The Neuromuscular Nexus: *Introducing torque chains as a paradigm-shifting framework for physical, mental, and emotional health*

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Abstract

This paper highlights a gap in the scientific understanding of the relationship between movement, muscular tension, breathing, the nervous system, and interoception, proposing a novel framework based on previously undefined neuromuscular '*torque chains*'. These torque chains, categorised as internal and external, influence musculoskeletal alignment, autonomic regulation, and emotional processing. Building upon the concept of a functionally integrated biomechanical model of the muscular system, we propose an expanded view that includes nervous system dynamics. By examining the interplay among these systems, this work brings awareness to how targeted interventions—such as breathwork guided by muscular tension and the application of specific movement patterns—can be developed and applied to alleviate chronic pain, improve nervous system regulation, and facilitate somatic-emotional integration. The proposed framework offers potential insights into the mechanisms that link all forms of somatic therapy used for chronic pain and stress-related conditions, encouraging further consideration and formal research.

Keywords: *Movement, Breathing, Torque Chains, Nervous System, Pain, Somatic Therapy*

Introduction

Movement is a fundamental aspect of the human experience. Yet, from a clinical perspective, it is poorly understood and seldom assessed. Movement specialists, such as the first and second author, view the body as a functionally integrated system—an outlook that often contrasts with centralised academic and medical systems, which compartmentalise information into distinct fields and specialties. While this separation serves practical purposes in terms of resource allocation and efficiency, it has inherent limitations. For instance, neuroscientists studying movement rarely communicate with orthopaedic surgeons treating patients in the clinic. Somatic therapists who work with fascia seldom engage with strength and conditioning coaches. Similarly, sports team doctors may not collaborate with breathwork practitioners, and radiologists focus on the state and positioning of bones, joints, and soft tissues, without commenting on apparent disparity in muscular length or tension in their reports. Each of these roles would benefit from a shared language grounded in the principles of movement.

In the age of artificial intelligence (AI) and decentralised science (DeSci), different academic fields have renewed opportunities to communicate and develop unified models with practical clinical applications. A model that proves effective—regardless of the underlying mechanisms—should be strengthened by real-world implementation. These frameworks can then be dissected for further refinement if desired. Conversely, when a model falls short, it can be updated based on new data. Here, we integrate concepts from diverse disciplines to enhance the human experience through movement, seeking to define its principles from the ground up for researchers, practitioners, and academics alike. By building these bridges between fields, the common language of movement can evolve, ultimately helping to alleviate human suffering.

Movement, muscles, and mechanobiology

Movement practices such as yoga, Tai Chi, and Qigong have been celebrated for their profound physical, mental, and emotional benefits for millennia (1). Contemporary literature advocates for integrated approaches that involve the physical body for healing from psychological trauma (2), and we know that some forms of exercise may be as, if not more, effective as antidepressant medications (3). The mechanisms underlying these effects remain poorly characterised in Western medicine, and recommending “exercise” as a broad intervention is almost comparable to recommending “medication” without specifying a drug or the dose. Ancient practices, along with the field of bioenergetic analysis pioneered by Wilhelm Reich and his student Alexander Lowen, suggest that muscular patterns are deeply intertwined with emotional and psychological health. Bioenergetics practitioners propose that chronic tension in specific muscle groups reflects emotional repression and that releasing this tension can unlock both physical and emotional healing (4). Similarly, breathwork practices (which are gaining interest as a non-pharmacological method to access altered states of consciousness) (5), underscore the therapeutic potential of controlled respiration. Breathing, a byproduct of movement and muscular contraction, highlights the indiscernible separation between life and movement. Building on these foundations, we propose that the neuromuscular system—via two distinct *torque chains*—plays a pivotal role in nervous system states, mental, physical and emotional health, underpinning many movement-based practices.

