

# Change in the Muscle Tension of the Shoulder Girdle Muscles in Patients with Spinal Pain, Using the Tone Control<sup>®</sup> Technique

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**Abstract:** The aim of the study was to verify the efficacy of the Tone-Control method in inducing a reduction in the tension of the muscles of the shoulder girdle, and therefore a normalisation of posture in the segment. The authors analysed the change in posture, which was related to the muscle tension of the pectoralis major muscle and the trapezius muscle, resulting from the administration of a programme of encoded exercises known as the Tone Control method. The study was conducted on 70 patients with postural back pain, aged between 25 and 81 years and with a mean age of 61.9 years, 11 male patients and 59 female patients, who attended group rehabilitation for a minimum of 10 and a maximum of 15 sessions. Acute phase patients, patients on anti-inflammatory pharmacological treatment and patients with hernias or bulging causing thecal sac impingement were excluded from the study. Measurements were taken of the angles of the joints in the scapulohumeral segment during the first and last sessions. The NRS (numeric rating scale) pain scale was administered at the start and end of the cycle of sessions. Conclusions: Patients in the study group experienced improvements in the angle measurements that were proportionally greater than those of the control group, together with a considerable reduction in perceived pain, with an overall improvement in posture and shoulder girdle function.

**Key words:** Tone control, muscle tone change, improvement in muscle contraction, shoulder girdle rehabilitation.

## 1. Introduction

The purpose of the study was to test the efficacy of the Tone Control technique.

This technique was developed when, in an attempt in routine practice to obtain a postural improvement in and harmonisation of muscle tone within the individual psychosomatic unit, the application of the principles of eutonia [1] was combined with biomechanical articular facilitations [2, 3]. On a practical level, it was seen that providing a fulcrum outside the joints considered and simultaneously increasing the proprioceptive inputs [4] in that segment produced positive responses. Moreover, if the perceptive input was provided by an elastic surface,

the gain in terms of tone and postural readaptation appeared to be greater than anticipated.

It was therefore decided to encode procedures that could be versatile enough to be adapted to the necessary individualisation of treatment to meet the specific needs of each patient, but that at the same time were reproducible with uniformity of technique, making them suitable for verification.

Attempting to adapt muscle tone [5] is one of the key aspects of a therapist's work, when dealing with posture and its alterations. One useful, albeit not exhaustive definition of posture, is chosen by F. Scoppa [6]. "Posture can be taken to mean the position of the body in space and the spatial relationship between the skeletal segments, the purpose of which is to maintain balance (antigravity function), in both static and dynamic conditions, to which a contribution is made by the

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neurophysiological, biomechanical, psychoemotive and interpersonal factors related to the evolution of the species". Scoppa's words allow us to highlight certain aspects that are fundamental to Tone Control, i.e. the spatiality and the concurrence of a number of factors.

To verify the efficacy of the approach with the Tone Control treatment, in this study it was therefore decided to evaluate the changes obtained when applying the technique to the rehabilitation of the shoulder girdle, thereby placing attention on the postural changes relating to different states of muscle tone in certain muscles in the girdle and in their main actions.

More specifically, the correlation between the tone of the anterior thoracic muscles (pectoralis major muscle) and the anteposed attitude of the shoulder was chosen together with the correlation between the tone of the trapezius muscle (upper and middle) + the levator scapulae muscle and the elevation of the entire girdle on the frontal plane. Shoulder flexion on the sagittal plane was chosen to investigate the possibility of joint movement, in the interests of a practical approach. As a subjective parameter, the authors also took into account the subject's assessment of pain.

The neurophysiological and biomechanical bases referred to are: proprioceptive stimulation [4], the stretch reflex and reciprocal inhibition principle [3]. The concept of fixation and facilitation studied by Dr. Irvin Korr in 1975 was also considered [2, 4].

The afferent discharge of the gamma motor neurons from the neuromuscular spindle produces a contractile reflex and blocks articular mobility in a given position. By controlling the contraction of the intrafusal muscle fibres by means of gamma motor neuron stimulation, the central nervous system is able to reset the degree of muscle length, the tone and the sensitivity of the spindles to stretching [7]. This mechanism generates a pre-alert state in the muscle, which is therefore able to respond even to small changes in lengthening. Moreover, the greater the gamma stimulation, the greater the muscle spindles' sensitivity to stretching

[4]. Muscle stretching with high gamma stimulation produces a more intense discharge by the muscle spindles and, consequently, a greater muscle contraction reflex. In dysfunctional tissue [4], with an alteration of muscle tone, the muscle spindles continue to discharge [6]. Tone control exercises aim to reduce muscle contraction by reducing the aberrant discharge at the origin of the spindle and, therefore, muscle tone [8].

The measurements were taken as follows [9]:

(1) shoulder anteposition: measured in cm from the frontal plane by putting the patient in a seated position, back against a wall, by measuring the perpendicular distance between the acromial process and the wall the patient is resting against. (Fig. 1.1)



(Fig. 1.1) Measuring shoulder anteposition.

(2) elevation of the shoulder girdle: it was decided to measure the angle formed by the sternum, in its vertical position and the line that joins the sternoclavicular joint and the acromial process, with the patient seated. (Fig.1.2)

This goniometric measurement provides information on girdle elevation and, indirectly, on the muscle tone adaptation strategies in antigravitary response.



(Fig. 1.2) elevation of the shoulder girdle.

(3) Shoulder flexion: evaluated in degrees using the goniometer, with the patient seated, back against the wall. (Fig.1.3)



(Fig.1.3) Shoulder flexion.

(4) pain: assessed by the subject using the NRS (numeric rating scale) scale.

These measurements, which were undoubtedly indirect compared to a direct evaluation of the tone of the muscles studied, were necessary and inevitable due to the peculiar limit of the tone assessment test using the Asworth scale, which is extremely operator-dependent.

The myometer, which is unfortunately not commonly used in clinical practice, is a more specific tool [10].

## 2. Materials and Methods

The patients participating in the study started group rehabilitation following a physiatrist's appointment and a diagnosis of back pain (inclusion criterion) without active peripheral radiations and in the absence of central neurological conditions (exclusion criteria).

The treatments were administered at IMMES and PAT Community Services Authority in Milan between September 2012 and November 2014, in small outpatient groups consisting of a maximum of 5 people, pursuant to article 26 bracket 2, for a maximum of 15 and a minimum of 10 60-minute sessions, twice or three times a week.

In the study group, the age of participants was between 47 and 81 years, with an average age of 63.1 years.

In the control group, the age of participants was between 25 and 81 years, with an average age of 60.3 years.

### 2.1 Study Group Rehabilitation Programme

Tone control exercises were included in the rehabilitation programme of certain work groups with patients suffering from back pain, proposing just some of the sequences of active exercises envisaged by the Tone Control method and focussing on the dynamics of the shoulder girdle and cervical and dorsal spine.

The exercises administered to the patients were as follows:

(1) Stock-take exercise: the patient, who is lying supine on the floor, is asked to focus attention on his/her perception of the surface of the body in contact with the floor. The patient is asked to press the various segments of the upper limb (hand, elbow, shoulder) to the ground in sequence from distal to proximal, for

both sides of the body, ending by pressing down the occipital area contact surface. The pressure is held for 5s, followed by release and then a 5-second perceptive listening window, to be repeated three times. This exercise constitutes the start and end of the Tone Control treatment. (Fig 2.1)



(Fig. 2.1) Stock-take exercise.

(2) Pressure against elastic resistance: the therapist places a rubber ball inflated to a pressure proportionate to the weight of the subject with a diameter of approximately 15 cm between the patient's body and the floor such as to allow support in the area without completely squashing the ball, but at the same time guaranteeing a skin contact area of at least 20 cm<sup>2</sup>. During the expiration phase, the patient is asked to push backwards to compress the ball against the floor. The pressure is held for 5 s, followed by release and then a 5-second perceptive listening

window, to be repeated three times.

The ball will be positioned, in sequence, under the following anatomical sites, on one side of the body:

- (a) subspinatous scapular notch.
- (b) between the medial border of the scapula and the dorsal spinous processes between D3 and D5.

This sequence should be repeated also on the other side.

(c) the ball is then positioned centrally on the spinous processes between D3 and D5, with the upper limbs in extrarotation. (Fig. 2.2)



(Fig. 2.2) Pressure against elastic resistance

(d) The ball is placed beneath the external occipital protuberance. From the occipital contact point, the patient is asked to perform a twisting motion of the head with a lateral inclination to reach a point of contact limited by the temporal mastoid process. From this position, the patient is asked to perform pressing motions with the same parameters as previously on both sides.

