Post-Ablation Atrial Arrhythmias; A Journey into the Left Atrial Labyrinth

One of the great heroes of Greek mythology was Theseus, son of Aegeus. Theseus volunteered to be 1 of 14 humans sent as sacrifices to the Minotaur; a half-man and half-bull monster hidden deep within a labyrinth. The labyrinth was so complex that no man had ever made it out. Theseus was fortunate as he met Princess Ariadne who fell in love with him and became a valuable aid in his journey. She gave him a red thread and told him to unravel it as he entered deeper and deeper into the Labyrinth. The thread would provide him a means to know the way out of the labyrinth after slaying the Minotaur. Theseus heroically killed the Minotaur ending this means of human sacrifice and escaped the labyrinth.

For all physicians that perform repeat ablations after a prior catheter ablation, minimally-invasive maze procedure, or a traditional surgical maze procedure understand the complexities and challenges of entering a left atrial labyrinth created by heterogeneity of scar, fibrosis, and myocardial tissue. Within this labyrinth often lie micro- and macro-reentrant tachycardias and focal tachycardias that slowly consume the procedural day siphoning the energy of the operator and staff. In the story of Theseus, the labyrinth was created by the great architect Daedalus as a means to control and hide the Minotaur. In the ablation world, the labyrinth that we enter is often a complex structure of the prior ablation strategy and atrial remodelling. In our repeat ablations, we encounter a labyrinth of our own creation designed to control an arrhythmia that unfortunately escaped.

In this issue of the journal, Misiri et al\(^1\) share their experience of tackling a complex atrial arrhythmia in a left atrium subjected to two prior ablations. The first ablation involved pulmonary vein isolation alone. The second ablation for recurrent atrial fibrillation involved pulmonary vein isolation and additional linear ablation along the left atrial roof and cavo-tricuspid isthmus. The authors nicely illustrate the use of a 64-electrode basket catheter for mapping that complete tachycardia cycle length. The tachycardia consistently oscillated between two distinct cycle lengths without change in the activation sequence recorded by the basket catheter. The authors concluded that the cycle length changes reflected variable conduction in the slow zone of the macro-reentrant tachycardia. They performed focal ablation along the prior roof line and shortly after beginning energy delivery the tachycardia appears to slow and then terminate.

For atrial fibrillation ablation, durable pulmonary vein isolation remains the cornerstone of the approach.\(^2\)–\(^5\) Pulmonary vein isolation relies on durable, contiguous, transmural lesions that are challenging to make with current catheter technologies. As such, recurrences of atrial fibrillation or tachycardia prompting the need for additional ablation attempts for long-term arrhythmia control are a relatively common occurrence.\(^2\)–\(^3\),\(^6\)–\(^7\) When recurrences develop, the next step for an ablation approach remains controversial. There are data to suggest in more aggressive subtypes of atrial fibrillation or with post-ablation recurrences of atrial arrhythmias that additional linear ablation may be helpful.\(^8\)–\(^11\) However, these ablation lines when not complete, provide extensive regions of slow conduction that can facilitate both macro- and micro-reentrant tachycardias (Figure 1).\(^12\)–\(^13\) After linear ablation is performed, differential pacing is required to determine if block is present. Differential pacing along a mitral annular line with a multi-electrode linear catheter is relatively straightforward and familiar to most operators due to experience with typical right atrial flutter. Additional lines that may be placed along the roof or anterior septum may be more difficult to confirm complete block due to their location and challenges in placing confirming catheters that span the line. Even in the best case scenario in which linear block is confirmed, recovery of conduction, particularly along the mitral annulus, is relative common.\(^13\) As such, it is not surprising that in one study linear ablation of the mitral annulus was the strongest predictor of subsequent mitral annular tachycardia.\(^14\) Unfortunately if these types of arrhythmias develop post ablation, freedom from all types of atrial arrhythmias over time is significantly reduced.\(^11\),\(^14\)–\(^15\)

These challenges continue to create a fertile environment for research into catheter ablation for atrial fibrillation. We still struggle with the concept of how much ablation to apply to each disease state to maximize the efficacy of the procedure without increasing risk or the potential of proarrhythmia. Studies and reports such as the one by Misiri
et al help our understanding of post ablation arrhythmia mechanisms and approaches. These same concepts can be applied to the upfront ablation strategy as we plan the long-term care of our atrial fibrillation patients.

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References


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