Elbow & Forearm

HOW VITAL IS THE ELBOW TO OUR DAILY LIVES?
Clarification of Terms

- The **elbow** includes:
  - 3 bones (humerus, radius, and ulna)
  - 2 joints (humeroulnar and humeroradial)
  - Allows for elbow flexion and extension of the elbow

- The **forearm** includes:
  - 2 bones (radius and ulna)
  - 2 joints (proximal radioulnar joint and distal radioulnar joint)
  - Allows for forearm pronation and supination

- The interaction among the 4 joints enables the hand to be placed in a nearly infinite number of positions, greatly enhancing the functional potential of the entire UE

Mansfield, p91-92
Osteology of the Elbow & Forearm (Bones)

4 bones relate to the function of the elbow and forearm:
- Scapula
- Humerus
- Ulna
- Radius

Mansfield, p92
Osteology of the Elbow & Forearm (Bones)...cont

- **Scapula:**
  - Infraglenoid tubercle
  - Supraglenoid tubercle
  - Coracoid process

Lippert, p149
Osteology of the Elbow & Forearm (Bones)...cont

- Humerus:
  - Trochlea
  - Capitulum
  - Medial Epicondyle
  - Lateral Epicondyle
  - Lateral Supracondylar Ridge
  - Olecranon Fossa
Osteology of the Humerus

Right Humerus
Anterior Distal Aspect

- radial fossa
- lateral epicondyle
- capitulum
- trochlea
- coronoid fossa
- ulnar nerve sulcus
- medial epicondyle
Right Humerus
Posterior Distal Aspect

Capitulum
Osteology of the Elbow & Forearm (Bones)...cont

- **Ulna:**
  - Olecranon Process
  - Trochlear Notch
  - Coronoid Process
  - Radial Notch
  - Ulnar Tuberosity
  - Styloid Process
  - Head

Lippert, p150
Osteology of the Elbow & Forearm (Bones)...cont

- **Radius:**
  - Head
  - Radial tuberosity
  - Styloid process
  - Fovea

Lippert, p150
Radial Head

Radial Tuberosity

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head

neck
Osteology of the Proximal Structures of the Forearm

- Ulna
  - trochlear notch
  - coronoid process
  - ulnar tuberosity

- Radius
  - head
  - neck
  - radial tuberosity
  - body
  - anterior margin
Osteology of the Distal Structures of the Forearm

- Olecranon process
- Head
- Neck
- Radial tuberosity
- Trochlear (semilunar) notch
- Coronoid process
- Radial notch of ulna
- Ulna
- Radius
- Head
- Styloid process
- Styloid process
What can you palpate?
What can you NOT palpate?

- Think-Pair-Share
Joint Structure of the Elbow

- **Humeroulnar Joint**
  - Provides most of the structural stability to the elbow through the jaw-like trochlear notch of the ulna interlocking with the spool-shaped trochlea of the humerus.
  - This hinge-like joint limits motion of the elbow to _________ and __________________

- **Humeroradial Joint**
  - Formed by the ball-shaped capitulum of the humerus with the bowl-shaped fovea of the radius.
  - This permits continuous contact between the radial head and the capitulum during pronation and supination, as the radius spins about its own axis.
Carrying Angle:
- With the forearm supinated and elbow fully extended, the forearm projects laterally about 15-20° relative to the humerus. This is normal, but tends to be greater in females.

Lippert, p148-149
Joint Movement of the Elbow

- **Osteokinematics:**
  - Flexion
  - Extension

- **Arthrokinematics:**
  - The concave radius/ulna move on the convex humerus

Mansfield, p97
Varum & Valgum
Supporting Structures of the Elbow

- **Anterior Capsule:**
  - Thin connective tissues encloses the humeroulnar joint, humeroradial joint and proximal radioulnar joint

- **Medial Collateral Ligament:**
  - Attaches proximally to the medial epicondyle and distally to the coronoid and olecranon processes, providing stability by resisting valgus forces

- **Lateral Collateral Ligament:**
  - Originates on lateral epicondyle and attaches to the lateral aspect of the proximal forearm, providing stability by resisting varus forces

Mansfield, p96
Joint Structure of the Forearm

- **Proximal Radioulnar Joint:**
  - The head of the radius articulates with the radial notch of the ulna

- **Distal Radioulnar Joint:**
  - The distal end of the radius rotates around the distal end of the ulna

- Functionally, they are considered one joint
- The radioulnar joint is a uniaxial pivot joint allowing only pronation and supination of the forearm

Lippert, p148
Joint Movement of the Forearm

- **Osteokinematics:**
  - Pronation
  - Supination
Joint Movement of the Forearm...cont

**Arthrokinematics:**
- The *distal* radius rotates around the ulna which is stationary
- The *distal* radius is larger and broader than the distal ulna

Lippert, p148
Joint Movement of the Forearm...cont

- **Supination & Pronation**
  - Shoulder rotation can often be functionally substituted for each motion
    - But not if the humerus is held tight against the thorax and the elbow is in 90° of flexion
Supporting Structures of the Forearm

- **Annular Ligament:**
  - Thick circular band of connective tissue that wraps around the radial head and attaches it to either side of the radial notch of the ulna.
  - This ring-like structure holds the radial head firmly against the ulna, allowing it to spin freely during pronation/supination.

