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Effect of intensive neuromuscular electrical stimulation on chronic neck pain: A case report

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Abstract: Chronic neck pain is a relatively common problem that can interfere with daily activities and is often experienced following musculoskeletal injuries. To identify the impact of intensive neuromuscular electrical stimulation (INES) for reducing chronic neck pain in a 21-year-old female athlete, following a traumatic sports injury, which occurred two years earlier. A treatment package including three separate sessions of INES and exercise therapy were prescribed. Outcomes measurements were short form McGill pain questionnaire (SF-MPQ), visual analogue scale (VAS), and the neck disability index (NDI). Measurements were performed at baseline, following the intervention, and three months later. Following our intervention; VAS score decreased from 6/10 to 3/10, and 1/10 after three months; and NDI decreased from 54/100 to 18/100, and 10/100 after three months. A combination of INES and resistance training significantly reduced neck pain after three months in a female gymnast. Further research is required to determine the effectiveness of this combination of treatments in larger cohorts with more diffuse musculoskeletal conditions.

Keywords*:* Neck pain, functional electrical stimulation, rehabilitation

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Introduction

Pain is a common consequence of injury (1), and some individuals suffer from persistent pain and require therapeutic intervention even after relatively minor injuries (2). Amongst individuals who suffer from a musculoskeletal injury, moderate to severe pain lasting >6 months is fairly common. Enduring pain which lasts from months to years without complete recovery, is mostly caused by damage to various spinal structures around the neck and lower back which interfere with activities of daily living (3,4). Chronic pain may present intermittently or continuously, and may not be eased following routine treatment (5).

Currently, some treatments are used to reduce chronic neck pain including oral and topical analgesics, physical therapies, acupuncture, exercise therapy, manual therapy, psychosocial interventions (6), and transcutaneous electrical nerve stimulation (TENS) (7). Although there is lack of evidence for physical therapy and multidisciplinary rehabilitation in chronic case of neck pain. Intensive neuromuscular electrical stimulation (INMES) has a broad spectrum of applications from muscle spasm or atrophy, chronic pain (e.g. knee osteoarthritis) to neurorehabilitation (8,9). Scientific evidence to support the effective role of INMES on muscle pain reduction is lacking. Therefore, we hypothesize that NMES associated with exercise therapy will decrease chronic muscular pain and improve function. To our knowledge, there are no studies which report the effects of a multidisciplinary treatment approach for chronic neck pain in athletes.

Case story

A 21 year-old female gymnast visited the neurorehabilitation clinic reporting persistent pain in the neck and upper back. She was suffering from pains around her neck and bilateral upper trapezius muscles for the past two years. The pain had initiated following a traumatic injury to her neck during exercise. At the time of the accident, neck MRI and CT scans excluded damage to the spinal cord, bony vertebral column, or supporting ligaments. Physical examination and X-ray imaging did not reveal any serious injuries and therefore conservative treatments were adopted. She had received treatments including relative rest, immobilization of the soft collar, physiotherapy, and acupuncture to reduce pain, but no permanent improvement was achieved. She had been forced to cease her professional sports activities because of consistent neck pain. She had no history of other medical problems or sports injuries, nor was scheduled for further treatment.

Evaluation

Baseline characteristics were initially recorded including gender, age, weight, height and BMI. In our examination, the pain was mainly felt in end-range of neck extension, and she felt pain performing activities which combined flexion and extension of the neck. Some local trigger points were palpated in the upper trapezius muscles on both sides. There were no limitations in active and passive range of motions. The physical examination was done by an independent sport medicine physician, one day before and after the last session of treatment and three month after the end of treatment. The Short Form McGill Pain Questionnaire (SF-MPQ) visual analogue scale (VAS) was used for the assessment of intensity of pain (10). The patient was asked to place an X to indicate the level of pain that fits best with their current pain intensity, where 0 indicated no pain and 10 showed the worst level of pain. Patient reported pain during active neck extension and lateral flexion in both sides of the upper trapezius. The Neck Disability Index (NDI) is a 10-item questionnaire that measures a patient's self-reported neck pain-related disability.

