Pelvic Floor Muscle Surface Electromyography

Reliability and Clinical Predictive Validity

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OBJECTIVE: To study the reliability and clinical predictive validity of pelvic floor muscle surface electromyography (sEMG) for use in early detection and prophylaxis of urogynecologic disorders.

STUDY DESIGN: Fifty-seven women ranging from 19 to 69 years of age completed a written questionnaire and underwent digital pelvic examination followed by pelvic floor muscle sEMG using an intravaginal sensor. Thirty-seven subjects underwent repeat evaluations one week or more later.

RESULTS: sEMG data demonstrated significant test-retest reliability ($P < .001$*) and significant clinical predictive validity (*$P < .05$*) for undifferentiated urinary incontinence, stress incontinence, urge incontinence, menstrual status and parity on both initial and repeat examinations.*

CONCLUSION: Pelvic floor muscle sEMG is reliable and consistently predictive of several important clinical status variables, suggesting that it can be a useful tool in early at-risk detection and prophylactic intervention for disorders of pelvic floor muscle laxity. Recent advances in sEMG technology make it cost-effective, convenient, noninvasive and easy to learn and administer by assisting staff. This technology is a powerful complementary tool for digital assessment of pelvic floor muscles and should be considered for use in gynecologic practice. (J Reprod Med 1999;44:779–782)

We suggest that pelvic floor muscle function assessment be incorporated into all well-woman evaluations.

Keywords: electromyography, urinary incontinence, pelvic floor.

Introduction

With the increase in the elderly population, symptoms of pelvic floor laxity will increase. It is impor-

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Supported in part by a grant from BARD Urological Division, CR BARD, Inc., to Dr. Glazer. BARD also provided the surface electromyography vaginal sensors used in this study.

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Financial Disclosure: CR BARD, Inc., supported this research with a grant and equipment. BARD decided not to proceed with development and distribution of the equipment. None of the authors ever received direct or indirect support or compensation from BARD.

tant to develop reliable and accurate methods to identify women with unreported symptoms or presymptomatic women at risk for these disorders so that pelvic floor muscle rehabilitation can be initiated to treat or prevent/delay symptom onset. This can be best accomplished by routine pelvic floor muscle screening of all women seeking gynecologic care.

Only pelvic floor muscle sEMG has the ability to predict continence status as well as parity and hormonal status.

Digital evaluation is clearly the easiest, fastest and most portable and cost-effective tool for assessing pelvic floor muscles. Recent research on digital pelvic muscle assessment conducted by Brink et al[1,2] demonstrated that digital scores are reliable and correlate with surface electromyography (sEMG) but show only a weak correlation with the stand-up pad test and no correlation to a history of urinary leakage. Thus, although reliable, digital pelvic muscle scores may have limited predictive validity for clinical status variables and represent only a first-line screening procedure.

Arnold Kegel recommended pelvic floor muscle evaluation in all patients,[3] employing manometric perineometry of pelvic floor muscles to provide a more accurate assessment for the examiner and enhanced feedback for the patient.[4] However, recent data presented by Martan et al[5] demonstrated that manometric measures of the contraction force of pelvic floor muscles did not show any relationship to continence status or grade of incontinence.

sEMG is an advance over manometric pressure readings and has been shown to be of clinical value in (1) assessing coordination between bladder contraction and sphincter relaxation,[6] (2) identifying specific pelvic floor muscle locations involved in assisting bladder neck opening and closure,[7] (3) screening to detect occult dyssenergia in patients who have failed urethral implantation,[8] (4) assessing upper and lower motor neuron lesions with irritable bladders,[9] and (5) differentiating essential vulvovaginal pain disorders from acute vaginal infections as a source of vulvovaginal pain.[10]

This study was designed to determine pelvic floor muscle sEMG reliability and predictive validity for self-reported clinical status in a number of areas related to pelvic floor muscle function.

Materials and Methods

This study protocol was approved by the institutional review board of the New York Hospital—Cornell Medical Center.

Study participants were nonpregnant, adult, female volunteers responding to a published advertisement inviting them to participate in a study of pelvic muscle function. The only exclusion criterion was unwillingness to complete all components of the study. After giving written consent, participants completed a written questionnaire detailing menopausal status, childbearing history, urinary status and sexual activity.

Study participants then underwent a pelvic examination to determine the degree of cystocoele, rectocele and/or uterine/vault prolapse using the system of Baden et al.[11] Within 45 minutes of completing the pelvic scale examinations, participants underwent sEMG of pelvic floor muscle function. The sEMG unit used was a single-user vaginal surface EMG sensor (Thought Technology, Montreal, Quebec, Canada) consisting of bipolar longitudinal electrode plates mounted in a plastic vaginal probe with sensor connector and abdominal reference electrode wire. The sEMG signal-processing unit (FlexiPlus surface EMG, Computerist, Inc., Jacksonville, Florida) consists of a portable, 1.5-lb, six-channel surface EMG unit operating at an analog-to-digital conversion rate of 1,000 per second, producing peak, average, minimum and maximum integrated EMG root mean squared measures and median spectral frequency calculations. The assessment protocol software is the Glazer Pelvic Muscle Assessment Program, Version 2.2 (Bio-behavioral Medical Rehabilitation Inc., Jacksonville, Florida).[10,12]

Participants were instructed to contract the pelvic floor muscles as strongly as possible and hold the contraction for 10 seconds. (A 10-second contraction is part of a standard sEMG assessment protocol.)[13] No other instruction about the equipment, biofeedback screen or personalized coaching during sEMG assessment was done.

