The narrow vesicourethral angle measured on postoperative cystography can predict urinary incontinence after robot-assisted laparoscopic radical prostatectomy

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Running title: cystgram predicting incontinence after RALP

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ABSTRACT

OBJECTIVE

Radical prostatectomy is associated with complications including urinary incontinence. A significant association between specific features of the vesico-urethral anastomosis and urinary incontinence after radical prostatectomy has been demonstrated. The aim of this study was to identify the most useful predictor of postoperative urinary incontinence after robot-assisted laparoscopic radical prostatectomy (RALP) according to the features of the vesico-urethral anastomosis as determined by postoperative cystography.

MATERIALS AND METHODS

The final study cohort consisted of 150 patients. Postoperative cystography was performed within 1 week after RALP. The ratio between the longitudinal and horizontal lengths (L/H) of the bladder, the position of the urethrovesical junction (UVJ), and the bladder neck angle as seen on the cystogram were evaluated. Post-operative continence status was evaluated by 1-hour pad test 1 day after the catheter removal and safety pad retrospectively from

patient records. The association between these variables and urinary incontinence was then analyzed. All patients were followed for at least 1 year postoperatively.

RESULTS

The continence rate of the pad test and 1 month and 1 year after RALP were 31.3%, 56%, and 93.3%, respectively. In multivariate analyses, urinary incontinence was significantly associated with nerve sparing, L/H, and the vesical angle as determined on the 1-hr pad test, but only the vesical angle at 1 month and 1 year postoperatively.

CONCLUSION

A narrow vesical angle measured on cystography is a useful predictor of postoperative urinary incontinence after RALP.

Keywords

Vesicourethral angle, postoperative, urinary incontinence,

robot-assisted laparoscopic radical prostatectomy, cystography

Abbreviations & acronyms

RALP=robot-assisted laparoscopic radical prostatectomy

L/H=The ratio between the longitudinal and horizontal lengths of the bladder

UVJ=urethrovesical junction

PVUA=the posterior vesicourethral angle

BMI=body mass index

PSA=prostate-specific antigen

NS=nerve sparing

OR=odds ratio

CI=confidence interval

Introduction

Radical prostatectomy is one of the definitive treatments for localized prostate cancer. However, radical prostatectomy has been associated with complications and sequelae, including erectile dysfunction and urinary incontinence; these complications markedly decrease patient quality of life. Factors contributing to urinary incontinence are surgical experience, nerve sparing technique, bladder neck preservation, periurethral suspension, posterior reconstruction, total reconstruction, functional-length urethral sphincter preservation, and athermal dorsal vein complex dividing [1-7].

Perioperative images may facilitate prediction of urinary incontinence after RALP. Coakley et al. reported that membranous urethral length determined on magnetic resonance imaging (MRI) was related to the time taken to achieve stable postoperative urinary continence [8]. However, MRI is excessively expensive for use as a routine follow-up survey. In contrast, cystography is a convenient method for evaluating anastomotic leakage in daily practice. Parameters measured on postoperative cystography that are reportedly significantly associated with urinary incontinence after laparoscopic radical prostatectomy or robot-assisted laparoscopic radical prostatectomy (RALP) include postoperative shorter membranous urethral length, a more downward-directed bladder neck and a sharper bladder neck angle, a more downward-directed position of the urethrovesical junction (UVJ), hypo urethral movement, the narrow posterior vesicourethral angle (PVUA), and the higher ratio between the longitudinal and horizontal length of the bladder (L/H ratio) [9-14].

In the present study, we aimed to determine the most useful predictor of postoperative urinary incontinence after RALP according to the vesicourethral anastomotic features as measured on postoperative cystography.

Methods

Patients

The Institutional Review Board of our hospital approved this study. RALP was introduced in our hospital in August 2013, and 112 RALP operations had been performed by the end of September 2014. We retrospectively collected data from patients who underwent RALP between October 2014 and January 2016. In total, 187 patients were assessed for study inclusion; nine refused to undergo the pad test, seven could not perform the pad test due to pain, desire for defecation, marked incontinence, hematuria, or restricted fluids, two did not have the catheter removed due to leakage of the anastomosis, and 19 had insufficient cystography results. The final study cohort included 150 patients. All patients were followed up for at least 1 year postoperatively. Postoperative cystography was performed within 1 week after RALP. The study was presented to the institutional review board and approved as a retrospective cohort study based on the available evidence. The research conformed to the Declaration of Helsinki and local legislation.

