# The Reliability of Examination for Tenderness in Patients with Myofascial Pain, Chronic Fibromyalgia and Controls

ELDON TUNKS, GLENN A. McCAIN, LAWRENCE E. HART, ROBERT W. TEASELL, CHARLES H. GOLDSMITH, GARY B. ROLLMAN, ANN J. McDERMID, and PETER J. DeSHANE

*ABSTRACT.* ***Objective.*** To establish the reliability with which tenderness could be evaluated in patients with chronic myalgias, using dolorimetry and palpation.

***Methods.*** Three blinded examiners using pressure dolorimetry and digital palpation compared 19 paired tender points and 8 paired control points in 4 matched groups of 6 patients with fibromyalgia (FM), myofascial pain, pain controls, and healthy controls.

***Results.*** Good interrater and test-retest reliability were found for dolorimetry scores. There were significant differences in tenderness ratings by dolorimetry between the diagnostic groups, with the patients with FM and myofascial pain having the greatest tenderness, the normals having the least tenderness, and the pain controls having tenderness levels midway between the patients with FM or myofascial pain and the normals. In all patients, control points had higher pain thresholds than tender points. One-third of patients with localized pain complaints demonstrated a significant relationship between region of clinical pain complaint and measured tenderness thresholds by dolorimetry. In ratings of tenderness by digital palpation, there was very good intrarater reliability over 26 of 27 paired points, and good interrater reliability at 75% of the points. One-half of patients with localized pain complaints demonstrated a significant relationship between region of clinical pain complaint and number of tender points by palpation.

***Conclusion.*** Both dolorimetry and palpation are sufficiently reliable to discriminate control patients from patients with myofascial pain and FM, but may not discriminate patients with myofascial pain from those with FM. Neither method appears to correlate well with the location of the clinical pain complaint, regardless of diagnosis. (*J Rheumatol 1995;***22:944–52**)

*Key Indexing Terms:*
MYOFASCIAL PAIN SYNDROME — FIBROMYALGIA
TENDER POINT — DOLORIMETRY — PAIN

There are several published studies concerning the reliability of diagnostic criteria in diagnosis of fibromyalgia (FM)[1-4]. In a multicenter study of chronic FM and control patients, conducted by FM experts, a consensus was reached on diagnostic criteria for FM[4]. These criteria were diffuse pain reported on both sides and upper and lower body, trunk and limbs, and pain reported on palpation of 11 or more of 18 specified points. In comparing these criteria with those reached in other research papers, the differences are mainly in the number and choice of tender point locations, the degree of tenderness expected, and whether or not historical (anamnestic) symptoms were needed in the diagnosis. Because these criteria are empirically derived, there is likely no serious inconsistency, although some sets of criteria may be more or less stringent[5].

The work of Kellgren in Lewis's laboratory provided an empirical basis for the study of referred pain[6-8]. These findings and other clinical observations were organized into a clinical approach to muscle pain[9,10]. Although numerous clinical studies have been carried out on myofascial pain, these for the most part do not address the reliability issues in its diagnosis. And there have been several studies that have cast some doubt on the clinical reliability of some key signs of myofascial pain[11-13].

Clinical features commonly found in patients with myofascial pain and FM[14-19] include soft tissue pain at characteristic sites, regional or diffuse pain, and associated symptoms such as sleep disturbance and fatigue. In clinical practice, many cases are found of individuals who have features that are consistent with both FM and myofascial pain. One needs to know the reliability with which patients with myofascial pain and FM may be distinguished clinically from each other.

A search of indexed publications reveals few published comparative studies of FM and myofascial pain[3,13,20-22].

*From the Faculty of Health Sciences, McMaster University, Hamilton, ON, and University Hospital, University of Western Ontario, London, ON, Canada.*

*E. Tunks, MD, Professor of Psychiatry, McMaster University; G.A. McCain, MD, Associate Director, Pain Therapy Center of Charlotte, South East Arthritis Care Center, 1521 East Third St., Charlotte, NC, 28204, USA; L.E. Hart, MD, Associate Professor, Department of Medicine, McMaster University; R.W. Teasell, MD, Associate Professor, Department of Physical Medicine and Rehabilitation, University of Western Ontario; C.H. Goldsmith, PhD, Professor, Department of Clinical Epidemiology and Biostatistics, McMaster University; G.B. Rollman, PhD, Professor of Psychology; A.J. McDermid, MA, Doctoral Candidate, Department of Psychology; P.J. DeShane, BSc (Hons), University of Western Ontario.*

*Address reprint requests to Dr. E. Tunks, Chedoke-McMaster Hospital, Chedoke Division, Box 2000, Hamilton, ON, Canada, L8N 3Z5.*

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Scudds, *et al*[20] found that patients with FM had higher reported pain levels, lower general pain thresholds, and they reported pain diffusely, whereas in patients with myofascial pain, pain was likely to be reported in one body quadrant. Regional pain levels seemed correlated with dolorimetry scores. Durette, *et al*[21] noted that tender points were found in similar proportions in both patients with myofascial pain and those with FM.

Yunus, Masi, and Aldag[3] compared patients with FM, rheumatoid arthritis, and localized musculoskeletal pain due to trauma or repetitive strain, with normal controls. The FM and traumatic FM groups differed on several symptoms including "hurt all over" and pain at 7 or more sites.

A group of experts on myofascial pain and on FM conducted blind clinical examinations on 23 women; 7 with FM, 8 with myofascial pain, and 8 healthy volunteers[13]. The main point of the study was to establish the reliability with which key diagnostic features essential to the diagnoses of these conditions could be discriminated. The FM experts found significantly more tender points in patients with FM (mean 15.2) than in those with myofascial pain (mean 11.2); however, the high frequency of tender points in patients with myofascial pain suggests a clinical resemblance between the FM and myofascial groups on the criterion of tender points. There was poor interobserver agreement on trigger point count, taut bands, twitches, reproduction of the patients' clinical pain complaint by palpation, or tender points associated with referred pain or paresthesiae.

## MATERIALS AND METHODS

Our aim was to examine the reliability of digital palpation and pressure dolorimetry in assessing tenderness in patients with FM, myofascial pain, other persistent pain, and non-pain control patients. The relationship of measured tenderness to location of clinical pain complaint was examined.

