Heart failure (HF) predisposes to atrial fibrillation (AF), with a prevalence ranging from 10% to 50% depending on the severity of HF.1–4 AF can exacerbate HF and increases mortality.1–5 Despite these findings, a large trial comparing rate control with conventional rhythm control in patients with AF and HF found no difference in outcomes.6 This might be explained by the difficulty maintaining sinus rhythm using drugs and direct current (DC) cardioversion alone. Furthermore, the adverse effects of antiarrhythmic drugs may negate the benefits of sinus rhythm. Therefore, current guidelines recommend an initial rate control strategy for patients with AF and HF.7

Background—Restoring sinus rhythm in patients with heart failure (HF) and atrial fibrillation (AF) may improve left ventricular (LV) function and HF symptoms. We sought to compare the effect of a catheter ablation strategy with that of a medical rate control strategy in patients with persistent AF and HF.

Methods and Results—Patients with persistent AF, symptomatic HF, and LV ejection fraction <50% were randomized to catheter ablation or medical rate control. The primary end-point was the difference between groups in LV ejection fraction at 6 months. Baseline LV ejection fraction was 32±8% in the ablation group and 34±12% in the medical group. Twenty-six patients underwent catheter ablation, and 24 patients were rate controlled. Freedom from AF was achieved in 21/26 (81%) at 6 months off antiarrhythmic drugs. LV ejection fraction at 6 months in the ablation group was 40±12% compared with 31±13% in the rate control group (P=0.015). Ablation was associated with better peak oxygen consumption (22±6 versus 18±6 mL/kg per minute; P=0.014) and Minnesota living with HF questionnaire score (24±22 versus 47±22; P=0.001) compared with rate control.

Conclusions—Catheter ablation is effective in restoring sinus rhythm in selected patients with persistent AF and HF, and can improve LV function, functional capacity, and HF symptoms compared with rate control.

Clinical Trial Registration—URL: http://www.clinicaltrials.gov. Unique identifier: NCT01411371

Key Words: atrial fibrillation • catheter ablation • heart failure

Heart failure (HF) predisposes to atrial fibrillation (AF), with a prevalence ranging from 10% to 50% depending on the severity of HF.1–4 AF can exacerbate HF and increases mortality.1–5 Despite these findings, a large trial comparing rate control with conventional rhythm control in patients with AF and HF found no difference in outcomes.6 This might be explained by the difficulty maintaining sinus rhythm using drugs and direct current (DC) cardioversion alone. Furthermore, the adverse effects of antiarrhythmic drugs may negate the benefits of sinus rhythm. Therefore, current guidelines recommend an initial rate control strategy for patients with AF and HF.7

Clinical Perspective on p 38

Several studies have now demonstrated the superiority of catheter ablation instead of medical therapy in maintaining sinus rhythm, albeit mostly in those with structurally normal hearts.8–12 This has prompted studies investigating whether a rhythm control strategy using catheter ablation might improve outcomes for patients with AF and HF.13–20 To date these studies have had mixed results, and the number of randomized studies remains small.18–20 We hypothesized that restoring sinus rhythm by catheter ablation improves left ventricular (LV) function and HF symptoms compared with a medical rate control strategy in patients with persistent AF and HF. We sought to prove this through a randomized controlled trial.
Methods

Study Design
This was a single center prospective randomized controlled trial. The study was approved by the local research ethics committee, and was prospectively registered on National Institutes of Health (NIH) clinicaltrials.gov. All patients were recruited at a single center (St Bartholomew’s Hospital). All patients gave written informed consent. Randomization involved a random number generator, with sealed envelopes opened after baseline investigations had been performed. The nature of the study did not allow blinding of the patients or physicians. However, all echocardiographic data at baseline and for the primary end-point were anonymized and core reported at another institution (St Mary’s Hospital).

Patients
To be eligible, patients had to meet all of the following criteria: persistent AF (as defined previously), symptomatic HF (New York Heart Association [NYHA] class II–IV), and LV systolic dysfunction (ejection fraction [EF] <50%).

