Examination and Treatment of Movement System Impairments of Selected Conditions of the Hand and Elbow

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Objectives

- Describe the key concepts and principles of examining alignment and movement of the elbow, wrist, and hand.
- Relate key concepts and principles to selected pain syndromes of the hand and elbow: lateral epicondylalgia and OA of CMC of thumb.
- Identify movement system diagnoses and the contributing factors for selected pain syndromes of the hand and elbow.
- Describe case examples illustrating concepts related to the movement system impairment theory, manual therapy, and the biopsychosocial approach.
- Describe individualizing the exercise program to include correction of alignment and movement associated with functional and fitness activities
- Challenge the clinician to think in a new way about routine tests used in the examination of movement of the elbow and hand.

Movement and Physical Therapy

APTA House of Delegates
- 1983 - PT's are responsible for the prevention, diagnosis, and treatment of movement-related dysfunctions.
- 2013 - Vision Statement for the Physical Therapy Profession
  - "The physical therapy profession will transform society by optimizing movement to improve health and participation in life."

PT's: Movement System is area of Expertise
Movement System

PTs primary responsibility: our area of expertise

Movement System

Movement System Syndromes (MSS)

Musculoskeletal  Neurmuscular  Cardiopulmonary

MSI Dx  Tissue Imp or Pathoanatomic Dx

Resources

Systematic Examination

• The key to treating a movement related problem is to first perform a systematic examination including:
  • Alignment and appearance
  • Movement:
    • AROM and Functional Activities
    • PROM, ligament and joint integrity, muscle length
    • Muscle performance: strength, muscle activation, timing
    • Selected special tests for source of symptoms as needed.
Examination: Systematic Assessment of Alignment – Elbow Frontview

Carrying Angle:
- Observe in anatomical position
  - Increased
  - Decreased
- Normal carrying angle:
  - 2-26° valgus
  - Less in males than females
  - Should be symmetrical

Alignment Frontview
- Forearm:
  - Normal = thumb facing anteriorly
- Wrist:
  - Normal = slight extension
- Fingers:
  - Normal = slight flexion (longitudinal arch)
- Correct shoulder alignment prior to determining distal alignment
- Are these alignments an indicator of muscle stiffness, length or joint mobility?

Normal and Impaired Alignment - Sideview
- Elbow:
  - Normal = slight flexion (about 15 degrees)
  - Extended
  - Exaggerated flexion (> 20 degrees)
- Wrist:
  - Normal = slight UD

Look for asymmetries in muscle development in addition to impairments in alignment.
Normal and Impaired Alignment - Backview
Normal = olecranon facing slightly laterally with correct scapular alignment

Right normal

muscle atrophy, wrist flexion, shoulder extension, decreased finger MP flexion

Watch for the Alignment or Movement in Associated Regions (eg. Shoulder) in Addition to the Symptomatic Region.

Normal Posture/Alignment of the Hand
Alignment During Functional Activities –
Arc of Thumb

OA of CMC of Thumb: May have MP joint hyperextension (Swan Neck) or MP joint flexion (Boutonniere)

Examination- Systematic Assessment of Movement

- Analyze the quality and quantity of movement during commonly used tests like AROM, PROM, resisted tests, and during functional activities.
- Look for recurring patterns across the examination
  - CMC joint subluxes into flexed and adducted position and MP joint hyperextends

Guidelines for Analyzing Movement:
Observing Movement During AROM

- Observe patient’s unique self-selected alignment or pattern of movement.
- Watch for subtle deviations.
Contributing Factors

• What could contribute to the movement pattern?
  • Asymmetrically overused and stiff interossei
  • Stiffness/shortness of finger flexors with relatively flexible joints.

• Standard Test for Length of Interossei

Interossei Muscle Shortness

• More subtle signs of shortness or stiffness of interossei are:
  • supination or pronation of the finger at the MP or IP joints
  • a more aggressive length test:
    • compare how much stiffness during MP abd or add there is with the PIP and DIP joints in full flexion and the MP joint extended (compared to the opposite hand)

Guidelines for Examining Movement: Performing Muscle Length Tests

• During PROM and length tests think more about stiffness than absolute length
  • Manual therapists refer to R1 as onset of resistance
  • Think “R1” when assessing muscle stiffness or length
  • Avoid just focusing on R2 (absolute length)

• During passive length tests compare stiffness of the muscle on the involved side to other muscles AND to the same muscle on the uninvolved side
Wrist Extensor Length Test

Wrist Flexor Length Test

Extrinsic Finger Flexor Length Test
Extrinsic Finger Extensor Length Test

- When do you first feel slight resistance (R1)?
- Perform the test slowly with a VERY light touch.
- Compare stiffness between 2-3 people.
- Wrist flexors and extensors
  - Finger flexors and extensors
  - Check finger flexor length both supine and standing with palm flat on table.
  - Forearm pronators (test supination with elbow flexed compared to elbow extended)

Lab – A New Way of Performing Length Tests

Guidelines for Analyzing Movement:
Observing Movement During AROM

- Identify the joint or region that is moving most easily?
  - Path of Least Resistance for Motion
  - Relative Stiffness/Flexibility
- During active wrist extension:
  - The fingers should move into flexion because of tenodesis. They should not extend.
  - s/p fracture of distal radius
    - Wrist is stiff; fingers move most readily
Guidelines for Analyzing Movement:
Observing Movement During AROM

- What moves most easily?
  - Path of Least Resistance for Motion
  - Relative Stiffness/Flexibility

- Is one joint flexing or extending too much or not enough relative to the other joints?

- Assess affect of alignment or movement on symptoms

- If symptomatic, immediately correct the alignment or movement to determine the effect on symptoms (secondary test).

Analyzing Movement During AROM of the Thumb

Examination of Alignment and Movement

- What repetitive activities might contribute to malalignment leading to excessive stresses on tissues?
Normal and Impaired Movements of the Hand

• During active finger flexion:
  • there should be increased range of flexion of the ulnar fingers versus the middle and index.
  • the transverse arches of the hand should deepen, especially on the ulnar side of the hand.
  • the wrist should extend slightly.  

Wrist flexion during active thumb abduction can result in stiff or short thumb adductors.

Examination of Functional Activities

• This is key!
  • The tissues of the body adapt to the repeated stresses that are put on them throughout the day.
  • Modifying the alignment and movement pattern during the frequently used daily activity may help alleviate stresses on the tissues and allow the tissues to heal.
  • This may also help decrease chances of recurrence.

Could this alignment and movement pattern be a cause of ulnar sided wrist pain?
Impact of Associated Region (Shoulder) on Wrist Pain.

- Increased shoulder abduction on left contributes to increased left wrist ulnar deviation.
- Arms are not supported at correct height.

Examining Movement Impairments During Writing:
Note Arc of Pinch and Position of CMC Joint of Thumb

Guidelines for Analyzing Movement:
AROM: If no impairments, add resistance.

- Movement impairments are sometimes not evident until resistance is applied.

Normal longitudinal arc of thumb during pinch and good thenar muscle bulk

Collapse of 1st MC into flexion and adduction during pinch – left worse than the right
### Movement Impairments

- Shoulder extension during elbow flexion
  - Normal for posterior deltoid to work as synergist during biceps contraction but should not see too much shoulder extension nor scapular anterior tilt.

- Assess impaired movement patterns of the shoulder and how they relate to the elbow
  - Increased shoulder MR may decrease need for as much forearm pronation allowing ECRL to get short.

### Importance of Good Function Proximally for Most Efficient Movement Distally

**Expert compared to novice pianists:**

- Use less force to keep a key depressed than recreational pianists.
- Seem to adopt a strategy to economize energy expenditure
- Exert smaller co-activation of finger muscles. The arm downswing was characterized by a sequence of joint rotations in an order from proximal to distal for expert pianists, but not for novice players
- Display less activity in the finger extrinsic muscles than novice players.

  Furuya S et al 2013

### Less Common Alignment & Movement Impairments

- Onset of left elbow posterolateral and anteromedial pain and locking while lowering load into elbow extension.
- Humerus laterally rotates relative to forearm (medial condyle of humerus appears prominent during elbow extension)
- Too much shoulder adduction increases valgus especially in thin females
Exam and Treatment of Movement System
Impairments of Selected Conditions of the Hand
and Elbow - Cheryl Caldwell, PT, DPT, CHT

Examination:
Identify the Contributing Factors

- daily activities that promote the movement impairment
- stiff/short muscles
- joint or region that is excessively flexible
- over activation of muscles
- structural variations that affect alignment and movement
  - Examples:
    - lax joints
    - decreased muscle stiffness
    - violinist with ulnar sided hand pain at MP joint area needed support of metacarpal arch of hand

Lab - Examining Alignment and Movement Patterns

- Observe the functional activity of writing and texting
  - See handout for guide to observation.
  - Observe the alignment of the whole UE.

