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Can acupoint S34 improve kick performance of Kickboxers?
A randomized controlled prospective study.

Dissertação de Candidatura ao grau de Mestre em Medicina Tradicional Chinesa submetida ao Instituto de Ciências Biomédicas Abel Salazar da Universidade do Porto.

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“Success consists of going from failure to failure without loss of enthusiasm”

Sir Winston Churchill

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Resumo

Introdução: Kickboxing é um desporto de combate em que são permitidos golpes de punho, perna joelho e cotovelo. Um torneio de kickboxing típico tem até oito lutas no mesmo dia; por conseguinte, a capacidade de um atleta recuperar rapidamente entre as lutas é muito importante.
A acupuntura pode ser uma maneira segura e livre de substâncias de melhorar a performance de kickboxers, uma vez que já foi demonstrado que a acupunctura no S34 pode aumentar o poder de salto e melhorar a marcha. Como o middle kick é um dos movimentos mais comuns em kickboxing, estudamos a viabilidade de observar e medir um possível efeito do S34 em middle kicks através de uma avaliação cinética e cinemática.

Material e Métodos: Para realizar este trabalho nós estudamos o middle kick de 9 kickboxers, divididos em grupo controlo (n = 4) e grupo experimental (n = 5) usando cinemática e cinética, com foco na velocidade máxima e aceleração da perna ativa, a força do pé ativo no chão antes do pontapé e duração total do movimento. Nós caracterizamos o movimento antes do exercício de esforço máximo (EEM), em seguida, pediu-se aos atletas para realizar 60 segundos de burpees (EEM), em seguida, teve lugar a fase de intervenção, a acupuntura no S34, para os atletas do grupo experimental e um descanso 2 minutos, para os atletas do grupo de controlo, e caracterizou-se novamente o pontapé.

Resultados: As medições cinemáticas que registaram uma tendência de melhoria tanto na velocidade e aceleração da perna para os atletas do grupo experimental após o eem e a intervenção, com 80% dos atletas melhorando ambos os parâmetros, por outro lado, registou-se uma tendência para a redução da velocidade máxima do grupo de controlo com 75% dos atletas que registam uma redução na velocidade máxima após o eem mas nenhuma tendência para a redução da aceleração máxima.
Em medições cinéticas, vemos uma tendência para a redução da duração do pontapé no grupo de controlo em que 100% dos atletas reduziu a duração do movimento e uma tendência para um aumento da duração no grupo experimental, onde 80% dos atletas aumentou a duração do pontapé; Estes resultados inesperados podem ser, no entanto, devidos à inadequação da técnica de medição, em relação à força do pé activo na preparação do pontapé, vemos uma tendência para um aumento na força no grupo de controlo em 75% dos atletas aumentou a força máxima e uma tendência para a redução no grupo experimental, onde 60% dos atletas reduzida a força máxima.

Conclusões: Os primeiros resultados obtidos neste estudo prospectivo não foram estatisticamente significativos, mas ainda assim mostram a viabilidade do estudo, se for utilizada uma amostra maior.
Os resultados atuais apresentam bons indícios de que a acupuntura no S34 pode melhorar o desempenho do middlekick em atletas de kickboxing nomeadamente melhorando a velocidade e a aceleração da perna e criando um movimento mais harmonioso.

Abstract

Background: Kickboxing is a full contact combat sport in which punches, kicks, elbow and knee strikes are allowed. A typical kickboxing tournament has up to eight fights (bouts) on the same day; therefore the ability of an athlete to recover quickly between bouts is very important.
Acupuncture might be a safe and substance free way to support kickboxers' performance, as acupuncture on S34 has been shown to enhance jumping power and improve gait. As the middle kick is the most common movement in kickboxing, we studied the feasibility of objectifying a possible effect of S34on middle kicks by kinetic and kinematic assessment.

Material and Methods: To accomplish this work we studied the middle kick of 9 kickboxers, divided in to control group (n=4) and experimental group (n=5) using kinematics and kinectics, focusing on the maximum velocity and acceleration of the active leg, force of the active foot on the floor before the kick and total duration of the kick. We characterized the movement before the Maximum Effort (me) exercise, then asked the athletes to perform 60 seconds of burpees (ME exercise), then had the intervention phase, acupuncture on S34, for the athletes in the experimental group and a 2 minute rest phase, for the athletes in the control group, and characterized the middle kick again.

Results: In kinematic measurements we registered a tendency towards improvement both in velocity and acceleration of the leg for the athletes in the experimental group after the ME exercise an intervention, with 80% of the athletes improving both parameters but, on the other hand, there was a tendency for reduction in maximum velocity in the control group with 75% of the athletes registering a reduction in maximum velocity after the ME exercise sand rest but no tendency for reduction in the maximum acceleration.

In kinetic measurements w registered, we see a tendency for reduction in the duration of the kick in the control group where 100% of the athletes reduced the duration of the kick and a tendency for an increase in the experimental group where 80% of the athletes increased the duration of the kick; these unexpected results might be, however, due to inadequacy of the measuring technique, and, regarding the force of the active foot on the preparation of the kick, we see a tendency for an increase in force in the control group where 75% of the athletes increased the maximum force and a tendency towards reduction in the experimental group where 60% of the athletes reduced the maximum force.

Conclusions: The first results obtained in this ongoing prospective study were not yet statistically significant, but still show the feasibility of the study if a larger sample is used.
The current results present good indications that acupuncture on S34 might improve the performance of the middle kick in kickboxing athletes namely enhancing the velocity and acceleration of the leg and creating a more harmonious flow of movement.

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1. Background

1.1 Kinematics and kinetics

Kinematics are the study of motion through image, using this technology we are able to track movements through a period of time and convert the motion in to mathematical functions that we use to understand and characterize the movement, thus studying relative positioning, velocity, acceleration and angles (Pozo et al., 2011;Thibordee & Prasatwuth, 2014). The kinematics system used in this study employs a series of infrared cameras that track reflecting markers placed on anatomical reference points on the subject; the image of the different cameras is captured and compiled in to a 3D model using a computer.

Kinetics are a branch of physics focused on the study of forces, and have been one of the most important fields of research for sports medicine. Using extremely sensitive force plates on the floor it is possible to track in a very precise manner the way in which the force from the subject's feet on the floor varies during the movement. This information is invaluable in the characterization of motion and is also added to our computer model.

These techniques have been utilized before with great success to characterize strikes in other martial arts such as Karate and Taekwondo. (Pozo et al., 2011; Quinzi et al., 2015; Thibordee & Prasatwuth, 2014).

1.2 Kicking Biomechanics

There have been a large number of works studying the biomechanics of kicking motions from different sports, such as different martial arts and football. Most of these works use kinematics and kinectics as their main tools (Abraham et al, 2001; Pozo et al., 2011; Quinzi et al., 2015; Thibordee & Prasatwuth, 2014).

Thibordee et al. (2014) studied the roundhouse kick in elite Taekwondo athletes, and described the motion as beginning with the active leg in slight ankle dorsiflexion and knee flexion, the lifting of the active leg then starts by gradually plantarflexing the ankle until reaching maximal angle, with the ankle maintaining maximal plantarflexion, the knee joint subsequently reaches maximal flexion angle, and then rapidly extends until the foot hits the target, while the foot moves towards the target, the ankle joint extends until reaching less

plantarflexion angle at the impact. After the impact, the ankle joint abruptly plantarflexes and then moves irregularly until returning to the floor. Based on the described changes in the ankle and knee angles, the roundhouse kick was then divided by the authors into four phases defined by five events. The lift-off phase was defined as a period from minimal ankle dorsiflexion angle to maximal ankle plantarflexion angle. Then, the preparation phase followed and ended at maximal knee flexion angle. The pre-impact phase subsequently occurred and ended at less ankle plantarflexion angle. Finally, the impact phase began and ended at greater ankle plantarflexion angle.

Studies using EMG alongside with kinematics and kinectics allow us to study the muscle activation patterns during the different phases of the kick, most of the studies indentify the quadriceps, namely the rectus femoris, as being the muscle group that is more active during kicking motions, being particularly active during the knee extension movement (impact phase) in soccer kicks (Brophy et al., 2007) and taekwondo front kick (Sørensen et al., 1996), during the full motion of the kick we can also identify the biceps femoris and gastrocnemius as the most important muscles during the flexion of the knee and foot, in the lift off and preparation phases, the Gluteus maximus and tensor fasciae latae are also very important in maintaining ballance during the motion. Torso muscles, such as the abdominals, erector spinae and anterior deltoid muscles, are also important in maintaining the balance of the body during the movement (Hodges & Richardson, 1997).

The quadriceps femoris, also known as quadriceps extensor, or quadricepss, are a muscle group that includes the four prevailing muscles on the front of the thigh. They are the great extensor muscles of the knee, forming a large mass which covers the front and sides of the femur.

The quadriceps femoris are constituted by the rectus femoris (occupiying the middle of the thigh, it is one of the main focuses of this work), the vastus lateralis, vastus intermedius and vastus medialis. There is a fifth muscle of the quadriceps complex called articularis genus.

All four quadriceps (Fig.1) are powerful extensors of the knee joint. The rectus femoris attaches to the ilium, it is also a flexor of the hip, making it one of the most important muscles for the kicking motion. This action is also crucial to walking or running as it swings the leg forward into the ensuing step.

The quadriceps, specifically the vastus medialis, play the important role of stabilizing the patella and the knee joint during gait (Gray, 2013; Kapanjii, 2008)

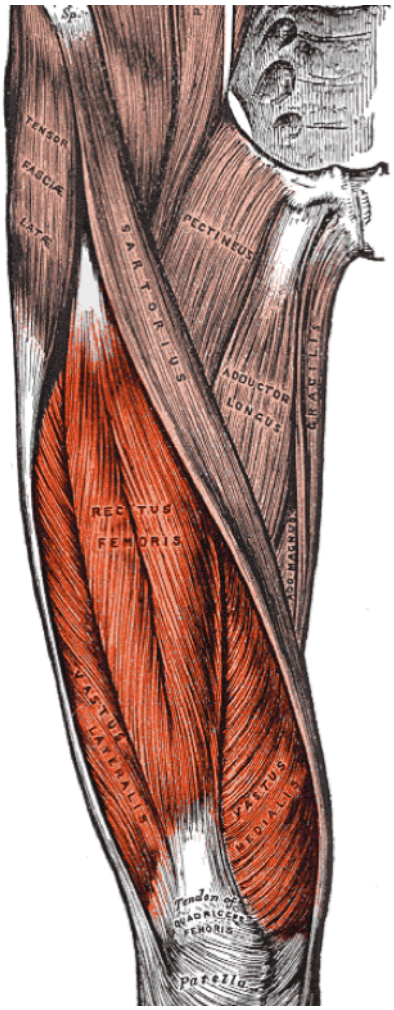

Fig. 1
Representation of the quadriceps (Gray, 2013)

1.3 Kickboxing

Muay Thai, also known as Thai-boxing is an ancient martial art originary from Thailand. The first records about Muay Thai dates back to the Sukhothai period (1238-1375), when Thailand was still known as Siam, this was a troubled period with numerous wars between neighbouring countries. Muay Thai was developed by monks who then taught it to soldiers who used it in hand on hand combat. (Duangjai, 2004)

In the 1970's a variation of Muay Thai started to develop in the west, mainly in the USA, it was a mixture of Muay Thai, Karate and western boxing, it was initially called Full Contact Karate, and it had a more defined set of rules and limitations in order to protect the athletes so it could be considered a modern sport, this sport grew in popularity during the 70's (WAKO; Ordas & Rochford, 2004). Finally in 1977 an organization called World Association of Kickboxing Organizations (WAKO) was created to regulate this sport, and with it the name kickboxing was coined.

Modern kickboxing can be defined as a full contact combat sport in which punches, kicks elbows and knee strikes are allowed (WAKO, Kordi et al. 2009). A more comprehensive analysis of the strikes allowed in kickboxing compared with other related combat sports can be observed in Table 1.

Table 1. Legal techniques and scoring areas in kickboxing and other related combat sports (adapted from Kordi et al. 2009)

Kickboxing style	Legal techniques	Legal scoring areas[a]
Thai (Muay Thai)	Punches, clinching, takedowns, elbow strikes,[b] knee strikes,[c] kicks	Head, neck, torso, upper and lower extremities
Japanese (International Rules)	Punches, clinching,[b] elbow strikes,[b] knee strikes,[c] kicks	Similar to Thai style
Chinese (San Shou)	Punches, clinching, takedowns, body throws, knee strikes,[b,c] kicks	Similar to Thai style
French (Savate)	Punches, kicks	Similar to Thai style
Indian (Adithada)	Similar to Thai style; includes pressure point techniques	Similar to Thai style
American/European (Full-Contact Karate)	Punches, foot sweeps, kicks	Except for foot sweeps, all blows are above the waist

[a] The posterior head, spine, and groin are not usually legal scoring areas
[b] Allowed variably in some organizations
[c] Head is a legal target variably with this technique

In this work our focus will be on the middle kick, which is a strike delivered with the shin to the opponents torso, similar to the taekwondo's roundhouse kick to the torso and to karate's moashi-geri (Estevan &Falco 2013, Chung-Yu Chen et al. 2013, Thibordee & Prasartwuth 2014, Pozo et al. 2011). Park (2009) defines the middle kick as a lower limb movement where the kicking leg (active leg) is lifted in an arc towards the front of the body, the knee then extends abruptly until the shin of the active leg hits the target,

In Fig.2, below we see a Muay- Thai athlete delivering a middle kick against an opponent.

Fig. 2
Middle Kick (from Muay Thai Fighting)

Modern Kickboxing requests bigger technical- tactical, psychological and conditional forms from the competitors (Kapo 1999, Krupalija et al. 2011) demanding both high aerobic and anaerobic capabilities, since, the repetitive delivery of high-power techniques makes kickboxing an anaerobically demanding sport (Francescato et al. 1995). Anaerobic replenishment of ATP is key to maximal power output, which is the maximum amount of work done in the least amount of time (Powers & Howley 2004). However, since rounds last between 2 and 4 min, and recovery is facilitated by aerobic metabolism, a kickboxer could conceivably derive more than 50% of ATP from aerobic metabolism (Kordi et al. 2009)

Zabukovec and Tiidus examined physiologic variables among elite professional kickboxers and realized that their mean anaerobic capacity was comparatively higher than that of elite wrestlers, while mean aerobic capacity exceeded that of elite karate competitors and boxers. Although the sample size

was small, limited to males weighing 68–76 kg, the researchers found that elite professional kickboxers developed relatively high anaerobic and aerobic capacities.

Both because of the growth in popularity and profitability of this sport, but also because of the evolution in training strategy and technologies, there is an ever-growing demand for stamina and athletic capabilities for elite kickboxers. In modern kickboxing tournaments the athlete may have to face up to 8 bouts in the same day and the tournament may go on for several days, meaning that there are very short periods of time to rest and recover between bouts, this creates a demand for solutions to enhance the athletes ability to recover quickly. (Kordi et al. 2009, Zazryn et al. 2003). One of the most common ways for athletes to improve their perfomance is the use of ergogenic supplements.

1.4 Ergogenic Suplements

Ergogenic effect is defined by Palacios et al. as a strategy using either nutritional, mechanical, psychological or pharmacological methods to improve ones physical capabilities and performance.

The consumption of performance enhancing supplements has increased among professional and amateur athletes, being one of the few industries that did not decline during the recent worldwide economic crisis this increase is due to the growing demands in physical capability in sports worldwide; this increased demand generated a market knish that is also in the uprising, there is a wide variety of supplements ranging from energy drinks to more complex supplements.targeted more specifically to performance athletes. (Gabriels et al. 2015, Sorkin et al. 2014)

Recent studies show that in the USA more than 85% of amateur athletes have already used some kind of supplement seeking ergogenic effects (Garrido et al. 2015, Hoyte et al. 2013)

Although there is wide range of products being marketed as ergogenic supplements not all of them have been properly tested, either for efficacy or, more important, for safety; and even those that have been tested can present nefarious side effects specially if the athlete consuming them is not seeking proper medical counselling. (Gabriels et al. 2015. Garrido et al. 2015)

1.5 Acupuncture in sports

Acupuncture literally means to puncture with a needle, it is one of the most important and well known components of TCM practice, it consists on the use of needles applied to different points along the body (acupoints) (Lu et al, 1990) .

The use of acupuncture has been shown to effectively treat many types of conditions. In 2003 the World Health Organization (WHO) and the National Institutes of Health (NIH) released a report called "Acupuncture: Review and Analysis of Reports on Controlled Clinical Trials, in it there is a reference to over 30 illnesses against which acupuncture treatments have proven to be effective (Zhang 2003).

Experiments show that acupuncture treatments can yield several beneficial effects for athletes including alleviation of muscle tension, improvement of local blood flow, increase of pain threshold, and modulation of the autonomic nervous system (Bardas et al. 2000, Knardahl et al. 1998). In fact, acupuncture has been used to treat injury, reduce fatigue, and to help manage the physical condition in many athletic fields (Karvelas et al. 1996, Miyamoto 1997)). There are however few scientific studies on the physiological effects and eficacy of acupuncture treatment in athletes (Akimoto et al. 2003, Peltham et al. 2001).

Several studies in neurophysiology concluded that acupuncture has the main function to mediate the body homeostasis.

Regarding the physiological mechanism behind the action of acupunture, there are three general mechanisms that gather the most consensus:

Energetic model – Interprets the conduits (to be discussed in the TCM chapter) as information pathways, and the acupoints as inputs. (Guan-Yuan, 2006; Porket & Hempen, 1995).

Neural model – Focusing on neural reflexes, such as the spinal reflex (Guan-Yuan, 2006).

Humoral model – Refers to the production of substances that are secreted into the blood through the action of acupuncture, like hormones and neurotransmitters (Guan-Yuan, 2006).

1.6 TCM

Throughout its history mankind has looked for ways to diagnose and treat disease, multiple therapeutic strategies have been developed in several different geographic areas and in different times, one of the oldest therapeutic systems created over 5000 years ago originated from Asia and is now known as Traditional Chinese Medicine (TCM). Although the records for the beginning of this practice are scarce, archaeologists have found artefacts used for acupuncture, such as, stone and bamboo needles dating from 4000 B.C. (Greten 2010, Hempen & Chow 2006)

The oldest medical book known about TCM is the Wangdi Neijing, known in English as the Yellow Emperor's Classic in Internal Medicine, scholars date it to the Han period, around 220 BC. (Wang B. 2013). In this book for the first time there are references to some of the most important concepts of TCM, that still stand today as cornerstones of the theory of TCM practiced all over the world, concepts such as the 12 meridians or conduits, the concept of inner and outer organs, the diagnose in TCM and even Yin Yang and it's application to TCM practice and diagnose. (Hempen & Chow 2006, Wang B. 2013).

The concept of Yin and Yang had is much older, it was in fact described although in a more abstract and philosophical way in the I Ching, in english The Classic of Changes, one of the older books ever published dating as far back as the Western Zhou period (1000-750 BC), this is a book dedicated to cosmology, divination and philosophy, this book was of extreme importance to the development of the Heidelberg Model of Chinese Medicine, to be described in more detail further in this chapter. (Greten 2010, Kern & Martin 2010)

TCM, along with other complementary medicines has seen a growing demand in the last decades. The OMS estimates that that 60 to 80% of the chronical patients, from developed countries, have already tried some kind of complementary medicine. The growth of the complementary medicines is due to some of the limitations, both in diagnostics and treatment, of the conventional medicine. (Greten 2010)

Kroenke & Mangelsdorff have shown that a tremendously high number of complaints from out-patients recurring to conventional medicine hospitals can't be correlated to measurable laboratorial parameters, this is illustrated in Fig 3.

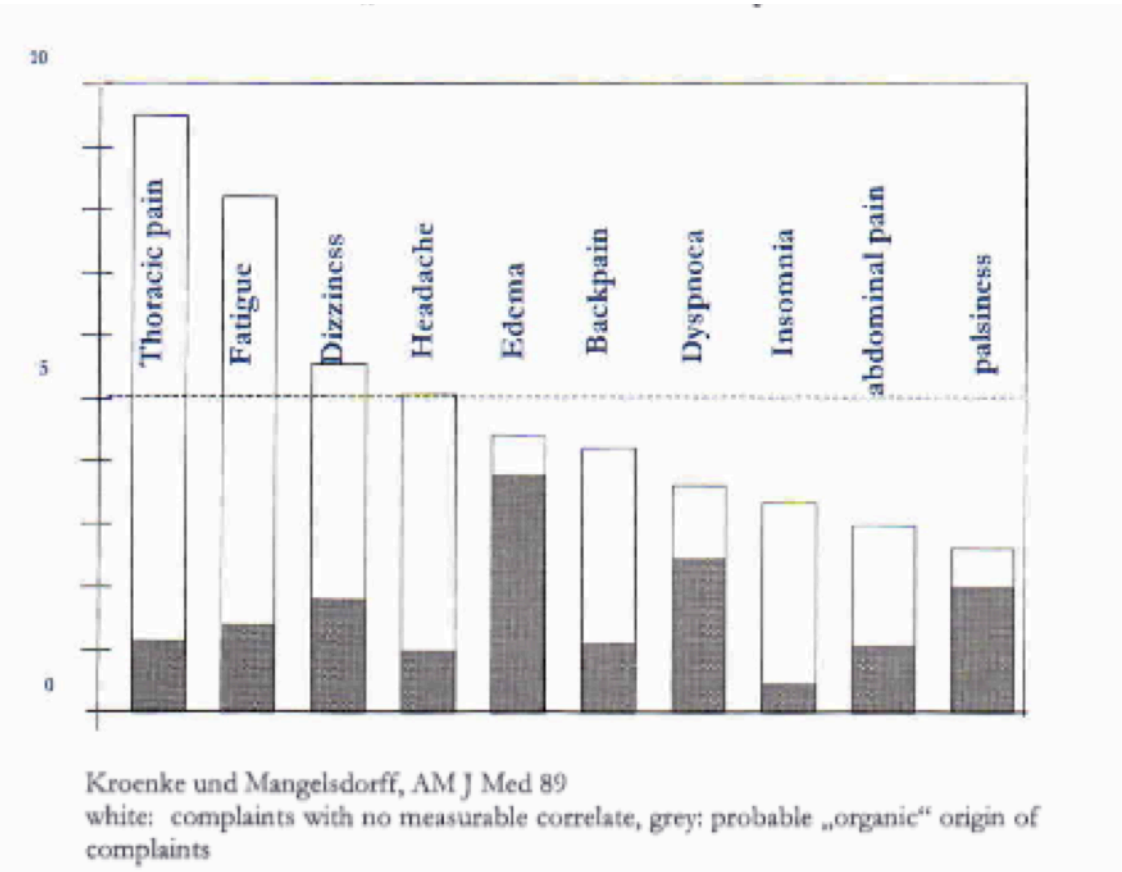

Fig. 3
Results of the study by Kroenke & Mangelsdorf regarding the medical the complaints of out-patients in American hospitals. (Adapted from Greten 2010)

1.6.1 Heidelberg Model of TCM

The Heidelberg Model (HM) of TCM is a modern and scientific approach to the traditional teachings of TCM, created in order to promote its integration in a modern, medically and scientific evolved society. This model was developed by Prof. Johannes Greten using as basis some of the groundbreaking work of Prof. Manfred Porkert. (Greten 2007).

Greten 2010 defines TCM as a system of sensations and findings designed to establish a functional vegetative state, and also defines the major intervention techniques of TCM as being, acupuncture, qigong, tuina, phytotherapy, dietetics and psychotherapy.

This model of TCM strides to present a rational concept of TCM interweaving the modern concepts of human anatomy and physiology with the classical Chinese models, there is also a concern with establishing a coherent scientific rigorous language in order to facilitate communication and reduce confusion. (Greten 2010)

The HM of TCM uses adapted a mathematical model, which is applied to biological systems as a way to systematize diagnosis and treatment (Greten 2010). There are some fundamental concepts that need to be clarified in order to understand the HM of TCM, such as:

Qi

"Vegetative capacity to function of a tissue or organ which may cause the sensation of pressure, tearing or flow."

Xue

"Form of functional capacity ("energy") bound to body fluids with functions such as warming, moisturizing, creating qi and nutrifying a tissue."

From a western medical view one can define it as the clinical effects of xue can be are comparable to the western concept of the effects of microcirculation, including the functional relations of microcirculation, blood cells, plasma factors, endothelium and parenchyma.

Shen

"Functional capacity to put order into mental associativity and emotions, thus creating "mental presence". "

The functional state of shen is evaluated by signs as the coherence of speech, the glow in the eyes and fluent fine motorics (control of motor functions).

Phases

- Part of a circular process
- Cybernetic (regulatory) terms
- Referring to man: vegetative functional tendencies
- The manifestations are called orbs (groups of diagnostically relevant signs)

Orb

a) Clinical manifestation of a phase, named after a region of the body (body island)
b) A group of diagnostically relevant signs indicating the functional state of a body island (body region), which correlates with the functional properties of a conduit.

Conduit

"Connection of a group of points with effect on the clinical signs of an orb, believed to serve as a conduit for the flow of qi and xue".

1.6.2 Yin Yang

Yin and Yang may be the most important concepts in order to understand the theory behind chinese medicine.

In 1943 Leibniz studied the I Ging and stumbled upon a mathematical concept hidden in the philosophical book. According to the interpretation of Leibniz the Yin Yang can be seen as a binary pair, 0 and 1, with the Yin representing the 0 and the Yang representing 1. This can also be represented graphically, in Fig.4 we can see this representation using the black bars to represent the yin and the white bars to represent the yang we can form monograms, bigrams and trigrams.

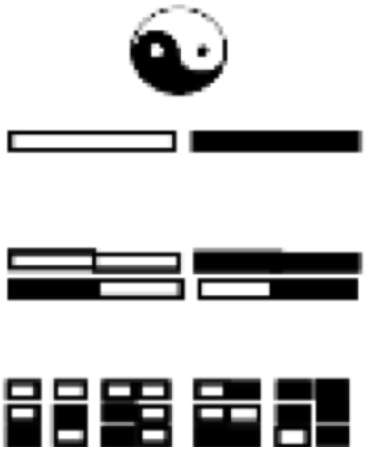

Fig. 4
The taiji above and the monograms, bigrams and trigrams representing the yin/yang combinations.
(Greten 2010)

This binary system and the comparison between Yin and Yang are central to the understanding of Chinese medicine and are also central for the understanding of the HM of TCM.

The yin and yang mean, originally, two sides of a hill, where one side is sunnier (the yang) and one side is shadier (the yin) (Greten 2010). This meaning can be used as a metaphor to represent an abstract comparison between two opposites, in the present context there are some interpretations for the yin and yang that are very important, for instance, in a regulatory comparison one can see the yin/yang pairs as below target value/above target value, descending values (downregulation)/ rising values (upregulation); and if we go into a medical context the same yin/yang pair can represent less vividity, less qi (depletion)/more vividity, more qi (repletion), colder (algor)/warmer (calor), inside (intima)/outside (extima) and structure/function (Greten 2010)

1.6.3 The Sinus Wave

Another central point of the HM of TCM are the circular regulatory processes. These processes can be described by a sinus wave. If we think of a basic

regulatory process like the heating of a water basin using a resistance connected to a thermostat set to a given temperature like the system depicted in Fig. 5.

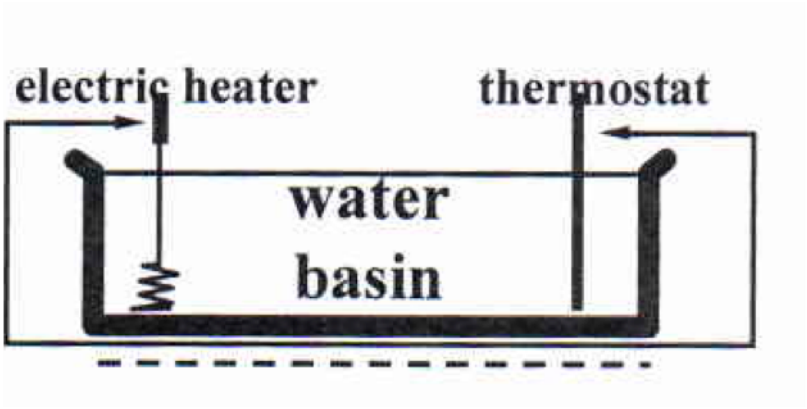

Fig. 5
Schematics of a water basin with a heating system.
(Adapted from Greten 2008)

We can divide the whole regulatory process in four stages that would be repeated on and on:

I. When the water is at the right temperature the thermostat will turn off the resistance. Nevertheless the resistance will still be hotter than the water and will raise the temperature above the target value. This is called afterheat.

II. The temperature gradually dissipates so the water cools down. When the water cools down enough to reach the target value the thermostat will turn on the resistance again.

III. The resistance is switched on but it is still warming up so the water temperature will fall below the target value. This is called latency.

IV. After some time the resistance is warm enough and the water temperature begins to rise again.

We can now easily project this process into a sinus wave like the one if Fig. 6.

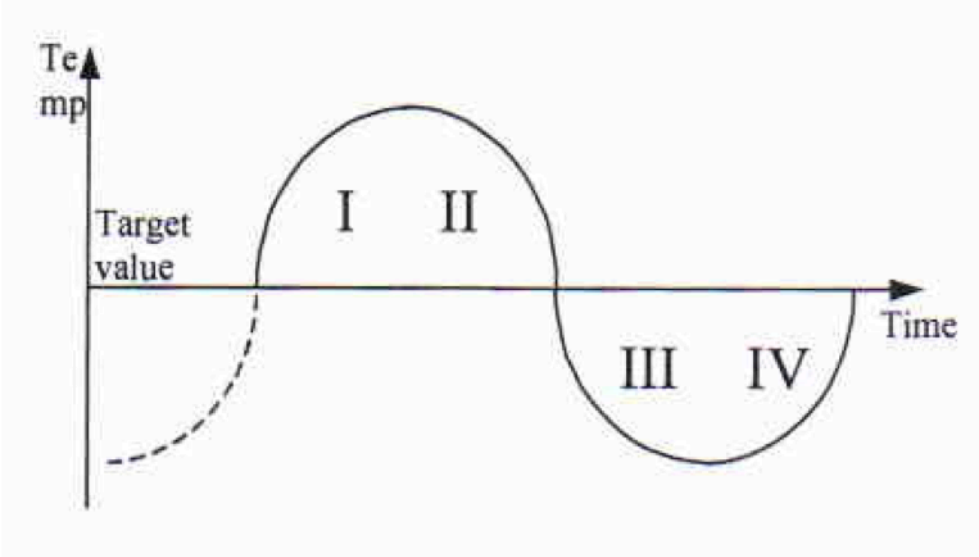

Fig. 6
Sinus wave, illustrating the different stages of the water heating system.
(Greten 2008)

The yin yang concept can be applied to this process as well, so we could describe the moments when the temperature is above the target value (I and II) as being in the yang and the moments when the temperature is below the target value (III and IV) as being in the yin.

1.6.4 The Phases

As explained above the phases are part of a circular process, so they too can be projected as vectors on the sinus wave, in fact, if we analyse the same water heating process seen before we can apply to it the five phases of TCM, by doing this we can then say that the phase Earth would represent the target value, the xx axis in Fig 6, the phase Wood would represent stage I, the phase Fire would represent stage II, Metal would represent stage III and finally Water would represent stage IV (Fig 7).

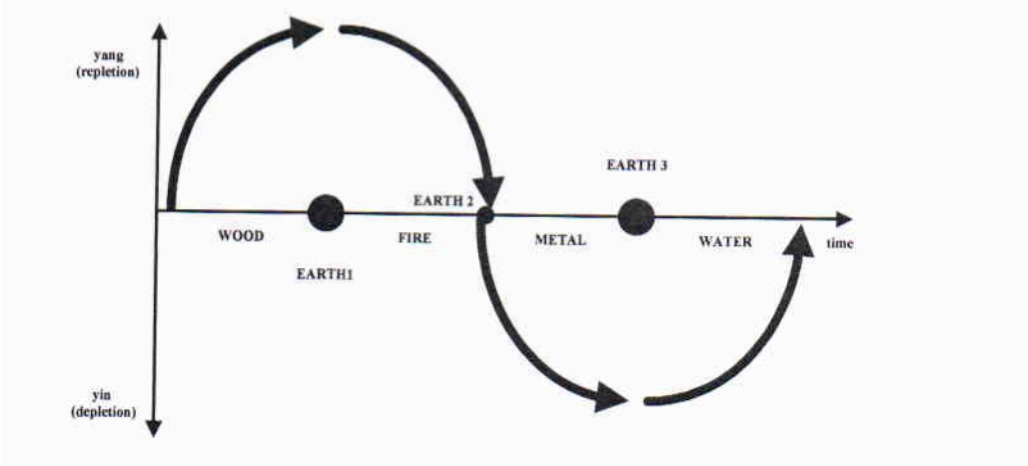

Fig. 7
Representation of the phases in the sinus wave.
(Greten 2008)

If we further analyse these phases we can also apply the yin yang concept to them, first by watching their positioning relative to the Earth we can call the phases Wood and Fire yang as they are above the target value, and at the opposite side we have Metal and Water as yin because they are below the target value, but we can still go deeper and use yin yang combinations to describe each phase, the bigrams, so using the water basin example for a better explanation: Wood starts already above the target value but it is still absorbing energy (heat) from the system making it yin yang, fire is also above the target value but it is already releasing energy so it is yang yang, metal is below the target value but still releasing energy so it is yang yin and finally water is below the target value and receiving energy from the system it is therefore yin yin.

We can use the phases to describe the vegetative regulation in humans and in short describe the phases by the following functions:

Earth – The centre, the target value;
Wood – Creation of Potential;
Fire – Transformation of potential in to function;
Metal – Relaxation, relative lack of potential;
Water – Regeneration.

In Fig. 8 we can see the phases in the sinus wave along with their bigrams and also a selection of vegetative functional mechanisms seen by western medicine as causes for the typical signs of each phase

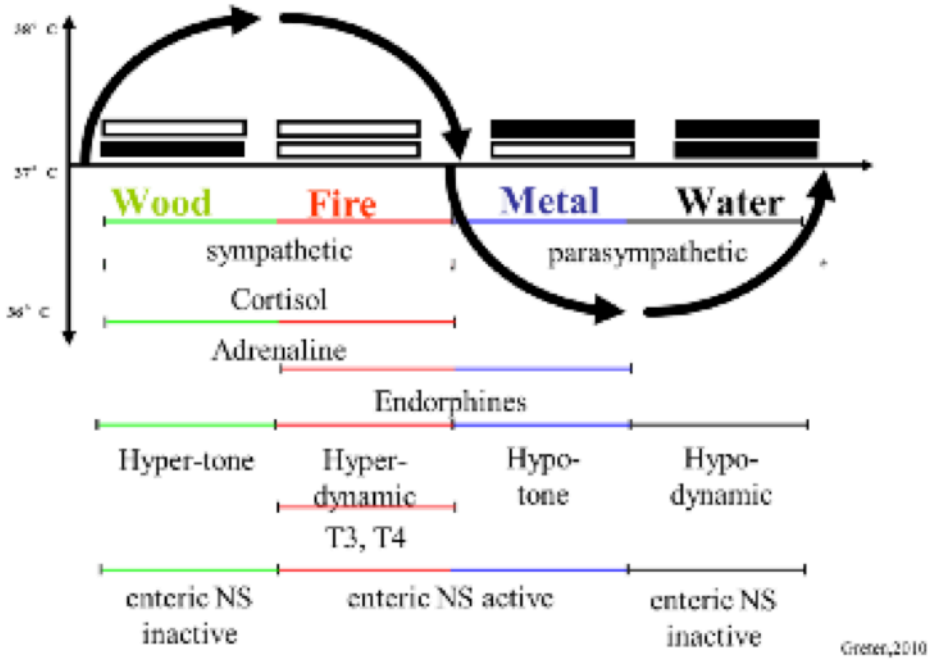

Fig. 8
Representation of the phases with their yin yang bigrams and the sinus wave on the top, along with functional mechanisms seen by western medicine as causes for the typical signs of each phase in the bottom.
(Adapted Greten 2010)

1.6.5 The Orbs

Orbs are a clinical manifestation of a phase, named after a region of the body (body island), also a group of diagnostically relevant signs indicating the functional state of a body island which correlates with the functional properties of a conduit. We can attribute 2 orbs to each phase, one external or aulici orb, the yang orb, and one internal or horreal orb, the yin orb these orbs are paired in yin yang combinations and are closely related to each other influencing each other's activity. The only exception to this rule is the Fire phase, which has 4 orbs, 2 yin and 2 yang grouped in two yin yang pairs. The 12 Orbs are:

Wood:

Hepatic: Known in classical TCM as the Liver is the yin orb of the phase wood and is responsible for the control of the excitation and flow.

Felleal: Known in classical TCM as the Gallbladder is the yang orb of the phase wood and is characterized by over-control of impulses and ambivalence.

Fire:

Cardiac: Known in classical TCM as the Heart is one of the yin orbs of the phase fire and is responsible for the control of emotionality and associativity.

Tenuintestinal: Known in classical TCM as the Small Intestine is one of the yang orbs of the phase fire and is characterized by shoulder pain and by the "emotional abdomen"

Pericardiac: Known in classical TCM by the same name is the other yin orb of the phase Fire and controls the psychological drive; it is also the pump of the body.

Tricaloric: Known in classical TCM as the Triple Burner is the other yang orb of the phase Fire and is in charge of the even distribution of qi and fluids on both sides and on the three calorics (divisions of the body in three parts, the three calorics).

Earth:

Lienal: Known in classical TCM as the Spleen is the yin orb of the phase Earth and is in charge of up-regulation, and holding the flesh, also brings the clear up.

Stomachal: Known in classical TCM as the Stomach is the yang orb of the phase Earth and is responsible for the down-regulation, digestion, brings the turbid down

The stomachal orb is important in the storage and metabolism of food but also in the distribution of fluids and xue, and harmonizing the actions of other orbs.

