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FUNCTIONAL AND ANATOMICAL DIFFERENCES BETWEEN CONTINENT AND INCONTINENT MEN POST RADICAL PROSTATECTOMY ON URODYNAMICS AND 3T MRI: A PILOT STUDY

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Abstract

Aims—There are competing hypotheses about the etiology of post prostatectomy incontinence (PPI).The purpose of this study was to determine the anatomical and functional differences between men with and without PPI.

Methods—Case control study of continent and incontinent men after radical prostatectomy who underwent functional and anatomic studies with urodynamics and 3.0 Tesla MRI. All men were at least 12 months post prostatectomy and none had a history of pelvic radiation or any prior surgery for incontinence.

Results—Baseline demographics, surgical approach and pathology were similar between incontinent (cases) (n=14) and continent (controls) (n=12) men. Among the cases, the average 24 hour pad weight was 400.0 ±176.9 grams with a mean of 2.4 ±0.7 pads per day. Urethral pressure profiles at rest did not significantly differ between groups; however with a Kegel maneuver the rise in urethral pressure was 2.6 fold higher in controls. On MRI, the urethral length was 31–35% shorter and the bladder neck was 28.9 degrees more funneled in cases. There were no differences in levator ani muscle size between groups. There was distortion of the sphincter area in 85.7% of cases and in 16.7% of controls (p=0.001).

Conclusions—Men with PPI were not able to increase urethral pressure with a Kegel maneuver despite similar resting urethral pressure profiles. Additionally, incontinent men had shorter urethras and were more likely to have distortion of the sphincter area. All suggesting that the sphincter in men with PPI is both diminutive and poorly functional.

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Introduction

One out of every six men will be diagnosed with prostate cancer (1) and half of those diagnosed with localized disease will choose radical prostatectomy (RP) as their primary treatment (2). Deaths from prostate cancer are on the decline (3) and far more men live with prostate cancer than die of their disease, therefore side effects of therapy take on a new level of importance. Up to 75% of men post prostatectomy report urinary incontinence of any kind (3)and it is this incontinence that has the most significant impact on quality of life after surgery(4).

There are competing hypotheses about the exact etiology of post prostatectomy incontinence (PPI) (5–7) and there is no consensus on the exact anatomy of the structures believed to be integral to continence (8,9). Potential causes of PPI include damage to the bladder neck, external urethral rhabdosphincter, (10–12) lissosphincter, pelvic floor (13) or the innervations to these muscles(6). Fibrosis at the urethral anastomosis has also been shown to be associated with incontinence (14) and causes the area to be rigid, unlike the normally elastic urethra that promotes continence.

The purpose of this pilot study is to test an investigative strategy designed to identify anatomical and functional differences between continent and incontinent men after radical prostatectomy using urodynamics and MRI evaluation. Our hypotheses are that incontinent men will have lower urethral pressures, shorter sphincteric mechanisms, more attenuated pelvic floor muscles, and more anatomical distortion from fibrosis at the urethral anastomosis than seen in their continent counterparts. These insights should advance the understanding of PPI which is paramount among the side effects experienced by RP patients (4).

Materials and Methods

Study Participants

This is an IRB approved case control study comparing both functional and anatomic differences in men with and without PPI. Men who underwent open retropubic or robotic radical prostatectomies a minimum of twelve months previously were recruited based on chart reviews from urology clinics at the University of Michigan and the Ann Arbor Veteran's Administration Hospital and via mailed invitation to participate in the study. Cases were defined as men status post RP who had stress urinary incontinence based on history and a net positive urine loss on 24 hour pad weights. Controls were defined as men who did not have any kind or amount of incontinence based on history and did not wear pads. Surgical and pathological data were obtained from patient charts. All subjects completed a three day voiding diary, the American Urological Association Symptom Index (AUA-SI) (15) and the Michigan Incontinence Symptom Index (16). Cases also submitted a 24 hour pad collection. Exclusion criteria for both groups included the presence of urgency incontinence, urinary retention, neurologic disease, high dose steroid use, pre-prostatectomy urgency or incontinence, pelvic radiation, prior incontinence surgery, current medical therapy for incontinence, pelvic recurrence or a perineal route of RP since this gives a

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distinctly different MRI appearance (17).Data were compared between cases and controls using unpaired T test for continuous data and Fisher's Exact test for all categorical data.

Study Protocol

All participants underwent multichannel urodynamic assessment and non-contrast 3.0 Tesla MRI without endorectal coil. Urodynamics were performed by a single urodynamics nurse (CN) blinded to continence status with a Laborie Aquarius™ unit. Prior to filling, urethral pressure profiles (UPP) were obtained three times at rest and three times with maximum Kegel effort while the catheter was withdrawn at a constant speed of 2mm per second and perfused with saline at 2ml/min. Then, with the patient in a standing position, the bladder was filled at 50cc/min with normal saline with an 8F air charged urodynamics catheter and rectal pressures recorded. All urodynamic definitions complied with the standardized terminology of the International Continence Society (18).

