ResearchHub

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

Key Messages:

1. **Introduction of Torque Chains as a Biopsychosocial Framework:**
   The authors propose a novel model of the neuromuscular system organized into two "torque chains"—internal and external—that generate centripetal and centrifugal tension, respectively. These chains provide a mechanistic link between movement, breathing, musculoskeletal alignment, and emotional regulation, integrating biomechanical, neurological, and psychological domains.
2. **Functional Relationship to Autonomic Nervous System:**
   The Internal Torque Chain (ITC) is associated with parasympathetic activation and interoceptive awareness, while the External Torque Chain (ETC) aligns with sympathetic activation and high-intensity output. This dichotomy suggests that muscular

engagement patterns can directly influence autonomic balance and emotional states through neuromechanical pathways.

3. **Therapeutic Applications in Pain and Emotional Dysregulation:** Clinical application of torque chain activation has been associated with improvements in chronic pain, autonomic regulation (e.g., heart rate variability), and emotional release. The model offers a theoretical foundation for understanding the efficacy of somatic therapies and supports a call for empirical validation through interdisciplinary research.

INTRODUCTION

Movement is a fundamental aspect of the human experience with physical and psychological benefits (1). Yet, in clinical practice, and particularly in primary care, its integrative nature remains under appreciated despite significant research in specialised fields such as sports science, biomechanics, and rehabilitation medicine (2). 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 an age of artificial intelligence (AI) and decentralised science (DeSci), diverse 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 present a novel neuro-biomechanical model that integrates concepts from several disciplines. The aim of our work is to enhance the human experience through movement, seeking to define its principles from the ground up for clinicians, practitioners, and academics alike. By building these bridges between fields, the common language of movement can evolve, ultimately helping to alleviate human suffering. In the present paper we introduce a unique perspective on the neuromuscular system by describing two distinct muscular ‘chains’, discussing how they may play a role in autonomic regulation, pain and emotion. To conclude, we lay out future work that is required to take this theoretical framework forward and obtain empirical data to support it. In doing so, we aim to lay the groundwork for this promising therapeutic avenue of research.

Movement for wellbeing

Movement and breathing practices such as yoga, Tai Chi, and Qigong have been celebrated for their profound physical, mental, and emotional benefits for millennia (3). Contemporary literature advocates for integrated approaches that involve the physical body for healing from psychological trauma (4), and we know that some forms of exercise may be as, if not more, effective than antidepressant medications (5). 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 (6). The sensorimotor approach to trauma therapy developed by Pat Ogden also emphasises the connection between movement, bodily sensations and their association with patterns of behaviour and cognition (7). Additionally, Ida Pauline Rolf's structural integration, a method of sensorimotor education and hands-on therapy has been applied to improve biomechanical functioning overall in place of targeting specific indications (8). It is important to note that we are not promoting these alternative approaches, nor one particular way of training. Physical activity may act as a preventative measure against mental health disorders such as depression and anxiety (9) and it likely does not matter what kind of exercise one engages in. For instance, regarding psychological and cognitive outcome improvements, structured dance of any genre has been found to be just as effective, and sometimes more than other forms of structured exercise (10). Breathwork practices (which are gaining interest as a non-pharmacological method to access altered states of consciousness) (11), also underscore the therapeutic potential of volitionally controlled respiratory patterns. 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 relevant to somatic therapies.

Neuromuscular system as an integrated system

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 in the system with other muscles.

To outline this concept, we first need to consider the human body as an integrated 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 (12). 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. A delicate balance is thus created by tension created towards the centre of the body and tension created away from it—expansion and contraction—which must also undergo dynamic oscillation with the breathing cycle.

When this system is dysfunctional, tension is altered, displaced, and inappropriately applied or unbalanced, likely underpinning the development of many common ailments such as osteoarthritis or musculoskeletal pain. If the positioning of joints and bones is dictated by the tension placed upon them it should be common practice for pain specialists and orthopaedic surgeons to assess muscular tension. Unfortunately, radiologists cannot comment on this parameter because it is not measurable with a static image like an MRI or CT scan.

