RADIO-FREQUENCY PROBE TREATMENT FOR SUBFAILURE LIGAMENT INJURY: A BIOMECHANICAL ANALYSIS OF RABBIT ACL

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Introduction: There has been a recent trend in arthroscopic shoulder surgery to apply a thermal, radio-frequency probe (RF probe) to patients showing symptoms of chronic, painful ligamentous laxity. A mono-polar probe delivers monitored heat (at 67°C) and is passed along the surface of the ligamentous shoulder capsule until the surgeon visualizes adequate shrinkage of the capsular tissue. Post-operatively, patients have decreased laxity to physical exam and report improvement of pre-operative pain.

RF probe treatment and its consequences have been under close scrutiny in many laboratories. However, no study has examined the effects of the radiofrequency probe treatment on injured soft tissue, which is the primary indication for its use.

Utilizing a previously published lapine ACL model of subfailure injury, we intended to learn the in vitro biomechanical properties of radio-frequency probe treatment on injured ligamentous tissue. Our hypothesis was that ligaments subjected to subfailure injury, followed by radio-frequency probe treatment would demonstrate biomechanical evidence of improved viscoelastic properties and tensile strength under normal, physiologic testing.

Methods: Eleven white New Zealand rabbits (4.00 ± 0.47 kg) were dissected to create femur-ACL-tibia complexes (FATC) of each knee. The specimen pairs were randomly divided into 3 groups: Control, Sham, and Treatment. The Control group (10 paired specimens) received the full protocol (Figure 1), but no injury and no treatment. Their load to failure curves were used to ascertain an 80% subfailure injury displacement. The Sham and Treatment groups consisted of 12 paired, but randomized specimens. The Sham group received injury and sham treatment, while the Treatment group received injury and RF probe treatment. Treatment was applied with a TAC-S ElectroThermal™ Probe (Oratec Interventions, Inc.) and consisted of 3 distinct passes (1 mm/sec) of the probe at 67°C. Treatment group ligaments received 425.65 ± 51.86 joules, sham 0.00 joules. Sham was performed with a cold probe.

The test protocol consisted of 8 modules (Figure 1). Modules CP1, CP2, and CP3 were cyclic preconditioning (0.3 mm stretch, 10 cycles). Modules RT1, RT2, and RT3 were relaxation tests (0.6 mm stretch, force recorded for 180 sec). I, T, and F were injury (31% strain), RF probe treatment, and failure. All testing was performed at 1 mm/sec, with the specimens in a 37°C normal saline solution bath.

Data analysis consisted of normalizing RT force values: for t = 0 and t = 180, Injured and Treated with respect to Intact. Mean values of the normalized data were analyzed statistically with a paired, two-tailed t-test.

Results: The RF probe treatment offered significant improvement when compared to sham at t = 0 (0.81 ± 0.13 vs. 0.49 ± 0.09, p = 0.004) and at t = 180 (0.72 ± 0.16 vs. 0.52 ± 0.11, p = 0.009). In addition, the treatment improved RT response when compared to Injured response at t = 0 (0.81 ± 0.13 vs. 0.53 ± 0.11, p = 0.004) and at t = 180 (0.72 ± 0.16 vs. 0.55 ± 0.12, p = 0.004).

No differences in Injured RT’s were observed between Sham and Treatment at t = 0 and t = 180. Also, Sham offered no significant improvement in relaxation testing when compared to Injured at t = 0 and t = 180 (Figure 2).

Discussion: Radio-frequency probe treatment offers the application of thermal energy to shrink capsular and ligamentous soft tissues. We believe this is the first study to document the resultant biomechanical behavior of injured and then thermally treated ligament. We found improved relaxation testing forces after thermal treatment of subfailure ligamentous injury. The relaxation testing consisted of a 6% strain of the ligament, which has been shown to be in the physiologic range without evidence of injury.[3] Consequently, treatment of subfailure ligamentous injury with the RF probe demonstrated improved ligament behavior under physiologic strain.

Although this in vitro methodology is limited in that it does not allow for long-term fibroblastic reaction to thermal treatment, it is an efficient injury model which evaluates the immediate biomechanical response of a ligament to injury and thermal treatment.