J Rehabil Med 2002; 34: 73–79

Taylor&Francis healthsciences

ARE PERCEIVED MUSCLE TENSION, ELECTROMYOGRAPHIC HYPERACTIVITY AND PERSONALITY TRAITS CORRELATED IN THE FIBROMYALGIA SYNDROME?

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The study was performed to investigate the relationship between perceived muscle tension and electromyographic hyperactivity and to what extent electromyographic (EMG) hyperactivity relates to personality traits in fibromyalgics. Thirty-six females with fibromyalgia performed isokinetic maximal forward flexions of the shoulder combined with surface EMG recordings of the trapezius and infraspinatus muscles. Signal amplitude ratio and peak torque were calculated in the initial and endurance test phases. Pain intensity, perceived general and local shoulder muscle tension, and personality traits using the Karolinska Scales of Personality were assessed pre-test. Neither perceived muscle tension nor muscular tension personality trait correlated with EMG muscle hyperactivity. Perceived general muscle tension correlated with aspects of anxiety proneness (including muscle tension) of the Karolinska Scales of Personality. Pain intensity interacted with many of the variables. We propose that when patients with fibromyalgia report muscle tension that they may be expressing something other than physiological muscle tension.

Key words: muscle tension, electromyography, personality traits, fibromyalgia.

J Rehabil Med 2002; 34: 73–79

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Accepted November 8, 2001

INTRODUCTION

The concept of muscle tension as somehow contributing to or even causing muscle pain is widely shared by the medical profession and patients alike. Patients with the fibromyalgia syndrome (FMS), are often asked about and report muscle tension, physiotherapists aim to reduce muscle tension in painful muscle groups and progressive muscle relaxation is often taught as part of a physical therapy programme, for FMS, for example. Simons & Mense have reviewed the complexity of muscle tension and pain: it is generally agreed that no increased electromyographic (EMG) activity is found *at rest* in patients with chronic pain (1); but distinctions between feeling psychological tension and muscle tension, and pain, may be blurred.

We have previously developed a standardized method to study the degree of hyperactivity during *dynamic* contractions (2). Normally there is minimal EMG activity (signal amplitudes) in the passive, relaxation phase of the isokinetic contraction cycle. The signal amplitude ratio (SAR) between the EMG signal amplitude (RMS; root mean square) during the passive phase and the active phase can be considered as a quantification of the amount of relaxation (i.e. degree of hyperactivity) in the passive phase. Higher SARs, indicating a relative inability to relax between muscle contractions, have been found in subjects with pain compared with pain free subjects (for references see 3).

Studies looking at stable personality traits in FMS using the Karolinska Scales of Personality (KSP) found that compared to healthy controls and rheumatoids, fibromyalgics scored significantly higher on the scales for muscular tension, somatic anxiety and psychastenia (4). An FMS group scored higher than a regional pain group and healthy controls in muscle tension and psychastenia scales and relationships between some of the scales of KSP and SAR in the endurance phase were reported (5).

We hypothesized from these previous results that perceived general or local (shoulder) muscle tension would correlate with electromyographic hyperactivity (a higher SAR) in patients with FMS. Thus, the aims of this study were to investigate the relationship between perceived muscle tension and EMG muscle (hyper)activity, and to explore to what extent personality traits (according to KSP) in a group of patients with FMS were related to the EMG activity during dynamic maximum shoulder flexions.

MATERIALS AND METHODS

Patients

Thirty-six female patients were recruited consecutively among patients diagnosed with FMS (6) referred to the Pain and Rehabilitation Centre, University Hospital, Linköping. All patients had a tender point, palpated digitally with approximately 40 N/cm^2 pressure (6) in the dominant trapezius muscle. Those with concomitant inflammatory disease or other serious medical condition were excluded. All subjects gave informed consent before study start and the local ethics committee approved the study.

