

GENERAL & SELECTED POPULATIONS SECTION

Original Research Article

Trigger Points, Pressure Pain Hyperalgesia, and Mechanosensitivity of Neural Tissue in Women with Chronic Pelvic Pain

Pedro Fuentes-Márquez, MSc,* Marie Carmen Valenza, PhD,* Irene Cabrera-Martos, PhD,* Ana Ríos-Sánchez, PT,* and Olga Ocón-Hernández, MD†

*Faculty of Health Sciences, Physical Therapy Department, University of Granada, Granada, Spain; †Obstetrics and Gynecology Clinic, Virgen de las Nieves Hospital, Granada, Spain

Correspondence to: Marie Carmen Valenza, PhD, Faculty of Health Sciences, Physical Therapy Department, University of Granada, Av Ilustración SN, 18071 Granada, Spain. Tel: 958242360; Fax: 958242360; E-mail: cvalenza@ugr.es.

Disclosure and conflicts of interest: The authors have no conflict of interest. The present study was conducted without any external funding or support.

Clinical trial number: NCT01994343

Abstract

Objectives. This study aims to evaluate the presence of myofascial trigger points (TrPs), widespread pressure pain sensitivity, and mechanosensitivity of neural tissue in women with chronic pelvic pain.

Design. Case-control study.

Setting. Faculty of Health Sciences.

Subjects. Forty women with chronic pelvic pain between age 18 and 60 years and 40 matched healthy controls were included in the study.

Methods. TrPs were bilaterally explored in gluteus maximus, gluteus medius, gluteus minimus, quadratus lumborum, and adductor magnus muscles. The referred pain reproduced lumbopelvic symptoms. Pressure pain thresholds (PPTs) were also bilaterally assessed over the Pfannenstiel

incision point on the abdominal, C5-C6 zygapophysial joint, second metacarpal, and tibialis anterior muscle. Mechanosensitivity of neural tissue was assessed with the neurodynamics tests of slump and the straight-leg raising.

Results. Significant between-group differences were found in TrP presence in patients with chronic pelvic pain ($P < 0.001$) compared with those included in the control group. Widespread pressure pain hyperalgesia was also found, with PPTs significantly reduced in the points assessed. Neurodynamics show a significantly decreased value in women with CPP.

Conclusions. Patients with chronic pelvic pain presented a high percentage of TrPs that reproduce their symptoms. Patients also showed a widespread pressure pain hyperalgesia and more mechanosensitive neural tissue due to a decrease on the range of motion related to neurodynamics.

Key Words. Myofascial Pain Syndrome; Pressure Algometry; Neurodynamics; Chronic Pelvic Pain

Introduction

Chronic pelvic pain (CPP) is defined as noncyclic pain of at least six months' duration located in the pelvis, the anterior abdominal wall, or below the umbilicus, as well as lower back or buttocks when not associated with menstruation or sexual intercourse [1,2]. It can occur continuously or intermittently, with intensity severe enough to interfere with activities of daily living and/or to require medical care [3]. Worldwide prevalence of CPP has been estimated to be between 5.7% and 26.6% [4].

The etiology of chronic pelvic pain has been proposed as multifactorial [5]. Despite the high prevalence and associated increased medical costs, the pathophysiology of CPP is not entirely understood [6]. Different causes have been suggested for CPP, including disorders of the reproductive tract, gastrointestinal system, urological

organs, musculoskeletal system, and psychoneurological system [7]. The challenge in identifying the pain generators and effectively treating this condition explains the tendency for pelvic pain to become chronic and the frustration associated with its management [8].

