JACC Vol. 25, No. 5
April 1995:984–8

Incidence of Symptomatic Atrial Fibrillation in Patients With Paroxysmal Supraventricular Tachycardia

MARK E. HAMER, MD,* WILLIAM E. WILKINSON, PHD, WALTER K. CLAIR, MD, RICHARD L. PAGE, MD, FACC, ELIZABETH A. MCCARTHY, RN, EDWARD L. C. PRITCHETT, MD

Durham, North Carolina

Objectives. **This study was performed to determine the incidence of symptomatic, sustained atrial fibrillation in a group of patients with paroxysmal supraventricular tachycardia. The effects of the mechanism of paroxysmal supraventricular tachycardia (atrioventricular [AV] node reentry vs. AV reentry through an accessory pathway) and heart rate during the tachycardia on the occurrence of atrial fibrillation were also assessed.**

Background. **There is a substantial incidence of atrial fibrillation in patients with paroxysmal supraventricular tachycardia, but the precise incidence and the factors that determine it are unknown.**

Methods. **One hundred sixty-nine patients with paroxysmal supraventricular tachycardia were followed up by regular clinic visits and transtelephonic electrocardiographic monitoring during symptomatic episodes of arrhythmia. The Kaplan-Meier product-limit method was used to estimate the proportion of patients remaining free of atrial fibrillation during the observation period. The Cox proportional hazards model was used to assess the effect of mechanism and heart rate during paroxysmal supraventricular tachycardia on the atrial fibrillation–free period.**

Results. **Thirty-two (19%) of the 169 patients had an episode of atrial fibrillation during a mean follow-up period of 31 months. The cumulative percent of patients experiencing an episode of atrial fibrillation was 6% within 1 month, 9% within 4 months and 12% within 1 year. The mechanism of paroxysmal supraventricular tachycardia was not associated with the time to occurrence of atrial fibrillation; the hazard ratio corresponding to classification in the AV node reentry group was 0.8 ($p > 0.6$). The heart rate during paroxysmal supraventricular tachycardia was not associated with the time to occurrence of atrial fibrillation; the hazard ratio associated with an increase in heart rate of 50 beats/min during the tachycardia was 1.15 ($p > 0.5$).**

Conclusions. **This study suggests that atrial fibrillation will develop in ~12% of patients with paroxysmal supraventricular tachycardia during a 1-year follow-up period. The occurrence of atrial fibrillation is not related to the mechanism or heart rate of the paroxysmal supraventricular tachycardia.**

(J Am Coll Cardiol 1995;25:984–8)

Patients with paroxysmal supraventricular tachycardia occasionally experience atrial fibrillation. The most common mechanisms of paroxysmal supraventricular tachycardia are atrioventricular (AV) node reentry and AV reentry through an accessory pathway. The occurrence of atrial fibrillation through the latter mechanism has been evaluated more extensively than that through other mechanisms, in part because of the potential for rapid conduction down the accessory pathway with resultant ventricular fibrillation and sudden cardiac death. There appears to be a greater incidence of atrial fibrillation in all patients with paroxysmal supraventricular tachycardia than in an age-matched normal population (1–3), but it is not known whether the atrial fibrillation is related to the mechanism or the frequency of recurrence of the paroxysmal supraventricular tachycardia or to other factors.

In this study, we evaluated the incidence of spontaneous episodes of atrial fibrillation in a large number of patients with various mechanisms of paroxysmal supraventricular tachycardia followed up over several years through transtelephonic electrocardiographic (ECG) monitoring.

Methods

Patient sample. Between February 1980 and November 1993, 169 patients (85 men and 84 women) with paroxysmal supraventricular tachycardia were followed up by regular visits to our Clinical Research Unit Arrhythmia Clinic and by transtelephonic ECG monitoring to document the ECG during symptoms. Fifteen patients with a history of paroxysmal supraventricular tachycardia had also experienced one or more episodes of atrial fibrillation before entry into our follow-up study. The ECG criteria for paroxysmal supraventricular tachycardia were a ventricular rate >120 beats/min, a QRS configuration that was normal or reflected functional bundle branch

From the Departments of Medicine (Divisions of Clinical Pharmacology and Cardiology) and Community and Family Medicine (Division of Biometry), Duke University Medical Center, Durham, North Carolina. This study was supported in part by Grant R01 HL40392 from the National Heart, Lung, and Blood Institute and by Grant M01 RR30 from the National Center for Research Resources, National Institutes of Health, Bethesda, Maryland.

