Original Research

A Systematic Comparison Between Subjects With No Pain and Pain Associated With Active Myofascial Trigger Points

Lynn H. Gerber, MD, Siddhartha Sikdar, PhD, Katee Armstrong, DPT, Guoqing Diao, PhD, Juliana Heimur, BA, John Kopecky, PhD, Diego Turo, PhD, Paul Otto, MS, Tadesse Gebreab, BS, Jay Shah, MD

Objective: To determine whether standard evaluations of pain distinguish subjects with no pain from those with myofascial pain syndromes (MPS) and active myofascial trigger points (MTrPs) and to assess whether self-reports of mood, function, and health-related quality of life differ between these groups.

Design: A prospective, descriptive study.

Setting: University.

Patients: Adults with and without neck pain.

Methods: We evaluated adults with MPS and active (painful) MTrPs and those without pain. Subjects in the "active" (A) group had at least one active MTrP with spontaneous pain that was persistent, lasted longer than 3 months, and had characteristic pain on palpation. Subjects in the "no pain" (NP) group had no spontaneous pain. However, some of these subjects had discomfort upon MTrP palpation (latent MTrP), whereas others in the NP group had no discomfort upon palpation of nodules or had no nodules.

Outcome Measures: Each participant underwent range of motion measurement, a 10-point manual muscle test, and manual and algometric palpation. The latter determined the pain/pressure threshold using an algometer of 4 predetermined anatomic sites along the upper trapezius. Participants rated pain using a verbal analog scale (0-10) and completed the Brief Pain Inventory and Oswestry Disability Scale (which included a sleep subscale), the Short -Form 36 Health Survey, and the Profile of Mood States.

Results: The A group included 24 subjects (mean age 36 years; 16 women), and the NP group included 26 subjects (mean age 26 years; 12 women). Group A subjects differed from NP subjects in the number of latent MTrPs ($P = .0062$), asymmetrical cervical range of motion ($P = .01$ for side bending and $P = .002$ for rotation), and in all pain reports ($P < .0001$), algometry ($P < .03$), Profile of Mood States ($P < .038$), Short Form 36 Health Survey ($P < .01$), and Oswestry Disability Scale ($P < .0001$).

Conclusion: A systematic musculoskeletal evaluation of people with MPS reliably distinguishes them from subjects with no pain. The 2 groups are significantly different in their physical findings and self-reports of pain, sleep disturbance, disability, health status, and mood. These findings support the view that a "local" pain syndrome has significant associations with mood, health-related quality of life, and function.

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INTRODUCTION

Soft tissue pain syndromes are prevalent in our population. It is reported that 15% of routine medical clinic visits are the result of soft tissue pain [22]. The prevalence is considerably greater in pain clinics [7] and is estimated to account for 85% of these visits. Direct medical costs for non—cancer-related back pain in the United States were estimated at $90.7 billion in 1998. Lost productivity is also high. Neck pain accounts for less than 33% of all back pain [8,10,25]. What emerges from these studies is that axial pain is expensive and has a great impact on function and disability [13].

L.H.G. Center for the Study of Chronic Illness and Disability, College of Health and Human Services, George Mason University, 4400 University Dr, Fairfax, VA 22030. Address correspondence to: L.H.G.; e-mail: ngerber1@gmu.edu
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S.S. Departments of Electrical and Computer Engineering and Bioengineering, Volgenau School of Engineering, George Mason University, Fairfax, VA
Disclosure: nothing to disclose

K.A. Center for the Study of Chronic Illness and Disability, College of Health and Human Services, George Mason University, Fairfax, VA
Disclosure: nothing to disclose

G.D. Department of Statistics, Volgenau School of Engineering, George Mason University, Fairfax, VA
Disclosure: nothing to disclose

J.H. Department of Rehabilitation Medicine, Clinical Center, National Institutes of Health, Bethesda, MD
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Author information continued on page 8.

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The impact of myofascial pain on a person's life activity is poorly understood, in part because no agreed-upon definition of myofascial pain syndromes (MPS) or definitive diagnostic criteria exist. In addition, treatment response in persons with pain syndromes relies on the use of patient-reported outcomes that use descriptors of the pain, its frequency, and its intensity. These measures are valid, but because of their sensitivity to change and the variation of interpretation by individual patients, quantitation is difficult.

Much has been written about MPS and the myofascial trigger point (MTrP) [2,5,7], but mechanisms generating and perpetuating pain have not yet been fully understood [9,14,23]. Our group has identified a biochemical profile associated with MPS, in particular with active versus latent MTrPs [21]. These findings have been correlated with the classification of MTrPs (active, latent, or none) but not with the clinical picture of the MPS, which includes physical findings of cervical and upper extremity range of motion (ROM), strength, and overall soft tissue palpation.

