

## CHANGES IN PRESSURE PAIN SENSITIVITY IN LATENT MYOFASCIAL TRIGGER POINTS IN THE UPPER TRAPEZIUS MUSCLE AFTER A CERVICAL SPINE MANIPULATION IN PAIN-FREE SUBJECTS

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### ABSTRACT

**Objective:** This study analyzed the immediate effects on pressure pain threshold (PPT) in latent myofascial trigger points (MTrPs) in the upper trapezius muscle of a single cervical spine manipulation directed at the C3 through C4 level.

**Methods:** Seventy-two volunteers (27 men and 46 women; mean age, 31 years; SD, 10 years) participated in this study. Subjects underwent a screening process to establish both the presence of MTrPs in the upper trapezius muscle as described by Simons et al (Myofascial pain and dysfunction: the trigger point manual, vol 2. 3rd ed. Baltimore: Williams & Wilkins, 1999. p. 23-34) and the presence of intervertebral joint dysfunction at the C3 through C4 level by the lateral gliding test for the cervical spine. Subjects were divided randomly into 2 groups: manipulative group, which received a cervical spine manipulation directed at the C3 through C4 level, and a placebo group, which received a sham manual procedure. The outcome measure was the PPT on the MTrP in the upper trapezius muscle ipsilateral to the side of the joint dysfunction, which was assessed pretreatment and 1, 5, and 10 minutes posttreatment by an assessor blinded to the treatment allocation of the subject.

**Results:** The analysis of variance showed a significant effect for time ( $F = 5.157$ ;  $P = .02$ ) but not for side ( $F = 0.234$ ;  $P = .63$ ). Furthermore, an interaction between group and time was also found ( $F = 37.240$ ;  $P < .001$ ). The experimental group showed a trend toward an increase in PPT levels after the manipulative procedure, whereas the control group showed a trend toward a decrease in PPT. Positive within-group effect sizes ranging from medium to small were found in the manipulative group ( $0.1 < d < 0.5$ ), whereas negative within-group effect sizes ranging from large to medium were found in the placebo group ( $0.3 < d < 1$ ).

**Conclusions:** Our results suggest that a cervical spine manipulation directed at the C3 through C4 segment induced changes in pressure pain sensitivity in latent MTrPs in the upper trapezius muscle. Different therapeutic mechanisms, either segmental or central, may be involved at the same time. (*J Manipulative Physiol Ther* 2007;30:578-583)

**Key Indexing Terms:** *Pressure Pain Threshold; Trigger Points; Joint Dysfunction*

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Paper submitted May 24, 2007; in revised form July 8, 2007; accepted July 19, 2007.

0161-4754/\$32.00

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doi:10.1016/j.jmpt.2007.07.014

Myofascial trigger points (MTrPs) are claimed to be a common source of musculoskeletal pain in people presenting to manual therapists for treatment. Simons et al<sup>1</sup> defined MTrPs as hypersensitive tender spots associated with a taut band of a skeletal muscle that is painful on compression and on stretch and gives rise to a typical referred pain pattern. From a clinical viewpoint, active MTrPs cause pain and their local and referred pain is responsible for patient complaints. Latent MTrPs have similar clinical features (tender spot within a taut band, local twitch response) as active MTrPs, but they are not responsible for pain symptoms; however, they can elicit referred pain, not recognized by patients as their usual pain, with muscle contraction or mechanical stimulation of the

tissues.<sup>1</sup> An active MTrP is distinguished from a latent one when the referred pain elicited by exploration of the MTrP is recognized as familiar.<sup>1,2</sup> This clinical distinction has been substantiated by histochemical findings because higher levels of chemical mediators (ie, bradykinin, substance P, or serotonin) have been found in active MTrPs as compared with latent MTrPs or control points.<sup>3</sup>

