Is Good Contact Enough for Atrial Fibrillation Ablation?*

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T
he use of new contact force catheters has become routine in atrial fibrillation ablation with the hope that the additional contact force information will improve outcomes and reduce complications. The excitement over the use of contact force catheters stems from the fact that long-term lesion creation has not been very reliable as evidenced by reconnection of pulmonary veins shortly after isolation or atrial scar imaging using MRI (1,2). Atrial scar imaging 3 months after ablation, before contact force, has shown that as much as 50% of areas targeted for ablation did not result in long-term scar and only one-third of the pulmonary veins are completely encircled by scar despite acute isolation of pulmonary veins (2). Early studies with contact force have shown promising results with reduced procedure and fluoroscopy time (3), but the parameters that will result in stable lesions without gaps is still unknown (4). Some studies have shown improved outcome with the use of higher contact force, but the results are equivocal (5,6). Prior studies have also shown a positive correlation between increasing contact force and lesion size, but greater contact force is also associated with steam pops and perforations (7). Numerous prior works have tried addressing the issue of ideal ablation parameters such as force, power, time of ablation, impedance, and stability, but the ideal force that will result in long-term lesions while minimizing the risk of rupture is work in progress.

In this issue of JACC: Clinical Electrophysiology, Williams et al. (8) study the use of contact force for atrial ablation in a chronic porcine model. The use of an animal model allows for accurate histologic assessment beyond drawing empirical conclusions, and the chronic model allows for long-term scar assessment after the resolution of acute injury. The protocol used all the clinical parameters such as Visitag and stability to replicate a clinical scenario. Ablation was done as a continuous drag with the catheter moving every 30 s using high (>20 g) and low (<10 g) force. Linear ablation of about a 4-cm length was done using an average force of 22.6 ± 11.4 g in the high-force and 7.8 ± 4.0 g in the low-force lines. There was no difference in the creation of transmural lesions per histology and the scar volume per the late gadolinium enhanced cardiac magnetic resonance between the high- and low-force lines. The only difference was in the creation of acute edema with high contact force areas having more edema based on T2-weighted cardiac magnetic resonance done immediately post-ablation. This study highlights an important aspect of using contact force that more force is not necessarily better, and, more importantly, force >10 g is not required when ablating in the relatively thin-walled atrium. This does not come as much of a surprise as numerous prior work, although most of it in the form of acute studies, has shown that even with minimal contact force, the smallest lesion is 3 to 4 mm deep.

Before we translate these important findings to the clinical world, we need to consider certain aspects of this study. The average time spent creating these lesions was 1.64 to 1.84 min/cm. As expected, the investigators were meticulous in creating the few linear lesions in these animals. The diligent ablation could contribute to transmural lesions without gaps. The study does show that even with potentially extended time at each site, there was no adverse outcome by way of perforation or steam pop. More importantly, the use of higher force did not result in a large volume

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of lesions per the late gadolinium enhanced cardiac magnetic resonance, indicating that more force is not necessarily better. Based on this study, it seems that having just adequate contact and stability is much more important than achieving even moderate contact force. In translating this to clinical studies when assessing the role of contact force, it might be more important to look at the areas ablated at the lower end of the force time integral spectrum as a measure of contact and catheter stability rather than just looking at the mean force time integral or the contact force. Focusing on areas with really low force or lack of stability might be a better measure of areas that are less likely to result in permanent scar.

Another important finding is the higher edema at higher forces seen in the MRI studies. The time course of edema creation is on the order of minutes and not hours, and hence even relatively short procedures are affected by it (9,10). Prior studies have shown that gaps with transient changes in conductive properties can result in acute block and as the conductivity recovers conduction can be restored (11). The reconnection of isolated pulmonary veins is clinically well recognized, and the use of higher force can be a contributing factor. The goal should be to minimize the edematous areas, and, based on this study, just having adequate contact with force of <10 g might be sufficient to create durable lesions. The human atrium in most areas is approximately 2 to 3 mm thick, so even low force will adequately create transmural lesions in most of the left atrium (12). Only certain parts of the human atrium have a larger thickness of as much as 5 mm, and those areas might need a slightly greater force (12,13).

Finally, as much as contact force is a significant advancement in our field, we still lack a method to visualize ablation-related tissue changes directly. The use of MRI in assessing ablation-related tissue changes highlights the importance of direct visualization. Using a real-time MRI system while ablating further enhances our ability to detect tissue changes acutely and distinguish reversible edematous changes from areas that will result in long-term scar. Developing such a system is work in progress (14,15).

In conclusion, the study contributes significantly to the growing knowledge base of optimal force for atrial fibrillation ablations in the new era of force-sensing catheters. It seems prudent to conclude that more force is not necessarily better and if anything could be causing more short-term, reversible conduction block in addition to increasing the risk of complications. We might need to establish that there is good tip-tissue contact when ablating in the left atrium for best results.

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