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Muscle Trigger Points, Pressure Pain Threshold, and Cervical Range of Motion in Patients With High Level of Disability Related to Acute Whiplash Injury

• **STUDY DESIGN:** Cross-sectional cohort study.

• **OBJECTIVE:** To analyze the differences in the prevalence of trigger points (TrPs) between patients with acute whiplash-associated disorders (WADs) and healthy controls, and to determine if widespread pressure hypersensitivity and reduced cervical range of motion are related to the presence of TrPs in patients with acute WADs.

• **BACKGROUND:** The relationship between active TrPs and central sensitization is not well understood in patients with acute WADs.

• **METHODS:** Twenty individuals with a high level of disability related to acute WAD and 20 age- and sex-matched controls participated in the study. TrPs in the temporalis, masseter, upper trapezius, levator scapulae, sternocleidomastoid, suboccipital, and scalene muscles were examined. TrPs are defined as hypersensitive spots in a palpable taut band, producing a local twitch response and referred pain when palpated. Pressure pain threshold (PPT) was assessed bilaterally over the C5-6 zygapophyseal joints, second metacarpal, and tibialis anterior muscle. Active cervical range of motion, neck pain, and self-rated disability using the Neck Disability Index were also assessed.

• **RESULTS:** The mean $\pm$ SD number of TrPs for the patients with acute WADs was 7.3 ± 2.8 (3.4 ± 2.7 were latent TrPs; 3.9 ± 2.5 were active TrPs). In comparison, healthy controls had 1.7 ± 2.2 latent and no active TrPs ($P < .01$). In patients with acute

WADs, the most prevalent sites for active TrPs were the levator scapulae and upper trapezius muscles. The number of active TrPs increased with higher neck pain intensity ($P < .001$) and a greater number of days since the accident ($P = .003$). Patients had significantly lower PPTs in all tested locations and less active cervical range of motion than controls ($P < .001$). In the patient group, there were significant negative correlations between the number of active TrPs and PPT over the C5-6 joints and cervical range of motion in flexion, extension, and rotation in both directions: the greater the number of active TrPs, the lower the bilateral PPT over the neck and the greater the cervical range-of-motion limitation.

• **CONCLUSION:** The local and referred pain elicited from active TrPs reproduced neck and shoulder pain patterns in individuals with acute WADs with higher levels of disability. Patients with acute WADs exhibited widespread pressure hypersensitivity and reduced cervical mobility. The number of active TrPs was related to higher neck pain intensity, the number of days since the accident, higher pressure pain hypersensitivity over the cervical spine, and reduced active cervical range of motion. *J Orthop Sports Phys Ther* 2012;42(7):634-641, Epub 7 June 2012. doi:10.2519/jospt.2012.4117

• **KEY WORDS:** neck, WAD, whiplash-associated disorder

Whiplash-associated disorder (WAD) is a disabling and costly condition that usually occurs as a consequence of a motor vehicle accident.² Persistent

pain and disability can occur in up to 40% of injured individuals, resulting in a considerable financial burden. Recently, it has been suggested that central sensitization mechanisms may exist in patients with WAD. In fact, there are data to support the presence of hyperexcitability of the central nervous system (central sensitization) in patients with WAD.⁷ Decreased pain thresholds or pressure pain hypersensitivity has been demonstrated both locally over the symptomatic area as well as at more distal, pain-free areas where there is no tissue damage in individuals with chronic WAD.²⁷ The presence of pressure pain hypersensitivity at remote pain-free sites suggests that central sensitization of nociceptive pathways may be the cause of sensitivity in those with chronic WAD.³ An important finding is that widespread pressure

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pain hypersensitivity is also present in individuals with acute WAD (duration of less than 1 month), particularly in patients with higher levels of pain and disability³⁵ and subsequent poor recovery at follow-up.³⁶ A recent study has found a weak relationship between widespread pressure hypersensitivity and pain rating scores, suggesting that mechanical sensitivity may be a complex process involving several factors.²¹

It has also been proposed that myofascial trigger points (TrPs) may be involved in sensitization processes of the central nervous system.⁷ Some studies have demonstrated an association between TrPs and central sensitization mechanisms in different pain syndromes, such as chronic tension-type headache,¹⁰ lateral epicondylalgia,⁹ shoulder pain,¹⁸ temporomandibular pain,¹¹ and fibromyalgia syndrome.¹⁴ But this association may actually be bidirectional. Active TrPs may serve as potent peripheral noxious input by sensitizing the central nervous system, or they may be expressions of secondary hyperalgesia due to central sensitization.⁷

