Journal of Hand Therapy 28 (2015) 375–381

Contents lists available at ScienceDirect

Journal of Hand Therapy

journal homepage: www.jhandtherapy.org

JHT Read for Credit Article #390.
Scientific/Clinical Article

First dorsal interosseous muscle contraction results in radiographic reduction of healthy thumb carpometacarpal joint

Corey McGee PhD [a,*], Virginia O'Brien OTD [b], Sara Van Nortwick MD [c], Julie Adams MD [d], Ann Van Heest MD [c]

[a] University of Minnesota, Program in Occupational Therapy, 300 University Square, 111 South Broadway, Rochester, MN 55904, USA
[b] University Orthopaedics Therapy Center, Fairview, 2450 Riverside Ave., Suite R102, Minneapolis, MN 55454, USA
[c] University of Minnesota, Department of Orthopaedic Surgery, 2450 Riverside Ave. South, Suite 200, Minneapolis, MN 55454, USA
[d] Mayo Clinic, Department of Orthopedic Surgery, 200 First St. SW, Rochester, MN 55905, USA

ARTICLE INFO

Article history:
Received 13 January 2015
Received in revised form
2 June 2015
Accepted 10 June 2015
Available online 27 June 2015

Keywords:
Carpometacarpal
First dorsal interosseous
Hand therapy
Osteoarthritis
Strength

ABSTRACT

Introduction: Hand therapists selectively strengthen the first dorsal interosseus (FDI) to stabilize arthritic joints yet the role of the FDI has not yet been radiographically validated.
Purpose: To determine if FDI contraction reduces radial subluxation (RS) of the thumb metacarpal (MC).
Methods: Fluoroscopy was used to obtain true anterior-posterior radiographs of non-arthritic CMC joints: 1) at rest, 2) while stressed and 3) while stressed with maximal FDI contraction. Maximal FDI strength during CMC stress and thumb MC RS and trapezial articular width were measured. The ratio of RS to the articular width was calculated.
Results: Seventeen participants (5 male, 12 female) participated. Subluxation of a stressed CMC significantly reduced and the subluxation to articular width ratio significantly improved after FDI activation.
Conclusions: Contraction of the FDI appears to radiographically reduce subluxation of the healthy thumb CMC joint. Further exploration on the FDI's reducibility and its carry-over effects in arthritic thumbs is needed.
Level of evidence: 4.

Introduction

Thumb carpometacarpal (CMC) joint osteoarthritis (OA) is the single most common and symptomatic form of hand OA and is often a substantial source of hand dysfunction[1–3] The precision, power, and mobility demanded from the thumb to perform pinch and grasp makes thumb CMC OA particularly debilitating.[4] Because of this, the thumb CMC joint is the most commonly reconstructed joint of the body due to OA.[5] Joint hypermobility is thought to be a major etiological factor in the development of thumb OA. Laxity-induced joint subluxation results in joint incongruity and abnormal joint loading which likely contributes to the development of OA.[6,7]

Non-operative approaches are the first line of intervention for thumb CMC arthritis.[8,9] The American College of Rheumatology conditionally recommends non-pharmacological interventions for hand osteoarthritis[8] including: activities of daily living training, joint protection education with assistive devices, instruction in thermal modalities for home use, use of orthoses, and general hand exercises.[10–19] Although there is evidence in support of hand exercises for OA, specific dosage and design of efficacious exercises are lacking.[10,20]

Stabilization exercises, which focus on neuromuscular training of select muscle groups rather than generalized strengthening, have been effective in reducing pain and dysfunction for patients in other joints, particularly the knee and the shoulder.[21–23] Recent investigations have focused on the use of similar exercises to stabilize the thumb CMC joint.[24,25]

In these regiments, the opponens pollicis (OP) and the first dorsal interosseous (FDI) muscles are targeted in order to center the thumb MC on the trapezium.[26–28] Biomechanical studies describe the superficial head of the FDI (Fig. 1) as being antagonistic to the radially subluxating forces of the adductor pollicis on the thumb MC.[26] Boutan,[28] through *in vivo* experimentation, described the force coupling effect of FDI and OP on enhancing stability the thumb CMC joint. Clinically, reduced pain and improved function has been demonstrated through targeting the FDI as a component of a thumb stability program.[25]

It is theorized that stabilization exercises for the CMC joint can reduce joint subluxation, and thus increase joint congruence and

* Corresponding author. Tel.: +1 507 258 8016.
E-mail address: mcge0062@umn.edu (C. McGee).

