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# Catheter ablation of atrial fibrillation in elderly population

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**Abstract**

**Background** Although elderly patients have been included in published series of catheter ablation for atrial fibrillation (AF), clinical benefit and safety remain still less defined in this population. A retrospective analysis of the results of catheter ablation for AF in a large volume center focused on comparison of elderly patients with the rest of the patient cohort was conducted in this study. **Methods** Consecutive patients who underwent catheter ablation for AF between January 2001 and December 2016 were analysed. A total population of 3197 patients was dichotomized by the age of 70 years (394 elderly *vs*. 2803 younger subjects). Patients were followed in terms of arrhythmia status and survival for a median period of 18 *vs.* 21 and 35 *vs.* 57 months, respectively. **Results** Elderly patients were more frequently females (49% *vs.* 29%, $P < 0.0001$), had a history of hypertension (79% *vs.* 57%, $P < 0.0001$), diabetes (16% *vs.* 11%, $P < 0.01$), stroke (9% *vs.* 6%, $P < 0.01$), coronary/peripheral artery disease (14% *vs.* 8%, $P < 0.0001$), and $CHA_2DS_2$-VASc score (3.1 ± 1.3 *vs.* 1.5 ± 1.2 s, $P < 0.0001$). Major complications were more frequent in elderly (5.3% *vs.* 3.2%, $P = 0.03$); however, this difference was driven by vascular complications (3.6% *vs.* 1.9%, $P = 0.04$). There were comparable rates of cerebrovascular (0.3 *vs.* 0.3%) or nonvascular complications (1.8 *vs.* 1.2%). Good arrhythmia control was inferior in elderly patients as compared with the rest of the cohort, both without and with antiarrhythmic drugs: 44.2% *vs.* 58.2% ($P < 0.0001$) and 78.2 *vs.* 83.2% ($P < 0.01$), respectively. Poor arrhythmia control was associated with relative risk of all-cause mortality of 2.7 (95% CI: 1.1–6.4) in elderly patients and 1.4 (95% CI: 0.9–2.0) in younger subjects. **Conclusions** Catheter ablation for AF in elderly patients is safe although somewhat less effective. Good arrhythmia control is associated with better survival, especially in elderly patients.

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**Keywords:** Atrial fibrillation; Catheter ablation; Complications; The elderly

## 1 Introduction

Atrial fibrillation (AF) is the most frequent arrhythmia in human with substantially higher prevalence among population > 70 years of age.[1–3] Although AF is not immediately life-threatening arrhythmia, it has been associated with an increased risk of cardiovascular events and mortality.[4,5] Importantly, there is a higher risk of these events with increasing age. All these factors increase socioeconomic burden of AF in a society.

Because elderly patients have not been well represented in previous studies on catheter ablation for AF, the safety and efficacy associated with this therapeutic strategy remain controversial in this population. In our study, we focused on clinical outcome of elderly subjects undergoing catheter ablation compared to the rest of the population.

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## 2 Methods

### 2.1 Study population

The study retrospectively analyzed the outcome of catheter ablation for AF in 394 patients older than 70 years in a comparison with 2803 subjects < 70 years of age. All patients underwent catheter ablation for atrial AF at our institution between January 2001 and July 2016. The study was approved by our local Ethical Committee.

### 2.2 Catheter ablation

Catheter ablation was performed under deeper conscious sedation using point-by-point delivery of radiofrequency current and electroanatomic navigation (CARTO 3, Biosense Webster or NavX, St. Jude Medical) in majority of patients (> 99%), as described previously by our group.[6,7] All patients underwent pulmonary veins isolation (PVI). Additional left atrial linear lesions, coronary sinus ablation, or electrogram-guided ablations were performed empirically according to the clinical presentation and inducibility of the arrhythmia during the procedure.