In order to understand these concepts, we need to consider the human body as a tensegrity (tensional integrity) system. The human body exemplifies the principles of a macrotensegrity structure, characterised by continuous tension and discontinuous compression. Muscles, tendons, and fascia form a network of continuous tension that interconnects the body, while bones act as compression elements (6). These bones do not directly touch each other but rather 'float' within the tensioned network, contributing to the system's structural integrity. This dynamic interplay between tension and compression allows the body to maintain balance and stability, resisting collapse while adapting to various stresses. Introducing the torque chains as layered within this tensegrity model adds depth to understanding how patterns of tension create stability while also influencing neural activity. This model also underpins improved posture, as the tension-compression balance supports the body against gravity with minimal muscular effort, reducing fatigue and promoting alignment. Furthermore, tensegrity explains the body's capacity to create stability while facilitating fluid and coordinated movement, demonstrating the elegance of its design. When this system is dysfunctional, tension is altered, displaced, and inappropriately applied or unbalanced, which likely explains the development of many common ailments such as osteoarthritic "wear and tear" or musculoskeletal pain.

Introducing torque chains

An important point to note here is that the positioning of joints and bones are dictated by the tension placed upon them. However, many pain specialists and orthopaedic surgeons place very little emphasis on assessing muscular tension in their clinical examinations. Neurological and musculoskeletal radiologists also do not routinely comment on this parameter, and certainly it is not measurable with a static image like an MRI or CT scan. This oversight may stem from the limited perspective that muscular tension is not a modifiable variable, a view not shared by those in the fitness industry or practitioners of somatic therapy. Through movement coaching and experiential application and learning, we have developed a working model that builds on the tensegrity framework where the baseline assumption is that some muscles generate tension toward the centre of the body, while other muscles generate tension away from it (Fig.1).

To the best of our knowledge, this binary system has not yet been characterised in the scientific literature. However, it builds on a functionally integrated perspective of the muscular system, a concept highlighted in particular by the late Moshe Feldenkrais (7). While a detailed exploration of this concept in modern scientific literature lies beyond the scope of this short paper, it is thoroughly examined in Krause et al.'s systematic review (8). We hope that the concept of torque chains fills a gap in modern physiotherapy. Classically, physiotherapists and anatomists will describe muscles based on their isolated function. For example the pectoralis major will be described as an internal rotator of the humerus. This is not entirely true in practice however, as there are many movements in which this muscle is active, and the humerus may externally rotate. What is more correct is the concept of torque, describing the tension that is created by this muscle. The added level of complexity and required knowledge is that there are two functionally distinct parts of the pectoralis major—the sternocostal and sternoclavicular heads that generate internal and external torque, respectively.