MRI image sequences were obtained in the supine position with a 3.0 Tesla Philips Achieva, Philips Medical Systems MRI unit with an eight channel cardiac coil positioned over the pelvis. Endorectal coils were not used since this would distort the natural anatomy and cause discomfort (19). Images were obtained in 2mm slices with T1- weighted and fast spin echo T2- weighted sequences of the entire pelvis in the axial, sagittal and coronal views.

MRI Measurements

Identification and measurement of structures was performed according to techniques that have already been established (5,8,13,14,17,19) (figure 1). The bladder neck was identified and the angular measurement of the lumen recorded. The anatomical urethral sphincter length was measured from the bladder neck to the entry of the urethra into the penile bulb in both the sagittal and coronal planes (5). The urethral thickness was measured in its thickest area in three views. The levator ani was measured in two views with the thickest area measured as the maximum length converging on the urethra (5, 13). Measurements were made by two urologists (APC and AMS) and the values averaged. In the event of a discrepancy of more than 3mm or 10 degrees the measurements were repeated and a consensus achieved.

Results

The incontinent cases (n=14) had a mean age of 68.2 years and the continent controls (n=12) 67.7 years ($p=0.84$). Medical comorbidities, surgical approach, surgical complications, time since surgery and pathologic stage were not significantly different between groups. All men had undetectable prostate specific antigen (PSA) at the time of study (Table I).

In cases, the average 24 hour pad weight was 400.0 grams with a mean of 2.4 pads per day. By definition, none of the controls wore any pads. AUA-SI scores were 12.1 in cases and 3.5 in controls ($p=0.0021$) with a quality of life of 4.1 "mostly dissatisfied" and 0.5 "pleased" respectively ($p< 0.0001$). M-ISI total severity scores were 17.1in cases and 2.7 in controls ($p< 0.0001$) (Table II).

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Mean UPP at rest were similar between cases and controls (92.4 mm cmH2O vs.91.1 mm cmH2O, p=0.95). However, a man's ability to raise his urethral pressure during pelvic muscle contraction was 2.6 times lower among cases compared with than controls (change of 56.3 vs. 147.5 mm cmH^2O p=0.040). Out of the three UPP measurements taken during a Kegel, if only each individual subject's highest value was analyzed the UPP of incontinent patients was half that of dry men (p=0.031). Functional urethral length was similar between groups. Maximum cystometric capacity was 95 ml lower in cases and their detrusor pressure at maximum flow was half that of the controls; however maximum flow rates did not differ (Table II).

On MRI, in cases, the anatomical urethral sphincter length was 35% shorter in the sagittal view and 31% shorter in the coronal view (Table II). Also, the bladder neck was 28.9 degrees more funneled (open) among cases on sagittal angular measurement (Figure 2). Scar could not be measured or clearly differentiated from muscle at the anastomosis since no intravenous contrast was administered; however subjective asymmetry and/or distortion of the sphincter area was noted in 85.7% of cases and in 16.7% of controls (p=0.001) (Figure 2). Measurements of levator ani length and thickness were not different in any view (Table II). Given the mixed surgical groups, all MRI and urodynamic measurements were compared between the open RP and robotic RP and there were no significant differences or trends found.

Discussion

In men with PPI, the visible urethral sphincter is 31–35% shorter and the bladder neck angle is 28.9 degrees more funneled compared to continent men on MRI. Also, there is more subjective distortion of the sphincteric area on MRI in the cases, but no difference in levator ani measurements between groups. Urodynamically, during a Kegel maneuver, incontinent men were much less able to augment their urethral pressures than their dry counterparts, although there were no differences in urethral pressure profiles at rest between groups. In our prior analysis of dynamic MRI measurements of this same patient population we did not find any difference in urethral or bladder neck mobility between the cases and controls (20).

These findings supported the hypothesis that the sphincteric urethra would be shorter in incontinent men compared to continent men after RP. Several authors have evaluated the impact of urethral sphincter length before RP and have found that continence was slower to recover in men with short urethras at baseline (12,13,21).

There are, however, few studies on the appearance of the urethra after surgery. Paparel et al. (21) in a retrospective study of 64 men reviewed 1.5T MRIs performed both before and after RP. This imaging was performed to evaluate for recurrence in the setting of a rising PSA after surgery. Both a shorter preoperative and post-operative membranous urethra was associated with incontinence. Also, a higher ratio of urethra lost during the surgery was associated with worse continence. The absolute loss of urethral length was small with the median preoperative urethral length being 14mm and post operatively reduced only to 13mm suggesting that little urethral length is lost. In contrast to our findings, Kordan et al (5) evaluated 30 patients, 14 continent and 16 incontinent, after nerve sparing RP with a

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1.0T MRI. They found no significant difference in urethral sphincter length between the continent and incontinent men.

An unexpected finding in our MRI analysis was that the bladder neck was significantly more funneled or widely angulated in patients with incontinence. The implications of a more funneled bladder neck in men are not well known. There have been several publications on the bladder neck appearance in females, where an open bladder neck on fluoroscopic urodynamic studies correlated strongly with stress incontinence (22,23). Also, in a study that evaluated funneling of the bladder neck via ultrasound in women both before and after colposuspension surgery found recurrent incontinence to be twice as common at 48 months in those patients who had persistent funneling (24).