(3) The sequence of Tone Control exercises ends by repeating the stock-take exercise, in order to allow the patient to perceive any differences between the body image before and after treatment.

These sequences were included in a programme involving a sequence of active mobilisation exercises for the lumbar spine and the lower limbs, to improve the segmental strength of the abdominal muscles, quadriceps muscles and of the stabilisers of the pelvis, the stretching of the posterior chain of the lower limbs and of proprioceptive stimulation during loading with both static and dynamic balance exercises.

## 2.2 Control Group Rehabilitation Programme

The exercises for the mobilisation and proprioceptive stimulation of the shoulder girdle administered to patients in the control group were as follows:

(a) Hand-guided passive anterior flexion of the head, from a supine position on the floor. The position is held for 5 seconds and repeated three times.

(b) Hand-guided passive twisting motion with lateral inclination of the head. The position is held for 5 s and repeated three times.

(c) Scapulothoracic sliding, with arms together and pushed forward during the expiratory phase. The position is held for 5 s and repeated three times.

(d) Stretching of the muscles of the forearm, pectoral muscle and of the entire upper limb chain, holding the positions for 30 s and repeating them twice.

(e) Active downward pulling of extrarotated upper limbs, placed on the floor. The position is held for 5 s and repeated three times.

As for the study group patients, the exercises described were included in the same sequence of active mobilisation exercises for the lumbar spine and the lower limbs, to improve the segmental strength of the abdominal muscles, quadriceps muscles and stabilisers of the pelvis, stretching of the posterior chain of the lower limbs and of proprioceptive stimulation during loading with both static and dynamic balance exercises.

During their initial physiatrist's appointment, following the prescription of small-group physiotherapy, the doctor explained the purpose of the rehabilitation pathway, by informing the patient that he/she would have to do exercises to improve global joint movement, spinal and global function, to control pain and for postural training. The patient was informed that a study was being conducted on the efficacy of the Tone Control technique, but was not informed whether he/she was part of the study group or control group.

## 3. Statistical Data Processing

### 3.1 Pain

Fig.3.1.1 shows the relationship between the pain self-assessment values obtained by administering an NRS before the first session and during the last session.

During the first session, the study group (circles) presented starting values between 8 and 3, with an average of 5; the control group (triangles) showed starting values of between 7 and 2, with an average of 4.7.

During the last session, the study group presented values of between 0 and 6, with an average of 2.4; the control group presented values of between 0 and 5, with an average of 2.6.

Both treatments therefore achieve the purpose of reducing pain, with an almost identical improvement.

(1) from ANOVA 1

$F_{(1,68)} = 6.92, p < 0.011$

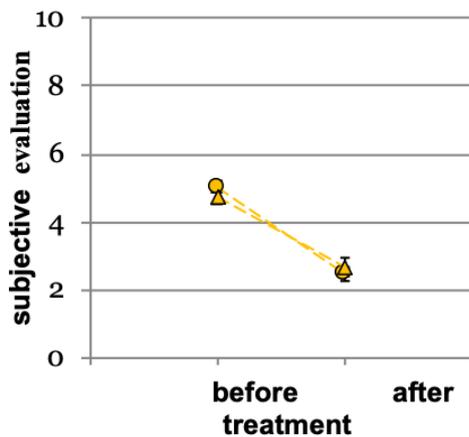


Fig. 3.1.1 Subjective evaluation of pain before and after treatment, in the special (circles) and in the standard (triangles) treatment groups.

The two groups show significantly different overall results, therefore the two treatments give significantly different results (better in the study group).

(2) from ANOVA 2

Wilks' lambda = 0.294, partial = 0.71 (Partial age squared),  $F_{(1,68)} = 163.5, p < 0.0000$ .

The main effect is significant: both the treatments achieve the purpose of significantly altering the pain assessment, reducing it.

The variance of error of the dependent variable is the same for both groups.

Levene's test:  $F_{(1,68)} = 0.858, p < 0.358$  (from ANOVA 5: on the differences between before and after).

The difference in the gain between the two groups is not significant  $F_{(1,68)} = 1.96, p < 0.166$ , partial = 0.028 (partial age-squared, ANOVA 5).

Conclusion: both treatments therefore achieve the purpose of reducing pain, with an almost identical improvement, although the gain of the special treatment group is 1.25 times that of the standard group.

