

Evaluative and therapeutic applications of electroneurofeedback : pilot study

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Abstract

The impedance is a vector physical quantity that represents the opposition power of a dipole to alternating energetic current or a variable one. The skin is a non-conducting tissue and hardly it is gone through by electrical current. Therefore, comparing the local impedance to ideals parameters, it can get information about the hydroelectric and tissue aspects of the study area. Aim of the study is to assess the effectiveness of electroneurofeedback system both in the evaluation of the most dysfunctional area, founded inside the muscle affected by myofascial syndrome and in treatment of this one. The skin impedance parameters that resulted altered in the area of major dysfunction have been compared with two system already verified in literature: myoton (myometry) and pressure algometer, to underline the efficacy of this device in the evaluation. Results indicate that ENF is immediately effective in neck pain treatment linked with myofascial dysfunction

Key words: posture, balance, exoskeleton

Key words: Electro System neurofeedback, zespół powięziowy, impedancja skóry

Introduction

The impedance is a vector physical quantity that represents the opposition power of a dipole to alternating energetic current or a variable one. [1]

It depends on materials conductive properties and on the electrical current flow generated by the voltage in the sample.

The skin is a non-conducting tissue and hardly it is gone through by electrical current. Therefore, comparing the local impedance to ideals parameters, it can get information about the hydroelectric and tissue aspects of the study area.

In a somatic dysfunction condition, the skin presents its own impedance that represents autonomic expression of the dysfunction; these dysfunctional expressions can be located at areas far away from the symptomatic one. [2][3]

All those who deal with manual therapy need to have a system that allows to objectify the essential operator skill.

The Interactive neuromodulator (ENF- Electro Neuro Feedback) (Figure 1) is a specific electrotherapy characterized by biphasic sinusoidal damped variable signal similar to ECG in morphology, width short and not harmful action potentials, feedback that always generates different signals

depending on skin impedance, the absence of the adaptation process (gate control). [4] [5]



Figure .1 E.N.F. Electro Neuro Feedback

Once the skin impedance values have been read, it realizes an electrical pulses transmission, generated from a complex algorithm.

In human peripheral nerves, 45% of the cutaneous afferent nerves belong to a subtype of sensory nerves that are mechano-heat responsive C fibers.

Both C and A fibers respond to a variable range of stimuli such as physical (trauma, heat, cold, osmotic changes, distension or mechanical stimulation, ultraviolet light) as well as chemical agents (toxic agents, allergens, proteases, microbes). [10]

The electrical stimulation of A fibers, which derive from tactile receptors (skin), provokes by reflex, through the connections at the spinal level

in the gelatinous substance laminae of Rolando (II) with the neurons of the fibers A delta and C, reduction of the presynaptic pain signal transmission defined as inhibition or segmental [11].

Moreover in lamina II of the gelatinous substance there are interneurons that produce enkephalins that inhibit neurons of C fibers contained in this area. The fibers A delta are connected with these interneurons and therefore the stimulation of A delta fibers with electrical pulses can determine reduction of signal transmission along the fibers of the system C of the pain. So it can be stated that low frequency electrical stimulation will inhibit the circuit of pain at spinal level causing a decreasing of the symptomatology at peripheral level.

Bossy et al propose that the neural message travels from the point stimulation into the spinal cord and then up (and down) several spinal segments (i.e dermatomes) via interneuronal networks in laminae 2 and 3 of Rexed of the dorsal horn. The brain then perceives this as a sensation travelling into these dermatomes. [12]

So it is another confirmation of the theory already highlighted that explains how there is more than only an influence of the spinal cord on the pain patterns.

The regulation of all vital functions is realized because of the close connection and interaction of the nervous and the endocrine systems, the effects of which are mediated through a release from the neural cells of biologically active substances called neuromediators (NM) such as amines (acetylcholine), and amino-acids (glutamine), which are characteristic of the myelinated A- and B-neural fibres and neuropeptides (NPs) which is the most important group of NMs (endorphins, enkephalines, neurotensin, bradykinin). [5]

So sensitizing and activating mediators in the skin target receptors on primary afferent nerve fibers involved in itch and pain processing. The skin as a neuroimmunoendocrine organ and it is associated with the peripheral sensory nervous system (PNS), the autonomous nervous system (ANS), and the central nervous system (CNS). Various stressors activate the hypothalamus/hypophysis within the CNS which results in the release of neuromediators such as corticotropin-releasing hormone (CRH), melanocyte stimulating hormone (MSH). They may stimulate either the release of norepinephrine and cortisol from the adrenal glands or directly stimulate leukocytes in the blood system which modulate immune responses during inflammation and immunity. Norepinephrine and cortisol effect several

immune cells including lymphocytes, granulocytes, and macrophages which release cytokines, chemokines, and neuropeptides that modulate inflammatory responses in the skin.