Although the etiology of MTrPs is not completely known, recent studies have hypothesized that the pathogenesis of MTrPs results from injured or overloaded muscle fiber.<sup>4</sup> This could lead to endogenous and involuntary shortening, loss of oxygen supply, loss of nutrient supply, and increased metabolic demand on local tissues.<sup>5</sup> The most credible etiologic suggestion for trigger point pathogenesis is the integrated hypothesis, which proposes that abnormal depolarization of motor end plates and sustained muscle contraction give rise to a localized "ATP energy crisis" associated with sensory and autonomic reflex arcs sustained by central sensitization.<sup>5,6</sup> The integrated hypothesis is based on the 2 most widely accepted theories (energy crisis theory and motor end plate) and, when combined, provide a plausible explanation for MTrPs.<sup>7</sup> There is a third theory, yet to be experimentally verified, which suggests the primary pathologic site of MTrPs to be the spinal nerve, with secondary muscle changes occurring after.<sup>8</sup> Nevertheless, the more widely accepted theory is centered on the muscle cell and motor end plate as the primary pathologic sites.<sup>9</sup> However, these events have not been completely proven, and more research is needed.

A clinical relationship between MTrPs and joint impairments has been suggested by some authors.<sup>1,10</sup> Fernández-de-las-Peñas et al<sup>11</sup> found a relationship between the presence of MTrPs in the upper fibers of the trapezius muscle and the presence of cervical impairment (hypomobility considered when an abnormal end feel, an increased resistance, and a decreased joint gliding were found) at the C3 through C4 vertebrae. Several theories on muscle-joint interrelationship have been proposed. Perhaps the increased tension of the taut bands and facilitation of motor activity can maintain displacement stress on the joint such that a trigger point would provoke the joint dysfunction.<sup>12</sup> On the other hand, an abnormal sensory input from the joint dysfunction may reflexively activate the trigger point.<sup>13</sup>

It may be hypothesized that the treatment of an intervertebral joint dysfunction could provoke a therapeutic effect in MTrPs located in those muscles innervated by the same segment. In clinical practice, therapists use a therapy approach that includes different techniques directed at both muscle and joint impairments. No previous controlled studies have investigated changes on MTrP pain sensitivity after the application of a cervical spine manipulation. The aim of the present study was to analyze the immediate effects on pressure pain sensitivity in latent MTrPs in the upper trapezius muscle

of a single cervical spine manipulation directed at the C3 through C4 level.

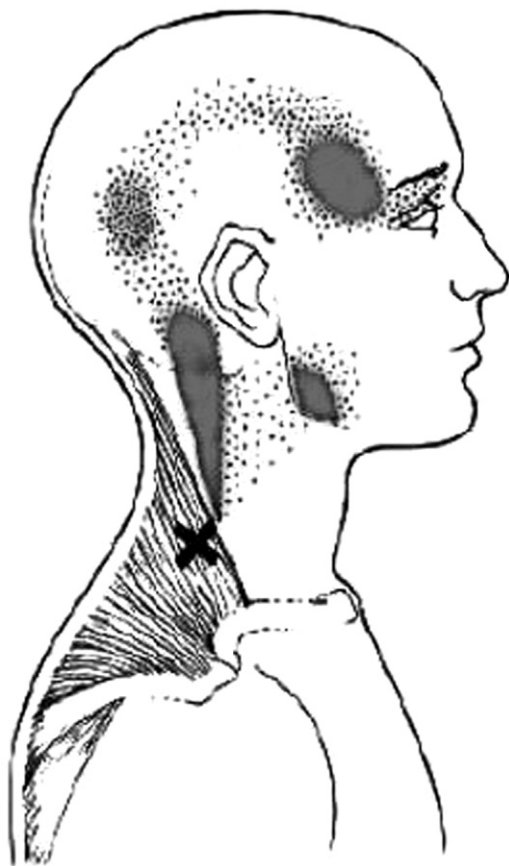
## METHODS

### Subjects

Seventy-two volunteers (27 men and 46 women) aged 19 to 45 years (mean,  $31 \pm 10$  years), recruited from a pain-free population by advertisement in the local press in Alicante, Spain, participated in this study. The sample size and power calculations were performed with a local software (Tamaño de la Muestra, 1.1, Madrid, Spain). The calculations were based on detecting a 20% difference in pressure pain threshold (PPT) at postintervention data, assuming an SD of 10%, an  $\alpha$  level of .05, and a desired power of 80%. These assumptions generated a sample size of at least 30 subjects per group. Inclusion requirements for subjects to be participants were (1) diagnosis of latent MTrPs in the upper trapezius muscle, either left or right side; and (2) clinical presentation of intervertebral joint dysfunction at the C3 through C4 level diagnosed by the lateral gliding test of the cervical spine,<sup>14</sup> ipsilateral to the MTrP.<sup>11</sup> Subjects underwent a screening process to establish the presence of latent MTrPs in the upper trapezius muscle with a therapist with more than 4 years of experience in MTrP diagnosis. The presence of latent MTrPs was determined using the diagnostic criteria described by Simons et al<sup>1</sup>: (1) presence of a palpable taut band in a skeletal muscle, (2) presence of a hypersensitive tender spot in the taut band, (3) local twitch response provoked by the snapping palpation of the taut band, and (4) reproduction of the typical referred pain pattern of the MTrP in response to compression (Fig 1). These criteria have good interexaminer reliability ( $\kappa$ ) ranging from 0.84 to 0.88.<sup>2</sup>