*Subjects.* There were 24 patients; 3 men and 3 women in each of the 4 conditions of FM, myofascial pain, pain controls who did not satisfy the criteria of either FM or myofascial pain, and normal non-pain controls. The patients were chosen from an outpatient musculoskeletal clinic by a physician who was independent of the blind examiners. Consecutive patients to this clinic who were diagnosed with either myofascial pain or chronic FM were asked to participate until 3 men and 3 women were chosen for each of the myofascial and FM conditions. Pain controls and non-pain controls were then chosen by systematically age and sex matching other clinic patients and healthy volunteers with the patients with myofascial pain and those with FM, until 3 men and 3 women were chosen for each of the 2 control conditions, with as close matching as possible of ages between the 2 clinical and the 2 control groups. Informed consent was obtained. Three assessors were blinded to the clinical diagnoses. Patients (Table 1) were selected according to the following criteria.

*Myofascial pain.* For this condition the minimum criteria were history of trauma or tissue injury, localized pain disorder arising from the injury, very tender points in characteristic locations, and demonstration of referred pain consistent with these points and consistent with the pain complaint. Because of findings of poor reliability reported in other studies[12,13], taut bands and twitches were not sought in this study.

Table 1. *Patient characteristics*

| Patient | Sex | Age (yrs) | Diagnosis | Cause | Duration, yrs | Pain Location |
|---|---|---|---|---|---|---|
| 1 | M | 41 | Myofascial | MVA | 3 | Left upper back, neck, headaches |
| 2 | M | 24 | Normal | | | |
| 3 | F | 39 | FM | MVA | 4 | Diffuse |
| 4 | F | 35 | Pain control | Guillain-Barre | 2 | Neuropathic foot pain |
| 5 | F | 24 | Myofasc. | MVA | 3 | Rt. and lt. upper thorax |
| 6 | M | 39 | Pain cntrl. | Lumbar disk | 3 | Low back |
| 7 | F | 38 | FM | MVA | 4.5 | Diffuse |
| 8 | M | 42 | Normal | | | |
| 9 | F | 42 | Myofasc. | Strain | 4.5 | Rt. upper back, (previously lumbar disk surgery) |
| 10 | M | 28 | Myofasc. | Strain | 2 | Rt. low back and leg |
| 11 | F | 29 | Pain cntrl. | Spontan. | Gradual | Low back and hips |
| 12 | M | 43 | Pain cntrl. | Lumb. disk | 3.5 | Low back, left leg |
| 13 | M | 39 | FM | Fall inj. | 4.5 | Diffuse upper back |
| 14 | F | 33 | Normal | | | |
| 15 | F | 43 | Normal | | | |
| 16 | F | 29 | FM | MVA | 1 | Diffuse |
| 17 | M | 42 | Myofasc. | Repetitive strain inj. | 5 | Left-sided pain; low back and leg since 1986; neck and arm since 1990 |
| 18 | F | 28 | Normal | | | |
| 19 | M | 46 | FM | Fall inj. | 5 | Low back inj. mid 1970s; low back inj. 1982; fell from chair injuring rt. shoulder in 1986; main pain in rt. upper quadrant |
| 20 | F | 42 | Pain cntrl. | Fracture ankle/foot | 1 | Left ankle/foot pain |
| 21 | M | 39 | FM | Labor and soccer inj. | 15 | Diffuse |
| 22 | M | 34 | Pain cntrl. | ? neck inj. | 10 | Severe migraines, since mild concussion and neck injury 10 yrs ago |
| 23 | F | 34 | Normal | | | |
| 24 | F | 40 | Myofasc. | Repetitive strain | 6 | Repetitive strain left upper quadrant |

FM = fibromyalgia patient; Myofasc. = myofascial patient; Pain cntrl. = pain control patient; MVA = Motor vehicle accident.

*FM.* For this condition the American College of Rheumatology Consensus Criteria[4] were used, namely, persistent widespread pain in upper and lower body, both right and left sides, both in trunk and extremities, and at least 11 of 18 tender points found at a palpation of 4 kg pressure.

*Control pain patients.* These were chosen from the same physical medicine and musculoskeletal clinic from which the patients with myofascial pain and FM were chosen. They had no florid joint disease and did not satisfy the criteria for either FM or myofascial pain (they lacked trigger points with referred pain or multiple tender points).

*Normals.* These were age and sex matched volunteers, recruited at the medical center. They admitted no painful or rheumatic disease.

Twenty-seven paired points were selected for study in each patient (Figure 1 and Table 2). These included the 9 paired points recommended by the American College of Rheumatology (ACR) consensus study[4], (with one slight variation), several points in which myofascial trigger points are frequently found and selected for being relatively accessible to palpation and distributed widely through the body, and control points that are unlikely to harbor either FM tender points or myofascial trigger points. (For purposes of distinction in our study, the 9 paired tender points used in the FM ACR consensus study were labelled "group 1 tender points." The variation was that instead of using the spinous processes of C5-7, we pressed lower sternomastoid fibers back against the spinous processes of C5-7. The intent was to identify FM points with myofascial symptoms wherever possible). It is worth noting that these type 1 tender points coincide almost always with points at which myofascial trigger points may also occur, with the possible exception of the point at the medial fat pad of the knee, and the posterior aspect of the greater trochanter. A further set of 10 paired tender points (we called these the "group 2 tender points") was chosen for the following characteristics: distributed over the same body regions in which the group 1 tender points are distributed, being sites in which myofascial trigger points might often be found, and being sites that are relatively accessible to palpation when done in a blinded fashion.

