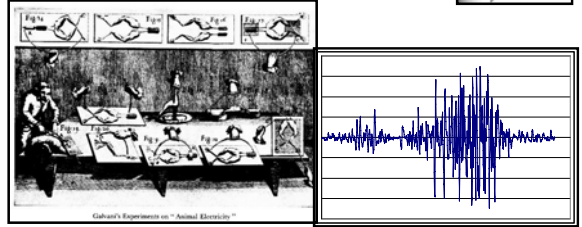


Electromyography (EMG)

1. What is EMG?
2. Various uses of EMG...
3. Recording EMG...
4. Processing EMG

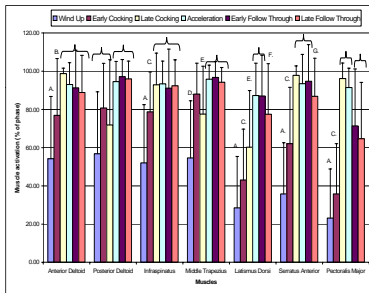
Electromyography (EMG)

EMG involves the study of electrical signals that are associated with activation of muscle; began in 1792 with Galvani; EMG signal arises from charged ions (Na^+ and K^+) crossing the muscle membrane during the excitation-contraction process



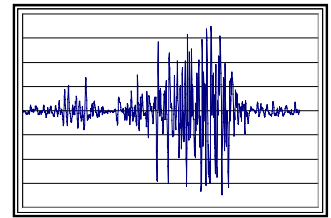
EMG

- What questions might EMG help us answer?
 - When is a muscle active? USTA...



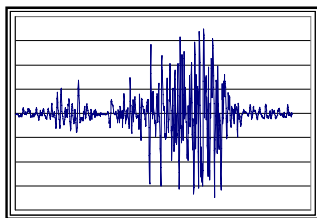
EMG

- What questions might EMG help us answer?
 - When is a muscle active? USTA...
 - How active is a muscle? KPS



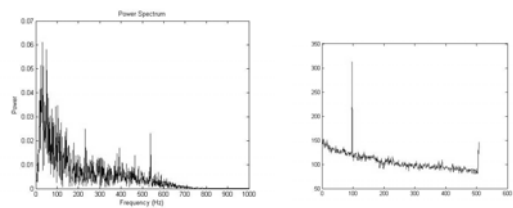
EMG

- What questions might EMG help us answer?
 - When is a muscle active? USTA...
 - How active is a muscle? KPS
 - In combination with kinematic data, is a muscle action concentric or eccentric? FAI



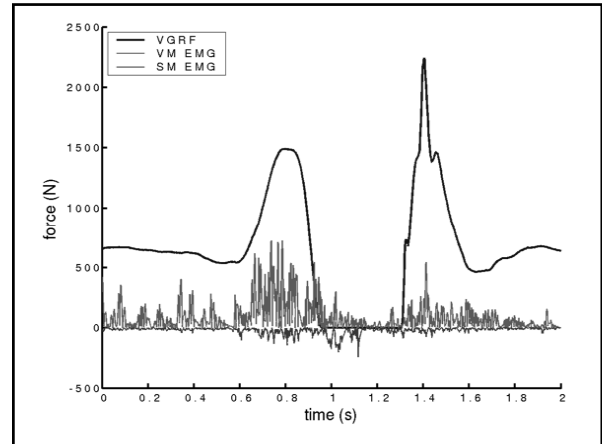
EMG

- What questions might EMG help us answer?
 - When is a muscle active? USTA...
 - How active is a muscle? Gait...
 - Is a muscle active primarily during shortening or lengthening? Gait...
 - Has a muscle fatigued during an activity?