After MTrP examination, the same therapist examined participants to establish the presence of intervertebral joint dysfunction at C3 through C4.<sup>14</sup> The subject was supine with the cervical spine in a neutral position. The therapist placed the fingers over the zygapophyseal joints of a specific vertebra. The examining therapist laterally glided each vertebra from right to left and from left to right. Passive lateral gliding, end feel, and quality of resistance were assessed. Although it seems that this procedure is as valid as dynamic x-ray films, the intra- and interrater reliability of the test has not been investigated yet.<sup>14</sup> The details about intervertebral joint manual assessment can be found elsewhere.<sup>14</sup>

Subjects were excluded if they exhibited any of the following: (1) any contraindication to manipulation, (2) diagnosis of fibromyalgia syndrome according to the American College of Rheumatology,<sup>15</sup> (3) history of a whiplash injury, (4) history of any surgery in the cranio-cervical region, (5) history of chronic neck pain, (6) having undergone myofascial pain therapy in the cervical region within the past 3 months before the study, or (7) exhibiting a positive extension-rotation test.<sup>16</sup>



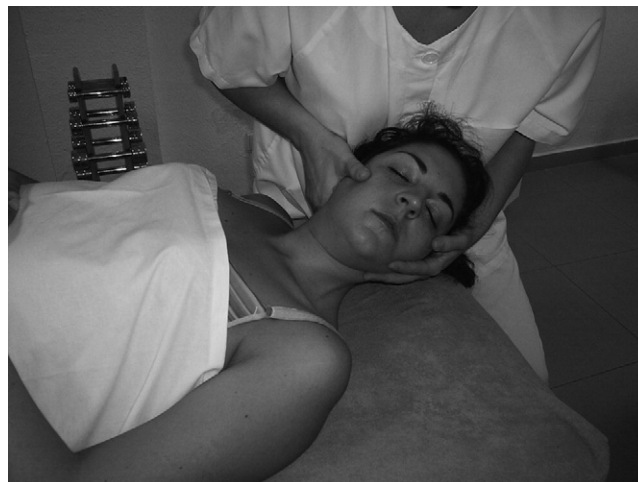
**Fig 1.** Referred pain from myofascial trigger points in the upper trapezius muscle. Reprinted with permission from Simons D, Travell J, Simons L. *Myofascial pain and dysfunction: the trigger point manual*, vol 2. 3rd ed. Baltimore: Williams & Wilkins, 1999.

This study was supervised by the Escuela de Osteopatía de Madrid (Spain). It was approved by the ethical committee in clinical research of the Escuela de Osteopatía de Madrid. All subjects signed the required consent before beginning the study.

### Interventions

Participants were divided randomly into 2 groups using a table of random numbers: manipulative group that received the high-velocity, low-amplitude (HVLA) thrust and a placebo group that received a sham manual procedure.

In the experimental group, a cervical manipulation directed at the C3 through C4 dysfunctional segment was applied by a therapist with a 6-year postgraduate background on spinal manipulative therapy (Escuela de Osteopatía de Madrid) and with more than 7 years of clinical experience in the management of spinal disorders. The manipulation was performed with the subject in the supine position (Fig 2). The index finger of the therapist applied contact over the posterior lateral aspect of the articular pillar at the dysfunctional side of the C3 vertebra (assessed by the lateral gliding test). The therapist's other hand cradled the subject's head. Gentle



**Fig 2.** Cervical spine manipulation directed at the C3 through C4 intervertebral joint segment.

ipsilateral side flexion and contralateral rotation were introduced from the restricted side until slight tension was palpated in the tissues at the contact point. A high-velocity, low-amplitude manipulation was directed medially in the direction of the subject's contralateral eye.<sup>17</sup> A cracking or popping sound accompanied all manipulations. If no popping sound was heard on the first attempt, the therapist repositioned the subject and performed a second manipulation. A maximum of 2 attempts were performed on each subject. The manipulative procedure was applied to either right or left side based on the location of both MTrPs and the joint impairment.

