A novel technique for measuring intraoperative bladder neck and urethral dimensions during robotic-assisted radical prostatectomy

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Introduction

Urinary incontinence (UI) remains an important cause of morbidity after radical prostatectomy (RP), bearing significant impact on quality of life regardless of oncologic and sexual functional outcomes.[1]

Urethral length (UL) has been found to predict continence recovery[2-6] and where possible, many surgeons aim to maximize intraoperative UL during dissection without compromising oncological margins.[7] However, due to study heterogeneity, current published data defining this parameter is limited.

In the current age of robotic surgery, it is now possible to measure anatomical variables in real-time and under high-image resolution. To our knowledge, no intraoperative anatomical technique or measurements are currently available to accurately guide or predict continence recovery after robotic-assisted RP (RARP). We describe a novel method of measuring intraoperative urethral and bladder neck (BN) dimensions, and examine the impact of these dimensions on UI after RARP.

Methods

We retrospectively reviewed all RARP cases (n=101) performed by a single surgeon between November 2015 to January 2019, with the aim of assessing practicality of intraoperative measurement of urethral dimensions. All consenting patients who underwent RARP with complete intraoperative video recordings, and three- and six-month postoperative followup data were included. Baseline data included age at time of surgery, cardiorespiratory and metabolic comorbidities, prostate-specific antigen (PSA) level, preoperative International Prostate Symptom Score (IPSS), postoperative Gleason score, and pathological stage. Patient-reported pad usage per day at three and six months after surgery was recorded. Full continence recovery was defined by usage of one or fewer pads a day.

To assess intraoperative BN diameter and urethral dimensions, a novel approach was employed. Each operation video was reviewed on two independent occasions by a surgical resident, with an average of two measurements taken for each parameter on each occasion. Still screenshots were taken from each video to obtain standardized operative views, defined as the time point after en bloc resection of the prostate but prior to anastomosis formation, and after 1–3 sutures were placed on the posterior wall of the urethra to the BN (Fig. 1A). This aimed to ensure that all measurements were consistently taken at a well-defined operative time point, and importantly, to minimize the effect of varying degrees of tissue traction on our measurements. For complete measurement standardization, all intraoperative images were taken when a 0° laparoscopic camera lens was in use. The known width of an 18 F catheter (6 mm) was used as a measurement constant, ensuring image magnification was accounted for on all measurements. A digital ruler application (ScreenRuler v1.2) was used to perform the required measurements (Fig. 1B)

UL was measured from the membranous urethra to the cut edge (Fig. 1B). BN width and urethral width (UW) were similarly measured at this time point. UW was measured by taking the widest measurement between well-defined mucosal edges on either side of the urethra (Fig. 1C).

Analysis of the relationship between UL and dichotomous continence measures were performed using Wilcoxon rank sum tests and multivariable logistic regression with bilateral nerve-sparing (yes/no) entered as a covariate. To further explore the nature and shape of the relationship between intraoperative dimensions and probability of incontinence measures, UL, UW, and BN width were modeled as restricted cubic splines and the predicted probabilities graphed. Analysis was performed using Stata v 13.0 SE (College Station, TX, U.S.), with statistical significance set at 0.05.

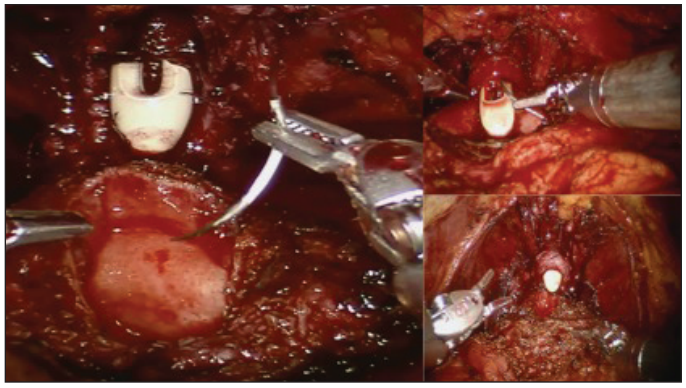

Fig. 1A. Standardized views capturing catheter width, bladder neck diameter, and urethral length.

