

Delayed Effects of Radiofrequency Energy on Accessory Atrioventricular Connections

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LANGBERG, J.J., ET AL.: Delayed Effects of Radiofrequency Energy on Accessory Atrioventricular Connections. The purpose of this study was to determine the incidence and characteristics of delayed effects on conduction through accessory atrioventricular (AV) connections after apparently successful attempts at radiofrequency catheter ablation. Among 450 patients who had 471 accessory AV connections, the ablation procedure was unsuccessful in 26 patients (6%), as defined by persistent conduction through the accessory AV connection 60 minutes after the final application of radiofrequency energy. In 6/26 unsuccessfully treated patients (24%), conduction through the accessory AV connection disappeared on a delayed basis. At least once during the ablation procedure, conduction through each of these 6 accessory AV connections was transiently eliminated for 10 seconds to 60 minutes. Five of these accessory AV connections were left-sided and one was posteroseptal; one was concealed and five were manifest. Conduction through the accessory AV connection disappeared on a delayed basis 6–18 hours after the ablation procedure in 4 patients, and at some time between 1–5 days or 1–60 days in the other 2 patients. In 2 patients, the delayed effect was only transient, while in 4 patients, conduction through the accessory AV connections did not return during 5–23 months of follow-up. In conclusion, up to 15% of patients who undergo an apparently unsuccessful attempt at radiofrequency ablation of an accessory AV connection may later manifest a permanent loss of conduction through the accessory AV connection. (*PACE*, Vol. 16, May, Part I 1993)

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Introduction

Conduction through accessory atrioventricular (AV) connections may occasionally disappear several minutes to days after an apparently unsuccessful attempt at ablation with radiofrequency energy.¹ However, conduction through these accessory AV connections has been reported to reappear at some later date.¹ In contrast, we have observed that conduction through accessory AV connections may disappear permanently following an apparently unsuccessful attempt at radiofrequency ablation. The purpose of this report is to

describe the incidence and characteristics of delayed effects on conduction through accessory AV connections after apparently unsuccessful attempts at radiofrequency ablation.

Methods

Characteristics of Patients

Between February, 1990 and August, 1992, 450 patients underwent an attempt at radiofrequency ablation of an accessory AV connection at the University of Michigan Medical Center. There were 264 men and 186 women, and their mean age was 36 ± 16 years (\pm standard deviation). Four hundred seventy-one accessory AV connections were present in these 450 patients. Two hundred seventy-eight were left-sided, 83 were posteroseptal, 82 were right-sided, and 28 were

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anteroseptal or midseptal in location. One hundred thirty-seven (29%) of the 471 accessory AV connections were concealed and the remainder were associated with manifest preexcitation.

Catheter Ablation

The catheter ablation procedures were performed in the fasting state after informed consent was obtained and at least four half-lives after discontinuation of antiarrhythmic drug therapy. The equipment and techniques for catheter ablation have been described previously.^{2,3} Radiofrequency energy was delivered between the distal electrode of the ablation catheter and a large skin electrode placed over the posterior chest at power settings of 30 to 40 watts for 20 to 30 seconds. After the procedure, patients underwent continuous electrocardiographic monitoring for 6 to 24 hours and then were discharged from the hospital and followed on an out-patient basis by one of the authors or referring physicians.

Results

The ablation procedure was successful in 424 of 450 patients (94%) and unsuccessful or apparently unsuccessful in 26 patients (6%) in whom conduction through an accessory AV connection

was present 60 minutes after the final application of radiofrequency energy. Conduction through the accessory AV connection disappeared on a delayed basis in six of these 26 patients (24%). This delayed effect of radiofrequency energy was permanent in four of the six patients and transient in two.