Simons et al¹⁰ defined a TrP as a hypersensitive spot within a taut band of skeletal muscle that is painful on contraction, stretching, or stimulation and elicits a referred pain distant from its location. From a clinical perspective, TrPs can be considered active or latent. Active TrPs, when stimulated, reproduce the patient's symptoms, and the patient recognizes the pain as familiar. Latent TrPs have similar findings to active TrPs but do not reproduce the patient's symptoms. Clinical distinction between active and latent TrPs has been substantiated by histochemical findings, with active TrPs containing higher levels of algogenic substances and chemical mediators (ie, bradykinin, substance P, serotonin) than latent TrPs and areas without TrPs.²⁸

Few studies have investigated the role of active TrPs in WAD. Ettlin et al⁸ found that TrPs in the semispinalis capitis muscle were more frequently found in individuals with chronic WAD than in patients with nontraumatic neck pain or

fibromyalgia. However, the prevalence of TrPs in the upper trapezius, levator scapulae, sternocleidomastoid, and masseter muscles was similar among these groups.⁸ To the best of the authors' knowledge, no study has yet investigated the relationship between active TrPs and widespread pressure hypersensitivity in subjects with acute WAD.

Therefore, the aims of the current study were (1) to analyze the differences in the prevalence of TrPs in head, neck, and shoulder musculature between patients with a high level of disability related to acute WAD and healthy controls, and (2) to determine if widespread pressure pain hypersensitivity and reduced cervical range of motion (CROM) commonly seen in individuals with acute WAD with higher levels of pain and disability are related to the presence of TrPs.

METHODS

Participants

PATIENTS REPORTING NECK PAIN AS A result of a motor vehicle accident that occurred within 1 month of their enrollment in the study, who were referred by their primary care physician to a physical therapist between January and June 2011, were screened for eligibility. Patients were eligible if they met the Quebec Task Force Classification of WAD II, defined as having neck complaints and musculoskeletal signs without evidence of nerve conduction loss on clinical neurological examination and local tenderness. Potential participants were excluded if they met the following criteria: they experienced a concussion during the motor vehicle accident; had a loss of consciousness; had head or upper-quadrant injury; had sought treatment for neck pain prior to their accident; reported a previous history of whiplash, headaches, or a psychiatric or psychological condition; were affected by any neurologic or circulatory disorders; had other somatic conditions (eg, fibromyalgia syndrome); or had a current claim for litigation or compensation.

Healthy controls were recruited from the general population by local newspaper announcement and had to report the following: (1) absence of current pain symptoms, (2) no history of chronic pain, (3) no pain experienced during the past 6 months prior to the study, (4) no pain-related diagnoses, and (5) not taking antidepressant medications. The study protocol was approved by the local Ethics Committee of the Universidad de Granada and conducted following the Helsinki Declaration. All participants signed an informed consent prior to their inclusion.

Self-Report Measures

An 11-point numeric pain rating scale (0 as no pain and 10 as maximum pain) was used to assess the current level of pain, as well as the worst and lowest levels of generalized pain experienced in the preceding week.¹⁹ Patients also completed the Neck Disability Index (NDI) to assess self-perceived disability. The NDI consists of 10 questions rated on a 6-point scale (0 as no disability and 5 as full disability).⁴¹ The numeric score for each item is summed for a score that ranges from 0 to 50, with higher scores reflecting greater disability. Multiplying the score by 2 enables the score to be expressed as a percentage ranging from 0% to 100%. The NDI has been shown to be a reliable and valid tool for measuring disability in individuals with neck pain.^{16,38} A literature review by MacDermid et al²⁴ has reported that the reliability of the NDI measured with intraclass correlation coefficients (ICCs) ranges from 0.50 to 0.98. The study also reported that the NDI is the most commonly used self-report measure for patients with neck pain.

Active CROM

CROM was assessed with the patient sitting comfortably on a chair, with both feet flat on the floor, both hips and knees at 90°, and buttocks positioned against the back of the chair. The CROM goniometer was placed on the top of the head, and the patient was asked to move the head as far as possible within the lim-

its of pain using a standard sequence of movements: flexion, extension, right and left lateral flexion, and right and left rotation. The values of 3 trials were recorded for each movement, and the mean was used for the analyses. The reliability of CROM measurements has yielded ICCs ranging from 0.66 to 0.94.^{1,6} Fletcher and Bandy²² have reported a standard error of measurement between 2.3° and 4.1° in subjects with and without neck pain, respectively. Audette et al¹ reported that the minimal detectable changes across the 6 movements ranged from 3.6° to 6.5°.