### 2.3 Anticoagulation

Heparin anticoagulation was used during the procedure to maintain an activated clotting time > 250 s until 2004 and > 325 s after that date because of the recognized risk of spontaneous soft thrombus on sheaths/catheters. Since 2013, uninterrupted anticoagulation with warfarin was used perioperatively in patients with $CHA_2DS_2VASc$ score ≥ 2.

### 2.4 Definition of complications

Major complications were defined as those that result in permanent injury or death, require intervention for treatment, or prolong or require hospitalization for > 48 h.[7] All complications documented during the procedure and within the three months follow up were recorded using departmental tracking process and reviewed by staff physicians of the arrhythmia service in morbidity and mortality meetings.

### 2.5 Follow up

After ablation, the patients were followed during regular visits for a minimum of one year in case of uneventful outcome and frequently longer because of arrhythmia recurrence requiring medical management and/or re-ablation procedures. Antiarrhythmic drugs were discontinued within the first three months after ablation, depending on clinical status and willingness of the patient. Arrhythmia recurrence was defined by occurrence of any documented symptomatic or asymptomatic episode of AF or atrial tachycardia (AT) lasting > 30 s, after a blanking period of three months. Final arrhythmia status was assessed in a binary fashion at the last clinical visit. Good arrhythmia control comprised either no documented AF/AT episodes (on or off antiarrhythmic drug therapy) or sporadic episodes of AF/AT with substantial reduction of arrhythmia burden compared to baseline. Data on all-cause mortality were obtained from central registry of insurance companies in April 2017.

### 2.6 Statistical analysis

Data are reported as percentage or mean ± SD. Group comparisons were performed using the Student *t*-test, Mann-Whitney test or $\chi^2$-test, as appropriate. Kaplan-Meier analysis and Cox regression model of proportional hazards were used to compare all-cause mortality between subgroups defined by long-term procedural outcome in terms of arrhythmia control. A *P* value of < 0.05 was considered significant

## 3 Results

### 3.1 Patient baseline characteristics

Clinical characteristics of the study population are listed in Table 1. Elderly patients were more frequently females, had a history of hypertension, diabetes, stroke and coronary

**Table 1. Clinical characteristics of the study population.**

| | Age < 70 yrs | | | Age > 70 yrs | | | *P* |
|---|---|---|---|---|---|---|---|
| | N | Mean | SD | N | Mean | SD | |
| Age, yrs | 2803 | 57.4 | 9.3 | 394 | 73.0 | 2.6 | 0.0001 |
| Female | 2803 | 29.4% | | 394 | 49.0% | | 0.0001 |
| Heart failure | 2803 | 15.4% | | 394 | 17.8% | | 0.23 |
| Hypertension | 2803 | 56.7% | | 394 | 79.2% | | 0.0001 |
| Diabetes | 2803 | 11.2% | | 394 | 15.7% | | 0.01 |
| Stroke/TIA | 2803 | 5.5% | | 394 | 8.9% | | 0.007 |
| CAD or PVD | 2803 | 7.7% | | 394 | 14.2% | | 0.0001 |
| $CHADS_2$ | 2803 | 0.9 | 0.9 | 394 | 1.5 | 1.0 | 0.0001 |
| $CHA_2DS_2$-VASc | 2803 | 1.5 | 1.2 | 394 | 3.1 | 1.3 | 0.0001 |
| BMI, kg/m$^2$ | 2773 | 29.2 | 8.1 | 393 | 28.1 | 4.1 | 0.01 |
| LAd, mm | 2786 | 42.3 | 5.7 | 393 | 42.5 | 5.4 | 0.52 |
| LVEDd, mm | 2774 | 52.9 | 5.2 | 393 | 51.6 | 5.3 | 0.0001 |
| LVEF mean, % | 2794 | 56.4 | 7.6 | 394 | 55.8 | 8.8 | 0.20 |
| OAC or NOAC | 2803 | 72.8% | | 394 | 88.8% | | 0.0001 |
| Antiplatelets | 2803 | 14.9% | | 394 | 8.1% | | 0.0003 |
| Amiodarone | 2803 | 27.3% | | 394 | 34.5% | | 0.003 |
| Beta blockers | 2803 | 64.7% | | 394 | 68.5% | | 0.14 |
| ACEI/ARB | 2803 | 45.3% | | 394 | 61.4% | | 0.0001 |
| Paroxysmal AF | 2803 | 68.2% | | 394 | 66.5% | | 0.49 |

