Evolving Modes of Energy Delivery for Catheter Ablation of Accessory Pathways

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Recognition of the possibility of ablating cardiac tissue by means of commonly used electrophysiological catheters has led to the development of the fulguration techniques. Unipolar DC (direct current) shocks delivered at the tip of a catheter by means of an ordinary defibrillator were applied to the atrioventricular node–His bundle area for control of refractory supraventricular tachycardias. This technique was then rapidly extended to other cardiac areas, among which is that of the accessory pathway. Because of its easy access and because of the excellent initial results, high-energy DC shocks initially appeared more suitable for all types of ablation than did radiofrequency alternating current.1-3 However, morbidity and probably long-term mortality of DC shocks were significant, and this was probably due to arcing and barotrauma at the site of energy delivery.4-6 This has stimulated research for a new energy source that could yield the same good results as that of high-energy fulguration yet remaining as safe as radiofrequency current. Based on the concept that voltage and current density rather than barotrauma were responsible for tissue ablation, British workers designed a new ablation system that uses a low-energy power supply connected to a special contoured electrode.7 In vitro and in vivo testing confirmed both effectiveness and lack of deleterious effects of low-energy DC shocks. This has also been shown to have no deleterious effects on dangerous locations such as the coronary sinus.8

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In this issue of Circulation, Lemery et al9 report the first large series of ablations of accessory pathways using this form of energy delivery. The same good short-term and long-term success rate in this series, which was previously observed using high-energy DC, confirms that low-energy ablation is extremely effective in creating desirable focal lesions in the human heart. Shocks not exceeding 40 J were able to interrupt conduction at the site of accessory pathway in 92% of the cases. This was accompanied by a moderate elevation of creatine kinase MB levels that were much lower than those observed with high-energy DC.10 Complications directly related to the mode of energy delivery were infrequent, although pericarditis was noted in six patients and asymptomatic echocardiographic pericardial effusion was noted in two patients. One case of cardiac tamponade occurred, but it is unclear whether this could have been related to catheter manipulation in the coronary sinus. No alterations of the normal atrioventricular conduction pathway occurred.

This report is particularly interesting in view of the recent publication of the two largest series of ablation of accessory pathways using radiofrequency energy.11,12 Both studies have also confirmed the effectiveness and the low morbidity of catheter techniques in this indication. Although these series cannot really be compared, they raise several important questions and comments.

What is the Best Approach for Left-Side Accessory Pathway Ablation?

As suggested by prior animal studies, the study of Lemery et al9 confirmed that nonarcing shocks can be delivered in the coronary sinus without complications, as demonstrated in seven patients. However, this series as well as others show no improvement in success rate with this approach compared with the retrograde or even the transseptal approach in ablating left-side accessory pathways.10-13 With the progressive evolution of electrophysiologists toward the use of radiofrequency and of steerable catheters, the retrograde arterial route is now the preferred route, and the transseptal approach has become restricted to patients with peripheral vascular disease. It has been suggested that ablating the ventricular insertion of the accessory pathway whatever the route might be the best approach. However, Haissaguerre et al10 in their recent study have shown that atrial or ventricular position of the catheter does not influence ablation results.

Should We Administer Anticoagulants During and After Ablation?

There are differences in the use of prophylactic anticoagulation during tissue ablation, which partly depends on the mode of energy delivery and on the accessory pathway location. In most previous studies that used DC shocks (except those for left-side pathways), no anticoagulation had been used during the procedure.1,2,10 On the contrary, heparin was used in all studies that used radiofrequency energy,12,14 particularly in cases of left-side pathways.11 In the study by Lemery et al, heparin was started only after shock delivery. Approaches differ by various workers in delivering anticoagulants during the first hours after the procedure and later maintaining the patients on long-term (up to 3 months) aspirin therapy.12 The long
duration of the ablation session supports the use of anticoagulants during the procedure. Nevertheless, previous studies in animals have shown fibrin layers at ablation sites, which perhaps warrants use of long-term anticoagulants. Some consensus should be reached in the future on this subject.

**Does Accessory Pathway Ablation Become a Reasonable Procedure for Asymptomatic Patients With Wolff-Parkinson-White Syndrome?**

In December 1989, the subcommittee of the American College of Cardiology/American Heart Association task force on assessment of diagnostic and therapeutic cardiovascular procedures gave a class II designation for the electrophysiological evaluation of the asymptomatic patients with ECG evidence of Wolff-Parkinson-White (WPW) syndrome, in whom knowledge of the electrophysiological characteristics of the accessory pathway may help in guidance of future participation in high-risk occupations or activities. These individuals are among the most difficult cases to deal with, especially when the cardiologist is asked his opinion regarding the feasibility of operating mechanical equipment or participating in competitive sports or high-risk occupations. At times, such asymptomatic individuals are found during electrophysiological study to be suitable candidates for ablation because they have a short antegrade refractory period of the accessory pathway. According to Kuck et al., radiofrequency ablation has been shown to have an excellent success rate and low morbidity, thus making it a procedure of choice as a prophylactic therapy in selected groups of patients. However, in a recent longitudinal assessment of 29 patients in whom two electrophysiological studies were done 36 months apart, it was found that the spontaneous event rate was low. Furthermore, without any intervention, 31% of patients lost their capacity for antegrade conduction over the accessory pathway. Review of the published series on long-term follow-up for 10 years suggests that the incidence of sudden death is 0.1% per year in the overall population of asymptomatic WPW patients and 0.56% per year in those in whom a short (<250 msec) antegrade refractory period of the accessory pathway is found. Given such a low natural risk, the decision to further investigate and possibly treat these patients should be balanced with the corresponding low risk of current ablation techniques by highly trained electrophysiologists. Decisions will be made by mutual agreement and on a case-by-case basis.

