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Preoperative Factors Predictive of Continence Recovery after Radical Retropubic Prostatectomy

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Purpose: We assessed the factors predictive of continence recovery after radical retropubic prostatectomy performed by use a single operative technique by a single surgeon.

Materials and Methods: Preoperative factors, including age, body mass index (BMI), prostate volume, prostate-specific antigen level, and anatomical information from preoperative magnetic resonance imaging (MRI), such as membranous urethral length, thickness of the levator ani muscle, and urogenital diaphragm, were evaluated in 94 consecutive patients who underwent radical retropubic prostatectomy between April 2005 and October 2010. Patients were also categorized into four different groups according to the overlying pattern of the prostatic apex and the membranous urethra. Continence status was evaluated by direct patient questioning at 12 months after the operation.

Results: The overall continence rate at 12 months after the operation was 79.8%. In the age- and BMI-adjusted logistic regression analysis, the membranous urethral length and the overlying pattern of the prostatic apex were significant predictive factors of the continence rate at 12 months after the operation (p=0.006 and p=0.007, respectively). Other predictive factors were not contributory. Patients with no overlapping observed between the prostatic apex and membranous urethra had longer membranous urethral lengths (14.24±2.73 mm) and higher rates of recovery of continence compared with other groups.

Conclusions: Membranous urethral length and shape of the prostatic apex as assessed by preoperative MRI are significantly associated with recovery of urinary continence after radical retropubic prostatectomy.

Key Words: *Prostate neoplasms; Prostatectomy; Urinary incontinence*

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INTRODUCTION

Radical retropubic prostatectomy (RRP) is the definitive treatment for localized prostate cancer [1]. One of the most troublesome side effects of RRP is urinary incontinence, which has both social and personal implications. Even in recent series from various accredited centers, 6 to 20% of patients reported some degree of postoperative incontinence despite improved surgical techniques [2-5]. The recent introduction of robotic surgery has allowed for the collection of more accurate anatomical information on periprostatic structures and has in turn facilitated various operative techniques aimed at enhancing postoperative outcomes in terms of continence and potency [6,7]. However, no single overwhelming surgical technique for preservation of urinary continence is believed to be feasible owing to various factors such as integral surgical factors, including the experience of the operator, as well as the patient's age, anatomical variations of the prostate and the urethral sphincter, and preoperative voiding status. This is understandable in light of the fact that the time elapsed until restoration of urinary continence varies significantly even in cases in which the same procedure has been applied by the same operator.

Several preoperative predictors of early recovery of continence after radical prostatectomy have been addressed in the literature, including age, obesity, bilateral neurovascular bundle (NVB) resection, membranous urethral length, shape of the prostatic apex, pelvic diaphragm thickness, and the ratio of levator ani thickness to prostate volume [8-14]. However, these studies possessed limitations in determining whether a predictive factor had significant and consistent effects on the achievement of continence as the result of various factors, such as encompassing a variety of surgical techniques, involving multiple operators, and utilizing no more than a single point measurement of continence. The purpose of our study was to determine the significant preoperative factors predictive of return of continence after RRP performed by use of a single operative technique by a single surgeon. The factors we studied were age, prostate-specific antigen (PSA) level, body mass index (BMI), NVB preservation, prostate volume, prostate length, preoperative estimated membranous urethral length, integrity of the pelvic floor muscle, and overlying pattern of the prostate apex in relation to the membranous urethra as determined by high-resolution magnetic resonance imaging (MRI).

MATERIALS AND METHODS

1. Subjects

Among 102 consecutive patients who underwent RRP between April 2005 and October 2010 for clinically localized prostate cancer, 94 patients were reviewed retrospectively. Three patients who had undergone radiotherapy or hormonal therapy preoperatively were excluded. Five patients who had a history of urinary incontinence or had undergone transurethral resection of the prostate before surgery were excluded as well. All operations were performed by a single operative technique by a single surgeon. All patients had a preoperative MRI of the prostate.

