18.7C: Blood Flow in Skeletal Muscle

Blood flow to an active muscle changes depending on exercise intensity and contraction frequency and rate.

Learning Objectives

• Summarize the factors involved in blood flow to skeletal muscles

Key Points

• The circulatory system is closely associated with skeletal muscle to provide efficient transfer of oxygen and nutrients required for contraction and the removal of inhibitory waste products.
• At rest, skeletal muscle uses approximately 20% of cardiac output, which can rise to 80% during exercise.
• Return of blood to the heart, especially from the legs, is facilitated by the skeletal muscle pump. Deep-lying veins are compressed by skeletal muscle, forcing blood through the circulatory system back to the heart.
• After repeated stimulation, vascular recruitment can lead to an increase in the number of capillaries present in a muscle tissue, facilitating better supply and more efficient removal of waste products.

Key Terms

• **skeletal muscle pump**: The mechanism whereby skeletal muscles aid the return of blood to the heart by compressing embedded veins.
• **vascular recruitment**: The increase in the number of capillaries in response to a stimulus; for example, repeated exercise results in an increase in the number of capillaries in a skeletal muscle.
Skeletal muscles are important in maintaining posture and controlling locomotion through contraction. For this reason, they receive approximately 20% of cardiac output at rest, which can increase up to a maximum of approximately 80% with exercise. Due to the requirements for large amounts of oxygen and nutrients, muscle vessels are under very tight autonomous regulation to ensure a constant blood flow, and so can have a large impact on the blood pressure of associated arteries.

Blood vessels are closely intertwined with skeletal muscle tissues lying between the fascicles, or bundles of muscle fibers. Each muscle is supplied by many capillaries. This close association reduces the diffusion distances, allowing for the efficient exchange of oxygen and nutrients required for contraction and the rapid removal of inhibitory waste products.

Blood Flow During Exercise

Blood flow within muscles fluctuates as they contract and relax. During contraction, the vasculature within the muscle is compressed, resulting in a lower arterial inflow with inflow increased upon relaxation. The opposite effect would be seen if measuring venous outflow.

This rapid increase and decrease in flow is observed over multiple contractions. If the muscle is used for an extended period, mean arterial inflow will increase as the arterioles vasodilate to provide the oxygen and nutrients required for contraction. Following the end of contractions, this increased mean flow remains to resupply the muscle tissue with required nutrients and clear inhibitory waste products, due to the loss of the inhibitory contractile phase.

Skeletal Muscle Pump

Skeletal muscles also play a key role in the movement of blood around the body. Veins embedded within a muscle are compressed during contraction of that muscle, causing an increase in blood pressure due to the presence of one-way valves within the veins. This increase in pressure drives the blood towards the heart. The skeletal muscles of the legs are particularly important skeletal muscle pumps as they prevent pooling of the blood in the feet and calves due to
Skeletal Muscle Pump: During contraction of the skeletal muscle the vein is compressed which increases blood pressure. Due to the presence of one way valves the blood can pass only in one direction, back towards the heart.

It is unclear whether the action of skeletal muscle pumps influences arterial flow or if this is maintained purely by the pumping of the heart.

Vascular Recruitment

Following repeated stimulus such as through exercise, the number of capillaries present in a muscle tissue can increase. This vascular recruitment increases the capillary surface area within a muscle, allowing for enhanced oxygen exchange with the muscle fibers, prolonging the period of aerobic respiration and thus muscle output, and facilitating a more rapid removal of inhibitory waster factors such as lactic acid, reducing fatigue.