INTRODUCTION
The use of electrosurgical devices in arthroscopic surgery has gained increasing popularity in recent years as a tool for resection, ablation and coagulation. Efforts have also been made to extend its application to soft tissue thermal shrinkage and chondroplasty. Radiofrequency (RF) probes create a high frequency alternating current between their tips. Heat is generated by friction of ions in the tissue treated; they try to follow this alternating current. When the temperature exceeds 100°C, water in the tissue treated is vaporized and ablation of the tissue occurs. Temperatures of approximately 60°C unwind the collagen triple helix, reducing of the length of the molecule, causing tissue shrinkage.

The development of small joint RF probes permits use in the wrist. Triangular fibrocartilage complex debridement and scapholunate intersesous ligament thermal shrinkage are the first applications in the wrist. However, there have been concerns of inadvertent increases in arthroscopic irrigation fluid temperature in the wrist during RF probe application resulting in thermal damage of the capsular and ligamentous tissues of the joint and leading to restricted range of motion. Similar issues have not been previously encountered in shoulder and knee arthroscopy because the larger joint volume and massive outflow rates convect the heat out of the joint. The wrist joint, however, has a much smaller volume and outflow is restricted through the standard use of an 18G needle in wrist arthroscopy. The purpose of this study was to examine effect of RF probe activation on the irrigation fluid temperatures in the wrist joint.

MATERIAL AND METHODS
Wrist arthroscopy was performed using standard techniques on four cadaveric arms, intact from the midhumerus. The arm was fixed proximally to the arthroscopic table and supported using a tower distraction. A 7-Kgr distraction force was applied using finger traps. The 3-4 portal was used for viewing, the 6U portal for outflow and the 4-5 portal was used for instrumentation. Each specimen was at room temperature (21°C). An arthroscopic pump (Stryker Endoscopy, San Jose, CA) supplied a constant intra-articular pressure of 50 mmHg with an inflow rate of 80 ml/min. Outflow was achieved through an 18G needle in the 6U portal. Flow was gravity assisted and was unrestricted but was not otherwise controlled.

Temperatures were recorded using four fiber optic phosphorescent probes (Model 3100 Fluoroptic Thermometer, Luxtron, Corp, Santa Clara, CA) in a rate of four measurements per second. Two probes were inserted four millimeters into the joint space: the radial temperature probe was inserted at the site of the 1,2 portal and the ulnar temperature probe at the 6U portal. One probe was inserted into the outflow tube at the base of the 18G needle outlet and one probe was inserted into the inflow supply.

Ablation was performed using a RF probe (VAPR 2.3mm, side effect, Mitek, Westwood, MA). The manufacturer’s default energy settings were used; 60W for ablation and 45W for coagulation. New RF electrodes were used for each specimen and the temperature probes were not reused for the specimens.

The RF probes were placed into the joint space and activated without tissue contact and without outflow. The RF probe was first located 10 mm from the temperature sensor on the ulnar side. Ablation and coagulation cycles of 60 seconds were performed. This was repeated with the RF probe 10 mm from the sensor on the radial side. Next, outflow was obtained by inserting an 18G needle and the sequence was repeated.

RESULTS
Table 1 shows the overall average temperatures over 60 seconds as well as maximal (peak) and average maximal temperatures for the ablation testing. The maxima listed are the absolute peak values across all tests and the averages are across all specimens. All tests in all four specimens showed higher maxima and average ablation temperatures without outflow. The reduction was statistically significant (p = 0.006).

The results show that adequate inflow-outflow is imperative in maintaining safe temperatures during RF discharge in the joint space. Additional work should consider actual tissue ablation and will focus on TFCC and scapholunate reduction.

DISCUSSION
This study investigated the scenario of inadvertent RF probe activation without tissue contact in the wrist. This scenario represents the maximum possible thermal energy delivery to the irrigation fluid. Tissue debridement will probably absorb energy and decrease the thermal energy delivery to the irrigation fluid. Standard wrist arthroscopy inflow-outflow through a 18G needle clearly reduced temperatures. However, the averages and maxima showed substantial variability. Maxima greater than 60°C, lasting longer than 1 second, were observed with ablation (high energy settings) in two specimens in the “no-outflow” condition. Such temperatures have the potential for damage to adjacent tissues. Although no average of the peak temperatures for any specimen reached above 50 degrees, the average is not the relevant value. In all specimens, the presence of inflow reduced the peak values to 35°C or less. It is therefore imperative in clinical practice to maintain adequate inflow-outflow from the joint when RF probes are used.

The irrigation fluid temperature rises were observed in the first seconds after RF probe activation and quickly returned close to baseline values after de-activation. There seemed to be no merit in intermittent RF probe activation for a few seconds at a time in order to protect the joint from overheating as is practiced by some surgeons.

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