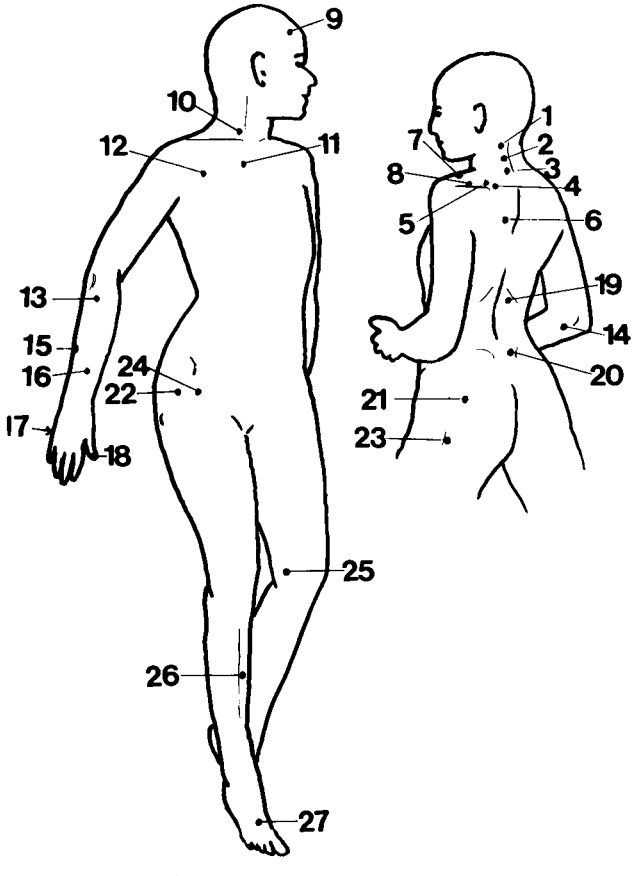


*Fig. 1.* Locations of tender points and control points, as in Table 2.

Table 2. *Examined points*

| Point No. | Location |
|---|---|
| Tender points characteristic of FM | |
| 1 | Splenius capitis occiput insertion* |
| 5 | Medial end of supraspinatus* |
| 7 | Trapezius, anterior fold* |
| 10 | Deep sternomastoid, lower tender point, pressed against C5-7 transverse process* |
| 11 | Border of second rib near sternum (insertion of pect. major)* |
| 13 | Tendon of 3rd finger extensor just distal to elbow* |
| 21 | Midbuttock gluteal muscles (point at upper outer quadrant)* |
| 23 | Posterior aspect of greater trochanter |
| 25 | Medial fat pad of the knee |
| Control points | |
| 9 | Forehead 4 cm above orbit |
| 15 | Midulna dorsal aspect |
| 16 | Dorsum of forearm, distal 1/3 |
| 17 | Hypothenar eminence |
| 18 | Thumbnail |
| 24 | 4 cm distal to anterior superior iliac spine |
| 26 | Midshin over tibial bone |
| 27 | 3rd metatarsal midpoint |
| Points that might be tender in myofascial pain | |
| 2 | Midneck paraspinal |
| 3 | Low cervical paraspinal |
| 4 | Near upper medial scapular tip (levator scapulae) |
| 6 | Paraspinals in interscapular region, lower 1/3 |
| 8 | Trapezius behind anterior fold (includes supraspinatus midpoint) |
| 12 | 4th rib at anterior axillary line |
| 14 | Tendon just distal to medial epicondyle |
| 19 | Paraspinals about $L_2$ level |
| 20 | Paraspinals about $S_1$ level |
| 22 | Point midway between anterior superior iliac spine and greater trochanter |

* It was understood that most of these points coincided with anatomic structures that may equally harbor myofascial trigger points and also FM tender points.

*Training sessions for examiners.* Examiners were experienced clinicians who were familiar with myofascial and FM pain. They viewed training tapes and participated in training to standardize blind examinations and ratings. They agreed on a method for examination of tender points, referred pain, and related features, and on use of the pressure dolorimeter. One day was spent conducting blind examinations of a group of patients, as a training procedure. The results from this pilot group were examined, along with a videotape of the examination techniques used by each blinded examiner. These data were discarded and not used further in the study.

Blinded examinations were conducted and patient histories taken in sequence, until each patient had been seen 4 times. The basic design was a 3×3 Latin square, with the first examination then repeated in the 4th position (for intrarater comparisons).

With flat palpation, the examiners systematically looked for tenderness at 27 paired points comprising control points or tender points. Tenderness was rated using the rating scale, 0 = no pain; 1 = pain; 2 = pain + grimace or flinch; 3 = pain + marked flinch or withdrawal; and 4 = patient untouchable, withdraws without palpation. Verbal instructions given to the patients were to tell if the palpation was "distinctly painful."

The blinded examiner then used a dolorimeter to measure the tenderness

thresholds over the same 27 paired points. The dolorimeter was applied perpendicular to the tissues, increasing the pressure at a rate of about 1 kg/s, and instructing the patient to report the exact moment when the pressure becomes distinctly painful.

*Equipment.* Equipment included 3 pressure dolorimeters (Pain Diagnostics and Thermography, Great Neck, NY) and rating tools printed for each patient.

*Statistical analyses.* Analyses of variance were conducted with SPSS Release Version 4.0[23]. F values and Tukey's studentized range test[24] were calculated for dolorimetry values at each tender point for estimating test-retest reliabilities, calculating differences in tenderness threshold between diagnoses and those between control points and tender points, and correlating dolorimetry scores with area of pain complaint. Tukey's test adjusts the critical value for all possible pairwise comparisons among the groups. The Wilcoxon matched pairs signed ranks test was used to assess test-retest reliability of palpation tenderness ratings, and F values and Tukey's studentized range test for calculating the correlation of mean tender point counts in body regions with areas of pain complaint.

## RESULTS

*Interrater and test-retest (intrarater) reliability.* F values were calculated for dolorimeter readings at each of the 27 (paired) points in all patients to determine the reliability of readings between blind examiners and in test-retest within blind examiners. Statistically significant differences between blind examiners' ratings were found at 3 of 27 points (sternomastoid, 3rd finger extensor, and 3rd metatarsal), supporting overall quite good interrater and intrarater reliability (Table 3).

Interrater and intrarater reliability for dolorimeter readings at each of the individual 27 points was assessed using the Tukey's studentized range test, with the alpha at 0.05. One significant difference was found between dolorimeter readings between the 3 blind examiners, at the 3rd metatarsal midpoint. No significant differences were found in testing for intrarater reliability (Table 4).

