Dynamic Stability of the Thumb

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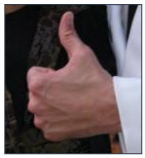


Conservative Management of the Painful Thumb is a CHALLENGE!

Teamwork is Important

Person –Therapist –Doctor – Family

Why is the human thumb at risk for pain?

Is it because there is only a 35 year warranty on the 1st CMC joint ?

*What is the mystery of **dynamic stability** for the CMC joint?*

Can something be done about it ? ***YES!***

Effects of Exercise, Orthoses & Joint Protection Education

Evidence Based/Informed Practice

- Reduction in Pain & Improvement in Function
- ***No consensus*** for which orthosis is best
- No consensus *(YET)* for which exercises are best
- Little is known about **dosage of exercise** for the **small muscles** of the hand (ACSM 2011)
- **EULAR** and **ACR** recommend Exercises, Orthoses & JPE
- **1st Dorsal Interosseous & the Opponens are *emerging* as key muscles for thumb stability**

Adams, O'Brien et al. 2017, Magnuson et al. 2016, McGee et al. 2015,Moubargha et al. 2015, Dziedzic et al. 2011, Boudreau 2010, Stamm et al. 2002, Wajon 2000, Swigart 1999.

History of Dynamic Thumb Stability

- **Brand & Hollister: 1st DI** as a **lateral thenar,** has a **stabilizing effect on CMC (1993)**
- **Use** of **thumb muscles during function** to stabilize and **prevent suluxating** forces at the CMC, with **web space restoration** and orthotic support (Taylor, 2000)
- **Promote stability and functional strength** about the **CMC** with **resistive** thumb **exercises** (Neuman & Bielefield, 2003)
- **Dynamic Stability:** known rehab **strategies** for **other joints** for injuries and OA: i.e. **Knee, Shoulder** (Braun, Hurd, Meister, Wilks, Chmieleweski, Zeni, Elenbecker)
- **Lack of Neuromuscular coordination** of motion seen often in those with CMC OA, thumb pain. (Van Heest & Kallemeier, 2008)

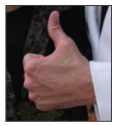
What is *Dynamic Stability* of the Thumb?

- **Restore** Functional **ROM**; at joint & soft tissues
- **Re-education** of specific muscles to **improve** the **strength** of the hand and thumb
- **Reduce pain and disability:** May not change the course of the disease (if present)
- **Self-management of pain** during function
- **Stabilizing orthosis, as needed &** a plan to **wean out** of orthosis or to **wear** only **as needed** for heavy tasks

3 Important Points for a Stable Thumb….

1. Widen Thumb Webspace: Keep it SUPPLE
2. Use of *ALL* Thumb Motors to Stabilize and Centralize the 1st metacarpal as it moves on the trapezium.
3. Educate the Person to stabilize own thumbs for a lifetime.

Including Therapists and Surgeons…



"Effects of a Dynamic Stability Approach in Conservative Intervention of the Carpometacarpal Joint of the Thumb: A Retrospective Study"

Primary Purpose:
- to investigate change of pain and disability from using a *DYNAMIC STABILITY* modeled approach

Secondary Purpose:
- Ave.# visits
- Average "date-range" of visits

"Effects of a Dynamic Stability Approach in Conservative Intervention of the Carpometacarpal Joint of the Thumb: A Retrospective Study"

Primary Purpose Results:
(Using QuickDASH as outcome measure)
- Reduction in **Pain:** 17.9% (p<.01)
- Reduction in **Disability**:
  - Group change : 19.3% improvement
  - Individual change: 15.7% improvement
- Both exceeded MDC_{90} change of 15%

Secondary Purpose Results:
- Average total **visits:** 2.37 (~ 2-3 visits)
- Average number of **days** : 44.5 (6-7 wks)

These results align with prospective studies of conservative care

(O'Brien & Giveans, 2013)

Effects of Selective Activation of the 1stDI & OP on Thumb CMC Kinematics: A Synopsis of 2 Cadaver Studies

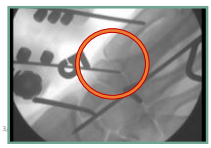
Hypotheses:

- **Study #1:** …increased loads in the FDI and OP will result in effects to the joint kinematics and kinetics of the 1st CMC
- **Study #2:** …that a more uniform distribution of loads and reduced subluxation ratio will be realized across the surface of the thumb CMC joint.