Experimental design

Isokinetic dynamometry and EMG. The methods have been extensively presented elsewhere (2, 3, 7) and the following is a summary: using an isokinetic dynamometer Kincom 500H (Chattanooga Group Inc., Hixon, TN, USA) the subjects performed dynamic maximum shoulder flexions seated in the chair of the dynamometer with comfortable fixture. The arm

 ISSN 1650–1977

was held with the elbow extended and hand pronated, gripping a handle, the length of the lever arm being adjusted for each subject. The dominant arm of each subject was investigated. Before electrode attachment, the skin area was dry shaved and rubbed with alcohol and ether (4:1). EMG signals using surface electrodes (Medicotest, Ølstykke, Denmark; centre-to-centre distance: 20 mm) were obtained from the ascending part of the trapezius, mid-way between vertebra prominens and acromion, and the infraspinatus muscles. A bipolar multi-channel EMG amplifier (EMGAmp, Braintronics BV ISO-2104, Almere, the Netherlands) (CMMR higher than 100 dB, input noise less than 1 microV) was used to register the surface EMG activity. The skin impedance was checked to achieve a balance between the electrodes using the common mode test of the amplifier. Pre-test contractions were also made to ensure good electrode-skin contact and RMS noise levels less than 10 microV. The preset angular velocity chosen was 1.05 rad s^{-1}. Subjects were informed about the intentions of the experiment, but not about the number (100) of flexions in the protocol. Pre-test subjects were familiarized with the procedure using submaximal contractions as a warm-up. Each contraction cycle started with the hand against the thigh. After having performed a maximal shoulder flexion from approximately 30°–90° (i.e. the active flexion part of the contraction cycle) the subject was instructed to relax completely while the arm was passively extended and followed the lever arm/handle down through gravitational torque (i.e. the passive relaxation part of the contraction). When the lever arm/handle reached the thigh the subject was instructed to immediately perform a new shoulder forward flexion. Contraction frequency was thus standardised. Subjects were frequently encouraged throughout the experiment to perform maximally during each flexion and to relax completely during the passive extension. All signals were amplified and analogue-to-digital converted with 12-bit accuracy in the signal range $\pm$ 5 V, with a sampling rate of 2 kHz. Analogue low-pass filters of 800 Hz were used to eliminate aliasing of sampled EMG signals. For the biomechanical signals i.e. torque and position, 40 Hz low-pass filters were used. A high-pass filter of 16 Hz was used to avoid the influence of movement artefacts and low-frequency noise of the EMG signals. The data acquisition system MYSAS (7) uses the position signal from the dynamometer to synchronize the calculation of parameters during isokinetic contractions. The isokinetic part of a phase during the contraction cycle was used to verify that a contraction has a minimum range, and at the same time eliminating values outside the active part of the contraction cycle. Calculated parameters from EMG and torque signals were RMS (μV) and peak torque (Nm). The time window for the RMS calculation was the isokinetic part of the active flexion and the passive extension, respectively. The ability to relax between the maximum shoulder forward flexions was calculated for the contraction cycle: RMS passive phase/RMS active phase equals the signal amplitude ratio (SAR). The following measurement variables were used:

Biomechanical output. Peak torque initially (PTi): the highest value of one of the three initial contractions (Nm) (i.e. strength). Peak torque endurance level (PTe): mean of peak torque of contraction nos. 50–100 (Nm) (i.e. the endurance level). Peak torque relative endurance level: the ratio PTe/PTi. EMG variables: Signal amplitude ratio (SAR): the ratio (in %) RMS passive phase/RMS active phase equals SAR. A high SAR means a high activity during the passive shoulder extensions and by implication a relative inability to relax. Signal amplitude ratio initially (SARi): the mean SAR of contraction cycles 1–3. Signal amplitude ratio endurance level (SARe): the mean SAR of contraction cycles nos. 50–100.

Muscle tension. Perceived general muscle tension and shoulder muscle tension were rated on the same day, recorded on a 100 mm Visual Analogue Scale (VAS) anchored at 0 mm "no tension feeling" and 100 mm "greatest possible tension feeling". In our experience, patients asked to report shoulder symptoms point first to the trapezius area.

$Pain_{VAS}$. The medians of pain intensity (at rest) and pain intensity (movement) during the week prior to test recorded once daily on horizontal 100 mm VAS anchored at 0 mm "no pain" and 100 mm "worst pain possible".

Pain map. Pain experienced in week prior to test were registered in number of body areas on a mannequin. Maximal score 36 indicates pain in all areas (8).

