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ORIGINAL RESEARCH

Pelvic floor muscle tenderness on digital palpation among women: convergent validity with central sensitization

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Abstract
Background: Tenderness on palpation of the pelvic floor muscles (PFMs) is a clinical assessment tool used alongside other tests to identify PFM involvement in pelvic complaints including pelvic pain. Although reliability of PFM tenderness has been determined, validity has yet to be established.
Objectives: To assess convergent validity of PFM tenderness on digital palpation with the presence of central pain mechanism, as determined by a score of greater than 40 on the Central Sensitization Inventory (CSI). A secondary objective was to assess the agreement between PFM tenderness and self-reported symptoms of PFM sensitivity.
Methods: Participants completed a battery of self-report questions, the CSI, and various physical assessments (blinded assessors). Convergent validity was assessed between tenderness on palpation and the CSI. Kappa statistics were used to determine agreement between tenderness on palpation and self-reported perineal pain, urinary urgency, dyspareunia, and dysmenorrhea.
Results: Ninety-nine female participants with hip or back pain and at least one self-reported symptom of pelvic floor dysfunction were included in the study (mean age 40.56 ± 12.72 years). Convergent validity was found between PFM tenderness on palpation and scores greater than 40 on the CSI ($X_1^2 = 4.2$, $p = 0.04$). There was poor agreement between tenderness on palpation with dyspareunia (agreement 62.83%, Kappa = 0.27), dysmenorrhea (agreement 55.75%, Kappa = 0.14), or perineal pain (agreement 53.04%, Kappa = 0.10).

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Conclusions: PFM tenderness on digital palpation confirmed convergent validity with CSI scores, suggesting central pain mechanisms. Clinicians may need to consider the role of central pain mechanisms in their clinical decision making when treating PFM dysfunction.

Introduction

Pelvic floor muscle dysfunction (PFMD) is an umbrella term used to describe a variety of neuromusculoskeletal problems involving the pelvic floor muscles (PFMs), namely muscle weakness, muscle overactivity, impaired coordination, and muscle tenderness.[1] PFMD includes urinary and fecal incontinence, pelvic organ prolapse,[2] and a variety of pelvic pain conditions.[3–5] The prevalence of worldwide pelvic pain ranges from 5.7% to 26.2% of women in childbearing years.[6] This includes persistent pelvic pain conditions such as dyspareunia, dysmenorrhea, vulvodynia, endometriosis, and bladder pain syndromes.[6]

Persistent pelvic pain involves multiple tissues (e.g., somatic, visceral) and systems (e.g., central pain).[7] As such, pelvic pain conditions can involve nociceptive input, peripheral sensitization, central sensitization, or a combination of these.[7] Given the complex nature of the pelvic area, pathophysiologic changes and associated sensitization can occur between two organs (e.g., viscero-visceral sensitization), between the organs and the musculoskeletal system (e.g., viscero-somatic or somato-visceral) and within the central nervous system itself (central sensitization).[7,8] Common clinical examples of pelvic pain conditions associated with comorbid visceral pain symptoms and PFMD include, but are not limited to: interstitial cystitis/bladder pain syndrome, endometriosis,[8] vulvodynia,[9,10] as well as constipation and delayed voiding.[8,11] These complex pelvic pain conditions are still predominately treated using a biomechanical approach focusing on soft tissue dysfunction specifically ''trigger points''.[12–14] However, recent studies have associated these conditions with central pain mechanisms, leading to new approaches of understanding and managing these conditions.[9,10,15] Hyperalgesia and allodynia, key characteristics of pelvic pain conditions such as vulvodynia[9,10] are associated with central pain mechanisms[16,17] and have a 30:1 odds ratio for predicting central pain mechanisms.[16]

PFM tenderness and central pain mechanisms have been found to co-exist among a group of women with acute lumbopelvic pain and viscero-somatic pain conditions.[18,19] Pelvic pain conditions associated with the viscera are often not considered in orthopedic practice when treating low back pain (LBP)[20–22] although empirical research suggests that lumbopelvic pain and PFMD are highly associated.[23–25] Given that PFM tenderness has previously been found to be the most frequent physical finding of PFMD among women with acute or chronic lumbopelvic pain,[23] and both PFMD and central pain mechanisms have been found to co-exist among another group of women with acute lumbopelvic pain,[19] further exploration of the relationship between central pain mechanisms and PFM function is warranted.

The objective of this study was to assess the validity of digital palpation in individuals with lumbopelvic pain and symptoms of PFMD. The specific objectives were to evaluate: (1) the convergent validity of PFM tenderness against the score on the Central Sensitization Inventory (CSI) and (2) agreement between PFM tenderness and self-reported symptoms linked to PFM sensitivity including perineal pain, urinary urgency, dysmenorrhea, pain with bowel movement, and dyspareunia.

