Can acupoint S34 influence kick performance in kick-boxers? A prospective study

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Abstract
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 S34 on middle kicks by kinetic and kinematic assessment.

To accomplish this work we developed a protocol to study the middle kick, and tested it on 9 kickboxers, divided in to control group (n=4) and experimental group (n=5) using kinematics and kinetics, focusing on the maximum velocity and acceleration of the active leg. 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.

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 showing a reduction in maximum velocity after the ME exercise sand rest but no tendency for reduction in the maximum acceleration.

As conclusion, the current results indicate that acupuncture on S34 might improve the performance of the middle kick in kickboxing athletes namely enhancing the velocity and acceleration of the leg. So, the first results obtained in this prospective study were not yet statistically significant, but still show a positive tendency and the feasibility of the study if a larger sample is used.

Keywords: kickboxing, athlete performance, acupuncture, kinematic assessment; velocity, acceleration

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

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 plantar-flexing the ankle until reaching maximal angle, with the ankle maintaining maximal plantar-flexion, 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 plantar-flexes 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
A small drop of blood through the action of acupuncture, like hormones and neurotransmitters (Guan-Yuan, 2006).

The main objective of this work is to create a protocol capable of determining what the effects of acupuncture are, 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. A small scale pilot test (n=10) was conducted and will be presented as a proof of concept.

**Material and Methods**

**Study Design** - 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. 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. 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.

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. 1.

**Selection of the acupuncture point** - The point S 34 – Monticulus Septi (Liangojü) was chosen both for its functions, but also because it is a point of the stomatch conduit, as can be observed on Fig. 2. It is located 2 cun above the superior pole of the patella and aligned with the lateral edge of the patella, on the quadriceps. There is a wide number of different needling techniques, the one used in this work is the Leopard Spot Technique (LST) 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).

**Recruitment and preparation of athletes** - Some
athletes (n=10) from the club from a kickboxing and Muay Thai club (Norte Forte) accepted the invitation to participate in the study, fitting the inclusion criteria specifically created for this proposal. In the beginning of the work each athlete filled a socio demographic questionnaire (annex iii) and was explained about the procedures of the exercise, afterwards the athletes were measured using a SECA 206 stadiometer and weighed using a Biospace InBoidy 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 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. 3 - Location of the point S34. (Flocks 2008)

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

**Intervention Phase** - The athletes were placed on the force platforms Bertec FP6090-15-2000 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. 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.

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. (Knappic & East, 2014). 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.

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

**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 for 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.

![Fig. 4 - Qualisys 3D model of one of the athletes in the study standing (left) and performing a middle kick (right)](image)
4. With these models we were able to analyse by a formula the movement in detail.

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.

Results
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 1.

Unfortunately due to an informatics 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.

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.

Table 1 - Sample Characterization

<table>
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<tr>
<th>Sociodemographic data</th>
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<tr>
<td></td>
<td>2</td>
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<td></td>
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Table 2 - Results of the maximum velocity of the leg during the kicks before (T0) and after (T1) ME exercise for the experimental and control groups

Table 3 - Results of the maximum acceleration of the leg during the kicks before (T0) and after (T1) ME exercise for the experimental and control groups

Fig. 5 - Graphical representation of the evolution of the maximum velocity of the leg during the kicks.

Fig. 6 - Graphical representation of the evolution of the maximum acceleration of the leg during the kicks.
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 2 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). Analysing the differences between before (T0) and after the ME exercise and our intervention/the rest period (T1), we 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. 5 we can observe a graphic representation of the evolution of the average maximum velocity of the leg.

**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 3 we see once again remarkable values, with the lowest value being above 49G.

Analysing the differences between before (T0) and after the ME exercise and our intervention/the rest period (T1), we 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. 6 we can observe a graphic representation of the evolution of the average maximum acceleration of the leg.

**Discussion**

The selection of point for applying, in general, during any treatment according to the traditional Chinese medicine, is surely a very rigorous operation depending on specific diagnosis, objectives and results to obtain. Here, in the present work, a particular point Stomach 34 – Monticulus Septi (Lianguju) was adequately chosen. 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). On the other hand, the selection of point needling process is another relevant and selective operation. 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)

Concerning the obtained data in the present work, we need to take into consideration that this is only a pilot study and the number doesn’t carry statistical significance, so we can only discuss tendencies being shown by our results. A bigger sample would have been crucial for us to obtain statistically 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. 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%

**Conclusions**

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. The results obtained in the pilot study show that this protocol is promising and should be carried out in a full scale study.

Aknowledgement
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