Our clinical research team is engaged in a controlled clinical trial with the aim of assessing the pathophysiology of the MTrP. This report presents the systematic approach we use to evaluate people with active MTrPs. For the purposes of this study, we recruited subjects who have had persistent cervical pain for more than 3 months and other subjects who have had no spontaneous pain. On the basis of history and physical examination, subjects in the group with pain were determined to have at least one active MTrP in the upper trapezius muscle as a contributor to their spontaneous pain complaint. We adopted the classic definition of active and latent MTrPs [24]. The former is a palpable, discrete nodule within a taut band of skeletal muscle that is spontaneously painful, and its palpation reproduces the typical pain. The pain may radiate, but it need not radiate to be considered active. A latent MTrP is a nodule with the same physical characteristics as an active one, but it requires palpation to elicit pain. Some nodules are not tender to palpation.

We devised a systematic approach to describe the physical findings in subjects who identified spontaneous pain in the upper trapezius or neck region and in subjects with no pain, permitting us to compare persons with and without MPS and active MTrPs. The aim is to develop a standardized approach to assess MPS with the use of objective and self-report data. This article presents the results of our application of the systematic approach.

METHODS

The study was approved by the Chesapeake Institutional Review Board. To recruit subjects, flyers were posted on the campus of George Mason University in Fairfax, Virginia. Participants were almost exclusively faculty, students, and staff of the University. The study subjects were classified as either "active" or "no pain." Those in the "active" (A) group underwent a standard physical examination and ultrasound imaging evaluation plus the prescribed 3 consecutive weekly treatments of dry needling into the most active MTrP (ie, the MTrP that, upon palpation, reproduced and/or exacerbated the subjects' spontaneous pain complaint; if more than one MTrP was active, the most symptomatic was selected). Only one MTrP was treated. Subjects in the "no pain" (NP) group were control research subjects and underwent a physical examination and ultrasound imaging evaluation only.

Subjects were entered into the A group if they had neck pain (in the upper trapezius) for longer than 3 months' duration and their pain was present without provocation. In addition, on physical examination the subject had to have a palpable nodule in the upper trapezius, the palpation of which reproduced or exacerbated the spontaneous pain symptoms. Radicular pain upon MTrP palpation to other regions of the head and neck was acceptable but was not required for acceptance into the A group. Subjects in the NP group did not have neck or low back pain. However, they could have nontender palpable nodules or nodules that were tender to palpation., which are classified as latent MTrPs. The definition of a latent MTrP is a tender palpable nodule dependent upon palpation to produce local and/or referred pain. Our MTrP classification scheme is presented in Figure 1.

Exclusions for study entry included the presence of chronic fatigue syndrome, Lyme disease, other chronic pain conditions, recent medication change, and nonpharmacological interventions such as the use of acupuncture and chiropractic treatment. These criteria are presented in Table 1.

Evaluations for all subjects included a thorough musculoskeletal history and physical examination of the neck and shoulder girdle, as well as any treatment history. The medical history also included questions about medications, supplements, the nature of the subject's work (occupation), leisure activity, and whether the subjects participated in routine physical therapies and regular exercise. An assessment of pain was determined by asking the subject to rate the current level of pain in the neck/trapezius region on both sides, as well as a recalled average level of pain during the past week. Pain was verbally rated from 0 (none) to 10 (worst possible) using a visual analog scale (VAS).

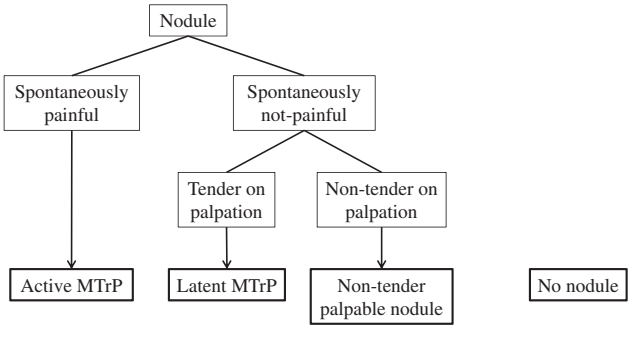


Figure 1. Classification of nodules assessed by palpation.

Table 1. *Inclusion and exclusion criteria and standard assessments*

Inclusion criteria
Adults 18-65 y
Active group must have neck/upper trapezius pain for 3 months or longer and a palpable nodule that, when palpated, produces pain that is characteristic of the pain they identify
Control group must have a normal physical examination and no active trigger points
Exclusion criteria
Fibromyalgia or other pain syndromes
Cervical or lumbar radiculopathy
Atypical facial neuralgia
History of head, neck, cervical spine, or shoulder surgery
Recently prescribed pain medication (within the past 6 weeks)
Current throat or ear infection
Assessments
Palpation of neck and upper trapezius
Relevant medical history
Kendall 10-point Manual Muscle Test: cervical and shoulder muscles
CROM measure neck ROM
Algometry: 4 upper trapezius sites (see Table 2)
Standardized self-reports: Visual Analog Scale for Pain, Short Form 36 Health Survey, Profile of Mood States, Oswestry Disability Index, and Brief Pain Inventory

CROM = cervical range of motion; ROM = range of motion.

