

Article

Not peer-reviewed version

Tensegrity-Based Needling: An Integrative Rehabilitative Treatment for Post Covid-19 Widespread Musculoskeletal Pain

[Shiloh Plaut](#)*

Posted Date: 6 November 2025

doi: 10.20944/preprints202511.0400.v1

Keywords: acupuncture; fibromyalgia; long covid-19; post acute covid-19 syndrome; tensegrity-based needling; treatment



Preprints.org is a free multidisciplinary platform providing preprint service that is dedicated to making early versions of research outputs permanently available and citable. Preprints posted at Preprints.org appear in Web of Science, Crossref, Google Scholar, Scilit, Europe PMC.

Copyright: This open access article is published under a Creative Commons CC BY 4.0 license, which permit the free download, distribution, and reuse, provided that the author and preprint are cited in any reuse.

Disclaimer/Publisher's Note: The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.

Article

Tensegrity-Based Needling: An Integrative Rehabilitative Treatment for Post Covid-19 Widespread Musculoskeletal Pain

Shiloh Plaut

Independent Researcher, Israel; shilowhale@gmail.com

Abstract

Post-COVID condition - the long-term illness seen after coronavirus infection - often presents with chronic refractory widespread musculoskeletal pain, for which no well-formulated treatment or rehabilitation strategy has so far been established in studies. Integrative medicine aims to optimize treatment outcomes while incorporating a holistic patient centered approach. A valuable yet underused modality available to practitioners since antiquity is the acupuncture practice of needling therapy, whose working mechanism of action remains poorly elucidated and disputed - which is part of the reason why it is often met with skepticism by many medical practitioners. One of the most difficult chronic pain conditions to treat, and for which modern medicine provides symptomatic and insufficient therapies, is the syndrome of fibromyalgia. Fibromyalgia is a prevalent pain condition of unknown etiology that manifests with a peculiar cluster of symptoms such as myalgia/arthralgia, fatigue, low mood, and cognitive difficulties. Its pathophysiology is largely attributed to dysregulated central neural pain pathways, although fascio-musculoskeletal pathology is evident. Recent studies indicate that fibromyalgia-type manifestations occur often after coronavirus infection, in what can be termed "long-covid-19 syndrome", a condition which also seems to involve myofascial histopathological abnormalities in a significant number of affected individuals. Empirical studies suggest that needling therapy may improve chronic widespread pain and it has been recommended by professional medical societies to be used in fibromyalgia and "neuroplastic pain," but the biological mechanisms are poorly known and are mainly attributed to central nervous system neurophysiology. In this manuscript a new mechanism of action for manual needling is formulated as a global percutaneous needle fasciotomy that respects tensegrity principles, and is discussed as part of the rehabilitative approach for the treatment of post-covid widespread musculoskeletal pain and stiffness. This approach, complementing known neurophysiological mechanisms, offers a more holistic understanding of acupuncture's usefulness as a rehabilitative treatment for idiopathic chronic musculoskeletal pain and refractory post-covid myofascial and nociplastic-type pain. Tensegrity-based needling aligns with traditional medical principles of the body-mind as a unit by recognizing the global interconnectedness of the myofascioskeletal system and aiming to restore balance and function.

Keywords: acupuncture; fibromyalgia; long covid-19; post acute covid-19 syndrome; tensegrity-based needling; treatment

Introduction

Idiopathic musculoskeletal pain conditions and psychosomatic pain syndromes are a major hassle in almost every medical field. Fibromyalgia syndrome is a disputed chronic pain condition of unknown etiology, characterized by widespread musculoskeletal pain, chronic fatigue, stiffness, and cognitive difficulties [1–3]. Fibromyalgia-type symptoms and medically unexplained chronic widespread pain are a common condition seen in primary care settings. Its estimated prevalence is approximately ~1-6 percent of the general population or higher, depending on diagnostic method.

Chronic widespread pain and fibromyalgia lead to a significant burden on the healthcare system and considerably impact patients' life quality and daily life functions [1,4].

Lately, fibromyalgia-type symptoms such as widespread musculoskeletal pain are being identified as a frequent manifestation in convalescent individuals following acute coronavirus disease 2019 (covid-19) [2,5,6] in what is termed 'post covid-19 syndrome' [5,7,8]. 'Post covid syndrome' refers to long-lasting symptoms after recovery from the acute phase of covid-19, demonstrating typical post-viral infection syndrome symptoms of fatigue, post-exertional malaise, and cognitive symptoms, which overlap considerably with fibromyalgia, though a variety of multiorgan symptoms have been documented [9].

Despite extensive research over recent decades, the patho-mechanisms underlying fibromyalgia are still poorly elucidated and the field remains in relative stagnation in terms of translation to therapeutic clinical impact. Even though fibromyalgia was previously thought to be a connective tissue disorder in past centuries [10], the most accepted and widely investigated theory nowadays concerns a neurological pathology [3] presumed to be governed by a complex interaction of stressful life events, genetic predisposition, inflammatory processes, and cognitive and emotional factors [11]. This nervous system abnormality is said to lead to centrally mediated hyperalgesia, allodynia, and chronic primary pain ("nociceptive pain") despite no peripheral organic justification [3]. The therapeutic strategy for fibromyalgia is usually derived from this theory of "central nervous system sensitization" [1,12] and is generally considered by clinicians to be ineffective [13,14].

In common clinical practice, treatment approaches for fibromyalgia focus mainly on symptom management by combining aerobic exercise, physical therapy, cognitive behavioral therapy, and pharmacological agents, such as pain medication, muscle relaxants, pregabalin, or serotonin-norepinephrine reuptake inhibitors. Some practitioners prescribe drugs that are not recommended for fibromyalgia such as z-drugs and opioids, despite their proven lack of efficacy, lack of endorsement from official guidelines, risk of drug tolerance and dependency, and despite the availability of other approved pharmacotherapy options [15,16]. While pharmacotherapies are able to provide certain relief for some individuals (often only temporarily) they usually fail to address the putative underlying mechanisms of the disorder, leaving many patients with persistent symptoms and overwhelming functional and occupational impairment.

Ineffective treatment for fibromyalgia is a major cause of frustration for both physicians and patients [4], to the point where some clinicians even refuse fibromyalgia patients in their clinic [17,18]. Furthermore, in a survey that was conducted in Norway among senior physicians, general practitioners, medical students, and nurses, fibromyalgia was ranked, by all groups, last- the least prestigious disease of the lot [19,20].

Osteopathic medicine and integrative medicine are two branches of medicine that meanwhile offer a more holistic approach for the management of chronic pain patients by recognizing the body's innate ability to self-regulate and heal, and view the body as an interconnected whole where structure and function are reciprocally interrelated. Osteopathic medicine is fundamentally rooted in the understanding that the body is an interconnected and dynamic unit of structure and function, where each part influences the others. Also, by combining conventional treatments with evidence-based complementary therapies tailored to the individual, integrative medicine aims to optimize treatment outcomes while incorporating a holistic patient-centered approach.

