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A comparison of the clinical manifestation and pathophysiology of myofascial pain syndrome and fibromyalgia: implications for differential diagnosis and management

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Two prominent forms of chronic musculoskeletal pain disorders are fibromyalgia (FM) and myofascial pain syndrome (MPS). Inconsistent diagnosis of chronic musculoskeletal pain is an important clinical issue, as MPS is often mistaken for FM. Distinction between the two diagnoses depends largely on identification of either tender points or myofascial trigger points in FM and MPS, respectively. However, there currently is no standard diagnostic protocol for MPS. Consequently, this results in a lack of consistency across health care practitioners diagnosing both FM and MPS. Therefore, developing sensitive and reliable mechanism-based diagnostic criteria is imperative

La fibromyalgie (FM) et le syndrome de douleur myofasciale (SDM) sont deux formes de douleur musculosquelettique chronique. Le SDM est souvent confondu avec la FM; un manque de cohérence dans l'établissement d'un diagnostic de douleur musculosquelettique constitue un problème clinique grave. La différence entre les deux diagnostics dépend en grande partie de l'identification des points sensibles ou des points déclencheurs de FM et du SDM, respectivement. Mais il n'existe toujours pas de protocole normalisé pour diagnostiquer le SDM, ce qui explique le manque de cohérence observé chez les professionnels de la santé qui posent des diagnostics de FM ou de SDM. Il est donc primordial d'établir des critères diagnostiques fondés sur un mécanisme cohérent et fiable pour ce qui est de la douleur musculosquelettique. La présente revue vise à examiner

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to the field of musculoskeletal pain. The focus of this review is to discuss the common and unique features of FM and MPS in the context of their epidemiology, clinical features, and pathophysiology. This review will address inconsistency among health care practitioners' diagnoses, and present alternative diagnostic tools with potential for inclusion into a mechanism-based diagnostic protocol.

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KEY WORDS: chiropractic, myofascial pain syndrome, fibromyalgia, treatment, differential diagnosis

*les caractéristiques communes et particulières de la FM et du SDM en tenant compte de leur épid*émiologie, leurs caractéristiques c*liniques et leur physiopathologie. Dans la présente revue, nous abordons l'incohérence des diagnostics posés par des professionnels de la santé et présentons d'autres outils diagnostiques permettant l'inclusion d'un protocole fondé sur un mécanisme.*

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MOTS-CLÉS : chiropratique, syndrome de douleur myofasciale, fibromyalgie, traitement, diagnostic différentiel

Introduction

Musculoskeletal pain is an extremely prevalent clinical condition affecting up to 80% of the general population, 10-20% of which are classified as chronic.[1,2] Two of the most common forms of chronic musculoskeletal pain encountered by chiropractors in daily practice include fibromyalgia (FM) and myofascial pain syndrome (MPS). In the general United States population, the reported prevalence of FM and MPS is 6 million and 9 million, respectively.[1,3] Although the specific Canadian prevalence is unclear, it is likely to show similar prevalence to that of the United States. The prevalence of FM has been reported as high as 15% in clinical populations, while the reported prevalence of MPS in clinical populations varies widely, ranging from 9%-85%.[1,2,4-7] Clinically, FM and MPS present themselves very similarly, although there are significant differences that substantially impact their respective diagnosis and treatment. Chiropractors play an important role in primary care management of chronic musculoskeletal pain. Accurate and reliable differential diagnosis between FM and MPS is essential to ensuring optimal management and patient outcomes.

The greatest societal burden associated with chronic musculoskeletal disorders stems from chronic pain suffering.[1,2] Given its widespread prevalence, it is not surprising that chronic musculoskeletal pain is one of the leading burdens of illness in Canada, with a total financial cost (direct and indirect) of $5.8 billion CAN in 2008.[8] Similarly, the annual national economic burden of chronic pain in the United States in 2010 (healthcare expenses, lost income, lost productivity) is estimated at $560 - $635 billion USD.[9] Given the inconsistency of diagnosis[10,11], the financial burden of FM and MPS are difficult to ascertain from the current literature. Based on a 9% estimated prevalence of MPS in general internal medicine practices[1,7], the estimated contribution of MPS to the financial burden of illness in Canada is $522 million CAN and $50.4 - $57.15 billion USD in the United States. The economic burden of FM alone has been estimated at $10,000 USD per patient over 12 months (2002-2005) in the United States, resulting in an overall cost of $60 billion USD annually.[12]

The existing body of literature suggests that the diagnostic accuracy and reliability of FM and MPS is inadequate.[10,11] Although the two conditions present with some distinctive characteristics, MPS is commonly mistaken for FM.[1,13-15] Similarity in the clinical presentation between myofascial trigger points (MTrP) and tender points (TP) has been suggested as a primary reason for this.[13] Additional explanations include the lack of reliable differential diagnostic laboratory tests[14], potential co-morbidity of FM and MPS[15] and the potential for widespread MPS to present with clinical similarity to FM[1]. Previous research has reported that FM was correctly diagnosed in only 34% of patients presenting with musculoskeletal pain[10], based on the American College of Rheumatology (ACR) 1990 criteria. This poor diagnostic accuracy has been attributed to inconsistent awareness of the 1990 ACR diagnostic criteria between practitioner subspecialties.[16] While up to two-thirds of patients with musculoskeletal

pain complaints are misdiagnosed as FM[10], the proportion of those who exhibit MPS has not yet been established. Moreover, common musculoskeletal complaints such as rheumatoid arthritis and inflammatory spinal disease are also mistaken for FM.[10] This prevalence in FM misdiagnosis raises awareness of the need to consider other differential diagnoses, such as MPS, in patients presenting with chronic musculoskeletal pain.[10]

