INTRODUCTION:
Failure of a chronic rotator cuff repair is a common problem. Many attempts have been made to augment the repair with allografts or synthetic materials and more recently, the use of porcine small intestine submucosa (SIS) has been promoted as an alternative tool for rotator cuff and other tendon repairs [1]. Few studies have examined the effects of SIS on acute rotator cuff injuries. Initial studies on acute infraspinatus injuries have shown that SIS graft tendons have similar mechanical properties to injured and repaired tendons [2]. Even less information is available about the material’s behavior in a chronic tendon tear which represents a more clinically relevant situation. Therefore, the objective of this study was to investigate the use of SIS in acute and chronic rotator cuff repairs. Our hypotheses were: 1) Acute injuries repaired with SIS would have similar mechanical properties compared to those repaired without SIS, and 2) Chronic injuries repaired with SIS would have increased mechanical properties compared to those repaired without SIS.

METHODS:
Eighty-six Sprague-Dawley rats were used in this IACUC approved study. Animals were divided into acute repair (n=41) and chronic repair (n=45) groups. Additionally, each group included animals that received either a non-SIS (primary) repair or a SIS graft repair. In the acute non-SIS repair groups, the supraspinatus tendon was surgically detached at its insertion site and repaired directly back to bone as described previously [3]. In the acute SIS repair groups, the tendon was detached, a 3 mm long defect was created at the distal tendon edge, and a 3 mm long x 3 mm wide 10-layer SIS graft was used to replace the space created by the defect before being repaired to the bone. The animals were then sacrificed 4, 8, or 16 weeks after repair. In the chronic repair groups, the supraspinatus tendon was detached from its bony insertion and the tendon end was marked with a suture. The animals were allowed 4, 8, or 16 weeks of normal cage activity before a repair surgery was performed. At the time of a chronic non-SIS repair, the native tendon was identified by the marking suture and was repaired back to the bone. For a chronic SIS repair, the tendon was identified and the tendon end was removed. A SIS graft averaging 4.5 mm long x 3.5 mm wide was used to fill the gap created by retraction of the tendon. Chronic animals were sacrificed 4, 8, or 16 weeks after repair.

For geometric and biomechanical evaluation, one tendon from each of the eighty-six rats in the study was evaluated. In order to calculate tissue cross-sectional area, thickness and width were measured [4]. To determine biomechanical properties, tensile testing was performed using an Instron 5543 with the specimen immersed in a 39°C PBS bath. Following ten cycles of preconditioning from 0.1 to 0.5 N, a stress-relaxation test was performed at 5% strain at a fast rate of 2.5 mm/sec and held for 600 sec. A ramp to failure test was then performed at 0.015 mm/sec (~0.3%/sec) and strain was measured optically. Elastin and viscoelastic properties were determined from these tests. Statistical significance was evaluated in Systat using a one-way ANOVA and a Fisher’s post-hoc test.

RESULTS:
For acute repairs, the area of SIS graft specimens was significantly decreased (p<0.05) compared to non-SIS specimens (fig 1). There were no changes in modulus (fig 2) and stiffness (fig 3). Similar results for area (fig 4) and modulus (fig 5) were found in chronic specimens. Stiffness was significantly larger in chronic non-SIS specimens (fig 6). While additional changes were observed, the findings were not reported due to brevity and lack of direct clinical relevance.

DISCUSSION:
This study utilized an accepted rat model to investigate the use of small intestine submucosa (SIS) grafts in acute and chronic supraspinatus tendon repairs. This model is the first to provide data on chronic supraspinatus tendon repairs performed with the SIS graft.

REFERENCES: