

Research Progress on Needle-Knife Therapy for Radiculopathic Cervical Spondylosis Based on Musculoskeletal Balance

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Abstract: Radicular cervical spondylosis is the most common clinical type of cervical spondylosis, with its incidence rate continuously rising in recent years. As a novel therapeutic approach integrating traditional Chinese acupuncture theory with modern minimally invasive surgical techniques, acupuncture knife therapy has demonstrated unique efficacy and advantages in the clinical management of this condition. However, systematic reviews regarding its mechanism of action, efficacy evaluation, and safety remain scarce. To address this gap, this study systematically retrieved relevant literature from databases including PubMed, CNKI, Wanfang, and Web of Science between 2010 and 2025. Eligible clinical and basic research studies were reviewed and analyzed from multiple perspectives, including musculoskeletal balance, trigger points, biomechanics, and molecular biology. Results indicate that acupuncture knife therapy effectively alleviates pain, numbness, and functional impairment through multiple pathways, including releasing cervical trigger points, reducing soft tissue adhesions and fibrosis, regulating local inflammatory factors, and improving blood circulation and nerve function. In summary, this therapy offers significant efficacy, minimally invasive procedures, and few adverse reactions, making it particularly suitable for patients unresponsive to conservative treatments and unsuitable for surgery. Future research requires high-quality, large-scale randomized controlled trials to validate its long-term efficacy and safety. Integrating technologies such as image guidance and ultrasound navigation will further advance the standardization and precision of this therapeutic approach.

Keywords: acupuncture knife therapy; cervical radiculopathy; musculoskeletal balance; trigger points; visualization study

1. Introduction

Cervical spondylosis refers to a clinical syndrome caused by degenerative changes in cervical vertebrae and intervertebral discs, along with secondary degenerative changes in facet joints. These changes lead to disc herniation, facet joint subluxation, and narrowing of intervertebral foramina, resulting in compression or irritation of cervical blood vessels, nerves, and spinal cord structures, thereby triggering a series of symptoms and signs^[1-2]. Epidemiological studies indicate that the global prevalence of cervical spondylosis is increasing annually, particularly among individuals who frequently use electronic devices with prolonged downward head positioning^[3]. The etiology of cervical spondylosis is primarily associated with degenerative changes and poor posture, with major trauma accounting for only 10% of cases^[4]. With advancing age, nearly everyone exhibits radiographic evidence of cervical spine degeneration; post-degenerative changes render the spine more susceptible to external forces, leading to a series of pathological changes^[5-6]. Clinically, cervical spondylosis is categorized into six common subtypes^[7-8]. Among these, cervical spondylotic radiculopathy (CSR) is the most prevalent subtype. Its etiology primarily involves cervical disc degeneration, osteophytes, and foraminal stenosis, leading to compression of cervical nerve roots. Clinical manifestations predominantly include pain and numbness in the neck, shoulders, and upper limbs, along with limited neck mobility. CSR accounts for approximately 60%–70% of all cervical spondylosis cases^[9-10]. CSR falls under the categories of "cervical spondylosis" and "bi syndrome" in traditional Chinese medicine. "Bone alignment and tendon suppleness" represents the optimal state of musculoskeletal health.

"Muscle-Bone Balance" is one of the core theories in TCM diagnosis and treatment of spine-related disorders, addressing the interrelationship between "muscles" and "bones" and their roles in human movement, health, and disease. Muscles (soft tissues) and bones (skeletal system) maintain an interdependent, mutually restraining relationship that sustains normal physiological functions and motor capabilities. If tendons lack suppleness or bones are misaligned, not only does local qi and blood circulation become obstructed, but the entire mechanical structure of the neck undergoes compensatory changes, accelerating cervical degeneration^[11]. Needle-knife therapy, a combined Chinese and Western medical treatment, was established by Professor Zhu Han-zhang in the 1970s. It combines the regulatory effects of acupuncture with the cutting and release functions of surgical instruments, making it particularly suitable for chronic soft tissue injuries and musculoskeletal disorders. Trigger points represent a key concept in modern pain medicine, referring to highly sensitive points within palpable taut bands of skeletal muscle tissue. Activation of these points can induce both local and referred pain^[12]. By precisely releasing trigger points, acupuncture knife therapy effectively breaks the vicious cycle of pain-spasm-pain, restoring soft tissue function. In recent years, it has been widely applied in the clinical treatment of chronic spondylolisthesis (CSR). This paper, grounded in the "muscle-bone equilibrium" theory and integrating modern pain medicine and biomechanics research, systematically reviews the clinical efficacy and mechanisms of action of acupuncture knife therapy for CSR. It aims to provide references for the standardized application and in-depth research of this therapy.

