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Case Report

Effect Of Combined Neuromuscular Electrical Stimulation (Comb-Nmes) On Muscle Myofiber Distribution And Glucose Signaling In A Patient With Lower Motor Neuron Lesion And Acute Spinal Cord Injury.

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Abstract

Introduction: In this case study, a patient with acute spinal cord injury (SCI) and lower motor neuron lesions (LMNLs) has their muscle glucose signaling, fiber type distribution, and metabolic function evaluated in relation to a novel combined neuromuscular electrical stimulation (Comb-NMES) regimen. Report on the Case: The quadriceps were the focus of a ten-session Comb-NMES intervention for a 32-year-old individual with complete T9 SCI. To assess changes in muscle fiber types, important metabolic proteins, fasting insulin, glucose, and lipid profiles, muscle biopsies and blood samples were examined both before and after the intervention.Fasting insulin and glucose were reduced by 74.7% and 28.2%, respectively, as a result of the intervention. Improved glucose metabolism was indicated by muscle analysis, which revealed notable increases in CaMK II, Hexokinase II, and IRS-1.Conclusions: In a patient with acute SCI and LMNLs, Comb-NMES training significantly enhanced muscle glucose metabolism and metabolic regulation. Enhanced insulin sensitivity and glucose consumption were indicated by upregulated metabolic proteins, which implies that Comb-NMESisapromisingintervention for enhancing muscle and metabolic health in SCI.

Keywords : *Spinal Cord Damage, Lesion Of A Lower Motor Neuron, Coupled Neuromuscular Electrical Stimulation, Muscle Atrophy, Muscle Glucose Uptake.*

INTRODUCTION

A severe traumatic occurrence, spinal cord injury (SCI) frequently results in major secondary health problems, such as an increased risk of cardiovascular and diabetic disorders [1,2]. Significant muscle atrophy usually occurs underneath the lesion site after SCI, mostly as a result of chronically reduced contractile activity [3]. Usually characterized by a reduction in muscle mass and cross-sectional area, this muscle atrophy mostly affects muscles innervated by spinal cord segments below the damage level, leading to noticeable weakness and decreased function [4].

About 20–25% of people with SCI develop LMNLs, which lead to severe muscular atrophy from denervation and related fibrosis and adipose infiltration, further impairing muscle function and metabolic health. Compared to people with upper motor neuron (UMN) injuries, those with LMNLs are more likely to experience metabolic and cardiovascular problems as a result of these alterations [7]. The pathophysiological characteristics of LMN and UMN lesions differ. Spasticity, hyperreflexia, and disuse atrophy—mostly the disturbance of descending motor pathways—are characteristics of UMN lesions. On the other hand, denervation atrophy brought on by LMN injuries is characterized by laccidity, reflex loss, and severe muscle atrophy [8]. When UMN and LMN lesions combine, as occurs in thoracic segment injuries . The effectiveness of anovelCombinedNMES (Comb-NMES) regimen on the distribution of muscle fiber types and the signaling pathways involved in muscle glucose absorption is discussed in this case study. Whether a person is lying

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Received: 02-Jan-2025, **; Editor Assigned:** 03-Jan-2025 **; Reviewed:** 19-Jan-2025, **; Published:** 28-Jan-2025.
Citation: pmal Alharbi. Effect Of Combined Neuromuscular Electrical Stimulation (Comb-Nmes) On Muscle Myofiber Distribution And Glucose Signaling In A Patient With Lower Motor Neuron Lesion And Acute Spinal Cord Injury Advances in Behavioral Neuroscience. 2025 January; 1(1).

in a hospital bed or seated in a wheelchair, the routine was made to be easy for them to follow independently. Thus, the purpose of this report is to describe how the Comb-NMES affected the metabolic function and muscle health of acute SCI patients with LMN lesions who showed a significant decrease in fasting insulin and glucose concentrations as well as a markedly decreased ability to contract their muscles with fibrillations.

