

REDUCED RANGE OF MOTION AND HIGHER MOVEMENT-EVOKED PAIN IN INDIVIDUALS WITH CARPOMETACARPAL OSTEOARTHRITIS

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Introduction

The first carpometacarpal (CMC) joint has 3 degrees of freedom and facilitates complex motions, such as grasp. When osteoarthritis (OA) impacts this joint, it can hinder one's ability to perform activities of daily living. Although it is accepted that there is often a disconnect between self-reported pain and functional disability in patients with OA [1-2], only a limited number of studies include both pain and movement measurements [3]. An important metric for examining the intersection of pain and movement is movement-evoked pain (MEP), or pain elicited during motion. Evaluation of MEP can highlight the bi-directional association of pain and movement [2] since the adaptation and feedback response of pain guides movement changes. To our knowledge, only one study measured range of motion (ROM) in individuals with CMC OA, yet this study only included pain-at-rest measurements [4]. Incorporating MEP with biomechanical measurements will elucidate the paradoxical relationship of when movement evokes versus alleviates pain. In this context, the aim of this study was to examine movement and pain differences during CMC joint range of motion (ROM) tasks. We hypothesized that individuals with CMC OA would have significantly reduced ROM and higher pain ratings in comparison to age-matched healthy controls.

Methods

Six CMC OA participants (67.5 ± 9.8 years old) and six age-matched healthy controls (66.8 ± 13.4 years old) participated in this IRB-approved study (IRB#201900693). All participants were female given the high prevalence of CMC OA in women.

Motion data were collected at 100 Hz using a 12-camera Vicon system. The upper limb marker set importantly included 31 markers on the hand (4 markers on the CMC segment). Each participant completed two single plane (flexion/extension, adduction/abduction) and one multiplanar (circumduction) CMC joint ROM tasks. For single plane tasks, motion was constrained by having participants move their thumb along a guide. These tasks were performed 3 times each. For circumduction, participants were instructed visually and verbally to draw a circle as big as possible with their thumb. This task was performed 5 times. Pain rating were collected before, during, and after each task using a 101-mm visual analog scale (VAS) to evaluate MEP.

Motion capture data was processed in OpenSim (v. 4.2) using an upper limb model [5] anthropometrically scaled to match each participant. Inverse kinematics was performed to calculate joint angles from the collected motion data. ROM was calculated as the angle difference between the beginning and end position of the CMC joint during each task. Additionally, for circumduction, the area of the circumscribed circle was calculated from the position of the most distal thumb marker using a custom Matlab script. Participant data was averaged across trials and cohorts. Paired t-tests (pairing based on age matching) were performed to compare ROM and pain differences across cohorts and to compare differences between pain at rest and MEP for each task within the same cohort. A p-value <0.05 was deemed significant.

Results and Discussion

MEP during multiplanar motion was significantly different between CMC OA and healthy control participants ($p = 0.04$). Specifically, the CMC OA participants had a mean VAS score 15 mm higher during circumduction than controls. Although not statistically significant, the MEP during flexion/extension and adduction/abduction tasks were 10 and 11 mm higher, respectively, in the CMC OA participants as compared to the age-matched controls; a difference of 9 mm is considered clinically significant [6]. MEP and pain-at-rest (i.e., before and after the task) were also significantly different during circumduction in the CMC OA participants ($p = 0.02$). No significant differences were found between cohorts in CMC ROM during any of the performed tasks. However, similar to a previous study [4], CMC OA participants had decreased ROM during the adduction/abduction task and smaller filled area during circumduction (-633 mm^2) than age-matched healthy controls (Fig. 1). Overall, our data highlights the heterogeneity of movement and pain data across and within cohorts. Given the complexity of pain and OA, elucidating differences across the extremes in the CMC OA participants and age-matched healthy controls can inform treatment and surgical decisions.

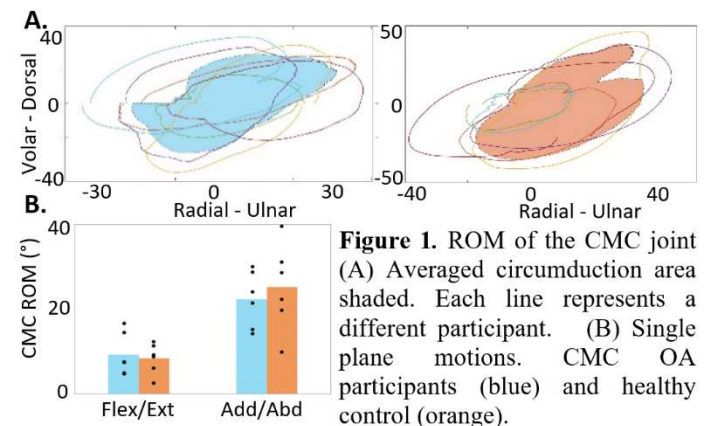


Figure 1. ROM of the CMC joint (A) Averaged circumduction area shaded. Each line represents a different participant. (B) Single plane motions. CMC OA participants (blue) and healthy control (orange).

Significance

Effective treatments for CMC OA are lacking. Understanding the interplay of pain and movement can improve patient outcomes through novel treatments aimed to provide pain relief without the unintended consequence of limiting mobility.

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References

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