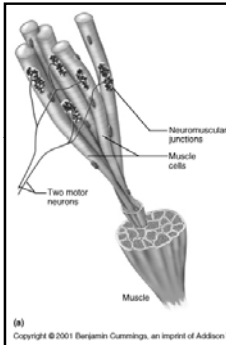


EMG

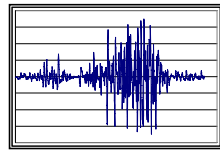
- What questions might EMG help us answer?
 - When is a muscle active? USTA...
 - How active is a muscle? Gait...
 - Is a muscle active primarily during shortening or lengthening? Gait...
 - Has a muscle fatigued during an activity? Frequency...
 - How much force is a muscle generating?? Isometric...
- EMG is often more valuable when combined with motion and/or force data



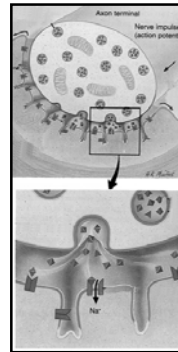
EMG: a basic review



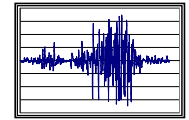
Motor unit: one α -motoneuron and all the muscle fibers that it innervates; the motor unit is the functional unit of the neuromuscular system



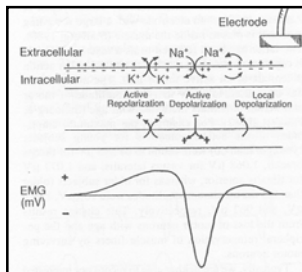
EMG: a basic review



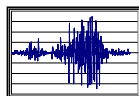
α -motoneurons connect to corresponding muscle fiber at the neuromuscular junction. ACh is released into the synaptic cleft, binds with receptor sites on the motor end plate of muscle, may lead to generation of an action potential that propagates outward along muscle membrane



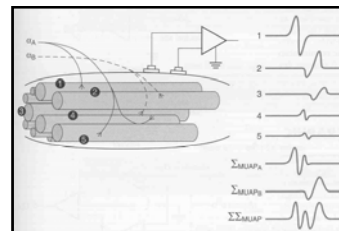
EMG: a basic review



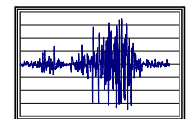
A muscle fiber action potential (MFAP) is a single moving action potential, associated with membrane potential changes that are due to propagation of action potential along muscle membrane; this is the basis for EMG and the contraction process



EMG: a basic review



The motor unit action potential (MUAP) is the algebraic sum of all MFAP in a motor unit; each muscle fiber has a unique MFAP and makes a contribution to MUAP



EMG: a basic review

What are two primary strategies used by the central nervous system to increase muscle force?

Recruitment - activation of previously silent motor units; small to large

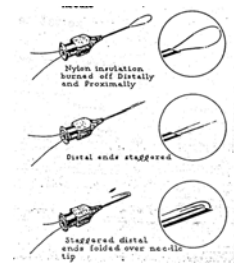
Rate Coding - previously active motor units are stimulated at a higher rate

Both processes will result in more force, and larger EMG amplitude, but not necessarily in a linear relationship

EMG: Electrodes

Electrode types

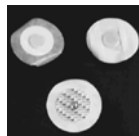
- **Indwelling** - Needle or fine-wire inserted into muscle of interest
 - smaller pick-up zone than surface electrodes
 - more selective, can be used for motor unit studies
 - can be used to reach deep muscles



EMG: Electrodes

Electrode types

- **Surface** - placed on the skin with adhesive over muscle of interest; advantages?
 - larger pick-up zone, may be more representative of whole muscle activation
 - more susceptible to cross-talk
 - can only be used with superficial muscles



Recording the EMG

Amplifier Gain

- Low amplitude of EMG signals (< 5 mV) sometimes necessitates amplification (e.g., $\times 100$, $\times 1000$, $\times 10,000$)
- Gain setting is typically user selectable
- Preamplifiers - some electrodes have built-in amplifiers to boost signal at recording site
 - Increases signal-to-noise ratio
 - Minimizes movement artifact

Recording the EMG

Electrode Application

1. Palpate the muscles on the subject
2. Prepare the skin
 1. Shave, if necessary
 2. Abrade
 3. Cleanse
3. Place the electrodes so they are parallel to muscle fibers
4. Place reference electrode

Analog to Digital Conversion

- The EMG signal is originally an analog signal, that must be transformed into a digital signal
- Once the signal is transformed into digital format, it is typically stored in a PC

Processing the EMG

The recorded EMG signal can be processed in a bewildering number of ways. We will only review three:

1. Rectification

2. Smoothing

3. Normalization:

- Maximal isometric voluntary contraction
- Submaximal isometric voluntary contraction
- Peak EMG amplitude during activity
- Average EMG amplitude during activity

Normalization: a static maximal effort for four different muscles