The Karolinska Scales of Personality (KSP) were used to assess personality traits. The instrument was completed by the patient at home 1–2 weeks before the EMG tests. KSP has been developed in order to operationalize and measure constructs defining vulnerability for different forms of psychopathology (9, 10). Most of the scales have been found to be fairly independent of the mental state of the subject (11). The inventory comprises 135 items grouped in 15 scales. Most of the scales are based on hypotheses of biologically relevant temperament dimensions (9). In most scales, the items were primarily selected on rational-theoretical grounds rather than by factor-analytical or empirical techniques. The scales have later been subjected to psychometric analyses and personality traits, as assessed by the KSP in a non-patient sample, have been found to be stable over 9 years, both with regard to absolute and relative stability (12). Four scales concern anxiety proneness: Somatic anxiety (autonomic disturbances, vague distress and panic attacks), Psychic anxiety (cognitive, social anxiety, worrying, insecurity), Muscular $Tension_{KSP}$ (subjective muscular tenseness and aches, difficulties in relaxing), and Psychasthenia (low degree of mental energy, easily fatigued). Three scales are related to vulnerability for disinhibitory psychopathology: Impulsiveness (non planning, impulsive), Monotony avoidance (need for change and action) and Socialisation (positive child hood experiences, good school and family adjustment). Six scales are related to aggression and hostility: Verbal aggression (aggressive feelings expressed in style and content of speech), Indirect aggression (undirected expressive aggression), Inhibition of aggression (non-assertive, sad rather than angry), Irritability (irritable, lacking patience), Suspicion (distrusting peoples' motives), Guilt (remorseful). Detachment, which is related to Social withdrawal and Social desirability, which refers to social conformity and control are also included.

Statistical analysis

All statistics were performed using the statistical packages SPSS for Windows (version 9.0) or SIMCA-P (version 7.01). For variables generally mean values $\pm$ one standard deviation ($\pm$1 SD) are reported. The KSP mean scores for the different scales were transformed into normative T scores (mean = 50, SD = 10), based on a Swedish age and sex-stratified, non-patient sample (4). Pearson's correlation analysis was used for bivariate correlations. In the multivariate analyses using SIMCA-P, we started with a principal component analysis in order to detect whether a number of variables reflected a smaller number of underlying factors or components. Some of our variables are inter-correlated and the new groups of variables shown by principal component analysis are labelled components. Principal component analysis can be viewed as a multivariate correlation analysis. A cross-validation method, which keeps part of the data out from the model development to assess the predictive power of the model, was used to test the significance of the components. Only significant components are presented in the tables. Components with Eigenvalues <2.00 were considered as trivial factors and excluded. We have considered loadings $\geq$0.25 in absolute numbers (irrespective of sign) to be high and therefore of interest. Outliers were identified using the two powerful methods available in SIMCA-P: 1) score plots in combination with Hotelling's T^2 identifies strong outliers and 2) distance to model in X/Y-space identifies moderate outliers (13).

In the present study two principal component analyses were made. The initial principal component analysis (data not shown) identified the three or four scales with the highest loadings in each component. These were included in the second principal component analysis (Table V) in which we investigated how selected scales of KSP correlated with the other variables registered. Thus not all scales of the KSP were included simultaneously, in order to make this analysis more focused.

Regression extension of the principal component analysis analyses were then made according to the partial least square technique, which relates 2, x and y, data matrixes to each other by a linear multivariate model. Pain at rest (Y-variable) was regressed using other variables as regressors (X-variables). The influence of each explanatory variable was measured as a variable influence on projection parameter (VIP). VIP was developed to facilitate model interpretation. SIMCA computes the influence of Y of every term (x_k) in the model and VIP is the sum over all model dimensions of the contributions' variable influence. The squared sum of all VIPs is equal to the number of X-terms in the model. Terms with VIP $\geq$1 are the most relevant in explaining Y (here, pain intensity at

Table I. *Mean values ± 1 S.D. for patients' height (cm), weight (kg), body mass index (BMI) (kg/m²) and durations of fibromyalgia diagnosis (years) and widespread pain (years) and age (years)*

Variables	Mean	SD
Age	44.2	9.6
Height	164.8	5.9
Weight	76.0	17.6
BMI	27.9	6.0
Fibromyalgia syndrome diagnosis	3.0	3.6
Widespread pain	5.9	4.1

rest) and one can compare the VIP of one term to other's (13). Multiple linear regression might have been an alternative method for the prediction but it assumes that the regressor variables are mathematically independent and, unlike the method used, high subject to variable ratios are required. All statistical tests were performed at the 5% significance level ($p \leq 0.05$, two-tailed).

RESULTS

Baseline characteristics of patients are shown in Table I.

