Atrial Fibrillation Ablation with Cryoballon and Rotors Modulation: Local Experience with Initial 40 Cases

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Abstract: Medical treatment for atrial fibrillation has been unsatisfactory for symptomatic patients who fail anti-arrhythmic drug therapies. Ablations, which have become safer and efficient, provide more options for some.

Atrial fibrillation (AF) currently affects more than 2 million US adults. It is a leading cause of hospitalization, congestive heart failure, death and perhaps dementia. Rates of inadequate responses to therapy intended to control ventricular rate, or to restore and maintain sinus rhythm have been disappointing. Since the observation of Haissaguerre, et al that ectopic beats from the muscle fibers in the vicinity of pulmonary veins can trigger AF in the vulnerable left atrial, percutaneous procedures were designed to electrically sequester the arrhythmogenic pulmonary veins (PVs) from the rest of the atrium. Point by point welding of the atrial tissue with radio frequency energy has been the standard method to isolate the PVs. That procedure is time-consuming and its effectiveness to achieve durable transmural lesions is unpredictable. Over the last decade, cryoballon ablation, by achieving a tissue temperature below -50°C, has emerged as an effective alternative method to induce durable circumferential lesions in the antrum of PVs with shorter procedure time. Medtronic Arctic Front cryoballon system was used in more than 70,000 procedures globally with long term success being equal to or perhaps better than radio frequency ablation and with a lesser risk of complications of thromboembolism and post-op atrial arrhythmias.

Ectopies from the PVs can surely trigger AF, but instances of sustained AF after the trigger mechanism had been suppressed defy explanation. Results from animal and clinical studies indicate that both paroxysmal and persistent AF are sustained by spiral waves (rotors) and focal sources. The locations of rotors and focal sources are patient specific and are sufficiently stable to be mapped and eliminated by localized ablation. Focal Impulse and Rotor Modulation, so called "FIRM" is an FDA-approved procedure for AF ablation since 2013.

The authors have been performing cryoballon ablations and FIRM-guided ablations for AF over the last two years. This article is reporting results of our first 20 cases of cryoballon and first 20 cascs of FIRM-guided ablations in patients with AF.

Methods
All patients with persistent symptomatic AF despite anti-arrhythmic therapy were informed of cryoballon ablations and FIRM-guided ablations as options. The inclusion criteria: candidates for general anesthesia, have TEE proven clean left atria with absence of thrombus in the atrium and atrial appendages, and established adequate oral anticoagulants for at least 3 weeks. Warfarin [Coumadin®] was continued throughout the pre-op and post-op periods. New oral anticoagulants (NOAC) were discontinued 36-48 hours before the procedures, and resumed 2-3 hours after the procedures once adequate hemostasis was achieved at the vascular access sites. During the procedure, all patients received heparin titrated to maintain ACT >350 seconds. Prior anti-arrhythmic drug therapies were continued for three months after the procedure (blanking period), and other than cardioversion for symptomatic arrhythmias, no repeated EP procedures were performed within that 3-month period. Recurrence of AF, defined as any AF lasting longer than 30 seconds was monitored at office visits ascertained using EKGS, Holter recordings at 3, 6 and 9 months, and some patients had clinically indicated pacemakers and ICDs with AF detection algorithms.

Cryoballon Ablation Procedure:
Deflectable "Flex Cath" is placed via trans-septal puncture into the left atrium. A 28mm diameter 2nd Generation Cryoballon with circular mapping catheter (Achieve-TM) is placed in the

![Image](image_url)

Fig 1. Contrast injection to the left superior pulmonary vein to confirm complete occlusion of the vein with no leaking of contrast back to the left atrium. Patient had mitral tissue prosthetic valve.

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pulmonary vein after ACT is > 350 seconds. Circumferential occlusion of the pulmonary vein is confirmed by contrast injection, (Fig 1) end-tidal CO2 reduction and wedge pressure recording from the distal port of the cryoballon.

Freeze and thaw cycle of 3-4 minutes was started. Dissociation of PV potential from the left atrium far-field potential is indicative of effective ablation. (Fig 2)

The esophageal temperature probe is moved as close as possible to the cryoballon. If at any time the esophageal temperature drops below -25°C, freezing is terminated to avoid esophageal damage. A rapid drop to -40°C within 30 seconds of freezing also requires that freezing is stopped immediately, because it indicates that the balloon is located too far distally, thus risking damage to the pulmonary veins. The sequence of ablation proceeds initially with the left superior pulmonary vein, followed by the left inferior pulmonary vein, right inferior pulmonary vein, and lastly the right superior pulmonary vein. Ablation of the right pulmonary veins confers risk of damage from hypothermia because of the close proximity of the right phrenic nerve. Using general anesthesia without paralytic agents, pacing the phrenic nerve is achieved by an electrode placed at the high SVC. The strength of diaphragmatic excursion is ascertained by placing the operator's hand over the patient's right lower abdomen. Any reduction of contractile power of abdominal muscle requires immediate termination of cryoablation to avoid phrenic nerve damage. After all the PVs are ablated, the circular mapping electrode is again placed into each vein to confirm continued electrical isolation. If the patient remains in AF, electric cardioversion is performed before the patient is recovered from general anesthesia. Patients are discharged after an over-night stay.