- Observe and identify the joint that moves most easily during:
  - Active thumb extension, flexion, and abduction
  - Active forearm supination and pronation

Biopsychosocial Considerations

- During the history and examination note behaviors that help you tailor the exercise prescription to the individual
  - Does this patient tend to over exercise? Do they seem ultra-compliant? Do they write down everything you say?
    - If over exercise,
      - I try to avoid taking everything away they enjoy but negotiate with them some changes.
      - Give them an alternate method of staying active.
      - Figure out ways to compromise to decrease stresses on injured tissues.
      - Educate them well regarding the risks of not backing off some and the benefits of rest. Give them some time frames so they have an approximate deadline after which they can build back up
      - Compliment them on their motivation and compliance but educate them regarding the need for tissues to have recovery/healing time.
Biopsychosocial Considerations:

- During the history and examination note behaviors that help you tailor the exercise prescription to the individual.
  - Do they seem hesitant to move the painful part?
  - Do they seem to have a lot of pain after what seems to be a small change in the program?
  - Patient s/p fx of Radial head had big increases in pain with small increases in stressors. Seemed like over reaction.
    - Progress exercises slowly.
    - Educate them regarding how they can change their movement pattern which gives them control. Serves as foundation for problem solving movement during functional activities which increases confidence.
    - Secondary test – show them how if they move differently they can move with less pain.
    - Encourage them to use the hand/arm functionally
    - If they have an exacerbation, encourage them that it will resolve; they can back off slightly but keep moving.
    - Encourage aerobic exercise if possible.
    - Communicate with MD

Biopsychosocial considerations

- Patient s/p fracture of olecranon
  - Ultra compliant
  - Wrote down everything. Kept logs of pain, exercise, etc.
  - Strategies:
    - avoid over compliance
    - decrease how much she’s doing exercises
    - avoid forcing through symptoms
    - communicated with MD

Biopsychosocial

Suggestions for teaching patient strategies:

- Replace negative thinking with positive thoughts
- Find the balance between rest and activity
- Manage setbacks by recognizing high risk situations
- Help patients identify enjoyable activities

Establish Movement Diagnosis to Guide Treatment
• Results of exam lead to movement system impairment diagnosis which guides treatment.
• Identification of the movement impairment that occurs repeatedly throughout the examination and aggravates symptoms that when corrected alleviates symptoms, becomes the diagnosis.

MSI Diagnoses of the Elbow
• Wrist Extension with Forearm Pronation Syndrome (Lateral epicondylalgia)
• Elbow Hypomobility
• Elbow Flexion Syndrome (Cubital Tunnel Syndrome)
• Elbow Valgus Syndrome (valgus extension overload syndrome)
  • With or without extension
• Elbow Extension Syndrome
• Anterior and Posterior Forearm Entrapment Syndromes
  • Pronation Syndrome vs. AINS
  • Radial tunnel syndrome vs. FINS
• Wrist Flexion with Forearm Pronation (medial epicondylalgia)
• Ulnohumeral and radiohumeral multidirectional accessory hypermobility
• Elbow Impairment

Elbow Grid – Available in Book
• General description under name of diagnosis
• Column Headings
  • Symptoms and History
  • Key Tests and Signs for Movement Impairment
  • Source of Signs and Symptoms
  • Associated Signs or Contributing Factors
  • Differential Diagnosis
• Treatment
Wrist Extension with Forearm Pronation Syndrome (Lateral Epicondylalgia)

This syndrome is characterized by lateral elbow pain provoked by gripping with reaching and lifting activities resulting in overuse of the wrist extensors.

- The lateral elbow pain is usually aggravated most when the wrist extensors are used with the forearm pronated and the elbow extended. This may also implicate the ECRL (Kendall).
- Correction: reaching and gripping with forearm supinated decreases symptoms.
- In this syndrome the biceps and supinator may be underused and wrist extensors and pronators overused.
  - Supinating the forearm decreases the symptoms by increasing performance of the biceps brachii and decreasing the overuse of the ECRL.

Wrist Extension with Forearm Pronation Syndrome (Lateral epicondylalgia):

**Movement/Function**
- Watch for habits that may incorporate frequent use of wrist and finger extensors:
  - Example: Expressing self with hand gestures while talking
  - Constant contraction of finger extensors: Holding fingers off mouse instead of relaxing fingers on mouse
- Movement impairments
  - Reaching and lifting is performed with forearm pronated and during this motion, the humerus medially rotates and abducts more readily than the forearm pronates

Wrist Extension with Forearm Pronation Syndrome (Lateral epicondylalgia):

**Muscle Length Tests**
- May have stiffness or shortness of finger and wrist extensors relative to opposite side.
- Associated muscles that are may be short or stiff
  - Finger flexors
  - Pronator teres
- Assess stiffness, not just length.
- Observe and feel for what joint moves most easily.
Wrist Extensor Length Test

- During length test resistance to forearm pronation is felt as the elbow is extended with the wrist flexed. The humerus medially rotates more readily than the forearm pronates.