Manuscript received March 30, 1994; revised manuscript received October 26, 1994, accepted November 7, 1994.

*Present address and address for correspondence: Dr. Mark E. Hamer, Division of Cardiology, Burch 300, Evanston Hospital, 2650 Ridge Avenue, Evanston, Illinois 60201.

0735-1097/95/$9.50
0735-1097(94)00512-O

block, <20 ms variation in successive RR intervals, no evidence of AV dissociation, and episodic occurrence. The ECG criteria for atrial fibrillation were an irregularly irregular ventricular rhythm, a QRS configuration during arrhythmia that was normal or reflected functional bundle branch block, and no visible P waves.

At the time of entry into the study, information was obtained regarding concomitant heart or lung disease and results of previous electrophysiologic studies. In addition to paroxysmal supraventricular tachycardia, 43 patients had heart disease, 25 had lung disease and 6 had both heart and lung disease. Eighty-seven patients underwent electrophysiologic study before or during the follow-up period with an intracardiac (82 patients) or an esophageal lead (5 patients) recording and programmed electrical stimulation to determine the mechanism of the tachycardia. The electrophysiologic studies were performed for clinical indications, not for research purposes. Patients who underwent electrophysiologic studies were classified according to the mechanism of tachycardia into four groups: 1) AV node reentry; 2) AV reentry through an accessory pathway; 3) ectopic atrial tachycardia; and 4) unknown (if no tachycardia could be induced).

Follow-up methods. Patients were given a transtelephonic ECG monitor (Cardiobeeper Memory Monitor, Survival Technology) for their use in recording and transmitting a 30- to 45-s ECG during symptoms (4). The patients were contacted by a cardiologist or nurse within 24 h of receipt of the ECG to assess their symptoms. The rhythm strips were interpreted by a cardiologist and archived in laboratory log books.

Medical therapy varied widely both before and during follow-up. It was generally our intent to withdraw all antiarrhythmic drugs at some point during the follow-up period to document the occurrence of symptomatic events during a drug-free observation period; 150 of the 169 patients had such a drug-free period during follow-up (5). Drug therapy included digoxin, verapamil, diltiazem, atenolol, quinidine, disopyramide, propafenone or flecainide for part of the follow-up period. Some patients participated in research studies of these drugs, but most were treated for clinical indications (i.e., frequent episodes of paroxysmal supraventricular tachycardia).

This protocol was approved by the Duke University Medical Center Committee on Clinical Investigations. All patients gave written informed consent before participating. Some of the patients in this study have been the subjects of previous scientific reports (3,5,6).

Data analysis. For the purposes of the analyses reported here, the observation period began on the day the patient was first seen in our clinic and given a transtelephonic ECG monitor; it continued until the patient was no longer being followed up by ECG monitor or until November 1, 1993, whichever occurred first. The length of the observation period varied, depending on the frequency of arrhythmic episodes and patient convenience, but we generally tried to monitor patients for at least several months. Patients who were still being followed up and had not had an outcome event were censored as of November 1, 1993. The outcome variable of interest was the length of time from the beginning of the observation period to the first occurrence of atrial fibrillation. The Kaplan-Meier product-limit method was used to estimate and to illustrate graphically the proportion of patients remaining free of atrial fibrillation on each day of the observation period.

To investigate the effect of the mechanism of paroxysmal supraventricular tachycardia on the length of time to the first occurrence of atrial fibrillation (the atrial fibrillation–free period), the patients were classified into one of three groups: 1) patients with AV node reentrant tachycardia induced during an electrophysiologic study; 2) patients with AV reentrant tachycardia involving an accessory pathway induced during an electrophysiologic study; 3) all other patients, including those who did not undergo an electrophysiologic study. Among the patients in the first two groups combined, the Cox proportional hazards model was used to assess the effect of mechanism on the atrial fibrillation–free period with and without adjustment for the potentially confounding effects of age and concomitant heart or lung disease.

