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The Effect of Russian Current Stimulation on Motor Outcomes in Stroke Patients: A Comprehensive Narrative Review

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Abstract:

Stroke is one of the leading causes of disability worldwide, resulting in persistent motor impairments that limit daily functional activities and reduce the quality of life for affected individuals. Electrical stimulation techniques, including neuromuscular electrical stimulation (NMES), have been extensively studied for their rehabilitative benefits. Among these, Russian current stimulation (RCS), a medium-frequency electrical stimulation technique, has gained increasing interest for its potential to enhance muscle strength, improve neuromuscular re-education, reduce spasticity, and promote motor recovery in stroke patients. This review explores the physiological mechanisms, clinical applications, and efficacy of RCS in stroke rehabilitation. Studies have shown that RCS enhances neuromuscular recruitment, modulates spasticity, and improves functional mobility, particularly when integrated with conventional physiotherapy. Furthermore, comparisons with other electrical stimulation modalities indicate greater muscle activation and endurance improvements with RCS. However, challenges such as the lack of standardized treatment protocols and patient-specific responses need further investigation. Future research should focus on optimizing treatment parameters and long-term clinical efficacy to establish RCS as a standardized rehabilitation tool.

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Introduction:

Stroke is a major global health issue, affecting nearly 12 million people annually and remaining a leading cause of long-term disability[1]. It occurs due to the interruption of blood supply to the brain, either through ischemic or hemorrhagic events, leading to neurological deficits such as motor dysfunction, cognitive impairment, and speech difficulties[2]. The burden of stroke is significant, not only for the individuals affected but also for caregivers and healthcare systems worldwide, emphasizing the need for effective rehabilitation strategies[1].

Among the most disabling consequences of stroke is motor dysfunction, which affects approximately 80% of stroke survivors in the early stages of recovery[3]. Motor impairments include hemiparesis, muscle weakness, spasticity, and loss of coordination, which significantly hinder a patient's ability to perform activities of daily living (ADLs) such as walking, dressing, and self-care[4]. If left unaddressed, these impairments can lead to chronic disability, reduced independence, and decreased quality of life[5].

Traditional rehabilitation approaches, including physical therapy, occupational therapy, and functional training, have been widely used to improve motor recovery post-stroke[6]. While these methods provide significant benefits, their effectiveness is often limited by neuromuscular deficits and the extent of brain damage sustained during the stroke event[7]. Therefore, complementary modalities, such as neuromuscular electrical stimulation (NMES), transcranial

magnetic stimulation (TMS), and robotic-assisted therapy, are being increasingly explored to enhance functional outcomes[8].
Neuromuscular electrical stimulation (NMES) has been widely studied as a potential adjunct therapy for enhancing motor recovery after stroke[9]. NMES works by applying electrical impulses to peripheral nerves or muscles, facilitating muscle contraction and improving motor control[10]. Among the various NMES modalities, Russian current stimulation (RCS) has gained significant attention due to its unique burst-modulated waveform, which optimally recruits both fast-twitch (Type II) and slow-twitch (Type I) muscle fibers, promoting greater muscle activation[11].
Developed by Dr. Yakov Kots in 1970s, Russian current stimulation utilizes a 2500 Hz medium-frequency alternating current delivered in 50 Hz bursts, allowing for strong muscle contractions with minimal discomfort (Ward, 2009). Unlike conventional NMES, which predominantly activates slow-twitch muscle fibers, RCS is particularly advantageous in strengthening atrophied muscles, improving neuromuscular coordination, and reducing spasticity in post-stroke patients[12]. By modulating synaptic activity and enhancing neuromuscular recruitment, RCS offers a promising approach to accelerating functional recovery in stroke rehabilitation[13].
Recent studies have demonstrated that RCS can lead to significant improvements in motor function, spasticity reduction, and muscle strength when integrated into stroke rehabilitation protocols[14,15]. Additionally, systematic reviews suggest that NMES, including RCS, may facilitate neuroplasticity, thereby promoting functional reorganization of the damaged motor pathways[9]. However, variability in stimulation parameters, treatment duration, and patient responsiveness highlights the need for further research to optimize clinical application and establish standardized guidelines[16].
This review aims to provide a comprehensive evaluation of the effects of Russian current stimulation on motor outcomes in stroke rehabilitation, detailing its physiological mechanisms, clinical applications, comparisons with other NMES modalities, and future research directions to enhance its effectiveness in stroke recovery programs.

