I. Anatomy

A. Osteology/Arthrology (Skeletal/Joint Structure)
   1. Distal radioulnar joint (DRUJ)
      a. Includes the TFCC (Triangular Fibrocartilage Complex)
      b. 1 deg of freedom - uniaxial pivot joint (sup/pron)
   2. Radiocarpal/Ulnomeniscotriquetral joint
      a. 3 deg of freedom (flex/ext/RD/UD/sup/pron)
   3. Midcarpal joint
      a. 2 degrees of freedom (flex/ext/RD/UD)
   4. Carpometacarpal joint (CMC)
      a. the 2-5th CMC joints are plane joints with 1deg of freedom
         (flexion/extension occur only)
      b. the 1st CMC joint has 3deg of freedom
         (flexion/extension/abd/add/sup/pron/circumduction)
   5. Intermetacarpal joints 2-5
      a. really synarthrosis, not synovial joint
      b. 1 degree of freedom (volar/dorsal glide)
   6. Metacarpophalangeal joint (MP)
      a. they have 3deg of freedom (flexion/extension/abd/add/sup/pron)
   7. Interphalangeal joint (IP joints - PIP’s and DIP’s)
      a. 1 deg of freedom (flexion/extension)

B. Musculature
   1. Extrinsic Hand Muscles
      a. volar side – Flexor carpi radialis
         - palmaris longus
         - flexor carpi ulnaris
         - flexor pollicis longus (FPL)
         - Flexor digitorum profundus (FDP)
         - Flexor digitorum superficialis (FDS)
      b. dorsal side – Abductor Pollicis Longus (APL)
         - Extensor Pollicis Brevis
         - Extensor carpi radialis longus ( ECRL)
         - Extensor carpi radialis brevis (ECRB)
         - Extensor pollicis longus
         - Extensor digitorum communis
         - Extensor indicis
         - Extensor digitii minimi
         - Extensor carpi ulnaris
   2. Intrinsics – lumbricales
- palmar interossei
- dorsal interossei
- thenar muscles
- hypothenar muscles

C. **Lymphatic System** — the only system that can remove large molecule substances such as excess plasma proteins, hormones, fat cells, and waste products from the interstitium that you see in **chronic edema**. The lymphatics are tubes which are in the dermis layer of the skin; they rely on changes in interstitial pressure to open and close (pressures>60mmHg will collapse the tubes).

1. “Squeezing” tissue removes the fluid from the lymph but not the large molecules, so the edema becomes more concentrated
2. The proteins are hydrophilic and when the pressure is removed, the fluid is attracted back into the interstitium

D. **Myofascial/Skin**
1. Dorsum of the hand is very different than the palm
2. The palmar fascia has longitudinal, transverse, and vertical fibers
   a. the vertical fibers run superficially to stabilize the thick palmar skin
   b. the lymphatics run through the dorsal hand

E. **Nerves**
1. Median
2. Ulnar
3. Radial

II. **Phases of Connective Tissue Healing**

A. **Inflammatory Phase**
1. vasodilation
2. hyperemia
3. increased cell permeability
4. increased vascularity
5. cell migration
6. debris removal

B. **Fibroplastic Phase**
1. **re-epithelialization** causing wound closure (skin)
2. **fibroplasia** — fibroblasts are activated and move along the fibrin meshwork to generate new collagen, elastin, GAG’s, proteoglycans, and glycoproteins
3. **neovascularization** — regeneration of small blood vessels
4. wound contraction
5. collagen with random alignment

C. **Remodeling Phase**
1. consolidation phase
2. increased wound strength
3. realignment of collagen
4. reduction of abnormal cross links
5. **maturation phase** – the scar links change from weak hydrogen bonds to strong covalent bonds

III. **Normal Synovial Joint Mechanics**
   A. **Osteokinematics**
      1. Movement of the bony segments around a joint axis
      2. Consists of AROM/AAROM/PROM
   B. **Arthrokinematics**
      1. involuntary joint movement that is occurring and has to occur for movement to take place
         a. **Accessory motion I** - joint motion that occurs as a result of active contraction of muscle
            - downward slide and roll of the humeral head during shoulder elevation (infraspinatus/teres minor/subscap)
            - generally these motions are described as **roll, spin, and slide**
         b. **Accessory motion II** – these motions are the result of an outside force which takes the joint beyond anatomical ROM
            - protective to the joint
            - ex. rotation at the mcp joints
   2. A joint capsule should have enough motion for Accessory I motions to occur and when applicable, Accessory II motions without having instability