Metal:

Pulmonal: Known in classical TCM as the Lung is the yin orb of the phase Metal and is responsible by breathing obtention of qi from the air, and also the extima (surface of skin and mucosa).

Crassintestinal: Known in classical TCM as the Large Intestine is yang orb of the phase Metal and is responsible for the surface of the guts and the conduction of nourishment and obtention of qi from the food.

Water:

Renal: Known in classical TCM as the Kidney is the yin orb of the phase Water and is responsible for regeneration.

Vesical: Known in classical TCM as the Urinary Bladder is the yang orb of the phase Water and is responsible for holding the fluids in body.

1.6.6 Conduits

A conduit, called in classical TCM meridian or channel, is a group of points with effect on the clinical signs of an orb, believed to serve as a conduit for the flow of qi and xue. There are 12 cardinal conduits linked to the 12 orbs previously discussed. Although, in western medicine, there are no direct equivalents to conduits and modern TCM approaches tend to treat them as combinations of the vascular, nervous and neuroendocrine systems (Greten, 2010) there have been recent Works showing that the conduits might represent actual physical structures (Fromknecht et al., 2013).

The stomachal conduit Fig. 9 starts in the face, and runs all the way down to the edge of the second toe, going through the torso (Porkert et al. 1995).

The stomachal conduit also has connections with the nervocardinal conduit, this is a muscle conduit influencing the muscles from the legs and abdomen (Porkert et al. 1995)

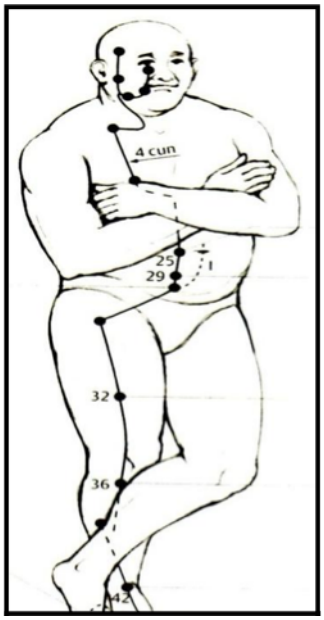

Fig 9.
Representation of the stomachal conduit.
(Greten 2010)

2. Research protocol

2.1 Aims of the study

The main objective of this study is to determine what are the effects of acupuncture, in particular of the point Stomach 34 – Monticulus Septi, on the performance of a middle kick in kickboxing athletes after a Maximal Effort (ME) exercise.

2.2 Study Outline

To accomplish this we designed a study in which we analyse the technique middle kick of the dominant leg in Kickboxing practitioners, using kinematics and kinetic studies before and after a ME exercise, with this technology we will be able to study variations in the acceleration and velocity of the leg, duration of the movement and time it takes for the athlete to prepare the kick and then get back in to balance after the strike. After the ME exercise the athletes will either be given a treatment of acupuncture over a 2 minute period, experimental group, or will just rest for 2 minutes, control group.

In the end we will compare the results for each group and with them assess if there are differences in the performance of the kick before and after the ME exercise and differences between the two groups.

2.3 Study Design

Prior to starting with this work we submitted our project to the approval of the ethical comity of Instituto de Ciências Biomédicas Abel Salazar da Universidade do Porto (annex i) and also to the direction of the Laboratório de Biomecânica da Universidade do Porto, both requests were accepted and so the study was conducted.

To achieve our goals we designed a randomized and controlled experimental study. According to McMillan and Schumacher a study of this kind is used to establish a causal relationship between two or more variables.

There is the necessity to use a control group in order to determine that any changes observed after our intervention are caused by it and not by any other external cause, with this we guarantee that we are studying only the variable that we choose and therefore validate our experiment (Gall et al., 1996).

Our study can be divided into a total of six steps, which are the same for the experimental and control groups, except for step number 4, as can be seen on Fig. 10.

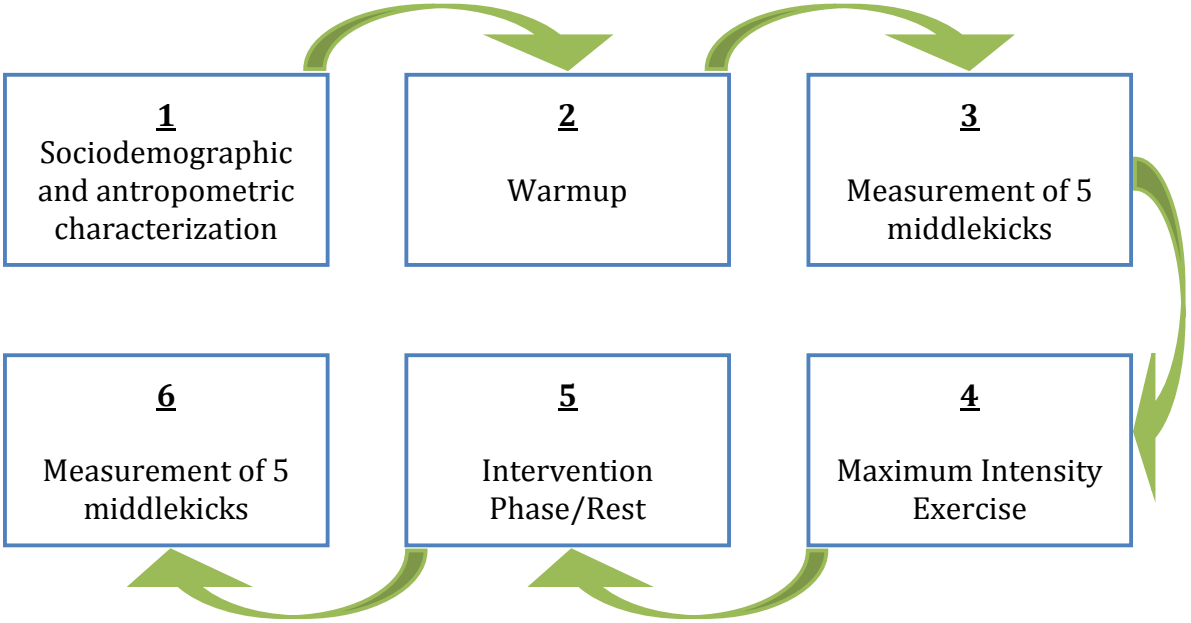

Fig. 10
Schematics of the work plan for this study.

2.4 Hypotheses

Hypothesis 1 – There will be a measureable and significant reduction in middle kick performance after ME exercise in both groups.

Hypothesis 2 – The control group will suffer a significantly more severe reduction in middle performance after the ME exercise, when compared with the experimental group.

2.5 Selection of the point and acupuncture technique

S 34 - Monticulus Septi (Liangqiu)

This is the rimicum point of the Stomachal Conduit, meaning that this point is able to make the qi flow dynamic when for some reason qi tends to congest and therefore cease to flow and stagnate (Porkert et al. 1995, Hempen& Chow, 2006). The S34 plays an important role, in pain management throughout the Stomachal conduit (Greten, 2010). In addition to local analgesic effect (mainly in disorders at knee) and distal (in the path of the conduit) this point is still traditionally used in muscle weakness and neurological changes in the leg (Hauer et al. 2011), it has also indicated in presence of algor patterns (decreased local microcirculation), cold extremities and lower digestive tract disorders (Porkert et al. 1995, Hempen & Chow 2006), as well as stimulation of metabolic functions (Hempen & Chow 2006, Tong et al. 2011).

This point was chosen both for its functions, but also because it is a point of the stomachal conduit, as can be observed on Fig. 11 it is located 2 cun above the superior pole of the patella and aligned with the lateral edge of the patella, on the quadriceps.

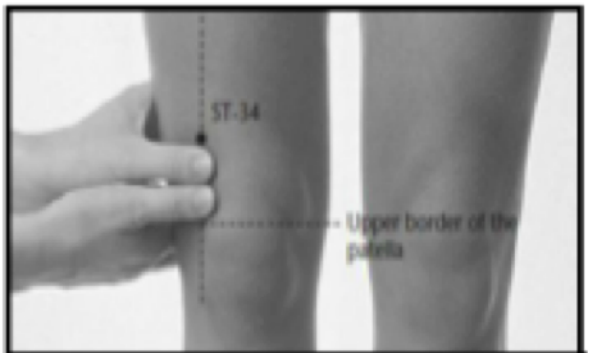

Fig. 11
Location of the point S34.
(Focks 2008)

Leopard Spot techniche

There is a wide number of different needling techniques, the one used in this work is the Leopard Spot also known as the sparrow pecking technique. This technique consists in fast and repeated needle punctures in the same acupuncture point with the intent of drawing a small drop of blood. (Hauer et al., 2011; Nabeta & Kawakita, 2002).

There are very few scientific studies on this technique and its effectiveness and underlying physiological mechanisms, but there have been some works focusing mainly on pain namely muscular pain ((Inoue et al., 2006; Shinbara et al., 2008; Nabeta and Kawakita, 2002).

According to the classical TCM knowledge the leopard spot technique is useful to stimulate a smooth qi and xue flow improving circulation, disperse qi and xue stasis, drain excess calor, and bring down the Yang in cases of uprising, it presents also very immediate results. (Skya, 2003)

2.6 Sample selection

Our sample was constituted by 10 kickboxing athletes. All the subjects were volunteers recruited from the Portuguese Kickboxing and Muay Thai team Norte Forte (Fig. 12).

Fig. 12
Participation of the Norte Forte team in the Portuguese Kickboxing Championship 2013/2014 in Algarve

2.7 Inclusion Criteria

To be eligible for the study the athletes must:

-Have a minimum technical knowledge of kickboxing that allows them to perform the technique correctly (white belt level);

-Have trained kickboxing consistently for at least six months prior to the study.

2.8 Exclusion Criteria

Athletes that:

-Do not fulfil integrally all the inclusion criteria;

-Are suffering from any kind of injury;

-Have taken any ergogenic supplement in the week prior to the test.

Are excluded from the study

All the athletes from the club were invited to participate in the study, and initially there was a group of forty athletes fitting the inclusion criteria that volunteered, unfortunately due to logistical constraints this group had to be reduced to ten.

2.9 Material and Methods

In the beginning of the work each athlete filled a socio demographic questionnaire (annex iii) and were explained about the procedures of the exercise, afterwards the athletes were measured using a SECA 206 stadiometer as shown as shown in Fig. 13A and weighed using a Biospace InBoidy 230 scale (Fig. 13B).

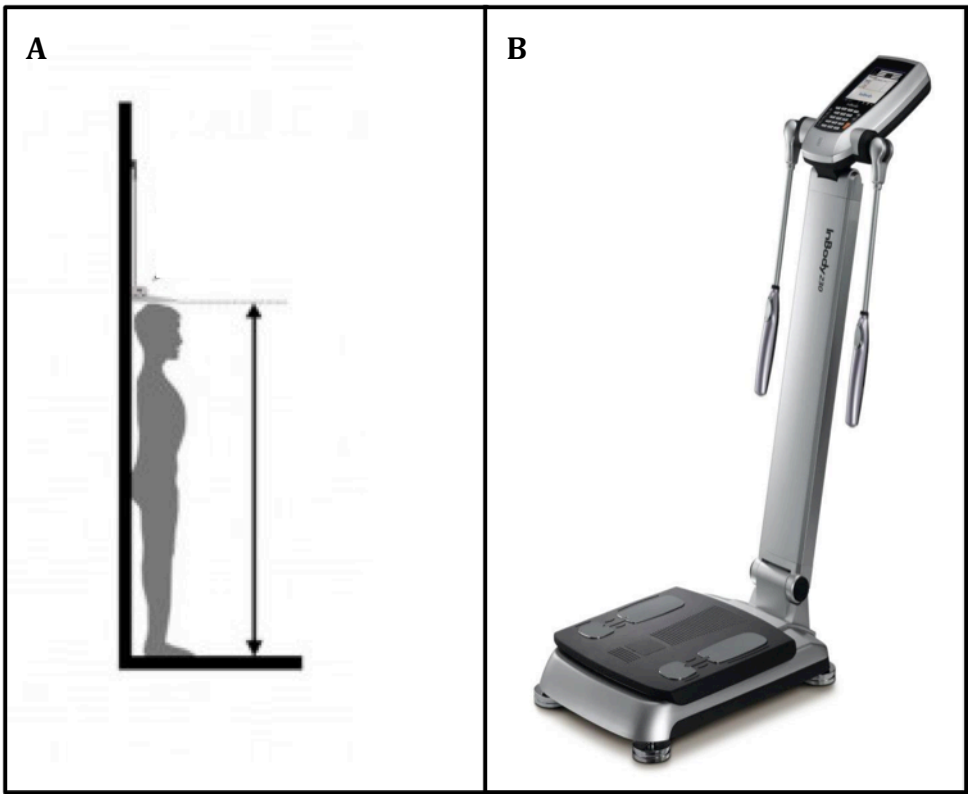

Fig. 13
A - Schematics representation of the measuring of a subject
B- Biospace InBody 230 scale

The athletes were wearing standard equipment for the practice of kickboxing, consisting of kickboxing shorts and a t-shirt; the tests were performed barefoot.

After the questionnaire and the measurements the athletes were randomly distributed to between the control and experimental groups and were then equipped with a series of infra-red reflecting markers placed in the more important anatomic references to be used for kinematic analysis (C7 vertebrae, shoulders, elbows, wrists, hip, knee, calcaneus, malleolus, and the 5th metatarsus, all bilateral) all the major joints were marked but the markers used to track the foot during the kick were the ones placed on the calcaneus, on the internal malleolus, external malleolus and on the 5th metatarsus. The marker placement can be observed in Fig. 14.

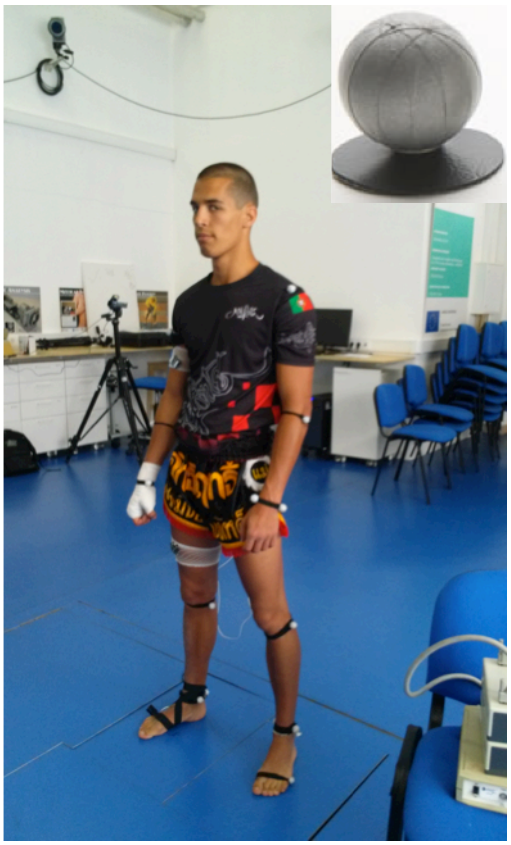

Fig. 14
Athlete equipped for the test, with the close-up of a reflective marker on the upper right-hand corner

2.9.1 Warmup

The athletes performed a quick warmup exercise (5 minutes) mobilizing all joints in order to reduce the risk of injury during the exercises.

2.9.2 First Measurement

The athletes were placed on the force platforms Bertec FP6090-15-2000 (Fig. 15) and were asked to perform a series of five middle kicks of the dominant leg (right leg to all participants) with maximum force on a training pad held by one of the researchers. The data from the platforms was retrieved at a rate of 1000Hz using the Qualisys Track Manager (QTM) program. The platforms were calibrated once at the beginning of every day to remove the offset.

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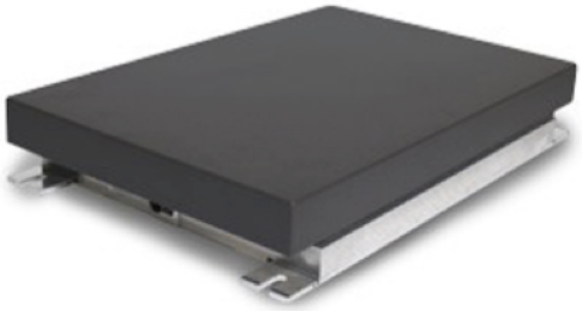

Fig. 15
Bertec FP6090-15-2000
Force Platform
(Bertec)

The athletes were asked to perform the kicks with the maximum force possible. The movement was captured using 12 Qualysis oqus series cameras (Fig. 16A) placed in such a way that all the space used for the test was being recorded, providing a 360º view (Fig. 16B) with a capture rate of 200 Hz using QTM, ensuring a synchronization with the platforms. The system was calibrated once at the beginning of every day, using the dynamic calibration, with a fixed L-shaped calibrator to mark the origin and a dynamic wand calibrator to obtain the volume of calibration, covering the full performance volume[1].

[1] Two examples can be found at times of 1min19s and 5min42s in this Qualisys video https://www.youtube.com/watch?v=ZWsPDWJAo0k; another video, showing a similar calibration process but from the Vicon company is available at https://www.youtube.com/watch?v=n6qW9frKPiA

Fig . 16A
Qualysis oqus series camera
(Qualysis)

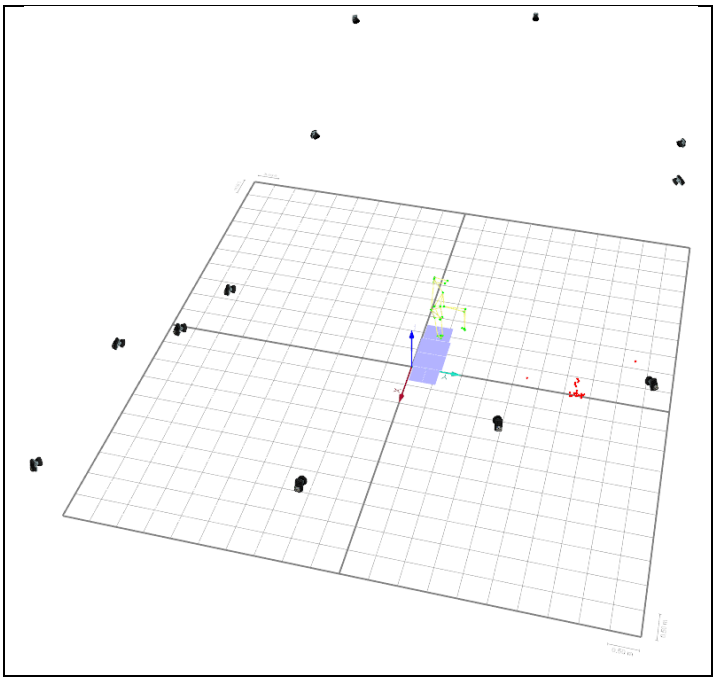

Fig. 16B

Positioning of the 12 Qualisys Oqus cameras (black features) around the subject and of the force platforms on the ground (grey rectangles).

The Oqus cameras detect the marker positions (2D for each camera), and the QTM software uses the Direct Linear Transform (DLT) algorithm to obtain the 3D coordinates of each marker by merging information from several cameras at once.

2.9.3 Maximum Effort Exercise

The athletes were asked to perform burpees during 60 seconds with the maximum frequency possible.

A Burpee is a high intensity exercise, ideal to generate fatigue, consisting of a push up followed by a maximum extension jump. (Knapic & East, 2014). In Fig.17 we can see one of the athletes performing the exercise.

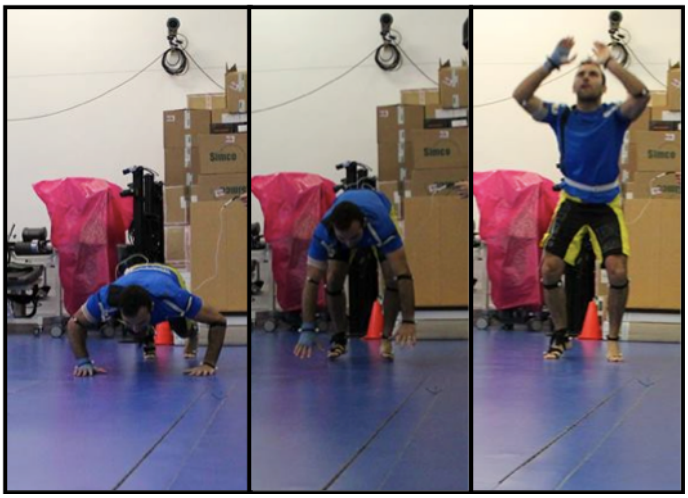

Fig. 17
Athlete performing burpees.

2.9.4 Intervention Phase/Rest

The athlete was asked to sit down for a period of two minutes.

The athletes in the control group just remained sitting for the duration of the time. The athletes in the experimental group were subjected to an acupuncture treatment; this treatment was performed using the leopard spot technique in the Stomach 34 point in both legs.

All the athletes independently of which group they belonged to remained sitting down for two minutes.

2.9.5 Second Measurement

The procedure was the same as that for the first measurement.

2.10 Data analysis

For the kinetic and kinematic analysis a computerized 3D model was built for each participant using the program Qualisys to compile the information from the Kinematic system cameras and the information from the force platforms.

The first step in building this model was to identify each IR reflecting marker as an anatomical part, ending up with a model such as the one shown below, Fig. 18.

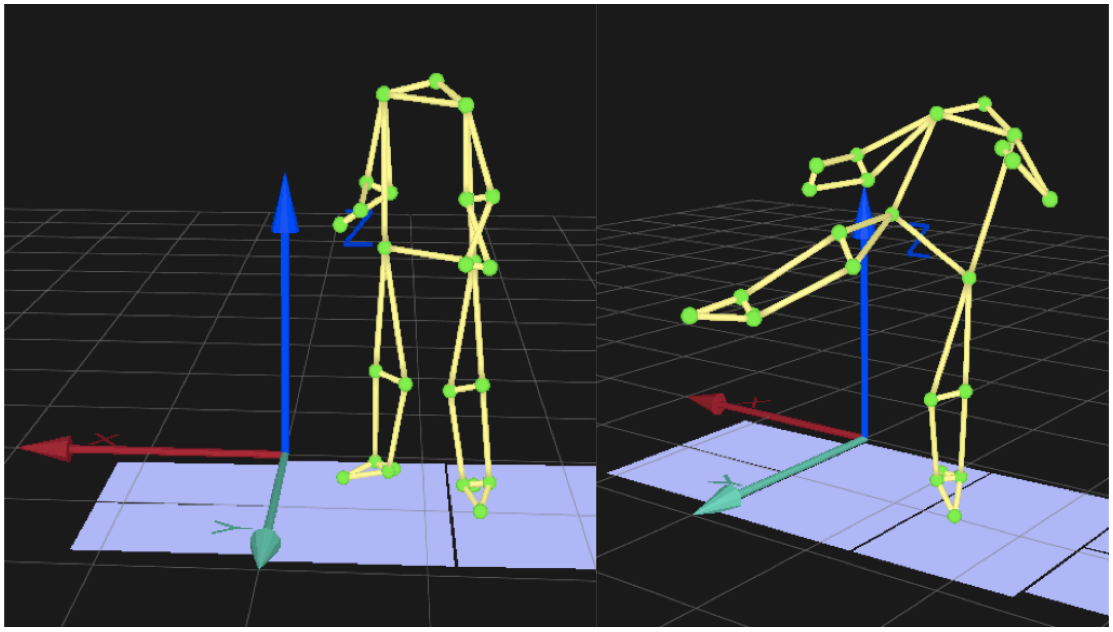

FIG. 18
Qualisys 3D model of one of the athletes in the study standing (left) and performing a middle kick (right)

With these models we were able to analyse the movement in detail.

The force data was filtered with a 4th order low-pass Butterworth filter at 100Hz, while the video data was filtered with a 4th order low-pass Butterworth filter at 50Hz.

To obtain the velocity of the markers, the position was numerically differentiated using the expression:

$$v_x(i) = \frac{x_{i-2} - 8x_{i-1} + 8x_{i+1} - x_{i+2}}{12(t_{i-1} - t_i)}$$

And similarly for vy and vz; the acceleration was computed from the numerical differentiated using the expression:

$$a_x(i) = \frac{-x_{i-2} + 16x_{i-1} - 30x_i + 16x_{i+1} - x_{i+2}}{12(t_{i-1} - t_i)^2}$$

The parameters we chose to study were:

- The amount of force exerted by the active foot in preparation for the kick, this is, how much force the athlete applies on the floor with the "kicking foot" before initiating the movement;

- The total duration of the movement, this is, how long it takes from the moment the subject lifts the foot of the ground to kick until the foot lands again;

- The maxim norm of the velocity of the leg during the kick;

- The maximum norm of the acceleration of the leg during the kick.

2.11 Statistical analysis

The data was collected using the programs Qualysis and Acknowledge, and afterwards processed using Matlab.

The Microsoft Excel 2008 for mac, was used to calculate the descriptive measurements, mean and standard deviations of the sample characteristics and to create graphics of the 4 parameters studied in this work.

SPSS Statistics 22 was used to perform statistical analysis of the data. First the Kolmogorov-Smirnov test was used for the assessment of normality, afterwards to study the evolution of the variables paired samples T test (n=5) and Wilcoxon test (n=4) were used.

2.12 Ethical Considerations:

Anonymity and confidentiality was guaranteed to every participant.

The participants signed the declaration of informed consent (annex v) as required by the ICBAS-UP ethical comity.

3. Results

3.1 Sample Characterization

The participants are all athletes from the kickboxing and Muay Thai club Norte Forte, all of them are associated to the Federação Portuguesa de Kickboxing e Muay Thai, and have all competed in official events during their careers, six of these athletes were current or former Portuguese Kickboxing Champions at the time of the study.

Analysing our sample in more detail we can observe that we have a total n=10 where there are mostly male subjects (90%). Half of the sample is of an age between 20 and 24 and the oldest participant is 34 years old.

All the subjects presented a normal BMI. Finally most of the subjects (80%) train at least 3 times a week, and have been practising the sport for over 3 years. The relevant data for sample characterization can be is compiled in Table 2.

Table 2 – Sample Characterization

Sociodemographic data	f	%
Gender		
Female	1	10
Male	9	90
Scholarity		
3rd cycle	3	30
Secundary level	3	30
Superior level	4	40
Employment		
Employed	7	70
Unemployed	3	30
Antropometric characteristics		
Age (years)		
20 – 24	5	50
25 – 29	2	20
30 – 34	3	30
Height (m)		
1,55 – 1,65	2	20
1,66 – 1,77	4	40
1,78 – 1,88	4	40

Antropometric characteristics (cont.)	f	%
BMI		
19.8 – 26	10	100
History		
Previous surgeries		
Yes	4	40
No	6	60
Years of kickboxing practice		
3	2	20
>3	8	80
Training sessions per week		
1	0	0
2	0	0
3	2	20
>3	8	80
Other sports		
Yes	2	20
No	8	80

3.2 Kinematic and Kinetic analysis.

Unfortunately due to an informatic error that resulted in the partial loss of the data collected for one of our subjects in the control group we were forced to exclude him from the trial. So the results presented will be for a total n=9 with n=5 in the experimental group and n=4 in the control group.

3.2.1 Force exerted by the active foot in preparation for the kick.

To analyze the force exerted by the active, "kicking foot", in the preparation of the kick we analysed the results from the force platforms, for each strike we could see the variation in the force applied to the plate during the time of the kick, the data for one of the kicks can be observed in Fig 19.

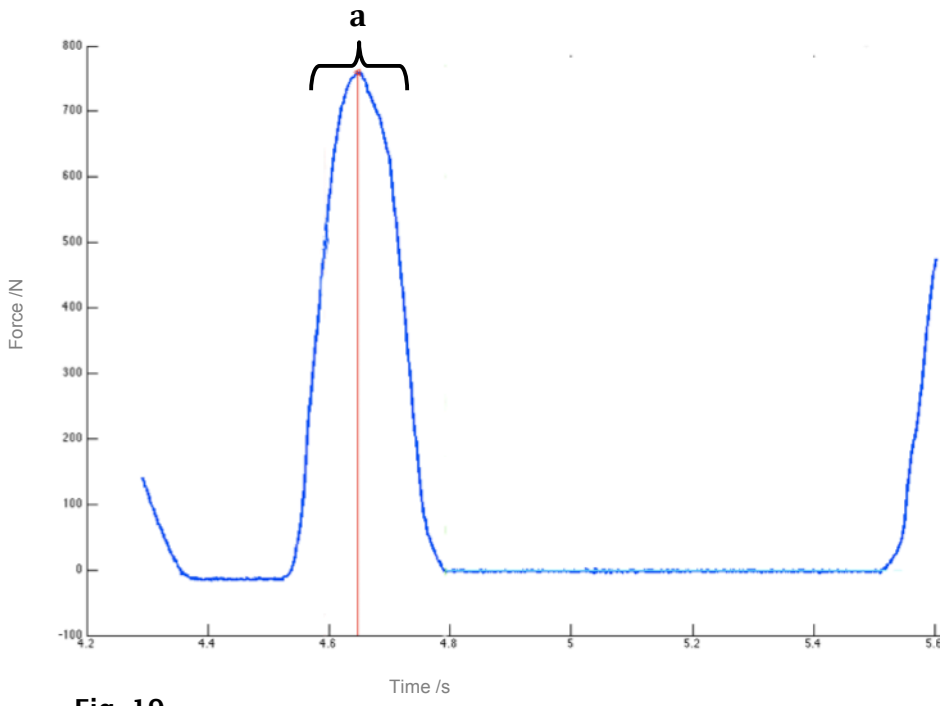

Fig. 19
Graphical representation of the force of the active foot (kicking foot) on the floor in the moment of one kick. The maximum force marked with a red line.

Analysing this graphic we can see the blue line, representing the force applied by the active foot of the athlete on force plate, rise as the athlete starts the movement forming a peak marked with the letter "a", the line will then go down to zero, representing the moment when the athlete lifts up the foot of the ground to start the kick. This is the typical graph obtained for a successful middle kick.

We will now focus on the maximum force, marked in the graph by the red vertical line.

Analysing the average forces exerted by our athletes before (T0) and after the ME exercise and our intervention/the rest period (T1), Table 3 we can see that for the athletes in the control group showed a 7.04% increase in force P=0.465 after the ME exercise and rest, the experimental group presented a reduction of 8.04% in force P=0.686 after the ME exercise and the acupuncture intervention.

Table 3 – Results of the maximum force exerted by the active foot on the ground during the kicks before(T0) and after (T1) ME exercise for the experimental and control groups

Control			Experimental		
Subject	**T_0**	**T_1**	**T_0**	**T_1**	**Subject**
1	1,436	1,471	2,194	1,411	**1**
2	1,232	1,135	1,215	1,458	**2**
3	1,652	1,705	1,106	1,060	**3**
4	1,316	1,745	1,265	1,254	**4**
5	No data	No Data	1,294	1,322	**5**
Average Force /% Bw	1.409	1.514	1.415	1.301	**Average Force /% Bw**
Std. Deviation	0.183	0.280	0.441	0.156	**Std. Deviation**

In Fig. 20 we can observe a graphic representation of the evolution of the force exerted by our athletes.

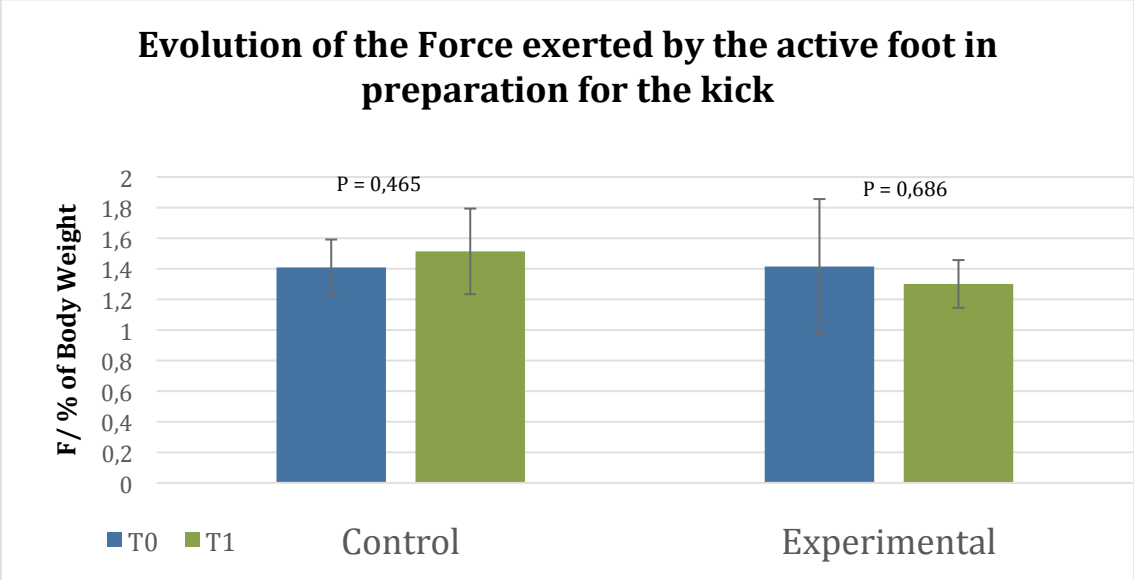

Fig. 20
Graphical representation of the evolution of the force exerted by the active foot in preparation for the kick

3.2.2 Duration of the movement

To analyse the duration of the kick we need first to define what is the movement we will analyse, so for the purpose of this work we will define the kick as the time the "active foot" is off the ground, so the time between the moment when the athlete lifts the foot from the ground to start the kick until the time when the foot touches the ground again for the first time after having hit the training pad. To analyze this parameter we will use, once again, the information from the force platform. Analysing again the graph in Fig. 21 representing the force applied on the force platform along the time for one of the kicks we can mark the point where athlete lifts the foot off the ground, the moment where the blue line goes to zero (marked as LO in the graph) and mark the time the foot touches down on the ground for the first time, the time when the blue line rises again to values above zero (marked TD on the graph) we can now calculate the duration of the kick as the time in TD minus the time in LO.

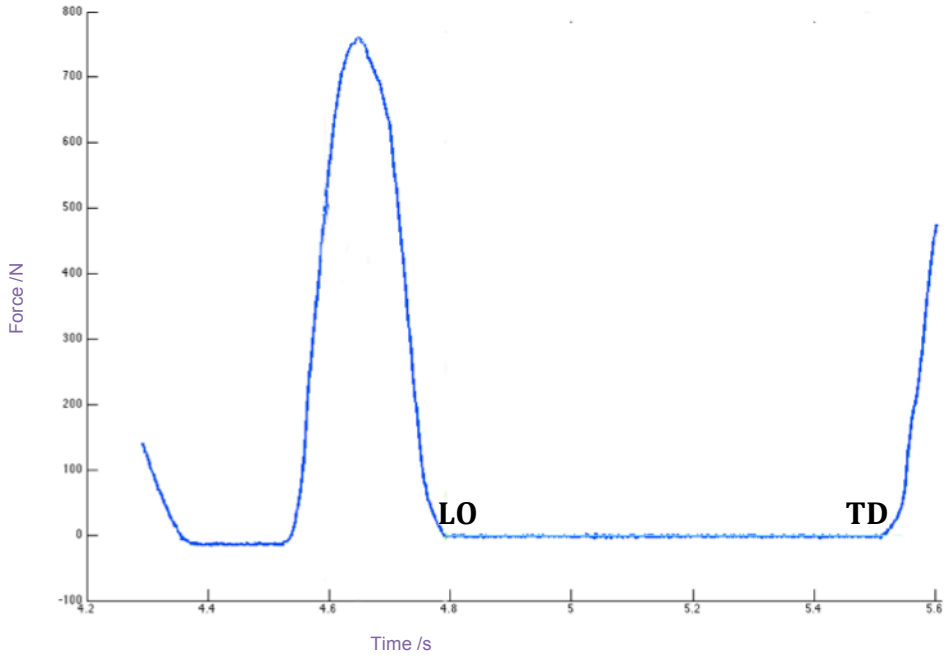

Fig. 21
Graphical representation of the force of the active foot (kicking foot) on the floor in the moment of one kick. LO, marks the point where the foot lifts off the ground and TD marks the point where the foot touches down again.

Analysing the average duration of the kicks before (T0) and after the ME exercise and our intervention/the rest period (T1), Table 4 we can see that for the athletes in the control group showed a 21.30% reduction in the average duration of the kicks P=0.141 after the ME exercise and rest, the experimental group presented a 11.99% increase in the duration of the movement P=0.096 after the ME exercise and the acupuncture intervention.

Table 4 – Results of the duration of the kicks before(T0) and after (T1) ME exercise for the experimental and control groups

Control			Experimental		
Subject	**T_0**	**T_1**	**T_0**	**T_1**	**Subject**
1	0,621	0,636	0,673	0,630	**1**
2	0,655	0,595	0,606	0,760	**2**
3	1,310	0,701	0,645	0,751	**3**
4	0,764	0,704	0,642	0,765	**4**
5	No data	No Data	0,609	0,649	**5**
Average duration /s	0.837	0.659	0.635	0.711	**Average duration /s**
Std. Deviation	0.321	0.053	0.028	0.066	**Std. Deviation**

In Fig. 22 we can observe a graphic representation of the evolution of the average duration of the kicks.

