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Evaluation of the role of pudendal nerve integrity in female sexual function using noninvasive techniques

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KEY WORDS
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Objective: Using quantitative sensory testing and a validated questionnaire, we investigated the role of pudendal nerve integrity in sexual function among women.
Study design: Participants completed the Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire (PISQ). Vibratory and pressure thresholds were measured at the S2 dermatome reflecting pudendal nerve distribution.
Results: A total of 56 women enrolled; 29 (51.8%) were asymptomatic and 27 (48.2%) had 1 or more forms of female sexual dysfunction (total sexual dysfunction) including: desire disorder 16.1%, arousal disorder 26.8%, orgasmic disorder 25%, and pain disorder 12.5%. Age, parity, menopausal status, and body mass index were similar between groups. PISQ scores were lower in symptomatic subjects compared with controls ($P < .001$). Decreased tactile sensation was found at the clitoris for women with total sexual dysfunction, desire disorder, and arousal disorder. Women with arousal disorder also had decreased tactile sensation at the perineum.
Conclusion: Pudendal nerve integrity may play a role in female sexual dysfunction.

Recent statistics suggest that up to 43% of women in the United States are afflicted by female sexual dysfunction (FSD).[1] Almost 10 million women between the ages of 50 and 74 report abnormal sexual complaints, including decreased desire, inability to reach orgasm, and increased pain with intercourse.[2] Despite these figures, most women with FSD remain undiagnosed. In contrast to men, clinical trials on sexual dysfunction in women are few, although sexual problems in women are prevalent and sexual dysfunction may be more common in women than in men.[1] Recently, attention has been directed to understanding the physiologic mechanisms responsible for sexual function in women. However, evaluation of the female sexual response is technically challenging and lacks standardized techniques. Precise diagnostic tools and defined outcome measures are essential to distinguish between normal and abnormal sexual function in women.

Few clinical studies to date have investigated neurologic sensory deficits as a cause of sexual dysfunction in women. The technique of quantitative sensory testing (QST), which involves measurement of vibration, pressure, and thermal thresholds, was first proven to be a valid technique of assessing peripheral and central nervous system function.[3-8] Vardi et al[9] later

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Table I Patient characteristics for women with sexual dysfunction and asymptomatic controls (n = 56)

	Sexual dysfunction (n = 27)	Asymptomatic (n = 29)	*P*
Age (y)	37.11 ± 11.52	38.41 ± 23	.64
Parity	1.81 ± 1.73	1.72 ± 1.36	.83
BMI	29.81 ± 5.86	28.42 ± 6.56	.43
Menopausal	23 (41.1%)	24 (42.9%)	.96

Data are expressed as mean ± SD and n (%).

demonstrated that QST could be effectively used to assess neurologic function of the genitalia in normal women. Romanzi et al[10] validated the use of tactile thresholds of the genitalia in patients diagnosed with FSD using a validated questionnaire. In a previous study, we found that age and menopause negatively influence vibratory sensation in the female genital region; however, these findings were not correlated to sexual function.[11] The goal of this pilot study was to determine whether neurologic deficits exist in patients with FSD using quantitative sensory testing in conjunction with a validated sexual function questionnaire.

Material and methods

After Institutional Review Board approval of the study, patients attending urogynecology and gynecology clinics at our institution between July 2002 and June 2003 were recruited with informed consent. All participants were prospectively enrolled and were assessed and tested by 2 of the investigating researchers (K. C. and M. K. G.). Each participant underwent a thorough evaluation, consisting of a detailed neurologic, gynecologic, and obstetric history. Significant neurologic conditions that were screened for in the study population were peripheral neuropathy and a history of central nervous system disorders. Menopause was defined as the cessation of menses for at least 1 year or absent menses for at least 3 months with a follicular stimulating hormone level greater than 20 IU/L. A careful gynecologic history and examination were performed. Exclusion criteria included age under 18 years, peripheral neuropathy, central nervous system disorder, HIV disease, pregnancy, menses, and active vulvar lesions. Only patients who were sexually active within the last 12 months were included.

