Catheter ablation using the third-generation cryoballoon provides an enhanced ability to assess time to pulmonary vein isolation facilitating the ablation strategy: Acute and long-term results of a multicenter study

Arash Aryana, MS, MD, FHRS,[*] Marcin Kowalski, MD,[†] Padraig Gearoid O'Neill, MD,[*] Charles H. Koo, MD,[‡] Hae W. Lim, PhD,[§] Asif Khan, MD,[†] Robert B. Hokanson, BA,[§] Mark R. Bowers, MS, MD,[*] David N. Kenigsberg, MD,[‖] Kenneth A. Ellenbogen, MD[¶] Cryo-DOSING Investigators

From the [*]Mercy General Hospital and Dignity Health Heart and Vascular Institute, Sacramento, California, [†]Staten Island Heart and North Shore-LIJ Health System, Staten Island, New York, [‡]Jersey Shore University Medical Center, Neptune, New Jersey, [§]Medtronic, Inc., Minneapolis, Minnesota, [‖]Florida Heart Rhythm Specialists, Fort Lauderdale, Florida, and [¶]Virginia Commonwealth University Medical Center, Richmond, Virginia.

BACKGROUND Limited data exist on cryoablation of atrial fibrillation (Cryo-AF) using the newly available third-generation (Arctic Front Advance-Short Tip [AFA-ST]) cryoballoon.

OBJECTIVE In this multicenter study, we evaluated the safety and efficacy of Cryo-AF using the AFA-ST vs the second-generation (Arctic Front Advance [AFA]) cryoballoon.

METHODS We examined the procedural safety and efficacy and acute and mid-term results from 355 consecutive patients (72% with paroxysmal AF) who underwent a first-time Cryo-AF using AFA-ST (n = 102) or AFA (n = 253).

RESULTS Acute isolation was achieved in 99.6% of all pulmonary veins (PVs) (AFA-ST: 100% vs AFA: 99.4%; $P = .920$). Time to pulmonary vein isolation was recorded in 89.2% of PVs using AFA-ST vs 60.2% using AFA ($P < .001$). PVs targeted using AFA-ST required fewer applications (1.6 ± 0.8 vs 1.7 ± 0.8; $P = .023$), whereas there were no differences in balloon nadir temperature (AFA-ST: −47.0°C ± 7.3°C vs AFA: −47.5°C ± 7.8°C; $P = .120$) or thaw time (AFA-ST: 41 ± 24 seconds vs AFA: 44 ± 28 seconds; $P = .056$). However, AFA-ST was associated with shorter left atrial dwell time (43 ± 5 minutes vs 53 ± 16 minutes; $P < .001$) and procedure time (71 ± 11 minutes vs 89 ± 25 minutes; $P < .001$). Furthermore, Cryo-AF using AFA-ST was more frequently completed by "single-shot" PV ablation (27.4% vs 20.2%; $P = .031$). Persistent phrenic nerve palsy (AFA-ST: 0% vs AFA: 0.8%; $P = .507$) and procedure-related adverse events (AFA-ST: 1.0% vs AFA: 1.6%; $P = .554$) were similar, as was the freedom from recurrent atrial arrhythmias at 10 months (AFA-ST: 81.8% vs AFA: 79.9%; $P = .658$).

CONCLUSION Cryo-AF using AFA-ST offers an enhanced ability to assess time to pulmonary vein isolation, allowing for fewer cryoapplications and shorter left atrial dwell time and procedure time. Consequently, Cryo-AF using AFA-ST could be completed more frequently through single-shot PV ablation with equivalent safety and efficacy.

KEYWORDS Catheter ablation; Atrial fibrillation; Cryoablation; Cryoballoon; Pulmonary vein isolation

(Heart Rhythm 2016;0:-1–8)

Introduction

Contemporary studies of cryoablation of atrial fibrillation (Cryo-AF) using the second-generation cryoballoon (Arctic Front Advance [AFA] Medtronic, Inc., Minneapolis, MN) have adopted shorter and fewer cryoapplications while still demonstrating acceptable clinical outcomes.[1–3] Although there are presently no uniform guidelines on the optimal Cryo-AF dosing, a greater emphasis has recently been placed on directing this procedure through objective and quantifiable procedural and biophysical markers.[2] Several studies have identified the time to pulmonary vein (PV) isolation (TT-PVI) as an essential indicator of acute and durable PVI.[4–7] Furthermore, this has shown to reduce the requirement for the number of cryoapplications as well as procedural duration and fluoroscopic utilization.[8] However, TT-PVI cannot always be

Dr Aryana, Dr Ellenbogen, Dr Kenigsberg, Dr Kowalski, and Dr O'Neill have received consulting fees and speaker honoraria from Medtronic. Dr Aryana and Dr O'Neill have received a research grant from Medtronic. Dr Koo is a member of the Medtronic strategic advisory board. Dr Lim and Mr Hokanson are employees of Medtronic. **Address reprint requests and correspondence:** Dr Arash Aryana, Department of Cardiology and Cardiovascular Surgery, Mercy General Hospital and Dignity Health Heart and Vascular Institute, 3941 J St, Suite #350, Sacramento, CA 95819. E-mail address: a_aryana@outlook.com.