(O'Brien, Rosenstein, Magnusson, Nuckley, Adams, 2016)

Cadaveric Study #1 Results

Positional
- OP alone changes metacarpal proximally & volarly, exacerbating subluxation
- FDI greatest effect is **distal and dorsal pull**.



Rotational
- OP tends to over-rotate MC volarly & ulnarly.
- FDI pulls Trapezium dorsally, attenuates MC translation
- **FDI & OP act to help center MC on Trapezium**

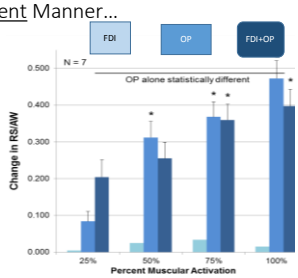
#2: Radiographic Analysis of Simulated FDI and OP Activation upon Thumb CMC Jt Subluxation: A Cadaver Study

Hypothesis & Purpose
- The FDI and OP work concomitantly to decrease subluxation in the CMC joint
- Investigation **of effect of load** application to the FDI, OP, and FDI+OP on cadaver model

Methods: (Capsulotomy of CMC jt)
- Loading the **FDI** from 0 to 30N
- Loading the **OP** from 0 to 40N
- Simultaneously loading the **FDI** and **OP** from 0 to 30 & 0 to 40N, respectively.

Results #2: In a Dose Dependent Manner…

- OP improved Subluxation Ratio (SR)
- FDI minimal effect on SR
- **OP+ FDI improved SR in all loading states**
- In **75% + greater**, significantly improved SR (p<.014)
- ***FDI in combination with OP*** may reduce subluxation, reduce pain and symptoms



Conclusions for Both Cadaveric Studies:

- These biomechanical data support use of **FDI and OP** in conservative **exercise programs. thumb CMC joint pain**

Activation of the First Dorsal Interosseous Muscle Results in Radiographic Reduction of the Thumb CMC Joint (Fluoroscopic Study)

- **Hypothesis**: Activation of the 1st Directly reduces subluxation of the 1st metacarpal to trapezium
- **Methods:** 17 healthy subjects
  - (5M, 12F)
- Mean age: 26, no CMC OA
- Measured Max. Voluntary Contraction 1st DI strength

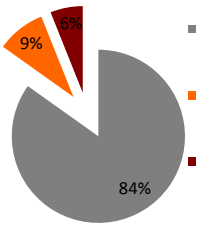
Rotterdam Intrinsic Hand Myometer (RIHM)

AP of thumb CMC joint:

- At rest
- Manual radial translation stress
- Manual stress w/ 1st DI
- At rest with 1st DI

(McGee, O'Brien, Van Nortwick, Adams, Van Heest, 2015)

Results



- Subluxation with Stress, Reduction with FDI Activation (27)
- No subluxation (3)

ICC > 0.74

- Subluxation at Rest, No Further Subluxation with Stress (2)

(McGee, O'Brien, Van Nortwick, Adams, Van Heest, 2014)

Stout deltoid-like CMC dorsoradial ligament structure

- Joint instability ALONE may not be the primary etiological factor in development of OA of CMC.
- Dynamic **proprioceptive** function of the joint is subject of continuing studies

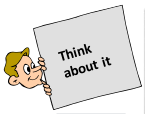
(Hallilaj et al. 2015) (Ladd et al. 2013) (Ladd et al. 2014) (Hagert et al. 2012)

Green: DorRadLig; Orange: DColLig; Magenta: PostOblLig; APL: red

Carpometacarpal (CMC) joint

- ❖ Loose capsule
- ❖ Joint surfaces are not congruent
- ❖ Stability from soft tissues
  - ❖ Ligamentous support
  - ❖ Muscular support

The anatomy and biomechanics of the thumb CMC is similar (in many ways) to that of the shoulder



Doesn't the thumb deserve the same amount of attention we have given to shoulder problems?

Muscles that influence the Thumb

9 muscles influence the thumb

Thumb is 70% of the dominant hand, 60% of the non-dominant hand (Disability ratings)

We have a big job to help our patients with their thumbs!!!!