Patients had to have adequate ventricular rate control as defined in the stricter guidelines in place at the time of the study design (since inadequate rate control would arguably have mandated some sort of intervention), with a heart rate <80 bpm at rest and <110 bpm on moderate exertion as assessed on ambulatory monitoring and exercise testing. Male and female patients aged ≥18 years were considered. There was no requirement for AF to be symptomatic, or for patients to have failed antiarrhythmic drug therapy or DC cardioversion. Patients were excluded from the study if they met any of the following criteria: HF that had a suspected reversible cause, previous left atrial ablation, any contraindication to catheter ablation, AF that was paroxysmal, symptoms that were clearly attributable to AF rather than HF (ie, palpitations or dizziness) that might arguably mandate a rhythm control strategy, any event during the past 6 months that might continue to effect on LV function (including implantation of a pacemaker or cardiac resynchronization therapy device, cardiac surgery, myocardial infarction, or coronary revascularization), or a realistic expectation of these occurring within the next year.

Period of Pharmacological Optimization
Once recruited, patients had HF treatment optimized during a 3-month period before baseline investigations and randomization. This also ensured all patients had been adequately rate controlled for ≥3 months before baseline investigations. All patients were taking β-blockers, and in selected patients spironolactone (if NYHA class ≥III and LV EF <35%). All patients were anticoagulated with warfarin with a target international normalized ratio of 2 to 3. These therapies were continued throughout the study period regardless of subsequent treatment allocation, although changes to medications were allowed.

Catheter Ablation of AF
Our periprocedural management and technique for catheter ablation of AF have been described previously. In brief, patients underwent transoesophageal echocardiography preprocedure, and heparin was administered to maintain an activated clotting time of 300 to 400 seconds. Antiarrhythmic drugs were not stopped preprocedure. Under general anesthesia (lidocaine) and moderate sedation (midazolam and diazepam), a decapolar catheter was inserted into the coronary sinus and, after double trans-septal puncture, a pulmonary vein mapping catheter and ablation catheter were introduced to the left atrium. All procedures were guided by 3-dimensional mapping systems either Carto ( Biosense Webster Inc, Diamond Bar, CA) or Ensite NavX (St Jude Medical, Minneapolis, MN), with computerized tomography or MRI image integration. Catheter ablation was performed using radiofrequency energy with an irrigated-tip catheter, with power and temperature generally limited to 30 W and 50°C. The pulmonary veins were isolated by wide area circumferential ablation, with lesions placed 1 to 2 cm outside the pulmonary vein ostia to isolate them as ipsilateral pairs. Electrical isolation was confirmed using the pulmonary vein mapping catheter. Complex or fractionated electrograms were then targeted throughout the left and right atria until all were abolished or sinus rhythm restored. If patients remained in AF, linear lesions were then added at the mitral isthmus and the roof. A cavotricuspid isthmus line was added only in patients with a history of typical right atrial flutter. If at any point AF organized into atrial tachycardia, this was mapped and ablated. If sinus rhythm was not restored following these lesions, the patient was cardioverted with a DC shock.

Follow-Up
A 3-month blanking period was observed during which arrhythmia recurrences were managed medically and were not counted as procedural failures because early recurrences may settle spontaneously. Those with atrial arrhythmia persisting at 3 months were offered a repeat procedure, and their follow-up was subsequently restarted. Antiarrhythmic drugs were stopped postablation and reintroduced only for recurrent arrhythmia. Oral anticoagulation was continued in all patients postablation regardless of rhythm status. Success in terms of maintaining sinus rhythm was defined as freedom from documented AF/atrial tachycardia lasting ≥30 seconds after the 3-month blanking period, as per current guidelines.

Patient Assessment and Investigation
Patients in both groups attended for clinical assessment and the following investigations at baseline (before randomization) and then at 1, 3, and 6 months:

- 12-lead ECG,
- 48-hour ambulatory ECG monitoring,
- measurement of B-type natriuretic peptide (BNP; Biosite Triage, San Diego, CA),
- transthoracic echocardiography,
- a symptom limited cardiopulmonary treadmill exercise test to determine maximal oxygen consumption at peak exercise (V̇O₂ max) using a modified Bruce protocol (at all time points except 1 month),
- NYHA functional class assessment,
- evaluation of HF symptoms using the Minnesota Living With Heart Failure questionnaire (MLWHF scores ranging from 0 to 105, with higher scores indicating worse symptoms),
- quality of life evaluation using the 36-item Short-Form Health Survey (scores given as a percentage with higher scores indicating a better quality of life).

