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Urinary continence following laparoscopic radical prostatectomy: Association with postoperative membranous urethral length measured using real-time intraoperative transrectal ultrasonography

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Abstract. Urinary incontinence is a major complication following radical prostatectomy. The aim of the present study was to assess the association between urinary continence following laparoscopic radical prostatectomy (LRP) and various factors measured using real-time intraoperative transrectal ultrasonography (TRUS). Patients (n=53) with localized prostate cancer underwent LRP in combination with real-time intraoperative TRUS navigation and were evaluated for urinary continence for more than 6 months following LRP. Prostate size, membranous urethral length (MUL) and bladder-urethra angle were measured using real-time intraoperative TRUS immediately before and after surgery. Urinary continence was regained by 4, 15 and 27 patients 1, 3 and 6 months after LRP, respectively. Longer postoperative MUL was significantly correlated with recovery of urinary continence 1, 3 and 6 months after LRP. In addition, an increase in difference between preoperative and postoperative MUL was also associated with superior continence. No correlation was observed between postoperative MUL and the rate of tumor-positive surgical margins. Larger prostate volume was correlated to postoperative continence 6 months after surgery. Shorter operation time and less blood loss resulted in postoperative urinary continence 1 month after LRP. Preoperative MUL, bladder-urethra angle, age and body mass index had no correlation with urinary continence. Postoperative MUL was the most significant factor for early recovery of urinary continence following LRP. These results indicate that preservation of longer urethra during surgery may be recommended without tumor-positive surgical margins.

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Abbreviations: BMI, body mass index; LRP, laparoscopic radical prostatectomy; MUL, membranous urethral length; RP, radical prostatectomy; SD, standard deviation; TRUS, transrectal ultrasonography

Key words: urinary continence, membranous urethral length, laparoscopic radical prostatectomy, transrectal ultrasonography

Introduction

Radical prostatectomy (RP) is one of the definitive therapy options for localized prostate cancer. However, one of the major adverse events that impair quality of life is urinary incontinence. It has been reported that the rates of urinary incontinence following RP range from 6 to 69% (1,2). This range is wide due to variations in the definition of urinary incontinence, patient selection and surgical technique. A number of risk factors for urinary incontinence have been analyzed (3,4). These include preoperative factors (patient age, body weight and prostate volume) and intraoperative factors (operative method: open vs. laparoscopy, bladder-neck preservation, urethral length preservation, neurovascular bundle sparing and puboprostatic ligament sparing). Although these factors have been examined, few achieved independent significance (i.e., high-level evidence) with regard to urinary continence. Moreover, several reported results have been controversial irrespective of their studying the same factors. Therefore, the identification of predictive markers for urinary continence following RP, which are easily measured, is essential.

Laparoscopic radical prostatectomy (LRP) is less invasive compared with open procedures and is therefore performed in our institution. In addition, the real-time intraoperative transrectal ultrasonography (TRUS) navigation system is combined with LRP to prevent surgical complications such as rectal injury and to identify anatomy such as bladder-prostate and prostate-urethra borders and neurovascular bundle for accurate dissection. To the best of our knowledge, no studies on various intraoperative anatomical evaluation of membranous urethral length (MUL), bladder-urethra angle and prostate size have been performed thus far in LRP using TRUS. The present study evaluated the relationship between urinary continence following LRP and various factors measured using real-time intraoperative TRUS.

Materials and methods

Patients. The current study was conducted at the Department of Urology, Faculty of Medicine, Osaka Medical College, Japan, between 2009 and 2010. The objectives and contents of this study and the significance of participation were explained to the patients. Their informed consent was obtained before the study commenced. This study was performed with the approval of the local Human Investigations Committee.

A total of 53 patients with localized prostate cancer underwent LRP in combination with the real-time intraoperative TRUS navigation system and were evaluated for urinary continence for >6 months after LRP. The age range of the patients was 60-78 years (median 71 years). Histological diagnosis revealed that the patients exhibited adenocarcinoma. Their pathological staging according to TNM classification was: T2 (n=48), and T3 (n=5), respectively. The Gleason score sum was: <7 (n=11), 7 (n=27), and >7 (n=15), respectively.

LRP procedure with real-time intraoperative TRUS navigation. Antegrade LRP was performed retroperitoneally. Preservation of membranous urethra, puboprostatic ligament sparing and bladder-neck sling suspension were performed for early recovery of urinary continence.

LRP was accompanied with real-time intraoperative TRUS guidance for the prevention of rectal injury, anatomical detection for accurate dissection of bladder-prostate border and prostate-urethra border and preservation of neurovascular bundle. The Aloka Prosound α6 ultrasound system with a 5.5-7.5 MHz bi-plane probe was used for TRUS navigation. TRUS was performed by an experienced urologist. MUL and bladder-urethra angle were measured immediately before and after LRP. Prostate size was also evaluated preoperatively. Pre- and postoperative MUL were defined as the distance from prostate apex to urethral bulb and the distance from bladder neck to urethral bulb, respectively. Bladder-urethra angle was defined as the angle between the anterior wall of the bladder and the membranous urethra.

