Pain Characteristics, Fear-avoidance Variables, and Pelvic Floor Function as Predictors of Treatment Response to Physical Therapy in Women With Provoked Vestibulodynia

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Objective: The aim was to investigate whether pretreatment pain characteristics, psychological variables, and pelvic floor muscle (PFM) function predict the response to physical therapy (PT) in women with provoked vestibulodynia (PVD).

Materials and Methods: One hundred-five women diagnosed with PVD underwent 10 weekly sessions of individual PT comprising education, PFM exercises with biofeedback, manual therapy, and dilators. Treatment outcomes were evaluated at pretreatment, post-treatment, and 6-month follow-up and included pain intensity (numerical rating scale 0 to 10) and sexual function (Female Sexual Function Scale). Multilevel analyses were used to examine the potential predictors of response over time including pain characteristics (PVD subtype, pain duration), psychological variables (fear of pain, pain catastrophizing), and PFM function assessed with a dynamometric speculum (tone, flexibility, and strength).

Results: PVD subtype and PFM tone were significant predictors of greater treatment response for pain intensity reduction. Secondary PVD (ie, pain developed after a period of pain-free intercourse) and lower PFM tone at baseline were both associated with greater reduction in pain intensity after PT and at follow-up. Among the psychological variables, fear of pain was the only significant predictor of better treatment response when assessed through improvement in sexual function, where higher fear of pain at baseline was associated with greater improvement after PT.

Discussion: This study identified PVD secondary subtype, lower PFM tone, and higher fear of pain as significant predictors of better treatment response to PT in women with PVD.

Key Words: vulvodynia, physiotherapy, dyspareunia, pelvic floor

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Vulvodynia or chronic vulvar pain is a highly prevalent and debilitating condition affecting 7% to 16% of women.[1,2] Considered as the leading cause of vulvar pain,[2] provoked vestibulodynia (PVD) is characterized by a severe, sharp and burning pain that occurs in response to a pressure at the entry of the vagina such as during penetration or tampon insertion.[3] Enhancing their distress and psychological burden, the women affected report multiplying medical visits before receiving a diagnosis and perceive low treatment efficacy.[1]

Physical therapy (PT) is recommended as a first-line treatment in various clinical guidelines[4,5] and is recognized by vulvodynia experts as one of the most effective treatments, according to a survey study.[6] Few pilot studies[7,8] and a large randomized controlled trial[9] have recently shown that multimodal PT is effective to reduce pain in women with PVD. The latter study demonstrated the superiority of PT when compared with overnight topical lidocaine, a frequent first-line treatment for PVD.[9,10]

In a perspective of implementing PT intervention, research is needed to identify women who will most benefit from this first-line treatment. To date, current recommendations for referral to PT are based on expert opinions.[4] Indeed, the examination of predictors of treatment response is central to the goal of individualized treatment. The available studies of women with PVD have examined predictors for surgical, oral and topical medication, and cognitive-behavioral treatments.[11–15] Exploring whether some pain characteristics were associated with treatment response, 2 studies showed that women with primary PVD (ie, pain from their first intercourse) had a lower reduction of pain intensity after treatment in contrast with women having secondary PVD (ie, pain after a period of pain-free intercourse).[11,15]

Furthermore, psychological factors, more specifically fear-avoidance variables, were found to influence treatment outcomes