Accessed at: **militarydisabilitymadeeasy.com**

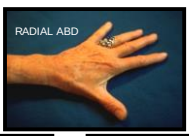
Know and USE Your ExtrinsicThumb Muscles:

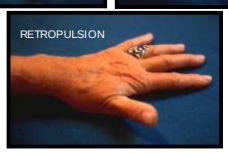
- Extensor Pollicis Longus
- Extensor Pollicis Brevis
- Abductor Pollicis Longus
- Flexor Pollicis Longus

Know and USE your Thumb Intrinsics Muscles

- Abductor Pollicis Brevis
- Flexor Pollicis Brevis – deep and superficial heads
- Opponens Pollicis (Deep)
  - AFO-acronym to remember the Thenars
- Adductor Pollicis
- **First Dorsal Interosseous!**

Range of Motion of the Thumb





The multidirectional pull of these muscles:

Opponens

First Dorsal Interosseous

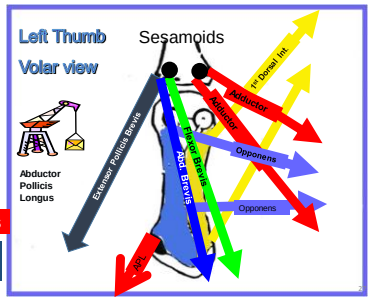
Adductor

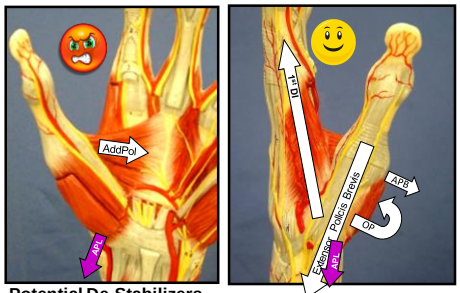
Abductor Brevis

Flexor Brevis

Abductor Longus

Extensor Pollicis Brevis





Potential De-Stabilizers

Dynamic Stabilizers

Intervention to Restore Dynamic Thumb Stability

- Manual release of the adductor and any over-active, dominant muscle
- Joint mobilization to reduce / realign the CMC
- Muscle re-education / strengthening
- Use of adaptive tools and joint protection techniques
- Orthosis/Orthoses as needed
- Strategy to wean from orthosis

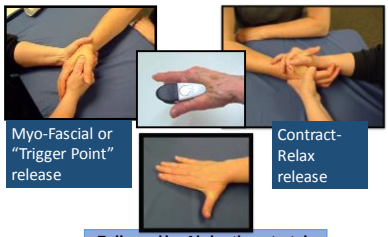
With respect for pain at each step

Manual Release

- **Adductor**: One of the strongest muscle per square measure in the body.
- Manual release of this muscle **increases** the potential **ROM** of the thumb lost due to web space contracture.
- Helps to "set the stage" to gain ***congruency*** *of* ***joint surfaces*** for the next portions of the exercise program.

Manual Release

Adductor Muscle Release is the KEY



Myo-Fascial or "Trigger Point" release

Contract-Relax release

Followed by Abduction stretch

Elongate Soft Tissues in the Web Space

1) Web to web: press in to relax tissues, 2) Extend Thumb and Index to stretch tissues, 3) Hold each 15-30 seconds. Repeat 3-5 times

Joint Mobilization

Initiated **after Manual Release:** adductor release and soft tissue elongation .....

AND before Muscle Re-education*

- To *Reduce Pain*
- To *Approximate Joint Surfaces*: centralize the MC on Trapezium to improve motion and production of nutritional substances in the joint.
- To *Restore* Stable Thumb Biomechanics

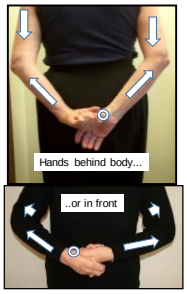
* Must be done pain free!

(Villafane et al., 2011) (Villafane et al. 2013)

Joint Mobilization by Distraction

- **Distraction** is the first level (grade I) of joint mobilization
- Opens joint spaces, relieves pain & increases nutrition
- Grasp the base of involved thumb, hold arms behind back The weight of the arms provides distraction

❖ If this position causes pain in shoulders, bring arms in front of body, relax, and bring elbows back to distract the CMC joint



In both photos, the subject's RIGHT CMC is being distracted

Self-Joint Mobilization

Must be **PAIN-FREE**: restores Retropulsion, improves CMC/STT glide

(Villafañe, Silva, Diaz-Perreno & Fernandez-Carnero, 2011)

Joint Mobilization With a "Skull Rock"

METHOD *ONE* **METHOD *TWO***

Feels a little uncomfortable initially; feels better later.