One potential source of pain that often is overlooked by the clinician is the musculoskeletal system [9]. Myofascial trigger points (TrPs) are reported to be commonly involved in the pain of pelvic structures [10,11]. Deactivation of these points has shown to improve or eliminate functional symptoms and pain [10]. Additionally, recent studies have demonstrated that CPP is associated with altered afferent sensory input due to maladaptive changes in the neural circuitry of pain [12]. Widespread hyperalgesia is defined as the result of increased sensitivity localized at sites segmentally unrelated to the primary source of nociception. Different studies have used pressure pain threshold (PPT) assessment, defined as the minimal amount of pressure applied for the pressure sensation to change to pain [13], to evaluate central sensitization and to clarify the role of nerve tissue in sensitization processes in different pain conditions [14–16]. Mechanosensitivity has been thought to be a mechanism that allows nerves to respond to mechanical stresses [17]. With body movement, nerves slide into their surrounding structures, tolerating compression and stretchability. However, the peripheral nervous system could present increased sensitivity to mechanical stimuli, with an altered response to levels of stretching or compression [18]. The concept of neurodynamics integrates biomechanical, physiological, and morphologic functions of the nervous system [19]. So, neurodynamic tests are used to assess the nervous system's mechanosensitivity through monitoring the response to movements that are known to alter the mechanical stresses acting upon the nervous system [20]. In our knowledge, there are no available data related to neurodynamics in patients with CPP.

This study aims to evaluate the presence of myofascial TrPs, pressure pain hypersensitivity, and mechanosensitivity of neural tissue in women with CPP.

Methods

Participants

This was a case-control study in which women diagnosed with CPP attending the University of Granada medical unit for CPP were recruited between November 2013 and December 2015. The protocol was approved by the local ethics committee. Before being included in the study, patients were informed about the purpose and the course of study, after which they gave written informed consent to participate. The protocol conformed to the standards for human experiments set by the Declaration of Helsinki.

Inclusion criteria were female gender, diagnosis of CPP, and having noncyclic pelvic pain for more than six

months. The control group consisted of age- and body mass index-matched women volunteers who had no pelvic pain. Exclusion criteria for both groups included syndromes and/or diseases involving chronic pain, pregnancy, active urogenital infection, prior urogenital malignancy, vaginal prolapse exceeding second degree, cancer, active pelvic inflammatory disease, surgical intervention involving the lumbo-pelvic region over the past year, fibromyalgia, chronic fatigue syndrome, rheumatic diseases, and other long-lasting musculoskeletal pain in the past year. Patients with psychiatric disorders, cognitive impairment, or dementia were also excluded.

All the data were collected by an independent researcher who was blinded to the allocation group of the patients in the laboratory of the Faculty of Health Sciences. Participants were asked to avoid any analgesic or muscle relaxant 24 hours prior to the examination. Demographic and clinical data including age, body mass index (BMI), gynecological history, and regular physical activity (≥ 4 hours per week) were collected at baseline via a semistructured interview. The clinical records of participants were also reviewed. Additionally, anxiety and depression symptoms were measured with the Beck Anxiety [21] and the Depression [22] inventories. Pain was assessed using the Brief Pain Inventory (BPI) [23]. It measures the degree of interference of pain with various aspects of life, including mobility and social activities (reactive pain). The BPI also includes a pain severity subscale (sensory pain). Disability related to pain was assessed using the Oswestry Disability Index [24].

Outcome measures were trigger point examination, pressure pain hypersensitivity, and mechanosensitivity of neural tissue.

TrP Examination

TrPs were explored bilaterally by a blinded assessor in muscles described to refer pain to the lumbopelvic area in response to compression [25], including the gluteus maximus, gluteus medius, gluteus minimus, quadratus lumborum, and adductor magnus muscles. In regard to the function and motion, the pelvis is the link through which loads are transmitted from the lower extremities to the spine and vice versa. In addition, the muscle groups we assessed are frequently injured due to overuse and are easy to evaluate, adding valuable information regarding the source of pain. The order of points was randomized between subjects with a two-minute rest period between muscles, as previously used [26], in order to avoid the referred pain interfering with the patient's response. TrP assessment was performed following the criteria described by Simons et al. [25]: presence of a hypersensitive spot within a palpable taut band in a skeletal muscle, local twitch response elicited by the snapping palpation of the taut band, and presence of referred pain in response to TrP compression. Patients were asked to indicate if they felt pain locally or in other areas and if this pain reproduced any symptom,

familiar or nonfamiliar, using these words: "When I pressed each of these muscles, did you feel any pain locally and/or in other areas? Please tell me whether the pain that you feel in the other area reproduced any symptom that you usually suffer from." Participants had to indicate whether the pain elicited by palpation was a familiar pain or a nonfamiliar pain. TrPs were considered active when the local and referred pain reproduced any clinical pain symptom perceived by the patients and the patients recognized the pain as familiar. TrPs were considered latent when the elicited local and the referred pain did not reproduce any symptoms familiar to the patient [25]. Inter-rater reliability has shown to vary between studies [27]. In our study, TrP examination was performed in all patients by the same examiner, blinded to group, who had prior training and more than 10 years of clinical experience.