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in women with PVD. In fact, higher pain catastrophizing levels predicted poorer response to topical treatment and cognitive-behavioral therapy while fear of pain was associated with a limited response to topical treatment.[14] This aligns with the literature in other chronic pain conditions as these psychological factors were also associated with treatment outcomes in patients with musculoskeletal pain.[16] As conceptualized in the fear-avoidance model,[17] a recent study confirmed the association between fear of pain, catastrophizing, and pain intensity in women with PVD.[18] They also showed that pelvic floor muscle (PFM) function significantly contributed to the model for explaining pain intensity[18] as proposed in the fear-avoidance model adapted for women with PVD.[19] Moreover, women with PVD showed altered PFM function compared with asymptomatic controls as assessed with validated assessment tools such as transperineal ultrasound and dynamometry.[20,21] More specifically, increased tone was found in women with PVD, which was proposed as an initiator of vestibular pain and/or a perpetuating factor resulting in a vicious cycle involving pain and further muscle tension.[20,22,23] Altered contractility or muscle control was also observed in women with PVD, which is yet another factor contributing to this vicious cycle.[20,21] Moreover, women with PVD showed reduced flexibility, defined as the maximal tolerated vaginal aperture during stretching.[21] This pain tolerance measure is representative of the pain experienced by women during vaginal penetration. Therefore, considering the altered PFM function found in women with PVD and given that these alterations are associated with pain intensity as a part of the fear-avoidance integrated model,[19–21] PFM function may plausibly influence treatment response. As no studies thus far have evaluated the potential predictors of response to PT in women with PVD and since predictors appear to differ from treatment to treatment, the aim of the study was to examine whether pretreatment pain characteristics, psychological variables (fear-avoidance variables), and PFM function predict the magnitude of changes in pain intensity and sexual function outcomes following multimodal PT and 6 months later.

MATERIALS AND METHODS

Study Design

Data of this study were derived from a randomized clinical trial evaluating the efficacy of multimodal PT in comparison to overnight topical lidocaine in women with PVD.[9] The data pertaining to the PT intervention were considered. Three assessment timepoints were conducted at: pretreatment, post-treatment, and a 6-month follow-up. A detailed description of the study and the primary outcomes have been reported elsewhere.[9,24]

Participants

Nulliparous women with PVD, aged from 18 to 45 years, were included in the study if they met the following criteria: (1) pain during intercourse of at least 5 on a 0 to 10 numerical rating scale (NRS) and (2) pain occurring in at least 90% of attempted sexual intercourse over a period of at least 6 months. They were also required to have a stable sexual partner in order to be able to attempt vaginal penetration and thereby, to assess the effects of treatment on pain and sexual function. The main exclusion criteria were: (1) other lower genital pain conditions (eg, deep dyspareunia and vaginismus as defined by Diagnosis and Statistical Manual of Mental Disorders IV[25]); (2) urogynecological conditions (eg, pelvic organ prolapse >1 stage of pelvic organ prolapse quantification scale); (3) current or previous pregnancy; (4) urinary or vaginal infection in the last 3 months; (5) having previously received PT treatment or overnight use of lidocaine; (6) refusal to abstain from other treatments during their participation in the study; (7) ongoing pain medication interfering with pain perception; (8) major psychological conditions (depressive symptoms and anxiety that could represent risk for women's health); and (9) any significant comorbidities that could interfere with assessment or treatment (cardiovascular, hematological, central nervous system, pulmonary, and renal conditions). More details on eligibility criteria are available elsewhere.[24] Participants were recruited through the web and social media (32.4%), health professional visits (15.2%), and conventional methods (52.4%) such as posters in universities, and affiliated hospitals, and newspaper advertising. In order to ensure eligibility, women had their diagnosis confirmed by one of our collaborating gynecologists. A standardized and validated diagnosis assessment[26] including a medical history and a physical examination was undertaken. More specifically, women included in the study had to report pain at the vestibule area during activities exerting pressure (eg, attempted vaginal penetration, tampon insertion, tight clothing) and had a positive cotton swab test (ie, acute pain elicited by the cotton swab test reproducing her symptoms). The pressure was randomly applied to the vulvar vestibule (at 3, 6, and 9 o'clock). Inter-rater reliability of this procedure was established as being good ($k = 0.66$ to 0.68) and moderate for test-retest reliability ($k = 0.54$).[26] Approvals by the institutional review board of the 2 directing sites (Sherbrooke and Montreal, QC, Canada) and participating hospitals were obtained for the present study and all women gave written informed consent.