ACEI: inhibitors of angiotensin-converting enzyme; ARB: angiotensine receptor blockers; BMI: body mass index; CAD: coronary artery disease; LAd: left atrial diameter; LVEDd: left ventricular end-diastolic diameter; LVEF: left ventricular ejection fraction; NOAC: novel anticoagulants; OAC: oral anticoagulants; PVD: peripheral vascular disease.

artery disease. Consequently, their $CHADS_2$ and $CHA_2DS_2$-VASc scores were significantly higher. They were more likely to receive oral anticoagulation and were treated more frequently with amiodarone and inhibitors of angiotensin-converting enzyme.

### 3.2 Procedure-related data

Comparison of procedural characteristics from the first ablation procedure between the two patients groups is shown in Table 2. Note that elderly patients had on average shorter procedures and more often substrate-based ablations in addition to PVI. They presented with significantly more complications (5.3% *vs.* 3.2%), however, this difference was predominantly driven by non-life-threatening vascular complications at venous access sites. No difference was observed between both groups in cerebrovascular or non-vascular complications. Importantly, cerebrovascular complications occurred in both groups only in 0.3% cases.

### 3.3 Clinical outcome

The follow-up data are presented in Table 3. Elderly subjects had lower number of re-ablation procedures and shorter follow up in terms of arrhythmia status assessment as well as in terms of survival. The arrhythmia control was worse compared with younger patients, with higher proportion of pacemaker implants and AV junction ablation. Without antiarrhythmic drugs, good arrhythmia control was achieved in 44.2% *vs.* 58.2% ($P < 0.0001$). Elderly patients were also more likely on antiarrhythmic therapy, including amiodarone at the final clinical visit. However, overall good arrhythmia control was achieved in elderly population in marginally less proportion (78.2 *vs.* 83.2%, $P < 0.01$) (Figure 1). Elderly population had, as expected, worse survival compared to younger patients (Figure 2). In both groups, good arrhythmia control (combined off and on antiarrhythmic drugs) was associated with better survival. This association

**Table 2. Procedural characteristics.**

| | Age < 70 yrs | | | Age > 70 yrs | | | *P* |
|---|---|---|---|---|---|---|---|
| | *N* | Mean | SD | *N* | Mean | SD | |
| Fluoroscopy time, min | 2802 | 13.7 | 11,1 | 394 | 11.4 | 8.6 | 0.0006 |
| Fluoroscopy dose, μGy.m$^2$ | | 1331.0 | 2375.5 | | 910.8 | 1497.1 | 0.0001 |
| RF time, s | | 2993.3 | 1236.5 | | 3010.6 | 1114.5 | 0.80 |
| Procedure time, min | | 227.4 | 69.7 | | 213.6 | 68.3 | 0.0002 |
| PVI | | 99.0% | | | 97.5% | | 0.01 |
| RFA CTI | | 20.5% | | | 21.6% | | 0.61 |
| Substrate ablation | | 30.2% | | | 36.4% | | 0.02 |
| Complications | | 3.2% | | | 5.3% | | 0.03 |
| Vascular complications | | 1.9% | | | 3.6% | | 0.04 |
| Non-vascular complications | | 1.2% | | | 1.8% | | 0.32 |
| Cerebrovascular complications | | 0.3% | | | 0.3% | | 0.82 |

RF: radiofrequency, PVI: pulmonary vein isolation, RFA CTI: radiofrequency ablation of cavotricuspid isthmus.

