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Effect of Continuous Urethro-Vesical Anastomosis Technique in Incontinence After Radical Retropubic Prostatectomy, 1:1 Matching Study

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Purpose: Vesicourethral anastomosis (VUA) is an important step in radical prostatectomy and can affect clinical course in hospital. However, few studies comparing VUA by standard interrupted and continuous suturing techniques in radical retropubic prostatectomy (RRP) have been reported. We compared the postoperative outcomes and continence recovery rates of patients undergoing these two variations of VUA using 1:1 propensity score matching.

Methods: From January 2008 to January 2014, a total of 188 patients underwent RRP. We conducted 1:1 propensity score matching based on age, prostate volume, pathological stage, status of nerve sparing, and two baseline characteristics (preoperative prostate-specific antigen [PSA] level and Gleason score determined by pathology). Patients were assigned to two groups based on the suturing method used (interrupted or continuous). After RRP, incontinence levels were assessed at 1, 3, 6, and 12 months based on pad usage per day (0, dry; ≤1, social continence; ≥2, incontinence).

Results: Each group consisted of 47 patients. The continuous group had a lower incidence of VUA site leakage (0% vs. 10.6%, P=0.022), but there were no significant differences in the rates of postoperative urethral stricture (6.4% vs. 6.4%, P=1.00) and pyuria (43.6% vs. 45.0%, P=0.770) between the two groups. The rate of recovery to social continence was greater in the continuous group at postoperative 3 months (85.1% vs. 66.0%, P=0.031). About 50% of patients had no incontinence (pad per day=0) after 6 months (59.6% in the continuous group and 51.1% in the interrupted group, P=0.407) and at postoperative 12 months, the dry rate 61.7% in the interrupted group and 80.4% in the continuous group (P=0.047). The times required to reach social continence (3.21 months vs. 3.77 months, P=0.056) and no incontinence (7.23 months vs. 7.63 months, P=0.132) were also shorter in the continuous group, but these differences were not statistically significant.

Conclusions: The results of this study suggest that earlier recovery to social continence and a higher rate of complete recovery (dry) could be expected with VUA by continuous suturing. Furthermore, if adequate surgical experience is accumulated, VUA with continuous suturing could be performed without difficulty.

Keywords: Urinary Incontinence, Stress; Anastomosis, Surgical; Prostatectomy

- **Research Ethics:** This study was approved by the Institutional Review Board of Samsung Medical Center (IRB No. 2014-12-042).
- **Conflict of Interest:** No potential conflict of interest relevant to this article was reported.

INTRODUCTION

Anastomosis site leakage after radical prostatectomy can cause prolonged urethral catheterization periods and complications such as pelvic abscess or the collection of infected fluid [1]. Prolonged urethral catheterization causes periurethral fibrosis and

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stricture [2,3], while postprostatectomy incontinence (PPI) can be considered a complication of anastomosis site leakage. PPI is an important and troublesome complication after radical prostatectomy because of the increasing incidence of prostate cancer. Several studies have recommended various techniques to reduce the severity of PPI.

Vesicourethral anastomosis (VUA) is an important step in radical prostatectomy, and has been found to affect hospital outcomes [4]. Open radical retropubic prostatectomy (RRP) is a modified version of the initial VUA technique described by Walsh et al. [5], which makes use of interrupted suturing and is used in modern practice. However, interrupted suturing techniques are not used in robot-assisted laparoscopic radical prostatectomy (RALRP) and laparoscopic radical prostatectomy (LRP) because of technical difficulties. Therefore, the VUA with continuous suturing technique introduced by Van Velthoven et al. [6] and modified by Menon et al. [7] is widely used. Several RALRP and LRP studies using VUA with watertight continuous suturing have reported successful urethral catheter removal on as early as postoperative day 7 [7-9]. Besides its use in RALRP and LRP, some studies have suggested that VUA with continuous suturing in open RRP can reduce VUA site leakage and contribute to the alleviation of PPI [1,10]. However, few studies comparing the two suturing techniques have been published. Considering the merits of continuous suturing in RALRP and LRP mentioned above, we hypothesized that it may be beneficial to apply continuous suturing to VUA during open RRP. In this study, we used 1:1 propensity score matching to compare the postoperative outcomes and continence recovery rates of patients who underwent VUA with two suturing techniques (continuous vs. interrupted).

