

Application of feedback-controlled non-invasive neurostimulation for muscular complaints in weight training. An observational study

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Summary

Problems in the musculoskeletal system are a performance limiting factor in sport. In strength and weight training, pain in the shoulder area (omalgia) is particularly common. In a study it was possible to successfully treat shoulder pain in weightlifters in only a few treatment sessions using a feedback-controlled non-invasive neurostimulation device. A comparison to conservative treatment methods would seem to be a meaningful future study.

Training in performance-oriented sports frequently takes place in the border region of extreme physiological capacity. Although a number of desired outcomes of the targeted change or body form can be realised through these high expectations, many sportspeople also perceive these demands to be too excessive mentally and these demands are realised in the form of pain within the musculoskeletal system. Following a training program under this strain can lead to nociception meaning there is then a price to pay in terms of coordination, strength and stamina as a result of physiological antecedents. Even great conscious efforts by the sportsperson to compensate for these injuries only allow for moderate levels of pain relief.

This type of disturbance characterises and defines the daily routine of the athlete in the most diverse sports. Long term training plans and the associated goals are often not achievable as a result. For these reasons new methods and techniques are always being sought to help reduce the pain levels and therefore allow for continuous development during training. Many types of sport have specific injuries associated with them. For example; weight training, swimming and also martial arts are examples of sports where more shoulder injuries are prevalent. In weight training in particular, missed training sessions in preparation for competitions are very difficult to compensate for. Athletes in this discipline often suffer from persistent and treatment resistant shoulder injuries despite medical intervention. Therefore it was of interest to test the therapeutic effectiveness feedback-controlled non-invasive neurostimulation therapy on a group of weight lifters with shoulder injuries during their ongoing training.

Feedback-controlled non-invasive neurostimulation

Feedback-controlled non-invasive neurostimulation devices were originally developed in Russia have a history going back to the Russian SCENAR device. The nature of feedback-controlled non-invasive neurostimulation allows for a unique evidenced based application that optimises certain treatment parameters and achieves consistently good results across a broad range of conditions, both acute and chronic in nature. not only provides direct therapeutic effect, but also activates the

natural defences of the body^{1 2}. The effect is achieved through the stimulation of trigger points and acupuncture points on the skin surface.

Overall, feedback-controlled non-invasive neurostimulation is an effective, non-invasive, advanced form of electrotherapy and may be effective in treating acute and chronic pain. By stimulating the body's inherent self-healing mechanisms, its direct effect is several times stronger than that of other physiotherapeutic devices, with no undesirable side effects^{3 4 5 6 7 8}

The device delivers a damped, bi-phasic, sinusoidal impulse delivered through two fixed concentric electrodes, and adjusts its output in response to changes in skin resistance or impedance. This means the device is applied *without the need for conductive gels*, directly onto the patient's skin. This advancement in treatment has a significant impact on the way neurostimulation can be delivered and subsequently on the results that can be achieved in the clinical setting.

Every treatment is designed to optimise the main aspects of any neurostimulation treatment to ensure better and lasting results. Research has shown that the optimisation of various treatment parameters can significantly increase the effectiveness of neurostimulation across a broad range of painful conditions^{9 10 11}.

Treatments using electrical current in competitive sport or in physiotherapy are not new. Despite this fact, feedback-controlled non-invasive neurostimulation therapy cannot be compared to devices like transcutaneous electrical nerve stimulation (TENS) or myostimulators. The variability of the stimulation corresponding to changes in to changes in skin resistance or impedance does not allow an undesired habituation effect in the body. The organism is forced to react

¹ Gorodetskyi I G, Gorodnichenko A I, Tursin P S, Reshetnyak V K, Uskov, O N: Non-invasive interactive Neurostimulation in the post-operative recovery of patients with a trochanteric fracture of the femur. J Bone Joint Surg [Br]2007;89-B:1488-94.

² G. Gorodetskyi et al, The effects of non-invasive, interactive Neurostimulation on pain and oedema during post-surgical rehabilitation following internal fixation of unstable bi-malleolar ankle fractures, Presented as a poster by Dr James Dillard at the IASP 2008, Glasgow, Scotland. Accepted for publication Dec 2009, Journal of Foot and Ankle Surgery.

