Repair of Partial Thickness Rotator Cuff Tears: a Biomechanical Analysis of Footprint Pressure and Strength in an Ovine Model

INTRODUCTION:
Traditionally, repair of undersurface partial thickness rotator cuff tears involved completion of the tear to a full thickness tear and subsequent repair of the tendon with single or double row anchors. Recently, new anchors have been developed to facilitate an in situ transtendon repair of undersurface partial thickness tears, avoiding the need to complete the tear. The purpose of this study was to determine if transtendon repair had enhanced mechanical properties compared with tear completion and repair. We hypothesized that transtendon repair would have better footprint contact pressure and a higher failure load than both single and double row repair.

METHODS:
75% undersurface partial thickness rotator cuff tears were created ex vivo in the infraspinatus of 24 ovine shoulders. An 8 mm hole was drilled through the medial rotator cuff footprint and a metal probe connected to a load cell was passed through the hole in order to dynamically measure footprint pressure. The specimens were divided into four groups of six shoulders: (1) no repair, (2) in situ repair (Twinlock anchor, Arthrocare), (3) completion of the tear with tension band single row repair (OPUS anchors, Arthrocare) and (4) completion of tear with double row repair (OPUS and Twinlock anchors) (figure 1).

Footprint contact pressures were measured in each group with increasing loads distracting the tendon (10N, 20N and 30N) at increasing abduction angles (0, 15 and 30 degrees). Repair strength was determined using a pull to failure test.

Differences in footprint contact pressures and load to failure were analyzed using one way analysis of variance (ANOVA) with correction for multiple comparisons using the Holm-Sidak method. The level of statistical significance was defined as p<0.05.

RESULTS:
Technical failure of the transtendon anchors occurred in three of fifteen shoulders. In two instances, an anchor pulled out while tightening the suture and in one instance the suture lock failed to fire. These shoulders were excluded and three extra shoulders were repaired and included in the study.

Transtendon repair (0.8 ± 0.1 MPa; mean ± SEM) and double row repair (1 ± 0.09 MPa) showed three-fold (p < 0.001) greater footprint contact pressures than tension band single row repair (0.3 ± 0.03 MPa) and no repair (0.3 ± 0.02 MPa) at zero degrees of abduction and at 30 degrees of abduction (transtendon repair 0.5 ± 0.1 MPa; double row repair 0.6 ± 0.1 MPa; single row repair 0.09 ± 0.01 MPa; no repair 0.06 ± 0.01 MPa) (figure 2). There were no significant differences in footprint contact pressure between transtendon repair and double row repair, except at 0 and 15 degrees abduction with 30N tension across the tendon (p<0.05) (figure 3).

The ultimate load to failure for transtendon repair (544 ± 22 N) was more than three times greater than for the double row (157 ± 23 N; p < 0.001) and the single row repair (116 ± 11 N; p < 0.001) (figure 4).

DISCUSSION:
The purpose of this study was to compare the biomechanical properties of transtendon repair of articular-sided partial thickness tears to tear completion and repair. Our first hypothesis was that transtendon repair would have a higher footprint contact pressure than tear completion and repair. This was true when compared to single row. However, compared to double row we found no significant differences. Our second hypothesis was that ultimate failure load would be higher in transtendon repair compared to both single and double row repair.

Transtendon repair of partial thickness tears had the best combination of high footprint contact pressure and high ultimate failure load. However, the high insertion failure rate (3/15) of the transtendon anchors used in this study is of concern.