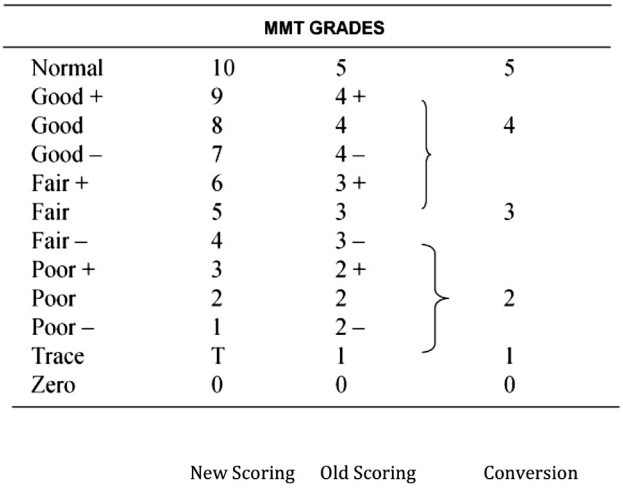


Figure 2. Kendall 10-point manual muscle test.

The physical examination included manual palpation of the cervical spine, neck extensor muscles, and trapezius. An effort was made to assess whether the tissue was homogeneous based on surface palpation along the upper trapezius (Table 2, picture). Measures of active ROM and manual muscle testing of the cervical spine and shoulders with use of the Kendall 10-point scale were performed with subjects in the seated position (Figure 2) [12]. Cervical ROM was measured with a cervical ROM device, Deluxe Cervical Range of Motion Instrument, Model #12-1156 (Fabrication Enterprises, White Plains, NY) [28]. The subjects were told to sit erect in a straight-backed chair to prevent substitution movements from the thoracic and lumbar spine. They were instructed to keep their arms by their sides and to position their feet flat on the floor. Cervical ROM was then measured in the sagittal, frontal, and rotational planes. Normal cervical ROM was determined with the use of standards provided by the *Sixth American Medical Association Guide to Permanent Impairment* [19]. Assessment of the symmetry of soft tissue by visual inspection was performed. Subjects were identified as having symmetric or asymmetric cervical ROM in the rotational and frontal planes. Asymmetry was defined as a 10% or greater difference between the 3 planar movements to the left when compared with the right.

Two sites for evaluation are identified on the left and right sides of the upper trapezius (for a total of 4 sites). These sites are 2 cm medial to the acromioclavicular joint and along the medial border of the upper trapezius as it moves cephalad from the shoulder girdle (Table 2). A measure of pain pressure threshold was obtained at the 4 sites with a pressure algometer (Commander Algometer, JTech Medical, Salt Lake City, UT). Subjects were instructed to identify when the algometer was inducing pain rather than pressure. The pressure in pounds was recorded for each site.

Each participant completed 4 questionnaires: the Brief Pain Inventory (BPI) [3]; the Oswestry Disability Scale, a measure of disability related to the spine and adjacent musculoskeletal system that includes subscales for musculoskeletal pain, sleep disturbance, and functional activities related to the musculoskeletal system [4]; the Medical Outcomes Study Short -Form 36 Health Survey, a health status questionnaire [26]; and the short version of the Profile of Mood States, a symptom checklist of moods [20].

We devised a series of questions, which were administered to all subjects, to help standardize the evaluation and characterize the nature of the pain in the neck/upper trapezius. These questions consisted of descriptive terms and were aimed at trying to characterize the pain the individual was experiencing. This assessment is presented in Table 2.

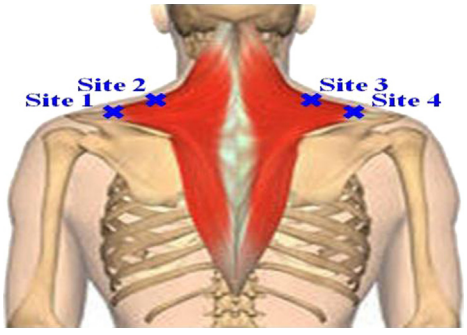
DATA ANALYSIS

We conducted 2-sample comparisons of variables of interest between the A group and the NP group. For all continuous variables, we first evaluated the normality assumption by using the Shapiro-Wilk test. If we failed to reject the null hypothesis of normality in both groups for a variable, a 2-sample *t*-test was used to compare the mean value of the variable; otherwise, a Wilcoxon rank sum test was performed. For binary variables, we used the Fisher exact test to assess whether a significant difference existed between group proportions. The Pearson χ^2 test for homogeneity and the Mantel-Haenszel χ^2 test for trend were used for nominal and ordinal categorical variables, respectively. For each variable of interest, subjects with missing data were excluded from