2. Surgical technique and postoperative evaluation

RRP was performed as originally described by Walsh, and in all cases, the endopelvic fascia, puboprostatic ligament, and bladder neck were not saved. Bladder neck reconstruction was selectively performed only when the bladder neck was widely opened. Urethrovesical anastomosis was performed by using 2-0 Vicryl sutures on a 5/8 circle tapered needle. The outside to inside suture was performed at the 11 o'clock position of the distal urethra with a distance of 0.5 cm on the urethral cutting margin, and then the inside to outside suture was done by using the same needle at the 1 o'clock position of the distal urethra leaving a 0.5-cm interval. Identical sutures were performed at the 3, 6, and 9 o'clock positions of the distal urethra. Then, using these stay sutures that had been placed in the outside of the distal urethra, inside to outside suturing was performed through the bladder neck at a position 1 cm distant from the dissection edge, leaving a 0.5-cm interval. While approximating the bladder neck to the distal urethra, the 6 o'clock position suture was tied first, and this was followed by sutures in the 12, 3, and 9 o'clock positions in order. When the vesicourethral anastomosis was finished, the end of the distal urethra was fixed 1 cm distant to the inside of the bladder neck. We named this anastomosis an "intussusception-like vesicourethral anastomosis". Neither the surgical approach nor the technique changed during the study period. NVB was preserved by the interfacial technique in 64 cases (25 unilateral or 39 bilateral). The Foley catheter was removed on the 7th day following surgery after checking for no extravasation by retrograde pericatheteral urethrography. When extravasation was present, the catheter was left in place until the retrograde pericatheteral urethrography showed no extravasation.

After surgery, postoperative continence status was recorded by direct patient questioning at 12 months after surgery. We assessed the predictive value of various preoperative factors including morphologic features at 12 months after RRP. Continence was defined as achieving zero pad use or the use of a liner for security reasons only.

3. MRI interpretation

All MR images in this study were retrospectively reviewed by single radiologist blinded to all pathological and clinical findings, including postoperative continence status. The membranous urethral length was measured on a midline sagittal T2-weighted image from a preoperative MRI and was cross-referenced to the coronal plane in 94 consecutive patients with newly diagnosed prostate cancer. The membranous urethral length was considered to be the distance from the most prominent portion of the prostate apex to the level of the urethra at the penile bulb, which is closely related to the residual urethral length after RRP. The prostate length was measured in the sagittal plane. The thickness of the levator ani muscle and urogenital diaphragm were measured in the coronal plane where it appeared the thickest (Fig. 1). To compare recovery of continence, patients were categorized into four groups (group 1, prostatic apex overlapping membranous urethra both anteriorly and posteriorly; group 2, prostatic apex overlapping membranous urethra anteriorly; group 3, prostatic apex overlapping membranous urethra posteriorly; and group 4, no overlapping observed between the prostatic apex and membranous urethra) according to the overlying pattern of the prostatic apex and the membranous urethra in the mid-sagittal MRI (Fig. 2), as previously reported [13].

4. Statistical analysis

Continuous variables were transformed to binary variables by dividing the values into two groups according to the mean value. The univariate association of the preoperative variables with continence state was tested with the chi-square test. We performed binary logistic regression analysis of each variable adjusted for age and BMI, because age and BMI are known to be associated with continence. Variables in the final model that exhibited a significant independent association with the outcome at a p-value of less

