Association Between Postoperative Pelvic Anatomic Features on Magnetic Resonance Imaging and Lower Tract Urinary Symptoms After Radical Prostatectomy

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OBJECTIVE To elucidate the etiology of lower urinary tract symptoms (LUTS) after radical prostatectomy, the present study investigated associations between postoperative urethral and vesical anatomic features on magnetic resonance imaging (MRI) and LUTS.

PATIENTS AND METHODS Fifty consecutive patients undergoing radical prostatectomy also underwent preoperative and postoperative MRI. Preoperative MRI only evaluated preoperative membranous urethral length (MUL). Postoperative MRI evaluated postoperative MUL, posterior-urethral vesical angle, depth of the urethrovesical junction (UVJ), and urinary pooling inside the urethra and bladder neck configuration. At the same time as postoperative MRI, International Prostate Symptom Score (IPSS), quality of life index, continence grade, and uroflowmetry parameters were investigated. Associations between preoperative or postoperative MRI variables and questionnaire results or uroflowmetry were analyzed to examine the relationships between the morphology of urethral and vesical anatomic features and LUTS.

RESULTS Preoperative and postoperative MRI variables were not significantly associated with IPSS total score or uroflowmetry results. Urinary pooling inside the urethra was significantly associated with urgency score in the IPSS ($P = .005$). Postoperative MUL ($P < .001$), depth of the UVJ ($P = .002$), and urinary pooling inside the urethra ($P = .04$) were significantly associated with continence grade.

CONCLUSION Urinary pooling inside the urethra might induce urgency, and postoperative MUL and depth of UVJ were related to urinary incontinence. Avoiding damage to the nerves involved in continence to prevent inflow of urine into the urethra, preservation of MUL, and development of procedures to prevent descent of the bladder neck during surgery are therefore recommended. UROLOGY 84: 642–649, 2014. © 2014 Elsevier Inc.

Urinary incontinence after radical prostatectomy (RP) is one of the most disappointing adverse events and represents a cause of anxiety for both patients and physicians.[1] Recent attention has focused on not only urinary incontinence but also other lower urinary tract symptoms (LUTSs) after RP.[2,3] During RP, dissection of the trigone, posterior urethra at the bladder neck, and posterolateral neurovascular bundle induces functional changes to the lower urinary tract (LUT) caused by ischemic changes and denervation.[4] Moreover, RP induces anatomic changes to the LUT, caused by removal of the prostate and subsequent reanastomosis of the urethra and bladder neck.

Several studies have reported relationships between functional changes to the LUT as measured by urodynamic studies (UDS) and subjective symptoms in patients.[5,6] However, the etiology of LUTS after RP cannot be completely elucidated based solely on UDS. Although anatomic information on the LUT after RP might thus help to elucidate the mechanisms underlying LUTS evoked by RP, no studies have specifically addressed the relationships between morphology of the LUT after RP, as evaluated by magnetic resonance imaging (MRI), and LUTS. Understanding these relationships could help further improve operative procedures. We examined whether the urethral and vesical features as evaluated by

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postoperative MRI are associated with subjective symptoms and uroflowmetry after RP.

PATIENTS AND METHODS

Patients

Participants in this prospective, clinical cohort, observational study comprised 53 consecutive patients who underwent postoperative MRI after RP at our institution between October 2012 and October 2013. LUTSs after RP gradually improve, reaching a plateau at about 6 months.[7,8] We therefore excluded 3 patients who underwent MRI <6 months after RP, as these patients were assumed to still be undergoing improvement of LUTS. All patients underwent preoperative MRI. Of these, 24 patients underwent laparoscopic RP and 26 patients underwent retropubic RP. In all cases, we did not perform neurovascular bundle preservation, Rocco stitch for posterior reconstruction of Denonvilliers fascia,[9,10] or intussusception of the bladder neck to achieve early urinary continence.[11] No patients had baseline LUT abnormalities, such as neurogenic bladder or bladder outlet obstruction with overactive bladder. No patients underwent salvage radiotherapy, took medications that affect the LUT function, such as alpha blockers or antimuscarinics, or underwent bladder neck contracture or urethral stricture surgeries and injectable treatments, such as collagen, into the membranous urethra until the date of postoperative evaluation for LUTS. All study protocols were approved by the Ethical Committee of Fukushima Medical University School of Medicine. Informed consent was obtained from all patients before enrollment in the study, after explaining the purpose and methods.

