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Improving posture: Comparing Segmental Stretch and Muscular Chains Therapy

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Summary Muscular Chains Therapy (MCT) that uses postural positions for a global stretching and Segmental Stretch Technique (SST) that stretches one muscle at a time, are two static stretching techniques currently used to improve, correct and treat postural imbalances. Aiming to identify which of these two techniques is most effective in order to improve standing posture, 30 women between 21 and 30 years old were evaluated and divided into three groups of 10 participants each: The SST group, the MCT Group and the Control Group (CG). Postures were evaluated before and after treatment through digital photographs. After transferring the images to the computer, tracings were made with Corel Draw software using six marked anatomical points: intertragic notch; anterior part of the lateral border of the acromion; suprasternal notch; posterior superior iliac spine (PSIS) and anterior superior iliac spine (ASIS) and scapula's inferior angle. The two experimental groups underwent eight sessions of stretching, twice a week, for about 30 min each session. The MCT Group was found more effective ($p < 0.05$) than the SST and CG in the variables ASIS ($p = 0.001$), PSIS ($p = 0.001$) and acromion ($p = 0.001$). No statistically significant differences were found in postural variables scapula, acromion-line and line-intertragic notch. In conclusion the MCT stretching was superior to the SST to treat postural deviations, once de SST stretched the same muscles treated by the MCT.

Introduction

Stretching exercises are commonly used with the intention to correct and prevent postural deviations, postural imbalances[1–3] and to provide greater muscular flexibility.[1–5] Muscular Chains Therapy (MCT) Technique and Segmental Stretch Technique

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(SST) are both modalities of Static Stretch which have been described as the most secure type of stretch because a relatively constant force is slowly and gradually applied to the patient. The ballistic stretch and eccentric stretch are, for example, not so safer than the static stretch.[2–4] Once the static stretch has its effect on posture, but the MCT and SST have different ways to work the muscles and the posture it is important to research which one is the more effective.

Posture

Static posture refers to the alignment and maintenance of body segments in certain positions. Some postural misalignments may adversely affect the muscular efficiency, predispose individuals to pain and pathological musculoskeletal conditions and provoke unesthetic alterations.[2,6] Bad posture is a problem more common nowadays probably because of sedentarism.[7]

According to Kappler,[8] a good postural balance creates less stress on joints, requires less muscle activity to maintain balance and, therefore, is the position of maximum effectiveness. An imbalanced posture should be compensated by changes in joint position which, in turn, must be maintained by an increase in muscle activity and cause injuries[8] as well as the imbalanced muscles.[9,10] Thus, the postural imbalance results in excess of energy consumption.[8]

Some authors support the theory that if the body segments are kept out of alignment for extended periods of time, the muscle adopts a shortened position, this shortened muscle is usually stronger compared with its elongated and weak antagonist.[11,12]

Based on the above discussion, the purpose of this article is to investigate the postural effects of these two types of stretching and establish clinical parameters as a basis for postural treatment based on scientific evidence.

Muscular Chains Therapy (MCT)

Muscular chains are formed by gravitational muscles that work synergistically in the same chain and it is very well explained by the theory of Anatomy Trains[13] and, of course, the maintenance of the standing position against the action of gravity.[14] The concept of muscular chains is based on the observation that the shortening of a muscle creates compensation in the adjacent and also distant muscles. In this study the fascial treatment was not added in order to emphasize the muscles. Therefore, the MCT is a global stretching technique that uses postural positions for stretching several muscles simultaneously rather than treating an isolated muscle.[2] These muscles belong to the same muscular chain.[14] Basically we have two main chains: anterior and posterior, which have a lot of similarities with the Superficial frontal line and Superficial back line,[13] respectively.

