

# Efficacy and Safety of Catheter Ablation in Octogenarians

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- OBJECTIVES** To determine whether catheter ablation is safe and effective in patients over the age of 80.
- BACKGROUND** There is a tendency to withhold invasive therapy in the elderly until it has been proven safe and effective.
- METHODS** Over a two-year period from February 1, 1996 to February 1, 1998, 695 consecutive patients underwent 744 catheter ablation procedures of supraventricular and ventricular arrhythmias. These patients were divided into three groups based on age:  $\geq 80$  years, 60 to 79 years and  $< 60$  years. Acute ablation success, using standard criteria and complication rates for these three groups were determined.
- RESULTS** There were 37 patients  $\geq 80$  years, 275 patients 60 to 79 years and 383 patients  $< 60$  years old. The overall acute ablation success rate for the entire group was 95% with no difference in rates among the three groups (97%,  $\geq 80$  years; 94%, 60–79 years; 95%,  $< 60$  years). The percentage of patients undergoing His bundle ablation was greatest in the  $\geq 80$ -year-old group (43% vs. 19% vs. 2%,  $p < 0.01$ ), and the percentage of patients undergoing accessory pathway ablation was greatest in the  $< 60$ -year-old patients (0% vs. 4% vs. 25%,  $p < 0.01$ ). The overall complication rate for the entire group was 2.6%, and there was only one major/life-threatening complication. There was no difference in complication rates among the groups (0%,  $\geq 80$  years; 2.2%, 60 to 79 years; 3.1%,  $< 60$  years). Based on the sample size, the 95% confidence interval is 0% to 7.8% for an adverse event in the octogenarian.
- CONCLUSIONS** Catheter ablative therapy for the arrhythmias attempted in the very elderly appears to be effective with low risk. Ablation results appear to be comparable with those noted in younger patients. (J Am Coll Cardiol 2000;35:458–62) © 2000 by the American College of Cardiology

There is a tendency to withhold invasive therapy in the elderly until it has been proven safe and effective in younger patients. Radiofrequency catheter ablation for supraventricular and ventricular arrhythmias has been shown to be effective. Success rates for eliminating atrioventricular (AV) nodal reentry and AV reentry involving accessory pathways (APs) have been reported to exceed 90% to 95% (1–3). Successful ablation of the His bundle to control rapid ventricular rates in response to atrial fibrillation and flutter also exceeds 95% (4). Complications associated with these ablative procedures occur at a low incidence of 2% to 5% (1–7). To date, published series on the outcome with ablation have included only small numbers of octogenarians. The purpose of our investigation was to determine whether

catheter ablation is safe and effective in patients over the age of 80.

## METHODS

We prospectively assessed acute outcome and complications for all catheter ablation procedures for supraventricular and ventricular arrhythmias performed at a single teaching institution with an active fellowship program in a two-year period between February 1, 1996, and February 1, 1998. Patients undergoing ablation were grouped according to age— $\geq 80$ , 60 to 79 and  $< 60$  years.

We classified the ablation types depending upon the arrhythmias initiated using standard electrophysiologic techniques and definitions. The arrhythmia types include: AV nodal reentrant tachycardia (AVNRT) both typical and atypical, AV reentrant tachycardia involving an AP either concealed or manifest, atrial flutter including clockwise or counterclockwise right atrial flutter, atrial tachycardia including inappropriate sinus tachycardia and focal or macro-

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#### Abbreviations and Acronyms

AP	= accessory pathway
AV	= atrioventricular
AVNRT	= atrioventricular nodal reentrant tachycardia
CS	= coronary sinus
IVC-TV	= inferior vena cava tricuspid valve
VT	= ventricular tachycardia

reentrant atrial tachycardia, atrial fibrillation with His bundle ablation or AV node modification for ventricular rate control and ventricular tachycardia (VT) in patients with and without structural heart disease.

Ablation procedures were performed using standard mapping and ablative techniques that have been previously described (8,9). With the exception of atrial flutter, radiofrequency energy was applied through the 4 mm tip of the ablation catheter. For atrial flutter, an 8 mm tip catheter was used for most procedures. Radiofrequency energy was typically delivered at a power necessary to achieve an impedance drop of 4 to 10 ohms or temperature increase from 50° to 65°C. Radiofrequency energy was applied from 30 s to 2 minutes during continuous electrocardiographic and intermittent fluoroscopic monitoring. Additional monitoring using intracardiac echocardiographic imaging or nonfluoroscopic magnetic imaging (CARTO-Biosense, New Brunswick, New Jersey) was used in 27 and 57 patients, respectively.