### 3.2 Degrees of Clavicle Elevation

Fig. 3.2.1 shows the degrees measured by goniometer between the vertical axis passing through the sterno-clavicular joint and the axis of the clavicle.

The angles measured on patients in the study group

(circles) started with values similar to those of the control group (triangles); however, the reduction of this angle during the last session is greater in the study group than in the control group.

In postural analysis, the shoulder appeared less prominent on the frontal plane.

The Box's test is not significant  $F_{(3)} = 1.5, p > 0.215$ . This means that the observed covariance matrices of the dependent variables are identical in the two groups.

Elevation: the main effect is significant (the treatment is efficacious):

Pillai's trace = 0.829; Wilks' lambda = 0.171,  $F_{(1,68)} = 328.9, p < 0.0000$ , (partial age-squared) = 0.829.

Significant interaction (the results are significantly different in the two groups):

Pillai's trace = 0.350; Wilks' lambda = 0.650,  $F_{(1,68)} = 36.5, p < 0.0000$ , (partial age-squared) = 0.350.

The variance of error of the dependent variable is the same for both groups.

Levene's test:

for anteposit 1:  $F_{(1,68)} = 0.89, p < 0.349$

for anteposit 2:  $F_{(1,68)} = 1.1, p < 0.298$

Also considering only the comparison between the gain in one group compared to the other, the variance of error of the dependent variable is the same for both groups.

Levene's test:  $F_{(1,68)} = 1.004, p < 0.950$ .

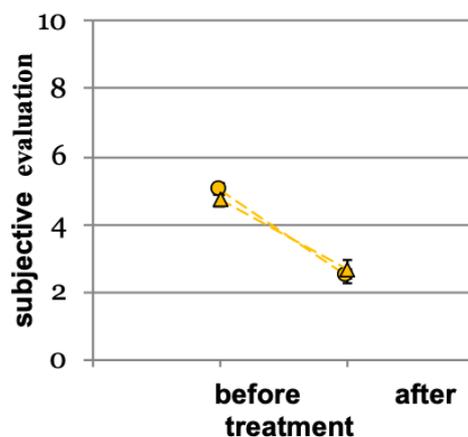


Fig. 3.2.1 Curvature angle of clavicle before and after treatment, in the special (circles) and in the standard (triangles) treatment groups.

The effect of the treatment, considered from the point of view of the result of the comparison between before and after, is significant in both groups (both groups receive a benefit, *gain*, that is significantly different from superior to zero, when considered separately):

Pillai's trace = 0.834; Wilks' lambda = 0.176,  $F_{(1,68)} = 341.1$ ,  $p < 0.0000$  (partial age-squared) = 0.834.

Pillai's trace = 0.485; Wilks' lambda = 0.515,  $F_{(1,68)} = 63.96$ ,  $p < 0.0000$  (partial age-squared) = 0.485.

From ANOVA 5: analysis based on the difference between two groups:

elevation// $F_{(1,68)} = 36.55$ ,  $p < 0.0000$  (partial age-squared) = 0.350.

The gain of the special group is double (twice) that of the standard group.

Conclusion: the two groups start on the same level and whilst the standard treatment group reaches a good level, the special treatment group reaches a significantly better level.

### 3.3 Shoulder Flexion

Fig 3.3.1 shows the modification in shoulder flexion before and after the treatment. Shoulder flexion was measured using a goniometer on orthostatic patients resting against a wall. This is a significant value because the possibility of raising the upper limb is representative of the functional capacities of the shoulder and shoulder girdle. Study group patients started from lower values (circles) than those of the control patients (triangles) and at the end of treatment they reached values that were objectively lower than those reached in control group patients, although gain was greater for the study group.

Flexion: the main effect is significant (the treatment is efficacious):

Pillai's trace = 0.728; Wilks' lambda = 0.272,  $F_{(1,68)} = 182.3$ ,  $p < 0.0000$ , (partial age-squared) = 0.728.

Significant interaction [the results are significantly different in the two groups]:

Pillai's trace = 0.063; Wilks' lambda = 0.937,  $F_{(1,68)} = 4.6$ ,  $p < 0.036$ , (partial age-squared) = 0.063.

The variance of error of the dependent variable is the same for both groups.

Levene's test:

for flexion 1:  $F_{(1,68)} = 0.016$ ,  $p < 0.9$

for flexion 2:  $F_{(1,68)} = 3.05$ ,  $p < 0.085$

Also considering only the comparison between the gain in one group compared to the other, the variance of error of the dependent variable is the same for both groups.