MATERIALS AND METHODS

Patient Selection

From January 2008 to January 2014, 188 patients with clinically localized prostate cancer (T1 to T3N0M0) underwent open RRP performed by a single surgeon (S.S.J.) at a single institution. None of the enrolled patients had urinary incontinence (stress or urge) before prostate surgery. VUA with interrupted suturing (interrupted group) was performed in 130 patients, and the remaining patients received continuous suturing (continuous group). Of the 58 patients in the continuous group, patients who were followed up for less than 12 months postopera-

Table 1. Characteristics of the two propensity-matched groups in all patients

Characteristic	Before matched		P-value	After matched		P-value
	Interrupted group (n=130)	Continuous group (n=58)		Interrupted group (n=47)	Continuous group (n=47)	
Age (yr)	70.0±5.6	67.6±7.7	0.015[a]	67.6±3.9	67.8±7.6	0.817[a]
Preoperative PSA (ng/mL)	10.1±10.9	13.4±19.6	0.139[a]	10.9±11.6	10.5±11.6	0.893[a]
Prostate volume (mL)	38.4±17.8	32.9±13.2	0.036[a]	32.5±19.8	33.4±13.3	0.784[a]
Nerve saving			0.584[b]			0.897[b]
None	88 (67.7)	36 (62.1)		31 (66.0)	29 (61.7)	
Unilateral	13 (10.0)	5 (8.6)		4 (8.5)	5 (10.6)	
Bilateral	29 (22.3)	17 (29.3)		12 (25.5)	13 (26.6)	
Pathologic stage			0.561[b]			0.908[b]
T2a	19 (14.7)	4 (6.9)		4 (8.5)	3 (6.4)	
T2b	1 (0.7)	0 (0)		-	-	
T2c	59 (45.4)	27 (46.5)		22 (46.8)	23 (48.9)	
T3a	27 (20.8)	15 (25.9)		10 (21.3)	12 (25.5)	
T3b	24 (18.5)	12 (20.7)		11 (23.4)	9 (19.1)	
Gleason score on pathology			0.031[b]			0.972[b]
≤6	34 (26.2)	7 (12.1)		7 (14.9)	7 (14.9)	
7	73 (56.2)	33 (56.9)		27 (57.4)	26 (55.3)	
≥8	23 (17.6)	18 (31.0)		13 (27.7)	14 (29.8)	

Values are presented as mean±standard deviation or number (%).
PSA, prostate specific antigen.
[a]Chi-square test. [b]t-test.

tively (n=2), had incomplete data (n=2), had severe urgency symptoms (an urgency score in the International Prostate Symptom Score of 4 or 5, n=1), or were not matched with patients from the interrupted group were excluded. A total of 47 patients were included in the continuous group, and the patients in the two groups were 1:1 matched (n=47).

Matching Method

Several risk factors for PPI have been studied in the attempt to develop preventative measures. However, the different risk factors for PPI have so far yielded contradictory results when investigated [11]. To reduce the effect of other risk factors that can influence PPI, we conducted 1:1 propensity score matching. Matching was based on age [12], prostate volume [13], pathological stage [14], status of nerve sparing [15], and two baseline characteristics (preoperative prostate-specific antigen [PSA] level and Gleason score on pathology). Patients were then assigned to two groups (interrupted and continuous). The matching method used was 1:1 individual matching without replacement using propensity scores (standard mean difference=0.0859). After matching, both groups were well balanced for all variables (Table 1).