Manual needling, or acupuncture, is a traditional Chinese healing practice that uses thin needles to achieve physiological improvement and a sort "internal energetic balance". The origins of this strange practice date back several thousand years to the far East [21]. While several explanations for its mode of action are given by modern science, acupuncture is mostly perceived as non-scientific or even ridiculous [21]. Many physicians refrain from recommending acupuncture to their patients due to the absence of a well-established and convincing mechanistic explanation for its method and mechanism of action, even in the presence of robust empirical evidence substantiating its usefulness in certain medical conditions. Indeed, the treatment modality should ideally be pertinent to the pathophysiology of the disease that it aims to treat.

A 2022 study offered an alternative connective tissue based mechanism for the theoretical pathogenesis of fibromyalgia-type syndromes (e.g., chronic fatigue syndrome, tension-type headache, “non-specific” chronic low back pain, primary fibromyalgia syndrome, somatic symptom disorder, chronic widespread pain etc.) and the psychosomatic manifestations of the post covid-19 condition [22,23]. It suggests that these syndromes have in common the involvement of pro-fibrotic pathways that lead to pathological remodeling of the extracellular matrix in myofascial tissue. The core of the suggested theoretical model concerns musculoskeletal abnormalities related to tensegrity. ‘Tensegrity’ is a term that refers to a balanced spatial system that maintains a steady state by continuous tensional force elements and non-contiguous compression elements.

Given new evidence that severe acute respiratory coronavirus 2 (sars-cov-2) infection may contribute to skeletal muscle pathologies [24,25] and may trigger new-onset fibromyalgia-type manifestations [2,5,6], there is a pressing need for treatment strategies that address such. The aim of this paper is to discuss a new mechanism of action for manual needling as a treatment for the refractory chronic musculoskeletal pain of “post-acute covid-19 syndrome.” When added to the holistic management of post-Covid refractory fibromyalgia-type manifestations, tensegrity-based needling might improve treatment outcomes by formulating a holistic personalized protocol based on individual patient physiology. Traditional and integrative medicine recognize the crucial role of fascia in maintaining structural integrity, facilitating movement, and influencing overall health.

Tensegrity-Based Needling

Tensegrity-based manual dry needling therapy (TBN) was developed conceptually as a treatment for fibromyalgia and related idiopathic chronic pain syndromes [22]. It is based on the following three points:

- (i) Tensegrity-like qualities of the fasciomusculoskeletal system: The fascia and extracellular matrix (ECM) form a complex, dynamic, and interconnected network of connective tissue that undergoes continuous remodeling, while it absorbs and transmits mechanical loads and exhibits properties akin to tensegrity structures [22,26,27]. ‘Tensegrity’ (a combination of the words tension and integrity) is an architectural concept that describes a complex pre-stressed structure that is stabilized under forces of compression and tension and functions as one connected spatial system [26,28,29]. The term ‘bio-tensegrity’ denotes a biophysical conceptual framework that incorporates the principles of tensegrity for a better understanding of living biological systems [27]. A continuous interplay between cell traction forces and resistance points within the ECM maintains reciprocal isometric mechanical tension in living tissues [26]. Through the bio-tensegrity-like dynamics and by having mechano-transducing signaling pathways, cells mechanically sense changes, modify their microenvironment, and promote ECM remodeling in homeostasis and in disease states [26].
- (ii) Myofascial chains [30–32]: Fascia is a most ubiquitous tissue that spans the human body, capable of transmitting and dispersing mechanical forces over distances due to the structural connectivity of the fascio-musculoskeletal system [27,31,33]. Internal mechanical forces are transmitted within myofascial tissue through mechanical linkages forming kinetic channels called “myofascial chains” [27,30–32]. In this manner, force in the lower limb can be transmitted to the trunk, impacting the lumbar musculature [31]. Stretching the upper limbs can contribute to an increased maximal range of motion in the lower limbs, and vice versa [31,34]. Muscle and fascial tissues do not operate in isolation but work together to support the body’s movements through interconnected structures, forming a myofascial tensional network that connects the parts of the body as a whole unit [35]. Most skeletal muscles in humans are connected through connective tissue [31].

(iii) Innervation and sensory functions of fascia: Fascia houses a densely interwoven network of sensory nerve endings that are involved in the perception of pain [27,36,37]. In myofascial tissue free and encapsulated nerve endings are found [27,38,39]. Researchers have shown the existence of an impressive network of sympathetic nerve fibers in fascia, as was demonstrated in samples of fascial tissue from mice [40].

Fascial dysfunction, overuse, strain injury, trauma, and inflammatory changes, are postulated to lead to pain due to pathological ECM remodeling along with chemical and mechanical alterations [41]. Pathological changes in fascia are characterized by increased tissue stiffness and changes in the ECM, including changes in both collagens and matrix metalloproteinases levels as well as alteration in myofibroblast activity [36]. Abnormal mechanical forces and nociceptive mediators that are secreted by myofibroblasts and local cells (e.g., interleukin 1-beta, tumor necrosis factor-alpha, neuropeptide Y, substance P) may trigger pain via activation of peripheral sensory receptors [27]. Myofibroblasts are contractile cells found in myofascial tissue [27] and are often compared to smooth muscle cells due to their natural contractile activity.

Nociceptor free nerve endings terminate in muscle interstitium. Non-myelinated C fibre receptors in muscle tissue are polymodal and respond to high mechanical pressure and chemical stimuli [42–44], as do A-delta fibres which are related to stretch receptors [42]. The biochemical milieu can therefore affect nociception when nociceptive substances accumulate in muscle interstitium [45].

ECM stiffness seems to be a crucial factor in the behavior and function of nerve cells [46]. Researchers have investigated the effect of matrix rigidity on neuronal cells in vitro, and found a marked difference in growth dynamics, synaptic density and electrophysiological activity of cortical neuronal networks when comparing cultures grown in substrates with 100-fold differences of young modulus [47].

The biomechanical basis for TBN is grounded in the tensegrity-like qualities of the myofascial system, its interconnectedness via myofascial chains for kinetic force transmission, and the role of fascia as a sensitive tissue involved in somatosensory functions. The following explains the mechanism of TBN in the context of fibromyalgia-type syndromes.

Tensegrity-Based Manual Needling as a Treatment for Chronic Widespread Musculoskeletal Pain

It is well-established that peripheral input significantly contributes to fibromyalgia pain, and addressing or eliminating peripheral impulse sources could potentially reduce or resolve pain [48]. Muscle tissue is a probable origin of nociceptive input that explains the pain seen in fibromyalgia [12,48]. The local pain in chronic widespread pain and fibromyalgia patients frequently corresponds with myofascial trigger points [48], and the correlation between these myofascial trigger points and fibromyalgia tender spots is appreciable [49].

