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Neurodynamic Techniques in Patients with Spastic Cerebral Palsy: Review of Current Evidence

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ABSTRACT

Most cerebral palsy forms are spastic in nature. Movement becomes more strenuous as the muscles become stiffer, leading to difficulties. Why? There is no control over muscles, strength remains low. The precision of movement diminishes over time. Without treatment, the physical changes to bones and joints become more severe. These problems gradually interfere with daily operations. The quality of life often declines in conjunction with physical ability.

For most people with spastic cerebral palsy, physiotherapy is necessary to recover their ability to move. Stretching aids in loosening tight muscles, whereas strength exercises promote better muscle control. Practical skills are nurtured through daily practice exercises.' A few therapists use neurodevelopmental techniques to direct motor learning. The range of motion can be improved through serial casting over time when progress slows down. Using braces with orthoses can improve activity stability. Muscle response may be enhanced by functional electrical stimulation when used alongside exercise.

The aim of neurodynamic techniques is to optimize the movement of peripheral nerves within adjacent structures, which is known as nerve gliding. These hands-on techniques aim at both the innate function and physical activity of the nervous system. Restoring movement through these techniques promotes better connections between nerves and nearby tissues. They consider biological responses as well, rather than solely examining mechanics. Treatment involves guided movements that promote seamless nerve sliding during activity.

Across different neuromuscular conditions, these methods exhibit improvements in neural movement and a decrease in sensitivity to mechanical stress. Enhanced motion capacity and increased nerve circulation lead to improved nerve activity as time passes. Clinical observation shows that the core benefits remain consistent, despite slight differences in outcomes.

The scarcity of studies focusing on neurodynamic methods in children with spastic cerebral palpitations persists, even when nerve-related limitations are the cause. Although some research has shown an increase in range of motion, stretch capacity, and movement ability with standard physical therapy, there are no

solid clinical trials using random assignment. This is a rare finding. Although the benefits are conceivable, there is no clear evidence that can be drawn from the proof.

Keywords: Spastic cerebral palsy, neurodynamic techniques, neural mobilization, nerve gliding, physiotherapy, pediatric rehabilitation.

1. INTRODUCTION

Cerebral Palsy is a chronic condition that results from early brain damage and inhibits motor growth. What are the symptoms? While the root cause doesn't worsen, it still has an impact on coordination and muscle control. Why? This disruption is usually present before birth, typically in the fetal development, but can arise shortly after delivery. Injuries that disrupt normal signaling in the brain's motion areas are the root cause. The delicate growth stage of the brain can result in lasting issues even through mino interference. This is a rare phenomenon. Physical ability is shaped in the long run by early impairments, which usually arise in young children. [1].

The primary brain injury remains unaffected, but abnormal muscle and musculoskeletal issues arise as a result of poor muscle function, uneven soft tissue development, and poor movement coordination. [2]

Roughly 75% of all children worldwide have cerebral palsy, with the majority being the spastic type. Children with spastic cerebral palsy typically exhibit greater muscle tension than usual. i. They exhibit a hyper-active response when their muscles are stretched.' Along with these symptoms, some muscles are often weak. Poor motor selection results in less precise, smooth movements. Why? Their ability to maintain footing becomes compromised, leading to difficulties with balance while standing or walking. The development of walking patterns is usually markedly distinct. Tight tissues can cause joints to lose range of motion as they age. Due to this combination, managing daily tasks on your own can be more challenging. [1]

Those deficits often lead to progressive musculoskeletal deformity, decreased mobility, pain and reduced quality of life when not properly treated. [2]

Spastic cerebral palsy is best managed through the use of physiotherapy. [2]

The current treatment options for the affected individual include stretching exercise, strengthening, gait training, balance training (e.g. non-verbal communication), neurodevelopmental treatment (NDT), task-specific training and serial casting, orthoses and/or functional electrical stimulation. Although many interventions have been developed for the control of the contractures, secondary soft tissue changes (such as reduced muscle extensibility, myofascial tightness, and decreased peripheral nerve mobility) often occur and compromise function.Neurodynamic techniques have been introduced as a type of manual therapy, which aim to normalize the function of peripheral nerves. The neurodynamic concepts suggest that the peripheral nerves need to have an adequate amount of mobility and flexibility as well as vascularization and axoplasmic transport to function normally. [4]

The peripheral nerves may experience mechanical restraint, resulting in pain, joint mobility issues, movement patterns that are impaired, and functional limitations. The objective of neural mobilization techniques is to restore these physiological properties by performing controlled nerve-gliding or tensioning maneuvers. Although neurodynamic interventions have been widely used for treating peripheral nerve entrapments, cervical and lumbar radiculopathy, and other injuries in the musculoskeletal area, their use in rehabilitation for pediatric neurological diseases has not been extensively researched. [3]

2. LITERATURE REVIEW

The literature on neurodynamic techniques for spastic cerebral palses was reviewed in a narrative manner.

A search of PubMed, PubMED Central (PMC), PEDro and Google Scholar, as well as peer-reviewed journals were used to identify electronic literature on rehabilitation.

A combination of cerebral palsy, stress cerebral phsia and neurodynamic techniques, neural mobilization, nervousness exercises, neurogliding (calming), neuroscience, nutrition, physiotherapy, pediatric rehabilitation were used as search terms.

English articles, including RCTs, observational, systematic and narrative reviews, as well as relevant experimental studies were included in the current scoping review. The limited number of studies investigating the efficacy of neurodynamic techniques on children with spastic cerebral palsy means that the articles also encompass findings related to other neurological groups and neurodynamic research in general. However,

2.1. PATHOPHYSIOLOGY OF SPASTIC CEREBRAL PALSY

SPASTIC CEREBRAL PALSY (CEREBRAL PALSY)

Spastic cerebral palsy (SCP) is the mildest of the clinical presentations of cerebral palsy; it is manifested by a non-progressive lesion of the developing brain, predominantly motor areas, which leads to disruption of the motor cortex and pyramidal tracts and causes spastic signs. Although the lesion of the central nervous system is non-progressive, the patterns of musculoskeletal involvement are variable throughout childhood and adolescence because of the altered motor activity, motor learning, and skeletal development. [1]

Active spasticity can result in adaptive changes to muscles, tendons, fascia, ligaments, and joints, leading to muscle contraction with reduced extensibility of the muscles due to chronic spasting. [1]

SCP is accompanied by motor impairments that decrease the ability to move the lower limbs voluntarily, leading to reduced neuromuscular control and limited functionality in daily living. This condition also affects many patients with other motor deficits. Hence, the current treatments for SCP patients are focused on recovering motor skills and engaging in activities rather than decreasing spasticity. [1]

NEURODYNAMIC TECHNIQUE

The goal of manual therapy is to restore the normal function of a peripheral nerve, which can be accomplished through techniques like neurodynamic techniques, neural mobilization, or neurodynamics. Any treatment that aims to enable nerves to move, extend, glide, and slide in accordance with normal physiological function is described by neurodynamic technique. [3]

Shacklock improved upon the concept of neurodynamics, which posited that successful motor activity is determined by the combination of peripheral nerve function and biomechanical properties. [3]

Normal nerve activity and intraneural circulation and axoplasmic transport are maintained by peripheral nerves that have varying levels of mobility relative to adjacent tissues. Mechanical restraint of neural mobility, caused by factors such as inflammation, fibrosis, prolonged immobility, or capsular or soft tissue tightness, can result in motor function decline, pain, range of motion reduction, muscle performance impairment, and increased neural mechanosensitivity. [3]

2.2. TYPES OF NEURODYNAMIC TECHNIQUES

NEURAL SLIDERS (GLIDERS)

Two joints being moved in such a way that results in the lengthening of one end of the nerve bed and the shortening on other ends are known as neural sliders, as described by the title. This type of sliding allows nerves to slide into and out without causing excessive strain on surrounding tissues. The most secure form of neurodynamic testing for neurological rehabilitation, particularly in children, is believed to be neural sliders. [3]

NEURAL TENSIONERS

Neural tensioners cause the nerves to experience increased pressure as they extend the bed from two sides. While the primary goal of tensioning techniques is to increase nerve elasticity and flexibility, they should be used with care as sliders result in greater mechanical strain. [3]

Sliders are preferred over aggressive techniques of tensioning in children with spastic cerebral palsy, pending further clinical evidence. [3]

PHYSIOLOGICAL MECHANISMS OF NEURODYNAMIC TECHNIQUES

Neurodynamic techniques are believed to produce several beneficial physiological effects.

A properly controlled nerve movement is likely to increase excursion relative to the surrounding connective tissues and reduce adhesion formation which can interfere with its motion. [3]

The benefits of neural mobilization include improved blood circulation, increased oxygen levels and metabolic waste removal to prevent ischemia. Additionally this function can be enhanced in the nervous system. [3]

Axoplasmic flow, which is crucial for the normal movement of protein, neurotransmitters, and organelles along the peripheral nerves, can be disrupted by mechanical means or restored by mobilization techniques, according to another theory. [3].

Inner neural edema, normalization of mechanosensitivity and viscoelastic properties of connective tissue, and improvement of motor performance can all be achieved through the use of neurodynamic techniques. [3]

Table 2.1- Conventional Physiotherapy vs Neurodynamic Techniques [12]

2.3. RATIONALE FOR NEURODYNAMIC TECHNIQUES IN SPASTIC CEREBRAL PALSY

Parameter	Conventional Physiotherapy	Neurodynamic Techniques
Primary target	Muscle, joint, function	Peripheral nervous system
Main objective	Improve strength and mobility	Restore neural mobility
Evidence in CP	Strong	Limited
Clinical use	Standard treatment	Adjunctive treatment
Research support	High	Low–Moderate

While cerebral palsy is caused by damage to the central nervous system, the development of compensatory musculoskeletal deformities during the course of disease progression is hypothesized to have a neurodynamic origin. [1].

Therefore, neurodynamic stretching techniques may be appropriate for individuals with cerebral palsy.' Spasticity causes a decrease in muscle length, fascial limitations, reduced range of motion of the affected joints, and connective tissue fibrosis. The neurodynamic compartment may be impacted by these manifestations, which can restrict nerve mobility and cause sensory and motor dysfunction. [1]

Limitations in flexibility, compensatory movement patterns and painful stretching may be accompanied by restricted neural mobility. How? Neurodynamic techniques may enhance the effectiveness of physical therapy interventions by restoring neural excursion. [3]

Evidence on Neurodynamic Techniques in Spastic Cerebral Palsy

Research on the use of neurodynamic techniques in treating spastic cerebral palses is limited, as stated in a review of the literature. Most of the literature on the subject is based on narrative reviews, theoretical articles, and extrapolations from studies conducted on other neurological or orthopedic conditions. [3]

According to the literature reviewed, neural mobilization may enhance nerve gliding and sliding, decrease neural adherence, improve axoplasmic flow, increase joint range of motion, and reduce muscle tone as an adjunct to rehabilitation programs, but further investigation is required. [7].

The absence of strong evidence to validate the efficacy of neurodynamic techniques as a first-line treatment for spastic cerebral palsy means that they are not recommended by any international guidelines. The management of children with cerebral palsy is still dependent on the use of evidence-based interventions, including neurodevelopmental treatment, strengthening, and other tasks. [6].

2.4. EVIDENCE FROM OTHER NEUROLOGICAL CONDITIONS

The insufficiency of CP-specific evidence led to an evaluation of the role of neurodynamic techniques in other neurological conditions.

In a recent scoping review of post-stroke rehabilitation, it was determined that the addition of neural mobilization to standard treatment could reduce upper-limb spasticity and improve electromyographic activity and clinical function, but researchers noted that high quality trials were necessary before they could provide conclusive results on this topic. [8]

A randomized study in patients with severe tetraplegia revealed that median nerve neurodynamic mobilization was effective in decreasing upper-limb spasticity and improving hand function. However, only some cases were successfully treated using traditional methods. [9]

2.5. COMPARISON WITH CONVENTIONAL PHYSIOTHERAPY

Biofeedback, hippotherapy, whole body vibration, task specific training, transcutaneous electrical nerve stimulation, extracorporeal shockwave therapy, and neurodevelopmental treatment have been found to be more effective than neurodynamic techniques in treating children with spastic cerebral palsy. As a result, these interventions can be recommended as part of broader physiotherapy plans. [6].

3. DISCUSSION

The peripheral nerves' normal function and physiology are being restored through the use of neurodynamic techniques, which are now widely recognized as a rehabilitative Physiotherapeutic approach. These methods have been proven effective in musculoskeletal pathology, but their application in various neurological disorders is still being researched, with only minimal evidence of their efficacy in children with spastic cerebral palsy.

The literature analyzed in this study indicates that spastic cerebral palsy is not solely caused by an injury to the central nervous system, but also by secondary changes such as muscle shortening, joint contractures, altered movement patterns, and peripheral nerve damage. These discoveries serve as evidence for the use of neurodynamic techniques in the rehabilitation of spastic cerebral palsy.

The physiological mechanisms of action proposed by neurodynamic techniques include the restoration of neural excursion, improved intraneural blood circulation, decreased inintense swelling, optimization of axoplasmic transport, and reduction of mechanosensitivity. These techniques are described below. Incompletely impaired neural mobility contributes to the improvement of human movement and flexibility. Only the CP population has been tested for these mechanisms.

Current treatment guidelines for cerebral palsy recommend evidence-based motor learning interventions such as task-oriented training, active motor training, biofeedback, functional electrical stimulation, hippotherapy, whole-body vibration, and specific pharmacologic treatments. Neurodynamic techniques are not considered evidence based because of a lack of clinical trials specific to cerebral palsy.

Research on stroke and spinal cord injuries demonstrates that mobilisation, when combined with standard rehabilitation activities, can improve upper limb function, decrease spasticity, and increase range of motion. This data lends credence to the notion that neurodynamic approaches are beneficial for treating neurological disorders. However, because the studies were so dissimilar, we cannot be certain that this will help for kids with palsy.