Anastomosis Technique

The VUA technique used in the interrupted group was similar to the classical technique described by Walsh et al. [5]. Furthermore, preservation of the bladder neck was achieved by eversion of the bladder neck mucosa with interrupted sutures. During surgery, eight sutures (3-0 Vicryl) were tied to the external aspect of the urethra. The VUA technique used in the continuous group was similar to that used in RALRP and LRP. The periurethral tissue (posterior rhabdosphincter), Denonvilliers' fascia, and posterior bladder neck tissue were reapproximated two times using 3-0 Vicryl sutures. After reapproximation, a bidirectional 3-0 Monocryl (Poliglecaprone) suture was prepared with two needles. VUA was then performed, starting at the 5- to 6-o'clock position in an outside-in direction on the posterior bladder wall. The tip of the 18-Fr urethral catheter could be seen emerging from the urethra, and a needle was passed inside-out on the urethral lumen. Next, 2–3 bites were made in the clockwise direction and the needle could be seen passing through the urethra. Anticlockwise anastomosis was then started from the 6- to 7-o'clock position, and the anastomosis was completed at the 12-o'clock position. Once the anastomosis was complete, each needle met at the contralateral side (urethra and bladder neck) near the 12-o'clock position, and both sutures were tied together with 8–10 knots (Fig. 1).

Data Analysis and Statistical Analysis

Clinical data were collected prospectively. Data on the following preoperative parameters were collected: patient age, preoperative PSA level, and prostate volume measured by prostate magnetic resonance imaging or transrectal ultrasound. Postoperative parameters assessed were urethral catheterization duration, VUA site leakage, urethral stricture, acute urinary retention (AUR), postoperative pyuria, and pelvic abscess or lymphocele. Cystourethrography was performed for each patient on postoperative day 7 in the continuous group and on postoperative day 14 in the interrupted group. Pyuria was defined as either >5 white blood cells per high power field or positive urine culture (at least 100,000 colony-forming units/mL). Urine

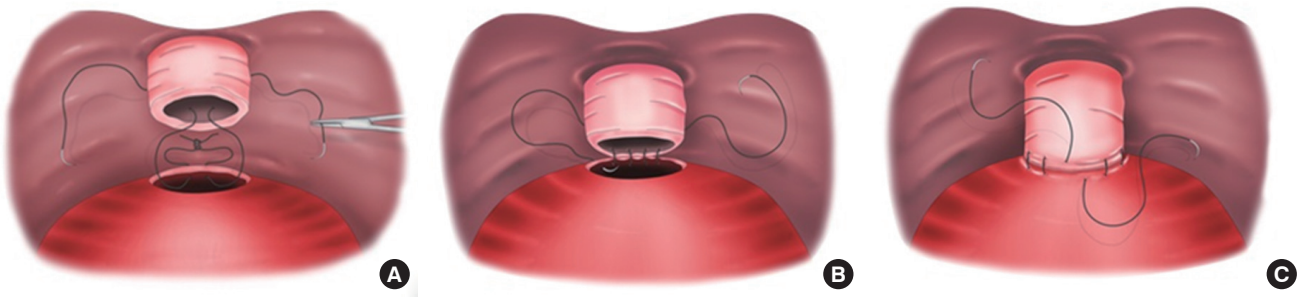

Fig. 1. Vesicourethral anastomosis (VUA) technique. (A) The VUA was started at the 5- to –6-o'clock position in the outside-in direction on the posterior bladder wall. (B) Then, 2–3 bites were made in the clockwise direction, and the needle could be seen passing through the urethra. Next, anticlockwise anastomosis was started from 6- to 7-o'clock position. (C) When the anastomosis was complete, the needles met at the contralateral side (urethra and bladder neck) near the 12-o'clock position, and both sutures were tied together with 8–10 knots.

analysis was performed at postoperative month 1. The level of incontinence was assessed at 1, 3, 6, and 12 months based on pad usage count per day (0, dry; ≤1, social continence; ≥2, incontinence).

The IBM SPSS Statistics ver. 20.0 (IBM Co., Armonk, NY, USA) was used to perform all statistical analyses. Numeric parameters were compared using Student t-test, and the chi-square test was used to compare nominal data. A P-value of <0.05 was considered statistically significant. The results were expressed as means±standard deviation and medians.

Ethics Statement

This study was approved by the Institutional Review Board of Samsung Medical Center (IRB No. 2014-12-042), who waived the requirement for written informed consent.

