Simulating Thermotherapeutic Response Induced By Thermal Padding for Treating Acute Injuries

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Abstract

Cryotherapy and thermotherapy are common methods of treatment for acute injuries ranging from ankle sprains to complex surgery. The idea behind such treatment is that a change in temperature will reduce pain and constrict fluctuations in blood flow at the targeted area. The purpose of this study is to simulate the vascularized tissue reaction and the resulting blood flow fluctuation from thermal changes in the surrounding environment. A numerical solution performed in COMSOL Multiphysics® that implements a coupling of the Navier-Stokes equation in the single phase laminar flow module and the energy equation from the Heat Transfer module has been studied for optimal thermal padding design. In this study, as shown in Figure 1, the influence of the temperature on the vessel diameter and fluid flow rate is studied in a two-dimensional model. The results, shown in Figure 2, illustrate that the vessel diameter is dependent upon the applied temperature as well as vessel geometric effect on fluid flow changes and perfusion rate in tissues. The simulation results provide useful insight in future therapeutic device design, which can be optimized to deliver maximum therapeutic results. In conclusion, the effects of thermal treatment have been studied using COMSOL to find the optimal design for thermal padding.

Reference

1. Denoble, Anna E., et al. "Patellar skin surface temperature by thermography reflects knee osteoarthritis severity." Clinical medicine insights. Arthritis and musculoskeletal disorders 3 (2010): 69.

2. Warren, Todd A., et al. "Intra-articular knee temperature changes ice versus cryotherapy device." The American journal of sports medicine 32.2 (2004): 441-445.

3. Lineykin, Simon, and Shmuel Ben-Yaakov. "Modeling and analysis of thermoelectric modules." Industry Applications, IEEE Transactions on 43.2 (2007): 505-512.

Figures used in the abstract

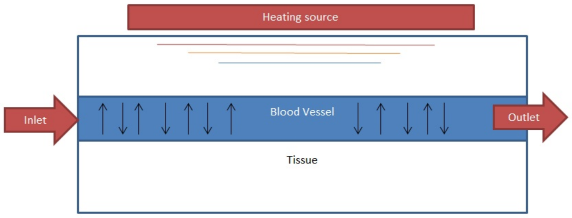

Figure 1: Schematic of Thermal Pad Setup.

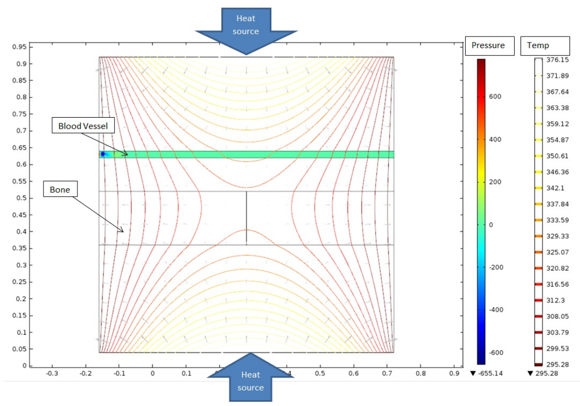

Figure 2: Heat Transfer Simulation.