STRUCTURE & FUNCTION OF SKELETAL MUSCLE

MUSCLE CONTRACTION

• “When a muscle contracts, it knows no direction; it simply shortens.” - Lippert

• Muscle is the sole producer of active force in the body which makes it responsible for all active motions.

• Muscles also control and stabilize posture through their action on joints.

TERMINOLOGY: MUSCLES

Muscle Origins

• Generally, the more proximal point of attachment
• Generally, the more stable point of connection
• The attachment point that the other end of the muscle moves towards
TERMINOLOGY: MUSCLES

• Muscle **Insertions**
  • Generally, the more distal point of attachment
  • The more moveable attachment point for the muscle
  • This attachment moves toward the more stable or proximal bony attachment point

TERMINOLOGY: MUSCLES

• **Action**
  • Motion that occurs when the muscle contracts

• **Innervation**
  • To supply (an organ or a body part) with nerves.
  • To stimulate (a nerve, muscle, or body part) to action.
  • The nerve that enables the body part to function...

TYPES OF MUSCLE ACTIVATION

• An active muscle develops force in only one of the following 3 ways:

<table>
<thead>
<tr>
<th>How</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>By contracting</td>
<td>Concentric</td>
</tr>
<tr>
<td>By resisting elongation</td>
<td>Eccentric</td>
</tr>
<tr>
<td>By remaining a constant length</td>
<td>Isometric</td>
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CONCENTRIC MUSCLE ACTIVATION

- As a muscle produces an active force and shortens the distance between the proximal and distal attachments of the muscle.

MUSCLE ACTIVATION

Eccentric
- As a muscle produces an active force attempting to contract but is simultaneously pulled to a longer length by a more dominant external force.
- Gravity is usually the external force which exceeds the internal ability of the muscle.
- The muscle is effectively lengthened.

MUSCLE ACTIVATION

Isometric
- When a muscle generates an active force while remaining at a constant length.
- There is no change in joint angle.
- No motion takes place.
MUSCLE TERMINOLOGY

• **Agonist**
  • The muscle performing the task

• **Antagonist**
  • The opposing muscle to the task being performed

In the image to the right, it’s clear that the triceps brachii is the prime mover and the little anconeus would only assist if anything...

MUSCLE TERMINOLOGY

• **Prime mover**
  • Primary muscle causing movement

• **Assisting mover**
  • Muscle that is not as effective in producing the movement, but does assist

MUSCLE TERMINOLOGY

• **Co-contraction**
  • Agonist and Antagonist contract simultaneously
  • Provide stabilization
  • There are many muscles co-contracting to permit her to hold this position
MUSCLE TERMINOLOGY

- **Synergists**
  - Muscles that work together
- **Force Couple**
  - Muscles that work together in opposite directions to produce torque in the same rotational direction

Anatomic Force Couple

MUSCLE NAMES

- **Location**
- **Shape**
- **Action**
- **Number of heads**
- **Attachments**
- **Direction of the fibers**
- **Size of the muscle**
MUSCLE NAMES

- Location
- Shape
- **Action**
- Number of heads
- Attachments
- Direction of the fibers
- Size of the muscle

Lippert pg 40

Extensor Indicis

MUSCLE NAMES

- Location
- Shape
- **Action**
- **Number of heads**
  - Biceps Brachii (2)
  - Triceps Brachii (3)
- Attachments
- Direction of the fibers
- Size of the muscle

Lippert pg 40

MUSCLE NAMES

- Location
- Shape
- **Action**
- Number of heads
- **Attachments**
  - Sternocleidomastoid
- Direction of the fibers
- Size of the muscle

Lippert pg 40
MUSCLE NAMES

• Location
• Shape
• Action
• Number of heads
• Attachments
• Direction of the fibers
  • Vastus Medialis Oblicus (VMO)
• Size of the muscle

Lippert pg 40

MUSCLE NAMES

• Location
• Shape
• Action
• Number of heads
• Attachments
• Direction of the fibers
• Size of the muscle
  • Pectoralis Major

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MUSCLE FIBER ARRANGEMENT

• Parallel
  • Tend to be longer
  • Have a greater range of motion

Lippert pg 41
MUSCLE FIBER ARRANGEMENT

- Oblique
  - Shorter
  - More numerous (Dense)
  - Great strength

Lippert pg 41

MUSCLE FIBER ARRANGEMENT

- Rhomboid muscle
  - Four sided
  - Usually flat
  - Broad attachments at each end
    - Pronator teres
    - Gluteus maximus
    - Rhomboids in the shoulder girdle

