IS COMPLETE SEGMENTATION OF THE OAI KNEE MRI FEASIBLE?

Erik B. Dam
Biomediq, Copenhagen, Denmark; and
The D-BOARD European Consortium for Biomarker Discovery

Objective

The Osteoarthritis Initiative (OAI) has approximately 50,000 knee MRI from the 4,769 participants. Comprehensive non-committed epidemiological research relies on automated analysis.

Methods

We analyzed the 3D DESS sequence (Siemens 3T Trio scanner, sagittal 3D DESS WE sequence, 25° flip angle, 16ms RT, 4.7ms ET, 0.36x0.36x0.7 mm voxels, scan time 10 min) using a fully automatic segmentation framework combining multi-atlas registration and voxel classification (KneeIQ, Biomediq). The method was trained on 44 manual annotation from iMorphics provided by OAI.
The inter-method agreements were evaluated by the linear correlation coefficient (r) and mean relative volume difference (%).
The analysis included all scans with public OAI volume quantifications from iMorphics, VirtualScopics, or Chondrometrics
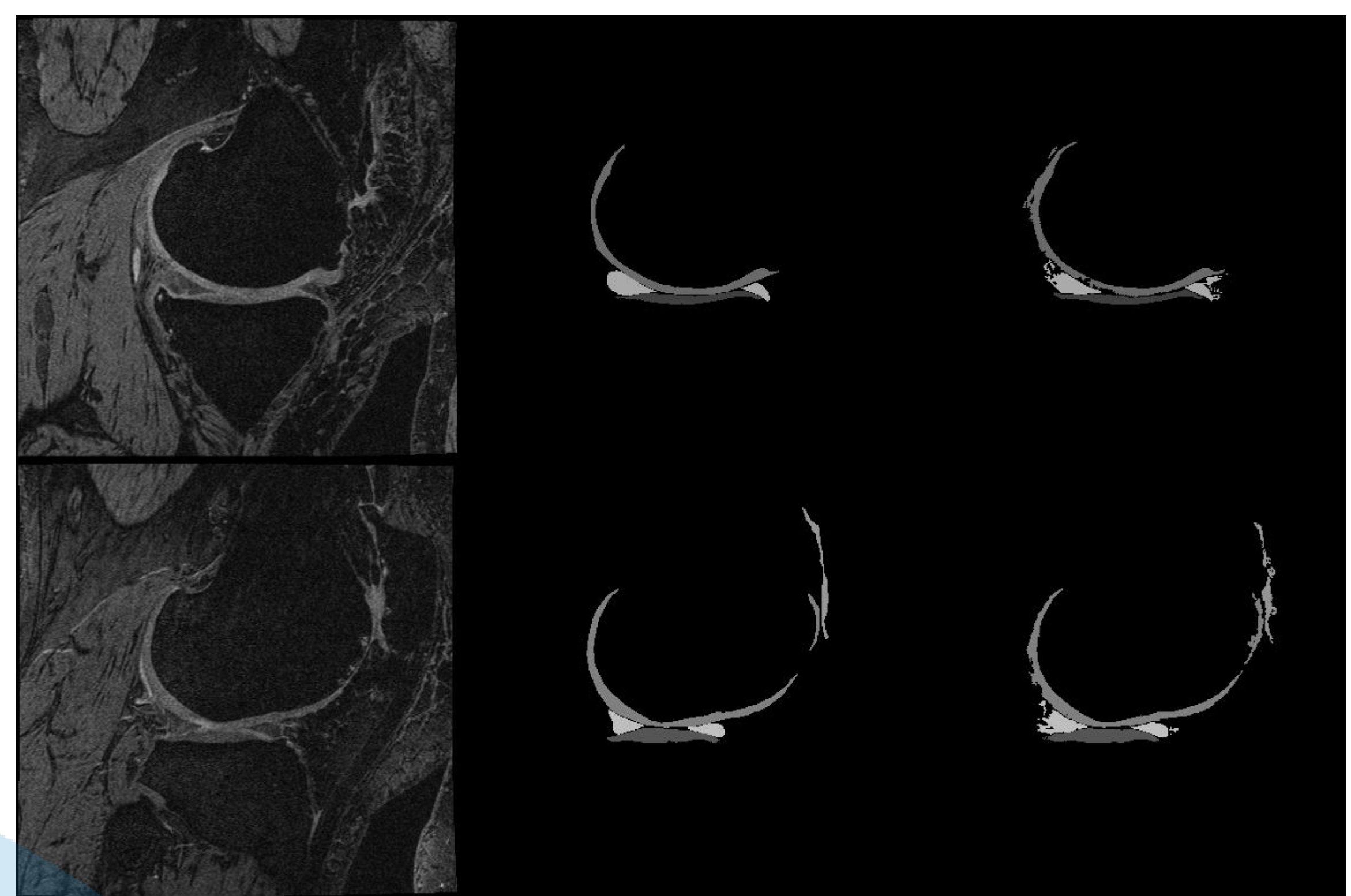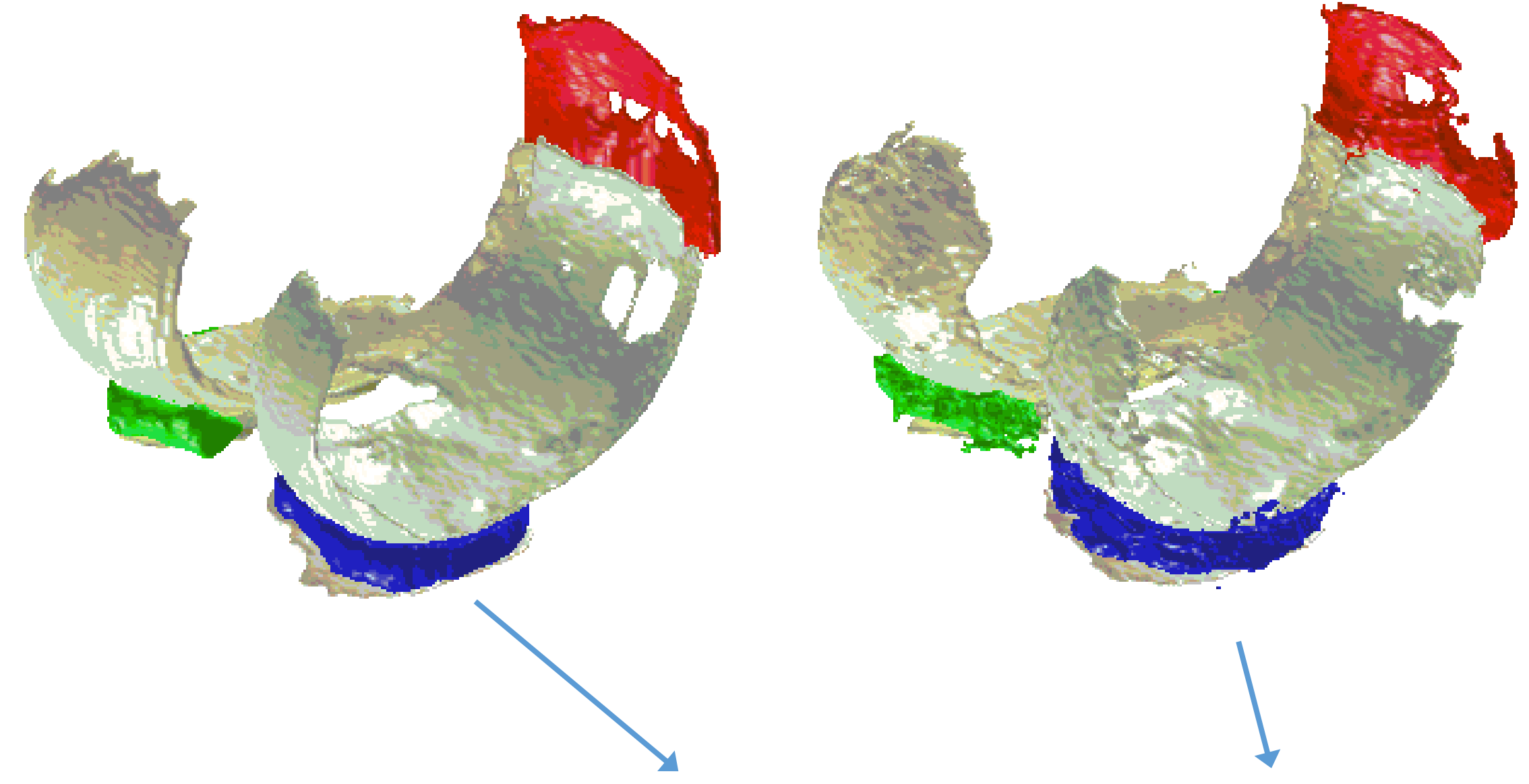

Manual (left) and automatic (right) segmentations visualized in 3D including tibial, femoral, and patellar cartilages and menisci.

Scan slice (left), manual outlines (center), and automatic segmentation (right) through center of medial (above) and lateral (below) tibial cartilages for validation scan.

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 medial/lateral tibial/femoral cartilage compartments.
Each method comparison in the table shows number of knees (n), r, and relative difference for medial and lateral tibial cartilages.

	iMorphics (semi-manual)		VirtualScopics (semi-automatic)		Chondrometrics (manual)	
Biomediq (automatic)	n=88 0.94 +5%	0.96 +4%	n=150 0.94 -1%	0.95 -1%	n=1436 0.91 +4%	0.90 +14%
iMorphics			n=88 0.93 -5%	0.97 -5%	n=58 0.92 +1%	0.96 +8%
VirtualScopics					n=95 0.95 +8%	0.96 +16%

Conclusion

The inter-method comparison were not using identical sub-populations and not KL/age matched. Even so, the results confirmed previous studies (Schneider, OAC 12), generally showing high correlations (r>0.9) between different segmentation methods. However, visual inspection reveals that Biomediq segmentations often include more cartilage around the compartment periphery. The absolute volume deviations 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 fully automatic method (and a large computer).