PRESENTATION OF THE CASE

A gunshot wound had caused a 32-year-old man to sustain a complete SCI (T9, AISA A). For two weeks, the patient was admitted to the Traumatic Intensive Care Unit at UAB Hospital in Birmingham, UK. Following the catastrophic injury, he was then taken to the Spain Rehabilitation Center (SRC) for treatment. He received ten sessions, three times a week, during his 23-day stay in the intervention. After signing a consent form, the patient became a participant in this study. The Institutional Review Board of the University of Alabama in Birmingham (UAB) gave its approval to the study protocol. This case report is a component of a larger study that looked into how combined neuromuscular electrical stimulation affected the metabolism and health of muscles following acute SCI. Our Comb-NMES regimen combines twitch contractions elicited by low-frequency electrical stimulation (5 Hz with a pulse duration/interval of 200/50 μs) for aerobic contraction, targeting the quadriceps muscle group of both legs, with dynamic contractions through electrical stimulation at a high frequency (50 Hz trains with 450 μs biphasic pulses) for resistance training, which aimed to induce a tetanic muscle contraction, facilitating complete knee extension (concentrically and eccentrically). The muscle is isometrically contracted by this twitch contraction. For stimulation, two electrodes (usually measuring 7.6 × 12.7 cm) were positioned on the distal portion of the vastus medialis and the proximal portion of the vastus lateralis.

LABORATORY AND CLINICAL TECHNIQUES

Using a Bergstrom-type needle and local anesthetic (1% lidocaine), muscle samples were taken from the vastus lateralis. Small muscle tissue samples (50–70 mg) were cross-sectionally mounted and quickly frozen in nitrogen-cooled isopentane for immunohistochemistry. The leftover tissues were then snap-frozen for further biochemical examinations. Samples of frozen muscle were divided into six musingacryostats. Using immunohistochemistry, myofiber types I, IIa, and IIax/IIx were determined. In accordance with conventional procedures, sections were stained with primary antibodies (NCL-MHCs for MHC I, NCL-MHCf for MHC II, and anti-laminin) and secondary antibodies (ALEXA Fluor 594 and 488). Because hybrid IIax fibers are so common, they were mixed with type IIx fibers.

ANALYSIS OF STATISTICS

Because this study was a case report, standard statistical techniques were not appropriate. With percentage change calculations and visual representations using protein blots and microscopic imaging, descriptive analysis was utilized to describe changes in the patient's measurements before and after the Comb-NMES intervention.

FINDINGS

Insulin and Glucose Levels During Fasting

There was a notable decrease (74.7%) in the fasting insulin levels (pre: There was a moderate drop (28.2%) in fasting glucose levels (pre: 117.00 mg/dL, post: 84.00 mg/dL) and a large decrease (74.7%) in fasting insulin levels (pre: 49.50 μIU/mL, post: 12.50 μIU/mL). 49.50 μIU/mL, post: 12.50 μIU/mL), and fasting glucose levels showed a moderate (28.2%) drop (pre: 117.00 mg/dL, post: 84.00 mg/dL).5.2. Profile of Fasting Lipids

Profile of Fasting Lipids

The lipid profiles were somewhat altered. For instance, there was an 8% increase in the fasting triglyceride levels (pre: 125.0 mg/dL, post: 135.0 mg/dL). There were minor alterations in the lipid profiles, with the LDL and HDL levels falling by 1.6% and 8.9%, respectively (before LDL: 191.0 mg/dL, post LDL: 188.0 mg/dL). For instance, there was an 8% increase in the fasting triglyceride levels (pre: 125.0 mg/dL, post: 135.0 mg/dL). Accordingly, the levels of HDL and LDL decreased by 8.9% and 1.6%, respectively (before HDL: 45 mg/dL, post HDL: 41 mg/dL; pre LDL: 191.0 mg/dL, post LDL: 188.0 mg/dL). There was a minor 2.8% increase in total cholesterol levels (pre: 247 mg/dL, post: 254 mg/dL).

Intracellular Signaling in Skeletal Muscle

The levels of AKT and pAKT_Ser473 dropped by 55% and 17%, respectively. Furthermore, there was a small decrease in AMPK and pAMPK_Thr172 (by 9% and 2.6%, respectively). Significant increases were observed in the levels of CaMKII and pCaMKII_Thr286 (76% and 159%, respectively). A 46.7% decrease in GLUT 4 expression was observed. Phosphorylated GS_Ser641 significantly dropped by 72%, whereas glycogen synthase rose by 42%. AKT and pAKT_Ser473 levels dropped (55% and 17%, respectively), while AS160 rose by 0.4%. Furthermore, there was a small decrease in AMPK and pAMPK_Thr172 (9% and 2.6%, respectively). The levels of CaMKII and pCaMKII_Thr286 rose considerably (76% and 159%, respectively). The expression of GLUT 4 decreased by 46.7%. Phosphorylated

GS_Ser641 significantly dropped by 72%, whereas glycogen synthase rose by 42%. While pAS160_Ser318 fell by 29%, AS160 rose by 0.4%.

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