

IS COMPLETE SEGMENTATION OF THE OAI KNEE MRI FEASIBLE?

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INTRODUCTION: Complete analysis of the Osteoarthritis Initiative (OAI) data has been limited by the task of quantifying the approximately 50,000 knee MRI in the multi-visit study with 4,769 participants.

OBJECTIVE: To investigate the feasibility of fully automatic, computer-based cartilage segmentation on a large OAI sub-population, and to validate the volume quantifications against independent measurements from Chondrometrics and VirtualScopics provided by the OAI.

METHODS: The knee MRI were acquired on a Siemens 3T Trio scanner using a sagittal 3D DESS WE sequence (25° flip angle, 16ms RT, 4.7ms ET, .36x.36x.7 mm voxels, scan time 10 min). The analysis population of 1436 knees was selected as those with publicly available year 0 cartilage volume scores from Chondrometrics including all OAI projects (excluding two with missing laterality). They had age 61±9 years, BMI 29±5, with 41% women. 78% of the knees were right knees. Their Kellgren and Lawrence grades were distributed with 16%, 10%, 39%, 30%, and 5% at KL0-4.

The KneeIQ segmentation framework from Biomediq combining multi-atlas registration with a multi-structure voxel classifier was trained and validated on baseline MRI with cartilage segmentations provided by OAI courtesy of iMorphics (44 for training and 44 for validation). For each knee, cartilage volumes were quantified for five compartments: patellar and medial/lateral tibial/femoral cartilages. The quantifications were validated against volume (VC) scores provided by OAI courtesy of Chondrometrics (Eckstein, Wirth) for tibial compartments (where all agreed on compartment definitions). The volume scores agreement were evaluated by the linear correlation coefficient (r) and the median of the deviation from the median on the relative differences (MM).

RESULTS: On the iMorphics validation set ($n=44$), the segmentation accuracy given as Dice volume overlap was 0.74 for patellar cartilage and between 0.81 and 0.87 for the four tibio-femoral compartments. The linear correlations were between $r=0.90$ and $r=0.96$. The tibio-femoral compartments had MM between 5% and 6% and the patellar compartment had MM 9%.

The correlations r and MM for the medial and lateral tibial cartilage volume scores were as in the table. For each comparison five numbers are given: number of knees included, r medial/lateral, MM medial/lateral.

	Biomediq (fully automatic)			iMorphics (semi-automated)			Chondrometrics (manual)		
	N	r	MM	n	r	MM	n	r	MM
Biomediq				58	.95/.96	5/5	1436	.91/.90	8/9
iMorphics	58	.95/.96	5/5				58	.92/.96	6/7
Chondrometrics	1436	.91/.90	8/9	58	.92/.96	6/7			

CONCLUSION: We presented results including fully automatic segmentation of 1436 OAI knee MRI. The results confirmed previous studies showing high correlations between different segmentation methods. However, the typical volume deviations between 5-9% also demonstrated that measurements from different methods should not be pooled. Therefore, the feasibility of complete segmentation of all OAI knee MRI relies on a single, fully automatic method (and a large computer).

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