Table 2. *Physical examination data form*

1. Subject identification number: _____
2. Do you have neck pain? Yes No Side: _____
3. On a scale of 1–10, rate your current pain on the Left Side___ and on the Right Side___
4. On which side is the pain? Left Right Both
5. Is the pain local or widespread? _____
6. How long have you experienced neck pain? _____
7. How long has this particular episode lasted? _____
8. Does the pain occur intermittently or for extended periods? _____
9. Does it occur for most of the day? Yes No
10. Is the pain worse at a particular time of day? (eg, morning, evening, or night) _____
11. What alleviates pain?
    a. Exercise (eg, stretching)
    b. Therapeutic modalities (eg, heat, ultrasound, and massage)
    c. Medication (eg, anti-inflammatory, analgesic, and muscle relaxer)
12. What aggravates the pain? _____
13. Describe the nature of the pain: for example, sharp, dull, shooting, stabbing, tight, or aching
14. Do you experience any numbness or tingling? Yes No Location: _____

On the picture below, please mark the areas where you feel pain.



the data analysis. All tests are 2-sided, and a P value $<.05$ was considered statistically significant. All data analyses were conducted with SAS software, version 9.3 (SAS Institute, Cary, NC).

RESULTS

In this analysis, we report the results of 24 subjects who met the criteria for active MTrPs (A group) and 26 who were placed into the control group because they had no spontaneous pain in the upper trapezius, even in the presence of a palpable nodule (NP group). Members of the NP group had no active MTrPs in the upper trapezius. However, various physical findings were observed within the group, including latent MTrPs, nontender nodules, and no palpable nodules. Seventeen of the 24 subjects in the A group described their pain as "aching/dull," 10 described their pain as "nagging," and 9 described their pain as "tender." Most of the A group subjects indicated that the pain increased in intensity as the day wore on. The pain intensity was partially influenced by the type of activity in which they were engaged. Eighteen of the 24 A group subjects reported that computer work aggravated their neck pain, and 14 reported that the pain was aggravated by prolonged sitting. Fifteen of the 24 subjects in the A group reported that lifting weights worsened their neck pain. Twenty of the 26 subjects in the NP group and 18 of 24 in the A group reported having a sedentary job. In addition, 19 of the 24 A group subjects reported that their sleep is occasionally disturbed by pain. Concordance was found between the hand of dominance and the side of neck pain in 7 of 10 subjects with unilateral neck pain in A group subjects. Fourteen of 24 A group subjects presented with bilateral neck pain at the initial evaluation.

Members of the A group used analgesic medication more frequently than did the NP group (63% versus 7%, respectively). They also used mood regulators more frequently (25% versus 0%). Members of both groups used dietary supplements frequently (45% versus 34%). A distribution of descriptive (categorical) variables of interest in the A group is presented in Table 3.

Table 3. *Descriptive features of pain in subjects with active myofascial trigger points*

Variable	Frequency
Duration of pain	
Intermittent	7
Extended	15
Temporal occurrence of pain	
Morning	5
Afternoon	0
Evening	9
Night	3
Other	4
Pain influences activity	
Yes or somewhat	14
No	6
Nature of pain	
Local	16
Widespread	6
Other	2
Sleep difficulties (Oswestry Disability Index)	
0 (none)	4
1 (some)	18
2 (frequent)	1
Pain disrupts sleep	
1 (yes)	14
2 (no)	8
Trigger point location	
Both sides	14
Left side	2
Right side	6
Duration of pain	
3-11 mo	3
1-2 y	4
≥3 y	15
Exercise frequency	
≥3×/wk	15
<3×/wk	7

The distribution of nodules in all subjects was assessed. A greater percentage of subjects had one latent MTrP in the A group compared with the NP group ($P = .0062$), and a greater percentage of subjects had 4 normal sites in the NP group compared with the A group ($P < .001$). By definition, no one in the NP group had an active MTrP. Table 4 presents MTrP types in the A group compared with those in the NP group. The sites were classified (1, active MTrPs; 2, latent MTrPs; 3, palpable but asymptomatic nodules on compression; and 4, normal sites) with their frequencies at 4 possible site distributions.

We also examined cervical and shoulder ROM and strength in both groups. We measured the cervical strength of subjects in the A and NP groups with use of the 10-point Kendall scale. We tested cervical flexion, extension, side bending, and rotation. At the initial evaluation, 10 of the 24 subjects in A group presented with cervical strength limitations compared with none of the 26 subjects in the NP group. Comparison of side bending or rotation of the neck in the A group who had one MTrP versus more than one MTrP demonstrated no significant difference when we used the Wilcoxon rank sum test ($P = .6$). However, when comparing the asymmetry between left and right sides for side bending and rotation, we found that members of the A group and NP group were significantly different for side bending ($P = .01$) and rotation ($P = .002$). Additional comparisons between the 2 study groups include an analysis of continuous variables (Table 5).