Poor diagnostic sensitivity and specificity for the differential diagnosis of FM and MPS is an important current limitation in the field of chronic musculoskeletal pain research and clinical practice. Previous research suggests that this may largely be due to inadequate insight into the similarities and differences between the pathophysiology and clinical manifestation of these two conditions.[10,11,13,17] These differences reflect the important differences in clinical management. MPS is largely a regional pain condition which is often managed using conservative interventions including manual and physical therapy, along with exercise.[5] FM, on the other hand, is a more complex condition of widespread pain which, in addition to conservative measures above, often requires a multidisciplinary approach including cognitive-behavioural and psychological interventions along with a wide-scope of potential pharmaceutical interventions that may include tricyclic antidepressants or serotonin reuptake inhibitors.[18]

The objective of this review is to address this gap by comparing and contrasting the clinical presentation and pathophysiology of FM with MPS. The PubMed database was searched using the following main key terms: 'Myofascial Pain Syndrome', 'Fibromyalgia', 'Trigger Points', and 'Tender Points'. Further terms were combined with main key terms including; 'Classification', 'Diagnosis', 'Prevalence', 'Epidemiology', and 'Clinical Decision Rule'. Several of the articles that were included use language such as 'chronic widespread' and 'chronic regional' pain as surrogates for FM and MPS, respectively. Inclusion was determined based on relevance to the primary objectives of the scoping review.

This review emphasizes the urgent need for research in the field of musculoskeletal pain to assist in the development of objective, mechanism-based criteria to properly diagnose FM and MPS. An improved understanding of the clinical and physiologic differences between FM and MPS could help to inform the development of objective diagnostic criteria to reliably distinguish these two prevalent conditions clinically. Increasing awareness of the similarities and differences between FM and MPS is a timely and important priority in the areas of musculoskeletal pain diagnosis and management, given the significant impact of misdiagnosis on unnecessary medical tests and referrals, prolonged time to diagnosis, patient frustration, poor patient outcomes, and increased burden on the health care delivery system.[9,19,20]

Comparison of myofascial pain syndrome and fibromyalgia

Pathophysiology

The etiology and pathophysiology of MPS is still poorly understood. Current prevailing consensus among practitioners is that MPS is characterized by the expression of regionally distributed muscular pain associated with the manifestation of palpable regions of hypersensitivity known as a myofascial trigger point (MTrP). According to the Integrated Hypothesis[21], MTrPs form within the motor endplate region of the muscle[5,21,22] and their pathophysiology is believed to be initiated by local injury from gross or repetitive micro-trauma[5,13]. Local injury leads to an excessive release of acetylcholine and resultant increase in motor endplate activity to mediate the manifestation of a discrete, palpable, hyperirritable locus within the peripheral muscle.[5,21,23,24] Persistent contraction leads to a cascade of biochemical responses, including the release of vasoactive components and inflammatory factors[13,21,23,24] such as bradykinin, that contribute to the expression of localized muscle pain. Concurrently, persistent peripheral nociceptive input releases substance P into the dorsal horn, leading to neuroplastic changes (increased excitability) within the central nervous system, known as central sensitization.[23,25] Alternative hypotheses suggest that neurogenic mechanisms may play an important role in mediating the pathophysiology of MTrPs and MPS, including the expression of sensitized spinal circuits[26] and sensitized motor neurons following the induction of central sensitization[27]. Recent work suggests that neurogenic inflammation, subsequent to central sensitization, could initiate and facilitate the formation of the localized hyperirritable MTrP locus in the absence of local peripheral muscle injury.[28]

The pathophysiology of FM is similarly poorly understood. In contrast to the regionally distributed pain and

Table 1.
Summary of the pathophysiology of fibromyalgia and myofascial pain syndrome.

Characteristic	Fibromyalgia	Myofascial Pain Syndrome
Initiation	• Unknown etiology[13,17,29]	• Initiated by local injury from gross or repetitive micro-trauma[5,13]
Location	• Bilateral, systemic expression of tender points[13,30,31]	• Myofascial trigger points observed at the motor end plate[21,22]
Nature of Pain	• Tender points are an expression of central neural maladaptation	• Increased spontaneous release of acetylcholine[5,23,24] • Increased vasoactive components and inflammatory factors[13,23,24]
Mechanistic Hypothesis	• Central sensitization[33,34] ○ Hyperalgesia ○ Allodynia	• Central sensitization[25,27] ○ Hyperalgesia ○ Allodynia
Symptoms Timeline	• Widespread pain for greater than three months[29,30,31]	• Persisting pain for more than three months[1,3,6,13]

palpable tender nodules associated with MPS, consensus amongst clinicians is that the diagnosis of FM is predicated on the presence of widespread pain greater than three months[29-32] with the expression of symmetrically distributed tender points (TPs) within muscle[13]. Although the etiology of FM is still poorly understood[13,17,29], it is believed that maladaptive central processing[13] may be an important underlying mechanism driving the clinical features of FM. This is supported by the commonly reported expression of generalized muscle soreness[13] and symmetrically arranged tender points in FM sufferers[13,30,31]. Consistent with this theory, it is believed that TPs reside within regions of secondary hyperalgesia[33,34], as increases in the levels of synaptic modulators, such as substance P, have been observed in cerebrospinal fluid samples[35,36]. A potentially key determinant in the differential diagnosis of FM and MPS might include the fact that TPs do not typically express inflammatory factors[13], whereas changes in the biochemical milieu of MTrP regions have been previously reported in MPS[23].