1547-5271/$-see front matter http://dx.doi.org/10.1016/j.hrthm.2016.08.011

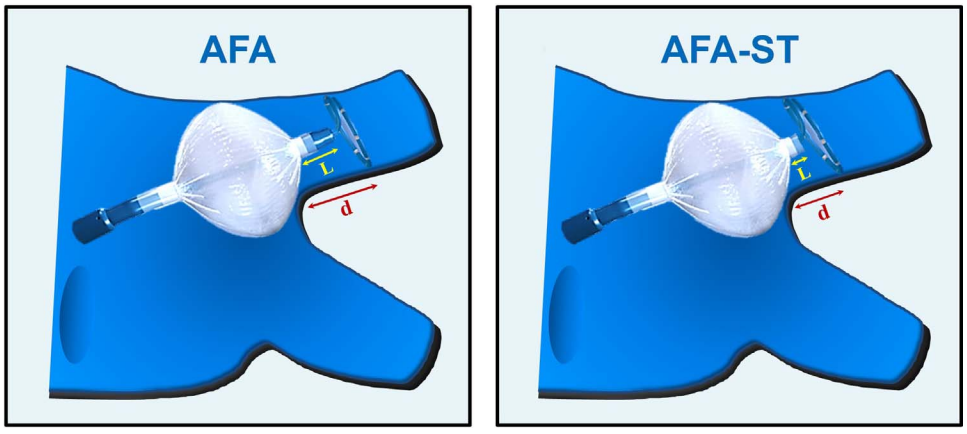

Figure 1 An illustration depicting the principal design change between AFA and AFA-ST cryoballoons. As shown, the length of the distal tip (L) of the AFA-ST cryoballoon is ~40% shorter than that of the AFA cryoballoon (8 mm vs 13 mm, respectively), thereby allowing farther withdrawal (d) of the inner lumen circular mapping catheter via the cryoballoon to a more proximal location within the pulmonary vein ostia. AFA = Arctic Front Advance; AFA-ST = Arctic Front Advance-Short Tip.

measured during Cryo-AF using the AFA balloon.[9] This is at least in part related to the design of this catheter. That is, the AFA catheter's long distal tip can frequently impede sufficient withdrawal of the inner lumen circular mapping catheter (Achieve, Medtronic, Inc.) to a proximal location in the PV ostia where the muscular sleeves typically lie. Consequently, this has led to the development of a third-generation cryoballoon (Arctic Front Advance-Short Tip [AFA-ST], Medtronic, Inc.). Specifically, the 8-mm distal tip of the AFA-ST cryoballoon is ~40% shorter than the 13-mm tip of the AFA cryoballoon. Aside from its significantly shorter distal tip, the design of this novel balloon is overall remarkably similar to that of the AFA cryoballoon (Figure 1). However, there is little data on the safety and efficacy of Cryo-AF using the AFA-ST ablation catheter.

In this multicenter study using a nonrandomized, double-arm, prospective design, we retrospectively analyzed the acute procedural characteristics and the clinical outcomes (acute and mid-term safety and efficacy) of Cryo-AF using the AFA-ST vs the AFA cryoballoons in a large cohort of patients with symptomatic paroxysmal and persistent atrial fibrillation (AF).

Methods

Study patients

The study cohort consisted of consecutive patients undergoing a first-time Cryo-AF for symptomatic paroxysmal/persistent AF between March and November 2015. The procedures were performed by 6 experienced operators at 5 centers. The study sites included Mercy General Hospital (Sacramento, CA), Staten Island University Hospital (Staten Island, NY), Jersey Shore University Medical Center (Neptune, NJ), Westside Regional Medical Center (Plantation, FL), and Broward Health Medical Center (Fort Lauderdale, FL). Approval for this study was granted by each facility's institutional review board.

Procedural details

Briefly, diagnostic electrophysiology catheters including a coronary sinus decapolar and a right atrial quadripolar catheter were positioned for recording and pacing, followed by single transseptal catheterization. Intravenous heparin was administered at the time of transseptal puncture followed by an infusion (target activated clotting time ≥300 seconds). All patients underwent PVI using a 23-mm or a 28-mm AFA or AFA-ST cryoballoon catheter inserted through a 12-F steerable sheath (FlexCath, Medtronic, Inc.) over a 20-mm inner lumen circular mapping (Achieve) catheter. In the first phase of the study, all procedures were performed using the AFA balloon. During the second phase, once the AFA-ST balloon became commercially available, all the procedures were then completed using the AFA-ST balloon. Balloon size selection was guided by PV size/anatomy as determined by preprocedural computed tomographic angiography, intraprocedural left atrial (LA) angiography, or intraprocedural intracardiac echocardiography. Optimal cryoballoon positioning was confirmed by PV angiography. All operators followed the same protocol for cryoablation. Attempts were made to specifically record TT-PVI during ablation of each PV during every case. Based on the currently available data, between 1 and 2 effective cryoapplications were delivered to each PV, guided by TT-PVI. That is, a single cryoapplication was delivered to a PV if TT-PVI measured ≤60 seconds, whereas a second cryoapplication was delivered if TT-PVI >60 seconds or simply could not be measured. Those cryoapplications that did not achieve a TT-PVI of ≤90 seconds were abandoned. PVI was confirmed by testing for entrance/exit block and after the administration of intravenous adenosine. Luminal esophageal temperature was monitored throughout ablation. Esophageal temperatures <15°C were avoided. During cryoablation of the right PVs, high-output right phrenic nerve (PN) stimulation (10–25 mA; 1000–1200 ms) was performed using the diagnostic quadripolar catheter from within the superior vena cava. Whenever diminished or loss of pacing capture was