Pressure Pain Sensitivity

Pressure pain hypersensitivity was evaluated by establishing the pain pressure thresholds (PPTs) with a mechanical pressure algometer (Pain Diagnosis and Treatment Inc., NY, USA). One of the main characteristics of central sensitization is a generalized rather than a localized decrease in PPT. Thus, increased sensitivity is localized at sites segmentally unrelated to the primary source of nociception [28]. A local point over the pelvic area on the abdominal wall, located below the umbilicus and just above the pubic symphysis (Pfannenstiel incision point), was assessed. Three distant pain-free points were bilaterally evaluated, over the C5-C6 zygapophyseal joint, the second metacarpal, and the tibialis anterior muscle, to determine widespread pressure sensitivity. These points have been used previously [29]. PPT examination was performed with subjects lying supine (Pfannenstiel, second metacarpal, and tibialis anterior muscle points) and prone (C5-C6 zygapophyseal joint). Patients were instructed to press a switch when the sensation first changed from pressure to pain. The mean of the three trials was calculated and used for analysis. The order of point assessment was randomized between participants. A 30-second resting period was allowed between each trial. Several studies have documented high intraexaminer and interexaminer reliability (intraclass correlation coefficient = 0.80 to 0.97) for PPT assessment [30,31].

Mechanosensitivity of Neural Tissue

Mechanosensitivity of neural tissue was assessed using neurodynamics. These tests consist of series of passive movements applied to the lower extremity to identify neural tissue dynamics following a standardized sequence [32,33]. These tests use movement at a site remote to the painful area to further load or unload the nervous system. The slump test and the straight-leg raising (SLR) test were selected given that they involve lumbar and lower limbs. Both tests were performed

according to the operational definition described by Butler [33]. To perform the slump test, patients were placed in a sitting position with popliteal creases flush against the edge of the plinth, and they were instructed to place their hands behind their backs. The sequence of movements included flexion of the thoracic and lumbar spine (arms behind their backs), head and neck flexion, ankle dorsiflexion, and knee extension. In the SLR test, the patients were positioned supine with the legs straight. The sequence of movements included passive straight leg raise with ankle dorsiflexion during hip flexion with knee extension. Before performing the tests, patients were instructed to communicate the onset of any sensation (e.g., stretch, tingling, pain). The movements were performed until the end of the range of motion or until the start of specific symptoms. The final angles of movement of knee extension and hip flexion were measured with a manual goniometer (Figure 1).

Analysis of Data

Data were analyzed using IBM SPSS Statistics (20.0 version; IBM Corp., Armonk, NY, USA). A priori sample size calculation indicated that 36 patients would be required to complete each group to detect a statistically significant difference (alpha value of 0.05, 90% power, 0.70 effect size) based on a pilot study and using the G*Power software. This sample was increased to 40 patients per group to estimate a dropout of 10%.

Descriptive statistics (mean \pm standard deviation or percentage) were used to determine participant characteristics. The Kolmogorov-Smirnov test revealed that all data showed a normal distribution ($P > 0.05$); therefore, parametric tests were used in the analysis. The χ^2 test was used to analyze the differences in the distribution of muscle TrPs (active or latent) for each muscle within both study groups. A one-way analysis of variance test was used to evaluate the differences in PPT levels and neurodynamics. Statistical analyses were conducted at a 95% confidence level, and a P value was considered significant when $P < 0.05$.

Results

The total sample of 80 women included 40 in the CPP group and 40 in the control group, whose mean ages were 41.61 ± 7.65 years and 43.94 ± 6.83 years, respectively ($P = 0.341$). Patient characteristics for both groups are summarized in Table 1. Patients with CPP had suffered for a mean duration of symptoms of 6.45 years and more often showed a previous history of irregular menstruation (44% vs 16.7%, $P = 0.033$). CPP patients were less likely to engage in moderate physical activity ($P = 0.041$) and more likely to endorse depressive ($P = 0.011$) and anxious ($P = 0.001$) symptoms than controls. Specifically, women included in the experimental group exhibited mild to moderate values of anxiety and depression (scores 10–18) while those in the



Figure 1 Straight-leg raising and slump tests.

Table 1 Sociodemographic and clinical variables of the participants included in the study

	CPP Group (N = 40)	Control Group (N = 40)	P
Age, y	41.61 ± 7.65	43.94 ± 6.83	0.341
BMI, kg/m ²	23.23 ± 3.06	24.60 ± 4.58	0.302
Regular physical activity (≥4 h/wk), %	22.2	55.6	0.041
Clinical variables			
Gynecological history (% of patients)			
Pregnancies	67.7	77.8	0.651
Cesarean	25	41.7	0.178
Irregular menstruation	44.4	16.7	0.033
Dysmenorrhea	27.8	11.1	0.201
Pain (BPI)			
Sensory pain (0–10)	4.83 ± 1.54	0.33 ± 0.57	P < 0.001
Reactive pain (0–10)	5.02 ± 2.4	0.11 ± 0.4	P < 0.001
Duration of CPP, y	6.45 ± 8.48	–	–
Disability (Oswestry Disability Index), 0–100%	28.39 ± 14.59	1.03 ± 2.96	P < 0.001
Comorbidities (% of patients)			
Digestive	22.2	16.7	0.082
Urinary	5.6	0	0.5
Migraine	5.6	0	0.5
Anxious symptoms (BAI), 0–63	13.22 ± 9.6	3.78 ± 5.34	0.001
Depressive symptoms (BDI), 0–63	11.72 ± 8.28	4.5 ± 7.75	0.011

The categorical variables are expressed as percentage and the noncategorical as mean ± SD.

BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory; BMI = body mass index; BPI = Brief Pain Inventory; CPP = chronic pelvic pain.

control group presented scores within the normal range (0–9).

Table 2 summarizes the distribution of active and latent TrPs for all muscles in patients with CPP and controls. Significant differences were found in the distribution of TrPs (gluteus maximus, gluteus medius, gluteus minimus, lumbar square, and adductor magnus muscles), with the presence of active TrPs being most prevalent in the patients with CPP. A similar number of latent TrPs can be observed when compared with healthy controls.

Table 3 shows pressure pain and mechanosensitivity values. Pressure point values were significantly different in all the anatomical sites evaluated between groups ($P \leq 0.001$), being lower in women with CPP. Therefore, it displays the presence of widespread pressure pain

hypersensitivity. Also, the mechanosensitivity of neural tissue shows lower range of motion values in the CPP group when compared with healthy women ($P < 0.05$).

Discussion

This study aims to evaluate the presence of myofascial TrPs, widespread pressure pain sensitivity, and mechanosensitivity of neural tissue in women with chronic pelvic pain. Our results show that women with CPP showed a different distribution ($P < 0.001$) of TrPs, with a high number of active ones. Also, significantly lower values for widespread pressure pain and range of motion related to neurodynamics were found in the CPP patients.