RESULTS

The mean patient age was 67.6±6.0 years (range, 51–80 years), and the mean follow-up duration was 42.0±23.2 months (range, 11–86 months). Each group consisted of 47 patients. Because this study involved 1:1 propensity score matching, patients were comparable with respect to age, preoperative PSA level, prostate volume, pathological stage, Gleason score on pathology, and status of nerve sparing. Two instances of VUA in the continuous group failed and had to be changed to the interrupted suturing technique. One patient had a short urethra, and the other had a narrow and deep pelvic cavity.

In terms of postoperative parameters, urethral catheterization duration was shorter in the continuous group (12.5 days vs. 16.2 days, P<0.001). The rate of VUA site leakage was also significantly lower in the continuous group (0% vs. 10%, P=0.022). Five patients with VUA site leakage underwent urethral catheterization for 27.4 months (range, 24–35 months) and recovered with the urethral catheter in place. When we excluded patients with VUA site leakage, the urethral catheterization duration was also shorter in the continuous group (12.6 months vs. 15.0 months, P<0.001). Six cases of urethral stricture occurred (3 vs. 3, P=1.00). One patient had VUA site stricture in each group, and another four patients had mild mid-to-distal urethral strictures. Two patients with VUA stricture were treated with repeated urethral sounding and subsequently improved without endoscopic surgery. Mid-to-distal urethral strictures were also treated with urethral sounding without complications. The rates of postoperative pyuria were similar in both groups (45.0% in the interrupted group vs. 43.6% in the continuous group, P=0.770) (Table 2). Pelvic abscess or lymphocele were detected more in the continuous group (2.1% vs. 4.3%), but this difference was not statistically significant (P=0.557). One case of AUR occurred in the interrupted group and was resolved with clean intermittent catheterization.

With respect to PPI, the rate of recovery to social continence (pad per day≤1) was higher in the continuous group at postoperative month 3 (85.1% vs. 66.0%, P=0.031). However, after 6 months, the rates of social continence in both groups equalized, and at postoperative month 12, the percentage of those with social continence was 93.6% in the interrupted group and 93.5% in the continuous group (P=0.978). The time required to reach social continence was also shorter in the continuous group (3.21 months vs. 3.77 months, P=0.056). About 50% of patients recovered from incontinence completely (pad per day=0) after 6 months (59.6% in the continuous group vs. 51.1% in the inter-

Table 2. Postoperative outcomes

Postoperative outcome	Interrupted group (n=47)	Continuous group (n=47)	P-value
Anastomosis site leakage	5 (10.6)	0 (0)	0.022[a]
Urethral catheterization duration (day)	16.2±4.6 (10–35)	12.5±3.3 (7–17)	<0.001[b]
Urethral stricture	3 (6.4)	3 (6.4)	1.000[a]
Anastomosis site	1	1	
Distal urethra	2	2	
Postoperative pyuria	9/20 (45.0)	17/39 (43.6)	0.770[a]
Pelvic abscess/lymphocele	1 (2.1)	2 (4.3)	0.557[a]
Abscess	1	0	
Lymphocele	0	2	

Values are presented as number (%) or mean±standard deviation (range).
[a]Chi-square test. [b]t-test.

Table 3. Incontinence recovery rate

Variable	Interrupted group (n = 47)	Continuous group (n = 47)	P-value
Social continence[a] rate			
Postoperative			
1 month	22/47 (46.8)	19/47 (40.4)	0.210[c]
3 months	31/47 (66.0)	40/47 (85.1)	0.031[c]
6 months	40/47 (85.1)	43/47 (91.5)	0.336[c]
12 months	44/47 (93.6)	43/46 (93.5)	0.978[c]
Time to social continence (mo)	3.77 ± 3.88	3.21 ± 3.24	0.056[d]
Dry[b] rate			
Postoperative			
1 month	9/47 (19.1)	7/47 (14.9)	0.583[c]
3 months	18/47 (38.3)	17/47 (36.2)	0.831[c]
6 months	24/47 (51.1)	28/47(59.6)	0.407[c]
12 months	29/47 (61.7)	37/46 (80.4)	0.047[c]
Time to dry (mo)	7.63 ± 5.09	7.23 ± 4.65	0.132[d]