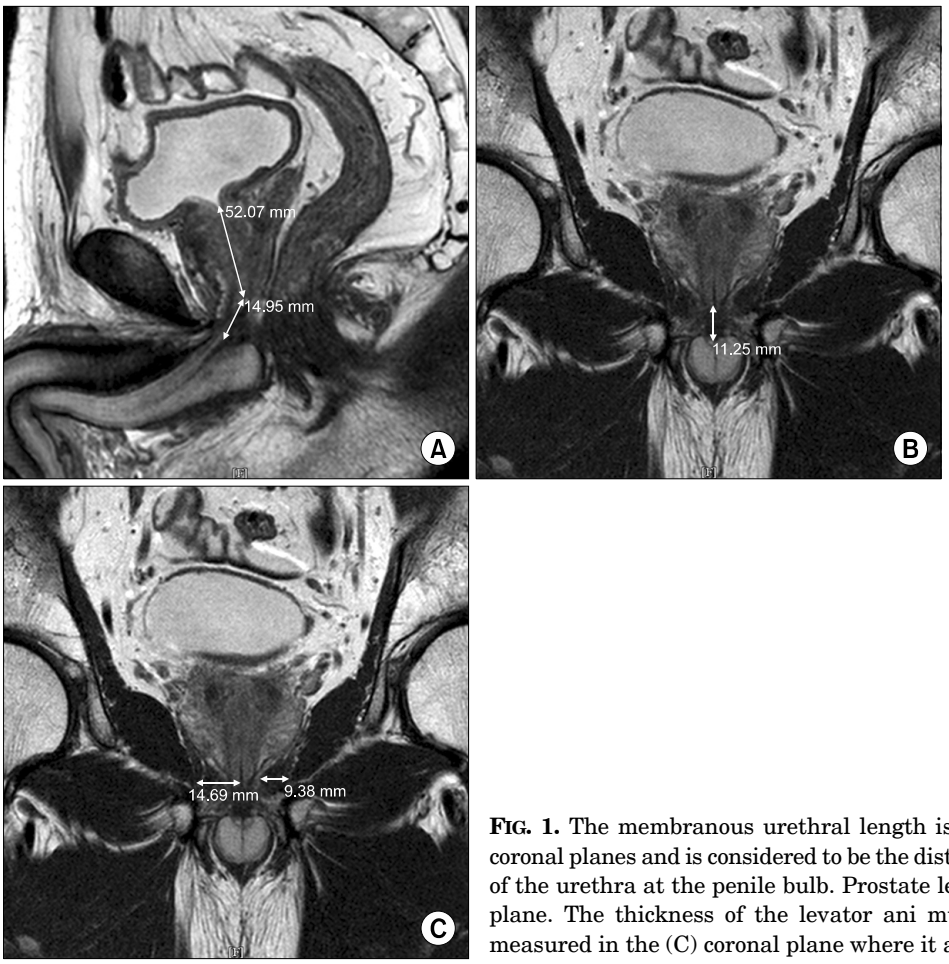

FIG. 1. The membranous urethral length is measured in the (A) sagittal and (B) coronal planes and is considered to be the distance from the prostatic apex to the level of the urethra at the penile bulb. Prostate length was measured in the (A) sagittal plane. The thickness of the levator ani muscle and urogenital diaphragm were measured in the (C) coronal plane where it appeared the thickest.

than 0.05 were considered as risk factors. The differences in various groups according to the overlying pattern of the prostatic apex into the membranous urethra were analyzed by the chi-square test and Kruskal-Wallis test. P-values of less than 0.05 were considered significant. All statistical analyses were performed with IBM SPSS ver. 19.0 (IBM Co., Armonk, NY, USA).

RESULTS

The patients' mean age was 65.13±5.82 years. The mean PSA level at diagnosis was 9.69±7.42 ng/ml, and the mean prostate volume was 29.74±13.51 ml. The pathological stage was T2 in 82 patients (87.2%) and T3 in 12 patients (12.8%). The mean membranous urethral length was 10.40±3.75 mm, and the mean thickness of the levator ani muscle and urogenital diaphragm were 10.31±2.24 mm and 19.29±4.17 mm, respectively (Table 1).

The overall continence rate at 12 months was 79.8%. The continence rate after 12 months for the first 47 patients and the second 47 patients was 74.5% and 85.1%, respectively. Return of continence at 12 months after RRP was significantly related to the membranous urethral length and overlying pattern of the prostate apex (p=0.003 and p=0.001, respectively). Age, PSA level, BMI, NVB preservation, prostate volume, prostate length, the thickness of the levator ani muscle, and urogenital diaphragm were not contributory (p=0.792, 0.210, 0.095, 0.558, 0.797, 0.722, 0.500, and 0.379, respectively) (Table 2).

