The Effect of 2 MHz Ultrasound on Intramuscular Temperature at 1.5, 2.5, and 3 cm Depths

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Abstract

Context: There is little research on 2 MHz ultrasound although it is an option on the Dynatron Solaris® 700 Series. We wanted to research the depth of penetration of 2 MHz for medium depth tissues.

Objectives: To determine the increase in intramuscular temperature of 2 MHz therapeutic ultrasound at 1.5, 2.5, and 3 cm depth after a 20 minute treatment at 1.0 W/cm². Design: A two-factor repeated measures ANOVA experimental design guided this study. Independent variables were time (pre- and post treatment) and tissue depth (1.5, 2.5, and 3 cm). The dependent variable was the gastrocnemius muscle temperature change. Setting: University Research Laboratory.

Patients/Other Participants: Twenty individuals (11 males and 9 females; 20 ± 2.2 years). Intervention: We inserted 3 thermocouples into the medial gastrocnemius at the depths of 1.5, 2.5, and 3 cm. Therapeutic ultrasound was delivered for 20 minutes with the following parameter settings: 2 MHz, continuous, 1.0 W/cm². Main Outcome Measures: The temperature was recorded every 5 seconds for 20 minutes. Results: The mean rate per minute temperature increase was the greatest at the 1.5 cm depth (0.4°C/min), followed by the 2.5 cm depth (0.26°C/min), and then the 3 cm depth (0.17°C/min). The mean intramuscular temperature increase at 10 minutes was the greatest at the 1.5 cm depth (increase = 4.18°C ± 2.45°C), then the 2.5 cm depth (increase = 3.59°C ± 1.61°C), and finally the 3 cm depth (increase = 2.57°C ± 1.48°C). Conclusion: There was a significant difference in the increase in intramuscular temperature of 2 MHz therapeutic ultrasound at all depths, however, only the 1.5 cm depth reached a 4°C increase. Treatment goals and the type of machine need to be taken into account when delivering an ultrasound treatment. Key Words: therapeutic ultrasound, thermal, intramuscular temperature, ultrasound parameter settings.

Background

• One of the main uses for US is for the treatment of orthopedic injuries in the field of sports medicine.
• Tissue temperature increase is desired with the use of US because as the tissue temperature increases, different physiological effects occur which provide an ideal environment for healing.
• One and 3 MHz are the most frequently used, a 2 MHz frequency is a setting on some therapeutic ultrasound machines.
• To date there has been no published research performed on 2 MHz US and the depth to which it can penetrate the tissue.

Research Question

• What is the increase in intramuscular temperature of 2 MHz therapeutic ultrasound at 1.5, 2.5, and 3 cm depths after a 20 minute treatment at 1.0 W/cm²?

Methods

• Experimental Design: A two-factor ANOVA experimental design guided data collection in this study. The independent variables were time (pre- and post treatment) and tissue depth (1.5, 2.5, and 3 cm). The dependent variable was gastrocnemius temperature change.
• Procedures: A 20 gauge x 1.16 in. needle catheter was inserted into the medial gastrocnemius muscle, perpendicular to the carpenter’s square, at depths of 1.5, 2.5, and 3 cm. The thermocouples were connected to the IsoThermex electronic thermometer (Columbus Instruments, Columbus, OH), which measured and recorded intramuscular temperature every 5 seconds from the tip of the thermocouple.
• Intervention: 20 minutes of 2 MHz therapeutic ultrasound at 1.0 W/cm² was administered.

Results

• Mean intramuscular temperature increase at 20 minutes was the greatest at the 1.5 cm depth (increase = 4.18°C ± 2.45°C), then the 2.5 cm depth (increase = 3.59°C ± 1.61°C), and finally the 3 cm depth (increase = 2.57°C ± 1.48°C).

Conclusions and Clinical Significance

• The primary conclusion was that there is a significant difference in the increase in intramuscular temperature of 2 MHz therapeutic ultrasound at 1.5, 2.5, and 3 cm depths after 20 minutes of treatment at 1.0 W/cm². However, the goal of the individual ultrasound treatment needs be assessed each time. While there was a significant difference in the increase in intramuscular temperature, this does not translate over to be applicable in the clinical setting because ultrasound treatments that last at least 10 minutes is not common. (Table 1).

Further Research

• Future research studies should be done to investigate the use of multiple Dynatron machines to see if intramuscular temperature increases at the same rates, increasing the intensity of the different frequencies offered on the Dynatron Solaris machine, as well as explore other common depths with 1 and 3 MHz in order to establish treatment guidelines specific to the Dynatron Solaris therapeutic ultrasound machine.
• Further research is needed using the Dynatron Solaris ultrasound machine to determine if it is more beneficial to increase the intensity of the ultrasound treatment at 2 MHz or to use the 3 MHz frequency setting.

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References