Title: “Acute effects of spinal manipulation on sports performance in amateur cyclists. Pilot study”

Title (spanish): “Efectos agudos de la manipulación espinal en el rendimiento deportivo en ciclistas amateur. Estudio piloto”

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Introduction

Spinal manipulative therapy (SMT), which consists on the application of high-speed, low-amplitude movements, slightly above the range of passive movement of the spinal joints (Bronfort, Haas, Evans, & Bouter, 2004), is widely used for the treatment of various musculoskeletal conditions such as acute or chronic back pain, having shown that it provides benefits both in terms of pain and function (Bronfort et al., 2004; Gross et al., 2015; Paige et al., 2017).

The use of the SMT is also expanding to the sports field, being used by many athletes before their competitions, trusting in a potential ergogenic effect. In fact, greater corticospinal excitability and greater electromyographic activity have been observed acutely after a single session of SMT (Christiansen et al., 2018; Niazi et al., 2015), effects that could result in greater muscle strength and ultimately in better sports performance.

However, the evidence regarding the benefits of SMT in performance is scant and contradictory. Some studies have observed greater muscular strength both in subjects with spinal dysfunction (Niazi et al., 2015) and in elite athletes (Botelho & Andrade, 2012; Christiansen et al., 2018). On the contrary, others did not find benefits in muscle force (Humphries et al., 2013; Sanders et al., 2015). Neither have benefits been observed in a running incremental test (Ward et al., 2012) or in other specific sports actions such as jumping or sprinting (Shrier, Macdonald, & Uchacz, 2006). Therefore, there is still not enough evidence to support the ergogenic role of this technique for the acute improvement of sports performance.

In a recently published study, an increase in parasympathetic modulation of the autonomic nervous system was found after performing SMT with Activator throughout the entire spine (at the discretion of the chiropractic specialist) (Valenzuela, Pancorbo, Lucia, & Germain, 2018). However, no acute benefits in performance were observed. Given these results, we hypothesized that the absence of such benefits could be due to the global manipulation of the spine, instead of a specific action on the segments related to the dorsal roots that innervate the lower limbs. The aim of the present project is to verify if SMT performed on the dorsal roots of the lumbar segments is able to enhance the neuromuscular performance of the lower limbs in amateur cyclists.

Hypothesis

Our hypothesis is that SMT performed on the dorsal roots of the lumbar segments is able to improve neuromuscular performance, improving the maximum force, power or muscle activation, or at least reducing the perceived effort to achieve the same performance.

Objectives

- General objective: To determine the effects of SMT on neuromuscular performance in athletes.

- Specific objective: To determine the effects of SMT on muscle strength, voluntary activation and power.

Methodology

Participants

In this pilot study we will try to include 40 participants. Participants will be recruited from local sports clubs. The inclusion criteria will be: being male between 18 and 45 years old, training a minimum of 3 hours per week, and not having received SMT in at least one year. The exclusion criterions will be: having suffered an injury or illness during the two months prior to the test, or having been unable to maintain the usual training rhythm during the previous month. Prior to their participation, the subjects must sign an informed consent form after reading the corresponding information sheet of the study.

Experimental design

The present study will follow a randomized, double-blind (participant and assessor), parallel and sham-controlled design. Participants must attend to the facilities twice; and these visits will be separated by 7 days. Subjects will be randomly assigned to receive the actual SMT intervention or a sham intervention. Once randomized, all participants will make a first control visit in which the tests will be carried out without receiving any type of intervention. At the second visit, the corresponding treatment (real or sham) will be applied before the tests. Each subject will perform the tests at the same time of day. Participants should maintain their eating habits during the experimental period, as well

as to avoid caffeine consumption and physical exercise in the 48 hours prior to each visit.

Measurements

The descriptive and anthropometric variables of the athletes will be measured by means of a scale and a stadiometer. We will also ask participants about the number of hours that they usually train per week.

Subsequently, participants will perform an isometric maximum voluntary contraction (MVC) with the knee extensors. Specifically, they will perform tree 5-second repetitions with the dominant leg, and the maximum force attained will be measured by means of a handheld dynamometer (microFET®2, Hoggan Scientific). The highest force reached in these contractions will be used for analysis. In addition, the maximum activation level of the vastus lateralis muscle will be also assessed by means of surface electromyography (ML856 PowerLab 26T, LabChart, ADInstruments, New Zealand) during these MVCs.

Muscle power and overall 'anaerobic' performance will be assessed by means of the Wingate test, performed on a cycle ergometer with electromagnetic brake (Cardgirus Medical, Bikemac, Sabadell, Spain). This test, one of the most popular for the evaluation of anaerobic power (Driss & Vandewalle, 2013), will last 30 seconds. Participants should try to achieve the maximum possible power during the test. We will analyze both the peak power (greatest power reached in periods of 1 second) and the mean power attained during the test. In addition, immediately after the test we will assesses the rating of perceived exertion on a 1-10 scale (Borg, 1998).

Intervention

The actual SMT intervention will always be performed by a chiropractic specialist, while the placebo intervention will be performed by the other chiropractor. The actual SMT intervention will consist of spinal manipulation with high velocity and low amplitude movements. Participants will be evaluated according to the basic Activator protocol (Fuhr, 2005). This protocol consists of the visual evaluation of possible differences in the length of the legs by performing maneuvers with the participant in prone position. These maneuvers are performed to locate the spinal areas that may present a possible dysfunction, applying a manipulation in these areas with the

Activator instrument (AAI IV, Activator Methods International, Ltd, Phoenix, AZ). This instrument will allow us to exert the same pressure on all subjects. In the actual SMT intervention the Activator will be placed in the force position 4, which exerts a pressure of very short duration (5 ms) and a force peak of approximately 176 N.

In the sham SMT condition all the maneuvers and evaluations will be carried out as in the actual SMT one. However, the Activator will be placed in the 0-force position, which means that the instrument will generate noise, but practically no movement will occur (approximately 19.5 N). Neither in the sham nor in the actual SMT intervention there are physical or mental risks for the participant, which is why they are considered non-invasive procedures.

Although the chiropractors who administer the interventions (real SMT or placebo) will know the condition assigned to each participant, the latter and the researchers in charge of the outcomes assessment and of the statistical analysis will remain blind to this information. As it is not a cross-over study (each participant is tested after only one condition, actual or sham SMT), the participants will not know the real pressure that the Activator instrument exerts. Therefore, all participants will believe that they are receiving the actual SMT intervention.

Statistical analysis

The normality of the data will be checked using the Shapiro-Wilk test. In case the data present a normal distribution, differences between conditions will be analyzed by means of a two-way analysis of variance (ANOVA) test (intervention [real or placebo] x time [pre and post]). In case of non-normal distribution, we will try to make a logarithmic transformation of the data prior to the analysis of differences to achieve a normal distribution. If the non-normality of the data is maintained, the differences between interventions will be analyzed using the Friedman test. The analysis will be carried out with a statistical analysis software (SPSS 23, USA) setting the level of significant at $p<0.05$.

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