Epidemiology

Prevalence

Both MPS and FM are highly prevalent conditions of chronic musculoskeletal pain, demonstrating broad distribution across populations (Table 2). The prevalence of MPS in chronic pain clinics has been estimated to be as high as 90%[2,5], and 30% of pain-related visits to general internal medicine and orthopedic clinics have been reported to meet the diagnostic criteria for MPS[5]. MPS represents one of the most common reasons for patients to visit a clinic[7] as it affects more than 9 million Americans[1,3]. FM is also highly prevalent in the general population of the United States, presenting in approximately 2% of the general population[1,3] and 15% of hospitalizations in internal medicine[4].

Gender

The reported gender distribution of FM and MPS is similar between men and women (Table 2); however, significant gender differences exist in the development and maintenance of these conditions. It was originally believed that females were more commonly affected by FM than males[1]; however, recent data challenges this belief[29]. While data collected from a Swedish cross-sectional survey determined a two-fold higher prevalence of chronic widespread pain (FM) in women (15.3%) compared to men (7.5%)[37], more recent observations from a survey of the general population in Germany found that FM was not statistically more common in women than men (2.4% versus 1.8%)[29]. As explanation, it was suggested that previously reported gender differences for FM may be attributed primarily to behavioural differ-

Table 2.
Summary of the epidemiology discussed for fibromyalgia and myofascial pain syndrome.

Characteristic	Fibromyalgia	Myofascial Pain Syndrome
Prevalence	• 6 million Americans[1,3] • 15% of hospitalizations in internal medicine[4]	• 9 million Americans[1,3] • 30% of pain-related visits to general internal medicine[5]
Financial Burden	• Contributes approximately $60 billion USD annually in the United States	• Contributes approximately $50.4 – $57.15 billion USD in the United States
Gender	• Similar prevalence between men and women[29]	• Similar prevalence between men and women[37]
Age	• Positively correlated with age • Peak prevalence observed in the 50-74 year age range[41]	• Positively correlated with age • Peak prevalence observed in the 59-74 year age range[37]
Ethnicity	• Not specific to one geographical location	• Not specific to one geographical location

ences between males and females.[29] Women demonstrate health seeking behaviours more frequently than men, a factor that may partially explain the reported 90% female dominance in FM seen in clinics.[29] Moreover, self-report surveys based on the ACR 2010 criteria showed that although men and women report similar widespread pain index (WPI), significant increases in symptom severity score (SS) exist in females versus males.[29,38] One suggested explanation for this observation is that males with FM have lower health awareness[1,29,38] and are socialized to suppress outward signs of pain[38]. In contrast, females with FM exhibit greater pain sensitivity, greater impact on daily life, more frequent work absenteeism and lower quality of life.[1,29,38] The increased pain sensitivity in females is thought to reflect a number of factors including higher levels of trait and state anxiety, increased prevalence of depression, use of maladaptive coping strategies, and increased behavioural activity in response to pain.[38] In comparison to FM, while MPS distribution is balanced between genders, females report greater disease severity over males. A Swedish cross-sectional survey showed that no significant differences exist in the prevalence of chronic regional pain (MPS) between men (23.8%) and women (24.1%).[37] Despite this similarity, females tend to report greater disease severity as measured through higher pain scores, reduced pain thresholds and more frequent work absenteeism.[2,39] Rollman and Lautenbacher[39] noted that women also report greater pain severity, characterized by a greater number of regions affected by pain[37,39]. Rollman and Lautenbacher[39] also postulated that these differences may reflect an underlying gender-dependent state of enhanced sensitivity to deep tissue pain, predisposing women to the development and maintenance of chronic regional musculoskeletal pain such as MPS.

Therefore, recent data suggest that FM and MPS affect men and women equally, although, females with either musculoskeletal condition exhibit greater pain sensitivity, more interference with regular activities, and lower quality of life. Women are more limited by musculoskeletal pain with increased pain scores and more frequent absences from work and other commitments.[1,29] These collective findings suggest that despite the lack of gender effect on the prevalence of MPS and FM, significant gender-differences likely exist in the development and maintenance of chronic musculoskeletal pain due to social and behavioural factors.[1,29,38,39]

Age

Current research suggests that chronic musculoskeletal pain is strongly influenced by age. The number of cases of MPS and FM is positively correlated with age, with the highest prevalence most frequently seen in adults over the age of 60 (Table 2).[29,37] Bergman *et al*.[37] studied a target population of 20-74 years and reported a strong association between the incidence of chronic regional pain (MPS) with age, with the highest occurrence be-

Table 3.
Summary of the clinical presentation of fibromyalgia and myofascial pain syndrome.