Table 3. *Test-retest reliability for dolorimeter readings at each point*

| Points | F Statistic | p Value |
|---|---|---|
| Splenius capitis | 0.61 | 0.61 |
| Mid-neck paraspin. | 0.12 | 0.94 |
| Low cervical paraspin. | 0.67 | 0.57 |
| Upper medial scapula | 1.30 | 0.28 |
| Supraspinatus origin | 0.28 | 0.84 |
| Paraspinal interscap. | 2.25 | 0.09 |
| Trapez. ant. skinfold | 1.11 | 0.35 |
| Trap. behind ant. fold | 1.06 | 0.37 |
| Forehead | 0.97 | 0.41 |
| Sternomastoid/lower | 2.96 | 0.04 |
| 2nd rib, upper surface | 1.00 | 0.40 |
| 4th rib | 1.29 | 0.28 |
| Near lat. epicondyle | 2.82 | 0.04 |
| Near med. epicondyle | 1.43 | 0.24 |
| Mid-ulna | 0.87 | 0.46 |
| Dorsum of forearm | 1.25 | 0.30 |
| Hypothenar | 0.64 | 0.59 |
| Thumbnail, dorsum | 0.79 | 0.50 |
| Upp. lumb. paraspinal | 0.89 | 0.45 |
| Paraspinal, lumbosacral | 0.42 | 0.74 |
| Gluteal, mid-buttock | 1.20 | 0.31 |
| Ant. gluteus medius | 0.73 | 0.54 |
| Greater trochanter | 1.39 | 0.25 |
| Near A.S. iliac spine | 1.59 | 0.20 |
| Medial fat pad of knee | 1.95 | 0.13 |
| Mid-shin | 2.02 | 0.12 |
| 3rd metatarsal midpoint | 3.45 | 0.02 |

*Differences between examiners in dolorimetry.* Notwithstanding the evidence for test-retest reliability for dolorimetry over individual points, there is an examiner effect for tenderness by dolorimetry. On examining the means of the tenderness of each point by dolorimetry it was found that the mean tenderness measured by Examiner 1 was usually greater than that measured by Examiner 3, with values measured by Examiner 2 generally lying intermediate between the other 2 examiners. These differences achieved statistical significance when the means of dolorimetry values across all points across all patients were calculated. These means were 4.58, 4.93, and 5.44 kg/cm$^2$ measured, respectively, by Examiner 1, 2, and 3. This same differential relationship also held true for means of all points within each of the 4 diagnostic groups.

*Dolorimetry scores at each test point in the 4 experimental diagnostic groups.* For each of the 27 points, dolorimetry values were compared across the 4 diagnostic groups, FM, myofascial, pain control, and healthy control. Using the F statistic, statistically significant differences in dolorimetry tenderness across these diagnostic groups were found at each of the 27 points, with p values varying from 0.0001 to 0.0081.

Tukey's studentized range test was then used to examine dolorimetry tenderness at each of the 27 paired test points between the diagnostic groups. A very consistent relationship was found for each of the 27 body sites, in which tenderness in myofascial and patients with FM was significantly greater than in normals. Tenderness in pain control patients was less than in FM or with myofascial pain but was more than in healthy controls. This relationship between diagnostic groups also held for "Group 1 and Group 2 tender points," and control points (see Figure 2).

*Dolorimeter tenderness in tender points vs control points.* Tukey's studentized range test was used to compare mean tenderness in the tender points versus control points. Mean tenderness was significantly different at the 0.05 level, for all patients (across all diagnostic groups), for the myofascial group, for the normal group, in comparing Group 1 and 2 tender points, and comparing control points with either Group 1 or Group 2 tender points. For the patients with FM, and for the pain control patients, tenderness was statistically significantly different between the control points and Group 1 or 2 tender points, but not between Group 1 and Group 2 tender points (Figure 2).

F values indicated that for all diagnostic groups, control points were significantly less tender than Group 1 or Group 2 tender points, at the 0.0001 level.

Table 4. *Mean tenderness (dolorimetry) kg/cm² for each paired tender point over 4 times (Tukey's test: alpha = 0.05, df = 92, N = 24; critical value of studentized range = 3.70)*