The six patients in whom there was a delayed effect on conduction through an accessory AV connection are described in Table I. There were five men and one woman, and their mean age was 48 ± 19 years. Five of the accessory AV connections were left sided and one was posteroseptal. One was concealed and the other five were associated with manifest preexcitation. The mean anterograde and retrograde block cycle lengths of the accessory AV connections were 282 ± 22 and 286 ± 50 milliseconds, respectively. A mean of 22 ± 9 applications of radiofrequency energy were delivered during the ablation procedures that produced a delayed effect. On at least one occasion during the catheter ablation procedure, conduction through the accessory AV connection was transiently eliminated for 10 seconds to 60 minutes. At the end of the catheter ablation procedure, neither the anterograde nor retrograde block cycle length of the accessory AV connection was significantly changed from baseline in the four patients

Table I.

Patient	Age	Loc	Baseline BCL (msec)		#RF	BCL Post-RF (msec)		Disappearance of Delta Wave	Reappearance of Delta Wave	Follow-Up (Mos)
			Ant	Retro		Ant	Retro			
1	49	LL	260	240	14	260	240	1-60 days	No	23
2	29	PS	310	340	33		NM	6-18 hours	No	15
3	52	LL	300	350	8		NM	6-12 hours	No	14
4	22	LAL	260	240	30	250	240	12-18 hours	No	5
5	68	LAL	280	300	25	450	400	12-18 hours	Yes	13
6	66	LPL	Conc	250	20	Conc	250	NA*	NA**	12

* Retrograde conduction not present during electrophysiology test 5 days after ablation session.

** Retrograde conduction over accessory pathway again present during electrophysiology test 14 days after ablation session. Ant = anterograde; BCL = block cycle length; Conc = concealed; LAL = left anterolateral; LL = left lateral; LPL = left posterolateral; Loc = location of accessory pathway; NA = not applicable; NM = not measured; PS = posteroseptal; Retro = retrograde; RF = radiofrequency energy.

in whom these parameters were remeasured. In two patients in whom delta waves reappeared 60 minutes after the last application of radiofrequency energy, the catheters had already been removed and therefore the conduction properties of the accessory AV connection were not remeasured.

Among the five patients who had manifest accessory AV connections, delta waves were noted to have disappeared between 6 and 18 hours after the ablation procedure in four patients and at some time between 1 and 60 days after the ablation procedure in one patient (Table I). The patient who had a concealed accessory AV connection underwent an electrophysiology test five days after the first ablation attempt and was found to have no evidence of conduction through the accessory AV connection.

In patients 1–4, conduction through the accessory AV connection did not recur during follow-up (Table I). Patient 1 underwent an electrophysiology test 2 months after the ablation procedure and was found to have no evidence of anterograde or retrograde conduction through an accessory AV connection; neither delta waves nor symptoms of paroxysmal tachycardia have recurred during 23 months of follow-up. Patients 2, 3, and 4 did not undergo follow-up electrophysiology tests and did not have a recurrence of delta waves or symptoms of paroxysmal tachycardia during 5 to 15 months of follow-up.

In patients 5 and 6, the delayed effects of radiofrequency energy on conduction through the accessory AV connection were not permanent (Table I). In patient 5, delta waves were noted to have reappeared 10 days after the first ablation session and an electrophysiology test demonstrated attenuated conduction through the accessory AV connection (anterograde block cycle length 500 msec compared to 280 msec baseline, and retrograde block cycle length 450 msec compared to 300 msec baseline). Further attempts at ablation of this accessory AV connection were unsuccessful. In patient 6, retrograde conduction through the concealed accessory AV connection and inducible orthodromic tachycardia were found to have recurred during an electrophysiology test 14 days after the first ablation session. Radiofrequency ablation was repeated and was successful.

Discussion

Main Findings

The results of this study demonstrate that attempts at catheter ablation using radiofrequency energy may have delayed effects on conduction through accessory AV connections. Among 26 patients in whom catheter ablation was apparently unsuccessful and in whom conduction through the accessory AV connection was documented to be present during the first hour after the ablation session, conduction later disappeared in six patients (23%). Furthermore, the delayed elimination of conduction through the accessory AV connections was permanent in 4 of the 26 patients (15%). In the patients in whom there was a delay in the disappearance of conduction through an accessory AV connection, the duration of the delay was most often in the range of 6 to 18 hours. At least one application of radiofrequency energy during the first ablation session was successful in transiently eliminating conduction through the accessory AV connection in each of the 6 patients where a delayed effect was observed.