Methods

Sample

This study received ethics approval through the Hamilton Integrated Research Ethics Board (#2596, Hamilton, Ontario, Canada). This paper is a secondary data analysis from a study that investigated self-report and physical factors that could predict PFMD in lumbopelvic pain.[19] The original analysis demonstrated that the only self-report factors that were strongly correlated with tenderness on palpation were urinary urgency and a score of greater than 40 on the CSI Part A, indicating the presence of central pain mechanisms.[19] Therefore, women with stress urinary incontinence were not included in this secondary analysis.

For the original study recruitment, males and females presenting for physical therapy care at four clinical sites in Ontario, Canada were invited to participate if they reported having lumbopelvic pain in the last week prior to presenting for physical therapy care and had the ability to read and write fluently in the English language. In addition, all individuals (health care professionals) who attended post-graduate continuing education courses through an educational company in Ontario, Canada meeting the specified inclusion criteria above were invited to participate. Specific inclusion criteria were the presence of self-reported lumbopelvic pain in addition to at least one self-reported symptom of pelvic floor disorders as outlined in the methods. Lumbopelvic pain was defined as pain reported predominately in the low back, pelvis, hip, and gluteal area with or without referral to the leg.[26] Exclusion criteria were the presence of lumbar radiculopathy (dominant pain report below the level of the gluteal fold) which may indicate nerve root or other associated causes of pain that may not be related to the pelvic floor and having received treatment from a physical therapist specializing in treatment of the pelvic floor within the last 12 months. Participants were recruited between November 2016 and June 2017. A post hoc exclusion of men was performed due to the inability to recruit male participants

for this study ($n = 3$). All participants signed a consent form before participation in the study.

Procedures

In the original study, participants first completed a battery of self-report measures and underwent an internal digital pelvic floor exam by one of 4 assessors who were blinded to participants pain status or self-report assessment findings[19] They were all rostered pelvic health physical therapists with the College of Physiotherapists of Ontario. Three of the assessors had 20 years of experience treating the pelvic floor, with the remaining physical therapist's experience being less than one year.

Self-reported pelvic floor disorders

A series of questions were used to assess self-reported pelvic pain symptoms which are often connected to tenderness on palpation of the PFMs. These questions were based on clinical expertise within the research team. Specifically, the items were: (1) Do you experience pain or cramping with menstruation that requires intervention (heating pad, medication, rest, etc.)? (Dysmenorrhea: primary versus secondary dysmenorrhea was not assessed separately because visceral upregulation in either situation can result in overactivity of the PFM vis a vis the viscero-somatic reflex); (2) Do you experience very strong and/or uncontrollable urges to go to the bathroom? (Urinary Urgency); (3) Do you ever experience painful intercourse? (Dyspareunia); (4) Do you experience pelvic pain and/or pelvic pressure (i.e., vaginal, rectal, penile, testicular, bladder, tailbone, or pelvic girdle)? (Perineal Pain); (5) Do you experience pain during or after a bowel movement? (pain on bowel movement). The response options for the items were binary (yes or no) and participants were postulated to have subjective pelvic floor dysfunction related to potential sensitivity in the PFM if they answered yes to at least one of these questions.

The Central Sensitization Inventory

The Central Sensitization Inventory (CSI) was utilized to identify the presence of central pain mechanisms.[27] The CSI is a two-part clinical questionnaire designed to assess the potential for central sensitization. Part A includes 25 questions about symptom presentation and Part B has 10 questions about specific conditions associated with central sensitization that have been diagnosed by a medical doctor.[27] A cut off score of 40 on Part A of the questionnaire has been found to correlate with central pain mechanisms in individuals with persistent pain.[27] Two hallmark signs of central pain mechanisms are tenderness with light touch (allodynia) and increased pain with firm pressure (pressure hyperalgesia).[10,16,17] The CSI was utilized to assess for the convergent validity of tenderness on palpation and potential central pain mechanisms.

Pelvic floor muscle assessment

Starting with firm digital palpation of the obturator internus, anterior levator ani, and iliococcygeus bilaterally, the physical therapists in this study first assessed PFM tenderness. Strength and coordination of the PFM were assessed next by utilizing the relevant components of the Laycock ''PERFECT'' scheme which assesses, power, endurance, repeated endurance, fast contractions, co-ordination and timing of the PFMs.[28]

PFM tenderness was defined as pain elicited by firm palpation of the left or right pelvic floor musculature. Assessment for PFM tenderness has moderate to substantial inter- and intra-rater reliability with Kappa values ranging from 0.76 to 0.91[29] and this examination technique is reliable between experienced and novice therapists.[29,30] All assessment procedures were completed with participants in a supine, crook lying position. For the purposes of this study, the PFM tenderness scores (0 = no tenderness, 1 = tenderness) and not the PERFECT scheme score were analyzed.

