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Mechanisms of phrenic nerve injury during radiofrequency ablation at the pulmonary vein orifice.

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Abstract

BACKGROUND: The phrenic nerve can be injured with radiofrequency energy delivery. Nevertheless, the mechanisms of injury are unknown. This study was undertaken to examine phrenic nerve tissue temperatures during ablation at the pulmonary vein (PV) orifice, assess the temperature dependence of injury, and to delineate the possible mechanisms of untoward nerve effects. **METHODS:** Ten dogs underwent ablation at the right superior PV (RSPV) orifice. Phrenic nerve temperatures were assessed with implanted thermocouples overlying the endocardial ablation site. Using an 8-mm ablation catheter tip, energy was titrated to 50 degrees C and incremented by 5 degrees C for 120 seconds. **RESULTS:** Phrenic nerve capture was achieved in nine (90%) dogs after thermocouple implantation. A RSPV orifice tissue temperature >60 degrees C occurred in 32 (84%) of energy deliveries with a power of 34 +/- 22 W. In three (33%) dogs, this resulted in nerve dysfunction (maximum nerve temperature: 41 degrees C, 41 degrees C, and 91 degrees C) with histology consistent with acute thermal injury. In four additional dogs, 17 energy deliveries were made directly to the phrenic nerve using a novel in situ model. In 5 (29%) energy deliveries, nerve function was impacted immediately by the generated current, with resolution simultaneous with discontinuing radiofrequency. Transient phrenic nerve injury occurred in all dogs at a temperature of 47 +/- 3 degrees C (range: 43-53 degrees C) after 38 +/- 32 seconds (range: 20-120 seconds). After termination of the energy delivery, nerve function returned in 15(88%) during 30 seconds of postablation pacing. In two (12%) ablation attempts, nerve recovery was delayed (>3 minutes). Permanent injury occurred in all dogs after 92 +/- 83 seconds (range: 20-280 seconds) of additional energy delivery at a temperature of 51 +/- 6 degrees C (range: 45-65 degrees C). **CONCLUSION:** Phrenic nerve injury can be more common than anticipated with RF ablation at the RSPV orifice. Relatively low tissue temperatures can injure the nerve. Immediate nerve effects suggest a second mechanism of nerve dysfunction related to electrical current. Transient nerve effects occur prior to permanent damage, providing an opportunity to discontinue energy delivery before permanent injury.