ID: 523

Title: Measurement of Articular Cartilage Thickness Using a 3D Image Reconstructed from B-mode Ultrasonography Mechanical Scans -Comparison with MRI-derived Data-

Abstract: The purpose of this study was to develop a method to measure 3D articular cartilage thickness at the femoral condyle using B-mode ultrasonography (US) and to compare results with 3D measurements using MRI to clarify the feasibility of US in clinical evaluations of articular cartilage. Subjects comprised 2 healthy male volunteers (age, 37 and 59 years) and 2 male patients with knee osteoarthritis (age, 73 and 81 years). A B-mode 10.0-MHz linear ultrasound probe (UST-5411; Aloka, Tokyo, Japan) connected to an ultrasound device (Prosound alpha 10; Aloka) was attached to a probe scanner stabilized by a holding arm, allowing the ultrasound probe to move along the surface of the flexed knee. The base of the holding arm was rotated by a gear and data on angle of rotation of the arm was transferred to the ultrasound device by an encoder. Scans with angle data were recorded. The medial surface of the right knee of each participant was scanned using the ultrasound probe with the knee flexed at 120 degree. The range of the angle of probe rotation for the arm was 0-80 degree and the US B-mode images (total, 101 images) were acquired every 0.8 degree. System settings were optimized to image the cartilage surface. Image and position data were imported to the originally developed software and slice images were aligned in 3D in the proper position. Parallel slice images were then created using the multiple plane reconstruction method and imported to the 3D model creation software (Mimics; Materialize, Leuven, Belgium). Cartilage area was extracted in each image and a 3D cartilage model was created from the extracted cartilage area. MR images of the knees were acquired using the sequence previously described from the MRI device (Achieva 3.0T X-series; Philips, Eindhoven, the Netherlands). DICOM data from MRI were imported to Mimics and a 3D cartilage model was created after extraction of cartilage area in each image as similarly done for US. The 3D data for 3D cartilage models from US and MRI were imported to 3D inspection software (Rapidform XOV; INUS Technology, Seoul, Korea) and aligned using the point registration method. Cartilage thickness was determined at 400 points 1 mm apart from one another in the US model (Tc-US) and the MRI model (Tc-MRI). Linear regression analysis was performed and Pearson's coefficient of correlation was used to compare Tc-US with Tc-MRI. Tc-US correlated significantly with Tc-MRI in all participants ($p<0.001$, each). Pearson's coefficient of correlation tended to be slightly higher in volunteers than in patients with osteoarthritis. This is the first study to clinically measure Tc using a 3D US cartilage model. Our results show that, like MRI, Tc-US measurement using 3D models also allow accurate measurement of Tc, in both healthy individuals and patients with osteoarthritis.