Long-term efficacy and safety of radiofrequency ablation in elderly patients with atrioventricular nodal re-entrant tachycardia

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Aims The purpose of this study was to evaluate the efficacy, risks, safety, and follow-up of radiofrequency (RF) catheter ablation of atrioventricular nodal re-entrant tachycardia (AVRNT) in patients (pts) ≥75 years old (n = 42) (GpI) compared with pts younger than 75 years (n = 234) (GpII).

Methods and results The study population consisted of 276 consecutive pts (39.5% men/60.5% women), from 15 to 98-year-old (average 56 ± 17 years) with AVRNT referred for RF ablation (RFA) from October 1997 to January 2004. Combined anatomical and electrogram approaches were used to guide RFA. The cumulative risk of AVRNT recurrence was analysed by the Kaplan–Meier method and log-rank test. The average follow-up was 34 ± 18 months. GpI (80 ± 4 years) differed significantly from GpII (51 ± 14 years) regarding: heart rate tachycardia (160 ± 20 vs. 180 ± 30 bpm; P = 0.0001), the slow pathway antegrade refractory period (370 ± 70 vs. 340 ± 60 ms; P = 0.01), the fast pathway antegrade refractory period (360 ± 60 vs. 330 ± 60 ms; P = 0.0003), retrograde refractory period (360 ± 60 vs. 330 ± 60 ms; P = 0.0007), left ventricular ejection fraction (60 ± 12 vs. 65 ± 7%; P = 0.0009), and ischaemic ECG signs during tachycardia (76.2% vs. 61%; P = 0.09). RFA was successfully obtained in 275/276 (99.6%), 42/42 in GpI (100%), and 233/234 (99.6%) in GpII. Five complications occurred (1.8%): major complications in two pts (0.7%) and minor complications in three pts (1.1%). Major complications were deep venous thrombosis with pulmonary embolus (n = 1) and pericardial effusion (n = 1), minor complications were groin haematoma (n = 3). One complication was observed in GpI (groin haematoma) (2.4%) and four in GpII (deep venous thrombosis with pulmonary embolus in one, groin haematoma in two, and pericardial effusion in one) (1.7%). The number of recurrences was not statistically different between the two groups (0 vs. 3.4%; P = 0.5) with a respective average follow-up of 28 ± 18 and 35 ± 18 months, respectively.

Conclusion Catheter ablation of AVRNT in elderly and very elderly pts appears to be a reasonable approach regarding feasibility and effectiveness without increasing the risk of AV block.

Although usually well tolerated in youth, supraventricular tachycardias such as atrioventricular nodal re-entrant tachycardia (AVRNT) may be associated with disabling symptoms in the elderly. In addition, anti-arrhythmic agents are not as well tolerated and may be associated with a higher incidence of toxicity in this age group. Despite the high peri-ablation success rate of AVRNT, few elderly patients (pts) are included in reports as age may be a limiting inclusion criterion. Recently, Zado et al. analysed the acute success and complication rates of radiofrequency ablation (RFA) for supraventricular and ventricular arrhythmia in three groups based on age. This included only 11 AVRNT pts over 80 years. In addition, two studies demonstrated that elderly pts had a higher incidence of complications in both the electrophysiological study and the RFA, including AV block in pts who underwent AVRNT RFA. Our study aims to compare the success rate and complications of AVRNT RFA in two groups based on age: ≥75 years and <75 years. The follow-up and long-term risk of developing AV block were also compiled.

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Methods

Study population

The study population consisted of 276 consecutive pts (pts) (39.5% men/60.5% women), from 15 to 98-year-old (average 56 ± 17 years) with AVRNT referred for RFA from October 1997 to January 2004.

Electrophysiological study

All pts gave written informed consent before ablation procedure. Patients were admitted to undergo an electrophysiological study and were weaned off all anti-arrhythmic drugs for at least five half-lives. The investigations were performed using a conventional method of intracardiac recording and stimulation. 12 Three catheters were introduced through the right femoral vein into the right atrium: 6-F quadrupolar catheters with an inter-electrode distance of 5 mm (Bard Electrophysiology, Tewksbury, MA, USA) were positioned under fluoroscopic guidance, then a decapolar catheter with a 5 mm bipolar separation (Bard Electrophysiology) was positioned in the coronary sinus (CS). Continuous anticoagulation was main-

