Transcatheter Ablation of Posteroseptal Accessory Pathways Using a Venous Approach and Radiofrequency Energy

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Background The efficacy of transcatheter ablation of atrioventricular (AV) accessory pathways (APs) located in the posteroseptal region using a right atrial approach and radiofrequency energy was evaluated.

Methods and Results Fifty consecutive patients with APs in the posteroseptal region underwent radiofrequency catheter ablation. Manifest preexcitation was present in 36 patients and a concealed AP in 14. In 18 patients (group 1), the ventriculoatrial (VA) interval during orthodromic tachycardia was prolonged by 21±7 milliseconds (range, 10 to 30 milliseconds) with functional left bundle-branch block. In 16 patients (group 2), functional left bundle-branch block caused no VA interval prolongation. The remaining 16 patients (group 3) had no inducible left bundle-branch block during orthodromic tachycardia. Functional right bundle-branch block was induced in 30 patients with no effect on the VA interval. In group 1, of 14 patients with manifest preexcitation during sinus rhythm, 10 patients had a positive delta wave in lead V_1. Of 10 group 2 patients with manifest preexcitation, only 5 had a positive delta wave in lead V_1. In group 3, of 12 patients with manifest preexcitation, 7 exhibited a positive delta wave in lead V_1. All posteroseptal APs were successfully ablated, and this was achieved via a right atrial approach in 48 patients and left ventricular approach in only 2. Successful sites were at the posteroseptal region of the tricuspid annulus (30 patients), within the terminal 1 cm of the coronary sinus including its ostium (16 patients), and at the inferomedial aspect of the right atrium posterior to the coronary sinus ostium (2 patients). The posteroseptal region of the left ventricle was the site of successful ablation in 2 patients. Six patients with a recurrence of AP conduction required a repeat ablation, with successful results in 5. Thirty-five patients had a complete electrophysiological evaluation 2 to 3 months after their successful ablation and were found to have no functioning AP. In 49 patients with a final successful ablation, no recurrence of symptoms was noted during a mean follow-up period of 12±9 months. Complications occurring in 3 patients were cardiac tamponade requiring surgical drainage and repair of a right ventricular tear, pericardial effusion with no hemodynamic consequence that spontaneously resolved, and a transient 2:1 atrioventricular block.

Conclusions These data suggest that posteroseptal APs are amenable to successful ablation using a right atrial approach. Success was achieved in 47 cases (94%) in this series even though the ECG and/or electrophysiological characteristics of the posteroseptal APs of some patients were suggestive of "left-sided" pathways. (***Circulation*. 1994;90:1799-1810.**)

Key Words • posteroseptal accessory pathways • catheter ablation • radiofrequency

Posteroseptal accessory pathways (APs) are anomalous atrioventricular (AV) fibers that are anatomically located in the region of the AV sulcus between the posterosuperior process of the left ventricle and the inferior wall of the right atrium. Because of the anatomic complexity of the posteroseptal region, the ablation of APs situated in this area has posed a challenge to both surgeons and electrophysiologists. The first surgical intervention in patients with Wolff-Parkinson-White syndrome was performed in 1968.[1] Due to the close proximity of the posteroseptal region to the AV node and its artery, initial attempts at a surgical interruption of posteroseptal APs were associated with a low success rate and a high incidence of complete AV block.[2] However, modification of the endocardial approach[3] and introduction of the epicardial technique[4,5] improved the surgical results. Subsequently, transcatheter ablation of APs using high-energy, direct-current electrical shock was introduced as a new nonpharmacological intervention.[6] More recently, by providing a safer and more effective source of energy, radiofrequency current has superseded the electrical shock for transcatheter ablation.[7-9]

Based on their manifestation on the surface ECG[10] and their electrophysiological characteristics,[11] posteroseptal APs have been subdivided into "right-sided" and "left-sided" pathways. However, it remains unclear whether this classification necessarily has any impact on the outcome of the ablation when the atrial or ventricular insertion site of the AP is targeted. Therefore, the purpose of this study was to determine whether posteroseptal APs could be successfully ablated using a right atrial approach even when the AP characteristics were compatible with a left-sided location.