The study period was originally 6 months, but follow-up was extended in the ablation group, and investigations were repeated at 1 year to see if any benefits were sustained (this could not be performed in the medical group because many went on to have pulmonary vein isolation, atioventricular node ablation, and device implantation).

End Points
The study primary end-point was a comparison of the LV EF between the 2 groups at the 6-month time point on an intention to treat basis. This was determined from transthoracic echocardiography using Simpson biplane method. All echocardiographic data for the primary end-point were anonymized for blinded reporting by a core laboratory at another institution (St Mary’s Hospital), with all measurements made during 5 cardiac cycles as per guidelines on reporting trials in AF. Secondary end-points compared between groups at 6 months were the percentage reduction in LV end systolic volume, V̇O₂ max, plasma BNP, NYHA class, MLWHF score, and 36-item Short-Form score.

Statistics
Sample size was estimated based on previous nonrandomized data. With 30 patients in each group, the study had 80% power to detect a 6% absolute difference between groups in LV EF (assuming...
an SD of 8% in each group) using an independent samples Student t test with an α of 0.05.

Continuous variables that were normally distributed are described as mean±SD, or where comparisons are made between groups mean and 95% confidence intervals (CI). Data that were not normally distributed are described as median and interquartile range. Categorical data were compared by Fisher exact test. Kaplan–Meier curves were used to analyze freedom from AF in the catheter ablation group. Continuous data that were normally distributed were compared by Student t test, including assessment of the primary and secondary end-points at 6 months. To avoid repeated t tests at every time point, a repeated measures analysis of variance was performed for each of the primary and secondary end-point variables. The effect of ablation was assessed using the interaction between ablation as a between-subjects factor and time point as a within-subjects factor.

Results

Study Patients

In total, 390 patients were screened, 98 were eligible for inclusion, and 55 of these consented and were enrolled in the study (Figure 1). However, during the 3-month period of optimizing medications LV function normalized in 2 patients (one from each group), and these were withdrawn from the study. A further 3 patients withdrew their consent at randomization (2 from the medical group and 1 from the ablation group). These 5 patients were therefore excluded from all analysis. The baseline characteristics of the 50 patients comprising the study population are shown in the Table.

One of the 26 patients in the catheter ablation group had a procedural stroke followed by recurrence of AF and withdrew from the study. One of the 24 patients in the medical treatment group died after baseline investigations. Although baseline demographic data for these 2 patients are included in the Table, and the procedural complication and recurrence of AF are reported for the patient in the ablation group, there were no other follow-up data available for these patients, and hence they are excluded from all subsequent analysis. Otherwise all patients reached 6 months follow-up and were included in the analysis of the primary and secondary end-points (ie, regardless of the success of ablation and whether sinus rhythm was maintained), and all patients in the ablation group were followed up once more at 12 months.

Procedures and Complications

Of the 26 patients in the ablation group, 14 underwent a second procedure and 3 underwent a third (8 for recurrent AF and 7 for atrial tachycardia), giving a mean of 1.7±0.7 procedures per patient. There were 2 major complications (1 stroke and 1 tamponade) giving a major complication rate of 4.7% per procedure or 7.7% per patient.

No patient in either group underwent device implantation, revascularization, or any other procedure during the study period. One patient in the medical group died from sudden cardiac death, and another had a small intracranial hemorrhage but recovered completely.

Table. Patient Demographics

<table>
<thead>
<tr>
<th></th>
<th>Ablation Group</th>
<th>Medical Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>55±12</td>
<td>60±10</td>
</tr>
<tr>
<td>Male sex</td>
<td>25/26</td>
<td>23/24</td>
</tr>
<tr>
<td>AF history</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Months continuous AF</td>
<td>24 (17–33)</td>
<td>24 (12–48)</td>
</tr>
<tr>
<td>Long-lasting persistent AF</td>
<td>25/26</td>
<td>21/24</td>
</tr>
<tr>
<td>No of AADs failed</td>
<td>1 (0–1)</td>
<td>1 (0–1)</td>
</tr>
<tr>
<td>Previous attempt at rhythm control</td>
<td>14/26</td>
<td>10/24</td>
</tr>
<tr>
<td>HF pathogenesis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>History of hypertension</td>
<td>8/26</td>
<td>8/24</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>6/26</td>
<td>7/24</td>
</tr>
<tr>
<td>Dilated cardiomyopathy</td>
<td>8/26</td>
<td>7/24</td>
</tr>
<tr>
<td>Codiagnosis of AF and HF</td>
<td>15/26</td>
<td>13/24</td>
</tr>
<tr>
<td>Time since HF diagnosis</td>
<td>33 (20–56)</td>
<td>24 (14–48)</td>
</tr>
<tr>
<td>Baseline NYHA class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NYHA II</td>
<td>11/26</td>
<td>12/24</td>
</tr>
<tr>
<td>NYHA III</td>
<td>15/26</td>
<td>12/24</td>
</tr>
<tr>
<td>Baseline LV ejection fraction, %</td>
<td>31.8±7.7</td>
<td>33.7±12.1</td>
</tr>
<tr>
<td>Left atrial diameter, cm</td>
<td>5.2±1.1</td>
<td>5.0±1.0</td>
</tr>
</tbody>
</table>

