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Original Investigation

Muscular hypertonicity: a suspected contributor to rheumatological manifestations observed in ambulatory practice

Alfonse T. Masi[1], Sona Kamat[2], Richard Gajdosik[3], Naila Ahmad[4], Jean C. Aldag[1]

Abstract

Objective: The objective of this retrospective study of non-inflammatory rheumatic disease patients was to investigate if the individuals clinically identified with muscular hypertonicity (MHT) had increased clinical manifestations compared with those of age- and gender-matched patients with the same disorders.

Material and Methods: The MHT status was clinically identified in the rheumatologist's myofascial protocol examination as relatively increased passive resistance of relaxed muscle on a slow gentle stretch. Clinical and laboratory data were abstracted on a pre-coded form, including symptom and physical examination features, serum assays, and medications.

Results: The 19 MHT cases complained of greater subjective stiffness (p=0.010) and tiredness (p=0.018) at initial encounters and increased aching pain (p=0.049) and were prescribed more (p=0.003) mild narcotic analgesics than the 19 comparison patients. The cases had higher (p=0.027) serum creatine kinase levels, and patients with diffuse MHT had greater frequency of heavy (30+pack-years) cigarette smoking (p=0.002) than comparison subjects. Narcotic usage was also greater in cases with diffuse involvement.

Conclusion: Non-inflammatory rheumatic disease patients with MHT had an overall similar profile as that of comparison patients but had greater musculoskeletal complaints, and those with diffuse involvement had greater narcotic usage. Further research, including quantitative measurements of muscle stiffness, are required to determine whether MHT is a documented entity associated with increased rheumatological manifestations.

Keywords: Skeletal muscle, myofascia, hypertonicity, creatine kinase, stiffness, fibromyalgia syndrome

Introduction

Muscular hypertonicity (MHT) is recognized in neurological practice as occurring in various pathological conditions, e.g., post-stroke spasticity (1-3) or rigidity in Parkinson's disease (4). In rheumatologic and physiatric practices, MHT may also be observed in patients with pericranial and cervical muscle stiffness of tension-type headache (TTH) (5, 6) or associated with other painful syndromes of the neck and shoulders (7). Increased trapezius muscle hardness or tightness has been observed in TTH patients compared with that in control patients (5, 6); however, quantitative measurements remain limited.

Muscular hypertonicity is generally believed to be either an associated or secondary consequence of various pain generating or other underlying abnormalities (1-5, 8) but has not been viewed as a form of primary, constitutional MHT (9, 10). Human resting muscle tone/tonus or tightness (HRMT) is a challenging intrinsic physical property, independent of the central nervous system (6, 9-11). Consequently, a differentiation of passive HRMT from central nervous system (CNS) activated tension is challenging (6, 9-13).

Actively contracted muscle stiffness can be detected by electromyography (EMG) (14). However, even without concurrent EMG monitoring, reliable clinical evaluation of passive tonus can be performed, provided that proper techniques are used in the maneuvers (Table 1). Among juveniles and young adults, phenotypic variations (polymorphisms) in muscular hypertonicity are known to affect various regions of the body, e.g., hamstring tightness. Increased tonus may be related to the individual's body build, gender, or degree of flexibility training (15, 16). Athletic coaches and directors have expressed beliefs that sports injuries can be increased when overloaded muscles are either too tight or insufficiently strengthened (15). A wide range of muscle tightness vis-à-vis extensibility or flexibility has been documented among young sports participants, which tends to correlate with the chosen type of athletic competition (15, 16). Different degrees of constitutional muscular tonicity (or tightness) may be advantageous in one or another sport (17), as is observed for strength and physical endurance (18).