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Methods

Patient Population

Between December 1990 and October 1993, 50 consecutive patients with posteroseptal APs underwent radiofrequency catheter ablation. There were 24 males and 26 females with a

mean age of 35 years (range, 8 to 76 years). Structural heart disease was documented in 6 patients who had coronary artery disease, and 1 of these 6 patients had a prior myocardial infarction; mild to moderate Ebstein's anomaly was present in 5 patients.

Baseline Electrophysiological Study

Before catheter ablation, each patient underwent a complete electrophysiological evaluation that was performed in a postabsorptive state after informed consent was obtained. All antiarrhythmic medications had been discontinued for at least five half-lives before the study. The ablation protocol was approved by the Institutional Review Board of Sinai Samaritan Medical Center. Patients were either sedated with intravenous midazolam hydrochloride or anesthetized with intravenous propofol. Three quadripolar catheters were introduced percutaneously via the femoral veins and positioned under ECG and fluoroscopic guidance in the high right atrium, His bundle region, and right ventricular apex. A fourth decapolar catheter, with a center-to-center interelectrode spacing of 2 to 5 mm, was inserted via the internal jugular vein and placed in the coronary sinus with the most proximal pair of electrodes positioned close to the coronary sinus ostium. Surface ECG leads (I, II, and V_1), intracardiac electrograms, and time lines were displayed simultaneously on a multichannel oscilloscope and printed on a thermal recorder. Data were recorded on optical disks by the EP Lab System (Biomedical Instrumentation Inc) for subsequent reproduction. Electrical stimulation was performed with a digital stimulator (Bloom Associates). The stimulation protocol consisted of atrial and ventricular incremental pacing and extrastimulation. Attempts were made to induce functional bundle-branch block during orthodromic tachycardia.[12] In cases where orthodromic tachycardia could not be induced or sustained at baseline, isoproterenol was infused and titrated to achieve a minimum of a 20% increase in heart rate. In patients requiring isoproterenol, all electrophysiological parameters (before and after ablation) were measured again during the isoproterenol infusion. Intravenous heparin was administered at an initial dose of 3000 U at the onset of the procedure. When a left heart catheterization was performed, a continuous heparin infusion was instituted to maintain the activated clotting time at twice baseline.

Mapping and Ablative Procedures

Once the initial electrophysiological assessment localized the AP in the posteroseptal region, a 7F deflectable quadripolar catheter with a 4-mm bulbous tip electrode (Mansfield Scientific) was introduced via the right femoral vein for precise mapping along the posterior aspect of the interatrial septum and the coronary sinus ostium. In 30° to 45° right and left anterior oblique radiographic views, the septal annulus of the tricuspid valve, extending from the coronary sinus ostium to the His bundle recording site, was divided into posteroseptal, midseptal, and anterior regions (Fig 1).

In 11 patients whose AP characteristics were suggestive of left-sided locations, another 7F deflectable quadripolar catheter with a large-tip electrode was inserted in the left side using a transseptal or transaortic approach. The latter catheter was used to map the posterior paraseptal and posteroseptal regions of the left atrium, left ventricle, or both and to compare the earliest electrograms obtained from the right and left sides of the septum. Once the AP location was confirmed to be in the posteroseptal region, the ablation was attempted from the atrial aspect of the tricuspid annulus adjacent to the coronary sinus ostium, or within the coronary sinus ostium if deemed necessary. Radiofrequency current was delivered between the distal, large-tip electrode of the ablation catheter and an external adhesive patch electrode (Scotchplate 1149C, 3M Co) placed on the chest wall. A Liz-88 (American Cardiac Ablation Corp) was used as the source of radiofrequency energy for ablation. This unit generates a continuous, unmodulated sine wave output at