Functionally integrated models of the muscular system have been presented before, most notably by Moshe Feldenkrais (13). While a detailed exploration of this concept in modern scientific literature lies beyond the scope of this short paper, it is thoroughly examined here (14). Myofascial chains (and other related models such as the anterior and posterior serape (15)) do outline an integrated model of the muscular system from a biomechanical perspective, but do not integrate these ideas with neural or autonomic states, something that we aim to do with our model.

Introducing torque chains

Through movement coaching, experiential application and learning, we have developed a working model that builds on these integrated frameworks where the baseline assumption is that some groups of muscles generate tension toward the centre of the body, while others generate tension away from it, and use this to define two distinct *torque chains* (Fig.1), a binary classification that has not yet been described in the scientific literature.

The *Internal Torque Chain* (ITC), which generates tension toward the centre of the body, includes core stabilising muscles (Fig. 1). These muscles, which the authors consider to be foundationally important for structural integrity, contribute not only to postural stability but also have direct connections to the diaphragm and pelvic floor. The ITC can be engaged effectively with continuous, cyclical movements and breathing patterns. The authors discovered and developed this model by loading the lower abdomen whilst pursed lip breathing (inhaling through the nose and exhaling through the mouth, without holds or pauses), finding that individuals would gradually gain awareness of the chain over time through coordinated contraction and relaxation. Further, proper activation of the ITC with appropriate breathing techniques appears to promote a sense of subjective relaxation, and what appears to be a heightened level of interoceptive awareness.

In contrast, the *External Torque Chain* (ETC) generates tension away from the centre of the body (Fig. 1). This chain supports explosive movements, such as jumping, throwing and bracing for impact. These movements promote a grunt or a single, more powerful exhale, that is more difficult to cycle. Movements engaging these muscles tend to fatigue after fewer repetitions and elevate heart rates more rapidly, correlating with sympathetic activation. Hence, they are more challenging to cycle repeatedly. While ITC focused movement tends to result in more blood flow

and the pleasant sensation known as a 'pump', the ETC is more challenging to 'feel' in the same way.

