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HYPERTENSION

MICROANATOMY IMPACTS ON RDN

Catheter-based renal denervation (RDN) has had variable success in ameliorating high blood pressure in patients with drug-resistant hypertension. New results from Rami Tzafriri (CBSET, Inc.) and colleagues suggest that the dependence of ablation geometry on regional tissue microanatomy could explain the inconsistencies in RDN outcomes and why it has been less effective than originally anticipated.

The researchers used a histomorphometric analysis to determine the geometry of maximal ablation zones and the percentage of ablated nerves after RDN treatment in pigs. Complex and variable ablation geometries were identified, which contrasted with previous hypotheses that energy is distributed in symmetric cones around the electrodes, with maximal temperatures at the electrode–tissue interface.

A computational model was developed to characterize this phenomenon and provide a quantitative framework for RDN optimization. "From our model we found that tissue anatomy can dictate the depth and circumferential arc of radiofrequency energy dissipation in the tissue," explains Tzafriri. "The peak power density is achieved at interfaces of fatty and water-rich tissues, and the presence of heat sinks, such as large veins, can in some cases entirely abolish efficacy."

Data obtained from the computational model suggest that a single electrode catheter might not provide sufficient radiofrequency energy to reach the target nerves, due to distortions in the energy path caused by local anatomic variations. In support of this finding, multi-electrode irrigated catheters elicited a significant reduction in blood pressure in normotensive pigs, which correlated with the size-weighted number of degenerative nerves. "The complexity of RDN has likely been under appreciated, in part due to the intricacy of the renal artery microanatomy compared to that of the myocardium," says Tzafriri. "We now plan to evaluate how efficacy in catheter-based ablation therapies might be optimized, focusing on advancements in technologies that enable peri-procedural visualization of target nerves and their functional state, the location of neighbouring blood vessels, and development of peri-operative biomarkers."

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