**Table 3. Follow up data.**

| | Age < 70 yrs | | | Age > 70 yrs | | | *P* |
|---|---|---|---|---|---|---|---|
| | *N* | Mean | SD | *N* | Mean | SD | |
| Arrhythmia follow-up, days | 2803 | 1013.5 | 1030.1 | 394 | 764.0 | 721.5 | 0.0001 |
| AADs at the last visit | 2802 | 32.7% | | 394 | 44.4% | | 0.0001 |
| Amiodarone at the last visit | 2802 | 9.7% | | 394 | 18.3% | | 0.0001 |
| Good arrhythmia control without AADs | 2802 | 58.2% | | 394 | 44.2% | | 0.0001 |
| Good arrhythmia control without amiodarone | 2802 | 75.9% | | 394 | 63.7% | | 0.0001 |
| Good arrhythmia control overall | 2802 | 83.2% | | 394 | 78.2% | | 0.01 |
| Survival follow-up, days | 2803 | 1894.0 | 1279.1 | 394 | 1276.0 | 953.8 | 0.0001 |
| Death | 2803 | 4.6% | | 394 | 5.3% | | 0.52 |
| RFA AVJ | 2803 | 1.2% | | 394 | 2.8% | | 0.02 |
| Pacemaker implant | 2803 | 4.9% | | 394 | 8.1% | | 0.007 |
| Standalone RFA CTI | 2803 | 8.2% | | 394 | 5.6% | | 0.07 |
| Total RFA count | 2803 | 1.38 | 0.68 | 394 | 1.18 | 0.43 | 0.0001 |

AADs: antiarrhythmi drugs; RFA: radiofrequency ablations; RFA AVJ: radiofrequency ablation of AV junction; RFA CTI: radiofrequency ablation of cavotricuspid isthmus.

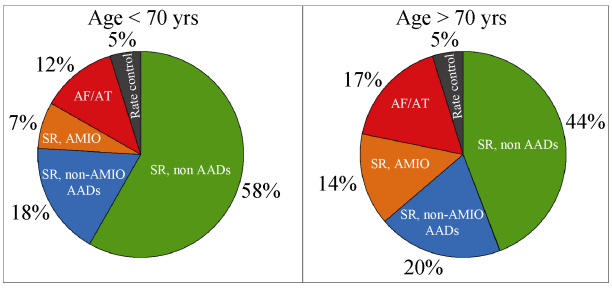


**Figure 1. Arrhythmia control at the final clinical visit for both patient groups in three subcategories of good arrhythmia control (off-AADs, with the use of non-amiodarone AADs, and with the use of amiodarone), poor arrhythmia control, and rate control.** AADs: antiarrhythmic drugs; AF/AT: atrial fibrillation/tachycardia; AMIO: amiodarone; SR: sinus rhythm.

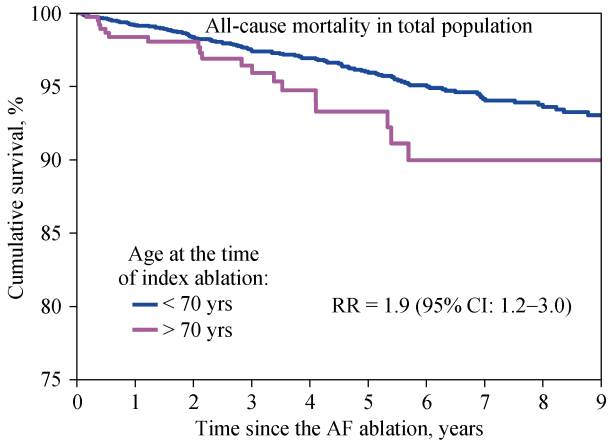


**Figure 2. Kaplan-Meier curves of all-cause mortality for both study groups.** AF: atrial fibrillation/tachycardia; RR: relative risk.

was of borderline significance in younger patients while in elderly, poor or absent arrhythmia control was associated with significant (2.7-fold) excess of mortality (Figure 3).