Characteristics	Fibromyalgia	Myofascial Pain Syndrome
Distribution	• Widespread muscle pain[29,30]	• Regional muscle pain[1]
Palpatory Findings	• Tender points[1,13,29,30,31] • Discrete areas of soft tissue that are painful in response to 4kg of palpatory pressure[1,13,46]	• Myofascial trigger points[1,5,13,46] • Palpable taut band of muscle containing hyperirritable nodules[21,22]
Associated Observations	• Indistinguishable from normal tissue[13]	• Weakness without atrophy[21,22] • Reduced range of motion[21,22] • Local twitch response [21,22]
Secondary Symptoms	• Fatigue[13,32] • Cognitive dysfunction[13,32] • Depression[13,32] • Headache[13,32] • Numbness[13,32]	• Diaphoresis[5] • Lactrimation[5] • Flushing[5] • Pilomotor activity[5] • Temperature changes[5]

tween 59–74 years. Although FM can occur at any age for either gender, it is typically considered a disorder of women between the ages of 20-50 years of age.[38,40] A recent general population survey in Germany confirmed the strong association between FM and age, with peak prevalence in women reported between 60-70 years.[29] Less is known about the prevalence of MPS and FM among adolescents and children.[41] Gran[41] summarized the evidence relating to population studies from 1991-2001 across several age groups, reporting a peak prevalence of chronic widespread musculoskeletal pain (FM) among those in the 50-74 year age group, highlighting the distinct lack of data in the prevalence and incidence of widespread pain complaints among children and adolescents. However, previous research has reported that young athletes subjected to training overload can experience symptomatic presentation similar to FM.[42]

The aging societal demographic[43] is setting the stage for chronic musculoskeletal pain to be one of healthcare's greatest challenges in the future. Additionally, further research is urgently needed in young and adolescent populations to inform our understanding of the emergence and pathophysiology of these two conditions.

Ethnicity

The body of literature on the relationship between ethnicity and chronic musculoskeletal pain is limited and equivocal (Table 2). Research has shown that ethnic background is an important confounder for the prevalence of FM in Europe but not the US. A Swedish cross-sectional survey by Bergman *et al*.[37] reported significant increases in the prevalence of chronic widespread pain (FM) in immigrant European women (20%) compared to native Swedes (10.2%). These authors also reported higher rates of sick leave and disability pension payouts in Sweden among immigrants from southern Europe when compared to native Swedes.[37] Felson *et al*.[44] found similar findings, with an increased prevalence of widespread pain (FM) in both American and European women, in comparison to Chinese women. In contrast, however, Gansky and Plesh[45] did not report any significant differences in the prevalence of FM (using the ACR 1990 criteria) within 21-29 year old African-American women when compared to Caucasian women (3% vs 2%). Despite this similarity, increased subjective pain and tenderness were reported in Caucasian women when compared with African-American women, who tend to internalize pain more.[45] In contrast to their own findings with chronic widespread pain (FM), Bergman *et al*.[37] did not observe differences in regional pain (MPS) prevalence between immigrants (23.3%) and native Swedes (23.9%). Gansky and Plesh[45], however, did report contrasting findings by demonstrating a significant effect of race on chronic regional pain (MPS) between African-American and Caucasian women.

While the limited research in this area remains equivocal, it does suggest that chronic widespread pain (FM)

Table 4.
The 1990 Criteria for the diagnosis of Fibromyalgia (adapted from Wolfe et al.[30]).

Criteria	Definition
History of Widespread pain for at least 3 months	1. Pain is on both sides of the body 2. Pain is above and below the waist 3. Axial skeletal pain is present (neck, chest, thoracic or low back)
Pain in 11 of 18 tender points on palpation	Pain upon palpation of approximately 4 kg of pressure in 11 of the 18 following points: 1. Occiput: at the suboccipital muscle insertion. 2. Low cervical: at the anterior aspects of the intertransverse spaces C5-C7. 3. Trapezius: at the midpoint of the upper border. 4. Supraspinatus: above the spine of the scapula near the medial border. 5. Second Rib: upper lateral aspects of the 2nd costochondral junction. 6. Lateral Epicondyle of the Humerus: 2cm distal to the epicondyles. 7. Gluteal: upper quadrant of buttocks in anterior fold of muscle. 8. Greater Trochanter: posterior to the trochanteric prominence. 9. Knee: at the medial fat pad proximal to the joint line.

and chronic regionalized pain (MPS) may be related to ethnicity, however, the strength of this association is still unclear.

Clinical presentation

MPS and FM differ primarily in the anatomic distribution and clinical characteristics of muscle pain (Table 3). MPS typically manifests as regional muscle pain[1] associated with abnormalities in both motor and sensory function. It is characterized clinically by the presence of a palpable taut band of muscle containing localized, hyperirritable nodules known as a MTrP.[1,5,13,46] Muscles expressing MTrPs also exhibit altered function in the form of weakness without atrophy and loss of range of motion.[13] A local twitch response (LTR) is also often observed in association with MTrPs, identified as a rapid and transient twitch of the taut band, but not the entire muscle[1], subsequent to dynamic physical stimulus (plucking) or intramuscular needle insertion[1,23]. Although some consider the LTR a confirmatory diagnostic sign of a MTrP[1,13,23], others consider it to be less reliable, adding to the diagnostic confusion[13,17,24,47]. In comparison, FM is a syndrome defined by chronic widespread musculoskeletal pain and the presence of palpable TP.[1,13,29-31] TPs are defined as discrete areas of soft tissue that are painful to less than four kg of palpatory pressure[1,13,46]; however, in contrast to MTrPs, they do not present as overt palpable, nodular structures within the muscle[13]. Other than their discrete tenderness, TPs are indistinguishable from the normal surrounding tissue.[13] Therefore, an important clinical distinction between MPS and FM is the palpatory findings in involved muscles, with MPS presenting with MTrPs and FM presenting with localized TPs.

Another important clinical distinction between FM and MPS is the presence of unique and secondary findings commonly observed in the clinical manifestation of FM including sleep disorders, irritable bowel syndrome, nervous bladder, fatigue, cognitive dysfunction, anxiety, depression, headaches, temporomandibular joint disorders, numbness, tingling, and Raynaud's phenomenon.[13,31,32] These findings are important contributors to the significantly decreased quality of life often reported by FM sufferers[13,29-32], when compared with MPS. Although less commonly, MPS patients have also reported autonomic dysfunction including diaphoresis, lacrimation, flushing, dermatographia, pilomotor activity, and temperature changes[5], which adds to the uncertainty surrounding the sensitivity and specificity of differential diagnosis of FM versus MPS.

