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Clinical Implications of Combining Dry Needling with Cervical Stabilization Exercises in the Management of Non-Specific Neck Pain: A Narrative Review

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Abstract

Background
Non-specific neck pain (NSNP) is one of the leading musculoskeletal disorders worldwide and represents a major cause of pain, functional limitation, work absenteeism, and reduced quality of life. Its multifactorial nature involves biomechanical dysfunction, myofascial trigger points, impaired neuromuscular control, postural abnormalities, and psychosocial influences. Consequently, contemporary physiotherapy has shifted from isolated treatment modalities toward multimodal rehabilitation strategies that simultaneously address pain and movement dysfunction. Dry needling has demonstrated effectiveness in reducing myofascial pain and muscle hypertonicity, whereas cervical stabilization exercises target deficits in deep cervical flexor function, motor control, proprioception, and segmental spinal stability. Although both interventions have been extensively investigated individually, evidence synthesizing their combined clinical application remains limited.

Objective
This narrative review critically evaluates the current evidence regarding the combined use of dry needling and cervical stabilization exercises in individuals with non-specific neck pain. The review explores their physiological mechanisms, clinical rationale, therapeutic benefits, practical implications for physiotherapy practice, and existing gaps that warrant further investigation.

Methods
A comprehensive narrative review of the literature was undertaken using evidence from randomized controlled trials, systematic reviews, meta-analyses, clinical practice guidelines, and observational studies. Relevant publications addressing dry needling, cervical stabilization, deep cervical flexor training, motor control rehabilitation, and non-specific neck pain were examined and synthesized to provide an evidence-informed overview of current rehabilitation strategies.

Results
The available evidence indicates that dry needling effectively reduces pain by deactivating myofascial trigger points, improving local circulation, decreasing muscle tension, and modulating nociceptive processing through peripheral and central neurophysiological mechanisms. Cervical stabilization exercises restore deep cervical flexor activation, enhance neuromuscular coordination, improve proprioception, and increase cervical stability. When integrated within a rehabilitation programme, these interventions appear to exert complementary effects. Pain reduction achieved through dry needling may facilitate more effective participation in motor control training, while stabilization exercises address the neuromuscular impairments responsible for persistent dysfunction and recurrent symptoms. Although current findings support multimodal rehabilitation, considerable heterogeneity in treatment protocols, exercise progression, and outcome measures limits direct comparison across studies.

Conclusion
The integration of dry needling with cervical stabilization exercises represents a promising evidence-informed strategy for the conservative management of non-specific neck pain. By simultaneously addressing pain modulation and restoration of neuromuscular function, the combined approach has the potential to improve pain intensity, functional performance, cervical stability, and quality of life beyond that achieved by either intervention alone. Nevertheless, high-quality randomized controlled trials employing standardized intervention protocols and long-term follow-up are required to establish optimal treatment parameters and strengthen the existing evidence base.

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Introduction

Non-specific neck pain (NSNP) is one of the most prevalent musculoskeletal disorders worldwide and represents a substantial source of pain, disability, and socioeconomic burden. Characterized by pain in the cervical region without an identifiable pathological cause such as fracture, infection, inflammatory disease, cervical radiculopathy, or malignancy, NSNP accounts for the majority of neck pain cases encountered in clinical practice. Although it is rarely associated with serious pathology, its recurrent nature and tendency to become chronic frequently impair physical function, work productivity, and health-related quality of life. As a result, NSNP has become a major public health concern and remains one of the leading contributors to years lived with disability globally.

The increasing prevalence of NSNP reflects profound changes in occupational demands and modern lifestyle behaviours. The widespread use of computers, smartphones, and other digital devices has led to prolonged static postures, sustained cervical flexion, and reduced physical activity, all of which increase mechanical stress on the cervical spine. Office workers, healthcare professionals, students, drivers, and individuals engaged in repetitive upper-limb activities are particularly vulnerable because of prolonged sitting, inadequate ergonomic practices, and limited opportunities for postural variation throughout the working day. These cumulative mechanical stresses contribute to persistent neck pain and explain the growing incidence of NSNP among both working-age adults and younger populations.

The pathogenesis of NSNP extends beyond structural abnormalities and is now recognised as a complex interaction of biomechanical, neuromuscular, physiological, and psychosocial factors. Mechanical overload, repetitive microtrauma, sustained muscle contraction, emotional stress, sleep disturbances, and reduced physical activity collectively influence the onset and persistence of symptoms. Persistent pain alters normal movement behaviour, promotes fear of movement, and contributes to central sensitisation, creating a self-perpetuating cycle in which pain, movement dysfunction, and disability reinforce one another. Consequently, contemporary management of NSNP requires an understanding of the condition from a biopsychosocial perspective rather than a purely biomedical model.

A characteristic feature of NSNP is impaired neuromuscular control of the cervical spine. Efficient cervical function depends on coordinated activation of the deep cervical flexor muscles, particularly the longus colli and longus capitis, which provide segmental stability and maintain cervical alignment during functional activities. In individuals with persistent neck pain, these muscles frequently demonstrate delayed activation, reduced endurance, and impaired motor control. This dysfunction is often accompanied by excessive activation of superficial muscles, including the sternocleidomastoid, upper trapezius, levator scapulae, and cervical extensors. The resulting muscle imbalance increases mechanical loading across cervical structures, alters movement patterns, and perpetuates pain and functional limitation.

Myofascial dysfunction further contributes to the clinical presentation of NSNP. Active myofascial trigger points are commonly identified within the upper trapezius, levator scapulae, sternocleidomastoid, scalenes, and suboccipital muscles. These hyperirritable foci generate local and referred pain, restrict cervical mobility, reduce muscle performance, and interfere with normal motor control. Persistent trigger point activity may therefore not only

increase symptom severity but also hinder the effectiveness of rehabilitation if left untreated.

Current clinical practice guidelines recommend conservative, exercise-based management as the first-line treatment for NSNP. However, increasing evidence suggests that interventions targeting a single mechanism rarely provide sustained clinical benefit because of the multifactorial nature of the disorder. Contemporary physiotherapy therefore advocates multimodal rehabilitation strategies that integrate pain-modulating techniques with interventions aimed at restoring neuromuscular control, improving movement quality, and enhancing functional capacity.

Among the available conservative interventions, dry needling has gained widespread acceptance for the management of myofascial pain. The technique involves the insertion of a solid filiform needle into myofascial trigger points or dysfunctional muscle tissue to reduce muscle tension, improve local circulation, elicit local twitch responses, and modulate nociceptive processing through peripheral and central neurophysiological mechanisms. Clinical studies consistently demonstrate favourable short-term improvements in pain intensity, pressure pain sensitivity, and cervical range of motion following dry needling. Nevertheless, symptom reduction alone does not restore the neuromuscular deficits responsible for persistent dysfunction and recurrent episodes of neck pain.

