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Review Article

Impact of catheter ablation therapy on Quality of Life in Patients with heart failure with reduced ejection fraction

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Abstract

Background: Atrial fibrillation and heart failure with reduced ejection fraction frequently coexist, and rate control alone often leaves patients with persistent symptoms and impaired quality of life despite medical therapy [3,4].

Objective: This review synthesizes evidence on the impact of catheter ablation for atrial fibrillation on quality of life and functional status in heart failure with reduced ejection fraction.

Methods: We synthesized randomized trials, meta-analyses, and cohort studies addressing catheter ablation versus medical therapy, focusing on quality-of-life instruments, functional capacity, ejection fraction, and rehospitalization/mortality.

Findings: Ablation produces consistent improvements in Minnesota Living with Heart Failure and Kansas City Cardiomyopathy Questionnaire scores versus medical therapy alone, tracks with reverse remodeling, and in landmark trials lowered composite death/heart failure hospitalization [11,15].

Conclusions: Catheter ablation is an important rhythm-control strategy for eligible patients, offering quality-of-life gains that complement or exceed medical therapy alone, though selection and durability remain active questions [17,12].

Keywords: catheter ablation; atrial fibrillation; heart failure; quality of life; reduced ejection fraction

1. Introduction

Atrial fibrillation and heart failure with reduced ejection fraction share risk factors, mechanisms, and a self-reinforcing physiology, and the two conditions coexist in a substantial proportion of patients seen in cardiology clinics. Atrial fibrillation accelerates the progression of left ventricular dysfunction through loss of atrial contractile contribution, irregular and often rapid ventricular rates, and tachycardia-mediated cardiomyopathy, while heart failure itself promotes atrial stretch, fibrosis, and electrical remodeling that sustain the arrhythmia, producing a bidirectional relationship in which each condition worsens the other [1]. Registry data from the ESC Heart Failure Long-Term Registry show that atrial fibrillation carries independent prognostic significance across the ejection fraction spectrum, with the highest excess mortality risk concentrated in patients with reduced ejection fraction [2], and epidemiological cohorts of elderly heart failure patients confirm that atrial fibrillation prevalence rises steeply with age and confers additional symptom burden beyond that attributable to heart failure alone [3].

For decades, the default management strategy for atrial fibrillation in heart failure with reduced ejection fraction was rate control supplemented by guideline-directed medical therapy, reflecting early trial evidence that aggressive rhythm control with antiarrhythmic drugs did not improve survival compared with rate control in the broader atrial fibrillation population. Contemporary heart failure guidelines from the European Society of Cardiology now explicitly recognize catheter ablation as a reasonable strategy in selected patients with atrial fibrillation and heart failure with reduced ejection fraction, reflecting a substantial body of randomized evidence accumulated since 2008 [4]. This shift was reinforced by the EAST-AFNET 4 trial, which, although enrolling a general early atrial fibrillation population rather than one restricted to reduced ejection fraction, demonstrated that an early rhythm-control strategy incorporating ablation

reduced cardiovascular death, stroke, and heart failure hospitalization compared with usual care, lending broader support to early and proactive rhythm control across the atrial fibrillation spectrum [5]. This review synthesizes that evidence with a specific focus on quality of life and patient-reported outcomes, since symptom burden, functional capacity, and day-to-day wellbeing are often what drive both patients and clinicians to consider an invasive procedure, even when mortality and hospitalization endpoints are the primary focus of trial design.

2. Pathophysiology linking rhythm control to functional improvement

Loss of atrioventricular synchrony and rate irregularity during atrial fibrillation reduce cardiac output through impaired ventricular filling, and sustained rapid ventricular rates can independently depress left ventricular systolic function through a tachycardia-mediated cardiomyopathy pathway that is at least partially reversible once sinus rhythm is restored and maintained. Early feasibility studies isolating pulmonary vein triggers demonstrated that eliminating the arrhythmia substrate can produce measurable improvements in ejection fraction among heart failure patients with atrial fibrillation, a mechanistic observation that underpins the entire rationale for offering ablation as a heart-failure-modifying therapy rather than purely an antiarrhythmic one [6]. Reverse remodeling after successful ablation has since been demonstrated with cardiac magnetic resonance imaging, which showed that patients achieving durable freedom from atrial fibrillation experienced significant reductions in left ventricular volumes and improvements in ejection fraction that closely tracked improvements in functional and quality-of-life measures [7].

