

Recurrence rate after accessory pathway ablation

Carl Timmermans, Joep L R M Smeets, Luz-Maria Rodriguez, Giuseppe Oreto, Eduardo Medina, Walter Notheis, Georgios Vrouchos, Arnd Weide, Hein J J Wellens

Abstract

Objective—To evaluate characteristics of patients and accessory pathways as well as additional technical factors involved in the reappearance of accessory pathway conduction after successful ablation.

Design—Analysis of recurrences after radiofrequency ablation.

Setting—163 consecutive patients with 167 accessory pathways.

Subjects—97 men and 66 women with a mean (SD) age of 36 (14) range (11 to 75) years.

Results—After a mean (SD) follow up of 14 (7) range (2 to 27) months, conduction recurred in 13 out of 167 (7.8%) accessory pathways. The initial manifestation of recurrence was circus movement tachycardia in 7 patients and reappearance of delta waves on a 12 lead electrocardiogram in 6 patients. The interval to the return of accessory pathway conduction ranged from 3 hours to 90 days. Age, sex, presence of multiple accessory pathways, criteria to determine the target ablation site, number and duration of radiofrequency applications, and cumulative energy did not significantly differ between the groups with recurrence and without. Recurrence was less common with concealed accessory pathways (2/44) than with overt accessory pathways (11/110). The difference was not significant. The only variable to influence the recurrences in this study group was the location of the accessory pathway. Reappearance of conduction through right sided accessory pathways occurred significantly more often than through left sided ones (8/40 v 5/114, $P = 0.01$).

Conclusion—After radiofrequency ablation the recurrence rate of accessory pathways is low and there are no predictors of the risk of reappearance of conduction apart from the right sided location of the accessory pathway.

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Radiofrequency catheter ablation is considered to be the treatment of choice in patients with arrhythmias associated with an extra connection between atria and ventricles. Although several studies have reported a high success rate with this technique,¹⁻⁴ only limited data are available on the recurrence rate after a successful ablation.⁵⁻⁷ The purpose of

this study was to evaluate characteristics of patients and accessory pathways, as well as additional technical factors on the reappearance of accessory pathway conduction after successful ablation.

Patients and methods

PATIENTS

Between May 1991 and July 1993, 188 patients with 192 accessory pathways were referred to our hospital for radiofrequency catheter ablation. Of these patients 163 (86.1%) were successfully ablated and this group formed the basis of our analysis. The study population consisted of 97 men and 66 women with a mean (SD) age of 36 (14) range (11 to 75) years. Multiple accessory pathways were present in three patients of whom two had two accessory pathways. The third patient with three accessory pathways was the subject of an earlier publication.⁸ Classification of the location of accessory pathways in 11 different subgroups was based on criteria that have been described previously.^{9,10} Associated cardiac disorders occurred in six patients (Ebstein's anomaly with atrial septal aneurysm (one); secundum atrial septal defect (one); tachycardiomyopathy (one); patent ductus arteriosus (two), and coronary sinus aneurysm (one)). Antiarrhythmic medication was discontinued at least five half lives before the procedure. All patients underwent a physical examination, an exercise test, an echocardiogram, and an electrophysiological examination.

ELECTROPHYSIOLOGICAL EXAMINATION

All patients were studied in a fasting, non-sedated state; only minor sedatives were given if necessary. Catheters were passed through both femoral veins and positioned in the heart under fluoroscopic guidance. These included a quadripolar catheter in the right atrium and the right ventricular apex and a bipolar catheter in the region of the bundle of His. A quadripolar catheter was also inserted into the coronary sinus to obtain detailed information with unipolar recordings about the earliest retrograde atrial activation. The technique for unipolar recording used in our laboratory is that reported by Farré *et al.*¹¹ Methods for stimulation and recording used in our laboratory have been described previously.¹² Briefly, the stimulation protocol included the use of the extrastimulus method (one to three extrastimuli) from the high right atrium, coronary sinus, and right ventricle during sinus

Department of
Cardiology, Academic
Hospital, Maastricht,
The Netherlands

C Timmermans
J L R M Smeets
L-M Rodriguez
G Oreto
E Medina
W Notheis
G Vrouchos
A Weide
H J J Wellens

Correspondence to:

Dr Joep L R M Smeets,
Academic Hospital
Maastricht, PO Box 5800,
AZ 6202 Maastricht, The
Netherlands.