Conversely, cervical stabilization exercises directly address the motor control impairments associated with NSNP. These exercises selectively activate the deep cervical flexor musculature, improve proprioceptive function, restore normal muscle recruitment patterns, and enhance cervical segmental stability. Unlike conventional strengthening programmes, stabilization training focuses on the quality and coordination of movement rather than force production alone. By improving neuromuscular control and postural stability, these exercises reduce abnormal mechanical loading and contribute to long-term functional recovery.

The complementary mechanisms of these interventions provide a strong rationale for their combined application. Dry needling may reduce pain and muscle guarding sufficiently to allow patients to perform stabilization exercises with greater comfort and improved movement quality. In turn, cervical stabilization exercises reinforce these early improvements by restoring efficient motor control, improving postural alignment, and reducing the likelihood of symptom recurrence. Rather than functioning as independent treatments, the two interventions may therefore act synergistically, addressing both the symptomatic and functional components of NSNP.

Although the individual effectiveness of dry needling and cervical stabilization exercises has been examined extensively, comparatively few publications have synthesised the evidence supporting their combined use within a structured rehabilitation programme. Clarifying the potential advantages of integrating these interventions is important for evidence-based clinical decision-making and may assist physiotherapists in designing more comprehensive rehabilitation strategies for individuals with NSNP.

Therefore, the purpose of this narrative review is to critically synthesise the current evidence regarding the combined use of dry needling and cervical stabilization exercises in the management of non-specific neck pain. In addition to examining their underlying physiological mechanisms and clinical effectiveness, this review discusses the therapeutic rationale for combining these interventions, highlights their implications for physiotherapy

practice, and identifies priorities for future research.

Burden of Non-Specific Neck Pain

Non-specific neck pain (NSNP) has emerged as one of the most significant musculoskeletal disorders affecting global health. Despite the absence of a clearly identifiable structural pathology, the condition is associated with substantial pain, disability, reduced work capacity, and diminished quality of life. According to the Global Burden of Disease (GBD) study, neck pain consistently ranks among the leading causes of years lived with disability (YLDs), highlighting its considerable impact on individuals, healthcare systems, and society. Unlike many acute musculoskeletal disorders, NSNP frequently follows a recurrent or persistent course, with many patients experiencing repeated episodes over several years. This chronicity contributes to prolonged functional limitations and increasing healthcare utilization.

The epidemiology of NSNP demonstrates considerable variation across populations; however, its overall prevalence remains consistently high. Lifetime prevalence has been reported to range between 30% and 70%, while annual prevalence is estimated at 15–50%, with approximately one in five adults experiencing neck pain at any given time. The disorder is particularly common among individuals aged 25–55 years, representing the most economically productive segment of the population. Women generally report higher prevalence rates than men, a difference that has been attributed to a combination of biological, occupational, and psychosocial influences. More recently, an increasing incidence has also been observed among adolescents and young adults, reflecting changing behavioural patterns associated with extensive use of smartphones, tablets, and computers.

Rapid technological advancement has fundamentally altered occupational and recreational behaviours, contributing substantially to the growing burden of NSNP. Modern work environments frequently require prolonged computer use, sustained visual display terminal exposure, repetitive upper-limb tasks, and extended periods of sitting. These occupational demands promote sustained cervical flexion, static muscle loading, and reduced postural variability, all of which increase mechanical stress on cervical tissues. Consequently, office employees, healthcare professionals, teachers, dentists, drivers, laboratory personnel, and university students represent populations at particularly high risk. Furthermore, excessive smartphone use has led to the widespread development of forward head posture, often referred to as *text neck*, which further increases compressive forces across the cervical spine and predisposes individuals to muscle fatigue, postural dysfunction, and myofascial pain.

The consequences of NSNP extend well beyond physical discomfort. Persistent neck pain commonly interferes with occupational performance, daily activities, sleep quality, and participation in social and recreational pursuits. Psychological factors, including anxiety, depression, fear of movement, stress, and pain catastrophizing, frequently coexist with chronic symptoms and have been shown to influence both pain intensity and recovery. Reduced physical activity resulting from persistent pain may further contribute to muscular deconditioning, impaired neuromuscular control, and functional decline, reinforcing the cycle of chronic pain and disability. These observations support the contemporary biopsychosocial model of musculoskeletal pain, in which biological, psychological, and social factors collectively influence symptom persistence and treatment outcomes.

From an economic perspective, NSNP imposes a considerable financial burden on healthcare systems worldwide. Direct costs include medical consultations, diagnostic investigations, pharmacological management, physiotherapy, and rehabilitation services, whereas indirect costs arise from absenteeism, reduced workplace productivity, compensation claims, and early retirement. As sedentary occupations and digital technology become increasingly integrated into daily life, the socioeconomic impact of NSNP is expected to continue rising, emphasizing the importance of effective preventive and rehabilitative strategies.

Several modifiable risk factors have been consistently associated with the development and persistence of NSNP, including prolonged static posture, inadequate workplace ergonomics, repetitive cervical loading, reduced physical activity, obesity, smoking, poor sleep quality, and psychological stress. In contrast, advancing age, female sex, and a previous history of neck pain represent important non-modifiable risk factors. Recognition of these contributors is clinically important because many can be addressed through patient education, ergonomic modification, exercise therapy, and lifestyle interventions aimed at preventing symptom recurrence.

Growing evidence indicates that NSNP should no longer be viewed solely as a localized mechanical disorder. Rather, it represents a multidimensional condition involving interactions between altered biomechanics, neuromuscular dysfunction, impaired sensorimotor control, pain sensitization, and psychosocial influences. Consequently, contemporary rehabilitation has shifted away from passive symptom management toward comprehensive, patient-centred interventions that combine pain reduction with restoration of movement quality, muscular endurance, and functional capacity.

Within this context, multimodal physiotherapy has become the cornerstone of conservative management. Clinical practice guidelines consistently recommend combining therapeutic exercise, manual therapy, patient education, ergonomic modification, and self-management strategies rather than relying on isolated interventions. Among the available treatment options, the integration of dry needling with cervical stabilization exercises has attracted increasing clinical interest because it simultaneously addresses myofascial pain, neuromuscular dysfunction, and movement impairment. Understanding the substantial burden imposed by NSNP reinforces the need for evidence-based rehabilitation approaches that not only alleviate symptoms but also improve long-term function and reduce recurrence.

Anatomy and Biomechanics of Cervical Stabilization

A thorough understanding of cervical anatomy and biomechanics is fundamental to appreciating the rationale for cervical stabilization exercises in the management of non-specific neck pain (NSNP). The cervical spine is a highly specialized structure that must simultaneously provide extensive mobility and sufficient stability to support the head, protect neural and vascular structures, and facilitate coordinated movement during functional activities. Achieving this balance depends on the harmonious interaction of osseous structures, ligaments, intervertebral discs, muscles, and the neuromuscular control system. Disturbance of any component may compromise spinal stability and contribute to the development or persistence of neck pain.

The cervical spine comprises seven vertebrae (C1–C7), each contributing uniquely to cervical motion. The atlanto-occipital and atlanto-axial joints account for a substantial proportion of flexion-

extension and rotational movement, whereas the lower cervical segments primarily permit flexion, extension, lateral flexion, and rotation while distributing mechanical loads during daily activities. Although these anatomical characteristics provide remarkable mobility, they also require precise muscular control to maintain joint integrity and minimize excessive stress on passive tissues.