Manual needling, as a therapeutic modality, has demonstrated beneficial effects in managing chronic pain, and is known to have beneficial effects both on the nervous system [21], by increasing endogenous opioid secretion [50], decreasing myofascial trigger point pain [51], and affecting local soft tissue in the vicinity of the inserted needle [52–55]. Studies of needling have shown that soft tissue alterations take place during or after dry needling including changes in tissue stiffness [56–58]. A 2022 randomized controlled trial further revealed that dry needling of a taut band in the trapezius muscle led to significantly decreased pressure pain thresholds in the tibialis muscle of individuals with myofascial neck pain [51].

Despite these observed clinical benefits, the precise mechanism of action for manual needling, particularly in complex conditions like fibromyalgia, has remained largely vague. This gap in mechanistic understanding limits its widespread acceptance and optimal application.

TBN emerges as a therapeutic method that aligns with principles of osteopathic medicine, which identifies and treats somatic dysfunction that often involves impaired or altered function of the musculoskeletal system and related fascial structures. TBN is a therapeutic needling method that adopts principles of tensegrity to treat myofascia-related pain, which sets it apart from conventional western dry needling methods. This technique uses multiple needles in multiple locations throughout the myofascioskeletal spatial system and aims to reduce the overall fascial rigidity and facilitate a synchronized release of tension throughout the pre-stressed fascio-musculoskeletal system. Accomplishing this while respecting the biotensegrity-like qualities of fascia is the primary principle of TBN and its underpinnings [59].

The proposed mechanism of TBN involves a dynamic interaction between the needle and the myofascial tissue. Upon insertion, the needle creates a shaft and induces a local disruption through the connective tissue layers. Pre-existing shear forces and pre-stress in the tissue then act on the fine needle to gradually continue tearing fascia against the needle, facilitating micro-disruption of fascial layers. A small calibre needle makes it easier to tear fibers when pulled on horizontally with perpendicular force vectors. The penetrating needle is postulated to also create micro tears in adhered tissue layers that allow for the release of substances trapped in deep tissues [22]. Movement of viscous fluids between layers could help correct adhesions and accumulated densifications of ground substance. A needle inserted into the perimysium, for example, would have a different effect compared to a needle inserted more superficially.

The initial mechanical signal generated by the inserted needle is expected to stimulate proto/myofibroblasts to contract in collaboration around the needle and cause fascia to grasp the needle. The stronger the grasp, the more a sign it is that fascia and myofibroblasts in that area are participating in the process. Prolonged sharp pain when a needle is inserted can indicate excessive tension in response to the needle insertion or perhaps nerve injury. Micro injury to capillaries can release plasma to the interstitium and promotes the “wash out” of nociceptive substances, which can also affect myofibroblasts. By doing so, TBN potentially leads to a decrease in the local pre-stress and to healthier remodeling of fascia in a lower stiffness state [22]. Altering biomechanics of fascia via needling directly modulates the overall imbalanced bio-tensegrity system, and can help improve tissue perfusion by reducing adhesions, improve sympathetic tone, and improve perfusion [22]. Choosing points that aren't too close to important delicate anatomical structures yet can potentially operate on the desired myofascial chains or related tensegrity nodes effectively, is paramount to the technique.

Data from shear wave elastography studies suggest that manual dry needling leads to a reduction in the degree of stiffness of myofascial tissue [56–58]. Dry needling of myofascial trigger points may be associated with improved local blood flow after treatment[56] as well as a palpable reduction in muscle stiffness [58]. Langevin and colleagues studied the mechanical effect of acupuncture and found evidence indicating deep involvement of the connective tissue in its mechanism and suggest even distant mechanotransducing effects [52,54]. They suggest that mechanical signaling and tissue displacement and windup during acupuncture are related to its mechanism of action [52,55]. According to their cumulative research, the downstream effect of a needle insertion and rotation within connective tissue is suggested to stimulate processes of cell secretion, modify the ECM and/or propagate a mechanical or mechano-transducing signal along connective-tissue planes, cause resident cell cytoskeletal morphological rearrangements, and modify afferent sensory input via changes to the biochemical milieu of interstitial substances.

Insertion of multiple needles throughout the system aims to lower pre-stress and allow for better remodeling of the ECM and for healthier connections to be formed. When viewed within a framework of tensegrity, needling one area may change the overall steady-state of the system as a whole and exert distal effects on the structures linked to it by means of its myofascial chains.

Disregarding principles of tensegrity might result in more imbalance and pain either in the short, intermediate, or long-term, or seemingly unrelated complications at distant anatomical sites. The objective of TBN is not to achieve immediate short-term noticeable local relief, but to balance the system while avoiding pain and major physiological complications.

Allowing relaxation during treatment and avoiding the induction of pain is essential for this method. The process should be done gradually over multiple treatment sessions to avoid sudden changes in existing tensional forces among anatomical structures. Each intrafascial/subcutaneous manual needling intervention needs to be tailored according to the current state of the bio-tensegrity structure. Since each patient can have a different steady-state and a distinct imbalance, one protocol does not fit all and does not fit one at all times.

Given that “fibromyalgia” is viewed within this framework as a severe late-stage advanced disease likely to be refractory to many treatment modalities [22], TBN has a larger role in the prevention of fibromyalgia rather than standalone monotherapy. If using TBN as a method that is integrated into the integrative rehabilitative treatment plan (in combination with movement therapy, diet, lifestyle modification, etc.), we would expect relapses until eventual remission. Relapses would occur due to the persistence of contractile cells in myofascial tissue and their continuous remodeling of the fascia in a high pre-stressed state [22].

Empirical studies are first needed to establish this suggested mechanism. Cadaveric studies might not be the best choice for investigating these concepts. Given the dynamic nature of biotensegrity, *in vivo* studies and advanced mathematical modeling and computational biomechanics, may be particularly useful for investigating these proposed mechanisms.

Discussion

In 2020 the World Health Organization officially announced covid-19 a global pandemic [60]. An estimated 10–20% of individuals recovering from covid-19 experience persistent symptoms beyond the acute phase [61,62], in was is referred to as ‘post-covid syndrome’ – a condition which shares characteristics with other post-viral syndromes [61]. While the societal and economic impacts of post covid-19 are still being figured, many affected individuals report a significant symptom burden, often resembling fibromyalgia syndrome [8,63]. According to empirical data, the manifestation of fibromyalgia occurs frequently after covid-19, even in mild and asymptomatic patients who were previously healthy [5], though research on this issue is still in its early stages [6,8].

The symptomatologic similarities between post-covid-19 syndrome and psychosomatic conditions such as fibromyalgia have prompted researchers to speculate on the possibility of shared underlying mechanisms [2,5,8,64]. Current pharmaceutical drugs do not seem to ameliorate or attenuate symptoms (or radiological and blood biomarker abnormalities) of post-covid-19 in controlled or large-scale cohort studies [65], and there is an urgent need for effective treatments [62]. Treatments repurposed from other conditions such as chronic fatigue syndrome, which significantly overlaps with fibromyalgia, may be useful in treating post-covid syndrome [66].