Statistical analysis. Patients with urinary continence were defined as those using 0-1 pad per day. For statistical analysis, the Student's t-test was used. P<0.05 was considered significant.

Results

Association between preoperative factors and urinary continence following LRP. Patients (n=53) with prostate cancer were evaluated for urinary continence for >6 months after LRP. Urinary continence was regained by 4 (7.5%), 15 (28.3%) and 27 (50.9%) patients 1, 3 and 6 months after LRP, respectively.

The correlation between preoperative factors and urinary continence following LRP was examined. Preoperative factors included patient age, body mass index (BMI) and prostate volume measured by intraoperative TRUS. Patients with urinary continence 6 months after LRP exhibited larger prostate size, although no significant association was observed 1 and 3 months after surgery (Table I). There was no relationship between postoperative urinary continence and age or BMI (Table I).

Table I. Relationship between preoperative factors and urinary continence after LRP.

Preoperative factors (mean ± SD)	Urinary continence	Postoperative period		
		1 M	3 M	6 M
Patient age	+	73.0±3.0	72.0±3.0	71.0±4.0
(71±4 years)	-	70.0±5.0	70.0±5.0	70.0±5.0
BMI	+	22.7±1.8	24.1±1.8	23.4±1.9
(23.4±2.1)	-	23.5±2.1	23.2±2.2	23.4±2.3
Prostate size	+	17.2±6.1	24.0±10.3	23.5±10.7[a]
(20.8±9.3 cm^3)	-	21.1±9.5	19.6±8.7	18.0±6.7

[a]p<0.05 vs. urinary continence (-).

Table II. Relationship between perioperative factors and urinary continence after LRP.

Perioperative factors (mean ± SD)	Urinary continence	Postoperative period		
		1 M	3 M	6 M
Operation time	+	193±9[a]	216±48	222±48
(224±47 min)	-	226±48	227±46	226±46
Blood loss	+	393±239[a]	602±561	651±532
(663±521 ml)	-	685±533	687±511	676±520

[a]p<0.05 vs. urinary continence (-).

Association between perioperative factors and urinary continence after LRP. Perioperative factors were operation time and blood loss. The mean time of operation was 224 min (SD: 47 min). A correlation was found between short operation time and urinary continence 1 month after LRP; however, no significant association was observed 3 and 6 months after surgery (Table II). The mean intraoperative blood loss was 663 ml (SD: 521 ml). Urinary continence 1 month after LRP was associated with low blood loss; however, no statistical significance was observed 3 and 6 months after LRP (Table II).

Relationship between intraoperative factors measured using real-time TRUS and urinary continence following LRP. Intraoperative factors measured by TRUS were MUL and bladder-urethra angle. MUL and bladder-urethra angle were evaluated immediately prior and subsequent to LRP. Preservation of membranous urethra, puboprostatic ligament sparing and bladder-neck sling suspension were performed for early recovery of urinary continence.

The mean pre- and postoperative MUL were 1.0 and 2.2 cm (SD: 0.2 and 0.3 cm), respectively. The mean difference between pre- and postoperative MUL was 1.2 cm (SD: 0.3 cm). Urinary continence following LRP was correlated with longer MUL (Table III). Increased difference between pre- and post-

Table III. Relationship between intraoperative factors measured by real-time TRUS and urinary continence after LRP.

Intraoperative factors (mean ± SD)	Urinary continence	Postoperative period		
		1M	3M	6M
Preoperative MUL	+	1.2±0.2	1.1±0.2	1.0±0.2
(1.0±0.2 cm)	-	1.0±0.2	1.0±0.2	1.1±0.2
Postoperative MUL	+	2.6±0.1[a]	2.4±0.3[a]	2.3±0.2[a]
(2.2±0.3 cm)	-	2.1±0.3	2.1±0.3	2.0±0.3
Difference between pre/postoperative MUL	+	1.5±0.2[a]	1.3±0.2[a]	1.3±0.2[a]
(1.2±0.3 cm)	-	1.1±0.3	1.1±0.3	1.0±0.3
Preoperative bladder-urethra angle	+	125±13	133±12	134±13
(133±14˚)	-	134±14	133±14	132±14
Postoperative bladder-urethra angle	+	105±13	111±14	110±16
(107±17˚)	-	107±17	105±18	104±18
Difference between pre/postoperative bladder-urethra angle	+	20±8	22±9	24±11
(26±15˚)	-	27±16	28±17	29±18

[a]p<0.05 vs. urinary continence (-).

operative MUL was also associated with urinary continence. However, there was no association between urinary continence and preoperative MUL.

The mean bladder-urethra angles prior and subsequent to LRP were 133˚ and 107˚ (SD: 14˚ and 17˚), respectively. Urinary continence after LRP was not associated with pre-/postoperative bladder-urethra angle and the difference between pre- and postoperative bladder-urethra angle (Table III).