Levene's test:  $F_{(1,68)} = 0.321$ ,  $p < 0.573$ .

The effect of treatment is significant in both groups:

Pillai's trace = 0.677; Wilks' lambda = 0.323,  $F_{(1,68)} = 142.7$ ,  $p < 0.0000$ , (partial age-squared) = 0.677.

Pillai's trace = 0.454; Wilks' lambda = 0.546,  $F_{(1,68)} = 56.5$ ,  $p < 0.0000$ , (partial age-squared) = 0.454.

From ANOVA 5: Comparing the gains between the two flexion groups:  $F_{(1,68)} = 32.06$ ,  $p < 0.0000$ , (partial age-squared) = 0.320.

The gain of the special group is 1.38 times that of the standard group.

Conclusion: the two groups start on different levels (special treatment group worse level) and whilst they reach the same level, the improvement is greater in the special treatment group.

### 3.4 Shoulder Anteposition

Fig. 3.4.1 shows the shoulder anteposition evaluated in cm of distance from the considered surface, with

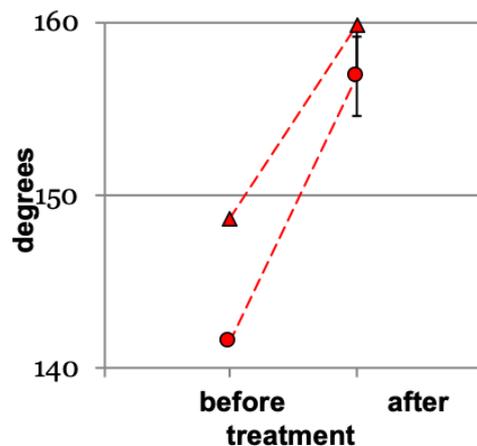


Fig. 3.3.1 Shoulder flexion before and after treatment, in the special (circles) and in the standard (triangles) group.

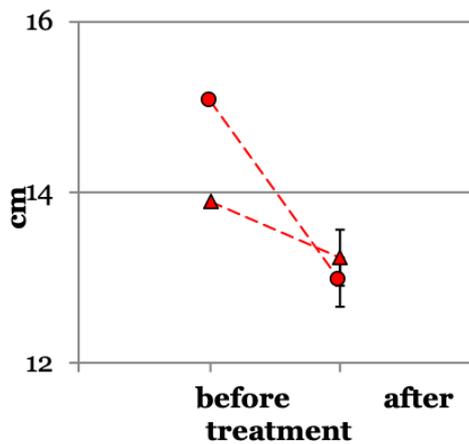


Fig . 3.4.1 Shoulder ante-position.

the patient orthostatic and the dorsal segment resting against a wall. In the postural analysis, this value was related directly with the anterior closure of the shoulder girdle and the scapula's outward sliding on the dorsal contact surface.

The values for the patients in the study group started off worse (circles) than the values of the control group (triangles), but by the last session, a considerable improvement had been seen with an exceeding of the values obtained—again in the last session—by the control group.

Main effect significant (the treatment is efficacious):

Pillai's trace = 0.645; Wilks' lambda = 0.355,  $F_{(1.68)} = 123.5$ ,  $p < 0.0000$ , (partial age-squared) = 0.645.

Significant interaction [the results are significantly different in the two groups]:

Pillai's trace = 0.328, Wilks' lambda = 0.672,  $F_{(1.68)} = 33.1$ ,  $p < 0.0000$ , (partial age-squared) = 0.328.

The variance of error of the dependent variable is the same for both groups.

Levene's test:

for shoulder 1:  $F_{(1.68)} = 4.8$ ,  $p < 0.031$

for shoulder 2:  $F_{(1.68)} = 6.6$ ,  $p < 0.012$

The effect is significant in both groups:

Pillai's trace = 0.709, Wilks' lambda = 0.291,  $F_{(1.68)} = 165.98$ ,  $p < 0.0000$ , (partial age-squared) = 0.709.

Pillai's trace = 0.156, Wilks' lambda = 0.844,  $F_{(1.68)} = 12.55$ ,  $p < 0.001$ , (partial age-squared) = 0.156.

As regards the comparison between the two gains, the variance of error of the dependent variable is the same for both groups.

Levene's test:  $F_{(1.68)} = 2.123$ ,  $p < 0.150$

The difference in the gain between the two groups is significant.

