CATHETER ABLATION FOR ATRIAL FIBRILLATION USING THE ABLATION INDEX-HIGH POWER STRATEGY. Do we have the ideal target?

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Abstract

Pulmonary vein isolation (PVI) is the cornerstone of catheter ablation for atrial fibrillation (AF) However AF recurrence after a single ablation procedure is common and often attributed to ineffective lesion delivery during PVI. In this issue of the Journal of Cardiovascular Electrophysiology, Chen et al reported their experience with 122 patients who underwent an ablation index-high power (AI-HP) strategy RF ablation for AF using 50W power, targeting AI values of 550 on the anterior left atrium (LA), 400 on the posterior wall and inter-lesion distance (ILD) 6mm. They achieved 1st pass PVI in 96.7% of cases, mean RF time was 11.5min and total procedure time was only 55.8min. All patients had 72h-Holter monitor and trans-telephonic follow up. They reported 89.4% arrhythmia free survival among patients with paroxysmal AF and 80.4% among patients with persistent AF at 15-month follow up. Sixty (49%) patients had luminal esophageal temperature (LET) >390C out of which 3 (2.5%) had asymptomatic endoscopic esophageal erosions/erythema. Four (3%) patients had clinically apparent steam pops during ablation with no adverse clinical sequela. While AI-HP guided RF ablation may be an attractive strategy for PVI that likely reduces procedure times and probably has comparable efficacy to conventional ablation settings, its safety requires further evaluation. Feedback from the ablated tissue may need to be incorporated into optimized ablation energy parameters to further improve outcomes.

Catheter ablation for atrial fibrillation using the Ablation Index-High power strategy. Do we have the ideal target?

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Pulmonary vein isolation (PVI) is the cornerstone of catheter ablation for atrial fibrillation (AF). Radiofrequency (RF) ablation has evolved significantly over the past two decades with the evolution of 3D electroanatomic mapping, intracardiac echocardiogram (ICE), contact force sensing catheters and catheter irrigation. Nonetheless, the overall freedom from AF after a single ablation is only about 70% using conventional ablation strategies(1–3). Many AF recurrences can be attributed to incomplete PVI due to ineffective lesion delivery at the index ablation(4).

When performing PVI, the goal of ablation is to create a transmural lesion while avoiding collateral damage to vital structures especially the esophagus given its proximity to the posterior wall of the left atrium. Energy delivered during ablation is converted to heat and causes tissue damage by resistive and conductive heating. Resistive heating occurs when energy delivered from the ablation catheter is converted to heat as it passes through tissue to the ground electrode while conductive heating is due to heat energy being passively transferred from the hot lesion core to the adjacent tissues(5). Several variables have been evaluated in the search for ideal ablation parameters including power and duration of energy application, impedance fall, contact force, catheter stability and inter-lesion distance among others. Ablation index (AI) is a proprietary objective descriptor calculated from contact force, power and duration of a stable catheter position in a weighted formula. AI is independent of impedance fall, though an analysis of 1,013 ablations by Ullah et al showed that AI had a strong correlation with impedance fall(6).

In this issue of the Journal of Cardiovascular Electrophysiology, Chen et al reported their experience with 122 patients who underwent an ablation index-high power (AI-HP) strategy RF ablation for AF using 50W power, targeting AI values of 550 on the anterior left atrium (LA), 400 on the posterior wall and inter-lesion distance (ILD) 6mm. They achieved 1st pass PVI in 96.7% of cases, mean RF time was 11.5min and total procedure time was only 55.8min. All patients had 72h-Holter monitor and trans-telephonic follow up. They reported 89.4% arrhythmia free survival among patients with paroxysmal AF and 80.4% among patients with persistent AF at 15-month follow up. Sixty (49%) patients had luminal esophageal temperature (LET) >39^{0}C out of which 3 (2.5%) had asymptomatic endoscopic esophageal erosions/erythema. Four (3%) patients had clinically apparent steam pops during ablation with no adverse clinical sequela.