Pathological findings of surgical margin. We then examined the relationship between postoperative MUL and the rate of tumor-positive surgical margins. There was no correlation between postoperative MUL and the frequency of pathological surgical margins (Table IV).

Table IV. Relationship between postoperative MUL and tumor-positive surgical margin rate.

Postoperative MUL	Tumor-positive surgical margin rate
≥2.2 cm (n=26)	11.5%
<2.2 cm (n=27)	7.4%

Discussion

A number of studies have discussed a variety of risk factors that influence urinary incontinence following RP. Identification of the reliable risk factors may aid in the prevention of postoperative urinary incontinence and selection of patients. However, substantial controversy exists regarding the risk factors. The findings regarding the real-time intraoperative TRUS navigation system in combination with LRP in the present study have demonstrated for the first time that longer postoperative MUL was markedly associated with early recovery of urinary continence after LRP. Additionally, longer MUL was not correlated with an increase in the tumor-positive resection margin rate. Although the data reported herein correspond to a small number of patients during a short-term follow-up, these results indicate that preservation of longer MUL during LRP may be significant in preventing postoperative urinary incontinence.

Several studies emphasized the significance of maximizing urethral length for favorable urinary control after RP. Myers recommended various operative methods for maintaining the length of urethral stump to achieve urinary continence after RP (5). Van Randenborgh *et al* maintained long urethral stump by intraprostatic dissection for a more rapid recovery of urinary continence following RP (6). A significant difference was observed in functional urethral length between urinary continent and incontinent patients who underwent RP (7,8). We also demonstrated that long postoperative MUL was associated with early recovery of urinary continence following LRP. However, maximizing MUL at the risk of compromising tumor-positive surgical margins should be discouraged. In this study, there was no correlation between the length of postoperative MUL and the rate of tumor-positive surgical margins. These findings indicate that preservation of longer MUL without tumor-positive surgical margins may be crucial for the early recovery of postoperative urinary continence.

Certain authors measured MUL using urodynamic assessment (5,7-10). In other studies, MUL was examined using endorectal magnetic resonance imaging (11,12). However, to the best of our knowledge, no studies are currently available regarding the measurement of pre- and postoperative MUL by real-time intraoperative TRUS navigation system combined with LRP. Real-time intaroperative TRUS navigation system is easily utilized. In addition, real-time intraoperative TRUS guidance with the doppler system is advantageous for the identification of accurate bladder-prostate and prostate-urethra borders for dissection, prevention of rectal injury and preservation of neurovascular bundle. These findings indicate that the combination of LRP and real-time TRUS may be recommended.

Puboprostatic ligament sparing and bladder-neck sling suspension were performed for early recovery of urinary continence following LRP (13). Poore *et al* demonstrated an earlier return to urinary continence for patients who underwent puboprostatic ligament sparing (14). In contrast, Deliveliotis *et al* revealed that puboprostatic ligament sparing was not essential for rapid return to urinary continence after RP (15). In the present study, puboprostatic ligament sparing and bladder-neck sling suspension was evaluated by bladder-urethra angle measured using real-time intraoperative TRUS. Urinary continence following LRP was not associated with pre/postoperative bladder-urethra angle and the difference between pre- and postoperative bladder-urethra angle. These findings indicate that puboprostatic ligament sparing and bladder-neck sling suspension may not be significant for the early recovery of continence after LRP.

A review of CaPSURE data revealed that patients with large prostate volume exhibited a lower urinary continence rate (16). Conversely, the present study demonstrated that large prostate size was associated with postoperative urinary continence 6 months after LRP. However, no significant association was observed 1 and 3 months after LRP. Another study found that no correlation was observed between prostate volume and urinary continence following RP (17). Since the mechanisms responsible for the discrepancy are unclear, further investigations are required.

Eastham *et al* found that there was an association between intraoperative blood loss and urinary incontinence following RP (17). However, Lepor *et al* demonstrated that there was no relationship between blood loss and continence following RP (18). This study revealed that reduced blood loss resulted in urinary continence 1 month after LRP; however, no significant association was observed 3 and 6 months after surgery. Blood loss is thought to be associated with other technical factors. These findings indicate that blood loss may not be a significant predictive indicator for urinary continence following LRP.

A number of studies have shown that there was a correlation between patient age and postoperative urinary continence following RP (1,8,17,19,20). Eastham *et al* reported 615 radical prostatectomies performed by a single surgeon (17). Catalona *et al* reviewed a large series (20). However, findings of other studies showed that age was not a risk factor for urinary incontinence following RP (18,21). Our data confirmed the latter results. The discrepancy may be due to patient selection and methodology.

Patient weight and BMI were reported to be predictive markers for urinary incontinence following RP (16,17). However, the present study revealed that there was no correlation between BMI and urinary continence following LRP. One of the reasons responsible for the discrepancy may be technical factors affected by BMI.

In conclusion, the preservation of long MUL and a low tumor-positive surgical margin rate appears to be feasible in prostate cancer patients undergoing LRP and offers a more favorable quality of life by reducing postoperative urinary incontinence.

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