TRABECULAR BONE TEXTURE CHANGES IN OSTEOARTHRITIC KNEES DETECTED BY PLAIN RADIOGRAPHY AND FRACTAL METHODS

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Changes in bone occur in early osteoarthritis (OA) (1,2). Through analysis of X-ray images of trabecular bone (TB), a method for detection of early OA and monitoring of OA progress in knee joints may be developed. Early detection of trabecular bone changes may also be helpful in assessing the role of such changes in initiating OA and in disease progression. We compared trabecular bone texture in OA and control knees as a step in evaluating temporal changes of trabecular bone texture during OA development, and the role of such changes in OA development.

METHODS
We used a matched case-control study design. Plain standardized anteroposterior knee radiographs were taken in the semiflexed weight-bearing position. Individual radiographic features were graded with the OARSI atlas. Case knees (n=26) were from 26 subjects (7 women) with prior medial meniscectomy and radiographic OA Kellgren & Lawrence grade 2 or worse in the medial femorotibial compartment. This grade was given if one of three criteria was met: a grade 1 joint space narrowing (JSN) plus a grade 1 osteophyte, JSN grade ≥ 2 or a sum of marginal osteophyte grades ≥ 2 (3). Each case knee was individually matched by sex, age, BMI and medial or lateral compartment with a control knee from 26 volunteers who did not have any previous knee surgery, meniscal or cruciate ligament injury, and no signs of radiographic OA (JSN = 0 and sum of marginal osteophyte grades = 0 in the tibiofemoral joint). Comparisons between cases and controls were made with paired t-test. Radiographs were digitized and 256 by 256 pixel (12 mm by 12 mm) TB regions of interest (ROI) were manually selected in the tibia immediately under the medial and lateral cortical plates (4). The horizontal distance of the ROI from the tibial border was set to about 1/4 of the compartment width measured from the outer tibial border to a vertical line drawn from the medial or lateral tibial spine. This was to avoid the periarticular osteopenia adjacent to marginal osteophytes, and the fibula. A modified Hurst orientation transform (HOT) method (5) and a modified fractal signature analysis (FSA) (6) were used to calculate fractal dimensions at particular sizes can be calculated in all individual patients. Future work will combine the FSA and HOT methods so that fractal dimensions in OA knees can be explained by thickening of the coarse horizontal bone trabeculae and a reduction in trabecular number (merging of adjacent trabeculae). This implies that OA TB exhibits a lower complexity compared with controls. The increase in anisotropy of OA TB could be associated with an increase in both the connectivity of vertical trabeculae and the thickness of horizontal trabeculae of OA joints. These changes in bone structure may be caused by changes in loading of the OA joint. They may also be associated with changes in biomechanical properties of the bone. We will further characterize these changes and their importance in OA initiation and development.

RESULTS
Compared with controls, TB texture in the medial tibial condyle of OA knees showed significantly (P < 0.01) lower mean values of fractal dimensions calculated in all directions by HOT (MEAN), and calculated in the vertical (VD) and horizontal (HD) directions at trabecular sizes 0.2-1.1mm (Fig. 1).

DISCUSSION
Unlike other fractal methods, the HOT method calculates a 2D fractal dimension for the medial tibial condyle of control and OA knees.

REFERENCES

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