After the first assessment, each woman was asked to return for a repeat evaluation in one to four weeks. Subjects were instructed not to practice pelvic floor contractions in the interval between evaluations.

Table I *Clinical Variable Subgroup Means for sEMG on Initial and Follow-up Evaluations*

	Initial evaluation		Follow-up evaluation	
Clinical variable	**n**	**sEMG (μV)**	**n**	**sEMG (μV)**
Any urinary incontinence				
Yes	25	9.9*	17	11.6*
No	24	15.5	20	16.4
Stress incontinence				
Yes	17	9.7*	13	10.4*
No	27	14.7	24	15.5
Urge incontinence				
Yes	20	10.1*	18	12.5*
No	24	14.9	19	15.5
Urinary urgency				
Yes	22	11.9	18	10.8
No	22	13.7	19	13.4
Cystocele				
Yes	11	10.4	8	10.9
No	32	13.4	28	14.8
Rectocele				
Yes	9	12.6	9	12.5
No	35	14.2	27	14.4
Menstrual status				
Pre	24	14.8	18	15.0
Peri/post	14	9.0*	14	6.0*
Post, on hormone replacement therapy	5	15.6	5	17.4
Parity				
0	26	16.2*	21	18.3*
1 Or more	18	9.3	15	7.4
Sexually active				
Yes	26	13.0	17	14.8
No	25	12.0	18	12.4
Does Kegel exercises				
Yes	13	13.7	8	15.5
No	38	12.4	29	13.4

*$P < .05$.

Results

Pearson correlation coefficients were used to determine sEMG reliability by comparing sEMG contraction amplitude in the first examination to that in the second examination. Student's *t* tests were used to test sEMG contraction amplitude differences between patient subgroups to determine clinical predictive validity of sEMG.

A total of 57 women completed the first evaluation, and 37 returned for the second evaluation. The mean age was 44.2 ± 14.2 year and ranged from 19 to 69 years.

The reliability correlation for sEMG between the first and second examinations was significant, with $r = .86$ ($P < .001$). Predictive validity for clinical status for sEMG data for each examination appears in Table I. sEMG data demonstrated statistically significant ($P < .05$ in all cases) predictive validity for undifferentiated urinary, stress and urge incontinence, menstrual status and parity.

For both examinations 1 and 2, sEMG data demonstrated statistically significant lower microvoltage contractions for subjects with any urinary, urge or stress incontinence as compared to their continent counterparts. Parous women were weaker on sEMG than nulliparous women, and peri/postmenopausal women not on hormone replacement therapy were weaker than their premenopausal counterparts and postmenopausal ones with hormone replacement.

Although not statistically significant, those with clinical examination findings of cystocele or rectocele showed lower contractile amplitudes, as did those reporting urinary urgency. Those reporting abstinence from sexual activity showed lower contractile amplitudes, and those who reported doing Kegel exercises showed greater contractile amplitudes. For each of these statistically nonsignificant findings, the sEMG data were in the expected direction, so lack of significance may represent lack of statistical power due to sample size.

Discussion

This study demonstrated that pelvic floor muscle sEMG is a highly reproducible measure that is able to consistently predict certain clinical status variables, including urinary incontinence, related to pelvic floor muscle functioning. Neither digital[2] nor manometric[5] measures of pelvic floor musculature predict incontinence. Furthermore, the most recent research has demonstrated that neither patient history nor physical examination findings add predictive validity to symptom reports[14] of incontinence. Thus, only pelvic floor muscle sEMG has the ability to predict continence status as well as parity and hormonal status.

We suggest that pelvic floor muscle function assessment be incorporated into all well-woman evaluations. sEMG of pelvic floor muscles has demonstrated reliability and consistent predictive validity for a subset of clinical variables. Recent advances in sEMG technology make it cost-effective, convenient, noninvasive, quick, and easy to learn and administer by clinical support staff. In addition, sEMG biofeedback for the rehabilitation of pelvic floor muscle dysfunction has been demonstrated to be effective in the treatment of both incontinence[15] and

pelvic pain disorders[12] and also has been demonstrated to significantly improve clinical outcomes when used as part of a home training program.[16]

More research is necessary and is now under way to develop a database for pelvic floor muscle sEMG norms associated with clinical status variables. Further support for the integration of pelvic floor muscle sEMG into gynecologic practice awaits additional research.

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