Procedure

Women interested in participating in the study were invited to contact the research coordinator for a telephone eligibility screening questionnaire. Once the diagnosis was confirmed by one of our collaborating gynecologists, the eligible women proceeded to the pretreatment assessment, which took place in one of the 2 university hospitals, both located in metropolitan areas. Randomization took place after the pretreatment assessment that included an interview conducted by an experienced pelvic floor physical therapist blinded to group assignation on sociodemographic information, and medical and gynecologic history. The women then completed self-report validated questionnaires on pain, psychosocial and sexual variables. It should be noted that women were asked, before their assessment, to attempt vaginal penetration before completing the questionnaires in order to provide a more accurate and current assessment of their condition. They were instructed to empty their bladder before physical evaluation and were taught how to perform an adequate pelvic floor contraction using digital palpation. Only then was a physical examination, including PFM testing with a dynamometric speculum, undertaken. The evaluation was repeated after 10 weeks of multimodal PT and at 6-month follow-up.

Measures and Instruments

Outcome Variables: Pain Intensity and Sexual Function at Pretreatment, Post-treatment, and 6-month Follow-up

Pain intensity was evaluated with a NRS from a 0 to 10 scale where 0 represents no pain and 10 characterizes the worst pain tolerable. The NRS was recommended by the

Initiative on Methods, Measures, and Pain Assessment in Clinical Trials (IMMPACT) as a valid instrument that showed adequate reliability in chronic pain populations.[27,28] Women were asked to report the average pain intensity they felt during intercourse or attempted vaginal penetration.

Sexual function was assessed with the Female Sexual Function Index (FSFI), a 19-item self-report questionnaire.[29] Desire, arousal, lubrication, orgasm, sexual satisfaction, and pain are the 6 dimensions included in the FSFI with a total ranging from 2 to 36 (ie, higher value indicating better sexual function).[29] This questionnaire has demonstrated excellent psychometric properties.[30]

Potential Predictors of Outcomes Evaluated at Pretreatment

Fear of pain. The short version of the Pain Anxiety Symptoms Scale (PASS) was administered. Women had to rate 20 items on a 6-level Likert scale (score from 0 to 100) where a score of 30 or more is considered to reflect a high level of pain anxiety.[31] This questionnaire assesses avoidance behaviors, fearful appraisal of pain, cognitive anxiety, and physiological anxiety. Psychometric evaluation of the short version showed good internal consistency ($\alpha = 0.81$), criterion validity and construct validity.[32]

Pain catastrophizing. Catastrophic thoughts related to pain were assessed using the Pain Catastrophizing Scale (PCS). This self-administered questionnaire has excellent psychometric properties and is commonly used in chronic pain research.[33,34] Each of the 13 items is related to 1 of the 3 constructs: rumination, magnification, and helplessness. A total score from 0 to 52, where a high score indicates highest catastrophizing, is obtained by the sum of every item.[33,34]

PFM function. The PFM function evaluation took place while women were in a supine position with hips and knees flexed, feet flat on a conventional examination's table. The intravaginal dynamometric speculum was used to evaluate PFM tone, maximal strength, and flexibility. Muscle tone was recorded during dynamic stretches from minimal (speculum branches closed) to maximal aperture (maximum tolerated aperture). Five stretch-releases were recorded but only the last 3 were used to calculate the mean of the passive force (in newtons [N]) at minimal aperture according to a validated protocol.[35,36] The maximum strength (N) was obtained by asking the participant to contract PFM maximally, as she was taught before dynamometric testing, against the dynamometer branches. Flexibility refers to the maximal aperture tolerated in millimeters (mm) with the speculum branches separated in the anteroposterior direction. Psychometric properties of this methodology have been assessed in multiple studies.[35–39]