**Is Recording of the Accessory Pathway Potential a Prerequisite for Successful Accessory Pathway Ablation?**

Direct recording of accessory pathway activation in the form of isolated discrete electrograms has been advocated as an approach for localizing the optimal ablation site. It has been shown in various studies that discreet potentials may indeed represent accessory pathway conduction, and this is supported by their ability to be dissociated from both atrium and ventricle by pacing techniques. In our opinion, some limitations exist regarding interpretation of these electrograms. Multiple-spike electrograms and continuous local electrical activity, which seem fused in one single electrogram, are frequently observed at the ablation site even when using closely spaced recording electrodes, rendering identification of the critical potential difficult or arguable (see Figure 1 in Reference 12). Moreover, we have previously shown that it was possible to dissociate electrograms inside a single chamber. For example, intra-atrial dissociation between the two components of a double-spike electrogram has been shown to occur spontaneously during atrial flutter, and when this did not occur spontaneously, we eventually observed it during transient (pacing induced) tachycardia entrainment. Finally, whether or not such electrograms indeed represent true accessory pathway potentials may be a matter of semantics. In fact, if distinct potentials seem recordable by special catheter techniques minimizing atrial and ventricular noise, they also have been claimed with interelectrode spacing as wide as 1 cm when, during continuous electrical activity, a discrete electrogram was recorded and ablation was successful. Moreover, in studies by Jackman and Warin, the ablation was far more successful than the number of recorded accessory pathway potentials. Conversely, in a recent study that analyzed the electrogram patterns predictive of successful ablation, no correlation was found between success of ablation and accessory pathway potentials recording, but a rather good one was found with a PQS pattern of the local unipolar electrogram. In addition, validation of accessory pathway potentials is time-consuming and fastidious. Given a mean duration of the procedure as long as 8.3±3.4 hours in one study, it should be questioned whether such attempt at recording and validation is really clinically mandatory. Indeed, in most of the published studies, presumed accessory pathway potentials were not systematically sought before attempting ablation, and this per se did not appear to limit their success.

**Accessory Pathway Ablation: Future Directions**

Besides the need for a particularly highly trained electrophysiological team, one of the main limitations of catheter ablation of the accessory pathway is the duration of the procedure, which is accompanied by particularly long fluoroscopy times. As emphasized by Lemery et al., the location of the accessory pathway as well as the progressive learning curve of the operator might reduce this problem. However, even in experienced hands, fluoroscopy time still reaches a mean of 53 minutes, for a total procedure duration of 4.3 hours. In another study, the longest total procedure duration was 21 hours (W. Jackman, personal communication). In these cases, operator's irradiation ranges 6–30 mrem per procedure. The U.S. Council on Radiation Protection officially recommends staying within the maximal permissible doses of 100 mrem/wk for eye protection and 300 mrem/wk for the thyroid. This would allow three to 15 procedures per week per operator provided no other procedure using fluoroscopy is done. Operator irradiation is further worsened (28 times) if cinefilming of the position of the catheter is used. This point has been highlighted in some studies in which ablation is done immediately at the end of the diagnostic procedure or by reducing the amount of information concerning accessory pathway physiology. Along the same line, one study has shown the use of a single catheter in ablating left-side accessory
pathways. Impressive results by Kuck et al in 10 patients by using this simplified technique, during which the mean total ablation session lasted only 95 minutes, strongly support this approach.

Is There a Future for Low-Energy DC Catheter Ablation?

With the impressive results of radiofrequency energy in ablation of accessory pathways at a remarkably low complication rate, it seems quite difficult to pursue the technique with low-energy shocks for accessory pathway ablation. However, one should not forget that the excellent published success rates are obtained by highly specialized teams, imply long duration procedure, and have not yet been reproduced by others. When time becomes an issue and the procedure has to be shortened, the success rate may be slightly lower. Particularly in cases of difficult catheter positioning or catheter instability, low-energy shocks may prove useful as a backup mode of energy delivery. Furthermore, the effect of low-energy DC in other types of tachycardias in which the reentrant circuit is less well defined, such as atrial flutter or ventricular tachycardia, is poor or unknown. Given the potential hazards of high-energy DC, this technique may be safer and should be tried in these groups of patients.

References


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