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 difference in the prevalence of trigger points (TPs) between patients with acute whiplash-associated disorders (WADs) and healthy controls.

**Background:** The relationship between active TPs and cervical sensitivity 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. TPs in the levator scapulae, upper trapezius, levator scapulae, sternocleidomastoid, suboccipital, and scalene muscles were examined. TPs are defined as hyperreflexive spots in a palpable tail band, producing a local twitch response and referred pain when palpated. Pressure pain thresholds (PPT) were assessed bilaterally over the C5-6 hyperreflexive spots, sternocleidomastoid, and scleral anterior muscle. Active cervical range of motion, neck pain, and self-rated disability using the Neck Disability Index were also assessed.

**Results:** The mean ± SD number of TPs for the patients with acute WADs was 2.3 ± 2.8 (range 0–9) and for healthy controls was 2.1 ± 2.2 (range 0–9). In comparisons, healthy controls had lower active TPs and no active TPs (P < 0.05). In patients with acute WADs, the most prevalent sites for active TPs were the levator scapulae and upper trapezius muscles.

**Conclusion:** The local and referred pain elicited from active TPs reproduced neck and shoulder pain patterns in individuals with acute WADs with higher levels of disability. Patients with acute WADs exhibit widespread pressure hyperalgesia and reduced cervical mobility. The number of active TPs was related to higher neck pain intensity, the number of days since the accident, higher pressure pain hyperalgesia over the cervical spine, and reduced active cervical range of motion.

**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. Persistent pain and disability can occur in up to 40% of injured individuals, resulting in 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 hyperalgesia of the central nervous system (cervical sensitivity) in patients with WAD.

Decreased pain thresholds or pressure pain hyperalgesia 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.

The presence of pressure pain hyperalgesia at remote pain-free sites suggests that central sensitization of nociceptive pathways may be the cause of sensitivity in those with chronic WAD. An important finding is that widespread pressure...
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 disability and subsequent poor recovery at follow-up. 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.

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

Simons et al defined a TrP as a hyperirritable spot within a taut band of skeletal muscle that is painful on touch, stretch, 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. Clinical distinction between active and latent TrPs has been substantiated by histological findings, with active TrPs containing higher levels of algogenic substances and chemical mediators (e.g., bradykinin, substance P, serotonin) than latent TrPs and areas without TrPs.

Few studies have investigated the role of active TrPs in WAD. Eftim et al found that TrPs in the semimembranosus capsulitis 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. 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 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 to determine if widespread pressure pain hypersensitivity and reduced cervical range of motion (ROM) are 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 1 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 psychiatric or psychological condition; were affected by any neurologic or circulatory disorders; had other somatic conditions (e.g., 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 diagnosis, 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. Patients also completed the Neck Disability Index (NDI) to assess self-perceived disability. The NDI consists of 10 questions rated on a 0-to-10 scale (0 as no disability and 10 as full disability).

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. A literature review by MacDermid et al 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 0.94.13 Fletcher and Band14 have reported a standard error of measurement between 2.3° and 4.1° in subjects with and without neck pain, respectively. Andrette et al15 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,14 was assessed with an electronic algometer (Samedic AB, Kirch, 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 6 separate days (ICC = 0.94–0.97).16

**Table 1.**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Patients With Acute Whiplash</th>
<th>Healthy Controls</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>28.7 ± 12.8 (9, 4.2)</td>
<td>251 ± 12.3 (13.3, 4.8)</td>
<td>.25</td>
</tr>
<tr>
<td>Height, cm</td>
<td>163 ± 6 (1, 7.4)</td>
<td>154 ± 6 (1, 7.5)</td>
<td>.20</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>70.2 ± 30.5 (65.3, 75.9)</td>
<td>180 ± 30.2 (142.1, 175.9)</td>
<td>.57</td>
</tr>
<tr>
<td>Time from accident, d</td>
<td>26.2 ± 18 (10.2, 20.3)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Current pain (NPRS, 0-10)</td>
<td>6.2 ± 15 (6.4, 10.3)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Rest pain (NPRS, 0-10)</td>
<td>8.2 ± 20 (5.8, 22)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Lower pain (NPRS, 0-10)</td>
<td>33 ± 23 (13.6, 47)</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

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

**TTP Examination**

TTP was performed following the criteria described by Simons et al:17
1. palpable taut band within a skeletal muscle,
2. presence of a hypertensive 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 TTP manual compression. TTPs 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. TTPs were considered latent when the pain elicited during examination did not reproduce any clinical symptom familiar to the subject.18 These criteria, when applied by a trained assessor, have exhibited good interexaminer reliability (kappa ranging from 0.84 to 0.88).19 TTP examination was performed as follows. After TTP assessment in each muscle, participants were asked by a different assessor, “When this muscle was pressed, did you feel any pain locally or in another area (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, nonusual pain. Hence, the TTP 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 C6-7 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 investigations of acute and chronic WAD.20,21,22,23 In addition, some studies conducted by Walton et al24,25 support the clinical use of pressure algometry for assessment of pain sensitivity in patients with acute neck pain.

Finally, the presence or absence of TTPs 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 TTP diagnosis. The order of TTP 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 Tama’s 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, 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 Kalmogorov-