DIFFERENTIAL ACOUSTIC PROPERTIES OF EARLY CARTILAGE LESION IN LIVING HUMAN KNEE AND ANKLE JOINTS

INTRODUCTION
Osteoarthritis (OA), also referred to as degenerative joint disease, is one of the most prevalent chronic conditions, although not all joints are equally affected by the disease. Numerous studies have been performed to determine whether there are histological, biochemical, biomechanical and metabolic differences between knee and ankle cartilage, no studies have tried to prove whether such differences exist in living human cartilage. We previously developed a novel system for evaluating articular cartilage, in which the acoustic properties of articular cartilage are measured by introducing an ultrasonic probe into the knee joint under arthroscopy [1]. However, the point at which this system can detect acoustic differences between two joints is unknown. If our evaluation system can elucidate differences between two joints in vivo, it may provide a means for solving the problem of how the progression of degenerative changes may be enhanced or retarded in living human articular cartilage. The purpose of the current study was to determine whether there were differences in the acoustic properties of early cartilage lesions in the knee and ankle under arthroscopy. Therefore, we used our evaluation system to assess living human articular cartilage with and without visible disruption under arthroscopy.

MATERIALS AND METHODS
Ultrasound measurements. The ultrasonic examination was performed under arthroscopy using an ultrasonic probe and a pulser receiver. The ultrasonic probe was 4 mm in width and 2.5 mm in thickness, and its tip-mounted transducer sent and received a flat ultrasonic wave of 10 MHz center frequency. The reflect echogram from the cartilage was transformed into a wavelet map using wavelet transformation. As quantitative indices on the wavelet map, the maximum magnitude and the echo duration, defined as the length of time that included 95% of the echo signal, were selected. These indices were calculated automatically by a computer.

Articular cartilage assessment. Between January 2000 and March 2005, 28 patients were subjected to ultrasonic evaluation under arthroscopy. All the patients provided informed consent and agreed to have their articular cartilage evaluated using an ultrasonic probe during arthroscopy. In total, 18 knee joints (group K) and 10 ankle joints (group A) were evaluated. The tali of the ankles and the femoral condyles of the knees were used for the ultrasonic assessment. Group K consisted of 9 males and 9 females with an average age of 29.4 years (range: 15-59 years) at the time of the ultrasonic measurement. Group A consisted of 4 males and 6 females with an average age of 24.0 years (range: 16-53 years) at the time of the ultrasonic measurement. There were no significant differences in the age and gender distributions between the two groups. All the articular cartilage was observed under arthroscopy and graded according to the Collins scale as modified by Muehleman et al [2]. After completion of the arthroscopic assessment, the ultrasonic evaluation was performed. Articular cartilage with grade 3 or 4 changes was excluded from the study. The measurement points on the tali or femoral condyles, from grade 0 to grade 2, were selected randomly (10-40 points for each patient; 624 points in group K and 208 points in group A, producing an overall total of 832 points). The reflex echo from each measurement point was transformed into a wavelet map, and the maximum magnitude and echo duration were calculated automatically using this map. Each group was divided into two subgroups, according to the arthroscopic grading (normal: grade 0; lesional: grades 1 and 2). The acoustic properties of the normal and lesional cartilage were compared between groups K and A.

RESULTS
Distributions of the acoustic properties. The data obtained for all the measurement points in groups K and A are shown in Figures 1, in which the echo duration is plotted on the X-axis and the maximum magnitude is plotted on the Y-axis. The distribution pattern of the living knee cartilage data (group K) showed a smooth curve with a steep initial gradient that gradually flattened at the highest value of the echo duration, whereas that of the living ankle cartilage data (group A) showed a spindle-shaped mode along the Y-axis. The distribution of results from ankle cartilage samples (group A) lack the correlation between decrease in maximum magnitude and increase in echo duration as seen in the knee cartilage samples (group K).

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REFERENCES

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