Data Analysis

Analyses were conducted using SPSS 24.0 (Statistical Package for the Social Sciences, IBM). Because of the interdependent nature of repeated measures, multilevel modeling analyses were conducted to examine which variables were important for predicting treatment efficacy. The latter was operationalized as change over time on 2 outcome variables: average pain intensity during intercourse on NRS from 0 to 10, and sexual function as measured by the FSFI questionnaire. Separate multilevel models were first derived for each potential predictor. This enabled us to examine each predictor's (1) relation with baseline values of outcome variables and (2) influence on treatment efficacy (relation with change from baseline to post-treatment and with change from baseline to 6-month follow-up). Potential predictors were pretreatment pain characteristics, psychological variables, and PFM function. The choice of predictors was based on existing literature and a conceptual model (fear-avoidance model).[18] Time was treated as a categorial variable with pretreatment as the reference value. The intercept and time periods (post and follow-up) were included as random effects, the potential predictors were included as fixed effects and an unstructured covariance structure was retained. The standardized beta coefficients were reported and can be interpreted as the average variation in outcome for a one SD change in predictor value. Predictors with significant effects at the 5% level were retained to be included simultaneously at level 2 in a multivariable model.

RESULTS

Of the 105 women assigned to the PT group, 94% (n = 99) completed the post-treatment assessment, and 89% (n = 94), the 6-month follow-up. Most of the participants were aged 25 or under (73%, mean age 23.6, SD 4.3). Regarding their relationship status, 62% had a regular partner and 38.1% were cohabiting/married. The median for relationship duration was 2.7 years (interquartile range: 1.1 to 4.1). Before participating in the study, 28.6% had not seen any doctor for their condition (including general practitioner and gynecologist), 36.2% had consulted 1 doctor and 35.2% had seen 2 doctors or more. A total of 30% of women had tried at least 1 treatment before the study with the most frequent being topical lidocaine prior intercourse (13%), psychotherapy (6%), and topical estrogen (6%). Most participants (83%) were using a hormonal contraceptive. Further pretreatment characteristics are described and discussed elsewhere.[9] Pretreatment pain characteristics, psychological variables, and PFM function are given in Table 1. Participants presented mainly secondary PVD (60%) and had an average pain intensity of 7.3 on NRS (SD: 1.6) for a mean duration of 4.3 years (SD: 3.5).

Relationship between each factor and pain intensity changes are presented in Table 2. PVD subtype was associated with pain intensity outcomes as indicated by the significant interactions with time in both separate and multivariable analysis. Indeed, as illustrated in Figure 1, secondary PVD subtype predicted greater reduction of pain, as depicted by a steeper slope at post-treatment and 6-month follow-up, relative to pretreatment. As for the duration of symptoms, no significant association was found with change in pain intensity. Therefore, a longer time since onset of symptoms did not predict limited benefit from treatment.

Regarding the psychological variables, both higher pain catastrophizing and fear of pain were positively associated with a higher pain intensity at pretreatment when analyzed separately (Table 2). In the multivariable analysis, only the association between pretreatment pain intensity and pain catastrophizing remained significant. The fact that the interactions between these psychological variables and time periods were found nonsignificant suggests that changes in pain at post-treatment and 6-month follow-up were similar across levels of pretreatment catastrophizing and fear of pain.

Concerning the PFM function, the association between tone, strength, flexibility, and pain outcomes are presented in Table 2. Lower pretreatment PFM tone predicted greater reduction of pain from pretreatment to post-treatment and from pretreatment to 6-month follow-up. Women with