Table 2 TrPs examination values in the women included in the study by group

	Right Side		<i>P</i>	Left Side		<i>P</i>
	Patients with Chronic Pelvic Pain (N = 40)	Healthy Controls (N = 40)		Patients with Chronic Pelvic Pain (N = 40)	Healthy Controls (N = 40)	
Gmed1, No.						
Active TrPs	21	0	<0.001	20	1	<0.001
Latent TrPs	3	2		2	3	
No TrPs	16	38		18	36	
Gmed2, No.						
Active TrPs	24	0	<0.001	27	0	<0.001
Latent TrPs	8	5		5	6	
No TrPs	8	35		8	34	
Gmed3, No.						
Active TrPs	27	1	<0.001	26	0	<0.001
Latent TrPs	3	5		7	5	
No TrPs	10	34		7	35	
Gmin1, No.						
Active TrPs	20	1	<0.001	18	2	<0.001
Latent TrPs	4	5		3	3	
No TrPs	16	34		19	35	
Gmin2, No.						
Active TrPs	20	0	<0.001	21	1	<0.001
Latent TrPs	4	1		2	2	
No TrPs	16	39		17	37	
Gmin3, No.						
Active TrPs	22	1	<0.001	23	0	<0.001
Latent TrPs	4	4		3	5	
No TrPs	14	35		14	35	
Gmax1, No.						
Active TrPs	23	0	<0.001	38	11	<0.001
Latent TrPs	3	2		2	6	
No TrPs	14	38		0	23	
Gmax2, No.						
Active TrPs	17	1	<0.001	22	1	<0.001
Latent TrPs	2	5		4	4	
No TrPs	21	34		14	35	
Gmax3, No.						
Active TrPs	10	0	<0.001	14	0	<0.001
Latent TrPs	0	2		2	0	
No TrPs	30	38		24	40	
QL1, No.						
Active TrPs	21	3	<0.001	23	3	<0.001
Latent TrPs	2	1		6	2	
No TrPs	17	36		11	35	
QL2, No.						
Active TrPs	21	3	<0.001	20	1	<0.001
Latent TrPs	2	1		3	4	
No TrPs	17	36		17	35	
AM1, No.						
Active TrPs	18	0	<0.001	18	0	<0.001
Latent TrPs	8	2		6	3	
No TrPs	14	38		16	37	

(continued)

Table 2 Continued

	Right Side		<i>P</i>	Left Side		<i>P</i>
	Patients with Chronic Pelvic Pain (N = 40)	Healthy Controls (N = 40)		Patients with Chronic Pelvic Pain (N = 40)	Healthy Controls (N = 40)	
AM2, No.						
Active TrPs	13	0	<0.001	11	0	0.001
Latent TrPs	5	1		3	1	
No TrPs	22	39		26	39	

Variables are expressed as mean \pm SD.

AM = adductor magnus; CPP = chronic pelvic pain; Gmax = gluteus maximus; Gmed = gluteus medius; Gmin = gluteus minimus; QL = quadratus lumborum; TrPs = trigger points.

Table 3 Pressure pain hypersensitivity and mechanosensitivity of neural tissue in the patients included in the study

		CPP Group (N = 18)	Control Group (N = 18)	<i>P</i>
Pain pressure hypersensitivity, kg				
Pffannestiel incision point		1.14 \pm 0.72	2.2 \pm 0.67	<0.001
Anterior tibialis muscle	Right	1.88 \pm 1.04	3.76 \pm 1.23	<0.001
	Left	1.68 \pm 0.99	3.39 \pm 1.2	<0.001
2nd metacarpal	Right	1.35 \pm 0.74	2.25 \pm 0.69	0.001
	Left	1.25 \pm 0.5	2.31 \pm 0.73	<0.001
C5–C6	Right	1.14 \pm 0.57	1.91 \pm 0.71	0.001
	Left	0.98 \pm 0.45	2.1 \pm 0.75	<0.001
Mechanosensitivity of neural tissue, degrees				
Slump test	Right	58.25 \pm 18.07	71.95 \pm 14.91	<0.001
	Left	58.80 \pm 19.08	71.08 \pm 14.78	0.002
SLR test	Right	46.75 \pm 14.70	72.53 \pm 16.22	<0.001
	Left	47.45 \pm 18.56	69.90 \pm 17.18	<0.001

Variables are expressed as mean \pm SD.

CPP = chronic pelvic pain; SRL = straight leg raising test.

The ability to identify the tissue origin of symptoms and to recognize the neurophysiological mechanisms involved in a patient's pain state is a key part of clinical assessment and is often challenging. Sterling et al. have stated the importance of developing a systematic evaluation of chronic symptoms, including all the mechanisms of pain in addition to the specific structural pathology [34]. In our study, myofascial TrPs of muscles reproducing the symptomatology, pressure pain sensitivity, and mechanosensitivity of neural tissue were included in the assessment.

