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Acupuncture Improves Flexibility: Acute Effect of Acupuncture Before a Static Stretch of Hip Adductors

Alessandro O. de Carvalho, PT, Leonardo Cabral, PE, and Ercole Rubini, MSc

ABSTRACT

Background: Acupuncture has been used for many years to treat illnesses and seems to have benefits when combined with other interventions such as exercise, although little investigation has been done of this relationship.

Objective: The aim of this study was to investigate the acute effect of acupuncture on the maximum range of motion of hip abduction.

Design, Setting, and Subjects: This study was a randomized controlled trial carried out on 44 healthy and untrained undergraduate students at a university located in Rio de Janeiro, Brazil.

Intervention: Subjects were randomly assigned to four groups and received one session of acupuncture treatment, followed by four sets of static stretches of the hip abductors. Group 1 (G1) participants were treated with acupuncture in five points (acupoints), followed by stretching of the hip abductors (n = 10). Group 2 (G2) was given the acupuncture treatment in the adductor magnus muscle (no-acupoints), also followed by stretching of the hip abductors (n = 12). Group 3 (G3), the control group, was given a placebo acupuncture treatment succeeded by stretching of the hip abductors (n = 10). Group 4 (G4) received treatment of just the acupoints, with no stretching (n = 12).

Main Outcome Measure: Maximum range of motion of hip abduction was evaluated with a flexometer before and after intervention.

Results: There was a significant increase in the amplitude of hip abduction when measures before and after the intervention were compared in G1 (P = 0.007; confidence interval [CI] 95%, = −7.46 to −1.54) and G2 (P = 0.009; CI95% = −13.14 to −2.36). There was no significant difference in the comparison between groups (P = 0.399).

Conclusions: The results have demonstrated that the accomplishment of an acupuncture application in acupoints and no-acupoints before exercises of static stretching can generate an acute significant increase on hip range of motion.

Key Words: Acupuncture, Range of Motion, Muscular Relaxation.

INTRODUCTION

Acupuncture is a therapy that has been used by the ancient Chinese Traditional medicine (CTM) for approximately 2500 years and has been practiced in the West for a few decades, where this therapy has become well-known for its analgesic and anesthetic effects and for treating a certain number of orthopedic, rheumatic, respiratory and neurological diseases.¹ According to CTM, there is a network of meridians (jingluo) connecting functional
organs in the human body. Acupuncture at specific acupoints along the meridians exerts therapeutic effects on nearby and/or distant regions. The physiological effects are yet to be well-explained, and some researchers have observed the interaction between the effects of acupuncture and physical exercise, showing that acupuncture appears to improve exercise performance, although the mechanisms of how it does so are not well understood.

Stretching is an activity included in most training programs and is practiced by professional athletes and practitioners of recreational exercise for flexibility training. Some of the physiological effects of stretching in the musculoskeletal complex are similar to those of acupuncture, mainly in relation to the decrease in pain perception and analgesia. The main physiological effects of muscular stretching are the viscoelastic accommodation in the tendon–muscle unity, increased tolerance for stretching, and decreased excitability and that of 1a fibers. These effects generate mechanical and neurophysiological responses of which the most commonly observed results are muscular relaxation and gain in range of motion, induced by an increase in the threshold of nociceptors and by a decrease in passive tension in the muscle.

The analgesia caused by acupuncture seems to occur through the change in the perception of pain, which is generated by the nociceptive inhibitory action in the spinal cord, as well as by the activation of several cortex areas, such as the somatosensory area, hypothalamus and limbic system. Some researchers have observed the effects of acupuncture in the central nervous system (CNS) in areas such as the hypothalamus, nucleus accumbens, and descending nociceptive structures. A theory presented by Langevin about one of the traditional acupuncture techniques, the “De-Qi” (i.e., a sensation of shock that can occur after inserting an acupuncture needle), showed this to be essential to the effectiveness of acupuncture therapy, for De-Qi generates a biomechanical response that involves the connective tissue. The sensation of De-Qi seems to activate nervous fibers, generating inhibition of pain in the spinal cord and in the brain.

Both methods, acupuncture and stretching exercises, present similar physiological effects with respect to analgesia caused by nociceptive inhibitory action. Our hypothesis is that acupuncture given prior to passive stretching of hip adductors will enhance abduction range of motion (ROM) more than stretching exercises alone.

This study aims to compare the acute effects of acupuncture on adjacent traditional acupoints (Dadun LR 1, Taichong LR 3, Ququan LR 8, Qugu REN 2, Yanglingquan GB 34), local no-acupoints (adductor magnus muscle), and sham acupuncture before static stretching exercise on the maximum range of motion of hip abduction.