70°  45°

Wrist Extension with Forearm Pronation Syndrome (Lateral epicondylalgia):

Muscle Strength/Performance Impairments

Resisted tests:
- Wrist and finger extensors
  - Resisted wrist extension is often more painful with elbow extended vs. flexed Nirschl RP 2009
- Elbow flexors and extensors
  - Elbow flexion is more likely to increase pain with forearm pronated than supinated.
- Watch for shoulder impairments during resisted tests

Manual Therapy: Joint Accessory Mobility Testing

Theoretically
- Due to limited forearm pronation may have:
  - ↓ R-U post glide at proximal R-U joint
  - ↓ UH abduction with forearm pronation
- May have ↑ compression/proximal glide at R-H/U-H joints (gripping increases compression at these joints)
  - During pronation the radius moves proximally "screw home mechanism" adding compression to the RH joint, van Riet RP et al. Radial Head Fracture. In The Elbow and Its Disorders. 2009.
  - Correction: Long axis distraction of forearm and wrist decreases symptoms
  - Increased compression may be due to muscle stiffness or shortness

Correction: Long axis distraction of forearm and wrist decreases symptoms
Manual Therapy:
Joint Accessory Mobility Testing

- Lateral glide of ulna on humerus may relieve symptoms (Mulligan)
- I have not used a lot of formal joint mobilization for patients with this particular diagnosis but I believe a systematic method of examining and correcting alignment and movement incorporates manual techniques including:
  - Careful assessment of stiffness during length tests
  - Careful instruction in stretching exercises avoiding compensatory joint motions
  - Addressing the region that is moving most easily during functional activities
  - Redistributing motion from one joint to another through education in precise movement patterns

Elbow Case
Lateral Epicondylalgia

- Observation of functional activities is most helpful in identifying key alignment and movement impairments compared to AROM.
- AROM provides helpful information regarding movements that are painful that can be retested subsequent visits

Wrist Extension with Forearm Pronation Syndrome (Lateral epicondylalgia):

Aggravating functional activities:
- Constant contraction of finger extensors (eg. Holding fingers off keyboard on left > right).

Corrected

Her extrinsic finger extensors were short and stiff; 50° wrist flexion with fingers flexed; 80° wrist flexion with fingers extended
Wrist Extension with Forearm Pronation Syndrome (Lateral epicondylalgia):

**Conservative Treatment**
- Patient education
- Exercises
- Splinting/Orthoses or straps
  - splinting: immobilize just long enough to decrease the acute pain
- Modalities
- Joint mobilization

**Patient Education**
- There is evidence for the association between risk factors such as force, repetition, and posture and lateral epicondylalgia.
- Therefore it makes sense that patient education regarding the modification activity performance might be helpful.
- However, overall evidence to support patient education is lacking.
  
  Fedorczyk JM 2012

Wrist Extension with Forearm Pronation Syndrome (Lateral epicondylalgia):

**Treatment: Patient Education**
- During easily irritable phase: patient to avoid painful activities by correcting movement impairments as described below.
  - Train elbow flexion and gripping with forearm supinated vs. pronated as possible to increase use of biceps and decrease use of wrist extensors.
  - Grip and lift objects with elbow flexed versus extended
  - Correct shoulder alignment and movement patterns during gripping activities.
Wrist Extension with Forearm Pronation Syndrome (Lateral epicondylalgia):

Treatment: Patient Education
Modify habits, work and sports activities as appropriate.
- Balance rest with activity:
  - Avoid using hands for repetitive gesturing while talking
  - Avoid repetitive or prolonged contraction of the finger and wrist extensors
- Take breaks to stretch frequently throughout the day.
  - This seems to help relax wrist extensors, not just stretch.
- May need to change tools; alter grip throughout the day
- Use splint if needed to remind patient to avoid aggravating activities
- Forearm strap – contraindicated if suspect radial tunnel syndrome.

