INDENTATION MAPPING OF ARTICULAR CARTILAGE MECHANICAL PROPERTIES IN NORMAL AND OSTEOARTHRITIC MICE

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Introduction

Mechanical assessment of articular cartilage can identify early cartilage degradation (Armstrong 1982). Murine models are often used to study osteoarthritis (OA) and to assess the efficacy of therapeutics. Due to their size, mouse models pose significant challenges to map mechanical properties over their knee articular surfaces (~5mm^2). This study aims to determine if an automated indentation technique could be used to map the mechanical properties of murine knee articular surfaces; in order to assess early OA lesions in the mouse strain (STR/ort) that spontaneously develops osteoarthritis (OA) on the medial side of their knees (Walton 1977).

Methods

Mechanical measurements were performed *ex vivo*, on left femoral condyles and tibial plateaus of five healthy Balb/c males (12-15 weeks old) and five age- and sex-matched STR/ort mice, using a 3-axis mechanical tester (Mach-1 v500css) equipped with a multiple-axis load cell. Indentation measurements (30-42/surfaces) were performed using a 0.35 mm diameter spherical indenter. Data are reported as the structural stiffness at an indentation depth of 10 µm. To compare the stiffness between healthy and OA-developing animals, each articular surface was divided in 4 zones corresponding to the exterior and inner halves of each surface. Data is reported as the mean ± SE (n=5 animals). Statistical analysis was performed with ANOVA.

RESULTS

In healthy animals, mapping of the structural stiffness showed that regions with higher value of stiffness are mostly located at the exterior halves of each cartilage surface. In OA animals, the stiffness appeared reduced on the medial condyle and the tibial plateaux showed a larger area of lower stiffness in the load bearing region. Comparison with healthy mice of zone averages shows a lower stiffness in the external half of the medial condyle of OA mice (Fig.1, zone I), the external half of the medial and the inner half of the lateral tibial plateaux (Fig.1, zones I & III).

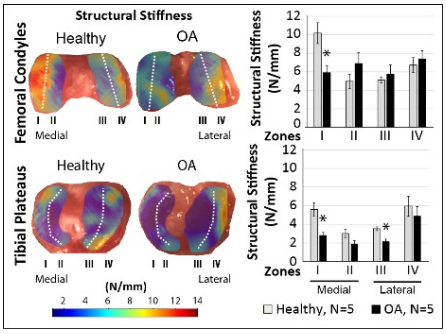

Figure 1: Mapping and quantification of structural stiffness at 10 µm indentation on healthy and OA mice (= p<0.05).*

DISCUSSION

This study shows that this automated indentation technique can map the mechanical properties of murine knee joints. The stiffness mapping of healthy mice shows similar distribution patterns to those previously observed for larger species (horse, sheep and rat) (Sim 2013a,b). In OA mice, regions identified with lower structural stiffness were at sites reported to develop OA in the STR/ort strain (Walton 1977). This will be corroborated by ongoing studies, using histology. These results suggest that indentation mapping can be used in mice to identify or characterize OA affected articular surfaces and potentially test the efficacy of drugs aiming to inhibit cartilage degradation or promote healing in OA.

References

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