Panjabi's spinal stability model provides a useful framework for understanding cervical function. According to this model, spinal stability is maintained through the coordinated interaction of three interdependent subsystems: the passive subsystem, the active subsystem, and the neural control subsystem. The passive subsystem consists of the vertebrae, facet joints, intervertebral discs, ligaments, and joint capsules, which provide structural support and restrict excessive motion. The active subsystem comprises the cervical musculature responsible for generating movement and maintaining spinal alignment, while the neural control subsystem integrates sensory input from mechanoreceptors and coordinates appropriate muscle activation. Dysfunction within any of these subsystems alters cervical biomechanics and increases susceptibility to pain and movement dysfunction.

Among the active stabilizing structures, the deep cervical flexor muscles—particularly the longus colli and longus capitis—play a pivotal role in maintaining segmental stability. Unlike superficial muscles that generate powerful movements, these deep muscles function continuously at low levels of activation to preserve cervical lordosis, control intersegmental motion, and provide dynamic stability during static postures and functional tasks. Efficient activation of the deep cervical flexors allows movement to occur with minimal mechanical stress on passive spinal structures, making them essential for maintaining normal cervical biomechanics.

Substantial evidence indicates that individuals with NSNP demonstrate impaired function of the deep cervical flexors. Electromyographic and imaging studies consistently report delayed activation, reduced endurance, diminished cross-sectional area, and altered recruitment patterns in these muscles. As their stabilizing capacity declines, superficial muscles—including the sternocleidomastoid, upper trapezius, levator scapulae, anterior scalene, and cervical extensors—become increasingly active to compensate. Although this compensatory strategy initially preserves movement, prolonged overactivity increases muscle fatigue, compressive loading across cervical joints, and mechanical stress on surrounding soft tissues. Consequently, inefficient muscle recruitment contributes not only to pain but also to the persistence and recurrence of symptoms.

Forward head posture (FHP) represents one of the most frequently observed biomechanical alterations in individuals with NSNP. In this position, anterior displacement of the head increases the external flexion moment acting on the cervical spine, requiring greater activation of posterior cervical musculature to maintain an upright gaze. Continuous activation of the upper trapezius, levator scapulae, and cervical extensors leads to muscular fatigue, increased joint compression, and greater susceptibility to myofascial trigger point formation. Simultaneously, the deep cervical flexors become lengthened and functionally inhibited, further compromising segmental stability. This imbalance creates a mechanical environment that favours persistent pain and dysfunctional movement patterns.

Cervical biomechanics cannot be considered independently of adjacent regions. The cervical spine functions as part of an integrated cervicothoracic and scapulothoracic kinetic chain. Increased thoracic kyphosis, rounded shoulders, reduced thoracic mobility, and scapular dyskinesis alter muscle activation patterns and modify load distribution throughout the cervical region. These interconnected adaptations explain why rehabilitation programmes that address only local cervical symptoms frequently achieve suboptimal outcomes. Contemporary physiotherapy therefore advocates a regional interdependence approach, emphasizing restoration of coordinated function throughout the cervicothoracic complex.

Another essential component of cervical stability is sensorimotor control. Mechanoreceptors within cervical muscles, ligaments, facet joints, and joint capsules continuously transmit information regarding head position and movement to the central nervous system. Accurate proprioceptive feedback enables precise coordination of cervical motion, gaze stabilization, and postural control. Individuals with NSNP commonly exhibit impaired joint position sense, reduced movement accuracy, altered balance, and diminished postural stability, indicating disruption of normal sensorimotor processing. These deficits not only contribute to functional impairment but may also predispose patients to recurrent episodes of neck pain.

The primary objective of cervical stabilization exercises is to restore normal neuromuscular control rather than simply increase muscular strength. Rehabilitation typically begins with selective activation of the deep cervical flexors using low-load motor control exercises such as the cranio-cervical flexion exercise (CCFE). Pressure biofeedback devices are frequently used to facilitate selective recruitment while minimizing compensatory activity of superficial muscles. As motor control improves, rehabilitation progresses to endurance training, dynamic stabilization, postural retraining, functional strengthening, and integration of cervical control into upper-limb and whole-body movements. This progressive approach promotes efficient muscle recruitment and improves the cervical spine's capacity to tolerate occupational and daily functional demands.

Evidence supporting cervical stabilization exercises continues to strengthen. Randomized controlled trials and systematic reviews consistently demonstrate improvements in pain intensity, cervical muscle endurance, postural alignment, proprioception, cervical range of motion, and functional disability following structured stabilization programmes. Importantly, these improvements appear to result from restoration of neuromuscular coordination rather than increases in muscle strength alone, reinforcing the concept that motor control retraining is central to successful rehabilitation of NSNP.

These biomechanical principles also explain why cervical stabilization exercises complement dry needling. While dry needling effectively reduces pain, muscle hypertonicity, and myofascial dysfunction, it does not restore the impaired motor control that characterizes persistent NSNP. Cervical stabilization exercises address this limitation by retraining deep cervical flexor activation, improving postural control, and enhancing segmental stability. Consequently, combining pain modulation through dry needling with restoration of neuromuscular function through stabilization exercises provides a comprehensive rehabilitation strategy that addresses both the symptoms and the underlying mechanisms contributing to persistent neck pain.

Pathophysiology of Non-Specific Neck Pain

Non-specific neck pain (NSNP) is increasingly recognised as a multifactorial disorder arising from the interaction of biomechanical, neuromuscular, neurophysiological, and psychosocial mechanisms rather than from a single identifiable structural lesion. In most individuals, symptoms develop gradually following repeated exposure to mechanical loading, sustained postural stress, repetitive movements, or prolonged static positions. These cumulative mechanical demands initiate a cascade of physiological and neuromuscular adaptations that, if unresolved, contribute to persistent pain, impaired function, and recurrent episodes of disability.

Mechanical overload represents one of the earliest contributors to NSNP. Daily activities such as prolonged computer work, smartphone use, driving, studying, and repetitive occupational tasks subject cervical muscles, ligaments, facet joints, and intervertebral discs to sustained low-level loading. Although these forces rarely produce gross structural injury, repetitive microtrauma and inadequate tissue recovery stimulate peripheral nociceptors and initiate inflammatory responses. Consequently, pain may develop even in the absence of radiographic abnormalities, highlighting the poor relationship between structural findings and clinical symptoms in many individuals with NSNP.

A hallmark feature of persistent NSNP is altered neuromuscular control. Under normal conditions, cervical stability is maintained through coordinated activation of the deep cervical flexors and extensors, while superficial muscles generate movement with minimal unnecessary activity. Pain disrupts this finely regulated system. Numerous studies have demonstrated delayed activation, reduced endurance, and impaired recruitment of the longus colli and longus capitis, accompanied by excessive activation of superficial muscles such as the sternocleidomastoid, upper trapezius, levator scapulae, and scalenes. Although this compensatory strategy initially protects painful tissues, prolonged muscle overactivity increases compressive loading across cervical joints, accelerates muscular fatigue, and perpetuates dysfunctional movement patterns.