This difference in the amount of bladder neck angulation was significant on sagittal images. On coronal images there was only a trend towards the bladder neck being 15.9 degrees more open in incontinent patients (p=0.12). The impact of bladder neck funneling on incontinence in men deserves further study.

Asymmetry and distortion of the sphincteric urethra was observed to be fivefold more common in the incontinent men. There is scant data on the impact of distortion and urethral fibrosis on MRI. Although we could not definitively identify fibrous scar tissue on MRI since muscle can have similar enhancement without the use of intravenous contrast, morphologic distortions were clearly visible and different between cases and controls. Regarding previous evaluations of fibrosis, Tuygun et al. (14) evaluated 22 men with incontinence and 14 men who were dry after transurethral resection, RP or simple prostatectomy with 1.5 T MRI. The severity of periurethral and urethral fibrosis was graded on T2 weighted images as none, mild, moderate or severe. Fibrosis at the anastomotic junction was seen in 100% of the incontinent group and in 29% of the continent group. In contrast, Paparel et al (21) devised a classification system to grade periurethral and urethral fibrosis from grade 0 (no fibrosis) to grade three (circumferential fibrosis) on post radical prostatectomy axial images. In their study, they found only a trend towards worse grades of fibrosis in patients with post-surgical incontinence. Other authors have also not been able to find a difference in the amount of periurethral fibrosis between continent and incontinent men (5). Our finding of anatomical distortion in incontinent men is not surprising given that a non-pliable, scarred urethra and sphincter would coapt less than one without fibrosis.

We did observe a large difference between groups in the ability to increase UPP during a Kegel maneuver. It is interesting that there were no differences in UPP at rest. There are controversial findings in the published literature with urethral closure pressures at rest being worse in men with PPI in several studies but no difference found in others (25). However, all of these studies evaluated urethral pressures at rest only. The finding that continent men are better able to augment their urethral pressure with a Kegel maneuver is novel, but not surprising. Either these men are routinely performing this effective maneuver to prevent leakage or it is an indicator of more normal urethral pliability and intact sphincter muscles and innervation. Our continent controls also had a higher detrusor pressure at maximum flow. Other authors with larger series have previously found no difference in this value

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between continent and incontinent men after RP (26), suggesting that this finding may be due to our small patient population or is perhaps a novel finding requiring future study.

A full understanding of the effects of RP on the continence mechanism would consider the location of the different elements of the sphincter along the length of the urethra and whether or not they are excised or damaged during surgery. In addition, the possibility that the nerves that supply them may have been injured. The bladder neck and the lissosphincter receive autonomic innervation while the striated urogenital sphincter has both an autonomic innervation that influences resting tone and somatic innervation that affects contraction under volitional control (6). The findings of our study reveal that there is a dramatic difference between men who are continent and incontinent in the degree to which men can voluntarily increase their urethral closure pressure when instructed to perform a pelvic muscle contraction and that they have an anatomically shorter urethra. This is consistent with a hypothesis that more distal removal of the prostate damages this voluntary sphincter mechanism or its nerve supply. It would also be consistent with a shorter urethra, as those in whom the distal dissection removes more of the urethra would be expected to go low enough to affect the distal striated sphincter. In the same way, a more distal dissection would pull the anastomosis further down resulting in the funneling appearance seen in these individuals.

It is not known if the compromise to the innervation of these structures, the resulting scar or the damaged structures themselves is responsible for incontinence. Our findings cannot distinguish between nerve damage to the distal striated urogenital sphincter or to its somatic innervation from the pudendal nerve. It does, however, suggest that voluntary structures controlled by the pudendal are involved rather than just autonomically controlled structures that are affected. Although the autonomic fibers are critical to erectile function (6), it may be the somatic fibers of the pudendal nerve that preserve continence. This would be consistent with our observation that the resting pressures are not different between continent and incontinent men.

This study should be interpreted with certain limitations in mind. This unblinded pilot study involved a small sample size of patients who had two different approaches to RP with the aim of obtaining baseline data for future larger studies. The men had a wide range of severity of incontinence (<10g to >1800g/day) therefore these results are not generalizable to men with moderate incontinence.

This small sample size also precluded multivariate analysis and subgroup analyses. Second, we do not have MRI and urodynamic measurements before prostatectomy which would be of great value in quantifying the impact of the actual surgery on each of our measures and would assist in establishing the causation of the PPI. It is certainly possible that our incontinent cohort had shorter urethral sphincters and poor Kegel effort at baseline. Also the distortion and scar present in the urethra may have made UPP measurements inaccurate in the cases.

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Conclusions

In continent men, the visible urethral sphincter is longer, there is less distortion of the sphincteric area and the bladder neck is less funneled compared to incontinent men on MRI. Urodynamically, during a Kegel maneuver, continent men were much better at augmenting urethral pressures than their wet counterparts although there were no differences in urethral pressure profiles at rest between groups. All of these findings suggest that the sphincter in men with PPI is both diminutive and poorly functional possibly due to scar. A new finding is the importance of a more widely open bladder neck contributing to incontinence that warrants further investigation.