Surgical procedure

Nerve sparing technique, anterior and posterior reconstruction, and bladder neck preservation were selected as required. Obturator lymph node dissection was performed in selected patients who had > 10% incidence of lymph node metastasis according to the Partin nomogram. The nerve sparing technique was performed in selected patients, most of whom underwent unilateral intrafascial dissection. After the prostate was removed from the rectal bed, Rocco's suture was performed. The vesicourethral anastomosis was performed using continuous suturing with 4-0 monofilament double needle using the Van Velthoven technique, and was confirmed to be watertight. Anterior fixation was performed between the bladder wall and the sutured dorsal vein complex. A pelvic drainage tube was passed through the da Vinci port on the right side.

Postoperative cystography

Cystography was performed on postoperative day 6 or 7. A total of 100 ml of saline solution containing contrast media was infused into the bladder, and front-view images were obtained. The 45°-semilateral-view images were not included in the current study, as they were inaccurate and unstable due to unstable patient positioning. Provided there was no leakage at the anastomosis, the balloon catheter was removed. If leakage was detected, cystography was repeated 7 days later. Anatomical features were evaluated using the following methods.

Cystography parameters

The following parameters were measured on front-view cystography: the L/H ratio, and the craniocaudal distance from the most proximal margin of the symphysis pubis to the position of the UVJ (Fig. 1). The bladder neck angle was measured as the angle of the bladder neck relative to the bilateral margin over the pelvic inlet (Fig. 2). The measurements were done blinded to the continence results.

Urinary incontinence definition

The continence status was assessed by the 1-hour pad test conducted the day after catheter withdrawal, and the patient-reported pad usage over the 1 month and 1 year interval after RALP.

The 1-hour pad test was performed according to the International Continence Society recommendations. The patient was instructed not to void, and to then drink 500 ml of sodium-free liquid. After sitting or resting for 30 minutes, the patient performed the recommended activities. The continence group consisted of patients with a pad weighing ≤ 2 g after the test, while the incontinence group consisted of patients with a pad weighing > 2 g [15].

Regarding the patient-reported pad usage, recovery of urinary continence was defined as wearing no pads or wearing an occasional pad for security.

Statistical analysis

The Mann-Whitney U test was used to determine significant differences in parameters. Univariate logistic regression analysis was carried out to determine the predictive factors for urinary incontinence. The independent predictive factors were then confirmed using multivariate logistic regression analysis with a stepwise procedure. Finally only remaining factor listed in table. Cutoff values for independent predictive factors of urinary continence were determined using receiver operating characteristics (ROC) analysis. All analyses were performed with the SPSS statistical package, version 21 (SPSS, Chicago, IL, USA). A p value of < 0.05 was considered significant.

Results

The patient characteristics are shown in Table 1. The respective urinary continence rates at the 1-hour pad test, and 1 month and 1 year after RALP were 31.3%, 56%, and 93.3%.

Univariate analysis revealed four significant predictors of urinary incontinence at the 1-hour pad test (Table 2). Multivariate analysis revealed that nerve sparing technique, L/H ratio, and vesical angle were significantly associated with urinary incontinence at the 1-hour pad test; vesical angle was also significantly associated with urinary incontinence at 1 month and 1 year after RALP (Table 3, 4). There were no significant differences in vesical angle between the patients who underwent nerve sparing (100.2°±13.9) and those who did not (98.3°±11.2), respectively, p= 0.8288.

We performed ROC analysis to elucidate the optimal cutoff value for vesical angle. Respective cutoff values of 100.47°, 100.47°, and 86.5° yielded the best accuracy in ROC analysis at the 1-hour pad test, and at 1 month and 1 year post-RALP. The bigger angle is better. According to the area under the ROC curve, the respective sensitivities at the 1-hour pad test, and at 1 month and 1 year post-RALP were 0.6705, 0.6567, and 0.7726 (Fig. 3).

Discussion

Among a variety of factors, including cystography parameters, the vesical angle was the strongest predictor of both very early and late urinary continence after RALP. ROC analysis showed that a vesical angle 100° < was associated with poor urinary continence in the early postoperative period.

The early recovery of urinary incontinence after radical prostatectomy is reportedly related to various demographic and anatomical factors, as well as surgical techniques. Many investigators have reported that modified surgical techniques improve the time to recovery of urinary incontinence [1-7].

However, none of these technical efforts completely enabled the prediction of early recovery of urinary incontinence, and it might be difficult to validate the surgical techniques carried out by each individual surgeon.