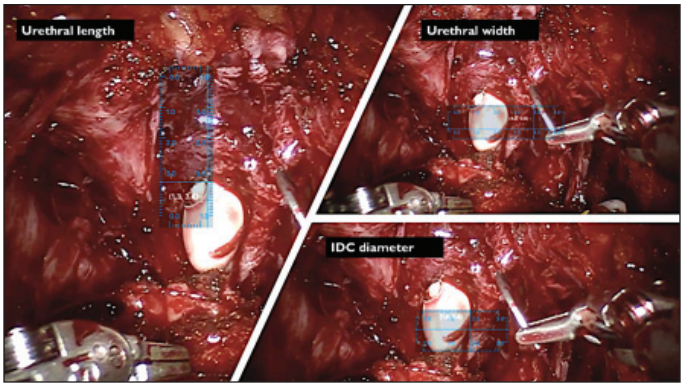

Fig. 1B. Measurement of urethral length and width using standardized intraoperative views.

Results

After accounting for irretrievable videos due to damaged or incomplete files or loss to three- or six-month followup, 62 subjects were analyzed.

Median age at surgery was 64.2 years. The median UL was 0.95 cm (interquartile range [IQR] 0.77–1.16), median BN width 1.24 cm (IQR 0.99–1.79), and median urethral width 1.41 cm (IQR 1.26–1.56). It was technically feasible to obtain all measurements of UL, UW, and BN using the technique described.

At three months postoperative, shorter UL was associated with use of ≥2 pads/day (median 0.81cm) vs. ≤1 pad/day (median 1.04 cm) (p=0.008). After adjustment for bilateral nerve-sparing, this relationship retained statistical significance (p=0.034). The predicted probability of needing ≥2 pads/day at three and ≥1 pad/day at six months generally decreased with increasing UL and UW, while the corresponding predicted probabilities were stable across the domain of BN width values (Fig. 2).

Discussion

Preservation of UL has been shown to improve continence outcomes.[4-6] However, differences in methodology (magnetic resonance imaging [MRI], ultrasound) and timing of measurements (pre-, intra-, postoperative) hinders its practical definition and undermines its clinical utility.

In the current era of robotic surgery, surgeons have the advantage of operating with superior visual magnification, allowing for more precise intraoperative measurements to be performed. There is value in broadening the utility of current technologies to allow for intraoperative measurements of important anatomical variables, such as urethral dimensions, to optimize anatomical preservation. One study addressed the use of intraoperative urethral measurements via transrectal ultrasound to guide postoperative continence recovery, and highlighted that the preservation of distal continence mechanisms are important for continence recovery.[4] However, this lacks precision compared to our novel method described.

To our knowledge, our study is the first offering practical utility of real-time measurements during RARP. It is precise, quick, and easy to perform. If a digital ruler application software is not available, measurements could be performed by passing a sterile ruler strip into the patient and using the same technique described in our study. Intraoperative measurements are a precise and clinically meaningful way of enabling surgeons, in real-time, to maximize preservation of UL, thus optimizing patients' postoperative continence recovery.

Furthermore, our findings of UL as an important function of continence recovery after RARP add to the growing evidence that preservation of the UL is important to maximizing continence outcomes.[3,5,7] Paparel et al measured UL using MRI and showed that a longer UL both before and after surgery, as well as preservation of UL during surgery, correlated with earlier continence recovery.[5] These findings were corroborated in larger studies, including a meta-analysis,[3,6] highlighting the importance of using meticulous dissection and surgical techniques for maximal UL preservation during RP for achieving improved continence outcomes.

