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ORIGINAL RESEARCH

Application of shortwave diathermy to lower limb increases arterial blood flow velocity and skin temperature in women: a randomized controlled trial☆

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KEYWORDS
Diathermy;
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Abstract
Background: Shortwave diathermy (SWD) and microwave diathermy (MWD) are frequently used by physical therapists to treat musculoskeletal conditions. The therapeutic benefits are usually associated with an increase in tissue temperature; however, there is no consensus on the changes in blood flow.
Objectives: 1) To evaluate the behavior of temperature and arterial blood flow after the application of SWD and MWD to the lower limb of healthy women aged 18–30 and 2) to assess whether changes in limb positioning can influence SWD response.
Method: Among the subjects analyzed, 40 women were eligible to participate in the trial and were randomly allocated to the SWD group or the MWD group. Each group received 20 min of diathermy. After receiving the interventions, all patients crossed over to the other group, but the devices were detuned (sham). SWD was applied to the posterior compartment of the thigh and leg, with the knee in 0° and 90° of flexion, and the MWD applied to the posterior thigh. Skin temperature evaluation (digital infrared thermography) and assessment of blood flow velocity (Doppler ultrasound) were performed immediately before and 10 and 20 min after the application.

Abbreviations: SWD, shortwave diathermy; MWD, microwave diathermy; BMI, body mass index; CONSORT, Consolidated Standards of Reporting Trials; RRJG, Rinaldo Roberto de Jesus Guirro; JGC, João Guilherme Calió; MCQ, Mariane Cristina de Queluz; ECOG, Elaine Caldeira de Oliveira Guirro; NTAS, Natanael Teixeira Alves de Sousa; ANOVA, analysis of variance; P0, pre-application; P10, 10 min of application; P20, immediately after application; P30, 10 minutes after the end of the application; P40, 20 minutes after the end of the application.

☆ Clinical trial registration number: NCT01872117 - https://clinicaltrials.gov/ct2/show/NCT01872117

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Results: Arterial blood flow increased after SWD diathermy (vs. Sham), but not after MWD diathermy. SWD promoted skin heating at the end of therapy in all areas analyzed, remaining above baseline even 20 min after the end of the application. MWD diathermy promoted skin heating in the posterior thigh, reflecting a rise in the temperature of the popliteal fossa area that remained for 10 min after the end of the application.
Conclusion: The increase in arterial blood flow velocity depends on the size of the heating area, since it was only observed in the application of the SWD. However, after 20 min of application, the position of the lower leg did not affect the heating.

Introduction

Shortwave diathermy (SWD) or microwave diathermy (MWD) are frequently used by physical therapists for the treatment of musculoskeletal conditions. The mechanisms of action of these devices are related to the increase in tissue temperature. Among their therapeutic effects, SWD and MWD decrease tendinous inflammation and chronic and acute pain and improve function. These effects stand as evidence to justify the use of these methods.[1]

According to Rabini et al.,[2] deep heating promoted by MWD may reduce the intensity of pain and physical function in patients with knee osteoarthritis, and these benefits are maintained up to 12 months after the end of the treatment. As a preventive action, MWD treatment one day before eccentric exercise has a prophylactic effect on muscle damage.[3]

In 2010, Abib et al.[4] reported that, 20 min after SWD application, there was an average temperature increase of 2.41 °C in the anterior thigh. Verrier et al.[5] and Oosterveld et al.[6] reported a similar temperature increase in the thigh area, with an average temperature rise of 2.4 and 2.2 °C, respectively. However, these authors only observed local temperature under the electrode, disregarding differences in heating in the areas located in the electromagnetic field generated between the electrodes.

Infrared thermography is a noninvasive and highly sensitive method of measuring skin temperature. It provides a safe, painless, non-ionizing examination that determines the degree of distribution of local cutaneous blood perfusion.[7] According to Sikdar et al.,[8] thermography has become an important tool for measuring temperature in specific areas. Thermography detects alterations in skin temperature affected by the activation of autonomic nervous system pathways and by heat itself, which is conducted from one tissue to another at different depths.[9] Studies have shown that the increase in tissue temperature is directly related to the increase in local blood flow.[10,11] Blood flow analysis can be based on ultrasound Doppler flowmetry (UDF), which can estimate blood velocity. UDF probe emits the ultrasonic wave to a moving red blood cell and the cell reflects the incident wave. Therefore, the frequency of the reflected wave is altered according to the Doppler principle. This frequency shift is detected and analyzed by the UDF. The UDF monitor shows real-time wave patterns within given time periods, and the UDF unit calculates the blood flow rate, pulsation index, and circulation index. Furthermore, the examiner can listen to pulsation sounds in real time.[12]

Therefore, we believe the use of SWD and MWD increases the skin temperature and arterial blood flow of the lower limb. This clinical trial is unique and can contribute to a better understanding of the use of SWD and MWD as this has never been investigated in a high-quality trial. Therefore, the aim of this study is to evaluate the behavior of skin temperature before, during, and after the application of SWD and MWD in healthy women and to evaluate the effect of heat on local arterial blood flow using infrared thermography and ultrasound Doppler.

Method

Subjects, recruitment, and eligibility criteria

A total of 56 female university students were invited, recruited, and screened for eligibility to participate in the study. Among those, 40 subjects between 18 and 30 years of age were selected. All subjects were physically active and had no history of circulatory or nervous disease. Subjects who were taking antipyretics, who had a history of pain, injury, or surgery in the lower limbs, or who were in their menstrual period were not included in the study.

This study was approved by the Research Ethics Committee of Hospital das Clínicas, Faculdade de Medicina da Ribeirão Preto, Universidade de São Paulo (USP), Ribeirão Preto, SP, Brazil (approval number 313.882/2013). All subjects signed an informed consent form. This trial was also prospectively registered at www.clinicaltrials.gov (# NCT01872117).[13] The study was conducted between May 2013 and May 2015. The methods of this study were reported using the CONSORT statement.[14]

Outcome measures

The primary outcome of the study was change in arterial blood flow velocity and the secondary outcome was skin

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