The results from the isokinetic test, shoulder muscle tension, general muscle tension and pain at resting, pain (movement) and pain map score are shown in Table II.

The FMS group scored significantly higher on three KSP scales measuring anxiety proneness (i.e. Muscular Tension$_{KSP}$, psychasthenia, somatic anxiety) and indirect aggression compared with a normative reference population (Table III). In addition, they scored significantly lower on the detachment scale.

Are the muscle tension and EMG hyperactivity variables intercorrelated?

Muscular Tension$_{KSP}$ correlated significantly with general muscle tension but not with shoulder muscle tension (Table IV). The two perceived muscle tension variables were intercorrelated. The four SAR variables (i.e. the EMG hyperactivity)—positively intercorrelated—showed no significant correlations with Muscular Tension$_{KSP}$, general muscle tension or shoulder muscle tension (Table IV).

Relationships between KSP, pain, general muscle tension, shoulder muscle tension and the isokinetic test variables

The principal component analysis explored the multivariate relationships between KSP scales, pain, general muscle tension, shoulder muscle tension and the variables of the isokinetic test (Table V). One subject was removed from multivariate analysis as being an outlier in the multivariate model.

The *first* component showed that general muscle tension intercorrelated positively with the four of the scales of anxiety proneness (including Muscular Tension$_{KSP}$) and irritability. Thus the relationships between general muscle tension and Muscular Tension$_{KSP}$ reported in Table IV are reproduced in the multivariate context, unspecifically, since all scales of anxiety proneness correlated with general muscle tension.

The *second* component showed that SARi of the two muscles intercorrelated positively with aspects of vulnerability for disinhibitory psychopathology (i.e. impulsiveness and monotony avoidance) and negatively with psychasthenia, pain (movement) and shoulder muscle tension. Thus, high SARi was associated with low shoulder muscle tension and low pain (movement). High SARi was also associated with high impulsiveness and monotony avoidance and low psychastenia trait scale scores.

The two biomechanical variables of the endurance level (peak torque endurance and relative endurance) loaded upon the *third* component and correlated positively with inhibition of aggression and psychic anxiety and negatively with SARe of trapezius, pain (movement) and verbal aggression.

Table II. *Mean ± 1 S.D. for signal amplitude ratio initially (SARi) and endurance (SARe) of the trapezius and infraspinatus, biomechanical output (peak torque initially (PTi), peak torque endurance (PTe) and relative peak torque endurance (PTer), pain intensity at rest and pain intensity (movement), perceived shoulder muscle tension (SMT) and general muscle tension (GMT) and number of pain areas on pain map*

Variables	Mean	SD
SARi trapezius	17.3	14.0
SARe trapezius	14.8	14.4
SARi infraspinatus	18.0	12.5
SARe infraspinatus	12.9	9.9
PTi (Nm)	29.9	8.5
PTe (Nm)	16.2	4.7
PTer (%)	55.8	22.4
Pain at rest (mm)	44	18.5
Pain (movement) (mm)	56	18.5
SMT (mm)	59	23.9
GMT (mm)	56	21.8
Pain areas (numbers)	20.6	7.3

Table III. *The Karolinska Scales of Personality trait scores compared with the sex- and age-matched reference population. *p < 0.05 level versus reference population*

Scales	Mean	SD	*p*
Somatic anxiety	56.7	11.1	*
Psychic anxiety	47.7	10.2	
Muscular Tension$_{KSP}$	65.3	10.3	*
Psychasthenia	61.9	9.7	*
Impulsiveness	52.2	6.4	
Monotony avoidance	52.5	9.8	
Socialization	49.3	10.0	
Indirect aggression	54.8	8.6	*
Verbal aggression	51.9	10.1	
Inhibition of aggression	47.4	10.5	
Irritability	51.4	9.0	
Suspicion	51.5	9.5	
Guilt	47.7	8.4	
Social desirability	48.6	10.3	
Detachment	46.7	7.3	*

Table IV. *Bivariate correlation coefficients (Pearson) for the interrelationships of Muscular Tension$_{KSP}$, perceived shoulder muscle tension (SMT), general muscle tension (GMT) and EMG hyperactivity in the isokinetic test (i.e. the four signal amplitude ratio (SAR) variables). * Denotes significant correlation (case no. 13 excluded as multivariate outlier)*

	Muscular tension$_{KSP}$	Shoulder muscle tension	General muscle tension	SARi trapezius	SARi infraspin	SARe trapezius
SMT	0.33					
GMT	0.52*	0.65*				
SARi trapezius	−0.02	−0.23	−0.09			
SARi infraspinatus	0.04	−0.30	−0.29	0.52*		
SARe trapezius	−0.03	−0.01	0.08	0.67*	0.36*	
SARe infraspinatus	0.29	0.07	0.27	0.40*	0.58*	0.49*

SARi = signal amplitude ratio initially; SARe = signal amplitude ratio endurance level.