5 mm bipolar separation (Bard Electrophysiology) was positioned in the His-bundle region and in the right ventricular apex under fluoroscopic guidance, then a decapolar catheter with a 5 mm bipolar separation (Bard Electrophysiology) was positioned in the coronary sinus (CS). Continuous anticoagulation was maintained throughout the procedure with an initial bolus injection of 2500 units of heparin, followed if necessary by 1000 units i.v. hourly. A 7-F quadrupolar deflectable catheter with a 4 mm tip elec-

trode, 2-5-2 mm interelectrode spacing (Cordis Biosense Webster, Diamond Bar, CA, USA) was introduced via a femoral vein and used for endocardial mapping and catheter ablation. Surface ECGs (leads I, II, III, and V1) were filtered through a 1–500 Hz bandpass filter, whereas bipolar intracardiac electrograms were filtered at 30–500 Hz and amplified at high gain (0.1 mV/cm). These were simul-

taneously recorded with the 12-lead surface ECG at paper speeds of 25 mm/s and stored digitally with a polygraph (Cardiolab system, Prucka Engineering, Houston, USA). All measurements were performed with the Cardiolab system. An external pacemaker (Medtronic, Minneapolis, MN, USA) programmed with a 2 ms output pulse duration has been used with an amplitude four times greater than the threshold amplitude. This investigation included determination of the effective refractory periods of the AV node (fast and slow pathways in the antegrade) and in retrograde directions. Dual AV nodal physiology was identified by an increment of ≥50 ms in the A2H2 interval in response to a decrement of 10 ms in the A1A2 interval during programmed atrial stimulation. The diagnosis of AVRNT was made according to the previously published criteria including ventricular extrastimulus testing during tachycardia when the His-bundle was refractory. 13 Reproducible tachycardia induction was confirmed before ablation. Intra-atrial re-entrant tachycardia and tachycardia incorporating a midseptal or paraseptal accessory pathway were excluded. 13 When sustained AVRNT could not be reinduced, atropine (0.01–0.02 mg/kg i.v. and, if necessary, isoprenaline were administered (titration to achieve a sinus rate increment of 25%). The protocol of electrophysiological stimulation was the same during the entire study period and so was the operator (ADC).

Mapping and RFA

In all pts, combined anatomical and electrogram approaches were used to guide RFA (12.14,15). All RF procedures were performed through the posterior approach. The ablation catheter tip was position-

ed in the posteroseptal region of the tricuspid annulus by the use of fluoroscopy. Fluoroscopic angulations were standardized to the 25° RAO and 40° LAO projections. Ablation was guided primarily by a search for slow pathway potentials or a fractionated atrial electrogram at the base of the triangle of Koch. 14 The site was considered optimal for catheter ablation if the atrial-to-ventricular electrogram amplitude ratio was 0.1 to 0.5 (usually <0.25). Catheter stability was assessed. Energy of 30 W for a 10–30 s dur-

ation was applied each time with a maximal temperature of 60°C. Application was stopped if junctional rhythm did not appear within 10 s, impedance rose, PR interval prolonged, or AV nodal block occurred. After each RF lesion, we tested for success only after lesions that produced junctional rhythm. We stopped ablation once the endpoint was obtained with no more than one echo after RF or absence of antegrade slow pathway conduction. Presence of residual antegrade slow pathway conduction with or without single AVN echo was not considered a failure. 15 If more than one AV nodal echo beat was identified, further RF applications were given. Otherwise, we tested for inducibility and ablation was considered successful if AVRNT could not be induced even after isopre-

naline infusion (1–4 μg/min i.v. graded infusion) and/or atropine (0.01–0.02 mg/kg i.v.). The protocol for electrophysiological stimu-

lation was the same before and after RFA. Thirty minutes later the endpoint was validated. All pts underwent a post-ablation check. Venous thrombosis was systematically prevented by subcutaneous low molecular weight heparin for 7 days and aspirin was systemati-

cally given for 6 weeks.