The control group received a sham manual procedure. The index finger of the therapist applied contact over the posterior lateral aspect of the articular pillar at the dysfunctional side of the C3 vertebra, whereas the other hand cradled the subject's head. Gentle ipsilateral side flexion and contralateral rotation were introduced until slight tension was palpated in the tissues at the contact point. That position was maintained for 30 seconds.

### Pressure Pain Threshold Assessment

Pressure pain threshold is defined as the minimal amount of pressure where a sense of pressure first changes to pain.<sup>18</sup> A mechanical pressure algometer (Pain Diagnosis and Treatment Inc, Great Neck, NY) was used in this study. This device consists of a round rubber disk (area, 1 cm<sup>2</sup>) attached to a pressure (force) gauge. The gauge displays values in kilograms. Because the surface of the rubber tip is 1 cm<sup>2</sup>, the readings are expressed in kilograms per square centimeter. The range of the algometer is 0 to 10 kg with 0.1-kg divisions. Previous articles have reported an intraexaminer reliability of this procedure from 0.6 to 0.97, whereas the interexaminer reliability ranges from 0.4 to 0.98.<sup>19,20</sup>

**Table 1.** Pressure pain threshold in the upper trapezius muscle during the study in both groups

	Placebo group	Manipulative group
Preintervention	1.34 ± 0.4	1.27 ± 0.5
Postintervention	1.27 ± 0.4	1.35 ± 0.5
5 min postintervention	1.15 ± 0.4	1.38 ± 0.5
10 min postintervention	1.1 ± 0.5	1.39 ± 0.5

Values are expressed as mean ± SD (kg/cm<sup>2</sup>).

Three consecutive measurements of PPT levels on the upper trapezius MTrP at intervals of 30 seconds were obtained by the same assessor (intrarater reliability) and the mean was considered in the analysis. The intraexaminer repeatability of our PPT readings was 0.94 (95% confidence interval, 0.93-0.98), suggesting high repeatability of the PPT data. Furthermore, the standard error of measurement was 0.08 kg/cm<sup>2</sup>.

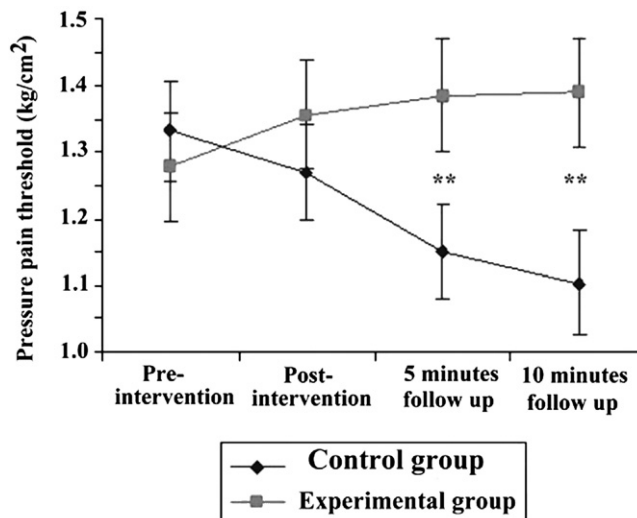
Pressure pain threshold levels were assessed pretreatment and 1, 5, and 10 minutes postintervention by a second investigator who was blinded to the experimental condition administered to the subject.