| Tender Point | Tukey Group | Mean | Time | MSE* | Min. Sign. Diff. |
|---|---|---|---|---|---|
| 1 | A | 3.78 | 3 | 2.14 | 1.10 |
| | A | 3.68 | 4 | | |
| | A | 3.54 | 2 | | |
| | A | 3.24 | 1 | | |
| 2 | A | 3.41 | 1 | 2.12 | 1.10 |
| | A | 3.27 | 3 | | |
| | A | 3.25 | 2 | | |
| | A | 3.16 | 4 | | |
| 3 | A | 4.77 | 1 | 4.47 | 1.60 |
| | A | 4.16 | 4 | | |
| | A | 4.06 | 2 | | |
| | A | 4.01 | 3 | | |
| 4 | A | 5.09 | 3 | 4.07 | 1.52 |
| | A | 4.81 | 2 | | |
| | A | 4.58 | 4 | | |
| | A | 3.99 | 1 | | |
| 5 | A | 4.81 | 3 | 4.49 | 1.60 |
| | A | 4.77 | 4 | | |
| | A | 4.55 | 2 | | |
| | A | 4.31 | 1 | | |
| 6 | A | 5.77 | 3 | 5.54 | 1.78 |
| | A | 5.53 | 4 | | |
| | A | 4.83 | 2 | | |
| | A | 4.17 | 1 | | |
| 7 | A | 4.08 | 3 | 2.85 | 1.28 |
| | A | 3.90 | 4 | | |
| | A | 3.39 | 2 | | |
| | A | 3.35 | 1 | | |
| 8 | A | 4.14 | 1 | 2.96 | 1.30 |
| | A | 4.00 | 4 | | |
| | A | 3.48 | 3 | | |
| | A | 3.43 | 2 | | |
| 9 | A | 3.69 | 3 | 1.55 | 0.94 |
| | A | 3.56 | 4 | | |
| | A | 3.28 | 2 | | |
| | A | 3.15 | 1 | | |
| 10 | A | 1.91 | 4 | 0.55 | 0.56 |
| | A | 1.88 | 3 | | |
| | A | 1.84 | 1 | | |
| | A | 1.36 | 2 | | |
| 11 | A | 4.06 | 4 | 3.25 | 1.36 |
| | A | 4.03 | 3 | | |
| | A | 3.68 | 2 | | |
| | A | 3.27 | 1 | | |
| 12 | A | 3.72 | 4 | 2.61 | 1.22 |
| | A | 3.65 | 2 | | |
| | A | 3.36 | 3 | | |
| | A | 2.89 | 1 | | |
| 13 | A | 5.70 | 3 | 4.93 | 1.68 |
| | A | 4.63 | 4 | | |
| | A | 4.09 | 1 | | |
| | A | 4.08 | 2 | | |
| 14 | A | 6.28 | 3 | 5.91 | 1.84 |
| | A | 5.26 | 2 | | |
| | A | 5.24 | 4 | | |
| | A | 4.91 | 1 | | |
| 15 | A | 8.02 | 3 | 7.00 | 2.00 |
| | A | 7.70 | 2 | | |
| | A | 7.36 | 4 | | |
| | A | 6.84 | 1 | | |
| 16 | A | 7.36 | 3 | 7.87 | 2.03 |
| | A | 6.50 | 4 | | |
| | A | 6.09 | 2 | | |
| | A | 6.03 | 1 | | |
| 17 | A | 7.87 | 3 | 7.29 | 2.04 |
| | A | 7.87 | 2 | | |
| | A | 7.35 | 4 | | |
| | A | 6.95 | 1 | | |
| 18 | A | 7.42 | 3 | 7.53 | 2.07 |
| | A | 7.32 | 2 | | |
| | A | 7.05 | 4 | | |
| | A | 6.32 | 1 | | |
| 19 | A | 6.21 | 3 | 5.76 | 1.81 |
| | A | 5.57 | 4 | | |
| | A | 5.31 | 2 | | |
| | A | 5.17 | 1 | | |
| 20 | A | 6.29 | 3 | 8.21 | 2.16 |
| | A | 5.99 | 4 | | |
| | A | 5.59 | 3 | | |
| | A | 5.46 | 1 | | |
| 21 | A | 6.45 | 3 | 6.68 | 1.95 |
| | A | 5.73 | 4 | | |
| | A | 5.26 | 2 | | |
| | A | 5.19 | 1 | | |
| 22 | A | 6.34 | 3 | 6.06 | 1.86 |
| | A | 5.92 | 4 | | |
| | A | 5.88 | 2 | | |
| | A | 5.30 | 1 | | |
| 23 | A | 6.45 | 3 | 7.12 | 2.02 |
| | A | 6.31 | 2 | | |
| | A | 6.00 | 4 | | |
| | A | 5.02 | 1 | | |
| 24 | A | 5.51 | 3 | 4.31 | 1.57 |
| | A | 4.99 | 4 | | |
| | A | 4.55 | 1 | | |
| | A | 4.30 | 2 | | |
| 25 | A | 5.49 | 3 | 4.90 | 1.67 |
| | A | 4.87 | 4 | | |
| | A | 4.34 | 1 | | |
| | A | 4.06 | 2 | | |
| 26 | A | 6.60 | 3 | 6.03 | 1.86 |
| | A | 6.30 | 4 | | |
| | A | 6.13 | 2 | | |
| | A | 4.97 | 1 | | |
| 27 | A | 6.49 | 2 | 5.02 | 1.69 |
| | AB | 5.78 | 4 | | |
| | AB | 5.69 | 3 | | |
| | B | 4.45 | 1 | | |

Means with the same letter (A-B) are not significantly different.

Time refers to 1st, 2nd, and 3rd examination by blind examiners; 4th is retest by the 1st examiner.

* Mean square error; a reflection of variance in measure.

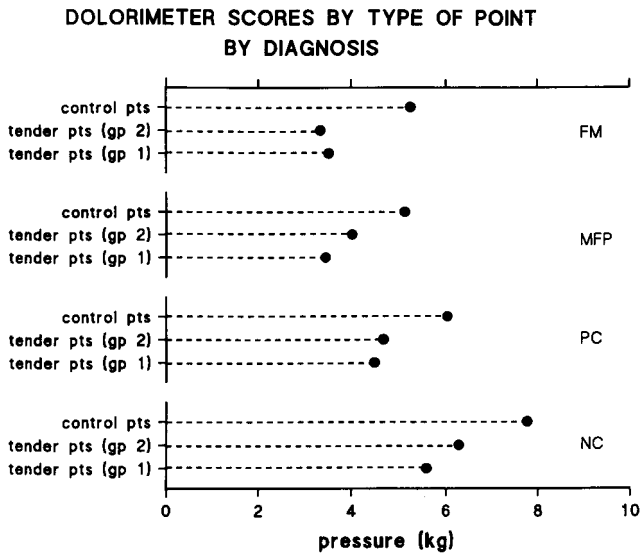


*Fig. 2.* Mean dolorimeter values across diagnoses; fibromyalgia (FM), myofascial pain (MFP), pain controls (PC), and normal controls (NC). Group 1 and 2 tender point means are not statistically different (alpha at 0.05), whereas control means are statistically different from tender point means for all diagnoses.

*Dolorimeter measured tenderness across diagnostic groups and across tender and control points.* Figure 2 and Table 5 display the relationship of mean tenderness in control points and Group 1 and Group 2 tender points, across all diagnostic groups. A very consistent relationship is shown between tenderness at control versus tender points, and tenderness at Group 1 and 2 tender points, and tenderness across all diagnostic groups from FM at one extreme to healthy controls at the other. Of interest is that control points become progressively more tender in relationship to the tenderness at tender points as one goes from healthy controls to patients with FM or myofascial pain.

*Localized pain and dolorimeter scores.* Of the 24 patients, 13 reported pain as localized to a body region (as opposed to having either no pain, or having diffuse pain with no notable localized pain). These 13 patients with localized complaint included all 6 patients with myofascial pain, 5 of the pain control patients, and two of the patients with FM (who had both diffuse and also localized pain). For the sake of this part of the study, the body was considered as 4 quadrants; upper and lower body and right and left sides. Counting all the painful quadrants in the 13 patients with localized pain, a total of 6 were in the lower body and a total of 12 were in the upper body, i.e., upper body pain complaints were twice as common.