TABLE 1. Pretreatment Characteristics

	Mean ± SD or n (%), n = 105
Pain characteristics and sexual function	
PVD subtype	
Primary	42 (40.0)
Secondary	63 (60.0)
Symptom duration (y)	4.3 ± 3.5
Pain intensity during intercourse or attempted vaginal penetration (NRS/10)	7.3 ± 1.6
Sexual function (FSFI/36*)	20.1 ± 6.11
Psychological variables	
Pain catastrophizing (PCS total score/52†)	27.8 ± 9.9
Fear of pain (PASS total score/100†)	41.8 ± 16.5
PFM function	
PFM tone—passive force at minimal aperture (N)‡	0.27 ± 0.52
PFM flexibility—maximal tolerated aperture (mm)‡	21.73 ± 8.30
PFM maximum strength (N)‡	3.36 ± 2.21

*Higher FSFI scores indicate better sexual function.
†Higher PCS and PASS scores denote more catastrophizing and fear of pain, respectively.
‡Higher dynamometric values are related to higher tone, lower flexibility, and greater strength.
FSFI indicates Female Sexual Function Index; NRS, numerical rating scale; PASS, Pain Anxiety Symptoms Scale; PCS, Pain Catastrophizing Scale; PFM, pelvic floor muscle; PVD, provoked vestibulodynia.

lower tone before multimodal PT showed a higher pain relief after treatment and at 6-month follow-up. These associations remained statistically significant in the multivariable model. Lower flexibility and lower maximal strength, as assessed with the maximum tolerated aperture and with the forces (newtons) exerted against the dynamometer during a PFM maximal voluntary contraction, respectively, were associated with higher pain intensity at pretreatment. They both were, however, not significant predictors of pain changes at post-treatment and 6-month follow-up.

Relationships between pain characteristics, psychological variables, and PFM function with sexual function are presented in Table 3. Among the potential predictors assessed, only 1 psychological variable reached the significance level of $P < 0.05$; multivariable modeling was therefore irrelevant. Fear of pain, as assessed with the PASS questionnaire, was associated with sexual function at pretreatment, indicating that women with higher fear of pain had lower sexual function at pretreatment. Pretreatment fear of pain was also significantly associated with changes in sexual function from pretreatment to post-treatment. Hence, higher fear of pain at pretreatment predicted higher improvement in sexual function at post-treatment. When evaluating a longer time effect, changes in sexual function from pretreatment to 6 months were however similar, regardless of the level of pretreatment fear of pain.

DISCUSSION

This is the first study to examine predictors of response to PT treatment in women with PVD. More specifically, we sought to investigate whether pretreatment pain characteristics, psychological factors, and PFM function were associated with changes in pain intensity and sexual function using multilevel analyses. Our results revealed that PVD subtype, more specifically secondary PVD, predicted greater response to PT

TABLE 2. Predictors of Pain Intensity During Intercourse After Multimodal Physical Therapy in Women With PVD

	Separate Models Standardized Beta (SE)	Multivariable Model Standardized Beta (SE)
Pain characteristics		
Secondary PVD	0.490 (0.303)	0.426 (0.271)
Secondary PVD×post-treatment	−1.168 (0.378)**	−1.234 (0.364)**
Secondary PVD×6-month follow-up	−1.191 (0.413)**	−1.252 (0.392)**
Symptom duration (mo)	−0.154 (0.150)	
Symptom duration×post-treatment	0.115 (0.189)	
Symptom duration×6-month follow-up	0.090 (0.214)	
Psychological variables		
Pain catastrophizing (PCS total score)	0.552 (0.141)**	0.506 (0.167)**
Pain catastrophizing×post-treatment	−0.222 (0.190)	
Pain catastrophizing×6-month follow-up	−0.214 (0.204)	
Fear of pain (PASS total score)	0.477 (0.147)**	−0.103 (0.164)
Fear of pain×post-treatment	−0.331 (0.189)	
Fear of pain×6-month follow-up	−0.247 (0.203)	
PFM function		
PFM tone—passive force at minimal aperture (N)	−0.247 (0.149)	−0.205 (0.131)
PFM tone×post-treatment	0.490 (0.185)**	0.533 (0.177)**
PFM tone×6-month follow-up	0.620 (0.202)**	0.662 (0.193)**
PFM flexibility—maximal tolerated aperture (mm)	−0.514 (0.143)**	−0.365 (0.115)**
PFM flexibility×post-treatment	0.106 (0.191)	
PFM flexibility×6-month follow-up	0.096 (0.205)	
PFM maximal strength (N)	−0.386 (0.147)*	−0.136 (0.115)
PFM maximal strength×post-treatment	0.277 (0.189)	
PFM maximal strength×6-month follow-up	0.348 (0.202)	