All included participants completed the Pelvic Organ Prolapse/Urinary Incontinence Sexual Function Questionnaire, (PISQ) in a private room and examiners were blinded to the subjects' responses. The PISQ is a 31-item questionnaire that was designed to evaluate the sexual function of women and has been validated in both normal women and women with pelvic organ prolapse and urinary incontinence.[12] This questionnaire was judiciously selected given that the more than 60% of the patients presenting to our subspecialty clinic have urinary complaints and/or prolapse.

Table II Mean PISQ scores of women with sexual dysfunction compared with asymptomatic controls

Sexual dysfunction group	n	Mean PISQ ± SD	*P* value
Asymptomatic controls	29	99.6 ± 12.6	N/A
TSD	27	82.9 ± 19.1	< .001
DD	9	73.3 ± 24.6	< .001
AD	15	75.7 ± 19.3	< .001
OD	8	78.1 ± 21.5	< .001
PD	8	76.1 ± 23.3	< .001

N/A, Not applicable.
Student's *t* test was performed to evaluate PISQ scores in sexual function groups compared with asymptomatic controls.

The PISQ inquires about different forms of FSD. All the PISQ responses are measured on a 5-point Likert-type scale as originally described.[12] Briefly, the responses "always," "usually," "sometimes," "seldom," and "never" are assigned the numbers 0 through 4, respectively. In question 12, the responses include variations of vaginal dryness. Similarly, the responses "extremely dry," "pretty dry," "somewhat dry," "not very dry," and "not dry at all" were also assigned numbers 0 through 4, respectively. Reverse scoring was used for selected questions according to the original validation to maintain consistency of higher numbers, reflecting better sexual function. Assigned numbers were summed and PISQ scores were determined. Lower scores indicate worse sexual function. Missing data were handled by multiplying the number of items by the mean of the answered items as described by Rogers et al.[12]

Patients were grouped into 4 subcategories, desire dysfunction (DD), arousal dysfunction (AD), orgasmic dysfunction (OD), and pain dysfunction (PD), using responses from the PISQ and criteria set by The International Consensus Development Conference on FSD.[13] Women who were classified as dysfunctional in any of the 4 subcategories collectively constituted the total sexual dysfunction group (TSD). Question 6 inquires about a person's ability to acheive orgasm during intercourse. Questions 8, 9, and 12 inquire about the ability to become sexually aroused, including increased respiratory and heart rate, pleasurable sensations in the breast and genital region, sexual excitement, and vaginal lubrication. Desire for intercourse is addressed with question 10, whereas question 11 assesses for the frequency of painful intercourse. Values of 0 and 1 were pooled to reflect sexual dysfunction. Responses of 2, 3, or 4 were classified as normal.

Sensory testing was conducted along the S2 dermatome regions of the vulva, clitoris, external urethral meatus, the right and left sides of the perineum, and the

Table III Quantitative sensory thresholds in patients with DD compared with asymptomatic controls

	DD n = 9	Asymptomatic n = 29	*P* value
Tactile threshold (grams)			
Right ankle*	0.67 ± 0.65	0.51 ± 0.91	.09
Vulva	0.12 ± 0.12	0.05 ± 0.07	.12
Clitoris	0.11 ± 0.12	0.03 ± 0.02	< .01
Urethral meatus	0.19 ± 0.19	0.17 ± 0.40	.06
Right perineum	0.59 ± 0.73	0.04 ± 0.03	.07
Left perineum	0.45 ± 0.73	0.25 ± 1.10	.37
Vibratory threshold			
Right ankle*	7.57 ± 4.31	5.67 ± 3.31	.33
Vulva	4.67 ± 3.54	3.29 ± 1.37	.49
Clitoris	3.56 ± 2.46	2.28 ± 0.84	.27
Urethral meatus	5.44 ± 4.45	3.53 ± 1.66	.47
Right perineum	7.44 ± 5.22	5.12 ± 2.70	.25
Left perineum	6.56 ± 5.46	6.07 ± 5.77	.99

Wilcoxon rank sum test used for statistical analysis.
* DD n = 7; Asymptomatic n = 21.

