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# MATHEMATICAL MODELING OF THE TRAPEZIOMETACARPAL JOINT FOR IN VIVO STRESS DISTRIBUTION ANALYSIS

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**INTRODUCTION.** Evaluating the stress distribution within the trapeziometacarpal (TMC) joint during daily activities is a clinically relevant way to investigate the biomechanical behavior of this complex joint. Such insights are essential to achieve a better understanding of joint functioning and are particularly important in establishing new prevention approaches for osteoarthritis (OA).

**METHODS.** Static CT scans of the hand region of 20 female volunteers (mean age: 60.8 years) were taken in three different configurations: relaxed neutral, lateral pinch and power grasp, using a radiolucent jig with embedded load cell (Brown University, USA). Four subjects showing signs of OA were excluded from the study. Scans were segmented using Mimics (Materialise, Belgium) and 3D models of the first metacarpal (MC1) and the trapezium were created. The articular area of each bone was quantified based on manual measurements performed on the 3D bone models. A custom-written Matlab code - based on the finite deformation biphasic theory[1] and cartilage deformation properties[1, 2] - was used to evaluate the contact area and stress distribution of each bone. A quadrant division method[3] was used to identify articular sub-regions subjected to the highest stress.

**RESULTS.** No significant difference was observed between the total articular area of the MC1 and trapezium. The contact area of the trapezium was slightly smaller compared to MC1, but this was only statistically significant in the lateral pinch position ($p < 0.05$). Contact stress calculation revealed a similar amount of stress between neutral and lateral pinch. More stress was reported during power grasp. Very consistent results for high stress location on the volar/ulnar articular sub-region were found in the neutral and power grasp configuration. More variation was reported during lateral pinch.

**DISCUSSION**. The findings suggest that a power grasp task elicit higher contact stresses and might therefore represent a more critical configuration for clinical evaluation of the TMC joint. Lateral key pinch, on the other hand, is less reproducible and might create a higher joint instability. The mathematical model presented in this paper offers the possibility to predict contact stress and stress distribution based on in vivo CT scans, which is relevant for the investigation of the onset of OA and might contribute towards better prevention and treatment strategies.

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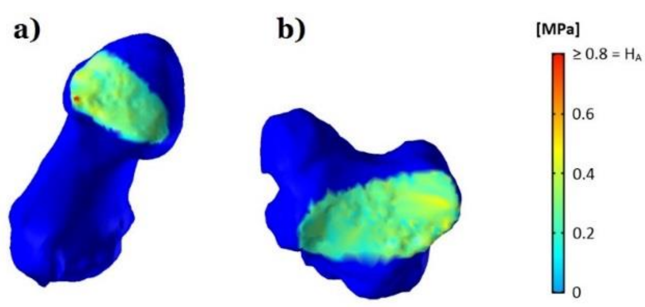
**References**. [1] Kwan et al., J. Biomech, 23: 145-155, 1990; [2] Koff et al., J Hand Surg, 28A: 597-604, 2003; [3] Momose et al., J. Hand Surg, 24A: 491-495, 1999

**COI**. The author reports no potential conflict of interests.

**FIGURE:** Stress distribution pattern of one subject during power grasp: a) MC1; b) Trapezium (right hand)




**Abstract 01**