Catheter Ablation in Atrial Fibrillation

J. Thanavaro DNP, AGACNP-BC, AGPCNP-BC, DCC, FAANP

Learning Objectives

• Identify indications and rationale for catheter ablation (CA) for Atrial Fibrillation (AF) and summarize primary ablation techniques including pulmonary vein isolation, pulmonary vein antrum isolation, circumferential ablation and advanced techniques
• Explain hospital management for patients undergoing CA including screening for LA thrombus, interrupted and uninterrupted anticoagulation, intraprocedural anticoagulation monitoring and antiarrhythmic therapy
• Describe and select appropriate management strategies for complication of CA and summarize discharge planning and follow up care

Significance of AF

• 33 million people have AF world wide
• 3–5 million people in the United States
• By 2050, app. 8 million people will be affected in the United States
• AF increases risk of stroke on average 5-fold
• AF increases heart failure, dementia, and total mortality
• 450000 hospitalizations in the United States
• 90000 deaths related to AF in the United States

Basic Foundations of AF Management

• Anticoagulation & rate control for all patients
• Rhythm control for patients with symptoms
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Rate control

- More frequently considered for newly diagnosed AF
- Younger patients with fewer comorbidities & severe symptoms
- Those more likely to gain added benefits from this tx

Rhythm Control

- Not all patients with AF need to have SR restored
- Highly symptomatic patients with recurrent AF may have symptom improvement with sinus rhythm

Rate Control for AF

- Rate reduction allows time for ventricular filling
- May help avoid rate–related ischemia
- Improves hemodynamics

General Recommendations
- Ventricular rates between 90-115 with moderate exercise
- 60-80 beats/min during rest

Factors for rhythm Control

- Severity of symptoms
- Absence of comorbidities for AF recurrence
- Likelihood of successful cardioversion
- Patient’s eligibility for AF ablation

Benefits of Sinus Rhythm Restoration

- May terminate or reverse pathological atrial and ventricular remodeling
- Restores the atrial contribution to cardiac output
- Does not reduce stroke risk or increase long term survival

Individualized plan of care

- Patient preference
- Analysis of risk & potential benefits
- Cost factors
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- CA has become the most commonly performed technique for treating patients with severe symptomatic AF
- CA is a feasible alternative for rhythm control for patients with drug intolerance or medical treatment failure
- Many indications which depend heavily on the AF classification system

Catheter Ablation of AF

Indications for AF Ablation

Surgical AF Ablation

Indications for Concomitant Closed (Such as CABG or AVR) Surgical Ablation of AF

Indications for Stand-Alone Surgical Ablation of AF
After review of relative safety and efficacy vs catheter ablation.

**Surgical AF Ablation**

**AF Mechanisms and Ablation Concepts**

**Pulmonary Vein Isolation**
- Empiric isolation of all pulmonary veins (PVs) is favored procedure because of difficulty in identifying the arrhythmogenic foci during the initial ablation.
- Multiple ectopic foci from the same or other pulmonary veins may be present with AF recurrence.

**Types of Catheter Ablation**
- **Pulmonary Vein Isolation**
  - Pulmonary Vein isolation (PVI) or pulmonary vein antrum isolation (PVAI), antrum pulmonary vein ablation (APVA), & circumferential ablation are the most commonly performed techniques.
Advanced Catheter Ablation

• Stepwise ablation
  • Creating more linear lesions in the left atrium similar to those recommended for the Cox-Maze III procedure

Advanced Catheter Ablation

• Ablation of complex fractionated atrial electrograms (CFAE)
  • Ablation of a macro re-entry site with various electrical frequency (a maximum or a minimum), duration of the electrical wave (short or long), or the velocity of conduction (slow or fast)

Advanced Catheter Ablation

• Ganglionic plexi ablation
  • Ablation of an area rich in autonomic innervation located 1-2 cm from the pulmonary vein ostia (ganglion plexi)

Advanced Catheter Ablation

• Ablation of dominant frequency/rapid atrial drivers
  • Ablation of a high frequency re-entry focus in the atrium with random dispersion and different wavelengths

Advanced Catheter Ablation

• Ablation of Marshall ligament/vein
  • Ablation of Marshall ligament/vein, a vestigial fold of the cardinal vein, rich in ganglion plexi.