The clinical assessments of resting muscle tonus are influenced by the muscle length, which affects joint range of movement (ROM). The resistance an examiner feels on passive stretching could also be attributed

1 Department of Medicine, Illinois University Faculty of Medicine, Peoria, United States

2 Department of Medicine, Barnes West Medical Consultants, St. Louis, United States

3 Department of Physical Therapy and Rehabilitation, Montana University Faculty of Health Professions & Biomedical Sciences, Missoula, United States

4 Department of Medicine, Washington Minor and James Medical University, Seattle, United States

Address for Correspondence: Alfonse T. Masi, Department of Medicine, Illinois University Faculty of Medicine, Peoria, United States

E-mail: amasi@uic.edu

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Table 1. Outline of maneuvers to assess passive resistance on stretching

Examiner's maneuvers	Neck muscles	Shoulder muscles	Lower body muscles
Reassure the patient	Yes	Yes	Yes
Facing the patient	Yes, patient is sitting	Yes, patient is sitting	Yes, for calves, but supine or prone for hamstring and back examination
Preparatory ROMs	Yes	Yes	Not routinely
Placement of hands	Examiner's thenar eminences on mandables and fingers extended to occiputs to hold the head firmly during passive neck movements	Ipsilateral palm on top of shoulder to stabilize the scapula, allowing extended thumb and fingers to feel the deltoid muscle for consistency. Contralateral hand supports the elbow for passive abduction	In grading hip joint stiffness, the patient is supine with hips and knees flexed 90 degrees. The left hand stabilizes the flexed knee and hip. Right (or dominant) hand rotates the leg at the ankle
Slow and gentle passive movements	Short-range: arcs of rotation; lateral bending; flexion; extension, and combined directions, and repeated twice	The arm is abducted in ramp-up stretch to the horizontal (and tested 5–10 degrees extra, as is normal). Internal and external rotation is tested in abduction to evaluate ROM but is not graded for stiffness	Hamstring resistance is tested in straight leg raising, and terminal elevation is recorded as well as the palpable degree of firmness
Assessment of stiffness	Resistance is graded from static balanced head position to the minimal, comfort passive arcs of movements. Localized resistance can be detected in muscle groups on one or both sides	Resistance is graded at end-stretch or near the terminal end-range of movement (circa the horizontal level)	Paralumbar firmness is tested in the prone, relaxed supported position on the exam table. Calf firmness is palpated in sitting position while the ankle is passively dorsi-and plantar-flexed
Patients reactions	Grading not performed if discomfort occurs	Typically relaxed for testing resistance	Typically relaxed for testing resistance
Can asymmetrical tightness be assessed?	Yes	Yes	Yes

ROMs: range of movement

to connective tissue elasticity or laxity (16, 19). Range of joint mobility varies considerably in the normal population, depending upon age, gender, and ethnic origin (20, 21). Correlations occur in the ROMs of different joints studied in individuals. Findings imply constitutional as well as localized mechanisms influencing variations in joint mobility (20, 21).

Stiffness of normal and diseased joints is largely a result of elastic (velocity independent) and viscoelastic (velocity dependent) resistance of soft tissues, particularly muscles (9-11, 22). Besides studies on young athletes (15, 16), little attention has been given to the possible consequences of phenotypic variations in adult muscle tone (9, 10, 23).

Material and Methods

Patients studied

The recorded data on adult patients with non-inflammatory conditions included in this study were acquired by a senior attending rheumatologist (ATM) in the course of clinical care from 1980 to 2001. Patients with any medical or neurological condition, which could have been predisposed to MHT, were systematically excluded from study, e.g., hypothyroidism, hypocalcemia, hyperventilation, use of statin drugs, Parkinson's disease, CNS ischemic events, stiff-persons' syndrome, Persian Gulf War syndrome of myalgia, and consistently elevated muscle enzymes (1, 8, 24-27). To reduce bias, the comparison subjects were selected from a complete index of patients who had the same categories of non-inflammatory rheumatic disorders, were of the same gender, and were closest in age to the cases but without notations of muscular hypertonicity. The analyzed data were abstracted from medical records of study subjects, during 2001–2003, by two residents of the Rheumatology service (SK&NA, now practicing rheumatologists). Preliminary results were presented at the 2004 American College of Rheumatology meetings (28). The research was approved and is in compliance with the Institutional Review Board (IRB) requirements (Community IRB UICOM-P, exempt study #01-107).