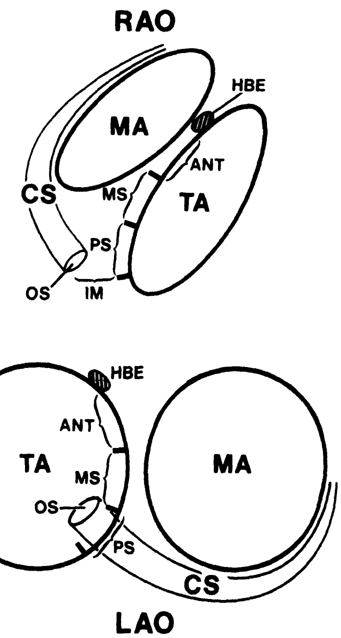


FIG 1. Radiographic definition of the posteroseptal region. Schematics of right and left anterior oblique (RAO and LAO, respectively) views of the mitral and tricuspid annuli (MA and TA, respectively) are shown. The septal annulus of the tricuspid valve extending from the coronary sinus (CS) ostium (OS) to the site of recording the His bundle electrogram (HBE) is divided into the posteroseptal (PS), midseptal (MS), and anterior (ANT) regions. IM indicates inferomedial aspect of the right atrium.

540 kHz. If manifest preexcitation was present, radiofrequency current was applied during sinus rhythm or paced atrial rhythm. In cases of concealed APs, the ablation was attempted during orthodromic tachycardia or ventricular pacing at cycle lengths associated with a predominant or exclusive retrograde conduction via the AP. Radiofrequency pulses were set at 60 to 70 V and delivered for 30 to 60 seconds. If the AP conduction persisted during the first 10 seconds of the pulse delivery, radiofrequency energy was discontinued and the ablation catheter was repositioned. The stability of the ablation catheter was checked periodically by fluoroscopy. Whenever changes in the catheter tip position or impedance rise were noted, the radiofrequency energy delivery was immediately terminated.

Follow-up

Incremental pacing and premature stimulation were performed in both the atrium and ventricle to confirm successful results at 30 minutes and 24 to 48 hours after completion of the ablation procedure. A complete 6- to 8-week follow-up electrophysiological study was recommended to all patients. Isoproterenol infusion was routinely used as part of a complete evaluation. Two-dimensional echocardiography and Doppler studies were carried out 1 to 2 days after ablation to specifically assess the integrity of the cardiac structures and to search for pericardial effusion.

Definition of Terms

The AP location was considered to be posteroseptal when the following criteria were fulfilled. (1) The earliest site of ventricular activation during antegrade AP conduction or of atrial activation during retrograde AP conduction was recorded in the posteroseptal region of the tricuspid annulus or within the terminal (proximal) 1 cm of the coronary sinus, and (2) there was a ≤30-millisecond ventriculoatrial (VA) interval prolongation during orthodromic tachycardia with functional left bundle-branch block and no VA prolongation with functional right bundle-branch block.

The site was considered optimal for ablation when the electrogram obtained from the ablation catheter was stable and had one or more of the following characteristics: (1) short AV intervals with an A:V ratio of ≤1.0 and discrete, high-frequency potentials or fractionated electrograms between local atrial and ventricular deflections; (2) ventricular activation occurred simultaneously with or earlier than the delta wave during sinus rhythm with manifest preexcitation; and (3) atrial activation occurred simultaneously with or earlier than that recorded in the reference coronary sinus electrogram during retrograde AP conduction.

Statistical Analysis

All data are expressed as mean±SD. Statistical analysis was performed using the Student's *t* test for paired and unpaired values. A value of $P<.05$ was considered significant.

Results

Baseline Electrophysiological Studies

Thirty-six patients had manifest preexcitation during sinus rhythm (Table 1); of these, 4 patients exhibited antegrade AP conduction only. The remaining 14 patients had a concealed AP with unidirectional retrograde conduction. Orthodromic tachycardia was inducible in 46 patients with a mean cycle length of 312±41 milliseconds (range, 220 to 420 milliseconds). Isoproterenol infusion was required for the induction of sustained orthodromic tachycardia in 15 of these patients (Table 2). Functional bundle-branch block was induced during orthodromic tachycardia in 39 patients (78%). Functional right bundle-branch block, which was induced in 30 patients, did not cause any VA interval prolongation. Functional left bundle-branch block, however, was induced in 34 patients and resulted in VA interval prolongation (10 to 30 milliseconds; mean, 21±7 milliseconds) in 18 patients (Fig 1) and no VA lengthening in 16 patients.