Program in Physical Therapy

Wrist Extension with Forearm Pronation Syndrome (Lateral Epicondylalgia):

Treatment: Splinting/Braces
Tennis Elbow Strap Pre-Fab Wrist Splint

Purpose: to absorb and dissipate forces to the extensor muscle mass. (Takasaki H, et al JOSPT 2008)
Goal of splint is to prevent wrist flexion. Recommended position is 10-25 degrees of wrist extension

Program in Physical Therapy

Use of Orthoses
- "No definitive conclusions can be drawn concerning the effectiveness of orthotic devices for lateral epicondylitis." Cochrane Review 2005
- May be used in acute phase Fedorczyk JM 2012
- Quality of studies examining use of orthoses for lateral epicondylalgia is low. Fedorczyk JM 2012

Program in Physical Therapy
Wrist Extension with Forearm Pronation Syndrome (Lateral Epicondylalgia):

Treatment – Patient Education
- Correct shoulder alignment and movement patterns during activities.
  - Correct alignment for typing on laptop including:
    - supporting shoulders at the correct alignment
    - supporting forearms to decrease use of ECRL as elbow flexor
  - Relaxing left finger extensors when possible while typing or using mouse.
- Take frequent breaks to rest including: resting with forearms neutral or supinated in lap, varying type of grip, doing stretches.
- Lift with forearm supinated vs. pronated

Correction of shoulder alignment and movement patterns during activities.

Elbow Patient Case

Treatment - Exercises:
Select exercises based on exam findings.
- Sitting gentle active stretch for left finger extensors with cues to avoid humeral medial rotation and perform in painfree ROM
- Standing with palms resting on table finger flexor stretch with cues to avoid PIP flexion during stretch, limit weight bearing, and perform in painfree ROM
  - Passive stretch avoids irritating wrist extensors
- Standing with back against wall shoulder flexion with cues to keep fingers and wrists relaxed, allow scapulae to move, and keep LB stable
Wrist Extension with Forearm Pronation Syndrome (Lateral Epicondylalgia):

**Treatment: Exercises**

Key is gradual progression.

- These patients need gradual increased stresses to the wrist extensor tissues to increase threshold for injury or increase tolerance for activity.
- The exercises should be performed without aggravating symptoms at least in the easily irritable stage.

Resistive Exercises for Improving Muscle Strength/Performance for Lateral Epicondylalgia

Progression of exercises as follows:

- Isometric – Isotonic (eccentric vs concentric)
  - Can progress isotonic exercises by strengthening with the muscle in a more lengthened position.
- Little evidence for dosage of exercise
- Moderate evidence for use of isotonic eccentric exercise and weak evidence for isokinetic and isometric ex.
  - Best evidence at that time says eccentric ex done 6-12 weeks; 3 sets of 10-15 reps daily

Review of Evidence for Eccentric Exercise for Tendinopathies of the Elbow, Wrist and Hand

Eccentric Exercise for Lateral Epicondylalgia

- Results from studies may still be inconclusive
- Not commonly used by hand therapists
- Wrist extensor tendons may not respond like Achilles tendon
  - Achilles is involved 3-6 cm from insertion
  - Wrist extensors are involved at insertion
  - Tendon characteristics at those locations differ
- Studies to date are not clear regarding amount of pain allowed during the eccentric exercise
- Question remains how much load is necessary to make changes
  - More difficult to load wrist muscles than using body weight for Achilles.

Fedorczyk JM 2012
Wrist Extension with Forearm Pronation Syndrome (Lateral epicondylalgia):
Treatment: Physical Agents

- Iontophoresis
- High volt ES
- Ice or heat

- No consensus regarding the effectiveness of physical agents for tendinopathy of the elbow, wrist, and hand
  Fedorczyk JM 2012

Wrist Extension with Forearm Pronation Syndrome (Lateral epicondylalgia)
Treatment: Joint Mobilization
Lateral glides of ulnohumeral joint (mobilization with movement)

Evidence
- Effectiveness of exercise, mobilization, and bracing is unknown  Buchbinder R 2008
- 90% improve with conservative treatment  Morrey BF 2009
- Those that are less severe are most likely to respond to conservative treatment  Nirschl RP 2009
**Injection vs. PT??**
Coombes K et al. JAMA 2013;309(5)
- Study included 4 groups:
  - Corticosteroid alone
  - Placebo injection
  - Corticosteroid with PT
  - Placebo with PT
- PT treatment in this study included:
  - Elbow mobilization with movement
  - Exercise: including retraining of gripping and concentric and eccentric exercise to wrist extensors with elastic bands
- All patients: avoid pain provoking activities and all patients could use braces, heat, ice and oral meds PRN.
- PT x8 over 8 weeks

**Corticosteroid with PT**
- Exercise: including retraining of gripping and concentric and eccentric

**Placebo injection**
- Edema and scar may be associated impairments with all of these diagnoses and must be addressed early.