Assessment of muscular hypertonicity as a clinical rheumatological finding (Table 1)

Muscular hypertonicity (i.e., increased passive stiffness or tightness) was defined as an unexpected degree of physical resistance to manual movement of a joint(s) on slow, gentle stretching, e.g., rotation of the neck or abduction of a shoulder. During assessments, the patients were encouraged to psychologically relax to diminish self-guarding or segmental stretch reflexes. Cervical and shoulder girdle muscle tightness were routinely and systematically assessed by a myofascial protocol (Table 1). The senior author (ATM) executed the protocol as part of the full diagnostic musculoskeletal examination during the initial and follow-up visits of all referred patients with such localized pain. Lower extremity muscle tightness was generally assessed in patients with symptoms in the pelvic girdle or lower limbs (Table 1).

The ease by which tissues can be physically deformed is compliance (10). It was assessed by the degree of resistance felt on firm palpa-

Table 2. Clinical features of muscular hypertonicity (MHT) cases and control (CN) patients

Muscular hypertonicity (MHT) cases					Control patients			
		Resistance tostretch†				Resistance to stretch†		
Pair and gender	Entry Age	Neck	Other MHT	Diagnoses	Entry Age	Neck	Other MHT	Diagnoses‡
1 - M	50	3	shoulders-1, axial-1	FMS, TBS	43	1	shoulders-1	OA, Sh strain‡
2 - M	75	3	-	FMS, TMS	70	1	shoulders-1	DISH
3 - F	32	1	trismus-3	LF, TMS	39	1	-	LF
4 - M	43	3	axial-2	FMS, TBS	40	0	-	LF
5 - M	54	2	axial-2	LF, TMS	49	1	-	LF
6 - M	72	2	shoulders-1	LF, TMS	62	0	axial-1	OA
7 - M	60	2	shoulders-1, axial-1, calves-1	OA, TMS	55	0	-	LF
8 - M	61	0	shoulders-1, axial-1, calves-1	OA, TBS	59	0	shoulders-1	OA, Sh strain
9 - F	48	2	shoulders-1	LF, TMS	47	0	shoulder-1	LF
10 - F	52	0	axial-1, hamstrings-1	FMS, TMS	51	0	-	FMS
11 - F*	29	2	axial-1	FMS, TMS	33	1	-	LF
12 - M	59	2	shoulders-1, axial-1,calves-1	FMS, TBS, also OA	52	0	shoulders-1, calves-1	FMS
13 - F	66	2	shoulders-1, axial-1	LF, TMS	66	1	axial-1	OA
14 - M*	39	0	shoulders-1 hamstrings-1	FMS, TMS	39	0	-	LF
15 - F	42	0	shoulders-1 axial-2	FMS, TMS	46	0	-	LF
16 - M	46	1	shoulders-1, axial-3, calves-3	LF, TBS	45	1	-	FMS
17 - F	42	0	shoulders-1 axial-1	LF, TMS	46	1	-	OA
18 - F	78	1	axial-2	OA, TMS	77	1	axial-1	FMS
19 - M	46	0	shoulders-1	TMS	46	0	-	LF

*HLA-B27 positive, †0=Not detected, 1=Mild, 2=Moderate, 3=Marked.
‡Sh strain: shoulder strain; FMS: fibromyalgia syndrome; LF: localized fibromyalgia; MHT: muscular hypertonicity; OA: osteoarthritis; TBS: tight body syndrome/generalized form; TMS: tight muscle syndrome

tion or pressure. Decreased muscle compliance (i.e., hardness) can be clinically referred to in qualitative degrees of firmness. In physical terms, compliance is the reciprocal of stiffness (10). Compliance of the proximal deltoid was routinely assessed by palpation as part of the shoulder examination. The lower back, hamstring, and calf muscle firmness was also assessed when clinically warranted.