Physiological Mechanisms of Russian Current Stimulation:

Russian current stimulation (RCS) operates through a unique burst-modulated electrical waveform that facilitates neuromuscular activation, spasticity reduction, and neuroplastic adaptation in stroke patients. Understanding its physiological impact is crucial to optimizing its application in rehabilitation programs.

Muscle Activation and Strengthening: Russian current stimulation (RCS) is a neuromuscular activation technique designed to enhance muscle function by inducing strong, tetanic contractions. Unlike conventional Neuromuscular Electrical Stimulation (NMES), which primarily activates slow-twitch (Type I) muscle fibers, RCS simultaneously recruits both slow-twitch and fast-twitch (Type II) fibers, leading to more efficient muscle engagement and strength development[12]. The ability to recruit fast-twitch fibers is particularly significant, as these fibers are crucial for power and speed-related movements, making RCS a potentially superior alternative to traditional NMES in rehabilitation settings[11].
Beyond enhancing muscle activation, RCS has been shown to increase muscle cross-sectional area (CSA), improve fiber recruitment efficiency, and counteract muscle atrophy, particularly in patients with neuromuscular impairments. Research indicates that this form of stimulation induces hypertrophic changes in muscle tissue, which is vital for individuals suffering from disuse atrophy due to stroke, prolonged immobilization, or critical illness[17]. A study on stroke patients found that RCS was more effective than conventional electrical stimulation in restoring muscle mass and functional strength, leading to improved gait patterns and mobility[18]. Additionally, studies suggest that RCS may enhance motor unit recruitment, facilitating better neuromuscular coordination and improve voluntary muscle activation in patients undergoing rehabilitation[19].
Furthermore, RCS contributes to better neuromuscular control, enhanced endurance, and improved functional outcomes by optimizing the balance between muscle activation and fatigue resistance. The repetitive, high-intensity contractions induced by RCS mimic natural movement patterns, which can lead to greater neuroplasticity and functional recovery in stroke and spinal cord injury patients[20]. Recent advancements in functional electrical stimulation (FES) combined with RCS have shown promise in assisting individuals with severe motor impairments, allowing them to regain mobility and independence[10].
Given its ability to stimulate a broader range of muscle fibers, enhance muscle hypertrophy, and improve neuromuscular efficiency, RCS is an innovative tool in neuromuscular rehabilitation, sports science, and muscle re-education therapies. Future research should focus on optimizing stimulation parameters, integrating RCS with robot-assisted rehabilitation, and expanding its applications in clinical populations, including individuals with Parkinson’s disease, multiple sclerosis, and post-ICU syndrome.

Reduction in Spasticity: Spasticity is a common and debilitating post-stroke impairment caused by an imbalance in motor neuron excitability, leading to hyperreflexia, involuntary muscle contractions, and reduced voluntary motor control[9]. This disruption results from damage to the descending inhibitory pathways, leading to excessive excitability of the spinal stretch reflex. Spasticity negatively impacts mobility, dexterity, and quality of life, making it a significant challenge in post-stroke rehabilitation[21].

Russian current stimulation (RCS) has been shown to modulate motor neuron excitability by enhancing reciprocal inhibition, a mechanism where the activation of agonist muscles suppresses the activity of antagonist muscles. By promoting reciprocal inhibition, RCS can reduce hypertonicity and spasticity, thereby improving functional movements[14]. Several studies have demonstrated that patterned electrical stimulation decreases hyperreflexia, leading to enhanced passive and active range of motion, which is crucial for restoring limb function in stroke survivors[22].

In addition to reducing spasticity, RCS plays a critical role in diminishing antagonist muscle co-contraction, which often impairs coordinated movements. By suppressing involuntary co-contractions, RCS allows for smoother and more precise voluntary muscle control, which is essential for performing functional tasks such as walking and grasping objects[15]. Moreover, studies suggest that this neuromodulatory approach enhances corticospinal excitability and promotes neuroplasticity, leading to long-term benefits in motor recovery[20].Furthermore, RCS contributes to functional independence by inhibiting excessive reflex activity and improving motor control. This makes it an effective non-pharmacological intervention for spasticity management, complementing conventional physiotherapy and botulinum toxin injections[19]. Future research should explore optimal stimulation parameters, combination therapies (e.g., robotic-assisted RCS), and long-term effects of this technique in chronic stroke patients.