Trigger point assessment showed a significant number of active TrPs in CPP patients compared with the control group. It has been previously reported that central sensitization should be considered in assessing regional chronic pain with the presence of tender and/or trigger points in the absence of structural pathology [35]. Central sensitization is reported in patients with

myofascial pain syndrome including chronic whiplash-associated disorders, temporomandibular disorders, and chronic nonspecific low back pain [28,36]. Additionally, there are other factors involved in the central pain amplification including anxiety and depression. In our study, women in the CPP group reported significantly higher values of anxiety ($P=0.001$) and depression ($P=0.011$) when compared with healthy women. Patients with long-term chronic pain frequently develop these symptoms, but those with psychological distress are also at increased risk for chronic pain and central sensitization [37].

Different quantitative sensory tests have been proposed for investigating the presence of sensitization mechanisms in several pathologies involving chronic pain, proposing that central sensitization in patients with musculoskeletal pain implies a generalized decrease in their pressure pain threshold [38]. While central

sensitization has been suggested in different pelvic pathologies like vulvodynia [39], painful bladder syndrome [40], and endometriosis [41] as characteristic factors, other studies [42,43] have not found differences in pressure pain thresholds between painful bladder syndrome and healthy controls. Our results show that women with CPP present pressure pain hyperalgesia that is extended to the pelvic region with a nonsegmental significant decrease in pain pressure threshold. Patients with CPP may have some component of central or regional neurologic sensitization, showing a complexity of the clinical picture and the increased difficulty of the rehabilitation process [44].

Mechanosensitivity of neural tissue examination is designed to assess minor nerve disorders, which do not necessarily show conduction abnormalities but often accompany increased mechanosensitivity of the nerve [33]. In asymptomatic subjects, the application of neurodynamic tests results in a reduced range of motion of the joint and unpleasant feelings such as tingling, pricking, or burning [33]. Our study found significant differences in neurodynamic tests between women with CPP and controls. To our knowledge, our study is the first to show mechanosensitive neural tissue. This finding needs to be taken into account when designing therapeutic approaches for CPP. Additionally, the tests we selected (the slump test and straight-leg raising) have been previously proposed as simple [45] and useful [46].

There are some limitations that need to be addressed in this study. Some authors have reported high rates of psychological dysfunction among women with this disorder, including depression, psychological and somatic symptoms, and sexual abuse history [47]. Further research should include these variables given the importance of psychological variables in central sensitization. An additional limitation of the study is the homogeneity of participants recruited from the same medical unit. We think the applicability of the results to everyday clinical practice is feasible given the complexity of clinical profile of these patients. Thus, it would be important to include musculoskeletal evaluation into the assessment of patients with chronic pelvic pain. Further research should include prospective population-based studies in order to establish clearly the conditions in which abnormal musculoskeletal findings influence the development of chronic pelvic pain syndromes. In addition, the outcome of the evaluation process can be used to determine the appropriate treatment parameters of the therapeutic rehabilitation program, including manual therapy techniques focused on trigger points, pressure pain hyperalgesia, and obtaining mechanosensitive neural tissue values.

Conclusions

Women with chronic pelvic pain present a high percentage of TrPs that reproduce their symptoms. Patients also show a widespread pressure pain hyperalgesia and

more mechanosensitive neural tissue due to a decrease in the range of motion associated with neurodynamics.

References

- 1 ACOG Committee on Practice Bulletins–Gynecology. ACOG Practice Bulletin No. 51. Chronic pelvic pain. *Obstet Gynecol* 2004;103(5): 589–605.
- 2 George SE, Clinton SC, Borello-France DF. Physical therapy management of female chronic pelvic pain: Anatomic considerations. *Clin Anat* 2013;26 (1):77–88.
- 3 McGowan L, Escott D, Luker K, Creed F, Chew-Graham C. Is chronic pelvic pain a comfortable diagnosis for primary care practitioners: A qualitative study. *BMC Fam Pract* 2010;11:7.
- 4 Ahangari A. Prevalence of chronic pelvic pain among women: An updated review. *Pain Physician* 2014;17(2):E141–7.
- 5 Moore J, Kennedy S. Causes of chronic pelvic pain. *Best Pract Res Clin Obstet Gynaecol* 2000;14(3): 389–402.
- 6 Williams RE, Hartmann KE, Steege JF. Documenting the current definitions of chronic pelvic pain: Implications for research. *Obstet Gynecol* 2004;103:686–91.
- 7 Howard FM. Chronic pelvic pain. *Obstet Gynecol* 2003;101(3):594–611.
- 8 Gunter J. Chronic pelvic pain: An integrated approach to diagnosis and treatment. *Obstet Gynecol Surv* 2003;58:615–23.
- 9 Tu FF, Holt J, Gonzales J, Fitzgerald CM. Physical therapy evaluation of patients with chronic pelvic pain: A controlled study. *Am J Obstet Gynecol* 2008;198(3):272.e1–7.
- 10 Pastore EA, Katzman WB. Recognizing myofascial pelvic pain in the female patient with chronic pelvic pain. *J Obstet Gynecol Neonatal Nurs* 2012;41: 680–91.
- 11 Chaitow L. Chronic pelvic pain: Pelvic floor problems, sacro-iliac dysfunction and the trigger point connection. *J Bodyw Mov Ther* 2007;11:327–39.
- 12 Simis M, Reidler JS, Duarte Maceia D, et al. Investigation of central nervous system dysfunction in chronic pelvic pain using magnetic resonance

