COMPARISON OF FIXATION STRENGTH AND CONSTRUCT STIFFNESS OF APERFIX™, ENDOBUTTON™, AND INTERFERENCE SCREW ACL FIXATION METHODS

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BACKGROUND: There exists a trend in ACL reconstruction toward soft-tissue grafts in lieu of the traditional gold-standard BPTB grafts. Soft-tissue grafts have been proven to provide lower patient morbidity at the harvest site, making them an attractive option for surgeons performing ACL reconstruction. Recent advances such as AperFix (Cayenne Medical, Inc.) have greatly improved the fixation of soft-tissue grafts. Until the development of the AperFix technology, soft-tissue ACL reconstruction was perceived to have less-than-acceptable fixation strength and higher graft construct laxity.

Fixation strength and stiffness of the construct are the weak links in ACL reconstructions that utilize soft-tissue grafts. Interference screws and cortical buttons have been the gold standard fixation methods for soft-tissue ACL reconstructions, but they both have weaknesses as compared to BPTB ACL reconstruction methods.

METHOD:
Our model consisted of 6-to-8 month old, fresh-frozen bovine femora from a local abattoir, and fresh-frozen human cadaveric quadrulpled hamstring tendon and semitendinosus grafts. Three groups of 10 constructs each were formed to compare the following devices: (1) EndoButton (Smith & Nephew); (2) Interference Screw (Arthrex); and (3) Aperfix (Cayenne Medical). All products were donated by the respective manufacturer. Tendons and femora were thawed to room temperature and cleared of adherent muscle and soft tissue. Limited notchplasty was performed at the native femoral insertion of the ACL to prevent graft impingement during testing. Femoral tunnels were drilled at the site of the native ACL femoral footprint toward the lateral wall of the lateral femoral condyle in standard fashion. Specimens were kept moist with physiologic saline during preparation, graft fixation, and biomechanical testing. All operative procedures were performed by the same surgeon according to manufacturers' instructions and in most cases in the presence of a company representative.

Single load-to-failure mechanical testing was performed on an Instron 1011 test frame, using a 5,000-N load cell operating in the 0-2,000-N range. The custom restraint apparatus allowed degrees of freedom in varus/valgus rotation, anterior-posterior translation, and rotation of the graft relative to the femoral tunnel. Vertical movement of the femur was restrained by a ½-inch

stainless steel pin passing through the femur and the freely-translating mounting cup, which was tilted at 20° to approximate the intact angle of the ACL during the Lachman examination maneuver. After matching the tension in each of the free tendon ends, the soft tissue graft was wrapped in sandpaper and clamped in a compression fixture with interdigitating ridges. The clamp-graft unit was then immersed in liquid nitrogen to solidify the fixation, freezing 2-4 mm of free length tendon adjacent to the clamp. A mean length of 25 mm of graft traversed the clamp-femoral "joint space." The construct was pretensioned at 50 N for 2 min. prior to performing a single load to failure test at 25 mm/min. Crosshead displacement was transduced by an external potentiometric displacement transducer (model TRS, 25-mm range, Novotechnik, Southborough, MA). Force and displacement data were acquired at 10 Hz through an A/D board (model 1208LS, Measurement Computing, Norton, MA) connected to a PC running LabView (v8, National Instruments). Data reduction yielded peak load and stiffness from 300-500 N. ANOVA was applied to test for an effect of device, with post-doc pairwise comparisons by the Mann-Whitney test.

RESULTS

The lowest ultimate load was found for the Interference Screw constructs, averaging 935 N (SD, 147 N; $p<0.05$ vs. the other 3; Table 1). The EndoButton produced the next highest ultimate load at 1311 N. The ultimate load of the Aperfix was 1479 N (261 N). Stiffness values were significantly different: 97.2 +/-38.5 N/mm for AperFix, 62.7 +/-16.4 N/mm for EndoButton; and 58.3 +/-16.4 N/mm for Interference Screw. All comparisons were statistically significant ($p<0.05$), except for EndoButton versus Interference Screw in graft construct stiffness.

TABLE 1. *Fixation Strength (N)*

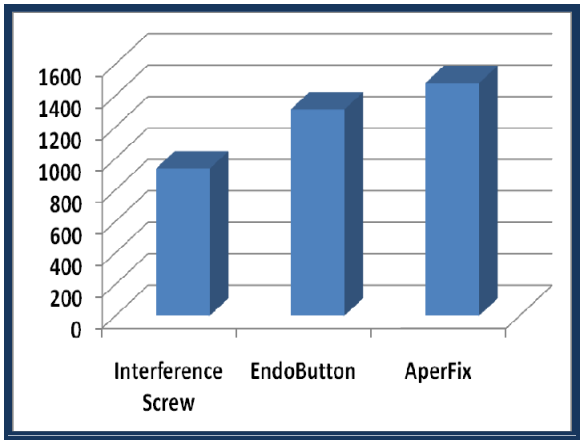
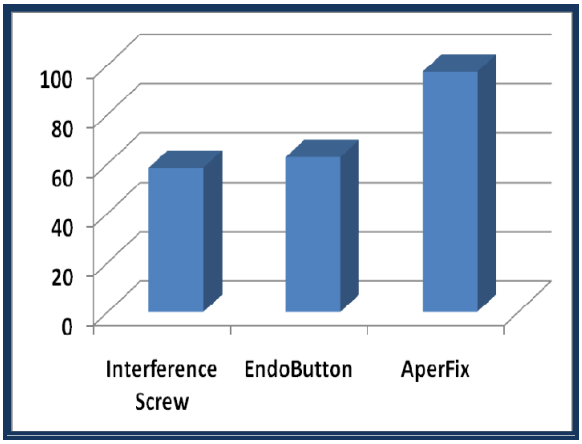


TABLE 2. *Stiffness (N/mm)*



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