Numbers show proportions, mean±SD, or median (interquartile range). Long-lasting persistent AF was defined as continuous AF for ≥12 mo as per guidelines. AAD indicates antiarrhythmic drugs; AF, atrial fibrillation; HF, heart failure; LV, left ventricle; and NYHA, New York Heart Association.
Freedom From AF
The single procedure success rate off antiarrhythmic drugs at 1 year was 10/26 (38%). Freedom from AF after the last ablation procedure was achieved in 21/26 patients (81%) off antiarrhythmic drugs at the 6-month primary end-point and was sustained up to a year in 19/26 patients (73%) off antiarrhythmic drugs (Figure 2). In 1 patient, AF persisted at the end of the catheter ablation procedure and was resistant to DC cardioversion, and hence no further ablation was attempted. In 3 patients, persistent AF recurred early but the patients declined a repeat procedure. Three further patients had infrequent asymptomatic paroxysmal arrhythmia (1 AF and 2 atrial tachyarrhythmia) captured on ambulatory monitoring, and a repeat procedure was not thought appropriate. All patients in the medical group remained in persistent AF.

Primary End-Point: Effect on LV Function
There was an early improvement in LV function in the catheter ablation group, with a difference in EF between groups evident from 1 month onwards (P=0.004; Figure 3A). The LV EF at 6 months (the primary end-point) was 39.9% (CI, 35.2%–44.7%) in the catheter ablation group compared with 31.0% (CI, 25.5%–36.6%) in the medical group (P=0.015). This equated to an absolute increase in the EF of 8.1% (CI, 3.0%–13.1%) in the catheter ablation group compared with a change of −3.6% (CI, −7.7% to 0.5%) in the medical group (P<0.001). The improvement in LV function in the ablation group was sustained at 1 year (41.0%; CI, 35.9%–46.0%).

The percentage change in LV end systolic volume at 6 months was −14.2% (CI, −26.2% to −2.2%) in the ablation group compared with +4.7% (CI, −7.9% to 17.2%) in the medical group (P=0.030).

Effect on Functional Capacity
There was a progressive improvement in VO₂ max in the catheter ablation group (P=0.046; Figure 3B). There was a significant difference between groups at the 6-month end-point, with a VO₂ max of 22.4 mL/kg per minute (CI, 19.7–25.1 mL/kg per minute) in the catheter ablation group versus 17.7 mL/kg per minute (CI, 15.0–20.4 mL/kg per minute) in the medical group (P=0.014). This improvement in VO₂ max in the catheter ablation group was sustained at 1 year (21.5 mL/kg per minute; CI, 18.8–24.3 mL/kg per minute).

Effect on BNP
There was an early divergence between groups in BNP values from 1 month onwards (P=0.021; Figure 3C). At 6 months, BNP was 126 pg/mL (CI, 63–189 pg/mL) in the ablation group compared with 327 pg/mL (CI, 172–481 pg/mL) in the medical group (P=0.014). This improvement in BNP was sustained at 12 months (123 pg/mL; CI, 73–173 pg/mL).

Effect on Symptoms and Quality of Life
NYHA score was significantly better from 1 month onwards in the catheter ablation group (P<0.001; Figure 3D). At 6 months, the NYHA score was 1.6 (CI, 1.4–1.9) in the ablation group compared with 2.4 (CI, 2.1–2.6) in the medical group (P<0.001). This improvement in the catheter ablation group was sustained at 1 year (1.7; CI, 1.4–2.0).

