) and 150 (53.8%) patients on the right side and 167 (59.9%) and 112 (40.1%) on the left side, respectively. The median console times were similar in two procedures of peritoneal incision.

The median follow-up was 32.7 months. Postoperative IH occurred in 35 (12.5%) patients, in 39 (7%) of 558 groins. The laterality was bilateral in 4, right in 29, and left in 10. Only one case was a direct hernia (Table 2).

On multivariate Cox regression analysis, right side (Hazard ratio 2.17, P = 0.041), dilatation of the internal inguinal ring (Hazard ratio 2.77, P = 0.006) and distal incision (Hazard ratio 4.80, P <0.001) were significant risk factors for postoperative IH (Table 3).

The Kaplan-Meier analysis is shown in Figures 2, 3A and 3B. The inguinal hernia-free rate was sig-

Table 1. Patient demographics

Number of patients (number of groins)	279 (558)
Median age, years (IQR)	66 (48–76)
Median BMI, kg/m ² (IQR)	23.6 (18.0–35.4)
Median preoperative PSA, ng/ml (IQR)	8.25 (1.2–50.5)
Median prostate volume, ml (IQR)	28.3 (9.6–130.9)
History of previous abdominal surgery (%)	176 (31.4)
Median console time, min (IQR)	247 (109–479)
Clinical T stage (%)	
T1c	61 (21.9)
T2a	126 (45.2)
T2b	11 (3.9)
T2c	52 (18.6)
T3	28 (10.0)
Nerve-sparing techniques, right side (%)	
Intra fascial dissection	30 (10.8)
Inter fascial dissection	45 (16.1)
Extra fascial dissection	113 (40.5)
Non nerve-sparing	91 (32.6)
Nerve-sparing techniques, left side (%)	
Intra fascial dissection	27 (9.7)
Inter fascial dissection	36 (12.9)
Extra fascial dissection	109 (39.1)
Non nerve-sparing	107 (38.4)
PLND (%)	
limited	174 (68.4)
extended	88 (26.5)
Dilatation of internal inguinal ring, right side (%)	
Yes	58 (20.8)
No	221 (79.2)
Dilatation of internal inguinal ring, left side (%)	
Yes	31 (11.1)
No	248 (88.9)
Procedure of peritoneum incision, right side (%)	
proximal incision	129 (46.2)
distal incision	150 (53.8)
Procedure of peritoneum incision, left side (%)	
proximal incision	167 (59.9)
distal incision	112 (40.1)

IQR – interquartile range; BMI – body mass index; PSA – prostate-specific antigen; PLND – pelvic lymph node dissection

Table 2. The incidence of postoperative inguinal hernia

n = 279 (558 groins)	
Median follow-up, mths (IQR)	32.71 (6–72)
Postoperative inguinal hernia, n (%)	35 (12.5)
Postoperative inguinal hernia, groins (%)	39 (7.0)
bilateral	4 (1.3)
right	29 (10.4)
left	10 (3.6)

IQR – interquartile range

nificantly lower in the dilatation of the internal inguinal ring group (P = 0.006) (Figure 2). In terms of the difference in the peritoneal incision around the medial side of the internal inguinal ring, the

Table 3. Univariate and multivariate analysis for postoperative inguinal hernia

Variables	Univariate	Multivariate	
	p-value	HR (95% CI)	p-value
Age (<66 vs. 66≤)	0.185		–
BMI (≤25 vs. 25<)	0.023	2.49 (1.04–5.95)	0.040
Preoperative PSA (<10 vs. 10≤)	0.999		–
Prostate volume (<30 vs. 30≤)	0.439		–
Previous abdominal surgery (yes vs. no)	0.478		–
Laterality (right vs. left)	0.002	0.43 (0.21–0.91)	0.026
Console time (<247 vs. 247≤)	0.138		–
Clinical T stage (<cT2c vs. cT2c≤)	0.684		–
Nerve-sparing (NS vs. non NS)	0.343		–
PLND (limited vs. extended)	0.596		–
Dilatation of internal inguinal ring (yes vs. no)	0.002	0.39 (0.19–0.74)	0.005
Peritoneum incision (proximal vs. distal)	<0.001	4.03 (1.77–9.17)	0.001

IQR – interquartile range; BMI – body mass index; PSA –prostate-specific antigen; NS – nerve-sparing; PLND – pelvic lymph node dissection

inguinal hernia-free rate was significantly lower in the distal incision group, regardless of the presence or absence of the dilatation of the internal inguinal ring (Figures 3A and B).

