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CROSS-SECTIONAL STUDY: EXAMINATION PROCEDURES

A preliminary report of musculoskeletal dysfunction in female chronic pelvic pain: A blinded study of examination findings

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Summary *Introduction and hypothesis:* Female chronic pelvic pain is prevalent and causes disability. Can women with self-reported chronic pelvic pain (CPP) be distinguished from pain-free women by demonstrating a greater number of abnormal musculoskeletal findings on examination?
Methods: In this cross-sectional study, blinded examiners performed 9 physical exam maneuvers on 48 participants; 19 with CPP, and 29 pain-free. Frequency of positive findings between groups, total number of positive exam findings, cluster analysis, and sensitivity - specificity analyses were performed.
Results: Women with CPP presented with significantly more abnormal findings than pain-free women. By using two examination maneuvers, examiners correctly classified women with self-reported CPP from pain-free women 85% of the time.
Conclusions: Abnormal findings on musculoskeletal exam are more common in women with self-reported CPP. Women with CPP might benefit from a faster time to diagnosis and improved treatment outcomes if a musculoskeletal contribution to CPP was identified earlier.

Abbreviations: CPP, Chronic Pelvic Pain; PT, Physical Therapist; MD, Medical Doctor; ASLR, Active Straight Leg Raise test; FET, Fisher's Exact Test; MSKD, Musculoskeletal Dysfunction; FABER, Flexion Abduction External Rotation; ROM, Range of Motion; ROC, Receiver operating curve; P4, Posterior Pelvic Pain Provocation; LR, Likelihood Ratio; SIJ, Sacroiliac Joint; PGP, Pelvic Girdle Pain; ICC, Intraclass Correlation; ASIS, Anterior Superior Iliac Spine.

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Introduction

Musculoskeletal impairments are often overlooked as a source of pain in women with chronic pelvic pain (CPP). Whether a cause or an effect of chronic pain, the musculoskeletal system in women with CPP can be compromised even in the presence of visceral dysfunction (Hetrick et al., 2003; Montenegro et al., 2010; Tu et al., 2007, 2008; Zondervan et al., 2001a). Women may undergo a variety of medical and surgical interventions for presumed visceral dysfunctions, including laparoscopy and hysterectomy, for CPP before a musculoskeletal basis for pain is investigated (Burnett et al., 2006). Such treatments may not relieve pain (Daniels et al., 2009) and may delay appropriate diagnosis and effective treatment of musculoskeletal causes of pelvic pain.

Female chronic pelvic pain is a prevalent condition, affecting as many as 24% of community dwelling adult women (Latthe et al., 2006) and causing disability and reduced quality of life. Chronic pelvic pain (CPP) involves direct and indirect costs in the US exceeding $12 billion annually (Mathias et al., 1996). CPP is generally defined as non-cyclic pain in the lower abdomen and/or pelvis lasting 3–6 or more months that is not exclusively associated with intercourse or menstruation (Zondervan et al., 2001a).

Studies suggest that as many as 61% of women with self-reported CPP have reported that the etiology of their pain was unknown (Zondervan et al., 2001b). The cause of CPP is difficult to diagnose because pain symptoms may be the result of complex interactions between multiple body systems including urological, gynecological, neurological, endocrine, gastroenterological, musculoskeletal, sexual, and psychological. The musculoskeletal system, as a cause or contributor to CPP, may not be considered until after women have accessed a variety of different specialists in order to obtain diagnosis and treatment.

Women with CPP might benefit from improved treatment outcomes if a musculoskeletal basis or contribution to CPP were identified earlier. The purpose of this study, therefore, is to determine if women with (CPP) can be distinguished from pain-free women by demonstrating a greater number of abnormal musculoskeletal findings. Specifically we asked:

- Are women who self-report CPP more likely to present with a higher number of clinically significant musculoskeletal exam findings?
- Do women with self-reported CPP present with different patterns of clinically significant musculoskeletal findings than pain-free women?
- Which physical examination maneuvers best differentiates women with and without self-reported CPP?

