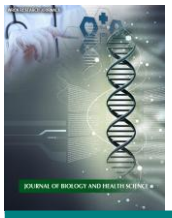

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Review Article

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The Three Archimedean Muscle-Tension Centers (AMTC) as Levers of Emotional Regulation: An Integrated Approach through ACT Therapy and Biofeedback

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Abstract

The concept of Archimedean Muscle-Tension Centers (AMTC) is inspired by Archimedes' principle of the lever, applied to the context of emotional regulation through specific muscle groups. The three main AMTCs identified are the diaphragm, the iliopsoas muscle and the trapezius. These areas are crucial for managing stress and emotions, as they accumulate chronic tension related to emotional and postural factors. Intervening in these centers through techniques such as Acceptance and Commitment Therapy (ACT), biofeedback and diaphragmatic breathing can promote deep relaxation and improve psychophysical well-being.

Keywords: Archimedean Muscle-Tension Centers (AMTC); Emotional regulation; ACT therapy; Biofeedback; Autonomic Nervous System (ANS); Diaphragmatic breathing; Iliopsoas muscle; Trapezius muscle; Chronic muscle tension; Heart Rate Variability (HRV); Psychophysical well-being; Mindfulness techniques; Stress management; Myofascial release; Fight-or-flight response; Parasympathetic activation; Musculoskeletal stability; Cortisol reduction; Somatic therapy; Holistic approach

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Introduction

Interpreting the concept of Archimedean muscle-tension centers

The term 'Archimedean centers' refers to Archimedes' principle of the lever, where applying minimal effort at a strategic point yield significant effect. In this context, the AMTC can be interpreted as muscle areas or groups that, if properly stimulated or released, can have a profound impact on overall body relaxation and the regulation of the autonomic nervous system.

Muscle-tension centers: Areas of muscular tension

In muscular physiology and somatic therapy, there are specific areas of the body prone to accumulating muscle tension as a result of emotional stress, poor posture or repetitive movements. These "centers" mainly include, but are not limited to:

1. **Trapezius muscle (especially the upper part):** Associated with stress and anxiety responses.
2. **Iliopsoas muscle:** Known as the muscle of the soul, involved in the fight or flight response.
3. **Diaphragm:** Essential for breathing, closely linked to the regulation of the autonomic nervous system.

These muscles can be considered muscle-tension centers because they tend to stiffen under emotional stress, affecting not only posture but also psychological well-being.

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Behind the scenes of Archimedean Muscle-Tension Centers (AMTC)

By merging the concepts of muscle-tension centers and the Archimedean lever, we can hypothesize that:

- There are specific points in the body (such as the muscles mentioned above) that function as levers to influence overall relaxation and emotional regulation.
- By intervening on these centers through techniques such as biofeedback, ACT Therapy, stretching, joint mobility and motor exercise, significant improvements can be achieved in managing stress and emotions.

This integrated approach enhances emotional regulation, reduces muscle tension and promotes sustainable psychophysical well-being.

The First Archimedean Muscle-Tension Centers (AMTC): The Role of the Diaphragm in Breathing and Emotional Regulation

The diaphragm is the primary muscle of respiration, located between the thoracic and abdominal cavities. While its main function is mechanical facilitating breathing recent studies suggest that the diaphragm also plays a crucial role in emotional regulation and stress management [1]. The connection between the diaphragm and the Autonomic Nervous System (ANS) makes this muscle particularly influential in shaping our emotional state, demonstrating how breath control can impact psychological well-being. This section explores the mechanisms through which the diaphragm can influence stress and emotions, delving into its physiological foundations and potential therapeutic interventions.

Anatomy and function of the diaphragm

The diaphragm is a dome-shaped muscle that separates the chest from the abdomen. During inhalation, the diaphragm contracts and moves downward, increasing the volume of the thoracic cavity and allowing air to enter the lungs. During exhalation, it relaxes and rises, decreasing thoracic volume and facilitating the expulsion of air [2].

In addition to its respiratory function, the diaphragm also has a crucial postural role. It is connected to the muscles of the abdominal wall, pelvic muscles and lumbar spine, forming a functional unit for trunk stabilization [3].