DISCUSSION

The estimated lifetime risk of IH in males is approximately 27%, which is 9-fold higher than the risk for women [11]. IH generally develops in old and thin males. It has been reported to occur readily in cases with hiatal hernia, varicose veins, benign prostatic hyperplasia, hemorrhoids, and so on [12]. Moreover, many risk factors for IH in adult males have been reported, including family history of IH, lifting heavy materials for a long period of time, chronic cough, chronic obstructive pulmonary disease, drinking alcohol, and so on [11, 13]. Postulated etiologies of primary IH include the presence of a patent processus vaginalis, failure of shutter mechanisms, increased intra-abdominal pressure, and altered metabolism of collagen connective tissue and extracellular matrix. These pathological processes can be triggered by multiple patient-related factors, such as older age, sex, family history, and comorbidities [14]. Since the days of open abdominal surgery, postoperative IH has been a well-known complication after open RP, occurring in 15% to 20% of patients within 3 years [1]. Since Regan et al. reported postoperative IH after retropubic radical prostatectomy (RRP) in 1996 [15], many studies have documented a similar incidence of postoperative IH. Stranne et al. demonstrated that the incidence of postoperative IH was significantly higher in the open RP

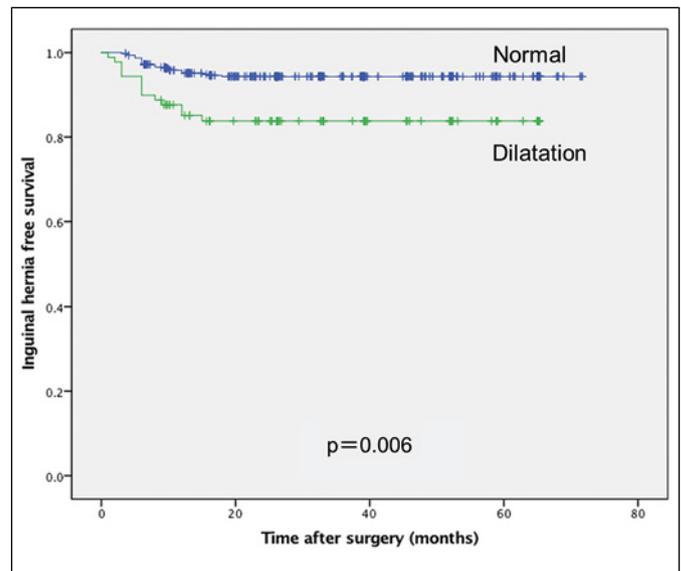


Figure 2. Postoperative inguinal hernia-free rate according to the presence of the dilatation of internal inguinal ring (Kaplan-Meier analysis, log-rank test, $P = 0.006$).

cohort than in the prostate cancer patient cohort treated without surgery [16]. Although the precise mechanism is still unclear, it is almost certain that operation is the cause of postoperative IH after RP. Some previous studies have reported the risk factors for IH after RRP, including old age, low BMI, subclinical inguinal hernia, previous history of major abdominal surgery, postoperative bladder neck contracture, and so on [2, 3]. On the other hand, in the era of minimally invasive surgery, represented by RARP, the incidence of post-

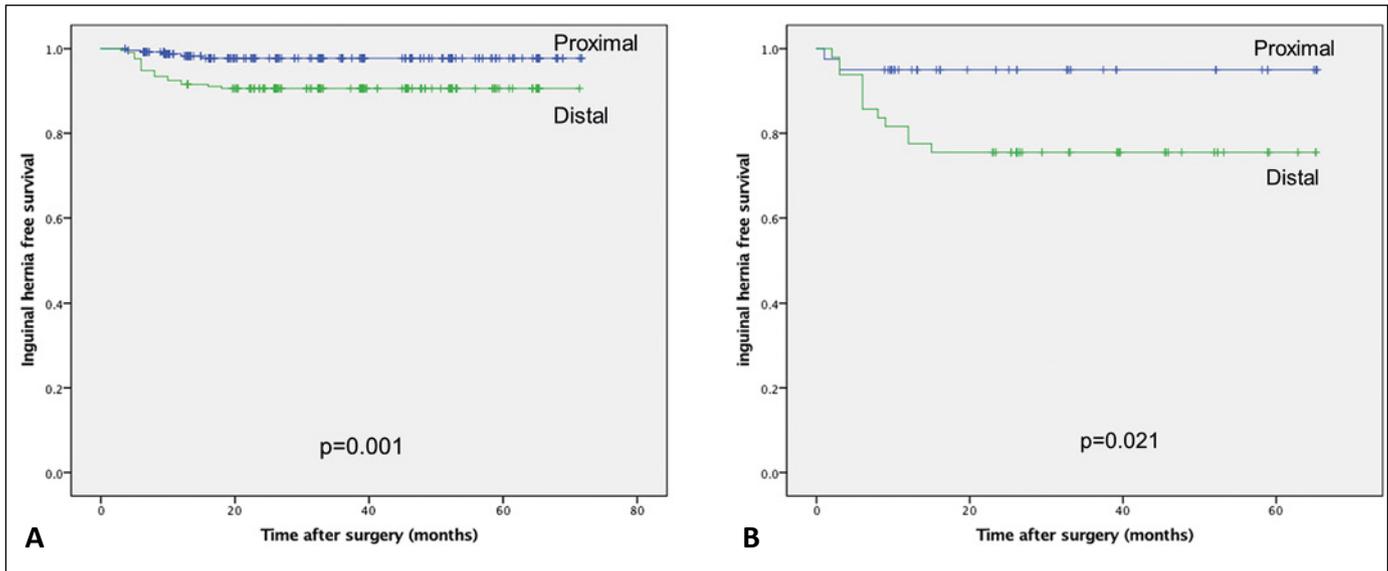


Figure 3. Postoperative inguinal hernia-free rate according to the difference of peritoneum incision between proximal incision and distal incision. **(A)** Comparison in patient cohort with normal internal inguinal hernia and **(B)** patient cohort with the dilatation of internal inguinal ring. (Kaplan-Meier analysis, log-rank test, $P = 0.001$ and 0.021 , respectively).