Advanced Catheter Ablation

• Hybrid Ablation
  • A dual ablation approach in which an electrophysiologist performs catheter ablation from the endocardium and a cardiac surgeon performs ablation from the epicardium
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Ablation for Rate Control Strategy
• Ablation of the atrioventricular (AV) nodal to create a permanent inhibition of electrical conduction from the atria to the ventricles. Permanent pacemaker implantation is required to maintain adequate ventricular rate

Preablation Screening for Left Atrial Thrombus (LAT)
• Screening transesophageal echocardiogram (TEE) to detect LAT has been recommended
• LAT is an absolute contraindication to ablation
• Need for TEE now called into question especially when consistent concomitant DOACs have been used for several weeks
• Current studies consider uninterrupted DOACs without TEE safe
• Use of pre-ABL TEE has decreased over the past few years

Periprocedural Management
• Minimize thromboembolic risk without significantly raising chance of excessive bleeding
• Two approaches to anticoagulation
  • Interrupted
  • Uninterrupted

Interrupted Drug Strategy
• Stopping oral anticoagulation before the procedure with or without bridging with another anticoagulant
• Early experience: stop warfarin and bridge with either unfractionated heparin (UFH) or low molecular weight heparin (LMWH)

Uninterrupted Approach
• Continuation of anticoagulation therapy throughout the periprocedural period
• Now generally accepted as standard of care

Recommendations for Pre-ablation Anticoagulation
• For patients undergoing AF catheter ablation who have been therapeutically anticoagulated with warfarin or dabigatran, performance of the ablation procedure without interruption of warfarin or dabigatran is recommended

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Recommendations for pre-ablation anticoagulation
• For patients undergoing AF catheter ablation who have been therapeutically anticoagulated with a NOAC other than dabigatran or rivaroxaban, performance of the ablation procedure without withholding a NOAC dose is reasonable
• Anticoagulation guidelines that pertain to cardioversion of AF should be adhered to in patients who present for an AF catheter ablation procedure
• For patients anticoagulated with a NOAC prior to AF catheter ablation, it is reasonable to hold one to two doses of the NOAC prior to AF ablation with reinitiation post ablation

HRS/EHRA/ECAS expert consensus statement on catheter and surgical ablation of atrial fibrillation. Heart Rhythm, Vol 14, No 10, October 2017

Recommendations for anticoagulation during ablation
• Heparin should be administered prior to or immediately following transseptal puncture during AF catheter ablation procedures and adjusted to achieve and maintain an ACT of at least 300 seconds
• Administration of protamine following AF catheter ablation to reverse heparin is reasonable

HRS/EHRA/ECAS expert consensus statement on catheter and surgical ablation of atrial fibrillation. Heart Rhythm, Vol 14, No 10, October 2017

Recommendations for anticoagulation post ablation
• In patients who are not therapeutically anticoagulated prior to catheter ablation of AF and in whom warfarin will be used for anticoagulation post ablation, low molecular weight heparin or intravenous heparin should be used as a bridge for initiation of systemic anticoagulation with warfarin following AF ablation
• Systemic anticoagulation with warfarin* or a NOAC is recommended for at least 2 months post catheter ablation of AF

HRS/EHRA/ECAS expert consensus statement on catheter and surgical ablation of atrial fibrillation. Heart Rhythm, Vol 14, No 10, October 2017

Recommendations for anticoagulation post ablation
• Adherence to AF anticoagulation guidelines is recommended for patients who have undergone an AF ablation procedure, regardless of the apparent success or failure of the procedure
• Decisions regarding continuation of systemic anticoagulation more than 2 months post ablation should be based on the patient’s stroke risk profile and not on the perceived success or failure of the ablation procedure

HRS/EHRA/ECAS expert consensus statement on catheter and surgical ablation of atrial fibrillation. Heart Rhythm, Vol 14, No 10, October 2017

CHADS2 Score | CHA2DS2-VASc Score | Adjusted Stroke Rate (%) / year
---|---|---
0 | 0 | 0%
1 | 1 | 1.3%
2-6 | 2-9 | 2.2-15.2%

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Monitoring Post Ablation

<table>
<thead>
<tr>
<th>Differential</th>
<th>Suggested evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>Physical exam, CT imaging</td>
</tr>
<tr>
<td>Chest pain</td>
<td>Physical exam, chest X-ray, ECG, echocardiogram, stress test, cardiac catheterization, chest CT</td>
</tr>
<tr>
<td>Cough</td>
<td>Physical exam, chest X-ray, chest CT</td>
</tr>
<tr>
<td>Dysphagia</td>
<td>Physical exam, chest CT or MRI</td>
</tr>
</tbody>
</table>

Signs and symptoms of complications within a month postablation:

<table>
<thead>
<tr>
<th>Complications</th>
<th>Signs and symptoms</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back pain</td>
<td>Unilateral, nonreproducible herniation</td>
<td>Physical exam, CT imaging</td>
</tr>
<tr>
<td>Chest pain</td>
<td>Pericardial, pericardial effusion, coronary artery disease, ablation related, pulmonary vein stenosis, musculoskeletal (after cardioversion), worsening asthma</td>
<td>Physical exam, chest X-ray, ECG, echocardiogram, stress test, cardiac catheterization, chest CT</td>
</tr>
<tr>
<td>Cough</td>
<td>Acute or chronic, bronchitis, bronchospasm, mechanical, crystalloid, pulmonary vein stenosis</td>
<td>Physical exam, chest X-ray, chest CT</td>
</tr>
<tr>
<td>Dysphagia</td>
<td>Esophageal irritation related to transesophageal echocardiography, AE fistula</td>
<td>Physical exam, chest CT or MRI</td>
</tr>
<tr>
<td>Early satiety, nausea</td>
<td>Weight determination</td>
<td>Physical exam, gastric emptying study</td>
</tr>
</tbody>
</table>

Fever:
- Infectious process, pneumonitis, AE fistula
- Physical exam, chest X-ray, chest CT, MRI

Chest pain:
- Pericarditis, pericardial effusion, pulmonary vein stenosis, musculoskeletal (after cardioversion), worsening reflux
- Physical exam, chest X-ray, chest CT, ECG, echocardiogram, stress test, cardiac catheterization, chest CT

Cough:
- Acute or chronic, bronchitis, bronchospasm, mechanical, crystalloid, pulmonary vein stenosis
- Physical exam, chest X-ray, chest CT

Dysphagia:
- Esophageal irritation related to transesophageal echocardiography, AE fistula
- Physical exam, chest CT or MRI

Earache:
- Acute or chronic, pneumonitis, AE fistula
- Physical exam, chest X-ray, chest CT, MRI

Fever:
- Infectious process, pneumonitis, AE fistula
- Physical exam, chest X-ray, chest CT, MRI

Complications of AF Ablation

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Complications of AF Ablation

Types of Ambulatory Cardiac Monitoring Devices

<table>
<thead>
<tr>
<th>Type of recorder</th>
<th>Continuous duration</th>
<th>Sensing channel</th>
<th>Memory</th>
<th>Use of telemetry</th>
<th>Unique benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holter monitor</td>
<td>24-48 hours</td>
<td>1-30 leads</td>
<td>Yes</td>
<td>Yes</td>
<td>Excellent</td>
</tr>
<tr>
<td>Event monitor</td>
<td>1-24 hours</td>
<td>3 leads</td>
<td>Yes</td>
<td>Yes</td>
<td>Improved</td>
</tr>
<tr>
<td>External loop recorder</td>
<td>1 month</td>
<td>3 leads</td>
<td>No</td>
<td>No</td>
<td>Medium to short term intermittent</td>
</tr>
<tr>
<td>Ambulatory ECG monitor</td>
<td>1 day</td>
<td>12 leads</td>
<td>No</td>
<td>No</td>
<td>Short term intermittent</td>
</tr>
<tr>
<td>Implantable loop recorder</td>
<td>5 years</td>
<td>3 leads</td>
<td>No</td>
<td>No</td>
<td>Long term intermittent</td>
</tr>
<tr>
<td>Recorders of ICDs with atrial leads</td>
<td>1 year</td>
<td>3 leads</td>
<td>No</td>
<td>No</td>
<td>Long term intermittent</td>
</tr>
<tr>
<td>Wearable multichannel ECG monitors</td>
<td>Continuous</td>
<td>12 leads</td>
<td>No</td>
<td>No</td>
<td>Long term intermittent</td>
</tr>
</tbody>
</table>

ECG Monitoring Postablation

The two main reasons to perform arrhythmia monitoring following catheter ablation are clinical care and as part of a clinical research trial.

Complaints of palpitations often result from atrial or ventricular premature beats and are not an accurate predictor of recurrent AF.

Arrhythmia monitoring can also be of value in asymptomatic patients and can influence decision making regarding anticoagulant therapy after ablation.

Multiple studies have demonstrated that asymptomatic AF commonly occurs in patients following catheter ablation.

Detection of these asymptomatic episodes of AF impact the characterization of the procedure as "successful."

Different Monitoring Methods to Detect AF

Different Monitoring Methods to Detect AF
The more you look, the more you find!

Early recurrences of AF after ablation:
Recurrence of AF >30 seconds during the first 3 months of follow-up.
Late recurrence (LR): recurrence of AF >30 seconds between 3 and 12 months after AF.