### MATERIALS AND METHODS

#### Participants

A convenience sample of 44 healthy male subjects ages, 18–45, from the University Estácio de Sá, in Rio de Janeiro, Brazil, were invited to participate in this study. The exclusion criteria included presence of orthopedic injuries in the lower limbs; needle phobia; skin lesions; or use of anti-inflammatory drugs, nutritional supplements, or anabolic androgenic steroids. All subjects signed an informed consent form containing all information about the procedures, as well as possible risks and discomfort involved in studies of this nature. The Committee of Ethics in Research at University Estácio de Sá approved the study methods and procedures.

#### Study Protocols

Subjects visited the laboratory twice and were placed randomly into four groups. The choice for each group was made through the drawing of lots (numbers) from a previously sealed envelope.

In their first visit, subjects were familiarized with the experimental treatment according to the group to which they were assigned, and a morphologic evaluation was conducted (Table 1). Measures taken were: stature (cm), body mass (kg), and skinfold thickness. From the measures of skinfold thickness, body density was predicted through the chemical model of two compartments, using the equation proposed by Jackson and Pollock. After body density prediction, fat (%) was determined by Siri’s equation.

In the second visit, the procedures were: (1) a pretest, which corresponds to the measure of maximal hip abduction ROM; (2) experimental treatment (acupuncture); and (3) a post-test, which was the new measure of maximal hip abduction ROM being taken immediately after the treatment.

All subjects in the four groups had their eyes covered during the acupuncture treatment to minimize the possibility of any kind of motivation that might affect the results.

#### Experimental Procedures

In G1, as a pretest, the measure of maximum ROM (MRM) was taken. Immediately following this, the subjects

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>27 ± 5.8</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>71.9 ± 12.5</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>174.5 ± 6.2</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>14.4 ± 5.8</td>
</tr>
</tbody>
</table>

Values are mean ± standard deviation for age, body mass, height, and fat.
received treatment with acupuncture in five traditional acupoints: Dadun LR 1, located on the ungual lateral angle of the hallux; Taichong LR 3, in the instep, on the space between the first and second metatarsals, 1.5 cun\(^2\) from the web between the toes; Ququan LR 8, just superior to the medial end of the popliteal crease, in the depression anterior to the tendons of semitendinosus and semimembranosus muscles; Qugu REN 2, in the pubic region, on the superior edge of the pubic symphysis, on the midline of the body. These four points give origin to an extra meridian called “Jue Yin Liver Tendinomuscular Channel” (Channel of the Liver Tendon–Muscle Energy). Besides these points, Yanglingquan GB 34 was also selected. This acupoint is located in the depression anterior and inferior to the fibular head and is traditionally recommended for treatment of decreased joint mobility.\(^{29}\) Immediately after the acupuncture treatment, subjects were given four sets of static stretches for the hip adductors, each lasting 30 seconds and having an interval of 1 minute between them. The post-test, with a new measure of MRM, was performed immediately after stretching.

In G2 the pretest was done, followed by acupuncture on no-acupoints, then static stretching of the hip abductor muscles, then a post-test. Five needles were inserted along the muscular belly of the adductor magnus muscle (bilaterally); the distance between the points was 6 cm, starting from the point of origin of the muscle up to the point of insertion, taking into consideration the anatomical and morphological characteristics of the individual.

In G3, which was the control group, subjects had the pretest and then received a superficial stimulus on the same no-acupoints used in G2, where the needle was inserted in the skin and immediately taken out (sham acupuncture), similar to the studies of Vincent et al.\(^{30}\) and Goddard et al.\(^{31}\) Right after that, subjects were given the stretching protocol and the post-test.

In G4, subjects had the pretest and then were given a treatment using the same acupoints as those used with G1. This was followed by a new measure of MRM (post-test), without the stretching exercise protocol.

**Acupuncture**

The acupuncture treatment was conducted on a mattress, at the same hour of the day for all subjects, and at a room temperature of 21°C. Individual disposable needles of 0.25 × 30 mm (HUA-TUO, Korea) were used. The trained acupuncturist conducted all procedures. All acupoints selected were fixed according to muscle and bone anatomical references and the measures recommended by CTM theory.\(^{28}\) Before insertion of needles, the skin was cleaned with 70% alcohol. The needles were inserted perpendicularly, bilaterally, with stimulus of unilateral clockwise rotation for attainment of De-Qi\(^{18}\) at depths varying from 8 to 50 mm, according to the anatomical location of the points.