³ Lee KH, Chung JM, Willis WD. Inhibition of primate spinothalamic tract cells by TENS. J Neurosurg. 1985; 62: 276-287

⁴ Linda S. Chesterton, Nadine E. Foster, Christine C. Wright, G. David Baxter and Panos Barlas Effects of TENS frequency, intensity and stimulation site parameter manipulation on pressure pain thresholds in healthy human subjects Pain, Volume 106, Issues 1-2, November 2003, Pages 73-80

⁵ Garrison DW, Foreman RD: Effects of prolonged transcutaneous electrical nerve stimulation (TENS) and variation of stimulation variables on dorsal horn cell activity, Eur J Phys Med Rehabil 6:87-94, 1997

⁶ Reilly JP, Applied Bioelectricity: From Electrical Stimulation to Electropathology, 1998 Springer-Verlag NY. pg 130 and 233

⁷ Christie Q. Huang, Robert K. Shepherd Reduction in excitability of the auditory nerve following electrical stimulation at high stimulus rates: Varying Effects of electrode surface area Hearing Research 146 (2000) 57-71

⁸ Pyne-Geithman G, Clark J F, InterX elicits significantly greater physiological response than TENS: Lymphocyte metabolism and Cytokine production. Presented as a poster at IASP 2010, Montreal, Canada. Aug. 29th 2010.

⁹ Jan Magnus Bjordal, Mark I. Johnson, Anne Elisabeth Ljunggreen; Transcutaneous electrical nerve stimulation (TENS) can reduce postoperative analgesic consumption. A meta-analysis with assessment of optimal treatment parameters for postoperative pain. European Journal of Pain 7 (2003) 181-188

¹⁰ Melzack R: Prolonged relief of pain by brief, intense transcutaneous somatic stimulation. Pain. 1975;1: 357-373.

¹¹ Somers D, Clemente F R, TENS for the management of neuropathic pain: The effects of frequency and electrode position on prevention of allodynia in a rat model of CRPS type II, Phys Ther, Vol. 86, no.5, 2006: pg 698-709

continuously and our body is then forced to harmonise the discrepancies in its control and regulatory processes. From this perspective, a combination of the delivery of impulses from the device in connection with the mechanical movement of the device upon the skin is important.

Heine¹² concluded that through manipulation of connective tissue structures, a piezoelectric effect can be created. It therefore seems likely that the input of energy from impulses would also add extra effects over and above those which can be realised by the mechanical electrical yield alone, this has not been investigated to a great extent until now. This could lead to phenomena of reinforced electro-physiological processes and the activation of complex healing processes, despite the interpretation of the combination of both effects still appearing very speculative at present.

Investigation

Within the framework of a study, we wanted to test the extent to which treatment of shoulder injuries through weight training could be reduced by feedback-controlled non-invasive neurostimulation therapy. The pain experienced and the changes in this were assessed by a visual analogue scale (VAS) and evaluated. The treatments were conducted following the operating instructions of the device.

Methodology

9 weightlifters aged between 21 and 61 years old (median 36 ± 11.6 years) were assessed. All participants in the study suffered with medically diagnosed impingements of the shoulder and the accompanying complaints and performance deficits. The shoulder pains had been evident for an average of 14 Months \pm 24.4. During the therapy, none of the participants in the study were receiving any other therapeutic treatment. To evaluate the effects of the therapy, an observational study with a single group pre-post design was carried out. The evaluation of the pain experienced was carried out through the collection of pain results using the usual visual analogue scale (VAS). In doing this, the sensation of pain was rated on an 11 step scale which ranged from 0 for no pain and 10 for maximum bearable pain levels over the 72 hours prior to the therapy session as well as at the time of the interview. After completion of each treatment, another evaluation was made of the current level of pain using the VAS, then a follow up interview was carried out a week after the treatment.