### Analysis of Data

Data were analyzed with the SPSS package version 13.0 (SPSS Inc, Chicago, Ill). Mean and SD of the values were calculated for each variable. A normal distribution of quantitative data was assessed by means of the Kolmogorov-Smirnov test ( $P > .05$ ). Baseline features were compared between groups using the independent  $t$  tests for continuous data and  $\chi^2$  tests of independence for categorical data. A 2-way analysis of variance for repeated measures with 2 within-subject factors (time and side) and 1 intergroup factor (manual intervention) was used to assess differences in PPT levels. The Student-Newman-Keuls test was used for post hoc comparison. Within-group effect sizes were calculated using Cohen's  $d$  coefficient.<sup>21</sup> An effect size greater than 0.8 was considered large; around 0.5, moderate; and less than 0.2, small.<sup>21</sup> The statistical analysis was conducted at a 95% confidence level. A  $P$  value of less than .05 was considered as statistically significant.

### RESULTS

Thirty-six subjects were in each group. The intervention group had 14 men and 22 women, ages 19 to 44 (mean, 31 ± 7 years) and the placebo group had 12 men and 24 women, ages 20 to 45 (mean, 32 ± 11 years). No significant differences were found for sex ( $P = .5$ ), age ( $P = .5$ ), or baseline PPTs ( $P = .6$ ) between groups. Twenty-nine subjects (82%) of the placebo group and 32 (91%) of the experimental group showed both joint and muscle disorders on the right side, whereas the remaining subjects showed both disorders on the left side ( $P > .5$ ). No adverse effects were reported by any participant after the manipulative procedure.



**Fig 3.** Pressure pain threshold levels in latent trigger points in the upper trapezius muscle in either group. \*\*\*Statistically significant effect for time ( $F = 5.157$ ;  $P = .02$ ) and for group × time ( $F = 37.240$ ;  $P < .001$ ).

The analysis of variance showed a significant effect for time ( $F = 5.157$ ;  $P = .02$ ) but not for side ( $F = 0.234$ ;  $P = .63$ ). Furthermore, an interaction between group and time was also found ( $F = 37.240$ ;  $P < .001$ ). The experimental group showed a trend toward an increase in PPT levels after the manipulative procedure, whereas the control group showed a trend toward a decrease in PPT. Table 1 and Figure 3 summarize PPT levels on MTrP in the upper trapezius muscle in both groups at each time of the assessment.

Positive within-group effect sizes ranging from medium to small were found in the manipulative group ( $0.1 < d < 0.5$ ), whereas negative within-group effect sizes ranging from large to medium were found in the placebo group ( $0.3 < d < 1$ ). Table 2 summarizes within-group changes and within-group effect sizes at each assessment during the study in both groups.

### DISCUSSION

Our study is the first to analyze changes on PPT levels in latent MTrPs in the upper trapezius muscle after a cervical thrust manipulation.<sup>22</sup> We found that the application a single cervical spine manipulation directed at the C3 through C4 segment evoked changes in pressure pain sensitivity in latent MTrPs in the upper trapezius muscle. Subjects who received the manipulative intervention showed a trend toward an increase in PPT vs those subjects receiving a sham manual procedure who showed a trend toward a decrease in PPT levels (Fig 3). One possible explanation for the decreased PPT levels found in our control group could be a peripheral sensitization of muscle nociceptors stimulated by the repeated measures over the same point.

**Table 2.** Within-group changes and within-group effect sizes at each assessment on both study groups

	Placebo group	Manipulative group
Pre-post intervention	-0.06 (-0.17) kg/cm <sup>2</sup> ; <i>d</i> = 0.35	0.08 (0.2) kg/cm <sup>2</sup> ; <i>d</i> = 0.4
Pre-5 min postintervention	-0.2 (-0.18) kg/cm <sup>2</sup> ; <i>d</i> = 1.1	0.1 (0.2) kg/cm <sup>2</sup> ; <i>d</i> = 0.5
Pre-10 min postintervention	-0.22 (-0.2) kg/cm <sup>2</sup> ; <i>d</i> = 1.1	0.12 (0.27) kg/cm <sup>2</sup> ; <i>d</i> = 0.44
Post-5 min postintervention	-0.13 (-0.14) kg/cm <sup>2</sup> ; <i>d</i> = 1	0.02 (0.23) kg/cm <sup>2</sup> ; <i>d</i> = 0.08
Post-10 min postintervention	-0.15 (-0.15) kg/cm <sup>2</sup> ; <i>d</i> = 1	0.04 (0.3) kg/cm <sup>2</sup> ; <i>d</i> = 0.12
5 min postintervention-10 min postintervention	-0.05 (-0.15) kg/cm <sup>2</sup> ; <i>d</i> = 0.34	0.01 (0.1) kg/cm <sup>2</sup> ; <i>d</i> = 0.1

Values are expressed as mean (SD); effect sizes (*d*). Within-group effect sizes were positive, that is, toward an increase in PPT, in the manipulative group; but negative, that is, toward a decreased in PPT, in the placebo group.