Three out of four SAR variables and peak torque relative endurance correlated positively with pain (movement) and pain at rest and negatively with verbal aggression and irritability according to the *fourth* component. Pain (movement) showed relatively high absolute loadings (≥0.25) on three of the four components, indicating interaction with many of the investigated variables.

Muscle tension versus pain intensity

In the next step we regressed pain (movement) and pain at rest using the other variables as regressors (X-variables; cf Table V). It was only possible to significantly regress pain at rest ($R^2 = 0.47$). The significant variables were: general muscle tension (VIP = 2.07), indirect aggression (VIP = 2.06), psychasthenia (VIP = 1.95), pain map (VIP = 1.85), shoulder muscle tension (VIP = 1.60), SARe of infraspinatus (VIP = 1.18), Muscular Tension$_{KSP}$ (VIP = 1.16), monotony avoidance (VIP = 1.08). All had positive correlations with pain at rest, except indirect aggression and monotony avoidance. Thus, even though the EMG hyperactivity and perceived muscle tension are not intercorrelated, they are linked to pain at rest, number of areas with pain and some of the KSP scales.

Table V. *Loadings from the principal component analysis of selected scales of Karolinska Scales of Personality, pain variables, perceived general and shoulder muscle tension and the variables of the isokinetic endurance test (peak torque initially (PTi), peak torque endurance (PTe) and relative peak torque endurance (PTer), signal amplitude ratio initially (SARi) and endurance (SARe) of the trapezius and infraspinatus). Four significant components (p1–p4) were found. Absolute loadings >0.25 are shown in bold type. The variation explained (R^2) of each significant component is shown on the two bottom lines (case no. 13 excluded as multivariate outlier)*

	Component			
Variables	p[1]	p[2]	p[3]	p[4]
PTi	−0.23	−0.13	0.19	0.12
PTe	−0.06	0.01	**0.48**	−0.15
PTer	0.11	0.15	**0.27**	**−0.30**
SARi trapezius	0.09	**0.30**	−0.11	**−0.31**
SARi infraspinatus	0.12	**0.32**	−0.03	−0.14
SARe trapezius	0.09	0.24	**−0.25**	**−0.28**
SARe infraspinatus	0.22	0.16	−0.11	**−0.29**
Shoulder muscle tension	0.17	**−0.32**	0.02	−0.20
General muscle tension	**0.27**	−0.20	−0.13	−0.21
Pain map	0.02	−0.22	−0.07	−0.01
Pain at rest	0.20	−0.22	−0.06	**−0.28**
Pain (movement)	0.05	**−0.25**	**−0.27**	**−0.27**
Somatic anxiety	**0.32**	0.09	0.06	0.23
Psychic anxiety	**0.37**	0.01	**0.25**	0.07
Muscular Tension$_{KSP}$	**0.37**	−0.09	0.03	0.07
Psychasthenia	**0.26**	**−0.28**	−0.18	0.09
Impulsiveness	0.08	**0.31**	−0.02	0.01
Monotony avoidance	−0.10	**0.32**	−0.04	0.07
Inhibition of aggression	0.17	−0.09	**0.42**	−0.08
Verbal aggression	0.13	0.12	**−0.33**	**0.37**
Irritability	**0.33**	0.08	−0.09	**0.27**
Suspicion	0.19	0.15	0.11	−0.03
Guilt	0.19	0.17	0.22	0.21
Detachment	0.17	−0.08	0.14	0.16
R^2	0.20	0.16	0.13	0.10
R^2(cum)	0.20	0.36	0.49	0.58

DISCUSSION

The main findings of this study were:

- Perceived muscle tension and muscle tension as a personality trait did not correlate with EMG hyperactivity (high SAR).
- EMG hyperactivity and perceived general and local (shoulder) muscle tension were associated with pain (pain intensity at rest and number of areas with pain), psychastenia, indirect aggression and monotony avoidance.
- EMG hyperactivity was associated with high impulsiveness, monotony avoidance, pain at rest and relative endurance and with low psychastenia, verbal aggression and irritability.
- Perceived general muscle tension correlated with aspects of anxiety proneness (including Muscular $Tension_{KSP}$) of the trait scales.
- The FMS patients scored higher than a reference population on the trait scales psychasthenia, somatic anxiety, indirect aggression and muscular tension, and lower on detachment.

