Active Index Finger Abduction Stabilizes the Thumb Carpometacarpal Joint : An Ultrasonographic Study in Healthy Volunteers

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INTRODUCTION: Thumb carpometacarpal (CMC) osteoarthritis is a common condition that impairs activities of daily living and quality of life due to pain and functional disability. In thumb CMC osteoarthritis, the first metacarpal displaces dorsoradially relative to the trapezium, leading to subluxation. Preventing dorsoradial displacement of the first metacarpal may help stabilize the joint and potentially prevent the onset or progression of the disease.

The primary function of the first dorsal interosseous (FDI) muscle is index finger abduction. Cadaveric studies have demonstrated that FDI can also cause ulnar shifting of the first metacarpal relative to the trapezium. However, it remains unclear whether the FDI exerts a similar effect in clinical settings. We hypothesized that the FDI induces ulnar displacement of the first metacarpal and therefore, index finger abduction, a primary action of the FDI, would result in ulnar displacement of the first metacarpal. This study aimed to determine whether active index finger abduction produces ulnar shifting of the first metacarpal in ultrasonographic assessment.

METHODS: This study was approved by the institutional ethics committee of our facility, and written informed consent was obtained from all participants. With a statistical power of 80% and a significance level of 5%, the required sample size was calculated to be 6 hands. Six healthy volunteers (mean age, 34.4 years) were recruited, and the right hand was evaluated in all participants. All participants were male, which occurred coincidentally.

Grip strength, pinch strength, and index finger abduction strength were measured for each participant. The right thumb CMC joint was then examined using an ultrasonography system (Aplio i700, TUS-AI700; Canon Medical Systems Corporation). Participants' hands were positioned on a custom-made platform (Fig. 1), and a 24-MHz ultrasonographic probe was placed on the lateral aspect of the thumb CMC joint to obtain joint images.

Ultrasonographic images were recorded under three conditions: at rest, during active index finger abduction, and during passive index finger abduction. Image acquisition was performed in three sets for each condition. From the images, the distance from the extension line of the lateral border of the trapezium to the radial border of the base of the first metacarpal (Fig. 2) was measured and defined as the distance of lateral offset. The mean of the three measurements for each condition was used as the representative value.

Differences in the distance of lateral offset between the resting condition and active abduction, and between the resting condition and passive abduction, were evaluated using paired t-test. Correlations between the changes in the distance of lateral offset (from rest to active abduction and from rest to passive abduction) and grip strength, pinch strength, and index finger abduction strength were analyzed using linear regression. Pearson's correlation coefficient was used to assess the presence of correlations. A p value of < 0.05 was considered statistically significant.

RESULTS: The mean distance of lateral offset at rest, during active abduction, and during passive abduction was 1.99 ± 0.83 mm, 1.34 ± 0.96 mm, and 1.98 ± 0.90 mm, respectively. The distance of lateral offset during active abduction of the index finger was significantly smaller than that at rest ($p < 0.05$) (Fig. 3a). No significant difference was observed between the distance of lateral offset during passive abduction of the index finger and that at rest (Fig. 3b). No significant correlations were observed between the change in the distance of lateral offset from rest to active abduction and grip strength, pinch strength, or index finger abduction strength. Similarly, no significant correlations were found between the change in the distance of lateral offset from rest to passive abduction and these strength measurements.

DISCUSSION: This study demonstrated that active index finger abduction resulted in ulnar displacement of the first metacarpal, whereas passive abduction did not. This finding suggests that the ulnar displacement is attributable not to the positional change of the index finger itself, but to muscle contraction associated with active movement. The primary agonist muscle for index finger abduction is the FDI, which originates from the ulnar aspect of the base of the first metacarpal and inserts into the base of the proximal phalanx of the index finger. We consider that contraction of the FDI during active index finger abduction pulled on its origin at the first metacarpal, thereby producing the observed ulnar displacement.

In thumb CMC osteoarthritis, dorsoradial displacement of the first metacarpal leads to joint instability. Index finger abduction may cause ulnar shifting of the first metacarpal, counteracting dorsoradial displacement, thereby contributing to joint stabilization. This may have potential implications for the prevention and conservative management of thumb CMC osteoarthritis. As a limitation, all participants in this study were healthy males. It remains unclear whether the results can be generalized to females or to individuals with thumb CMC osteoarthritis. In conclusion, active abduction of the index finger shifts the first metacarpal ulnarly relative to the trapezium, which may contribute to the stabilization of the thumb CMC joint.

SIGNIFICANCE/CLINICAL RELEVANCE: Thumb CMC osteoarthritis is a common condition, and the development of preventive measures and effective conservative treatments is of great importance. The present study's findings suggest that index finger abduction may contribute to stabilizing the thumb CMC joint and could be effective for preventing or conservatively treating thumb carpometacarpal osteoarthritis.

Figure 1.
Ultrasound images were obtained by placing the hand on a custom-made hand platform and applying the probe to the lateral aspect of the thumb

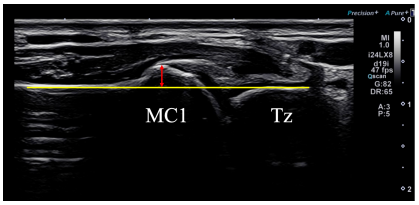

Figure 2.
The distance from the extension line of the lateral border of the trapezium to the radial border of the base of the first metacarpal was measured (double-headed arrow). This distance is referred to as the lateral offset.
Tz: trapezium, MC1: first metacarpal

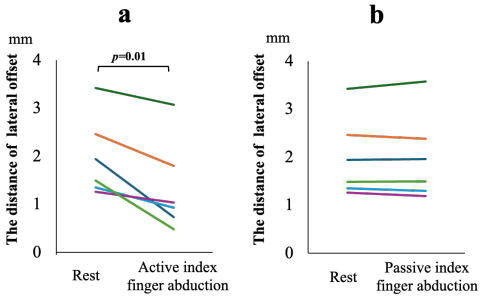

Figure 3.
a: Comparison of the distance of lateral offset between the positions of resting and active index finger abduction.
b: Comparison of the distance of lateral offset between the positions of resting and passive index finger abduction.