Empirical data from clinical trials indicates that needling/acupuncture therapy may be effective in managing myofascial and psychosomatic syndromes, including tension type-headache [67,68], migraine [67,69], irritable bowel syndrome [70], chronic fatigue syndrome [71], fibromyalgia [72,73], and other functional and “non-specific” pain syndromes [74,75]. The European league against rheumatism (EULAR) recommendations for fibromyalgia management have endorsed this treatment modality with an overall positive rating (“weak for”, 93% agreement) [72], and it is recommended by the National Health Service (NHS) for fibromyalgia patients [76]. However, its therapeutic mechanism for fibromyalgia-type syndromes remains unclear.

Recent studies provide evidence that sars-cov-2 infection might lead to strain and tension on skeletal muscles, and thus to myofascial taut bands and painful trigger points [77]. Histological analysis of muscle tissue samples from patients that had severe covid-19 revealed evidence of muscle fiber atrophy and immune cell infiltration was found on autopsy [78]. Musculoskeletal symptoms following sars-cov-2 infection may be caused by myocyte alterations and reduced force generating

capacity, decreased neural activation, fibre atrophy, necrosis, fibrosis, compromised muscle perfusion and endothelial damage, and decreased metabolic and aerobic respiration capacity [78]. Patients who deceased after severe covid-19 were shown to exhibit inflammatory reactions in skeletal muscles on autopsy, suggesting that coronavirus infection may be associated with an immune-mediated myopathy [79]. The skeletal muscle structure and the ECM in post-covid-19 patients that have symptoms of post-exertional malaise are altered compared to non-post covid individuals [25]. Extracellular abnormalities and amyloid deposition were found when analyzing biopsy of muscle from 25 “post covid-19 syndrome” patients after a maximal exercise test. Clinically, myalgia and myofascial pain are common manifestations of post-covid syndrome [80–82]. On that account, addressing myofascial tissue during therapy might be imperative for better recovery. TBN focuses on restoring optimal joint motion, reducing restrictions in movement, and promoting biomechanical harmony.

Research into manual needling therapy for post-covid syndrome is still in its early stages [83–86], though the potential of needling therapy as a treatment for post covid symptoms has been acknowledged in the literature by several authors [87–89]. Preliminary findings suggest that needling therapy could be beneficial for post-covid syndrome treatment, particularly in relation to its impact on myofascial tissue and trigger points. This was shown by a case report documenting a patient who suffered from lasting symptoms such as exertional dyspnea, myalgia, and brain fog after covid-19, without previous medical history of chronic illness [90]. The patient underwent a comprehensive multisystem medical evaluation, revealing normal results for cardiac, pulmonary, and end organ functions. His persistent fatigue and chronic pain following covid-19 were diagnosed as “long covid syndrome”, with additional fulfillment of the diagnostic criteria for fibromyalgia, having a Fibromyalgia Impact Questionnaire score of 88 out of 100 (thus indicating “severe fibromyalgia”). Despite treatments with both wet and dry needling aimed at alleviating myalgia, which initially provided some relief for myalgia, symptoms persisted and occurred also in other areas of the body. Eventually, twelve months after his initial episode of acute covid-19, after repetitively dry-needling him with a 21-gauge 1-inch needle in various locations, his pain went into remission. Case reports such as this offer potential evidence that the myalgia characteristic of “long covid syndrome” may constitute a form of new-onset myofascial pain [90]. More reports of dry needling therapy as a treatment for myofascial pain following sars-cov-2 infection are gradually surfacing in the literature [77].

Since current treatments for fibromyalgia-type syndromes are disappointing, which leaves many patients with impairment to daily life functions and a decreased quality of life [4], and on the background of the opioid crises, TBN might be worth considering as a valuable modality to study in this context. In line with osteopathic medicine, the primary goal of the treatment is to restore the body’s inherent capacity for self-regulation and healing by addressing structural imbalances that impede physiological processes, ultimately aiming to re-establish homeostasis.

Osteopathic medicine aims to restore the body’s inherent ability to regulate and heal itself by addressing structural imbalances that impede physiological processes. TBN, by aiming to balance the myofascioskeletal system, restore optimal mobility, reduce restrictions in movement, and improve tissue perfusion, can be seen as a modality that supports the osteopathic goal. Furthermore, osteopathic palpatory assessment seeks to identify areas of altered tissue texture and tension. The tensegrity model, with its emphasis on interconnected tensional forces, can provide a framework for interpreting these palpatory findings in conditions like fibromyalgia.

Conclusions

This paper presented a conceptual framework for the mechanism of action of tensegrity-based manual needling in the integrative treatment toolbox of chronic widespread musculoskeletal stiffness and pain – two of the main bothersome features of fibromyalgia. Tensegrity-based needling, stemming from the principles of tensegrity, focuses on restoring balance and function to the myofascioskeletal system. Understanding the modes of action of manual dry needling has a potential

to improve the integrative management of specific conditions such as chronic widespread pain and lead to better treatment outcomes.

The framework of TBN might help explain the mechanism of action of acupuncture, since both treatments, fundamentally, use multiple needles inserted into multiple body regions during therapy and aim to address a whole-body imbalance. TBN is suggested to act as a global percutaneous needle fasciotomy that respects tensegrity principles alongside the previously known positive physiological effects of needling. Mechanisms other than those described above may also be involved in acupuncture/TBN. Despite being typically grouped with other alternative non-evidence-based therapies under one “Eastern medicine” umbrella, acupuncture distinguishes itself as a minimally invasive intervention targeting myofascia.

Physical therapists and osteopathic practitioners recognize the significance of fascia in maintaining musculoskeletal health and addressing somatic dysfunction. TBN directly targets the fascial network to reduce rigidity, release tension, and promote healthier remodeling of the extracellular matrix, thereby aligning with approaches that aim to restore fascial balance and function. Since post covid-19 often involves muscle pathologies such as muscle tension and fibrosis, manual needling, when added to the integrative treatment of post covid-19, might be beneficial for addressing such abnormalities. While the focus of this paper is on the potential of manual needling as a treatment of the psychosomatic subtype of post covid syndrome, it has not been tested empirically. Empirical studies are warranted to understand the mode of action of needling therapy and its possible benefits in post-covid new-onset chronic pain.

Abbreviations

ECM- extracellular matrix, TBN- tensegrity-based needling.