Muscle stiffness was graded by perceived resistance to passive movements on the following ordinal scale: none or 0, being no perceived increase in resistance; mild or 1, being a slight increase or giving a catch; moderate or 2, being definitely resistant but relatively easily maneuvered; and marked or 3 (the highest category), being considerable resistance to passive motion. The gradations were personally modified from the scale of Ashworth (29, 30), and any patient suspected of Parkinson's disease during follow-up was excluded from the study.

Stiffness of neck myofascia on rotation and other passive slow, gentle movements were assessed in a most limited comfort range of a few degrees (Table 1). The maneuvers did not exceed any limitation of movement (LOM) elicited by reflex or joint pain. Neck stiffness was routinely assessed following the evaluation of its range of movements (ROMs) to further relax and stretch these muscles and achieve a baseline status of stiffness. Thus, the feel of a stiffened muscle in the restricted arc could be differentiated from a shortening or from a reflex muscle contraction. The maneuvers are consistently free from induced pain. Stiffness of shoulder muscle movement was assessed near the end-range during the passive abduction (Table 1). It was also graded as none, mild, moderate, or marked, as modified from the scale of Ashworth (29, 30).

Categorization of MHT cases into the subgroups of TMS vs. TBS

The MHT cases were patients generally diagnosed with either fibromyalgia [localized (LF) or generalized (FMS)] or osteoarthritis (OA) and who were clinically assessed to have increased muscle tonicity without a recognized underlying contributory condition or factor. Such patients had consistent hypertonicity on multiple visits, generally at the neck of moderate or greater degree or at a combination of other sites of mild or greater degree (Table 2). The total 19 MHT cases had either localized (n=14) tight muscle syndrome (TMS) or more generalized (n=5) tight body syndrome (TBS), depending upon the degree and extent of clinically ascertained MHT. The patients with TBS (nos. 1, 4, 8, 12, and 16) had chronic and persistent MHT of greater degrees than the 14 TMS patients (Table 2), and both their subjective and objective stiffness hardly varied between visits.

Comparison subjects (controls)

Comparison patients also had primary diagnoses of either fibromyalgia (LF or FMS) or OA but without recognized MHT of moderate or greater degree at one or more sites over their

course of follow-up. Typically, control patients had either no clinical evidence of hypertonicity or a mild and localized degree intermittently. If present, it may have affected the neck and often was associated with stressful states. Six controls had mild muscular hypertonicity at two separate sites over their follow-up course. Because secondary MHT could be associated with or result from trigger point(s), as found in the myofascial pain syndrome (8, 31), such patients were excluded from both the case and control groups. To increase comparability, control subjects were paired based on gender and matched to the cases within 5 years of age, except for pairs 1 and 3 (7 years) and the oldest 72-year-old patient (10 years). One of the MHT patients was an African American, who was matched to a Caucasian control subject.

Laboratory variables analyzed

Recorded laboratory data in the study subjects' clinic records were abstracted as relevant to excluding diagnoses (e.g., rheumatoid factor and HLA-B27 status), degree of inflammation (hemogram, ESR, serum albumin and globulin), muscle enzyme levels (CK, AST/SGOT, ALT/SGPT), and other relevant variables (serum calcium, cholesterol, and TSH levels) on entry (or earliest value) and at the last visit (or most recent value).

Statistical analysis

A pre-coded data retrieval form was used to extract predefined items retrospectively from the clinic charts by the physician research assistants (SK and NA). Screening for variables of interest was performed on unpaired sets. Data analysis began with examining descriptive statistics (means, standard deviations, frequencies, ranges, and correlations). Differences in dichotomous variables were tested using the chi-square test, unless the cells were small (n=5 or less). In addition, Fischer's exact test was computed for comparisons of either two or three subject groups (<http://vassarstats.net/fisher2x3.html>). When the variable was ordinal (e.g., none, mild, moderate, or marked), the Mann–Whitney U test was used to assess differences between two groups. When an interval variable was normally distributed, t-tests were used to assess differences between two groups. The study groups were also stratified as ordinal gradients of muscular tonicity, CN=0, TMS=1, TBS=2. Those subgroups were further analyzed with selected variables by Pearson partial correlations (adjusted for gender). All computations were accomplished with Statistical Package for the Social Sciences SPSS version 12.0 (SPSS Inc., Chicago, IL, USA). Alpha was set at $p \leq 0.05$, and no correction was made for multiple comparisons because the sample sizes were relatively small (32).