Myofascial dysfunction further amplifies these biomechanical alterations. Active myofascial trigger points commonly develop within muscles exposed to repetitive loading or sustained contraction, particularly the upper trapezius, levator scapulae, sternocleidomastoid, scalenes, suboccipital muscles, and cervical extensors. These trigger points are characterised by localized hyperirritable nodules capable of producing both local tenderness and referred pain. Biochemical investigations have demonstrated increased concentrations of inflammatory mediators, including substance P, calcitonin gene-related peptide (CGRP), bradykinin, and pro-inflammatory cytokines within active trigger points. These biochemical changes contribute to peripheral sensitisation, increased muscle stiffness, reduced flexibility, and diminished contractile efficiency, thereby reinforcing pain and movement dysfunction.

Persistent nociceptive input also induces significant adaptations within the central nervous system. Continued afferent stimulation from cervical tissues may lead to central sensitisation, a condition in which neurons within the spinal cord and brain become hyper-responsive to sensory input. As central sensitisation develops, pain becomes amplified and may persist despite minimal ongoing tissue pathology. Individuals frequently exhibit reduced pain thresholds, widespread mechanical hypersensitivity, and pain responses that appear disproportionate to the degree of

peripheral tissue injury. Recognition of central sensitisation has fundamentally changed contemporary understanding of chronic NSNP and underscores why interventions directed solely at peripheral tissues often provide only temporary symptom relief.

Sensorimotor dysfunction represents another characteristic feature of NSNP. Mechanoreceptors located within cervical muscles, ligaments, and facet joints provide continuous proprioceptive information regarding head position and movement. Persistent pain disrupts this sensory feedback, impairing joint position sense, movement accuracy, postural control, and gaze stability. These deficits not only contribute to functional limitations but also increase the likelihood of recurrent injury because cervical movements become less precise and mechanically less efficient. Restoration of sensorimotor control has therefore become an important objective of modern rehabilitation programmes.

Psychological and behavioural factors further influence symptom persistence. Anxiety, depression, emotional stress, poor sleep quality, fear of movement, and pain catastrophising have all been associated with increased pain intensity, greater disability, and delayed recovery in individuals with chronic neck pain. Fear-avoidance behaviours frequently result in reduced physical activity, muscular deconditioning, diminished endurance, and progressive loss of function. Consequently, current evidence supports a biopsychosocial model, recognising that biological, psychological, and social factors interact dynamically throughout the course of the disorder.

These interacting mechanisms explain why interventions targeting only a single aspect of NSNP rarely achieve sustained clinical success. Pain reduction alone does not restore normal motor control, while exercise programmes may be difficult to perform effectively when pain and muscle guarding remain severe. Contemporary rehabilitation therefore favours multimodal strategies capable of simultaneously addressing pain, neuromuscular dysfunction, movement impairment, and psychosocial influences.

Within this framework, the integration of dry needling and cervical stabilization exercises is supported by strong physiological reasoning. Dry needling primarily modulates peripheral nociception, reduces myofascial trigger point activity, decreases muscle hypertonicity, and facilitates pain relief through both local biochemical and central neurophysiological mechanisms. This reduction in pain creates a more favourable environment for active rehabilitation. Cervical stabilization exercises subsequently restore deep cervical flexor activation, improve proprioceptive function, re-establish efficient movement patterns, and enhance dynamic spinal stability. Rather than acting independently, these interventions address complementary components of the pathophysiological process, providing a more comprehensive approach to rehabilitation than either modality alone.

In summary, NSNP should be regarded as a multidimensional disorder involving reciprocal interactions among mechanical loading, altered neuromuscular control, myofascial dysfunction, pain sensitisation, sensorimotor impairment, and psychosocial influences. Appreciating this complexity reinforces the need for rehabilitation strategies that extend beyond symptom management and focus on restoring normal movement, improving function, and preventing recurrence.

Dry Needling: Mechanisms of Action and Clinical Evidence

Dry needling (DN) has become an increasingly established intervention within

contemporary musculoskeletal physiotherapy, particularly for the management of myofascial pain disorders, including non-specific neck pain (NSNP). Unlike acupuncture, which is based on traditional Chinese medicine, dry needling is grounded in modern anatomical and neurophysiological principles. The technique involves inserting a sterile, solid filiform needle into myofascial trigger points (MTrPs), taut bands, or dysfunctional soft tissues with the aim of reducing pain, restoring normal muscle function, and improving movement. Over the past two decades, an expanding body of evidence has supported its clinical effectiveness as part of a comprehensive rehabilitation programme for musculoskeletal pain.

Myofascial trigger points are considered one of the principal peripheral pain generators in NSNP. They are hyperirritable nodules located within taut bands of skeletal muscle that produce local tenderness, referred pain, restricted range of motion, muscle weakness, and altered movement patterns. Trigger points commonly develop in the upper trapezius, levator scapulae, sternocleidomastoid, scalenes, suboccipital muscles, splenius capitis, and cervical paraspinal muscles due to sustained postural loading, repetitive mechanical stress, muscle overuse, or trauma. Persistent trigger point activity increases muscle stiffness, disrupts normal recruitment patterns, and contributes to chronic pain and functional impairment.

The pathophysiology of trigger point formation is explained by the integrated trigger point hypothesis. Repetitive mechanical loading or excessive muscle contraction results in local muscle fibre shortening and sustained sarcomere contraction. This compresses intramuscular blood vessels, producing local ischaemia and reduced oxygen availability. The resulting energy crisis impairs calcium reuptake within the sarcoplasmic reticulum, preventing complete muscle relaxation and perpetuating sustained contraction. Accumulation of metabolites and inflammatory mediators—including substance P, calcitonin gene-related peptide (CGRP), bradykinin, serotonin, prostaglandins, and pro-inflammatory cytokines—sensitises peripheral nociceptors, generating pain and maintaining trigger point activity. These biochemical changes explain the tenderness and referred pain patterns frequently observed in individuals with NSNP.

The therapeutic effects of dry needling are mediated through several complementary physiological mechanisms. One of the most recognised responses is the local twitch response (LTR), an involuntary spinal reflex elicited when the needle penetrates an active trigger point. Elicitation of an LTR is believed to mechanically disrupt dysfunctional motor end plates, reduce excessive acetylcholine release, normalise muscle fibre contraction, and decrease spontaneous electrical activity within the affected muscle. Although clinical improvement can occur without an observable twitch response, several studies suggest that successful elicitation of one or more LTRs may be associated with greater reductions in pain and muscle tension.

Beyond its local mechanical effects, dry needling induces important biochemical changes within the treated muscle. Microdialysis studies have demonstrated reductions in concentrations of substance P, CGRP, inflammatory cytokines, and other nociceptive mediators following treatment. Simultaneously, local blood flow increases, facilitating oxygen delivery, removal of metabolic waste products, and restoration of tissue homeostasis. These physiological changes contribute to decreased muscle stiffness, improved tissue extensibility, and enhanced contractile function.