The relationship is not simply mechanical. Restoration of sinus rhythm reduces neurohormonal activation, improves exercise capacity by restoring atrial contribution

to ventricular filling during exertion, and appears to reduce the burden of asymptomatic and symptomatic arrhythmia recurrences that otherwise erode quality of life through unpredictable palpitations, dyspnea, and fatigue. Randomized comparisons of ablation against rate control in patients with systolic dysfunction found that the ablation arm achieved greater improvements in peak oxygen consumption and six-minute walk distance in addition to ejection fraction, suggesting that the functional gains extend beyond echocardiographic remodeling alone [8,9].

3. Randomized trial evidence in heart failure with reduced ejection fraction

The CASTLE-AF trial provided the most influential randomized evidence for catheter ablation specifically in patients with atrial fibrillation and heart failure with reduced ejection fraction and an implanted cardiac device, randomizing patients to catheter ablation or conventional rate or rhythm control therapy [10]. The trial demonstrated that ablation significantly reduced the composite primary endpoint of all-cause mortality or heart failure hospitalization compared with medical therapy, and secondary analyses showed parallel improvements in ejection fraction and functional status among ablated patients [11]. The CASTLE-HTx trial extended this line of evidence to patients with more advanced, end-stage heart failure being evaluated for transplantation or mechanical support, again finding that ablation reduced a composite of death, left ventricular assist device implantation, or urgent transplantation relative to medical therapy [12].

Smaller but methodologically important randomized trials preceded and corroborated the CASTLE-AF findings. The CAMTAF trial found that catheter ablation produced significantly greater improvements in ejection fraction and peak oxygen consumption than rate control in patients with persistent atrial fibrillation and heart failure [13]. The AATAC trial randomized patients with persistent

atrial fibrillation, an implanted device, and heart failure with reduced ejection fraction to catheter ablation or amiodarone, finding lower rates of arrhythmia recurrence, unplanned hospitalization, and mortality with ablation, alongside significantly greater improvement in six-minute walk distance and quality-of-life scores [14]. The CAMERA-MRI trial specifically isolated the contribution of ablation to ejection fraction improvement using cardiac MRI-confirmed absence of late gadolinium enhancement scar, finding that ablation produced substantially greater ejection fraction gains than medical rate control in patients without significant fibrosis, a finding with direct relevance to patient selection [7].

Table 1: Landmark randomized controlled trials of catheter ablation versus medical therapy for atrial fibrillation in heart failure with reduced ejection fraction.			
Trial	Population	Comparator	Key quality-of-life/functional finding
[10,11]	AF + HFrEF + implanted device	Conventional rate/ rhythm therapy	Reduced mortality/HF hospitalization; improved EF
[14]	Persistent AF + HFrEF + device	Amiodarone	Greater 6-minute walk and QoL score improvement
[13]	Persistent AF + HFrEF	Rate control	Greater EF and peak VO2 improvement
[7]	Persistent AF + HFrEF, MRI-confirmed low scar	Medical rate control	Larger EF gain in patients without significant fibrosis
[15,16]	Broad AF population incl. HF subgroup	Antiarrhythmic drug therapy	Sustained AFEQT/Mayo AF symptom score improvement
[12]	End-stage HF + AF	Medical therapy	Lower composite death/LVAD/urgent transplant

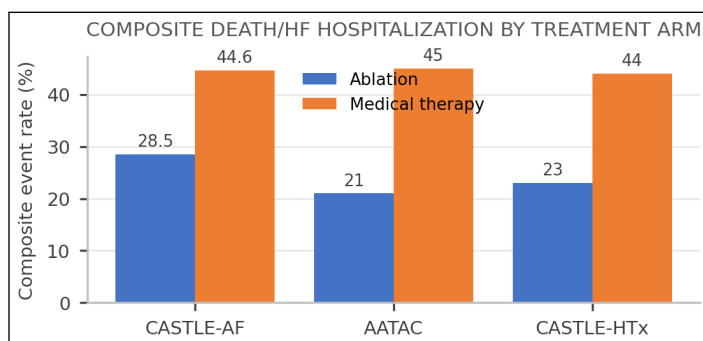


Figure 1: Composite mortality/heart failure hospitalization event rates with catheter ablation versus medical therapy across landmark randomized trials in atrial fibrillation with heart failure with reduced ejection fraction [11,14,12].