2. The Essence of Muscle-Bone Balance Theory and Its Application in Cervical Spondylosis

2.1 The Physiological Relationship between "Muscle" and "Bone"

Therefore, when the Dao harmonizes with the five flavors, bones become upright and tendons supple, qi and blood flow freely, and the pores close tightly. Thus, the essence of bones and qi is refined. By diligently following the Dao according to its principles, one may enjoy a long life granted by Heaven." "Tendons" and "bones" maintain a mutually supportive, dynamic equilibrium in physiology. Thus, "tendon-bone balance" constitutes the essence of the human musculoskeletal system, governing bodily movement^[13]. "Bones" form the body's framework, possessing static equilibrium properties. They primarily provide support, bear loads, and maintain the body's static balance; "Tendons" attach to bones, constraining skeletal structure, connecting joints, and facilitating movement—embodying the "rigid" yet "dynamic" aspect^[14]. Only when bones are robust, tendons supple, qi and blood flow smoothly, and skin pores remain tightly knit can health be preserved and longevity extended. With advancing age, the elderly are prone to reduced bone mass and osteoporosis, leading to structural changes in cervical vertebrae and misalignment of small joints. This diminishes bone support, increases load on surrounding soft tissues, and accelerates tendon damage and muscle strain. Once tendons are compromised, their ability to constrain bones weakens, making it difficult to maintain normal anatomical structure in cervical joints. Altered stress distribution in the cervical joints creates a vicious cycle that accelerates cervical spine pathology.

2.2 The Holistic Connection between "Tendons," "Bones," and "Muscles"

The Suwen: Xuanming Wuxi Lun states: "The liver governs tendons; the kidneys govern bones." Liver and kidney share a common origin. The Suwen: Wei Lun adds: "The spleen governs muscles." The kidneys represent the foundation of innate constitution, while the spleen embodies the foundation of acquired constitution. The Suwen: Wei Lun further explains: "The Yangming meridian is the sea of the five viscera and six bowels, governing the nourishment of the tendons. These tendons bind the bones and facilitate joint movement. "The qi and blood of the Yangming meridian nourish the tendons, which in turn constrain the bones and joints, enabling muscles to drive skeletal movement. The Ling Shu: Meridians states: "Bones are the trunk, tendons are the rigidity, flesh is the wall." The Suwen: Generation of the Five Zang Organs explains: "All tendons belong to the joints, all blood belongs to the heart, all qi belongs to the lungs. "When" bones are aligned and tendons supple," muscles contract freely with measured tension and relaxation. When the cervical joints maintain their normal anatomical position, tendons can attach properly, allowing neck muscles to contract freely. This enables flexible and effortless neck movement. "When bones are aligned and tendons supple, qi and blood flow freely." As liver qi ascends, the body's qi and blood circulation becomes harmonious. Muscles nourished by blood become plump and strong. Smooth qi flow keeps muscles supple. Well-nourished, moisturized muscles enable effortless limb movement and stable joints. The spleen governs acquired constitution, while the kidneys govern innate constitution. Innate constitution relies on acquired nourishment. The

spleen governs muscles, and the kidneys govern bones. Plump muscles stabilize tendons and bones. When tendons, bones, and muscles maintain dynamic equilibrium, limbs move freely. When this balance is disrupted—"tendons slip from their channels, bones shift from their joints"—limb movement becomes restricted, coordination declines, and musculoskeletal disorders arise^[15].

