ORIGINAL RESEARCH PAPER

INFLUENCE OF EXCHANGED NEUROMUSCULAR REGULATION OF *M.GASTROCNEMIUS* ON THIS MUSCLE TONE

Normunds Vārpa[1], Alvis Paeglītis[1], Zinta Galeja[1], Mati Paasuke[2], Jaan Ereline[2], Helena Gapeyeva[2], Tatjana Kums[2]

[1]Latvian Academy of Sport Education
Address: 333 Brivibas Street, Riga, LV – 1006, Latvia
Phone: +37126766214
E-mail: normunds.varpa@lspa.lv
[2]University of Tartu
Address: 4 Ujula Street, Room 202, 51008 Tartu, Estonia
Phone: + 37 27 376 286
E-mail: Mati.Paasuke@ut.ee

Abstract

On last year's more popular become muscle testing method of applied kinesiology (AK). There is question about what the tester determines with this muscle testing method – maximum voluntary contraction (MVC), force or myothatical reflex? On science this method is called subjective method. Therefore it is necessary to explain this term "week-tested muscle" and record changes in the body with objective methods. One of the recent articles show that it's significant changes on muscle local blood flow in muscle with normal neuromuscular regulation and exchanged neuromuscular regulation or normal and week-tested muscle. Subcortical level of central nervous system (CNS) coordinates all these systems (muscle local blood flow, motor pattern of active muscle or muscle tone). On literature are articles about normal and exchanged neuromuscular regulation equally about muscle tone, but there is just few interdisciplinary articles. The aim of the study is to compare differences of muscle tone with normal contraction motor pattern and in weak-tested muscle condition on every controlled position. In this experiment participated young healthy women in age 20 – 25. We analyzed myotonometry parameter – frequency (Hz) in 18 gastrocnemius muscles with normal contraction motor pattern and in weak-tested condition obtained irritating the greater omentum in pyloric part of stomach. For tonometry we used Myometer Myoton-3 (Muomeetria Ltd, Estonia). To get results we putted myotonometer on the belly of medial muscle gastrocnemius. Muscles tone was registrated in rest

p-ISSN: 1691-7669/e-ISSN: 1691-9912/ISO 3297

DOI: 10.1515/ljss-2016-0016

position, during isometric contraction 60 degree flexion of the knee, then during isometric contraction with 5% of MVC, and then again in rest position for both condition of m.gastrocnemius motor pattern. Results. Analyzing obtained results we didn't found statistically significant changes in muscle tone of every position in both conditions of m.gastrocnemius motor pattern what can be connected with changes of the muscles local blood flow.

Key words: *Normal and weak-tested muscle, muscle tone*

Introduction

From theory of applied kynesiology (AK) (Walther, 2000; Frost, 2002; Rosner, Cuthbert, 2012) it is known that different external or internal influences to the men`s body could exchange neuromuscular regulation on the level of organization of motor patterns and observed muscle could become weak-tested or become hypertonic.

From literature it is also known that metabolic activity of muscle cells during static voluntary contraction even in one separate muscle differs. If oxygen consumption rate differs between muscle`s motor units, then blood flow through capillaries supplying muscle cells must be regulated according to their metabolic activity (Paeglitis, Kukulis, Eglitis & Galeja, 2014). In the literature from 1970th is described experimentally proved concept of muscle local blood flow redistribution to capillaries feeding active muscle fibers (Paeglitis, 1986; Skards & Paeglitis, 1982; Skards & Paeglitis, 1985; Paeglitis, Kukulis, Eglitis, & Galeja, 2014). These research results showed that parallel with somatic nervous system, which regulates recrutation of muscle motor units, the vegetative nervous system regulates local blood flow redistribution through capillaries feeding active muscle fibers. Incoherent action of these two neural systems leads to inadequate energy supply for active motor units.

Coordination of these two systems takes place in the same regulatory level where motor pattern of active muscle is organised (Solms &Turnball, 2002). These coordination problems were observed in experiment where dynamics of blood flow during static voluntary contraction of leg muscles in two conditions were compared – normal muscles motor pattern organization and in situation when controlled muscles were weak- tested (Gavrona, et al., 2015).

Muscle tone is the normal state of balanced tension in the tissues of the muscle. Coordination of the system takes place in sub cortical level where also motor pattern of active muscle is organized (Solms & Turnball, 2002). If there is motor pattern coordination problems that mean there is

changed muscle local blood flow then this process can be related with changes in muscle tone (Fig.1).

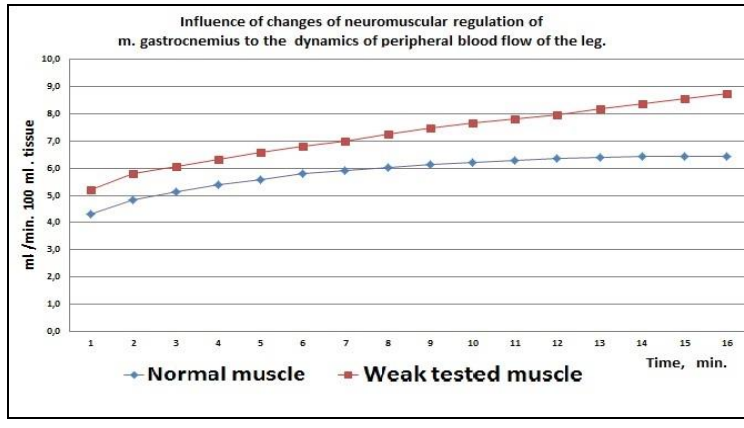

Figure 1. Influence of changes of neuromuscular regulation of *m.gastrocnemius* to the dynamics of peripheral blood flow of the leg *(Gavrona, et al., 2015)*

From neurophysiology theory it is known if muscle contraction is in tonic condition there will don't be myothatical reflex. When muscle is tested with AK method, muscle get impulse from CNS cortical level, but after approximately 3 seconds must dominate impulse from CNS subcortical level. If muscle still "works" in cortical level there will don't be or will be delayed myothatical reflex. In AK theory it calls "Weak – tested" muscle (Paeglitis & Veseta 2005).

The aim of the study is to compare differences of muscle tone with normal contraction motor pattern and in weak-tested muscle condition on every controlled position.

Material and methods

In this experiment participated young healthy women in age 20 – 25. We analyzed myotonometry parameter – frequency (Hz) in 18 gastrocnemius muscles with normal contraction motor pattern and in weak-tested condition obtained irritating the greater omentum in pyloric part of stomach, because from AK literature it is known that the stomach is the relation with *m.gastrocnemius* (Ramšak & Gerz, 2005). To test condition of *m.gastrocnemius* person was lying on stomach, one leg 60 degree of knee flexion. Subject makes isometric contraction of knee flexion while tester makes provocation (3 seconds knee extension with the same force) (Walther, 2000; Frost, 2002; Rosner & Cuthbert, 2012). If muscle

contraction is in tonic condition there will don't be myothatical reflex (Paeglitis & Veseta 2005) and AK theory calls it "weak – tested muscle". Experiment was continued for both condition (normal contraction motor pattern and in weak-tested muscle) of *m.gastrocnemius*.

To get tone results we used Myometer Myoton-3 (Muomeetria Ltd, Estonia). The working principle of device is based on dosed impact on muscle belly, after which a muscle as viscous – elastic structure reply with damped oscillation. The muscle elasticity is the ability of the muscle to restore its initial shape after contraction; it is characterized by logarithmic decrement of oscillations amplitude damping. Muscle with high elasticity has lower logarithmic decrement value. Stiffness of muscle characterized the ability of tissue to restore its shape after removing of external force acting on muscle. Myoton 3 has mass of testing end 18 g and it induces oscillation of muscle tissue by a mechanical impact with minimal force (up to 0,4N). The diameter of Myoton 3 testing end was 3mm and stroke time of testing end of device during all measurements was 15 ms (Gapeyeva, et. al., 2012). The area for measurements (on the belly of medial muscle *gastrocnemius*) was identified by manual palpation at muscle contraction. The testing end of myotonometer was placed on previously palpated muscle belly. Points for measurement has been marked by marker symmetrically for muscles of right and left body side. Registering tone characteristics of the observable person was lying on stomach. Muscles tone was registrated in rest position (BEFORE 1 and 2), during isometric contraction in 60 degree flexion of the knee (POSITION 1and 3), then during isometric contraction with 5% of MVC (POSITION 2 and 4), and then again in rest position (AFTER 1 and 2) for both condition of *m.gastrocnemius* motor pattern.

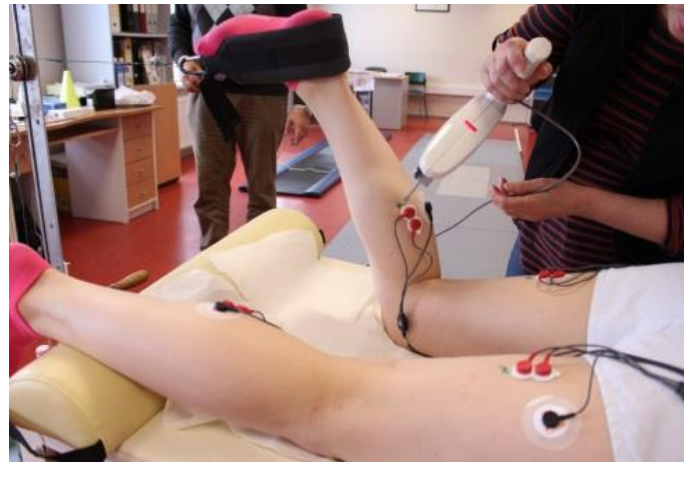

Figure 2. Test position 2 and 4

Results

For comparing differences of muscle tone characteristics between two muscle conditions in every controlled position we transposed obtained results in pairs – during normal and during weak-tested conditions accordingly with normal local blood flow regulation and with limited local blood flow.

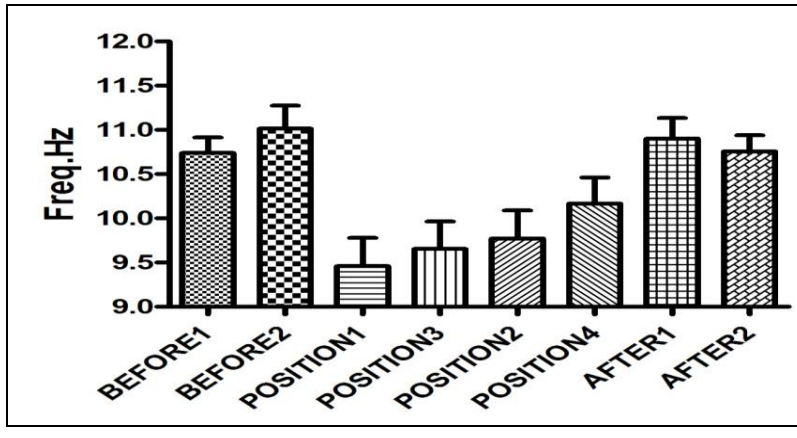

Fig.3. Frequency of muscle tone of *m. Gastrocnemius* in analyzed positions with during normal and weak-tested condition (with and without normal redistribution of local muscles blood flow)

Analyzing obtained results we didn't found statistically significant changes in muscle tone of every position in both conditions of *m.gastrocnemius* motor pattern.

Discussion

From literature it is known that muscle elasticity is the ability of the muscle to restore its initial shape after contraction, it is characterized by logarithmic decrement of oscillations amplitude damping. Muscle with high elasticity has lower logarithmic decrement value. Stiffness of muscle characterized the ability of tissue to restore its shape after removing of external force acting on muscle (Gapeyeva, et.al., 2012). Myotonometer dumping results represents all tissues elasticity. It means, tone includes stiffness results of muscles, blood vessels, etc. This could be point why there are not significant changes on muscle tone on week-tested muscle *gastrocnemius*.

From literature it is known that muscle contraction control could be conscious or unconscious – automatically performed (Solms, Turnbull 2002). From neurophysiology there is information that motor control mainly

is realized involving subcortical levels of CNS – it is unconscious (Shumway-Cook, 1995). In this motor pattern organizing level muscles realize contraction with normal neuromuscular regulation and normal local blood flow redistribution. If muscles contraction control could not be realized in subcortical level of CNS the active muscle shows weak-tested symptoms. If there is exchange neuromuscular regulation, but muscles tractive force is the same, from literature of applied kinesiology we could conclude that this muscles realize contraction in tonic condition – controlled in cortical level (Paeglitis & Veseta 2005), or muscles of synergists must realize the same contraction force (Walther, 2000; Frost, 2002; Rosner & Cuthbert, 2012). This could be another point why there are no significant changes on muscle tone on week-tested muscle *gastrocnemius*.

Local blood flow results of *m.gastrocnemius* with normal and weak – tested muscle is significantly different (Gavrona, et al., 2015), but difference is low on first minutes and test time of myotonometry could be too short what could explain insignificant changes of tissue tone. From obtained results it could be speculated that during myotonometry of weak-tested muscles when motor control realizes through involvement of motor centers of cortical level, test must be done for a long time. And this could be third point why there are no significant changes on muscle tone on week-tested muscle *gastrocnemius*.

Conclusions

There are insignificant differences of muscle tone with normal contraction motor pattern and in weak-tested muscle. Tested normal or exchanged neuromuscular regulation of *m.gastrocnemius* with myotonometer must use several preconditions:

-myotonometer represents various elasticity of tissues;
-synergist muscles can replace agonist muscles contraction force;
-test must be done for a long time.

References

1. Frost, R. (2002). Applied Kinesiology. North Atlantic Books.
2. Gavrona, U., Paeglitis, A., Varpa, N., Galeja, Z., Dzerve, V., & Kukulis, I. (2015). Influence of exchanged neuromuscular regulation of m.gastrocnemius on leg blood flow regulation during static voluntary contraction of knee flexors. *LASE Journal of Sport Science*, Vol.6 (1), 16-23.
3. Gapeyeva, H., Sakniit, K., Sokk, J., Ereline, J., Ratsepsoo, M., Haviko, T., & Paasuke. M. (2012). Influence of home exercise programme on thigh muscle tone and function of knee joint before total knee arthropasty.

University of Tartu, Acta Kinesiologiae Universitatis Tartuensis, Vol.18, 119

4. Paeglītis, A., Eglītis, E., Galeja, Z., & Kukulis, I. (2014). Muscle blood supply during prolonged static voluntary contractions. *LASE Journal of Sport Science,* Vol.5 (1), 9-14.
5. Paeglītis, A., & Veseta, U. (2005). Kustību neiroloģiskās vadības principi. *Zinātniski metodiskie raksti.* Latvijas Sporta pedagoģijas akadēmija.
6. Ramsak, I., & Gerz, W. (2001). *AK muscle tests at a glance.* AKSE Verlag.
7. Rosner, A., & Cuthbert, S. C. (2012). Applied kinesiology: Distinctions in its definition and interpretation. *Journal of Bodywork and Movement Therapies, Vol.16,* 464-487.
8. Shumway – Cook, A., & Woollacott, M. (1995). *Motor control*. Philadelphia, London, Munich: Williams & Wilkins.
9. Solms, M., & Turnbull, O. (2002). *The brain and the inner world*. London. New York: Karnag.
10. Walther, D. S. (2000). *Applied Kinesiology*. Synopsis, second ed. International College of Applied Kinesiology, SYSTEMS DC, Colorado, USA.
11. Паэглитис, А. (1986). *Кровообращэниэ, энэргэтика и утомляэмость скэлэтных мышц чэловэка при их произвольном сокращении в статичэском режимэ*. Дисэртация, Рига, 1986.
12. Скардс, Я., & Паэглитис, А. (1982). *Роль симпатической нервной системы в формировании рабочей гиперемии скелетных мышц человека*. Тез. докл. Всесоюзн. сими. "Кровообращение в скелетных мыщцах". Рига, 137-138.
13. Скардс, Я., & Паэглитис, А. (1985). *Факторы нарушающие перераспределение кровотока в скелетных мыщцах.* В кн. "Механизмы регуляции кровоснабжения скелетных мышц', Рига, "Зинатне', 1985, (с. 108.-113.).

Submitted: April 18, 2016
Accepted: December 27, 2016