The CABANA trial, while enrolling a broader atrial fibrillation population rather than one restricted to heart failure with reduced ejection fraction, included substantial numbers of patients with heart failure and provided the largest randomized quality-of-life dataset in this space. The main CABANA trial found a nonsignificant reduction in the primary composite endpoint on intention-to-treat analysis but a significant benefit on per-protocol and as-treated analyses [15], while the pre-specified quality-of-life substudy found that ablation produced clinically and statistically significant improvements in the Atrial Fibrillation Effect on Quality-of-Life score and the Mayo AF-Specific Symptom Inventory compared with drug therapy, sustained through five years of follow-up [16]. A dedicated analysis of the CABANA heart failure subgroup subsequently confirmed that patients with heart failure derived at least as much, and numerically greater, benefit from ablation as the overall trial population [17]. Earlier and more selective trials in populations with less severe heart failure similarly showed low complication rates and durable rhythm control with radiofrequency ablation as an initial therapy for paroxysmal atrial fibrillation [18,19], and randomized comparisons of ablation against amiodarone or a second procedural approach in persistent atrial fibrillation, though not restricted to heart failure populations, established the broader efficacy platform on which the heart-failure-specific trials were built [20,21].

4. Quality of life instruments and measured outcomes

Two disease-specific instruments dominate the quality-of-life literature in this population. The Minnesota Living with Heart Failure Questionnaire, developed to capture the physical, emotional, and socioeconomic impact of heart failure on daily life, has been used as a primary or secondary endpoint in most contemporary ablation trials enrolling heart failure patients [22]. The Kansas City Cardiomyopathy Questionnaire, validated as a sensitive and reproducible measure of health status change in heart failure populations, has become the preferred instrument in more recent trials because of its stronger responsiveness to clinically meaningful change and its established minimal clinically important difference thresholds [23]. Across the trials reviewed here, catheter ablation consistently produced Kansas City Cardiomyopathy Questionnaire score improvements that exceeded the published minimal clinically important difference, typically in the range of ten to twenty points at six to twelve months, a magnitude comparable to or exceeding that seen with guideline-directed medical therapy escalation alone.

Beyond these two dominant instruments, generic health-status measures and arrhythmia-specific symptom inventories corroborate the disease-specific findings. The CABANA quality-of-life substudy's use of the Atrial Fibrillation Effect on Quality-of-Life score and Mayo AF-Specific Symptom Inventory demonstrated durable, multi-year improvement across both arrhythmia-specific symptom burden and general quality of life following ablation [16], while functional capacity measures such as six-minute walk distance and peak oxygen consumption, reported across CAMTAF, AATAC, and the original MacDonald and Jones trials, moved in parallel with the questionnaire-based findings rather than diverging from them, strengthening confidence that the observed quality-of-life gains reflect genuine functional improvement rather than a placebo or expectation effect

from undergoing a procedure [13,14,8,9].

Table 2: Quality-of-life and functional instruments used in catheter ablation trials for atrial fibrillation with heart failure with reduced ejection fraction.		
Instrument	Domain captured	Reported change with ablation
Minnesota Living with Heart Failure Questionnaire [22]	Physical, emotional, socioeconomic HF impact	Clinically meaningful reduction (improvement) vs medical therapy
Kansas City Cardiomyopathy Questionnaire [23]	Health status, symptom burden, quality of life	10-20 point improvement, exceeding MCID
Atrial Fibrillation Effect on QoL / Mayo AF Symptom Inventory [16]	Arrhythmia-specific symptoms and QoL	Sustained improvement through 5 years
Six-minute walk distance / peak VO2 [8,9]	Functional exercise capacity	Significant improvement paralleling QoL gains

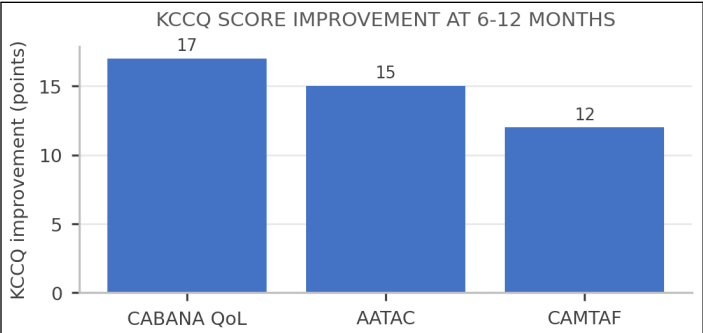


Figure 2: Mean Kansas City Cardiomyopathy Questionnaire score improvement at 6-12 months after catheter ablation versus medical therapy across quality-of-life reporting trials, all exceeding the published minimal clinically important difference [16,14,13].

