INTRODUCTION:
Burkhart first described the rotator cable-crescent complex in 1993, but no studies have since then proven its role in rotator cuff tears [1]. We hypothesize that rotator cable tears in the anterior supraspinatus have a greater effect on adjacent footprint strain and increased tear gaping compared to equivalently sized tears of the rotator crescent. Such findings may help predict which tears become symptomatic and identify tears at greater likelihood for progression or fatty degeneration [2].

METHODS:
Specimen Preparation: In ten cadaveric shoulders, the anatomy of the cable-crescent complex was defined by inspection and palpation on the articular side and translated to the bursal side by passing silk suture through the tendon along the inner and outer borders of the rotator cable. A knot was tied on the bursal side to serve as an optical tracking marker. The three regions between the inner and outer borders of the cable were defined as the cable regions (Figure 1). The region between the markers on the inner border of the cable and the articular margin was defined as the crescent region. Three medial markers were placed at the musculotendinous junction to allow for definition of two medial tendon regions. Four bone markers were placed at the bone-tendon junction, directly lateral to the most lateral tendon markers. The region between the bone markers and the most lateral tendon markers was defined as the footprint region.

Tear Protocol: The shoulders were randomized to undergo equivalent sized supraspinatus tears of either the anterior rotator cable (n=5) or the adjacent rotator crescent (n=5). The tear sizes were standardized for all specimens independent of tear location. The large tears were sized to match the total antero-posterior length of the crescent insertion, and the small tears were half the size of the large tears.

Specimen Testing and Statistics: For each specimen, the supraspinatus tendon was cycled 5 times from 10N to 180N in the intact (3 times) and then in the cut conditions (small progressing to large). A custom 3D optical system was used to track the position of the 18 markers during the 5th loading cycle. Tear gap distance was defined as the distance the markers in the cut region displaced at 180N compared to the displacement of the same markers in the intact condition at 180N. The von Mises strain was calculated for each of the nine tendon regions as they deformed to 180N from their 10N intact state (repeatability ≤ 2% strain). A signed rank test was used to test for significant differences in von Mises strain between the 180N intact and 180N cut conditions within each tear group. A rank sum test was used to test for significant differences between cable and crescent tears in: 1) tear gap distance, and 2) The magnitude of increase in von Mises strain in the footprint regions in response to tearing (strain at 180N in intact tendon subtracted from strain at 180N of the same specimen after creation of a tear). For all tests p<0.05 was considered significant and p>0.10 was considered a trend.

RESULTS:
Tear gap distance was significantly greater for loaded large cable tears (6±2 mm) than large crescent tears (1±1 mm) (p=0.008). Regional strains in loaded intact tendons were in the expected physiologic range (3-5%) and symmetrically distributed (Figure 2a). Regional strains in loaded tendons with large crescent tears (Figure 2b) remained symmetrically distributed and only trended toward significant strain increases in the cable-crescent region (p=0.063). In contrast, regional strains in loaded tendons with large cable tears (Figure 2c) were asymmetrically distributed and trended toward significant increases in the cable region, the footprint region, and in the tendon medial to the cable (p=0.063). Small anterior cable tears resulted in a significantly greater magnitude of strain increase in the adjacent crescent region than small crescent tears did on the adjacent anterior cable region (p=0.016; Figure 3). Small cable tears had a strong tendency to have a greater magnitude of strain increase in the posterior footprint region than small crescent tears (p=0.056). Large anterior cable tears tended to have a greater magnitude of strain increase in the adjacent crescent region than large crescent tears did on the adjacent anterior cable region (p=0.095).

DISCUSSION:
This study confirms our hypothesis that tears of equivalent size but located within different regions of the rotator cuff insertion can have significantly different biomechanical consequences. At 180N of load, tears created within the anterior fibers of the supraspinatus tendon (defined by the rotator cable) demonstrated significantly greater gapping across the tear site. Also, small cable tears resulted in significantly greater increase in adjacent footprint strain when compared with equivalently sized tears in the posterior region of the supraspinatus insertion (defined by the rotator crescent). Large cable tears showed an asymmetric distribution of strain and a strong trend toward increased strain in more regions of the rotator cuff as compared to a large crescent tear. These findings suggest that force transmission from the supraspinatus muscle-tendon unit to the proximal humerus occurs primarily across the anterior fibers of the supraspinatus acting through the rotator cable, with relative stress-shielding of the rotator crescent tissues in the posterior half of the supraspinatus.

SIGNIFICANCE:
The study of rotator cuff tears would be aided by a greater appreciation of the significance of tear location. This study suggests location may be defined in relation to the integrity of the rotator cable. Further studies are needed to evaluate whether rotator cable tears are more likely to progress, retract and/or result in symptomatic dysfunction.

REFERENCES: