Tissue Rupture and Bubble Formation During Radiofrequency Catheter Ablation

“Echoes of a Pop”

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The popping phenomenon during radiofrequency catheter ablation is well known to experienced electrophysiologists. When the electrode-tissue interface temperature increases rapidly above the boiling point, it can vaporize blood, thus causing a mini-explosion and an audible pop. Evaporation may occur intramurally, leading to gas bubble formation within the tissue. With continued energy application, this bubble expands and erupts through the weakest path, cleaving the tissues. Whether the intramural vaporization and explosion can lead to shock-wave production, with consequent cavitation and microbubble formation akin to high-energy direct-current ablation, is not known.

An intracardiac echogram at 7.5 MHz using the AcuNav catheter (Acuson Inc) during an experimental study on a pig model is shown in Figure 1. Linear epicardial radiofrequency energy applications to the left atrial appendage were delivered under direct vision using an irrigated tip catheter. Serial 60-s lesions at a power output of 25 W were applied to create a linear lesion. During one of the applications, there was an audible pop, which was seen as a mini-explosion of microbubbles in the left atrial cavity. Perforation of the left atrium occurred at this site (note the forceps through the hole in Figure 2).

Popping during radiofrequency catheter ablation is associated with unwanted effects such as blood boiling and vaporization, endocardial rupture, clot formation over the catheter/endocardium, catheter dislocation, and impedance rise. Poor electrode-tissue contact with high power during energy delivery increases the probability of pops. The images presented are a visual testimony to these physical effects within the heart; in this case, these effects were of such severity that they perforated the atrial wall.

Figure 1. Intracardiac echogram showing left atrium, interatrial septum, and a small part of right atrium on top. A mini-explosion of microbubbles can be seen emanating from 7 o’clock area and filling entire left atrial cavity.
Figure 2. Photograph of epicardial surface of pig atrium at end of procedure (4 hours after pop had occurred). A linear, greyish-white scar can be seen over left atrial appendage at site of lesion. A forceps has been passed through left atrial perforation caused by pop.
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