Radiofrequency Catheter Ablation of a Concealed Atrioventricular Accessory Pathway Associated With a Coronary Sinus Diverticulum

Kiyotaka Matsuo, MD; Yoshiyuki Doi, MD; Satoki Fukae, MD; Kojiro Nakao, MD; Ivan Iliev, MD; Norihiro Komiya, MD; Shojiro Isomoto, MD; Motonobu Hayano, MD; Katsusuke Yano, MD

A 31-year-old woman underwent radiofrequency catheter ablation of a concealed left posteroseptal accessory pathway associated with a coronary sinus diverticulum. The patient had previously undergone unsuccessful catheter ablation of the posteroseptal region of the mitral annulus. Coronary sinus venography revealed the presence of the diverticulum near the ostium. An electrogram in the neck of the diverticulum showed the shortest ventriculoatrial conduction time and a large accessory pathway potential during atrioventricular reciprocating tachycardia. The pathway was successfully ablated within the neck of the diverticulum. The findings in this case underscore the importance of coronary sinus venography before ablation. (Jpn Circ J 2000; 64: 393–395)

Key Words: Accessory pathway; Catheter ablation; Coronary sinus; Diverticulum

Radiofrequency catheter ablation (RFCA) of an atrioventricular accessory pathway is established as a nonsurgical, curative therapy of atrioventricular reciprocating tachycardia in patients with Wolff-Parkinson-White (WPW) syndrome. Accessory pathways of the posteroseptal region, however, are sometimes difficult to interrupt, mainly because of the complex anatomic arrangement of the coronary sinus. Although some patients with WPW syndrome and atrioventricular reciprocating tachycardia have been found to have a posteroseptal accessory pathway associated with a coronary sinus diverticulum, in almost all the cases, accessory pathways were reported to have bidirectional atrioventricular conduction properties.

We describe a patient with a concealed accessory pathway showing exclusive retrograde atrioventricular conduction properties that was successfully ablated with radiofrequency energy applied within the neck of a coronary sinus diverticulum.

Case Report

A 31-year-old woman had had attacks of palpitation from the age of 9. In 1985, supraventricular tachycardia at a rate of 150 beats/min was documented by a 12-lead ECG during the attacks, and the patient was admitted to our hospital for therapy. Physical examination and two-dimensional echocardiography disclosed no abnormalities, and repeated 24-h Holter ECGs showed no pre-excitation pattern at any time. An electrophysiological study confirmed atrioventricular reciprocating tachycardia, in which a premature ventricular depolarization introduced at the right ventricular apex during the His bundle refractory period advanced the atrial electrogram. No delta wave could be seen, however, even with right atrial rapid pacing, indicating an accessory pathway with exclusive retrograde atrioventricular conduction properties. The effective refractory period of the pathway was less than 230 ms. The patient’s symptoms improved with verapamil (240 mg/day), but the attacks gradually increased after her discharge from the hospital. Changing her treatment to a β-blocker led to general fatigue as a side effect, and the patient was referred for RFCA of the accessory pathway in 1994.

Four quadripolar catheters were inserted to record signals from the high right atrium, coronary sinus, right ventricular apex, and His bundle area. Mapping during the atrioventricular reciprocating tachycardia revealed the earliest atrial activation of the coronary sinus ostium, with a ventriculoatrial interval of 130 ms. A 7F ablation catheter with a 4-mm distal electrode (Mansfield/Webster Scientific, Watertown, MA, USA) was introduced via the femoral artery and placed under the mitral valve close to the annulus. However, neither atrial activation times of less than 130 ms nor accessory pathway potentials were recorded from the endocardium. Three applications of radiofrequency energy (20 W, 10 s) delivered in the posteroseptal region of the mitral annulus failed to ablate the accessory pathway. The catheter was then placed via the femoral vein into the coronary sinus, and the earliest atrial activation time of 125 ms was obtained 1.0 cm distal from the ostium at the inferior wall of the coronary sinus. However, RFCA at this site was abandoned because of a risk of rupture or thrombosis of the coronary sinus.

In February 1999, re-ablation of the accessory pathway appeared to be justified because the patient had frequent attacks 3 or 4 times a month. Also, thermister-embedded catheter systems had become available, enabling titration of the radiofrequency power during the ablation to avoid complications.

During the second RFCA procedure, biplane coronary
Fig 1. Retrograde angiography of the coronary sinus. (A) Right anterior oblique projection; (B) left oblique projection. An Amplatz angiographic catheter was positioned in the coronary sinus after insertion through the femoral vein. Coronary sinus venography revealed the presence of a 0.6×1.0 cm diverticulum (D) attached to the inferior wall of the coronary sinus near its ostium by a relatively narrow neck. (+) Successful ablation site; RA, right atrial catheter; RV, right ventricular catheter; CS, coronary sinus catheter; AC, ablation catheter.

