NEUROLOGICAL CHANGES FOLLOWING APPLICATION OF TRIGENICS SENSORIMOTOR TREATMENT PROTOCOLS

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Summary Abstract:

This paper represents a pilot study into the neurological effects of the Trigenics treatment system using the Trigenics Myoneural Strengthening Procedure (TS). Multiple measurements of neurological function were conducted on the soleus, as the primary mover and the tibialis anterior as it's antagonist. The results were as follows:

- ***Increased muscle contractile power by way of increased number of motor units recruited and activated by way of increased Hmax / Mmax ratio value.***
- ***Significant increase in maximal voluntary contraction force (MVC) and peak contraction force (PT) of the main mover for significant strength increase.***
- ***Increased speed of movement by way of decreased contraction time (CT)***
- ***Less electrical activity needed to maintain isometric contraction force. This means that muscle tone(gamma bias) for structural support is maintained more efficiently and movement will also occur more efficiently and with less stress.***
- ***Possible reduction of injury risk by way of reduction of pre-synaptic inhibition (PSI)***

Introduction

The present study was designed to investigate the neurological effect of using the Trigenics sensorimotor treatment system. A case of achilles tendonitis was used with Trigenics applied to the affected tendon and the soleus muscle. In a recent pilot study using 40 sugjects, it was found that application of the Trigenics myoneural stengthening procedure (TS) to inhibited-weak muscles measurably increased strength from 20-70% (mean average 37%). This study was also designed to investigate how this might occur.

Trigenics is a neuromanual sensorimotor assessment and treatment system that uses and an interactive multimodal approach. Trigenics is distinctly different than other manual treatments in that it is primarily based upon a neurological rather than mechanical model of treatment. Trigenics myoneural procedures involve the synergistic, simultaneous application of 3 treatment techniques/modalities to achieve a ***summative neurological effec***t.
These are:
1) Resisted Exercise Neurology via proprioceptive overload.
2) Soft-tissue Mechanoreceptor Stimulation.
3) Concentrative Biofeedback Respiration

Its main mode of action works on the basis of integrating neurological convergence projection and amplitude summation from both segmental (PNS) and suprasegmental (CNS) pathways. The multimodal stimulation approach utilized in Trigenics is consistent with the principles of neuroplasticity and enhanced corticoneural reorganization of the somatosensory and sensorimotor systems.

The synergistic application has demonstrated that it can instantaneously relax, strengthens and/or lengthen muscles, as well as reduces inflammation and pain. It is expected that restoration of sensorimotor afferentation to the affected area will enable proper joint neurokinetics with the effect of associated pain reduction. It is known that restoring the normal length- tension relationship will affect EMG- and reflex patterns.

Surface electromyography (EMG) has a long tradition, and broad applications, for measuring muscular activity (Hagg 1992). In studies of occupational musculoskeletal disorders, EMG has been used to obtain quantitative measures of physical exposure. EMG reflects the internal load and is thus dependent on both the external load, implied by the task, and individual factors.

The surface electromyogram (EMG) provided an enticing way to examine the role of the CNS. In this study the main reason using the EMG was investigate the agonist-antagonist relationship during isometric contraction in low intensity level. The mean frequency (MF) of the power spectrum presenting the changes in: (1) muscle fiber-conduction velocity (Stulen and De Luca 1981) and (2) synchronization of the MU firing (Bigland-Ritchie et al 1981). A popular opinion is that MF shifts are caused by a decrease in the membrane conduction velocity occuring during the fatiguing process due to local metabolic changes and ion shifts in the muscles (Brody et al. 1991). At or below 30% MVC, when blood flow is likely maintained, MF shifts are primarily due to neural changes (Löscher et al. 1994).

The H-reflex technique was used to evaluate the motoneuron exitability of triceps surae muscles. The soleus H-reflex has been shown to be a monosynaptic reflex elicted by electrial stimulation of Ia afferents in the posterior tibial nerve (Magladery and McDougal 1950). The size of the reflex is thus a measure of the central gain of the monosynaptic stretch reflex and it is determined by:

1. The transmission across the synapses of the Ia afferents and
2. The exitability of the motoneuronal pool.

Changes in the size of the reflex during various voluntary tasks express the ***short-term*** changes in these two parameters. ***In particular, we have measured the maximal reflex electromyographic (EMG) response (H-max) and the maximal direct EMG response (M-max) to determine the ratio between the two (H/M-response), since this is considered a suitable value for illustrating, within a pool, the efficacy of type Ia-alphamotoneuron synapses*** (Schieppati 1987).

MATERIALS AND METHODS

Subject

25 year old female elite sprint runner height 168 cm; weight 58 kg. Achilles tendonitis was diagnosed 1 month prior to her original presentation.