Enhancement of Neuromuscular Coordination: By stimulating peripheral nerves, RCS facilitates motor unit synchronization and improves functional coordination between agonist and antagonist muscles[13]. This effect is particularly beneficial for restoring voluntary movement control in stroke-affected limbs[15]. Enhanced neuromuscular coordination results in better intermuscular communication, leading to increased joint stability and movement efficiency. Furthermore, incorporating task-specific exercises alongside RCS enhances motor relearning and overall rehabilitation outcomes.

Increased Blood Circulation and Metabolic Activity: Russian current stimulation has been shown to enhance local blood perfusion, which contributes to increased oxygen supply, improved nutrient delivery, and faster tissue healing[16]. Enhanced circulation helps reduce muscle atrophy and optimize metabolic efficiency in recovering stroke patients. The vasodilatory effects of RCS also contribute to increased capillary density and improved mitochondrial function, leading to long-term benefits in muscle endurance and resistance to fatigue[6]. Increased metabolic activity allows stroke patients to engage in longer rehabilitation sessions with reduced muscle exhaustion.

Promotion of Neuroplasticity: RCS-induced afferent feedback plays a role in cortical reorganization and motor pathway remodeling[6]. This mechanism supports functional recovery by encouraging synaptic reinforcement and adaptive neuroplastic changes[4]. The repetitive activation of sensory and motor pathways via electrical stimulation encourages synaptic pruning, which improves signal transmission efficiency in affected neural networks. RCS has also been linked to increased activation in the primary motor cortex (M1) and enhanced corticospinal excitability, facilitating better voluntary motor control over time.

Functional Improvements in Mobility and Motor Performance: Multiple studies have reported improvements in motor function, walking ability, and balance following RCS intervention[1]. When combined with task-specific training, RCS contributes to enhanced gait dynamics and overall motor recovery[2]. Patients receiving RCS show greater postural stability, reduced risk of falls, and improved weight distribution, which are critical for safe ambulation and mobility independence. Additionally, RCS has been found to positively impact reaction time and lower limb coordination, further supporting its application in comprehensive stroke rehabilitation programs.

These physiological effects collectively support the use of Russian current stimulation as a therapeutic adjunct for post-stroke rehabilitation, aiding in muscle strengthening, spasticity reduction, and neuromuscular adaptation. The combination of targeted muscle activation, improved circulation, enhanced neuroplasticity, and functional integration makes RCS a versatile and effective tool for post-stroke motor recovery.

Application of Russian Current Stimulation in Stroke Rehabilitation:

Russian current stimulation (RCS) has been integrated into rehabilitation protocols to enhance recovery in stroke patients by targeting both upper and lower limb impairments. The clinical application of RCS in stroke rehabilitation focuses on muscle re-education, gait improvement, spasticity reduction, and functional restoration.

Upper Limb Rehabilitation: Russian current stimulation (RCS) is an emerging neuromuscular rehabilitation strategy applied to the shoulder, elbow, wrist, and hand muscles to restore functional movement following neuromuscular impairments, particularly post-stroke paralysis. Stroke survivors commonly experience upper limb weakness, spasticity, and impaired motor control, significantly limiting their ability to perform activities of daily living

(ADLs). RCS facilitates muscle re-education by inducing patterned electrical stimulation, enhancing neuromuscular activation, and promoting neuroplasticity[9].

A key mechanism of RCS is its ability to stimulate both extensor and flexor muscle groups, which are crucial for grasp strength, fine motor control, and voluntary movement coordination. Conventional electrical stimulation methods, such as neuromuscular electrical stimulation (NMES), primarily activate slow-twitch fibers. However, RCS recruits both slow-twitch (Type I) and fast-twitch (Type II) muscle fibers, allowing for more balanced muscle engagement and improved strength, endurance, and functional recovery[23]. Research shows that targeted RCS application to the forearm muscles can improve grip force, reduce spasticity, and enhance wrist extension, which are critical for regaining fine motor skills[24].

To optimize motor recovery, RCS is often integrated with task-specific rehabilitation exercises, such as grasp-and-release tasks, object manipulation, and reach-to-grasp training. This combination enhances cortical reorganization and neuroplasticity, reinforcing the connection between stimulation-induced contractions and voluntary motor control[16]. A randomized controlled trial demonstrated that stroke patients undergoing RCS-assisted therapy combined with functional hand training exhibited greater improvements in hand dexterity and coordination compared to conventional therapy alone[25].

Additionally, robot-assisted rehabilitation and virtual reality-based interventions have been increasingly combined with RCS to improve patient engagement, movement precision, and neurorehabilitation outcomes[26]. These hybrid approaches provide real-time biofeedback, helping patients refine motor control, muscle activation timing, and strength symmetry between affected and unaffected limbs.