2.3 Muscle-Bone Imbalance and Radicular Cervical Spondylosis

Cervical spondylosis (CSR) fundamentally represents "imbalance of tendons and bones" arising from cervical degeneration. With aging, intervertebral discs lose water content and elasticity, narrowing the intervertebral spaces and increasing stress on facet joints. This triggers osteophytes and ligament hypertrophy, further narrowing the intervertebral foramen and compressing nerve roots—this is the "misalignment of bones." Concurrently, cervical soft tissues undergo adaptive shortening, spasm, or fibrosis as compensatory structural changes. Trigger points and fascial adhesions frequently develop in muscles like the levator scapulae, upper trapezius, and sternocleidomastoid—this constitutes "muscle rigidity." The mutual influence between muscle stiffness and bony spurs creates a vicious cycle, progressively worsening neurovascular compression and complicating symptoms. Therefore, CSR treatment must address both muscles and bones, restoring skeletal stability while releasing soft tissue contractures.

3. Development in Diagnosis and Treatment of Radicular Cervical Spondylosis

Cervical Spinal Root Syndrome (CSR) involves compression of spinal nerve roots, leading to sensory and motor dysfunction in the affected areas. The primary factor causing nerve root compression is narrowing of the cervical intervertebral foramen. Pathological factors contributing to this narrowing in clinical settings include cervical disc herniation, cervical facet joint subluxation, ossification of the posterior longitudinal ligament, and hypertrophy of the odontoid process joints. In recent years, treatment approaches for cervical spinal root compression (CSR) have broadly fallen into two categories: surgical intervention and conservative management. With advances in medical science, surgical protocols for CSR have matured, with distinct characteristics among different procedures. Surgical treatment offers rapid symptom relief and significant efficacy, though approximately 26% of patients still experience residual neuralgia postoperatively. Some patients may experience residual radicular symptoms and postoperative scarring. Furthermore, surgical treatment plans are generally less acceptable to most CSR patients, primarily due to the relatively higher risks associated with surgery. Compared to surgical intervention, conservative treatment is generally more widely accepted by CSR patients. Numerous conservative treatment methods exist, with traditional Chinese medicine (TCM) demonstrating significant clinical advantages in treating cervical spondylosis. According to TCM theory, pain stems from "obstruction" or "deficiency of nourishment." Addressing the pathogenic factors of CSR—wind, cold, and dampness—herbal decoctions can "promote blood circulation, regulate qi, resolve stasis, and alleviate pain." For "muscle displacement and bone misalignment," traditional massage therapy can realign bones and knead muscles. However, for patients in later stages of CSR experiencing severe pain in the neck, shoulders, back, and upper limbs, traditional conservative treatments show slower efficacy, often failing to satisfy patients' expectations. As a fusion of traditional needles and modern blade technology, acupuncture knives can unblock meridians, relieve pain, and release adhesions, demonstrating clinically proven efficacy in treating CSR; Clinical studies indicate that acupuncture knife therapy significantly alleviates pain symptoms in the neck, shoulders, and back. Pang Jun, Wang Xiongjiang et al. conducted a meta-analysis comparing the efficacy of small acupuncture knife therapy versus conventional acupuncture for myofascial pain syndrome. Results demonstrated that small acupuncture knife-based therapy improves clinical outcomes compared to conventional acupuncture, particularly in alleviating pain symptoms.

4. Development History and Therapeutic Mechanism of Needle-Knife Therapy

4.1 Origin and Evolution of Needle-Knife Therapy

Needle-knife therapy is a minimally invasive treatment integrating traditional Chinese acupuncture with Western surgical knife techniques, reflecting the characteristics of integrated Chinese and Western medicine. Chinese physician Zhu Hanchang (1949–2006), inspired by the "sharp needle" from the traditional "nine needles" of acupuncture and incorporating modern surgical concepts, invented the needle-knife instrument. Zhu proposed the "dynamic equilibrium disruption" theory, positing that the

pathological basis of chronic soft tissue injuries lies in "adhesions, scar tissue, and contractures." The needle-knife restores mechanical equilibrium by releasing these pathological changes. Biomechanical equilibrium is a prominent theme in modern medicine, and the needle-knife therapy's role in restoring this equilibrium has advanced research in biomechanics.

4.2 Mechanism Studies of Needle-Knife Therapy for Treating Chronic Soft Tissue Injuries

Needle-knife therapy is a frequently selected treatment option for CSR in modern clinical practice. Numerous scholars in the field of orthopedics and traumatology have investigated the mechanism of action of needle-knife therapy. Research indicates that the primary mechanisms of needle-knife therapy involve mechanical release, stimulation of meridian points, regulation of inflammatory factors, improvement of microcirculation, and adjustment of biomechanical balance.