Follow-up

After RFA, all pts underwent continuous ECG monitoring for at least 24 h before hospital discharge. All pts underwent two-dimensional echocardiography/Doppler studies 1 day after the procedure to seek any complications. Complications were classified as major or minor in reference to Calkins’ paper. 16 Patients were seen for 2 to 3 months in our outpatients department and thereafter by their referring physicians. Follow-up included history, physical examination, and 12-lead surface ECG. If there were any rhythm-related symptoms, ambulatory Holter monitoring was performed. Cumulative risk of AVRNT recurrence was determined by outpatient follow-up and on recurring symptoms or palpitations. The outpa-


tient follow-up was performed by the referring cardiologist and by the general practitioner. Electrocardiograms were performed at each consultation, at the end of the follow-up (September 2004) and on recurring symptoms.

Statistical analysis

Data are expressed as mean ± SD. The differences among groups were analysed by ANOVA. A probability value of $P<0.05$ was accepted as statistically significant. The average follow-up for the entire population was evaluated by the use of the Kaplan-Meier method and by the log-rank test.

Results

Study population

The study population consisted of 276 pts (39.5% men/60.5% women), from 15 to 98-year-old (average 56 ± 17 years) with AVRNT referred for RF from October 1997 to January 2004. Seventy seven pts (27.9%) had structural heart disease: 22 coronary artery diseases, 9 dilated cardiomyopathy; hypertrophic cardiomyopathy in four cases, and 42 valvular heart diseases: mitral regurgitation in 22 (≥grade II), aortic regurgitation in 17 (≥grade II), mild mitral stenosis with regurgitation in one, and aortic stenosis in two. The left ventricular ejection fraction (LVEF) average was 64 ± 8%. Symptoms before RFA were as follows: chest pain ($n=95$), palpitations ($n=61$), dyspnoea ($n=24$), pre-
syncope ($n=44$), syncope ($n=21$), heart failure ($n=15$), lethargy ($n=15$), and ischaemic stroke ($n=1$).

AVRNT RFA

Patients underwent catheter ablation with the same oper-

ator (ADC). Type of AVRNT was predominantly slow-fast
different between GpI (145 + 34) and slow-slow in two pts (0.8%). An ablation success was obtained in 275/276 pts (99.6%), but junctional rhythm during RF application was observed in 273/276 pts (98.9%), and persistence of residual antegrade slow pathway with or without single AV nodal echo was observed in 35/276 pts (12.7%). Five complications occurred (1.8%): groin haematoma treated medically without requirement for blood transfusion (n = 3), deep venous thrombosis with pulmonary embolus (n = 1) and pericardial effusion requiring a percutaneous pericardiocentesis (n = 1). In this pt, pericardial effusion occurred when the decapolar catheter was being positioned in the CS before the AVRNT ablation. This complication was due to CS catheterization. All complications were resolved without permanent injury. None of the pts required surgical treatment. In addition, short transient AV block occurred during RF application (recovery of normal AV conduction < 3 s) (n = 2) without consequences. During the in-patient observation of continuous ECG monitoring for 48 h, and at the end of the follow-up, no AV abnormality was documented in these two pts.

Long-term AVRNT recurrence
Of the 276 consecutive pts undergoing ablation of AVRNT, long-term follow-up was obtained in 274 pts (99.3%), two were lost to follow-up (0.7%). AVRNT recurred in eight pts (3.4%) and a second ablation procedure was successfully performed in 7/8 pts (88%). The last pt refused the second procedure.

Comparison between pts ≥ 75 years and pts <75 years
Patient comparisons are summarized in Table 1. AVNRT was accompanied by atrial arrhythmias in eight pts of GpI (19%) (atrial fibrillation in six, atrial flutter in one and atrial tachycardia in one) and in 20 pts of GpII (8.5%) (atrial fibrillation in seven, atrial flutter in eight and atrial tachycardia in five) (P = 0.05). Symptoms were similar between GpI and GpII: angina pectoris (24 vs. 36%), palpitations (21.5 vs. 22.2%) syncope or pre-syncope (31 vs. 22%), and dyspnoea (4.8 vs. 9.4%) despite a trend toward a higher risk of heart failure (12 vs. 4.3%; P = 0.06). Differences were found between the two groups regarding LVEF, tachycardia cycle length, effective antegrade, and retrograde refractory period pathways. The average duration of RF applications was 135 ± 70 s (range: 30–390) and did not differ between GpI (145 ± 70) and GpII (135 ± 70 s) (P = 0.5). Acute complication rates were similar and no pts required a pacemaker. After an average follow-up of 34 ± 18 months, recurrence of AVRNT was 0% in the older group of pts and 3.4% in the group < 75 years (P = 0.5).

