The primary goal of this study is to evaluate the clinical potential of APD for Achilles tendon repair in a sheep model. The secondary goal is to assess the ability of PRPFM to augment the healing process and final repair strength.

Materials and Methods: 18 skeletally mature (>3.5 year old) ewes were assigned to each of three groups (n=6). Group 1 consisted of tendon sutures only, Group 2 consisted of tendon sutures + APD patch, Group 3 consisted of APD patch + PRPFM with a 1.5cm gap left between tendon ends. The unoperated contralateral limb allowed each animal to act as its own control. All procedures were approved by the Animal Care and Use Committee Guidelines at Colorado State University. Under general anesthesia, the larger of the two branches of the gastrocnemius tendon was isolated from the lateral head of the m. gastrocnemius and transected. The two ends were then anastomosed using the synthetic absorbable monofilament glycomer suture material (Biosyn; USS Davis and Geck) in a Kessler locking loop pattern (Group 1 or 2), or a gap was left between tendon ends (Group 3). The APD patch was then applied for reinforcement (Group 2) or bridging (Group 3) and anchored using simple interrupted suture placement. The remnant gap in Group 3 was filled with autogenously harvested PRPFM (Cascade® Harvest System, Cascade Medical Enterprises LTD, Devon, UK) that was sutured in place using simple interrupted sutures. A soft padded bandage was applied and sheep remained inside for the entire convalescence period. Several sheep required the placement of a fiberglass splint to combat fetlock knuckling, but most improved in a short period of time. All sheep were humanely euthanized at 24 weeks post-operatively.

Biomechanical testing was performed to evaluate tensile strength in a longitudinal direction using an Instron 4500 model retro-fed to 5500 device (Norwood, MA) at an increment load of 6 mm/min, recording values just past peak strength, leaving specimens intact for histological testing. Specimens were then embedded in paraffin and stained with hematoxylin and eosin. All sections were examined under transmitted and polarized light microscopy for tissue and cell reactions, tendon healing and repair.

Statistical analysis was performed using one-way ANOVA with paired analysis for between group comparisons. Significance was reported at p < 0.05.

Results: There was no statistically significant difference among groups undergoing biomechanical testing (load to failure: group 1, 35.93 ± 34.17 N; group 2, 34.38 ± 11.67 N; group 3, 41.61 ± 21.58 N). All operated tendons appeared healed with no apparent fibrosis under light microscopy and thus histological scores were not assigned. In Group 1 (a, suture only), all six specimens had identifiable surgical separation sites. Healing occurred via increasing tendon width and bridging the defect with horizontally arranged fibers and some larger fibers in spiral fashion along the outer surface. In Group 2 (b, suture + APD), healing occurred with new tendon fiber bundles directly across the separation, without increasing total tendon width. Group 3 (c, gap + PRPFM + APD) showed complete bridging of the gap in all specimens. Axial orientation of new fiber bundles around those pre-existing was similar to Group 2 and the degree of ingrowth of fibers into the scaffold was slightly deeper than that seen in group 2. In Groups 2 and 3, integration of the patch to new and existing tendons was found in peripheral zones (Fig. 1) with ingrowth of vasculature, and surgical sites of two animals in each group were indiscernible with polarization microscopy. Group 3 also demonstrated occasional blend-in of new fibers within tip portions of the patch.

Discussion: These findings support the use of both PRPFM and APD in combination to augment healing of a severed Achilles tendon in the sheep model. Based on histological data, healing occurred in all specimens but was best achieved in Group 3, despite the presence of a 1.5cm gap. Group 2 also showed promising results in regards to extension in longitudinal biomechanical testing. There were also noticeable differences between healing seen between Groups 1 and 2, with increased healing noted with APD application. Future study to evaluate how APD would perform when used solely to bridge a remnant gap is warranted. The combination of the APD patch and PRPFM could serve as a therapeutic regimen for the clinical condition when resection of a torn tendon is necessary to aid with quality and strength of healing. It should also be noted that this is an acute injury model. The benefits of an augmentation matrix may be more evident in a chronic injury model and need to be investigated.