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Efficacy of Dry Needling in Enhancing Hand Function and Reducing Spasticity in MCA Stroke Patients: A Prospective Case Report

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Abstract: Stroke, particularly involving the middle cerebral artery (MCA), often leads to persistent disability, significantly impairing hand function and inducing severe spasticity in the forearm flexors due to complex motor pathway involvement. This case report evaluates the effectiveness of combining dry needling therapy (DNT) with task-oriented training (TOT) in reducing spasticity and improving hand function in a post-MCA stroke patient. A 61-year-old male with right-side hemiplegia following a left MCA stroke, compounded by a history of diabetes, hypertension, and recent kidney stone diagnosis, participated in this study. The patient experienced severe functional limitations due to spasticity (grade 3 on the Modified Ashworth Scale) and scored 31 on the CAHAI-13, indicating significant hand dysfunction. DNT was applied to key forearm muscles (flexor carpi radialis, flexor carpi ulnaris, flexor digitorum superficialis, flexor digitorum profundus, and pronator teres), followed by TOT targeting daily tasks. Post-intervention, the patient demonstrated significant improvements: spasticity was reduced (Modified Ashworth Scale score decreased from grade 3 to grade 2), and muscle hypertonicity, as measured by EMG, was reduced in all targeted muscles. Functional hand use improved markedly, with the CAHAI-13 score increasing from 31 to 45. These improvements led to enhanced independence in daily activities. This case report highlights the clinical relevance of integrating DNT with TOT in stroke rehabilitation. The combined intervention not only reduced spasticity and improved neuromuscular function but also led to meaningful gains in hand function, enhancing the patient's ability to perform daily activities independently. Given the promising results, this combined approach could serve as a practical and effective strategy for improving motor recovery and functional independence in post-stroke patients. Further studies with larger sample sizes are necessary to confirm these findings and explore the broader application of this approach in clinical practice.

Introduction

Spasticity is a significant challenge among chronic stroke patients, characterized by increased muscle tone due to heightened stretch reflex activity (Feigin et al., 2021; Liao et al., 2023). Approximately 42.6% of stroke survivors develop spasticity within six months, severely affecting upper limb motor function and impeding rehabilitation efforts (Analan and Ozdemir, 2020). Middle cerebral artery (MCA) strokes, in particular, often result in substantial impairments such as hemiparesis and spasticity, impacting both motor control and upper limb functionality (Nogles and Galuska, 2023; Chacon-Barba et al., 2024; Asgari et al., 2024).

Various rehabilitation strategies are employed to manage post-stroke spasticity, including stretching exercises, strength training programs, neurodevelopmental techniques, functional electrical stimulation, and task-oriented training (TOT) (Ramanathan and Alhalaiqa, 2024; Suputtitada et al., 2024; Tilborg et al., 2024; Tedeschi, 2023). Among these, TOT stands out by utilizing neuroplasticity to enhance essential motor functions for daily activities, aiming to restore

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independence and improve the overall quality of life (Akhtar et al., 2024).

Recently, dry needling therapy (DNT) has emerged as a promising treatment for post-stroke spasticity. DNT involves precise needle insertion into tense muscles or trigger points to alleviate muscle tension, increase range of motion, and reduce hypertonicity, all based on Western anatomical and neurophysiological principles (Núñez-Cortés et al., 2020). While most research on DNT in post-stroke patients has focused on its immediate effects when used alone, combining multiple therapeutic approaches may offer greater efficacy in managing spasticity and improving rehabilitation outcomes (Babazadeh-Zavieh et al., 2022; Cuenca Zaldívar et al., 2021).

Although some studies have examined the impact of combining DNT with rehabilitation programs on upper limb spasticity in stroke patients, there has been no prior investigation into the effects of combining DNT with task-oriented training on motor function improvement in these individuals (Choobsaz et al., 2024; Aliasgharpour et al., 2024; Ansari et al., 2015). Research by Ansari et al. demonstrated that dry needling significantly reduces muscle tone and improves range of motion in stroke patients with spasticity, supporting its role in modulating neuromuscular activity and facilitating relaxation in hypertonic muscles. This reduction in spasticity contributes to improved motor function and greater ease in performing daily activities. Moreover, studies like the one conducted by Rodríguez-Fernández et al. (2021) have shown that DNT can produce sustained reductions in spasticity over time, with follow-up assessments indicating prolonged benefits post-intervention. These findings suggest that DNT not only provides immediate relief but also has long-lasting effects, making it a valuable addition to comprehensive stroke rehabilitation programs aimed at optimizing functional recovery.

Task-oriented training is widely recognized as an effective approach for motor rehabilitation in stroke patients (Srilakshmi et al., 2024; Thant et al., 2019). Previous studies have demonstrated that DNT alone can immediately reduce spasticity and improve range of motion. We hypothesize that combining DNT with task-oriented training may more effectively reduce spasticity in MCA post-stroke patients compared to either treatment used individually and enhance hand function

This case study explores how combining dry needling therapy and task-oriented training improves hand function and reduces forearm flexor spasticity in a patient with chronic MCA post-stroke. By addressing both neuromuscular and functional deficits, this integrated approach aims to optimize treatment effectiveness, offering a comprehensive strategy for stroke rehabilitation. The findings underscore the potential benefits of this combined therapeutic approach, highlighting its role in enhancing motor recovery and improving the quality of life for stroke survivors.

Materials and methods:

The study was approved by the Institutional Scientific Review Board on human subjects (01/024/2023/ISRB/PGSR/SCPT). The study procedure was explained, and the subject was willing to receive the treatment. The subject was given written, informed consent for the case report to be published, and their anonymity was maintained.

This case report details the treatment journey of a 61-year-old male patient who experienced a stroke in the middle cerebral artery (MCA), leading to paralysis on the right side of his body. Two months prior to the initiation of this report, the patient experienced a left-sided cerebral vascular accident (CVA), which led to significant difficulty in performing daily activities, primarily due to the involvement of his dominant hand. With a medical history including diabetes for 12 years, hypertension for seven years, irregular medication adherence, and a history of alcohol consumption spanning 20 years (though abstinent for the last two months), the patient faced compounded health challenges. Additionally, he had reported COVID-19 symptoms in 2021 and had been diagnosed with and treated for a kidney stone post-stroke. He was alert and could follow the instructions.

Upon initial assessment, the patient was diagnosed with grade 3 spasticity according to the Modified Ashworth Scale (MAS). He scored 31 on the Chedoke Arm and Hand Activity Inventory (CAHAI-13), indicating significant difficulty and dependency in performing daily tasks involving the affected arm and hand (Naghdi et al., 2008; Abdelaziz et al., 2023). Surface electromyography (sEMG) motor unit action potential (MUAP) values were recorded for the following forearm muscles: flexor carpi radialis, flexor digitorum superficialis, flexor carpi ulnaris, flexor digitorum profundus, and pronator teres (Johnson et al., 2017; Wang et al., 2017). These muscles were selected due to their susceptibility to spasticity and their critical role in fine motor control, particularly in hand function and rehabilitation efforts.

The therapeutic intervention aimed to address the significant challenge of managing spasticity and impaired hand function, particularly in patients with MCA involvement. Spasticity, characterized by muscle stiffness and involuntary contractions, significantly impedes functional independence and complicates recovery efforts.

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Recent literature highlights that spasticity affects a considerable number of stroke survivors, hindering their performance of daily activities and their engagement in rehabilitation programs. These challenges underscore the pressing need for effective interventions that can alleviate spasticity and enhance functional recovery in individuals with MCA-related stroke.

Intervention

The patient underwent a four-week intervention program consisting of dry needling therapy (DNT) combined with task-oriented training (TOT). The total duration of each treatment session was 45 minutes, conducted three times per week on alternate days. Dry needling was administered for 10 minutes per session. The patient was positioned in a high sitting position, and the treatment area was sterilized with an alcohol swab. The flexor carpi radialis, flexor carpi ulnaris, flexor digitorum superficialis, flexor digitorum profundus, and pronator teres muscles were palpated to identify trigger points or tight muscle bands. Disposable stainless needles (0.25 x 25 mm) were inserted perpendicularly into the muscles at depths ranging between 10 to 15 mm. Using a rapid in-and-out technique, the needle was advanced until a local twitch response (LTR) was elicited. Once an LTR was achieved, the needle was moved up and down approximately (3–5 mm) for 60 seconds without rotation until no further twitch responses were observed.

Following the dry needling treatment, the patient engaged in a 35-minute task-oriented training program. This program included six specific upper limb functional tasks aimed at improving independence and hand function. The tasks were washing one's face, brushing teeth, applying toothpaste, washing dishes, ironing a shirt, and using the toilet independently. These activities were selected to enhance upper limb functionality by engaging the patient in meaningful, practical tasks directly related to daily life.

Inclusion and Exclusion Criteria

The patient was selected based on the following inclusion criteria: age 40 or older, first-time MCA stroke during the subacute phase, a Modified Ashworth Scale (MAS) score between 1 and 3, and a Mini-Mental State Examination score greater than 24 to ensure cognitive capability. Exclusion criteria included recent Botox injections, poorly controlled seizures, recurrent strokes, neurological or orthopedic conditions that might affect the study, needle phobia, contraindications such as the use of blood thinners, infections, bleeding risks, or significant cognitive impairments.

Results and Discussion

After four weeks of the combined intervention, significant improvements were observed in the patient. Table I demonstrates a marked reduction in muscle spasticity, evidenced by the decrease in the Modified Ashworth Scale (MAS) score from grade 3 to grade 2. The functional capability of the affected hand and arm, assessed by the CAHAI-13, showed notable improvement, with the score increasing from 31 to 40. Furthermore, Table II illustrates that sEMG values across all targeted muscles notably decreased, indicating reduced muscle hypertonicity and improved neuromuscular function post-intervention.

Table I. Analysis of pre- and post-interventions of CAHAI and MAS.

SCALES	Pre test	Post test
Modified Ashworth scale (MAS)	Grade 3	Grade 2
Chedoke arm and hand activity inventory (CAHAI-13)	31	40

Table II. Analysis of pre- and post-interventions of Surface Electromyography (sEMG) Values.

Surface Electromyography (sEMG) Values (µV)	Pre-test	Post-test
Flexor carpi radialis	720 µV	600 µV
Flexor digitorum superficialis	690 µV	580 µV
Flexor carpi ulnaris	670 µV	560 µV
Flexor digitorum profundus	680 µV	570 µV
Pronator teres	710 µV	590 µV

Figure 1. Surface electromyography.

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Figure 2. Dry Needling Intervention.

The primary goal of this case report was to determine the effectiveness of dry needling therapy (DNT) combined with task-oriented training (TOT) in decreasing spasticity and improving hand function in a patient who had suffered a stroke affecting the middle cerebral artery (MCA). Our findings are consistent with previous research demonstrating the positive impact of dry needling on motor function and spasticity reduction in stroke patients.

In this case, the 61-year-old male patient with right-side hemiplegia and significant daily activity difficulties showed notable improvements following the intervention. The patient's Modified Ashworth Scale score decreased from grade 3 to grade 2 and the CAHAI-13 score improved from 31 to 40. These outcomes suggest that integrating dry needling with TOT is effective in enhancing motor recovery and reducing spasticity in MCA stroke patients. This aligns with the findings of Sandra Calvo et al. (2022), who highlighted the beneficial effects of dry needling on motor function and spasticity reduction.

Dry needling targets trigger points within the affected muscles, modulating neural excitability, regulating muscle tone, and promoting tissue healing. The release of local twitch responses disrupts the neuromuscular feedback loop associated with spasticity and stimulates the release of endogenous opioids and neurotransmitters, contributing to pain relief and enhanced motor control. Additionally, dry needling may promote cortical map reorganization and neuroplasticity, further aiding in motor recovery.

The integration of dry needling with TOT provided a comprehensive rehabilitation strategy. TOT focuses on meaningful activities that improve upper limb functionality, directly addressing the patient's difficulties in performing daily tasks. This combined approach emphasizes both motor relearning and neuromuscular mechanisms, leading to better functional outcomes for stroke patients. Alashram et al. (2019) also supported this approach, demonstrating restored hand function and reduced spasticity in post-stroke patients.

Surface electromyography (sEMG) readings, in this case, demonstrated a decrease in muscle hypertonicity, underscoring the therapeutic efficacy of dry needling in alleviating spasticity. This observation is consistent with the study by Luque-Moreno et al. (2020), which highlighted the potential of dry needling in managing spasticity by targeting specific trigger points and modulating neural activity.

Furthermore, utilizing the Chedoke Arm and Hand Activity Inventory (CAHAI) provided a systematic method to evaluate upper limb functionality, which is crucial for assessing the impact of rehabilitation interventions in post-stroke patients. The CAHAI's proven validity and reliability make it an invaluable tool for monitoring patient progress and refining treatment plans.

Overall, this case report highlights the potential of integrating dry needling with TOT as a cost-effective and valuable supplementary intervention for enhancing hand function and reducing spasticity in MCA post-stroke patients. The observed improvements in this case underscore the need for further research to refine rehabilitation strategies and optimize outcomes for stroke survivors. By targeting both neuromuscular and functional impairments, this combined approach offers a holistic method to improve motor recovery and quality of life in stroke patients.

