Introduction
Radiofrequency (RF) or laser energy is most commonly used in the treatment of shoulder instability and remains controversial regarding effects on mechanical properties and long-term clinical effects. The principle is to shorten the capsular tissue to stabilize the joint. The shoulder capsule consists of type I collagenous tissues in the form of capsule and ligament. Though these tissues are regular connective tissues there are important differences in ultrastructural organization, and mechanical properties which may respond differently to radiofrequency treatment. This study examined the effects of radiofrequency energy treatment intensity and time on ovine tendons and human cadaveric shoulder capsule. The percentage shrinkage, dynamic and failure properties were examined.

Method
Seventy-two extensor tendons from skeletally mature sheep and sixty cadaveric glenohumeral capsule strips from 12 human cadaver shoulder girdles were harvested for testing. Treatment consisted of the application of radiofrequency energy at 5, 10 and 20W using the Mitek VAPR System (Mitek, Westwood, MA) for 10 or 30 seconds to a 10mm gauge length. Percent shrinkage was investigated in six tendon and five capsule specimens in each treatment group. A constant tension of 0.1N was applied to the specimens. Length was measured before and after treatment to calculate the percentage of shrinkage with treatment.

Non-destructive dynamic testing was performed before and after treatment followed by testing to failure. Five tendon and capsule specimens were tested for each treatment setting. Testing was performed on an 858 MTS Materials Testing Machine (MTS Systems, MN). The specimen were suspended in a 0.9% NaCl solution and preloaded to approximately 5N. The pretreatment sequence consisted of 10 cycles from 1mm to 6mm at 0.1Hz followed by stress relaxation for 6 minutes. The tissues were treated with radiofrequency energy and testing repeated before testing to failure at a rate of 1mm/sec. Stiffness and phase lag were determined from the dynamic testing as well as linear stiffness and load to failure from destructive testing. Data was analysed using 1 and 2-way ANOVA using STATISTICA (Statsoft, Tulsa, OK).

Results
Tendon and capsule shrinkage was statistically significant with regard to the treatment power (p<0.01) (figure 1). The dynamic properties of both tissues demonstrated an increase in stiffness following radiofrequency treatment. The stiffness of the tendon was altered more than the capsule with treatment power and time having no obvious effects. Capsular tissues demonstrated a change in regard to treatment time but there were no significant interaction effects. The failure force for tendon and capsule were significantly different but treatment did not alter the failure force for capsule (figure 2). Tendon exhibited a statistically significant decrease in failure force which was related to power and treatment time (p<0.01).

Discussion
Optimal RF power and treatment time has not been determined. A reduction in stiffness in animal tissue capsule has been reported [1,2]. Osmond et al., [3] reported the changes in shrinkage and area following laser and RF treatment. Our study agrees with this work with regards to shrinkage. Mechanically, tendon and capsule did not behave in the same manner following RF treatment. Conflicting data on the mechanical properties following RF treatment may be related tissue type and quality.

Tendon is a dense regular connective tissue composed of mainly Type I collagen. The collagen is arranged into densely packed longitudinal bundles. Capsule is a loose connective tissue also primarily composed of Type I collagen but more elastic fibres and a less longitudinal arrangement of collagen with more orthogonal fibres. Tissue thickness is also significantly different with capsule being a thinner sheet compared to oval extensor tendons. Both tissues “shrink” following in-vitro RF treatment but differences were found in the mechanical properties post treatment. Tendon’s increase in stiffness may be due to its longitudinal arrangement of fibres allowing for more an increased change from the crystalline extended state to a more contracted random coil state to be formed compared to capsule. The alteration in failure force for tendon may also be due to structural differences between the tissues. The density of tendon suggests radiofrequency effects may be concentrated to the treated surface creating a flaw in the tissue thereby making it susceptible to early failure. Initial clinical reports following radiofrequency treatment are encouraging, however the long-term benefit of the procedure is yet to be established.