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References

1. Ries L, Melbert D, Krapcho M, Stinchcomb D, Howlader N, Horner M, et al. SEER Stat Fact Sheets. 2007 Available at: http://seer.cancer.gov/statfacts/html/prost.html.
2. Harlan LC, Potosky A, Gilliland FD, Hoffman R, Albertsen PC, Hamilton AS, et al. Factors associated with initial therapy for clinically localized prostate cancer: prostate cancer outcomes study. J Natl Cancer Inst. 2001 Dec 19; 93(24):1864–1871. [PubMed: 11752011]
3. Thompson I, Thrasher JB, Aus G, Burnett AL, Canby-Hagino ED, Cookson MS, et al. Guideline for the management of clinically localized prostate cancer: 2007 update. J Urol. 2007 Jun; 177(6): 2106–2131. [PubMed: 17509297]
4. Katz G, Rodriguez R. Changes in continence and health-related quality of life after curative treatment and watchful waiting of prostate cancer. Urology. 2007 Jun; 69(6):1157–1160. [PubMed: 17572206]
5. Kordan Y, Alkibay T, Sozen S, Bozkurt Y, Acar C, Talu T, et al. Is there an impact of postoperative urethral and periurethral anatomical features in post-radical retropubic prostatectomy incontinence? Urol Int. 2007; 78(3):208–213. [PubMed: 17406128]
6. Narayan P, Konety B, Aslam K, Aboseif S, Blumenfeld W, Tanagho E. Neuroanatomy of the external urethral sphincter: implications for urinary continence preservation during radical prostate surgery. J Urol. 1995 Feb; 153(2):337–341. [PubMed: 7815577]
7. Koraitim MM. The male urethral sphincter complex revisited: an anatomical concept and its physiological correlate. J Urol. 2008 May; 179(5):1683–1689. [PubMed: 18343449]
8. Myers RP, Cahill DR, Devine RM, King BF. Anatomy of radical prostatectomy as defined by magnetic resonance imaging. J Urol. 1998 Jun; 159(6):2148–2158. [PubMed: 9598561]
9. Brooks JD, Chao WM, Kerr J. Male pelvic anatomy reconstructed from the visible human data set. J Urol. 1998 Mar; 159(3):868–872. [PubMed: 9474171]
10. Nguyen L, Jhaveri J, Tewari A. Surgical technique to overcome anatomical shortcoming: balancing post-prostatectomy continence outcomes of urethral sphincter lengths on preoperative magnetic resonance imaging. J Urol. 2008 May; 179(5):1907–1911. [PubMed: 18353395]
11. 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 Sep; 168(3):1032–1035. [PubMed: 12187216]
12. von Bodman C, Matsushita K, Savage C, Matikainen MP, Eastham JA, Scardino PT, et al. Recovery of urinary function after radical prostatectomy: predictors of urinary function on preoperative prostate magnetic resonance imaging. J Urol. 2012 Mar; 187(3):945–950. [PubMed: 22264458]

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13. 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 Jul; 178(1):208–211. [PubMed: 17499806]
14. Tuygun C, Imamoglu A, Keyik B, Alisir I, Yorubulut M. Significance of fibrosis around and/or at external urinary sphincter on pelvic magnetic resonance imaging in patients with postprostatectomy incontinence. Urology. 2006 Dec; 68(6):1308–1312. [PubMed: 17169652]
15. Barry MJ, Fowler FJ Jr, O'eary MP, Bruskewitz RC, Holtgrewe HL, Mebust WK, et al. The American Urological Association symptom index for benign prostatic hyperplasia. The Measurement Committee of the American Urological Association. J Urol. 1992 Nov; 148(5): 1549–1557. discussion 1564. [PubMed: 1279218]
16. Suskind AM, Dunn RL, Morgan DM, DeLancey JO, McGuire EJ, Wei JT. The University of Michigan Incontinence Symptom Index: A Clinical Measure for Urinary Incontinence Severity and Bother. Neurourol Urodyn. 2013; 32 (0000):0000.
17. Allen SD, Thompson A, Sohaib SA. The normal post-surgical anatomy of the male pelvis following radical prostatectomy as assessed by magnetic resonance imaging. Eur Radiol. 2008 Jun; 18(6):1281–1291. [PubMed: 18270715]
18. Abrams P, Cardozo L, Fall M, Griffiths D, Rosier P, Ulmsten U, et al. The standardisation of terminology in lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. Urology. 2003 Jan; 61(1):37–49. [PubMed: 12559262]
19. Kim HW, Buckley DL, Peterson DM, Duensing GR, Caserta J, Fitzsimmons J, et al. In vivo prostate magnetic resonance imaging and magnetic resonance spectroscopy at 3 Tesla using a transceive pelvic phased array coil: preliminary results. Invest Radiol. 2003 Jul; 38(7):443–451. [PubMed: 12821859]
20. Suskind AM, DeLancey JO, Hussain HK, Montgomery js, Latini JM, Cameron AP. Dynamic MRI evaluation of urethral hypermobility post radical prostatectomy. Neurourol Urodyn. 2013; 32 (0000):0000.
21. 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 Mar; 55(3):629–637. [PubMed: 18801612]
22. English SF, Amundsen CL, McGuire EJ. Bladder neck competency at rest in women with incontinence. J Urol. 1999 Feb; 161(2):578–580. [PubMed: 9915452]
23. Digesu GA, Khullar V, Cardozo L, Salvatore S. The open bladder neck: a significant finding? Int Urogynecol J Pelvic Floor Dysfunct. 2004 Sep-Oct;15(5):336–339. [PubMed: 15580420]
24. Skala C, Emons G, Krauss T, Hilgers R, Gauruder-Burmester A, Lange R, et al. Postoperative funneling after anti-incontinence surgery--a prognostic indicator?--Part 1: colposuspension. Neurourol Urodyn. 2004; 23(7):636–642. [PubMed: 15382191]
25. Dubbelman YD, Bosch JL. Urethral sphincter function before and after radical prostatectomy: Systematic review of the prognostic value of various assessment techniques. Neurourol Urodyn. 2013; 32(7):957–963. [PubMed: 23371847]
26. Dubbelman YD, Groen J, Wildhagen M, Rikken B, Bosch R. Quantification of Changes in Detrusor Function and Pressure-Flow Parameters After Radical Prostatectomy: Relation to Postoperative Continence Status and the Impact of Intensity of Pelvic Floor Muscle Exercises Neurourology and Urodynamics. 2012; 31:637–641.

