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Comparison between a novel knotless technique and the conventional single knot technique of laparoscopic radical prostatectomy by novice laparoscopists

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Abstract

Objectives: This study aimed to investigate a novel knotless technique for novice laparoscopists in traditional laparoscopic radical prostatectomy.

Methods: We studied 68 patients who had a novel technique performed in laparoscopic radical prostatectomy (knotless group) and 89 who had the conventional single knot technique (single knot group). The operations were all performed by novice laparoscopists with experience of fewer than 100 cases of laparoscopic radical prostatectomy. Knotless suture of the dorsal vein complex was conducted using a barbed self-retaining suture with three bites at the same location. The knotless urethrovesical anastomosis technique was conducted using a unidirectional single running fashion with a barbed self-retaining suture.

Results: There were no significant differences in the estimated blood loss, complication rate, postoperative hospital stay, anastomotic leakage rate, continence at 6 months after surgery, and positive margin rate between the two groups. The mean anastomotic time (24.9 vs. 44.2 min), operative time (168.1 vs. 201.8 min), and duration of catheter placement (12.8 vs. 19.8 days) were shorter in the knotless group than in the single-knot group.

Conclusions: The knotless technique of laparoscopic radical prostatectomy is a safe and effective procedure.

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Introduction

Prostate cancer is the most common cancer among men worldwide.[1] Radical prostatectomy is the standard care for localized prostate cancer. Traditional laparoscopic radical prostatectomy (LRP) is the most popular technique worldwide because robot-assisted radical prostatectomy (RARP) is not available in most institutions, especially in developing countries. However, LRP is a technically difficult operation with a lengthy learning curve. Therefore, refining this procedure is important to easily overcome the steep learning curve of LRP.

Dorsal vein complex (DVC) ligation and urethrovesical anastomosis (UVA) are two major obstacles for novice laparoscopists with limited experience in LRP. To overcome these two obstacles, many modalities have been introduced to facilitate control of DVC[2–4] and many devices have also been introduced to reduce or avoid knot tying during UVA.[5–7] Previous studies have reported that as many as 50 to 250 cases are required to overcome the learning curve.[8–10]

This study aimed to compare the safety and satisfactory efficacy of a novel knotless technique to facilitate the two steps of DVC ligation and UVA with the conventional single knot technique in LRP. To the best of our knowledge, this study is the largest study on self-retaining sutures for DVC ligation and UVA. Our perioperative outcomes may encourage novice laparoscopists with limited suturing experience to easily overcome the steep learning curve.

Patients and methods

Selection of patients

A total of 337 consecutive LRPs were carried out at our institution from December 2013 to December 2016. A retrospective analysis of data was conducted by reviewing surgical records and surgical videos. We excluded LRPs that were performed by laparoscopists with experience of more than 100 cases, using interrupted sutures and hybrid procedures of the single knot or knotless techniques to perform DVC ligation or UVA. A total of 68 cases using the knotless technique were included in the knotless group and 89 cases using the single knot technique were included in the single knot group. These surgeries were all performed by novice laparoscopists with experience of fewer than 100 cases of LRP. There were six surgeons who performed the knotless and single knot techniques and two surgeons who only performed the single knot technique. This is because six surgeons tried this new suture technique, while the other two surgeons were not willing to try this new technique.

Approval for the study protocol was waived by the institutional review board. Written informed consent was obtained from all of the patients.

Preoperative preparation

Demographic and perioperative data of the patients were collected for further analysis. Preoperatively, all patients with localized

prostate cancer underwent routine preoperative evaluations, including a complete medical history, physical examinations, and laboratory investigations, such as serum liver function tests, renal function tests, electrolytes, and prostate-specific antigen levels. Additionally, radiological imaging, such as abdominal ultrasound, magnetic resonance imaging of the prostate, and transrectal biopsy of the prostate for pathology, were performed. Bone scanning or positron emission tomography/computed tomography was necessary for selected patients who were suspected of having metastasis. Surgery videos were collected and analysed for further comparison.

