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Comparison of Multi-Lesion Geometry and Bovine Tissue Impedance Change between Radiofrequency Ablation Devices

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Introduction

We have noticed in practice we have variable clinical outcomes between two devices, referred to as Machine A and Machine B, and so chose to investigate the difference in lesion geometry and impedance change in bovine tissue, similar to Dr. Christian Gonzalez's previous study, with a few modifications to account for some potential confounding variables, to verify this observation [1]. Examined were two different RF Machines, Machine A and Machine B in regards to their thermal radiofrequency ablation performance, comparatively, in ex vivo bovine liver tissue. Investigated were their apparent temperatures (qualitatively) as reported by each device, reported impedance changes, and lesion geometry (modeled as ellipsoid volumes). We found a clear difference in several ways as well as some issues in comparing the devices' performances.

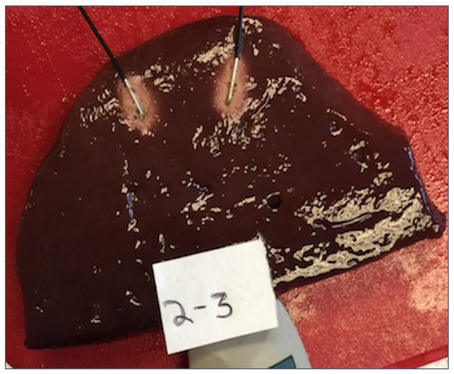

Figure 1: Example bovine tissue sample 2-3

Methods

One of each ablation machine was used with three electrodes used per machine. The electrodes were used with 20G cannulae of 10 cm in length with 1 cm tips. Using semicircle sections of radius 5 cm, the electrodes were placed at 36° intervals from one another along the sample with their tips 1 cm past the edge of the sample. The sample was verified using the RF device to be of 17-22°C before testing began. Each sample was subjected to either the two or three electrode configuration, with the two electrodes being each 18° off of the semicircle's mid-line and the three electrodes being placed at the mid-line and 36° bilaterally. It was not possible to repeat the same tests on the same tissue due to destructive testing. Each machine was used to measure initial impedances in three-electrode configuration on five slabs under the consistent temperature conditions. A total of 90 samples were tested. Lesions were approximated as ellipsoids.

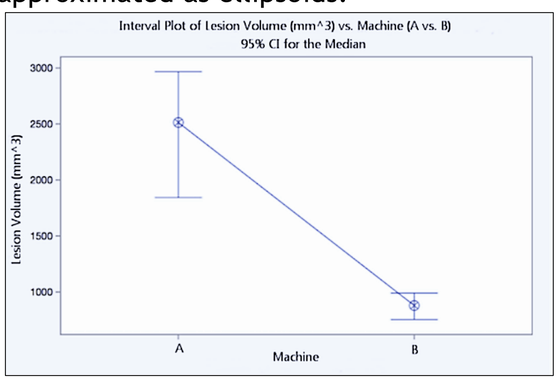

Figure 2: Volumes differ between devices

Results & Discussion

No significance was found between electrode configurations. Lesion volume was found to be highly significantly different between the two devices ($p < 0.01$). Initial impedance measurements were found to be highly significantly different between the devices ($p < 0.01$), so it was difficult to compare the impedance differences between the devices however there was a difference based on the data collected with $p<0.01$. Due to non-normality of results, the nonparametric Mood's Median test was used to evaluate statistical comparisons of the results giving a significant difference for the lesion volume between machines ($p<0.0001$). A difference was also noted, qualitatively, of the difference in electrode thermal step response rise time and percent overshoot of both devices based on the displays provided by each device. Device B appeared to suggest a higher percent overshoot and faster rise time.

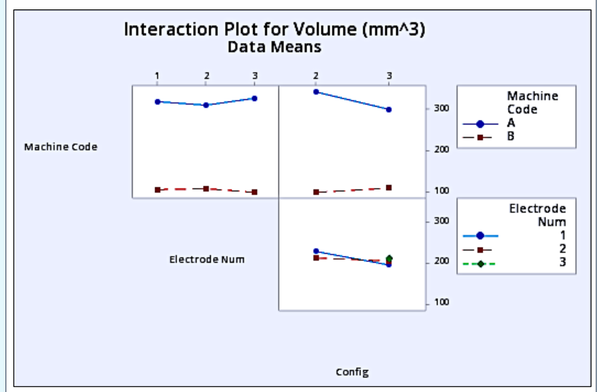

Figure 3: Factor Impacts on Lesion Volume

Conclusions

As one of each machine was investigated, further investigation of the performance of each machine is necessary to evaluate consistent performance of each device, but the results seem to suggest a significant difference in lesion volume. We would like to investigate the impedance changes in more detail. Our initial cursory assessment seems to suggest that device B may be better for a slower, less variable-speed procedure whereas machine A's larger variability in lesion volume produced under the same settings and time, regardless of electrode or configuration suggest it is more useful for something which must be ablated quickly at the cost of precise timing of the lesion creation. This leads us to believe that further investigation will reveal a clear difference between the devices and effects on clinical outcomes and patient satisfaction.

References

[1] Jr. ERC, Gonzalez CD. Bipolar Radiofrequency Lesion Geometry: Implications for Palisade Treatment of Sacroiliac Joint Pain. *Pain Practice*. 2011;11(1):3-22. doi:10.1111/j.1533-2500.2010.00400.x.

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