Intervention

The treatments were conducted using the principles of feedback-controlled non-invasive neurostimulation therapy:

- Pain provocation
- Local Pain Treatment
- Treatment to zones of general self regulation.
- If the stimulation of the general zones does not evoke a recognisable response reaction pattern, then methods are employed that cause a more noticeable reaction.
- Renewed pain stimulus/assessment of pain reduction.

¹² Heine H. Textbook of Biological Medicine. 2nd Edition. Hippocrates, Stuttgart 1997

- In the case of no significant reduction in pain levels, then local zones or reciprocal zones are treated again or specialised applications are used directly on osseous structures (e.g. three minute long treatment of the AC joint employing a different attenuation and frequency modulation).

Results: rapid pain reduction

Upon evaluation of the various pain sensations, the study participants who achieved a “null” rating (0 VAS), i.e. pain free, were placed into the following treatment categories.

There were 19 participants in the first treatment. After this treatment, 5 of them were free of long term pain (26% of the total population). Following the second treatment, two of the remaining 14 participants were free from pain in the long term.

The most success was observed upon the third treatment session, where seven of 12 treated participants were pain free. There were only 5 candidates who took part in the last three treatments and only two participants in the final two treatments.

After six treatments, all 19 participants were able to train and go about their daily routine without pain (fig. 1). A pre-post comparison was carried out based on the first treatment. The first treatment was used for the comparison due to there being the largest number of candidates for comparison. During the first treatment, a significant ($p < 0.001$; t-Test for paired samples) reduction in the actual pain level from an average of 3.2 to 0.9 was observed (fig. 2). Based on the individual participants, 18 of the 19 participants demonstrated a reduced VAS value and therefore a reduction in their pain levels (fig. 3). In the case of one participant there was no change.

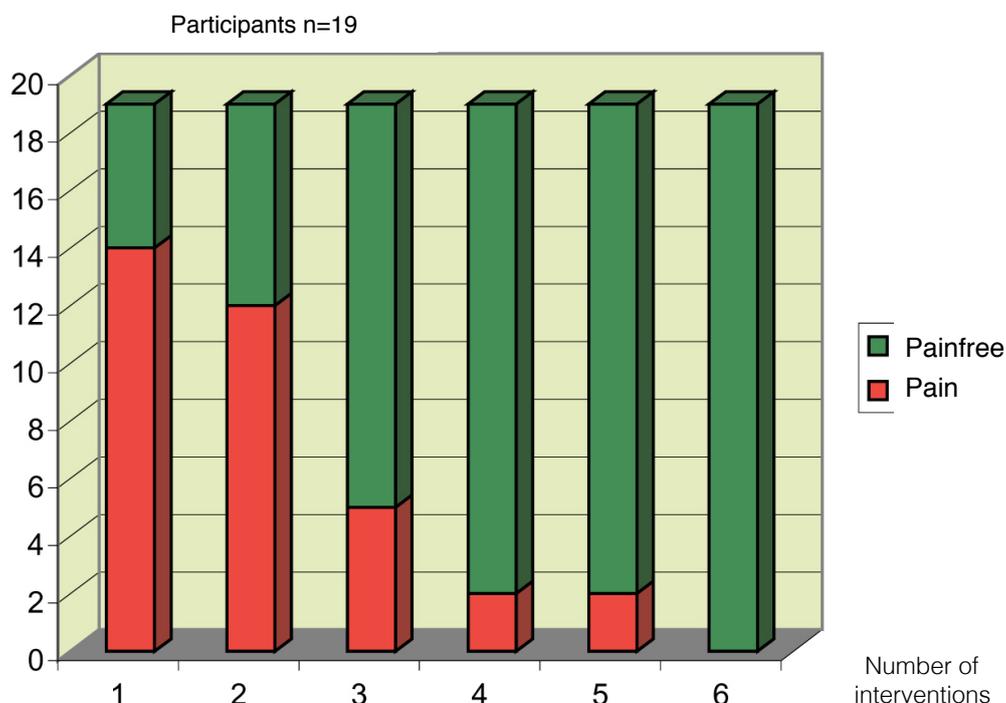


Fig.1: Proportion of pain-free subjects, based on the total population (n = 19) and the number of interventions