The posterior chain covers the following muscles: Gastrocnemius and Soleus; Flexor Hallucis Brevis, Flexor Hallucis Longus, Short Flexor of Fingers and Flexor Digitorum Longus; Hamstrings; Lower Limb Adductors and Iliopsoas; Gluteus; Paraspinals; Subscapularis; Deltoid; Upper Trapezius.[3,14]

The anterior chain: Iliopsoas; Adductor brevis; Adductor longus; Adductor magnus; Adductor minimus; scalenus; sternocleidomastoid; Pectoralis Major; Pectoralis Minor; Brachial biceps and Brachialis; Pronator Teres and Pronator Quadratus; Flexor Digitorum Profundus; Flexor Digitorum Superficialis; Flexor Pollicis Longus and Adductor Pollicis.[3,14]

This muscular chain concept differs from the segmental stretch which treats each shortened muscle separately, usually those directly involved in the joint with decreased range of motion. MCT applies a long duration stretch, which lasts approximately 15 min per postural position while coupled with eccentric physical exertion for the posture maintenance, featuring an active form of stretching.[2,3] Clinically, the MCT has been efficient treating postural deviations and providing grater flexibility.[3]

Segmental Stretch Technique (SST)

This technique is the most typical type of stretch,[15] also known as passive stretch, made without muscle contraction of the segment in question, performed by placing muscles at their greatest possible length and holding that position.[2] SST applies stretching in specific muscular groups for a short period of time, approximately 30 s.[4,15] Stretching exercises, and the passive stretch as well, are commonly used in the Physical Therapy practice because it has been suggested to enhance muscular flexibility and performance.[2,16] It is also used to prevent muscle injury[17,18] but some authors have putted in doubt the stretching efficiency as a mechanism of injury prevention.[9,19]

Therefore, the main features that distinguish SST from MCT are the time of application of the stretching as well as the method of application of the stretching. SST requires a relatively shorter duration of stretch compared to MCT which requires a much longer duration of stretch.

Also SST stretches the muscles group by group while MCT applies the stretch from a global stretched postural position.

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Material and methods

Subjects

30 women, students of the University of Sao Paulo, participated voluntarily, were randomly divided into three groups of 10 participants each: SST Group that performed passive static stretching, MCT Group that performed the global postural streches, and the Control Group that was not stretched.

Inclusion criteria included healthy individuals between 21 and 30 years old; consented to participate in the study.

We excluded those who met the following conditions: patients with any type of pain in the hamstring muscles, knee and hip; patients with some pathology, like back pain, rheumatic disease or strain that would limit the range of motion or produce an antalgic posture. Subject were excluded from the study if missed a session which was not made up within in the same week as well as if there was a change in frequency and/or intensity of any sports activities.

The project was approved by the Ethics Committee of the Clinics Hospital of University of São Paulo.

Material

The materials used in this study were an acrylic transparent Carci® goniometer with markings 0–360°; circular patches of one inch and three tenths in diameter to mark the measured points; a digital camera Cannon® Powershot A400; and Corel Draw© software to calculate the postures taken by the digital camera.

Procedure

Evaluation

All subjects underwent the same evaluation protocol, performed before and after treatment. The following parameters were evaluated:

- Demographic data: age (in years), sex.
- Photos: a digital camera held by a tripod, 1 m from the ground, 2.20 m from the wall. The subjects were positioned at 50 cm from the wall, in bipedalism, with feet together and upper limbs near the body. Frontal, dorsal and right lateral views were taken (Fig. 1). This model was based on work by Munhoz and Marques[20] Photographic evaluation of body posture. A qualitative posture evaluation was made using an analysis of photographs. Full body photographs were taken with subjects in standing position in frontal, right lateral, and dorsal views. Wearing sports clothing, with feet together and eyes aimed at the horizon, each subject was positioned on a ladder-type step, at a distance of 1.70 m from the photographic camera placed on a tripod at the level of the subject's umbilical scar and at 50 cm from the squared panel on the wall behind the subject.

The following anatomical points were marked with self-adhesive circular labels (0.5 cm radius) based on work by Rosário et al.[3]: intertragic notch; anterior part of the lateral border of the acromion; suprasternal notch; posterior superior iliac spine (PSIS) and anterior superior iliac spine (ASIS), scapula's inferior angle, right lateral malleolus.

