Simultaneous Measurement of Muscle Activity, Kinetics, and Pain in Women with Carpometacarpal Osteoarthritis

Tamara Ordonez Diaz[1], Samuel Licht[1], Kevin A. Hao[2], Yenisel Cruz-Almeida[3], and Jennifer A. Nichols[1]

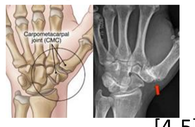
J. Crayton Pruitt Family Department of Biomedical Engineering[1], College of Medicine[2], and College of Dentistry[3], University of Florida

SCAN ME

BACKGROUND

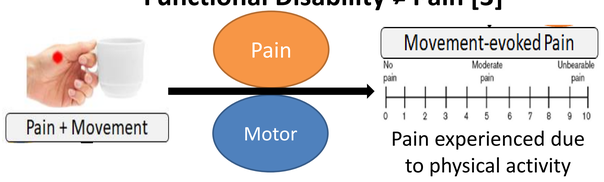
Carpometacarpal osteoarthritis (CMC OA) affects 85% of postmenopausal women [1], and leads to [2]:

- Severe pain
- Decreased strength
- Decreased range of motion



[4-5]

Functional Disability ≠ Pain [3]



Pain experienced due to physical activity

***Objective**: Examine the relationship between movement and pain by simultaneously measuring pinch force, muscle activity, and movement-evoked pain in individuals with CMC OA and healthy older adults.*

Hypotheses: Compared to healthy age-matched adults, participants with CMC OA would

(1) generate lower forces,
(2) activate extrinsic muscles more than intrinsic muscles,
(3) have higher movement-evoked pain.

DISCUSSION

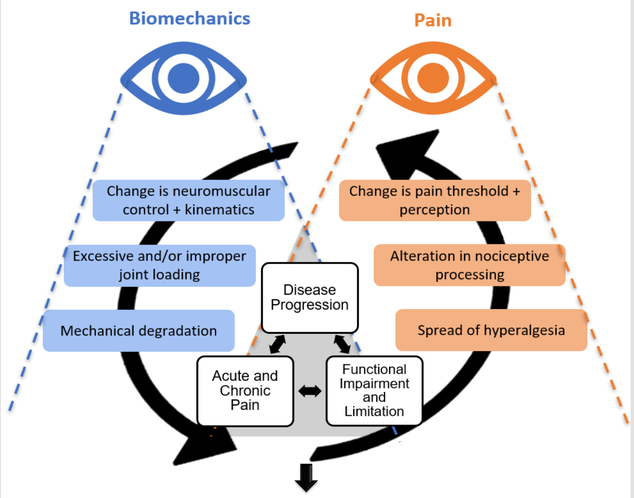
Results from this study highlight the need to perform *patient-specific analysis* to understand the extent to which different levels of **force exertion** and **muscle activity** uniquely impact the **experience of pain.**

Despite CMC OA participants having increased sensitivity to pain, their force data suggest that they have learned to push through the pain and/or compensate to accomplish tasks.

Whether CMC OA participants have found an optimal muscle activation pattern to avoid pain or protect the joint is still unknown.

SIGNIFICANCE

Understanding the interplay of biomechanics and pain can:



Inform and improve targeted treatment to restore full joint mobility and eliminate pain.

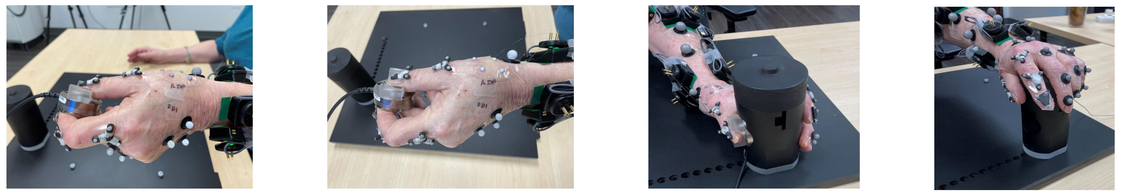
MATERIALS AND METHODS

Subject Recruitment:

- 5 participants diagnosed with CMC OA
  - Female, age: 70.8 ± 8.4 years
- 5 healthy older adults
  - Female, age 68.2 ± 12.0 years

IRB-approved study (UF IRB #201900693)

Tasks:



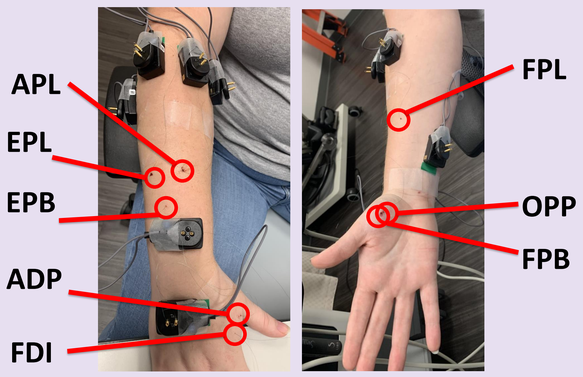
Key Pinch ***Tip Pinch*** ***Jar Grasp*** ***Jar Twist***

3D force sensor (ATI)

1D sensor (Honeywell)

Fine-Wire Electromyography (f-EMG)

- Muscle activity was collected from 4 extrinsic and 4 intrinsic thumb muscles.
- All f-EMG was performed by 1 experimenter and insertions were ultrasound guided.

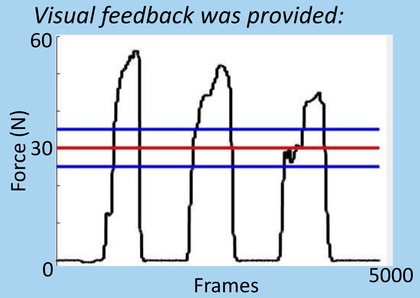


- EMG data were sampled at 3,000 Hz.
- Data was filtered, rectified, and RMS was calculated using Python.
- To compare across cohorts, data was amplitude normalized to maximum activation of each muscle for all tasks.

Isometric Force

- Force was collected before- and after- EMG insertions.
- All tasks were completed 3 times with at least 10 s rest between trials.
- For each task participants were asked to complete:
  - 3 s MVC's
  - 5 s 50% suboptimal force

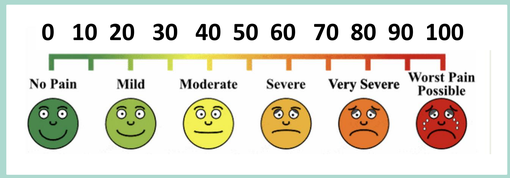
Visual feedback was provided:



- Force data were sampled at 3,000 Hz.
- Maximum pinch force was calculated in MATLAB as the average across the 3 peaks for each task.
- Data was averaged within cohorts and independent t-tests were performed.

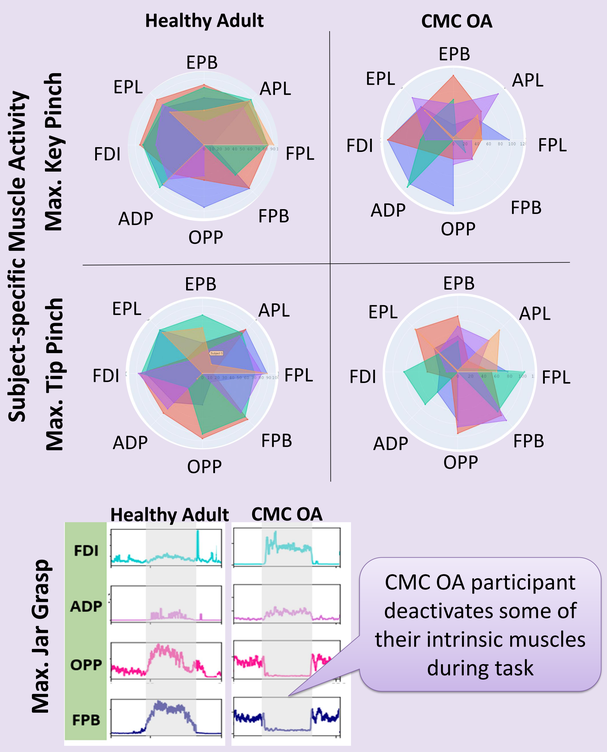
Movement-Evoked Pain (MEP)