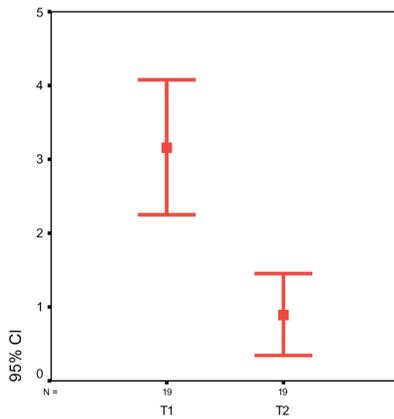


Fig.2: Pre-post comparison of group averages of VAS of the current pain with 95% confidence interval (n = 19)

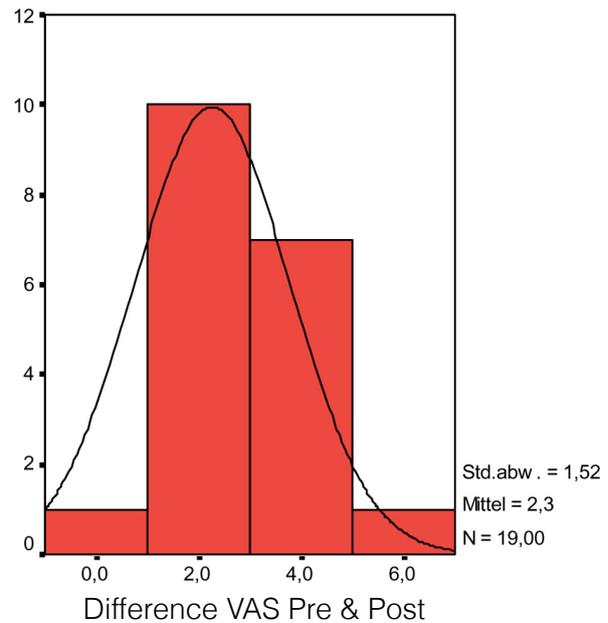


Fig.3: Histogram of the differences pre & post of VAS of current pain (values in positive territory mean a reduction in the complaints)

Discussion

Regarding the anamnesis of the participants with shoulder injuries, who had on average suffered from these for 14 months and had taken part in several medical and physiotherapy interventions prior to the study, the results shown in this observational study were far more positive than initially predicted.

All 19 participants were free from pain following the application of feedback-controlled non-invasive neurostimulation therapy. To increase the significance of these results, further investigations with a randomised placebo control design as well as further control parameters (e.g. standardised, sport specific performance tests) should be carried out. Also, a comparison of the effectiveness compared to traditional treatment methods appears to have relevance for further studies.

Case Reports

Case 1: A strength athlete (47 years) with several national successes suffered shoulder complaints since a skiing accident. As part of the medical assessment no structural damage was detected. Nevertheless, severe painful symptoms in the area of the left shoulder and left elbow were recorded during bench press that led to deficits in performance. Various medical and physiotherapeutic interventions brought no relief. Symptoms persisted over a period of three years.

Within six treatments of feedback-controlled non-invasive neurostimulation therapy the above complaints were completely eliminated. An examination five weeks later showed sustained relief, and despite high training intensity the athlete was still symptom free.

Therapy procedure:

- Local treatment on area of elbow
- Treatment to zone of general self regulation - spine
- Local treatment on area of Shoulder
- Treatment to zone of general self regulation - cervical

Case 2: A strength athlete (27 years) suffered for nine years painful complaints in the right shoulder. The painful and chronic symptoms were exacerbated under load. Various medical and physiotherapeutic interventions brought no relief. Within six treatments of feedback-controlled non-invasive neurostimulation therapy the above complaints were completely eliminated. An examination four weeks later showed sustained relief, with the athlete still symptom free.

Therapy procedure:

- Treatment of dorsal region of shoulder, with specific attention to acromioclavicular joint
- Treatment to zone of general self regulation - spine
- Local treatment to area of deltoid muscles
- Local treatment to area of infraspinatus muscle
- Treatment to zone of general self regulation - spine