Table 3. Comparable clinical features between study groups*

	MHT (n=19)		Controls (n=19)		
Clinical features	Numbers (Percent)	Means	Numbers (Percent)	Means	p
Entry age (years) mean		50.8		52.0	0. 714
Localized (vs. more diffuse) presenting complaints	10 (52.6)		11 (57.9)		1.00
Widespread pain by FM criteria (need ref)	11 (57.9)		7 (36.8)		0.330
Cramping or spasms by history	9 (47.4)		6 (31.6)		1.00
Poor sleep quality	13 (68.4)		8 (42.1)		0.19
Anxiety or depression recorded by attending	8 (42.1)		13 (68.4)		0.192
Anxiety or depression treated by attending	3 (15.8)		5 (26.3)		0.713
Functional modifications	9 (47.4)		7 (36.8)		0.526
Chronic headaches	7 (36.8)		7 (36.8)		1.00
Chronic fatigue	1 (5.3)		3 (15.8)		0.597
Irritable bowel symptoms	6 (31.6)		5 (26.3)		1.00
Body mass index, mean		27.5		27.3	0.917
Body mass index 30+	8 (42.1)		4 (21.1)		0.295
Tender points, mean		9.9		7.2	0.119
11 or more tender points	11 (57.9)		6 (31.6)		0.183
Years of illness, mean		14.3		7.9	0.181
Improvement noted in response to initial therapy	9 (47.4)		13 (68.4)		0.325

*No variable differed significantly between the MHT vs. CN groups.
MHT: muscular hypertonicity; FM: fibromyalgia

Results

All five cases with TBS are males, as opposed to 6 (43%) of the 14 TMS counterparts (p=0.044) (Table 2). Among the 19 MHT cases, 10 (53%) had moderate (=2) or marked (=3) resistance to passive neck rotation on repeated visits, which was not noted in any control patient (Table 2). Five of the remaining nine MHT patients had mild bilateral shoulder muscle tightness on passive abduction associated with axial firmness, which was not observed in any control. The four remaining MHT cases, who had absent or mild neck stiffness, had either combined regional or moderate (=2) or marked (=3) tightness in other muscle groups. One control male patient (pair #12) had chronic mild (=1) shoulder tightness and calf muscle stiffness (=1) on one visit when perceived to be anxious and tense. No control patient showed persistent indication of MHT, as assessed in this study.

The MHT cases and control patients had similar clinical diagnoses by conventional criteria and by study design (Table 2). Accordingly, many clinical features were comparable in the MHT and CN patients, as summarized in Table 3. None of the listed features differed significantly between the groups (Table 3).

Several clinical features differed significantly between the total 19 MHT and19 control patients (Table 4). The MHT cases had greater degrees of subjective complaints of feeling stiff (p=0.010) at the initial encounter as well as increased tiredness (p=0.018) compared with those of the control subjects (Table 4). Muscle mass was palpably or visually assessed to be somewhat increased or more bulky in the MHT cases (p=0.027), although body mass index (Table 3) was closely comparable (p=0.917) between the groups. A ratio of the highest serum creatine kinase (CK) levels recorded in patients'

Table 4. Clinical features which differed between study groups

	Muscular hypertonicity (n=19)		Controls (n=19)		
Clinical features	Number (%)	Mean (SEM)	Number (%)	Mean (SEM)	p
Degree of subjective stiffness at entry*		1.76 (0.24)		0.88 (0.21)	0.010
Degree of tiredness complaint at entry*		1.68 (0.17)		1.26 (0.15)	0.018
Clinical assessment of increased muscle mass†		0.67 (0.22)		0. 25 (0.11)	0.027
Entry CK ratio >2.0x the upper normal limit	5 (26.3)		0		0.046
Entry cholesterol (mg/dL)		205.1 (5.60)		220.6 (7.25)	0.034
Entry cholesterol <200 mg/dL	10 (52.6)		3 (15.8)		0.038