- All participants were instructed on how to use the 101-point visual analog scale (VAS).
- Pain ratings were obtained:
  - before- and after- EMG insertions and
  - before-, during-, and after- each task

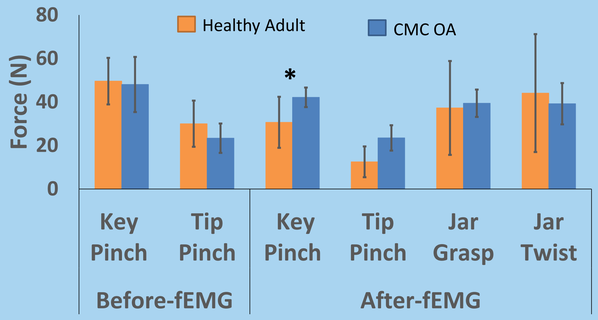


- Pain data were averaged within study cohorts.
- Independent t-tests were performed to compare study cohorts.
- Paired t-test were performed for MEP *before, during, and after* meas. within study group

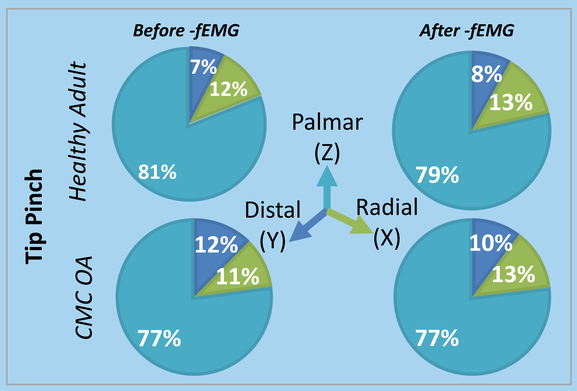
RESULTS



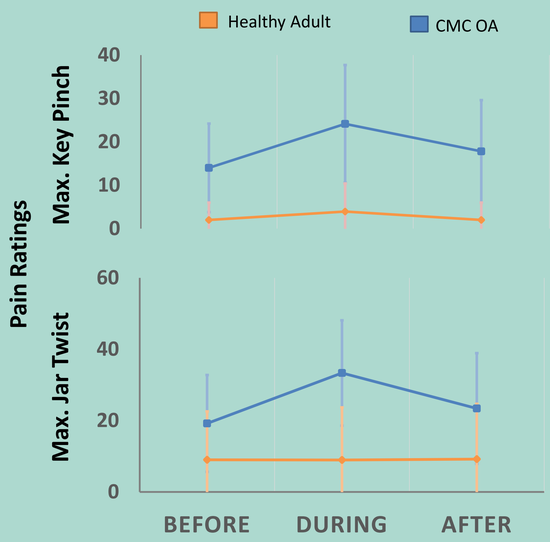
The heterogeneity of muscle activation patterns within the same tasks demonstrates the presence of muscle redundancy in the upper limb.



CMC OA participants generated **similar forces** as healthy older adults before fEMG with a trend toward **greater forces** after fEMG.



Healthy adults had a decrease of force production in the palmar direction after fEMG.



MEP measurements were **significantly greater** ($p<0.03$) in the CMC OA versus healthy older adults during maximum key pinch.

In the CMC OA cohort, MEP was significantly greater ($p<0.04$) than pain-at-rest during tip pinch.

REFERENCES: [1] Becker et al. 2013 *CORR* 471(12):3738-44. [2] Kloppenburg et al. 2015 *Osteoarthr Cartil* 23(5):772-86 [3] Corbett et al. 2019 *Pain* 160(4):757-61 [4] Basilar Thumb Arthritis *Orthobullets* [5] March et al. 2016 *OARSI* 1-103

J. Crayton Pruitt Family Department of Biomedical Engineering