So upon stimulation, sensory nerves release neuromediators that modulate cutaneous inflammation, pain, and pruritus. Skin inflammation affects activation of immune cells via cytokines, chemokines, prostaglandins, leukotrienes and MSH which may have a proinflammatory or antiinflammatory effect by upregulating or downregulating inflammatory mediators such as cytokines. [13]

Repeated stimuli or the continuous production of inflammatory molecules (E2 prostaglandins, bradykinin, 5HT, growth factors) define peripheral sensitization phenomenon with reduction of the threshold pain level and increase of action potentials transmitted to the spinal cord. Even at the level of the posterior horn this increase in electrical activity causes, through an increase of aminoacids and neuropeptides neurotransmitters, an increase of synaptic thanks to an action on ionic channels. This activity, which results in an increase of the pain perception and an enlargement painful area, is called central sensitization.[5]

Moreover Autonomous nerves, in the skin mainly sympathetic cholinergic and rarely parasympathetic cholinergic nerves innervate several cells in the skin, thereby maintaining skin homeostasis and regulating inflammation as well as host defence. [13]

So in this way is very important to consider the galvanic skin response (GRS). This one is controlled by the autonomic system and, in particular, by sympathetic component. So the GSR indicates the activation of the SNS and that the information, that you obtained from the analysis of GSR, are directly related to the activity of the sympathetic nervous system.

In fact the SNS is one of the key structures that regulate, at different levels, many of the regulator processes and the human body's control mechanisms such as the cutaneous thermoregulatory processes controlled through a dual mechanism: the sweat glands and the cutaneous vascular system.

The term Galvanic Skin Response (GSR) refers to changes in time of the electrical properties of the skin, that occur in response to different types of stimulation. These changes can be observed on different parts of the body and are due, almost exclusively, to ionic content changes of various levels, caused by sweating and therefore dependent on the activity of sweat glands.

Because the entire apparatus secretory of the exocrine glands is all innervated by the sympathetic autonomic nervous system so, thanks to the analysis of the changes of skin electrical properties over time, can be obtained direct information on the activity of this system. [14] The simultaneous activation of many components of the sympathetic nervous system strengthen the body's ability to sustain a ,vigorous physical activity through various mechanisms for example an increase of blood pressure and of blood flow ,an increase of the entire organism basal metabolism of cells and an increase of muscular power. [14][15][16].

We can so conclude that using the ENF we will obtain a regulation and improving both at spinal level and at peripheral level of pain. At spinal level there is a modulation of the pain sensation caused by the stimulation of ascending and descending pathways that will cause an inhibition of the pain pathways at central level. Instead at peripheral level ENF will produce a response by the neurovegetative nervous system both at circulatory level and at muscular level provoking an increase of blood flow a termoregulation an improving of metabolism and so causing a direct release of the muscular structure.

Aim of the study is to assess the effectiveness of electroneurofeedback system both in the evaluation of the most dysfunctional area, founded inside the muscle affected by myofascial syndrome and in treatment of this one.

The skin impedance parameters that resulted altered in the area of major dysfunction have been compared with two system already verified in literature: myoton (myometry) [6] [7] [8] and pressure algometer [9], to underline the efficacy of this device in the evaluation.

Materials and methods

The pilot study was conducted in accordance with the Helsinki Declaration of 2013 (vii revision). It was conducted at the Centre of Physical and Rehabilitation Medicine, „Gabriele d'Annunzio" University in Chieti-Italy.

We enrolled 40 subjects (18 females, 22 males) afflicted by neck pain with trapezius muscle myofascial syndrome diagnosed after clinical assessment were evaluated and treated.

Inclusion criteria were:

- neck pain;
- trapezius muscle myofascial syndrome;
- Aged between 20 and 50 years.

Exclusion criteria were:

- Diagnosis of radicular syndromes;
- cervical discs herniation;
- presence of metabolic disorders;
- concomitant pharmacological treatment.

A single session of 15 minutes is carried out consisting of 4 phases :

- manual scan to look for „painting" areas resulting from stimulation of skin surface through the ENF electrode;
- digital scan to identify the most dysfunctional area by assessing skin impedance ;
- rebalancing phase to prepare the tissue to the treatment and rebalance it with the ENF impulse;
- pre-set decontracting protocol on the area identified with previous stages, lasted five minutes, to treat the selected area .

