INTRODUCTION: Abnormal transmission and attenuation of loads in the knee can result in osteoarthritis and fractures of the tibial plateau etc. Many structures in the knee contribute to the transmission and attenuation of compressive loads. However, the role of the cancellous bone in this process is not well understood. In this study, we measured compressive stress in the cancellous bone of porcine tibia to evaluate the influence of the changing leg alignment and the role of the meniscus and articular cartilage.

METHODS: Materials were fresh-frozen 40 knee joints in 6 month-old pigs. The knee joint was trimmed 10 cm above and below the joint line. All soft tissues were removed except the ligamentous structures and the meniscus. Six mini pressure sensors (diameter 5mm, width 3mm: PS-100KAM; Kyowa-dengyo, Tokyo) to measure compressive stress were inserted into the medial and lateral side of the tibia (subchondral bone, metaphysis and diaphysis). The specimen was mounted on a drop-tower type test machine. The static load was 30 kgf (294 N), and the impact load was applied by dropping an iron bar (length 300mm, diameter 16mm, weight 0.47kg) from 100mm height. The compressive stress under impact loading was measured as the peak of the first shock wave. The test was performed in three alignments (neutral, varus and valgus). Tests were repeated after removing each meniscus and again after removing the articular cartilage on the same side of meniscus removal.

RESULTS: On the medial side, the compressive stress of metaphysis was higher than that of the subchondral bone under both static and impact load in the neutral and varus alignments. Significant difference was found between the subchondral bone and metaphysis in the varus alignment under the impact load. On the lateral side, the stress of subchondral bone was higher than that of the metaphysis under both static and impact load in the neutral and valgus alignments. Significant difference was found between the subchondral bone and metaphysis in valgus alignment under the impact load. After removal of the meniscus, the stress of subchondral bone was the highest on both sides under both static and impact load. Subsequently, the cartilage was removed, whereupon the stress of subchondral bone furthermore increased. In all test series, the stress of diaphysial cancellous bone was the lowest.

DISCUSSION: In the intact knee, the metaphysis showed the highest compressive stress on the medial side and the subchondral bone showed the highest compressive stress on the lateral side. These results were considered attributable to the morphological feature of the proximal tibia. At the level of the subchondral bone, the cross sectional area on the lateral side was smaller than that on the medial side. The cross sectional area of the subchondral bone on the lateral side was similar to that of the epiphysis, although that of the epiphysis on the medial side was smaller than that of the subchondral bone on the medial side. In addition, Medial tibial condyle becomes narrow from the joint surface to metaphysis, while on the lateral side, the cortical shell from the joint surface to the epiphysis is convex, and the area of this region becomes the largest on the lateral side. Therefore, unlike on the medial side, the force may be dispersed before the load reaches the epiphysis. The compressive stress without the meniscus was 2 to 5 times higher than that with the meniscus intact at all measurement levels. These findings demonstrated that the menisci have an important role in load attenuation and force transmission. Therefore, removal of the menisci may affect not only the underlying subchondral bone, but also the cancellous bone far from the articular surface. Our results indicated that the articular cartilage plays less of a role in attenuating or spreading the load than the meniscus, but it still contributes to protecting the underlying subchondral bone.

**Department of Orthopaedic Surgery, Kyoto Prefectural University of Medicine, Kyoto, JAPAN. Kamigyo-ku, Kyoto 602-8566, JAPAN, +81-75-251-5549, Fax: +81-75-251-5841, acltakai@koto.kpu-m.ac.jp

IMPACT LOAD TRANSMISSION OF THE KNEE JOINT

*Fukuda, Y; **Yoshino, N; ***Takai, S; ****Murase, K; *****Ikeuchi, K; ******Tsutsumi, S; *******Hirasawa, Y

+*Department of Orthopaedic Surgery, Kyoto Prefectural University of Medicine, Kyoto, JAPAN. Kamigyo-ku, Kyoto 602-8566, JAPAN, +81-75-251-5549, Fax: +81-75-251-5841, acltakai@koto.kpu-m.ac.jp