Autonomic nervous system and stress response

The autonomic nervous system is divided into two branches:

- **Sympathetic Nervous System (SNS):** Responsible for the fight or flight response, activated during acute stress situations.
- **Parasympathetic Nervous System (PNS):** Promotes the rest and digest response, encouraging relaxation and regeneration.

The diaphragm is innervated by the phrenic nerve, which originates from the Cervical plexus (C3C5). Deep diaphragmatic breathing stimulates the vagus nerve, the primary nerve of the PNS, promoting a state of relaxation and reducing levels of cortisol, the stress hormone [1].

By incorporating diaphragmatic breathing exercises, it is possible to activate the parasympathetic response, thereby improving emotional regulation and fostering overall psychological well-being. This approach not only reduces physical tension but also serves as a powerful tool for managing stress-related disorders.

The diaphragm and emotions

The connection between the diaphragm and emotional well-being is supported by numerous scientific studies. When a person is anxious or under stress, they tend to breathe shallowly and rapidly, using accessory muscles in the neck and shoulders rather than the diaphragm. This inefficient breathing pattern reduces oxygenation and can heighten anxiety levels [4].

The role of diaphragmatic breathing in reducing stress has been demonstrated through techniques like mindfulness and biofeedback. Slow, deep breathing engages the diaphragm, stimulates the Parasympathetic Nervous System (PNS) and reduces the activity of the Sympathetic Nervous System (SNS), leading to lower heart rate and blood pressure [5].

Mechanisms connecting the diaphragm and stress

Influence on Heart Rate Variability (HRV): Diaphragmatic breathing is associated with increased HRV, an indicator of autonomic nervous system resilience. Higher HRV is linked to improved stress management and recovery [6].

Effects on intra-abdominal pressure: The contraction of the diaphragm during deep breathing increases intra-abdominal pressure, which in turn stimulates vagal nerve receptors. This process promotes a deeper state of relaxation and reduces sympathetic activation [7].

Connection with the psyche: Chronic anxiety and stress can lead to diaphragm rigidity, limiting its ability to contract and relax. This creates a negative cycle where inefficient breathing exacerbates anxiety, which in turn worsens breathing patterns [8].

Supporting scientific studies

- Jerath et al. demonstrated that deep diaphragmatic

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breathing can enhance cognitive function and reduce symptoms of anxiety [4].

- Brown and Gerbarg found that breathing techniques that activate the diaphragm can be effective in treating Post-Traumatic Stress Disorder (PTSD) [9].

- Porges, developed the Polyvagal theory, which describes how vagal nerve stimulation through diaphragmatic breathing influences emotional regulation [1].

Therapeutic interventions

Using diaphragmatic breathing and relaxation techniques can have significant benefits for psychophysical well-being:

- **Mindfulness and meditation:** These practices focus on using breath to activate the PNS, reducing symptoms of anxiety and depression [10].

- **Yoga and pranayama:** Techniques like pranayama leverage breath control to enhance body awareness and promote relaxation [11].

- **Biofeedback:** Guided breathing through biofeedback helps patients become aware of their physiological responses and improve stress control [12].

A deeper understanding of how diaphragmatic breathing affects the autonomic nervous system and emotions can open new avenues for treating stress and anxiety-related disorders.

The second AMTC: The role of the iliopsoas muscle in managing emotions, tension and stress

The iliopsoas muscle is a complex and central structure in the human body, playing a crucial role in posture, movement and spinal stabilization. Recent interest has emerged regarding the link between chronic tension in this muscle and emotional and psychological well-being. Several theories suggest that the iliopsoas muscle is influenced by emotions, acting as a bridge between the musculoskeletal system and the emotional state [1]. This review explores the mechanisms by which the iliopsoas muscle can contribute to the manifestation of stress and emotional distress.

Anatomy and function of the iliopsoas

The iliopsoas consists of two distinct muscles:

- **Psoas major:** Originates from the vertebral bodies and transverse processes of T12-L5 vertebrae, inserting on the lesser trochanter of the femur.

