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Effect of Acupuncture on delayed onset muscle soreness: series of case studies

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Abstract

Delayed onset muscle soreness (DOMS) is a common form of muscle soreness, experienced by individuals who perform unaccustomed exercise as a result of exercise induced muscle damage (EIMD) (Aminian-Far et al., 2011). Scientific studies have shown contradictory results on the effects of acupuncture on DOMS.

The aim of this study was to evaluate acupuncture effects on DOMS. For this preliminary study, 3 healthy participants, after completing a screening questionnaire and providing written informed consent, were randomly distributed into three groups (verum acupuncture group (VA), sham acupuncture group (SA) and a control group (CG). Pressure pain threshold (PPT), vertical jump (VJ) and an isokinetic evaluation were performed before and after (immediately and after 24h) an EIMD protocol which subjects performing a five sets of 20 drop jumps from a height of 0,6m step, with a 10 seconds interval between jumps and 2 minutes rest period between sets.

The present protocol of EIMD showed success in inducing DOMS. When VA, SA and CG groups were compared, it was found that VA had better results in all outcome measures. However, SA group showed better results than CG, when PPT was compared.

As a conclusion, the results showed that acupuncture applied after an EIMD protocol, had a positive effect on PPT, VJ and Average Peak Torque.

Key words: Acupuncture, Traditional Chinese Medicine, delayed onset muscle soreness, exercise induced muscle damage.

Introduction

Delayed onset muscle soreness (DOMS) is a common form of muscle soreness, experienced by individuals who perform unaccustomed exercise as a result of exercise induced muscle damage (EIMD) (Aminian-Far et al., 2011). It results in symptoms such as: tenderness, edema, muscle stiffness, and typically involves an eccentric component, and has a peak between 24 and 48 hours post-exercise and spontaneously disappears within 5 to 7 days (Aminian-Far et al., 2011; Torres et al., 2012).

Research commonly suggests that DOMS is the result of an inflammatory process caused by micro-tears in the muscle fibers during unaccustomed repetitive activity and/or eccentric contractions (Barbe, Barr, 2006;Barr, Barbe, Clark, 2004) but it has also been suggested that muscle soreness can occur without micro-trauma (Zainuddin, Newton, Sacco, Nosaka, 2005).

While western medicine attributes DOMS to local inflammation, due to either mechanical damage or swelling, leading to ischemia and muscle spasms, Traditional Chinese Medicine (TCM) views DOMS as localized "*Qi*" and "*Xue*" stasis that manifests as pain and soreness of the joints, muscles and/or tendons. Collectively, this is known as muscle Bi-syndrome (Xinnong, 1987).

Acupuncture has shown to increase of muscular power (Huang, et al., 2007; Hubscher, et al., 2010; Ozerkan, et al., 2007; Yang, et al., 2006; Zhou, et al., 2012), to improve microcirculation (Kuo, Lin, Ho, 2004), to decrease inflammatory processes (Moon et al, 2007), to inhibit spinal and supraspinal nociceptive transmission (Ikeda, Asai, Murase, 2000), as well as to improve vertical jump (Sousa, 2012). Therefore, from a theoretical standpoint acupuncture might be an attractive, beneficial, low-cost, quick and low-risk treatment strategy for DOMS treatment, improving performance on athletes and productivity in workers.

The major aim of this study is to evaluate the effects of acupuncture on DOMS.

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Materials and Methods

Ethics - All research was undertaken at Hospital-School of Fernando Pessoa University and was previously approved by the Ethical Committee of Fernando Pessoa University. All participants signed an informed consent form in accordance with the Helsinki Statement being informed that they could quit at any moment without consequences and guaranteeing them anonymity.

Table 1. Sample data characterization

Variables	N	Gender	Age (years)	Weight (kg)	Height (cm)	BMI (Kg/m^2)
VA	1	Male	24	57	160	22,27
SA	1	Male	24	74	175	22,44
CG	1	Male	24	74	188	20,94

Recruitment - The sample of this study was only comprised of a total of three university students volunteers. The subjects were randomly divided in three groups using a software available *at www.graphpad.com/quickcals*: in a *verum* acupuncture group (VA), a sham acupuncture group (SA) and a control group (CG) with no loss in the follow up period.

Treatment Protocol - Participant in the VA was submitted to an acupuncture treatment using the "Leopard spot" technique (Greten, 2010) in the acupuncture points of S34 (*liangqiu*), S36 (*zusanli*), and H3 (*taichong*), on the non-dominant limb with an insulin needle, in the SA he received the same technique but in three other points also on the non-dominant lower limb, but that were not associated with any conduit (with no therapeutic evidence). The CG didn´t received any type of treatment.