Abbreviations

AUA-SI	American Urological Association Symptom Index
MRI	Magnetic resonance imaging
PSA	prostate specific antigen
PPI	Post prostatectomy incontinence

PVR	post void residual
RP	radical prostatectomy
UPP	urethral pressure profile

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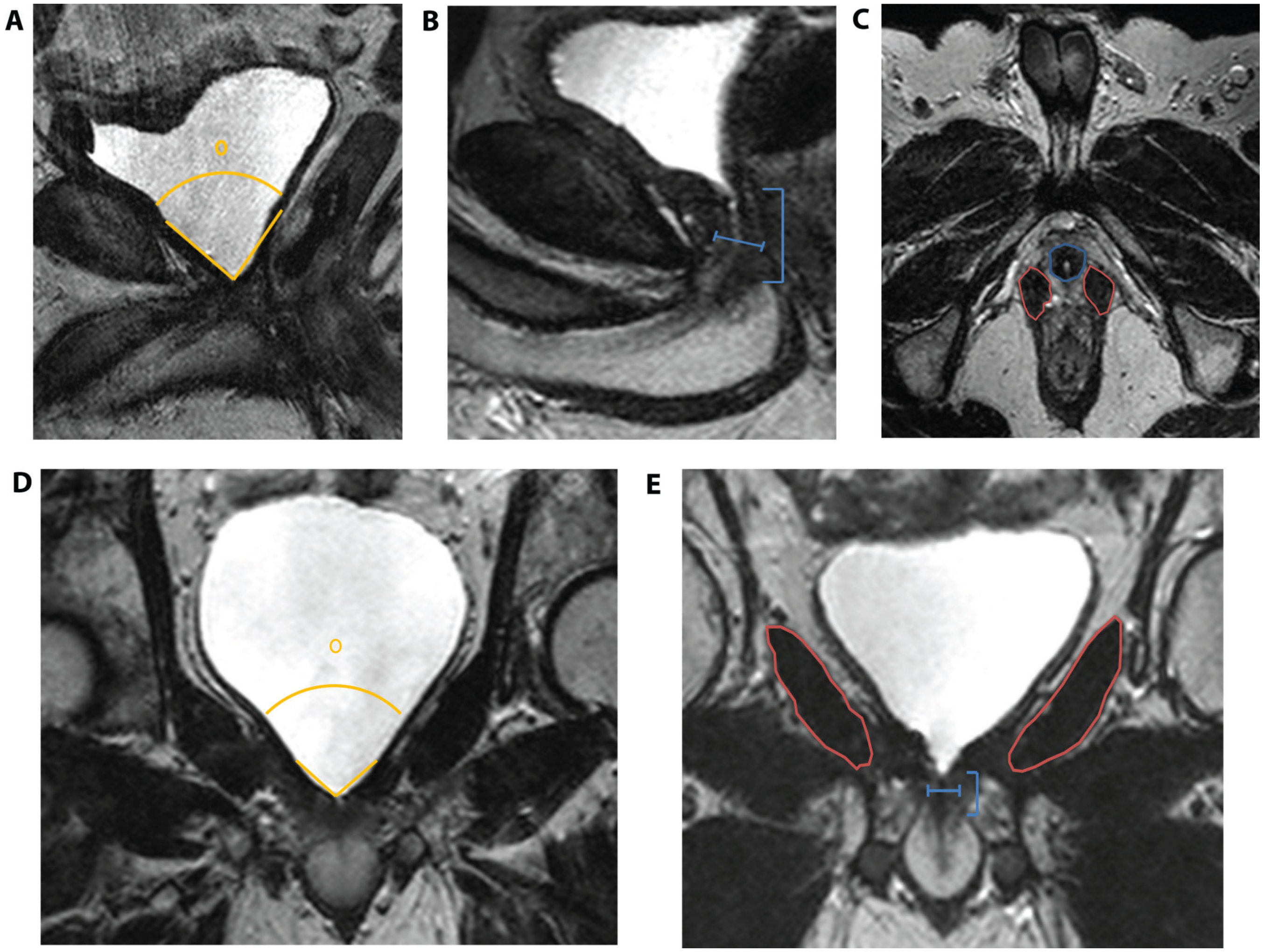