Dry needling also exerts significant neurophysiological effects at both the

spinal and supraspinal levels. Needle stimulation activates A-delta sensory fibres, which influence nociceptive transmission through spinal segmental inhibitory mechanisms. At the supraspinal level, stimulation of descending inhibitory pathways originating in the periaqueductal grey, rostroventral medulla, and other brainstem centres promotes the release of endogenous opioids, serotonin, noradrenaline, and endocannabinoids. Collectively, these mechanisms reduce pain perception, increase pressure pain thresholds, and improve tolerance to movement. Functional neuroimaging studies further suggest that dry needling modulates cortical regions involved in pain processing, supporting the concept that its benefits extend beyond local tissue effects.

Pain reduction following dry needling frequently results in secondary improvements in muscle activation and movement quality. Individuals with persistent neck pain often exhibit reflex inhibition of the deep cervical flexors and excessive activation of superficial cervical musculature. By decreasing pain and muscle guarding, dry needling may partially restore normal muscle recruitment, allowing patients to perform therapeutic exercises with greater accuracy and reduced discomfort. However, these improvements are primarily facilitative rather than corrective, as the intervention does not directly retrain neuromuscular control or restore impaired motor patterns.

A growing body of clinical research supports the effectiveness of dry needling in NSNP. Randomized controlled trials and systematic reviews consistently report short-term reductions in pain intensity, increased pressure pain thresholds, improved cervical range of motion, and modest improvements in disability following treatment. Meta-analyses generally conclude that dry needling is superior to sham or no intervention for short-term pain relief, although differences between dry needling and other active physiotherapy interventions are often smaller. The greatest clinical benefits appear to occur when dry needling is incorporated into a broader rehabilitation programme rather than delivered as a stand-alone intervention.

Despite encouraging evidence, several limitations should be acknowledged. Considerable heterogeneity exists regarding treatment protocols, including needle placement, depth of insertion, number of trigger points treated, manipulation techniques, session frequency, and overall treatment duration. Variability in clinician experience and differences in outcome measures further complicate comparisons between studies. Moreover, although short-term benefits are well established, evidence supporting sustained long-term improvements remains less consistent, suggesting that dry needling alone may be insufficient to address the underlying causes of persistent NSNP.

Current clinical practice guidelines increasingly recommend integrating passive and active treatment strategies for chronic musculoskeletal disorders. Within this context, dry needling should be regarded as an adjunct rather than a definitive treatment. While it effectively reduces pain, muscle hypertonicity, and trigger point irritability, it does not directly restore deep cervical flexor function, improve proprioception, or correct dysfunctional movement patterns. These deficits are central contributors to symptom persistence and recurrence.

This limitation provides the principal rationale for combining dry needling with cervical stabilization exercises. Pain relief achieved through dry needling creates a therapeutic window during which patients can more effectively engage in motor control retraining. Subsequent stabilization exercises reinforce these improvements by restoring deep cervical flexor activation,

enhancing neuromuscular coordination, improving postural control, and increasing dynamic cervical stability. Through these complementary mechanisms, the combined approach addresses both the symptomatic and functional components of NSNP, offering a more comprehensive rehabilitation strategy than either intervention alone.

In summary, dry needling is an evidence-supported intervention that effectively reduces myofascial pain and improves short-term clinical outcomes through mechanical, biochemical, and neurophysiological mechanisms. Nevertheless, its greatest clinical value appears to lie within a multimodal rehabilitation framework in which pain modulation is combined with interventions that restore normal movement and neuromuscular function. This integrated perspective forms the foundation for combining dry needling with cervical stabilization exercises in the contemporary management of non-specific neck pain.

Cervical Stabilization Exercises: Mechanisms and Clinical Evidence

Cervical stabilization exercises (CSEs) constitute one of the most effective evidence-based interventions for the conservative management of non-specific neck pain (NSNP). Unlike conventional strengthening exercises that primarily aim to increase muscle force, stabilization exercises focus on restoring neuromuscular control, segmental spinal stability, proprioception, and coordinated muscle recruitment. Their primary objective is to re-establish the normal function of the deep cervical musculature, thereby improving movement efficiency, reducing mechanical stress on cervical structures, and preventing recurrent episodes of neck pain.

The concept of cervical stabilization is founded on the understanding that efficient cervical function depends on precise coordination between the deep and superficial muscle systems. The longus colli and longus capitis serve as the principal deep cervical flexors responsible for maintaining cervical lordosis, controlling intersegmental motion, and providing dynamic stability during both static postures and functional activities. These muscles work synergistically with the deep cervical extensors, multifidus, and suboccipital muscles to maintain spinal alignment while permitting smooth and controlled movement. Under normal conditions, superficial muscles such as the sternocleidomastoid and upper trapezius generate movement without excessive compensatory activation.

In individuals with NSNP, this neuromuscular balance becomes disrupted. Pain-induced inhibition reduces activation of the deep cervical flexors, whereas superficial muscles become increasingly dominant to compensate for the loss of segmental stability. Electromyographic studies consistently demonstrate delayed activation, reduced endurance, altered recruitment patterns, and diminished motor control of the deep cervical musculature in patients with chronic neck pain. These changes increase cervical joint loading, promote muscular fatigue, impair movement efficiency, and contribute to the persistence of pain. Consequently, successful rehabilitation requires restoration of coordinated muscle activation rather than isolated strengthening of superficial muscles.

Motor control retraining is therefore considered the cornerstone of cervical stabilization programmes. Rehabilitation commonly begins with low-load activation of the deep cervical flexors using the cranio-cervical flexion exercise (CCFE). This exercise selectively recruits the longus colli and longus capitis while minimizing

compensatory activity of the sternocleidomastoid and anterior scalene muscles. Pressure biofeedback devices are frequently incorporated to provide visual feedback, allowing patients to perform gradual increments of cranio-cervical flexion while maintaining precise muscle activation. This approach facilitates motor learning and improves neuromuscular coordination before progression to more demanding functional tasks.

As motor control improves, rehabilitation progresses through sequential phases emphasizing muscular endurance, dynamic stabilization, postural correction, and functional integration. Endurance training enables the deep cervical muscles to sustain low-level activation during prolonged postural activities such as computer work, reading, and driving. Dynamic stabilization exercises subsequently challenge cervical control during upper-limb movement, trunk motion, and balance activities, encouraging coordinated activation of the cervicoscapular musculature. Ultimately, rehabilitation extends beyond isolated cervical exercises to include functional tasks that replicate occupational and daily living demands, thereby improving the transfer of therapeutic gains into real-world activities.

An additional therapeutic benefit of cervical stabilization exercises lies in their ability to improve proprioception and sensorimotor control. Persistent neck pain frequently impairs cervical joint position sense, movement accuracy, gaze stability, and postural balance because of altered sensory input from cervical mechanoreceptors. Targeted stabilization training enhances afferent feedback, improves integration of sensory information within the central nervous system, and restores precise head and neck positioning during movement. Improved proprioception has been associated with enhanced postural control, greater movement confidence, and reduced risk of recurrent symptoms.