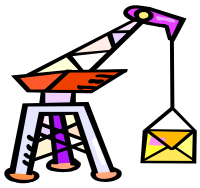
(Villafañe, Silva, Diaz-Perreno & Fernandez-Carnero, 2011)

Muscle Re-education first: Before Strengthening

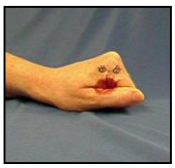
Re-education of the thumb muscles to restore stable balance IN **PAIN FREE** CONTEXT

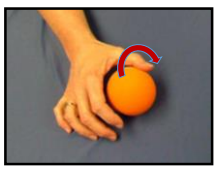
Focus: Retrain in Kinetic Chain

- Abductor Pollicis Brevis
- Opponens Pollicis
- **1st Dorsal Interosseous**
- Extensor Pollicis Brevis
- Abductor Pollicis Longus
- Flexor Pollicis Brevis



Isolate the Abductor and Opponens



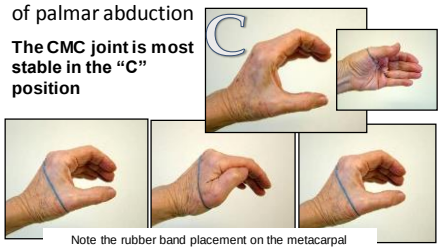


Make the thumb puppet sing

Closed Chain Exercise

Isometric and Isotonic Muscle Re-education of palmar abduction

The CMC joint is most stable in the "C" position



Note the rubber band placement on the metacarpal

This exercise is done **pain free**

Strengthen the 1st Dorsal Interosseous

1st DI has a distal and ulnar-ward pull on 1st Metacarpal:
NOT A COMPRESSIVE FORCE

(Mobargha, 2016) (Obrien et al. 2016)

1st Dorsal Interosseous Exercise

Rubber Band Exercise: Abduct the Index away from the Middle Finger

NEW GOAL: 100 repetitions per day???

Thumb Stability Exercises: Using a Rubber Band

In Palmar Abduction is best!

Start with a thinner rubber band at P 1 IF. Lift IF up and down slowly and smoothly.
ISOKINETIC: Concentric/eccentric

To progress, advance RB distally on IF toward P2 and P3: PAIN-FREE ONLY.

Advance to thicker RB, and repeat the same progression.

DOSE: 10 reps 2-3 sets/session

GOAL: 100 x / day !!???!!??!!

Functional Muscle re-education with strengthening: EPB APL APB OP & FDI

"Piano playing" or Other Functional tasks

(Active to isometric to isotonic)

- Extensor Pollicis Brevis
- Abductor Pollicis Longus
- Abductor Pollicis Brevis
- Opponens Pollicis
- **AND the 1st Dorsal Interosseous**

Train to Abduct and Extend without losing the MP flexion posture

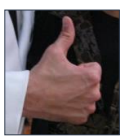
1st Dorsal Interosseous with Instability

- For the patient who has a very unstable CMC, performing 1st DI strengthening may be painful initially.
- External support may be needed
  - with co-contraction of the "C" position
  - manual support of the metacarpal
  - OR performing exercise with orthotic support at the CMC.

If the program is unsuccessful in stabilizing the CMC and relieving pain, reconstruction may be a consideration.

3 Important Points for a Stable Thumb…

1. The thumb webspace: Keep it ***SUPPLE***
2. Use of *ALL* thumb motors to ***Stabilize*** and ***Centralize*** the 1st metacarpal as it moves on the trapezium.
3. ***Educate*** the person to stabilize their own thumbs for a lifetime.



Are Your Thumbs Stable?

Recap: Intervention to Restore Dynamic Thumb Stability

- Manual release of the adductor and any over-active dominant muscle
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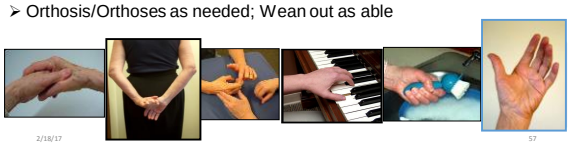
- Muscle re-education / strengthening
- Use of adaptive tools and joint protection techniques
- Orthosis/Orthoses as needed; Wean out as able



More Research…For Thumb Stability

- Which are the **key exercises**?
- What is the least **optimal number** of exercises?
- What is the **dosage** of exercises which effect change?
- For **which DX, which OA grades** is dynamic stability optimal? Effective?
- Will you contribute to **Evidence for Thumb Stability?**

In Remembrance: Jan Albrecht (1935-2016) OT & Hand Therapist Extraordinaire

- Jan Albrecht, OTR, CHT (1991-2011)
- She discovered the power of dynamic thumb stability for her own painful thumb
- Used her passion and commitment to teach others: patients, therapists, and physicians

Thank you

Questions ?

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