Based on the VA interval response to functional left bundle-branch block during orthodromic tachycardia, patients were divided into three groups: group 1 included 18 patients in whom the VA interval was prolonged by left bundle-branch block (Fig 2) indicating that the posteroseptal AP was attached to the left side of the interventricular septum; group 2 consisted of 16 patients with no VA prolongation due to functional left bundle-branch block during orthodromic tachycardia; and group 3 included 16 patients in whom functional left bundle-branch block could not be induced.

Nine patients had inducible, sustained, narrow QRS complex AV nodal reentrant tachycardia in addition to their AP-related tachycardia. The AV nodal reentry was of the common variety in 8 patients and of the uncommon form in 1.

ECG Features

In group 1, 14 patients had manifest preexcitation with the delta wave in lead V_1 being positive in 10 patients, biphasic in 2, and negative in 2 (Table 1). The QRS complex in lead V_1 exhibited a uniphasic R wave in 2 patients, R>S in 4, R=S in 2, and R<S in 2. Two patients had an rS morphology, and the remaining 2 patients had a QS/Qr morphology. In the inferior leads, the delta wave was negative in leads II (10 patients), III (14 patients), and aVF (13 patients); positive in lead II (3 patients); and biphasic in leads II (1 patient) and aVF (1 patient).

In group 2, 10 patients had manifest preexcitation during sinus rhythm with the delta wave in lead V_1 being positive in 5 patients, biphasic in 3 patients, and negative in 2. The QRS complex in lead V_1 exhibited R=S in 1 patient, R<S in 3 patients, rS in 4, and QS in 2. In the inferior leads, the delta wave was negative in leads II (8 patients), III (10 patients), and aVF (10 patients) and positive in lead II (2 patients).

In group 3, 12 patients had manifest preexcitation with the delta wave being positive in 7 patients, biphasic in 2, and negative in 3. The QRS complex in lead V_1 exhibited a uniphasic R wave in 1 patient, R>S in 2, R=S in 1, R<S in 1, rs in 4, qrS in 1, and QS in 2. In the inferior leads, the delta wave polarity was negative in leads II (7 patients), III (11 patients), and aVF (9 patients); biphasic in leads II (1 patient), III (1 patient), and aVF (2 patients); and positive in leads II (4 patients) and aVF (1 patient).

Mapping and Ablative Procedures

For group 1, in 10 patients (1 through 10) with a positive delta wave in lead V_1, the left atrium was entered using a transaortic (8 patients) or transseptal (2 patients) approach for mapping the earliest atrial and ventricular activations via the AP recorded at the atrial aspect of the mitral annulus (Table 2). The earliest ventricular activation recorded at the mitral annulus was 5 to 25 milliseconds (mean, 16±7 milliseconds) later than the delta wave, and the earliest retrograde atrial activation was 5 to 20 milliseconds (mean, 14±6 milliseconds) later than that recorded in the proximal coronary sinus electrograms in these 10 patients. In 7 of these 10 patients, the posteroseptal region of the left ventricle was mapped via a transaortic approach, and the earliest ventricular activation was found to occur simultaneously with that recorded on the right side using an atrial approach (Fig 3). The site of successful ablation (Fig 4) was within 1 cm of the terminal coronary sinus (3 patients), at the coronary sinus ostium (2 patients), at the inferomedial aspect of the right atrium posterior to the coronary sinus ostium (2 patients), or at the posteroseptal aspect of the tricuspid annulus (2 patients). In the remaining patient (patient 9) during right-sided mapping, the earliest atrial and ventricular activations were both recorded within the terminal 1 cm of the coronary sinus. Radiofrequency current was delivered at the earliest site of activation within the coronary sinus on five occasions. Although each attempt was associated with a temporary loss of the delta wave, radiofrequency energy could not be continuously delivered beyond 12 seconds at any time because of the impedance rise. The posteroseptal region of the left ventricle adjacent to the AV junction was, therefore, mapped using a transaortic approach, which showed the local ventricular activation being 20 milliseconds earlier than the delta wave. A single radiofrequency pulse delivered at that region successfully abolished the AP conduction.

