Tension, abduction and surgical technique effect footprint compression following rotator cuff repair in an ovine model.

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INTRODUCTION:  
Shoulder motion following rotator cuff repair is unavoidable and may result in changes in tension on the repair and changes in compression forces at the rotator cuff footprint. We set out to determine how tension within the rotator cuff tendons and motion of the shoulder affect the footprint compression forces of a rotator cuff repair using multiple repair techniques. Ultimately, our goal was to determine which rotator cuff repair technique provides the best compression at the footprint and pull out strength in the face of shoulder motion and changing tension across the repair.

METHODS:  
Rotator cuff tears were created ex vivo in the infraspinatus of thirty ovine shoulders. These specimens were divided into five groups of six shoulders based on the type of rotator cuff repair performed: single row, double row, tension band, trans-osseus equivalent, or a combined tension band over single row repair (Fig. 1). We developed a new technique to-measure compression force at the footprint in a quantitative fashion. This entailed drilling an 8.5 mm hole through the center of the infraspinatus footprint. A 4.5 mm metal probe connected to an Instron load cell was passed through this hole and positioned 2 mm prominent to the surrounding bone. The infraspinatus tendons were repaired over this probe using the five techniques described above. Compressive force of the repair at the footprint was measured with variable tension placed on the repaired tendon at 10 N, 20 N and 30 N and at variable shoulder abduction angles from -20 to +30 degrees. After measuring compression, the repairs were cyclically loaded and the repair strength was then determined using a pull to failure test.

RESULTS:  
In all five types of repairs, increasing tension on the repaired tendon in 10 N increments resulted in a significant increase (P < 0.05) in compression at the repair site (Fig. 2). In addition, increasing the abduction angle by 20 degrees resulted in a decrease (P < 0.05) in compression force in all groups (Fig. 3). At all abduction and tension combinations, the trans-osseus equivalent and tension band over single row groups recorded significantly higher compressive forces (P < 0.05) than the other repairs. At 30 degrees of abduction, compression was negligible in all groups except the trans-osseus equivalent and tension band over single row repairs. The results of the pull to failure tests are shown in figures 4 and 5. Of note, the tension band over single row repair group had a significantly higher total energy to failure than the single row and trans-osseus equivalent groups (P < 0.05).

DISCUSSION:  
In all rotator cuff repair techniques tested compression at the footprint increased as tension increased across the repair and decreased as the shoulder was abducted. While the double row repair showed good pull-out strength, this group recorded the lowest footprint compression readings. The trans-osseus equivalent and tension band over single row rotator cuff repairs maintained the best footprint compression in all conditions, but the tension band over single row technique demonstrated superior pull-out strength and energy to failure compared to the trans-osseus equivalent group. These results suggest that traditional single row and double row rotator cuff repair techniques may not provide the optimal combination of compression at the footprint and repair strength. Reinforcing a single row repair with tension band using inverted mattress sutures appears to offer the best combination of strength and compression at the footprint. This type of repair may help to improve our success rate in repairing large and massive tears.