Firstly it should be noted that across all 13 patients, the mean tenderness by dolorimetry was significantly greater in the upper right and left quadrants than in the lower right and left quadrants, by Tukey's test.

Using F values for dolorimetry tenderness in each of the 13 patients across the 4 quadrants, in 6 of the 13 patients with localized pain, the dolorimetry tenderness appeared to be significantly correlated with the quadrant(s) harboring the area of pain complaint (but in 4 of these 6 the pain complaint correlated with low mean threshold, whereas in 2 of these 6 the pain complaint correlated with high mean threshold). Most of the correlations were consistent with the observation that the patients more frequently had upper body pain, and the patients most frequently demonstrated the lowest mean tenderness threshold (dolorimetry) in the upper body.

Examining this relationship another way, we used a Tukey's studentized range test, with alpha set at 0.05, in a patient specific analysis for these 13 patients to compare the mean dolorimetry tenderness in each body quadrant, with respect to the quadrant(s) harboring or not harboring the patient's spontaneous pain complaint. This analysis enabled

Table 5. *Dolorimetry: tenderness in tender vs control points*

| | Type of Point | | | Simultaneous Lower | Difference Between | Simultaneous Upper |
|---|---|---|---|---|---|---|
| | 1 | 2 | Control | Confidence Limit | Means | Confidence Limit |
| All patients | | x | x | 1.169 | 1.337 | 1.505* |
| | x | | x | 1.649 | 1.819 | 1.990* |
| | x | x | | 0.321 | 0.483 | 0.645* |
| FM | | x | x | 1.092 | 1.511 | 1.931* |
| | x | | x | 1.450 | 1.876 | 2.302* |
| | x | x | | −0.040 | 0.365 | 0.769* |
| Myofascial | | x | x | 0.633 | 1.126 | 1.619* |
| | x | | x | 1.162 | 1.663 | 2.164* |
| | x | x | | 0.062 | 0.537 | 1.013* |
| Pain control | | x | x | 1.007 | 1.388 | 1.768* |
| | x | | x | 1.170 | 1.557 | 1.944* |
| | x | x | | −0.197 | 0.170 | 0.537 |
| Healthy | | x | x | 0.894 | 1.322 | 1.750* |
| controls | x | | x | 1.746 | 2.181 | 2.617* |
| | x | x | | 0.446 | 0.859 | 1.272* |

* Indicates significance at the 0.05 level; x indicates type of point compared.
Tukey's test: alpha at 0.05, df = 3856, MSE = 3.257. Critical value of studentized range = 3.316.

us to determine if the dolorimetry tenderness was more pronounced in the quadrant harboring the pain complaint. In 5 of the 13 patients, Tukey's test showed that the quadrant(s) harboring the pain complaint had significantly lower mean scores on the dolorimetry (i.e., greater tenderness) compared to one or more of the other quadrants. Three of these came from the patients with myofascial pain and 2 from those with FM. Moreover, there was a total of 78 such comparisons of mean tenderness between quadrants over 13 patients, of which 17 comparisons showed significant differences, and 16 of these were consistent with the relationship of tenderness being greater in the upper body than in the lower.

*Interrater and intrarater reliability in rating tenderness by palpation.* The Wilcoxon matched pairs signed rank test was used to compare the number of times that tender points were or were not elicited by palpation (tenderness rated as 0 versus tenderness rated as 1 or more) by the blinded examiners at the 27 paired body points. Statistically significant interrater differences were found for 7 of these 27 points (splenius capitis, paraspinal interscapular, 4th rib, lumbosacral paraspinal, gluteal midbuttock, near anterior superior iliac spine, and medial fat pad of the knee).

A statistically significant difference in the intrarater test-retest was found at one point (control point near anterior superior iliac spine).

*Correlation between localized pain complaint and tender point counts.* Again for the 13 patients who had localized pain complaints, F values were used to analyze the relationship between the tender point count from each body quadrant with respect to the area of the patient's pain complaint. Overall, it should be noted that in these patients there was a significantly higher tender point count in the right and left upper quadrants (means, respectively, 6.31 and 5.46) than in the lower right and left body quadrants (means 2.90 and 2.59) (Tukey's studentized range test, alpha = 0.05). It was also noted in these 13 patients that the means of total numbers of tender points in all quadrants tended to be greater in patients with myofascial pain and those with FM, than in pain controls (Table 6). Significant associations using F values in tender points with respect to the painful quadrant were found in 6 of the 13 patients with localized pain; in 3 of the 6 patients with myofascial pain, in both patients with FM with localized pain, and in one of the 5 pain control patients who complained of localized pain (Table 7).

Tukey's studentized range test was used to compare the tender points in each body quadrant with respect to the quadrants harboring or not harboring the pain complaint. The quadrant harboring the pain complaint had a statistically significantly greater tender point count than at least one other quadrant in 6 of the 13 patients, and 4 of these 6 came from the patients with myofascial pain, while 2 came from those with FM who had localized pain complaints.

## DISCUSSION

The diagnostic criteria for FM currently include diffuse pain complaint and the finding of a certain number of tender points at specific locations; some criteria also emphasize certain anamnestic features[1-4]. Because of the empirical way these criteria have been developed, the diagnosis of FM lends itself

Table 6. *Tender points in patients with localized pain*

| Tukey Group | | | | | Mean | Patient | Diagnosis |
|---|---|---|---|---|---|---|---|
| | | A | | | 11.58 | 5 | Myofascial |
| | | A | | | 10.92 | 9 | Myofascial |
| | | B | | | 6.75 | 21 | FM |
| | C | B | | | 5.33 | 10 | Myofascial |
| | C | B | | | 5.17 | 11 | Pain control |
| | C | B | D | | 4.17 | 24 | Myofascial |
| | C | E | D | | 3.58 | 17 | Myofascial |
| | C | F | E | D | 3.42 | 19 | FM |
| G | C | F | E | D | 2.75 | 1 | Myofascial |
| G | | F | E | D | 1.08 | 20 | Pain control |
| G | | F | E | | 0.92 | 12 | Pain control |
| G | | F | | | 0.33 | 6 | Pain control |
| G | | | | | 0.08 | 22 | Pain control |