FIRM-guided procedure: An intra-cardiac echocardiogram (ICE) catheter is used to guide trans-septal puncture, and to measure the left atrial size, which dictates selection of the optimal 50, 60 or 70 cm diameter mapping basket size. Electro-anatomical mapping of the left atrium is obtained using Carto system (BioSense Webster, Diamond Bar, California). A 64-pole mapping basket of proper size is deployed inside the left atrium with a deflectable sheath. (Fig 3)

Contact of the basket to the atrial wall is of paramount importance for accurate mapping of rotors and focal impulses. Mapping is done in AF, so if the patient is in sinus rhythm, then rapid atrial pacing is performed to induce AF. AF recordings from the widefield-of-view basket are exported for analysis to a computa-

Fig 2. Progressive separation of atrial potential (A) from pulmonary vein potential (PV) until complete block in the 4th complex

Fig 3. 64 poles Mapping basket deployed in left atrium with ablation catheter placed over base of left appendage for energy application to the rotor

Fig 4. AF termination during rotor ablation

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A pressure-sensitive electrode was used recently for ablations. The area of ablation averaged 2 square cm. The rotors have no local electronic "finger print", and was not related to complex fractionated atrial electrogram (CFAE). After all rotors and foci are ablated, repeat mapping is done to confirm rotor elimination. Based on the results of PRECISE-PAF Trial and other recent studies, no pulmonary veins isolation is performed. Electrical cardioversion is done if the patient is still in AF and patients are discharged after an overnight stay. The demographic characteristic of the patients and the results are tabulated in Table 1.

Discussion:
Both cryoballoon ablation and FIRM-guided procedures effectively achieve sinus rhythm in patients with paroxysmal and persistent AF, with a success rate in excess of 70%. In our small study, FIRM-guided ablation patients had more unfavorable demographic factors such as sleep apnea, COPD, obesity, low left ventricular ejection fraction, longer duration in AF and larger left atrial size. Our lab acquired the equipment to perform FIRM ablation procedures later, so follow-up of FIRM cases was accordingly shorter. Two of the 4 patients who had AF recurrence after cryoballoon ablation subsequently underwent FIRM procedures with no clinical recurrence.

Cryoballoon ablation can stop AF "Cold". FIRM-guided ablation is "Scorching Hot". These ablations can be accomplished "Fast and Furious" with minimal collateral damage to the surrounding tissues. There were no major complications in our series. Perhaps, we are closer to a cure for the arrhythmia than before. With ongoing technical advances and clinical experience, the procedures can stop AF among patients, and thus prevent complications of AF such as congestive heart failure, stroke, cardiovascular disease. Especially in younger patients, it is important to terminate AF early to preempt progression to irreversible mechanical and electrical remodeling of the atria.

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REFERENCES
9. Calkins H Has the time come to abandon the concept that "Pulmonary vein isolation is the cornerstone of AF ablation"? Circ Arrhythm Electrophysiol 2013; 6:241-242

Table 1 Demographic of all the 40 patients

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Cryoballoon (first 20 patients)</th>
<th>Topera FIRM (first 20 patients)</th>
</tr>
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<tbody>
<tr>
<td>Age</td>
<td>74 years</td>
<td>72 years</td>
</tr>
<tr>
<td>Male/female</td>
<td>8/12</td>
<td>14/6</td>
</tr>
<tr>
<td>Left atrial dimension by echo</td>
<td>4.6 cm</td>
<td>4.9 cm</td>
</tr>
<tr>
<td>LV Ejection fraction by echo</td>
<td>50%</td>
<td>45%</td>
</tr>
<tr>
<td>Presence of hypertension</td>
<td>100%</td>
<td>95%</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>30%</td>
<td>35%</td>
</tr>
<tr>
<td>Body weight</td>
<td>356 lb [separate M/F]</td>
<td>344 lb [separate M/F]</td>
</tr>
<tr>
<td>AF duration (estimate)</td>
<td>3.5 years</td>
<td>4.8 years</td>
</tr>
<tr>
<td>Implantable cardiac monitor/pacemaker/ICD</td>
<td>7/20</td>
<td>6/20</td>
</tr>
<tr>
<td>Follow-up from procedure up to 10/1/2015</td>
<td>415 days</td>
<td>224 days</td>
</tr>
<tr>
<td>Recurrence of AF during follow-up</td>
<td>20% (4/20)</td>
<td>25% (5/20)</td>
</tr>
<tr>
<td>Success rate (sinus rhythm with no anti-arrhythmic)</td>
<td>80%</td>
<td>75%</td>
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