Diagnosis of fibromyalgia and myofascial pain syndrome

Current diagnostic criteria for fibromyalgia

The diagnosis of FM is currently based on the ACR 1990 and 2010/2011 diagnostic criteria. The first set of criteria was initially developed by Wolfe *et al.*[30] in 1990, and included the implementation of both clinical history and physical examination (Table 4). These criteria include a

Table 5.
The 2010 Criteria for the diagnosis of Fibromyalgia (adapted from Wolfe et al.[31]).

Criteria	Definition
Scores	1. WPI ≥ 7/19 and SS score ≥ 5/12 or 2. WPI is 3–6/19 and the SS ≥ 9/12 or 3. PSD ≥13 (combined WPI and SS score)
Duration	Symptoms persisting for more than 3 months duration
Differential Diagnosis	Patient does not have a disorder that would otherwise explain the pain (hypothyroidism, rheumatoid arthritis, other autoimmune disorders)

history of widespread pain lasting at least three months along with the clinical presence of palpable tender points in at least 11 out of 18 standardized bilateral tender points.[30] Widespread pain is defined as bilateral pain, above and below the waist, with or without axial skeletal pain.[30] The sensitivity and specificity of the 1990 ACR criteria was reported as 88.4% and 81.1%, respectively.[30] A significant limitation to this conclusion, however, is that these criteria were tested against FM patients previously diagnosed by "usual method of diagnosis" from investigators at 16 medical centers throughout North America. Participating investigators underwent physical examination training prior to study recruitment but no details in the training or diagnostic criteria were provided.

Over the next two decades, it became apparent that the 1990 criteria were inadequate for the diagnosis of FM. In particular, the physical examination requiring the identification of at least 11 of 18 TPs was arbitrary and did not address the complete clinical presentation of FM patients.[48] Even when the physical examination was performed, it was often incorrectly implemented, especially by non-specialists, and there was poor inter-examiner reliability for the identification of the TP locus.[46,48] For instance, results reported by Tunks *et al*.[46] found the inter-examiner and intra-examiner reliability of physical examination for tenderness was not a reliable method to accurately distinguish MPS patients from FM patients. Furthermore, these criteria could not be used for epidemiological studies given the need for physical examination.[49-51] For this reason, Wolfe *et al*.[31] proposed a new set of diagnostic criteria in 2010 which removed the requirement for TP identification via physical examination (Table 5). The 2010 self-report criteria were not designed to replace the 1990 criteria, but instead to provide an alternative for those practitioners who do not perform a physical examination.[31] This set of diagnostic criteria additionally consisted of a SS scale and a WPI.[31] The SS was aimed at addressing the pain and secondary symptoms presenting with FM, including fatigue and cognitive dysfunction, while the WPI employs a questionnaire and body diagram for patients to record the pattern of pain, including local pain at any of the 19 sites associated with FM.[6] A combined WPI and SS score ≥13, known as the Polysymptomatic Distress scale (PSD), is considered threshold for the diagnosis of FM. While these criteria require physician assessment, modified criteria were adopted in 2011 to create a patient self-report version that could be applied experimentally, without the need for practitioner intervention.[32] The reliability of these criteria was reported to be very high, with a sensitivity of 96.6% and specificity of 91.8%[31], and patients previously diagnosed by a physician according to the 1990 criteria[30] were accurately diagnosed with FM 93% of the time using the combined WPI and SS scores[31].

Several additional studies have investigated the sensitivity and specificity of the 2010 criteria. A pervasive limitation to interpreting these data is the fact that the sensitivity and specificity are determined using the gold standard, FM cases diagnosed a priori using 1990 criteria and/or expert clinical assessment, the details of which are often unreported. Ferrari *et al*.[40] reported high sensitivity and specificity of 90.2% and 89.5%, respectively, when applied to 451 subjects diagnosed a priori using a rheumatologist's clinical assessment as the gold standard;

however, the diagnostic criteria employed were not provided. Carrillo-del-la-Pena[52] and Segura-Jimenez[53] also employed FM cohorts diagnosed a priori by rheumatologists, without providing specific details on the diagnostic criteria employed. Other studies have shown contrasting results, however, reporting poor sensitivity (64%)[54] and specificity (67%)[55] when using the 2010 criteria against a priori FM patients diagnosed with the 1990 ACR criteria.

Prevalence studies using the different ACR diagnostic criteria (1990, 2010, 2011), and even within the same criteria, have demonstrated highly variable results. Jones *et al*.[56], reported significant (4-fold) differences in the prevalence of FM between the different criteria, with higher prevalence reported using the modified 2010 criteria, along with differences in sex ratios and rheumatologic comorbidities. Only 12.5% of participants met the criteria for all three sets.[56] Similarly, Vincent *et al*.[57] studied 830 people using the 2010 criteria and determined a prevalence of FM of 6.4% in the general population of Minnesota (USA), while a second study[29] reported a 2.6% prevalence in the general population of Germany; a third study[56] investigating the prevalence of FM in a Scottish general population reported a prevalence of 5.4%. Reasons for this variability may be due to bias from variable response rates, misclassification, or variability in the actual prevalence of FM within sample populations. Additionally, Wolfe *et al*.[58] reported that the 2010/2011 criteria are not used effectively on patients with asymmetrical or regional pain who do not satisfy a widespread pain criterion. Clearly, further research is needed in this area. A recent 2016 revision[58] to the 2010/2011 criteria was proposed which aims to mitigate the misclassification of regional pain disorders. The 2016 revisions emphasize the chronic widespread pain aspect of FM, which is required for diagnosis.[58,59] These revisions continue to employ the WPI and SS scales, with the added criterion stipulating the presence of pain for at least three months in at least four of five anatomic regions (left and right upper extremity, left and right lower extremity, and axial). Jaw, chest, and abdominal pain are no longer included as a component of the generalized pain presentation when applying these criteria.[59]