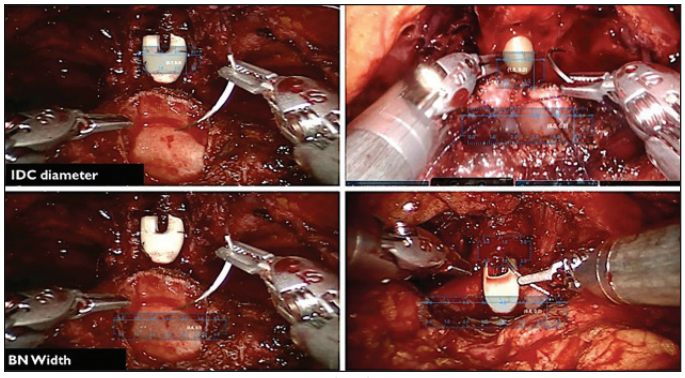

Fig. 1C. Measurement of bladder neck (BN) width using digital ruler application.

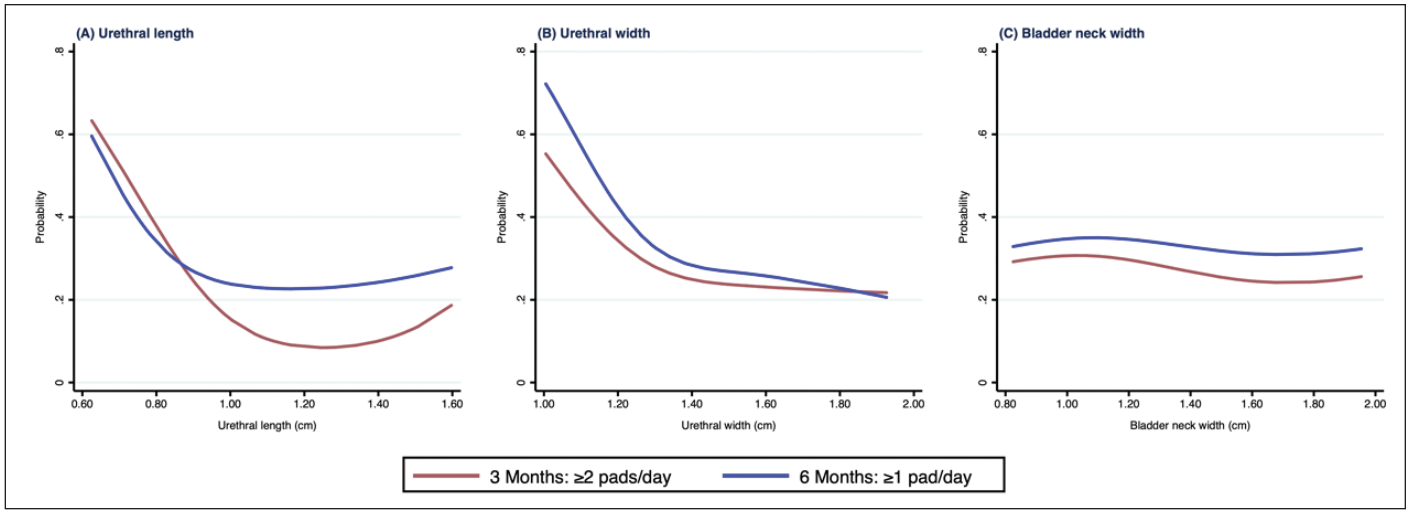

Fig. 2. (A) Predicted incontinence probabilities by urethral length; ***(B)*** predicted incontinence probabilities by urethral width; ***(C)*** predicted incontinence probabilities by bladder neck width.

Conclusions

Our novel technique introduces a simple and reliable method of measuring intraoperative urethral and BN dimensions with greater precision. Furthermore, our findings support UL preservation for improving continence outcomes; however, further analysis with a larger series is required.

Competing interests: The authors do not report any competing personal or financial interests related to this work.

This paper has been peer-reviewed.

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