Materials and methods

This was a cross-sectional study of women with self-reported CPP and pain-free women in Chicago, IL. Study participants were females age 18–55 recruited via advertising on posters placed in and around the hospital and academic campus. Forty-eight non-pregnant women were enrolled in the study between April 2006 and July 2007. Participants' mean age was 35.1 ± 9.1 years ($n = 44$). Twenty-nine participants (controls) had no history of back or pelvic pain. Nineteen participants self–identified themselves as experiencing CPP, not solely related to menstruation, through an initial telephone interview with a physical therapist who was not an examiner in the study. CPP was defined to the participants as *pain between the umbilicus and the thigh, anterior or posterior, for at least 3 months* (Howard, 2003). Exclusion criteria for participation included ongoing pregnancy, active malignancy, documented lumbar pathology of herniated disc, previous lumbar surgery, and previous or current physical therapy for pelvic pain. Subjects also were also excluded if they were known to one of the examiners. This study was approved by the Institutional Review Board of Northwestern University and all patients gave written informed consent to participate prior to entering the study. Funding for the study was used to compensate participants for parking expenses and to pay them a stipend for participation.

Physical therapist examiners performed each of 9 musculoskeletal physical exam maneuvers (Table 1) on study participants. Further details of this study, including inter-examiner agreement of the examination maneuvers, have been described elsewhere (Neville, 2010). As described in Table 1, the maneuvers were chosen for their perceived utility and relevance in diagnosing musculoskeletal dysfunction related to CPP.

The relative frequency of positive findings between groups for each maneuver was calculated using two-sided Fisher's exact test (FET). A Total Musculoskeletal Dysfunction (MSKD) Score was obtained by summing the number of positive findings on the 9 maneuvers (range 0–9) for each participant. Significant differences on the MSKD score between groups was evaluated using an unpaired t test. Hierarchical cluster analysis (Ward's method) was used to examine similarity in participants' response patterns on the 9 musculoskeletal tests. The Stata ROCTAB procedure was used to identify the accuracy of examination maneuvers in classifying participants with and without self-reported CPP.

Results

Women with self-reported CPP were more frequently found to demonstrate abnormal musculoskeletal findings than pain-free women, see Table 1. Women with pelvic pain were more likely to have abnormal musculoskeletal findings than pain-free women when examined by physical therapists on the following tests: Forced FABER's FET $p < 0.001$, Pelvic floor pain to palpation FET $p < 0.001$, and P4 FET $p = 0.045$.

The mean total MSKD score for the participants with self-reported CPP was significantly higher than for the pain-free participants (Table 2). The mean total score for the pain-free group was 2.83 ± 0.28 positive findings, while the mean total score for the CPP group was 5.32 ± 0.36 ($t = -5.55$, df = 46, $p < 0.001$).

Forty-eight percent of the participants in the pain-free group had score of 2 positive findings or less (Table 3). All of

Table 1 Description of positive findings as indicators of musculoskeletal dysfunction on physical exam maneuvers.