IV. **Synovial Joint Dysfunctions**
   A. **Arthrosis**
   B. **Degeneration**
   C. **Capsular Restriction/Tightness**
   D. **Relative capsular fibrosis**
   E. **Joint Effusion**

V. **Mobilization Principles**
   A. **Edema (Acute versus Chronic) Mobilization**
      1. **Acute** – the **venous system** relies on valves, the heart pumping, and muscle pumping to remove low plasma protein swelling (acute edema)
         a. the treatment goal for **acute edema** is to decrease the fluid flow into the tissue/interstitium by:
            - ice
            - compression/higher pressure devices
            - elevation
      2. **Chronic** – the lymphatic system relies on changes in interstitial pressure to remove large molecule substances
a. The treatment goal for chronic edema is to reduce the excess plasma proteins in the interstitium by stimulating the lymphatics by:
   - coban/edema glove
   - contrast bath
   - edema massage (light) to dorsum
b. this treatment can also include Manual Edema Mobilization (MEM) which incorporates the following:
   - light proximal to distal, then distal to proximal massage of the skin
   - specific pre and post exercises
   - massaging the lymph node areas proximal to the edema
   - the massage must follow the direction of lymphatic pathways

**B. Joint Mobilization – generally, any active or passive attempt to increase movement at a joint**

1. **Indications for joint mobilization** (Why is joint motion restricted/limited?)
   a. pain
   b. swelling/edema
   c. muscle spasm
   d. capsular/ligamentous tightness/connective tissue change
   **bony or cartilage block may limit joint motion but is not appropriate for joint mobilization**

2. **Physiologic Effects of Joint Mobilization**
   a. Decrease edema
   b. Increases capsular extensibility
   c. Nutrition by movement of synovial fluid
   d. Muscle relaxation by the oscillating rhythm
   e. Decrease pain by increasing proprioceptive input and inhibiting ongoing nociceptive input

3. **Convex-Concave Rule**
   a. when a convex surface moves on a concave surface, the convex articular surface moves in the opposite direction as the osteokinematic motion
   b. when a concave surface moves on a convex surface, the concave articular surface moves in the same direction as the osteokinematic motion

4. **End Feel** – the resistance felt by the clinician at the end range of a passive joint motion.
   a. End Feels that are normal or pathologic include:
      - capsular
      - ligamentous
      - bony
      - soft-tissue approximation
      - muscular
b. End Feels that are strictly pathologic include:
   - muscle-spasm
   - abnormal capsular
   - boggy
   - springy rebound
   - empty

5. Grades of joint mobilization (Maitland)
   a. I – small amplitude at beginning of joint range
   b. II – large amplitude that does not reach limit of joint range
   c. III – large amplitude that is up to the limit of joint range
   d. IV – small amplitude at end of joint range
   e. V – small amplitude, high velocity through limit of joint range (manipulation)
   ***this refers to end range of joint play/motion not ROM
   f. low load stretch at end range (Mary MZ)

6. Criteria for proper mobilization grade selection
   a. the degree of pain or protective muscle spasm during joint motion assessment (irritability)
   b. the degree of restriction of joint play
   c. skill and experience of the operator
   d. the greater the irritability, the lower the grade of mobilization used
      - Grade I-II – pain, swelling, and muscle spasm
      - Grade III-IV – joint capsule limitation

7. Open-packed/Closed-packed Position
   a. Open-packed (Loose-packed) – the position of a joint in it’s ROM where the synovial joint surfaces are least congruent
      - the capsule will have the most extensibility
      - the joint surface contact areas are reduced
   b. Closed-packed – the position of the joint where the two joint surfaces are most congruent
      - the ligaments and capsule of the joint are maximally tight

8. Contraindications
   a. Absolute
      - an undiagnosed lesion
      - joint ankylosis
      - closed packed position
      - where the integrity of the ligaments has been compromised (ex. steroid use) **asthmatics**
      - active inflammatory and infective arthritis
   b. Relative
      - pregnancy
      - joint effusion
      - rheumatoid arthritis
      - metabolic bone disease (TB, etc)
      - internal derangement
- hypermobility
- bony malalignment