0894-1130/$ – see front matter © 2015 Hanley & Belfus, an imprint of Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jht.2015.06.002

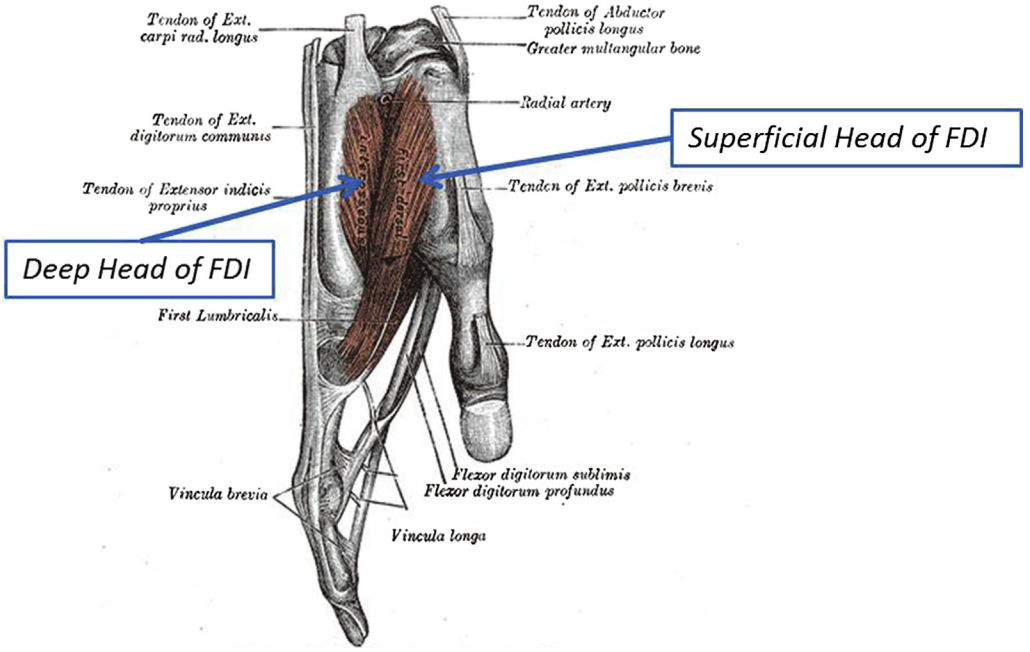

Fig. 1. Anatomy of first dorsal interosseous muscle.

decrease abnormal joint loading forces upon the joint resulting in pain-relief and potentially altering the progression of arthritis.[25,29] To date, the effect of contraction of thumb CMC stabilizers has not been studied radiographically.

In this study, we provided selective resistance to and quantified maximum contractile strength of the FDI in healthy volunteers while radiographically assessing the changes in radial joint subluxation in resting and stressed states. We hypothesized that 1) maximum-resisted contraction of the FDI, a thumb CMC joint stabilizing muscle, will radiographically reduce subluxation of the thumb metacarpal relative to the trapezium as measured by fluoroscopy and 2) the maximal voluntary strength (MVC) of the FDI will significantly and positively predict vulnerability to subluxation. The primary purpose of this study was to determine if FDI contraction reduces radial subluxation (RS) of the thumb metacarpal (MC).

Materials and methods

Design

Institutional review board approval was sought and obtained (IRB # 1208M19273). A pre-post experimental design was used to test our primary hypothesis with the independent variable being FDI contraction and the dependent variables being 1) radial subluxation and 2) subluxation to articular width ratio. Our secondary research hypothesis was tested via a descriptive cross-sectional design with age, hand dominance, gender, MVC FDI strength, and normalized FDI strength as predictors and RS and subluxation to articular width ratio as response variables. To detect a reduction of radial subluxation of 2.0 mm (SD 1.25), which is in agreement with Cheema and Tahseen (2012),[30] with a two-tailed 5% significance level and a power of 90%, a minimum sample size of 12 participants was required.

Participants

Healthy adult volunteers aged 18 years and older were recruited from a U.S. university campus via convenience sampling. Exclusion criteria included: history of hand osteoarthritis, pregnancy, any major medical conditions resulting in ligamentous laxity (e.g., Ehlers Danlos, Marfan's), and inability to follow standardized commands. Additionally, participants were excluded if a positive CMC grind test or radiographic evidence of OA was discovered upon entry to the study.

Procedures

The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Participants consented to participate and completed a questionnaire upon arrival including items on hand dominance, age, and medical history. Bilateral hands were assessed. A certified hand therapist administered a CMC grind test, and measured maximum grip strength via the Jamar dynamometer (Lafayette Instrument, Lafayette, IN).

In a randomized fashion, a board certified hand surgeon obtained three separate true anterior-posterior (AP) views of each thumb CMC joint using fluoroscopy at 1) rest, 2) while stressed without contraction of the FDI and 3) while stressed with contraction of the FDI. During the two stress views, a second board certified hand surgeon manually applied radial translation stress to the thumb metacarpal through passive positioning of the metacarpal into adduction as described by Wolf et al (2009)[31] (Fig. 2). This varied from what was described by Wolf et al[31] only in that the surgeon was passively adducting the thumb rather than through use of the participant's contralateral hand. A certified hand therapist measured maximum voluntary FDI strength using the Rotterdam Intrinsic Hand Myometer (RIHM) (Med Engineers, Rotterdam, Netherlands) as described below.

Measurement tools

Grind test

The thumb CMC Grind test was administered to screen out participants with CMC arthritis. The specificity of this screen has