Thermal Response of the Arthrex Apollo$^{RF®}$ MP50 and Smith & Nephew Super MultiVac™ 50 Ablation Probes in a Simulated Joint Space

Arthrex Research and Development

Purpose

During radiofrequency ablation procedures, management of intra-articular fluid temperature is critical due to the onset of cellular and tissue damage at temperatures ranging from 45-55°C.[1,2] The purpose of this testing was to compare the temperature change in a simulated joint space environment between the Arthrex Apollo$^{RF®}$ MP50 and Smith & Nephew Super MultiVac 50 (SMV50) bipolar ablation probes.

Methods and Materials

The simulated joint space was a clear cylindrical plastic tube with a volume of approximately 115 mL within the range of knee joint-space volumes.[3] The probe was placed into an inorganic test substrate composed of fiberglass cloth used to simulate tissue and provide a consistent testing environment (Figure 1).

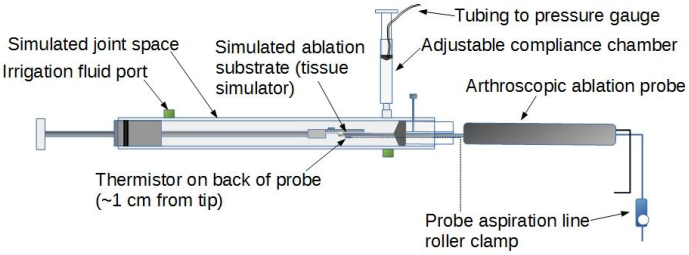

Figure 1. Experimental test setup.

A range of device ablation settings (3, 4, 5, 6, 7) and device aspiration vacuum settings (50, 200, 300, 400 mm Hg) were evaluated. Power was applied for 3 minutes using an Arthrex Synergy$^{RF™}$ console for the MP50 probes and an Arthrocare Quantum™ 2 console for the SMV50 wands. Irrigation pressure was set by an Arthrex DualWave™ pump at 35 mm Hg for all tests and aspirated material was measured at the end of the test to determine an aspiration rate. Temperature was measured by a thermistor bonded to the end of each probe's shaft insulation near the tip of the device. The thermistor did not affect the RF power delivered to the devices. While the device power and aspiration were active, temperature was measured every 20 seconds for 3 minutes. Increases in temperature were calculated accounting for differences in starting temperatures, which ranged from 23-28˚C.

Statistically significant differences between devices and their aspiration rates at different vacuum settings were determined by 2 way analysis of variance (ANOVA). In addition, average temperature increase was calculated for the 3- minute test period and paired *t* tests were performed to determine differences between devices across the different aspiration vacuum settings.

Results

Both probes followed the trend that as aspiration vacuum pressure increased, aspiration rate increased (Figure 2, P <.001). Additionally, there was a significant difference in aspiration rate between the devices (P = .005) with the MP50 showing greater aspiration rates.

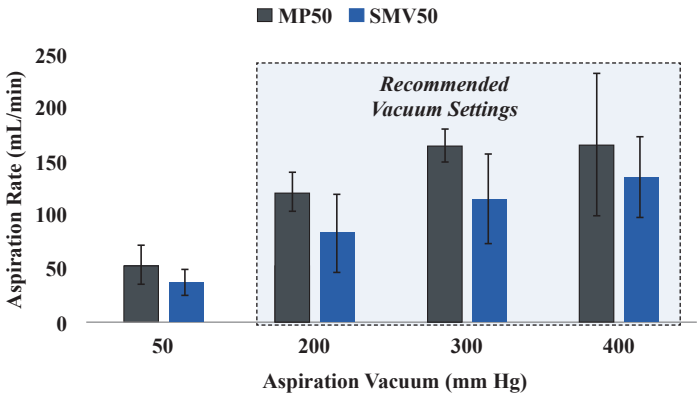

Figure 2. Aspiration rate increased with higher aspiration vacuum settings, and there was a significant difference in aspiration rate between devices, with the MP50 having a higher aspiration rate (data shown is averaged for all power settings).