Examination Maneuver	Description of Examination Maneuver	Indicator(s) of Musculoskeletal Dysfunction	Reported Reliability, Sensitivity and Specificity
Posture	Positive finding: increased lumbar lordosis or decreased lumbar lordosis viewed in the sagittal plane (Kendall et al., 2005). Negative finding: " neutral " posture.	Core muscle weakness. Compensatory response to pain	kappa = 0.49–0.5 (Van Dillen et al., 1998) ICC* = 0.567 (Dunk et al., 2004).
Trendelenberg Sign	Positive finding: during single leg standing, the hip on the non-stance leg drops indicating functional hip muscle weakness. Negative finding: no hip drop was observed and pelvis remained level (Cook, 2007).	Core muscle and gluteus medius muscle weakness. Compensatory response to pain.	kappa = 0.75 (Roussel et al., 2007).
Hip Range of Motion	Positive finding: asymmetrical passive hip range of motion. Negative finding: symmetrical hip range of motion.	Muscle imbalance of the hip. Intra-articular hip pathology	kappa = 0.95 for prone active hip ROM[†]. (Van Dillen et al., 1998).
FABER Test (aka Patrick Faber Test)	Positive finding: patient reported pain when her leg is flexed, abducted and externally rotated while in supine (Albert et al., 2000). Negative finding: no pain was elicited during this maneuver (Cook, 2007; Magee, 1997).	Pain in hip or pelvic girdle joints	kappa = 0.38–0.62, Sensitivity 40–77%, Specificity 16–100% (Cook, 2007).
Forced FABER	Positive finding: patient reported pain when her leg is flexed, abducted and externally rotated while in supine. Pain is provoked in SIJ[††] when examiner applies overpressure to knee and opposite ASIS[§]. Negative finding: this maneuver did not provoke pain (Cook, 2007).	Pain in hip or pelvic girdle joints	kappa = 0.38–0.62, Sensitivity 40–77%, Specificity 16–100% (Cook, 2007).
Posterior Pelvic Pain Provocation (aka P4 test)	Patient's hip is flexed to 90° while in supine. Positive finding: patient reported pain in ipsilateral SIJ[††] when examiner applies force through the femur (Albert et al., 2000; Kristiansson et al., 1996; Mens et al., 2002; Ostgaard et al., 1994). Negative finding: no pain was produced or reported during this maneuver.	Pain in hip or pelvic girdle joints	kappa = 0.76–0.7, Sensitivity 36–93%, Specificity 50–100% (Cook, 2007).
Abdominal Muscle Test	Patient lies supine hips and knees flexed to 90° off of table. Test is positive for weakness if patient is unable to maintain lumbar neutral spine while simultaneously extending one hip to 45° and one knee to 0 (Sahrmann, 2002). *(Test modified from Sahrman)*	Core abdominal muscle weakness	kappa = 0.97–0.99 (Van Dillen et al., 1998).
Pelvic Floor Muscle Tenderness	Positive test: Pain is elicited during firm digital vaginal palpation of right or left pelvic floor muscles (Bo and Sherburn, 2005; Weiss, 2001). Negative test: no pain to firm digital palpation of pelvic floor muscles. (*Test modified from Weiss)*	Muscular tenderness and/or myofascial pain	kappa = 0.76–0.91 (Slieker-ten Hove et al., 2009).

(*continued on next page*)

Table 1 (*continued*)

Examination Maneuver	Description of Examination Maneuver	Indicator(s) of Musculoskeletal Dysfunction	Reported Reliability, Sensitivity and Specificity
Pelvic Floor Muscle Strength	Positive test for weakness if patient is unable to lift, squeeze, and maintain contraction of right or left pelvic floor muscles for at least 5 s during digital vaginal muscle test (Bo and Sherburn, 2005; Laycock et al., 2001). (*Test Modified from Laycock*)	Internal core pelvic floor muscle weakness	kappa = 0.17–0.56 (Slieker-ten Hove et al., 2009).

*ICC — intraclass correlation, †ROM — range of motion, ††SIJ — sacroiliac joint, §ASIS — anterior superior iliac spine.

the women in the CPP group had at least 3 positive findings and 48% had 5 or more positive findings.

Hierarchical cluster analysis (Ward's method) was used to examine similarity in participants' response patterns on the 9 musculoskeletal tests. Participants were distributed into 3 distinct clusters (see Table 2). *Cluster 1* - This cluster included 12 women, none of whom had self-reported CPP. Women in this cluster present with few positive findings, and the findings are varied. Half of the women in this cluster had poor posture, half of them had abdominal muscle weakness, and 40% had asymmetrical hip range of motion. We named this group the "General Population", because they were all pain-free and had few and varied positive findings, which may be similar to the general population of women.