*$P < 0.05$.
**$P < 0.01$.
The predictors with significant effects ($P < 0.05$) in the separate models were retained to be included in the multivariable model.
PASS indicates Pain Anxiety Symptoms Scale; PCS, Pain Catastrophizing Scale; PFM, pelvic floor muscle; PVD, provoked vestibulodynia.

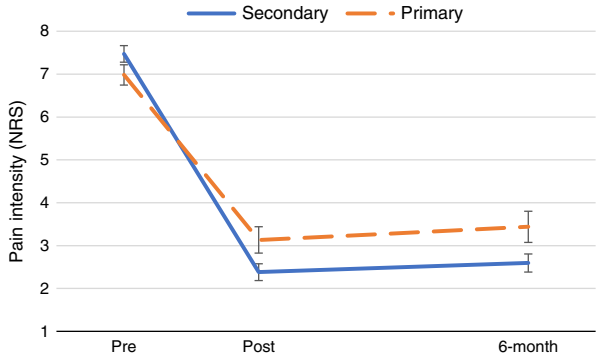

FIGURE 1. Changes in pain intensity evaluated with the numerical rating scale (NRS) for women with primary and secondary provoked vestibulodynia. Secondary provoked vestibulodynia subtype predicted greater reduction of pain at post-treatment and 6-month follow-up, relative to pretreatment.

treatment when assessed through pain intensity reduction. Challenging current clinical guidelines, the results showed that lower PFM tone at baseline was related to greater reduction in pain intensity from pretreatment to post-treatment and pretreatment to 6-month follow-up.[40–42] Analysis of the psychological factors showed that fear of pain was the sole predictor of change in sexual function with higher fear of pain at baseline being associated with greater improvement from pretreatment to post-treatment.

Regarding the association between baseline pain characteristics and the changes in pain intensity after treatment, results showed that PVD subtypes significantly predict the magnitude of response to PT treatment with secondary PVD showing greater pain relief and primary PVD having a significant but lower response, which aligns with previous studies investigating other treatments for PVD.[11,15,43] In fact, the studies of Bornstein et al[11] and Lambert et al[43] found that women with primary PVD had less change in pain intensity after vestibulectomy than women with secondary PVD. Heddini et al[15] obtained the same result in their retrospective study investigating several combined or isolated treatments including botulinum toxin A, pelvic floor PT, and topical lidocaine application. In contrast, Brown et al[13] reported a nonsignificant association between PVD subtype and change in pain intensity following oral antidepressant treatment. This conflicting result may be explained by the small sample size involved in that study. The differential treatment response in women with primary and secondary PVD obtained in our study and in the current literature may be related to distinct underlying pathophysiological pathways characterizing PVD subtypes along with the pathways that are more specifically targeted with each treatment. For instance, PT modalities and vestibulectomy may have specific effects on localized pain pathways as opposed to medication, which mainly targets central pain sensitization. Women with primary PVD were shown to have more central sensitization as they present lower peripheral pain thresholds (eg, pain sensitivity measured in nonvulvar sites)[44] and heightened levels of altered brain activity measured with functional magnetic resonance imaging[45,46] in comparison with women with secondary PVD. Therefore, it could be hypothesized that women with primary PVD with pain centralization may be less likely to respond to treatments that address more predominantly local pain pathways.

