Introduction: A joint contracture is often seen in daily examinations, but its pathogenesis has been unsolved. Disadvantages of limited motion of the joints include various degrees of limitation in the activities of daily living. Once the joint contracture is established, it is extremely difficult to regain a full range of motion with vigorous and extensive rehabilitation or even with surgical treatment. (1). Causes of joint contracture are classified into two types of components, arthrogenic and myogenic. (2). Range of motion was still remained restricted even after total extra-articular myotomies, which suggested the arthrogenic components were more important as causes of joint contracture. Among the arthrogenic components, synovial membrane or capsule may be suggested to be a cause of joint contracture. (3). From our previous study, elasticity of the posterior capsule detected by scanning acoustic microscopy was increased after 8 weeks of immobilization. (5). There have been no reports solely evaluating the effects of arthrogenic components and a capsule on the range of motion. The purpose of this study was to evaluate the effect of the posterior capsule on the limitation of extension.

Materials and Methods: Animals: Adult male Sprague-Dawley rats weighing from 380 to 400 g were used. Their knee joints were immobilized at 150° in flexion by rigid internal but extra-articular fixation for various periods (2, 5). Sham operated animals had holes drilled in the femur and tibia and screws inserted but none of them were plated. The immobilized animals and the sham operated animals made up the immobilized group and the control group, respectively. One hundred eight rats (1, 2, 4, 6, 8, 12, and 16 weeks) were prepared for measuring joint angle. Each group was composed of 52 immobilized and 56 control animals. Calculation of a joint angle: To measure the joint angle correctly with reproducibility, we made a special apparatus for taking lateral x-rays of the knees (Figure 1B).

We measured the angle between the longitudinal axis of the femur and a line passing through the center of the ankle joint and the center of the eminence of the tibia. A, The joint angle was defined as an angle between the longitudinal axis of the femur and a line passing through the center of the ankle joint and the center of the eminence of the tibia. B, Schematic illustration of an apparatus to fix the hind limb for taking x-rays. C, Photograph of the posterior capsule after release. The posterior capsule was incised at the insertion to the femoral condyle with a surgical knife. Bilateral femoral condyles appeared after releasing. (Dotted line indicates the cutting line of the posterior capsule)

Statistics: Statistical analysis among groups was performed using the Kruskal-Wallis test, with Bonferroni/Dunn post-hoc multiple comparisons. Differences between the experimental and control groups were compared at each time point by Mann-Whitney’s U test. Data were expressed as mean ± SD. A value of P < 0.05 was accepted as statistically significant.

Results: Limitation in extension: In the immobilized group, limitation in extension progressed gradually over time, which was significantly reduced compared with the control group (Figure 2A).

Influence of the posterior capsule on limitation in extension: After release of the posterior capsule, both the immobilized and control groups gained the angle of knee extension. The acquired angle in the immobilized group was significantly greater than in the control group after 4 weeks and became plateau after 8 weeks (Figure 2B).

Discussion: Measurement of joint angle was simple but indispensable method to evaluate a joint contracture. Range of motion was still restricted even after total extra-articular myotomies and its degree was gradually increased after immobilization, which supported again the arthrogenic components had an important role in making joint contracture. Among the arthrogenic components, the posterior capsule significantly contributes to the limitation in extension.