After transferring the images to the computer, tracings were made with Corel Draw software to quantify postural alignment before and after intervention. The goal of the postural assessment through photos of the frontal plane with ventral and dorsal incidence was to analyze the symmetry of the body with the aid of a sagittal line with origin between the feet.[12]

Treatment

After evaluation of individuals, we used the treatment program described below according to the group, which in the MCT and the SST groups consisted of 30-min sessions, held twice a week with an

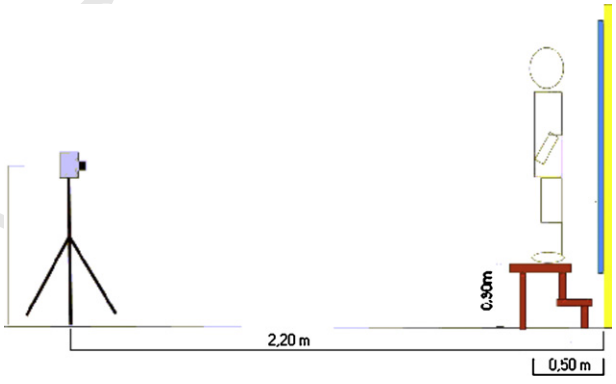

Figure 1 Schematic draw of the photographic method.

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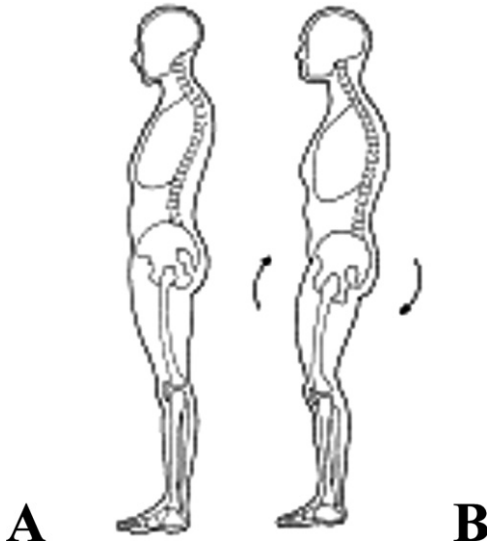

Figure 2 Schematic draw of the first test: (A) normal standing position; (B) straightening the lumbar spine avoiding flexion of the knee.

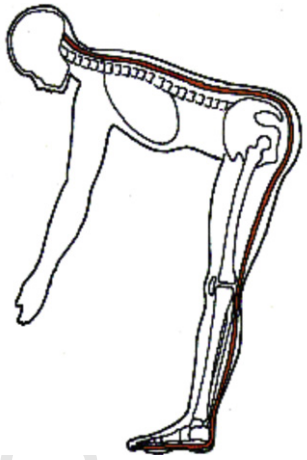

Figure 3 Schematic draw of second test: hip flexion avoiding a flexion on the lumbar spine.

interval of at least 48 h, over a four-week period. This protocol dictating time and frequency of treatment was recommended by Rosário et al.[3]

SST group. This group was stretched bilaterally, by the subjects themselves, oriented to feel the stretching sensation, in the same muscular groups that are part of the muscular chains. Each stretch lasted for 1 min,[15] held passively avoiding compensations. They were the same muscles stretched by the MCT on the anterior and posterior chains: Gastrocnemius and Soleus; Flexor Hallucis Brevis, Flexor Hallucis Longus, Short Flexor of Fingers and Flexor Digitorum Longus; Hamstrings; Lower Limb Adductors and Iliopsoas; Gluteus; Paraspinals; Upper Trapezius; Iliopsoas; Adductor brevis; Adductor longus; Adductor magnus; Adductor minimus; scalenus; sternocleidomastoid; Pectoralis Major; Pectoralis Minor; Brachial biceps and Brachialis; Subscapularis; Deltoid; Pronator Teres and Pronator Quadratus; Flexor Digitorum Profundus; Flexor Digitorum Superficialis; Flexor Pollicis Longus and Adductor Pollicis.