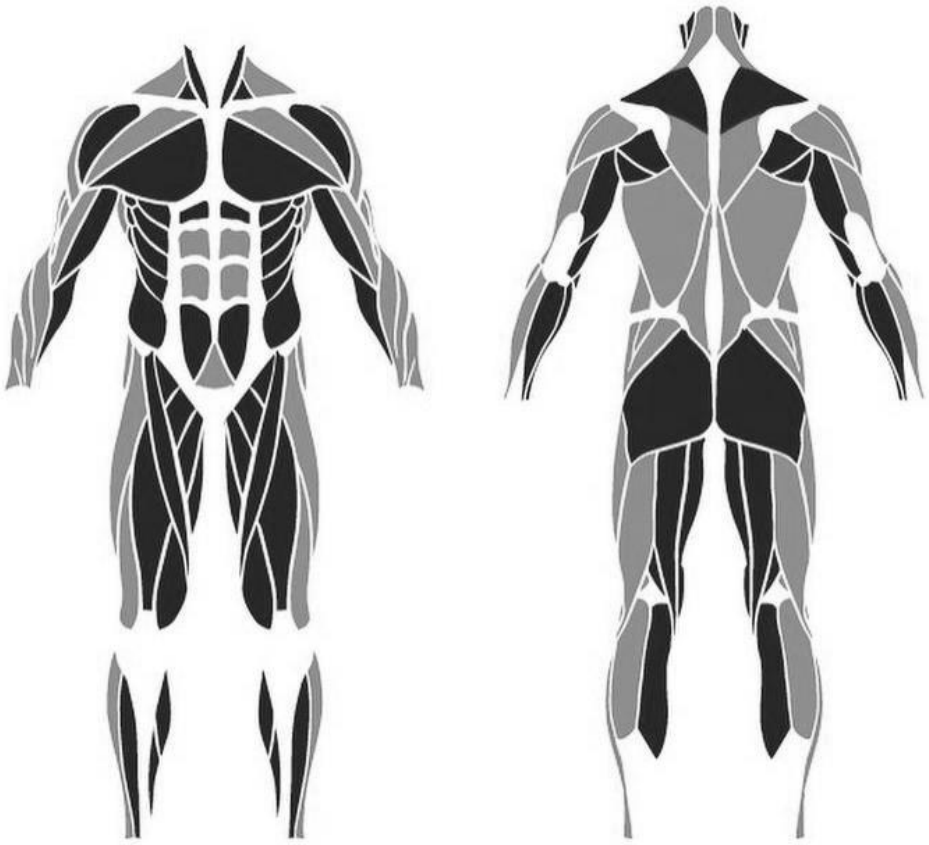

Figure 1. Internal & External Torque Chains schematic—front and rear views. A number of large structural muscles in the body can be defined as creating internal or external torque. The internal torque chain (ITC, black) generates tension towards the centre of the body and includes the transverse abdominis, external obliques, psoas major, lower abdominals, teres major, anterior deltoids, sternocostal head of the pectoralis major, short head of the biceps, medial head of the triceps, medial quadriceps (vastus medialis obliquus, rectus femoris, sartorius), medial hamstrings (semimembranosus, semitendinosus), gluteus maximus, medial heads of the gastrocnemius and soleus. The external torque chain (ETC, grey) generates tension away from the centre of the body and includes 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, lateral quadriceps and hamstrings (biceps femoris).

Due to this functional dichotomy, we further propose that the ITC and ETC and their corresponding movement patterns align with the parasympathetic and sympathetic arms of the autonomic nervous system. This might help explain how environmental conditions influence both movement patterns and muscular tension (13), and why in our experience proper activation and balance between both the chains, combined with the correct breathing patterns, may improve

nervous system regulation. Thus far this relationship appears to hold true regardless of gender and other individual differences. Fundamentally, this broadly applicable model may have a profound impact not only on physical tension and pain, but also neurological and emotional states across diverse populations.

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' (6). The importance of the ITC muscles may be particularly relevant in conditions with overlapping phenomena that involve movement and the autonomic nervous system such as joint hypermobility, fibromyalgia, postural orthostatic tachycardia syndrome (POTS) and associated symptoms such as anxiety or fatigue.

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 (16). Modulations in muscular tension—particularly within the core and diaphragm—could alter afferent signalling 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 (17). 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 (17,18). Interoception—the perception of internal states like the heartbeat and breath—has been associated with emotional regulation and resilience (19). Energy metabolites, such as lactate, have also been shown to link sympathetic activity, muscular engagement, and stress; they further serve as signalling molecules in key areas of the brain (20). 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 (21). 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. Including a proper movement assessment prior to medical or surgical intervention for any type of pain might reduce the number of unnecessary procedures that occur as a product of imbalanced tension in the torque chains. Hence, we see this framework as an adjuvant to standard practice that can reduce suffering and prevent iatrogenic harm.

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 (22). 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 (22). 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.

Based on this theoretical framework, several key research directions warrant investigation to provide robust quantitative validation. Longitudinal studies should measure physiological markers, including HRV, electromyography (EMG) readings and relevant cellular metabolites, in participants before and after structured movement interventions. The implementation of standardised assessment protocols and detailed case report templates across multiple practitioners would enable systematic documentation of interventions and outcomes in a database, which we have already begun collecting. Mechanistic investigations could utilise

advanced imaging techniques, such as fMRI or fMRS, to observe real-time changes in neural activity during specific muscular contractions, whilst measuring interoceptive accuracy using established protocols during muscular tension modulation through proper coaching. Cross-disciplinary validation through partnerships with breathwork practitioners and psychedelic researchers could help identify common physiological mechanisms, whilst collaborations with biomechanists and neuroscientists would enable quantification of forces through the proposed torque chains and mapping of neural correlates alongside phenomenological reports.

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. 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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AUTHOR CONTRIBUTIONS

Conceptualisation, E.C., R.A; writing—original draft preparation, E.C.; writing—review and editing, R.A, G.W.F. All authors have read and agreed to the published version of the manuscript.

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.