The scale consists of daily living activities including pain intensity, personal care, lifting, sleep, driving, sex life, headache, concentration, reading, and work. Each question is measured on a scale from 0 (no disability) to 5(full disability). The numeric response for each item is summed for a score varying from 0 to 50 (11). We decided to provide a score out of 100%, particularly as a strategy to deal with questions left unanswered. The higher the NDI score, the greater the perceived disability due to neck pain. The validity and reliability of this scale has been reported previously (11).

Intervention

The intervention was carried out in a seated position as the participant was leaning forward against a table with hands under the forehead; the neck was placed in a relaxed position where they felt no pain. After cleaning the target area with an alcohol swab, the electrodes were placed within two cm of the bilateral upper trapezius muscles. We applied three sessions of INES using four 5×9 cm electrodes (RehaTrode, Hasomed, Germany). The duration of each session was 20 minutes followed by 48 hours of rest. The ES device (RehaMove2, HasoMed, Germany) was set at a frequency of 40 Hz, 400 micro-seconds pulse width (3,12), and the high intensity setting based on patient tolerance in order to obtain the required motor responses during each session. Following treatment, an exercise package including resistance exercises was offered to the patient, and she was instructed to continue them three times per week for a minimum of 12 weeks (13). The protocol contained isometric flexion exercises for the neck in a supine position and dynamic neck resistance exercise (13,14). Patients was asked to visit the clinic weekly to perform one therapy session under the supervision of the sport medicine specialist. A certified physiotherapist under the supervision of a neurorehabilitation and sports medicine specialist preformed all the assessments.