- **Iliacus:** Originates from the iliac fossa of the pelvis and joins the psoas major before inserting on the femur.

This muscle is the primary hip flexor and a vital stabilizer of the spine [2]. It plays a crucial role in daily activities such as walking, running and sitting. Additionally, it is closely connected to the lumbar plexus, a critical nerve center that regulates parts of the autonomic nervous system (SNS and PNS) [13].

The role of the iliopsoas in emotional responses

In chronic stress conditions, the SNS remains constantly active, leading to persistent muscle contraction, including the iliopsoas. Its chronic activation has been linked to anxiety disorders, depression and psychophysical fatigue [14].

In psychosomatic literature, the iliopsoas has been referred to as the muscle of the soul due to its role in connecting the body and emotions [15]. The iliopsoas is involved in primary emotional responses such as fear and the sense of safety. When a person perceives danger or feels anxious, the SNS triggers an involuntary contraction of the iliopsoas, preparing the body for a fight-or-flight response.

Mechanisms connecting muscle and emotions

- **Tension and posture:** Chronic tension in the iliopsoas can alter posture, causing an anterior pelvic tilt that increases pressure on the lumbar vertebrae, contributing to back pain [16]. Posture significantly influences emotional states, with misalignment potentially heightening perceptions of stress and anxiety [17].

- **Effects on breathing:** A contracted iliopsoas can limit the diaphragm's movement, negatively impacting diaphragmatic breathing. Shallow breathing is associated with heightened stress responses and SNS overactivation [5].

By understanding these muscle-emotion connections, interventions targeting the iliopsoas can be developed to reduce tension, improve posture and enhance emotional well-being.

- **Effects on breathing:** A contracted iliopsoas muscle can restrict diaphragm movement, negatively affecting diaphragmatic breathing. Shallow breathing patterns are associated with an increased stress response and heightened Sympathetic Nervous System (SNS) activity [5].

- **Neurological connection:** The iliopsoas muscle is linked to the lumbar plexus, which interacts with the vagus nerve a key component of the Parasympathetic Nervous System (PNS). Tension in this area can reduce the body's ability to relax, increasing cortisol levels, the primary stress hormone [1].

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Scientific evidence supporting the emotional connection

A growing number of studies have explored the relationship between muscle tension and emotional well-being. For instance:

- Anderson et al. found that chronic tension in deep hip muscles, including the iliopsoas, was significantly higher in patients with anxiety disorders compared to healthy control groups [18].
- A 2016 study by emerson and hopper showed that relaxation and stretching exercises targeting the iliopsoas can improve PTSD (Post-Traumatic Stress Disorder) symptoms in war veterans, reducing blood cortisol levels.

The iliopsoas muscle plays a fundamental role not only in physical stability but also in emotional well-being. Its connection to the autonomic nervous system makes it a central muscle in stress responses. Managing tension in this muscle can be a promising therapeutic strategy for enhancing both physical and psychological health.

The third AMTC: The role of the trapezius muscle in managing emotions, tension and stress

The trapezius muscle is one of the most important muscles in the upper body, extending from the base of the skull to the upper back and shoulders. It is involved in numerous motor functions, including the movement and stabilization of the scapula and neck. Beyond its biomechanical functions, the trapezius is often associated with the management of emotions and stress. Chronic tension in this muscle is commonly observed in individuals experiencing prolonged stress, anxiety and other forms of emotional distress [16]. This section explores the link between trapezius muscle tension, stress and emotions, analyzing the underlying physiological mechanisms and potential therapeutic applications.

Anatomy and function of the trapezius muscle

The trapezius muscle is a broad, diamond-shaped muscle that covers much of the upper back and neck. It is divided into three main parts:

- **Upper trapezius:** Originates at the base of the skull and cervical vertebrae, inserting into the clavicle.
- **Middle trapezius:** Originates from the upper thoracic vertebrae and inserts into the acromion and scapula.
- **Lower trapezius:** Originates from the lower thoracic vertebrae and inserts into the scapula.

Primary functions

- Stabilization of the scapula during arm movements.
- Elevation, retraction and rotation of the scapula.
- Supporting the posture of the neck and upper back.