Means with the same letter (A-G) are not statistically different.
Tukey's test: alpha at 0.05, df = 140, MSE = 5.25. Critical value of studentized range = 4.77. Minimum significant difference = 3.15. n = 12 (3 examiners × 4 quadrants)

Table 7. *Association of tender point count with painful quadrants*

| Patient | Diagnosis | Location | F Value | p |
|---|---|---|---|---|
| 1 | Myofascial | Lt upper vs others | 4.46 | 0.07 |
| 5 | Myofascial | Rt & lt upper vs others | 34.24 | 0.00 |
| 6 | Pain cntrl. | Rt & lt lower vs others | 8.00 | 0.02 |
| 9 | Myofascial | Rt upper vs others | 56.38 | 0.00 |
| 10 | Myofascial | Rt lower vs others | 0.34 | 0.58 |
| 11 | Pain cntrl. | Rt & lt upper vs others | 4.36 | 0.07 |
| 12 | Pain cntrl. | Rt & lt upper vs others | 1.00 | 0.35 |
| 17 | Myofascial | Lt upper & lower vs others | 6.42 | 0.04 |
| 19 | FM | Rt upper vs others | 17.86 | 0.00 |
| 20 | Pain cntrl. | Lt lower vs others | 0.17 | 0.69 |
| 21 | FM | Lt upper vs others | 19.50 | 0.00 |
| 22 | Pain cntrl. | Rt & lt upper vs others | 1.00 | 0.35 |
| 24 | Myofascial | Lt upper vs others | 2.00 | 0.20 |

to a standardized blinded technique. By contrast, myofascial pain has traditionally been diagnosed on the basis of a complex of factors: specific history of an injury; localized very tender areas which on provocation are able to refer pain to the area of spontaneous clinical pain, reproducing the patient's problem; and other confirmatory signs. Such a procedure does not totally lend itself to a standardized examination or a blind examination. On the other hand, it should be possible to subject some of the key diagnostic elements of myofascial pain to a reliability study. Some such testable elements are the presence of exquisitely tender points (a necessary criterion for trigger points), and the capacity of these points to reproduce the patient's clinical pain complaint.

*Reliability of tenderness measures.* The interrater and intrarater reliability in dolorimeter measures of tenderness at these various points was quite good, in keeping with other studies[25,26]. The nature of dolorimetry demands an exact localization and angle, and even a patient's body posture could alter this. Furthermore, we did not allow skin marking as a guide for successive examiners since this would have allowed an element of agreement not present in the usual clinical situation. In a previous study, we found a very high level of agreement between blind examiners when allowing for skin marking[25].

There was no evidence that patients became progressively more tender over 4 examinations (Table 4), and thus it did not appear that tender points were being iatrogenically created by repeated examinations.

Despite the fact that we had evidence of good interrater reliability for dolorimetry values at points taken separately, the consistent differences in dolorimetry values measured by the blinded examiners likely reflect a subtle difference in technique in evoking pain by dolorimetry between these examiners, despite pretraining[27].

The palpation evoked tenderness was also subjected to analysis of interrater reliability. Significant differences were found at 7 of the 27 paired points — hence there was interrater reliability in about 75% of the points. Other studies have reported reliability problems in finding trigger points[11,12], which may be analogous to the reliability problems here in finding tender points. The test-retest analysis found a difference at one of the 27 paired points. The fact that test-retest reliability for palpation tenderness was calculated on Sessions 1 and 4 of each patient, suggests that the repeat examination procedure was not an important factor in iatrogenically creating tender points.

From Figure 2, it is noted that there is a gradual change of tenderness threshold from normals, through pain control patients, to those with myofascial pain and FM, and that reduction in threshold applies to control points as well as to tender points. This might suggest that, since the normal body has differences in tenderness threshold depending on the tissue, tender points are the product of global lowering of tenderness thresholds.

Our finding that in patients with FM (and those with myofascial pain) the control points are more tender than in normals, is contrary to findings by Campbell, *et al*[2], but is in keeping with Tunks, *et al*[25], Scudds, *et al*[26], and Smythe, *et al*[27]. The explanation for the discrepancy may lie in selection factors.

The observation that successive examiners showed some variation of tender points counted in examinations of the same patient raises the question of the stability of the FM diagnosis, if considered in the context of myofascial pain. For example, with this degree of observed variability, one examiner might find 9 tender points localized mostly on the right body side, and call it myofascial pain, while a 2nd might find 8 on one side and 3 on the other, and call it FM because of its diffuseness and bilaterality. This mirrors the problems noted in the clinic where one often finds variability in the degree of pain and tender point counts in successive clinic visits of patients with FM or those with myofascial pain. How do we deal with categories of diagnosis when this happens?[5,28].

The ACR criteria for FM, based as they are mainly on tender point counts, may be appropriate for distinguishing FM from other rheumatic disease and from normals, but may be inadequate for distinguishing patients with myofascial pain from those with FM.

In the myofascial pain literature, it is noted that referred pain includes the property of referred hyperalgesia that, if there are active trigger points in a body quadrant, one might also expect a lowering of tenderness threshold near or within the referred pain zone in the same quadrant. (Because it would require a very large sample size to statistically detect tenderness with respect to individual unique patterns of myofascial referred pain for each individual trigger point location, we had to accept this approximation.) Scudds, *et al*[20] found that there was a correlation between low tenderness threshold measured by dolorimetry and the region of complaint in patients with myofascial pain. In our results, among the 13 patients who had localized pain, 2 patients with myofascial pain and 2 with FM showed a correlation between low tenderness thresholds (dolorimetry values) and presence of localized pain complaint in the same quadrant.

Overall, dolorimetry scores showed greatest tenderness in the upper (right and left) body quadrants. Tender point counts were greater in the upper body quadrants. This confirms studies that found myofascial pain and tender points more frequent in upper body quadrants[16,29], but this predilection for tender points and tenderness in upper body quadrants seems not to be restricted to patients with myofascial pain.

In most cases, the significant differences found between tenderness in quadrants reflected upper body having generally lower thresholds than lower body, regardless of diagnosis.