Protocol

Before treatment the active plantarflexion and dorsiflexion with straight leg was measured using standard goniometer. After that the subjects were seated in a specially designed dynamometric chair with the involved leg flexed to 90° at the knee angle. The foot was strapped to an aluminum footplate and the ankle was dorsiflexed to 20°.

A strain-gauge transducer connected with the footplate sensed the torque acting on the footplate. The plantarflexors strength (maximum voluntary contraction force MVC) was measured using the dynamometer connected with footplate. After another break, the H-reflex (Hmax) and maximum M-wave (Mmax) were elicited. After that the subject continued with the sustained isometric contractions 20% of MVC with 60 sec to determinate EMG activity. After inital mesurments recording, the Trigenics strengthening treatment protocol was carried out within 15 min. Same measuring protocol were repeated after Trigenics treatment.

To determine the H- reflex and M-wave the posterior tibial nerve was stimulated through a pair of surface carbon-rubber electrodes by square wave pulses of 1-ms duration. The cathode was placed over the tibial nerve in the popliteal fossa and the anode was placed under the posterior-medial side of the thigh. The evoked compound action potential (M-max) and H-reflex (H-max) of the soleus muscle was recorded using bipolar electromyography (EMG) electrodes. The following static contraction EMG activities were recorded from soleus muscle as a main mover and from tibialis anterior as antagonist muscle during voluntary and reflex contractions using bipolar Beckman miniature skin electrodes. The skin was dry shaved and then cleaned with alcohol. A reference electrode was placed over the medial condyle of the tibia. The EMG signals were amplified and displayed with Medicor MG-440 preamplifiers with frequency band ranging 1 Hz-1 kHz.

The output signals from strain-gauge transducer and EMG preamplifiers were digitized on-line (sampling frequency 1 kHz) by analogue-to-digital converter installed in personal computer. The digitized signals were stored on a hard disk for further analysis.

RESULTS

The main results are presented in the Table 1.

	Before Trigenics	After Trigenics
Plantar flexion (º)	68	77
Dorsal flexion (º)	10	12
MVC (kg)	104	111
H-max (mV)	1,7	2,3
M-max (mV)	6,2	5,4
H/M (m/V)	0,27	0,43
PT (N)	175	183
CT (s)	0.083	0,075
IEMG-soleus	0,0125	0,0066
IEMG-tbialis anterior	0,0026	0,0018
MF-soleus (Hz)	95,2	87,3
MF-tibialis anterior (Hz)	72,3	58,4

Table 1

Discussion

To minimize the pain 2 Trigenics treatments were given before the experimental session. After 5 days and 2 prior Trigenics treatments, the subject had no pain and she was ready to participate in the experiment.

As seen in the chart, the results of this study showed ***a significant increase in maximal voluntary contraction force*** **(MVC)** ***and electrically eveoked contraction peak force*** **(PT)** of plantarflexor muscles after the Trigenics treatment. The increase in MVC may involve processes associated with ***central command*** of contraction (Bigland-Richie et al. 1986) as well as ***peripheral processes*** of intramuscular electrical and mechanical activity (Brody et al. 1991). The ability to generate force for **strength increase** can also be related to neural factors (muscle activation) associated with excitation, recruitment and firing rate of motor unit. The increase of PT after Trigenics treatment, showing the changes on an intramuscular level, bearing in mind that a direct relationship exists between the number of active cross bridges and the force output as well as the muscle active stiffness (Metzger and Moss 1990). Also ***decrease of contraction time*** **(CT)** ***after Trigenics*** treatment showing the improvement of the intramuscular processes, specifically indicating more rapid calcium release from the sarcoplasmic reticulum.

Synchronization of MUs has been reported by several authors (Bigland-Ritchie et al 1981), has been shown to generate an increase in spectral components in the low frequency range of the EMG power spectrum (Hagg 1992). A tendency towards synchronization reflects a common presynaptic input to α-motoneurons (Farmer et al. 1997). After the Trigenics treatment the average MF of plantarflexors and dorsiflexors shifted to lower value representing increased synchronisation of MUs or decreased muscle fiber-conduction velocity. Average IEMG of plantarflexors and dorsiflexors also shifted to lower value after the Trigenics treatment.

