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How do muscles move blood?

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The venous system plays a crucial role in circulation by serving as a reservoir that stores and redirects blood. Compared to arteries, venous flow is more complex due to low pressure, variable flow rates, gravitational effects, vessel collapsibility, the presence of valves, and a large storage capacity. In an upright position, venous return from the lower extremities must work against gravity, but forward flow is supported by venous valves and the action of the muscle pump.

In this talk, we present a closed-loop ODE model of blood circulation that includes the heart, as well as the arterial and venous systems of the upper and lower body. The model incorporates muscle pump activity, venous valves, and gravity, and reproduces physiologically realistic flows, volumes, and pressures. Simulations quantify how leg muscle contractions increase venous return, while sensitivity analysis identifies contraction frequency, intramuscular force, and contraction time as important parameters influencing venous return and cardiac output.

The model also provides a framework for studying circulation during activities such as walking, jogging, and squatting, and offers insights into conditions like vertigo associated with insufficient blood supply to the brain due to pooling of blood in the lower extremities.

Keywords: Cardiovascular Modeling, Venous System Dynamics, Muscle pump, Sensitivity Analysis

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