Postural correction represents another important component of cervical stabilization rehabilitation. Individuals with NSNP commonly demonstrate forward head posture, increased thoracic kyphosis, rounded shoulders, and altered scapular positioning, all of which modify cervical loading patterns and increase muscular demand. Stabilization programmes therefore frequently incorporate postural education, ergonomic advice, thoracic mobility exercises, and scapular stabilization to address regional interdependence within the cervicothoracic complex. By improving postural alignment and movement efficiency, these interventions reduce excessive loading of cervical structures during prolonged occupational and functional activities.

The effectiveness of cervical stabilization exercises is supported by a substantial body of clinical evidence. Randomized controlled trials consistently report significant improvements in pain intensity, Neck Disability Index (NDI) scores, cervical muscle endurance, range of motion, proprioception, and health-related quality of life following structured stabilization programmes. Systematic reviews and meta-analyses similarly conclude that exercises targeting the deep cervical flexors are superior to general neck exercises for improving motor control and reducing disability, particularly in individuals with chronic NSNP. Importantly, these improvements are maintained more consistently over the long term than interventions focused solely on passive pain relief.

Nevertheless, several challenges remain. Patient adherence is a critical determinant of treatment success, as meaningful neuromuscular adaptation requires regular practice over several weeks. Incorrect exercise performance may encourage

compensatory activation of superficial muscles, limiting the effectiveness of rehabilitation. Furthermore, differences in exercise progression, programme duration, supervision, and outcome measures contribute to variability across clinical studies. Standardization of rehabilitation protocols remains an important priority for future research.

Although cervical stabilization exercises effectively restore neuromuscular function, they may be difficult to perform during periods of severe pain or pronounced muscle guarding. Individuals with active myofascial trigger points often struggle to selectively activate the deep cervical musculature because pain alters normal motor recruitment and limits movement. Under these circumstances, improvements in motor control may be delayed despite appropriate exercise prescription.

This limitation provides the physiological basis for integrating cervical stabilization exercises with dry needling. Dry needling reduces pain, muscle tension, and trigger point irritability, thereby creating favourable conditions for active rehabilitation. Once pain is reduced, patients can perform stabilization exercises more comfortably and accurately, facilitating selective activation of the deep cervical flexors and improving motor learning. The exercises subsequently reinforce these gains by restoring normal movement patterns, enhancing proprioception, improving postural control, and increasing dynamic cervical stability. Consequently, the combination of dry needling and cervical stabilization exercises addresses both the immediate symptoms and the underlying neuromuscular deficits responsible for persistent NSNP.

In summary, cervical stabilization exercises represent a cornerstone of evidence-based physiotherapy for NSNP because they target the fundamental impairments in motor control, proprioception, and segmental stability that characterize the disorder. While they may require several weeks to achieve meaningful neuromuscular adaptation, their long-term benefits extend beyond pain reduction to include improved functional capacity, movement quality, and reduced recurrence. When integrated with dry needling, cervical stabilization exercises contribute to a comprehensive rehabilitation strategy that combines effective symptom relief with restoration of optimal cervical function.

Rationale for Combining Dry Needling and Cervical Stabilization Exercises

The management of non-specific neck pain (NSNP) has progressively shifted from isolated treatment modalities toward multimodal rehabilitation approaches that address the multifactorial nature of the disorder. Current evidence indicates that persistent neck pain is maintained by a complex interaction of myofascial dysfunction, altered neuromuscular control, impaired proprioception, pain sensitisation, and psychosocial influences. Because these mechanisms coexist and interact throughout the course of the condition, interventions targeting a single impairment are unlikely to achieve sustained clinical success. Consequently, combining dry needling (DN) with cervical stabilization exercises (CSEs) has emerged as a logical rehabilitation strategy that simultaneously addresses both symptom reduction and restoration of functional movement.

Dry needling and cervical stabilization exercises possess distinct yet complementary mechanisms of action. Dry needling primarily targets the peripheral and neurophysiological mechanisms responsible for pain. By deactivating myofascial trigger points, reducing muscle hypertonicity, improving local circulation, and modulating nociceptive processing, it creates rapid reductions in pain and muscle guarding. Cervical stabilization exercises,

in contrast, primarily target neuromuscular dysfunction by restoring deep cervical flexor activation, improving proprioception, enhancing segmental stability, and correcting abnormal movement patterns. Rather than competing interventions, they address different components of the same pathological process.

One of the principal advantages of this combined approach is the creation of a therapeutic window for rehabilitation. Pain is a major inhibitor of normal motor performance. Individuals experiencing moderate or severe neck pain often demonstrate protective muscle guarding, altered movement strategies, and difficulty selectively activating the deep cervical musculature. Under these conditions, motor control exercises may be performed incorrectly, with excessive recruitment of superficial muscles, thereby limiting rehabilitation effectiveness. Reduction of pain through dry needling allows patients to participate more comfortably in stabilization exercises and improves the quality of motor retraining during the early stages of rehabilitation.

Pain relief alone, however, does not restore normal cervical function. Although dry needling effectively decreases nociceptive input and muscle tension, it does not correct impaired motor control, postural dysfunction, or deficient sensorimotor integration. Without active rehabilitation, dysfunctional movement patterns frequently persist despite symptomatic improvement, increasing the likelihood of symptom recurrence. Cervical stabilization exercises therefore become essential in consolidating the analgesic effects of dry needling by retraining efficient muscle recruitment, restoring postural control, and improving functional movement. This sequential relationship explains why dry needling should be considered a facilitator of active rehabilitation rather than a stand-alone intervention.

The concept of regional interdependence further supports the integration of these interventions. Cervical dysfunction rarely occurs in isolation; altered thoracic posture, scapular dyskinesis, and impaired shoulder girdle mechanics frequently influence cervical loading and muscle activation. Dry needling reduces excessive tension within overactive cervical and scapular muscles, whereas stabilization exercises promote coordinated activation throughout the cervicoscapular kinetic chain. Together, these interventions improve movement efficiency across interconnected anatomical regions rather than focusing exclusively on the site of pain.

From a neurophysiological perspective, the combination may also optimise motor learning. Persistent pain alters cortical representation of cervical musculature, disrupts proprioceptive accuracy, and impairs sensorimotor integration. By reducing nociceptive input, dry needling may normalise afferent feedback and improve the central nervous system's ability to process proprioceptive information. Stabilization exercises subsequently reinforce these neuroplastic changes through repeated, task-specific motor practice, promoting more efficient movement patterns and long-term functional adaptation. Although further research is required to clarify these mechanisms, emerging evidence suggests that combining pain modulation with motor retraining may produce greater improvements than either intervention alone.