- **Distal Radioulnar Joint Capsule:**
  - Provides stability to the distal radioulnar joint

- **Interosseous Membrane:**
  - Helps bind the radius to the ulna; serves as a site for muscle attachments, and acts as a mechanism to transmit forces proximally through the forearm

Mansfield, p99
Supporting Structures of the Forearm...cont
Supporting Structures of the Forearm...cont

Interosseous Membrane
The Muscles of the Elbow & Forearm:
- Biceps
- Brachialis
- Brachioradialis
- Triceps
- Anconeus
- Supinator
- Pronator teres
- Pronator quadratus
## Biceps Brachii

<table>
<thead>
<tr>
<th>Origin</th>
<th>Long Head: Supraglenoid tubercle of the scapula</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short Head: Coracoid process of the scapula</td>
</tr>
<tr>
<td>Insertion</td>
<td>Bicipital tuberosity of the radius</td>
</tr>
<tr>
<td>Innervation</td>
<td>Musculocutaneous n.</td>
</tr>
<tr>
<td>Action</td>
<td>Elbow flexion, sh flexion and forearm supination</td>
</tr>
</tbody>
</table>

Lippert, p153
Biceps brachii

- How do we stretch the biceps brachii?
- How do we strengthen the biceps brachii concentrically?
- Eccentrically?
- Isometrically?
- Closed chain?
- Open chain?
Biceps Brachii

- **Reversal of Function:**
  - Open chain: the bicep causes what to happen?
  - Closed chain: the bicep causes what to happen?
# Myology of the Elbow & Forearm (Muscles)

<table>
<thead>
<tr>
<th><strong>Brachialis</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
<td>Anterior aspect of the distal humerus</td>
</tr>
<tr>
<td><strong>Insertion</strong></td>
<td>Coronoid process of the ulna</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Musculocutaneous n.</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Elbow flexion</td>
</tr>
<tr>
<td><strong>“tidbit”</strong></td>
<td>“workhorse” for elbow flexion</td>
</tr>
</tbody>
</table>

Lippert, p152
<table>
<thead>
<tr>
<th><strong>Brachioradialis</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
<td>Lateral supracondylar ridge of the humerus</td>
</tr>
<tr>
<td><strong>Insertion</strong></td>
<td>Near the styloid process of the distal radius</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Radial n.</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Elbow flexion, Pronation or supination of the forearm to the neutral position</td>
</tr>
</tbody>
</table>

Lippert, p153
Brachialis & Brachioradialis

- How do we stretch the brachialis & brachioradialis?
- How do we strengthen them concentrically?
- Eccentrically?
- Isometrically?
### Triceps Brachii

| **Origin** | **Long Head**: infraglenoid tubercle of the scapula  
**Lateral Head**: posterior aspect of the superior humerus,  
**Medial Head**: posterior aspect of the superior humerus, |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insertion</strong></td>
<td>Olecranon process of the ulna</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Radial n.</td>
</tr>
</tbody>
</table>
| **Action** | Elbow extension  
Sh extension: *Long head only* |
Triceps brachii

- How do we stretch the triceps brachii?
- How do we strengthen the triceps brachii concentrically?
- Eccentrically?
- Isometrically?
- Closed chain?
- Open chain?
## Myology of the Elbow & Forearm (Muscles)

**Anconeus**

<table>
<thead>
<tr>
<th><strong>Origin</strong></th>
<th>Posterior aspect of the lateral epicondyle of the humerus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insertion</strong></td>
<td>Olecranon process of the ulna &amp; the annular ligament</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Radial n.</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Elbow extension?</td>
</tr>
<tr>
<td><strong>“tidbit”</strong></td>
<td>Believed to “clear” the joint space of soft tissue to permit full elbow extension. Too small to create torque for elbow extension.</td>
</tr>
</tbody>
</table>

Lippert, p153
## Myology of the Elbow & Forearm (Muscles)

<table>
<thead>
<tr>
<th>Supinator</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
<td>Lateral epicondyle of the humerus and supinator crest of the ulna</td>
</tr>
<tr>
<td><strong>Insertion</strong></td>
<td>Lateral surface of the proximal radius</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Radial n.</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Forearm supination,</td>
</tr>
</tbody>
</table>