In the remaining 8 (group 1) patients, mapping was only performed on the right side. The APs were successfully ablated at the coronary sinus ostium (4 patients) and at the posteroseptal region of the tricuspid annulus (4 patients).

Successful AP ablation using a venous approach was accomplished via the femoral vein (12 patients) or the

TABLE 1. Clinical and Electrocardiographical Data

Patient	Age, y	Sex	Manifest AP	Delta Wave Polarity and QRS Morphology							
				I	II	III	aVR	aVL	aVF	V_1	V_2
Group 1											
1	26	M	+	+, R	+, R>S	−, QS	−, QS	+, R	±, Rs	+, R	+, R
2	43	M	+	+, R	−, QS	−, QS	−, QS	+, R	−, QS	+, R	+, R
3	16	M	+	+, R	−, Qrs	−, Qrs	−, Qr	+, R	−, Qrs	+, R>S	+, R>S
4	74	F	+	+, R	−, R<S	−, QS	+, Rs	+, R	−, QS	+, R>S	+, R
5	48	F	+	+, R	−, QS	−, QS	±, Rs	+, R	−, QS	+, R>S	+, R
6	61	M	+	+, R	−, R<S	−, QS	−, QS	+, R	−, QS	+, R>S	+, R
7	65	F	+	+, R	±, R>S	−, R<S	−, Qr	+, R	−, R=S	+, R=S	+, R>S
8	46	F	+	+, R	−, QS	−, QS	−, QS	+, R	−, QS	+, R=S	+, R
9	16	F	+	+, R	−, QS	−, QS	−, QS	+, R	−, QS	+, R<S	+, R
10	29	F	+	+, R	−, QR	−, QS	±, Rs	+, R	−, QS	+, R<S	+, R>S
11	34	M	+/INT	+, R	−, R>S	−, QS	−, QS	+, R	−, QS	±, rS	+, R
12	29	M	+	+, R	+, R>S	−, QS	−, QS	+, R	−, qrs	±, rS	+, R>S
13	11	M	+	+, R	+, R>S	−, QS	−, Qr	+, R	−, QS	−, Qr	+, R=S
14	8	M	+	+, R	−, R>S	−, QS	−, QS	+, R	−, QS	−, QS	+, R>S
15	42	M	−	NA	NA	NA	NA	NA	NA	NA	NA
16	14	F	−	NA	NA	NA	NA	NA	NA	NA	NA
17	37	F	−	NA	NA	NA	NA	NA	NA	NA	NA
18	35	M	−	NA	NA	NA	NA	NA	NA	NA	NA
Group 2											
19	47	M	+	+, R	−, QS	−, QS	−, QS	+, R	−, QS	+, R=S	+, R>S
20	22	M	+	+, R	−, Qr	−, Qr	−, QS	+, R	−, Qr	+, R<S	+, R>S
21	27	F	+	+, R	+, R>S	−, QS	−, QS	+, R	−, QS	+, R<S	+, R>S
22	10	M	+	+, R	−, QS	−, QS	−, QS	+, R	−, QS	+, R<S	+, R=S
23	38	F	+	+, R	−, QS	−, QS	−, QS	+, R	−, QS	+, rS	+, R>S
24	32	F	+	+, R	−, Qr	−, QS	−, QS	+, R	−, QS	±, rS	+, R=S
25	32	F	+	+, R	−, QR	−, QS	−, QS	+, R	−, QS	±, rS	+, R>S
26	36	F	+	+, R	−, QS	−, QS	−, QS	+, R	−, QS	±, rS	+, R>S
27	42	M	+	+, R	+, R=S	−, QS	−, QS	+, R	−, QS	−, QS	+, R>S
28	43	M	+	+, R	−, qR	−, QS	−, QS	+, R	−, QS	−, QS	+, R=S
29	10	F	−	NA	NA	NA	NA	NA	NA	NA	NA
30	24	M	−	NA	NA	NA	NA	NA	NA	NA	NA
31	37	M	−	NA	NA	NA	NA	NA	NA	NA	NA
32	75	F	−	NA	NA	NA	NA	NA	NA	NA	NA
33	46	F	−	NA	NA	NA	NA	NA	NA	NA	NA
34	33	F	−	NA	NA	NA	NA	NA	NA	NA	NA
Group 3											
35	61	F	+	+, R	−, QS	−, QS	−, QS	+, R	−, QS	+, R	+, R
36	76	M	+	+, R	−, QS	−, QS	−, QS	+, R	−, QS	+, R>S	+, R=S
37	49	F	+	+, R	+, rs	−, QS	−, QS	+, R	−, QS	+, R>S	+, R=S
38	16	M	+	+, R	−, R=S	−, QS	−, QS	+, R	−, QS	+, R=S	+, Rs
39	27	F	+	+, R	+, R>S	−, QS	−, QS	+, R	±, r=s	+, R<S	+, R=S
40	11	M	+/UNI	+, R	+, rS	±, rS	−, QS	+, R	+, rS	+, rS	+, R>S
41	22	M	+/UNI	+, R	−, qR	−, QS	−, QS	+, R	−, QS	+, rS	+, R=S
42	18	M	+	+, R	−, QS	−, QS	−, QS	+, R	−, QS	±, rS	+, R=S
43	20	F	+/UNI	+, R	−, QS	−, QS	−, QS	+, R	−, QS	±, rS	+, R=S
44	21	M	+/UNI	+, R	±, Rs	−, QS	−, QS	+, R	−, QRs	−, qrS	+, R>S
45	36	F	+	+, R	−, QRs	−, QS	−, QS	+, R	−, QS	−, QS	+, R=S
46	33	M	+	+, R	+, R	−, QS	−, QS	+, R	±, rS	−, QS	+, R>S
47	28	F	−	NA	NA	NA	NA	NA	NA	NA	NA
48	32	F	−	NA	NA	NA	NA	NA	NA	NA	NA
49	64	F	−	NA	NA	NA	NA	NA	NA	NA	NA
50	46	F	−	NA	NA	NA	NA	NA	NA	NA	NA

