

Morphological analysis of three-dimensional MR images of patellofemoral joints in asymptomatic subjects

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INTRODUCTION: Patellofemoral (PF) osteoarthritis (OA), like medial femorotibial (FT) OA and lateral FTOA, is a subset of knee OA [1]. The prevalence of PFOA has been studied anatomically, radiographically, and by magnetic resonance imaging (MRI) [2]; however, the existing methods for analyzing PFOA are limited. One technique that has the potential to resolve these limitations is three-dimensional (3D) MR image analysis. Using this method, we previously reported a positional relationship between the medial tibial cartilage defect and the medial meniscus by organizing the cartilage defects shown in the 3D MR images in order, from smallest to largest [3]. The cohort data used in that analysis was The Kanagawa Knee Study. We considered that the availability of 3D MRI data for this cohort could enhance the understanding of the pathogenesis of PFOA by elucidating the onset and progression of asymptomatic PFOA. Our purpose was to clarify the frequency, localization, and morphological progression of PFOA by observing 3D MR images from a cohort population.

METHODS: This study was approved by the Medical Research Ethics Committee of TMDU, and written informed consent was obtained from all subjects. The subjects were 561 volunteers (277 females and 284 males) aged 30 to 79 years. They were current and former desk workers with no history of hospital visits for lower extremity symptoms for more than 3 months. The MRI system (Achieva 3.0TX) was used at 3.0 T with 16-channel coils. The sagittal plane of the knee joint was acquired to obtain both a fat-suppressed spoiled gradient echo sequence (SPGR) image and a proton density-weighted (PDW) image (Fig. 1A, B). The software used for the MRI analyses was a 3D image analysis system volume analyzer (SYNAPSE VINCENT 3D, Collaborative version) (Fig. 1C-F). Inner margins of 5 mm of the original or predicted original patellar cartilage are set as the region of interest (ROI) (Fig. 1C). The software also automatically computed a “cartilage area ratio,” which represented the ratio of the cartilage area to the total area of the ROI. A cartilage defect area with the center located in the medial 2/5 of the patellar cartilage area was classified as a medial type, while one located in the lateral 3/5 of the patellar cartilage defect area was classified as a lateral type (Fig. 1D). A patellar cartilage defect that did not extend to the boundary of the original cartilage was classified as a confined defect, while a defect that extended to the boundary of the original cartilage was classified as an unconfined defect. The difference in the population proportions between medial lesions and lateral lesions in the patellar cartilage was examined by “hypothesis testing for the difference in the population proportions” using the BellCurve software for Excel. A value of $p < 0.05$ was considered statistically significant.

RESULTS: Cartilage defects in the patella were detected in 37 subjects (6.6%). Medial lesions (4.6%) were significantly more frequent than lateral lesions (2.0%) ($p < 0.01$) (Fig. 2, Number of patella cartilage defects from 3D MRI). For both medial and lateral lesions, the patellar cartilage defects were divided into confined type and unconfined type. The 3D MR images showed femoral cartilage defects along the proximal or medial/lateral edge (Fig. 3, blue/green arrow), and defects at the center of the femoral trochlear cartilage (Fig. 3, orange arrow).

DISCUSSION: Our results are lower than previous reports [2], probably because the definition of cartilage defect is full cartilage thickness loss with 3D MR images, and because the subjects were current and former desk workers with no history of hospital visits for lower extremity symptoms for more than 3 months. Medial lesions were significantly more frequent ($p < 0.01$) and the patellar cartilage will be more susceptible to OA on the medial side than on the lateral side. The 3D MR images in decreasing order of the cartilage area ratio suggests that the patellar cartilage defect initiates at the center of the medial/lateral facet and that if environmental factors lower the cartilage area ratio, the defect may extend to the center and then further distally and medially/laterally.

SIGNIFICANCE/CLINICAL RELEVANCE: The 3D MR images can easily determine PF morphology and cartilage defect location, making them useful in understanding the pathophysiology and etiology of PFOA.

REFERENCES: [1] Hinman, R. S. et al. *Rheumatology (Oxford)* 2007. [2] Hart, H. et al. *Br J Sports Med* 2017. [3] Katano, H. et al. *Sci Rep* 2022.

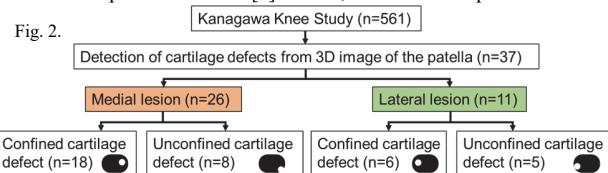
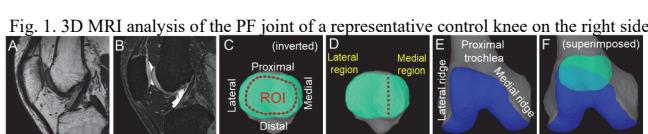


Fig. 3. Cartilage thickness mapping