Patients were brought routinely to the electrophysiology laboratory in the postabruptive state. Conscious sedation was administered with continuous monitoring of blood pressure, oxygen saturation and body surface electrocardiogram. Detailed electrophysiologic evaluation was performed using standard stimulation and recording techniques to establish the correct diagnosis and identify the appropriate site for ablation. Acute ablation success was defined based on arrhythmia type as follows: AVNRT— inability to initiate more than single AV node “echoes” with and without isoproterenol; atrial tachycardia— inability to reinitiate after radiofrequency energy application; sinus node ablation for inappropriate sinus tachycardia— decrease (>30 beats/min) in maximum heart rate on isoproterenol and change in P wave morphology in lead 3 to an inverted or flattened P wave; atrioventricular reentry— absence of antegrade and retrograde conduction over the AP with and without isoproterenol; atrial flutter— conduction block through the inferior vena cava tricuspid valve (IVC-TV) isthmus as determined by HALO or CARTO recordings or His-coronary sinus (CS) reversal (10); His bundle ablation— complete heart block. One patient underwent AV modification for rate control of atrial fibrillation and demonstrated a decrease in the mean ventricular response to atrial fibrillation to <100 beats/min on isoproterenol. Ventricular tachycardia— inability to reinitiate targeted tachycardia mor-

phology. Programmed stimulation was also performed on isoproterenol in patients without structural heart disease.

Thirty-five patients (9%) underwent ablation of two arrhythmia types (i.e., AVNRT and AP) at the same or two different procedures. These patients were counted once in each type of ablation procedure.

**Complications.** Complications were grouped into three categories according to the seriousness or permanence of the event.

- 1) Major or life-threatening complications: death, myocardial infarction, bradycardia-dependent polymorphic VT (as described in patients following His bundle ablation), embolic stroke involving transient or permanent neurologic alteration, persistent unintentional heart block (second or third degree), valve disruption defined as any new regurgitant lesion in either the mitral or aortic valves, and pulmonary embolus.
- 2) Serious complications: deep venous thrombosis, retroperitoneal bleeding and pericardial effusion requiring drainage.
- 3) Minor complications: hematoma, defined as a sizable (>5 × 5 cm) collection or blood loss sufficient to cause a >1 g hemoglobin drop whether or not transfusion was required, oversedation resulting in altered mental status and early termination of the procedure and ischemic chest pain without infarction (angina) that necessitated interruption of the procedure for evaluation and treatment.

Events that did not result in early termination/failure of the procedure, patient compromise or prolonged hospitalization were not included in analysis. Examples of such events include transient hypotension that responded to fluid resuscitation and minor vagal reaction.

**Statistical analysis.** Results are presented as mean ± SD where appropriate. Success rates and incidence of complications were compared using 2 × 3 contingency table with a p value <0.05 considered significant. The one-sided, 95% binomial confidence interval for an adverse event in the octogenarian was also determined. Finally, we performed a post hoc analysis to determine the power to detect an increase in risk of complications in octogenarians of greater than 10% when compared with the risk identified in the population <80 years of age.

## RESULTS

Six hundred and ninety-five patients underwent 744 ablation procedures. The mean age was 54 ± 18 years and included 368 men (53%). Table 1 presents the demographic information of the three age groups. The groups were similar with respect to gender distribution. Ablations were performed for AVNRT in 221 patients, for APs in 101 patients, for atrial flutter in 157 patients, for atrial tachycardia in 73 patients, for His bundle ablation in 75 patients

**Table 1.** Group Demographics

Group	≥80 yrs	60-79 yrs	<60 years	Total Group
Number of patients	37	275	383	695
Mean age (yrs)	83 ± 2.4	69 ± 5.3	41 ± 13.3	54 ± 18
Age range (yrs)	80-96	60-79	12-59	12-96
Males (%)	16 (43%)	156 (57%)	197 (51%)	368 (53%)

and for VT in 68 patients. Forty-eight patients (7%) underwent two or more procedures because of an unsuccessful first procedure (10 patients) or late recurrence of the arrhythmia (38 patients). Table 2 categorizes the incidence of short-term success by arrhythmia type in each of the age groups. There was no difference in the success rates among the three groups in arrhythmia types with more than five patients represented. The age groups did differ in their make-up with respect to arrhythmia type (Table 3). Patients >60 years of age underwent significantly more AP ablations than either the 60 to 79 year age group or the ≥80 year age group ( $p < 0.01$ ). The ≥80 year age group underwent significantly more His bundle ablations (43%) than either the 60 to 79 year group (19%) or the <60 age group (2%),  $p < 0.01$ . Only a small number of patients in the ≥80 age group underwent ablation procedures for atrial tachycardia, VT and APs.