# 4 Discussion

## 4.1 Major findings

The results of this single-center retrospective study can be summarized as follows: (1) the efficacy of catheter ablation in maintenance of good arrhythmia control was only marginally reduced in elderly patients, with higher need for continuing antiarrhythmic drugs and/or pacemaker implant to achieve such effect; (2) there was no difference in rate of serious cerebrovascular and cardiac complications in elderly patients despite significantly higher thromboembolic risk; and (3) the favourable impact of good arrhythmia control on all-cause mortality was more evident in elderly compared to younger population.

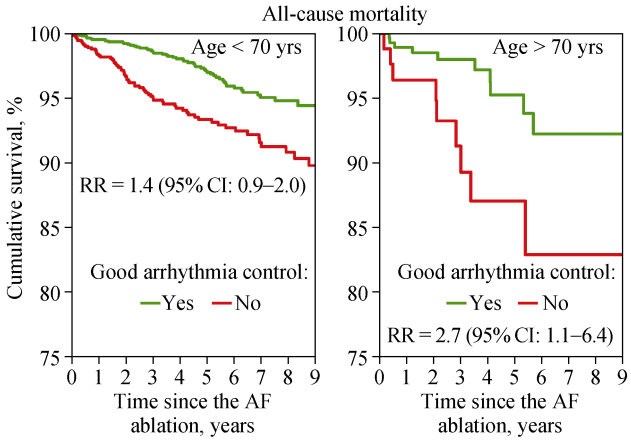


**Figure 3. Kaplan-Meier curves of all-cause mortality when both study groups are dichotomized according to arrhythmia status at the final clinical visit.** Relative risks for all-cause mortality associated with absence of good arrhythmia control are provided. AF: atrial fibrillation/tachycardia; RR: relative risk.

## 4.2 Characteristics of elderly population

The older patients were more likely to be women and to suffer from diabetes, structural heart disease and/or hypertension. This was reflected by significantly higher $CHADS_2$ and $CHADS_2VA_2Sc$ scores in our study. Similar findings, i.e., higher prevalence of women among elderly, were also found in earlier studies,[8–10] and one of them also described higher occurrence of hypertension and structural heart disease.[10] The authors of the latter study suggested that gender difference may mirror age-related epidemiologic differences in the incidence of AF.

## 4.3 Efficacy of catheter ablation

During the past decade, a series of studies have specifically focused on reporting the outcomes of AF ablation in older individuals.[8–12] However, the age limit for selecting elderly population varied between ≥ 60 and ≤ 80 years, which makes comparisons more difficult. In addition, the number of older people in these studies was small (four studies enrolled less than 100 patients, the largest cohort consisted of 261 older people). Some studies showed more recurrences of AF after single procedure without antiarrhythmic drugs,[11] other reported more frequent use of antiarrhythmic drugs to maintain sinus rhythm.[9,11] Altogether, the studies observed on average the success rate with re-do procedures and/or additional use of antiarrhythmic drugs around 80%.[8–12]

Three studies are available in octogenarians with AF reported favourable outcomes of PVI with and without additional ablation lines, with a success rate of maintaining normal sinus rhythm ranging between 70% and 87%, including repeat ablations (mean follow-up of one year).[13–15]

None of these studies found significant difference in success rates between AF patients with advanced age compared to the rest of the population.

One other study compared specifically results of catheter ablation of persistent AF in patients ≥ 70 years with antiarrhythmic therapy and found it more effective in maintaining sinus rhythm (76% *vs.* 46%, $P = 0.001$) with significant improvement of quality of life.[16]

Our study describes outcome of catheter ablation for AF in the largest elderly patient population and confirms that despite all the above differences in baseline characteristics, the elderly benefited from catheter ablation similarly as younger subjects. However, to achieve such results, more patients required previously ineffective antiarrhythmic therapy. These observations reflect the fact that elderly patients who continue to have AF episodes after ablation often prefer trial with antiarrhythmic drugs. Their attending physicians may also prefer conservative approach. This is also in line with lower number of re-ablation procedures and shorter clinical follow-up in this population. Interestingly, as emerged from other studies, some patients remained on antiarrhythmic medication even in the absence of documented recurrences of AF. Thus, symptomatic relief with good arrhythmia control is probably the main objective in the elderly. On the contrary, in younger subjects, ablation is more often viewed as a strategy to alleviate the need for antiarrhythmic therapy.