The proportional hazards model was also used to assess the effect of heart rate during paroxysmal supraventricular tachycardia on the recurrence time distribution of the atrial fibrillation–free period with and without adjustment for age and concomitant heart or lung disease. Heart rate during the first episode of paroxysmal supraventricular tachycardia in the observation period was used for this assessment.

Results

Electrophysiologic study data. Of the 169 patients in the study, 87 had electrophysiologic studies. Forty-eight of the 87 were classified as having AV reentry through an accessory pathway, 32 had AV node reentry, 2 had ectopic atrial tachycardia and 5 had no inducible arrhythmia. Of the 48 patients whose mechanism was classified as AV reentry through an accessory pathway, 29 had an accessory pathway that functioned in both the anterograde and the retrograde direction, 18 had an accessory pathway that functioned in the retrograde direction only and 1 patient had a "pseudo-Mahaim fiber" (decremental anterograde-only atriofascicular accessory pathway).

One patient with AV node reentry induced during electrophysiologic study also had an accessory AV pathway that functioned in the retrograde direction only and was not observed to participate in tachycardia. This patient was classified as having AV node reentry as the mechanism of spontaneous paroxysmal supraventricular tachycardia. The remaining 48 patients with an AV accessory pathway proved by electrophysiologic study had inducible AV reentrant tachycardia. An attempt was made to induce atrial fibrillation during electrophysiologic study in most of these patients. In 38 of the 48 patients, sustained (>30 s) atrial fibrillation was induced by single or double atrial extrastimuli or atrial burst pacing. Of the seven patients who had spontaneous atrial fibrillation, six had inducible, sustained atrial fibrillation; in the seventh

JACC Vol. 25, No. 5
April 1995:984–8

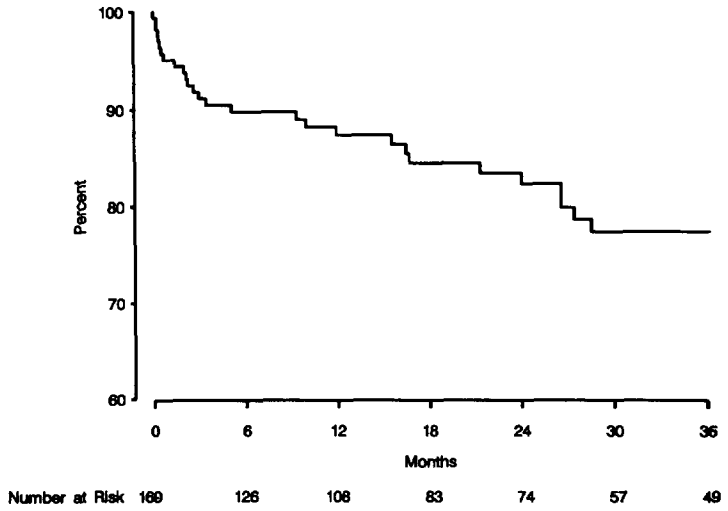


Figure 1. Graph showing time to occurrence of symptomatic atrial fibrillation in all 169 patients with paroxysmal supraventricular tachycardia.

patient, who had an accessory pathway with retrograde function only, no attempt was made to induce atrial fibrillation.

Of the 32 patients in whom atrial fibrillation developed, 12 were taking no antiarrhythmic drugs at the time of its first occurrence during follow-up. The other 20 patients were taking a variety of antiarrhythmic drugs, including atenolol (n = 4), diltiazem (n = 3), verapamil (n = 3), propranolol (n = 2), digoxin (n = 2), quinidine (n = 2), propafenone (n = 2), flecainide (n = 1) and disopyramide (n = 1) at the time of their first documented episode of paroxysmal atrial fibrillation during follow-up. Because of the long follow-up time and frequent changes in medical therapy, we did not attempt to adjust the analysis on the basis of antiarrhythmic therapy.