Eighteen of the 695 patients (2.6%) experienced complications while undergoing 744 catheter ablation procedures (Table 4). Six patients with pericardial effusions were drained percutaneously, and one patient required surgical drainage because of recurrent effusion. The episode of deep venous thrombosis was not complicated by pulmonary embolus. None of the patients with hematomas required a blood transfusion. There were no obvious sequelae in two patients that were oversedated or three that developed angina requiring termination of the procedure. The single patient with embolic stroke was the only one who experienced any long-term adverse sequelae from the catheter ablative procedure.

Complications occurring in each of the age groups are listed in Table 4. There was no difference in the incidence of complications among the three age groups (0% vs. 2.2% vs. 3.1%,  $p = NS$ ). The upper limit of the 95% confidence interval for an adverse event in the octogenarian is 7.8%. In

addition, based on the described sample size, the power to detect an increase in complication rate in octogenarians from 2.8% (risk in patients <80 years of age) to >10% was 61% with an alpha of 0.05 (two-tailed).

## DISCUSSION

**Efficacy of catheter ablation in elderly patients.** Ablative therapy has traditionally been withheld from the very elderly because it is an invasive procedure with small but well defined risks that might be anticipated to be higher than those observed in younger patients. In addition, the success rates of catheter ablative therapy for the arrhythmias that occur in the very elderly have not been firmly established. Catheter ablative therapy is frequently withheld despite the fact that with advancing age the frequency of symptomatic episodes of supraventricular tachycardia and atrial fibrillation increase and antiarrhythmic drugs are poorly tolerated (11-14). Our results establish that successful ablation of the described arrhythmias which are commonly seen in the very elderly can be achieved with the same high success rate (>95%) and low risk achieved in younger patients. Importantly, we purposely divided our patients into three age groups but could not determine a graded increase in risk or reduction in anticipated success with advancing age.

**Comparison with previous studies.** Patients in this analysis were separated into three age groups to permit a closer comparison with previous reports in which the influence of age on outcome with catheter ablation was assessed. Epstein et al. (14) reported on the outcome of 68 patients over the age of 70. The number of patients over 80 was not stated, but the mean age ranged from 72 to 77 years depending on the arrhythmia type. These investigators noted that success rates for ablative therapy were also comparable with those reported in younger patients. Of note, similar to our

**Table 2.** Short-Term Success Rates of Different Arrhythmia Types for the Total Group and in the Three Age Groups

	≥80	60-79	<60	Total Group
AVNRT	11/11 (100%)	78/78 (100%)	130/132 (98%)	219/221 (99%)
Accessory pathway	0	11/12 (92%)	95/98 (96%)	97/101 (96%)
Atrial tachycardia	1/1	18/23 (78%)	41/49 (84%)	60/73 (82%)
Atrial flutter	6/6 (100%)	83/85 (98%)	65/66 (98%)	154/157 (98%)
His bundle	16/16 (100%)	50/52 (96%)	7/7 (100%)	73/75 (97%)
VT	2/3	18/25 (72%)	37/40 (93%)	57/68 (84%)
Totals	36/37 (97%)	258/275 (94%)	365/383 (95%)	659/695 (95%)

AVNRT = atrioventricular nodal reentry; VT = ventricular tachycardia.

**Table 3.** Percent of Patients in the Age Group with Each Arrhythmia Type

	≥80	60-79	<60	p Value
AVNRT	30%	28%	34%	NS
Accessory pathway	0%	4%	25%	< 0.01
Atrial tachycardia	3%	8%	12%	NS
Atrial flutter	16%	31%	17%	0.05
His ablation	43%	19%	2%	0.01
VT	8%	10%	10%	NS

AVNRT = atrioventricular nodal reentrant tachycardia; VT = ventricular tachycardia.

experience, all nine of their elderly patients undergoing radiofrequency ablation of accessory pathways were less than 80 years. Chen et al. (15) also reported on the influence of age on outcome with ablative therapy for AP and AV nodal reentrant tachycardia ablation. Importantly, this study demonstrated comparable success rates in younger and older (>65 years old, mean age 69 years) patients. Our results support the previous reports and suggest that success of ablative therapy for the described arrhythmias should be anticipated even when the procedure is performed on the very elderly.