Pressure Pain Thresholds

The pressure pain threshold (PPT), defined as the minimal amount of pressure by which a sensation of pressure first becomes one of pain,⁴⁰ was assessed with an electronic algometer (Somedic AB, Hörby, Sweden). The pressure was applied at a rate of 30 kPa/s. All participants were instructed to press a button when the sensation changed from pressure to pain. The mean of 3 trials, with a 30-second period between trials, was calculated and used for the main analysis. The reliability of algometry with this device has been found to be high when measures are repeated on the same day (ICC = 0.91; 95% confidence interval [CI]: 0.82, 0.97)⁴ and between 4 separate days (ICC = 0.94–0.97).²⁰

TrP Examination

TrP diagnosis was performed following the criteria described by Simons et al³⁰: (1) palpable taut band within a skeletal muscle, (2) presence of a hypersensitive spot in the taut band, (3) local twitch response elicited by the snapping palpation of the taut band, and (4) production of referred pain in response to TrP manual compression. TrPs were considered active when the referred pain elicited during examination reproduced any clinical symptom reported by the subjects and the subject recognized the pain as familiar. TrPs were considered latent when the pain elicited during examination did not reproduce any clinical symptom familiar

TABLE 1	DEMOGRAPHIC DATA OF PATIENTS WITH ACUTE WHIPLASH-ASSOCIATED DISORDERS AND HEALTHY CONTROLS*		
	Patients With Acute Whiplash	Healthy Controls	P Value
Age, y	28.7 ± 12.4 (22.9, 34.4)	29.1 ± 12.2 (23.3, 34.8)	.919
Height, cm	67.7 ± 16.3 (60.1, 75.4)	64.1 ± 23.3 (53.2, 75.1)	.410
Weight, kg	170.0 ± 10.6 (165.0, 175.0)	160.7 ± 39.1 (142.3, 179.0)	.576
Time from accident, d	26.6 ± 3.8 (24.8, 28.4)	..	..
Current pain (NPRS, 0–10) [†]	6.2 ± 2.6 (5.0, 7.5)	..	..
Worst pain (NPRS, 0–10) [†]	8.0 ± 2.0 (7.0, 8.9)	..	..
Lowest pain (NPRS, 0–10) [†]	3.3 ± 2.9 (1.9, 4.7)	..	..

Abbreviation: NPRS, numeric pain rating scale.
 *Values are expressed as mean ± SD (95% confidence interval).
 †Higher scores represent more pain.

to the subject.³⁰ These criteria, when applied by a trained assessor, have exhibited good interexaminer reliability (kappa) ranging from 0.84 to 0.88.¹⁵

TrP examination was performed as follows. After TrP assessment in each muscle, participants were asked by a different assessor, "When this muscle was pressed, did you feel any pain locally or in other areas [referred pain]? Please tell me whether the pain that you feel reproduced any symptom that you usually experience." Subjects had to indicate whether the pain elicited during examination reproduced their symptom (familiar pain) or a different, unusual pain. Hence, the TrP assessor was blinded to the results of the reproduction of the patient's symptoms.

Study Protocol

Participants were asked to abstain from performing any kind of general exercise over the previous 24 hours and were not allowed to take analgesics or muscle relaxants over the previous 48 hours. They attended a preliminary session for familiarization with PPT assessment. CROM was first assessed. Second, PPT was measured bilaterally over the articular pillar of the C5–6 zygapophyseal joints, the second metacarpals, and the tibialis anterior muscles. The order of assessment was randomized between participants. These sites have been previously

used in investigation of acute and chronic WAD.^{21,27,32,35,36} In addition, some studies conducted by Walton et al^{42,43} support the clinical use of pressure algometry for assessment of pain sensitivity in patients with acute neck pain.

Finally, the presence or absence of TrPs was assessed bilaterally for the temporalis, masseter, upper trapezius, levator scapulae, sternocleidomastoid, scalene, and suboccipital muscles by an assessor with more than 9 years of experience in TrP diagnosis. The order of TrP evaluation was also randomized between each participant, with 2 minutes between muscles. All outcomes were assessed by an individual blinded to the subjects' conditions.

Sample-Size Determination

Sample size was determined using Tamayo de la muestra Version 1.1 software (Hospital Universitario San Ignacio, Bogotá, Colombia) and based on detecting a significant between-group difference of 20% for PPTs,²⁶ with an alpha level of .05 and a desired power of 80%. This generated a sample size of at least 16 participants per group.

