Subregional Analysis of Tibial Cartilage Changes in Persons with Knee Osteoarthritis and Malalignment

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Introduction:

Magnetic resonance imaging (MRI) is ideally suited for visualization of articular cartilage and other synovial joint tissues in osteoarthritis (OA), with no other imaging modality displaying similar abilities [(1)]. Cartilage loss (thinning) is considered the hallmark of OA, with MRI having been successfully used to measure disease progression, by determining cartilage volume changes over time [(2,3)]. The progression of cartilage changes, however, is still low, and presumably not all regions of the cartilage plate are affected to the same degree.

Objective:

To determine the progression of cartilage loss (thinning) in various anatomical subregions of the femoro-tibial compartment of the knee joint over a period of two years in persons with knee osteoarthritis and various degrees of knee alignment (neutral, varus, valgus). To test the hypothesis that certain anatomical subregions display a higher rate of cartilage thinning than others.

Methods:

A community-recruited cohort with mild to moderate knee OA (n = 86, age 72 ± 9 years [mean ± SD], 72% women) had alignment measurement by full limb x-ray. 38 participants had neutral alignment (-2° to +2° knee angle), 28 had varus (> 2°), and 20 valgus malalignment (<-2°). A coronal FLASHwe MRI sequence (1.5 x 0.31 x 0.31 mm^3 resolution) was acquired at baseline and approximately two years later. Segmentation was performed by tracing the total subchondral bone (tAB) and cartilage surface area (AC) throughout the medial (MT) and lateral tibia (LT)[(4)]. Baseline and follow up scans were processed in parallel in the same session, with readers blinded to acquisition order. Cartilage thickness (including denuded areas as 0 mm = ThCtAB[(5)]) was determined for the total medial and lateral tibia cartilage plates as well as for central, external, internal, anterior, and posteror subregions, using proprietary software (Chondrometrics, Ainring, Germany). The central tibial area was designed as an ellipse around the center of gravity covering 20% of the tAB, based on the individual shape of each tibial plateau. Other subregions in the tibia were defined by an anatomical coordinate system, cutting the connecting plane between the MT and LT center sof gravity at 45° angles, respectively (Figure 1).

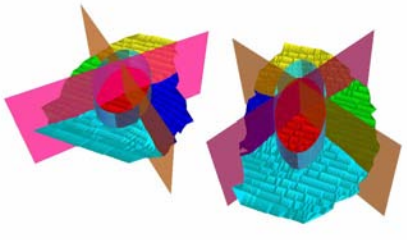
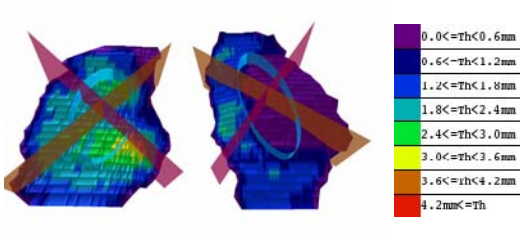


Figure 1: Graph showing the subdivision of the tibial subchondral bone in central (red), external (green), internal (blue), anterior (turquoise) and posterior (yellow) subregions (left), and the cartilage thickness distribution in the tibia (purple = denuded area) , with the anatomical subregions displayed.



Results:

In the persons with neutral alignment, annual cartilage thinning was -0.9 ± 2.6% in the medial and-1.2 ± 4.3% in the lateral tibia. Medially, changes were highest in the external subregion (-1.9 ± 6.0%) and were -1.0 ± 3.0% in the anterior, -0.8 ± 3.2 in the central, -0.7 ± 4.4% in the posterior, and -0.2 ± 2.5% in the internal subregion. Laterally the highest changes were observed centerally (-1,5 ± 5,9) and internally (-1.5 ± 4.8) and were -1.1 ± 3.8% in the anterior, -1.0 ± 6.6% in the posterior, and -1.0 ± 0.6% in the external subregion. In persons with varus malalignment, changes for the total tibial plate were higher medially (-3.0± 3.3%) than laterally (-1.1± 1.6%). Medially, the external subregion displayed the highest changes (-5.4 ± 8.4%) and changes were -3.8 ± 5.8% in the central, -2.6± 5.3 % in the anterior, -2.5± 6.0% internal and -2.0 ± 4.7% in the posterior subregion. In persons with valgus malalignment, changes for the total tibial plate were higher laterally (-2.9 ± 4.6%) than medially (+0.7 ± 2.4%). Laterally, the central subregion displayed the highest change (-4.9 ± 6.0%), with changes being -4.7 ± 5.4% in the internal, -2.7 ± 9.0% in the external, -1.3 ± 6.4% in the posterior, and -0.8 ± 7.8% in the anterior subregion.

Discussion and Conclusions:

The changes in cartilage thickness throughout total tibial cartilage plates were relatively low, but were higher in the stressed versus non-stressed compartment in persons with varus and valgus malalignment. As expected, certain tibial subregions display a higher rate of change than others, with the external and central subregions tended to display higher rates of cartilage thinning than the anterior, posterior, and internal tibial subregions.

References:

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