**Complications.** Our complication rate of 18 out of 695 (2.6%) patients and 18 out of 744 (2.4%) procedures is low

and is comparable with the incidence of complications reported in other large series. Indeed, in our experience the risk of life threatening complications was extremely low (Table 4). Only one patient (0.2%), age 59, experienced a stroke with residual right arm weakness following an ablation for VT in the setting of chronic coronary artery disease. Transatrial placement of the catheter was required because of the extent of peripheral vascular disease, and it is believed that thrombus associated with a transient impedance rise during radiofrequency energy delivery was jettisoned free when removing the catheter through the transseptal sheath at the end of the ablation procedure. No other patient experienced death, myocardial infarction, valve disruption,

**Table 4.** Complications of Catheter Ablative Therapy and Overall Incidence in Study Population Undergoing 744 Ablation Procedures (N = 695 patients)

Complication	Total Group	≥80	60-80	<60
	N = 695	N = 37	N = 275	N = 383
<b>Major or life-threatening</b>				
Death	0	0	0	0
Myocardial infarction	0	0	0	0
Bradycardia-dependent PMVT	0	0	0	0
Embolic stroke	1	0	0	1
Persistent unintentional heart block	0	0	0	0
Valve disruption	0	0	0	0
Pulmonary embolus	0	0	0	0
Total major complications	1/695 (0.1%)	0 (0%)	0 (0%)	1/383 (0.3%)
<b>Serious</b>				
Deep venous thrombosis	1	0	0	1
Retroperitoneal bleeding	1	0	0	1
Pericardial effusion requiring drainage	7	0	2	5
Total serious complications	9/695 (0.9%)	0 (0%)	2/275 (0.7%)	7/383 (1.8%)
<b>Minor</b>				
Hematoma	3	0	2	1
Over-sedation resulting in altered mental status	2	0	0	2
Ischemic chest pain without infarction (angina)	3	0	2	1
Total minor complications	8/695 (1.1%)	0 (0%)	4/275 (1.4%)	4/383 (1.0%)
Total complications/patient (percentage)	18/695 (2.6%)	0/37 (0%)	6/275 (2.2%)	12/383 (3.1%)

PMVT = polymorphic ventricular tachycardia.

heart block or pulmonary emboli. Our findings corroborate the low risk of the catheter ablative procedure for right sided ablative procedures in the elderly population (60 to 79 years) and extend the results even in the very elderly ( $\geq 80$ ). The two previous reports that addressed efficacy and risk associated with catheter ablative therapy in the elderly suggested a higher risk of ablative procedures for accessory pathways. They noted complications in 2 of 9 (22%) and 4 of 29 (14%) elderly patients with left sided accessory pathway ablations. Of note, only one of the 20 left sided procedures in the 60 to 79 year range and none of the four left sided procedures in the patients  $\geq 80$  years experienced a serious complication. A single patient developed a pericardial effusion. Despite the low complication rate observed, a cautious approach must be taken in the elderly patient undergoing left sided ablative procedures. Vascular access is frequently difficult and vigilance is required to minimize thromboembolic and cardiac perforation risks.

**Study limitations.** The major limitation of this study is related to the limited sample size of patients who were very elderly who underwent ablation procedures for elimination of atrial tachycardia, VT and AP. Thus, we need to refrain from generalizing and indicating that ablative therapy is effective and safe for all arrhythmia types in the very elderly until more data are available for assessing efficacy and risk in arrhythmias that occur less frequently in the elderly. In addition, because of the relatively small number of patients who were  $\geq 80$  years of age, one should be cautious about concluding that there is no ablation risk in the octogenarian. In fact, the power calculation of 61% for detecting an increased complication risk to  $>10\%$  suggests that the sample size with respect to the number of octogenarians represents a limitation of the study. Importantly, however, confidence interval results have been reported to be a better reflection of the precision of a study than the post hoc power analysis (16). Based on the sample size, the 95% confidence interval is 0% to 7.8% for an adverse event in the octogenarian. Therefore, at the very least, we can indicate with confidence that the complication rate is likely to be less than 7.8% for octogenarians undergoing the described ablation procedures based on our study results.

**Conclusions.** Catheter ablation for arrhythmia syndromes that are common in the very elderly can be performed with efficacy and risk profiles that are similar to those observed in younger patients. Our results suggest that catheter ablative therapy in the elderly for atrial flutter, AV nodal reentry and atrial-ventricular junction ablation for rapid ventricular response to atrial fibrillation should probably be considered as an appropriate therapeutic option. The strategy used for these arrhythmias should be independent of age. In fact, given the potential for greater intolerance to drug therapy coupled with the documented tendency for increased frequency and severity with the arrhythmia episodes that occur

with aging, ablative therapy should be considered the initial treatment of choice for many patients.

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