In-vitro analysis of the origin and characteristics of gaseous micro-emboli during catheter electroporation ablation.

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Topic(s): Basic Science - Cardiac Diseases: Arrhythmias

Citation: Introduction: Recent studies have demonstrated that electroporation ablation may be an alternative method to thermal ablation for pulmonary vein isolation. Gas formation during arcing with direct current catheter ablation has been studied in the past, however not with non-arcing electroporation ablation.

Purpose: The aim of the present study was to visualize, quantify and characterize gas formation during non-arcing electroporation application using a multi-electrode circular catheter.

Methods: In vitro, gas formation during electroporation application was studied using a high-speed camera analysis, direct volume measurements and a bubble counter (Figure, Panel A: Set up as used for direct volume measurements. The catheter was placed underneath a funnel, attached to a 1 mL syringe. The indifferent electrode was positioned 20 cm from the ablation catheter. Figure, Panel B: Flow set up as used for BCC200 bubble counter measurements. The catheter was placed underneath a cylinder and connected to a parallel tubing system. A flow of 1 L/min was created by a centrifugal pump, which was placed between a bubble trap and an air filter. The indifferent electrode was positioned 20 cm from the ablation catheter). Gas formation was compared between cathodal and anodal electroporation applications and between a small and large catheter hoop diameter.

Results: High-speed images showed the location and speed of gas formation during cathodal and anodal electroporation applications. The direct volume measurements demonstrated a significantly larger volume for cathodal compared to anodal electroporation applications (p<0.001). A strong linear relationship was found between charge delivered and total gas volume (r=0.99) (Figure, Panel C: Mean gas volume per electroporation application vs. delivered charge (milli-coulombs). A significant difference was observed for all energy levels between cathodal and anodal electroporation applications. For both cathodal and anodal electroporation applications, a strong positive relation was seen, with a slope of 0.133 µL/mC and 0.031 µL/mC, respectively). There was no significant difference between small and large hoop diameters (Figure, Panel D: Volume per electroporation application for both 16-mm and 27-mm hoop diameters, for cathodal and anodal electroporation applications). Bubble counter measurements showed that cathodal electroporation applications produced more and larger gas bubbles as compared to anodal electroporation applications. Ratio of total gas volume between cathodal and anodal electroporation applications is different from the theoretical volume as predicted by electrolysis.

Conclusions: Anodal electroporation applications produce significantly less and smaller gas bubbles than cathodal electroporation applications. There was no significant difference between small and large hoop diameters. In-vivo experiments are required to investigate the clinical implications.
Abstract: In-vitro analysis of the origin and characteristics of gaseous micro-emboli during catheter electroporation ablation.

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