This symptomatic improvement was confirmed by the early difference in the MLWHF scores between groups, with a significantly lower score in the catheter ablation group (meaning less symptoms) from 1 month onwards (P=0.001; Figure 3E). MLWHF score at 6 months was 23.7 (CI, 14.6–32.8) in the ablation group compared with 47.0 (CI, 36.5–57.6) in the medical group (P=0.001). This improvement in MLWHF score was sustained at 1 year in the ablation group (26.5; CI, 16.9–36.2).

The 36-item Short-Form scores produce a large volume of data, hence for brevity only the 6-month data are presented (Figure 3F). Despite no difference between groups at baseline, 36-item Short-Form scores were higher (meaning better quality of life) for several parameters in the catheter ablation group at 6 months. There was a significant difference between groups for physical functioning (71.0%; CI, 60.5%–81.5% in the ablation group versus 49.1%; CI, 36.9%–61.4% in the medical group; P=0.007), physical role functioning (67.5%; CI, 56.2%–78.8% versus 42.4%; CI, 29.5%–55.2%; P=0.004), bodily pain (78.8%; CI, 68.7%–88.8% versus 57.1%; CI, 46.0%–68.3%; P=0.005), and vitality (54.3%; CI, 44.8%–63.7% versus 36.4%; CI, 26.7%–46.1%; P=0.009).

Factors Predicting Resolution of HF
Five of 26 patients in the ablation group and 0/24 in the medical group had complete normalization of LV function (EF ≥50%) and resolution of HF symptoms at 6 months (P=0.051). Although the sample size was insufficient for a full analysis of factors predicting this response, a post hoc finding was that all 5 of these patients had been codiagnosed with AF and HF (ie, had no previous history of HF and were then simultaneously diagnosed with AF and HF) out of the 15 such patients in this group. This compared with 0/13 such patients having resolution of HF in the medical group (5/15 versus 0/13; P=0.044). None of these 5 patients had previous ischemic heart disease, although 3 had significant LV dilatation and had been labeled a dilated cardiomyopathy.

Main Findings
Catheter ablation was able to restore sinus rhythm in the majority of patients with persistent AF, although most patients

Discussion

required >1 procedure. The safety profile of catheter ablation in patients with HF was similar to that in patients with structurally normal hearts. A catheter ablation strategy resulted in an early improvement in LV function, which was evident at 1 month and was sustained at 1 year compared with the rate control group. This was accompanied by reversal of LV remodeling as evidenced by the reduction in end systolic volume compared with the medical group. Catheter ablation resulted in improved exercise capacity, BNP, NYHA class, HF symptoms, and quality of life compared with a medical rate control strategy.

**AF and Heart Failure**

Although the consequences of poor rate control for LV function are widely understood, the effect of an irregular ventricular filling time and the loss of atrial contraction on LV function have also been well documented. Cardioversion to sinus rhythm improves cardiac function, and several retrospective studies have suggested an association between the subsequent maintenance of sinus rhythm and improved HF symptoms and survival. Despite this, the largest trial to compare rate control to rhythm control in patients with AF and HF found no benefit in aggressively pursuing sinus rhythm. This might be explained by the difficulty maintaining sinus rhythm in this cohort using medication and DC cardioversion alone. Furthermore, the adverse effects of antiarrhythmic drugs may negate the benefits of restoring sinus rhythm.

These limitations of a conventional rhythm control strategy have prompted several studies investigating whether definitive restoration of sinus rhythm by catheter ablation might improve outcomes for patients with AF and HF.
However, these studies have had mixed results, and few have been randomized.18–20

**Freedom From AF After Catheter Ablation**

Although freedom from AF was achieved in 73% off antiarrhythmic drugs at 1 year after the final procedure (a mean of 1.7 procedures per patient), the single procedure success rate was much lower at 38%. This is similar to success rates reported in other randomized studies, which have varied from 40% to 68% after a single procedure and 50% to 88% after repeated procedures at 6 to 12 months.18–20 At 7.7% per patient (or 4.7% per procedure), the major complication rate in this study was also comparable with that in other randomized studies in this context (2%–20%).18–20 A recent meta-analysis of studies investigating catheter ablation of AF in the context of HF and a large registry published subsequently have placed the major complication rate at 3.5% to 5.6%.35,36 which is comparable with that in patients with structurally normal hearts.