Perioperative images may facilitate prediction of urinary incontinence. Studies have investigated whether postoperative cystography can assist with the prediction of urinary incontinence by evaluating postoperative membranous urethral length, vesical angle, UVJ position, urethral movement, PVUA, and L/H ratio. Ito et al. reported that the L/H ratio and PVUA are significantly associated with urinary incontinence in univariate analysis, but the evaluated point was not reported [14]. Shao et al. reported that a more downward-directed bladder neck and a sharper bladder neck angle are associated with urinary incontinence at 1, 6, 12, and 24 months post-RALP in univariate analysis; however, they evaluated the bladder neck angle and the level of the bladder neck on postoperative cystography, and did not include the L/H ratio [12].

One of the unique aspects of our study is that the 1-hour pad test was used to define very early urinary continence after RALP. The pad test was performed the day after catheter removal, and 30% of the patients were continent (≤ 2 g urine leakage). Haga et al. also used the pad test to define continence after RALP, and reported that the postoperative degree of external urethral sphincter atony was significantly associated with urinary continence at the 1-hour pad test [9] ; however, the evaluated point was not provided.

To determine why a narrow vesical angle was associated with urinary incontinence, we need to consider the normal male voiding mechanism. Nishio et al. reported that striated urethral sphincter relaxation and anterior fibromuscular stroma contraction occurred at initiation of voiding to open the bladder neck and urethra, and change the posterior vesical urethral angle (narrow the bladder neck angle) on real-time MRI [16] ; this situation resembled urethral incontinence. We also considered the effect of urethral stress. To prevent postoperative incontinence, it is reportedly important to avoid tension on the final anastomosis by releasing the bladder from the peritoneum [17]. The vesical angle could be related to the stress applied to the urethra, which is an important factor affecting urinary incontinence. When the urethra was stressed along the longitudinal axis, the urethral lumen was tensioned and opened. The stronger the urethral stress along the longitudinal axis, the longer the longitudinal length of the bladder, which pulled the UVJ position down caudally, and consequently increased the L/H ratio and narrowed the vesical angle. Therefore, urinary incontinence occurred. Among the various factors affecting urinary incontinence, the vesical angle was one of the most important.

Although not demonstrated *in vivo*, an oblate bladder may have better compliance than a prolate bladder, and higher storage pressure may work against urinary continence [18]. That is, the wider the vesical angle, the more compliant the bladder. These anatomic features may cause these effects by sparing the functional urethral length, bladder neck preservation, and posterior and anterior reconstruction. Tewari et al. described a reproducible technique for supporting the urethral continence mechanism by anterior and posterior reconstruction, referred to as the ‘total anatomic reconstruction’ technique ; cystography showed that patients that underwent total reconstruction had minimal descent of the UVJ compared with a control group and an anterior reconstruction group [19]. However, in the current study, the position of the UVJ was not significantly associated with urinary incontinence at the 1-hour pad test in multivariate analysis; we considered that a wide vesical angle revealed the same condition in the current study. Our results indicate that support of the lateral side of the vesicourethral anastomosis to the pelvic floor, such as the iliopubic tract, may be good for maintaining urinary continence.

The recovery of urinary incontinence is not only positively affected by nerve sparing, but also by preserving as much as possible of the anatomical cradle of the prostate, its associated investing fascia, its anterolateral tissues, and its posterolateral neurovascular bundles. However, the present study found no significant differences in vesical angle between the nerve sparing group and the non-nerve sparing group. Hence, the most useful predictor of urinary incontinence is controversial.

For patients with urinary continence, physical therapy with pelvic floor rehabilitation is the most common first-line treatment. If the vesical angle measured on cystography was less than 100° and urinary incontinence was remarkable, patients may require medical therapy or pelvic floor rehabilitation in the early postoperative period.

To the best of our knowledge, the present study is the first to perform multivariate analysis of a variety of cystography parameters and report that the vesical angle is significantly associated with both short- and long-term urinary incontinence.

The present study included the following limitations. First, most of the surgeries were carried out by a total of six surgeons. However, three experienced surgeons supervised all operations performed by the other three surgeons. Second, this was a non-randomized retrospective study conducted in a single institute. Third, there was a small number of patients. Fourth, 1hr pad test was not performed 1 months and 12 months after RALP. Fourth, The continence status by safety pad was evaluated interview by physician, not the validated questionnaire. Further prospective, randomized, multicenter studies are required to confirm our findings.