In the binary logistic regression analysis of each variable adjusted for age and BMI, membranous urethral length and overlying pattern of the prostate apex were the variables exhibiting significant association with return of continence at 12 months (p=0.006 and p=0.007, respectively). Longer membranous urethras had higher postoperative continence rates with an odds ratio (OR) of 8.245 (95% confidence interval [CI], 1.830 to 37.149). When the patients were divided into four groups on the basis of the pattern of the prostatic apex, group 1 had 15 (16%) patients, group 2 had 15 (16%), group 3 had 28 (30%), and group 4 had 36 (38%) patients. The percentage of patients showing return of continence at 12 months after RRP was significantly different among the four groups ($p < 0.001$). Group 4, which comprised patients without an anterior or posterior overlying pattern, had a longer membranous urethral length (14.24±2.73 mm) ($p < 0.001$) (Table 3) and a higher rate of recovery of continence at 12 months after RRP with an OR of 16.282 (95% CI, 2.115 to 125.330) compared with the other groups (Table 2).

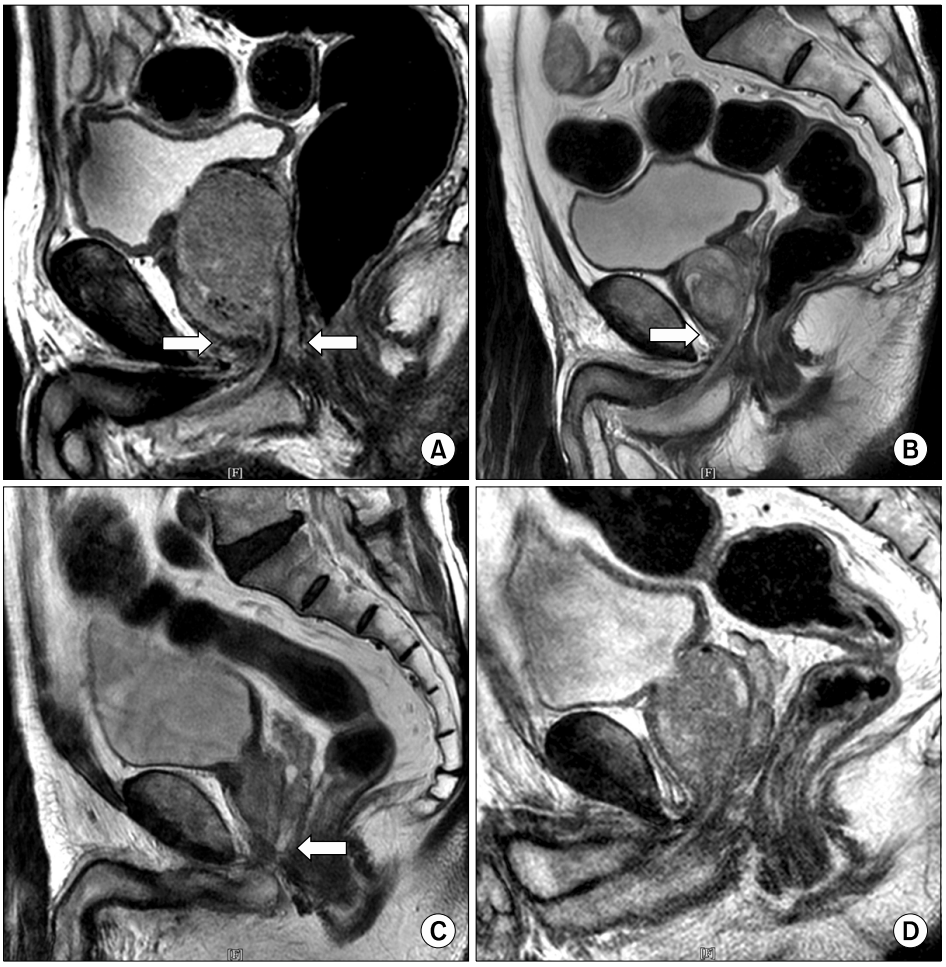

FIG. 2. Patients were categorized into four groups according to the overlying pattern of the prostatic apex into the membranous urethra on the midsagittal magnetic resonance imaging. (A) Group 1, prostatic apex overlapping membranous urethra both anteriorly and posteriorly; (B) group 2, prostatic apex overlapping membranous urethra anteriorly; (C) group 3, prostatic apex overlapping membranous urethra posteriorly; and (D) group 4, no overlapping observed between the prostatic apex and membranous urethra.

