Practical Lab Physiology

Simple Muscle Twitch (Human)

2021-2022

Overview:

The electrical activity in the motor units during a muscle contraction can be recorded as bursts of muscle action potentials that are collectively known as an electromyogram (EMG). The duration of the bursts of electrical activity in the muscle is about equal to the duration of the muscle contraction. When the electrical activity in the muscle begins, the muscle fibers begin to contract; when the electrical activity stops, the muscle begins to relax. The strength of a muscle contraction is related to the number of motor units in the muscle that are activated during the contraction, and the strength is directly proportional to the intensity of electrical activity in the muscle.

Muscles are only one component in a system that is responsible for the movement of a body part. In the skeletal system, muscles work together with bones to create a system of levers that move a part of the body. In a lever, the muscle in anchored on a stationary bone at a point known as the origin. The muscle provides the effort or force that moves bone that is the lever. The point of attachment of muscle on the lever is known as the insertion. As the muscle contracts and relaxes, the bone, functioning as the actual lever, rotates around a joint in the skeletal system.

The joint is the fixed point that functions as the fulcrum for the lever. The body part being moved is the load on the lever. Because body parts have different groups of muscle attached to them, the part can be moved in different directions by muscles that act on the same bone from different directions. Muscles that move body parts toward the body are called flexors. Conversely, muscles that move body parts away from the body are called extensors. Flexors and extensors that work on the same lever or body part are known as antagnostic muscles. When performing a function, like throwing a baseball, muscles in various parts of the body relax and contract in a coordinated manner to accelerate and release the ball at the right moment.

Not all muscles use bones as the levers to move body parts. Even though a bone may be involved as a point of origin. Some muscles are attached to skin, such as the muscles that control the facial experssions. Other muscles are attached to organs. The muscles that are attached to the eye control its position and movement without the use of a bone as a lever. The collective activity of the muscles that control the position of the eye is known as an electroculogram (EOG). Even within the eye, there are muscles that control the thickness of the lens that allows control of the eye's focusing.

Experiment background:

About 40% of the total body mass of a human is skeletal muscle. Skeletal muscle is intimately associated with the skeletal system and, combined, these muscles and bones are responsible for supporting and moving the body. While all skeletal muscle fibers have sarcomeres and the same banded appearance, different muscles can function in different ways. For example, some are relatively weak and fatigue resistant, while others are strong but fatigue quickly. These features may be explained in terms of biochemical properties.

The muscle fibers found in most mammalian skeletal muscles are either fast- or slow- twitch types. Each type contains a different type of myosin, with different rates of ATPase activity and cross-bridge binding.

Within the group of fast-twitch fibers, there are fibers that use both glycolysis and oxidative phosphorylation. There are also fast-twitch fibers that just use glycolysis; this group tends to need less oxygen and is much stronger than the fibers that also use phosphorylation. However, these stronger glycolytic fibers breakdown glucose very inefficiently; a burst of contractile activity uses most of the available glucose, causes lactic acid to accumulate, and leads to fatigue more quickly.

Even though a motor neuron synapses with many muscle fibers, all the muscle fibers connected to that motor neuron are the same type. So, the stimulation of one particular motor neuron will cause contractions of only one type of muscle fiber. Motor neurons that supply the weak, slow, oxidative fibers have the lowest threshold. When a muscle tries to lift any weight, the muscle first shortens to put tension on the tendons which hold the muscle to the bones. Development of this tension before movement occurs takes time, known as the latency period, which is directly proportional to the weight attached to the muscle.

Once the tension exceeds the weight of the object, any further muscle contraction produces a shortening of the muscle and a movement of the weight. The time that a muscle is in its active state (contracting) is finite; so, muscles have less time to shorten when they move heavier weights. In this experiment, demonstrate the effect of increasing the stimulus strength on the strength of contraction of a muscle. This experiment involves the application of stimulus pulses to the skin on the back of the hand to produce a twitch in the muscles that move the subject's little finger. The stimulus pulses used in this experiments are generated by a high voltage stimulus isolator. While the sensation of evoked muscle contractions may initially feel peculiar, electrical stimulation of the muscles in the hand is safe and painless.

Clinical disease:

Hypotonia: means decreased muscle tone. It can be a condition on its own, called benign congenital hypotonia, or it can be indicative of another problem where there is progressive loss of muscle tone, such as muscular dystrophy or cerebral palsy. It is usually detected during infancy.

Hypertonia: is when someone has too much muscle tone in their body, making it hard to flex and move around normally. People with hypertonia will have issues with stiff movements, balance, walking and reaching. In some cases, someone can also have problems with feeding

Amyotrophic lateral sclerosis (ALS): also known as motor neurone disease (MND) or Lou Gehrig's disease, is a neurodegenerative disease that results in the progressive loss of motor neurons that control voluntary muscles. ALS is the most common type of motor neuron disease.

Procedure:

1. Place a small amount of electrode paste on the 2 metal pads of the stimulating bar electrode.
2. Place the stimulating bar electrode over the volunteer's ulnar nerve at the elbow. The approximate position is shown in the diagram, above.
3. Apply pressure to the stimulating bar electrode to ensure the electrode does not move.
4. Set the current to 8 milliamperes (mA) in the Isolated Stimulator .
5. The Isolated Stimulator switch should be set to the ON position. The Isolated Stimulator only becomes active during a recording. It is switched off internally at all other times.

6. Select Start, and a short pulse current will pass through the volunteer's skin every second. Refer to these if the light flashes yellow.
7. If you cannot achieve a response, increase the stimulator current by 2 mA or reposition the stimulus electrode.
8. Take note of the twitch contractions affecting the little finger and other fingers. Examine the effect of small adjustments in the position of the electrodes, and locate the position which produces the largest twitches.
9. When a good response is achieved select Stop on the device.
10. With a ballpoint pen, lightly mark two small crosses on the skin indicating the position of the electrode that produces the most effective stimulation.
11. Use these marks to reposition the stimulating bar electrode at the elbow for EMG recordings in the following activities.

Electrode replacement:

1. Remove any jewelry from the volunteer's wrists.
2. Wrap the dry earth strap around the volunteer's wrist. Note, this can be replaced with a disposable electrode. Ensure that you leave enough space to place the stimulating bar electrode at the wrist.
3. Mark 2 small crosses on the skin over the abductor digiti minimi muscle where the recording electrodes will be placed, as shown in the figure. The crosses should be 3–4 cm apart.
4. Obtain 2 new disposable electrodes. The adhesive pads may need to be trimmed slightly so they will fit on smaller hands.
5. Place the stimulating bar electrode over the volunteer's ulnar nerve at the elbow (using the marks you made previously).
6. Ask the volunteer to position his or her arm in a relaxed position on a table so that the little finger rests lightly on the pulse transducer. The forearm should be resting on the table with the elbow hanging over the edge to allow access to the ulnar nerve.