A key strength of this study is the innovative combination of DNT and TOT, which has not been extensively explored in previous research. This approach offers a holistic rehabilitation strategy that may benefit other stroke survivors with similar conditions. However, the case study design limits the generalizability of the findings. The improvements observed in this single patient need to be validated in larger, controlled studies to confirm the broader applicability of the combined therapy.

While the immediate and short-term benefits of the combined therapy are evident, further research is needed to investigate the long-term effects of DNT and TOT on spasticity and hand function. Additionally, understanding the underlying mechanisms through which DNT and TOT interact to enhance neuroplasticity and motor recovery will provide deeper insights into optimizing rehabilitation protocols.

Future studies should explore the integration of DNT and TOT with other established rehabilitation methods,

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such as functional electrical stimulation and strength training programs. Investigating the combined effects of multiple therapies could lead to the development of comprehensive, multimodal treatment plans that maximize recovery outcomes for stroke patients.

Collecting qualitative data on patient perceptions and satisfaction with the combined therapy is crucial for understanding its impact on quality of life. Future research should incorporate patient-reported outcomes to capture the holistic benefits of the integrated approach and identify any areas for improvement.

Clinical Implications

Overall, this case report highlights the potential of integrating dry needling with task-oriented training (TOT) as a cost-effective and valuable supplementary intervention for enhancing hand function and reducing spasticity in MCA post-stroke patients. The observed improvements in this case underscore the need for further research to refine rehabilitation strategies and optimize outcomes for stroke survivors. By targeting both neuromuscular and functional impairments, this combined approach offers a holistic method to improve motor recovery and quality of life in stroke patients. A key strength of this study is the innovative combination of DNT and TOT, which has not been extensively explored in previous research. This approach offers a holistic rehabilitation strategy that may benefit other stroke survivors with similar conditions.

Limitations and Future Research Directions

However, the case study design limits the generalizability of the findings. The improvements observed in this single patient need to be validated in larger, controlled studies to confirm the broader applicability of the combined therapy. While the immediate and short-term benefits of the combined therapy are evident, several limitations must be acknowledged. These include the lack of a control group, which makes it challenging to determine whether the observed improvements were solely due to the intervention. Additionally, the short duration of follow-up prevents an assessment of the long-term sustainability of the benefits. Moreover, the absence of statistical analyses limits the ability to assess the significance of the observed changes comprehensively.

Further research is needed to investigate the long-term effects of DNT and TOT on spasticity and hand function. Understanding the underlying mechanisms through which DNT and TOT interact to enhance neuroplasticity and motor recovery will provide deeper insights into optimizing rehabilitation protocols. Future studies should explore the integration of DNT and TOT with other established rehabilitation methods, such as functional electrical stimulation and strength training programs. Investigating the combined effects of multiple therapies could lead to the development of comprehensive, multimodal treatment plans that maximize recovery outcomes for stroke patients. Collecting qualitative data on patient perceptions and satisfaction with the combined therapy is crucial for understanding its impact on quality of life. Future research should incorporate patient-reported outcomes to capture the holistic benefits of the integrated approach and identify any areas for improvement.

Conclusion

This case report highlights the effectiveness of combining dry needling therapy (DNT) with task-oriented training (TOT) in improving motor function and reducing spasticity in a patient with middle cerebral artery (MCA) stroke. Significant improvements were observed, including a reduction in spasticity (Modified Ashworth Scale score decreased from grade 3 to grade 2), enhanced functional hand use (CAHAI-13 score increased from 31 to 40), and decreased muscle hypertonicity as shown by surface electromyography (sEMG). These findings indicate that the integrated approach effectively targets both neuromuscular and functional impairments, offering a promising method for stroke rehabilitation. The practical implication is that DNT combined with TOT could be a valuable addition to stroke rehabilitation protocols, potentially leading to improved functional outcomes and quality of life. Future research should validate these results through larger, controlled studies, investigate the long-term benefits of the therapy and incorporate patient feedback to ensure the approach is patient-centered. Addressing these aspects will refine the intervention and potentially enhance overall stroke rehabilitation strategies.

Ethics approval

The study was approved by the Institutional Scientific Review Board (ISRB No. 01/024/2023/ISRB/PGSR/SCPT) at the Saveetha Institute of Medical and Technical Sciences. It was conducted in compliance with the 1975 Declaration of Helsinki and its 2000 revision, following the ethical standards set by the Local Ethics Committee of the institution where the research took place.

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Conflict of Interest

No conflict of interest.

Consent for publication

The authors confirm that they have secured all required patient consent forms. The patient consented to the publication of clinical data in the journal and was informed that their anonymity would be preserved, with their name and initials not being disclosed, despite all efforts to conceal their identity.

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