In conclusion, the vesicourethral anastomosis features measured on postoperative cystography could facilitate prediction of postoperative urinary incontinence after RALP. Narrow vesical angle is significantly associated with urinary incontinence at the 1-hour pad test performed the day after catheter removal, and at 1 month and 1 year after RALP. The vesical angle on cystography is a useful predictor of urinary incontinence after RALP.

Disclosure statement

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Figure legends

Fig. 1 Front view. The figure shows the measurement of the longitudinal (a) and horizontal (b) (L/H) length ratio. (c) Craniocaudal distance from the most proximal margin of the symphysis pubis to the position of the urethrovesical junction.

Fig. 2 The bladder neck angle was measured as the angle between the bladder neck and the bilateral margin over the pelvic inlet.

Fig. 3 The ROC curve of the vesical angle to predict urinary incontinence at (a) 1hr-pad test, (b) 1 month and (c) 1 year was shown with AUC of the parameters. The most accurate cut off values at 1hr-pad test, 1 month, and 1 year were 100.47, 100.47, and 86.5 degree, respectively.

Fig. 1

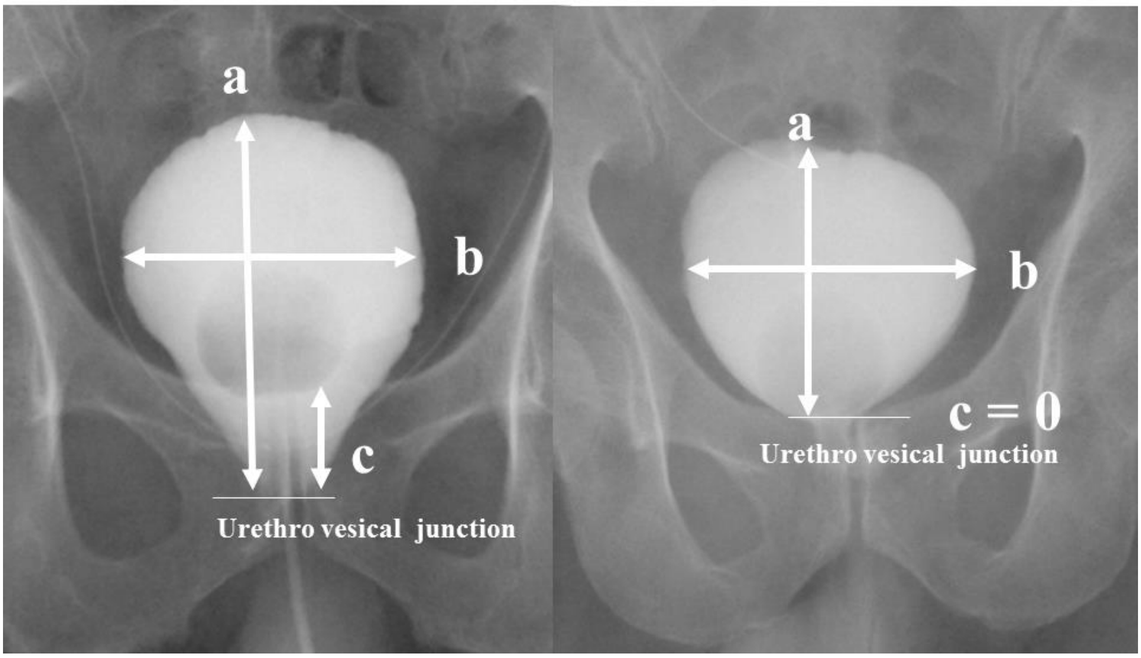

a
b
c
Urethro vesical junction
a
b
c = 0
Urethro vesical junction

Fig. 2

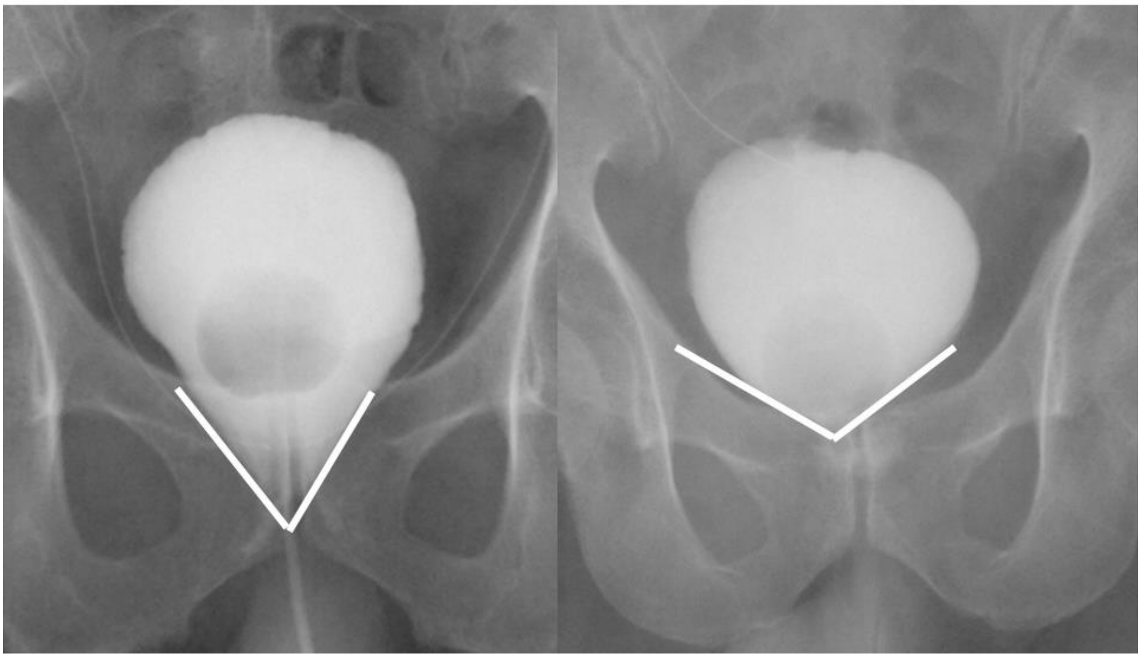
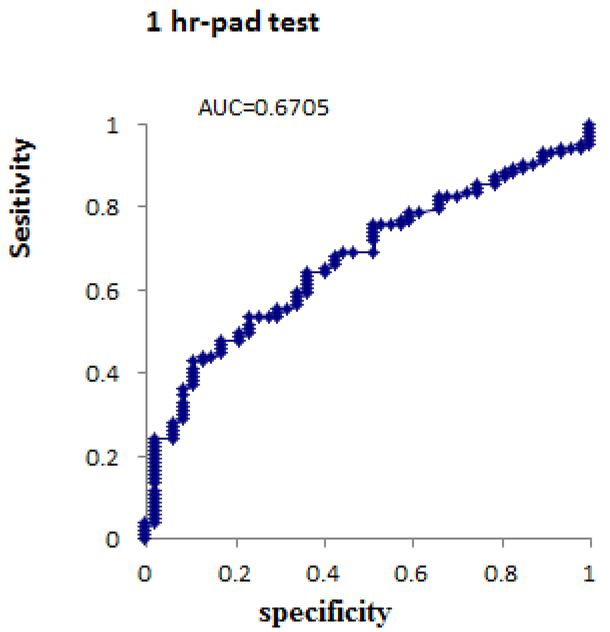
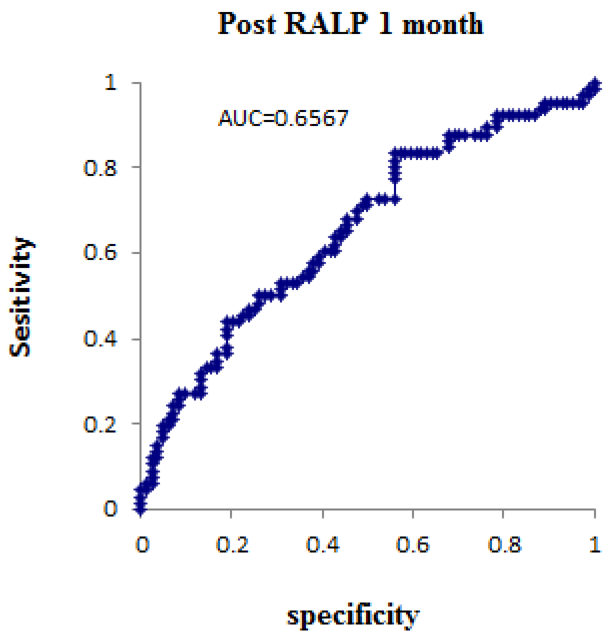


Fig. 3

(a)


1 hr-pad test
AUC=0.6705
Sesitivity
specificity
0
0.2
0.4
0.6
0.8
1

(b)