Perceived muscle tension and electromyographic tension

Contrary to our initial hypothesis, we found in this group of FMS patients no positive association between perceived muscle tension and EMG hyperactivity. Neither bivariate nor multivariate analysis showed positive significant correlations between SAR variables, general muscle tension and shoulder muscle tension and Muscular $Tension_{KSP}$. This contrasts with earlier results which identified a (non-significant) positive correlation between SARe of trapezius and Muscular $Tension_{KSP}$ (5). In that study the material was smaller, heterogeneous (9 each of healthy subjects, patients with trapezius myalgia and patients with FMS). Other groups have reported similar results to the present study for other subjects: neither Vasseljen and colleagues (in subjects with neck-shoulder pain) (14) nor Bansevicius and colleagues (in pain-free subjects) (15) found a correlation between perceived muscle tension and EMG activity.

Even though perceived muscle tension, Muscular $Tension_{KSP}$ and SAR variables were not intercorrelated they were all to some extent related to intensity of pain. Muscular $Tension_{KSP}$, general muscle tension and shoulder muscle tension and SARe of infraspinatus correlated positively with pain at rest. It was not possible to regress pain intensity (movement) (data not shown) and this variable showed complex interrelations with others (loaded significantly upon 3 out of 4 components of Table V). The consensus in the literature is that patients with chronic pain do not have increased muscle activity according to EMG at *rest*. However, during *dynamic* muscle activity several studies have indicated that pain is associated with increased EMG activity especially in parts of the contraction cycles in which low activity or none are normally seen (for references see 16). Thus, in a study of chronic low back pain patients compared to experimentally induced acute pain in back muscles of healthy controls, both acute and chronic pain were correlated significantly to increased EMG activity during gait (17). However, perceived muscle tension may affect differently the relationships between chronic pain and dynamic EMG activity, and acute pain and dynamic EMG activity. Pain-reducing therapies resulted in reduction in regional pain and perceived general tension, while trapezius EMG activity was unchanged or increased in neck-shoulder pain patients (14). Bansevicius and colleagues, using a mental stressor combined with maximal voluntary contractions protocol, noted a tendency to higher EMG activity in the trapezius region seen in pain v pain-free subjects at end of test (15). Vasseljen & Westgaard found differing relations between perceived tension and EMG activity in office workers and manual workers with regional pain and their respective controls. They suggest one interpretation might be that general tension represents a physiological activation response in which muscle fibre activation is not necessarily included (18).

Electromyographic variables versus personality traits

Increased "unnecessary" muscle tension or hyperactivity can according to Simons & Mense (1) be linked to (i) psychological stress and anxiety, (ii) overload from sustained contraction or repetitive activity and (iii) inefficient (untrained) use of muscles. Evidence for the first factor—psychological stress and anxiety—operant in this FMS group is indirect. FMS patients scored higher than the reference population for somatic anxiety. But we found no positive significant correlations of high SAR with the scales covering anxiety proneness in KSP (Table V, second and fourth components). The only scale (one of four) within anxiety proneness that correlated with the SAR-variables was psychastenia, a negative correlation. High SAR in the initial part of the test (SARi) here were associated with traits of high impulsiveness and high degree of monotony avoidance and low psychastenia (Table V; second component). These personality traits *might* lead to life stress in a person who limits her activities because of pain and other FMS symptoms. Increased muscle activity in response to mental stressors has been found experimentally, although not consistently (15, 20). The loading of SAR variables and KSP variables upon two different components (second and fourth components of Table V) may reflect the structure of KSP, since verbal aggression and irritability, and impulsiveness and monotony avoidance, loaded upon different components in the initial exploratory principal component analysis i.e. low or no correlations between the scales in these two components. SARi of the trapezius and both SARe variables also correlated (negatively) with verbal aggression and irritability (Table V, fourth component). Thus EMG hyperactivity was not linked to high but to low aggression. To summarize: two areas of KSP (i) vulnerability for disinhibitory psychopathology and (ii) aggression and hostility) seem to correlate with EMG hyperactivity and the group as a whole has a high somatic anxiety personality trait.