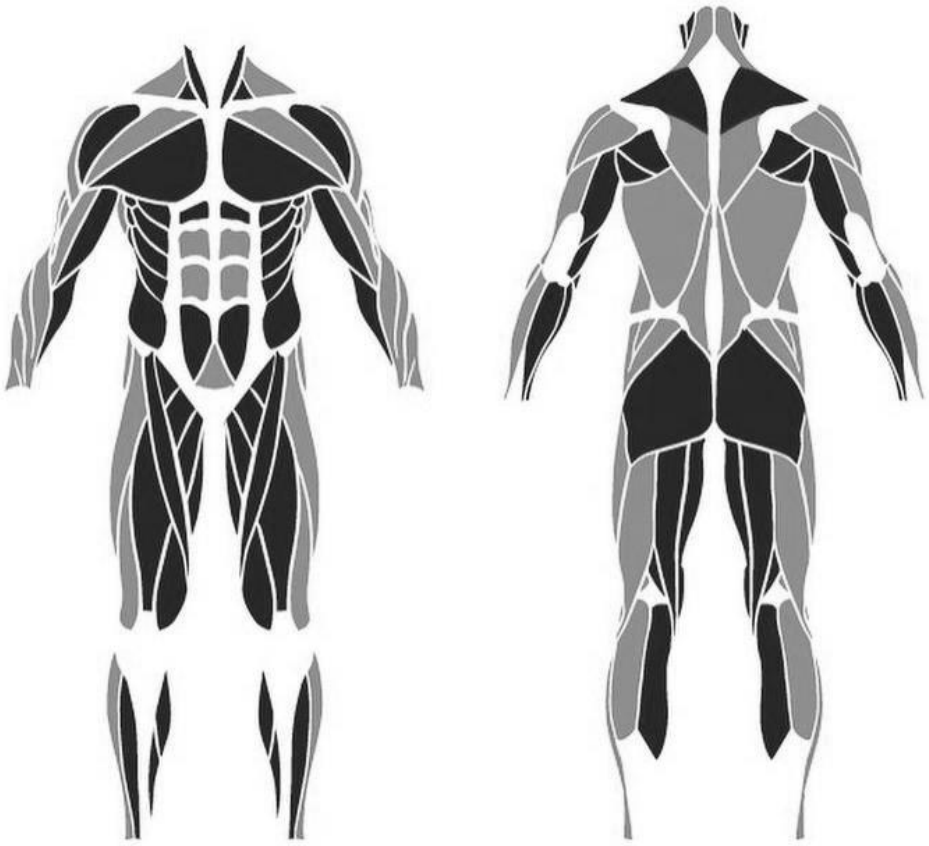

Figure 1. Internal & External Torque Chains schematic—front and rear views.
Dark grey = Internal. Light grey = External.

The *Internal Torque Chain* (ITC), which generates tension toward the centre of the body, includes core stabilising muscles such as the transverse abdominis, external obliques, psoas major and lower abdominals, as well as the teres major, the sternocostal head of the pectoralis major, short head of the biceps and medial head of the triceps. In the lower body, the medial quadriceps (vastus medialis obliquus, rectus femoris, sartorius), medial hamstrings (e.g., the semimembranosus, semitendinosus), gluteus maximus, and medial heads of the gastrocnemius and soleus. These muscles, which the authors refer to as ‘structural muscles’, contribute not only to postural stability but also have direct connections to the diaphragm and pelvic floor, influencing parasympathetic regulation and likely interoceptive awareness. Interoception—the perception of internal states like the heartbeat and breath—has been associated with emotional regulation and resilience (9). In our experience, proper activation of the ITC combined with the correct breathing patterns (e.g., inhaling through the nose, and exhaling through pursed lips without pausing nor holding the breath) can restore balance to the autonomic nervous system and promote a state of relaxation.

In contrast, the *External Torque Chain* (ETC) generates tension away from the centre of the body, and contains muscles such as the rectus abdominis, internal obliques,

sternoclavicular head of the pectoralis major, latissimus dorsi, medial and posterior deltoids, long head of the biceps, lumbar erectors, gluteus medius, and lateral quadriceps and hamstrings. This chain supports explosive movements, such as jumping, bracing for impact, and is more closely associated with sympathetic activation. Movements engaging these muscles tend to fatigue quickly, elevate heart rates significantly, and are more challenging to cycle repeatedly. Therefore, optimising the balance between the two chains can have a profound impact on how tension is distributed throughout the body. If these chains do indeed map onto both arms of the autonomic nervous system, this might help explain how environmental conditions influence both movement patterns and muscular tension (7).

Connection to pain and emotion

In our collective experience, having worked with thousands of cases and coaches applying the same principles, when the key structural muscles of the ITC are weak or underdeveloped, smaller muscles tend to compensate, leading to pain. In these cases, the ETC often holds onto excessive tension, leading to imbalances that can manifest as dysfunctional movement patterns, chronic pain or protective muscle spasms. This displacement of tension can perpetuate physical discomfort and limit emotional expression, mirroring Reich's concept of muscular 'armour' (4). The importance of the ITC muscles may be particularly relevant in conditions with overlapping phenomena that involve movement and the nervous system such as joint hypermobility, fibromyalgia, postural orthostatic tachycardia syndrome (POTS) and anxiety.

From a mechanistic standpoint, several physiological pathways may link muscular tension to emotional states. For instance, muscle spindle and Golgi tendon organ feedback can influence central nervous system circuits that govern not only motor control but also autonomic and limbic regulation (10). Modulations in muscular tension—particularly within the core and diaphragm—could alter afferent signaling to the vagus nerve and hypothalamic-pituitary-adrenal (HPA) axis, thus shifting the balance between sympathetic and parasympathetic activity. Changes in sympathetic drive could, in turn, impact the release of stress-related neurochemicals, such as cortisol, which are closely tied to emotional states (11). Additionally, the proprioceptive and interoceptive signals triggered by torque chain activation might engage brain regions involved in emotion processing (e.g., the insula, anterior cingulate cortex), potentially enhancing emotional regulation and resilience (11,12). Energy metabolites, such as lactate, have also been shown to link sympathetic activity, muscular engagement, and stress; they further serve as signaling molecules in key areas of the brain (13). While further empirical studies are needed to quantify these effects, this mind-body interplay provides a plausible neurophysiological basis for why clients often experience both pain relief and emotional shifts when retraining neuromuscular patterns.

