INTRODUCTION: Joint instability caused by anterior cruciate ligament (ACL) deficiency is a known risk factor for posttraumatic osteoarthritis (OA). It has also been reported that there is a significant correlation of ACL and cartilage degeneration at end-stage OA in knees without trauma history. However, the intrinsic aging-related changes in the ACL and their relationship with changes in cartilage at earlier stages of OA have not been analyzed in human joints.

The aim of this study was to investigate the types and temporal sequence of aging-related ACL changes and establish the correlation with cartilage lesion patterns at all stages of OA development in human knee joints without prior joint trauma.

MATERIALS AND METHODS: Human knee joints were obtained at autopsy with approval of the Scripps Human Subjects Committee. In this study 120 human knee joints were analyzed and none of the donors had a history of knee joint trauma. There were 30 male donors and 35 female donors with mean age of 66.1 years (range 23-92 years).

Tissue grading: Macroscopic grading of all cartilages was performed using a modified Outerbridge grading system and the ICRS knee map by dividing the cartilage into several compartments: 3 areas in the trochlea, and 9 areas each in each femoral condyle and tibial plateau. For each area, a score ranging from 1 to 4 was assigned and total compartment and total knee cartilage scores were calculated. The total knee cartilage scores range from 39 (normal) to 156 (maximum severity).

Statistical analysis: Spearman’s nonparametric correlation coefficient r was computed when comparing continuous and ordinal variables, or two ordinal variables. 95% confidence intervals (CI) for the Spearman rank correlation coefficients were determined from percentiles of 1000 bootstrap samples.

RESULTS: Relationship between ACL pathology, aging and OA

On macroscopic examination 68 knees had normal, 40 abnormal and 12 ruptured ACLs. ACL histological scores increased with aging (r = 0.42, 95% CI 0.23 to 0.57) and synovial sheath score also increased with aging (r = 0.41, 95% CI 0.24 to 0.54). We compared the total ACL score with summed cartilage scores to determine the relationship between ACL and cartilage degeneration. ACL degeneration correlated with cartilage degeneration, especially in the medial compartment of the knee joint (Fig.1).

To test if histological ACL changes can occur before cartilage degeneration, we investigated the correlations between each histological ACL grade and each cartilage grade (Fig.2). There were no normal ACLs in knees with Grade III or IV cartilage (moderate and severe OA knee group). However there were not only normal ACL but also degenerated ACL in Grade I (normal knee group). This result suggests ACL degeneration occurs before cartilage degeneration at least in a subpopulation of individuals.

DISCUSSION: Based on the relatively large sample available in this study for histological analysis of ACL, there is a general association between ACL degeneration and aging and between degeneration of ACL and cartilage. Furthermore, there are subpopulations where ACL changes may precede or initiate cartilage damage, whereas in other subsetting the ACL changes occur simultaneous or subsequent to cartilage lesions. Subsets can also be differentiated based on the degree of inflammation and on the type of cellular change within the ACL.

SIGNIFICANCE: This is the first study to address ACL changes and their relationship with cartilage degradation in human knee joints across the entire adult age spectrum and at all stages of OA development.


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