AP indicates accessory pathway; F, female; INT, intermittent; M, male; NA, not applicable; and UNI, unidirectional pathway with antegrade conduction only.

Table 2. Electrophysiological Data

				Local Electrograms										
Patient	OT-CL, ms	FLBBB	VA ↑	CSp-Delta, ms	ACd-Delta, ms	Aac-Acs, ms	A:V Ratio	Successful Site	Total Lesions	RF Voltage (RMS)	RF Energy, W	RF Pulse Duration, s†	Fluoroscopy Time, min	Procedure Time, min
Group 1														
1	310	+	25	0	20	15	0.3	PS-TA	1	75	56	15	15	425
2	300	+	30	15	20	UK	0.7	CS-OS	4	75	47	40	25	335
3	280‡	+	30	10	15	5	1.0	CS-TERM	16	60	40	41	20	365
4	320	+	10	15	20	0	1.0	CS-TERM	5	70	49	60	120	690
5	300	+	15	10	10	UK	0.6	CS-OS	10	70	39	60	115	705
6	350	+	30	0	15	10	0.2	IM-RA	24	70	41	26	40	180
7	310	+	20	15	25	5	0.3	IM-RA	3	70	33	16	15	395
8	270‡	+	15	20	25	0	0.2	CS-TERM	4	70	49	34	120	765
9	290	+	30	15	20	5	0.2	PS-LV	6*	60	33	29	60	340
10	275	+	15	10	20	5	0.7	PS-TA	1	69	48	21	20	120
11	350‡	+	20	10	15	0	0.8	CS-OS	2	78	55	55	80	380
12	300‡	+	15	0	10	10	0.5	PS-TA	17	70	49	23	20	270
13	300	+	20	10	15	15	0.3	PS-TA	2	74	61	40	45	185
14	280	+	15	15	20	10	1.2	CS-OS	6	65	42	60	55	230
15	280‡	+	30	NA	NA	10	1.0	CS-OS	7	55	30	15	30	180
16	320	+	10	NA	NA	5	0.5	PS-TA	6	65	38	35	15	270
17	280‡	+	20	NA	NA	5	0.5	CS-OS	1	70	49	17	15	280
18	280	+	20	NA	NA	15	0.5	PS-TA	1	76	48	15	80	530
Group 2														
19	250	+	0	40	40	5	1.0	CS-OS	1	75	40	40	5	195
20	280‡	+	0	0	15	20	0.2	PS-TA	12	80	53	40	95	310
21	320	+	0	10	15	UK	1.0	PS-TA	3	70	49	40	15	300
22	290	+	0	0	35	UK	0.1	PS-TA	21	75	56	38	55	415
23	280	+	0	10	25	15	0.3	PS-TA	8	70	44	40	15	180
24	300	+	0	10	20	0	1.0	CS-OS	2	75	51	40	15	195
25	310	+	0	0	15	UK	0.3	PS-TA	3	70	49	60	5	145
26	330	+	0	10	15	0	1.0	CS-OS	7	70	49	30	30	225
27	250	+	0	10	15	10	0.2	PS-TA	11	75	56	40	75	290
28	380	+	0	0	0	10	0.5	PS-TA	7	75	43	15	20	195
29	380	+	0	NA	NA	25	0.5	PS-TA	14	70	49	40	45	310
30	320‡	+	0	NA	NA	10	1.0	CS-OS	5	75	62	60	35	465
31	260‡	+	0	NA	NA	20	0.5	PS-TA	1	75	51	43	10	130
32	300	+	0	NA	NA	15	0.7	PS-TA	3	70	41	40	65	360