Figure 1.

Demonstration of MRI measurement technique. All imaging was measured on T2 weighted images. **A)** bladder neck angle measured sagittally, **B)** Urethral sphincter length and width measured sagitally, **C)** Identification of urethra (blue) and levator muscles (red) on axial image at the thickest portion of the urethral sphincter **D)** bladder neck angle measured coronally, **E)** levator muscles identified (red) and urethral length and width measured (blue) coronally.

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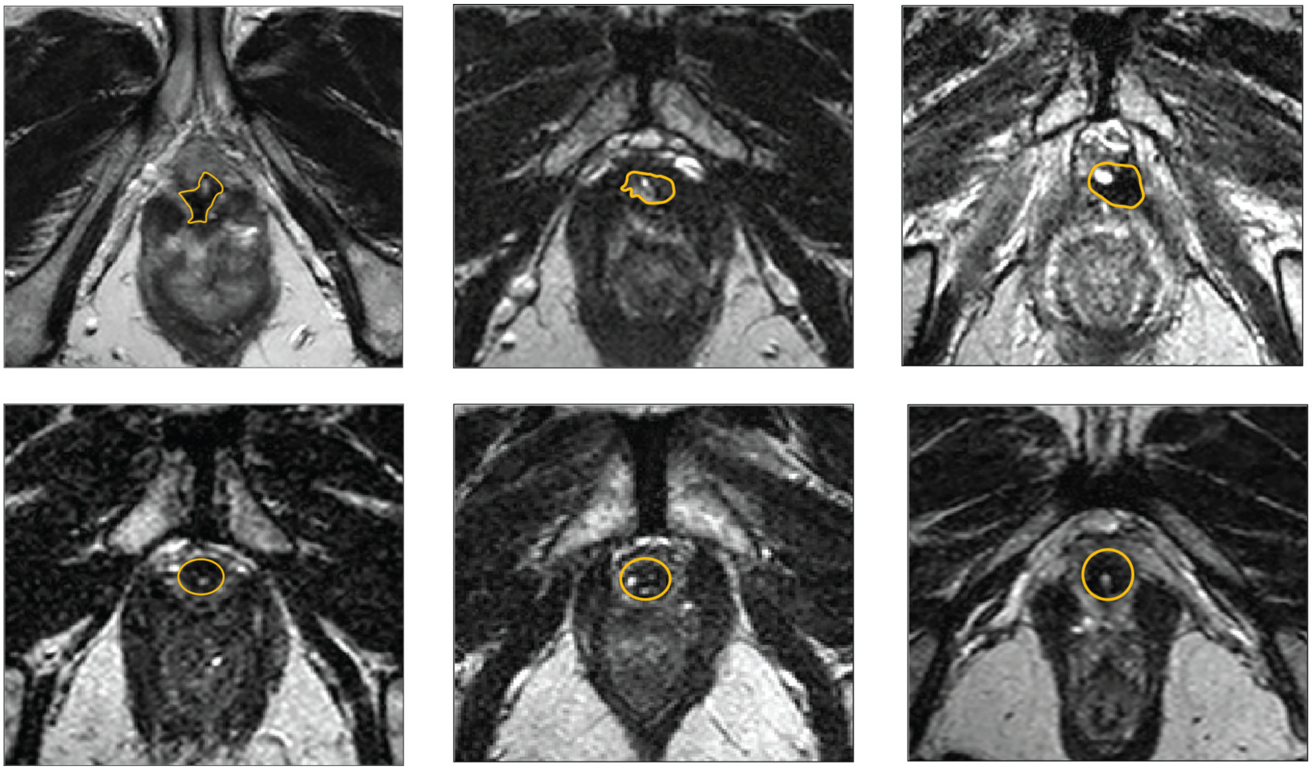

Figure 2.
Examples of sagittal MRI measurements of urethral sphincter length and bladder neck angle in three incontinent men (A–C) and three continent men (D–F).

