Common and Early Cartilage Degradation Patterns in Aging and Osteoarthritic Human Knees  
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Introduction  
A better understanding of early tissue degradation patterns in the aging knee can help to find new targets for osteoarthritis (OA) prevention and treatment. The objective of this study was to identify common and early morphologic patterns of cartilage degradation during human joint aging, and to establish their correlation with changes in anterior cruciate ligament (ACL), meniscus, and synovium.

Methods  
The 130 human knees (67 donors, age range 23–96), obtained from tissue banks, were divided into eight age groups: 21–30 (n=8), 31–40 (n=6), 41–50 (n=18), 51–60 (n=21), 61–70 (n=22), 71–80 (n=20), 81–90 (n=26) and >91 (n=9). All cartilage compartments were macroscopically assessed according to the ICRS mapping system by using a modified Outerbridge grading system. 1,2 (Fig. 1) Menisci and ACL were evaluated macroscopically and by histopathology. 1,4 Synovium histopathology was assessed using a modified Krenn grading system for chronic synovitis.5 Osteophytosis was macroscopically assessed.

Results  
We found a strong correlation between cartilage, meniscus, and ACL degradation with aging. The earliest cartilage lesions were detected in the central area of the lateral tibial plateau that is not covered by the meniscus, followed by changes in patella and trochlea.

Cartilage degradation in the medial femoral condyle appeared later than in the tibia plateau but progressed rapidly to become the most severely affected among all articular surfaces. (Fig.2) On the other hand, degradation in the lateral femoral condyle progressed less rapidly in all age groups. In the lateral tibio-femoral joint (TFJ), more knees had a higher tibial than femoral average grade at all ages. This pattern was similar but reversed with aging in the medial TFJ. Degradation of the meniscus-covered tibia surface correlated with increased meniscus degradation. A common macroscopic pattern (33%) was degradation in the tibia and meniscus with a normal-appearing femoral condyle. In 14%, we found degradation in the tibia while meniscus and femoral condyles were normal. In 18%, we found a macroscopically normal meniscus while there were degenerative changes in tibia (uncovered portion) and femoral condyle. ACL scores increased with cartilage degradation at all stages of OA development and correlated with cartilage as well as meniscus degradation, especially in the medial compartment. Moderate and severe OA groups showed significantly higher ACL substance scores than the minimal/mild OA groups. Synovitis correlated with cartilage degradation and the presence of osteophytes. In our donor population, osteophytes were always accompanied by synovitis. (Fig.3)

Discussion  
By examining younger age groups, we were able to identify early patterns of cartilage degradation. Our data suggest that in younger subjects the lateral tibial plateau shows the earliest and most severe degradation. Contrary to the notion that the medial TFJ compartment in severe OA is most affected, we found that the lateral tibia plateau is affected the earliest. The uncovered part of the tibia plateau degenerated first, followed by early surface degradation in the inner rim of the menisci. Degradation of the covered tibia region increased with cumulative meniscus degradation, supporting the protective role of menisci. This cross-sectional study emphasizes the importance of interaction of the different joint tissues in OA initiation and progression and defines specific regions in the joint for future studies on biomechanical and cellular factors that determine early stages of OA initiation to reveal novel targets for preventing or delaying OA.

Fig. 1 ICRS Mapping system according to Brittberg et al.

Fig. 2 Overall average grades were highest for the lateral tibia in the age group 31-40. In the age groups over 40 years the patella and trochlea (PFJ) show the highest overall average scores.

Fig. 3 Significant correlations between total cartilage knee score and the appearance of synovitis and between osteophytes and synovitis.

References  

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