FINDING DISCRIMINATIVE REGIONS THAT OPTIMALLY SEPARATE HEALTHY AND OSTEOARTHRITIS KNEES

BiomedIQ
Biomedical Image Quantification

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Introduction

Based on knee MRI, we investigated whether specific regions of the articular cartilage were particularly different between healthy and osteoarthritis (OA) knees; providing evidence for OA to be mainly a focal or a global cartilage disease.

Method

1. Demographics & Image aquisition

- 286 right and left knees from 159 community recruited subjects aged 21 to 81 years were scanned using a Turbo 3D T1 sequence on a 0.18T MRI Esaote scanner.
- Radiographs were acquired to grade the severity of OA by the KLG.
- The knees were divided in two groups, KL=0 (healthy, 144) and KL>0 (OA, 142).
- The medial tibial cartilage compartments were segmented. From the segmented cartilage sheets, average thickness was quantified on a 7x15 grid, aligned for anatomical correspondence.

2. The Dynamic Partitioning Framework

- Given features on a spatially defined grid, the framework initially treats the spatial domain as a single region which is then adaptively partitioned into smaller subregions.
- Each partitioning of the data is chosen in such a way that the best discrimination between two classes of objects is achieved.
- The framework was used to split the cartilage grid into discriminative regions to optimize the separation of healthy and OA knees.
- The process generates a non-negative importance weight for each of the 105 regions.

Results

- The reference ability to separate healthy from OA knees based on thickness was evaluated were all regions were equally important and evaluated in terms of required sample size. The median sample size for the reference experiment was 302.
- For the optimized weight map, the sample size was 122.
- The improvement, in terms of required sample size, was significant, p=1.4*10-18.
- The optimal weight map highlighted a sub-region in the medial tibial cartilage located in the central, external area

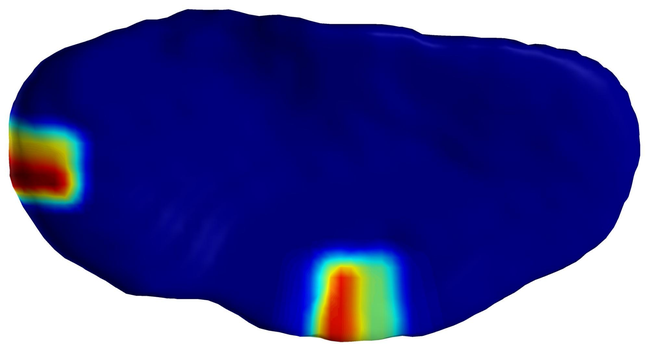

Figure 1: The median weight map projected onto an example of a medial tibial cartilage.

Conclusion

The results demonstrated that there was a focal region providing improved discrimination between healthy and OA knees. The effect in this area could be explained by excess, focal load due to meniscal subluxation and/or varus alignment of the knee. This supports a biomechanically oriented disease progression. Initially, the framework can generate hypotheses for continued research into OA etiology. Eventually, the resulting reductions in sample size could lead to more cost-effective clinical trials.

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