Canadian diagnostic criteria pertaining to FM have also been established. Fitzcharles *et al*.[14] put forth the 2012 Canadian Guidelines for the diagnosis and management of FM, which consists of five domains: clinical evaluation, testing and confirming the diagnosis, differential diagnosis and coexisting conditions, the health care team, and education. This set of criteria makes reference to the ACR 1990 and 2010 diagnostic criteria, however the Canadian guidelines are focused on clinical application rather than being utilized for research purposes. These guidelines emphasize that the diagnosis of FM should be made in the primary care setting, and strongly suggest that examination of tender points should not be used to either confirm or validate a diagnosis of FM, such that the TP examination is too subjective of a technique. However, most of the development of the Canadian guidelines stems from clinical experience, expert opinion, and consensus among the health care professionals who contributed to the guidelines. Evidence to support these guidelines is sparse and highly variable, therefore it is suggested that these guidelines merely be used as a template for diagnosing FM.

Although FM diagnostic criteria appear to be well established in the literature, there are limitations attributed to each subset of criteria. For example, study design limitations are present when testing the 1990 criteria sensitivity and specificity; the 1990 criteria is based on an arbitrary physical examination; the 2010/2011 criteria was tested against the gold standard, FM cases diagnosed a priori using 1990 criteria; prevalence studies have demonstrated highly variable results among all subsets of criteria; and many aspects of the Canadian guidelines are not strongly supported. For these reasons, further research is required to validate the existing FM diagnostic criteria, thus allowing for a clearer distinction between FM and MPS diagnoses.

Current Diagnostic Criteria for Myofascial Pain Syndrome

Travell and Simons' landmark publication, the "Trigger Point Manual"[21,22], proposed the original set of diagnostic criteria for MPS which included essential features of point tenderness within a palpable taut band of muscle, LTR, referred pain, weakness without atrophy, autonomic symptoms and restricted range of motion (Table 6). At the core of this diagnosis is confirmation of the presence of a MTrP, a palpable, hyperirritable nodule within the target muscle. Despite these clearly defined signs and symptoms, there is still no uniformly accepted diagnostic protocol for MPS, and the reliability of the current pro-

Table 6.
MPS diagnostic material according to Travell and Simons Trigger Point Manual (adapted from Travell and Simons[21,22]).

Criteria	Definition
Major Criteria	1. Regional pain complaint 2. Pain pattern follows a known distribution of muscular referred pain 3. Palpable taut band 4. Focal tenderness at one point or nodule within taut band 5. Restricted range of motion or slight muscle weakness
Minor Criteria	1. Manual pressure on MTrP nodule reproduces chief pain complaint 2. Snapping palpation of the taut band at the MTrP elicits a local twitch response 3. Pain is diminished or eliminated by muscular treatment

posed diagnostic criteria for MPS is still largely based on clinical judgement.[60,61]

In an attempt to address this controversy, Lucas *et al*.[60] published a systematic review in 2009 on the reliability of the various physical examination diagnostic criteria for MTrPs. A total of nine studies were included in this review, despite none of the studies satisfying all inclusion criteria and the presence of significant limitations in study design, blinding, reporting, statistical integrity and clinical applicability. Only one study reported interrater agreement on the presence of a MTrP (κ=0.66-0.95)[62] and two studies reported location agreement of less than 21%[63,64]. Of these studies, none reported the interrater reliability of identifying the location of a MTrP in symptomatic muscle; however, good reliability estimates were noted for individual diagnostic signs including local tenderness (κ=0.22 to 1.0) and pain recognition (κ=0.57 to 1.0). In contrast, lower reliability estimates were observed for referred pain (κ= -0.13 to 0.84), taut band (κ= -0.08 to 0.75), jump sign (κ=0.07 and 0.71), and LTR (κ= -0.05 to 0.57). These collective results suggest that the reliability was greater for the subjective signs of tenderness, and pain recognition; counter intuitively, reliability estimates for objective signs of a taut band and twitch response were lower. Although some components of the physical exam appear to be better diagnostic indicators than others, their detection in isolation is inadequate for diagnosis of MTrPs. At present, physical examination is not adequately reliable for diagnosing MTrPs in MPS.