The pathophysiological mechanisms:
1. Incomplete isolation of the PVs
2. Acute inflammatory changes owing to energy delivery
3. Recovery of conduction in a previously isolated PV
4. Modification of the ANS
5. Changes in the atrial substrate
6. Delayed effect of RF ablation due to lesion consolidation

The occurrence of atrial arrhythmias early after ablation does not necessarily indicate treatment failure later during follow-up.
Nevertheless, early recurrences have been shown to predict atrhythmia recurrences late after catheter ablation of AF in some patients.

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Management of Early Recurrences

1. **AADs**
The SA study usefulness of initiation or discontinuation of AAD therapy during the postablation healing phase in an effort to improve long-term outcomes is unclear (Class Ib, IDe C-Lo, Table 3).

2. **Corticosteroid**
Two different results, negative vs. positive effect of prevention of late recurrence of AF (125 patients vs. 138 patients undergoing PV ablation).

3. **Colchicine**
Has been shown to reduce postoperative AF following cardiac surgery. Two studies were positive; however, 94% of the writing group members do not routinely administer colchicine.

Deleted “The impact of ARB/ACEI and statin on outcome of AF ablation” from 2012 document. www.HRSonline.org

4. **Early Cardioversion**
“CV within 30 days of arrhythmia recurrence” An aggressive approach with early DC CV after LA catheter ablation appears important to maintain SR in order to minimize late arrhythmia recurrences, reduce chronic AAD use, and prevent reablation procedures. CV ≥3 times was a predictor of ablation failure (n = 40).

5. **Early Reablation**
Early reablation was associated with greater freedom from LR. Although the clinical benefit of early reablation was demonstrated, the first month following the procedure might not be the optimal time for a repeat intervention. Reablation is not recommended in an early recurrence of AF that might be a transient phenomenon. www.HRSonline.org

Atrial Tachycardias After AF Ablation

**1. Antiarrhythmic and Other Pharmacological Therapy**
- #1 AADs have been used unsuccessfully prior to ablation; include flecainide, propafenone, sotalol, dofetilide, dronedarone, and amiodarone.
- The short-term use of AADs after AF ablation decreased early recurrences of atrial arrhythmias and need for hospitalization or CV, but had no effect on the prediction or prevention of arrhythmia recurrence at 6 and 12 months.
- #2. Corticosteroids/PPIs or H2 blockers/ARB or ACEI: remains unproven.

**2. Later-Term Repeat Ablation Procedures**
The first step in second AF ablation procedure is to check each PV for reconnection. If, however, there is no evidence of PV reconnection, ablation can be guided by:
- Electrogram voltage
- CT
- More PV trigger sites commonly associated with non-PV triggers such as the SVC, focal impulse, and rotor activity targeting
- Posterior PV modulation and automatic mapping

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**Benefits of AF Ablation**
- quality of life
- hospitalizations
- dementia
- stroke
- mortality

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Atrial Tachycardias After AF Ablation

**1. Antiarrhythmic and Other Pharmacological Therapy**

**2. Later-Term Repeat Ablation Procedures**

**3. Autonomic Alterations**
Most autonomic alterations associated with AF ablation were self-terminating and asymptomatic. However, severe symptomatic periablation vagal nerve injury can occur after LA posterior wall ablation (25–30 W).

**Very Late Recurrence (More Than 1 Year) After AF Ablation**

Despite of late recurrence, a low incidence of progression (0.3% per year) from paroxysmal to persistent AF as well as stroke rates <1% have been reported. More likely to have sporadic episodes and a better response to AADs and repeat ablation procedures than those with earlier recurrences. The most consistent predictor of late recurrence

- #1. Persistent AF
- #2. Hypertension, age, LA size, diabetes, VHD and LV dysfunction, and higher thromboembolic risk scores
- #3. PV reconnection, non-PV foci, and gaps in prior ablation lines, non-PV triggers from LAA and LA posterior wall www.HRSonline.org

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Benefits of AF Ablation

- quality of life
- hospitalizations
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Quality of Life Scales, Definitions, and Strengths

<table>
<thead>
<tr>
<th>Scale</th>
<th>Abbreviation</th>
<th>Definition</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>EuroQol Five-Dimensional Questionnaire (EQ-5D) General</td>
<td>AQoL</td>
<td>Two components, health state evaluations are measured on five dimensions: mobility, self-care, usual activities, pain/discomfort, anxiety/depression. Answers may be converted into a one-level EQ-5D index level.</td>
<td>Advantages: efficacy, validity, subjective data</td>
<td>Disadvantages: only one level EQ-5D index level.</td>
</tr>
</tbody>
</table>
Benefits of AF Ablation

- quality of life
- hospitalizations
- dementia
- stroke
- mortality

OUTCOMES OF AF ABLATION IN POPULATIONS NOT WELL REPRESENTED IN CLINICAL TRIALS

1. Outcomes of Catheter Ablation of Persistent and Long-Standing Persistent AF

PVI remains the cornerstone. Several new ablation strategies, including mapping and ablation of rotational activity, ablation of areas of low voltage, ablation of areas identified on MRI as showing fibrosis, ablation of non-PV triggers, as well as LAA focal ablation, isolation, and/or ligation. A single-procedure efficacy of stepwise approach was 35% at 1 year, falling to 17% at year 5 and the 5-year outcome after repeated procedures was 63%.

