Published in final edited form as:

Female Pelvic Med Reconstr Surg. 2011 ; 17(5): 226–230. doi:10.1097/SPV.0b013e31822dd012.

Neuromuscular Characterization of the Urethra in Continent Women

Kimberly Kenton, MD, MS, Elizabeth Mueller, MD, MSME, and Linda Brubaker, MD, MS
Division of Female Pelvic Medicine & Reconstructive Surgery Departments of Obstetrics & Gynecology and Urology Loyola University Stritch School of Medicine Maywood, IL

Abstract

Objectives—To describe quantitative urethral function parameters in a racially diverse group of continent women.

Materials and Methods—Following Institutional Review Board approval, we recruited women without urinary incontinence from the community. To be considered continent, participants answered “never” to the first six questions on the stress subscale of the Medical, Epidemiologic, and Social Aspects of Aging urinary incontinence (MESA) questionnaire. Participants all underwent quantitative concentric urethral electromyography (EMG) and urodynamic testing (UDS).

Results—Thirty-one women with a mean±SD age of 39±14 years underwent EMG and UDS. The cohort was racially diverse with 13 Caucasians (43%), 13 African Americans (43%), and 4 Hispanics (14%). Body mass index (BMI) ($P=.12$, .06), age ($P=.40$, .64), and vaginal parity ($P=.53$, .76) did not differ by race or ethnicity. We did not detect differences in any EMG parameter by race, ethnicity or vaginally parity. A mean (range) of 30 motor unit action potential analysis (MUP) (10-55) were identified and analyzed in Multi-MUP analysis and 14 (8-21) were identified and analyzed in IP analysis. On average, 37±20% MUPs were polyphasic.

Age significantly correlated with several measures of urethral sphincter function. Increasing age was inversely correlated with interference analysis (IP) turns ($r=-.57$, $p=.001$), IP amplitude ($r=-.43$, $p=.02$), IP turns/amplitude ($r=-.54$, $p=.003$), maximum urethral closure pressures (MUCP) ($r=-.41$, $p=.04$). Similarly, MUCP correlated with IP amplitude ($r=.38$, $p=.04$).

Conclusions—This urethral neuromuscular function data on the largest cohort of continent women fully characterized with quantitative urethral EMG demonstrates significant neuropathic MUP changes with advancing age.

Keywords

Electromyography; EMG; Urethra; Urethral sphincter; Stress Incontinence

Corresponding author: Kimberly Kenton, MD, MS, Associate Professor Female Pelvic Medicine & Reconstructive Surgery, Departments of Obstetrics & Gynecology and Urology, Loyola University Stritch School of Medicine, 2160 South First Avenue Maywood, IL 60153, Tel (708)216-2170 Fax (708)216-2171, kkenton@lumc.edu.

*Supported by The Eunice Kennedy Schriver National Institute of Child Health and Human Development K23HD047325-05 and National Institute of Diabetes and Digestive and Kidney Disease K24 DK064044-03 IRB Approval: 107881111704

No reprints will be available.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Introduction

The importance of urethral sphincter neuromuscular integrity in maintaining urinary continence is widely accepted, but poorly understood. Two major components of the urinary continence mechanism are the urethral sphincter, responsible for urethral closure, and the levator ani responsible for bladder neck support(1). Recently, DeLancey et al compared urodynamic and clinical measures of urethral function and support in a large cohort of well-characterized women with stress urinary incontinence (SUI) to women without urinary symptoms(2). Urethral closure pressure alone predicted half of the occurrence of SUI, while measures of urethral support only predicted 16% of SUI cases. The authors concluded that maximum urethral closure pressure is the factor most strongly associated with SUI, and improving urethral function may have therapeutic benefit.

Urethral closure pressure measurements as indirect measures of urethral sphincter neuromuscular function(3) are subject to artifact and vary based on the instrument used for measurement. Electrodiagnostic studies directly quantify afferent and efferent neural function and more directly reflect the neuromuscular integrity of the muscle under study. Electromyography (EMG) can differentiate neuromuscular injury from primary muscle pathology; localize injury; and provide important information about chronicity and prognosis of the injury. Quantification of urethral EMG parameters in stress-continent women may aid our understanding of the neuromuscular contributions to SUI etiology.

The majority of prior pelvic floor EMG reports describe consistent findings of denervation with reinnervation in the levator muscles of women with stress incontinence(4-6). Two studies reported urethral sphincter EMG findings from women undergoing SUI surgery. Fischer et al found that women with pre-operative intrinsic sphincter deficiency have evidence of more severe neuromuscular injury⁷. We previously reported women who undergo successful continence surgery demonstrate better activation of the urethral sphincter on EMG as compared to those with persist SUI. These findings highlight the relationship between continence, neuromuscular integrity and treatment outcome but are limited by a lack of normative data. In this study, we measured quantitative urethral function parameters in a racially diverse group of continent women.

Materials & Methods

Following Institutional Review Board approval, we recruited asymptomatic adult women without urinary incontinence from the community using flyers and web-based advertisements. To be included in the study as a continent control, participants were limited to those who answered “never” to the first six questions on the stress subscale of the Medical, Epidemiologic, and Social Aspects of Aging (MESA) urinary incontinence questionnaire(7). Consented research participants completed demographic information and the short form of the Pelvic Floor Distress Inventory (PFDI-20), a validated, condition specific bother questionnaire for pelvic floor disorders with 3 subscales: urinary, prolapse, and colorectal (8). Race and ethnicity were determined by self-reporting according to the guidelines of The Office of Management and Budget Directive No. 15. Participants choose from 2 ethnic categories, “Hispanic or Latino” and “Not Hispanic or Latino”, and from 5 racial categories: American Indian or Alaska Native; Asian; Black or African American; Native Hawaiian or Other Pacific Islander; and White. Appropriate definitions were included on the questionnaire.

Participants also underwent standardized physical examination, including Pelvic Organ Prolapse Quantification (POP-Q)(9). After voiding, participants underwent catheterized postvoid residual urine volume assessment and urine dipstick analysis. Women were

excluded if they reported a history of neuromuscular disease, prior continence surgery, or coagulaopathy, had stage III or IV pelvic organ prolapse, were less than 6 months from their most recent vaginal delivery, were taking an anticoagulant medication, had an elevated post-void residual urine volume or urine dipstick positive for nitrites or leukocytes or had urodynamic stress incontinence or detrusor overactivity. All eligible participants underwent standardized quantitative EMG and multichannel urodynamic testing in a birthing chair reclined to 45°. Urodynamic evaluation was performed using Laborie Dorado urodynamics equipment and included retrograde filling cystometry at a fill rate of 80mL/min, static urethral pressure profilometry, and vesical valsalva leak point pressure determinations. An 8 French microtip catheter (Millar Instruments, Houston, TX) was placed in the vagina to measure abdominal pressure, and an 8 French dual micro-tipped catheter with infusion port was placed with the distal transducer in the bladder and the proximal transducer in the midurethral facing 9 o'clock to measure vesical and urethral pressures, respectively. Detrusor pressure and urethral closure pressure were electronically subtracted and recorded throughout the study. Two maximum urethral closure pressures (MUCP) were determined 300 ml with use of a profilometer set at a withdrawal rate of 1mm/s and averaged for analysis.

Concentric Needle EMG

We performed three methods of concentric needle EMG of the urethral sphincter on all participants. Anesthetic cream containing 2.5% lidocaine and 2.5% prilocaine (EMLA cream, Astra, Westborough, MA) was applied to the external urethral meatus 20 minutes prior to the study to optimize participant comfort. We used a Medtronic [Keypoint.NET](#) electromyography instrument (Medtronic Corporation, Minneapolis, MN) equipped with automated software to perform multiple motor unit action potential analysis (Multi-MUP) and interference pattern analysis (IP) at baseline, and a Nicolet Viking IVP electromyography instrument (Nicolet Instrument Corporation, Madison, Wisconsin) was used to process EMG signals during filling cystometry. We used standard filter settings (10Hz to 10Kz) and an amplifier gain of 50.

A disposable 30 gauge, 1-inch concentric needle electrode was inserted into the striated urethral sphincter muscle using 3 different insertion sites: 12 o'clock (5 mm above the external urethral meatus), 3 o'clock, and 9 o'clock. Needle electrode was positioned at each insertion site using auditory and oscilloscope guidance. Three different insertion sites were used on each participant to ensure an adequate number of discrete MUP were sampled for quantitative analysis. Multi-MUP and IP analyses were done at each insertion site prior to repositioning the electrode at another site; the electrodiagnostic instrument stores MUP capture at each site for later review and averaging.

Multi-MUP Analysis

At baseline with the bladder empty, the Multi-MUP software on the Medtronic [Keypoint.NET](#) electrodiagnostic instrument automatically obtained amplitude (measure from positive to negative peak), duration (measure of MUP length from initial spike to terminal portion), phases (number of times MUP crosses baseline plus 1), turns (change in direction of MUP where amplitude changes by 100µV), and % polyphasia (% of all MUP that are polyphasic). Any MUPs with an unstable baseline were discarded as previous investigators demonstrated that unstable baseline precludes accurate analysis(10).

Interference Pattern (IP) Analysis

With an empty bladder, we instructed participants to gradually "squeeze as if they were trying to hold in urine" to recruit more MUP and create an IP. The IP analysis was done at each insertion point during resting muscle activity and as the participant increased urethral

sphincter muscle activity with a voluntary squeeze. At each site, a 500 millisecond epoch of EMG activity was automatically obtained and analyzed. The following EMG parameters were obtained: turns (change in direction of MUP where amplitude changes by 100 μ V), amplitude, turn/amplitude ratio (measure of the number of MUP activated during muscle contraction), number of short segments (portion of EMG signal with sharp activity characterized by short rise times), % activity (percent of time during an epoch that sharp activity occurs), and envelope (peak to trough amplitude exceeded by only 1% of the amplitudes during the epoch).

Quantitative MUP Analysis

The needle electrode was re-positioned at the 9 o'clock position using auditory and oscilloscope guidance for the Multi-MUP and IP analyses. Maximum voluntary activity software on the Nicolet Viking IVp electromyography instrument (Nicolet Instrument Corporation, Madison, Wisconsin) was used to analyze the activity of the striated urethral sphincter during bladder filling. This automated motor unit analysis software program quantifies several EMG parameters using IP analysis. Maximum voluntary activity software measures the mean rectified voltage (MRV) or the mean amplitude calculated over the entire tracing after the waveform is rectified. A recording of MUP activation was made with subject at rest with an empty bladder and during filling cystometry to 300 ml bladder volume.

Data Analysis

Data were maintained in an Health Insurance Portability and Accountability Act (HIPAA) compliant dataset. SPSS Version 16 (Chicago, IL) was used for data management and analysis. Histograms were created to determine if demographic and MUP from Multi-MUP and IP analysis were normally distributed. Median (range) or mean $\pm$ standard deviation are reported based normality. Mean urethral EMG parameter data from the subjects were pooled to calculate mean, standard deviations, and 95% confidence intervals for each parameter. We used independent Student's t-test to compare means of independent groups, and Chi-square test of association to compare nominal data. Pearson's correlations were used to assess the relationship between MUP parameter and age. We used a significance level of 0.05, and all tests were two-sided.

Results

Thirty-one women met pre-urodynamic inclusion criteria and underwent EMG and urodynamic testing. One woman had urodynamic evidence of detrusor overactivity incontinence and was excluded from analysis. The 30 analyzed continent subjects had a mean $\pm$ SD age of 39 $\pm$ 14 years and Body Mass Index (BMI) of 28 $\square$ 9. More than half (59%) had delivered at least one child vaginally with a median (range) vaginal parity of 1 (0-4). The cohort was racially diverse with 13 Caucasians (43%), 13 African Americans (43%), and 4 other (14%). Four participants (14%) self-reported as Hispanic ethnicity. Mean $\pm$ SD age and BMI for Caucasians and African Americans were 49 $\pm$ 16 versus 36 $\pm$ 11 and 27 $\pm$ 2.7 versus 33 $\pm$ 11, respectively. Fifty percent of Caucasians were vaginally parous compared to 67% of African Americans. Age did not differ by parity (mean age $\pm$ SD nulliparous 35 $\pm$ 10 versus parous 41 $\pm$ 16, p =.280). Neither BMI (P =.12, .06), age (P =.40, .64), or vaginal parity (P =.53, .76) differed by race or ethnicity. Table 1 displays questionnaire scores for the cohort, which did not differ by race or ethnicity.

Table 2 displays urodynamic measures of urethral sphincter function for the cohort and by race. Table 3 displays EMG parameters for the cohort. We did not detect differences in any EMG parameters by race, ethnicity or vaginally parity. A mean $\pm$ SD of 30 $\pm$ 17 MUP were

identified and analyzed in Multi-MUP analysis and 14 ± 5 were identified and analyzed in IP analysis. On average, $37 \pm 20\%$ MUPs were polyphasic. Age significantly correlated with several measures of urethral sphincter function. Increasing age was inversely correlated with IP turns ($r = -.57$, $p = .001$), IP amplitude ($r = -.43$, $p = .02$), IP turns/amplitude ($r = -.54$, $p = .003$), MUCP ($r = -.41$, $p = .04$). Similarly, MUCP correlated with IP amplitude ($r = .38$, $p = .04$). We used backward linear regression to determine if any demographic factors (race, ethnicity, parity), IP MUP parameters, or MUCP were independently associated with age. In the final model, only IP turns/amplitude ($p = .008$) and IP amplitude ($p = .04$) were independently associated with age. Figure 1 demonstrates the relationship between increasing age and IP turns/amplitude.

Discussion

Our findings are the first to provide urethral sphincter normative values using EMG with urodynamics in a racially diverse group of continent women. The mean and 95% confidence intervals are reported for each MUP parameter and can serve as normative values for future work on EMG findings of symptomatic, incontinent women. We did not detect differences in EMG or urodynamic urethral parameters between continent Caucasian and African American women, suggesting there may not be measureable differences in urethral neuromuscular function in continent Caucasian and African American women. Weidner et al recently reported similar findings in the urethras of pregnant nulligravid and primigravid women without pelvic floor symptoms (11). Using IP analysis in the urethral sphincter, turns and turns/amplitude data (measures of motor unit recruitment) did not differ by race in pregnant women. However, in contrast to our finding, Weidner reported that African American women had larger amplitude MUP than Caucasians; although the African Americans subjects in that study were more likely to be nulligravid, while we had similar proportions of nulligravid African American and Caucasian women. Although our inability to detect urethral MUP difference amongst Caucasian and African American women is similar to previous reports, both studies are underpowered to make definitive conclusions. However, these data can be used to power future studies specifically designed to look at racial differences.

Consistent with neuromuscular changes elsewhere in the body, we found that advancing age was consistently associated with decreased urethral sphincter function. Previous histologic studies on female cadavers demonstrated a decrease in nerve and muscle fiber density in the striated urethral sphincter with advancing age and estimated that approximately 2% of striated urethral sphincter muscle fibers are lost per year. Perucchini et al suggested that loss of muscle fibers with aging is consistent with the hypothesis that muscle loss is a result of neural injury, but conclude that the way nerve injury would affect urethral function remains unclear (12).

Both MUP and urodynamic changes reflected poor urethral neuromuscular function. Older women demonstrated decreased MUP recruitment as measured by decreasing numbers of *turns* and lower *turns/amplitude* ratio. This relationship between age and urethral function is consistent with urodynamic measures of urethral function, histologic studies, and clinical rates of stress incontinence. Similar to our findings, prior urodynamic studies consistently report decreases in urethral closure pressures in continent women with advancing age (12, 13). Our urethral EMG data, which show MUP changes consistent with neuropathy not myopathy, support that the histologic findings of decreased muscle are likely secondary to neuromuscular decline rather than primary muscle pathology (14, 15).

The important association between MUP parameters suggestive of urethral neuromuscular dysfunction and age are consistent with clinical data, which show increasing rates of stress

urinary incontinence with aging. In a large study of Norwegian women, Rortveit et al found no difference in the prevalence of urinary incontinence in women over age 65, who were nulliparous, had delivered by Cesarean, or delivered vaginally; although, vaginal parity was a risk factor at earlier ages (16, 17). Other investigators demonstrated similarly high stress incontinence prevalence in postmenopausal nuns and twins regardless of vaginal parity (17, 18). Our study population had a mean age near 40 and, given the prevalence of SUI, it is likely that some of these currently continent women will develop SUI.

Unlike other pelvic floor muscles (levator ani and anal sphincter), urethral function is commonly measured using urethral pressure measurements to quantify muscle function. MUCP is one of the most common clinically reported parameters of urethral function, although data on the relationship between urethral pressure, urethral function, and incontinence severity is variable (19). Similar to our findings, early studies reported that urethral pressure decreases with age, suggesting a decline in urethral function with aging (13). Likewise, lower MUCP are associated with higher failure rates after incontinence surgery (20). At least some MUP parameters (IP amplitude) in our study correlated with MUCP, supporting the hypothesis that urethral EMG provides another measure of urethral function which is related to urodynamic urethral pressure measurements.

MUP parameter differences were more likely to be significant in IP analysis than Multi-MUP analysis. Motor unit action potential (MUP) analysis identifies individual motor unit action potentials in a muscle. Interference pattern (IP) analysis describes the electrical activity of a muscle from weak effort up to maximal effort. MUP analysis may reflect pathological changes in MUP recruited at weak effort, while IP analysis may reflect changes in MUP recruited in the whole force range. Re-innervation changes may be more prominent in MUP activated at higher levels of muscle force generation; therefore, by analyzing different MUP, the techniques together may offer additive insight into neuromuscular function. Other investigators have reported similar findings in the external anal sphincter (21, 22) suggesting that MUP changes associated with reinnervation may be more prominent in MUP activated at higher levels of muscle force generation. Therefore, IP analysis may be a better method to detect small changes in MUP parameters.

Strengths of our study include collection of prospective, urethral EMG data in a racially/ethnically diverse group of nulliparous and parous women. We used standardized quantitative EMG software allowing for comparisons of our data to previous EMG data in the external anal sphincter. Our conclusions are limited by a relatively small sample size that does not permit adequately powered comparisons between subgroups; although, these data can be used to power future comparative studies.

Conclusion

The urethral neuromuscular function data from the largest cohort of continent women fully characterized with quantitative urethral EMG demonstrates that significant neuropathic MUP changes occur with advancing age. These findings support histologic and clinical data that age-related neuromuscular decline affects the urethral sphincter and may be associated with an increasing prevalence of urinary incontinence symptoms. Urinary incontinence may be amenable to targeted therapy, such as neural therapies directed at prevention and/or repair of neuro-muscular function to improve urethral sphincter function.

References

1. Ashton-Miller JA, Howard D, DeLancey JO. The functional anatomy of the female pelvic floor and stress continence control system. *Scand J Urol Nephrol*. 2001; 207:1–7. discussion 106-25.

2. DeLancey JO, Trowbridge ER, Miller JM, et al. Stress urinary incontinence: Relative importance of urethral support and urethral closure pressure. *J Urol.* Jun; 2008 179(6):2286–2290. discussion 2290. [PubMed: 18423707]
3. Weber AM, Taylor RJ, Wei JT, et al. The cost-effectiveness of preoperative testing (basic office assessment vs. urodynamics) for stress urinary incontinence in women. *BJU Int.* 2002; 89(4):356–63. [PubMed: 11872024]
4. Weidner AC, Barber MD, Visco AG, et al. Pelvic muscle electromyography of levator ani and external anal sphincter in nulliparous women and women with pelvic floor dysfunction. *Am J Obstet Gynecol.* 183(6):1390–9. [PubMed: 11120502]
5. Aanestad O, Flink R. Urinary stress incontinence. A urodynamic and quantitative electromyographic study of the perineal muscles. *Acta Obstet Gynecol Scand.* 1999; 78(3):245–53. [PubMed: 10078588]
6. Podnar S, Rodi Z, Lukanovic A, et al. Standardization of anal sphincter EMG: Technique of needle examination. *Muscle Nerve.* 1999; 22(3):400–3. [PubMed: 10086902]
7. Herzog AR, Diokno AC, Brown MB, et al. Two-year incidence, remission, and change patterns of urinary incontinence in noninstitutionalized older adults. *J Gerontol.* 1990; 45(2):M67–M74.
8. Barber MD, Walters MD, Bump RC. Short forms of two condition-specific quality-of-life questionnaires for women with pelvic floor disorders (PFDI-20 and PFIQ-7). *Am J Obstet Gynecol.* Jul; 2005 193(1):103–113. [PubMed: 16021067]
9. Bump R, Mattiasson A, Bo K, et al. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. *Am J Obstet Gynecol.* 1996; 175:10–7. [PubMed: 8694033]
10. Podnar S, Vodusek DB. Standardization of anal sphincter electromyography: Utility of motor unit potential parameters. *Muscle Nerve.* 2001; 24(7):946–51. [PubMed: 11410923]
11. Weidner AC, South MM, Sanders DB, et al. Change in urethral sphincter neuromuscular function during pregnancy persists after delivery. *Am J Obstet Gynecol.* Nov; 2009 201(5):529.e1–529.e6. [PubMed: 19766981]
12. Obrink A, Bunne G, Ulmsten U. Intra-urethral and intra-vesical pressure in continent women. *Acta Obstet Gynecol Scand.* 1977; 56(5):525–9. [PubMed: 564130]
13. Rud T. Urethral pressure profile in continent women from childhood to old age. *Acta Obstet Gynecol Scand.* 1980; 59(4):331–5. [PubMed: 7192471]
14. Perucchini D, DeLancey JO, Ashton-Miller JA, et al. Age effects on urethral striated muscle. I. changes in number and diameter of striated muscle fibers in the ventral urethra. *Am J Obstet Gynecol.* 2002; 186(3):351–5. [PubMed: 11904590]
15. Pandit M, DeLancey JO, Ashton-Miller JA, et al. Quantification of intramuscular nerves within the female striated urogenital sphincter muscle. *Obstet Gynecol.* 2000; 95(6 Pt 1):797–800. [PubMed: 10831969]
16. Rortveit G, Hannestad YS, Daltveit AK, et al. Age- and type-dependent effects of parity on urinary incontinence: The norwegian EPINCONT study. *Obstet Gynecol.* 2001; 98(6):1004–10. [PubMed: 11755545]
17. Rortveit G, Daltveit AK, Hannestad YS, et al. Vaginal delivery parameters and urinary incontinence: The norwegian EPINCONT study. *Am J Obstet Gynecol.* 2003; 189(5):1268–74. [PubMed: 14634552]
18. Buchsbaum GM, Chin M, Glantz C, et al. Prevalence of urinary incontinence and associated risk factors in a cohort of nuns. *Obstet Gynecol.* 2002; 100(2):226–9. [PubMed: 12151141]
19. Nager CW, Kraus SR, Kenton K, et al. Urodynamics, the supine empty bladder stress test, and incontinence severity. *Neurourol Urodyn.* 2010; 29:1306–11. [PubMed: 20127832]
20. Nager CW, Sirls L, Litman HJ, et al. Baseline urodynamic predictors of treatment failure 1 year after midurethral sling surgery. *J Urol.* 2011; 186:597–603. [PubMed: 21683412]
21. Gregory WT, Clark AL, Simmons K, et al. Determining the shape of the turns-amplitude cloud during anal sphincter quantitative EMG. *Int Urogynecol J.* Jul; 2008 19(7):971–976.
22. Podnar S, Vodusek DB. Standardization of anal sphincter electromyography: Effect of chronic constipation. *Muscle Nerve.* 2000; 23(11):1748–51. [PubMed: 11054754]