Table IV Quantitative sensory thresholds in patients with AD compared with asymptomatic controls

	AD n = 15	Asymptomatic n = 29	*P* value
Tactile threshold (grams)			
Right ankle*	0.56 ± 0.58	0.51 ± 0.91	.19
Vulva	0.17 ± 0.35	0.05 ± 0.07	.20
Clitoris	0.15 ± 0.17	0.03 ± 0.02	< .01
Urethral meatus	0.17 ± 0.17	0.17 ± 0.40	.05
Right perineum	0.49 ± 0.73	0.04 ± 0.03	< .02
Left perineum	0.44 ± 0.72	0.25 ± 1.10	.07
Vibratory threshold			
Right ankle*	7.50 ± 4.80	5.67 ± 3.31	.38
Vulva	4.13 ± 2.95	3.29 ± 1.37	.60
Clitoris	3.27 ± 2.34	2.28 ± 0.84	.47
Urethral meatus	4.67 ± 3.72	3.53 ± 1.66	.68
Right perineum	6.20 ± 4.71	5.12 ± 2.70	.81
Left perineum	5.60 ± 4.84	6.07 ± 5.77	.50

Wilcoxon rank sum test used for statistical analysis.
* AD n = 12; Asymptomatic n = 21.

medial right ankle. Before commencing, patients were told which areas would be evaluated and a demonstration was performed on the patient's hand to ensure a thorough understanding of the sensations to be reported. Pressure thresholds were determined with the use of Semmes-Weinstein monofilaments (North Coast Medical, Morgan Hill, Calif). The Semmes-Weinstein monofilaments have increasing diameters and are labeled to provide a logarithmic scale of applied force in grams. Monofilaments were applied to the genital testing sites according to ascending thickness (transmitting increasing pressure) until the patients indicated that they felt the tactile stimulus. Vibratory thresholds were determined with the use of a biothesiometer with a stimulus frequency fixed at 120 Hz signal (Biomedical Instrument Company, Newbury, Ohio). The intensity was roughly proportionate to the square of the applied voltage as measured by a sensitive galvanometer. The biothesiometer has distinct amplitude markings. With the use of the method of limits, the stimulus intensity was gradually increased at the aforementioned sites until the patient indicated the minimal energy needed to distinguish between vibration and static touch.[14]

The study was then conducted with the patient in the lithotomy position and blinded to the voltage and pressure of the instruments being applied. The first 25 patients enrolled underwent testing performed by both examiners to confirm standardization of the technique including the instructions to the patient, location and application of the stimulus, and accurate reading of the amplitude markings and filament diameter. All subsequent examinations were performed by either of the 2 investigators.

Data were analyzed with STATA 8.2 (Statacorp, College Station, Tex). Descriptive statistics were reported as percentages, means, and SDs. Continuous data were analyzed with the Student's *t* test. Comparisons of categorical data were analyzed with the χ^2 analysis. Results from the quantitative sensory testing were analyzed with the use of the Wilcoxon rank sum test because the normality assumption was not satisfied (Shapiro-Wilks $<.01$). Multiple logistic regression was performed to evaluate for confounding variables. Due to the small values obtained by the Semmes-Weinstein monofilaments, all of the thresholds were multiplied by a consistent value of 100 to facilitate analysis. Statistical significance was defined as a *P* value less than .05.

Results

A total of 56 women underwent neurologic testing and completed the PISQ. The mean age and body mass index (BMI) of all participants were 37.79 ± 10.33 years and 29.16 ± 6.17, respectively. The majority of the subjects (85%) were premenopausal. Table I provides the characteristics for patients with sexual dysfunction compared with asymptomatic controls. The mean age, parity, and BMI were similar in both groups. Of the 56 patients, 29 women (52.8%) were asymptomatic and constituted the control group, and 27 women (48.2%) represented the TSD group. The percentage of women with FSD included: DD 16.1% (n = 9), AD 26.8% (n = 15), OD 25% (n = 14), and PD 12.5% (n = 8). Thirteen participants (23.2%) of the TSD group qualified for more than 1 form of FSD.