MCT group. The group was kept in two postures for 15 min in each posture. These postures were modified in all sessions according to postural changes. The decision of which posture would be used in each session depended on what was more difficult for the subject in standing position: (1) straightening the lumbar spine with hip in neutral position avoiding flexion of the knee (Fig. 2) and; (2) hip flexion avoiding a flexion on the lumbar spine (Fig. 3). For the treatment, if the first option was the most difficult to perform, two positions, supine and standing, were made with hip extension, increasing its difficult extending the knee, both positions with straightened lumbar spine. If the second option was the most difficult, the treatment consisted of two positions, supine and standing, with the progression of the hip flexion and knee extension during the 15 min. In case of a tie, the treatment consisted of two supine positions, one with extension and one with knee flexion. Evaluation and treatment were based on the description of Marques.[14]

Data analysis

Analysis of photography tracings

The photos of the frontal plane with ventral incidence provided the difference in absolute value of the distances between each anterior superior iliac spine (ASIS) to the sagittal line and the difference of the acromiums by that same line (Fig. 4). A value of zero indicates symmetry. This was followed by the subtraction of the measured pre-treatment to post-treatment values. A positive result indicated improvement, zero values no change, and a negative result would be an indicator of worsening of the imbalance.

In the photos of frontal plane dorsal incidence (Fig. 4) the researchers measured the distance between the lower edges of the scapulas. A positive result in the subtraction of the post-treatment from pre-treatment values shows a better positioning of the shoulders. In the same way as ASIS, the posterior superior iliac spines (PSIS) were measured.

In photos of the sagittal plane the researchers measured the distance from the midpoint of the acromion and the distance of the intertragic notch to a line perpendicular to the ground which passed over the lateral malleolus.[12] The smaller the

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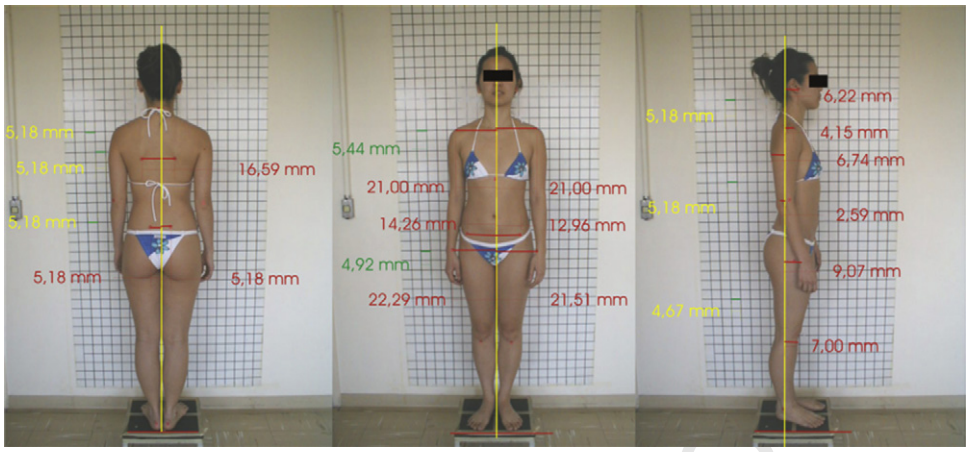

Figure 4 Pictures of the frontal plane with ventral and dorsal incidence and sagittal plane.

distance, the better the postural alignment (Fig. 4). These two variables were also calculated by subtracting the post from pre-treatment values, and, once again, positive values indicate improvement, zero values no change, and negative values indicates a worsening of the postural imbalance.

All linear measurements were standardized and corrected with the mathematical formula above[20] in order to reduce possible errors inherent to the image processing and to express values of the individual real discrepancy:

$$\frac{RV}{50} = \frac{MS}{A} \longrightarrow RV = \frac{MS \times 50}{A}$$

RV: real value of postural discrepancy in millimeters; MS: measure, in millimeters, obtained by tracing in photography; 50: value in millimeters of the edge of the background's square; *A*: arithmetic mean of the three background's edges.