Figure 1.
Scatterplot demonstrating relationship between advancing age and IP turns-amplitude ratio.

Table 1
Pelvic Floor Symptoms

	Continent Women N = 30
<i>Pelvic Floor Distress Inventory (Mean±SD)</i>	
<i>Urinary Distress Inventory</i>	5.7±13.4
<i>Prolapse Distress Inventory</i>	1.9±6.5
<i>Colorectal Distress Inventory</i>	2.9±6.1
<i>Medical Epidemiologic Social Aspects of Aging (Mean±SD)</i>	
<i>Stress Subscale</i>	2.3±1.7
<i>Urge Subscale</i>	3.7±7.7

Table 2
Urodynamic Measures of Urethral Sphincter Function at 300 ml Bladder Volume

	N=30 Mean±SD	Caucasian N=13 Mean	African American N=13	P Value
<u>Maximum Urethral Closure Pressure</u>	143±62	146±67	141±42	.96
<u>Functional Urethral Length</u>	18±5.1	16±4.5	20±5.8	.10
<u>Area Continnence Zone</u>	960±531	941±683	1026±430	.72

Table 3
EMG Findings: Motor Unit Action Potential Parameters

	N=30 Mean±SD	95% Confidence Interval	Caucasian N=13 Mean	African American N=13	P Value
MULTI-MUP Parameters					
<i>Amplitude (μV)</i>	377±174	315, 446	331±152	432±212	.18
<i>Duration (msec)</i>	9.8±3.4	8.6, 11.2	9.1±3.5	9.9±3.8	.57
<i>Phases (N)</i>	5.0±1.5	4.4, 5.8	4.4±1.1	5.0±1.4	.37
<i>Turns (N)</i>	5.6±2.4	4.5, 6.8	4.6±1.9	5.4±2.1	.48
Interference Pattern Parameters					
<i>Turns (N)</i>	199±108	160, 242	160±90	228±131	.14
<i>Amplitude (μV)</i>	637±366	490, 765	649±431	559±346	.58
<i>Turns/Amplitude</i>	.72±.35	.59, .86	.57±.28	.82±.44	.11
<i>Activity (%)</i>	8.2±5.7	6.1, 10.5	6.3±4.0	9.6±7.2	.17
<i>Number Short Segments (N)</i>	111±77	83.6, 141	86±57	134±89	.12
<i>Envelope (μV)</i>	547±225	462, 633	505±223	584±257	.42
Mean Rectified Voltage During Cystometry					
<i>Baseline (0 ml)</i>	17.1±14.6		16.3±12.3	13.5±11.4	.55
<i>Change 300 ml-Baseline</i>	10.9±12.5		8.1±5.3	12.5±11.1	.27
<i>Change cough - Baseline</i>	13.4±12.6		10.1±7.1	16.5±17.4	.24