9. Guidelines for joint mobilization
   a. the athlete must be relaxed
   b. the clinician must be comfortable with the technique
   c. the mobilization should be relatively painfree
   d. one hand must stabilize while the other hand performs the mobilization
   e. the more surface area that is contacted increases the comfort of the athlete as long as the clinician’s hand placement is accurate
   f. mobilization techniques can be used for assessment or treatment
   g. slight distraction while mobilizing the joint allows better glide and comfort
   h. gliding mobilizations are applied parallel to the treatment plane and performed in the direction that was shown to be restricted
   i. one joint and one mobilization should be done at a time
   j. mobilization can vary in movement terms of:
      a. direction
      b. velocity
      c. amplitude
   i. re-assessment must be done before and after mobilization techniques

10. Techniques (see Section VI)

C. Scar Mobilization
   1. A tendon cannot slide if it is stuck to the skin or the tissues underneath
      a. a scar that is adhered to tendon adds resistance to the tendon
      b. Mild scar restriction – sometimes gentle massage or tendon function is enough to remodel the tissue
      c. Moderate scar restriction –
         - stabilize the scar with manual contact or other substance (such as elastomere)
         a. mobilize the tendon that is adhered by active contraction
      d. Established scar –
         2. low load, long duration stretch

D. Tendon Mobilization
   1. Tendons can get adhered at a fracture site as the bone is healing.
      a. wrist fractures – always work to restore fisting first
      b. prevention – start tendon gliding exercises ASAP
         - keeps the mobility of the tendons and fingers while the bone heals
         - prevents swelling from accumulating between the tissue layers
2. **Differential Tendon Gliding**
   a. The hand/wrist soft tissue is primarily tendon and all the tendons must slide on each other
   b. The 5 tendon gliding positions (see figure 1)
      - extensors sliding proximally
      - maximal excursion between the FDS and FDP
      - maximal FDP tendon excursion
      - intrinsics (lumbricals and interossei)
      - maximal FDS excursion
   c. ***crucial to do these in the case of pip joint injuries because that is where the FDP has to slide between the split in the FDS

3. Joints must be moved through their newly acquired range actively
   a. new motor programs have to be established
   b. it is easier to teach a new skill than correct an existing one
   c. the muscle spindles/golgi tendon organs/joint receptors have to be educated about where the new “normal” is
   d. “place-holds” at end range

4. **Volar Plate Mobilization** – restriction of the volar plate is often contributory to pip flexion contractures

E. **Neural Glides** – refer to David Butler for general periphery nerve evaluation and mobilization
   1. Common Median Nerve glides - See Figure 2

VI. **Joint Mobilization Techniques**
   A. **Wrist** - Normal wrist anatomy must be considered while mobilizing the component joints (ex. alignment of the 1st CMC joint should be maintained)
      1. Generally the proximal carpal row and distal carpal rows are mobilized each as a unit
      2. The radiocarpal and ulnomeniscotriquetral joints’ closed packed position is full extension. The midcarpal joint’s closed packed position is full extension as well. Normal joint arthrokinematics
         a. wrist flexion – convex on concave – so the distal carpal row glides **dorsally** on the proximal carpal row, and the proximal carpal row glides **dorsally** on the radius and ulna. The scaphoid actually glides further than the other proximal carpals causing it to **supinate** as well.
         b. wrist extension – the distal carpal row glides **volarly** on the proximal carpal row, and the proximal carpal row glides **volarly** on the radius and ulna. The scaphoid also **pronates**
         c. radial deviation – the proximal carpal row flexes, glides dorsally, and **translates ulnarily**. The distal carpal row extends, glides volarily, and **translates radially**.
d. ulnar deviation – the proximal carpal row extends, glides volarly, and translates radially. The distal carpal row flexes, glides dorsally, and translates ulnarily.

e. pronation – see DRUJ

f. supination – see DRUJ

B. Distal Radioulnar Joint

1. The DRUJ closed packed position is 5 degrees supination

2. The movement of the radius on the ulna is a combination of rolling and sliding.

3. Pronation-the radius crosses the ulna by gliding volarly and rotating volarly and medially.

4. Supination-the radius glides dorsally and rotates dorsally and laterally.

VII. Special Considerations When Treating Hand or Wrist Injuries

A. Infection

B. Clean laceration versus a crush or shear type injury

C. Smoking

D. Mobilize the joint and then have them do the function that is limited (ex. Pitcher)

VIII. Case Study: Distal Radius Fracture in a High School Pitcher

REFERENCES

Cooney WP, Linscheid RL, Dobyns JH: The Wrist: Diagnosis and Operative Treatment, St. Louis, Mosby, 1998