**Stretching**

Static stretching of hip abductor muscles was done in the same position as the test for MRM. Four sets of stretching were done with a duration of 30 seconds\(^3\) each and an interval of 1 minute between them. None of the subjects performed any kind of exercise involving the adductor muscles of the hip joint from 24 hours preceding the beginning of the study to the end of the study.

**Flexibility Outcome Measure**

Two flexometers (FLs; Fleximeter, Instituto Code de Pesquisas, Code Institute of Research, Brazil) were used for the measure of joint ROM. Three trained evaluators applied the tests. The first evaluator performed the maximum passive stretching on the subjects. The second and third evaluators were responsible for reading the amplitude of movement, in degrees, in the FLs.

The FLs were fixed right below the head of fibula, having their faces placed right below the tibial tuberosity. Each subject stayed lying with his or her back on the ground, with the hip flexed at approximately 90°, with the knees totally extended, the gluteus and the lower limbs leaning against the wall. Both FLs started from 0°, which is the angle associated with the position in which the feet touch each other. The feet of subjects stayed united and in slight abduction, leading the hip to a slight external rotation during the test (Fig. 1). After putting the subject in the right position, the first evaluator calibrated the FLs to 0° and then performed the stretching of the hip adductor muscles, pressing the subject’s thighs down with the hands by touching them right above the knees, and preventing the knees from flexing (Fig. 2). MRM was measured when the subject reported discomfort (pain). This position was sustained for about 3

**FIG. 1.** Initial position of the measure of flexibility and stretching exercise for hip abduction.
seconds, so that the evaluators could read the measure. The second and third evaluators were placed on each side of the subject, reading the measures for each leg when the point of MRM of the hip adduction was reached.

The final measures read on both FLs was added up, and the result was considered the MRM. A pilot study performed with 45 volunteers showed that these measurement procedures have 95% limits of agreement of $-10.1^\circ$ to $-17.3^\circ$ and high intraday reliability (ICC = 0.91; confidence interval [CI], 95% = 0.80–0.95).

Statistical Analysis
A paired t-test was used to determine the effect of the treatment on the amplitude of hip abduction, from the pre- to postintervention situation. A one-way analysis of variance (ANOVA) of the percent rates of change from the moment of pretreatment to the moment of postintervention was used to determine the effects of the different types of treatment on hip ROM. Tukey’s post hoc test was used when F was significant. All analyses were done by the statistical pack SPSS® v.13.0 (SPSS Inc., Chicago, IL). The level of significance used was $P \leq 0.05$.

RESULTS
In the intra-group analysis, groups G1 ($P = 0.007$; CI 95% = $-7.46$ to $-1.54$) and G2 ($P = 0.009$; CI 95% = $-13.14$ to $-2.36$) showed significant differences from pre- to postintervention. There was no significant difference from pre- to postintervention in groups G3 ($P = 0.115$; CI 95% = $-12.39$ to $1.59$) and G4 ($P = 0.079$; CI 95% = $-9.08$ to $0.58$; Fig. 3). The ANOVA showed no significant difference in the delta (%) between the groups ($P = 0.399$).

DISCUSSION
The results have shown that, in an acute form, there was a significant difference in degrees of flexibility in hip abduction in subjects treated with static stretching preceded by acupuncture either in acupoints (G1) and no-acupoints (G2).

Our hypothesis was that the acupuncture treatment given before performing stretching exercises would improve flexibility of hip abduction more than stretching exercises alone. These results were observed in groups G1 and G2, but not in the comparison between groups.

Until this time, no study specifically investigating the effect of acupuncture on flexibility has been published, which makes the comparison of these results more difficult. Experimental study results have shown combining acupuncture treatment with exercise therapy is beneficial. In one of the few studies that measured the effect of acupuncture on flexibility, Huguenin found no significant differences in ROM for internal rotation or flexion of the hip after treatment with acupuncture intervention.32 Among the limitations of that study was that the evaluation of flexibility was made via pictures and treatment with acupuncture where needles were inserted only superficially into the skin.32 Another study by Edwards and Knowles showed a significant improvement in myofascial pain in the group treated with an intervention that combined acupuncture and active stretching exercises, compared with a group treated only with active stretching exercises and a control group.33

There is a consensus about the alteration in the perception of pain and in the analgesia caused by the stimulus of acupuncture needles, either in acupoints or in no-acupoints.2,17,32,33 Chu34 reported that insertion and intra-muscular manipulation of acupuncture needles may generate depolarization of single muscle fibers and electromyographic
alterations classified as micro-twitches. These micro-twitches are capable of causing a “micro” stretching effect in the shortened fibers adjacent to the stimulated muscle and reducing the effect of mechanical traction of those fibers in nociceptive structures, including nerves and intramuscular blood vessels. As a result, muscular relaxation may occur in the stimulated area through the increase of blood circulation, which may induce the relief of local muscular pain. This, in turn, may have an effect on the gate of pain in the spinal cord.