While early post-stroke rehabilitation focuses on preventing muscle atrophy and contractures, RCS is also beneficial in chronic stroke recovery, where patients often struggle with persistent upper limb deficits. Studies indicate that long-term RCS interventions contribute to sustained improvements in movement quality, reduced muscle co-contraction, and enhanced functional independence[27]. Moreover, functional electrical stimulation (FES), a subset of RCS, has been linked to improved voluntary muscle recruitment, increased range of motion, and greater ADL performance in patients even years post-stroke[28].

Beyond stroke, RCS is being explored for upper limb rehabilitation in conditions such as spinal cord injury, cerebral palsy, and neurodegenerative diseases (e.g., multiple sclerosis and Parkinson’s disease). Its ability to modulate motor control, reduce involuntary muscle activity, and enhance neuromuscular recovery makes it a valuable therapeutic tool in diverse clinical populations. Future research should explore optimal stimulation parameters, frequency, and intensity to maximize long-term motor recovery.

Lower Limb Rehabilitation with Repetitive Contraction Stimulation (RCS): Gait impairments are a major concern in post-stroke rehabilitation, significantly affecting mobility, independence, and quality of life. Stroke often results in weakness, spasticity, and abnormal synergy patterns in the lower limbs, leading to poor weight-bearing ability, impaired balance, and inefficient walking mechanics. Repetitive Contraction Stimulation has been integrated into stroke rehabilitation protocols to improve motor control, muscle strength, and neuromuscular coordination of key lower limb muscles, such as the quadriceps, tibialis anterior, and gastrocnemius[14].

The quadriceps play a crucial role in knee extension and weight-bearing stability, while the gastrocnemius and tibialis anterior are essential for push-off and foot clearance during walking. RCS applied to these muscle groups enhances postural control, symmetrical weight distribution, and dynamic stability, ultimately leading to improvements in walking efficiency and endurance[29]. Research suggests that electrical stimulation combined with task-specific gait training improves stride length, cadence, and muscle coordination, enabling stroke patients to walk with greater confidence[20].

Foot drop, characterized by insufficient ankle dorsiflexion during the swing phase of gait, is a common post-stroke impairment leading to tripping, imbalance, and increased fall risk. Targeted RCS application to the tibialis anterior muscle has been shown to significantly enhance foot clearance, ankle stability, and walking speed, facilitating smoother and more controlled ambulation[6]. Studies have demonstrated that patients receiving RCS-assisted therapy experienced a reduction in compensatory gait patterns, such as excessive hip hiking or circumduction, which often develop due to weak dorsiflexors[30].

Additionally, functional electrical stimulation (FES) gait training has been combined with RCS to further improve gait biomechanics and lower limb motor control. FES-RCS hybrid approaches provide continuous stimulation during ambulation, reinforcing voluntary muscle activation and neuroplastic adaptation, which are essential for long-term walking recovery[26].

Emerging evidence suggests that prolonged use of RCS leads to sustained improvements in gait parameters, increased lower limb strength, and reduced dependence on walking aids[27]. Wearable stimulation devices, robotic exoskeletons, and smart biofeedback systems are being explored to enhance RCS-based rehabilitation, allowing for more personalized and adaptive therapy approaches[25]. Future research should focus on determining optimal stimulation parameters, exploring its effectiveness in combination with virtual reality gait training, and assessing long-term neuroplastic changes associated with RCS-based lower limb rehabilitation.

Spasticity Reduction with Repetitive Contraction Stimulation (RCS): Spasticity is a prevalent complication following stroke, characterized by increased muscle tone, exaggerated stretch reflexes, and involuntary co-contractions that limit voluntary movement and functional independence. This condition arises from damage to descending motor pathways, leading to disrupted spinal inhibitory control and excessive excitability of motor neurons[13]. If left untreated, spasticity can result in contractures, pain, and joint deformities, further hindering rehabilitation progress.

Russian current stimulation has emerged as a promising intervention to modulate muscle tone and reduce spasticity, thereby enhancing joint mobility, range of motion (ROM), and motor function. Studies suggest that RCS promotes reciprocal inhibition, a mechanism where stimulating an agonist muscle leads to the inhibition of its antagonist, effectively balancing muscle co-activation and reducing abnormal stiffness[15]. This neuromodulatory effect contributes to improved voluntary control, reduced resistance to passive movement, and better functional limb use[19]. RCS also influences spinal and supraspinal mechanisms involved in spasticity regulation. Research indicates that RCS can normalize hyperactive stretch reflex responses, thereby minimizing involuntary contractions and improving limb flexibility[20]. Additionally, integrating electrical stimulation with functional movement training enhances motor cortex reorganization, leading to long-term improvements in muscle control and spasticity reduction[22].

