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Ele 482-Biomedical Seminar
Presentation #1
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Mechanical Energy Converter and Implantable Afterload Chamber

The human body at rest generates 1.5 kilocalories of energy every minute. The most abundant contractile tissue in the body is muscle. The original idea behind the MEC was to create a device that could generate internal power in order to provide its services as a cardiology assist device. Cardiology assist devices in use now use external power. The patient is confined to the limitations of an external battery, which needs to be recharged and monitored. Using skeletal muscle as an endogenous power source is an attractive solution.

Experiments have been undertaken in several labs (including the California Pacific Medical Laboratories) monitoring the energy generation capabilities of skeletal muscle. The MEC itself is a device attached by a hook to the humeral tendon in the Latissimus Dorsi. When the muscle lengthens, the tendon contracts, and the piston is pulled into the hydraulic chamber, generating hydraulic energy. The device has a “spring-loaded” mechanism that will return the device to its maximum Potential energy position.

The IAC was created to measure the function of the device and general muscle performance, in reference to its abilities of providing enough energy needed for cardiac assist. It is a fluid-filled pressure chamber that uses Boyle’s Law to assist the MEC. Once the contraction of the MEC creates enough pressure to overcome IAC resting pressure, the IAC chamber expands in order to allow additional air from the MEC chamber. Once the IAC reaches minimal fluid pressure and maximal air pressure, the IAC forces the fluid out. This pushes the MEC back to its pre-contractile position. The difference in volume between the chambers can be used to measure stroke volume, and thereby overall muscle stroke efficiency.

This experiment was conducted in vitro, to simulate long term muscle reactions to such an implant. Piston displacement, actuation forces, and MEC stroke lengths were all calculated accurately with the pressure readings when compared against more conventional measurement techniques.

It has been surmised that certain muscles can generate the energy needed for cardiac assist. However, results will vary between trained and untrained muscles from subject to subject. Stroke lengths of muscles will also vary widely. This makes it difficult to predict the maximum power capacity possible to be generated by human muscle. Monitoring chronic muscle will certainly bring new avenues for research with: changes of muscle functioning with training, measuring the steady state capacity of skeletal muscle, the effects of pharmacy products on skeletal function, the effects of gene therapy on muscle function.

Sources:

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