TABLE 1. Patient characteristics (n=94)

Characteristic	Value
Age (yr)	65.13±5.82
BMI (kg/m^2)	23.73±2.29
Serum PSA (ng/ml)	9.69±7.42
Gleason sum	
≤6	52 (55.3)
7	30 (31.9)
≥8	12 (12.8)
Prostate volume (TRUS, ml)	29.74±13.51
Prostate length (mm)	37.09±7.34
MUL (mm)	10.40±3.75
LA thickness (mm)	10.31±2.24
UGD thickness (mm)	19.29±4.17
Pathologic stage	
T2a	82 (87.2)
T3a	12 (12.8)
Positive margin	13 (13.8)

Values are presented as mean±SD or number (%).
BMI, body mass index; PSA, prostate-specific antigen; TRUS, transrectal ultrasound; MUL, membranous urethal length; LA, levator ani; UGD, urogenital diaphragm.

DISCUSSION

The rate of urinary incontinence after RRP has been reported to be between 6% and 20% in recent studies [2-5]. In our study, 19 of 94 patients (20.2%) reported some degree of incontinence at 1 year after surgery, including those who reported wearing only 1 pad daily, which agrees with previous studies.

We used MRI to examine possible anatomical reasons for urinary incontinence after RRP because MRI has led to an improved anatomical understanding of periprostatic structures. Myers et al. [15] examined and defined the membranous urethral length, levator ani muscles, rectourethralis muscles, puboprostatic ligaments, and their anatomic relations, which are relevant to RRP, by use of MRI. Coakley et al. [10] first reported that preoperative membranous urethral length, measured by MRI, correlates with urinary continence after RRP. They examined 211 patients by MRI before RRP and reported a mean membranous urethral length of 14 mm (range, 6 to 24 mm). A longer preoperative membranous urethral length was associated with a significantly more rapid return of urinary continence after RRP. In addition, 89% of patients with a preoperative membranous urethral length greater than 12 mm were completely continent 1 year after surgery, com-

TABLE 2. Univariate analysis and age- and BMI-adjusted logistic regression of factors affecting continence rate

	Continence rate (%)	Univariate (p-value)	Age- and BMI-adjusted logistic regression	
			Odds ratio (95% CI)	p-value
Age (yr)		0.792	-	-
≤65	78.6			
>65	80.8			
PSA (ng/ml)		0.210	0.883 (0.340-2.294)	0.799
≤9.69	83.6			
>9.69	72.7			
BMI (kg/m^2)		0.095	-	-
<23	70.6			
≥23	85.0			
NVB preservation		0.558	1.212 (0.522-2.817)	0.655
No	83.3			
Yes	78.1			
Prostate volume (ml)		0.797	1.759 (0.710-4.362)	0.223
≤29.74	78.7			
>29.74	80.9			
Prostate length (mm)		0.722	1.565 (0.521-4.706)	0.425
≤37.09	78.6			
>37.09	81.6			
MUL (mm)		0.003	8.245 (1.830-37.149)	0.006
≤10.40	69.9			
>10.40	94.7			
LA thickness (mm)		0.500	1.112 (0.463-2.669)	0.813
≤10.31	82.4			
>10.31	76.7			
UGD thickness (mm)		0.379	2.084 (0.741-5.862)	0.164
≤19.29	76.8			
>19.29	84.2			
Overlying pattern of the prostatic apex		0.001	16.282 (2.115-125.330)	0.007
Group 1-3	69.0			
Group 4	97.2			

BMI, body mass index; CI, confidence interval; PSA, prostate-specific antigen; NVB, neurovascular bundle; MUL, membranous urethal length; LA, levator ani; UGD, urogenital diaphragm. Group 1, apex overlapping membranous urethra both anteriorly and posteriorly; Group 2, apex overlapping membranous urethra anteriorly; Group 3, apex overlapping membranous urethra posteriorly; Group 4, no overlapping observed between the apex and membranous urethra.

