Dark-Field Imaging to Detect Articular Cartilage for Orthopedic Clinical Application

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Plain X-ray radiography has been most available, economical, and frequently utilized for orthopedic surgeons to assess bone and joint diseases. However, plain X-ray has not clearly detected the articular cartilage, because articular cartilage has little X-ray absorption contrast. We have developed X-ray dark-field imaging (DFI) method and achieved the high-contrast and high-spatial-resolution images. In this study, we introduce X-ray DFI using synchrotron radiation at SPring-8 and KEK to depict the articular cartilage under nearly clinical condition.

The shoulder and knee joint amputated from the cadaver, those contained soft tissue such as muscle, fat and skin, was used as the object specimen in order to simulate the real human body. X-ray DFI clearly showed the articular cartilage of both humeral head of shoulder joint and femoral condyle of knee joint, those could never be seen on the absorption contrast images (ordinary plain X-ray imaging technique).

Since clinical treatment for joint diseases may be often selected according to the grade of damaged cartilage, it is of great importance to assess how much the articular cartilage is injured. However, there have been few imaging methods to evaluate the damaged cartilage. Plain X-ray is unable to show the articular cartilage despite of its convenience and its less invasiveness on daily clinical use. Although arthrography with contrast media injected into the joint may be able to detecte the damage of articular cartilage, it can lead to the risk of allergic reaction and joint infection. MRI could be now the only clinical technique to have a potential for representing the articular cartilage, although MRI could not enough show the articular cartilage so far in daily clinical use. We can only evaluate the damage of articular cartilage surgically, such as with arthroscopic inspection.

Our new technique of X-ray DFI achieved the visualization of articular cartilage of the shoulder joint and the knee joint under nearly clinical condition. Although our results are preliminary, in the future DFI technique could provide us with clinically useful assessment for the condition of damaged articular cartilage and the grade of joint disease.

KEYWORDS: articular cartilage, orthopedic surgery, osteoarthritis