Values are presented as number (%) or mean ± standard deviation.
[a]Social continence (pad per day ≤ 1). [b]Dry (pad per day = 0). [c]Chi-square test. [d]t-test.

rupted group, P = 0.407) and at postoperative month 12, the dry rate was 61.7% in the interrupted group and 80.4% in the continuous group (P = 0.047). Compared with the interrupted group, the continuous group had a higher rate of complete recovery from incontinence (Table 3). The time required for complete recovery was 7.23 months in the continuous group and 7.63 months in the interrupted group, but this difference was not statistically significant (P = 0.132).

DISCUSSION

The continuous suturing technique commonly used in RALRP is not widely implemented in open RRP because of technical difficulties such as the narrow nature of the pelvic cavity, the fear of an increased incidence of anastomotic strictures, and the perceived tenuous nature of an anastomosis dependent on a single running suture versus several interrupted sutures. In the present study, we performed interrupted suturing from case 1 to 130 with eight sutures between the urethra and bladder neck. Continuous suturing has been shown to possess several strengths, including watertight anastomosis, secure tying under direct vision, and the possibility of urethral catheter reinsertion because of the lack of gaps between sutures [10]. Given these strengths, we wanted to apply continuous suturing to VUA in open RRP. In this study, we examined the relationships between two VUA suturing techniques and postoperative complications such as VUA site leakage and the rate of recovery from incontinence.

There is no standard duration for the placement of urethral catheters. In most cases, the duration was therefore decided by the surgeon's experience and personal preferences. Compared with continuous suturing, interrupted suturing showed a higher risk of urine extravasation through gaps at the VUA site. This urine extravasation can lead to urethral fibrosis, urethral stricture, pelvic abscess, and pelvic urinoma. In many cases, the urethral catheter was in place for 14 days before the VUA site completely healed. In our study, AUR occurred in one patient (1%), and this result was perhaps a sign that an adequate urethral catheterization duration was used. However, a long duration of urethral catheterization also causes urethral stricture, urinary infections, and patient discomfort [10]. In recent studies with continuous suturing, the early removal of the urethral catheter before postoperative day 7 has been reported. Despite the increase in the incidence of AUR associated with postoperative urethral edema, several studies insist that early urethral catheter removal has certain merits. As in these studies, our study also tried to decrease the urethral catheterization duration. The mean duration of urethral catheterization of the interrupted group was 16.2 days, while that of the continuous group was 12.5 days. The duration of catheterization was therefore decreased by about 4 days. After using continuous suturing, we were concerned about bladder neck contracture and urethral stricture. However, no significant differences were detected between the two groups, and the incidence of VUA site leakage was significantly lower in the continuous group. Furthermore, we were concerned that the longer duration of urethral catheterization might be associated with urethral strictures and uri-

nary tract infections. However, the decreased urethral catheterization duration used in the continuous group did not significantly affect the rates of postoperative pyuria and urethral stricture. The incidences of pelvic abscess and lymphocele also showed no significant differences between the continuous and interrupted groups (4.3%, n=2 vs. 2.1% ,n=1, P=0.557). In our study, the urethral catheterization duration was decided solely on the experience and preferences of the surgeon. Based on the observations made in this study, we have now changed the routine urethral catheterization duration at our institution from 14 to 7 days. If the urethral catheterization duration is shortened even further, additional investigations into the strengths and weaknesses of shorter catheterization durations will be required. To assess VUA site leakage, cystourethrography was performed for every patient on postoperative day 7. Patients with VUA site leakage had cystourethrography repeatedly performed at 7-day intervals. If VUA site leakage persisted for longer than 1 month, the urethral catheter was changed with a cystoscopy-guided urethral catheter. During cystoscopic urethral catheter switching, a guide wire was inserted to prevent the insertion of the urethral catheter through the leakage site or additional injury to the VUA site. All patients with VUA site leakage recovered without additional intervention. After changing to the continuous suturing technique after case 130, the rate of VUA site leakage significantly decreased (P=0.022).