TABLE 3. Overlying pattern of the prostatic apex and the percentage of patients showing return of continence

	Group 1	Group 2	Group 3	Group 4
No. of patients (%)	15 (16)	15 (16)	28 (30)	36 (38)
MUL	7.43±1.42	8.50±2.07	8.00±1.45	14.24±2.73
Continence at 12 months (%)	5 (33.3)	12 (80.0)	23 (82.1)	35 (97.2)

MUL, membranous urethral length; Group 1, apex overlapping membranous urethra both anteriorly and posteriorly; Group 2, apex overlapping membranous urethra anteriorly; Group 3, apex overlapping membranous urethra posteriorly; Group 4, no overlapping observed between the apex and membranous urethra.

pared with 77% of patients with a preoperative length of 12 mm or less. Paparel et al. [12] also reported that patients with a longer preoperative membranous urethral length experienced faster recovery of urinary incontinence (p=0.011).

Our study confirms these findings, showing that a longer membranous urethral length was significantly associated with continence recovery 1 year after RRP (p=0.006), whereas PSA level, NVB preservation, prostate volume, prostate length, thickness of the levator ani muscle, and urogenital diaphragm were not contributory.

Additionally, Coakley et al. [10] reported a mean urethral length of 14 mm. Paparel et al. [12] also reported a median urethral length of 14 mm. However, in the present

study, the mean and the median membranous urethral lengths were shorter than previously reported, at 10.40 mm and 9.06 mm, respectively. The present study exclusively enrolled ethnic Koreans, and although previous studies have not addressed the issue of ethnic differences, the difference in membranous urethral length may be partially accounted for by the difference in ethnicity.

Lee et al. [8] reported that the variations in the shape of the prostatic apex, in relation to the membranous urethra, may significantly affect the early recovery of urinary continence within 3 months after RRP. They concluded that patients with a prostatic apex overlapping the membranous urethra had a higher risk of excessive shortening of the urethra after RRP and therefore had a greater chance of delayed return of urinary continence. They suggested that assessing the apical shape on a preoperative mid-sagittal MRI may be just as important as measuring the urethral length in predicting the postoperative recovery of urinary continence.

Our data demonstrated that patients without an anterior or posterior overlying pattern had higher rates of recovery of continence not only during the early (within 3 months) postoperative period as Lee et al. [8] reported, but also 12 months after the operation. Patients without an anterior or posterior overlying pattern also had longer membranous urethral length (14.24±2.73 mm). This result suggests that patients without an anterior or posterior overlying pattern have a longer membranous urethra and have an easier time of obtaining an adequate membranous urethral length after RRP, resulting in an early return of urinary continence as well as better continence recovery 1 year after RRP.

As we have shown, preoperative evaluations of the membranous urethral length and the most prominent part of the prostatic apex on a mid-sagittal MRI are useful predictors of the return of urinary continence. Even though the most important goal of RRP is to control cancer, quality of life after the surgery is also important [16]. Both measurement of the membranous urethra length and assessment of the shape of the prostatic apex may be useful in determining the best treatment for localized prostate cancer. These measurements can be made during a routine prostate MRI to localize and stage the cancer and thus do not require any additional examination. Evaluating both the membranous urethra and the shape of the prostatic apex can give patients more information about postoperative incontinence and can help in the patient's decision making.