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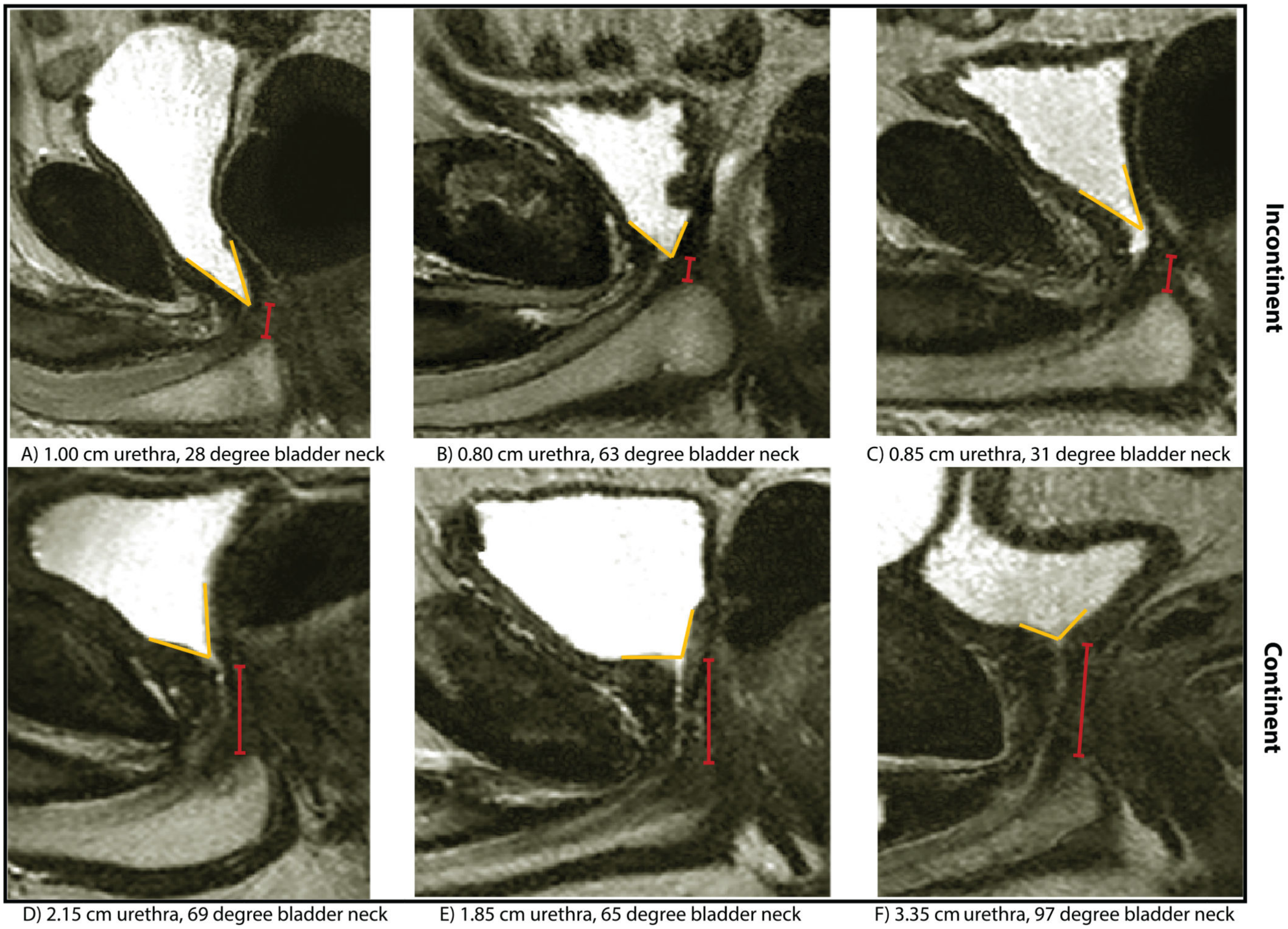

Figure 3.

Axial MRI images at the level of the thickest area of the sphincter with urethra circled in orange demonstrating the visible distortion of the anatomy in three incontinent men (A–C) and three continent men (D–F).

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Table I

Patient demographics and surgical history

	Cases (n=14)	Controls(n=12)	P value
Demographics:			
Age (years)	68.2 ± 1.6	67.7 ± 1.8	0.84*
Body Mass Index (kg/m^2)	28.4 ± 1.2	28.9 ± 1.0	0.76*
Race:			
Caucasian	85.7% (12/14)	91.7% (11/12)	1.00
AA	14.3% (2/14)	8.3% (1/12)	
Other	0	0	
Diabetic	21.4 % (3/14)	25% (3/12)	1.00
Smoker:			
Current	7.1% (1/14)	8.3% (1/12)	1.00
Past	50.0% (7/14)	41.7% (5/12)	0.71
HTN	50.0% (7/14)	33.3% (4/12)	0.45
Peripheral vascular disease	7.1% (1/14)	0% (0/12)	1.00
History of MI	0% (0/14)	8.3% (1/12)	0.46
Surgical History			
Time since surgery (years)	4.9 ± 1.0	5.6 ± 1.3	0.64*
Pre op PSA	8.6 ± 1.5	5.9 ± 1.1	0.17*
% Open RRP vs. Robotic	57.1% (8/14)	33.3% (4/12)	0.27
% Nerve sparing	61.5% (8/13)	83.3% (10/12)	0.38
Blood Loss during prostatectomy (ml)	407.3 ± 102.3	308.3 ± 142.4	0.57*
Surgical details:			
Bladder neck spared	0% (0/9)	16.7% (2/12)	0.49
Bladder neck reconstructed	66.7% (6/9)	63.6% (7/11)	1.00
Anterior urethropexy performed	11.1% (1/9)	36.3% (4/11)	0.32
Running anastomosis	55.6% (5/9)	72.7% (8/11)	0.64
Pathology prostate weight (grams)	65.1 ± 7.6	50.5 ± 3.0	0.11*
Surgical Gleason Score	6.8 ± 0.2	6.9 ± 0.1	0.48*
Surgical stage:			
T2N0M0	92.9% (13/14)	75.0% (9/12)	0.31

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	Cases (n=14)	Controls(n=12)	P value
T3N0M0	7.1% (1/14)	25% (3/12)	
T4N0M0	0% (0/14)	0% (0/12)	
Bladder neck contracture incision	15.4% (2/13)	0% (0/12)	0.45
Did formal physical therapy post op	35.7% (5/14)	8.3% (1/12)	0.17
Took medical therapy post op	28.6% (4/14)	8.3% (1/12)	0.33

RRP= Radical Retropubic Prostatectomy

* unpaired T test (all other Fisher's Exact test)

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Table II

Urodynamics and MRI measurement result

Table II	Cases(n=14)	Controls (n=12)	P value*
Clinical Findings:			
AUASI:			
Total score	12.1 ± 2.1	3.5 ± 0.9	0.0021
Quality of Life	4.1 ± 0.4 “mostly dissatisfied”	0.5 ± 0.2 “pleased”	< 0.0001
M-ISI:			
Total severity	17.1 ± 2.3	2.7 ± 0.7	< 0.0001
Total bother	2.4 ± 0.5	0.1 ± 0.1	0.0010
Pad weights (grams)	400.0 ±176.9	none	-
Pads per day	2.4±0.7	none	-
Urodynamics:			
PVR (ml)	21.4±12.5	21.2±9.2	0.99
First desire (ml)	180 ± 24	243 ± 30	0.11
Max. Cystometric Capacity (ml)	314 ± 33	409 ± 34	0.062
Detrusor overactivity	7.1% (1/14)	0% 0/12	1.00
Pdet Qmax (cmH^{2}O)	33.1 ± 4.4	67.3 ± 16.0	0.021
Qmax (ml/sec)	15.2 ± 2.5	15.5 ± 2.0	0.92
Urethral Profilometry:			
Functional Urethral length (mm)	23.7±1.8	25.6±2.6	0.55
Mean UPP at rest (mm cmH^{2}O)	92.4 ± 9.0	91.1 ± 9.5	0.95
Rise in UUP with Kegel (mm cmH^{2}O)	56.3 ± 20.1	147.5 ± 38.9	0.040
Highest UPP with Kegel (mm cmH^{2}O)	161.8 ± 23.5	306.0 ± 74.6	0.031
MRI Measurements:			
Urethral measurements:			
Coronal urethral length (cm)	1.43 ± 0.15	1.87 ± 0.21	0.049
Sagittal urethral length (cm)	1.30 ± 0.10	1.75 ± 0.23	0.033
Coronal urethral thickness (cm)	0.91 ± 0.06	1.03 ± 0.06	0.18
Sagittal urethral thickness (cm)	0.91 ± 0.04	0.99 ± 0.05	0.10
Axial urethral diameter AP(cm)	1.35 ± 0.07	1.26 ±0.07	0.37
Axial urethral diameter lateral (cm)	1.35 ± 0.06	1.27 ± 0.07	0.39
Bladder neck measurements:			

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Table II	**Cases(n=14)**	**Controls (n=12)**	**P value***
Coronal bladder neck angle (degrees)	88.4 ± 3.9	104.3 ± 9.6	0.12
Sagittal bladder neck angle (degrees)	52.2 ± 5.2	81.1 ± 11.8	0.030
Presence of scar or distortion	85.7% (12/14)	16.7% (2/12)	0.0011**
Presence of pubovesical ligament	23.1% (3/13)	63.6% (7/11)	0.10**
Levator ani measurements:			
Coronal thickness right (cm)	1.62 ±0.07	1.62 ± 0.10	1.0
Coronal thickness left (cm)	1.65 ± 0.08	1.60 ±0.09	0.73
Coronal length right (cm)	4.79 ± 0.25	4.77 ± 0.26	0.96
Coronal length left (cm)	4.82 ± 0.23	4.80 ± 0.22	0.97
Axial thickness right (cm)	0.99 ± 0.05	1.08 ± 0.05	0.27
Axial thickness left (cm)	0.98 ± 0.07	1.01 ± 0.05	0.75

AUASI-American Urological Association Symptom Index, M-ISI= Michigan Incontinence Symptom Index, UPP= urethral pressure profile, MCC= maximum cystometric capacity, Pdet= detrusor pressure, Qmax= maximum flow, AP= anterior-posterior

* unpaired T test unless otherwise indicated,

** Fisher's Exact test