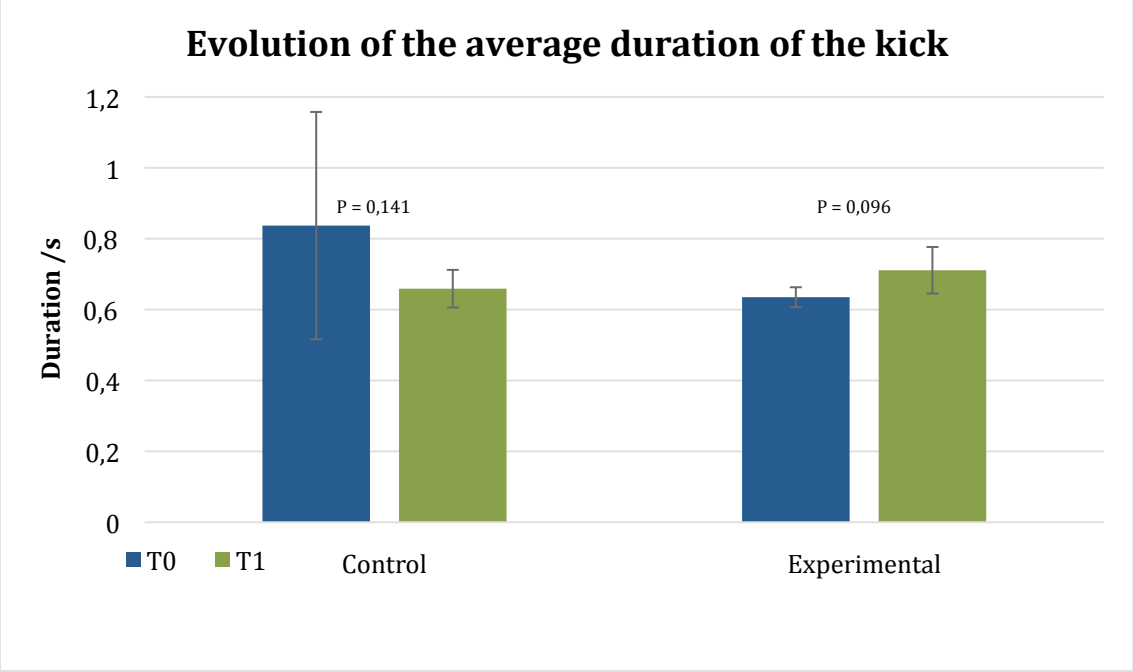

Fig. 22
Graphical representation of the evolution of the duration of the the kicks.

3.2.3 Maximum Velocity

In this part of the work we will analyse the maximum velocity achieved by the legs of the practitioners during the kick.

To calculate the velocity of the leg we used the kinematics system, as explained on the Methodology chapter we were tracking 4 markers on the foot, the calcaneus, the 5th metatarsus and the external and internal malleolus, when analysing the data we realized that because of the speed and the angle of motion of the athletes during the kick some of the markers were not visible during the whole movement, so after reviewing all of the footage we opted to use only the external malleolus marker to track the movement since it was the one with more reliable tracking being visible to the computer in most situations the velocity was then calculated using a linear regression as supported by Quinzi et al.

Looking at the average maximum velocities Table 5 we can see, at first that the numbers are very impressive with both the groups having average velocities above 11m/s (approximately 40 Km/h).

Table 5 – Results of the maximum velocity of the leg during the kicks before(T0) and after (T1) ME exercise for the experimental and control

Control			Experimental		
Subject	**T_0**	**T_1**	**T_0**	**T_1**	**Subject**
1	13,059	12,928	10,244	9,555	**1**
2	14,852	14,302	13,622	14,401	**2**
3	13,192	13,589	13,039	14,460	**3**
4	14,055	13,983	11,587	12,639	**4**
5	No data	No Data	10,901	11,373	**5**
Average Maximum Velocity /m/s	13,789	13,700	11,878	12,485	**Average Maximum Velocity /m/s**
Std. Deviation	0,835	0,592	1,423	2,086	**Std. Deviation**

Analysing the differences between before (T0) and after the ME exercise and our intervention/the rest period (T1), can see that the control group shows a very slight reduction of 0.65% P=0.465 after the ME exercise and rest while the

experimental group shows an improvement of 5.11% P=0.167 after the ME exercise and the acupuncture intervention

In Fig. 23 we can observe a graphic representation of the evolution of the average maximum velocity of the leg.

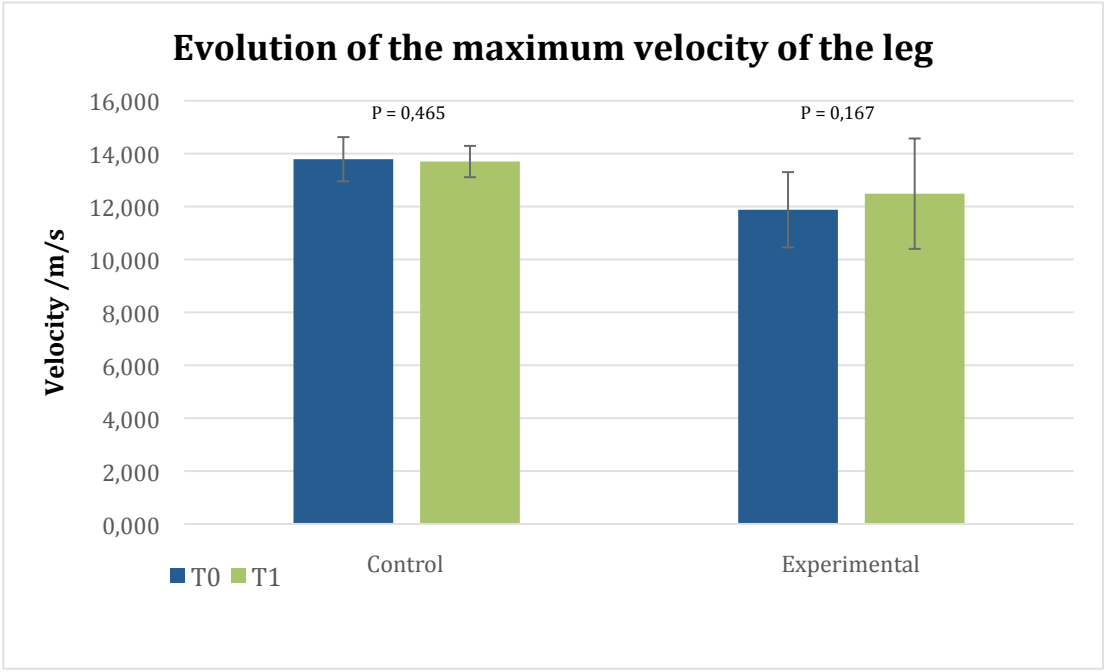

Fig. 23
Graphical representation of the evolution of the maximum velocity of the leg during the kicks.

3.2.4 Maximum Acceleration

The acceleration is one of the most important results from this work because it is directly proportional to the force of the kick since force equals mass times acceleration.

As for the velocity, the acceleration was calculated using the data from the kinematics, and in the same way was calculated using the data corresponding to the external malleolus marker.

Analysing the average maximum acceleration for each group shown in Table 6 we see once again remarkable values, with the lowest value being above 49G.

Table 6 – Results of the maximum acceleration of the leg during the kicks before(T0) and after (T1) ME exercise for the experimental and control groups

Control			Experimental		
Subject	T_0	T_1	T_0	T_1	**Subject**
1	46,129	45,267	56,389	44,743	**1**
2	59,860	51,841	57,931	65,074	**2**
3	49,145	51,476	52,638	58,310	**3**
4	50,044	52,969	36,599	39,282	**4**
5	No data	No Data	45,101	46,861	**5**
Average Maximum Acceleration /G	51,294	50,388	49,732	50,854	**Average Maximum Acceleration /G**
Std. Deviation	5,951	3,473	8,859	10,547	**Std. Deviation**

Analysing the differences between before (T0) and after the ME exercise and our intervention/the rest period (T1), can see that the control group shows a reduction of 1.77% P=1.00 after the ME exercise and rest while the experimental group shows an improvement of 2.26% P=0.754 after the ME exercise and the acupuncture intervention.

In Fig. 24 we can observe a graphic representation of the evolution of the average maximum acceleration of the leg.

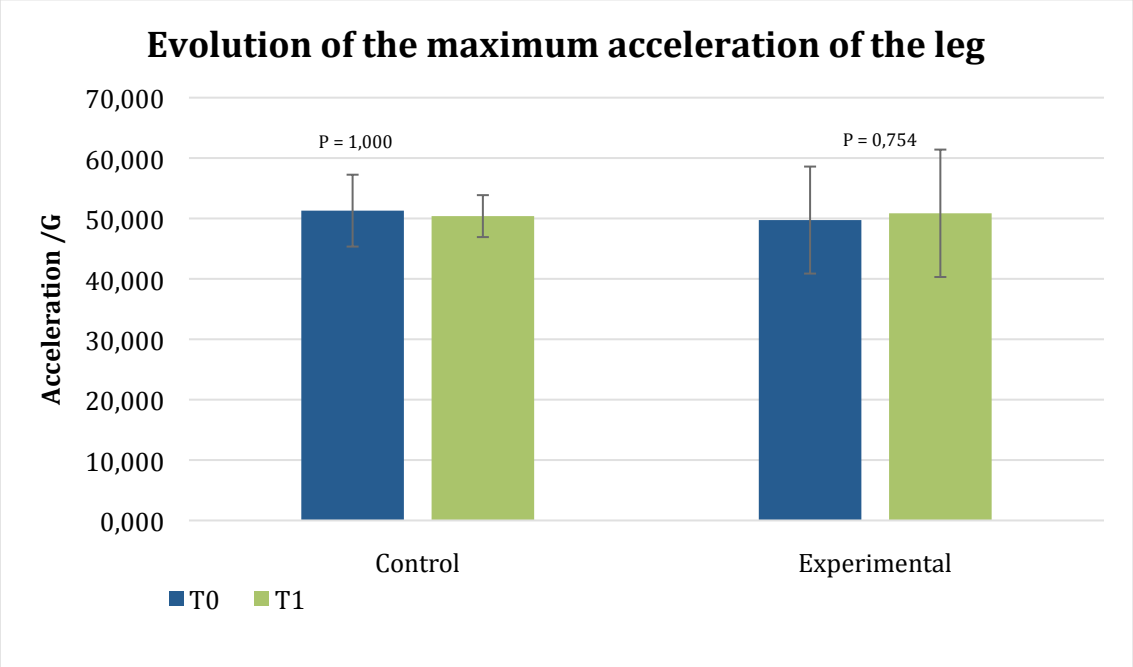

Fig. 24
Graphical representation of the evolution of the maximum acceleration of the leg during the kicks.

4. Discussion

4.1 First Considerations

Despite the best efforts of the investigators in the planning and realization of this work there was a second variable conditioning the performance of the athletes that was not accounted for during the planning, this variable was the adaptation to the procedures in this study because even though all the subjects were top athletes and very proficient in the art of kickboxing they were facing the difficulty of coping with the conditions of the test. Two major factors were conditioning the performance of the athletes: the need to stand on a specific place (the force platforms) during the kicks and the measuring equipments that were placed on the body. Similar hindrances are described by Gupta (2011) regarding the protective gear in Taekwondo. What we could observe was that in the first measurement of the kicks (T0) the athletes had a greater difficulty coping with the previously mentioned distractions than in the second measurement (T1), showing adaptation. This has to be considered when analysing our results.

Finally we need to take in to consideration that that the results we present carry no statistical significance, so we can only discuss tendencies being shown by our results. A bigger sample would have been crucial for us to obtain statically significant results, since our results don't have statistical significance we cannot express tendencies just by analysing the average differences between the two groups. But if we analyse the individual results within each group we can see and analyse tendencies.

Given the lack of scientific research in this topic and also the small sample size available for the study, this work must be regarded as a prospective study.

4.2 Kinematic and Kinetic analysis.

4.2.1 Force exerted by the active foot in preparation for the kick.

The force exerted by the active foot in preparation of the kick marks the transition between the preparation and the lift off phases described by Thibordee

(2014), these phases depend heavily on the biceps femoris and the gastrocnemius to lift the foot off the ground and get the leg into position. So the amount of force the athlete needs to apply on the floor may work as an indicator of the state of these muscles, since the better these muscles actuate the less impulse the athlete will need to lift the leg providing a more harmonious movement flow.

There is a tendency for a reduction of the force exerted by the active foot in preparation of the kick in the experimental group, since 60% of the athletes in this group showed a reduction in force after the intervention, in the control group we have a tendency for the increase in force, with 75% of the athletes in this group showing an increase in force after the intervention.

4.2.2 Duration of the movement

In a combat sport such as kickboxing it is very important that the athlete can perform the techniques as fast as possible so he can strike his opponent and be ready to defend a possible counter attack. But when we look at movements such as kicks a second parameter must be taken in to consideration, the balance, it is important that the kick is as fast as possible but also that when the athlete lands he is in a balanced position ready to attack again or defend without falling. For an athlete to perform a middle kick and land in a balanced position it is important to combine the correct technique with the muscle strength to maintain balance. Ideally we would study this movement in two parts, the first part representing the time between lifting off the foot until hitting the target, and the second part the time from hitting the target until the foot lands again.

Pozo (2011) has shown that the duration of the kick is one of the measurements that tends to have the least repeatability even in very skilled athletes.