DISCUSSION

Significant efforts have been made to better understand MPS and the role of MTrPs in its pathogenesis. Progress has been made in understanding the dynamic roles of peripheral and central sensitization [14,21,23,24] in the unique neurobiology of muscle pain [15]. Such information is essential for identifying the pathogenesis of MPS and its relationship to the MTrP and for developing effective treatments for active MTrPs. Research in this area is ongoing.

Table 4. *Distribution of the number of sites with latent trigger points and the number of normal sites*

Group	No. of sites					
	0	1	2	3	4	Total
Sites with latent trigger points*						
Active group	10	9	4	1		24
No pain group	20	1	4	0		25
Total	30	10	8	1		49
Frequency missing = 1						
Normal sites†						
Active group	1	7	14	2	0	24
No pain group	0	0	4	1	20	25
Total	1	7	18	3	20	29
Frequency missing = 1						

*A greater percentage of subjects in the active group have one latent site compared with the no pain group ($P = .0062$).

†A greater percentage of subjects have 4 normal sites in the no pain group compared with the active group ($P < .0001$).

However, research on pathogenesis does not address the important components of how to classify clinical syndromes and findings, evaluate patients, and assess outcomes after treatment. One obstacle to developing a comprehensive approach to MPS, and the subject of this report, is the need for a standard approach to the clinical examination. Most clinicians and investigators have accepted the definition of active and latent MTrPs [24]. Agreement about what constitutes this pain syndrome and whether it is attributable to or the result of the MTrP has not been resolved.

This report presents data gathered from 2 groups of research subjects, one with and the other without active MTrPs. The outcome sought was to identify pain measures that were both sensitive and specific to distinguish the 2 study groups with respect to pain and to identify clinical change over time. In addition, a variety of measures were selected to further characterize symptoms, physical findings, and function in subjects with active MTrPs (ie, spontaneous pain), as well as to determine whether they reliably distinguish the 2 groups. To the best of our knowledge, no standard evaluations have yet been shown to reliably distinguish the various differences between the two study groups, although significant effort and some progress have been made [8,17].

We standardized the physical examination by identifying 2 sites along each upper trapezius (total of 4 sites). One at its origin in the region of the acromioclavicular joint and the other at the base of the neck, on each side. Years of clinical experience have shown that the former site infrequently has active MTrPs and the latter site frequently has active MTrPs. These observations enable us to compare structurally different parts of the muscle. We excluded the vertical portion of the muscle because assessment of the contribution of the splenii and cervical structures would be difficult.

What factors should be included in a standard evaluation of people with MPS? Clinical practice necessitates judicious and efficient use of the time of the patient and the health professional in the evaluation process. Because most patients seek relief of their pain and return to or maintenance of their usual function, both concerns should be assessed. Measurements should be brief, specific, and sensitive. We present the results of a systematic prospective assessment used as part of a research project; hence it is lengthy and addresses impairments, performance, and mood/perception of MPS. This assessment reliably distinguishes subjects with active MTrPs from subjects without pain.

Data gathered on the 50 subjects reported here show that the 2 groups are different in physical findings, pain measures, sleep disturbance, disability, health status, and mood. What is typically thought of and reported as a "local" pain problem primarily involving the shoulder girdle is associated with more general symptoms and disability. It is always possible that additional physical/physiological factors contribute to