Surgical methods

Our knotless technique of LRP has been previously published.[11] Two important technical steps are briefly introduced below. First, a knotless suture of the DVC was conducted using a 15-cm 1-0 1/2 circle barbed self-retaining suture (V-Loc 180; Covidien, Mansfield, MA, USA) with three suture bites at the same location without any clips. Second, the knotless anastomosis technique was conducted using a unidirectional single running fashion with a 23-cm 3-0 5/8 circle barbed self-retaining suture with one needle driver (V-Loc 90; Covidien). The first suture started at 3 o'clock and then travelled clockwise. After the first suture from 3 o'clock to approximately 8 o'clock clockwise, a catheter was then inserted, and the suture proceeded clockwise to complete the anastomosis. The barbed suture kept the anastomosis tightly retained without any knot. The main steps of the knotless LRP are shown in Figure 1.

Data analysis

Continuous parametric data are expressed as mean ± standard deviation (range) and nonparametric data are expressed as median (range). Data were collected for further analysis using IBM SPSS Statistics for Windows, version 19.0 (IBM Corp., Armonk, NY, USA). Statistical significance was assessed with the Student's t test for parametric data and Pearson's chi-square test for nonparametric data. A p value less than 0.05 was considered as significant.

Results

Operative results

The perioperative results are shown on the Table 1. There were no significant differences in the mean age , volume of the prostate, body mass index, preoperative prostate-specific antigen levels, DVC ligation time, and estimated blood loss between the knotless and single-knot groups. The mean anastomotic time ($p = 0.035$) and operative time ($p = 0.037$) were significantly shorter in the knotless group than in the single-knot group. There was no blood transfusion or open conversion. The rates of lymphadenectomy and preservation of the neurovascular bundle were not significantly different between the knotless and single-knot groups.

Postoperative results

The postoperative outcomes of the patients are shown in Table 2. There were no significant differences in median postoperative prostate-specific antigen levels at 1 month after surgery, continence at 6 months after surgery, Gleason score, complication rate, postoperative hospital stay, anastomotic leakage rate, and positive margin rate between the knotless and single-knot groups. The median duration of the catheter was significantly shorter in the knotless group than in the single-knot group ($p = 0.042$). There were no serious complications, such as reoperation or massive