The second factor—overload from sustained contraction or repetitive activity—is difficult to assess. The patients' peak torque declined during the initial part of the test but this pattern is also seen in healthy subjects and the *relative* peak torque level (relative endurance) in the present FMS patient group was similar to healthy controls (19). Even though a positive correlation existed between intensity of pain (at rest and movement) and SAR (Table V, fourth component) it was not associated with different pattern (i.e. lower relative peak torque). These findings do not indicate overload. But the *absolute* peak torque variables of the group with FMS were significantly lower compared to healthy controls' (19). The negative correlation between SARe of trapezius and the absolute levels of PTi and endurance, inhibition of aggression and psychic anxiety (Table V, third component) *might* be interpreted as that high SARe and lower output throughout the test is associated with a physiological or psychological overload situation, but this is speculation. So an overload situation may exist, but the evidence from this study is limited.

The third factor—inefficient (untrained) use of muscles—seen as EMG activity and force variables, has been shown to distinguish the wrist action of the novice from the experienced pilot (21). It is conceivable, possibly because of pain, that FMS patients need a longer familiarizing procedure pre-test than (pain-free) controls or need repeated trials before a more "normal" level of SAR can be achieved. However not all patients with pain (FMS or chronic whiplash disorder) have increased SAR (19) and how neural mechanisms of musculoskeletal pain moderate muscle performance is not completely understood (for a review see 22).

Personality traits according to KSP

In agreement with the previous studies (4, 5) the FMS patients scored higher than healthy controls in traits of somatic anxiety, muscular tension and psychastenia and lower in detachment traits, but in addition, in this study scored higher in indirect aggression (Table III).

The Muscular Tension scale of KSP includes at least 2 out of 10 items that might be influenced by FMS pain and symptom severity: "I often have aches in my shoulders and in the back of my neck" and "In the late afternoon I often get a headache that feels as if there were an iron band across my forehead". However, general muscle tension correlated with Muscular Tension_{KSP} (Table IV) even though the degree of correlation was moderate (R = 0.52).

We also considered the possibility that the psychasthenia scale of KSP in patients with fibromyalgia was influenced by other symptoms or consequence of the symptoms (pain, sleep disturbance, less stress tolerance, aerobic deconditioning, for example) themselves. Higher psychasthenia trait score compared with patients with rheumatoid arthritis was found in a FMS group with diagnosis mean duration of 10.3 (S.D. ± 5.8) years. Analysis of each scale item in FMS versus healthy controls showed significant differences only in the 5 of 10 items that were more readily interpreted as physical symptoms of reduced energy and endurance and sleep disturbance (4). However, another group using the Minnesota Multiphasic Personality Inventory found higher score for psychastenia in FMS (symptom duration 7 years) compared with both rheumatoids (symptom duration 6.5 years) and healthy controls (23), compared with 5.9 (S.D. ± 4.1) widespread pain years in this study.

Detachment trait in FMS patients was lower in than in the reference population. Support for this may be indirectly found in an interview study of 22 female Swedish FMS patients in which internal demands to be capable, effective, caring and friendly were categorised as over-compensatory perseverance (one of four categories of psychosocial vulnerability) (24).

The present group of FMS patients had higher indirect aggression than the reference population, a result not previously found in FMS patients (4, 5). A higher anger (i.e. state anger and anger turned inward) has been reported in patients with pain (FMS, rheumatoid arthritis and low back pain) compared with healthy subjects (25). In idiopathic pain patients indirect aggression has been found to be lower than in age- and sex-matched healthy controls (26).

In conclusion, we were unable to find strong correlations between EMG hyperactivity and perceived muscle tension but both were associated with pain intensity, particularly pain at rest, in this group of patients with FMS. When patients report muscle tension they may be expressing something other than physiological muscle tension. This study suggests that clinicians should consider the possible influence of both pain and personality traits on perceived muscle tension in patients with fibromyalgia. Whether the multivariate relationships reported in this study also are valid for other groups of patients with chronic pain is not known and should be investigated in future studies.

ACKNOWLEDGEMENTS

Barbro Larsson for doing the EMG tests and data collection. Study support from the Swedish Medical Research Council (grants nos 9523, 12260 and 12345).

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