33	330	+	0	NA	NA	15	0.3	PS-TA	8	53	23	30	45	240
34	310	+	0	NA	NA	25	0.6	PS-TA	2	75	54	40	35	220
Group 3														
35	360	−	−	10	10	5	1.2	CS-OS	12	60	31	50	35	475
36	400	−	−	10	10	0	1.0	CS-OS	1	70	44	44	10	230
37	280‡	−	−	10	40	10	0.5	PS-TA	20	84	54	20	40	225
38	420	−	−	5	20	15	0.2	PS-TA	4	70	54	60	55	575
39	320‡	−	−	5	20	20	0.6	PS-TA	1	76	58	40	25	200
40	...	NA	NA	20	20	NA	0.3	PS-LV	5*	60	40	22	45	380
41	...	NA	NA	5	20	NA	0.5	PS-TA	1	75	37	40	10	150
42	270	−	−	15	15	10	0.3	PS-TA	3	75	56	33	35	310
43	...	NA	NA	0	30	NA	0.5	PS-TA	4	75	56	60	55	130
44	...	NA	NA	0	25	NA	0.6	PS-TA	1	65	47	22	40	375
45	330	−	−	10	10	UK	1.0	CS-OS	5	78	61	40	80	480
46	380	−	−	20	25	10	0.3	PS-TA	1	80	49	40	15	310
47	300‡	−	−	NA	NA	25	0.1	PS-TA	3	65	42	40	20	230
48	280‡	−	−	NA	NA	35	0.3	PS-TA	1	77	59	40	20	175
49	360	−	−	NA	NA	15	0.2	PS-TA	10	63	40	32	80	380
50	400	−	−	NA	NA	30	0.5	PS-TA	5	75	43	30	25	145

A:V indicates atrial deflection to ventricular deflection; Aac-Acs, the interval between atrial activation in the ablation catheter and reference coronary sinus during retrograde conduction over the accessory pathway; ACd-Delta, the interval between ventricular activation recorded at the site of ablation and the onset of the delta wave; CS-OS, coronary sinus ostium; CSp-Delta, the interval between ventricular activation in the reference coronary sinus electrogram and the delta wave; CS-TERM; terminal one centimeter of the coronary sinus; FLBBB; functional left bundle-branch block; IM-RA, inferomedial aspect of the right atrium; NA, not applicable; OT-CL, orthodromic tachycardia cycle length; PS-LV, posteroseptal aspect of the left ventricle; PS-TA, posteroseptal aspect of the tricuspid annulus; RF, radiofrequency; UK, unknown; and VA ↑, ventriculoatrial interval prolongation in response to functional left bundle-branch block.

*One lesion was made on the left side and the remaining pulses were delivered on the right side.

†Duration of energy application of successful pulse.