Table 5. *Pain measures, self-reports, health status, function, and mood*

Variable	Active, Mean (SD)	No Pain, Mean (SD)	*P* Value
Pain measures			
Age	35.79 (12.96)	25.62 (7.75)	.0015*
VAS Current Pain Score, right	2.091 (1.900)	0 (0)	<.0001†
VAS Current Pain Score, left	1.545 (1.625)	0 (0)	<.0001†
VAS Average Pain Score, right	3.363 (1.891)	0.115 (0.588)	<.0001†
VAS Average Pain Score, left	2.455 (1.945)	0.077 (0.392)	<.0001†
BPI score	3.326 (1.695)	0.702 (1.134)	<.0001†
BPI P! Interference Sleep Score	2.522 (2.874)	0.385 (1.235)	<.0001†
PPT Score Site 1	10.06 (2.79)	13.52 (3.90)	.0013*
PPT Score Site 2	9.09 (3.15)	11.62 (4.33)	.0296‡
PPT Score Site 3	8.29 (2.77)	11.76 (4.69)	.0038*
PPT Score Site 4	10.38 (3.58)	13.28 (4.24)	.0180*
Self-reports, health status, function, and mood			
SF-36, Bodily Pain Score	58.76 (20.20)	96.10 (10.40)	<.0001†
SF-36, General Health Score	67.24 (19.14)	86.38 (11.82)	.0016*
SF-36, Mental Health Score	71.47 (17.75)	85.00 (7.42)	.0044*
SF-36, Physical Function Score	85.00 (17.59)	99.05 (3.01)	.0001†
SF-36, Emotional Score	77.94 (27.47)	96.43 (7.71)	.0108‡
SF-36, Physical Score	77.20 (19.64)	99.70 (1.36)	<.0001†
SF-36, Social Functioning Score	79. 41 (25.36)	97.02 (7.81)	.0064*
SF-36, Vitality Score	47.43 (16.40)	71.73 (13.92)	<.0001†
POMS Anger Score	0.087 (0.191)	0.131 (0.450)	.2006
POMS Confusion Score	0.452 (0.483)	0.176 (0.323)	.0167‡
POMS Depression Score	0.185 (0.388)	0.065 (0.229)	.0382‡
POMS Fatigue Score	0.922 (0.962)	0.272 (0.404)	.0075*
POMS Tension Score	0.457 (0.498)	0.227 (0.438)	.0104‡
POMS Total Mood Disturbance Score	0.660 (2.257)	−1.082 (1.787)	.0024‡
Oswestry Score	12.22 (6.54)	1.667 (4.072)	<.0001†

VAS = Visual Analog Scale; BPI = Brief Pain Inventory; PPT = Pain Pressure Threshold (algometry)—sites correspond to anatomic areas across the upper trapezius; SF-36 = Short Form 36, a health-related quality-of-life measure; POMS = Profile of Mood States; Oswestry = the Oswestry Disability Scale.
*$P \leq .01$.
†$P \leq .001$.
‡$P < .05$.

this pain, as well. Nonetheless, the data we report support a recommendation that evaluations of people with MPS should include measures of pain, function, health status and mood because they provide valuable clinical information and should be used to demonstrate improvement in symptoms and functional status following treatment.

Self-reports of pain are essential for identifying the origin and type of pain a person experiences. Many questionnaires exist, and specific ones seem to be chosen for individual diseases and syndromes. Consensus has not yet been achieved for a universal pain assessment. However, substantial progress has been made in identifying common elements through the use of item reduction and other computer-assisted technologies, and many investigators believe that a single-dimensional instrument is inadequate for the assessment of pain (www.nihpromis.org). In this study, we measured pain using the VAS and BPI and tenderness using algometry. We used standard questions to describe the nature of pain. All 3 measures were able to distinguish the A group from NP group. The language the A group used to describe their pain is different from the way many persons describe neuropathic pain.

The descriptors we selected may help differentiate MPS/MTrP pain from other types of pain, but this differentiation has yet to be proven. Nonetheless, the quality of the pain, its location, and its temporal pattern (Table 3), in addition to the physical findings, may help differentiate it from neuropathic pain. Careful assessment of the upper trapezius using palpation for MTrPs and neck ROM, especially side bending, provides specific outcome measures to target, because they are significantly different when comparing subjects with and without pain. We selected a 10% difference in ROM laterality as a way of identifying asymmetry, which was an arbitrary decision and based on convenience. However, the data were also analyzed using a Spearman rank sum order of degrees of movement.

Describing pain quality, location, and temporal features (qualitative and quantitative characteristics) is also valuable because it informs the clinician of a patient's pain status. It is our hope that this combination of findings will have a high degree of sensitivity and specificity for this pain syndrome.

Published work suggests that female sewing machine operators are more likely to have shoulder/neck symptoms if they have little social support. Length of employment and ergonomics are risk factors [11]. These observations support the view that shoulder and neck problems are not likely to be confined to a single, localized symptom and have associations with global activity and participation in a variety of life

activities. This study supports these findings because the Oswestry Disability Scale data suggest that significant disability is associated with active MTrPs. Our findings similarly suggest that the active MTrP, although a specific physical finding, is associated with overall health status. Evaluations should assess the associations among a person's daily routines and his or her mood and health status. Treatments should target the findings that are abnormal, including those obtained from self-reports and physical findings.

This study has several weaknesses. The investigators were not naïve to which subjects had pain. However, we were able to mitigate this factor by using two independent examiners who are experienced clinicians and have good interrater reliability. In addition, the study used 3 pain measures, the VAS, BPI, and algometry. Each showed significant discrimination between the 2 groups.

We purposely accepted subjects who had chronic MPS into the A group to provide us with a steady baseline. However, the natural history of this syndrome is poorly understood, and we therefore have few data about how universal the signs, symptoms, and self-reports would be in people with acute MPS (<3 months' duration of symptoms). The importance of measures of disability, mood, and abnormalities of ROM may be present only in people who have had protracted symptoms.