References

1. Sarzi-Puttini P, Giorgi V, Marotto D, Atzeni F. Fibromyalgia: an update on clinical characteristics, aetiopathogenesis and treatment. *Nat Rev Rheumatol*. 2020 Nov;16(11):645-660. doi: 10.1038/s41584-020-00506-w.
2. Martínez-Lavín M, Miguel-Álvarez A. Hypothetical Framework for Post-COVID 19 Condition Based on a Fibromyalgia Pathogenetic Model. *Clin Rheumatol*. 2023 Nov;42(11):3167-3171. Doi: 10.1007/S10067-023-06743-0.
3. Häuser W, Ablin J, Fitzcharles MA, Littlejohn G, Luciano JV, Usui C, Walitt B. Fibromyalgia. *Nat Rev Dis Primers*. 2015 Aug 13;1:15022. Doi: 10.1038/Nrdp.2015.22.
4. D’Onghia M, Ciaffi J, Ruscitti P, Cipriani P, Giacomelli R, Ablin JN, Ursini F. The Economic Burden of Fibromyalgia: A Systematic Literature Review. *Semin Arthritis Rheum*. 2022 Oct;56:152060. Doi: 10.1016/j.Semarthrit.2022.152060.
5. Bileviciute-Ljungar I, Norrefalk JR, Borg K. Pain Burden in Post-COVID-19 Syndrome following Mild COVID-19 Infection. *J Clin Med*. 2022 Jan 31;11(3):771. doi: 10.3390/jcm11030771.
6. Savin E, Rosenn G, Tsur AM, Hen O, Ehrenberg S, Gendelman O, Buskila D, Halpert G, Amital D, Amital H. The Possible Onset of Fibromyalgia Following Acute COVID-19 Infection. *PLoS One*. 2023 Feb 10;18(2):E0281593. Doi: 10.1371/Journal.Pone.0281593.
7. Davis HE, McCorkell L, Vogel JM, Topol EJ. Long COVID: major findings, mechanisms and recommendations. *Nat Rev Microbiol*. 2023 Mar;21(3):133-146. doi: 10.1038/s41579-022-00846-2. Epub 2023 Jan 13. Erratum in: *Nat Rev Microbiol*. 2023 Jun;21(6):408. doi: 10.1038/s41579-023-00896-0.
8. Ursini F, Ciaffi J, Mancarella L, Lisi L, Brusi V, Cavallari C, D’Onghia M, Mari A, Borlandelli E, Faranda Cordella J, La Regina M, Viola P, Ruscitti P, Miceli M, De Giorgio R, Baldini N, Borghi C, Gasbarrini A, Iagnocco A, Giacomelli R, Faldini C, Landini MP, Meliconi R. Fibromyalgia: a new facet of the post-COVID-19 syndrome spectrum? Results from a web-based survey. *RMD Open*. 2021 Aug;7(3):e001735. doi: 10.1136/rmdopen-2021-001735.

9. Greenhalgh T, Sivan M, Delaney B, Evans R, Milne R. Long covid-an update for primary care. *BMJ*. 2022 Sep 22;378:e072117. doi: 10.1136/bmj-2022-072117.
10. Balfour W. Observations on the Pathology and Cure of Rheumatism. *Edinb Med Surg J*. 1815 Apr 1;11(42):168-187.
11. Pinto AM, Luís M, Geenen R, Palavra F, Lumley MA, Ablin JN, Amris K, Branco J, Buskila D, Castelhana J, Castelo-Branco M. Neurophysiological and Psychosocial Mechanisms of Fibromyalgia: A Comprehensive Review and Call for an Integrative Model. *Neuroscience & Biobehavioral Reviews*. 2023 Aug 1;151:105235.
12. Katz, R.S.; Leavitt, F.; Small, A.K.; Small, B.J. Intramuscular Pressure Is Almost Three Times Higher in Fibromyalgia Patients: A Possible Mechanism for Understanding the Muscle Pain and Tenderness. *Journal of Rheumatology* 2021, 48, 598–602, doi:10.3899/JRHEUM.191068.
13. Mascarenhas RO, Souza MB, Oliveira MX, Lacerda AC, Mendonça VA, Henschke N, Oliveira VC. Association of Therapies With Reduced Pain and Improved Quality of Life in Patients With Fibromyalgia: A Systematic Review and Meta-Analysis. *JAMA Intern Med*. 2021 Jan 1;181(1):104-112. Doi: 10.1001/Jamainternmed.2020.5651.
14. Goebel A, Krock E, Gentry C, Israel MR, Jurczak A, Urbina CM, Sandor K, Vastani N, Maurer M, Cuhadar U, Sensi S, Nomura Y, Menezes J, Baharpoor A, Brieskorn L, Sandström A, Tour J, Kadetoff D, Haglund L, Kosek E, Bevan S, Svensson CI, Andersson DA. Passive Transfer of Fibromyalgia Symptoms from Patients to Mice. *J Clin Invest*. 2021 Jul 1;131(13):E144201. Doi: 10.1172/JCI144201.
15. Goldenberg DL, Clauw DJ, Palmer RE, Clair AG. Opioid Use in Fibromyalgia: A Cautionary Tale. *Mayo Clin Proc*. 2016 May;91(5):640-8. Doi: 10.1016/j.Mayocp.2016.02.002.
16. Moldofsky H, Lue FA, Mously C, Roth-Schechter B, Reynolds WJ. The Effect of Zolpidem in Patients with Fibromyalgia: A Dose Ranging, Double Blind, Placebo Controlled, Modified Crossover Study. *J Rheumatol*. 1996 Mar;23(3):529-33.
17. Agarwal A, Emary PC, Gallo L, Oparin Y, Shin SH, Fitzcharles MA, Adachi JD, Cooper MD, Craigie S, Rai A, Wang L, Couban RJ, Busse JW. Physicians' Knowledge, Attitudes, and Practices Regarding Fibromyalgia: A Systematic Review and Meta-Analysis of Cross-Sectional Studies. *Medicine (Baltimore)*. 2024 Aug 2;103(31):E39109. Doi: 10.1097/MD.00000000000039109.
18. Ehrlich GE. Pain Is Real; Fibromyalgia Isn't. *J Rheumatol*. 2003 Aug;30(8):1666-7.
19. Johannessen LEF, Album D, Rasmussen EB. Do Nurses Rate Diseases According to Prestige? A Survey Study. *J Adv Nurs*. 2020 Jul;76(7):1691-1697. Doi: 10.1111/Jan.14394.
20. Album D, Westin S. Do Diseases Have a Prestige Hierarchy? A Survey among Physicians and Medical Students. *Soc Sci Med*. 2008 Jan;66(1):182-8. Doi: 10.1016/j.Socscimed.2007.07.003.
21. Kaptchuk TJ. Acupuncture: Theory, Efficacy, and Practice. *Ann Intern Med*. 2002 Mar 5;136(5):374-83. Doi: 10.7326/0003-4819-136-5-200203050-00010.
22. Plaut S. Scoping review and interpretation of myofascial pain/fibromyalgia syndrome: An attempt to assemble a medical puzzle. *PLoS One*. 2022 Feb 16;17(2):e0263087. doi: 10.1371/journal.pone.0263087.
23. Plaut S (2023) "Long COVID-19" and Viral "Fibromyalgia-Ness": Suggesting a Mechanistic Role for Fascial Myofibroblasts (Nineveh, the Shadow Is in the Fascia). *Front. Med*. 10:952278. Doi: 10.3389/Fmed.2023.952278.
24. Suh J, Mukerji SS, Collens SI, Padera RF Jr, Pinkus GS, Amato AA, Solomon IH. Skeletal Muscle and Peripheral Nerve Histopathology in COVID-19. *Neurology*. 2021 Aug 24;97(8):e849-e858. doi: 10.1212/WNL.00000000000012344.
25. Appelman B, Charlton BT, Goulding RP, Kerkhoff TJ, Breedveld EA, Noort W, Offringa C, Bloemers FW, van Weeghel M, Schomakers BV, Coelho P, Posthuma JJ, Aronica E, Joost Wiersinga W, van Vugt M, Wüst RCI. Muscle Abnormalities Worsen after Post-Exertional Malaise in Long COVID. *Nat Commun*. 2024 Jan 4;15(1):17. Doi: 10.1038/S41467-023-44432-3.
26. Tadeo I, Berbegall AP, Escudero LM, Alvaro T, Noguera R. Biotensegrity of the extracellular matrix: physiology, dynamic mechanical balance, and implications in oncology and mechanotherapy. *Front Oncol*. 2014 Mar 4;4:39. doi: 10.3389/fonc.2014.00039.