PISQ scores were significantly lower, indicating worse sexual function, for the TSD group, as well as the 4 subgroups compared with the asymptomatic controls

Table V Quantitative sensory thresholds in patients with OD compared with asymptomatic controls

	OD n = 14	Asymptomatic n = 29	*P* value
Tactile threshold (grams)			
Right ankle*	0.28 ± 0.16	0.51 ± 0.91	.60
Vulva	0.04 ± 0.04	0.05 ± 0.07	.51
Clitoris	0.04 ± 0.04	0.03 ± 0.02	.34
Urethral meatus	0.09 ± 0.11	0.17 ± 0.40	.85
Right perineum	0.12 ± 0.27	0.04 ± 0.03	.62
Left perineum	0.05 ± 0.10	0.25 ± 1.11	.38
Vibratory threshold			
Right ankle*	6.00 ± 3.28	5.67 ± 3.31	.66
Vulva	3.14 ± 1.29	3.29 ± 1.37	.77
Clitoris	2.29 ± 1.20	2.28 ± 0.84	.77
Urethral meatus	4.07 ± 2.64	3.53 ± 1.66	.80
Right perineum	5.79 ± 4.06	5.12 ± 2.70	.72
Left perineum	4.50 ± 3.70	6.07 ± 5.77	.11

Wilcoxon rank sum test used for statistical analysis.
* OD n = 12; Asymptomatic n = 21.

Table VI Quantitative sensory thresholds in patients with PD compared with asymptomatic controls

	PD n = 8	Asymptomatic n = 29	*P* value
Tactile threshold (grams)			
Right ankle*	0.45 ± 0.26	0.51 ± 0.91	.11
Vulva	0.02 ± 0.01	0.05 ± 0.07	.05
Clitoris	0.03 ± 0.02	0.03 ± 0.02	.98
Urethral meatus	0.06 ± 0.07	0.17 ± 0.40	.34
Right perineum	0.08 ± 0.13	0.04 ± 0.03	.67
Left perineum	0.07 ± 0.13	0.25 ± 1.10	.64
Vibratory threshold			
Right ankle*	6.14 ± 2.71	5.67 ± 3.31	.54
Vulva	3.25 ± 1.28	3.29 ± 1.37	.92
Clitoris	2.25 ± 1.28	2.28 ± 0.84	.57
Urethral meatus	2.88 ± 0.83	3.53 ± 1.66	.32
Right perineum	5.00 ± 2.14	5.12 ± 2.70	.97
Left perineum	4.00 ± 1.77	6.07 ± 5.77	.23

Wilcoxon rank sum test used for statistical analysis.
* PD n = 7; Asymptomatic n = 21.

($P < .001$, Table II). The symptomatic women also showed evidence of decreased tactile sensation in the genital area. Subjects in the TSD group had increased tactile thresholds (indicating worse neurologic function) at the clitoris ($P = .02$). This same finding was also seen in women with DD and AD. Women with AD also had increased tactile thresholds at the right perineum (Tables III through VI). After adjusting for age and menopause, the odds of developing sexual dysfunction increased by 27% for every increase of 100 g in force in the clitoral tactile threshold (Table VII).

Table VII Odds ratios assessing risk factors for the development of sexual dysfunction

Potential risk factors	Odds ratio	*P* value	95% CI
Decreased clitoral sensation	1.27	.02	1.04-1.55
Age	0.98	.08	0.86-1.01
Menopause	1.44	.75	0.14-14.21

Comment

The sexual response in women is a vasocongestive and neuromuscular event.[15] The elaborate neurologic pathways involved in this process include central, sympathetic, parasympathetic, and somatic interconnections.[16] The sensations of pressure and vibration are conducted by large myelinated fibers in peripheral nerves, and by the dorsal column of the spinal cord.[9,10] During genital stimulation, it is believed that recruitment of fibers in this pathway play a central role in the normal female sexual response mechanism.[9] Thus, any alteration of these nerve tracts could potentially lead to neurogenic FSD.