**MSI Diagnoses for the Hand**
- Insufficient Finger and/or Thumb Flexion due to...
- Insufficient Finger and/or Thumb Extension due to...
- Finger (or thumb) Flexion Syndrome (with or without rotation)
- Thumb CMC Accessory Hypermobility
- Insufficient Thumb Opposition/Palmar Abduction due to...
- Edema and scar may be associated impairments with all of these diagnoses and must be addressed early.

**Study included 4 groups:**
- Corticosteroid alone
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**PT treatment in this study included:**
- Elbow mobilization with movement
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- All patients: avoid pain provoking activities and all patients could use braces, heat, ice and oral meds PRN.
- PT x8 over 8 weeks

**Multimodal PT did not optimize long-term outcomes but was beneficial in the short term in the absence of corticosteroid injection**
- Significantly fewer patients receiving PT used pain or anti-inflammatory oral meds
- Corticosteroid injection resulted in worse long term outcomes and higher recurrence than placebo.

**Verdict is still out?? What effect would modifying movement have?**

Program is Physical Therapy
Grid for Hand MSI Syndromes

- Refer to Book

OA of CMC of Thumb

- Thumb CMC Accessory Hypermobility
  - OA of CMC of Thumb (early stages)

- Insufficient Thumb Opposition/Palmar Abduction due to...
  - Scar or contracture
  - Median nerve injury/weakness of abductors
  - OA of CMC of Thumb (later stages)

Causes of OA of CMC of Thumb

- Interplay between:
  - Genetic factors
  - Mechanical stresses – We can affect these!
    - Laxity of the volar oblique ligament predisposes the joint to incongruity because of subluxation Gielow et al., 2001
    - Chronic loading of joint surfaces Cooney et al., 1981
  - Modification in metabolic capacity of cartilage to repair itself
  - Trauma
Ligaments of the CMC Joint of the Thumb

- Most of the ligaments are taut with the thumb in abduction, extension and opposition.


- Clinical implication: when the thumb is used in pinch (adduction and flexion) the ligaments need the assistance of the balanced forces from the muscles to maintain optimal joint alignment.

Muscle Torque Potential at CMC of Thumb

- The adductor pollicis has the greatest torque potential of any of the muscles that cross the CMC joint of the thumb.

- The strong pull of the adductor pollicis and the other thumb intrinsic muscles that insert on the distal end of the 1st MC cause stresses that contribute to flexing and adducting the 1st MC.

- This results in dorsoradial subluxation of the 1st MC on the trapezium


Factors Contributing to Alteration in Mechanical Forces or Movement of the Thumb

Balanced muscle forces help the ligaments maintain correct joint alignment. Cooney WP, et al, 1977

- Common Muscle Impairments:
  - Insufficient function of the APL, APB, and opponens to help stabilize the CMC
  - Stiffness, shortness, and overuse of the MP flexors (FPB) and adductor of the thumb
  - Weak EPB
Factors Contributing to Alteration in Mechanical Forces or Movement of the Thumb

- Most commonly during function, the thumb is in a position of adduction and flexion. (Cooney WP et al 1981)
  - Adductor pollicis is very active in power grip and key pinch.
- Contributes to overuse of the adductor and underuse of the abductors.
- Ligament laxity

Classification of OA of CMC of Thumb

Eaton RG, 1987

**Stage I: early stage**
- articular contours are normal
- may have slight widening of joint space
- hypermobility of the CMC joint
- pain exacerbated by pinch activities

**Stage IV: late stage**
- complete deterioration of CMC joint and in addition the ST joint is narrowed with sclerotic and cystic changes apparent.

Thumb CMC Accessory Hypermobility

Patients with early OA of CMC may have this diagnosis

- Pain is located at the CMC joint but the alignment and movement impairments occur at all joints of the thumb.