At the recommended (default) set point for each device (4 for the MP50 and 7 for the SMV50), the 3-minute average temperature increase for MP50 probe was significantly less than for the SMV50 wand across all aspiration vacuums tested (Figure 3, P = .04). Within these recommended parameters, the average temperature increase for the MP50 was 3.4 ± 0.9°C and for the SMV50, 7.0 ± 1.6°C. The recommended vacuum settings for both devices are 200 to 400 mm Hg.

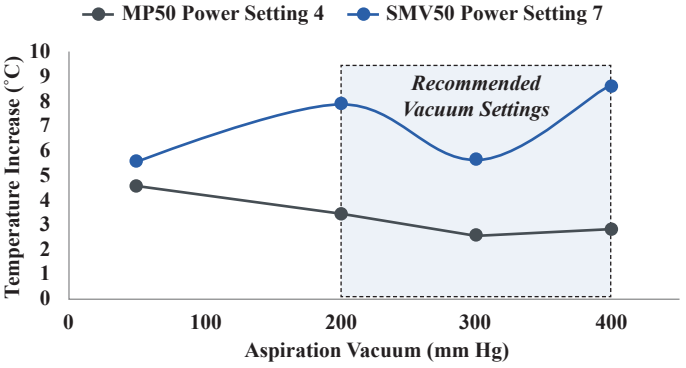

Figure 3. Three-minute average temperature increase for recommended ablation settings and all vacuum settings.

With both probes at the same power setting (7), the 3-minute average temperature increase on average was lower for the MP50 probe but was not significantly different (Figure 4, $P = .15$). The MP50 had an average temperature increase of 4.7 ± 1.1°C and the SMV50 had an average temperature increase of 7.0 ± 1.6°C.

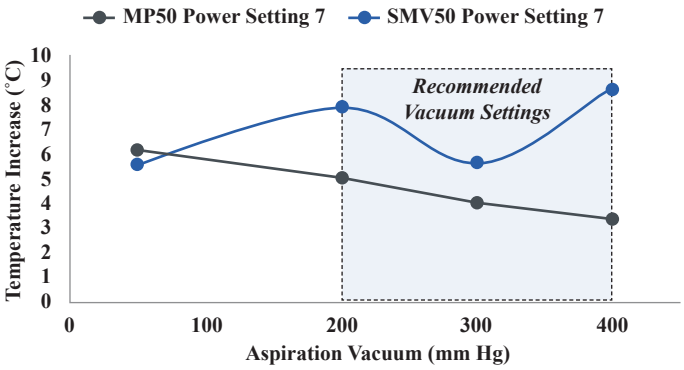

Figure 4. Three-minute average temperature increase for ablation setting 7 (SMV50 recommended setting) and all vacuum settings.

Conclusion

As aspiration vacuum pressure increased, aspiration rate increased with the MP50 showing significantly higher aspiration rates. According to the Smith & Nephew Instructions for Use, the default ablation set point 7 should be maintained at all times during wand use and the use of an ablation set point below the default setting has not been validated.[4] At recommended ablation settings for both devices, the Arthrex Apollo$^{RF®}$ MP50 performed at a lower average temperature than the Smith & Nephew Super MultiVac 50. When the MP50 probe was set to the Smith & Nephew Super MultiVac 50's recommended ablation setting of 7, there were statistically significant differences between devices and their temperature increase. Under all conditions discussed, even considering the highest temperature increases, both devices remained below the threshold for potential tissue damage. While this study only used a set inflow of irrigation fluid to replace what was aspirated by the device, additional fluid flow through the joint is possible clinically when outflow tubing is used to further moderate temperature increase.

References

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2. Voss JR, Lu Y, Edwards RB, Bogdanske JJ, Markel MD. Effects of thermal energy on chondrocyte viability. *Am J Vet* Res. 2006;67:1708-1712.
3. Matziolis G, Roehner E, Windisch C, Wagner A. The volume of the human knee joint. *Arch Orthop Trauma Surg.* 2015;135:1401-1403.
4. Smith & Nephew (ArthroCare). Instructions for Use, P/N62535, Rev.D January 2017.