While botulinum toxin (Botox) injections and oral antispasticity medications (e.g., baclofen, tizanidine) are commonly used for spasticity management, they often come with systemic side effects and limited duration of efficacy. RCS provides a non-invasive, drug-free alternative that can be used independently or in conjunction with pharmacological treatments to maximize spasticity reduction[24].

Furthermore, combining RCS with robotic-assisted therapy, task-specific training, and passive stretching has been shown to enhance spasticity management and promote greater functional recovery. Studies highlight that integrating RCS into daily rehabilitation programs can sustain improvements in muscle tone, prevent contractures, and enhance patient mobility even in chronic stroke cases[25].

Emerging evidence suggests that long-term application of RCS leads to neuroplastic adaptations, reducing reliance on external interventions and improving overall motor function. Wearable smart stimulation devices and brain-machine interface (BMI)-controlled electrical stimulation are being developed to provide personalized spasticity management strategies[26]. Future research should explore optimal RCS stimulation parameters, the interplay between RCS and neural plasticity, and the effectiveness of home-based RCS therapy to further improve patient outcomes.

Functional Motor Outcomes with Repetitive Contraction Stimulation (RCS): Functional motor recovery is a primary goal in post-stroke rehabilitation, aiming to restore mobility, coordination, and independence in activities of daily living (ADLs). Stroke survivors often experience muscle weakness, impaired motor control, and fatigue, which significantly reduce their ability to perform essential daily tasks such as walking, dressing, and eating. Integrating Russian current stimulation with physiotherapy and functional training has been shown to enhance movement efficiency, reduce muscle fatigue, and improve overall motor performance[4].

One of the key benefits of RCS is its ability to activate both fast-twitch (Type II) and slow-twitch (Type I) muscle fibers, allowing for more balanced muscle engagement. This leads to improved muscle endurance, better motor coordination, and reduced premature fatigue, enabling patients to engage in prolonged functional activities[28]. Studies have demonstrated that RCS combined with functional movement training results in better neuromuscular adaptation, reinforcing cortical reorganization and improving voluntary muscle activation patterns[16].

The application of task-specific training alongside RCS is particularly effective in promoting neuroplasticity, a critical factor in post-stroke recovery. Research indicates that patients undergoing RCS-assisted rehabilitation show greater improvements in functional task execution, including improved grip strength for object manipulation, better postural stability for standing and walking, and enhanced dexterity for fine motor tasks[27]. Furthermore, the ability of RCS to reduce compensatory movement patterns allows for more natural and biomechanically efficient movement strategies, preventing overuse injuries in unaffected limbs[25].

The integration of RCS with robot-assisted rehabilitation, virtual reality therapy, and wearable stimulation devices offers a comprehensive approach to functional recovery. Recent advances in sensor-based movement analysis and AI-driven biofeedback systems have made it possible to personalize RCS protocols based on real-time motor performance, further optimizing rehabilitation outcomes[26]. Future studies should focus on standardizing RCS treatment parameters, determining its efficacy in different stroke subtypes, and evaluating its long-term effects on functional independence.

Comparison with Other Electrical Stimulation Modalities:

Electrical stimulation techniques are widely utilized in stroke rehabilitation to restore muscle function, prevent atrophy, and improve neuromuscular control. While various modalities share overlapping therapeutic benefits, they differ in mechanism, application, and effectiveness. RCS is distinct from Neuromuscular Electrical Stimulation (NMES), Functional Electrical Stimulation (FES), and Transcutaneous Electrical Nerve Stimulation (TENS) due to its superior ability to generate strong, fatigue-resistant contractions.

RCS versus NMES: Neuromuscular Electrical Stimulation (NMES) is commonly used to facilitate muscle contraction and motor re-education, but RCS offers a more advanced stimulation pattern. Unlike NMES, which typically activates slow-twitch (Type I) muscle fibers, RCS delivers higher-frequency bursts, recruiting both slow-twitch and fast-twitch (Type II) fibers. This results in stronger, more sustained contractions with reduced muscle fatigue[11].