- Alignment/movement:
  - The CMC joint may be either extended/abducted or adducted/flexed. The impairments at the CMC joint are associated with either:
    - MP flexion with IP extension or (boutonniere)
    - MP extension with IP flexion and result in loss of the normal longitudinal arch of the thumb. (swan neck)
OA of CMC of Thumb

• Observation:
  • swelling at the CMC joint of thumb
  • may or may not be present
  • may have MP joint hyperextension (Swan Neck) or MP joint flexion (Boutonniere)

• Later Stages
  • prominent CMC joint (shoulder sign)
  • adduction deformity of thumb
  • bone spur formation

• AROM:
  • look at quality of movement especially in early stages of OA

You Get What You Train:
Poor Alignment of Thumb During Lateral Pinch

Early Stage - correctable

Unable to maintain the arc of pinch during functional activities and produces symptoms

Correction of arc of pinch decreases or abolishes symptoms

The impaired movement patterns may be due to an inability to coordinate the timing and sequencing of the movements between the IP, MP and CMC joints of the thumb and adaptive changes in the tissues.

Thumb CMC Accessory Hypermobility

Movement Impairments (cont) - videos

• During active thumb extension:
  • CMC extends relatively more (amount and timing) than MP (Boutonniere)
    • APL overused relative to EPL
  • IP extends relatively more than MP
    • EPL overused relative to EPL
Thumb CMC Accessory Hypermobility

**Movement Impairments (cont)**
- MP extends relatively more than CMC (Swan Neck)
- CMC adducts: EPL dominates over APL

**Movement Impairments (cont)**
- During active thumb flexion:
  - CMC is relatively more flexible than MP
  - IP is relatively more flexible than MP
- Insufficient IP flexion
- Correction of movement impairments listed above decreases or abolishes symptoms.

**Movement Impairments (cont) - video**
- During thumb palmar abduction:
  - MP abducts relatively more than CMC
  - Adductor overused relative to opponens pollicis and APL, and ABP
- Correction of movement impairments listed above decreases or abolishes symptoms.

(normal)
Patient Example

**History**
- Middle aged male with left thumb CMC pain
- Salesman who spent a lot of time driving
- Held steering wheel constantly with left hand

**Treatment**
- Educated patient regarding:
  - Movement impairment and how to correct it during thumb abduction and extension
  - Avoiding prolonged gripping of steering wheel with left hand
  - Vary grip
  - Take breaks to stretch (do exercises for thumb abduction and extension)
  - Once pain decreased strengthen APL, APB.
- Splint for night to stretch 1st web space and as needed during day for pain during acute phase

Later Stages of OA of CMC of Thumb

**Shoulder sign**

- CMC subluxation/deforrmity
- Swelling at the CMC
- Prominent CMC joint
- Adduction deformity (Eaton Stages III or IV)

**1st MC remains adducted during active thumb extension, MP hyperextension**

- Contracture of thumb adductor muscles, CMC joint structures
- Limited AROM-PROM
- Decreased accessory mobility

Poor Alignment of Thumb During Lateral Pinch

Unable to maintain the arc of pinch during functional activities and produces symptoms

_Deformity exists, correction of alignment and movement not possible, External support to joint may help decrease pain and improve function._
Conservative Treatment of OA of the CMC of the Thumb

- Patient Education
- Splints
- Exercises
- Joint protection
- Adaptive equipment
- Modalities –
  - paraffin may be useful for pain relief and can be done at home
- Joint Mobilization (not performed commonly)

There is currently inadequate evidence to determine the effectiveness of therapy.

Moe RH 2009

Patient Education

- Educate the patient regarding their impaired movement pattern and how to correct it during their functional activities. (stages I and II)
- Practice correcting the movement pattern during the therapy sessions
  - i.e. during writing, maintain the arc of the pinch
  - avoid collapse of the 1st MC into adduction and flexion
- Use assistive devices, splinting or taping as needed for joint stability.
- Modify tools used at work when possible
  - i.e. hairdressers have different options available regarding scissor styles that help in modifying the movement pattern

Correcting the Movement Pattern

Early stages

- May need to start with active place and hold
  - Passively place the joint in correct alignment and then isometrically contract muscles to maintain position.
- Progress to active through the ROM and then resistive
Manual Therapy or MSI???

- MSI - When there is no significant loss of physiological motion:
  - and a movement is painful, immediately correct the joint alignment/position and repeat the movement to determine the effect on symptoms.
- Manual Therapy – The statement above seems very similar to mobilization with movement (Mulligan)
  - "minor positional faults occur causing movement restrictions or pain"
  - "Sustained mobilization with movement can correct the fault"
- MSI - decrease load on muscles so patient is able to maintain correct alignment and movement of joint
  - Begin with place and hold and progress to active through the range as tolerated

Exercises (stages I and II)

- The Goal is to
  - Help to stabilize the CMC joint subluxation. Pellegrini Jr. VD, 1992
  - Avoid adduction deformity & strengthen the thumb abductors. Valdes K JHT 2012
  - Maintain the 1st web space. Valdes K JHT 2012

- Recommendations have been made to begin isometric and then progressive resistive exercises for palmar abduction after the acute symptoms have subsided. Pellegrini Jr. VD, 1992

If unable to correct movement with exercise, splinting or taping initially may help but wean as muscle control improves:

Splint to Support Thumb CMC in Abduction
Writing Posture: Self-selected and Corrected

Built-up pencil – increased circumference increases the moment arm so decreased force is required to write.

