LAVAGE SOLUTION TEMPERATURE INFLUENCES EFFECTS OF MONOPOLAR RADIOFREQUENCY ENERGY USED FOR THERMAL CHONDROPLASTY

*Lu, Y (D-Oratec Intervention Inc., A, B); *Edwards, R (D-Oratec Intervention Inc., A, B); **Nho, S; *Heiner, J; **Cole, B (D-Oratec Intervention Inc., C); +*Markel, M (D-Oratec Intervention Inc. A, B, E)
+*University of Wisconsin-Madison, Madison, Wisconsin. (608)262-3573, Fax: (608)265-8020, markelm@svm.vetmed.wisc.edu

Introduction: Radiofrequency energy (RFE) is gaining widespread acceptance for thermal chondroplasty. Typically, surgeons use RFE to treat chondromalacic cartilage via arthroscopy with room temperature (22°C) lavage solution. Based on a previous in vitro human cartilage study, monopolar RFE (mRFE) caused mean chondrocyte death of 800 µm from the articular surface using room temperature lavage solution. The purpose of this study was to determine the effect of lavage solution temperature on depth of chondrocyte death and articular cartilage contouring when mRFE is used to perform thermal chondroplasty. We hypothesized that lavage solution temperature would influence the depth of chondrocyte death when using a temperature controlled mRFE system.

Materials and Methods: Chondromalacic osteochondral samples (Outerbridge score 2) from 16 patients undergoing partial or total knee arthroplasty were used in this study. Samples were divided into two groups (16/group). One group was treated by mRFE for 10 sec, the other group for 15 sec. Each sample in each group was cut into two sections with a 1 cm² treated area marked on each section. One section was treated by mRFE in 22°C lavage solution and the other was treated in 37°C (n=8/lavage temperature/treatment time). Temperature controlled mRFE was set at 70°C/15W. RFE treatment was applied in a paintbrush pattern with light contact. After RFE treatment, the cartilage sections were processed for confocal laser microscopy (CLM) and scanning electronic microscopy (SEM).

Cell viability was determined with ethidium homodimer and calcein stains (Molecular Probes, Eugene, Oregon) and CLM as previously described. The depth of chondrocyte death was determined for each confocal image of the osteochondral sections with Adobe PhotoShop™ (Adobe PhotoShop, Version 5.5, San Jose, CA). The RF generator data was gathered on a personal computer. A custom-designed SEM scoring system (rough and irregular with fronds, 0; rough and irregular with melted fronds, 1; relatively smooth with melted fronds, 2; extremely smooth, 3) was used to determine the cartilage surface smoothing following chondroplasty. Higher scores indicated a smoother cartilage surface. Maximum depth of chondrocyte death, mean mRFE delivery power, time to reach RFE preset temperature, and mean mRFE treatment temperature (temperature measured from thermocouple located within the RF probe tip) were compared among groups of lavage temperatures and treatment time combinations using ANOVA. Factors included in the analysis were patient, treatment time, and lavage solution temperature. When differences among groups were demonstrated by ANOVA, appropriate post hoc tests were employed. Paired t-tests were used to compare the subjective scores between groups. P-values less than 0.05 were considered significant.

Results: CLM demonstrated that the depth of chondrocyte death in 37°C lavage solution was significantly less than that in 22°C solution for both 10 and 15 sec treatment time groups (Fig 1). SEM scores demonstrated that the chondromalacic cartilage surface treated by mRFE in 37°C lavage solution was smoother than that in 22°C solution in the 10 sec group (1.9 vs 0.9) (P<0.05) whereas there was no significant difference in surface smoothing between the 37°C and 22°C groups after 15 sec treatment (2.3 vs 2.4). Chondromalacic cartilage surfaces treated by mRFE in 15 sec treatment time group were smoother than those in the 10 sec treatment time group in both 37°C and 22°C lavage solution (p<0.05). The mean mRFE probe temperatures in 37°C was significantly higher than that in 22°C lavage solution, whereas delivered power in the 37°C was significantly lower than the 22°C lavage solution for both treatment time groups (Table 1).

Discussion: This ex vivo study indicated that 37°C lavage solution significantly reduced chondrocyte death compared to room temperature 22°C lavage solution during thermal chondroplasty with temperature controlled mRFE. Treatment of 1 cm² region of chondromalacic human cartilage (grade 2) for 10 and 15 sec resulted in mean depth of chondrocyte death of 420–590 µm. This depth is consistent with the zones of reduced chondrocyte density and death after mechanical debridement. RFE has the ability to contour articular cartilage surfaces and may be superior to mechanical debridement by producing a smoother surface with rapid treatment times, if safe treatment parameters can be established.

Based on the results of this study, further in vivo studies need to be performed.


Acknowledgments: Funded by Oratec Intervention Inc., Menlo Park, California.

**Rush University, Chicago, Illinois.