Results of Prior Studies

Leitch, et al.¹ described four patients in whom conduction through an accessory AV connection disappeared 5 minutes to five days after an apparently unsuccessful attempt at radiofrequency ablation. However, conduction through each of these accessory AV connections was again present by 3–5 months after the ablation procedure. Therefore, these authors concluded that the delayed loss of conduction through accessory AV connections after radiofrequency ablation is not permanent. In contrast, 4 of the 6 patients with delayed effects in the current study went on to have permanent block in the accessory AV connection without recurrence during 5 to 23 months of follow-up. The reasons for this discrepancy are unclear, but possible explanations include differences in mapping technique, energy delivery, or in the accuracy of localization of the accessory AV connections.

Delayed effects of radiofrequency energy have also been noted after attempts at ablation of AV nodal reentrant tachycardia. Lee et al. and Jazayeri et al.^{4,5} reported the delayed onset of complete AV block after attempts at selective ablation of the

“fast” AV nodal pathway. Therefore, the delayed effects of radiofrequency energy are not specific to accessory AV connections and may also occur in the AV node.

Possible Mechanisms of Delayed Effects of Radiofrequency Energy

Experimental studies have demonstrated that lesions created by radiofrequency energy consist of a well-demarcated area of coagulative necrosis.⁶⁻⁸ Conduction through accessory AV connections located within the central area of a radiofrequency lesion therefore would be expected to disappear immediately and not on a delayed basis. However, a rim of inflammatory cell infiltrate and hemorrhage is present outside the area of necrosis,⁶ and it is possible that delayed effects on conduction might occur in accessory AV connections located in this peripheral zone. A delayed and permanent loss of conduction through an accessory AV connection located in the peripheral zone might be explained by cell membrane injury caused by an inflammatory reaction.

In an experimental study by Nath et al. hyperthermia induced by radiofrequency energy was found to result in a marked reduction in blood flow not only in the central zone of acute necrosis but also in the peri-lesion zone, probably because of microvascular endothelial injury.⁹ Nath, et al postulated that this might result in the extension of radiofrequency lesions over time. Accessory AV connections located in the peri-lesion zone could thereby be subject to a delayed effect of radiofrequency energy. It may be noteworthy that conduction in each of the six accessory AV connections in this study that manifest delayed effects was transiently eliminated during the ablation procedure. This is consistent with the accessory AV

connections being located in the peri-lesion zone, where the degree of hyperthermia may have been sufficient to only transiently interrupt conduction.

Limitations

A limitation of this study is that long term follow-up electrophysiology tests were not performed in three of the four patients in whom the delayed loss of delta waves was permanent. Therefore, objective evidence of complete loss of conduction through these accessory AV connections is lacking. However, before ablation, each of these accessory AV connections was associated with prominent delta waves that have consistently been absent during follow-up; the persistent loss of delta waves after ablation is only rarely associated with persistent retrograde conduction through the accessory AV connection.¹⁰ Furthermore, each of the three patients had experienced frequent symptoms of tachycardia before ablation, and the complete absence of recurrent symptoms during 5 to 23 months of follow-up provides additional evidence that conduction through the accessory AV connections was in fact eliminated.

Conclusions

With an increase in operator experience, a high success rate can be expected with radiofrequency ablation of accessory AV connections. However, in some patients, conduction through an accessory AV connection may persist even after multiple applications of radiofrequency energy. The results of this study suggest that up to 15% of patients who undergo an apparently unsuccessful attempt at radiofrequency ablation of an accessory AV connection may later manifest a permanent loss of conduction through the accessory AV connection.

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