Our results are similar to those reported by Vernon et al<sup>23</sup> who demonstrated that cervical manipulation produces significantly greater increases in PPT of tender points (which do not elicit referred pain) surrounding a cervical dysfunction. The neurophysiologic mechanisms by which spinal manipulative therapy may evoke changes in pressure pain sensitivity in MTrPs remain to be fully elucidated. Both peripheral, for example, reduction of chemical algogenic mediators<sup>24</sup> or activation of segmental inhibitory pathways,<sup>25</sup> and central descending inhibitory pathway activation<sup>26</sup> mechanisms have been suggested. For example, one possible segmental mechanism could be that the manipulation may induce a reflex muscle relaxation by modifying proprioceptive group 1 and 2 afferents.<sup>27</sup> Because the upper trapezius muscle receives nerve innervation from the C2 through C4 level, it may be possible that the stimulus induced by the manipulative procedure of this segment could have some effect on upper trapezius MTrP sensitivity. Furthermore, it seems that the spinal manual procedures can activate the periaqueductal gray substance resulting in central hypoalgesic effects.<sup>28,29</sup> Probably, more than one mechanism explains the effects of spinal manipulation on mechanical pain sensitivity.<sup>30</sup>

It has been suggested that cervical joint dysfunctions could be a perpetuating factor for MTrPs located in those muscles innervated by this spinal segment.<sup>11</sup> It has been found that intervertebral joint dysfunction could increase the responsiveness of motor neurons of adjacent MTrPs.<sup>31</sup> It seems that there is a remarkable neurophysiologic analogy between the nervous system effects produced by intervertebral joint dysfunctions and MTrPs.<sup>11</sup> Our findings are clinically relevant because they suggest that it would be reasonable to suspect at least a self-perpetuating relationship between MTrPs and cervical joint dysfunctions<sup>11</sup> because a manipulative procedure evoked changes on pressure pain sensitivity in MTrPs that receive innervation from the manipulated segment. However, the ideal order in which these musculoskeletal disorders should be best treated is not known, and it will require randomized controlled trials assessing the effectiveness of the different manual therapy procedures.

Our study has several limitations. First, this study only examined the immediate effect of the cervical spine manipulation. A trend toward an increase in PPT occurred after spinal manipulation provides impetus for future research in this area. Further studies are needed to examine

long-term effects of cervical manipulation on MTrPs. Second, the participants in this study were pain-free and may not be typical of the population presenting to manual therapists for treatment. It is probable that the clinical effect of cervical manipulation would be greater in active MTrPs, for example, neck pain<sup>32</sup> or tension-type headache.<sup>33</sup> Finally, joint cavitation bias can also have occurred because subjects in the experimental group were not “blinded” to the existence of joint cavitation. It is possible that joint cavitation can create an expectative or a placebo effect on patients. However, this situation is so difficult, if not impossible, to control in a spinal manipulation study. Finally, Ylinen et al<sup>34</sup> have recently suggested that although the repeatability of PPT assessment allows algometry to be used for research purposes, because considerable variations exist on an individual level, caution is advised when interpreting the results in clinical practice.<sup>34</sup>

## CONCLUSIONS

The application of a cervical spine manipulation directed at the C3 through C4 segment induces changes in pressure pain sensitivity in latent MTrPs in the upper trapezius muscle. Subjects who received the manipulative intervention showed a trend toward an increased in PPT vs those subjects receiving a sham manual procedure who showed a trend toward a decrease in PPT. Different therapeutic mechanisms, either segmental or central, may be involved at the same time.

### Practical Applications

- The application of a cervical spine manipulation directed at the C3 through C4 segment evokes changes in pressure pain sensitivity in latent MTrPs in the upper trapezius muscle in the pain-free subjects in this study.
- Different therapeutic mechanisms, either segmental or central, may be involved at the same time.
- Cervical joint dysfunctions could be a perpetuating factor for MTrPs located in those muscles innervated by this spinal segment.

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