Our study had several limitations. First, this study was retrospective and was based on a small group of patients. Second, we only examined the morphologic findings on high-resolution MRIs preoperatively, specifically, membranous urethral length, integrity of the pelvic floor muscle, and overlying pattern of the prostate apex. We did not examine the postoperative length of the membranous urethra or perform a functional urodynamic examination of the urethra. Third, the standard of reference was imperfect because the degree of postoperative incontinence was determined by direct patient questioning rather than by an objective urodynamic study.

CONCLUSIONS

Membranous urethral length and shape of the prostatic apex as observed in preoperative MRI are significantly associated with a return of urinary continence after RRP.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

REFERENCES

1. Henry RY, O'Mahony D. Treatment of prostate cancer. J Clin Pharm Ther 1999;24:93-102.
2. Catalona WJ, Carvalhal GF, Mager DE, Smith DS. Potency, continence and complication rates in 1,870 consecutive radical retropubic prostatectomies. J Urol 1999;162:433-8.
3. Steiner MS, Morton RA, Walsh PC. Impact of anatomical radical prostatectomy on urinary continence. J Urol 1991;145:512-4.
4. Eastham JA, Kattan MW, Rogers E, Goad JR, Ohori M, Boone TB, et al. Risk factors for urinary incontinence after radical prostatectomy. J Urol 1996;156:1707-13.
5. Graefen M, Walz J, Huland H. Open retropubic nerve-sparing radical prostatectomy. Eur Urol 2006;49:38-48.
6. Coughlin G, Palmer KJ, Shah K, Patel VR. Robotic-assisted radical prostatectomy: functional outcomes. Arch Esp Urol 2007;60: 408-18.
7. Mottrie A, Van Migem P, De Naeyer G, Schatteman P, Carpentier P, Fonteyne E. Robot-assisted laparoscopic radical prostatectomy: oncologic and functional results of 184 cases. Eur Urol 2007;52:746-50.
8. Lee SE, Byun SS, Lee HJ, Song SH, Chang IH, Kim YJ, et al. Impact of variations in prostatic apex shape on early recovery of urinary continence after radical retropubic prostatectomy. Urology 2006;68:137-41.
9. Song C, Doo CK, Hong JH, Choo MS, Kim CS, Ahn H. Relationship between the integrity of the pelvic floor muscles and early recovery of continence after radical prostatectomy. J Urol 2007;178: 208-11.
10. Coakley FV, Eberhardt S, Kattan MW, Wei DC, Scardino PT, Hricak H. Urinary continence after radical retropubic prostatectomy: relationship with membranous urethral length on preoperative endorectal magnetic resonance imaging. J Urol 2002;168:1032-5.
11. Wolin KY, Luly J, Sutcliffe S, Andriole GL, Kibel AS. Risk of urinary incontinence following prostatectomy: the role of physical activity and obesity. J Urol 2010;183:629-33.
12. Paparel P, Akin O, Sandhu JS, Otero JR, Serio AM, Scardino PT, et al. Recovery of urinary continence after radical prostatectomy: association with urethral length and urethral fibrosis measured by preoperative and postoperative endorectal magnetic resonance imaging. Eur Urol 2009;55:629-37.
13. Majoros A, Bach D, Keszthelyi A, Hamvas A, Mayer P, Riesz P, et al. Analysis of risk factors for urinary incontinence after radical prostatectomy. Urol Int 2007;78:202-7.
14. Sacco E, Prayer-Galetti T, Pinto F, Fracalanza S, Betto G, Pagano F, et al. Urinary incontinence after radical prostatectomy: incidence by definition, risk factors and temporal trend in a large series with a long-term follow-up. BJU Int 2006;97:1234-41.

15. Myers RP, Cahill DR, Devine RM, King BF. Anatomy of radical prostatectomy as defined by magnetic resonance imaging. J Urol 1998;159:2148-58.
16. Johansson E, Steineck G, Holmberg L, Johansson JE, Nyberg T, Ruutu M, et al. Long-term quality-of-life outcomes after radical prostatectomy or watchful waiting: the Scandinavian Prostate Cancer Group-4 randomised trial. Lancet Oncol 2011;12:891-9.