Clinical studies increasingly support this integrated rehabilitation model. Randomized controlled trials evaluating multimodal physiotherapy programmes consistently report greater improvements in pain intensity, functional disability, cervical range of motion, and patient satisfaction when passive interventions are combined with therapeutic exercise compared with isolated treatment

modalities. Although relatively few studies have specifically investigated the combination of dry needling and cervical stabilization exercises, the available evidence suggests superior short-term pain relief and improved functional recovery compared with exercise or dry needling alone. Nevertheless, heterogeneity in treatment protocols, intervention dosage, follow-up duration, and outcome measures limits definitive conclusions regarding optimal clinical practice.

The success of combined rehabilitation also depends on appropriate clinical reasoning. Dry needling should not be applied routinely to every individual with NSNP, nor should stabilization exercises be prescribed without considering pain severity, irritability, movement impairment, and patient-specific functional limitations. Treatment should be individualised according to clinical presentation. Patients with prominent myofascial pain and trigger point activity may benefit from early dry needling to reduce pain and facilitate exercise participation, whereas individuals with predominant movement dysfunction may require greater emphasis on progressive motor control training. Careful assessment and patient-centred decision-making remain fundamental to successful rehabilitation.

Despite its clinical promise, several research gaps remain. Existing studies differ considerably in the muscles treated, needling techniques, exercise progression, treatment frequency, and programme duration. Long-term follow-up data are limited, making it difficult to determine whether the combined intervention reduces recurrence beyond the short or medium term. Furthermore, relatively few trials have examined objective outcomes such as electromyographic activity, proprioception, movement quality, or biomechanical performance following combined treatment. Future high-quality randomized controlled trials using standardised intervention protocols and comprehensive outcome measures are required to strengthen the evidence base.

Based on the current literature, an evidence-informed clinical framework may be proposed. During the initial phase of rehabilitation, dry needling can be used to reduce pain, muscle guarding, and trigger point irritability. Once symptoms become more manageable, rehabilitation should progressively transition toward cervical stabilization exercises, emphasizing deep cervical flexor activation, postural correction, endurance training, proprioceptive retraining, and functional movement integration. As recovery progresses, exercises should be advanced to include cervicoscapular strengthening, dynamic stability tasks, and occupation-specific functional activities. This phased approach recognises that symptom relief is only the first step toward complete functional recovery.

In summary, the integration of dry needling and cervical stabilization exercises reflects contemporary evidence supporting multimodal rehabilitation for non-specific neck pain. Dry needling provides effective pain modulation and facilitates participation in rehabilitation, whereas cervical stabilization exercises restore neuromuscular control, improve movement quality, and promote long-term functional recovery. By addressing complementary components of NSNP pathophysiology, this combined strategy offers a more comprehensive and clinically meaningful approach than either intervention delivered in isolation.

Clinical Implications

The growing body of evidence supporting multimodal rehabilitation has important implications for contemporary physiotherapy practice. Non-specific neck pain (NSNP) is no longer regarded as a

condition arising solely from local tissue injury or structural abnormalities. Instead, it is recognised as a multidimensional disorder involving interactions among myofascial dysfunction, impaired motor control, altered sensorimotor processing, pain sensitisation, postural adaptations, and psychosocial influences. Consequently, successful management requires rehabilitation strategies that address multiple contributors to pain rather than relying on a single therapeutic modality.

Within this framework, the integration of dry needling (DN) and cervical stabilization exercises (CSEs) represents a clinically meaningful approach because the two interventions target complementary aspects of NSNP pathophysiology. Dry needling provides relatively rapid pain relief by reducing trigger point irritability, muscle hypertonicity, and peripheral nociceptive input, whereas cervical stabilization exercises restore neuromuscular control, improve proprioception, and enhance dynamic cervical stability. Together, these interventions offer a balanced rehabilitation strategy in which symptom reduction facilitates active movement retraining, and exercise consolidates the benefits achieved through pain modulation.

One of the most important clinical implications is the emphasis on active rehabilitation. Although passive treatments such as dry needling can reduce pain and improve short-term function, they should not be considered definitive treatment. Long-term recovery depends largely on restoring efficient movement patterns, improving muscular endurance, correcting postural dysfunction, and enhancing the patient's ability to independently manage symptoms. Physiotherapists should therefore use dry needling strategically as an adjunct that enables patients to participate more effectively in exercise-based rehabilitation rather than as an isolated intervention.

Clinical reasoning remains central to treatment selection. Not all individuals with NSNP present with the same impairments, and intervention should be guided by a comprehensive assessment rather than a protocol-driven approach. Patients demonstrating prominent myofascial trigger points, muscle guarding, and pain-limited movement may benefit from early dry needling to reduce symptom severity before commencing progressive motor control exercises. Conversely, individuals presenting primarily with postural dysfunction, impaired endurance, and reduced deep cervical flexor activation may require greater emphasis on stabilization training with selective use of dry needling when clinically indicated. Tailoring treatment to the patient's dominant impairments is likely to optimise clinical outcomes.

Patient education should be integrated throughout the rehabilitation process. Educating patients about the multifactorial nature of NSNP helps reduce fear of movement, improve adherence to exercise programmes, and encourage long-term self-management. Advice regarding workplace ergonomics, postural variation, physical activity, stress management, sleep hygiene, and regular home exercise should accompany hands-on interventions to minimise recurrence and promote sustained functional improvement.

The findings of this review also reinforce the importance of a phased rehabilitation approach. During the initial stage, treatment should prioritise pain reduction, restoration of cervical mobility, and reduction of muscle guarding. As symptoms become less irritable, rehabilitation should progress toward selective activation of the deep cervical flexors, endurance training, proprioceptive retraining, and postural correction. In the final stage, patients should advance to functional strengthening, dynamic stability exercises, cervicoscapular integration, and

occupation- or sport-specific activities. Such progression reflects the natural transition from symptom control to functional restoration and ultimately to recurrence prevention.

From a broader healthcare perspective, adopting multimodal rehabilitation may also improve resource utilisation. Effective rehabilitation that combines early pain management with active exercise has the potential to reduce repeated healthcare visits, decrease reliance on analgesic medications, shorten work absenteeism, and improve overall quality of life. Given the high global prevalence and socioeconomic burden of NSNP, implementing evidence-informed rehabilitation strategies may have meaningful benefits for both patients and healthcare systems.

Despite encouraging evidence, clinicians should recognise the current limitations of the literature. Considerable variability exists in dry needling techniques, stabilization protocols, treatment frequency, and outcome measures. As a result, no universally accepted protocol can currently be recommended. Clinical decisions should therefore integrate the best available evidence with clinician expertise and individual patient preferences, in accordance with the principles of evidence-based practice.

Future clinical practice is also likely to become increasingly technology-assisted. Pressure biofeedback devices, surface electromyography, ultrasound imaging, wearable motion sensors, and digital rehabilitation platforms may enhance assessment of cervical muscle function, improve exercise accuracy, and facilitate remote monitoring of rehabilitation progress. Incorporating these technologies into multimodal rehabilitation programmes may further optimise treatment outcomes and patient engagement.