There is a clear tendency for a reduction in the duration of the kick in the control group, where 100% of the athletes reduced the duration of the kick after the intervention. The experimental group on the other hand shows a tendency towards an increase in the duration of the kicks with 80% of the athletes increasing the duration of the kick after the intervention.

These results might not be a real representation of the performance of the athlete since we were not evaluating the quality of the landing in terms of balance, the movement should be analysed in two parts, and finally the athletes were not asked to be as fast as possible to complete the movement, the only prompt was to perform the kicks with maximum force.

4.23 Maximum velocity and acceleration

In this chapter we must first acknowledge the magnitude of the numbers. Both the groups presented very high values in velocity and acceleration, typical of elite athletes, illustrating the quality of the athletes present in this study. The values must however be looked at in a conservative manner since they were not measured directly but rather calculated using derivations, these calculations are very sensitive to small variations that may induce errors in the final values. The values we obtained are, nevertheless, within the range of the values found in the literature for the characterization of similar movements in athletes of other martial arts. (Pozo et al. 2011; Thibordee et al. 2014)

The maximum velocity and acceleration are registered during the phases Thibordee (2014) describes as the pre impact and impact phases. In these phases we have the quadriceps playing a major role I the extension of the leg. So these numbers could be good indicators of the state of these muscles.

There is a tendency for an increase in both parameters in the experimental group where 80% percent of the athletes increased both parameters after the intervention. The control group, on the other hand, shows a tendency for a reduction of the maximum velocity, with 75% of the members of the group showing a decrease, for the acceleration however we cannot talk about the same tendency because we have a reduction in 50% of the athletes and an increase in the remaining 50%

4.2.4 Limitations of the study

Two major limitations of this study were already mentioned in this chapter, the small n and the unaccounted variable “adaptation”.

Another limitation of this study was that perhaps the 60 seconds of burpees were not sufficient to significantly reduce the performance in athletes of this level, possibly with a more intense exercise we would be able to see more dramatic differences in the end results.

5. Conclusions and future perspectives

5.1 Conclusion

After analysing the results we verify that contrary to what we hypothesised in hypothesis 1, there was not a measureable and significant reduction in middle kick performance after ME exercise in both groups in all the parameters measured, this might be due to two factors already mentioned, the adaptation to the equipment used and also the possible inadequacy of the intensity of the ME exercise.

Regarding hypothesis 2, even though there were not significant differences between the groups there is in fact a tendency for a more severe decline in performance of the middle kick in the control group than in the experimental group.

So analysing the global aspect of the results of this study we can point to a positive effect of the use of the leopard spot technique in the S34 point in the performance of middle kick after a ME exercise, being particularly effective in improving the maximum velocity and acceleration (directly proportional to the force of the kick) and also the harmonious flow of motion of the kick.

S34 was chosen for this work, because of its actions on the flow of Qi and Xue, particularly in the course of the Stomachal conduit, the Stomachal conduit runs along the legs and torso and should therefore influence muscles that are essential for the movement in study, such as the quadriceps, but also muscles from the torso such as the muscles forming the abdominal wall. The tendencies shown by our results seem to corroborate that the S34 will act in a positive way, improving the performance of these muscles particularly on the quadriceps.

Granted that more work needs to be done in this field this study is a promising start and will hopefully open the way to more studies relating acupuncture and martial artists' athletic performance in order to provide a safe and effective alternative for athletes in search of improving their performance.

5.2 Future perspectives

The results of this study show promise but need to be continued, it would be beneficial to do a larger scale study within the same format as this one, ideally in this study we would use a larger sample at least n=45 so we could divide the subjects in to 3 groups of 15 elements each, and so we could have an experimental group using verum acupuncture, a placebo group using sham acupuncture and a control group without acupuncture. It would also be beneficial to the study to use a more extensive exercise plan in the ME exercise.

In this future study there should be added a direct way to measure the force of the kick, such as force sensitive training pads, amore kinematic parameters should be analysed, such as the angles of movement of the knee and foot of the athlete and the position and force of the foot when landing, after the kick, and also EMG of the muscles involved in the movement.

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7. Annexes

Comissão de Ética

U.PORTO

INSTITUTO DE CIÊNCIAS BIOMÉDICAS ABEL SALAZAR
UNIVERSIDADE DO PORTO

Parecer da Comissão de Ética do ICBAS-UP

PROJETO Nº 088/2015

Título: *Estudo do efeito da acupunctura na recuperação da fadiga muscular em atletas de kickboxing*
Investigador Responsável: Sérgio Gandra Ferreira (aluno do Mestrado em Medicina Tradicional Chinesa do ICBAS-UP, mestre em BQ)
Outros investigadores: Sara Moreira (aluna do Mestrado em Medicina Tradicional Chinesa do ICBAS-UP, fisioterapeuta, mestre em Ed. Para a Saúde)
Orientador do Mestrado em MTC ICBAS-UP: Prof. Doutor Jorge Machado
Duração do Projeto: até junho de 2015

A Comissão de Ética do ICBAS-UP reuniu dia 19 de maio de 2015 no edifício do ICBAS - Sala de reuniões do Departamento de Ciências do Comportamento, na presença de Liliana de Sousa, Manuel Vilanova, Margarida Araújo, Paulo Maia e Paula Faria. Decidiu emitir parecer favorável à realização do projeto supracitado, por unanimidade.

Com os melhores cumprimentos,

Pela Comissão de Ética do ICBAS-UP,

Prof. Doutora Liliana de Sousa (presidente)

The above project is in accordance with the Portuguese law and the ICBAS-UP Ethics Committee criteria.

Data ___/___/___

Questionário Sócio-demográfico

Este questionário foi concebido para dar ao profissional de saúde informação acerca das carateristicas sociodemográficas e gerais do atleta de Kickboxing. Por favor, responda a todas as questões e assinale em cada secção apenas **um quadrado** que se aplique ao seu caso.

A – Características Gerais

1. Género: ☐ Feminino ☐ Masculino

2. Qual é a sua data de nascimento? ___/___/_____ **2.** Qual é a sua altura? _____

3. Qual é a medida do seu pé? _____cm

4. Qual é o seu peso actual? _____ Kg

5. Qual o seu IMC? _____

6. Qual é o seu estado civil?

☐ solteiro(a) ☐ casado(a)/união de facto ☐ separado(a)/divorciado(a)

6. Habilitações literárias

6.1. Quais são as suas habilitações literárias?

_____

7. Profissão:

7.1 Qual é a sua profissão? _____

7.2 Qual é a sua situação em relação ao emprego? ☐ empregado ☐ desempregado ☐ outra. Qual? _____

8. Dados clínicos, pense na sua história clinica anterior

8.1 Fez alguma cirurgia? ☐ sim ☐ não Se sim, qual? _____

8.2 Portador de alguma doença? ☐ sim ☐ não Se sim, qual? _____

B – Características do atleta de Kicboxing

9. Actualmente pratica em que tipologia? ☐ Manutenção☐ Competição

10. Há quanto tempo treina? ☐ 1ano ☐ 2anos ☐ 3anos ☐ 3 ou mais anos

11. Em média, quantas vezes treina por semana? ☐ 1 ☐ 2 ☐ 3 ☐ 4 ou mais vezes por semana

12. Actualmente pratica mais alguma(s) modalidade(s) desportiva(s)? ☐ não ☐ sim

13. Pense nos últimos **6 meses**. Durante esse período, teve alguma lesão? ☐ sim ☐ não

10.1 Se teve alguma lesão qual? _____

Obrigada pela sua colaboração.

CONSENTIMENTO INFORMADO, LIVRE E ESCLARECIDO PARA PARTICIPAÇÃO EM PROJETOS DE DOCÊNCIA E/OU INVESTIGAÇÃO

de acordo com a Declaração de Helsínquia[2] e a Convenção de Oviedo[3]

Por favor, leia com atenção a seguinte informação. Se achar que algo está incorreto ou que não está claro, não hesite em solicitar mais informações. Se concorda com a proposta que lhe foi feita, queira assinar este documento.

Título do estudo: : "Estudo do efeito da acupunctura na recuperação da fadiga muscular em atletas de kickboxing"

Enquadramento: O estudo será realizado nas instalações do Labiomep, FADE-UP. No âmbito do projeto de Mestrado de Medicina Tradicional Chinesa do Instituto de Ciências Biomédicas Abel Salazar da Universidade do Porto, orientado pelo Professor Jorge Machado.

Explicação do estudo:

Com este estudo pretende-se determinar o efeito da acupuntura na recuperação da fadiga muscular e em atletas de kickboxing após a realização de um exercício de esforço máximo.

Para tal os voluntários serão sujeitos ao seguinte procedimento:

-Distribuição aleatória ao grupo em que serão inseridos(experimental – acupunctura ou controlo - descanso) e preenchimento do questionário sócio-demografico;

- Realização de técnicas de Kickboxing (Pontapé circular e directo ambos do lado dominante), avaliação da força muscular, velocidade de movimento e contração muscular;

- Execução de exercícios de esforço máximo (60 segundos de burpees – flexão seguida de salto de extensão máxima);

- Aplicação de Programa de Acupuntura ou descanso de 3 minutos dependendo do grupo em que está inserido;

- Realização de técnicas de Kickboxing (Pontapé circular e directo ambos do lado dominante), avaliação da força muscular, velocidade de movimento e contração muscular.

Depois de terem sido informados da natureza deste estudo todos os elementos da amostra deverão assinar a declaração de consentimento informado,

Com este estudo pretende-se determinar os efeitos de um programa de acupuntura ao nível do equilíbrio, força muscular, velocidade de movimento em atletas de kickboxing após a realização de um exercício de esforço máximo.

Relativamente à técnica da acupunctura, serão aplicadas agulhas no ponto S34; localizado 6cm acima do joelho na face lateral da coxa.

[2] http://portal.arsnorte.min-saude.pt/portal/page/portal/ARSNorte/Comiss%C3%A3o%20de%20%C3%89tica/Ficheiros/Declaracao_Helsinquia_2008.pdf

[3] http://dre.pt/pdf1sdip/2001/01/002A00/00140036.pdf

Os riscos associados a acupunctura são mínimos. Todas as agulhas de acupuntura são esterilizadas e descartáveis, de uso único. Antes da inserção das agulhas, a pele será desinfetada com uma solução antisséptica alcoólica. Poderá contudo sentir algum grau de dor ou desconforto e "formigueiro" no local das picadas com as agulhas de acupunctura. Mais raramente, poderá sentir tonturas, ansiedade ou náuseas. É possível que após o tratamento possam surgir ligeiros sangramentos, em particular se estiver a tomar a tomar medicamentos anti-agregantes (ex.: ácido acetilsalicílico) ou anticoagulantes (ex.: varfarina) e/ou aparecerem ligeiros hematomas no local onde foram inseridas as agulhas que se resolverão espontaneamente. Caso esteja a tomar a medicação acima referida (ou outra) deverá informar a equipa de investigação.

Condições e financiamento: O presente estudo será realizado sem qualquer custo para o participante ou para a escola em questão. Todos os custos serão suportados pelo Instituto de Ciências Biomédicas Abel Salazar da Universidade do Porto (ICBAS-UP). Sendo a sua participação voluntária terá o tempo que necessitar para ponderar sobre a sua participação neste estudo. É livre de consultar a opinião dos seus familiares ou amigos. Caso decida aceitar, poderá posteriormente a qualquer momento recusar continuar no estudo, sem quaisquer tipos de prejuízos assistenciais ou outros, caso não queira continuar a participar.
A responsabilidade de eventuais danos ocorridos durante o estudo, será da inteira responsabilidade da Heidelberg School of Chinese medicine, sito na Karlsruher Str. 12, 69126 Heidelberg, Germany, e cujo contacto telefónico é +49 (0) 6221 37 45 46.
Este estudo mereceu o parecer favorável da Comissão de Ética do ICBAS-UP

Confidencialidade e anonimato: Todos os dados recolhidos para o presente estudo asseguram uma total confidencialidade e anonimato dos participantes, os seus nomes nunca serão tornados públicos. Todos os resultados obtidos serão devidamente codificados; os dados serão apenas do conhecimento do investigador principal e dos orientadores do estudo.
Eu, abaixo-assinado,

_____BI/CC:_____

Declaro ter lido e compreendido este documento, bem como as informações que me foram fornecidas pela pessoa que acima assina e que considero suficientes. Foi-me garantida a possibilidade de, em qualquer altura, me retirar da participação neste estudo sem qualquer tipo de consequências. Desta forma, aceito a participação neste estudo e permito a utilização dos dados que de forma voluntária forneço, confiando em que apenas serão utilizados para esta investigação e nas garantias de confidencialidade e anonimato que me são dadas pelo investigador.

Porto, ____ de _____ de 2015

Assinatura do Participante

_____

Assinatura do investigador:

_____