$F_{(1.68)} = 33.14$ ,  $p < 0.0000$ , (partial age-squared) = 0.328.

The entity of the difference is considerable: the gain of the special group is 3.15 that of the standard group.

The repeated measurements on the results of the ANOVA 5 differences show the interaction between the two groups to be significant:

$F_{(3.204)} = 26.1$ ,  $p < 0.0000$ , partial age-squared = 0.277.

Levene (OK) for all four measurements/gains:

$F_{(1.68)} = 0.858$ ,  $p < 0.358$

$F_{(1.68)} = 0.004$ ,  $p < 0.950$

$F_{(1.68)} = 0.321$ ,  $p < 0.573$

$F_{(1.68)} = 0.858$ ,  $p < 0.358$

The variance of error of the dependent variable is the same for both groups.

Univariate test: ANOVA5

Interaction of measurements for each group (gain × groups) is significant:

$F_{(3.204)} = 24.15$ ,  $p < 0.0000$ , (partial age-squared) = 0.262.

1 pain:  $F_{(1.68)} = 1.961$ ,  $p < 0.166$ , (partial age-squared) = 0.028

2 antep:  $F_{(1.68)} = 36.550$ ,  $p < 0.000$ , (partial age-squared) = 0.350

3 flex:  $F_{(1.68)} = 32.065$ ,  $p < 0.000$ , (partial age squared) = 0.320

4 shoulder:  $F_{(1.68)} = 33.140$ ,  $p < 0.000$ , (partial age-squared) = 0.328

The differences in gain are significant for the three "objective" values.

#### 4. The Results

Overall, the results described show a significant improvement in the parameters chosen at the start of the study and make it possible to establish a

relationship with an effective postural improvement in the patients treated. Indeed, the general situation is characterised by an adaptation of patients' posture, with a reduction in shoulder girdle elevation, reduction in shoulder anteversion and an improvement in upper limb function in the physiological flexion motion.

It can therefore be concluded that the Tone Control method is as efficacious as conventional active mobilisation, whereas it was seen to be more efficacious in the postural improvement due to a more efficacious normalisation of muscle tone in the segments examined.

The study conducted made it possible to obtain the first data regarding the Tone-control option in the group rehabilitation setting, requiring completely active patient participation. It would be interesting to compare the results that can be obtained with patients of different types, such as, for example, young athletes, in order to obtain more useful information on patient compliance.

It would also be very interesting to further test the method in an individual rehabilitation situation, so as to also exploit operator-dependent stimulation techniques, which require direct contact between the therapist and the patient and make it possible to

combine active work with the listening of a passive movement induced by the therapist.

## References

- [1] Gerda, A. 1991. *Eutonia, Paidos*.
- [2] Korr, I. M. 1970. "The Segmental Nervous System as Mediator and Organizer of Disease Process." In *The Physiological Basis of Osteopathic Medicine*.
- [3] Kandel, S. J. 2003. "Principi di neuroscienze." *Ambrosiana* 36: 702-12.
- [4] Korr, I. M. 1975. "Proprioceptors and Somatic Dysfunction." *J AM Osteopath Assoc* 74: 638-50.
- [5] 1958. "Physiopathology & Clinical Manifestations of Skeletal Muscle Tone." *Arch Phys Ther (Leipzig)* 10 (4): 276-86.
- [6] Posturologia, S. F., and Corporeo, S. 2001. "Attualità in Terapia Manuale e Riabilitazione." 4: 5-16.
- [7] Radovanovic, D., Peikert, K., Lindstrom, M. and Domellof, F. P. 2015. "Sympathetic Innervation of Human Muscle Spindles." *J. Anat.* 226: 542-8.
- [8] 1986. "Controversial Aspects of Skeletal Muscle Tone." *Hnik P. Biomed Biochim Acta* 45 (1-2): S139-43.
- [9] 1962. "On the Problem of the Technic of Measurement of Skeletal Muscle Tone." *PANFILOV BK, Klin Med (Mosk)* 40 65-9.
- [10] Ianieri, G., Saggini, R., Marvulli, R., Tondi, G., Aprile, A., Ranieri, M., Altini, S., Goffredo, L., Megna, M., and Megna, G. 2008. "Tono, elasticità e stiffness: valutazione miometrica delle proprietà muscolari." *Eur. Med. Phys.* 44(Suppl. 1 to No. 3).