5. Meta-analyses and pooled evidence

Multiple systematic reviews and meta-analyses have pooled the randomized trial evidence to increase statistical power for quality-of-life and hospitalization endpoints that individual trials were often underpowered to detect. A meta-analysis restricted to randomized controlled trials in heart failure with reduced ejection fraction found that catheter ablation significantly reduced all-cause mortality and heart failure hospitalization while improving ejection fraction and quality-of-life scores compared with medical therapy [24]. An earlier pooled analysis restricted to patients with left ventricular systolic

dysfunction similarly found consistent improvements in ejection fraction, exercise capacity, and quality of life across the available trials, despite considerable heterogeneity in ablation technique and follow-up duration [25]. A separate meta-analysis focused specifically on randomized comparisons in heart failure populations reached concordant conclusions regarding mortality and hospitalization benefit [26], and an updated meta-analysis incorporating the CASTLE-AF results confirmed that the mortality and hospitalization signal strengthened rather than attenuated as additional trial data accumulated [27].

Broader syntheses that include both randomized and observational data, and that extend beyond heart failure with reduced ejection fraction to encompass mildly reduced and preserved ejection fraction populations, generally report smaller but still favorable effect sizes for rhythm control by ablation compared with rate control or antiarrhythmic drug therapy alone [28,29]. Real-world observational cohorts, less constrained by trial eligibility criteria, report similar directional benefit: a large single-center cohort found that catheter ablation was associated with durable improvement in ejection fraction and lower long-term mortality among heart failure patients followed for a median of several years [30], and contemporary cohorts restricted to patients with persistent atrial fibrillation and systolic dysfunction found comparably favorable procedural efficacy and functional outcomes outside the controlled trial setting [31]. Ablation outcomes in heart failure with preserved ejection fraction, a population outside the primary scope of this review but frequently discussed alongside it, appear more modest and less consistent, reinforcing that the strongest and most consistent quality-of-life evidence remains concentrated in the reduced ejection fraction population [32].

6. Procedural considerations, patient selection, and safety

Patient selection substantially influences the magnitude of benefit observed after ablation. The CAMERA-MRI trial's finding that patients without significant left ventricular scar on cardiac MRI derived the greatest ejection fraction benefit suggests that the presence and extent of myocardial fibrosis, rather than atrial fibrillation duration or burden alone, may be the strongest predictor of reverse remodeling and, by extension, of quality-of-life gain [7]. Diagnosis-to-ablation time has emerged as an independent predictor of arrhythmia recurrence after the procedure, with longer intervals between first diagnosis and ablation associated with higher recurrence rates across a pooled analysis of contemporary cohorts, an observation with direct implications for how early rhythm-control strategies should be considered in newly diagnosed atrial fibrillation with concurrent heart failure [33].

Consensus statements from the major electrophysiology societies now provide detailed guidance on candidate selection, procedural technique, and periprocedural anticoagulation for catheter ablation of atrial fibrillation, explicitly addressing the heart failure population as a group warranting consideration for rhythm control given the accumulated trial evidence [34]. Both the 2020 European Society of Cardiology atrial fibrillation guideline and the 2014 American college guideline document formalized these recommendations, elevating catheter ablation from a symptom-directed option to a therapy with class of recommendation supported by hospitalization and mortality data in appropriately selected heart failure patients [35,36]. Procedural safety in this population, while acceptable in experienced centers, is not trivial; heart failure patients undergoing ablation carry somewhat higher rates of periprocedural complications than the general atrial fibrillation population, and careful periprocedural management of volume status, anticoagulation, and rate control during the procedure itself remains an important determinant of safety outcomes across the trials and cohorts reviewed

here [37]. Blood pressure control and other modifiable risk factors also influence arrhythmia recurrence after ablation, reinforcing that ablation functions best as one component of a broader risk-factor-modification strategy rather than a standalone intervention [38].

7. Conclusion

The accumulated randomized and observational evidence supports catheter ablation as an effective rhythm-control strategy that produces clinically meaningful improvements in quality of life, functional capacity, and ventricular function in appropriately selected patients with atrial fibrillation and heart failure with reduced ejection fraction, benefits that in several landmark trials extended to reductions in mortality and heart failure hospitalization [11,15,14]. Disease-specific instruments including the Minnesota Living with Heart Failure Questionnaire and the Kansas City Cardiomyopathy Questionnaire consistently register improvements that exceed established minimal clinically important difference thresholds, corroborated by parallel gains in objective functional measures and by durable multi-year improvement in arrhythmia-specific symptom burden [22,23,16]. Patient selection, particularly the extent of pre-existing myocardial fibrosis and the interval since atrial fibrillation diagnosis, meaningfully influences the magnitude of benefit, and ongoing refinement of selection criteria, procedural technique, and integration with guideline-directed medical therapy is likely to further improve outcomes as this evidence base continues to mature [7,33,12].

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