Two studies confirm this hypothesis, as the researchers observed, through photoplethysmography, evidence of local increase of blood circulation after acupuncture treatment in the tibialis anterior muscle in healthy subjects and in the trapezoid muscle in subjects with fibromyalgia. Other studies, however, demonstrate that there is a possible controversy about the hemodynamic alteration caused by acupuncture. Knardahl observed an increase of 15%–20% in muscle electrical activity and increased tolerance of pain immediately after 30 minutes of treatment with electro-acupuncture, and this effect remained high at between 10 and 30 minutes after the intervention. Kimura conducted a stimulus with acupuncture for 2 minutes in 12 volunteers and found similar results regarding the increase of muscular activity and decreased skin perfusion during acupuncture stimulation. Both studies showed a negative correlation between the hemodynamic and autonomic responses that occurred during acupuncture.

One comprehensive literature review states that the alterations of the nociceptive system occur as a result of noxious stimuli—chemical, mechanical, or thermal in nature—in the skin or in the muscular and visceral tissues, and that those stimuli are perceived primarily by the afferent free nerve endings (fibers C and Aδ). Fibers C and some fibers Aδ innervate areas near the vascular wall in the muscular tissue in the zones of muscle–tendon insertions and in the tendons themselves. These fibers are susceptible to noxious mechanical stimulus such as stretching, torsion, and compression. De La Peña et al. also corroborated this hypothesis in their study. High thresholds of tensile or compressive stimulus generate a mechanism of transduction, and this results in the activation of cation channels in the free nervous endings, as well as neurochemical alterations in the neural membrane (increase in the influx of Na⁺, K⁺ and Ca²⁺, for example). The activation of cation channels occurs from the distortion of the collagen bridge between the free nerve endings and adjacent tissues. The depolarization of the nociceptor membranes occurs as a result of neurochemical alterations, and, as a consequence, there is an increase in their thresholds. Utilizing this knowledge, we can suggest that the stimulation with acupuncture needles (a “harmful” stimulus) and stretching exercises (a mechanical stimulus) cause alterations in the nociceptive system and that both forms of stimulation have a common physiological pathway.

In the case of acupuncture, one study on the remodeling of fibroblasts in the subcutaneous tissue and the possible mechanisms of mechanotransduction brought about by acupuncture through the connective tissues, reported that alterations in the extracellular matrix caused by the manipulation of acupuncture needles may generate modulation in the entrance of sensory stimuli in afferent nociceptors.

Another hypothesis of our study concerns the relation between tissue alterations and the neurophysiological responses caused by acupuncture and stretching exercises. There is a possible increase of the articular amplitude promoted by the stimulus of acupuncture through the mechanism of mechanotransduction; (i.e., mechanical alterations in the connective tissue generated by the insertion and rotation of the needles and, in the case of stretching, the mechanotransduction promoted by the pulling of the muscular tissue). Common to both interventions is the alteration of nociceptive thresholds and the increase of tolerance to pain. Although it has not been investigated in a direct way, the improvement in flexibility after acupuncture and stretching exercises in the comparison of two groups that received the treatment with different techniques, either only stretching exercises or only acupuncture, demonstrate the viability of this hypothesis, but other studies must be carried out to investigate this further and more objectively.

CONCLUSIONS

To the best of our knowledge, this is the first study to show that the use of acupuncture before performing a static stretching exercise for the hip adductors can generate a significant acute increase in flexibility. In the comparison between the groups who received acupuncture and static stretching with the control group (stretching exercises only), the first intervention proved to be significant in the comparison of pre- and postintervention results.

Acupuncture associated with stretching exercises is a clinical practice used by acupuncture specialists, and it may become useful in the treatment of injuries and/or training of athletes or practitioners of recreational exercises who need an acute increase of flexibility to perform a specific activity. Some of the physiological effects of acupuncture and of skeletal muscle stretching are similar, such as muscular relaxation and the increase of pain tolerance, which can justify the association of these methods for greater flexibility.

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DISCLOSURE STATEMENT

No competing financial interests exist.

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