Overall, the available evidence supports a patient-centred, multimodal approach to NSNP rehabilitation. Rather than viewing dry needling and cervical stabilization exercises as independent interventions, clinicians should consider them complementary components of a comprehensive rehabilitation programme that integrates pain management, neuromuscular retraining, patient education, ergonomic modification, and long-term self-management. This integrated approach is more consistent with the contemporary understanding of NSNP and is likely to provide greater improvements in pain, function, and long-term recovery than isolated treatment strategies.

Future Directions and Research Gaps

Although considerable progress has been made in understanding the management of non-specific neck pain (NSNP), several gaps remain in the current literature regarding the combined use of dry needling and cervical stabilization exercises. Most available studies have investigated these interventions independently, while relatively few have examined their combined effectiveness within a standardized rehabilitation programme. Consequently, despite encouraging clinical findings, stronger evidence is required before definitive treatment recommendations can be established.

One of the major limitations of existing research is the lack of standardized treatment protocols. Considerable variation exists in the muscles selected for dry needling, needle insertion techniques, treatment frequency, number of sessions, exercise progression, and duration of rehabilitation. Such methodological differences make it difficult to compare results across studies or determine the most effective combination of interventions. Future research should focus on developing standardized protocols that can be

consistently implemented in both clinical practice and research settings.

Another limitation is the relatively small sample size used in many randomized controlled trials. Several studies investigating dry needling or cervical stabilization exercises include fewer than fifty participants, reducing statistical power and limiting the generalizability of findings. Larger multicentre randomized controlled trials involving diverse patient populations are required to produce more reliable evidence and improve external validity.

Long-term follow-up remains another area requiring attention. Most published studies evaluate treatment outcomes immediately after intervention or within three months of rehabilitation. However, NSNP is often characterized by recurrent episodes and chronic symptoms. Future investigations should include follow-up periods of six months, one year, or longer to determine whether improvements in pain, disability, motor control, and quality of life are maintained over time.

The majority of current studies rely heavily on patient-reported outcome measures such as pain intensity and disability questionnaires. While these measures are clinically relevant, they provide limited information regarding the physiological changes associated with rehabilitation. Future studies should incorporate objective assessment tools, including surface electromyography (EMG), ultrasound imaging of deep cervical flexor muscles, motion analysis systems, pressure pain threshold measurements, and three-dimensional biomechanical assessments. These objective measures would provide greater insight into the mechanisms underlying treatment effectiveness.

Further research is also needed to identify patient subgroups most likely to benefit from combined rehabilitation. NSNP is a heterogeneous condition, and patients differ in symptom duration, pain severity, psychosocial factors, occupational demands, physical activity levels, and underlying movement impairments. Identifying clinical predictors of treatment response would allow physiotherapists to individualize rehabilitation programmes and improve treatment efficiency.

Psychological factors deserve greater attention in future research. Anxiety, depression, stress, fear of movement, pain catastrophizing, and poor sleep quality have all been associated with persistent neck pain and delayed recovery. Future studies should investigate whether integrating psychologically informed physiotherapy, patient education, and behavioural interventions with dry needling and cervical stabilization exercises results in superior clinical outcomes.

Technological advancements also provide new opportunities for rehabilitation. Digital exercise platforms, tele-rehabilitation, wearable motion sensors, smartphone applications, virtual reality, and biofeedback systems may improve patient adherence and allow more accurate monitoring of exercise performance outside the clinic. Evaluating these technologies alongside conventional physiotherapy interventions could further enhance rehabilitation outcomes.

Economic evaluations are another important area for future investigation. Although multimodal rehabilitation appears clinically effective, relatively few studies have assessed its cost-effectiveness. Future research should compare healthcare costs, return-to-work rates, productivity, and long-term healthcare utilization associated with combined rehabilitation programmes. Such information would be valuable for healthcare providers, policymakers, and insurance systems.

Another important research priority is establishing the optimal sequencing of interventions. Although clinical reasoning suggests that dry needling may be most effective when followed immediately by cervical stabilization exercises, the ideal timing, treatment frequency, and progression remain unclear. Comparative studies investigating different rehabilitation sequences would help optimize treatment protocols.

Finally, future clinical practice guidelines should be supported by high-quality evidence derived from well-designed randomized controlled trials with standardized intervention protocols, larger sample sizes, objective outcome measures, and longer follow-up periods. Such studies would strengthen the evidence base and provide physiotherapists with clearer recommendations for integrating dry needling and cervical stabilization exercises into routine clinical practice.

Overall, the current evidence supports the potential benefits of combining dry needling with cervical stabilization exercises; however, additional high-quality research is necessary to establish standardized treatment protocols, identify patient-specific indications, and determine the long-term effectiveness of this integrated rehabilitation approach. Addressing these research gaps will contribute to more effective, evidence-based management strategies for individuals with non-specific neck pain.

Conclusion

Non-specific neck pain is a multifactorial musculoskeletal condition that affects millions of individuals worldwide and remains a leading cause of pain, disability, and reduced quality of life. The condition arises from a complex interaction of biomechanical dysfunction, myofascial trigger points, impaired motor control, postural abnormalities, and psychosocial factors. Because of this complexity, successful management requires more than symptom relief alone and should focus on restoring normal movement, improving function, and preventing recurrence.

Dry needling has demonstrated effectiveness in reducing myofascial pain, decreasing muscle tension, improving cervical mobility, and modulating pain through both peripheral and central neurophysiological mechanisms. These effects are particularly valuable during the early stages of rehabilitation when pain limits movement and restricts participation in exercise. However, although dry needling provides meaningful short-term improvements, it does not directly address the motor control deficits and biomechanical impairments that contribute to the persistence of non-specific neck pain.

Cervical stabilization exercises complement dry needling by restoring deep cervical flexor function, improving neuromuscular coordination, enhancing proprioception, correcting postural abnormalities, and increasing muscular endurance. These exercises target the underlying functional impairments responsible for ongoing symptoms and help reduce the likelihood of recurrence by improving cervical stability during daily activities.

The available evidence suggests that combining dry needling with cervical stabilization exercises provides a logical and clinically relevant rehabilitation strategy. Pain reduction achieved through dry needling enables patients to participate more effectively in active rehabilitation, while stabilization exercises help maintain these improvements by restoring efficient muscle function and movement patterns. Together, these interventions address both the symptoms and the underlying causes of non-specific neck pain, making them consistent with current evidence-based physiotherapy practice.

Despite encouraging findings, the existing literature is limited by variations in treatment protocols, relatively small sample sizes, and insufficient long-term follow-up. Further high-quality randomized controlled trials are needed to establish standardized rehabilitation protocols, determine optimal treatment sequencing, and evaluate long-term clinical outcomes.

In conclusion, the integration of dry needling and cervical stabilization exercises represents a promising multimodal approach for the conservative management of non-specific neck pain. Physiotherapists should consider combining these interventions within individualized rehabilitation programmes that also include patient education, ergonomic modification, and progressive exercise therapy. Such an approach has the potential to improve pain, restore function, reduce disability, and enhance long-term quality of life for individuals living with non-specific neck pain.

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