Fig 2. Surface lead V5 and intracardiac recordings from the neck of the coronary sinus diverticulum (ABL), the right atrial appendage (RAA), the His bundle region (HBE), distal (CS1–2) to the proximal (CS7–8) coronary sinus, and the right ventricle (RV) during orthodromic reciprocating tachycardia. (A) Note the shortest (but still long) ventriculoatrial interval of 125 ms and the presence of a large, spiked accessory pathway potential (APP) in the neck of the coronary sinus diverticulum. (B) The application of radiofrequency (RF) energy (arrow) interrupted the orthodromic reciprocating tachycardia within 2.5 s. The electrogram at the ablation site could not be recorded during RF application in our system. The last ventricular electrogram of tachycardia is not followed by a retrograde A wave, indicating a block of the accessory pathway conduction. Vertical line ≡ onset of QRS complex; A, atrial electrogram; H, His electrogram; V, ventricular electrogram.

sinus venography was performed to clarify the anatomical arrangement of the ablation site. A diverticulum (0.6×1.0 cm) with a relatively narrow neck was found attached to the inferior wall of the coronary sinus near its ostium (Fig 1). A 7F ablation catheter with a 4-mm distal electrode (RF Marin, Medtronic CardioRhythm, Minneapolis, MN, USA) was advanced into the neck of the diverticulum, where the shortest (but still long) ventriculoatrial conduc-
tion time of 125 ms and a large, spiked accessory pathway potential were recorded (Fig 2A). At this site, we delivered radiofrequency energy with an automatic titration of power to maintain a temperature of less than 50°C during tachycardia. Within 2.5 s of the delivery of energy, the tachycardia was terminated (Fig 2B), and the disappearance of the retrograde atrioventricular conduction was confirmed with right ventricular pacing. The echocardiogram performed on the following day showed no signs of pericardial effusion. One week after the procedure, a 4-lead right atrial pacing study could not induce supraventricular tachycardia, which had been easily induced by right atrial pacing before the re-ablation. Without the use of any drugs, the patient still had not experienced any palpitation attacks 9 months after her discharge.

**Discussion**

To our knowledge, there are few reports of successful RFCA of a 'concealed' accessory pathways showing exclusive retrograde atrioventricular conduction properties associated with a coronary sinus diverticulum. Coronary sinus diverticula are rare congenital abnormalities of the intracardiac veins. Guiraudon et al reported that 6 of 65 patients operated on for posteropectal pathways had a coronary sinus diverticulum. Although several recent reports have documented the association of a coronary sinus diverticulum with an accessory pathway, these diverticula all occurred in patients with a 'manifest' accessory pathway, which showed a pre-excitation pattern during sinus rhythm due to bidirectional atrioventricular conduction properties. Manifest posteropectal accessory pathways ablated inside the coronary sinus system have only just recently been considered to have electrocardiographic features, including a steep positive delta wave in lead aVR, a deep S wave in lead V6, and negative delta wave in lead II. In the present patient, however, it was impossible to predict the effective ablation site from the 12-lead ECGs because of the concealed accessory pathway, which showed exclusive retrograde conduction properties.

Resection or ablation of the neck of the diverticulum during the operation and catheter ablation have been reported to be necessary to eliminate accessory pathway conduction in patients with an accessory pathway related to a diverticulum of the coronary sinus. The effective ablation site in the present patient was also located at the neck of the diverticulum. Postmortem studies have shown the presence of muscular bundles running within the wall of the diverticulum.

Gerlis et al proposed that the diverticulum results from an incomplete regression of the sinus venosus during development, and that remnants of muscle in the wall of the sinus venosus are responsible for the accessory atrioventricular electrical connection. At the effective ablation site, we found a relatively longer retrograde atrioventricular conduction time and a larger accessory pathway potential compared with those of the accessory pathways usually ablated from the endocardial surface. These findings suggest that either a long course of the accessory pathway, which may lie subepicardially in the atrioventricular groove, or an accessory pathway with slow conduction properties is located near the coronary sinus diverticulum. Anst et al recently clarified the significance of double potentials recorded by coronary sinus electrodes. According to these authors, one of the double potentials is a sharp potential, which represents the activation of coronary sinus musculature, and the other is a rounded potential, which represents left atrial activation. Therefore, the large, spiked potential, which we presumed to represent the accessory pathway activation, might originate from the activation of the coronary sinus musculature.

Hemopericardium and cardiac tamponade may occur when radiofrequency energy is delivered within a small venous branch of the coronary sinus! Therefore, we performed coronary sinus venography before the ablation to define the anatomy around the ablation site, and we used a thermistor-embedded ablation catheter to prevent the complications.

In summary, we report a patient with a concealed left posteropectal accessory pathway associated with a coronary sinus diverticulum. RFCA at the neck of the coronary sinus diverticulum effectively interrupted the accessory pathway conduction. When the earliest atrial activation is recognized at the coronary sinus ostium in patients with an atrioventricular accessory pathway showing exclusive retrograde conduction properties, coronary sinus venography preceding the ablation procedure is important to detect a possible association with a coronary sinus diverticulum.

**Acknowledgments**

The authors wish to thank Professor Emeritus Kunitake Hashiba from the Third Department of Internal Medicine, Nagasaki University School of Medicine, for his advice and encouragement in the re-ablation attempt.

**References**


Japanese Circulation Journal Vol. 64, May 2000