Limits of movement in the human knee. Effect of sectioning the posterior cruciate ligament and posterolateral structures


Abstract: We applied specific forces and moments to the knees of fifteen whole lower limbs of cadaver and measured, with a six degrees-of-freedom electrogoniometer, the position of the tibia at which the ligaments and the geometry of the joint limited motion. The limits were determined for anterior and posterior tibial translation, internal and external rotation, and varus and valgus angulation from zero to 90 degrees of flexion. The limits were measured in the intact knee and then the changes that occurred with removal of the posterior cruciate ligament, the lateral collateral ligament, the popliteus tendon at its femoral attachment, and the arcuate complex were measured. The cutting order was varied, allowing us to determine the changes in the limits that occurred when each structure was cut alone and the amount of motion of the joint that was required for each structure to become taut and to limit additional motion when the other supporting structures had been removed. Removal of only the posterior cruciate ligament increased the limit for posterior tibial translation, with no change in the limits for tibial rotation or varus and valgus angulation. The additional posterior translation was least at full extension and increased progressively, reaching 11.4 millimeters at 90 degrees of flexion. The progressive increase in posterior translation with flexion was apparently due to slackening of the posterior portion of the capsule, as the translation nearly doubled when the posterolateral structures subsequently were removed. Removal of only the posterolateral extra-articular restraints increased the amount of external rotation and varus angulation. The average increase in external rotation depended on the angle of flexion; it was greatest at 30 degrees of flexion and decreased with additional flexion. At 90 degrees of flexion, the intact posterior cruciate ligament limited the increase in external rotation to only 5.3 degrees, less than one-half of the 13.0-degree increase that occurred at 30 degrees of flexion. Subsequent removal of the posterior cruciate ligament markedly increased external rotation at 90 degrees of flexion, resulting in a total increase of 20.9 degrees. The limit for varus angulation was normal as long as the lateral collateral ligament was intact. When the lateral collateral ligament was cut, the limit increased 4.5 degrees (approximately 4.5 millimeters of additional joint opening) when the knee was partially flexed (to 15 degrees). (ABSTRACT TRUNCATED AT 400 WORDS)