Several factors can influence the rate of recovery from PPI. To exclude the effects of other factors besides VUA suturing technique as much as possible, all study patients were selected using a 1:1 propensity score matching method. Forty-seven pairs of patients were matched individually according to six factors (age, preoperative PSA level, prostate volume, pathological stage, Gleason score on pathology, and status of nerve sparing). We tried to compare VUA with continuous and interrupted suturing directly and identify the effect, if any, of the different techniques. In terms of recovery from PPI, a previous study utilizing VUA with continuous suturing by Harpster and Brien. [10] also reported a rapid return of urinary control. According to this study, if the urethral catheter was removed a mean of 4 days after surgery, the recovery rate from PPI was 51% at postoperative day 7 and 100% at postoperative month 4. Though differences in urethral catheterization duration were present, our study also demonstrated early recovery in the continuous group according to the criterion for social continence (pad per day≤1) at postoperative month 3 (P=0.031), and the time required to reach social continence was shorter in the continuous group. However, between months 6 and 12, the recovery rates were not significantly different between the two groups. With respect to full recovery, the continuous group showed a higher rate at 12 months (P=0.047). We identified a tendency for earlier recovery to social continence and a higher rate of full recovery in the continuous group.

A number of limitations of the present study should be considered. First, the number of patients was relatively small. In total, 188 patients underwent RRP performed by a single surgeon. However, only 58 patients underwent VUA with continuous suturing. We excluded 11 patients because their follow-up duration was under 12 months or they could not be matched with patients in the interrupted group. Only 47 patients were included in each group. Second, there were differences in the surgeon's skills between the two methods. Considering the learning curve involved in performing VUA, we could not exclude the possibility that the surgeon's previous experience of performing VUA in open RRP and RLRP decreased the rate of VUA leakage. More reliable results should be obtained through randomized trials or by comparing anastomosis techniques after the surgeon has acquired enough experience in performing the two different techniques. The third limitation was the presence of preoperative overactive bladder (OAB). OAB can influence the incidence of PPI. However, we could not check whether patients had preexisting OAB. To exclude the effect of other factors on recovery from PPI, we must consider external factors such as OAB in future studies. The final limitation was that we could not compare the operative time of each anastomosis technique directly. Changing surgical techniques during a procedure prolongs the operation time, and elevates of the risk of complications associated with prolonged anesthesia.

The results of the present study can be interpreted in a number of ways. Many studies of RRP use interrupted suturing in VUA, and studies using continuous suturing are relatively small in number. In our study, we made an effort to decrease the effect of other factors that can influence recovery from PPI. Our study was 1:1 propensity score matched, and we excluded six factors that can influence recovery from PPI. The results of the present study are therefore perhaps more useful than those of other studies. Furthermore, all open RRPs were performed by a single surgeon in the present study. It is arguably more effective to compare differences in the results of VUA techniques performed by a single surgeon than by multiple surgeons because there is no optimal method of comparing surgeons' experience. It was widely known that continuous suturing is hard to per-

form in open radical prostatectomy. However, with the exception of two early cases, one involving a patient with a short urethra and one with a deep and narrow pelvic cavity, the surgeon was able to perform continuous VUA safely in all cases. If the surgeon was to acquire more experience with this technique, VUA with continuous suturing could be performed without difficulty. Considering the merits and demerits of VUA with continuous suturing, further studies and discussions concerning the application of continuous suturing to VUA in RRP are needed. RRP using VUA with continuous suturing could provide benefits with respect to anastomosis leakage and recovery from PPI.

In conclusion, the results of this study suggest that the type of suturing technique used for VUA in PPI can affect VUA site leakage. Earlier recovery to social continence and a higher rate of full recovery were observed with continuous suturing. VUA site leakage was also significantly less prevalent in the continuous group. Furthermore, we suspect that if surgical experience is accumulated, continuous anastomosis technique could be performed without difficulty. Further prospective studies or comparisons with RALRP are required.

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