2. Outcomes of AF Ablation in Elderly Patients

Similar success rates with ablation therapy for AF in older patients compared with younger patients, with comparable complication rates. A consistent finding is that older patients are less likely to undergo a second procedure if the index procedure fails to eliminate the arrhythmia.

3. Outcomes of AF Ablation in Patients with CHF and the Impact of Ablation on LV Function

It is reasonable to use similar indications for AF ablation in selected patients with heart failure as in patients without heart failure.

4. Outcomes of AF Ablation in Patients with Hypertrophic Cardiomyopathy

The risk of procedure-related adverse events was low. Even though the likelihood of recurrence is twofold higher, catheter ablation can be effective in patients with HCM and AF, particularly in patients with PAF and smaller atria.

5. Outcomes of AF Ablation in Young Patients

The largest study on AF ablation in younger patients was a multicenter German registry in which 593 patients aged ≤45 years were compared with 6650 patients aged >45 years. The younger patients had lower rates of complication, shorter hospital stays, and lower rates of AF recurrence and AAD than older patients.

6. Outcomes of AF Ablation in Women

Studies have not shown a significant sex-related difference in outcomes with AF ablation in women compared with men, but complication rates are consistently higher in women.

7. Outcomes of Cryoballoon Ablation

FREEZE-AF (2015): 70.7% in the RF vs. 73.6% in the CB. Complications occurred in CB (12.2% vs 5.0% in RF), which was largely due to 9 transient PN injuries (5.8%) in CB arm. FIRE AND ICE trial (2016) CB appears to be associated with a favorable long-term outcome in patients with persistent AF, with arrhythmia-free survival ranging from 56% to 82%. In one nonrandomized study, arrhythmia-free survival after AF/RF was similar between CB and RF (80% to 50%).

8. Outcome of Rotational Activity Ablation for AF

“64-pole basket catheter/body-surface high-density mapping/Phase mapping” The usefulness of ablation of rotational activity as an initial or repeat ablation strategy for persistent and long-standing persistent AF is not well established.

9. Outcomes of Laser Balloon Ablation

The laser balloon is effective in achieving PVI, from 98% to 100%. The freedom from AF at follow-up ranged from 60% to 88%, which is comparable to the outcome of PVI using RF energy in similar populations.

10. Long-Term Ablation Efficacy

The predictors of late recurrence: persistent AF + comorbid conditions. Despite the low single-procedure, long-term success rate reported in virtually all of these clinical trials, they also reveal that with the use of repeat AF ablation procedures and/or AAD therapy, much higher rates of freedom from recurrent AF as well as concomitant reductions in AF burden can be achieved.

11. Impact of Catheter Ablation of AF on QOL

Substantial improvements in QOL with ablation; can more accurately reflect ablation efficacy. However, there is currently no general agreement that any of the “AF-specific” QOL instruments are superior to others or to the “general” QOL instruments.

12. Impact of Catheter Ablation of AF on LA Size and Function

The reverse remodeling of LA was more pronounced when SR had been successfully restored. It appears consistent with reverse remodeling due to the decreased burden of AF and scar formation from the ablation procedure. Restoration of SR in patients with persistent AF improves atrial function if SR is maintained. Ablation-related scarring with the risk of causing persistent atrial dysfunction still remains a major concern after extensive ablation for persistent AF.

13. Impact of Catheter Ablation on Stroke Risk

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13. Impact of Catheter Ablation on Stroke Risk

Long-Term Survival Free of Death

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Predictors of Success Following AF Ablation

Predictors of a poorer outcome, at least in some studies, include
1. non-PAF and particularly long-term persistent AF
2. LV dysfunction
3. deep apnea and obesity
4. increased LA size
5. increased age
6. hypertension
7. LA fibrosis as detected by cardiac MRI

Cost-Effectiveness of AF Ablation

Most formal cost-effectiveness studies have not found AF ablation to be cost neutral or cost saving in the short to intermediate term. “Second-line” therapy in patients with PAF vs. “first-line” setting or in patients with persistent or long-term persistent AF.

AF ablation might only be cost-effective as first-line therapy in younger patients.

References


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