Despite the fact that there was no comparison group in this study, their rate of 1st pass PVI is compelling. The paucity of randomized controlled trials on AI guided AF ablation makes it challenging to draw strong conclusions regarding its incremental benefit over conventional strategies. Moreover, what are the best AI targets and ablation power for an ideal ablation lesion? Taghji et al used strict criteria to define lesion depth and contiguity targeting ILD [?]6mm and AI [?]400 on posterior LA and [?]550 on anterior LA defined as the CLOSE protocol while using ablation power 25-35W(7). They reported 98% 1st pass PVI and 91% single procedure freedom from atrial tachycardia/atrial fibrillation (AT/AF) at 12 months among 104 consecutive patients with paroxysmal AF off antiarrhythmic drug therapy. Hussein et al showed similar success rates using the same AI targets (400/550) but higher power settings (30-40W) in 89 patients with drug refractory AF(8). Another study by Solimene et al showed only 10.8% atrial arrhythmia recurrence among 156 patients with symptomatic AF when the target AI values were 330-350 on LA posterior wall and 400-450 on anterior wall with ablation power 25-35W(9). These studies used different ablation power and AI targets but showed comparable acute success rates to the AI-HP strategy, which appear to be higher than those reported in prior randomized trials using conventional ablation techniques(1–3,10). However, caution should be taken when interpreting success results from small, non-randomized trials. For instance, the AI-HP study appears to have included a population with less advanced AF since the mean LA size and LV function were within the normal range even though 46% of their patients had persistent atrial fibrillation. Ablation beyond PVI was rare in this study, 17 (13.9%) underwent cavo-tricuspid isthmus ablation and only 4 patients underwent additional linear LA ablation.

Energy delivered is a product of power and duration of application of that power. Thus, high-power settings allow an equivalent amount of energy to be delivered over a shorter duration to achieve defined AI targets or impedance falls, potentially reducing total ablation and procedure times. Indeed, the authors report an impressive mean RF time of 11.5mins and total procedure time of 55.8mins, essentially less than half the time reported in the CLOSE protocol or the QDOT-FAST trial(7,11). Some of this difference may be explained by the use of deep sedation as opposed to general anesthesia, intracardiac echocardiogram (ICE) was not utilized and assessment of dormant PV conduction was not routinely performed post-ablation.

While high power short duration ablation with prespecified ablation index targets potentially saves time and appears acutely effective, improvement in safety endpoints compared to conventional ablation strategies has not clearly been established. In fact, the authors report a 3% (4/122) incidence of steam pops even though there was no documented pericardial effusion or cardiac tamponade. Much of the energy delivered during ablation is lost to convective cooling from catheter irrigation and surrounding blood pool. Therefore, using standard catheter irrigation settings, ablation using lower power needs to be delivered over a longer duration to allow the endocardium reach target temperatures for irreversible injury. This longer duration allows more time for conductive heating to occur in deeper tissues. Ablation using high power settings (50W) utilizes more resistive heating to create lesions and overcome the endocardial sparing with standard irrigation. This may potentially minimize the time for conductive heating to deeper tissues to occur. However, a significant proportion of patients in this study (49%) still had LET $>39^0$C although no reported cases of atrio-esophageal fistula occurs and a small fraction (2.5%) had asymptomatic esophageal erosions/erythema at endoscopy. This would suggest that in the thin posterior LA, high power settings will not somehow violate thermodynamic principles and completely eliminate heating of deeper structures. At the same power, decreasing catheter irrigation rate can allow target endocardial lesion formation to occur over a shorter duration and potentially reduce conductive heat injury to deeper tissues(12). It is also important to note that monitoring esophageal temperature using single thermistors may not accurately portray the risk of esophageal injury especially when these thermistors are far from the ablation site.

The durability of PVI using the AI-HP strategy cannot be assessed based on this study. Eighteen patients had recurrent AT/AF (12 AF, 6 AT), out of which 9 underwent redo ablation procedures. 5 patients had durable PVI, a rate comparable to prior published studies using conventional ablation strategies(1–3). One must exercise caution in equating freedom for AF with PVI durability since not all patients with reconnected PVs will manifest recurrent AT/AF.

The AI-HP strategy only considers ablation energy settings during stable catheter contact but does not include catheter irrigation. It also neglects other important parameters like tissue impedance fall and local electrogram attenuation post ablation which are more reflective of the effects of ablation on the tissue. While AI-HP guided RF ablation may be an attractive strategy for PVI that likely reduces procedure times and probably has comparable efficacy to conventional medium power ablation settings, the incidence of steam pops and continued observation of esophageal heating suggests that the safety of this strategy still requires further evaluation. Feedback from the ablated tissue may need to be incorporated into optimized ablation energy parameters to further improve outcomes, such that lower AI values may be acceptable if steep impedance falls and electrogram attenuation occurs before target AI values are reached.

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