Additionally, RCS promotes deeper muscle recruitment, enhancing strength gains and neuromuscular coordination. Patients undergoing RCS tend to experience faster muscle activation and fewer side effects such as discomfort, excessive soreness, or overstimulation, which are more common in standard NMES protocols. These factors make RCS a preferred option for post-stroke muscle reactivation and strength recovery[16].

RCS versus FES: Functional Electrical Stimulation (FES) is primarily applied to facilitate movement patterns in stroke survivors, such as assisting with walking, grasping, or standing. FES works by activating muscles in a coordinated manner to mimic natural movement sequences, making it ideal for task-specific rehabilitation[14].

By contrast, RCS focuses on muscle strengthening and neuromuscular reactivation rather than functional movement assistance. While FES is effective for repetitive task training, RCS is designed to improve muscle force, endurance, and hypertrophy, making it particularly beneficial for patients with profound muscle weakness or significant motor deficits[20]. In clinical settings, RCS is often used as a precursor to FES therapy, helping patients develop sufficient muscle strength before transitioning to functional movement training.

RCS versus TENS: Transcutaneous Electrical Nerve Stimulation (TENS) is widely used for pain management rather than muscle rehabilitation. Unlike RCS, which targets motor neurons to promote muscle contractions, TENS stimulates sensory nerves to block pain signals, offering no direct benefit for muscle strengthening or neuromuscular recovery[9].

Because TENS lacks the ability to produce sustained contractions, it is ineffective for preventing muscle atrophy or improving functional movement in post-stroke patients. In contrast, RCS directly engages motor pathways, leading to muscle activation, increased cross-sectional area, and improved neuromuscular control, making it a superior choice for rehabilitation purposes[24].

Clinical Preference: Why RCS is Favored over NMES and FES: Clinical studies indicate that RCS is preferred over NMES and FES for patients requiring muscle mass restoration and atrophy prevention[31]. It is particularly beneficial for stroke survivors in the chronic phase of recovery, where conventional electrical stimulation may not yield significant strength or endurance improvements. Clinicians often recommend RCS for individuals experiencing severe muscle weakness and functional decline, as its ability to recruit deep muscle fibers and generate fatigue-resistant contractions is unmatched by other modalities.

Additionally, hybrid approaches integrating RCS with NMES or FES are gaining attention, allowing for personalized treatment plans that maximize both strength development and functional movement recovery[25]. Future research should explore optimal combinations of these modalities and assess long-term neuroplastic changes associated with RCS therapy.

Challenges and Future Directions:

Despite its potential, several challenges must be addressed for optimal implementation of RCS in stroke rehabilitation.

Variations in stimulation intensity, duration, and frequency lead to inconsistent outcomes across studies[4]. A standardized RCS protocol must be established to ensure uniform clinical application and effectiveness across diverse patient populations.

Not all stroke patients respond equally to RCS, with some exhibiting greater improvements in function than others. More research is needed to identify predictive biomarkers[1]. Factors such as lesion location, severity of stroke, and individual muscle condition may influence the responsiveness to RCS interventions.

Integration with Other Therapies, RCS should be combined with conventional therapies like robotic-assisted rehabilitation and virtual reality training for maximized benefits[15]. Future studies should examine the synergistic effects of RCS combined with task-specific movement training.

Future Research Needs Further randomized controlled trials are essential to determine long-term efficacy, optimal parameters, and patient selection criteria[6]. Additionally, research into home-based RCS interventions could provide new rehabilitation opportunities for stroke survivors with limited access to clinical settings.

Conclusion:

Russian current stimulation (RCS) represents a promising adjunct therapy for post-stroke motor rehabilitation, offering muscle strengthening, neuromuscular re-education, and spasticity reduction. The burst-modulated stimulation of fast- and slow-twitch muscle fibers enhances functional recovery, particularly in patients with significant motor impairments. Clinical studies have demonstrated improvements in walking ability, upper limb function, and overall quality of life for stroke survivors undergoing RCS therapy.

Despite these benefits, variability in treatment protocols, patient responsiveness, and lack of standardized clinical guidelines pose significant challenges to the widespread adoption of RCS. Future research should prioritize large-scale randomized controlled trials to establish optimal parameters, treatment duration, and patient selection criteria. Additionally, exploring RCS integration with robotic-assisted therapy, virtual reality, and home-based rehabilitation models may enhance its accessibility and effectiveness. With further advancements, RCS could become a cornerstone of post-stroke motor rehabilitation, improving functional outcomes and independence for stroke survivors.

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