An important consideration in the interpretation of the findings of Lucas *et al*.[60] is that in two of these studies[62(A&B)], the examiners participated in pre-study training sessions in order to enhance reliability of MTrP identification. Only three studies[65,66,67] used standard representative examiners, and this was considered a limitation as it does not reflect the reality of daily practice. Given that practicing clinicians do not typically receive specialized training in the identification of MTrPs, the results of these studies should be interpreted with caution as they likely overestimate the reliability of diagnosis by representing the upper limits of expertise.[6]

In 2015, Rivers *et al*.[6] conducted an international study of 214 pain specialists to explore the consensus on the clinical features and presentation of MPS. The majority of practitioners (76%) agreed that MPS is distinct from other conditions of chronic musculoskeletal pain, with an estimated prevalence of 31.6%. The consensus amongst these clinicians was that a tender spot, with or without pain referral (72%), and pain recognition (58%) are essential diagnostic criteria for the identification of MTrP in MPS. However, commonly adopted criteria including palpable taut band (36%), palpable nodule (34%), and/or referred pain (35%) were not considered essential for the diagnosis of MPS. Confirmation of the diagnosis should include a combination of any three of the following signs: muscle stiffness/spasm, limited range of motion, symptoms that are aggravated with stress, and/or a palpable taut band/nodule. In addition, they emphasized that the diagnosis of MPS should be contingent upon the presence of pain for greater than three months, and that both local and broader regional pain expression may be present. However, a significant limitation to this study is that, despite

Table 7.
Summary of the diagnosis of fibromyalgia and myofascial pain syndrome.

Criteria	Fibromyalgia	Myofascial Pain Syndrome
Diagnostic Criteria	• American College of Rheumatology 1990 and 2010/2011 Diagnostic Criteria proposed by Wolfe *et al*.[30,31,32] • The 2012 Canadian Guidelines for the diagnosis and management of fibromyalgia syndrome developed by Fitzcharles *et al*.[14]	• "The Trigger Point Manual" by Travell and Simons[21,22]
Challenges in Proper Diagnosis	• Differentiating between TP and MTrP is challenging[6,46,60] • No agreement on the essential criteria for MTrP diagnosis in MPS ○ Poor reliability in detection of taut band[3,6,13,24,46,60,61,68] ○ Agreement on 'tender spot and recognizable pain stimulation' as criteria between pain specialists overlaps with the features of FM[6] • MPS has the potential to become widespread, mimicking the appearance of FM[1,3,13]	

its international scope, it selectively canvassed pain specialists predominantly comprised of anesthesiologists and physiatrists (75%) from the United States. Furthermore, this survey contained only published criteria; accordingly, the responses may be largely biased by awareness of the published material and may not reflect clinically relevant observation.

The current research in the area of MPS diagnostics is sparse and highly variable[46,47,61,68,69], with significant limitations in design that preclude unequivocal conclusions on the diagnostic reliability of physical examination. Two recommended criteria include local tenderness and pain reproduction, while in contrast, taut band and LTR responses show poor clinical reliability.[61,68,70] For this reason, the evidence supporting the diagnosis and treatment of MTrPs is insufficient[60], and therefore, physical examination alone should not be used in the diagnostic workup of the chronic musculoskeletal pain patient.

Challenges in the Differential Diagnosis of Myofascial Pain Syndrome and Fibromyalgia

Despite the acknowledgement and clinical application of a spectrum of diagnostic criteria for FM and MPS in the literature, a validated gold-standard set of differential criteria has yet to be established.[6,60,71] For this reason, clinically differentiating between FM and MPS is challenging. The clinical distinction between these two conditions is presently determined by careful clinical history or physical examination, or a combination of both (Table 7). In the case of physical examination, the clinician aims to identify a discrete hyperirritable locus within the muscle, a key feature used to distinguish the MTrP from the TP. Despite the fact that distinguishing between the MTrP and TP is a primary diagnostic consideration in the differential diagnosis of MPS from FM (1990 ACR criteria)[30], clinically differentiating between the two points is challenging[6,60]. A key distinguishing feature is the presence of a palpable taut band with a MTrP, but not TP; however, previous research has shown that a taut band is not viewed as an essential criterion for the diagnosis of MPS[6]; as well, there is poor inter-examiner reliability in its manual detection[3,6,13,24,46,60,61,68]. Additional challenges in the differential diagnosis of MPS from FM include the fact that the localized tender point and associated pain are non-discriminatory, being common to a broader profile of clinical conditions associated with chronic musculoskeletal pain. Adding further to the diagnostic difficulty is the fact that MPS, although largely considered a regional pain phenomenon, has the potential to become widespread, in addition to persisting for more than three months as is commonly observed with FM.[1,3,13,29] Furthermore, while some research groups and clinicians believe that FM and MPS are two very distinct and separate conditions[6,72], there is speculation that FM and MPS may occur concurrently[6,73]. Debate regarding MPS and FM coexistence promotes further confusion in distinguishing between the

Table 8.
Summary of potential novel diagnostic tools.

Diagnostic Tool	Fibromyalgia	Myofascial Pain Syndrome
Biomarkers	• Similar inflammatory factors are not typically observed at the TP site in FM patients[13]	• Altered biochemical milieu of inflammatory factors at active MTrP sites[13] • Increased proton concentrations (lower pH), substance P, bradykinin, serotonin, calcitonin gene-related peptide, and Interleukin 1β[23]
Ultrasound Imaging	• TPs do not express changes in local muscle stiffness, and do not have similar echotextural characteristics to MTrPs	• Elliptically shaped, hypoechoic regions within the muscle corresponded to focal areas of reduced vibration amplitudes[76]
Magnetic Resonance Elastrography	• Tissues without altered mechanical properties are expressed as planar wave fronts[3]	• Taut bands in muscle uniquely present as a chevron pattern at higher wave velocities within the central band[3]
Electromyography	• TPs do not present as a local contracture, and therefore do not exhibit the same spontaneous electrical activity as MTrPs	• MTrP regions exhibit enhanced spontaneous electrical activity at the motor endplate region in the absence of voluntary muscular contraction[77]

two conditions, as well as an ongoing controversy over the nature of a MTrP.[72,74,75]

These combined factors collectively limit the reliability of using physical examination alone to differentiating MPS from FM (Table 7). Recent advancements in the ACR criteria for FM (2010)[31] have aimed to address this issue by eliminating the requirement for physical examination. Furthermore, an urgent need exists to identify and advance novel, objective diagnostic criteria that can be reliably used to in the differential diagnosis of chronic musculoskeletal pain.