Lippert, p155
How do we stretch the supinator?
Strengthen it concentrically? Eccentrically?
### Myology of the Elbow & Forearm (Muscles)

#### Pronator Teres

<table>
<thead>
<tr>
<th><strong>Origin</strong></th>
<th>medial epicondyle of the humerus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insertion</strong></td>
<td>Lateral surface of the midshaft of the radius</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Median n.</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Forearm pronation, secondary elbow flexion</td>
</tr>
</tbody>
</table>

Lippert, p155
### Pronator Quadratus

<table>
<thead>
<tr>
<th><strong>Origin</strong></th>
<th>Anterior surface of the distal ulna</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insertion</strong></td>
<td>Anterior surface of the distal radius</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Median n.</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Forearm pronation</td>
</tr>
</tbody>
</table>

Lippert, p155
Pronators

- How do we stretch the pronator muscles?
- How do we strengthen them concentrically? Eccentrically? Isometrically?
Myology of the Elbow & Forearm (Muscles)

- **Anatomical Relationships:**
  - Muscle bellies of biceps, brachialis, and triceps are proximal to the elbow joint, while muscle bellies of brachioradialis, pronator teres, pronator quadratus, and supinator are distal to the elbow joint.
  - Anteriorly lies the biceps, brachialis, brachioradialis, pronator teres and pronator quadratus
  - The brachialis is deep to the biceps, except at the distal humerus where it can be palpated on either side of the biceps tendon
  - The brachioradialis and pronator teres are located superficially
  - The pronator quadratus is located deep to several wrist and hand tendons

Lippert, p155
Anatomical Relationships continued:
- Posteriorly, the triceps makes up the entire posterior arm proximal to the elbow joint.
- The long and lateral heads are superficial and the medial head is deep.
- The anconeus is very small and is located superficially on the posterior elbow, just distal to the triceps insertion.
- The supinator lies deep to the wrist extensors and the brachialis.

Lippert, p156
### Prime Movers:

<table>
<thead>
<tr>
<th>Action</th>
<th>Muscle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elbow Flexion</td>
<td>Biceps, brachialis, brachioradialis</td>
</tr>
<tr>
<td>Elbow Extension</td>
<td>Triceps</td>
</tr>
<tr>
<td>Forearm Pronation</td>
<td>Pronator teres, pronator quadratus</td>
</tr>
<tr>
<td>Forearm Supination</td>
<td>Biceps, supinator</td>
</tr>
</tbody>
</table>
## Myology of the Elbow & Forearm (Muscles)

### Summary of Muscle Innervation:

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Nerve</th>
<th>Spinal Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brachialis</td>
<td>Musculocutaneous</td>
<td>C5, C6</td>
</tr>
<tr>
<td>Biceps</td>
<td>Musculocutaneous</td>
<td>C5, C6</td>
</tr>
<tr>
<td>Brachioradialis</td>
<td>Radial</td>
<td>C5, C6</td>
</tr>
<tr>
<td>Triceps</td>
<td>Radial</td>
<td>C6, C7</td>
</tr>
<tr>
<td>Anconeus</td>
<td>Radial</td>
<td>C7, C8</td>
</tr>
<tr>
<td>Pronator Teres</td>
<td>Median</td>
<td>C6, C7</td>
</tr>
<tr>
<td>Pronator Quadratus</td>
<td>Median</td>
<td>C8, T1</td>
</tr>
<tr>
<td>Supinator</td>
<td>Radial</td>
<td>C6</td>
</tr>
</tbody>
</table>

Lippert, p158
Redundancy is a fact of life/function

- **Innervation**
  - The musculocutaneous n.
    - Supplies the elbow flexors EXCEPT the brachioradialis
  - The radial n.
    - Supplies the elbow extensors
  - The median n.
    - Supplies all the pronators of the forearm
Common Pathologies

- **Lateral Epicondylitis (Tennis Elbow)**
  - Overuse of common wrist extensor tendon where it inserts due to repetitive wrist extension activities

- **Medial Epicondylitis (Golfer’s Elbow)**
  - Inflammation and overuse of the common flexor tendon at its insertion site due to repetitive wrist flexion activities

- **Little League Elbow**
  - Overuse injury at medial epicondyle due to a repetitive throwing motion, creates valgus stress at elbow

- **Nursemaid’s Elbow**
  - Radial head subluxation due to being picked up by one hand

Lippert, p156-157
Pin the Tail on the Donkey

- Point to the...
  - Elbow flexors
  - Elbow extensors
Identify!

- Triceps brachii
- Anconeus
- Teres Major
- Teres Minor
- Infraspinatus
Identify!

- Biceps Brachii
- Brachialis
- Brachioradialis
- Pronator Teres
- Pronator Quadratus
References