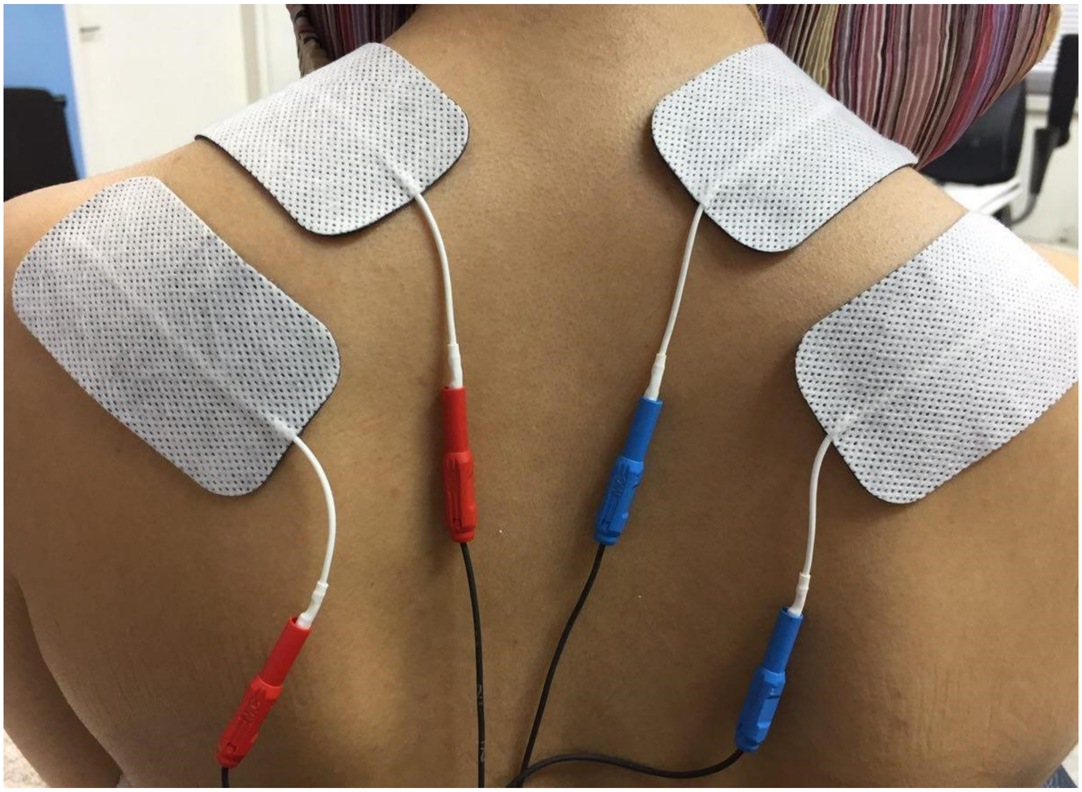

Figure 1. Location of electrodes on the bilateral upper trapezius muscles

Results

A comparison of data from baseline, immediately following treatment, and three months later showed improvements in pain level in our patient which was able to improve her daily activities and overall quality of life (see table 1).

Table 1. Pre- and post-test findings in our case study

Variable	Pre-intervention	Post-intervention	Follow-up (After three month)
VAS	6/10	3/10	1/10
NDI	54/100	18/100	8/100

Note: VAS: visual analogue scale, NDI: neck disability index, ADL: Barthel Index for Activities of Daily Living.

Discussion

Our case study improved chronic neck pain after three sessions of intensive neuromuscular electrical stimulation targeting the upper trapezius muscles, and 12 weeks of high load resistance exercise. Neck pain can influence motor control via numerous reflexes and central mechanisms. A reflex-mediated adaptation of motor unit discharges has been demonstrated in chronic neck pain (15). In addition, the upper trapezius has been shown to be more active during repetitive arm elevation for chronic neck pain (16). Although it has been suggested that retraining might need long-term application of NMES, the duration of treatment has not been directly correlated with more successful outcome (17). Moreover, NMES is provided at higher frequencies (20-50 Hz) to produce tetanic contractions; which can optimize force output and reduce fatigue in targeted muscles. Their anti-dromic transmission blocks both motor and sensory impulses resulting in less overall CNS activation (17). Stronger muscle contractions activate stretch receptors in muscles resulting in the release of opioids and stimulate the release of endorphins from the pituitary gland which reduces both the peripheral and central desensitization process (13). In addition, lower blood circulation has been shown in painful trapezoid muscles contributing to neck pain. This lower blood circulation is the main cause of chronic trapezius myalgia and nociceptive pain. Muscle contraction due to INES can increase muscle blood circulation (18), and may be another alternative for the significant improvements in our case study.

Our patient was instructed to perform long duration, high intensity resistance exercises for the neck based on evidence which supports its adaptive impact on muscle morphology and neuromuscular function (13). Several studies have shown that low strength of the neck muscles is more strongly associated with chronic neck pain (19), improving the strength of these muscles may have contributed to the positive outcomes in our patient. Increased levels of glutamate and beta-endorphin, and lower concentrations of cortisol have also been found in patients with chronic neck pain, In addition, substance P has been found in patients experiencing chronic painful in the trapezius muscles; exercise training has been shown to decrease levels of substance P, and increase beta-endorphin and cortisol (20). These adaptations may in some way have contributed to the decreased pain intensity and sensitivity in our patient (20). Moreover, resistance training can lead to increased sensitivity in muscle spindles, Golgi tendon organs, and joint proprioception (21).

To our knowledge, this is the case study which chronicles the impact of three sessions of INES and strength training on chronic neck pain in a female athlete. Future studies should establish a robust protocol for INES and identify the optimal number of therapy sessions. In addition, it is unclear whether INES may be effective for reducing pain in other musculoskeletal conditions. In conclusion, neck pain is very common and costly amongst athletes.

Conclusions

The present case report shows that a multidisciplinary approach consisting of INES therapy combined with resistance training can improve neck pain and function in a female athlete. Further studies are needed to ascertain the effects of intensive high frequency functional electrical stimulation on musculoskeletal conditions in a larger group of patients.