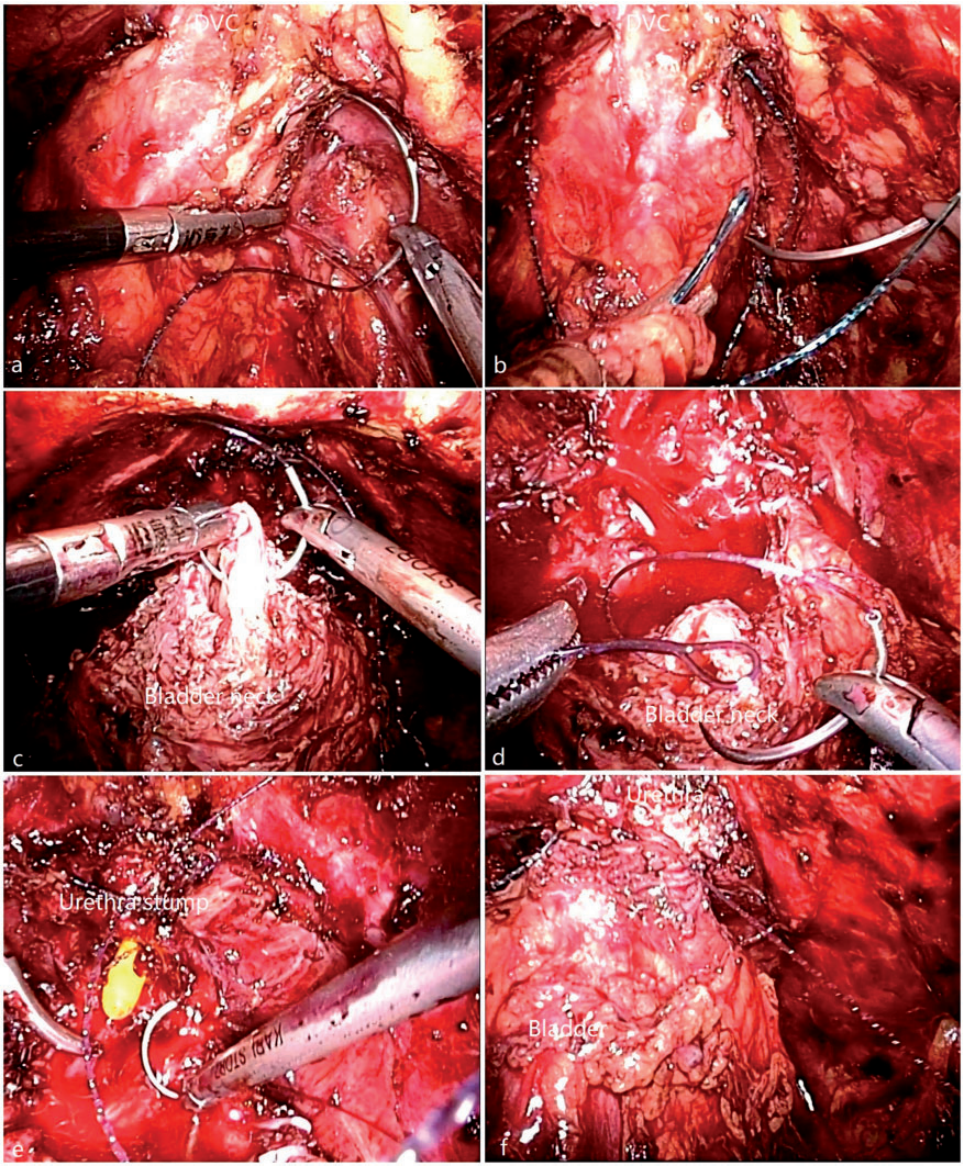

Figure 1. Illustration of knotless laparoscopic radical prostatectomy. (a) Suturing of the dorsal vein complex. (b) Knotting by threading into the end. (c) First anastomosis at 3 o'clock. (d) Threading into the end before biting. (e) Suturing the back wall of the bladder. (f) Completion of urethrovesical anastomosis.

bleeding. Six patients in the knotless group and nine in the single-knot group suffered from minor complications, but they were all cured by conservative treatments. There were two cases of anastomotic leakage, two cases of lymphatic leakage, and two cases of postoperative fever in the knotless group. There were four cases of

Table 1. Perioperative data of the patients.

Characteristic	Knotless group	Single-knot group	Overall	p value
No. of patients	68	89	157	
Age (years)	70.1 ± 5.3 (55–82)	68.3 ± 7.5 (56–84)	69.1 ± 6.4 (55–84)	0.462
Volume of prostate (mL)	41.6 ± 12.2 (13–78)	43.5 ± 21.3 (14–119)	42.7 ± 22.1 (13–119)	0.556
Body mass index (kg/m^2)	25.9 ± 1.9 (20–30)	26.8 ± 1.5 (21–29)	26.4 ± 1.7 (20–30)	0.757
Preoperative prostate-specific antigen (ng/mL)	16.2 (3.2–49.1)	19.2 (3.7–58.9)	17.9 (3.2–58.9)	0.682
Dorsal vein complex ligation time (min)	4.0 ± 1.5 (2–8)	5.3 ± 2.1 (3–10)	4.7 ± 2.1 (2–10)	0.398
Anastomotic time (min)	24.9 ± 12.5 (10–58)	44.2 ± 15.2 (25–72)	35.8 ± 17.5 (10–72)	0.035
Operative time (min)	168.1 ± 60.2 (96–307)	201.8 ± 62.9 (121–362)	187.2 ± 68.2 (96–362)	0.037
Estimated blood loss (mL)	162.2 ± 201.2 (20–800)	182.2 ± 176.5 (30–800)	173.5 ± 205.2 (20–800)	0.856
Open conversion	0	0	0	
Lymphadenectomy (%)	85.29	76.40	80.25	0.756
Neurovascular bundle preservation (%)	98.53	95.51	96.82	0.424

Table 2. Short-term outcomes of the patients.

Characteristic	Knotless group	Single-knot group	Overall	p value
Postoperative prostate-specific antigen (ng/mL)	0.14 (0–1.6)	0.28 (0–2.8)	0.22 (0–2.8)	0.212
Complication rate (%)	8.82	10.11	9.55	0.695
Postoperative hospital stays (days)	6.2 (5–12)	7.6 (5–13)	7.0 (5–13)	0.524
Anastomotic leakage (%)	2.94	4.49	3.82	0.631
Duration of catheter (days)	12.8 (7–18)	19.8 (7–32)	16.8 (7–32)	0.042
Continence at 6 months after surgery (pads/day)	0.7 (0–5)	1.0 (0–5)	0.9 (0–5)	0.224
Gleason score	6.5 (6–10)	7.7 (6–10)	7.2 (6–10)	0.561
Positive margin (%)	17.65	20.22	19.11	0.769
pTNM				
pT2aN0M0	17	18	35	
pT2bN0M0	20	35	55	
pT2cN0M0	25	33	58	
pT3aN0M0	5	3	8	
pT3bN1M0	1	0	1	

pTNM, pathological tumour-node-metastasis.

anastomotic leakage, three cases of lymphatic leakage, and two cases of postoperative fever in the single-knot group. There was no acute urinary retention, recatheterization, bladder neck contraction, or stenosis in the two groups during follow-up.

