INTRODUCTION:
Recent studies have shown that fixation of a hamstring graft with a titanium button and polyester tape (EndoButton fixation) in anterior cruciate ligament (ACL) reconstruction can result in relative motion of the graft within the bone tunnel (graft-tunnel motion) under cyclic tensile loading (1). Therefore, an aggressive post-operative rehabilitation may lead to significant graft-tunnel motion that impairs healing of the interface between the graft and the adjacent bone (2, 3). To avoid this problem, a biodegradable interference screw fixation (Biointerference fixation) has been used. However, the amount of graft-tunnel motion in-situ in response to external loads that mimic clinical examinations such as Lachman test should also be quantified. Therefore, the objective of this study was to compare the graft-tunnel motion of a replacement graft between EndoButton fixation and Biointerference fixation during the application of a 134 N anterior tibial load. We hypothesized that the EndoButton fixation would result in a larger graft-tunnel motion than the Biointerference fixation, and the majority of graft-tunnel motion would come from the low stiffness polyester tape in EndoButton fixation.

MATERIALS AND METHODS:
Hind limbs (N=6) of fresh frozen goats were used in this study. Both ACL reconstruction techniques were performed in the same knee using a graft composed of a 5-mm-diameter doubled flexor digitorum tendon. The looped portion of the graft (length of 20 mm), which was placed into the 5-mm femoral tunnel, was secured using EndoButton fixation (EndoButton® with single looped 5-mm-wide EndoButton® Tape, Smith & Nephew) or Biointerference fixation (5.5-mm-diameter Endo-Fix®, Smith & Nephew) in a randomized order. The tibial side of the graft was secured with a spiked washer and a 4.5-mm bicortical screw.

To measure graft-tunnel motion, metallic tendon markers (Marker P and Marker D) were embedded in each strand of the graft at 5 mm and 15 mm from the looped end, and a femoral marker pin of known length was inserted parallel to the femoral tunnel (Figure 1). Lateral radiographs were taken at 60° of knee flexion under 1) no load, 2) a 134 N anterior tibial load applied with a spring scale, and 3) no load again. The radiographic data were processed using a personal computer. The displacement of Markers P and D parallel to the femoral marker in response to the 134 N anterior tibial load was measured and corrected for magnification. The graft-tunnel motion of Markers P and D was obtained by averaging the displacement of the markers in both strands at the proximal and distal regions, respectively. The elongation of distance between Marker P and Marker D. (* indicates p<0.05 when compared to EndoButton fixation).

RESULTS:
In response to the 134 N anterior tibial load, the tendon markers were displaced distally in both fixation techniques. For the EndoButton fixation, the graft-tunnel motion of Marker P and Marker D was 2.0±0.5 mm and 2.4±0.6 mm, respectively, while that for the Biointerference fixation was 0.4±0.4 mm and 0.5±0.6 mm, respectively (Table 1). Thus, the graft-tunnel motion of both tendon markers was approximately five times larger for the EndoButton fixation than for the Biointerference fixation (p<0.05). Further, the elongation of distance between Marker P and Marker D was significantly greater for the EndoButton fixation than for the Biointerference fixation (p<0.05). However, there was minimal elongation of the graft within the femoral tunnel, smaller than 0.5 mm for both fixation techniques. The residual displacement of tendon markers was 0.2±0.3 mm after removing the anterior tibial load.

DISCUSSION:
The results of this study confirm the hypothesis that the graft-tunnel motion for the EndoButton fixation is larger than that for the Biointerference fixation under a 134 N anterior tibial load. In EndoButton fixation, the elongation of the graft accounts for only a small amount of graft-tunnel motion. The polyester tape, the tape-EndoButton and the tape-tendon interface contribute the majority of graft-tunnel motion, approximately 2 mm. In Biointerference fixation, since the graft is directly secured closer to the intra-articular outlet of the femoral tunnel, the graft-tunnel motion is minimized. Thus, in the early post-operative period, clinicians should consider that the fixation technique can have a large effect on graft-tunnel motion before graft incorporation is established, and appropriate rehabilitation programs should be determined based on each fixation technique. The methodology developed and quantitative data obtained can serve as a foundation for the in-vivo evaluation of graft-tunnel motion using the goat-model at successive time periods.

REFERENCES:

ACKNOWLEDGMENTS:
Supported by NIH grant AR39683 and Ms. Jennifer Zeminski.