27. Chaitow, L., Schleip, R., Huijing, P., & Findley, T. W. (2012). *Fascia: The Tensional Network of the Human Body—The Science and Clinical Applications in Manual and Movement Therapy*, 2nd ed, London, UK: Churchill Livingstone/Elsevier, pp 121-142, 156-163. <https://doi.org/10.1016/C2009-0-39594-X>.
28. Micheletti A, Podio-Guidugli P. Seventy years of tensegrities (and counting). *Archive of Applied Mechanics* 2022; 92: 2525–48.
29. Ingber DE. Tensegrity I. *Cell Structure and Hierarchical Systems Biology*. *J Cell Sci*. 2003 Apr 1;116(Pt 7):1157-73. Doi: 10.1242/Jcs.00359.
30. Wilke J, Krause F. Myofascial Chains of the Upper Limb: A Systematic Review of Anatomical Studies. *Clin Anat*. 2019 Oct;32(7):934-940. Doi: 10.1002/ca.23424.
31. Wilke J, Krause F, Vogt L, Banzer W. What is evidence-based about myofascial chains: A systematic review. *Arch Phys Med Rehabil* 2016; 97: 454–61.
32. Wilke J, Schleip R, Yucesoy CA, Banzer W. Not merely a protective packing organ? A review of fascia and its force transmission capacity. *J Appl Physiol* 2018; 124: 234–44.
33. Nordez A, Gross R, Andrade R, Le Sant G, Freitas S, Ellis R, McNair PJ, Hug F. Non-Muscular Structures Can Limit the Maximal Joint Range of Motion during Stretching. *Sports Med*. 2017 Oct;47(10):1925-1929. doi: 10.1007/s40279-017-0703-5.
34. Behm DG, Cavanaugh T, Quigley P, Reid JC, Nardi PS, Marchetti PH. Acute bouts of upper and lower body static and dynamic stretching increase non-local joint range of motion. *Eur J Appl Physiol*. 2016 Jan;116(1):241-9. doi: 10.1007/s00421-015-3270-1.
35. Chen B, Cui S, Xu M, Zhang Z, Liu C. Effects of Isometric Plantar-Flexion on the Lower Limb Muscle and Lumbar Tissue Stiffness. *Front Bioeng Biotechnol*. 2022 Feb 11;9:810250. doi: 10.3389/fbioe.2021.810250.
36. Fede C, Porzionato A, Petrelli L, Fan C, Pirri C, Biz C, De Caro R, Stecco C. Fascia and soft tissues innervation in the human hip and their possible role in post-surgical pain. *J Orthop Res*. 2020 Jul;38(7):1646-1654. doi: 10.1002/jor.24665.
37. Sinhorim L, Amorim MDS, Ortiz ME, Bittencourt EB, Bianco G, da Silva FC, Horewicz VV, Schleip R, Reed WR, Mazzardo-Martins L, Martins DF. Potential Nociceptive Role of the Thoracolumbar Fascia: A Scope Review Involving In Vivo and Ex Vivo Studies. *J Clin Med*. 2021 Sep 24;10(19):4342. doi: 10.3390/jcm10194342.
38. Stacey MJ. Free Nerve Endings in Skeletal Muscle of the Cat. *J Anat*. 1969 Sep;105(Pt 2):231-54. PMID: 5802932; PMCID: PMC1232131.
39. Fede, C.; Pirri, C.; Fan, C.; Petrelli, L.; Guidolin, D.; De Caro, R.; Stecco, C. A Closer Look at the Cellular and Molecular Components of the Deep/Muscular Fasciae. *Int J Mol Sci* 2021, 22, 1–13.
40. Fede C, Petrelli L, Guidolin D, Porzionato A, Pirri C, Fan C, De Caro R, Stecco C. Evidence of a new hidden neural network into deep fasciae. *Sci Rep*. 2021 Jun 16;11(1):12623. doi: 10.1038/s41598-021-92194-z.
41. Stecco A, Gesi M, Stecco C, Stern R. Fascial components of the myofascial pain syndrome. *Curr Pain Headache Rep*. 2013 Aug;17(8):352. doi: 10.1007/s11916-013-0352-9.
42. Kumazawa T, Mizumura K. Thin-fibre receptors responding to mechanical, chemical, and thermal stimulation in the skeletal muscle of the dog. *J Physiol*. 1977 Dec;273(1):179-94. doi: 10.1113/jphysiol.1977.sp012088.
43. Marchettini P, Simone DA, Caputi G, Ochoa JL. Pain from excitation of identified muscle nociceptors in humans. *Brain Res*. 1996 Nov 18;740(1-2):109-16. doi: 10.1016/s0006-8993(96)00851-7.
44. Laursen RJ, Graven-Nielsen T, Jensen TS, Arendt-Nielsen L. The Effect of Differential and Complete Nerve Block on Experimental Muscle Pain in Humans. *Muscle Nerve*. 1999 Nov;22(11):1564-70.
45. Gerdle B., Ernberg M., Mannerkorpi K., Larsson B., Kosek E., Christidis N., Ghafouri B. Increased Interstitial Concentrations of Glutamate and Pyruvate in Vastus Lateralis of Women with Fibromyalgia Syndrome Are Normalized after an Exercise Intervention—A Case-Control Study. *PLoS ONE*. 2016;11:E0162010. Doi: 10.1371/Journal.Pone.0162010.
46. Kayal C, Moendarbary E, Shipley RJ, Phillips JB. Mechanical Response of Neural Cells to Physiologically Relevant Stiffness Gradients. *Adv Healthc Mater*. 2020 Apr;9(8):E1901036. Doi: 10.1002/Adhm.201901036.