The framework has been particularly effective in assessing and alleviating chronic musculoskeletal and joint pain over the last seven or more years of development. One anecdotal example that we have worked with is femoroacetabular impingement syndrome (FAI), a common radiological diagnosis for hip pain. FAI is often attributed to structural abnormalities in the hip joint, and surgical intervention is frequently recommended when conservative measures fail (14). However, in many cases, we have observed significant improvements by addressing the client's connection to the psoas major, a key component of the ITC. Through breathing guided by proper muscular connection, flowing movements, and targeted activation of

the psoas, individuals not only experience reductions in pain and improved hip function, but also report concomitant emotional effects and a sense of lightness. This suggests that what is often interpreted as a structural issue may, in fact, reflect deeper neuromuscular imbalances with contributions from emotional states.

Other chronic pain conditions that have proven refractory to surgery or conventional rehabilitation often dramatically improve when the torque chains are engaged correctly with targeted retraining. Additionally, we observe not only pain relief but also anecdotal improvements in sleep and increases in heart rate variability (HRV), an objective marker of autonomic adaptability. Moreover, as tension patterns release, clients frequently report emotional shifts consistent with bioenergetic principles, underscoring the connection between physical alignment and emotional health.

It has been highlighted that ancient spiritual practices have been used to balance emotions, and that teaching patients to regulate their breathing has been shown to effectively alleviate negative emotions, decrease pain, enhance visceral functions, elevate mood, and boost learning abilities (15). Additionally, each inhalation leads to an increase in pupil size, quicker reaction time, heightened fear response, improved memory encoding and retrieval, and reduced likelihood of initiating voluntary movements, while the opposite occurs during exhalation (15). These lines of evidence are intriguing but lack necessary detail from the perspective that breathing through the nose or mouth may augment these effects, through altered muscular tension in the face and body. We extend this argument further to consider muscular engagement throughout the body, particularly with attention on the engagement of the torque chains.

Moving forwards

In essence, we wish to highlight that the neuromuscular system, particularly the interplay between the ITC and ETC, warrants further investigation as a mediator of physical, emotional, and psychological health. By integrating these principles, we can deepen our understanding of how movement practices influence wellbeing and explore novel approaches to chronic pain and trauma. Future research should aim to validate these clinical observations and elucidate the mechanisms by which torque chains influence interoception, autonomic regulation, and emotional resilience. Furthermore, we hope that this paper lays the groundwork for gathering empirical data from professionals, coaches, and other practitioners who apply these principles in clinical or training settings. By collecting physiological measurements (e.g., HRV, muscle tension readings) over time and systematically documenting outcomes in case reports and case series, the framework can be continually refined and strengthened across diverse disciplines.

The challenge facing further work in this area is to avoid reductionist perspectives (and fragmentation of the neuromuscular tensegrity system), a problem faced in the related fields of breathwork and psychedelic research at present. In addition to clinical observations, it will be crucial to investigate potential mechanisms directly, exploring how modulating muscular tension through the torque chain framework may influence emotional and nervous system states. Such research could include experimental protocols, imaging, or neurophysiological measures to identify the interplay between muscle activity and autonomic, cognitive, and affective processes. Movement and breathing, when understood as tools for both physical and emotional alignment, may hold untapped potential for healing and transformation, and are relevant across many fields

of medicine. Ultimately, by recognising these practices as the bridge between body and mind, we open the door to a new era of healing—one that transcends traditional boundaries and harnesses the full transformative power of the neuromuscular system to restore balance and resilience across innumerable aspects of human health.

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Competing interests. R.A. is founder of Moved Academy and Movement Ayahuasca, two companies which teach and apply the concepts introduced in this paper. E.C. is a practicing movement specialist as well as an instructor at Moved Academy and facilitator at Movement Ayahuasca. G.W.F. is a qualified Breath Teacher with The Breath-Body-Mind Foundation, New York.