Subjects have been evaluated at T0 (before the treatment), T1 (immediately subsequent to the treatment) and follow up to 30 days (T2) using manual and digital scan with ENF electrode to assess skin impedance and specific evaluative techniques characterized by an high degree of reliability :

- myoton to evaluate rheological muscular parameters;
- pressure algometer for the assessment of pain.

A week after the treatment the subjects have been interviewed by phone call to evaluate the subjective pain level using NRS scale.

Results

The evaluation of rheological muscular values underlined:

it was observed that the muscular tone, at T0 had a medium value of 15.177 Hz and at T1 a medium value of 14.268 Hz with a medium reduction of muscular tension of 3.26 % ($p < 0.05$);(figure 2).

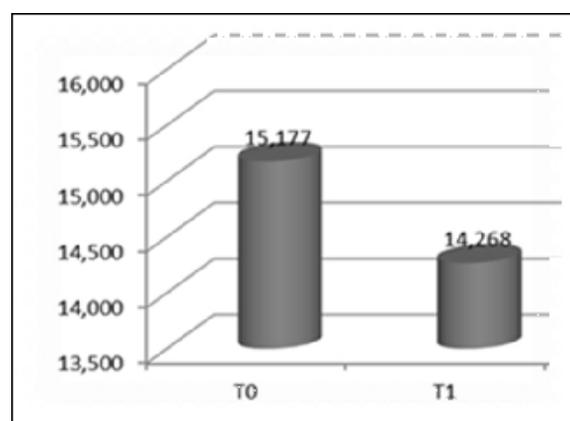


Figure 2. Muscular tone analysed at T0 and T1

It was observed that the elasticity, at T0 had a medium value of 1.080 and at T1 a medium value of 1.063 with a medium increase of 1.53% ($P < 0.05$);

It was observed that the stiffness, at T0 had a medium value of 277.375 N/m and at T1 a medium value of 262.850 N/m with a medium reduction of 5.53% ($P < 0.05$). (fig.3).

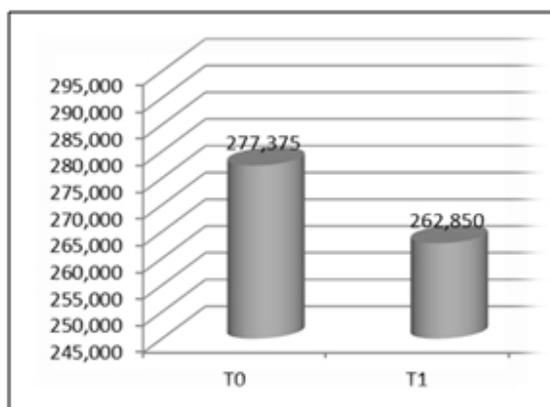


Figure 3. Stiffness analysed at T0 and T1.

Regarding the assessment with Fisher algometer, it can be observed at T0 a medium value of 5.925 and at T1 a medium value of 7.875 and the local pressure pain limit rises of 32.91% at T1 ($P < 0.05$). (fig.4)

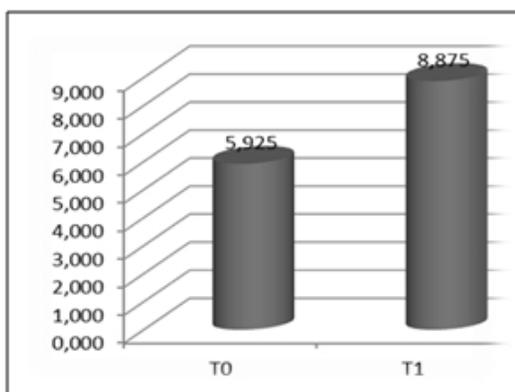


Figure 4. Pressure Algometer parameters analysed at T0, and T1

The level of skin impedance results decreased with a reduction of "painting" areas.

At telephone interview, conducted after a week, 55% of the subjects reported an improvement in pain symptoms of NRS scale with a medium value of 4 (T0: 7; T1: 3);

the 25% of the subjects reported an exacerbation of pain in the days following the treatment with spontaneous resolution within 24/48 hours; the 20% of the respondents did not indicate any change in the space of 7 days following the treatment.

