The role of the posterior cruciate ligament (PCL) in total knee arthroplasty (TKA) remains controversial. The treatment of PCL tear in young athletes is also a controversial matter due to the poor understanding of the biomechanics. These controversies, at least partly, arise from technical difficulties in visualizing the PCL at various angles of flexion. Such difficulties can now be overcome with magnetic resonance imaging (MRI). The purpose of the present study was to analyze the movement of the PCL with particular reference to the anterior cruciate ligament (ACL) and the patella tendon (PT) throughout the flexion arc.

Materials and Methods The subjects were 20 Japanese normal volunteers (all males, mean age of 29.7 years, range, 26-40 years). The left knee of each subject was scanned in an open MRI unit. The sagittal inclinations of the PCL, ACL and PT relative to the longitudinal axis of the tibia were measured. Briefly, 5mm thickness scans traversing the entire knee were obtained in the sagittal plane. Scanning was performed on the knees at neutral rotation through the following steps of knee flexion: Full extension, 15°, 90°, maximum active flexion and maximum passive flexion. The position of maximum active flexion was obtained by instructing the subject to maximally flex his knee and then the position was maintained using an elastic bandage. The position of maximum passive flexion was obtained and maintained by the subject’s body weight as in our previous study. The imaging parameters were 0.5 Tesla and TR: 500 ms, TE: 38 ms, and 256 x 256 scan matrix. Scanning time was approximately 2 minutes and 30 seconds.

From each sequence of scans, images were selected in which the femoral and tibial attachment of the PCL and ACL could be detected. The lines connecting the central position of the femoral and tibial attachment of the cruciate ligaments were drawn and the angles relative to the longitudinal axis of the tibia were measured at each flexion angle. The direction of the patella tendon was determined in the same manner in the most suitable image. The measured angle was expressed as a plus value when the ligament or tendon was anteriorly inclined relative to the tibia (e.g. The ACL showed negative value and the PCL showed positive value in extension.)

Results The actual measured degrees of flexion in the 20 subjects were –2.5 ± 3.3°, 14.7 ± 9.9°, 82.5 ± 7.9°, 129.2 ± 8.1° and 158.8 ± 5.8° respectively (mean ± SD). The appearance of the ACL, PCL and PT were shown in Figure 1.

In extension, the PCL was curved over the intercondylar eminence and appeared relaxed. At 90° flexion, the PCL appeared as a straight bundle suggesting tension showing an average inclination of 24.1 ± 5.1° to the longitudinal axis of the tibia. The PT was essentially parallel (2.9 ± 6.9°) and the ACL had – 55.5 ± 6.1° inclination to the longitudinal axis of the tibia. At maximum active flexion, the PCL then became parallel (3.9 ± 7.4°) to the longitudinal axis of the tibia. When the knee was passively brought into deep flexion, the averaged inclination of the PCL was reversed anterior-posteriorly (-23.0 ± 6.7°) and was curved over the intercondylar notch of the femur. The ACL was almost horizontal over the tibial intercondylar eminence (±80.4 ± 4.5°).

The measured inclinations were shown in Figure 2 and the PCL and PT moved in a corresponding manner within 20 degrees of discrepancy throughout the flexion arc.

Discussion The authors believe this is the first in vivo study to visualize and analyze the movement of the PCL with particular reference to the ACL and PT in living normal subjects throughout the flexion range. The fundamental kinematic role of the PCL should be the maintenance of the joint gap during flexion. The compensatory mechanism of the quadriceps for PCL insufficiency could be explained by the close resemblance in inclination to the tibia. The results of this in vivo study of the PCL have clinical relevance regarding it’s role in total knee arthroplasty and conservative therapy in PCL knee injuries. The results of this study could also be useful in PCL reconstruction surgery to determine the optimum graft position that allows maximum postoperative motion.