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Table 1 Data on patients, accessory pathways, and ablation procedure in relation to recurrence

	No recurrence	Recurrence
Patients (n)	150	13
Age (yr)	36 (14)	36 (12)
M/F	89/61	8/5
Multiple APs	2/150	1/13
AP location (O or C)		
Left sided	114 (74/40)	5 (4/1)
Left anterior	10 (6/4)	—
Left lateral	63 (42/21)	4 (3/1)
Left posterior	19 (12/7)	1 (1/0)
Left posteroseptal	17 (10/7)	—
True posteroseptal	5 (4/1)	—
Right sided	40 (36/4)	8 (7/1)
Right anterior	—	1 (1/0)
Right lateral	4 (4/0)	—
Right posterior	6 (5/1)	3 (3/0)
Right posteroseptal	16 (13/3)	4 (3/1)
Midseptal	9 (9/0)	—
Anteroseptal	5 (5/0)	—
Left + right sided	154 (110/44)	13 (11/2)
Shortest VACT (ms) (mean (SD))	85.1 (19.6) (58)*	106.7 (15.3) (3)*
Shortest delta-V (ms) (mean (SD))	—17.2 (12.7) (92)*	—18.9 (13.4) (9)*
RF applications (n) (mean (SD))	8.7 (8.5)	10.2 (7.6)
Duration of RF applications (s) (mean (SD))	20.5 (5.6)	20.3 (6.3)
Cumulative energy (W. s) (mean (SD))	5084 (5085)	6408 (5529)

AP, accessory pathway; C, concealed; delta-V, ventricular activation relative to the onset of delta wave; O, overt; RF radiofrequency; VACT, ventriculoatrial conduction time; (), *number of accessory pathways.

rhythm, pacing from the stimulation sites, and repetition of the protocol during infusion of isoproterenol ($3 \mu\text{g}/\text{min}$) when tachycardia could not be induced.

ABLATION PROCEDURE

After determination of the electrophysiological properties of the accessory pathway, a 7 French (F) steerable quadripolar catheter with a 4 mm distal tip electrode (Mansfield Boston Scientific, Watertown, MA, USA) was inserted. A thermister tipped catheter was not used. For right sided accessory pathways a femoral vein 6 F introducer sheath was replaced by a 7 F sheath. In three patients, the ablation catheter was positioned through the subclavian vein approach (right lateral accessory pathway (one); anteroseptal accessory pathway (two)). In cases of a left sided accessory pathway the steerable catheter was introduced through an 8 F introducer sheath via the femoral artery in all except one patient (brachial approach, left lateral accessory pathway). Heparin was given as a 100 IU/kg bolus dose followed by 5000 IU every two hours.

Mapping of the tricuspid and the mitral valve annulus was performed in the 30° right and 60° left anterior oblique fluoroscopic projection. The atrial point of insertion of overt and concealed accessory pathways was determined from the site of earliest retrograde atrial activation during orthodromic circus movement tachycardia. For left sided accessory pathways the coronary sinus electrode catheter was positioned in such a way that "bracketing" in the unipolar recording around the shortest ventriculoatrial conduction time could be shown.¹³ The ventricular point of insertion of overt accessory pathways was located from the earliest ventricular activation relative to the start of the delta wave during maximal pre-excitation obtained during atrial stimulation. After identifying the point of insertion of the accessory pathway with these methods, radiofrequency energy was applied. A HAT-200-Osypka generator supplying 500

kHz (Osypka GmbH, Grenzach-Wyhlen, Germany) was used as the energy source at a constant electrical power of 20 to 30 W for delivery of energy under the valve annulus and at 15 to 20 W for delivery of energy on the valve annulus. Most left sided pathways were ablated from under the mitral valve annulus. Ten accessory pathways were ablated on the mitral valve annulus, and in two patients successful elimination of accessory pathway conduction was obtained through the atrial aspect of the mitral annulus by way of a patent foramen ovale. All right sided accessory pathways were ablated on the tricuspid valve annulus. Preferably, in the overt accessory pathway, radiofrequency current was applied during sinus rhythm, whereas concealed accessory pathways were interrupted during orthodromic circus movement tachycardia. Radiofrequency energy was only applied after a stable catheter position was obtained as judged by fluoroscopy and stable intracardiac recordings. If catheter displacement occurred the application energy was immediately stopped. If impedance increased the catheter was removed and the coagulum cleaned from its tip. Ablation was regarded as successful if by at least 30 minutes after the last radiofrequency application a control stimulation protocol showed the absence of anterograde and retrograde conduction through the accessory pathway either before or after isoproterenol infusion. After the procedure patients were observed for 24 hours and seen in the outpatient clinic six weeks later.

STATISTICAL ANALYSIS

Continuous variables are expressed as the mean (SD). Quantitative variables were evaluated by *t* test and nominal findings by the χ^2 test. P values of < 0.05 were regarded as significant.

Results

CHARACTERISTICS OF PATIENTS IN WHOM ACCESSORY PATHWAY CONDUCTION RECURRENT AFTER RADIOFREQUENCY ABLATION

After a mean (SD) follow up of 14 (7) range (2–27) months, recurrences occurred in 13 out of 167 (7.8%) successfully ablated accessory pathways (table 1). Table 2 shows detailed information about the patients with recurrent accessory pathway conduction. Conduction recurred in four patients through a right posteroseptal accessory pathway and in four through a left lateral accessory pathway. In three patients conduction recurred through a right posterior accessory pathway, whereas in one patient there was recurrence through a right anterior and in another through a left posterior accessory pathway. Only patient 3 had multiple accessory pathways (three pathways, only one of which recurred). Eleven of the 13 recurrences occurred in patients with manifest pre-excitation during sinus rhythm; two patients had a concealed accessory pathway including one with decremental properties. All overt accessory pathways, except in

Table 2 Characteristics of patients with recurrence of accessory pathway conduction after radiofrequency ablation

Variable	Patient No												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Age (yr)/sex	45/M	16/F	17/M	45/F	36/M	54/F	35/M	45/F	24/M	44/M	42/F	29/M	33/M
APs (n)	1	1	3	1	1	1	1	1	1	1	1	1	1
Location of AP	RPS	RPS	RPS	RPS	RP	RP	RP	RA	LP	LL	LL	LL	LL
O or C AP	O	C	O	O	O	O	O	O	O	C	O	O	O
Shortest delta-V (ms)	-15	—	-40	-15	-10	-40	-40	0	—*	—	-10	—*	-20
Shortest VACT (ms)	—	110	—	—	—	—	—	—	90	110	—	120	—
Interval to recurrence (days)	4	30	90	0.25	88	90	39	0.125	14	19	1.5	30	14
Initial manifestation of recurrent conduction	T	T	E	E	E	T	E	E	T	T	E	T	T

*Target ablation site determined during circus movement tachycardia. A, anterior; E, delta waves on 12 lead electrocardiogram; L, left; LL, L lateral; P, posterior; PS, posteroseptal; R, right; T, tachycardia through an AP; Other abbreviations as for table 1.

patients 9 and 12, were ablated at their presumed site of ventricular insertion, with their shortest ventricular activation relative to the start of the delta wave ranging from 0 to -40 ms. The value of the shortest ventriculoatrial conduction time for the two concealed accessory pathways (patients 9 and 12) was 90 and 120 ms, respectively. The time interval between the day of the ablation procedure and reappearance of the accessory pathway conduction ranged from three hours to 90 days. In two patients accessory pathway conduction returned after three and six hours, in five patients within three weeks, and in six patients between one and three months after ablation. The initial manifestation of recurrence was tachycardia through an accessory pathway in seven patients and reappearance of delta waves on a 12 lead electrocardiogram in six patients.

RECURRENCE V NO RECURRENCE: DATA ON PATIENTS, ACCESSORY PATHWAYS, AND ABLATION PROCEDURE

Table 1 shows the comparison between patients with and without recurrent conduction through accessory pathways. No significant differences between the group with and without recurrences were found for age (36 (12) v 36 (14)), sex (eight v 89 men; five v 61 women), and presence of multiple accessory pathways (one of 13 v two of 150 patients). Reappearance of conduction through right sided accessory pathways occurred significantly more frequently than through left sided accessory pathways (eight of 40 v five of 114, P = 0.01). A lower recurrence rate was found in concealed than in overt accessory pathways (two of 44 (4.6%) v 11/110 (10%)), but the difference was not significant. The ventriculoatrial conduction time was studied in 58 patients without recurrence and three patients with recurrence. In the group without recurrence the mean ventriculoatrial conduction time was 85.1 (19.6) ms, whereas in the patients with recurrence it was 106.7 (15.3) ms. The difference was not statistically significant (NS, P = 0.07), perhaps because too few patients were studied. The interval between the local ventricular activation and the delta wave was the criterion used to determine the ablation target site in 92 patients in the group without recurrence and in nine patients with recurrence, and its mean value was -17.2