Cluster 2 - This cluster contains both pain-free women ($n = 15$) and women with CPP ($n = 9$). This cluster represents women with the same 3 positive musculoskeletal findings: poor posture, positive Trendelenberg sign, and abdominal muscle weakness. The women in this cluster predominantly displayed signs of core muscle weakness, thus named the "Core Weakness" cluster. This group is characterized by issues with postural asymmetry, abdominal weakness, and hip abductor weakness (positive Trendelenberg test). However, we found that the total MSKD score was significantly greater for women with CPP in this cluster compared to the pain-free women (CPP $= 4.3 \pm 1.2$, Pain-free $= 3.2 \pm 0.9$, $t = -2.7$, df $= 22$, $p \leq 0.01$). *Clusters 3* - Ninety percent of the women in this cluster were from the CPP group. These women presented with 6–7 positive musculoskeletal exam findings, including those 3 common to Cluster 2 but additionally showed positive findings for musculoskeletal dysfunction on Forced FABER, pelvic floor muscle pain to palpation, and pelvic floor muscle weakness. This group was named the "Musculoskeletal Dysfunction (MSKD)" cluster.

Table 3 shows the mean total Musculoskeletal Dysfunction Score by self-reported pelvic pain and cluster. This analysis shows that a score of ≤ 2 positive findings is inconsistent with self-reported pelvic pain. A score of 3–4 positive findings is commonly seen in both self-reported pelvic pain and pain-free participants. A score 5 or higher is consistent with women reporting CPP. Two women in the pain-free group had a high number of positive examination findings. Neither of these women had pain to palpation of the pelvic floor muscles.

In the final set of analyses we used the Stata ROCTAB procedure to examine the performance of pelvic floor muscle palpation and Forced FABER for identifying self-reported pelvic pain. These two maneuvers were selected because the chi-square tests were significantly different between women with and without self-reported CPP. The P4 test was not included because although the chi-square was significant, many women with CPP tested negative on this item. The procedure generated the following statistics: sensitivity, specificity, positive likelihood ratio (LR+), and overall percent correctly classified. Each statistic individually gauges the accuracy of these two screening maneuvers from a different perspective.

By using the combination of pelvic floor muscle palpation and the Forced FABER test, we achieved 100% specificity in identifying women with self-reported CPP. The odds that a women with self-reported pain will have more than one of these 2 positive findings is 5.34 (positive likelihood ratio) compared to pain-free women. The area under the receiver operating curve (ROC) is an indication of the "accuracy" of the tests, describing the relationship

Table 2 Number of participants by pelvic pain and cluster, physical therapist comparative assessment of musculoskeletal findings.

	Clusters		
	1. General Population	2. Core Weakness	3. Musculoskeletal Dysfunction
No Pelvic Pain	12	15	2
Pelvic Pain	0	9	10

Table 3 Mean total musculoskeletal dysfunction score by pelvic pain and cluster, comparative study of physical therapy findings.

	Clusters		
	1.General Population	2. Core Weakness	3. Musculoskeletal Dysfunction
No Pelvic Pain	1.8	3.2	6.5
Pelvic Pain	—	4.3	6.2

between sensitivity and specificity. An area of 1.0 would indicate that the tests are perfectly accurate at identifying the participants with CPP. For the combination of these two tests, the area under the ROC curve is 0.84 (SE 0.059), indicating that these two items may help at correctly classifying women with and without self-reported CPP.

An ROC curve comparing the women with self-reported CPP in Cluster 2 to the women with self-reported CPP in Cluster 3 revealed that Forced FABER test alone has a specificity of 0.78 and correctly classifies women in Cluster 3 89.5% of the time. For the women with self-reported CPP, the accuracy of using the combination of pain to palpation of the pelvic floor muscles and Forced FABER test was no different than using Forced FABER test alone. That is, Forced FABER test distinguishes the women with self-reported CPP in Cluster 3 from the women with self-reported CPP in Cluster 2. However, in order to distinguish all of the women in Cluster 2 (with and without self-reported CPP) from all of the women in Cluster 3, the combination of Forced FABER test and palpation of pelvic floor muscles is optimal.