Another important finding concerning the research in question is that, while little is known about the impact of peripheral nerve mobility, the evaluated trials mainly examine the role of physical therapy in the rehabilitation of walking capacity, gross motor function, or participation. Neurodynamic approaches can be used in the rehabilitation of children with cerebral palsy since diminished peripheral nerve mobility has been linked to functional limitation, according to an observational study.

Due to a lack of scientific trials, there is insufficient data to support the efficacy of therapies for children with spastic cerebral palsy.

For people with spastic cerebral palio, neurodynamic treatments are advised as an alternative to conventional physiotherapy.

All things considered, I think the study shows that employing neurodynamic techniques in addition to physical treatment was advantageous. However, they shouldn't replace any of the previously proven successful treatments in the absence of more research and randomised control trials on people with spastic cerebral palsy.

4. CLINICAL IMPLICATIONS

From a clinical perspective, I believe that neurodynamic approaches are better suited as an adjuvant to conventional physiotherapy than as a stand-alone treatment for spastic cerebral palsy. Therefore, before using neurodynamic exercises, doctors must evaluate the patient's range of motion and neural mechanosensitivity. Second, no neurodynamic treatment should be uncomfortable or result in an increase in tone.

Because of the possible synergistic benefits of combined treatment, neurodynamic approaches in conjunction with stretching and strengthening, gait training, balance exercises, task-specific training, and neurodevelopmental treatment will be very effective.

The following outcome metrics can be used to assess how well neurodynamic treatments work:

1. Motion range
2. The Ashworth Scale was modified.
3. The Tardieu Scale
4. The GMFM-66, or gross motor function measure
5. The Paediatric Balance Scale
6. The Functional Mobility Scale
7. The Six-Minute Walk Test
8. Analysis of gait

In the research on cerebral palsy, these outcome measures are frequently used to evaluate motor function and performance.

5. LIMITATIONS OF CURRENT EVIDENCE

Numerous important shortcomings in the included studies were identified by the current review.

First off, randomised control studies evaluating the efficacy of neurodynamic approaches for kids with spastic cerebral palsy are missing from the evaluated publications. Most research papers only discuss the use of neurodynamic treatments for individuals with neurological or musculoskeletal conditions.

Second, there were few cross-study comparisons since the therapies differed widely in terms of treatment frequency, duration, mobilisation, therapist expertise, and outcome measures.

Third, there is less confidence in these results because the majority of research had small sample numbers and short follow-up periods.

Finally, few studies have focused on participation, quality of life, caregiver burden, or long-term functional independence, which are important outcome domains for children with cerebral palsy.

6. FUTURE DIRECTIONS

Randomised controlled trials evaluating the efficacy of neurodynamic methods in children with spastic cerebral palsy should be the main focus of future research.

Neurodynamic intervention treatment dosages, frequencies, durations, and progressions should all be standardised in studies.

The efficacy of neurodynamic approaches in conjunction with conventional physiotherapy against conventional physiotherapy alone should be compared in future studies.

To ascertain the therapeutic applicability of neurodynamic approaches in paediatric neurorehabilitation, studies should evaluate long-term outcomes, including gait, gross motor function, participation, quality of life, and degree of independence.

7. CONCLUSION

According to the current analysis, there is very little data supporting the use of neurodynamic methods for kids with spastic cerebral palsy. While the evidence on cerebral palsy is indirect, the examined studies discuss the efficacy of neurodynamic treatments in individuals with musculoskeletal disorders or other neurological problems. The studies' findings imply that the application of neurodynamic approaches probably improves functional performance as well as range of motion, flexibility, and fluidity of motions. However, the results cannot be applied to children with spastic cerebral palsy since the conditions in the examined research differed from the condition and because there were no pertinent clinical trials.

According to recent studies, active participation in rehabilitation programs has been shown to be more successful than passive interventions in fostering motor recovery in people with cerebral palsy. Therefore, neurodynamic approaches should not be used as stand-alone interventions to treat the illness; rather, they should be used as an adjuvant to comprehensive physiotherapy.

Large-scale randomised controlled trials examining the efficacy of the chosen neurodynamic therapy strategies should be considered in future study. A significant number of participants should be included in the trials, and follow-up evaluations should be used to gauge the efficacy of the treatment. The Gross Motor Function Measure, Modified Ashworth Scale, Tardieu Scale, gait analysis, and quality of life measurements are examples of standardised and validated outcome measures that should be used in future research.

In conclusion, the study demonstrates that while neurodynamic treatments might be regarded as a biologically effective treatment, there is insufficient data to support their inclusion in the first line of treatment for spastic cerebral palsy.

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