**Effect of Restoring Sinus Rhythm on Heart Failure**

There was a marked difference between groups in LV EF from 1 month onwards (≈10% absolute difference), which was sustained at 1 year. The accompanying reduction in end systolic volume suggests both an acute effect of restoring sinus rhythm and possibly also an element of LV reverse remodeling. These changes are particularly important because they are not only associated with improved symptoms but may also predict a reduction in hospitalizations for HF and mortality.37,38

There was a progressive difference between groups in peak VO2, which reached significance at 6 months and was sustained at 1 year. This is likely because of the combined effect of restoring sinus rhythm (which in itself may produce a modest improvement in peak VO2)39 and continued subsequent LV reverse remodeling. The marked difference between groups of 4.7 mL/kg per minute at 6 months is striking. This is greater than is typically observed with other HF therapies such as medications or cardiac resynchronization therapy and again suggests a prognostic advantage with restoration of sinus rhythm.40,41

There was also a marked difference in HF symptoms and quality of life favoring the catheter ablation group, which was observed from 1 month onward. Likewise, changes in neurohumoral status favored the catheter ablation group.

Since commencement of the Catheter Ablation Versus Medical Treatment of Atrial Fibrillation (CANTAF) trial, there have been 3 trials published comparing catheter ablation with rate control in patients with AF and HF: PABA CHF (Pulmonary Vein Antrum Isolation versus AV Node Ablation with Bi-Ventricular Pacing for Treatment of Atrial Fibrillation in Patients with Congestive Heart Failure study) randomized patients to catheter ablation or atrioventricular node ablation and biventricular pacing,18 whereas ARC-HF (A Randomized Trial to Assess Catheter Ablation Versus Rate Control in the Management of Persistent Atrial Fibrillation in Heart Failure) and a study by MacDonald et al both randomized patients to catheter ablation or pharmacological rate control in a manner similar to the current study.19,20 Although PABA CHF showed changes in LV function, exercise capacity and HF symptoms in the catheter ablation group, ARC-HF, and MacDonald et al did not.

MacDonald et al19 showed no difference between groups in LV function, exercise capacity, HF symptoms or BNP, although the power of the study was limited by the low success rate (50% were in sinus rhythm at 6 months). ARC-HF showed a significant difference in exercise capacity and HF symptoms favoring the ablation group, but with no significant difference in LV function.30 Although LV function in the ablation arm of ARC-HF improved to a greater extent than was observed in this study or PABA CHF, they were the only study to observe a small improvement in the rate control group also, possibly because they included subjects who were not adequately rate controlled at baseline (46% of the cohort).

The current study adds to our understanding first because it demonstrates for the first time that effective rhythm control using an ablation strategy is superior to the guideline recommended strategy of medical rate control in patients with HF, in terms of LV function, exercise capacity, and symptoms. Second, because those thought to be clearly symptomatic from AF were excluded, catheter ablation was a treatment for HF rather than for symptomatic AF refractory to drug treatment (which is currently regarded as the only indication for catheter ablation of AF). Third, after catheter ablation, freedom from AF and the resultant benefits were maintained at 1 year in the majority.

**Subgroup Analysis and Implications for Patient Selection**

AF and HF are often diagnosed at the same time, and there is a high incidence of new onset HF in patients with AF.5 In the ablation group, a third of patients who were co-diagnosed with AF and HF had complete resolution of HF, suggesting that their HF may have been caused by AF. This could not have been tachycardia mediated because patients were all adequately rate controlled for ≥3 months before randomization, and furthermore no such response was seen during the subsequent 6 months in the medical group despite good rate control. This suggests the term tachycardia-mediated cardiomyopathy may be an over simplification because HF resolved after elimination of rate controlled AF, not tachycardia. These data imply that in a proportion of patients the onset of AF may precipitate a downward spiral of worsening HF, the cause for which may not be addressed by the current guideline recommended strategy of rate control.21

**Limitations**

This study was powered to evaluate the effect of a catheter ablation strategy on LV function, functional capacity, and symptoms over the medium term. Although these end points are important in their own right, large-scale randomized controlled trials are underway to determine whether catheter ablation of AF in HF might effect on hard end points such as HF admissions or mortality, and to examine cost-effectiveness.

