INTRODUCTION:
Rotator cuff tears are a common cause of shoulder pain and dysfunction. The prevalence of full and partial thickness tears increases linearly with age after 50 years, and by the age of 80, they exist in 80% of the population. Despite the prevalence of rotator cuff disease in our population, there is little literature on the effect of rotator cuff tears on active shoulder kinematics in a cadaver model. Furthermore, there are apparently no studies comparing the differences in active shoulder kinematics following different repair techniques. We hypothesized that double row suture anchor repairs of rotator cuff tendon tears will more closely restore normal active glenohumeral joint kinematics to those observed in the intact state than a single row suture anchor repair. Therefore, the purpose of this in-vitro biomechanical study was conducted to determine the effects of simulated tears and subsequent repairs of the rotator cuff tendons on joint kinematics.

METHODS:
Eight paired fresh-frozen cadaveric shoulder specimens (mean age: 66.0 ± 8.7 years) were tested using a custom loading apparatus designed to simulate unconstrained motion of the humerus. Cables were sutured to the tendons of the supraspinatus, subscapularis, and infraspinatus/teres minor muscles. Three cables were attached to the deltoid tuberosity to replicate the anterior, middle and posterior thirds of the deltoid muscle. Loads were applied to the cables to simulate the muscle loading in ratios with respect to the middle deltoid based on variable ratios of electromyographic (EMG) data and average physiological cross-sectional area (pCSA) of the muscles. An electromagnetic tracking device (Flock of Birds, Ascension Technologies, VT) was used to provide real-time feedback of abduction angle, to which the loading ratio was varied correspondingly.

An anterolateral deltoid muscle splitting incision was utilized, to access the rotator cuff interval and supraspinatus tendon. A 2 cm tear was made in the supraspinatus tendon insertion, beginning at the rotator cuff interval and extending in a posterior direction, and 1 cm of tendon was resected to simulate the clinical arthroscopic scenario of tendon retraction. The deltoid muscle and skin incisions were then sutured and simulated active glenohumeral abduction was performed with data collected. Specimens were randomized to receive either single or double suture anchor repair (Figure 1).

Following repair, the deltoid interval and skin were closed and active glenohumeral abduction repeated with data collection. Trials were also conducted after the enlarged lesion was repaired in the above mentioned fashion. In order to quantify repeatability, five successive tests on each specimen. However, as the abduction angle increased, differences in the kinematics between the single and double row repair lessened.

DISCUSSION AND CONCLUSION:
The initial posterior displacement in the plane of elevation with the sectioning of the supraspinatus is related to the diminished anterior moment on the glenohumeral joint. As the tear proceeds into the infraspinatus, the anterior and posterior forces become more balanced and a return to near normal intact kinematics was observed. These findings support the concept that an anatomically deficient rotator cuff can remain biomechanically sound, where location rather than size is the key variable.

Recently, double row suture anchor fixation has been proven to be biomechanically superior to single row fixation; however, active shoulder kinematic comparison has not yet been attempted. This study demonstrates that double row suture anchor repair more accurately reproduces active shoulder kinematics of the intact shoulder specimens.

REFERENCES:
4. Tuoheti et al., AJSM, 33 (12) 1-6, 2005.