Length of time to occurrence of atrial fibrillation. Thirty-two (19%) of the 169 patients in this study had a symptomatic episode of atrial fibrillation that was recorded and documented by transtelephonic ECG. The mean observation period was 956 days (31 months) (range 1 to 4,982 days [0 to 13 years]). The cumulative percent of patients experiencing an episode of atrial fibrillation was 6% within 1 month, 9% within 4 months and 12% within 1 year (Fig. 1).

Of the 32 patients who experienced atrial fibrillation during the study period, 4 had one or more documented episodes of atrial fibrillation before entry into our follow-up.

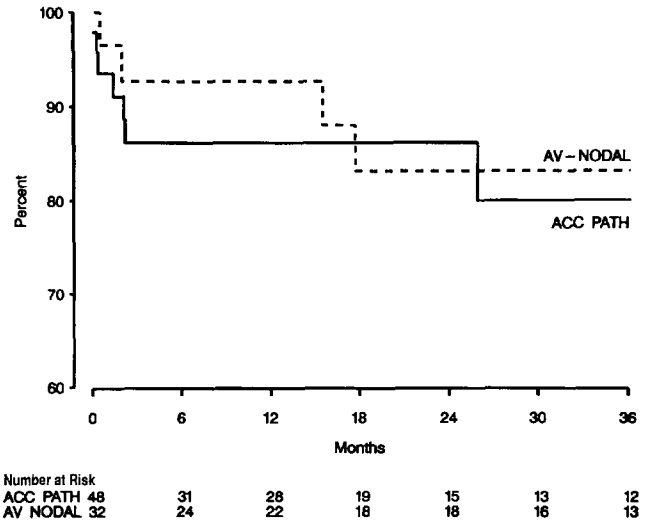
For the 80 patients who had electrophysiologic studies and a tachycardia mechanism classified as either AV node reentry or AV reentry through an accessory pathway, the mechanism was not associated with the time to occurrence of atrial fibrillation (Fig. 2); the hazard ratio corresponding to membership in the AV node reentry group was 0.8 ($p > 0.6$). Although the 32 patients with AV node reentrant tachycardia were older (mean age 44 vs. 31 years, $p < 0.0001$) and had a greater prevalence of heart and lung disease (44% vs. 25%, $p < 0.10$) than did the 48 patients whose mechanism was AV reentry through an accessory pathway, this hazard ratio remained insignificant (hazard ratio 0.6, $p > 0.3$) after adjustment for these two covariates (95% confidence interval [CI] for adjusted hazard ratio 0.14 to 2.2).

The heart rate during paroxysmal supraventricular tachycardia was not significantly associated with the time to occurrence of atrial fibrillation. The hazard ratio associated with an increase of 50 beats/min in heart rate during paroxysmal supraventricular tachycardia was 1.15 ($p > 0.05$, 95% CI 0.71 to 1.88) before and 1.24 (95% CI 0.72 to 2.14) after adjustment for age and presence of heart or lung disease.

Discussion

Incidence of atrial fibrillation. This study examined the occurrence of spontaneous atrial fibrillation in a large number of patients known to have paroxysmal supraventricular tachycardia. Previous studies (1,2) have noted the occurrence of spontaneous episodes of atrial fibrillation in 10% to 34% of

Figure 2. Graph showing time to occurrence of symptomatic atrial fibrillation in the 80 patients with electrophysiologic studies who were classified as having atrioventricular node reentrant tachycardia (**dashed line**, AV-NODAL) or atrioventricular reentry through an accessory pathway (**solid line**, ACC PATH).



patients with Wolff-Parkinson-White syndrome. Other studies from our patient population at Duke have noted an occurrence rate of atrial fibrillation of 22% in patients with paroxysmal supraventricular tachycardia of unknown mechanism (6) and 18% in patients with proved AV node reentrant tachycardia after 1 year of follow-up (3). In the current study, the cumulative proportion of patients known to have paroxysmal supraventricular tachycardia who experienced atrial fibrillation was 12% at 1 year.

Effect of mechanism of paroxysmal supraventricular tachycardia. Our study showed no significant difference in the incidence of atrial fibrillation between the patients with AV node reentrant tachycardia and those with AV reentry through an accessory pathway. This observation suggests that the occurrence of atrial fibrillation is not related to properties unique to patients with AV reentrant tachycardia through an accessory pathway, such as anterograde accessory pathway function, short anterograde effective refractory period of the accessory pathway or presence of multiple accessory pathways, as suggested by other investigators (7–9).

Effect of heart rate during paroxysmal supraventricular tachycardia. Heart rate during the first episode of paroxysmal supraventricular tachycardia was not associated with the time to occurrence of atrial fibrillation. Atrial vulnerability is increased at shorter cycle lengths as measured by repetitive atrial firing during atrial extrastimulus testing (10). However, studies of patients with AV reentrant tachycardia through an accessory pathway have shown no correlation between the cycle length of reciprocating tachycardia induced during electrophysiologic study and the occurrence of atrial fibrillation (2,7,8). Our study confirms the lack of association between heart rate during spontaneous paroxysmal supraventricular tachycardia due to a variety of mechanisms and the occurrence of atrial fibrillation.

Atrial fibrillation may develop in patients with paroxysmal supraventricular tachycardia as a result of factors not evaluated in this study. These include hemodynamic deterioration during the tachycardia, excessive atrial stretch or abnormalities of atrial conduction and refractoriness. Attempts by other investigators (2,8,9) to correlate variables such as PA interval, atrial effective refractory period and dispersion of refractoriness with the occurrence of atrial fibrillation have not produced consistent results.

Ablation of the accessory pathway in patients with Wolff-Parkinson-White syndrome leads to a significant reduction in the incidence of subsequent atrial fibrillation (9,11), suggesting that a functional reentrant circuit is usually necessary for the spontaneous induction of atrial fibrillation in these patients. Atrial fibrillation may occur as a result of sustained reciprocating tachycardia or as a result of premature atrial stimulation during sinus rhythm due to retrograde activation through the accessory pathway or the fast pathway of the AV node. If the cause of atrial fibrillation in these patients is sustained paroxysmal supraventricular tachycardia, the frequency of episodes of the tachycardia should be related to the occurrence of atrial fibrillation, but this association has not been rigorously tested.

Risk of thromboembolic events. The occurrence of atrial fibrillation in patients with paroxysmal supraventricular tachycardia raises the issue of attendant thromboembolic risk. Previous studies (12,13) have suggested that the risk of stroke is much less with paroxysmal atrial fibrillation than with chronic atrial fibrillation and probably no higher than that in the general population. In contrast, the Stroke Prevention in Atrial Fibrillation study (14) revealed that the incidence of thromboembolic events in patients with intermittent atrial fibrillation (5.6%/year) was equal to that of patients with chronic atrial fibrillation (5.9%/year). There are no data regarding the risk of thromboembolic events in patients who have both paroxysmal supraventricular tachycardia and paroxysmal atrial fibrillation, but in the presence of other risk factors for thromboembolic events (e.g., congestive heart failure [12] or left atrial enlargement [15]), aspirin or warfarin therapy may be considered. The most effective antithrombotic therapy may be elimination of the reentrant circuit by treatment with antiarrhythmic drugs or radiofrequency ablation, thereby greatly diminishing the recurrence rate of atrial fibrillation. The effectiveness of antiarrhythmic drug or ablation therapy on stroke prevention in these patients has not been tested.

Limitations of the study. Our study was designed to assess the occurrence of episodes of symptomatic atrial fibrillation that were long enough for the patients to record an ECG; it did not include asymptomatic episodes or those too brief to record. Episodes of atrial fibrillation lasting only a few seconds are generally less bothersome to patients and rarely cause the hemodynamic compromise that is occasionally associated with sustained episodes.

Because of the small number of patients who experienced atrial fibrillation in the groups with documented AV node reentrant tachycardia and AV reentrant tachycardia through an accessory pathway, our study may have failed to detect an important difference in the incidence of atrial fibrillation in the two groups. Although the use of antiarrhythmic drug therapy in some patients may have affected the occurrence rate of atrial fibrillation, it seems unlikely that it would have had a preferential effect on the occurrence of atrial fibrillation in patients in one of the two groups.

Conclusions. This study suggests that ~12% of patients with paroxysmal supraventricular tachycardia will develop atrial fibrillation during a 1-year follow-up period. The occurrence of atrial fibrillation was not significantly related to mechanism or heart rate of paroxysmal supraventricular tachycardia, although the small number of events limits the conclusiveness of this observation. Further study is required to determine which other factors lead to development of atrial fibrillation in patients with paroxysmal supraventricular tachycardia and whether the risk of thromboembolism warrants prophylaxis.

We thank Mark Willis, BA for technical assistance.

References

1. Campbell RWF, Smith RA, Gallagher JJ, Pritchett ELC, Wallace AG. Atrial fibrillation in the preexcitation syndrome. Am J Cardiol 1977;40:514–20.
2. Bauernfeind RA, Wyndham CR, Swiryn SP, et al. Paroxysmal atrial fibrillation in the Wolff-Parkinson-White syndrome. Am J Cardiol 1981;47:562–9.
3. Hurwitz JL, German LD, Packer DL, et al. Occurrence of atrial fibrillation in patients with paroxysmal supraventricular tachycardia due to atrioventricular nodal reentry. PACE 1990;13:705–10.
4. Pritchett ELC, Zimmerman JM, Hammill KF, Reiter MJ, Hammill SC. Electrocardiogram recording by telephone in antiarrhythmic drug trials. Chest 1982;81:473–6.
5. Clair WK, Wilkinson WE, McCarthy EA, Page RL, Pritchett ELC. Spontaneous occurrence of symptomatic paroxysmal atrial fibrillation and paroxysmal supraventricular tachycardia in untreated patients. Circulation 1993;87: 1114–22.
6. Roark SF, McCarthy EA, Lee KL, Pritchett ELC. Observations on the occurrence of atrial fibrillation in paroxysmal supraventricular tachycardia. Am J Cardiol 1986;57:571–5.
7. Sharma AD, Klein GJ, Guiraudon GM, Milstein S. Atrial fibrillation in patients with Wolff-Parkinson-White syndrome: incidence after surgical ablation of the accessory pathway. Circulation 1985;72:161–9.
8. Fujimura O, Klein GJ, Yee R, Sharma AD. Mode of onset of atrial fibrillation in the Wolff-Parkinson-White syndrome: how important is the accessory pathway? J Am Coll Cardiol 1990;15:1082–6.
9. Waspe LE, Brodman R, Kim SG, Fisher JD. Susceptibility to atrial fibrillation and ventricular tachyarrhythmia in the Wolff-Parkinson-White syndrome: role of the accessory pathway. Am Heart J 1986;112:1141–52.
10. Wyndham CRC, Amat-y-Leon F, Wu D, et al. Effects of cycle length on atrial vulnerability. Circulation 1977;55:260–7.
11. Haissaguerre M, Fischer B, Labbe T, et al. Frequency of recurrent atrial fibrillation after catheter ablation of overt accessory pathways. Am J Cardiol 1992;69:493–7.
12. Kannel WB, Abbott RD, Savage DD, McNamara PM. Coronary heart disease and atrial fibrillation: the Framingham study. Am Heart J 1983;106: 389–96.
13. Cairns JA, Connolly SJ. Nonrheumatic atrial fibrillation: risk of stroke and role of antithrombotic therapy. Circulation 1991;84:469–81.
14. The Stroke Prevention in Atrial Fibrillation Investigators. Predictors of thromboembolism in atrial fibrillation: I. Clinical features of patients at risk. Ann Intern Med 1992;116:1–5.
15. The Stroke Prevention in Atrial Fibrillation Investigators. Predictors of thromboembolism in atrial fibrillation: II. Echocardiographic features of patients at risk. Ann Intern Med 1992;116:6–12.