Although ambulatory monitoring was used to screen for asymptomatic paroxysmal arrhythmia as per current guidelines,22 it is recognized that further screening may have uncovered more recurrent AF in the ablation group. Furthermore, the long-term success after catheter ablation of persistent AF in HF is uncertain. A recent registry placed the rate of late recurrence occurring after 1 year at ≈5% per year.35 It is
therefore possible that the need for repeat procedures during subsequent years may alter the risk benefit ratio of ablation in these patients during the long term.

This was a single center study, and the nature of the study did not permit blinding. Nevertheless, echocardiographic data were core reported by a blinded center and were therefore robust.

Conclusions
A catheter ablation strategy in patients with persistent AF and HF resulted in improved LV function, functional capacity, HF symptoms, and quality of life compared with medical rate control. These data therefore suggest a beneficial effect of catheter ablation in treating selected patients with AF and HF. Additional work is needed to determine the effect of ablation on hard outcomes and to identify those most likely to benefit from restoration of sinus rhythm.

Acknowledgments
This work was facilitated by Barts and The London National Health Service (NHS) Trust National Institute for Health Research–Cardiovascular Biomedical Research Unit and Imperial College Healthcare NHS Trust Biomedical Research Centre.

Sources of Funding
This work was supported by a British Heart Foundation grant (PG/08/130).

Disclosures
None.

References


Atrial fibrillation can exacerbate heart failure. However, sinus rhythm is difficult to maintain in patients with atrial fibrillation and heart failure. In randomized trials, the strategy of using medications to maintain sinus rhythm is not superior to a rate control strategy. Several observational studies have shown improvement in left ventricular function with sinus rhythm maintained after catheter ablation. The current study randomized 50 patients with rate controlled persistent atrial fibrillation, symptomatic heart failure, and left ventricular systolic dysfunction to either rate control or catheter ablation to restore sinus rhythm. In the ablation group, sinus rhythm was maintained without antiarrhythmic drugs in 73% of patients at 12 months, although a majority required multiple ablation procedures and major complications occurred in 4.7%. At 6 months, the ablation group had better left ventricular ejection fraction (40% versus 31%; P=0.015), peak oxygen consumption, B-type natriuretic peptide, New York Heart Association class, and quality of life scores compared with the rate control group. These findings suggest a beneficial effect of catheter ablation for selected patients with atrial fibrillation and heart failure. Additional work is warranted to determine the effect of ablation on outcomes and to identify those heart failure patients most likely to benefit.

**CLINICAL PERSPECTIVE**

Atrial fibrillation can exacerbate heart failure. However, sinus rhythm is difficult to maintain in patients with atrial fibrillation and heart failure. In randomized trials, the strategy of using medications to maintain sinus rhythm is not superior to a rate control strategy. Several observational studies have shown improvement in left ventricular function with sinus rhythm maintained after catheter ablation. The current study randomized 50 patients with rate controlled persistent atrial fibrillation, symptomatic heart failure, and left ventricular systolic dysfunction to either rate control or catheter ablation to restore sinus rhythm. In the ablation group, sinus rhythm was maintained without antiarrhythmic drugs in 73% of patients at 12 months, although a majority required multiple ablation procedures and major complications occurred in 4.7%. At 6 months, the ablation group had better left ventricular ejection fraction (40% versus 31%; P=0.015), peak oxygen consumption, B-type natriuretic peptide, New York Heart Association class, and quality of life scores compared with the rate control group. These findings suggest a beneficial effect of catheter ablation for selected patients with atrial fibrillation and heart failure. Additional work is warranted to determine the effect of ablation on outcomes and to identify those heart failure patients most likely to benefit.
A Randomized Controlled Trial of Catheter Ablation Versus Medical Treatment of Atrial Fibrillation in Heart Failure (The CAMTAF Trial)


Circ Arrhythm Electrophysiol. 2014;7:31-38; originally published online January 1, 2014; doi: 10.1161/CIRCEP.113.000806

Circulation: Arrhythmia and Electrophysiology is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2014 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-3149. Online ISSN: 1941-3084

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circep.ahajournals.org/content/7/1/31

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation: Arrhythmia and Electrophysiology can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Arrhythmia and Electrophysiology is online at:
http://circep.ahajournals.org//subscriptions/