At follow-up after 30 days from the treatment, the results are :

-stabilization with an increase of muscular elasticity compared to T1, see graphic below; (figure 5)

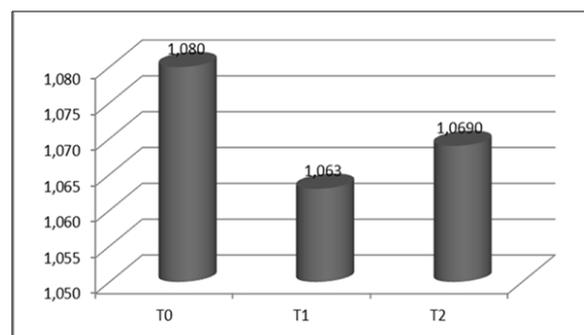


Figure 5. Elasticity analysed at T0, T1 and T2. At T2 it can be observed how the elasticity presents an increase, but it does not achieve the results of T0.

-Muscular tone increase of 3.28 % and stiffness increase of 5.41% compared to the first assessment ($p < 0.05$) see figure 6 and 7 below;

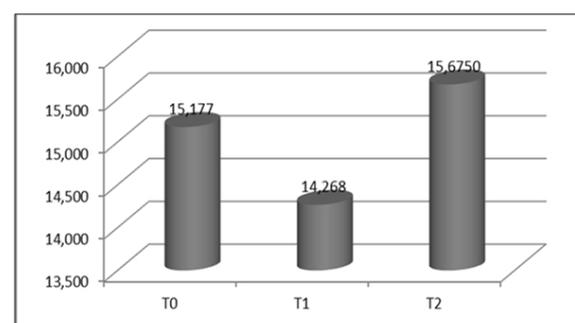


Figure 6 Muscular tone analysed at T0, T1 and T2. At T2 it can be observed how the tone presents an increase

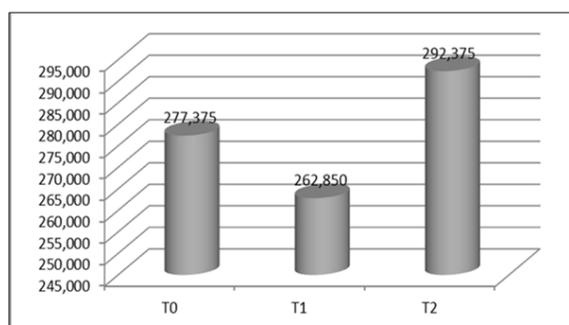


Figure 7. Stiffness analysed at T0, T1 and T2. At T2 it can be observed how the stiffness presents an increase.

-decrease of 22.68% of pressure pain limit compared to T1 ($p < 0.05$) see graphic 8 below. (fig 8)

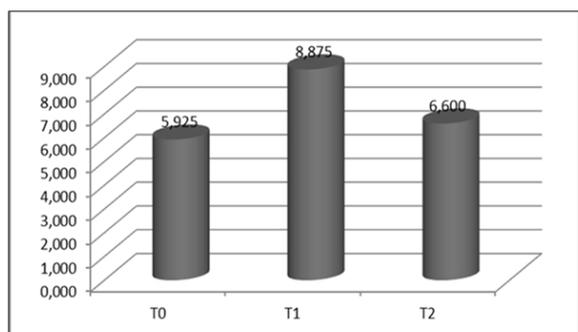


Figure 8. Pressure Algometer parameters analysed at T0, T1 and T2. At T2 it can be observed how the parameters presents an increase.

It can be highlighted that the elasticity at T2 presents an improvement of moderate impact of the values do not achieve the ones of T0, the same trend of data is evident in the parameters algometers at T2. It can be hypothesized that the maintenance of good results on muscular elasticity at T2 cause the stabilization of the pain situation in the subjects analysed, producing so an improving in sintomatology at T1 that continue also if with low values at T2.

Discussion

Finally, the described results indicate that ENF is immediately effective in neck pain treatment linked with myofascial dysfunction of trapezius muscle in the short term; in fact, in the space of a single session it was found a significant improvement over the studied sample about the pain and muscular rheological parameters ; moreover the improvement results significant in the 55% of subjects at one week after treatment. At follow-up after 30 days (T2) there was a survey substantially similar to that found at T0, both in rheological parameters tissue and in the pressure pain limit;

This phenomenon can be traced to the fact that a single therapeutic session was administered.

Therefore it was found that 10 of 12 patients, among those who reported an exacerbation of symptoms after a week, had better values than the initial ones about muscular tone and Stiffness.

In conclusion, despite not emerge data which can give clear information about the long-term effects on the entire sample, at T2 it was observed a good tissue response in patients who had shown an exacerbation of pain within the first week after treatment.

Moreover we must underline that the data obtained are referred to a single treatment and may

have been altered by other factors over the previous 30 days of follow up.

This study is to be located within a valuation approach of preliminary type in order to lay the groundwork for subsequent, more specific studies about the effects and effectiveness of treatment with Electro Neuro Feedback.

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