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References

1. Berben SAA, Schoonhoven L, Meijs THJM, Van Vugt AB, Van Grunsven PM. Prevalence and relief of pain in trauma patients in emergency medical services. Clinl J Pain 2011;27(7):587–92.
2. Au EHK, Holdgate A. Characteristics and outcomes of patients discharged home from the Emergency Department following trauma team activation. Injury 2010;41(5):465–9.
3. Hosseini L, Shariat A, Ghaffari MS, Honarpishe R, Cleland JA. The effect of exercise therapy, dry needling, and nonfunctional electrical stimulation on radicular pain: a case report. J Exerc Rehabil 2018;14(5):864.
4. Shariat A, TC Lam E, Kargarfard MK, Tamrin SBM, Danaee M. The application of a feasible exercise training program in the office setting. Work 2017;56(3):421-8.
5. Luomajoki H, Kool J, de Bruin ED, Airaksinen O, Surenkok O, Aytar A, et al. Comprehensive review of epidemiology, scope, and impact of spinal pain. BMC Musculoskel Disord 2007;136(4):2075–94.
6. Babatunde OO, Jordan JL, Van Der Windt DA, Hill JC, Foster NE, Protheroe J. Effective treatment options for musculoskeletal pain in primary care: A systematic overview of current evidence. PLoS One 2017;12(6):1–30.
7. Sayilir S. The short-term effects of TENS plus therapeutic ultrasound combinations in chronic neck pain. Complement Ther Clin Pract 2018;31:278–81.
8. Rosemffet MG, Schneeberger EE, Citera G, Sgobba ME, Laiz C, Schmulevich H, et al. Effects of functional electrostimulation on pain, muscular strength, and functional capacity in patients with osteoarthritis of the knee. J Clin Rheumatol 2004;10(5):246–9.
9. Jarosz R, Littlepage M, Creasey G, McKenna S. Functional electrical stimulation in spinal cord injury respiratory care. Topics Spinal Cord Injury Rehabil 2012;18(4):315–21.
10. Melzack R. The short-form McGill pain questionnaire. Pain 1987;30(2):191–7.
11. Vernon H, Mior S. The Neck Disability Index: A study of reliability and validity. J Manipul Physiol Therapeutics 1991;14(7):409–15.
12. Shariat A, Ansari NN, Shaw BS, Kordi R, Kargarfard M, Shaw I. Cycling training and functional electrical stimulation for post-stroke patients. Revista Brasileira de Medicina do Esporte 2018;24(4):300–2.
13. Ylinen J. Physical exercises and functional rehabilitation for the management of chronic neck pain. Eur Medicophysica 2007;43(1):119–32.
14. Chiu TTW, Hui-Chan CWY, Cheing G. A randomized clinical trial of TENS and exercise for patients with chronic neck pain. Clin Rehabil 2005;19(8):850–60.
15. Manresa JAB, Neziri AY, Curatolo M, Arendt-Nielsen L, Andersen OK. Reflex receptive fields are enlarged in patients with musculoskeletal low back and neck pain. Pain 2013;154(8):1318–24.

16. Falla D, Farina D. Neuromuscular adaptation in experimental and clinical neck pain. J Electromyogr Kinesiol 2008;18(2):255–61.
17. Doucet BM, Lam A, Griffin L. Neuromuscular electrical stimulation for skeletal muscle function. Yale J Biol Med 2012;85(2):201–15.
18. Boulton D, Taylor CE, Macefield VG, Green S. Contributions of central command and muscle feedback to sympathetic nerve activity in contracting human skeletal muscle. Front Physiol 2016;7:163.
19. Barton PM, Hayes KC. Neck flexor muscle strength, efficiency, and relaxation times in normal subjects and subjects with unilateral neck pain and headache. Arch Physical Med Rehabil 1996;77(7):680–7.
20. Karlsson L, Gerdle B, Ghafouri B, Bäckryd E, Olausson P, Ghafouri N, et al. Intramuscular pain modulatory substances before and after exercise in women with chronic neck pain. Eur J Pain 2015;19(8):1075–85.
21. Hutton RS, Atwater SW. Acute and chronic adaptations of muscle proprioceptors in response to increased use. Sports Med 1992;14(6):406–21.