

Impact of probe angulation on cryoablation zone geometry

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Purpose: The purpose of this study was to quantify any deficiencies in ice ball geometry when comparing parallel and convergent two and three cryoablation probe configurations.

Materials and Methods: Our phantom model consisted of a 8 – 10 pound beef round slab in a 37° water bath. Jigs were designed to hold 17 gauge cryoablation probes (HealthTronics, Inc) in seven different configurations. For the two-probe control experiment, the probes were placed parallel 1.0 cm and 2.0 cm apart. Convergent probe configurations were then used at 10° and 20° convergent with the tips coming to a point. For the three-probe control experiment, the probes were placed parallel 1.5 cm apart in an equilateral triangle configuration. The convergent configuration consisted of two probes placed parallel 1.0 cm apart with a third probe intersecting the tips at 10° and 20°. For each experiment, the probes underwent a 10 minute freeze- 8 minute thaw- 10 minute freeze cycle. Once the probes were removed, a volumetric CT was performed. Maximal diameters in three planes were determined and ellipsoid volume was calculated (height x width x length x 0.523). Diameter measurements were made 1 centimeter from the distal and proximal edges to evaluate polar ice loss. Significant loss of ice at the tips was defined as a 2.5 mm variation in any one direction when compared to the proximal aspect of the ice ball.

Results: The average ellipsoid volume was 53.0± 16.2 mL, 122± 35.6 mL, and 170± 23.2 mL for one, two and three probe configurations, respectively. Comparing the proximal diameter 1 cm from the edge to the distal diameter 1 cm from the edge demonstrated no clinically significant difference. The average difference in diameter for convergent probes was 0.63 mm (range -1 to 2 mm). The average difference for parallel probes was 0.28 mm (range -0.7 to 1.5 mm).

Conclusion: We found no significant variation in the distal cryoablation zone produced by parallel or converging probe configuration using two or three cryoprobes when compared to the proximal edge.

Clinical Relevance: Pre-procedure cryoablation planning can allow for 0-20° variation in convergence of 2 or 3 probes without concern for significant size variation at either the proximal or distal edge of the ice ball.