In Part 1 of this two-part column, we defined counterirritants and topical analgesics and presented possible mechanisms of how they might provide pain relief. We presented and discussed research on some leading topical analgesics (menthol and methyl salicylate). Finally, we presented a major weakness of topical analgesics—they do not penetrate into the muscle and therefore only provide surface pain relief.

In Part 2, we hope to answer the question, What can athletic trainers do to deliver the pain relief of topical analgesics and at the same time heat up the deep muscle? We will do this by presenting findings from our research in which we used an ultrasound coupling medium that contains menthol as an active ingredient. Please note that we are not suggesting that this technique provides phonophoresis of the topical cream into the deep tissues.

Ultrasound Couplants

Administering therapeutic ultrasound requires that a coupling agent be placed between the sound head and the skin to enable transmission of the sound waves to the target tissue. If the ultrasonic energy is impeded by the coupling agent, the integrity of the treatment is jeopardized. There have been many studies performed on the efficiency of coupling agents. Some researchers have suggested that there is no difference between ultrasound coupling agents, whereas others showed superiority of some couplants over others. Although there is controversy over which coupling agent to use, water-based gels have provided the most effective transmission of ultrasonic energy.

Some have suggested that topical analgesics be combined with water-based gels in order to enhance the benefits of therapeutic ultrasound. Topical analgesics stimulate superficial thermal response receptors, resulting in sensations of cold or hot. Some suggest that these sensations are responsible for pain relief after the application of a topical analgesic. The addition of topical analgesics to ultrasound gels, however, might change the physical properties of the coupling agent, blocking full transmission of the ultrasonic energy. Several studies have evaluated the efficiency of topical analgesics when mixed with water-based gels during therapeutic ultrasound. These studies yielded varying results depending on the topical analgesic used and the methods of the researchers.

Previous Research

The active ingredient in Flex-All is menthol (7%), an analgesic that provides a sensation of cool or cool-burning. Distributors of Flex-All claim that when it is mixed with ultrasound gel, it enhances therapeutic ultrasound by providing fast pain relief. In a study performed in 1996, a 1:1 mixture of Flex-All and ultrasound gel was compared with 100% ultrasound gel. The mixture heated muscle to 82.4% of that produced by the ultrasound gel at a 3-cm depth, and 72% at 5 cm. These results do not support the claim that Flex-All enhances therapeutic ultrasound. We speculate that the high concentration of Flex-All might have blocked some
of the sound waves from entering the tissues, resulting in lower muscle temperatures.

**Our Research**

We recently completed a study with a smaller amount of Flex-All mixed with ultrasound gel. The purpose was to compare muscle-temperature increases during ultrasound treatments using a 1:3 mixture of Flex-All and Aquasonic® ultrasound gel (FA/gel) with those of treatments with 100% ultrasound gel. We used a repeated-measures design for data collection.

Twenty-five volunteers (9 men, 16 women, age 22.40 ± 1.71 years, calf skinfold 6.72 ± 3.04 mm) completed this study. We randomly placed participants into a 1-MHz continuous-ultrasound group \((n = 10,\) intensity = 1.25 W/cm\(^2\), time = 10 min) or a 3-MHz continuous-ultrasound group \((n = 15,\) intensity = 1.42 W/cm\(^2\), time = 5 min).

To measure muscle temperature, we inserted sterile thermistors either 2 cm deep (3-MHz group) or 4 cm deep (1-MHz group) into the medial side of the triceps surae muscle. The thermistors were connected to an Isothermex™ electrothermometer that was interfaced with a desktop computer to record intramuscular temperature every 30 s. Participants received two ultrasound treatments from an Omnisound® 500 (Reno, NV) on separate days, one with the 1:3 FA/gel couplant and the other using the gel-only couplant. The treatment area was twice the size of the sound head.

The mean temperature rise for the 1-MHz group was 2.53 ± 0.25 °C with the FA/gel and 2.49 ± 0.25 °C with gel only (Figure 1). The mean temperature rise for the 3-MHz group was 3.32 ± 0.24 °C with the FA/gel and 3.06 ± 0.24 °C with gel only (Figure 2). There was no significant difference between the FA/gel and the gel only for peak change in temperature and time to peak temperature for either group \((p > .05)\).

Several participants were able to tell that they had received the FA/gel treatment simply by the sensation elicited by the Flex-All. The next day, these participants told us that they felt a comfortable warm or cool-burning sensation on their legs for several hours after they had left the modalities lab. This indicates a potential benefit of sustained pain relief after therapeutic ultrasound treatments with the FA/gel because of the analgesic effects of Flex-All. We suggest that future research test this mixed couplant (or others) on subjects who are experiencing pain to see if indeed the topical analgesics/counterirritants provide pain relief.

**Conclusion**

Based on the results of our study, we believe that an ultrasound treatment using a 1:3 mixture of Flex-All and Aquasonic ultrasound gel provides increases in intramuscular temperature equivalent to those of 100% Aquasonic ultrasound gel. In addition, the active ingredient (menthol) in the 1:3 mixture might provide further pain relief. The ability to combine surface pain-relieving aspects of topical analgesics with the deep-heating aspect of therapeutic ultrasound would be a powerful tool.