Evaluation of LUTS and Urinary Function After RP

At the same time as postoperative MRI, LUTS and urinary function after RP were evaluated using International Prostate Symptom Score (IPSS), a quality of life (QOL) index, uroflowmetry, and postvoid residual urine volume (PVR) as determined by ultrasonography. The degree of incontinence was evaluated using a questionnaire that graded continence level on a 5-point scale: 1 = complete continence; 2 = 1 pad daily; 3 = 2-3 pads daily; 4 = ≥4 pads daily; and 5 = complete incontinence.[12,13]

MRI Technique

MRI was performed using a 1.5-T whole-body magnetic resonance scanner (Signa, GE Medical Systems, Milwaukee, WI). At 1 hour before MRI, all patients were instructed to empty the bladder and drink 1-2 glasses of water and requested to try to empty the bowels.[14] When the patient felt accumulation of urine in the bladder, they were examined in the supine position, using the body coil for excitation and a pelvic-phased array coil (Signa). Axial fast spin-echo proton density-weighted imaging was performed using the following parameters: repetition time, 1400 ms; echo time, 22.8 ms; echo train length, 5; slice thickness, 4 mm; interslice gap, 0.4 mm; field of view, 20 cm; matrix, 320 × 224; and 3 excitations. Coronal and sagittal T2-weighted fast recovery fast spin echo imaging was performed with the following parameters: repetition time, 3500 ms; echo time, 102 ms; echo train length, 11; slice thickness, 4 mm; interslice gap, 0.4 mm; field of view, 20 cm; matrix, 320 × 256; and 2 excitations.

MRI Parameters Assessed

MRI was reviewed by 2 reviewers to assess the anatomic parameters mentioned in the following text and represented graphically in Figures 1 and 2. Two board-certified radiologists (O.H. and K.K., with 17 years and 6 years of experience in pelvic imaging, respectively) made all evaluations by consensus decision. These radiologists were aware that patients had prostate cancer and were undergoing RP but did not know any other clinical and pathologic findings. Preoperative membranous urethral length (MUL) was the only parameter evaluated on preoperative MRI.[15] Postoperative MRI variables evaluated were postoperative MUL,[13] posterior-urethral vesical angle,[16,17] depth of the urethrovesical junction,[18] and urinary pooling inside the urethra and bladder neck configuration, as measured in the midline sagittal plane and/or crossreferenced to the coronal plane on T2-weighted MRI. The anatomic parameters of MRI are listed in Table 1 and represented graphically in Figures 1 and 2.

Statistical Analysis

All values are presented as mean ± standard deviation or median. Two-sided Mann-Whitney *U* testing was used to determine significant differences in parameters of urinary function using binary variables. Correlations between parameters of urinary function and continuous variables were investigated by simple regression analysis using the Spearman rank correlation coefficient. Multivariate analyses were performed using multiple linear regression to identify risk factors associated with urinary dysfunction. Values of $P < .05$ were considered significant. Analyses were performed with StatView version 5.0 software (Abacus Concepts, Berkeley, CA).

RESULTS

Baseline characteristics of patients at postoperative MRI are listed in Table 2. The median duration between RP and postoperative MRI was 20 months. All MRI scans were performed successfully and resulted in high-quality images; so, complete datasets were obtained for all patients.

On univariate analyses, preoperative and postoperative MRI variables were not significantly associated with parameters of uroflowmetry, PVR, or IPSS total score (Tables 3 and 4). Postoperative MUL was significantly associated with QOL index ($P = .005$; Table 3). Urinary pooling inside the urethra was significantly associated with frequency ($P = .04$) and urgency ($P = .007$) in each domain of IPSS (Table 4). Postoperative MUL ($P < .0001$) was significantly associated with continence grade (Table 3).

Multivariate analyses were performed with regard to the parameters identified as significant on univariate analyses. Postoperative MUL ($P = .001$) was significantly associated with QOL index (Table 5). Postoperative urinary pooling inside the urethra ($P = .005$) was significantly associated with urgency (Table 5). Postoperative MUL ($P < .001$), postoperative depth of urethrovesical junction ($P = .002$), and postoperative urinary pooling inside the urethra ($P = .04$) were all significantly associated with continence grade.