Discussion

Prostate cancer is the most common cancer among men worldwide, accounting for 15% to 19% of all cancers diagnosed in men.[1] With development of technical refinements

and facilitating modalities, minimally invasive approaches, including traditional LRP and RARP, have become the most widely accepted procedures for localized prostate cancer. These approaches have fewer perioperative complications and improved recovery compared with the open approach.[12,13]

Traditional LRP is still the most popular procedure worldwide because of the higher costs and demanding training requirements of RARP, especially in developing countries. Laparoscopic suturing and knot tying are the most difficult steps, especially in the limited pelvic working space. DVC ligation and UVA are two of the major obstacles for novice laparoscopists to overcome.

To facilitate DVC ligation, many modalities have been introduced, including the bulldog clamp,[2] a titanium knot placement device,[3] and barbed sutures[4]. Inadequate ligation of the DVC could lead to massive haemorrhage, which not only prolongs operative time, but also injures the neurovascular bundle and sphincter fibres by repeat coagulation. Therefore, adequate control of the DVC is the most effective way to avoid this situation, but knot tying is not easy in a limited working space. The barbed self-retaining suture was introduced and proven to be effective and easily performed, and it has high continence rates.[4] The barbed self-retaining suture is conducted using the V-Loc from (Figure 1). This suture was introduced to control the DVC during RARP.[14] In this study, although there was no significant difference in the DVC ligation time between the groups, all of the novice laparoscopists felt that this ligation was easily performed, even without intracorporeal knot tying or advanced suturing skills.

To reduce or avoid knot tying during UVA, many techniques can be applied, including LAPRA-TY absorbable suture clips,[5] the three-U-stitches technique,[6] barbed sutures,[7] and Benique sound[15]. However, suboptimal UVA may result in urine leakage and poor continence. A significant decline in suture time, operative stay, and hospital stay using barbed sutures for UVA has been reported.[16] We used the unidirectional running fashion with a single needle driver and barbed self-retaining suture for UVA with the first bite at 3 o'clock, followed by a clockwise direction. The mean anastomotic time and operative time were significantly shorter in the knotless group than in the single-knot group.

The safety of the knotless technique is comparable with the single knot technique regarding the complication rate, postoperative hospital stay, anastomotic leakage rate, and continence at 6 months after surgery. The efficacy of the knotless technique was superior to the single knot technique in terms of mean anastomotic time and operative time. The main reason for this superiority of the knotless technique might be due to the self-retaining work for every stitch, which enables novice laparoscopists to easily pull the anastomosis tightly.

For better illustration of the feasibility of this novel knotless technique, we excluded experienced surgeons who had performed more than 100 LPRs. Therefore, a limitation of this study is selection bias related to the limited expertise of the novice laparoscopists. Additionally, the study was retrospective. Two surgeons were not willing to try this new technique because they could not clearly see the tiny thread on the screen and could not perform anastomosis with every stitch in good sequence. For novice surgeons, intrafascial radical prostatectomy other than the non-intrafascial technique was suggested in young patients with a low risk of localized prostate cancer.[17] The duration of catheter placement was slightly long in the single-knot group because two cases in the single-knot group had a catheter for longer than 1 month and surgeons with limited experienced wanted to guarantee anastomosis. Postoperative prostate-specific antigen levels were detectable because of the

high positive margin rate, but this was acceptable for novice surgeons who had not overcome the learning curve. Another limitation of this study is the individual expertise. Two surgeons who were approximately 50 years old were too old to sufficiently identify tiny stitches to make every stitch in sequence. We did not perform cystograms in every patient routinely, but only performed cystograms in selected patients when clinical findings were suspicious for anastomotic leakage.

Conclusions

In conclusion, the knotless technique of LRP is a safe and effective procedure compared with the conventional single knot technique. Perioperative outcomes may encourage novice laparoscopists with limited suturing experience to easily overcome the steep learning curve of LRP.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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