Physical examination

To aid in the characterization of the sample we also performed the Forced flexion–abduction–external rotation (FABER), a pelvic girdle pain provocation test and the active straight leg raise (ASLR) tests. Both tests were performed for both lower extremities and reported as positive if the test was positive on either side.

Validity

Agreement between PFM tenderness on palpation and self-reported measures of pelvic floor disorders associated with sensitivity was assessed. The conditions assessed were: perineal pain, urinary urgency, dysmenorrhea, pain with bowel movements, and dyspareunia.

Data analysis

Stata 14.2 Software was used for all statistical analysis.[31] Descriptive statistics were calculated for all demographic items using mean and standard deviation for continuous data or count and percentage for dichotomous data. Kappa was used as defined by Koch and Landis[32] where a Kappa value between 0.6 and 0.8 is considered substantial and between 0.81 and 1.0 is high.

Convergent validity: Chi-square statistics and point-biserial correlation analysis was used to evaluate whether those with tenderness on palpation were more likely to have central pain mechanisms (CSI score > 40). A two-tailed independent *t*-tests was used to calculate whether there was a mean difference in CSI scores between those with tenderness on palpation and those with no tenderness on palpation. The Shapiro–Wilk *W*-test was used to assess normality of the scores on the CSI.

Finally, Kappa statistic was used to evaluate agreement between the results of tenderness on palpation and self-reported measures of potential pelvic floor sensitivity (e.g.,

Table 1 Participant characteristics.

Characteristic	Total sample $n = 99$	Tenderness on palpation $n = 66$	No tenderness on palpation $n = 33$
Age (years)*	40.6 ± 12.7	40.6 ± 14.0	40.8 ± 10.0
CSI Part A*	31.1 ± 13.2	33.1 ± 13.6	27.1 ± 11.5
Forced FABER	50 (50.5%)	35 (53.0%)	15 (45.5%)
ASLR	80 (80.8%)	53 (80.3%)	27 (81.8%)
Urinary Urgency	35 (35.7%)	28 (42.0%)	7 (21.2%)
Dyspareunia	46 (46.8%)	34 (51.5%)	12 (36.4%)
Perineal pain	42 43.3%)	37 (56.1%)	15 (45.5%)
Dysmenorrhea	44 (46.3%)	29 (43.9%)	15 (45.5%)
Pain with a bowel movement	14 (14.3%)	11 (16.7%)	3 (9.1%)
PERFECT**			
• Power (0–5 on MOS)	3 (2)	3 (2)	3 (2)
• Endurance (s)	10 (5)	8 (5)	10 (3)
• Repetition (*n*)	4 (4)	4 (4.5)	5 (7)
• Fast contractions (*n*)	9 (6)	7.5 (6.5)	10 (5)

Data are *N* (%) except as indicated. *Abbreviations*: SD, standard deviation; CSI, Central Sensitization Inventory; IQR, interquartile range; ASLR, active straight leg raise; MOS, Modified Oxford Scale; *n*, number of contractions completed.
* Data are mean ± SD.
** Data are median (IQR).

reports of perineal, urinary urgency, and dyspareunia). A level of significance of 0.05 was used for all analysis.

Results

There were 108 female participants that had self-reported lumbopelvic pain in the previous week who participated in the assessment protocol. In total, 99 participants with lumbopelvic pain and at least one self-reported symptom thought to be associated with sensitivity of the PFM were included in this study (Table 1). The sample was on average 40.6 ± 12.7 years old with an average CSI score (Part A) of 31 ± 13.2. Table 1 also indicates the number and percentage of reported symptoms of pelvic floor sensitivity as well as the number of participants with a positive Forced FABER and/or ASLR test. The prevalence of pelvic symptoms thought to be associated with sensitivity was dyspareunia (47%), dysmenorrhea (46%), perineal pain (43%), urinary urgency (36%), and pain with bowel movements (14%). A positive Forced FABER test was present on 51% of the participants and 81% had a positive ASLR test. There was no missing data for any variable of interest.

Convergent validity

Those with PFM tenderness were more likely to have CSI scores > 40 (23/66, 34.9%) as compared to those with no tenderness on palpation (5/33, 15.2%; ($X_1^2 = 4.2$, $p = 0.040$)). The correlation of tenderness on palpation and CSI as a continuous variable using point biserial analysis was statistically significant (coef = 0.213, $t_{97} = 2.15$, $p = 0.034$). Furthermore, the mean difference in CSI scores (−5.97; 95% confidence interval = −11.5, −0.5) was statistically significant ($p = 0.033$), with those with tenderness on palpation having a higher score on the CSI. The Shapiro–Wilk test demonstrated that the CSI scorers were normally distributed.