For the execution of acupuncture protocols, all participants were positioned in the supine position and received treatment at total rest. All participants were blinded regarding the treatment and didn`t know to which group they were allocated (Witt, et al., 2005). Once properly disinfect the skin, the participants were intervened in points according to the group. The points were selected by experts' practitioners. The selection of points in VA was based on the Heidelberg model of Traditional Chinese Medicine (Greten, 2010). The "Leopard spot" technique consisted in 5 quick penetrations on skin (Hauer, et al., 2011; Nabeta, and Kawakita, 2002) in the selected points. The penetration depth was controlled by the size of the blade of the insulin needles (Hauer, et al., 2011).

Outcome measures

Biometric data collection - After the biometric data collection, weight and height of participants was accessed to calculate body mass index (BMI) and age in order to guarantee the homogeneity of the participants. Leg dominance was then assessed by asking the participant to kick a ball to the researcher, after having received it the same way (Lucena et al., 2010).

Pressure pain threshold - Pressure pain threshold (PPT) was assessed using a pressure algometer (Wagner Fdix®, USA). Constant pressure was exerted until the participant felt the lowest stimulus intensity at which an individual perceives mechanical pain at one reference point, marked on the thigh, along a line drawn from the anterior superior iliac spines to the superior pole of the patella. The point was at 5 cm above the superior pole of the patella (representing the musculotendinous junction) (Sellwood et al., 2007). The PPT recordings were carried out in a seated position with a 90˚ angle in the hip and knee joint and performed three times. The best result of PPT of the 3 recordings at each location was used in further analysis. During PPT recordings, the algometry was applied perpendicular to the skin (Aminiain-Far et al., 2011; Law et al., 2008). The subjects were instructed to say "yes" as soon as the pressure exerted by the algometer became "slightly unpleasant", as has been proposed in similar studies (Vanderween et al. 1996; Dhondt et al.1999) and was preferred to using the expression "pain" alone.

The vertical jump -Vertical jump (VJ) performance was performed using the ErgoJump® dynamometer (Globus®, Italy), which participants assumed a squat-jump test position. The subjects were then asked to perform 3 jumps with 2 to 3 minutes between jumps and it was chosen the best of the 3.

Isokinetic strength - After the above mentioned measurements, participants warmed-up in the cycle-ergometer (BH Fitness®, Confort Evolution) for 5 minutes, with a resistance equivalent to 2% of body weight, at a moderate power (50W) to avoid fatigue (Aminiain-Far et al., 2011).

This evaluation was assessed using an isokinetic dynamometer (Biodex System 4®, Biodex Medical Systems, Inc., Shirley, NY, USA). Participants performed the evaluation which consists of 1 set of 10 maximal concentric contractions of the quadriceps and hamstrings, unilaterally and in the non-dominant limb, at a running speed of 60º/s, in a range between 90º and 0º. Visual biofeedback, verbal commands and patient positioning were uniform for all groups in the study during the protocol (Barroso et al., 2010; Drouin et al., 2004).

Study Design - The study was divided in 3 phases: Pre-intervention phase, Exercise induced muscle damage (EIMD) protocol phase, and an Intervention phase

In the Pre-intervention phase the subjects, after being informed about the study design and procedures, sign a consent form. After completing a screening questionnaire for biometric and personal data, as well as, for detection of possible exclusion criteria (history of hamstring or quadriceps muscle injury, previously medical diagnosed musculoskeletal pathologies in the lower limb or renal, cardiac, metabolic, and endocrine disorders which might inhibit the performance of physical exercise, use of anti-inflammatory AID"s, pain and muscle relaxants, and individuals who had performed vigorous

physical exercise within seven days prior to the protocol (Abad et al., 2010; Milias et al., 2005). We excluded women with menstruation, pregnant, participants with intense fear of needles and any type of drugs consumption (Itoh et al., 2010) and participants who drank beverages containing caffeine or alcohol in a period of less than 12 hours prior to the measurements (Hübscher et al., 2008).

After being randomly assigned to one of three groups (VA vs. SA vs. CG), leg dominance was determined and baseline values established for the 3 separate main outcome measures on the non-dominant leg (Newton et al., 2012) in the following order: pressure pain threshold, isokinetic (average quadriceps peak torque) [Time 0 (T0)]. Vertical squat jump test was also performed using both legs to access muscle power.

In the EIMD protocol phase the participants performed the same EIMD protocol of the Miyama and Nosaka (2004a), that has been previously shown to cause significant elevation in muscle damage indices and produce DOMS (Miyama and Nosaka, 2004a; Goodall and Howatson, 2008; Howatson et al. 2012). In this protocol subjects dropped from a height of 0.6m step and jumped upward maximally immediately after landing from the box and landed on the surface again after the vertical jump. To perform the next drop jump, subjects had to climb two steps of stair into the platform. Five sets of 20 drop jumps were performed with a 10 s interval between jumps, and a 2 min rest period was given between sets. Subjects performed drop jumps with barefoot, because it has been reported that biomechanical factors are influenced dramatically by shoes (Ogon et al., 2001; Wit et al., 2000), and comparisons between bouts were thought to be easier by eliminating the effect of shoes.

Table 2, Fig 2. Differences between the groups in the different moments in PPT (kgf/cm²).

VA		SA		CG	
T0	4,63	T0	5,86	T0	4,61
T1	3,13	T1	3,59	T1	4,06
T2	4,10	T2	4,55	T2	3,90
T3	3,98	T3	4,29	T3	2,30
T4	5,05	T4	5,13	T4	2,02

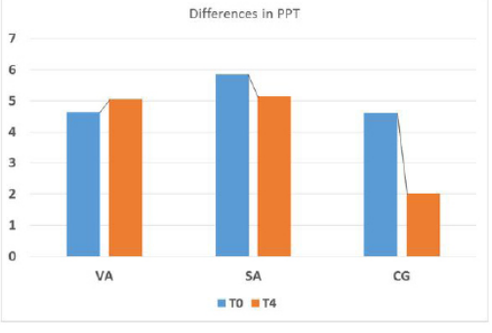


Table 3, Fig. 3. Differences between the groups in the different moments in VJ (cm).

VA		SA		CG	
T0	38,9	T0	36,7	T0	35,5
T2	38,6	T1	35,4	T1	34,7
T4	38,3	T2	33,9	T2	33,4

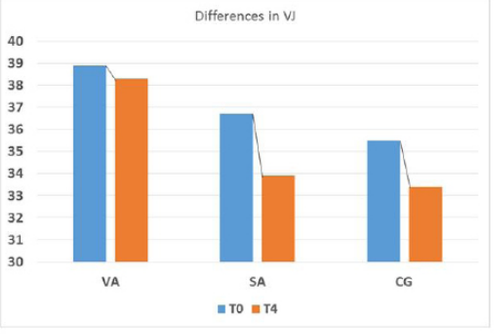
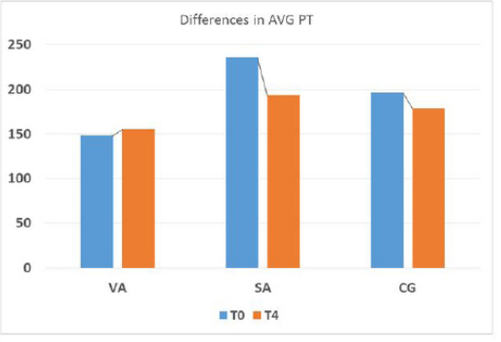


Table 4, Fig 4. Differences between the groups in the different moments in AVG PT (N.m).

VA		SA		CG	
T0	148,7	T0	235,8	T0	196,6
T2	150,6	T1	225,8	T1	190,8
T4	155,1	T2	193,6	T2	179,0



In the intervention phase, a second [Time 1 (T1), prior to the intervention], third [Time 2 (T2), 20 min after the intervention], a fourth [Time 3 (T3), 24h after, 10 min before the second intervention] and a fifth [Time 4 (T4), 24h after, 20 min after the second intervention] assessments were performed. In the T1, T2 and T3 assessments, only PPT was performed, as measures as VJ and isokinetic might exacerbate the muscle injury. In the T4 assessment, all T0 baseline measures were repeated. Acupuncture was performed or not, for 2 minutes immediately after T1 and T3 assessment moments, according the group they belong. In the CG they didn´t underwent acupuncture but a 2 minutes period of rest between assessments were assured as it was the necessary time to apply the acupuncture technique in the VA and SA groups.

Results

All groups showed different results in all outcome measures along the time. When PPT data was analyzed we found significant differences along the different moments for the different groups.

While in the CG we see a progressive decrease in PPT from a mean initial value (T0) of 4,61 Kgf/cm² to a final value of 2,02 Kgf/cm² (T4), the SA and VA groups showed an increase in PPT between T1/T2 and T3/T4, suggesting an immediate and a longer term effect of acupuncture, as the VA group was the only group that showed an increase of PPT comparing T0-T4 (Table 2, Fig 2).

When we compared the VJ in the different groups in the different moments, we observed a decrease along the different moments in all groups. However, comparing VJ values between T0 and T4, the VA

group showed a smaller decrease of VJ values, comparing to the other groups (Table 3, Fig. 3).
When we compared the AVG PT in the different groups in the different moments, VA group was the only one that increased AVG PT values along the time (T0-T4). The other groups showed a progressive decrease in AVG PT values from a initial value (T0) to final value (T4) (Table 4, Fig 4).

Discussion

In the literature, the few studies referring acupuncture effects on DOMS, present contradictory results, probably due to the kind of methodologies used in the different studies. However, in the therapeutic use of acupuncture, standardization of treatment protocols concerning the acupuncture duration, technique and the number and type of points used is not consensual or even desired, as each patient, despite subject to the same stimulus, will always present its own specific homeostatic imbalance and energetic compensation. Moreover, the muscular groups in which it was applied, the model of EIMD, and respective intensity, as the evaluator experience, varies among acupuncture studies (Barlas et al., 2000; Barroso et al., 2010; Barroso et al., 2011; Lin and Yang, 1999; Hübscher et al, 2008; Itoh et al., 2010).
In this study, was shown that DOMS worsens the PPT values like literature refers (Goodall and Howatson, 2008; Howatson et al., 2012, Jay et al., 2014; Miyama and Nosaka, 2004a). It was also found that VA improve PPT values, immediately and 24 hours after EIMD. It is important to point out that the VA results were better than the ones of the SA and the CG in PPT. This fact might suggest that acupuncture might be a factor to take into account on DOMS, especially in PPT.
Itoh et al. (2010) corroborates the results of this study showing significant differences in VAS for pain between the control group and acupuncture group immediately after treatment and three days after exercise. In the investigation of Hübscher et al (2008), there were no significant differences between groups in outcome measures at the baseline (T0). After 72 hours, muscle soreness was significantly lower in the acupuncture group compared to the sham acupuncture and control subjects. However, the mean PPT scores were not significantly different between groups. Another study which had similar results to the present study, Lin and Yang (1999) demonstrated significant reductions in muscle tenderness through acupuncture versus no acupuncture, whereas CK activity remained unchanged. These results could not be confirmed in a study by Barlas et al. (2000), who reported insignificant changes in tenderness and perceived muscle soreness when acupuncture was compared to sham acupuncture and no acupuncture. In addition, these last two studies did not include any measures of muscle function that might be, besides muscle soreness, tenderness, and inflammation, considered an important outcome when the objective is to appraise the efficacy of acupuncture in DOMS.
Literature analysis as shown several evidences of the acupuncture effectiveness on the increase of muscular power (Huang, et al., 2007; Hubscher, et al., 2010; Ozerkan, et al., 2007; Yang, et al., 2006; Zhou, et al., 2012). However, regarding VJ, some demonstrate controversial results when compared to the results in this study because in this investigation the acupuncture protocol shown a capacity to increase muscular power or more correctly to avoid a decrease in muscle performance when performing a functional task like a VJ. Some studies showed that after EIMD, muscle power decreases (Goodall and Howatson, 2008; Howatson et al. 2012, Jay et al. 2014; Miyama and Nosaka, 2004a) and this attenuation constitutes a more important finding than AVG PT as it is more applicable to real life situations. This study confirms these findings because VJ decreased in all groups (VA, SA and CG) as the other muscle power measurements (AVG PT). These results are in line with the study by Sousa (2012), where in VA group at the point S34 with the same technique used in this study, had better results in increased vertical jump in volleyball players than a SA group. The authors concluded that VA group significantly improved the VJ, while in the SA group, there was a slight loss of vertical jump.
A model of acupuncture mechanism on musculoskeletal pain conditions proposed by Gunn (1996) refers to the process of intramuscular stimulation. Muscle strength training has been shown to rehabilitate painful muscles as induces adaptation of metabolic and stress-related mRNA and protein responses in painful muscles (Sjøgaard and Søgaard, 2014) and is also one the treatment mechanisms proposed in trigger point treatments.
Eccentric and concentric exercise and trigger points have been associated with localized hypoxia which leads to the release of multiple algogenic substances like bradykinin (BK), calcitonin gene-related peptide (CGRP), substance P (SP), tumor necrosis factor-α (TNF- α), interleukin-1β (IL-1β), serotonin, and norepinephrine. Shah et al (2005) analyzed latent and active trigger points on affected muscle and, comparatively to normal muscles, found significantly increased concentrations of these substances in active trigger points, which in turn stimulate the muscle nociceptors and bind to specific receptor molecules decrease energy supply and possible increased metabolic demand which affects voltage-gated calcium channels of the sarcoplasmic reticulum and increases the intracellular calcium levels, which triggers sustained muscle contractures (Dommerholt, 2006). A similar effect can be proposed to be present in DOMS, although in this study active trigger points were not the target of treatment but could also explain the results observed when SA was used.

Conclusions

Acupuncture has been studied as a treatment for many causes of pain, being a promising treatment for DOMS because it showed that can reduce MS and improve PPT and VJ, yet with limited results in muscular power and ROM.

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