Statistical Analysis

Data were analyzed with the SPSS Version 16.0 statistical package (SPSS Inc, Chicago, IL). Results are expressed as mean ± SD (95% CI). The Kolmogorov-

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Table 1. Mean (SD) Age, Sex, and Race of Participants		Table 2. Mean (SD) Age, Sex, and Race of Participants	
Age (years)	61.6 (6.8)	Age (years)	61.6 (6.8)
Sex (male/female)	6/6	Sex (male/female)	6/6
Race (white/black/other)	6/0/0	Race (white/black/other)	6/0/0
Height (cm)	168.5 (6.2)	Height (cm)	168.5 (6.2)
Weight (kg)	78.5 (12.5)	Weight (kg)	78.5 (12.5)
Body mass index (kg/m ²)	28.5 (4.5)	Body mass index (kg/m ²)	28.5 (4.5)
Education (years)	12.5 (1.5)	Education (years)	12.5 (1.5)
Occupation (white/blue/other)	6/0/0	Occupation (white/blue/other)	6/0/0
Marital status (married/divorced/separated/widowed/single)	6/0/0/0/0	Marital status (married/divorced/separated/widowed/single)	6/0/0/0/0
Health status (good/fair/poor)	6/0/0	Health status (good/fair/poor)	6/0/0
Smoking status (current/former/never)	0/0/6	Smoking status (current/former/never)	0/0/6
Alcohol consumption (yes/no)	0/6	Alcohol consumption (yes/no)	0/6
Medication use (yes/no)	0/6	Medication use (yes/no)	0/6
Comorbidities (yes/no)	0/6	Comorbidities (yes/no)	0/6
Functional status (yes/no)	0/6	Functional status (yes/no)	0/6
Quality of life (yes/no)	0/6	Quality of life (yes/no)	0/6
Overall health (yes/no)	0/6	Overall health (yes/no)	0/6
Physical activity (yes/no)	0/6	Physical activity (yes/no)	0/6
Stress level (yes/no)	0/6	Stress level (yes/no)	0/6
Depression (yes/no)	0/6	Depression (yes/no)	0/6
Anxiety (yes/no)	0/6	Anxiety (yes/no)	0/6
Sleep quality (yes/no)	0/6	Sleep quality (yes/no)	0/6
Energy level (yes/no)	0/6	Energy level (yes/no)	0/6
Mood (yes/no)	0/6	Mood (yes/no)	0/6
Life satisfaction (yes/no)	0/6	Life satisfaction (yes/no)	0/6
Overall well-being (yes/no)	0/6	Overall well-being (yes/no)	0/6

Table 3. Mean (SD) Age, Sex, and Race of Participants		Table 4. Mean (SD) Age, Sex, and Race of Participants	
Age (years)	61.6 (6.8)	Age (years)	61.6 (6.8)
Sex (male/female)	6/6	Sex (male/female)	6/6
Race (white/black/other)	6/0/0	Race (white/black/other)	6/0/0
Height (cm)	168.5 (6.2)	Height (cm)	168.5 (6.2)
Weight (kg)	78.5 (12.5)	Weight (kg)	78.5 (12.5)
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Education (years)	12.5 (1.5)	Education (years)	12.5 (1.5)
Occupation (white/blue/other)	6/0/0	Occupation (white/blue/other)	6/0/0
Marital status (married/divorced/separated/widowed/single)	6/0/0/0/0	Marital status (married/divorced/separated/widowed/single)	6/0/0/0/0
Health status (good/fair/poor)	6/0/0	Health status (good/fair/poor)	6/0/0
Smoking status (current/former/never)	0/0/6	Smoking status (current/former/never)	0/0/6
Alcohol consumption (yes/no)	0/6	Alcohol consumption (yes/no)	0/6
Medication use (yes/no)	0/6	Medication use (yes/no)	0/6
Comorbidities (yes/no)	0/6	Comorbidities (yes/no)	0/6
Functional status (yes/no)	0/6	Functional status (yes/no)	0/6
Quality of life (yes/no)	0/6	Quality of life (yes/no)	0/6
Overall health (yes/no)	0/6	Overall health (yes/no)	0/6
Physical activity (yes/no)	0/6	Physical activity (yes/no)	0/6
Stress level (yes/no)	0/6	Stress level (yes/no)	0/6
Depression (yes/no)	0/6	Depression (yes/no)	0/6
Anxiety (yes/no)	0/6	Anxiety (yes/no)	0/6
Sleep quality (yes/no)	0/6	Sleep quality (yes/no)	0/6
Energy level (yes/no)	0/6	Energy level (yes/no)	0/6
Mood (yes/no)	0/6	Mood (yes/no)	0/6
Life satisfaction (yes/no)	0/6	Life satisfaction (yes/no)	0/6
Overall well-being (yes/no)	0/6	Overall well-being (yes/no)	0/6

Table 1. Mean (SD) Age, Sex, and Race of Participants

Table 1

Table 1. Mean (SD) Age, Sex, and Race of Participants

Table 2

Table 2. Mean (SD) Age, Sex, and Race of Participants

Table 3. Mean (SD) Age, Sex, and Race of Participants

Table 4

Table 4. Mean (SD) Age, Sex, and Race of Participants

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Table 6. Mean (SD) Age, Sex, and Race of Participants

Table 7. Mean (SD) Age, Sex, and Race of Participants

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