TABLE 3. Predictors of Sexual Function During Intercourse After Multimodal Physical Therapy in Women With PVD

	Separate Models Standardized Beta (SE)
Pain characteristics	
Secondary PVD	−2.096 (1.258)
Secondary PVD×post-treatment	1.430 (1.228)
Secondary PVD×6-month follow-up	1.725 (1.188)
Symptom duration (mo)	0.191 (0.631)
Symptom duration×post-treatment	−0.529 (0.599)
Symptom duration×6-month follow-up	−0.511 (0.598)
Psychological variables	
Pain catastrophizing (PCS total score)	−1.195 (0.629)
Pain catastrophizing×post-treatment	0.810 (0.593)
Pain catastrophizing×6-month follow-up	0.423 (0.587)
Fear of pain (PASS total score)	−1.606 (0.620)*
Fear of pain×post-treatment	1.526 (0.575)*
Fear of pain×6-month follow-up	0.750 (0.581)
PFM function	
PFM tone—passive force at minimal aperture (N)	1.229 (0.618)
PFM tone×post-treatment	−0.679 (0.603)
PFM tone×6-month follow-up	−1.127 (0.579)
PFM flexibility—maximal tolerated aperture (mm)	0.538 (0.633)
PFM flexibility×post-treatment	−0.485 (0.599)
PFM flexibility×6-month follow-up	−0.226 (0.584)
PFM maximal strength (N)	−0.248 (0.641)
PFM maximal strength×post-treatment	−0.245 (0.601)
PFM maximal strength×6-month follow-up	−0.866 (0.575)

*$P < 0.05$.
**$P < 0.01$.
PASS indicates Pain Anxiety Symptoms Scale; PCS, Pain Catastrophizing Scale; PFM, pelvic floor muscle; PVD, provoked vestibulodynia.

With regard to duration of symptoms, our results suggest no association with changes in pain intensity, which concurs with results of 2 recent studies including large cross-sectional studies.[15,47] Reporting contrasting results, Reed et al[48] found an association between shorter duration of symptoms and more favorable treatment outcome, which could be explained by the close interrelation between subtypes and duration of symptoms, that is, secondary PVD being related to shorter duration of symptoms.[49–53] Consequently, improvement can be achieved with PT regardless of duration of symptoms and thereby this should not influence referral to PT treatment.

With reference to psychological variables, baseline pain catastrophizing and fear of pain were not significantly associated with change in pain outcome. This result aligns with current literature as Desrochers et al[14] found no association between change in pain intensity and pretreatment level of fear of pain, and pain catastrophizing in women with PVD.[14] In a low back pain population, George and Beneciuk[54] also found no association between higher catastrophizing and fear of pain scores before PT and pain outcome at post-treatment. It should be emphasized, however, that our results show that pain catastrophizing and fear of pain were significantly associated with baseline pain intensity. This concurs with studies in PVD and other chronic pain conditions as it is well documented that pain catastrophizing and fear of pain are associated with transition to chronicity, maintenance, and intensity of pain.[16,18,55] A

meta-analysis in musculoskeletal chronic pain recently proposed an explanation concerning how these psychological variables could be associated with baseline pain and no pain changes over treatment.[56] As PT was shown to significantly reduce pain catastrophizing and fear of pain,[8] this treatment effect could explain why these psychological variables are not associated with change in pain from pretreatment to post-treatment and 6-month follow-up. In sum, our data suggest that fear of pain and catastrophizing are related to pain intensity at pretreatment (and potentially at each time point), but not to the changes in pain in response to treatment because the psychological variables are targeted by therapy.