The trapezius is heavily innervated by cervical nerves and the spinal accessory nerve (cranial nerve XI), which plays a key role in the autonomic nervous system's response to environmental stressors [19]. Chronic tension in the upper trapezius is often linked to SNS overactivation, which can lead to pain and stiffness in the neck and shoulder region.

The role of the trapezius in emotional and stress responses

Numerous scientific studies suggest that tension in the trapezius muscle is significantly influenced by emotional stress [20]. When exposed to prolonged stress or anxiety, individuals tend to involuntarily contract the trapezius, especially the upper portion. This phenomenon can lead to:

- Chronic neck and shoulder pain.
- Restricted movement of the head and arms.
- Tension headaches related to cervical nerve compression.

In acute stress situations, the body responds with involuntary contractions of the neck and shoulder muscles, preparing for a potential fight-or-flight response. However, in chronic stress conditions, prolonged trapezius contraction can cause muscle stiffness, inflammation and pain [21].

Mechanisms connecting the trapezius to stress

- **Muscle tension and posture:** Chronic contraction of the upper trapezius can lead to abnormal posture, with raised shoulders and a forward head position. This posture is often linked to increased perceptions of stress and anxiety [16].
- **Connection to the nervous system:** The trapezius is directly connected to the autonomic nervous system through the spinal accessory nerve. Prolonged activation can lead to reduced blood flow and decreased HRV, both indicators of chronic stress [22].
- **Effect on breathing:** Tension in the trapezius can impair chest expansion, limiting diaphragmatic breathing and promoting shallow, thoracic breathing. This type of breathing is associated with SNS activation, contributing to a constant state of anxiety [7].

Scientific studies on the link between the trapezius and emotions

Several studies have demonstrated the link between trapezius muscle tension and emotional stress:

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- Gerber et al. found that muscle tension levels in the trapezius were significantly higher among workers reporting high job stress compared to those with lower stress levels [20].

- Andersson et al. showed that progressive relaxation and myofascial release therapy targeting the trapezius can significantly reduce muscle pain and anxiety symptoms in patients with myofascial pain syndrome [21].

Understanding the connection between muscle tension and emotional regulation opens new pathways for therapeutic interventions that combine physical and psychological approaches to improve overall well-being.

Therapeutic interventions and strategies

There are several techniques that can help reduce tension in the trapezius muscle and improve psychological well-being:

- **Stretching and mobilization:** Targeted stretching exercises for the upper trapezius can help reduce stiffness and improve neck mobility [23].

- **Relaxation techniques:** Practices such as Jacobson's progressive relaxation and biofeedback have proven effective in reducing muscle tension associated with stress [12].

- **Massage and myofascial therapy:** Deep tissue massage and myofascial release can alleviate chronic trapezius tension and promote relaxation [24].

The trapezius muscle is not only essential for movement and posture but also plays a significant role in emotional and stress responses. The connection between trapezius tension, stress and psychological well-being suggests that relaxation and stress management techniques can have a positive impact on both physical and emotional health. An integrated approach that includes stretching exercises, myofascial therapy and relaxation techniques can be an effective strategy for enhancing overall well-being.

The role of biofeedback in improving muscle function and diaphragm efficiency

Biofeedback is a technique that uses devices to monitor physiological functions, such as muscle tension, heart rate and respiration, making them visible to patients in real time. This practice helps individuals become aware of their physiological states and voluntarily adjust these responses to improve well-being [12].

Biofeedback for the trapezius muscle

Biofeedback can be used to reduce chronic tension in the trapezius muscle, particularly effective for people suffering from work-related stress or poor posture. Using Electromyography (EMG) sensors, patients can observe real-time activation levels in the upper trapezius. Through guided relaxation, patients learn to voluntarily reduce tension, preventing chronic neck and shoulder pain [20].

Biofeedback for diaphragm function

Respiratory biofeedback focuses on optimizing diaphragmatic breathing, improving control of the vagus nerve and the Parasympathetic Nervous System (PNS). Using devices that monitor breathing rate and depth, patients can learn to breathe more slowly and deeply, reducing Sympathetic Nervous System (SNS) activation and promoting relaxation [5].

