Relationship between thinning of articular cartilage due to endochondral ossification and osteoarthritis

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INTRODUCTION:
In non-decalcified specimens, we detected the subchondral bone plate (Subcho.BP) divided into two layers of non-osteocyte and osteocyte region. In addition, several columnar alignments of chondrocytes were present in the non-osteocyte layer. Our purpose of this study is to verify the detailed mechanism of articular cartilage degeneration and thinning in osteoarthritis (OA). Our hypothesis is that articular cartilage (AC) thinning is due to endochondral ossification and to the resulting thickening of the non-osteocyte layer of the Subcho.BP. These are associated with the onset and progression of OA.

METHODS:
Age-related changes were evaluated in the thickness of AC, and both of non-osteocyte and osteocyte layer of Subcho.BP in non-decalcified specimens of Sprague Dawley (SD) rats at each month up to 18 months (n=8/group). The correlation was evaluated between thickness of radiographic sclerosis and those of the non-osteocyte and osteocyte layer of Subcho.BP in non-decalcified specimens, and their relationship to the onset and progression of OA was investigated. Age-related changes were also quantitatively evaluated by measuring cartilage morphology of articular cartilage and bone morphology of subchondral bone (epiphysis) and metaphysis.

RESULTS SECTION:
After 6 months of age, the thickness of AC decreased, while Subcho.BP thickness (Subcho.BP.Th) increased in aging rats, along with increasing angiogenesis in Subcho.BP. Cartilage morphometry showed that the presence of empty lacunae and hypocellularity in superficial and middle layer with age, while both hypertrophic chondrocytes and empty lacunas in deep layer were increased. This was similar to chondrocyte differentiation during growth but differed in that it was accompanied by apoptosis. Bone morphometry showed that bone metabolic turnover decreased from 6 to 18 months of age, however, increasing bone formation in the epiphysis at 18 months of age compared to the metaphysis. Subchondral bone OA score increased earlier than cartilage OA score with aging. There is a positive correlation between the thickness of radiographic sclerosis and the Subcho.BP.Th in histology, especially in the non-osteocyte layer (r=0.765, p<0.001).

DISCUSSION:
Previous studies reported that endochondral ossification of AC does not progress after maturation due to lack of blood supply. However, in our results, angiogenesis from the subchondral bone promoted chondrocyte differentiation in the AC accompanied by apoptosis, resulting in thinning of the AC and thickening of Subcho.BP. This was the same as endochondral ossification during growth except for apoptosis, and was strongly correlated with osteosclerosis in radiographic, suggesting that it is a factor of osteosclerosis in OA.

SIGNIFICANCE/CLINICAL RELEVANCE:
The endochondral ossification of AC may continue to progress with age, even post-6M SD rats, suggesting an association with osteosclerosis in OA.