Potential Novel Diagnostic Tools

Emerging research has identified several objective diagnostic tools with potential to provide enhanced reliability in the diagnosis of FM and MPS. Although this is not a complete review of available diagnostic tools this section provides an overall sense of the biomarkers and imaging techniques that are currently being developed in the field of musculoskeletal pain (Table 8). For instance, biomarkers may be used as objective indicators of normal and/or pathologic biological processes. Previous research has demonstrated an altered biochemical milieu of inflammatory factors at active MTrP sites of MPS patients.[13] These factors, which include increased proton concentrations (lower pH), substance P, bradykinin, serotonin, calcitonin gene-related peptide, and Interleukin 1β[23], are not typically observed at the TP site in FM patients[13], which suggests that these inflammatory biomarkers could play an important role in the objective differential assessment of the chronic musculoskeletal pain patient. Ultrasound imaging is another tool with significant potential for use in the objective assessment of a chronic pain patient. Research conducted by Sikdar *et al*.[76] demonstrated that elliptically shaped, hypoechoic regions within the muscle corresponded to focal areas of reduced vibration amplitudes. These findings suggest that echotextural characteristics could be a reliable and objective indicator of changes in local muscle stiffness that is commonly thought to represent MTrP loci, but not TP. Similarly, magnetic resonance elastography (MRE) employs phase contrast imaging to assess the mechanical properties of tissues. A recent study has shown that taut bands in muscle uniquely present as a chevron pattern at higher wave velocities within the central band in comparison to controls, which demonstrate planar wave fronts.[3] Given the poor reliability of manual detection of taut bands, MRE may prove to be a valuable tool for enhancing the detection of taut bands from normal tissue. Needle electromyography (EMG), which consists of electrodes inserted subcutaneously to record action potentials directly from the muscle fibers, has been used to identify abnormal motor neuron activity associated with changes in muscle tissue. A characteristic attribute of the MTrP locus is enhanced pain sensitivity and lo-

cal contracture due to increased excitability of the motor endplate region. Couppe *et al*.[77] demonstrated that MTrP regions exhibit enhanced spontaneous electrical activity at the motor endplate region in the absence of voluntary muscular contraction, suggesting that this may be a valuable objective measure of focal regions of hyperirritability within the muscle. Despite the potential of these tools in the diagnostic workup of the chronic musculoskeletal patient, the clinical utility of these modalities to assess MTrPs is limited. Biomarkers often require off-site analysis while MRE, EMG, and ultrasound require expensive, specialized equipment with advanced user training in data collection and processing; thus, limiting their feasibility in clinical practice.

It should be noted that these tools focus on identifying a physically distinguishable MTrP locus, characterized by increased acetylcholine release, regional sarcomere shortening and persistent contractile activity.[22,24] A recent review by Rivers *et al*.[6], however, challenges the requirement for including a taut band and tender nodule as confirmatory signs in the diagnosis of MPS, casting doubt on the relevance of the MTrP in the pathophysiology of the MPS. This is a foundational gap in our understanding of the pathophysiology of MPS; future research must focus on elucidating the underlying mechanisms of MTrP formation, and its relevance in the pathophysiology and clinical manifestation of MPS.

Summary

Chronic musculoskeletal pain is an extremely prevalent condition and a leading burden of illness in Canada.[8] While FM and MPS are the two most common forms of chronic musculoskeletal pain, they typically respond to distinctive treatment protocols. MPS is often managed conservatively using manual and physical therapy and exercise while, in contrast, FM is managed using a multidisciplinary strategy that may include cognitive-behavioural therapy, and pharmaceutical interventions that may include tricyclic antidepressants or serotonin reuptake inhibitors.[18] Ensuring consistent and reliable diagnosis between practitioners and specialties would hasten the delivery of appropriate treatment and expedite recovery for patients. Chiropractic treatment has been shown to be an important approach to the cost-effective management of chronic musculoskeletal pain conditions.[78-80]

Inadequate awareness of the underlying mechanisms, pathophysiology, and clinical manifestation is a current challenge in clinically differentiating MPS from FM. The current best practice for diagnosing either FM or MPS is the differential identification of TPs or MTrPs through manual palpation; however, research has shown this to be unreliable and should not be considered as the sole differential diagnostic criteria. This review emphasizes the urgent need for research in the field of musculoskeletal pain to advance the reliability of differentially diagnosing FM from MPS.

Considering the aging demographic[43], chronic musculoskeletal pain is poised to becoming healthcare's greatest challenge in the future. Chiropractic plays a major role in the daily ongoing management of chronic musculoskeletal pain. Advancing the diagnostic sensitivity and specificity will enable chiropractors, and all specialists managing chronic musculoskeletal pain, to improve diagnostic accuracy, reduce inappropriate treatment and ultimately improve patient outcomes and quality of life.

Abbreviations

ACR – American College of Rheumatology
EMG – Electromyography
FM – Fibromyalgia
LTR – Local Twitch Response
MPS – Myofascial Pain Syndrome
MTrP – Myofascial Trigger Point
MRE – Magnetic Resonance Elastography
PSD – Polysymptomatic Distress Scale
SS – Symptoms Severity
TP – Tender Point
WPI – Widespread Pain Index

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