Once the subject and the panel are at different distances from the camera, the measure of "*A*" should be corrected inversely proportional to the distance between the panel and the subject:

$$\frac{A}{A\ corr} = \frac{D}{D - d} \longrightarrow A\ corr = \frac{A \times D}{(D-d)}$$

A corr: corrected "*A*" value; *d*: distance between the subject and the background grid; *D*: distance between camera and background.

Statistical analysis

All statistical analysis was performed using Kruskal–Wallis analysis.

The variable used in all statistical tests was the relative gain (RG) measured before and after treatment.

RG = 100 × (post − pre)/pre in the case where increase means improvement or RG = 100 × (pre − post)/pre in the case where decrease represents improvement.

Results

The mean age and standard deviation for all the groups was 21.5 ± 1.7 years. All subjects were single female students.

Table 1 presents data concerning the assessment of posture, obtained by tracings made on photographs of the sagittal plane. These values represent the difference pre and post treatment. The first measure was the distance between an imaginary malleolar line and the acromion and the second was the distance of this line to the intertragic notch.

The Kruskal–Wallis result to the line-acromion measure, comparing the relative improvement from the three groups, was $p = 0.08$. The p value found for line-intertragic notch was 0.29.

Table 1 Mean and standard deviation of line-acromion and line-intertragic notch.

Variables	MCT	SST	CG
Line-acromion (cm)	2.21 ± 2.2	0.87 ± 2.1	−0.5 ± 2.0
Line-intertragic notch (cm)	1.23 ± 1.7	0.34 ± 1.9	−0.27 ± 1.6

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Table 2 Mean and standard deviation measures the anterior superior iliac spine (ASIS) and acromion on the frontal view.

Variables	MCT	SST	CG
ASIS (cm)	1.74 ± 0.8	−0.48 ± 1.1	0.2 ± 0.9
Acromion (cm)	2.11 ± 1.7	−0.16 ± 1.3	0.17 ± 1.2

Table 3 Mean and standard deviation of the measures outlined for photographic variables scapula and posterior superior iliac spine (PSIS) on back view.

Variables	MCT	SST	CG
Scapula (cm)	1.28 ± 1.8	1.66 ± 1.4	0.4 ± 2.1
PSIS (cm)	2.13 ± 1.9	0.58 ± 0.9	0.05 + 1.5

Table 2 shows the values obtained from tracings of frontal plane with ventral incidence, where it was possible to measure the tracings of the anterior superior iliac spine (ASIS) and the acromion.

Calculating ASIS, comparing the relative improvement of the three groups, was founded $p < 0.001$, concluding that there is significant difference between groups. Comparing only CG and SST Groups the p value was 0.53, and thus the conclusion is that it is not possible to reject equality between the SST and CG Groups, but we reject it for the MCT Group ($p = 0.01$).

In Table 2 is possible to see also the variable acromion. The value of p when comparing the relative improvement of the three groups was <0.001, made possible the conclusion that there is significant difference between groups. Comparing only the two groups and SST and CG in a non-parametric way, the p value was equal 0.79, and so it is not possible reject the equality between SST and CG groups. MCT and CG had a $p = 0.001$.

Table 3 shows the mean and standard deviation of the data for the frontal plane with dorsal incidence, where it was possible to study the distance from the bottom edge of the scapula. In the variable scapula, when comparing the relative improvement of the three groups the value of p was 0.35. It is not possible to reject equality between the groups.

Again, Table 3 shows the mean and standard deviation of the posterior superior iliac spine (PSIS) and in relation to the PSIS, the result comparing the relative improvement of the three groups was $p < 0.001$, allowing the conclusion that there is significant difference between groups. Comparing only the two groups, SST and CG $p = 0.57$, and equality cannot be rejected for the MCT group. MCT and CG had a $p = 0.001$.

Discussion

In physical therapy stretching exercises are used to correct and prevent postural deviation, increase flexibility and allow a greater range of motion.[1–5]

Therefore, based on the literature, the initial hypothesis was that individuals performing stretching exercises would improve the postural alignment. The data showed that postural alignment on the MCT Group was more effective in three of six variables. SST group was not statistically different from the CG in any of the tested variables.