(12.7) ms without recurrence and -18.9 (13.4) ms with recurrence (NS). The number and duration of radiofrequency applications and the cumulative energy required for interruption of accessory pathway conduction did not differ between patients with and without recurrence. Time to block an accessory pathway conduction during radiofrequency energy application ranged from one to eight seconds. Interruption of accessory pathway conduction more than 10 seconds after the start of the energy invariably resulted in the reappearance of accessory pathway conduction during the procedure.

OUTCOME OF PATIENTS WITH RECURRENT ACCESSORY PATHWAY CONDUCTION

A second ablation procedure was performed in 11 of the 13 patients with recurrent accessory pathway conduction. The remaining two patients did not undergo a new ablation either because of minor symptoms (patient 3) or because of being asymptomatic (patient 7). Permanent interruption of accessory pathway conduction after a mean follow up of 9 (6) range (1-19) months was reached after a second ablation session in nine out of 10 patients and in one patient after a third ablation session. Patient 4 had a second recurrence one hour after his repeat ablation that was successfully and permanently treated with a third ablation procedure. Another two recurrences occurred in patient 8, 18 hours and 43 days after the corresponding successful ablation session. Because of the absence of tachycardia no fourth ablation was attempted.

Discussion

In our study reappearance of conduction through an accessory pathway successfully ablated by radiofrequency current occurred in 7.8% of patients. The time to recurrence of an accessory pathway conduction ranged from three hours to three months. The initial manifestation of recurrent accessory pathway conduction was tachycardia through an accessory pathway (six cases) and reappearance of delta waves on the 12 lead electrocardiogram (seven cases). These figures are in agreement with previous studies, which reported an incidence of recurrence ranging between 8% and 12%, after a time delay varying from one hour to a maximum of 4.7 months.^{5,6}

Variables such as age, presence of multiple accessory pathways, number, duration, and cumulative energy of radiofrequency applications did not influence reappearance of conduction through the accessory pathways in our study. Twidale *et al*⁵ and Chen *et al*⁷ also noted that multiple accessory pathways as well as power and duration of radiofrequency application were not related to recurrence of accessory pathway conduction. On the contrary, in the study by Langberg *et al* patients with recurrence were younger, had a higher incidence of multiple accessory pathways, and received a significantly higher number of radiofrequency applications during the procedure.

The only variable that influenced the recurrence in our patients was location of the accessory pathway: a significantly higher incidence was found in right sided accessory pathways. This is in agreement with the results of Twidale and Langberg.^{5,6} It is generally accepted that a stable catheter position with a firm electrode tissue contact is more difficult to obtain in right sided than in left sided accessory pathways mainly due to anatomical limitations.⁵ This is probably the reason for the higher incidence of recurrence in right sided accessory pathways.

Our study showed a lower incidence of recurrence in concealed than in overt accessory pathways, although the difference did not reach significance, possibly due to the limited number of patients. Other authors, however, found a high recurrence rate in accessory pathways without anterograde conduction.^{5,7} They attributed this finding to difficulties in recording the retrograde accessory pathway potential, which was obscured by the large overlapping ventricular potential. Both studies used bipolar recordings, and considered the identification of the accessory pathway potential as the main indicator of the site of delivery of energy. In our study, unipolar electrograms have been used to measure the ventriculoatrial conduction time during circus movement tachycardia. In concealed accessory pathways the target ablation site was selected according to the shortest ventriculoatrial conduction time. The relatively low rate of recurrence of concealed accessory pathways in our study could be due to the use of unipolar recordings, which permit a clear distinction between atrial and ventricular depolarisation, and to the selection of the target site on the basis of the shortest

ventriculoatrial conduction time during circus movement tachycardia.

The overall recurrence rate is low and the patient can be reablated if necessary with a high success rate. Furthermore, there are no predictors of the risk of recurrence apart from the right sided location of the accessory pathways. Lack of anterograde conduction (concealed accessory pathway) does not seem to play a part in determining the recurrence of conduction. The use of better catheters and the increasing experience of the operators will probably lower the recurrence rate in the future.

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