TITLE: COMPARISON BETWEEN INTRA-ARTICULAR CONTACT PATTERNS IN THE TRAPEZIOMETACARPAL JOINT OF HEALTHY AND ARTHRITIC SUBJECTS.

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ABSTRACT

Purpose: 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. Mechanical factors play an important role in the development of OA, but how joint loading, intra-articular contact patterns and joint morphology are interrelated and linked to the onset of OA has not yet been determined. We want to address this issue by comparing trapeziometacarpal (TMC) intra-articular stress distribution patterns between healthy and OA subjects in different thumb postures and tasks 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 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 first metacarpal and trapezium were reconstructed as 3D bone models and the articular area was measured manually in the neutral configuration. Due to the inclusion of arthritic subjects with cartilage erosion at the TMC joint, we could not apply a cartilage contact model. Therefore, we developed an approach based on joint proximity, which can be considered as a surrogate for stress distribution assessment. We designed a custom-written code in Matlab which calculates Euclidian distances between neighboring points located on the articular surface of each bone within a 3 mm range. To assess the level of joint congruence, a normal joint space of 1.5 mm was defined based on the average thickness of healthy TMC joint cartilage. Each couple of points with a joint space below this threshold was considered within the proximity area. The results were displayed as proximity maps on the articular surface of each bone.

Results: We observed significantly larger articular areas in the OA group, combined with important morphological changes of the articular surfaces; from saddle-shaped in the healthy group to condyloid in the OA group. 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. We also observed a significant increase in proximity areas from healthy to OA subjects.

In the healthy group, we observed task-dependent proximity patterns (**Fig. 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 observed, the larger proximity areas found in the OA group suggest that the MC1 and trapezium are getting more congruent when the disease is progressing. The recurrent volar-central contact pattern for the MC1 in the healthy group might explain the important deformations observed on this articular subregion in the OA group. We also observed that the proximity patterns of the MC1 and trapezium were not always perfectly aligned (both in healthy and OA group), 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 cartilage degradation and disease progression.

FIGURE

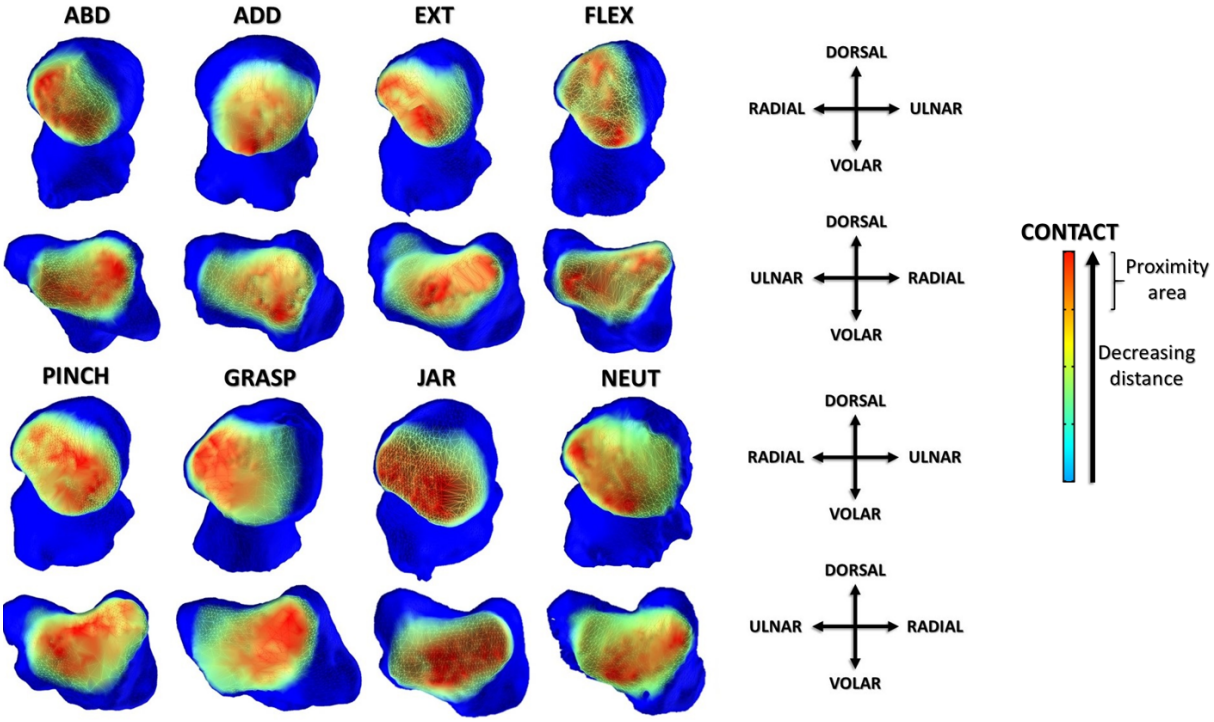

Fig. 1: 3D bone models representing the dominant proximity patterns (selected among subjects for being the most representative) observed on the articular surface of each bone for each configuration in the healthy group.