Key benefits

- **HRV:** Effective diaphragmatic breathing increases HRV, signaling a more balanced and resilient nervous system [23].

- **Reduced muscle tension:** Learning to breathe correctly with the diaphragm helps relax accessory muscles, such as the trapezius, preventing chronic tension.

- **Improved body awareness:** Through biofeedback, patients become more aware of their breathing patterns and muscle tension, allowing them to correct them in real-time.

Integrating biofeedback into therapeutic practices can be an effective approach to reducing stress, enhancing respiratory function and alleviating chronic muscle tension. This technique is particularly beneficial for treating musculoskeletal pain and anxiety-related disorders, promoting overall well-being.

The role of joint mobility and stretching exercises in enhancing trapezius and diaphragm function

Joint mobility and stretching exercises are essential techniques for improving muscle functionality, preventing chronic tension and promoting relaxation. These exercises not only enhance flexibility but also significantly reduce stress and increase psychophysical well-being [21].

Stretching and mobility for the trapezius muscle

The trapezius muscle, particularly its upper portion, is frequently subject to tension due to stress and poor posture. Targeted static and dynamic stretching exercises can:

- Reduce chronic muscle tension, improving flexibility and mobility in the cervical region [23].

- Relieve neck and shoulder pain, improving circulation and reducing nerve compression in the cervical area.

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- Encourage the release of endorphins, which help lower stress levels and improve mood [20].

Examples of exercises include:

- Lateral neck stretches to relax the upper trapezius.
- Shoulder rotations to enhance scapular mobility.

Stretching Exercises for the Diaphragm

The diaphragm can become rigid and inefficient due to chronic stress and shallow chest breathing.

Stretching and mobility exercises can help relax this muscle and enhance its function:

- Deep diaphragmatic breathing exercises, which combine thoracic and abdominal mobility, promote more effective breathing and greater relaxation.
- Thoracic extensions on a foam roller or bridge stretches, which improve rib cage flexibility, allowing for greater diaphragmatic expansion [7].

Incorporating these stretching and mobility exercises into a regular routine can help alleviate muscle stiffness, improve respiratory efficiency and enhance overall psychophysical well-being.

Key benefits

- **Stress reduction:** Improved diaphragm mobility enhances diaphragmatic breathing, stimulating the vagus nerve and lowering cortisol levels [1].
- **Posture improvement:** Stretching the trapezius and diaphragm promotes better spinal and shoulder alignment.
- **Increased body awareness:** These exercises help relax tense muscles and improve breath awareness, reducing anxiety and enhancing emotional regulation [5].

Integrating joint mobility and stretching exercises into a daily routine can be an effective strategy to improve the function of the trapezius and diaphragm, reducing muscle tension, alleviating stress and enhancing quality of life.

ACT Therapy (Acceptance and Commitment Therapy) and its impact on muscle tension and emotional experiences

Introduction to ACT Therapy

Acceptance and Commitment Therapy (ACT) is a psychotherapeutic approach focused on acceptance and commitment. Instead of trying to eliminate negative emotions, ACT Therapy encourages individuals to accept their emotional states and commit to actions aligned with their values, even in the presence of pain or discomfort [25]. ACT has proven effective in treating conditions related to chronic stress, anxiety and muscle tension [26].

Connection between ACT Therapy and muscle tension

Chronic muscle tension, particularly in muscles like the trapezius and iliopsoas, is often associated with negative emotional states such as anxiety and stress [16]. People tend to unconsciously contract their muscles in response to emotional stress, leading to stiffness, pain and even limited mobility.

Through ACT, patients learn to:

- Recognize and accept physical sensations and associated emotions without trying to eliminate them.
- Use mindfulness practices to observe muscle tension and anxiety without reacting to them with additional stress [25].
- Decenter from negative thoughts related to muscle pain, thereby reducing the tendency to further tighten muscles.