- spectroscopy and noninvasive brain stimulation. *Pain Pract* 2015;15(5):423–32.
- 13 Vanderweeen L, Oostendorp RB, Vaes P, Duquet W. Pressure algometry in manual therapy. *Man Ther* 1996;1(5):258–65.
 - 14 Hall T, Quintner J. Responses to mechanical stimulation of the upper limb in painful cervical radiculopathy. *Aust J Physiother* 1996;42(4):277–85.
 - 15 Fernández-de-Las-Peñas C, Cleland JA, Ortega-Santiago R, et al. Central sensitization does not identify patients with carpal tunnel syndrome who are likely to achieve short-term success with physical therapy. *Exp Brain Res* 2010;207(1–2):85–94.
 - 16 Sterling M, Pedler A. A neuropathic pain component is common in acute whiplash and associated with a more complex clinical presentation. *Man Ther* 2009;14(2):173–9.
 - 17 Nee RJ, Butler D. Management of peripheral neuropathic pain: Integrating neurobiology, neurodynamics, and clinical evidence. *Phys Ther Sport* 2006;7(1):36–49.
 - 18 Bove GM, Ransil BJ, Lin HC, Leem JG. Inflammation induces ectopic mechanical sensitivity in axons of nociceptors innervating deep tissues. *J Neurophysiol* 2003;90(3):1949–55.
 - 19 Ellis RF, Hing WA. Neural mobilization: A systematic review of randomized controlled trials with an analysis of therapeutic efficacy. *J Man Manip Ther* 2008;16:8–22.
 - 20 Boyd BS, Wanek L, Gray AT, Topp KS. Mechanosensitivity of the lower extremity nervous system during straight-leg raise neurodynamic testing in healthy individuals. *J Orthop Sports Phys Ther* 2009;39(11):780–90.
 - 21 Beck AT, Epstein N, Brown G, Steer RA. An inventory for measuring clinical anxiety: Psychometric properties. *J Consult Clin Psychol* 1988;56:893–7.
 - 22 Bonilla J, Bernal G, Santos A, Santo D. A revised Spanish version of the Beck Depression Inventory: Psychometric properties with a Puerto Rican sample of college students. *J Clin Psychol* 2004;60(1):119–30.
 - 23 Tan G, Jensen MP, Thornby JI, Shanti BF. Validation of the Brief Pain Inventory for chronic nonmalignant pain. *J Pain* 2004;5:133–7.
 - 24 Fairbank JC, Davis JB, Mbaot JC, O'Brien JP. The Oswestry Low Back Pain Questionnaire. *Physiotherapy* 1980;66:271–3.
 - 25 Simons DG, Travell J, Simons LS. *Myofascial Pain and Dysfunction. The Trigger Point Manual*. Baltimore: Lippincott Williams & Wilkins; 1999.
 - 26 Torres-Chica B, Núñez-Samper-Pizarroso C, Ortega-Santiago R, et al. Trigger points and pressure pain hypersensitivity in people with postmeniscectomy pain. *Clin J Pain* 2015;31(3):265–72.
 - 27 Gerwin RD, Shanon S, Hong CZ, et al. Interrater reliability in myofascial trigger point examination. *Pain* 1997;69:65–7.
 - 28 Nijs J, Van Houdenhove B, Oostendorp RA. Recognition of central sensitization in patients with musculoskeletal pain: Application of pain neurophysiology in manual therapy practice. *Man Ther* 2010;15(2):135–41.
 - 29 Palacios-Ceña M, Wang K, Castaldo M, et al. Trigger points are associated with widespread pressure pain sensitivity in people with tension-type headache. *Cephalalgia* 2016; in press.
 - 30 Chesterson LS, Sim J, Wright CC, Foster NE. Interrater reliability of algometry in measuring pressure pain thresholds in healthy humans, using multiple raters. *Clin J Pain* 2007;23:760–6.
 - 31 Jones DH, Kilgour RD, Comtois AS. Test-retest reliability of pressure pain threshold measurements of the upper limb and torso in young healthy women. *J Pain* 2007;8:650–6.
 - 32 Schmid AB, Brunner F, Luomajoki H, et al. Reliability of clinical tests to evaluate nerve function and mechanosensitivity of the upper limb peripheral nervous system. *BMC Musculoskelet Disord* 2009;10:11.
 - 33 Butler DS. *The Sensitive Nervous System*. Unley, AU: NOI Group Publications; 2000.
 - 34 Sterling M, Treleaven J, Edwards S, Jull G. Pressure pain thresholds in chronic whiplash associated disorder: Further evidence of altered central pain processing. *J Musculoskelet Pain* 2002;10(3):69–81.
 - 35 Yunus MB. Central sensitivity syndromes: A unified concept for fibromyalgia and other similar maladies. *J Indian Rheum Assoc* 2000;8:27–33.
 - 36 Roussel N, Nijs J, Meeus M, et al. Central sensitization and altered central pain processing in chronic low back pain: Fact or myth? *Clin J Pain* 2013;29(7):625–38.
 - 37 Crofford LJ. Chronic pain: Where the body meets the brain. *Trans Am Clin Climatol Assoc* 2015;126:167–83.

