IN VIVO PROXIMITY PATTERNS IN THE TRAPEZIOMETACARPAL JOINT: COMPARISON BETWEEN HEALTHY AND ARTHRITIC SUBJECTS

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INTRODUCTION
With an increasing life expectancy, the prevalence of age-related diseases, such as osteoarthritis (OA), is only expected to grow. To address this global health issue, a full understanding of its underlying pathomechanism is required. The trapeziometacarpal (TMC) joint is located at the base of the thumb and is important for normal hand function. However, the joint is also prone to OA, making the TMC joint a common site for surgical reconstruction in the hand [2]. Several factors have been correlated with the development of OA in the hand, including systemic susceptibilities and mechanical factors (e.g. excessive and/or unusual joint loading, ligament laxity, muscular weakness, variations in joint morphology). However, the potential correlation between OA development and TMC joint mechanics/morphology has not yet been clearly determined. The purpose of this study was to provide further insight on the in vivo contact biomechanics of the TMC joint by comparing healthy and OA subjects using a medical-imaging-based approach.

METHODS
Twenty-two female volunteers were recruited (mean age: 60.1 years) and divided in a healthy (n= 16) and OA group (n = 6, Eaton stage III-IV) based on a radiological assessment. The hand of each subject was CT-scanned in five physiological thumb postures (neutral, maximal extension, maximal flexion, maximal abduction and maximal adduction) and during three functional tasks (lateral key pinch, power grasp and jar twist). The CT images were used to create 3D models of the first metacarpal (MC1) and trapezium in each configuration using a medical imaging processing software (Mimics Research 18.0 x64, Materialise, Leuven, Belgium). These models were used to measure parameters such as articular areas and joint curvature. A method based on joint proximity was designed and used as a surrogate for stress distribution assessment. Results were displayed as proximity maps on the articular surface of each bone.

RESULTS AND DISCUSSION
We observed significantly larger articular areas in the OA group, combined with important morphological changes of the articular surfaces (healthy: saddle-shaped; OA: condyloid). The minimal joint space reported in the OA group was significantly smaller in comparison with healthy subjects. This agrees with the literature and confirms the occurrence of joint space narrowing reported in late stage OA [3]. We also observed a significant increase in proximity areas from healthy to OA subjects.

In the healthy group, we observed task-dependent proximity patterns (Figure 1) combined with the presence of an intra-articular stress shift that occurs during specific thumb movements. In every configuration, except the power grasp, we observed that the proximity area of the MC1 had a recurrent volar-central pattern, which indicates that the palmar beak of the MC1 is under constant pressure in most thumb configurations.

CONCLUSIONS
Together with the significant joint space narrowing, the larger proximity areas found in the OA group suggest that the proximity between the MC1 and trapezium is increasing when the disease is progressing. The important morphological changes observed on the volar-central aspect of the MC1 in the OA group might be correlated with the recurrent proximity pattern on this specific sub-region in the healthy group. We also observed that the proximity patterns of the MC1 and trapezium were not always perfectly aligned, especially in adduction, flexion and lateral key pinch. This might suggest that – during these specific tasks – a subluxation of the MC1 relative to the trapezium occurs, which can generate shear stresses and lead to further cartilage degradation.

REFERENCES