Regarding PFM function, it is well recognized that muscle tension is associated with pain in PVD and in other chronic pain conditions, as suggested by the fear-avoidance model and demonstrated in empirical studies.[16,19,57,58] Our study is, however, the first to investigate whether muscle function could have a predictive role in PT treatment response. Our results suggest that lower PFM tone at pretreatment was associated with greater pain relief after PT and at 6-month follow-up. These findings are therefore challenging current vulvodynia expert opinions, which recommend PT mostly for women with increased PFM tone, and tend to refer women with lower tone to other treatment options.[40–42] The greater improvement found in women with lower PFM tone may be attributed to the multiple mechanisms of action underlying PT intervention that are not limited to the reduction on PFM muscle tone. In fact, PT treatments target more than just alterations in PFM tone. This multimodal treatment also includes an educational component about pain physiology, PVD pathophysiology, sexual function, and relaxation techniques, which likely contributes to the improvement in psychosexual variables.[7–9] Desensitisation techniques are also part of the treatment to reduce vulvar sensitivity.[7] The PFM exercises were also shown to improve muscle control and blood flow,[7,59] which are 2 proposed factors contributing to pain.[21,60] Given that multimodal PT is not only targeting heightened tone, this may explain why women with lower tone are responding better to treatment. In contrast, women with higher PFM tone at baseline may have responded less to treatment as they would have benefited from a longer PT intervention. Our findings highlight the intricate role of tone in PVD as increased tone can be triggered by a protective mechanism in response to pain or fear of pain.[16,19] In addition, it is suggested that increased tone may yield to enhanced vulvar sensitivity, cross-organ sensitization and central pain processing alterations.[23,45] Hence, women with increased tone may present with a more complex clinical condition, including central sensitization and heightened muscle tone maintained by cortical and sacral upregulation.[45,58,61] Overall, despite PT showing an overall tremendous efficacy in our recent randomized controlled trial, women with higher PFM tone showed a lower pain response, which suggests that they may have benefited from a prolonged intervention or the addition of further modalities such as Botox,[62] dry needling[63] or diazepam suppository in order to further reduce tone.[64]

As for sexual function, baseline fear of pain was the only significant predictor where higher fear of pain at pretreatment was associated with higher improvement in sexual function after PT. Our results contrast with those of a previous study investigating topical cortisone and cognitive-behavioral therapy in women with PVD and reporting that higher fear of pain at baseline was associated with worse outcomes.[14] Given that PT treatments were shown to be effective for reducing fear of pain in women with PVD,[8] it could be hypothesized that higher baseline fear of pain predicts a higher response because it is specifically targeted with PT modalities. For instance, PT modalities such as internal manual therapy and the PT-instructed use of dilator may be useful to reduce fear of pain and pain intensity and thereby improve sexual function.

The use of data derived from a large randomized clinical trial with assessor-blinded assessment and multilevel analyses adjusting for dependence of observations are strengths of our study. Moreover, this study is unique in its use of a rigorous assessment of muscle function variables using a reliable and valid methodology.[37–39,65] Some limitations should be acknowledged, however. Our results can be generalized to nulliparous women below 45 years old with PVD. These criteria were chosen to prevent the confounding effects of other pathologies related to dyspareunia such as childbirth-related lesion and vulvovaginal atrophy. Also, the absence of a group receiving no treatment did not allow us to rule out that the 3 significant predictors could predict a more positive natural course of PVD rather than a better response to PT. Moreover, although the selection of potential predictors relied on the available evidence and prominent conceptual models, other variables may also be relevant such as self-efficacy or central sensitization assessed with a comprehensive methodology.

In conclusion, this study is the first to assess predictors of greater PT efficacy in women with PVD. Pain characteristics, PFM function, and psychological variables were identified as significant predictors of pain or sexual function outcomes where women with secondary PVD, lower tone, and higher fear of pain responded better to PT intervention. It is important to note that since all women experience benefits from PT, these findings should serve to consider additional modalities to multimodal PT as well as to investigate other treatments to improve treatment efficacy in women with a lower predicted response. Our findings warrant replication and additional research to better understand the mechanisms underlying poorer response to treatment. Our study is therefore a first step toward investigating predictive clinical rules for PVD treatment in order to improve clinical guidelines.

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