*0=None, 1=Mild, 2=Moderate, 3=Marked.
†0=Normal, 1=Increased, 2=Bulky, based upon clinical judgment of palpation and visual examination.
SEM: standard error of the mean; CK: creatine kinase

Table 5. Differences in clinical features of subjects by degree of muscular hypertonicity

	Controls (n=19)		TMS (n=14)		TBS (n=5)		
Clinical features	Number	(%)	Number	(%)	Number	(%)	p†
Limited lumbar spine mobility (Shober's test)	4	(21.1)	2	(14.2)	4	(80.0)	0.023[1]
Moderate or marked pain at last visit	4	(21.1)	7	(50.0)	4	(80.0)	0.026[2]
Codeine containing analgesics prescribed	1	(5.3)	3	(21.4)	4	(80.0)	0.03[3]
Cigarettes smoked (30+ pack-years)	3	(15.8)	3	(21.4)	4	(80.0)	0.023[4]
Muscle Enzyme Ratio:							
Entry creatine kinase >1.0x ULN	5	(26.3)	4	(28.6)	4*	(100.0)	0.024[5]

*One TBS case had a missing CK value.
†p values in the table were estimated by Fisher's exact test (see Methods). In addition, Pearson's partial correlation (adjusted for gender) of the degree of assessed muscle tonicity by subgroup categories: CN=0, TMS=1, TBS=2; provided the following probabilities: 1=0.007; 2=0.006; 3=0.001; 4=0.030, and 5=0.019.
TBS: tight body syndrome/generalized form; TMS: tight muscle syndrome; ULN: upper limit of normal

charts of greater than two times (>2.0x) the laboratory normal limits for such testing was more frequently (p=0.046) observed in the MHT cases than in the control patients (Table 4). On the contrary, entry mean serum levels of total cholesterol was lower (p=0.038) in the MHT group than in the CN group (Table 4).

Additional significant differences were observed with selected variables when the study groups were stratified on an ordinal scale: controls=0; TMS=1, and TBS=2, adjusted for gender (Table 5). The five TBS males had greater limitation of lumbar spine motion by the Schober's test (p=0.023). They also generally had a less response to analgesic therapy compared with that of the controls, as indicated by moderate or marked degree of pain at the last visit (p=0.026). The TBS cases were more frequently prescribed with codeine, containing analgesics (p=0.003). In addition, the TBS subgroup had more frequently smoked 30 or more pack-years of cigarettes than the controls (p=0.023). In addition, they had higher (p=0.024) serum levels of entry creative kinase (Table 5).

Discussion

This study deals with the passive component of myofascial tone/stiffness, as assessed by resistance to standardized slow, gentle, limited stretching movements (Table 1). The spectral disorder of inherent joint hypermobility is a commonly recognized syndrome (20, 21), which is genetically determined (33, 34). A question therefore arises: can MHT also be differentiated as a constitutional variant?

The novel findings raise the possibility that a minority of adults may have evidence of MHT clinically, which is possibly inherent, and may have contributed to greater chronic pain complaints or other manifestations. More definitive future studies can include developing instrumentation facilities to measure the muscle's passive properties of stiffness, tension, and viscoelasticity (35, 36) as well as monitor active contractions with surface EMG (14, 37).

In the clinic, muscle tone is conventionally assessed by the degree of tonic resistance to passive movement (28, 29). Manual assessments of muscle tone are challenging. They are only as reliable as the degree of standardization and experience of the examiners (Table 1), which have been variously reported to be both good (1-3, 15, 16) and poor (4, 30). As far as possible, it should be differentiated from the variable degrees of extraneous contractions (i.e., EMG-active) due to either incomplete relaxation or activation from pain, including active or latent trigger points (8, 12).

To increase comparability, control patients were selected with comparable chronic pain disorders as our cases. This type of a design diminishes the likelihood that the degree or type of musculoskeletal condition was a biasing factor in determining the differences found between study groups. For example, many features, including poor quality sleep, chronic fatigue, and functional modifications were similar in both study groups (Table 3).

