DIAGNOSIS OF OA BY AUTOMATIC QUANTIFICATION OF INCONGRUITY FROM KNEE MRI

BIOMEDIQ
Biomedical Image Quantification

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Introduction

Biomechanical factors play a vital role in the pathogenesis of OA. Incongruity may be an important factor responsible for the initiation and progression of OA in the load-bearing joints.

We investigated whether medial tibio-femoral incongruity computed automatically from MRI could be appropriate as a diagnostic marker of OA.

Methods

1. Demographics & Image aquisition

- The study population consisted of 159 subjects with 48% female.
- The age and BMI of the subjects were 21-82 years and 18-38 (kg/m^2).
- Radiographs were acquired to grade the severity of OA by the KLG.
- The MRI scans were acquired using an Esoate C-span scanner at 0.18T (40^0 flip angle, 50 ms repetition time and 16 ms echo time).

2. Incongruity quantification

- Contact area (CA) of the tibio-femoral compartment was estimated by employing the voxel width (0.7mm) as threshold.
- The point-by-point incongruity (dimensionless number) was quantified over CA as the inverse mean of the distance between local normal vectors scaled by signed curvature along local principal knee motion.

3. Statistical analysis & Cross-validation

- The precision of incongruity was quantified on 30 scan-rescan pairs as Root mean squared coefficient of variation (RMS CV).
- The ability of incongruity to separate healthy from OA was quantified as area under ROC curve (AUC).
- The parameters in the quantification (curvature scale and iteration number in mean curvature flow) were optimized for best AUC on train sub-set and evaluated on validation sub-set.
- The process was repeated 100 times and the resulting median scores on the validation sub-set were reported.

Results

- The precision of the incongruity measure was 7.7%.
- The incongruity map for a healthy knee is shown in the figure 1 (blue is good and red is bad).
- The ability of the incongruity to separate healthy (KL 0) and early OA (KL 1) was significant with AUC 0.64 ($p < 0.01$).
- The ability of the incongruity to separate KL (0-1) and KL > 1 was significant with AUC 0.71 ($p < 0.0001$) and the corresponding cross-sectional separation was also shown in the figure 2.

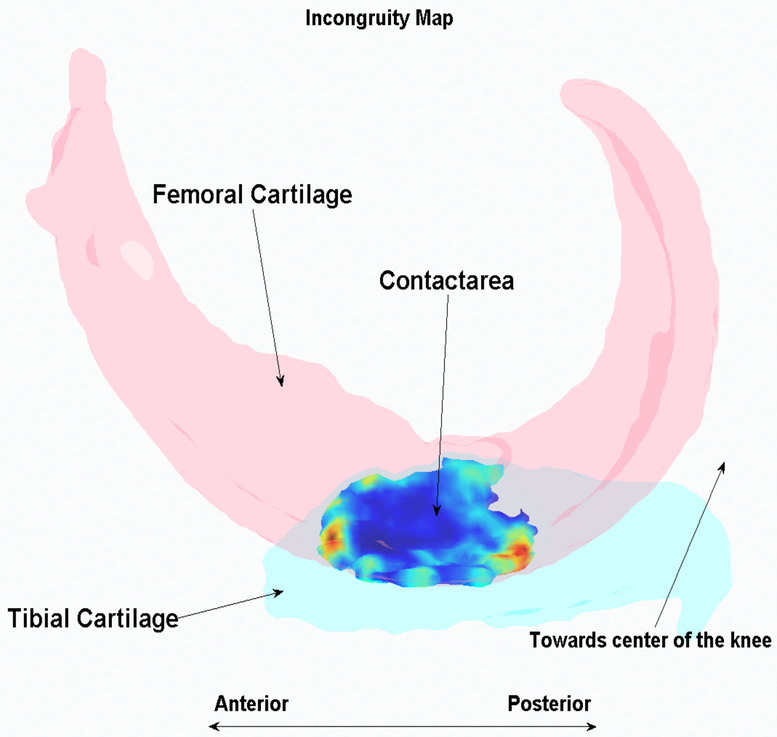

Figure 1: Incongruity map for a healthy medial tibio-femoral joint used in the study.

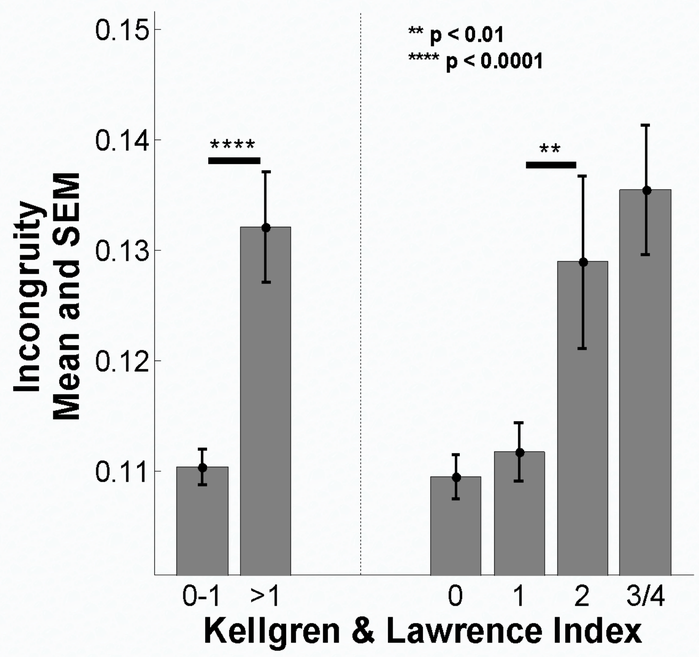

Figure 2: cross-sectional separation of healthy and different KL based on incongruity values.

Conclusions

We present a method to quantify the medial tibio-femoral joint congruity automatically from MRI. From the results, we conclude that the incongruity marker separated healthy from early OA with statistical significance.

In general, the healthy knees were less incongruent than OA knees in the medial tibio-femoral compartment.

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