

# An Implantable Transducer for Measuring Tension in an Anterior Cruciate Ligament Graft

Ventura, C.P.; Wolchok, J; Hull, M.L.; and Howell, S.M.

## **Abstract:**

The goal of this study was to develop a new implantable transducer for measuring anterior cruciate ligament (ACL) graft tension postoperatively in patients who have undergone ACL reconstructive surgery. A unique approach was taken of integrating the transducer into a femoral fixation device. To devise a practical in vivo calibration protocol for the fixation device transducer (FDT), several hypotheses were investigated: (1) The use of a cable versus the actual graft as the means for applying load to the FDT during calibration has no significant effect on the accuracy of the FDT tension measurements; (2) the number of flexion angles at which the device is calibrated has no significant effect on the accuracy of the FDT measurements; (3) the friction between the graft and femoral tunnel has no significant effect on measurement accuracy. To provide data for testing these hypotheses, the FDT was first calibrated with both a cable and a graft over the full range of flexion. Then graft tension was measured simultaneously with both the FDT on the femoral side and load cells, which were connected to the graft on the tibial side, as five cadaver knees were loaded externally. Measurements were made with both standard and overdrilled tunnels. The error in the FDT tension measurements was the difference between the graft tension measured by the FDT and the load cells. Results of the statistical analyses showed that neither the means of applying the calibration load, the number of flexion angles used for calibration, nor the tunnel size had a significant effect on the accuracy of the FDT. Thus a cable may be used instead of the graft to transmit loads to the FDT during calibration, thus simplifying the procedure. Accurate calibration requires data from just three flexion angles of 0, 45, and 90 deg and a curve fit to obtain a calibration curve over a continuous range of flexion within the limits of this angle group. Since friction did not adversely affect the measurement accuracy of the FDT, the femoral tunnel can be drilled to match the diameter of the graft and does not need to be overdrilled. Following these procedures, the error in measuring graft tension with the FDT averages less than 10 percent relative to a full-scale load of 257 N.