These results are consistent with those obtained by other authors who used SST aiming to lower muscle shortening[21,22] or tension to achieve a better posture and also found no statistical significant differences when studying postural improvements using stretches.[21–23] Shortening or tightness of the muscle are both factors that can produce an imbalanced posture.[24–28]

A possibility for the postural differences obtained on MCT group is that SST stretching allows for compensatory movements to occur using other parts of the body which may eventually lead to insufficient stretching of the specific groups of muscles that need to be stretched.[2]

Another possible reason is that MCT engages the muscles in a eccentric contraction during the applied stretch, while SST provides a mere passive stretch. Literature support that eccentric contraction during stretching is more efficient compared to passive stretch.[2,29–31]

Muscles contain a variety of afferent receptors like the Golgi tendon organs, responsible to sense changes in tension, and muscle spindles, responsible to sense changes in length. This proprioceptive information modulates reflex responses which are related to postural maintenance.[32] Other authors suggested that the development of proprioception might be the main factor for realignment of the posture.[26] Perhaps the MCT, treating all the muscular chain at once produces a bigger postural proprioceptive stimulation.

But not just the muscle is responsible for maintaining the posture but the fascia as well.[13,33] The fascia is a type of connective tissue that surrounds

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and joins muscles, bones and organs,[33,34] having important tension lines at the same place and direction of the muscular chains used by the MCT.[13] It seems that, in order to effectively stretch the fascia, is important to hold the stretch at least 90 s[33] and the passive stretch commonly used has a thirty seconds duration[4] as well as the SST utilized on this work. Consequently, the fascia may be responsible for the differences found on our results.

The MCT treats the postural deviations from proximal to distal. It first corrects the compensation of the spine and later the deviations from peripheral segments, such as the shoulders. It would not be interesting to make a primary correction at the shoulders letting central regions compensate, like an increased lordosis at the lumbar spine or even worse, a kyphosis at the lumbar spine, because if this anti anatomical position is sustained for too long it can worst the posture on that segment in the same way a good position can improve the posture. The spine also holds the spinal chord and its nerve roots, so it can be dangerous let the spine compensate. Thus, the variables ASIS, acromion and PSIS which relate to trunk and spine postural changes had differences statistically significant.

The same does not happened with the variables line-acromion, scapula, which relate to the positioning of the shoulder girdle and line-intertragic notch, related to the positioning of the head. Possibly these last three variables could provide a more substantial improvement if the treatment time was greater. Another explanation for that could be that the MCT, how it was practiced in this study, was better to improve the symmetry on the frontal plane then to improve the balance on the sagittal plane. Maybe a greater stretch at the anatomical trains that pass through the shoulder and arm could show a better result.

A great difficulty found on that study is about the anatomical spots to be marked. A lot of spots are easily mistaken giving no entirely trustful measures. Because of that we were limited to just six measures that may not pass the reality of the whole postural changes. Other type of measures could give others results. Maybe values based on angles could be better.

More research is needed in order to evaluate the permanence of the postural changes; evaluate pain relief; better joint function; to understand the effects on a bigger population including male subjects and bigger range of age of the subjects. The investigation of some pathologies like scoliosis and the use of other ways of postural measures like force plate, electromyography, goniometry or range of motion should be encouraged.

Conclusion

In terms of postural improvement, the MCT lengthening was better than the SST and CG variables in ASIS, PSIS and acromion; groups behaved the same way in variables line-intertragic notch, line-acromion and scapula. Therefore, the MCT showed better results the treatment of postural alignment in the present study, being proposed for use in this type of problem.

The evaluation parameters used in this work are not the only ones. Future studies including electromyography, balance measured by the force plate or shooting posture dynamically instead of static, can contribute to new data and other points of view on the subject, in order to better highlight the applications of these methods of treatment.

Competing interests

The authors state they have no competing interests.

Contributions

J.L.P.R. and A.P.M. developed the concept for this research. J.L.P.R., I.Y.N., K.R., D.K. and A.P.M. and H.N. designed the study. J.L.P.R. analyzed the data. J.L.P.R. wrote the first draft of the manuscript and all authors approved the final version.

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