Our data suggest that pudendal nerve impairment may play a role in sexual dysfunction in women. Of interest is that decreased sensation was found uniformly at the clitoris in women in the TSD, AD, and DD groups. The autonomic nervous system is believed to be responsible for the physiologic changes that occur during the desire and arousal phases of the female sexual response.[16] However, animal studies indicate that peripheral nerve innervation in the female may also play an essential role. In female rats and rabbits, clitoral and vaginal blood flow increase during stimulation of the dorsal clitoral and pelvic plexus nerves, respectively.[17-20] Human studies also show increased vaginal blood flow and clitoral engorgement in the normal human sexual response to stimulation, and that insufficient vasocongestion is associated with FSD.[15,21-25] Our findings suggest that physiologic changes that occur in the arousal and desire phases may be mediated by the autonomic nervous system and the pudendal nerve, and that pudendal nerve insufficiency may play a role in FSD.

Our findings correlate with those of Romanzi et al,[10] who also found decreased clitoral sensation in women with FSD. In addition, they found significantly decreased tactile sensation at all genital sites. Similarly, we noted decreased sensation at each of the tested genital sites; however, statistical significance was seen only at the clitoris and at the right perineum. Potential explanations for this discrepancy are that Romanzi et al[10] used an alternative validated sexual function questionnaire to identify the symptomatic subjects and they did not subcategorize women by the specific type of sexual function.

In addition, their study population was older (48.7 ± 13.8 years vs 37.8 ± 10.3 years) and more likely to be

postmenopausal (47% vs 15%). Although logistic regression did not find age or menopause to be confounding variables in our study, Romanzi et al[10] demonstrated that menopausal women had decreased tactile sensation of the genitalia. In other studies, age dependency has been shown for quantitative sensory thresholds in the genital region in women, and may reflect neural degeneration as a process of aging.[11,13] Given the small sample sizes in both studies, it is possible that the younger age and predominance of premenopausal patients in our study accounted for the different results found.

In our subjects, we would anticipate similar sensory deficits at the clitoris with the vibratory thresholds because the same neurologic pathway mediates vibratory and tactile stimuli. However, only tactile abnormalities were noted in our population. Post hoc power analysis indicated that our power to detect a difference in vibratory thresholds in women with and without FSD was 33% at an α of .05%. Larger studies are needed to better evaluate this relationship. In addition, a bias specific to vibratory thresholds is unlikely; however, further exploration is needed to identify potential confounders because of the paucity of scientific data in this area.

FSD is a multifactorial problem that is difficult to define. According to the World Health Organization International Classification of Diseases-10, the definition of FSD includes "the various ways in which an individual is unable to participate in a sexual relationship as he or she would wish."[26] One of the limitations of our study was the method of classifying women with FSD. We grouped our participants by using the Likert-type scale, with the top 3 responses as better sexual functioning and the lower 2 responses as lower sexual functioning. By including women who responded as having sexual complaints "sometimes" in our control group, we recognize that women with possible mild dysfunction may bias the data. With potential noise in our control group, there is bias toward the null hypothesis, which could also account for the lack of significance for some of our outcomes. An attempt was made to compare results when we included the "sometimes" responders in the dysfunctional group; however, when categorized in this way, 91.1% (n = 51) of women in our study population had FSD. Analysis of this classification of the data was therefore not possible with our current sample size.

Because of the sensitive nature of the study, some participants did not answer certain questions, which may also introduce bias. Incomplete data are a common problem when using self-reporting methods. Although sexuality is influenced by psychosocial cues (emotions, cultural beliefs) and the physical status of a person, the voluntary nature of this study, after a thorough explanation of the material involved, would make it unlikely that a differential bias exists. In addition, we would anticipate truthful responses from this cohort because of their willingness to participate in confidentiality without compensation. However, we recognize that the potential for bias does exist.

In conclusion, sexual dysfunction identified by the PISQ and categorized into AD and DD is associated with pudendal nerve sensory dysfunction. In addition, the odds of having sexual dysfunction are significantly higher in women with clitoral neurologic impairment. We are optimistic and hope that by elucidating etiologic factors and objective outcomes, we may be able to provide better treatment options for these patients in the future.

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