Tender point count was examined with respect to localized pain complaint in the 13 patients who admitted to such

pain. It was found that the tender point count was significantly higher in the upper body quadrants, consistent with the findings of Sola, *et al*[29]. It was noted that tender point counts for each quadrant were higher with respect to myofascial patients than pain controls, but similar to the tender point counts in patients with FM who had localized pain. A significant association was found in tender point counts per quadrant with respect to the location of the localized pain, in 6 of the 13 patients. At least in this study, the number of tender points per quadrant was not a significant discriminator between patients with FM and those with myofascial pain. Our study does not confirm an association between localized pain complaint and increased number of regional tender points.

In further reports we will examine the relationship of referred pain phenomena and clinical historical data to the diagnoses of myofascial and FM pain, versus pain controls and normals.

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## REFERENCES

1. Yunus MB, Masi AT, Calabro JJ, Miller KA, Feigenbaum SL: Primary fibromyalgia (fibrositis): clinical study of 50 patients with matched normal controls. *Semin Arthritis Rheum 1981;*11:151–71.
2. Campbell SM, Clark S, Tindall EA, Forehand ME, Bennett RM: Clinical characteristics of fibrositis: I. A "blinded" controlled study of symptoms and tender points. *Arthritis Rheum 1983;*26:817–24.
3. Yunus MB, Masi AT, Aldag JC: Preliminary criteria for primary fibromyalgia syndrome (PFS): multivariate analysis of a consecutive series of PFS, other pain patients, and normal subjects. *Clin Exp Rheumatol 1989;*7:63–9.
4. Wolfe F, Smythe HA, Yunus MB, *et al:* The American College of Rheumatology 1990 criteria for the classification of fibromyalgia: Report of the Multicenter Criteria Committee. *Arthritis Rheum 1990;*33:160–72.
5. Wolfe F: Methodological and statistical problems in the epidemiology of fibromyalgia. In: Fricton JR, Awad E, eds. *Advances in Pain Research and Therapy,* vol. 17; *Myofascial Pain and Fibromyalgia.* New York: Raven, 1990:147–63.
6. Kellgren JH: Observations on referred pain arising from muscle. *Clin Sci 1938;*3:175–90.
7. Kellgren JH: On the distribution of pain arising from deep somatic structures with charts on segmental pain areas. *Clin Sci 1939;*4:35–46.
8. Kellgren JH: The anatomical source of back pain. *Rheumatol Rehabil 1977;*16:3–12.
9. Travell J, Rinzler SH: The myofascial genesis of pain. *Postgrad Med 1952;*11:425–34.
10. Travell JG, Simons DG: *Myofascial Pain and Dysfunction: The Trigger Point Manual.* Baltimore: Williams and Wilkins, 1983:24–6.
11. Nice DA, Riddle DL, Lamb RL, Mayhew TP, Rucker K: Intertester reliability of judgments of the presence of trigger points with low back pain. *Arch Phys Med Rehabil 1992;*73:893–8.
12. Ohrbach R, Gale EN: Pressure pain thresholds, clinical assessment, and differential diagnosis: reliability and validity in patients with myogenic pain. *Pain 1989;*39:157–69.
13. Wolfe F, Simons DG, Fricton J, *et al:* The fibromyalgia and myofascial pain syndromes: a preliminary study of tender points and trigger points in persons with fibromyalgia, myofascial pain syndrome, and no disease. *J Rheumatol 1992;*19:944–51.
14. Campbell SM, Bennett RM: Fibrositis. *Dis Month 1986;* 11:659–722.
15. Simons DG: Fibrositis/fibromyalgia: a form of myofascial trigger points? *Am J Med 1986;*81:93–8.
16. Simons D: Muscular pain syndromes. In: Fricton JR, Awad E, eds. *Advances in Pain Research and Therapy,* vol. 17; *Myofascial Pain and Fibromyalgia.* New York: Raven, 1990:1–41.
17. Yunus MB, Kalyan-Raman UP, Kalyan-Raman K: Primary fibromyalgia syndrome and myofascial pain syndrome: clinical features and muscle pathology. *Arch Phys Med Rehabil 1988;*69:451–4.
18. Bennett RM: Myofascial pain syndromes and the fibromyalgia syndrome: a comparative analysis. In: Fricton JR, Awad E, eds. *Advances in Pain Research and Therapy,* vol. 17; *Myofascial Pain and Fibromyalgia.* New York: Raven, 1990:43–65.
19. Goldenberg DL: Fibromyalgia, chronic fatigue syndrome, and myofascial pain syndrome. *Curr Opin Rheumatol 1991;*3:247–58.
20. Scudds RA, Trachsel LC, Luckhurst BJ, Percy JS: A comparative study of pain, sleep quality and pain responsiveness in fibrositis and myofascial pain syndrome. *J Rheumatol 1989;*(suppl)16:120–6.
21. Durette MR, Rodriquez AA, Agre JC, Silverman JL: Needle electromyographic evaluation of patients with myofascial or fibromyalgic pain. *Am J Phys Med Rehabil 1991;*70:154–6.
22. Jacobsen S, Danneskiold-Samsoe B: Dynamic muscular endurance in primary fibromyalgia compared with chronic myofascial pain syndrome. *Arch Phys Med Rehabil 1992;*73:170–3.
23. SPSS Release Version 4.0, SPSS Inc., 444 N. Michigan Ave., Chicago IL, 60611.
24. Miller RG: *Simultaneous Statistical Difference.* 2nd ed. New York: Springer-Verlag, 1981.
25. Tunks E, Crook J, Norman G, Kalaher S: Tender points in fibromyalgia. *Pain 1988;*34:11–9.
26. Scudds RA, Rollman GB, Harth M, McCain GA: Pain perception and personality measures as discriminators in the classification of fibrositis. *J Rheumatol 1987;*14:563–9.
27. Smythe HA, Gladman A, Dagenais P, Kraishi M, Blake R: Relation between fibrositic and control site tenderness: Effects of dolorimeter scale length and footplate size. *J Rheumatol 1992;*19:284–9.
28. Wolfe F: Fibromyalgia: on diagnosis and certainty. *J Musculoskeletal Pain 1993;*1:17–35.
29. Sola AE, Rodenberger ML, Gettys BB: Incidence of hypersensitive areas in posterior shoulder muscles. *Am J Phys Med Rehabil 1955;*34:585–90.