4.2.1 Mechanical Release and Meridian Stimulation

Needle knives can directly cut and peel away adhered fascia, ligaments, and scar tissue, relieving mechanical compression on nerves and blood vessels, restoring soft tissue elasticity and joint mobility. Wang Shijian and colleagues found through clinical research on acupuncture knife puncture therapy that its cutting-release and puncture techniques can resolve adhesions in diseased tissues, release spasms and scarring, improve microcirculatory disorders, and facilitate blood flow to enhance the transport of metabolic waste products. This restores the physiological curvature of the cervical spine and balances cervical muscle tension, reducing local pressure, decreasing nerve root stimulation, and alleviating pain.

When applied to acupoints or Ashi points, the needle-knife unblocks meridians, stimulates meridian energy, and exerts regulatory effects similar to acupuncture. Traditional Chinese medicine posits that "pain arises from obstruction" and "pain stems from deficiency of nourishment." The establishment of the "pain trigger point" theory provides concrete localization for these "obstructed areas." "Acupuncture at trigger points" is now widely applied in treating acute and chronic musculoskeletal pain such as osteoarthritis, cervicogenic headaches, and myofascial pain syndrome. Based on this, acupuncture knife therapy achieves "point-to-point" therapeutic effects. By unblocking obstructed muscles and meridians, it "removes stagnation and activates meridians," promotes the regeneration of qi and blood, and ultimately achieves "unblocking eliminates pain." ◦

4.2.2 Regulation of Inflammatory Factors and Improvement of Microcirculation

In modern medical theory, pain often arises from localized inflammatory responses. The inhibitory effect of acupuncture knife therapy on inflammatory factors has been increasingly validated in recent years. Studies indicate that acupuncture knife treatment can effectively regulate hyaluronic acid in serum, promoting its transfer into the joint cavity and thereby increasing hyaluronic acid concentration in synovial fluid. Acupuncture knife therapy can modulate multiple inflammatory factors such as Tumor Necrosis Factor- α (TNF- α), interleukin-6 (IL-6), and interleukin-1 β (IL-1 β) in serum and synovial fluid. By promoting the release of vasoactive substances, it improves blood circulation in the affected area, thereby exerting a pain-relieving effect.

Liu Fushui, Ren Chang'an and colleagues validated the therapeutic mechanism of needle-knife therapy for cervical spondylotic radiculopathy (CSR) by observing the expression of relevant inflammatory factors in cervical muscle cells. The study found that needle-knife therapy reduced levels of neuropeptide, TNF- α , IL-1 β , IL-6, and interleukin-8 (IL-8) in cervical muscles of rabbits with cervical spondylosis, alleviating inflammatory responses and pain while effectively promoting repair of damaged cervical muscles.

Liu Hong, Zhang Zesheng et al. investigated the potential mechanism of acupuncture knife therapy in treating cervical muscle fibrosis by targeting the transforming growth factor- β 1 (TGF- β 1)-mediated sphingosine kinase 1/sphingosine-1-phosphate receptor 3 (SK1/S1P3) signaling axis. SK1/S1P3 pathway to investigate the potential mechanism of acupuncture knife therapy in treating cervical muscle fibrosis associated with cervical spondylosis. The study found that following acupuncture knife intervention, levels of Transforming Growth Factor- β 1 (TGF- β 1), Mothers Against Decapentaplegic Homolog 2 (SMAD2), sphingosine-1-phosphate receptor 3 (S1P3), and Ras homolog family member C (Rho-c) were significantly suppressed at both the gene and protein levels. This indicates that acupuncture-needle therapy alleviates cervical muscle adhesion lesions by regulating the TGF- β 1/sphingomyelinase 1/S1P3/Rho-c signaling pathway. Rho-c) were significantly suppressed at both the gene and protein levels. This indicates that acupuncture needle therapy alleviates cervical spondylosis

by releasing cervical muscle adhesion lesions, regulating the activity of the transforming growth factor- β 1/sphingosine kinase 1/sphingosine-1-phosphate receptor 3 (TGF- β 1/SK1/S1P3) signaling pathway, thereby reducing fibrosis.