Agreement

Kappa analysis for agreement of PFM tenderness on palpation and self-report symptoms expected to correlate with PFM sensitivity was conducted. There was poor agreement between tenderness on palpation with dyspareunia (agreement 62.8%, Kappa = 0.27), dysmenorrhea (agreement 55.8%, Kappa = 0.14), pain with a bowel movement (agreement 49.1%, Kappa = 0.09), urinary urgency (agreement 60.3%, Kappa = 0.25), or perineal pain (agreement 53.0%, Kappa = 0.10).

Discussion

PFM tenderness on digital palpation is an inexpensive and clinically feasible means of identifying women with PFM sensitivity associated with the potential presence of central pain mechanisms; hence, it is an important construct to validate through clinical research. The results of our study demonstrated good convergent validity between tenderness on palpation and CSI scores > 40. Our research points to the potential need for care providers to approach the patient population studied (women with lumbopelvic pain) from a biopsychosocial perspective considering both PFM sensitivity and potential central pain mechanisms in each patient's presentation. Importantly, the combination of clinical findings of PFM tenderness on palpation and a CSI score of >40 in a patient should prompt looking beyond the local physical characteristics of the PFMs and consider the role of the central nervous system. This represents an important paradigm shift in the management of women with PFM tenderness and lumbopelvic pain.

Our findings require a reconsideration of how the presence of PFM tenderness is interpreted. Rather than interpreting this clinical finding from the perspective of

''releasing PFM trigger points'' our findings highlight the need to consider the potential central pain mechanisms involved in the clinical presentation. Frasson et al.[33] suggest that overactivity of superficial PFM in vulvar pain may be linked to increased excitability of peripheral or cortical projections at the level of the central nervous system.[10,33] The potential presence of central pain mechanisms and PFM tenderness raises potential concerns around commonly enacted strength-based and other local tissue-oriented treatment approaches for lumbopelvic pain.[34]

The results of our study did not identify good agreement between PFM tenderness on palpation and self-reported signs of PFM sensitivity including dyspareunia, dysmenorrhea, pain with a bowel movement, urinary urgency, and perineal pain. These self-reported signs of PFM sensitivity are complex in nature with multiple potential drivers including visceral inputs, somatic inputs, and central inputs.[7–11] Isolating one factor in these conditions, tenderness on palpation, may not adequately explain the multisystem factors involved in these conditions. Further, participants were selected based on having pain in the last week, which could include both acute and chronic pain, potentially leading to selection bias contributing to the lack of correlation in this analysis.

A limitation of this study is that a portion of the participants were not seeking care; rather, they were health care professionals attending continuing education courses. Furthermore, self-report of lumbopelvic pain could have been misdiagnosed conditions such as visceral–abdominal pain. Those seeking care for their condition may have a different clinical presentation, which has the potential to impact the results and may explain why only a small portion of our participants had CSI > 40 indicating potential central pain mechanisms. Another limitation of this study is that the duration of symptoms was not collected which means that we cannot depict differences in our findings between acute and persistent lumbopelvic pain. Determining the length of symptoms and the presence of central pain mechanisms would strengthen the conclusions.

Other limitations relate to the lack of a gold standard or an operational definition of PFMD and current accepted clinical assessments for PFMD. Therefore, based on clinical expertise and the existing literature,[35,36] we included the clinical assessment of weakness, lack of coordination, and tenderness on palpation to define PFMD. There is not a robust connection in the literature between PFM tenderness and objectively measured PFM tone, with only some data to connect these entities in conditions such as vulvodynia but not specifically in lumbopelvic pain.[37] Therefore, the use of tenderness on palpation as a surrogate measure of pelvic floor tone needs to be further investigated. In future research, consensus related to operationally defining the terminology regarding the assessment of PFMD is needed to improve the rigor of future research on this topic. As these terms are operationalized, clinically relevant ways of measuring the functions of the PFM more objectively need to be developed. External measures, either through use of real-time ultrasound, or self-report tools need to be explored further so that more accurate measures of PFM function can be available.

Conclusion

PFM tenderness on digital palpation was found to have good convergent validity with central pain mechanisms measured using the CSI. Many clinicians who treat lumbopelvic pain do not screen for PFMD or associated central drivers of the presenting pelvic pain experience. The results of this study suggest that clinicians need to consider the role of central pain mechanisms in their clinical decision making when treating PFM dysfunction.

Conflict of interest

None to declare.

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