Discussion

Our study found that on average women with self-reported CPP had more positive musculoskeletal findings than pain-free women. The temporal relationship between musculoskeletal abnormalities and CPP is equivocal (Montenegro et al., 2008; Zondervan and Barlow, 2000). The literature supports the musculoskeletal system as both a cause (Montenegro et al., 2008) and consequence of CPP (Wesselmann and Lai, 1997). For example, women and men with urologic pelvic pain syndromes commonly demonstrate tension and tenderness of the pelvic floor musculature and other somatic tissues upon examination (Anderson, 2006; FitzGerald, 2005). But it is not clear whether musculoskeletal abnormalities are a primary disorder which leads to secondary urinary symptoms or if the musculoskeletal dysfunction is a consequence of the visceral symptoms (Bielefeldt et al., 2006; FitzGerald, 2003).

The women with self-reported CPP in this study presented with a different clinical picture than the pain-free women. None of the women with self-reported CPP appeared in the General Population cluster, while half were grouped in the cluster indicating core weakness, and half appeared in the cluster indicative of musculoskeletal dysfunction. Women with self-reported CPP in the "Core Weakness" cluster had higher total MSKD scores than pain-free women. These women might represent a group of women who have both CPP and core muscle weakness but have not yet developed extensive musculoskeletal dysfunction that can be provoked on physical exam.

Core weakness was common among both pain-free women and women with CPP and as such may have limited diagnostic utility for identifying musculoskeletal CPP. Women with self-reported CPP in the Core Weakness cluster (Cluster 2) may conceivably be representative of women with CPP at a high vulnerability to develop future pain problems of the pelvic girdle — a hypothesis that needs to be tested in longitudinal study designs. Indeed, motor control and strength of core muscles have emerged in the literature as an important factor in low back and pelvic girdle pain (Ferreira et al., 2004; Smith et al., 2008). If core muscles are weak or the timing of activation and control of the muscles is altered by pain or other disruption, then compensatory mechanisms for muscle imbalances themselves may contribute to the patients' pain complaints.

The women in the Musculoskeletal Dysfunction cluster (Cluster 3) not only had core weakness findings, but also had positive findings of musculoskeletal pain and specifically pelvic floor muscle pain. The women in this cluster may represent a distinct subcategory of women with significant musculoskeletal contributions to their CPP symptoms. Two pain-free women also presented with a high number of positive examination findings, which looked similar to other women in the Musculoskeletal Dysfunction cluster. These two women may simply be outliers, or could be early in the spectrum of developing a generalized pain syndrome such as fibromyalgia. Notably, neither of these women had pain to palpation of the pelvic floor muscles.

Specific examination items clearly distinguished women with self-reported CPP from pain-free women in this study. Examiners achieved 100% specificity in identifying women with self-reported CPP using pelvic floor muscle palpation and the Forced FABER test. Women with self-reported CPP are much more likely to have more than one of these 2 positive findings compared to pain-free women. Identifying musculoskeletal factors as a source of CPP would enable earlier and more precise diagnosis, and potentially earlier treatment, of musculoskeletal causes of pelvic pain. Future studies should attempt to validate these findings, and to confirm if specific clusters of tests can discriminate musculoskeletal from visceral presentations of CPP.

Our study has important limitations. The generalizability of these findings may be limited due to the small sample size and limited number of examiners. The categorization of CPP and pain-free participants was based on self-report rather than medical diagnosis or a pain classification system. Since there are no gold-standard diagnostic tests to compare these examination maneuvers to, we cannot use these tests to make a positive diagnosis of a musculoskeletal cause of CPP but rather only speculate that musculoskeletal abnormalities may cause or contribute to CPP. In addition, due to the small sample size, we were unable to examine the effects of possible confounding variables such as age and body mass index.

In conclusion, we found that women with CPP present with a greater number of positive musculoskeletal examination maneuvers, and can be distinguished from pain-free participants by specific maneuvers that are easily performed in the office setting. The presence of positive musculoskeletal findings in women with CPP may suggest the value of further examination by musculoskeletal specialists, such as physical therapists and physiatrists (Physical Medicine and Rehabilitation physicians). Earlier and more precise diagnosis of musculoskeletal factors may improve outcomes of women with CPP.

Conflicts of interest

None declared.

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