In addition, elderly patients may require antiarrhythmic medication to maintain sinus rhythm presumably because of more advanced atrial remodelling and non-pulmonary arrhythmogenic substrate. This is compatible with observation of comparable radiofrequency time despite higher percentage of substrate ablation in elderly that indirectly suggest relative effortless PVI is not enough to terminate the arrhythmia (or render it noninducible) during the procedure as well as to guarantee the uneventful off-drug follow up.

### 4.4 Prognostic benefit of good arrhythmia control

One previous study analyzed survival of elderly patients (> 75 years) after catheter ablation of AF and compared to subjects with AF without ablation.[12] Maintenance of sinus rhythm was independent predictor of better survival (HR: 0.36, 95% CI: 0.02–0.63; $P < 0.005$). Our study adds to this knowledge by analysis of mortality data in relationship to net result of catheter ablation of AF in elderly cohort (> 70 years). Our data support the notion that good arrhythmia control may result in better survival. Such observation is in agreement with a single centre experience,[17] or recent population study.[18] In addition, it appears from our study that mortality benefit from good arrhythmia control might be more pronounced in elderly patients than in the rest of population.

### 4.5 Complications of catheter ablation

Data on complications of catheter ablation of AF in elderly are somewhat controversial. On one side, some studies indicate that there is no evidence of an increased risk of major complications in older patients.[8–11] Others showed relatively higher vascular-entry bleeding complications, both acutely (4%) and within 30 days after the procedure (2.6%).[12] Metzner, *et al*.,[19] observed in a total of 137 procedures, in a population of subjects older than 75 years, 8 major (5.8%) and 26 minor (19%) periprocedural complications. Blandino, *et al*.,[16] reported higher rate of complications in patients ≥ 70 years in comparison with younger population (6.7% *vs.* 1.0 %, $P < 0.001$). The most worrisome was the increased rate of periprocedural strokes (3.3% *vs.* 0.7%, $P = 0.058$). Significant difference between periprocedural stroke rates in the elderly (> 75 years) versus the younger cohort (1.3% vs. 0.1%, $P < 0.01$) was found also in the recently published German ablation registry.[20] This is in contract with no[13–15] or low periprocedural embolic complications.[8–11] The reasons for the reported difference in procedure-related complications are unclear and possibly are multi-factorial, including anticoagulation management (stopping warfarin before the procedure) and different ablation techniques and tools. Indeed, one long-term study[21] and two studies from the same researchers[8,10] suggested that low risk of periprocedural thromboembolic complications can be attributed to more aggressive anticoagulation during the procedure.

It is important to emphasize that total complication rate in our elderly cohort reached 5.3%, however, 3.6% were less serious peripheral complication. Only 0.3% presented with cerebrovascular complications and this figure was identical as for younger subjects. No patient died due to the procedure. These data are reassuring and demonstrate that catheter ablation can be performed in elderly subjects without an increased risk.

### 4.6 Limitations

The limitation of our study is the low proportion of the very elderly patients undergoing ablation. Therefore, we accepted a cut-off at the age of 70 years instead of 75 years like in other studies. This makes, together with variable definition of complications and clinical success rates, all between-study comparisons difficult or inappropriate.

### 4.7 Conclusions

AF ablation in patients with age > 70 years compared to

the rest of population is reasonably safe without excess of complications that are either life-threatening or associated with permanent damage. The efficacy of AF ablation is statistically lower despite the significantly higher proportion of patients remaining on antiarrhythmic medication. This inferiority is, however, clinically modest (approximately 5%) and presumably results mainly from patient/physician preference. Most importantly, good arrhythmia control is associated with significantly better survival compared to younger population.

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