Discussion
Long-term anti-arrhythmic treatment has not been fully evaluated in pts with AVRNT, although it is accepted that elderly pts on anti-arrhythmic drugs, with underlying cardiac disease, are at greater risk of proarrhythmic side effects, recurring arrhythmia, and other adverse events (2, 9). Despite technological advances, ablative therapy has traditionally been withheld from the very elderly because it is an invasive procedure with potential risks anticipated to be higher than those observed in younger pts.3,8 In addition, Chen et al.5 demonstrated that older age was an independent predictor of complication in pts with RFA. But published series on the outcome of ablation have included very few elderly pts with AVRNT and relatively little is known for this pt population.3,4,6–8,10,17–20 Our main results establish the safety and efficacy of RF catheter ablation in the elderly pts with a low risk of long-term AV block.

Clinical aspects of AVRNT in elderly pts
Previous studies have shown that the main cause of paroxysmal supra-ventricular tachycardia in elderly pts is related to AVRNT.21,22 Generally, elderly and very elderly pts represent 12–21% of pts with AVRNT18,20. Our study is in agreement with 42/276 (15%) of AVRNT pts older than 75 years. It has been demonstrated that elderly pts more often exhibit syncpe or pre-syncpe.20 We found a similar rate of syncpe or pre-syncpe to that found by Kalusche et al.,20 but our results were not significantly different compared with young pts (31 vs. 22%; P = 0.1). In addition, more severe symptoms were found in older pts with AVRNT, whereas our data for the groups were quite similar with only a trend toward a higher risk for acute heart failure. Symptom severity explains, in part, why ablation was offered to old pts, even to a 98-year-old pt with heart failure signs due to incessant AVNRT. In our study, intracardiac conduction times (PR, AH, HV intervals) were significantly longer in the older pts, but remained in the normal range in the vast majority. These data were in agreement with previously published series in this field.17–18,20

Accordingly, we showed a higher incidence of wide QRS due to intraventricular conduction disturbance despite lower tachycardia rates related to longer antegrade nodal refractory periods in the subset of elderly pts.

Efficacy and safety of RF catheter ablation in elderly pts
Although the effectiveness of RFA is now well established in selected pts with drug refractory tachycardia,17,19 the correlation between advancing age and increasing complications could not be ascertained from the available medical literature on AVRNT RFA.10,18 Papers concerning the elderly and AVRNT ablation are composed of small series and with one exception, have been evaluated retrospectively with the inherent limitations of this design.6,7,10,17–19 In addition, the long-term follow-up of AVRNT RFA is either not fully available in this subset or results are controversial.7,10,17–20 Three of these studies focused on RFA, concluding that older pts were more likely to experience procedural complications.6,7,10 Severe complications reported with elderly pts involved arterial access for left sided accessory pathway ablations; for two of nine pts (22%) and four of 29 pts (14%).6,7 Zado et al.4 published a prospective study from which two major components can be highlighted. Peri-_ablation ‘results appear to be comparable with those in younger pts,’ effective and with low complication rates. Extracting their data on AVRNT ablation finds success rates of 98–100% immediately post-ablation, with no major complications in 11 procedures for the very elderly (> 80 years), 78 for the 60–79 years. (average 69 ± 5) and 130 long-term complications including AV block.
In our study, success rate was obtained in 272/274 pts (99.3%) (one failure, one recurrence, two pts lost to follow-up). Recurrence in eight pts was corrected in seven, with a final success rate of 273 pts of 274 (99.6%) at follow-up. The incidence of immediate complications was similar and no late AV block was found. Our data corroborate the low risk of the catheter ablative procedure for right-sided ablative procedures in an elderly and very elderly population which is comparable with that of other large series.4,8,18–20 Transient AV block is similarly reported in the elderly population which is comparable with that of other studies.5,6,18,19 The limitation of the study is the lower number of older pts compared with younger pts. However, this distribution between older and younger pts with AVNRT represents a normal demographic distribution pattern of pts referred for RFA.18,20

**Conclusions**

Catheter ablation of AVNRT in elderly and very elderly pts appears to be a reasonable approach regarding its feasibility, effectiveness, and low procedural risk without increase in risk of AV block in the long-term.

**References**

7. Chen SA, Chiang CE, Yang CJ et al. Accessory pathway and atrioventricular node reentrant tachycardia in elderly patients: clinical features,