47. Lantoine J, Grevesse T, Villers A, Delhay G, Mestdagh C, Versaevol M, Mohammed D, Bruyère C, Alaimo L, Lacour SP, Ris L, Gabriele S. Matrix Stiffness Modulates Formation and Activity of Neuronal Networks of Controlled Architectures. *Biomaterials*. 2016 May;89:14-24. Doi: 10.1016/j.biomaterials.2016.02.041.
48. Staud R. Peripheral Pain Mechanisms in Chronic Widespread Pain. *Best Pract Res Clin Rheumatol*. (2011) 25(2):155-64. Doi: 10.1016/j.berh.2010.01.010.
49. Ge HY, Wang Y, Danneskiold-Samsøe B, Graven-Nielsen T, Arendt-Nielsen L. The Predetermined Sites of Examination for Tender Points in Fibromyalgia Syndrome Are Frequently Associated with Myofascial Trigger Points. *J Pain*. 2010 Jul;11(7):644-51. Doi: 10.1016/j.jpain.2009.10.006.
50. Zhao ZQ. Neural Mechanism Underlying Acupuncture Analgesia. *Prog Neurobiol*. 2008 Aug;85(4):355-75. Doi: 10.1016/j.pneurobio.2008.05.004.
51. Martín-Sacristán L, Calvo-Lobo C, Pecos-Martín D, Fernández-Carnero J, Alonso-Pérez JL. Dry Needling in Active or Latent Trigger Point in Patients with Neck Pain: A Randomized Clinical Trial. *Sci Rep*. 2022 Feb 24;12(1):3188. Doi: 10.1038/S41598-022-07063-0.
52. Langevin HM, Churchill DL, Cipolla MJ. Mechanical Signaling through Connective Tissue: A Mechanism for the Therapeutic Effect of Acupuncture. *FASEB J*. (2001) 15(12):2275-82. Doi: 10.1096/Fj.01-0015hyp.
53. Langevin HM, Churchill DL, Wu J, Badger GJ, Yandow JA, Fox JR, Krag MH. Evidence of Connective Tissue Involvement in Acupuncture. *FASEB J*. (2002) 16(8):872-4. Doi: 10.1096/Fj.01-0925fj.
54. Langevin HM, Churchill DL, Fox JR, Badger GJ, Garra BS, Krag MH. Biomechanical Response to Acupuncture Needling in Humans. *J Appl Physiol* (1985). (2001) 91(6):2471-8. Doi: 10.1152/Jappl.2001.91.6.2471.
55. Langevin HM, Konofagou EE, Badger GJ, Churchill DL, Fox JR, Ophir J, Garra BS. Tissue Displacements during Acupuncture Using Ultrasound Elastography Techniques. *Ultrasound Med Biol*. (2004) 30(9):1173-83. Doi: 10.1016/j.ultrasmedbio.2004.07.010.
56. Sánchez-Infante J, Bravo-Sánchez A, Jiménez F, Abián-Vicén J. Effects of Dry Needling on Muscle Stiffness in Latent Myofascial Trigger Points: A Randomized Controlled Trial. *J Pain*. (2021) 22(7):817-825. Doi: 10.1016/j.jpain.2021.02.004.
57. Luan S, Zhu ZM, Ruan JL, Lin CN, Ke SJ, Xin WJ, et al. Randomized Trial on Comparison of the Efficacy of Extracorporeal Shock Wave Therapy and Dry Needling in Myofascial Trigger Points. *Am J Phys Med Rehabil*. (2019)98(8):677-684. Doi: 10.1097/PHM.0000000000001173.
58. Maher RM, Hayes DM, Shinohara M. Quantification of Dry Needling and Posture Effects on Myofascial Trigger Points Using Ultrasound Shear-Wave Elastography. *Arch Phys Med Rehabil*. (2013) 94(11):2146-50. Doi: 10.1016/j.apmr.2013.04.021.
59. Plaut S (2023) Suggesting a Mechanism for Acupuncture as a Global Percutaneous Needle Fasciotomy That Respects Tensegrity Principles for Treating Fibromyalgia. *Front. Med*. 9:952159. Doi: 10.3389/Fmed.2022.952159.
60. Opening Remarks at the Media Briefing on COVID-19. 2020 March 11. In: WHO Director- General. <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>. Accessed December 12, 2024.
61. Nalbandian A, Sehgal K, Gupta A, Madhavan MV, McGroder C, Stevens JS, Cook JR, Nordvig AS, Shalev D, Sehrawat TS, Ahluwalia N, Bikdeli B, Dietz D, Der-Nigoghossian C, Liyanage-Don N, Rosner GF, Bernstein EJ, Mohan S, Beckley AA et al. (2021) Post-Acute COVID-19 Syndrome. *Nat Med* 27(4):601-615.
62. Greenhalgh T, Knight M, A'Court C, Buxton M, Husain L. Management of Post-Acute Covid-19 in Primary Care. *BMJ*. 2020 Aug 11;370:M3026. Doi: 10.1136/Bmj.M3026.
63. Clauw DJ, Calabrese L. Rheumatology and Long COVID: lessons from the study of fibromyalgia. *Ann Rheum Dis*. 2024 Jan 11;83(2):136-138. doi: 10.1136/ard-2023-224250.
64. Goudman L, De Smedt A, Noppen M, Moens M. Is Central Sensitisation the Missing Link of Persisting Symptoms after COVID-19 Infection? *J Clin Med*. 2021 Nov 28;10(23):5594. Doi: 10.3390/Jcm10235594.
65. Yong SJ. Long COVID or Post-COVID-19 Syndrome: Putative Pathophysiology, Risk Factors, and Treatments. *Infect Dis (Lond)*. 2021 Oct;53(10):737-754. Doi: 10.1080/23744235.2021.1924397.