Lippert pg 41

MUSCLE FIBER ARRANGEMENT

- Triangular Muscle
  - Narrow attachment on one end (insertion)
  - Broad attachment on the other end (origin)
  - Pectoralis major

Lippert pg 41
MUSCLE FIBER ARRANGEMENT

- Oblique: Unipennate
  - Fibers arranged in a pattern that resembles one side of a feather
  - Short fibers attaching diagonally into a central tendon
  - Tibialis posterior

MUSCLE FIBER ARRANGEMENT

- Oblique: Bipennate
  - Short fibers that bilaterally attach into a central tendon
  - Featherlike in appearance
  - Rectus femoris
  - Rectus abdominus

MUSCLE FIBER ARRANGEMENT

- Oblique: Multipennate
  - Muscles have many tendons with oblique muscle fibers in between them
  - Deltoid
  - Subscapularis
LINE OF PULL

- The direction of a muscle’s force is referred to as its line of pull.
- This determines its action
  - If a muscle crosses a joint, it acts on that joint

MUSCLE: LENGTH-TENSION RELATIONSHIP

- **Active Length-Tension Relationship**
  - Strength of the muscle is the least when the muscle is in its shortest position and also when it is in its longest position
  - Strength is greatest at mid-length

MUSCLE: LENGTH-TENSION RELATIONSHIP

- **Passive Length-Tension Relationship**
  - A muscle generates greater internal elastic force when stretched
FORCE-VELOCITY RELATIONSHIP

• Speed Matters:
  • Concentric muscle contractions
    • Muscle produces less force as the speed increases
    • You can repeatedly lift lighter versus heavy objects at great speed
    • The muscle cannot produce force at great speeds when the objects are heavy

FORCE-VELOCITY RELATIONSHIP

• Speed Matters:
  • Isometric activation creates greater force than any speed contraction
  • Eccentric activation
    • Force production increases slightly as the speed of the elongation increases

MUSCULAR TIGHTNESS

• Due to the adaptability of muscular tissue:
  • Muscle will assume the length most common to it
    • “What you don’t use, you lose”
    • Immobility can cause muscle tightness and/or loss of motion
    • Severe loss of motion can lead to joint contracture
      • The joint is incapable of permitting full motion

• What position over an extended period of time do you think would have caused this to occur?
MUSCLE TIGHTNESS

• A protective mechanism:
  • This is referred to as **muscle guarding**
  • The muscular system “tightens” to help protect the body from further injury however:
    • Circulation is impaired
      • Metabolites build up
      • Pain results
      • Edema results

FUNCTIONAL CHARACTERISTICS OF MUSCLE

• Irritability
  • The ability to respond to a stimulus
  • A muscle contracts when stimulated.

• Contractility
  • The ability to shorten or contract, producing tension between the origin and insertion of the muscle.
  • Muscle may:
    • Stay the same length (isometric)
    • Shorten (concentric)
    • Lengthen (eccentric)
FUNCTIONAL CHARACTERISTICS OF MUSCLE

• Extensibility
  • The ability to stretch when a force is applied.

FUNCTIONAL CHARACTERISTICS OF MUSCLE

• Elasticity
  • The ability to recoil, or return to a normal resting length once the stimulus or force to stretch or shorten has been removed.

FUNCTIONAL CHARACTERISTICS OF MUSCLE

• Stretch a muscle and it will lengthen.
  • extensibility
FUNCTIONAL CHARACTERISTICS OF MUSCLE

- Remove the stretch, and it will return to its normal resting position.
- Elasticity

FUNCTIONAL CHARACTERISTICS OF MUSCLE

- Stimulate a muscle and it will respond.
  - Irritability
  - By shortening
  - Contractility

FUNCTIONAL CHARACTERISTICS OF MUSCLE

- Then remove the stimulus and it will return to its normal resting position.
- Elasticity
ACTIVE VS PASSIVE INSUFFICIENCY

• Active insufficiency
  • Occurs with 2-joint or multi-joint muscles
  • Point at which a muscle cannot shorten any farther

• Passive insufficiency
  • Occurs with 2-joint or multi-joint muscles
  • Point at which a muscle cannot be elongated any farther (without damage to its fibers)

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FUNCTIONAL CHARACTERISTICS OF MUSCLE

• Tenodesis (based upon passive insufficiency)
  • while resting the elbow on a table, flexing the wrist will have a tendency to extend the fingers

FUNCTIONAL CHARACTERISTICS OF MUSCLE

• Tenodesis (due to passive insufficiency)
  • Supinating the forearm and extending the wrist will have a tendency to flex the fingers

*This can help someone either grasp something or release something...
WHAT DO YOU THINK YOU NEED TO KNOW?

REVIEW THE MAJOR CONCEPTS...