Post RALP 1 month
AUC=0.6567
Sesitivity
specificity
0
0.2
0.4
0.6
0.8
1

(c)

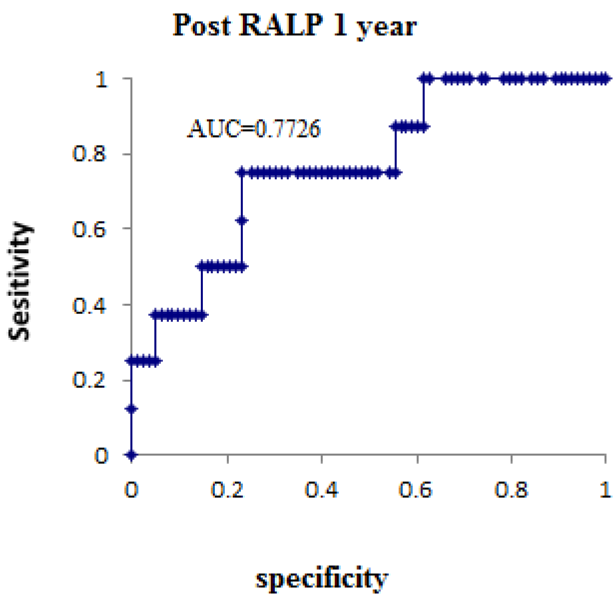


Table 1 Patients characteristics

Valuable	
N	150
Age(year)	69 ± 4.8
BMI	24 ± 2.8
PSA(ng/ml)	6.8 ± 8.6
Clinical stage	
T1c	115
T2a	26
T2b	4
T2c	2
T3a	3
NS(%)	72(48)
Specimen weight(g)	43 ± 18.1
L/H(%)	109 ± 19
Vesical angle(°)	98 ± 12.6
Position of UVJ(mm)	11.2 ± 6.9

Continuous various were reported as median (±standard deviation)

Table 2 Univariate and multivariate analysis for incontinence at 1 hr-pad test on the next day of the catheter removal

Valuable	Pad test ≦2g	2g<	P value univariate	P value multivariate
N	47	103		
Age(year)	68.0 ±5.0	69.0± 4.7	0.1702	
BMI	23.4 ± 3.1	24.1 ± 2.7	0.3369	
NS(%)	30(63.8)	42(40.8)	0.0103	0.0055
Specimen weight(g)	42.0 ± 14.7	44.0 ± 22.3	0.2731	
L/H(%)	105.2 ± 13.3	112.9 ± 20.5	0.0033	0.00354
Vesical angle(°)	103 ± 9.4	95.4 ± 13.2	0.0008	0.0059
Position of UVJ(mm)	9.9 ± 6.2	11.5 ± 7.1	0.0129	

Continuous various were reported as median (±standard deviation)

Table 3 Univariate and multivariate analysis for incontinence at 1M after RALP

Valuable	Safety pad(1M) 0-1	2≦	p value univariate	p value multivariate
N	84	66		
Age(year)	69.0 ± 5.2	68.0 ± 4.2	0.8350	
BMI	24.3 ± 3.1	23.9 ± 2.5	0.4156	
NS(%)	45(53.6)	27(40.9)	0.1839	0.127
Specimen weight(g)	41.5± 23.9	44.5 ± 14.7	0.1304	
L/H(%)	107.5 ± 17.9	112.5 ± 20.0	0.0745	
Vesical angle(°)	101.5 ± 11.1	93.4 ± 13.4	0.0010	0.006
Position of UVJ(mm)	10.4 ± 5.8	12.5 ± 7.8	0.0069	0.1184

Continuous various were reported as median (±standard deviation)

Table 4 Univariate and multivariate analysis for incontinence at 1year

	Safety pad(1year)		p value	p value
Valuable	0-1	2≦	univariate	multivariate
N	125	9		
Age(year)	69 ± 5.5	69 ± 3.6	0.6957	
BMI	23.8 ± 2.8	26.2 ± 2.9	0.1219	
NS(%)	68(54.4)	3(33.3)	0.3109	0.858
Specimen weight(g)	42 ± 16	50 ± 11.1	0.1505	
L/H(%)	107 ± 19.5	113.6 ± 20.1	0.2059	
Vesical angle(°)	98.4 ± 12.1	86.1 ± 14.5	0.0088	0.0103
Position of UVJ(mm)	11.0 ± 7.2	20.1 ± 8.2	0.0110	

Continuous various were reported as median (±standard deviation)