66. Komaroff AL, Lipkin WI. Insights from myalgic encephalomyelitis/chronic fatigue syndrome may help unravel the pathogenesis of postacute COVID-19 syndrome. *Trends Mol Med*. 2021 Sep;27(9):895-906. doi: 10.1016/j.molmed.2021.06.002
67. <https://www.nhs.uk/conditions/acupuncture/>. Last reviewed 12 October 2022.
68. Zheng H, Gao T, Zheng QH, Lu LY, Hou TH, Zhang SS, Zhou SY, Hao XY, Wang L, Zhao L, Liang FR, Li Y. Acupuncture for Patients With Chronic Tension-Type Headache: A Randomized Controlled Trial. *Neurology*. 2022 Oct 3;99(14):E1560-E1569. Doi: 10.1212/WNL.0000000000200670.
69. Xu S, Yu L, Luo X, Wang M, Chen G, Zhang Q, Liu W, Zhou Z, Song J, Jing H, Huang G, Liang F, Wang H, Wang W. Manual Acupuncture versus Sham Acupuncture and Usual Care for Prophylaxis of Episodic Migraine without Aura: Multicentre, Randomised Clinical Trial. *BMJ*. 2020 Mar 25;368:M697. Doi: 10.1136/Bmj.M697.
70. Pei L, Geng H, Guo J, Yang G, Wang L, Shen R, Xia S, Ding M, Feng H, Lu J, Li J, Liu L, Shu Y, Fang X, Wu X, Wang X, Weng S, Ju L, Chen X, Shen H, Sun J. Effect of Acupuncture in Patients With Irritable Bowel Syndrome: A Randomized Controlled Trial. *Mayo Clin Proc*. 2020 Aug;95(8):1671-1683. Doi: 10.1016/j.mayocp.2020.01.042.
71. Wang T, Xu C, Pan K, Xiong H. Acupuncture and Moxibustion for Chronic Fatigue Syndrome in Traditional Chinese Medicine: A Systematic Review and Meta-Analysis. *BMC Complement Altern Med*. 2017 Mar 23;17(1):163. Doi: 10.1186/S12906-017-1647-x.
72. Macfarlane GJ, Kronisch C, Dean LE, Atzeni F, Häuser W, Fluß E, Choy E, Kosek E, Amris K, Branco J, Dincer F, Leino-Arjas P, Longley K, McCarthy GM, Makri S, Perrot S, Sarzi-Puttini P, Taylor A, Jones GT. EULAR Revised Recommendations for the Management of Fibromyalgia. *Ann Rheum Dis*. 2017 Feb;76(2):318-328. Doi: 10.1136/Annrheumdis-2016-209724.
73. Deare JC, Zheng Z, Xue CC, Liu JP, Shang J, Scott SW, Littlejohn G. Acupuncture for Treating Fibromyalgia. *Cochrane Database Syst Rev*. 2013 May 31;2013(5):CD007070. Doi: 10.1002/14651858.CD007070.Pub2.
74. Vickers AJ, Vertosick EA, Lewith G, MacPherson H, Foster NE, Sherman KJ, Irnich D, Witt CM, Linde K; Acupuncture Trialists' Collaboration. Acupuncture for Chronic Pain: Update of an Individual Patient Data Meta-Analysis. *J Pain*. 2018 May;19(5):455-474. Doi: 10.1016/j.jpain.2017.11.005.
75. Busse JW, Casassus R, Carrasco-Labra A, Durham J, Mock D, Zakrzewska JM, Palmer C, Samer CF, Coen M, Guevremont B, Hoppe T, Guyatt GH, Crandon HN, Yao L, Sadeghirad B, Vandvik PO, Siemieniuk RAC, Lytvyn L, Hunskaar BS, Agoritsas T. Management of Chronic Pain Associated with Temporomandibular Disorders: A Clinical Practice Guideline. *BMJ*. 2023 Dec 15;383:E076227. Doi: 10.1136/Bmj-2023-076227.
76. <https://www.nhs.uk/conditions/fibromyalgia/treatment/>.
77. Patel J, Javed S. Myofascial pain syndrome and SARS-CoV-2: a case series. *Pain Manag*. 2022 Apr;12(3):255-260. doi: 10.2217/pmt-2021-0044.
78. Soares MN, Eggelbusch M, Naddaf E, Gerrits KHL, van der Schaaf M, van den Borst B, Wiersinga WJ, van Vugt M, Weijs PJM, Murray AJ, Wüst RCI. Skeletal muscle alterations in patients with acute Covid-19 and post-acute sequelae of Covid-19. *J Cachexia Sarcopenia Muscle*. 2022 Feb;13(1):11-22. doi: 10.1002/jcsm.12896.
79. Aschman T, Schneider J, Greuel S, Meinhardt J, Streit S, Goebel HH, Büttnerova I, Elezkurtaj S, Scheibe F, Radke J, Meisel C, Drost C, Radbruch H, Heppner FL, Corman VM, Stenzel W. Association Between SARS-CoV-2 Infection and Immune-Mediated Myopathy in Patients Who Have Died. *JAMA Neurol*. 2021 Aug 1;78(8):948-960. doi: 10.1001/jamaneurol.2021.2004.
80. www.uptodate.com Search "COVID-19: Evaluation and Management of Adults Following Acute Viral Illness" Section: Persistent Symptoms, by Mark E Mikkelsen & Benjamin Abramoff. Accessed February 2022.
81. Davis HE, Assaf GS, McCorkell L, Wei H, Low RJ, Re'em Y, Redfield S, Austin JP, Akrami A. Characterizing long COVID in an international cohort: 7 months of symptoms and their impact. *Eclinicalmedicine*. 2021 Aug;38:101019. doi: 10.1016/j.eclinm.2021.101019.
82. Willi S, Lüthold R, Hunt A, Hänggi NV, Sejdin D, Scaff C, Bender N, Staub K, Schlagenhauf P. COVID-19 sequelae in adults aged less than 50 years: A systematic review. *Travel Med Infect Dis*. 2021 Mar-Apr;40:101995. doi: 10.1016/j.tmaid.2021.101995.

83. Luo D, Liu B, Wang P, Liao H, Mao S, Chen H, Huang Y, Liu L, Lan W, Liu F. Traditional Chinese Medicine Combined with Moxibustion in the Treatment of “Long-COVID”: A Protocol for Systematic Review and Meta-Analysis. *Medicine (Baltimore)*. 2022 Oct 28;101(43):E31447. Doi: 10.1097/MD.00000000000031447.
84. Birch S, Alraek T, Gröbe S. Reflections on the potential role of acupuncture and Chinese herbal medicine in the treatment of Covid-19 and subsequent health problems. *Integr Med Res*. 2021;10(Suppl):100780. doi: 10.1016/j.imr.2021.100780.
85. Locke I, et al. (July 19, 2022-July 19, 2025). A Randomised Phase II Study to Investigate the Effectiveness of Acupuncture for the Relief of Long COVID Related Fatigue. Identifier NCT05212688. <https://Clinicaltrials.gov/Ct2/Show/NCT05212688>.
86. Omarova I, Akanova A, Kurmanova A, Kurmanova G, Glushkova N, Seidanova A, Turysbekov K. Acupuncture as an Additional Method of Rehabilitation Post-COVID-19: A Randomized Controlled Trial. *J Pharmacopuncture*. 2023 Sep 30;26(3):238-246. Doi: 10.3831/KPI.2023.26.3.238.
87. Dong J, Ni J, Zhang Z, Yan H, Xu J, Zhao J. The Impact of “Long COVID” on Menstruation in Chinese Female College Students and the Intervention of Acupuncture. *Medicine (Baltimore)*. 2024 Feb 9;103(6):E36818. Doi: 10.1097/MD.00000000000036818.
88. Kim SA, Lee JS, Kim T, Kim TH, Kwon S, Kang JW. Efficacy and Safety of Acupuncture Treatment for Fatigue after COVID-19 Infection: Study Protocol for a Pilot Randomized Sham-Controlled Trial. *Front Neurol*. 2023 Nov 15;14:1302793. Doi: 10.3389/Fneur.2023.1302793.
89. Estores IM, Ackerman P. Integrative Medicine in Long COVID. *Phys Med Rehabil Clin N Am*. 2023 Aug;34(3):677-688. Doi: 10.1016/j.Pmr.2023.03.006.
90. Zha M, Chaffee K, Alsarraj J. Trigger point injections and dry needling can be effective in treating long COVID syndrome-related myalgia: a case report. *J Med Case Rep*. 2022 Jan 17;16(1):31. doi: 10.1186/s13256-021-03239-w.

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.