Effects of ACT on the diaphragm and breathing

The diaphragm is often influenced by emotions; stressful situations lead to shallow, chest breathing, which worsens anxiety. ACT can help patients to:

- Accept feelings of anxiety and use diaphragmatic breathing exercises to promote relaxation [27].
- Reduce diaphragm tension through mindfulness, encouraging deeper, more conscious breathing that activates the Parasympathetic Nervous System (PNS) [1].

Key benefits

- **Reduced muscle tension:** ACT teaches individuals not to avoid physical discomfort, leading to decreased muscle tension associated with negative emotional states.
- **Improved body awareness:** Mindfulness exercises help identify and release chronic tensions, especially in muscles involved in stress responses.
- **Emotional regulation:** ACT improves the ability to tolerate difficult emotions, which can reduce the automatic muscle contraction response during stressful periods [26].

ACT Therapy, through acceptance, mindfulness and commitment to meaningful values, can reduce the negative impact of stress on muscle tension, thereby enhancing physical and psychological health. This therapy represents an effective approach to managing musculoskeletal

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conditions and related emotional sensations.

Conclusions

The interdisciplinary analysis conducted in this scientific review reveals how the diaphragm, trapezius and iliopsoas muscles (the three primary AMTCs) represent crucial intersection points between muscle physiology and human emotions, highlighting the profound connection between body and mind. Understanding these connections not only expands our anatomical and physiological knowledge but also offers new perspectives for integrated therapeutic approaches that promote overall well-being.

A Transdisciplinary vision: muscles, nervous system and emotions

The diaphragm, traditionally regarded solely as the main respiratory muscle, also emerges as a crucial regulator of emotional stress due to its connection with the Autonomic Nervous System (ANS), particularly the vagus nerve. Studies show that practices like diaphragmatic breathing can activate the parasympathetic system, reducing cortisol levels and promoting a state of relaxation.

Simultaneously, the trapezius muscle, often subject to chronic tension in stressful situations, demonstrates how emotional stress can manifest physically through muscle contractions that alter posture and motor functionality. This phenomenon suggests that therapeutic approaches should include not only physical interventions (such as myofascial release and stretching) but also psychological techniques to reduce sympathetic activation.

The integrated approach: Biofeedback and ACT Therapy

The integration of biofeedback as a tool to improve body awareness and reduce muscle tension is supported by numerous studies. Respiratory biofeedback, in particular, is effective in enhancing HRV, an indicator of nervous system resilience. This practice not only improves control over diaphragmatic breathing but also positively impacts tension reduction in the trapezius and iliopsoas muscles.

In parallel, Acceptance and Commitment Therapy (ACT) offers an innovative psychological approach focused on accepting difficult emotions and reducing chronic muscle tension through mindfulness. The effects of ACT on muscular well-being are significant, promoting both emotional resilience and physical relaxation.

Especially in the case of deeply stress-related muscles like the iliopsoas

The connection between chronic tension in muscles, particularly those like the iliopsoas which are deeply linked to emotional stress, underscores the need for a holistic approach that unifies body and mind. Techniques such as diaphragmatic breathing not only enhance tissue oxygenation but also stimulate the vagus nerve, thereby activating the parasympathetic nervous system and lowering cortisol levels the synergy between muscle relaxation induced by breathing techniques and the psychological acceptance of one's emotional states can increase HRV, a marker of resilience and balance in the autonomic nervous system.

A transdisciplinary theory for well-being

The framework that has emerged suggests a new transdisciplinary theory that integrates muscle physiology, psychology and neuroscience to understand how the body and mind interact in managing emotions and stress. Chronic tension in muscles like the diaphragm and trapezius is not merely a reflection of psychological stress but an indicator of systemic imbalance involving the autonomic nervous system, posture and breathing.

This approach indicates that treating chronic stress cannot be reduced to isolated interventions but must include:

- Muscle relaxation techniques (such as stretching and myofascial release).
- Biofeedback interventions to enhance awareness of bodily responses.
- Psychological therapies based on mindfulness, such as ACT, to address the emotional components.

The integration of these practices can improve emotional regulation, reduce chronic muscle tension and promote sustainable psychophysical well-being. Future research should focus on the interaction between these approaches to develop integrated therapeutic protocols that address not only the physical symptoms but also the psychological roots of stress.

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