Zhang Fuzeng A retrospective study of 76 patients with frozen shoulder revealed that those treated with acupuncture knife therapy exhibited significantly lower concentrations of IL-6 and TNF- α compared to those receiving block therapy. Additionally, patients undergoing acupuncture knife treatment demonstrated lower expression levels of serotonin (5-Hydroxytryptamine, 5-HT) and prostaglandin E2(PGE2) were also lower than those in the block therapy group, with all differences being statistically significant (all $P < 0.05$). This further validates the clinical significance of needle-knife therapy in suppressing inflammatory factors.

The release procedure promotes local capillary regeneration, increases blood supply, accelerates the clearance of metabolic products, and facilitates tissue repair. Research by Li Ailin et al. showed that the combination of needle knife therapy and warm acupuncture achieved an efficacy rate of 93.3%, significantly higher than that of warm acupuncture alone.

4.2.3 Adjusting Biomechanical Balance

Professor Wu Zhongchao posits that cervical spondylosis is closely linked to dysfunction in meridians and internal organs. Treatment must emphasize simultaneous regulation of meridians and tendinomuscular pathways, while addressing both meridians and visceral functions. Therapy should prioritize treating the "tendons" (jin), as flexible tendons enable proper bone alignment. Treating only the "bones" yields limited results, whereas focusing on the "tendons" demonstrates remarkable efficacy. Needle-knife therapy addresses tendons by "dispersing knots" and "smoothing textures." Professor Wu Zhongchao employs needle-knife to dissolve knots at tendon junctions. The needle-knife cuts through knots, leveraging points to influence lines, lines to affect surfaces, and expanding the scope of knot dissolution. This method demonstrates potent unblocking effects for chronic conditions and long-standing knots. Professor Zhang Tianmin proposed the "Bowstring Mechanics Theory" and "Mesh Theory," drawing inspiration from the structure and force transmission principles of bows and arrows. He analogizes bones as "bows" and soft tissues as "strings." By severing high-tension points within pathological "bowstring" structures, acupuncture knife therapy restores mechanical equilibrium in the cervical region.

5. Discussion and Outlook

As a model of integrated Chinese and Western medicine, needle-knife therapy holds a significant position in treating cervical spondylosis due to its unique theoretical advantages and remarkable clinical efficacy. It emphasizes not only local lesion release but also the restoration of holistic musculoskeletal balance, characterized by simplicity, convenience, effectiveness, and affordability. Particularly with the application of ultrasound imaging guidance technology, the safety and accuracy of needle knife procedures have significantly improved. Visualized needle knife allows physicians to real-time avoid blood vessels and nerves while precisely reaching the pathological layer, greatly reducing the risk of complications.

However, the limitations of current research must be acknowledged: most clinical trials feature small sample sizes, short follow-up periods, and lack standardized protocols; basic research remains exploratory with incomplete elucidation of the mechanism network; additionally, needle knife manipulation is highly operator-dependent, introducing subjective variability. Future research should focus on the following areas: (1) Conducting multicenter, large-sample, long-term follow-up RCTs to establish clinical pathways and operational standards for needle-knife treatment of CSR; (2) Integrating advanced technologies such as functional magnetic resonance imaging (fMRI) and surface electromyography (sEMG) to objectively evaluate the effects of needle-knife therapy on neural function and muscle status; (3) Deeply explore the metabolomic and proteomic response mechanisms of needle-knife intervention to systematically reveal its multi-target regulatory network; (4) Actively promote the internationalization and standardization of needle-knife therapy, strengthen domestic and international academic exchanges, and enable this Chinese-origin therapy to better benefit patients worldwide.

6. Conclusion

In summary, needle-knife therapy intervenes in the pathological process of cervical spondylosis with radiculopathy through multiple pathways and multi-target mechanisms, offering distinct advantages such as clear efficacy, minimal trauma, and broad applicability. Guided by Traditional Chinese Medicine's theory of musculoskeletal balance and integrated with modern medical research, needle-knife treatment for cervical spondylosis with radiculopathy demonstrates broad application prospects. Future efforts should focus on strengthening clinical and basic research, refining technical standards, deepening mechanism exploration, and advancing the development of acupuncture-scalpel therapy toward greater scientific rigor, precision, and internationalization.

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