The increase in EMG amplitude during sustained submaximal contractions **(IEMG)** has been explained by: (1) facilitated motor-unit recruitment (Moritani et al. 1986), coupled with an increase in their average firing frequency in order to maintain the constant force reguested (Maton and Gamet 1989) and (2) synchronization of motor-unit (MU) firing (Krogh-Lund and Jorgensen 1993). After Trigenics, it seems that less MU recruitment is needed to maintain the same force level. Also the antagonist activity is decreased, which means less presynaptic inhibition to the plantarflexor (target) muscle. ***In the present study the EMG parameters showed that, after Trigenics treatment, less electrical activity is needed for a muscle to maintain the same level of isometric contraction force. This means that muscle "tone" for structural support is maintained more efficiently and movement will also occur more efficiently with less stress.***

Electrical stimulation of the posterior tibial nerve in the popliteal fossa at various intensities evokes two electromyography responses in the soleus muscle: the M and the H wave. Whereas the M wave is due to direct activation of the axons of the soleus α-motoneuron pool, the H wave is the reflex discharge of the same pool in response to the orthodromic afferent volley traveling in the large diameter Ia fibers originating in the muscle spindles. The maximal H-reflex **(H_{max})** is elicited by submaximal nerve stimulation and is mainly due to the activation of the slow-twitch motor units (Calancie and Bawa 1990). The maximal M wave **(M_{max})** is elicited by supramaximal nerve stimulation and is the electrical counterpart of the activation of all motor units of the pool, including the fast-twitch units.

The **H_{max}-to M_{max} ratio** is considered a suitable index for illustrating the level of reflex excitability of the motor pool, which in turn is dependent on the facilitation of the transmission between the Ia fibers an the α-motoneuron (Schieppati 1987). The H_{max}/M_{max} increases after endurance type training (Pérote et al 1991), indicating an association between endurance and the capacity to recruit a large proportion of the whole motor pool in response to the electrically elicited Ia afferent volley.

Our result shows that the efficacy of the reflex transmission between Ia spindle afferent input and soleus α-MN, as witnessed by the H_{max}/M_{max} was increased after Trigenics treatment***. This, in turn, shows an increased number of MNs excited and activated following Trigenics by way of an electrically evoked Ia afferent volley***. The processes of altering afferent input and efferent output have been coined "***resafferentation"*** and ***resefferentation*** by the originator of the Trigenics treatment system, Dr. Allan Oolo Austin. (Oolo Austin, Trigenics Theory, 2004).

His concept is that a relative state of "dysafferentation' (Seaman/Winterstein, JMPT, 2004) develops in mechanoreceptors embedded in tissues which have become damaged or stressed and that these mechanoreceptors require "re-setting" though multi-pathway stimulation. (Oolo Austin hypothesizes that this is what occurs with Trigenics multimodal approach and draws analogy to the "resetting" of a computer when it malfunctions by way of "freezing".) In terms of performance augmentation for athletes, this would indicate that Trigenics treatments applied immediately prior to participation to specific muscles used in different sports, would increase performance and outcome.

Due to direct synaptic connection of Ia afferents and alpha motoneurons it has been tempting for researchers to assume that the H-reflex represents faithfully the excitability of the motoneuron pool under study. However, the synaptic connection between Ia afferents and alphamotoneurons is itself subject to modification. It is sensitive to mechanisms that cause changes in the ***presynaptic inhibition*** **(PSI)** of Ia afferent

transmission and that directly affect neurotransmitter release at the Ia/alpha-motoneuron synapse (Brooke et al. 1997). The primary reason for this is the effect of presynaptic inhibition. PSI is mediated by the action of inhibitory interneuron acting on the Ia afferent terminals, leading to a reduction in neurotransmitter release and a concomitant reduction in motoneuron depolarization induced by Ia activity. There is evidence that PSI could selectively alter transmission in a monosynaptic reflex pathway, and it has recently been demonstrated that this mechanism is selective enough to affect different collaterals from the same muscle spindle afferent (Rudomin et al. 1998). Many spinal mechanisms will come into play secondarily, particularly through changes in reciprocal inhibition and the many reflex effects evoked by the increasingly widespread contractions. In the cse of this study, the reduction in H-reflex excitability as found before Trigenics treatment in our study, may also represent a beneficial adaptation to ***avoid further injury*** of the Achilles tendon, possibly reflecting an increase in presynaptic inhibition of Ia afferents as a result of reciprocal inhibition mechanisms associated with co contraction of opposing muscle groups such as the tibialis and soleus muscles.

Based on this study, the Trigenics treatment system may also have effect of reducing the PSI to decrease risk of injury in the elite athlete.

Although the results of this pilot study are very promising, it must be noted that it was done with one subject only and that the results must be conclusively validated by way of further scientific research. . One of the most challenging aspects of providing optimum rehabilitative care to the clinician is their understanding the effect on proprioceptively mediated sensorimotor control after joint or muscle injury. As complex as the proper management of athletic-related or personal injuries can be, the neuromanual Trigenics sensorimotor treatment system appears to provide advanced, leading edge methodology for accelerated resolution and injury prevention.

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