- 38 Shy M, Frohman E, So Y, et al. Quantitative sensory testing report of the therapeutics and technology assessment subcommittee of the American Academy of Neurology. *Neurology* 2003;60:898–904.
- 39 Giesecke J, Reed BD, Haefner HK, et al. Quantitative sensory testing in vulvodynia patients and increased peripheral pressure pain sensitivity. *Obstet Gynecol* 2004;104:126–33.
- 40 Ness TJ, Powell-Boone T, Cannon R, Lloyd LK, Fillingim RB. Psychophysical evidence of hypersensitivity in subjects with interstitial cystitis. *J Urol* 2005;173:1983–7.
- 41 Giesecke T, Gracely RH, Grant MA, et al. Evidence of augmented central pain processing in idiopathic chronic low back pain. *Arthritis Rheum* 2004;50:613–23.
- 42 Fitzgerald MP, Koch D, Senka J. Visceral and cutaneous sensory testing in patients with painful bladder syndrome. *NeuroUrol Urodyn* 2005;24:627–32.
- 43 Yamashita T, Kanaya K, Sekine M, et al. A quantitative analysis of sensory function in lumbar radiculopathy using current perception threshold testing. *Spine* 2002;27:1567–70.
- 44 Jull G, Sterling M, Kenardy J, Beller E. Does the presence of sensory hypersensitivity influence outcomes of physical rehabilitation for chronic whiplash? A preliminary RCT. *Pain* 2007;129:28–34.
- 45 Kenneally M, Rubenach, H, Elvey R. The upper limb tension test: The SLR of the arm. In: Grant R, ed. *Physical Therapy of the Cervical and Thoracic Spine*. New York: Churchill Livingstone; 1988:167–94.
- 46 Coppieters MW, Kurz K, Mortensen TE, et al. The impact of neurodynamic testing on the perception of experimentally induced muscle pain. *Man Ther* 2005;10(1):52–60.
- 47 Leserman J, Zolnoun D, Meltzer-Brody S, Lamvu G, Steege JF. Identification of diagnostic subtypes of chronic pelvic pain and how subtypes differ in health status and trauma history. *Am J Obstet Gynecol* 2006;195(2):554–60.