Exercises – Early Stages

- Strengthening of the APL helps maintain stability of the CMC joint.
- Work on active contraction in the correct alignment
- The APL helps to maintain stability of the joint IF the joint is aligned well. If it is not aligned well, it may contribute to further deformity.

- The APB places the thumb in the position of maximal stability of the CMC joint.
  Poole JU, Pellegrini VD, 2000

Exercises

- The angle of pull of the first dorsal interosseous muscle is such that it would stabilize the base of the first metacarpal from dorsoradial subluxation 
  Brand P
- Therefore...consider strengthening this muscle.
- Caution with joint alignment as this muscle also adducts thumb!
Exercises

- Avoid:
  - Lateral pinch strengthening (strengthening adductor pollicis) in patients with advanced OA of CMC (thumb instability and deformity)
  
  Valdes K et al JHT 2012

Functional Activities and Assistive Devices (to decrease stress on CMC of Thumb)

- Avoid strong grip and pinch
  - Use of jar opener
  - Use of dycem or rubber pad to increase friction when opening jar
  - Use of key holder
  - Build up circumference of grip on handles

Principles for Orthoses

- Effectiveness: orthoses are most effective in earlier stages of disease (Day CS, Gelberman R 2004)
- Purpose:
  - Rest the joint to decrease inflammation and pain
  - Support the joint to alter the stresses on the painful structures Beasley J, JHT 2012
  - Allow more painfree function
  - Stretch the 1st web space
  - Position the thumb with the CMC joint abducted because this is the position of maximal congruence of the joint
  - Consider the position of the MP joint also (Moulton M, et al 2001)
Orthoses: static hand based thumb post orthoses

1 2 3

  describe splint or principles related to controlling MP position
  in order to increase TM joint stability
- Beasley J. JHT 2012

PUSH MetaGrip Splint & Silver Ring Splint

Pictures from

Static Forearm Based Thumb Spica Orthoses

Day CS, Gelberman R 2004

Weiss S, et al 2000
### Treatment for OA of CMC of Thumb

Treatment for stiffness or shortness of thumb adductor muscles and CMC joint structures

- **Early Stages:** (Hypermobility)
  - Exercises to actively and passively stretch the 1st web space (i.e. thumb abduction and opposition and extension) with correct pattern of movement
  - Progressive stretching of web space with splinting to be worn at night

- **Later Stages:** (Hypomobility)
  - In presence of fixed deformity stretching not appropriate

### Summary

We have:

- Reviewed the key concepts and principles of examining and treating alignment and movement impairments of the elbow, wrist, and hand including identifying the:
  - primary movement impairment or diagnosis based on the individual patient exam findings,
  - joint that moves most easily during tests of active and passive ROM AND during functional activities.
  - If no impairments are noted during active movements, add resistance.
  - Proximal (shoulder) alignment and movement impairments that may contribute to the distal pain problem

- Challenged you to think in a new way about routine tests used in the examination of movement of the elbow and hand.
  - Feeling for stiffness may be more important than determining absolute muscle length.
  - Feel for the onset of resistance (R1) when performing length tests.
  - Examining and correcting specific movement impairments involves manual therapy.

### Summary Continued

We have discussed:

- Basing treatment on individual exam findings and the primary movement impairment or diagnosis.
  - Addressing the contributing factors to the movement impairment
  - Educating the patient regarding how to correct the noted movement impairments and practicing the corrected precise movement pattern during therapy.
  - Adding resistance only after the patient is able to perform active motion precisely

- Individualizing the exercise program to include correction of alignment and movement associated with functional activities

- The key concepts and principles of examining and treating movement impairments related to selected pain syndromes of the hand and elbow: lateral epicondylalgia and OA of CMC of thumb.

- Some biopsychosocial factors that help direct selection, progression, and modification of the treatment

- How examining and treating movement system impairments involves “manual therapy”
Manual Therapy and MSI
Let’s move together!

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