In this study, muscle stiffness was not believed to be velocity-related or due to reflex spasm because of the technique involved in slow, gentle, limited stretching (Table 1). Exaggerated stretch reflexes could result from trigger points or neurological causes (1-3, 11); however, these factors are not believed to have operated meaningfully in the described assessments or the comparative results. Future studies of MHT may incorporate quantitative measures of stiffness or pressure compliance using myotonometry (4, 37), and their accuracy can be further enhanced with the use of EMG monitoring (14). Consistency in clinical measures of resting muscle stiffness and tightness requires patients to relax to maximal degree in comfortable, balanced postures (13, 38).

Selection bias is also a serious concern generally in clinical research on symptomatic disorders

(39) and even in the current study. Accordingly, our findings should be interpreted cautiously. The data were not collected prospectively to test a predefined hypothesis by structured interviews or protocol examinations. The possibility exists that some control patients may also have had MHT, particularly of lower body regions, which cannot be overlooked. However, such misclassification would have decreased the significance of the observed statistical differences. The possibility also exists that cases had greater overall severity of their respective rheumatologic conditions than the controls.

The largest study group differences were observed between the five TBS cases and the 19 controls or the 33 other combined patients (Table 5). Some of the TBS patients stated that cigarette smoking seemed to lessen their muscle discomfort, and limited data suggest that nicotine is a pharmacological skeletal muscle relaxant (40). The mean (±SEM) pack-years smoked by study subjects was 11.0 (4.3) for 17 CN, 15.5 (7.5) for 12 TMS, and 42.6 (9.3) for the five TBS patients (p=0.030). All five TBS cases had smoked more than 20 pack-years versus 8 (24%) of the 33 combined TMS and CN patients (p=0.003). The TBS patients indicated having had tight muscles since teen or young adult ages.

Presently, regional variants of MHT are recognized in young athletes (16) and in individulas with tight hamstring muscles (22, 41). However, studies have yet to confirm whether such muscles are measurably tight or short. To our knowledge, a more diffuse, inherent TBS has not been reported in juveniles or adults, as opposed to the recognized "stiff-persons' syndrome" (26).

Management of the MHT cases was more attentive and detailed overall than that of the controls, possibly because of their more resistant symptomatology (Table 5). Despite recognizing the described muscular features and advising benefits to be derived from regular stretching and other exercises (42), the TBS cases stated difficulty to adhere to these suggestions on a long-term basis. Prescribed exercises to stretch and relax muscles resulted in lesser subjective improvements in MHT, and particularly in TBS cases, than those in the CN patients. The TBS patients were prescribed increased mild narcotic analgesics (Table 5). If MHT is validated, an objective of future studies would be to develop more effective management programs for symptom control of such patients, including physical measures to reduce muscle stiffness, and to objectively monitor their outcomes.

In conclusion, among ambulatory patients having diagnoses of non-inflammatory rheumatic disorders, those case patients who had associated indications of MHT had greater musculoskeletal complaints than the matched comparison patients with similar diagnoses but without having had the clinical indicators of MHT.

The rarely encountered patients with diffuse MHT were more resistant to clinical management and had exaggerated symptoms, which induced greater prescription of narcotic analgesics. Those cases also had notably heavier chronic cigarette smoking usage.

Recognition of the observed clinical associations in patients with MHT would suggest that they could benefit from additional personalized guidance and physical management techniques (exercise, stretching, relaxation) during their course of treatment. Further research is required to confirm the present observations and associations using the current clinical examination techniques as well as additional recently available instrumentation for quantifying myofascial stiffness, tightness, and other related physical properties.

Ethics Committee Approval: Ethics Committee approval was received for this study from Institutional Review Board University of Illinois (#01-107 annual approval).

Informed Consent: Informed consent was not received due to the retrospective nature of the study. Exempt study based upon review of medical records.

Peer-review: Externally peer-reviewed.

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