INTRODUCTION: The role of the posterior cruciate ligament (PCL) in total knee arthroplasty (TKA) continues to be debated. Currently, cruciate-retaining and posterior-stabilized designs continue to be commonly implanted. Excellent clinical and radiographic results are seen with both designs. Only recently have biomechanical studies been undertaken to explore the PCL’s effects on TKA soft-tissue balancing and flexion-extension gap kinematics. The objective of this in-vitro study is to observe the effects of the PCL on TKA joint loading.

METHODS: Twelve fresh-frozen cadaveric knee specimens were amputated 20cm proximal to the distal femoral condyle and 25cm distal to the tibial plateau. Each femur was rigidly clamped to a frame that fixed the knee at five discrete flexion angles (0°, 30°, 60°, 90°, 100°) while allowing it to remain unconstrained in internal/external rotation and varus/valgus angulation. Cemented cruciate-retaining total knee arthroplasty (Nexgen, Zimmer, Warsaw, IN) was performed on each knee. Traditional bone cutting and alignment techniques were performed to prepare the bones for the implant.

An instrumented tibial load cell (TLC) was inserted into the knee joint. This load cell measured the magnitude of compressive loading as well as position of the centres of pressure in the medial and lateral compartments. Compressive forces on each plate were recorded in the unloaded situation prior to any ligamentous balancing, after coronal and sagittal-plane balancing (PCL-recessed), and after arthroscopic PCL resection (PCL-sacrificed). Valgus knees were excluded from this study, therefore all coronal plane balancing was performed on the medial side. Sagittal-plane balance included recession of the PCL from its femoral origin. All measurements were performed at the five discrete flexion angles.

RESULTS: There were no significant differences in lateral compartment forces. Once the PCL was recessed and sacrificed, there was a trend towards increased lateral compartment forces (Figure 1).

Significantly different medial compartment forces between PCL-recessed and PCL-sacrificed were observed at 30° and 60° (p<0.05). There were also significantly different medial compartment forces at 90° and 100° between pre-balance and PCL-recessed (p<0.05) (Figure 2).

DISCUSSION: It has been reported that PCL-sacrifice will increase flexion gap. A larger flexion gap should decrease compressive loads at 90°. In this study, after recessing the PCL, a significant decrease in medial forces was noted at 90° and 100°. Since the PCL was recessed from its femoral origin, its anterolateral bundle was preferentially sectioned. This bundle has been found to be tighter in flexion than in extension, therefore, its release should decrease loads at these high flexion angles.

Sacrifice of the PCL includes completely dividing the remaining fibers of the anterolateral bundle as well as resecting the entire posteromedial bundle. At these high flexion angles, further improvement in medial loads was not observed with complete resection of the PCL. This is likely due to the lesser contribution of the posteromedial bundle at these angles.

At mid-flexion, however, PCL-recession was not as effective at decreasing medial compartment loads. PCL-sacrifice was required to significantly decrease the forces at these angles. The anterolateral bundle has a relatively small contribution to PCL in-situ forces at these smaller angles. Therefore complete PCL resection, including sacrifice of the posteromedial bundle, was required to unload the joint. As expected, no differences were seen in extension.

ACKNOWLEDGEMENTS: The Canadian Arthritis Network