Anatomy and biomechanics of the TMC joint. In vitro and in vivo studies.

Priscilla D'Agostino[1], MD, Benjamin Dourthe[1], MSc, Filip Stockmans[1, 2], MD, PhD, Faes Kerkhof[1], MSc, and Evie Vereecke[1], PhD

1 Development and Regeneration, Campus Kulak, KULeuven, Kortrijk, Belgium
2 AZ Groeninge, Campus Loofstraat, Kortrijk, Belgium

Purpose: The overall aim of our research is to improve our understanding of trapeziometacarpal (TMC) joint function. A first study focused on the role of the dorsoradial (DRL) and anterior oblique (AOL) ligaments in stability of the TMC joint. The aim of the second study was to quantify the *in vivo* kinematics of the TMC joint during extension-flexion (Ex-Fl) and abduction-adduction (Ab-Ad) of the thumb in healthy volunteers.

Methods: For the *in vitro* study, 13 fresh-frozen cadaveric thumbs from 9 specimens were used. Length, width, and thickness of the AOL and DRL were measured on MRI and/or after dissection. Next, samples consisting of MC1-AOL-trapezium and MC1-DRL-trapezium were subjected to cyclic loading in displacement-controlled tests. The obtained force-displacement curves were used to calculate stiffness and hysteresis of each sample. For the *in vivo* study, the dominant hand of 16 asymptomatic female subjects (age range: 50-82yr) without signs of TMC joint osteoarthritis were CT scanned in positions of maximal thumb extension, flexion, abduction and adduction. The CT images were segmented and 3D surface models of radius, scaphoid, trapezium and MC1 were reconstructed for each sequence. Rotation, translation and helical axes for trapezium and MC1 were calculated between the extreme positions using in-house developed Matlab code.

Results: The *in vitro* study showed that the DRL is significantly shorter and thicker, and has a higher stiffness than the AOL, which is thin and ill-defined. The kinematical analysis demonstrated that Ex-Fl and Ab-Ad of the thumb result in rotation and translation of both MC1 and trapezium, with most motion occurring at MC1 including clear internal-external rotation. During both thumb motions, the helical axes of MC1 and trapezium are almost parallel and nonintersecting and located, respectively, in MC1 and trapezium.

Conclusions: In line with recent studies on TMC ligament function, our results show that the AOL is relatively weak and compliant compared with the DRL; the DRL being the strongest

and stiffest ligament of the TMC joint. The kinematical analysis demonstrated that Ex-Fl and Ab-Ad of the thumb result in rotation and translation of both MC1 and Trap, with rotation of MC1 being most important. Clinically, our findings suggest that the DRL should be repaired or reconstructed when disrupted to restore stability of the TMC joint and confirm the complexity of trapezium and MC1 kinematics during thumb motion. An accurate understanding of TMC joint function is essential to develop more effective surgical procedures and to improve implant design.