Another weakness of this study is that we recruited subjects by advertising on a college campus. Almost all of our subjects are students and staff at the University, and therefore the population may be atypical. The mean age of the NP group and A group are 10 years apart, and the mean age of subjects in both groups is well below 40 years, which is quite a young population. Age may be an important, confounding variable. Some of the data collected show that the groups are significantly different with respect to scores on several subscales of the POMS (depression, confusion, fatigue, and tension), health status measures, and some physical findings (pain pressure threshold and cervical side bending). Intergroup differences were found on the health status measure (Short Form 36), but both groups' scores are above the mean of the U.S. population, suggesting that their health status was normal or better than that of the general population. Nonetheless, the scores on the questionnaires from the NP group were significantly different from those of the group with active MTrPs.

Clinical research is likely to inform practice and improve desired treatment outcomes when we are able to correctly classify different clinical conditions. This study shows some heterogeneity in the physical findings among members of the NP group. Members of the NP group qualify if they have no spontaneous pain and any of the following upon palpation: no nodule, a nontender nodule, or a latent MTrP. Analysis of the subjects in the NP group was not performed with these subsets in mind. Hence some imprecision may be introduced by combining subjects on the basis of no spontaneous pain rather than on the presence or absence of MTrP, which would separate a group with active or latent MTrPs from another with no nodules or nontender nodules.

Chronic pain syndromes such as MPS exhibit profound neuroplastic changes that alter neuronal excitability and architecture in structures of the pain matrix (eg, the spinal cord, thalamic nuclei, cortical areas, limbic system, and periaqueductal gray area). This process can fundamentally alter the pain threshold, pain intensity, and affect [29]. A dynamic balance exists between supraspinal descending facilitation and inhibition because the rostral ventral medulla is a pivotal relay area between the periaqueductal gray and the spinal cord. The rostral ventral medulla contains a population of "on cells" and "off cells" that can either increase or decrease the level of pain and sensitization, respectively. It does so through projections that modulate activity in the dorsal horn. In chronic musculoskeletal pain conditions, an overall shift to a decrease in inhibition appears to occur, presumably because of an imbalance of "on-cell" and "off-cell" activity [27].

Muscle pain also impairs diffuse noxious inhibitory control [1]. Disrupted descending inhibition in persons with chronic musculoskeletal pain may lead to an increased pain sensitivity of muscle tissue [6]. Accordingly, clinical manifestations such as diffuse muscle tenderness and the findings of active and latent MTrPs on palpation could occur irrespective of events in the periphery. Our clinical findings of latent MTrPs in both the A group and NP group suggest that palpable nodules may exist along a spectrum that involves varying degrees of sensitization. Presumably, even subjects who do not have spontaneous pain may exhibit varying degrees of sensitization, manifesting as latent MTrPs and nontender nodules, as we found in the NP group. Current data suggest that MTrPs are not merely a peripheral phenomenon but rather that they activate and sensitize wide dynamic range neurons in the dorsal horn and higher brain centers and may in turn be dynamically modulated by these structures, leading to a spectrum of clinical findings [16,18].

Despite the shortcomings of this study, we present a careful, systematic, and comprehensive approach to the evaluation of research subjects with MTrPs. The pain measures selected are sensitive. Measures that assess physical findings (ie, strength, ROM, and palpation), self-reports of pain, fatigue, mood, and health status clearly distinguish the 2 study groups. The findings suggest that people with chronic, active MTrPs have local findings that impact many aspects of life activity, mood, and health status.

CONCLUSION

People with active MTrPs have pain that is evaluable with use of standardized tests. They also have more functional and health status abnormalities. When compared with control subjects who do not have active MTrPs, patients with MPS should receive a multidimensional systematic evaluation. This evaluation should use standardized, reliable

measures designed to assess physical findings, including ROM and strength of the neck and shoulders in addition to self-reports of mood, function, and health status.