operative IH was also reported to range from 4% to 20% [5]. Even though RARP has improved the outcomes of urinary incontinence and erectile dysfunction relative to open RP, RARP has not reduced the postoperative IH risk. In the present study, postoperative IH occurred in 7% of all groins. It was hard to say that RARP contributed to a reduction of that risk. Although relatively few data exist regarding the risk factors for IH after RARP, Lee et al. reported that the presence of a patent processus vaginalis was an important risk factor, in addition to the conventional risk factors, including age, BMI, previous history of major abdominal surgery, and so on [8].

In the present study, although conventional risk factors were not significant on multivariate analysis, right side, dilatation of the internal inguinal ring and different procedure of peritoneal incision around the medial side of the internal inguinal ring were found to be independent risk factors for IH after RARP. The reason why postoperative IH was more often present on the right side was unclear. We assumed that it was factored into the statistics that the number of dilatation of the internal inguinal ring was more on the right side. In addition, we want to emphasize the difference between a patent processus vaginalis and dilatation of the internal inguinal ring. Even if both the spermatic cord and vessels are cut during RARP, the incidence of postoperative IH is not significantly decreased. The cutting of both the spermatic cord and the vessels separates the processus vaginalis from the

pelvic wall entirely, and the processus vaginalis is closed, the patent processus vaginalis is dissolved at this point in time, and the correlation between a patent processus vaginalis before surgery and postoperative IH becomes poor. However, the presence of dilatation of the internal inguinal ring is related to postoperative IH in both retropubic and transperitoneal approaches, because the inguinal canal remains widely opened. Therefore, we believe that dilatation of the internal inguinal ring is a stronger risk factor than a patent processus vaginalis.

Some previous studies introduced feasible prophylactic procedures for postoperative IH during operation. In open abdominal surgery, Fujii et al. found, in a total of 576 Japanese patients, a significant reduction of postoperative IH by ligating the processus vaginalis close to the peritoneal cavity and transecting it [17]. Sakai et al. introduced prophylactic procedures involving blunt dissection of the peritoneum at the internal inguinal ring and isolation of the spermatic cord from the peritoneum [4]. Stranne et al. used a technique that involved placing a nonresorbable figure-of-8 suture between the transversus arch and the iliopubic tract lateral to the spermatic cord [1].

On the other hand, in RARP, both Finley et al. and Lee et al. introduced concurrent transperitoneal repair with prosthetic mesh [6]. In another study, Lee et al. performed a prophylactic procedure in 36 patients (47 groins), as described below. The inguinal floor of the patent processus vaginalis was incised and dissected along the spermatic cord. Then,

hemostatic agents were plugged into the end of the dissected canal. After plugging, the internal inguinal floor was simply closed. In their study, no patients who underwent the IH prevention procedure experienced postoperative IH during a follow-up of 11.8 ± 6.2 months [7]. They considered the mechanism of prevention that hemostatic agents could bring on adhesions of the internal inguinal floor inside where they dissected.

However, these prophylactic techniques involved the insertion of medical products inside the human body, with a potential risk of infection and a slight increase in operative time. On the other hand, our prophylactic procedure does not need them at all. As Lee et al. noted, we also assumed that inflammatory adhesions inside the inguinal canal contributed to prevention of postoperative IH. However, we considered that inflammatory adhesions were induced just by incision of the peritoneum close to the medial side of the internal inguinal ring. Shimbo et al. also reported a prophylactic technique without extra products and operative time, with sufficient incision of the peritoneum around the internal inguinal ring and separation and dissection of the spermatic vessels [18]. However, we think that a peritoneal incision around the medial side of the internal inguinal ring is enough to prevent postoperative IH. A future prospective study with a large number of patients will be needed to evaluate the usefulness of our technique.

There are several limitations to the present study. First, it was a retrospective study from one institution. It potentially contains some selection bias and overlooking of asymptomatic hernia before surgery. Second, it could contain the influence of learning curve. Pneumoperitoneum time and pressure, which are estimated to be risk factors of postoperative IH, decrease with decreasing operative time and blood loss by learning curve. Third, although the prophylactic technique is convenient, it can be ineffective for direct inguinal hernia. Fourth, the correlation between the degree of dilatation of internal inguinal ring and the ratio of postoperative IH was not evaluated. Finally, the follow-up period was relatively shorter than that of previous studies reported by high-volume centers. The incidence of postoperative IH may increase in the future.

CONCLUSIONS

The present results suggest that dilatation of the internal inguinal ring represents an important risk factor for postoperative IH after RARP. However, incising the peritoneum sufficiently close to the medial edge of the internal inguinal ring can cause inflammatory adhesions inside the inguinal canal and prevent postoperative IH without extra products and time.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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