

Measurements of Post-operative Subsidence after Trapeziectomy May be Inaccurate When Using Standard Posteroanterior and Lateral 2D Radiographs

Cortez L. Brown^{1,2}, Edward Godbold¹, Tom Gale¹, Maria Munsch^{1,2}, John Fowler², William Anderst¹

¹Biodynamics Lab, Department of Orthopaedic Surgery, University of Pittsburgh

²Department of Orthopaedic Surgery, University of Pittsburgh Medical Center

CLB299@pitt.edu

Disclosures: Brown (N), Godbold (N), Gale (N), Munsch (N), Fowler (N), Anderst (5:Smith&Nephew)

INTRODUCTION: The thumb carpometacarpal (CMC) joint is the most common site of surgical reconstruction for osteoarthritis (OA) in the upper extremity.¹ Patients with thumb CMC arthritis often report worsening thumb pain, instability, and strength. Trapeziectomy in combination with ligament reconstruction and tendon interposition (LRTI) or suture-only suspension arthroplasty (SSA) are two commonly utilized arthroplasty options. Surgeons can assess the arthroplasty construct by the amount of metacarpal subsidence seen with radiographic imaging. Although prior studies described methods to measure subsidence, there is no standard method.^{4,5} The long-term goal of this study is to identify the optimal imaging configuration for estimating dynamic three-dimensional (3D) thumb CMC subsidence on two-dimensional (2D) radiographs. The aim of this interim analysis was to determine the accuracy of standard posteroanterior (PA) and lateral radiographic imaging methods to measure trapezoidal gap distance.

METHODS: Written informed consent was obtained for this IRB-approved study. CT scans of each participant's post-operative hand and wrist were segmented to create three-dimensional (3D), subject-specific bone models. Digitally reconstructed radiographs of the hand and wrist were then created to simulate PA and lateral radiographs (Figure 1), as well as radiographs depicting the hand supinated and pronated in 5-degree increments from the PA view from -25° to +25°, and 15-degree increments from the lateral view from -75° to +75°. For each of the simulated radiographs, ImageJ was used to manually measure the shortest trapezoidal gap distance from the distal articular surface of the scaphoid to the proximal articular surface of the first metacarpal. Two orthopaedic surgery residents independently measured each gap distance three separate times, for a total of six measurements per simulated radiograph. The averages were then compared against the known trapezoidal gap distance which was calculated from the 3D model.



Figure 1. 2D Generated PA and Lateral radiographs of a subject post-trapeziectomy

RESULTS: This interim analysis included two participants (Mean Age: 60 ± 5 years, Sex: 2 Females, LRTI: 2, SSA: 0). The true minimum trapezoidal gap distance was 4.0 mm and 2.7 mm for the two participants, respectively (Figures 2 and 3). For participant one, there were three positions where trapezoidal gap distance was measured within 0.5 mm of the true value: 25° supination away from PA (3.7 ± 0.3 mm), 20° supination away from PA (4.2 ± 0.3 mm), and 60° supination away from lateral (4.5 ± 0.7 mm) views. For participant two, there were also three positions where trapezoidal gap distance was measured within 0.5 mm of the true value: 20° supination away from PA (2.5 ± 0.26 mm), 25° pronation away from PA (3.2 ± 0.6 mm), and 60° pronation from lateral (2.7 ± 0.18 mm) views. Overall, both participants' trapezoidal gap distances were most accurately measured at 20° supination away from PA. All other measurements either underestimated or overestimated trapezoidal gap distance by at least 0.5 mm (Figures 2 and 3).

DISCUSSION: These preliminary findings suggest post-trapeziectomy PA and lateral views are not optimal for determining true subsidence. It appears oblique views were more accurate. These results are limited to the simulated radiographic views evaluated; other radiographic views may be more accurate. The generalizability of these findings will be assessed as more patients and radiographic imaging views are evaluated in this ongoing study.

SIGNIFANCE: These preliminary data suggest oblique radiographs may be preferable to true PA and lateral views for evaluating post-trapeziectomy subsidence.

REFERENCES: 1) Van Heest et al., *JAAOS* 2008 2) Wolf et al., *CORR* 2021 3) Weiss et al., *JHS* 2019 4) Miller et al., *J Hand Microsurg* 2018 5) Bhat et al., *J Hand Surg Am* 2003

ACKNOWLEDGEMENTS: This work was supported by the National Institutes of Health under the award number R21AR081556

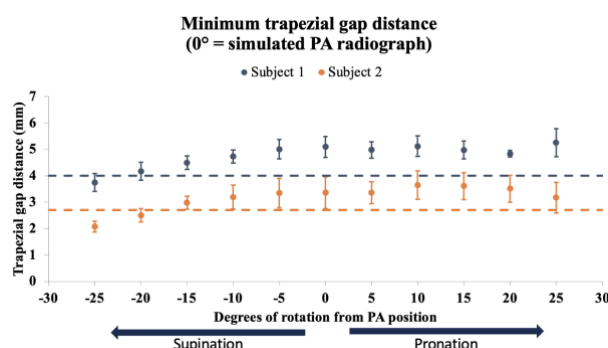


Figure 2. Minimum trapezoidal gap distance for both participants at 5° intervals of supination or pronation from the PA position. Along the horizontal axis, negative and positive numbers represent amount of supination and pronation, respectively.

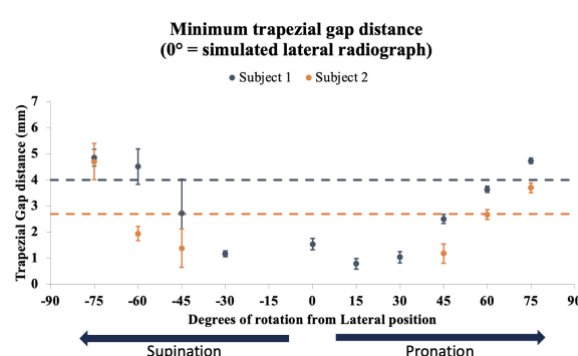


Figure 3. Minimum trapezoidal gap distance for both participants at 15° intervals of supination or pronation from lateral position. Along the horizontal axis, negative and positive numbers represent amount of supination and pronation, respectively. *Both reviewers were unable to determine trapezoidal gap distance for subject two from 30° supination to 30° pronation.