REFERENCES

1. Arendt-Nielsen L, Sluka KA, Nie HL. Experimental muscle pain impairs descending inhibition. Pain 2008;140:465-471.
2. Bron C, Dommerholt JD. Etiology of myofascial trigger points. Curr Pain Headache Rep 2012;16:439-444.
3. Daut RL, Cleeland CS, Flanery RC. Development of the Wisconsin Brief Pain Questionnaire to assess pain in cancer and other diseases. Pain 1983;17:197-210.
4. Fairbank JC, Couper J, Davies JB, O'Brien JP. The Oswestry Low Back Pain Disability Questionnaire. Physiotherapy 1980;66:271-273.
5. Fricton JR, Kroening R, Haley D, Siegert R. Myofascial pain syndrome of the head and neck: A review of clinical characteristics of 164 patients. Oral Surg Oral Med Oral Pathol 1985;60:615-623.
6. Ge HY, Fernández-de-las-Peñas C, Yue SW. Myofascial trigger points: Spontaneous electrical activity and its consequences for pain induction and propagation. Chin Med 2011;6:13.
7. Gerwin RD, Dommerholt J, Shah JP. An expansion of Simons' integrated hypothesis of trigger point formation. Curr Pain Headache Rep 2004;8:468-475.
8. Hogg-Johnson S, van der Velde G, Carroll LJ, et al. The burden and determinants of neck pain in the general population: Results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. Spine 2008;33(suppl 4):S39-S51.
9. Hoheisel U, Unger T, Mense S. Excitatory and modulatory effects of inflammatory cytokines and neurotrophins on mechanosensitive group IV muscle afferents in the rat. Pain 2005;114:168-176.
10. Hough J. Estimating the health care utilization costs associated with people with disabilities: Data From the 1996 Medical Expenditure Panel Survey (MEPS). MMWR Weekly 2001;50:120-125.
11. Kaergaard A, Andersen JH. Musculoskeletal disorders of the neck and shoulders in female sewing machine operators: Prevalence, incidence, and prognosis. Occup Environ Med 2000;57:528-534.
12. Kendall FP, McCreary EK, Provance PG, Rodgers MM, Romani WA. Muscles: Testing and Function, With Posture and Pain. 5th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2005.
13. Martin BI, Deyo RA, Mirza SK, et al. Expenditures and health status among adults with back and neck problems. JAMA 2008;299:656-664.
14. Mense S. The pathogenesis of muscle pain. Curr Pain Headache Rep 2003;7:419-425.
15. Mense S, Simons DG, Russell IJ. Muscle Pain: Understanding Its Nature, Diagnosis and Treatment. Philadelphia, PA: Lippincott Williams & Wilkins; 2000.
16. Mense S. How do muscle lesions such as latent and active trigger points influence central nociceptive neurons? J Musculoskel Pain 2010;18:348-353.
17. Murphy DR, Hurwitz EL. Application of a diagnosis-based clinical decision guide in patients with neck pain. Chiropr Man Ther 2011;19:19.
18. Niddam DM, Chan RC, Lee SH, Yeh TC, Hsieh JC. Central modulation of pain evoked from myofascial trigger point. Clin J Pain 2007;23:440-448.
19. Rondinelli R. Guides to the Evaluation of Permanent Impairment. 6th ed. Chicago, IL: American Medical Association; 2008.
20. Shacham S. A shortened version of the Profile of Mood States. J Pers Assess 1983;47:305-306.
21. Shah JP, Phillips TM, Danoff JV, Gerber LH. An in vivo microanalytical technique for measuring the local biochemical milieu of human skeletal muscle. J Appl Physiol 2005;99:1977-1984.
22. Skootsky SA, Jaeger B, Oye RK. Prevalence of myofascial pain in general internal medicine practice. West J Med 1989;151:157-160.
23. Sluka KA, Kalra A, Moore SA. Unilateral intramuscular injections of acidic saline produce a bilateral, long-lasting hyperalgesia. Muscle Nerve 2001;24:37-46.
24. Travell J, Simons D. Myofascial Pain and Dysfunction, Vol. 1: The Trigger Point Manual, the Upper Extremities. Philadelphia, PA: Williams & Wilkins; 1983.
25. Trescot AM, Helm S, Hansen H, Benyamin R, et al. Opioids in the management of chronic non-cancer pain: An update of American Society of the Interventional Pain Physicians'(ASIPP) Guidelines. Pain Phys 2008;(suppl 2):S5-S62.
26. Ware JE Jr, Sherbourne CD. The MOS 36-Item Short-Form Health Survey (SF-36). I. Conceptual framework and item selection. Med Care 1992;30:473-483.
27. Willard F. Basic mechanisms of pain. Future trends in CAM research. In: Audette JF, Bailey A, eds. Integrative Pain Medicine: The Science and Practice of Complementary and Alternative Medicine in Pain Management. Totowa, NJ: Humana Press; 2008.
28. Youdas JW, Carey JR, Garrett TR. Reliability of measurements of cervical spine range of motion—comparison of three methods. Phys Ther 1991;71:98-104.
29. Zieglgänsberger W, Berthele A, Tölle TR. Understanding neuropathic pain. CNS Spectrums 2005;10:298-308.

Footnotes Continued From Page 1.

J.K. College of Science, George Mason University, Fairfax, VA
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D.T. Department of Bioengineering, Volgenau School of Engineering, George Mason University, Fairfax, VA
Disclosure: nothing to disclose

P.O. Departments of Electrical and Computer Engineering and Bioengineering, Volgenau School of Engineering, George Mason University, Fairfax, VA
Disclosure: nothing to disclose

T.G. Department of Rehabilitation Medicine, Clinical Center, National Institutes of Health, Bethesda, MD
Disclosure: nothing to disclose

J.S. Department of Rehabilitation Medicine, Clinical Center, National Institutes of Health, Bethesda, MD
Disclosure: nothing to disclose