‡Isoproterenol infusion needed for sustained tachycardia.

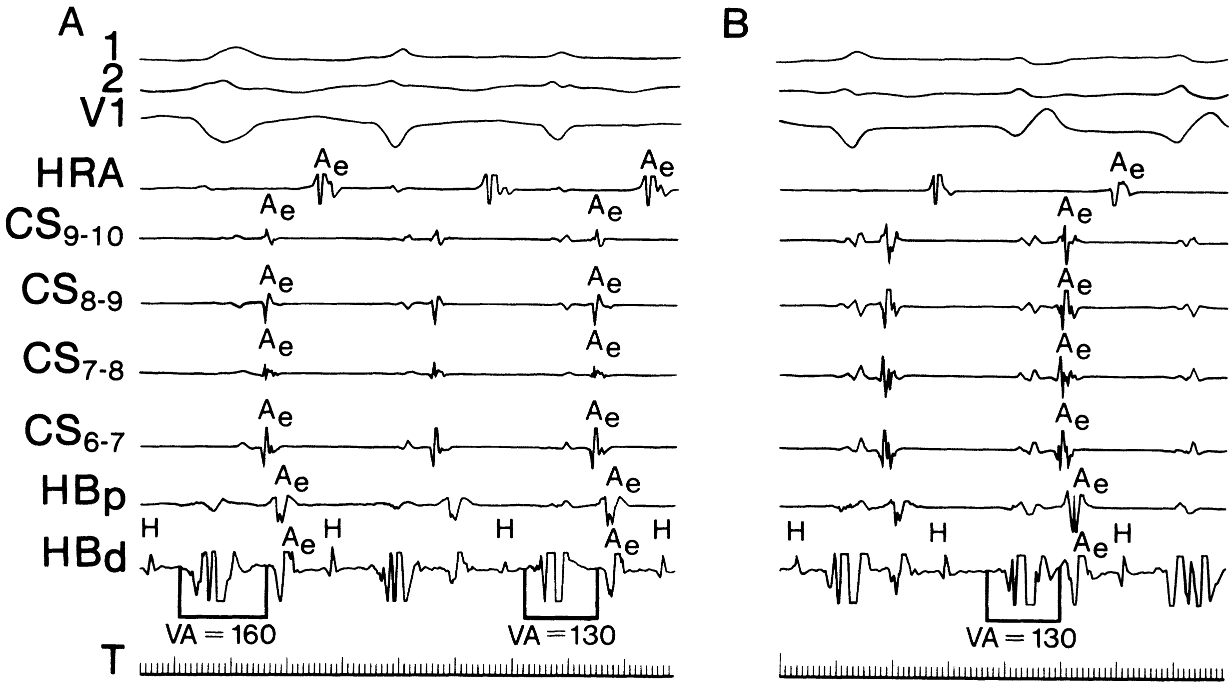


FIG 2. VA interval during orthodromic tachycardia with functional bundle-branch blocks. Tracings from top to bottom are ECG leads (I, II, and V_1), high right atrial (HRA) electrogram, coronary sinus (CS) electrogram from proximal to distal, proximal and distal His bundle (HBp and HBd, respectively) electrograms, and time lines (T). A similar format is also used in subsequent tracings. Functional left bundle-branch block (A, first complex), functional right bundle-branch block (B, second and third complexes), and narrow QRS complexes during orthodromic tachycardia induced in patient 3 are shown. Note that the functional left bundle-branch block prolongs the VA interval by 30 milliseconds whereas the functional right bundle-branch block has no effect on the VA interval. The earliest site of atrial activation is recorded within the terminal 1 cm of the CS (ie, CS_{8-9}, CS_{7-8}, and CS_{6-7}).

right internal jugular vein (5 patients). In the remaining patient, successful ablation was achieved using a transaortic approach via the femoral artery. The mean procedure time was 369±191 minutes, and the mean fluoroscopic time was 49±39 minutes. Four patients required a single radiofrequency pulse, and in the remaining 14 patients, the mean number of radiofrequency pulses was 8±6. Of the 14 patients receiving multiple radiofrequency pulses, 8 patients had their AP successfully ablated in the terminal coronary sinus including its ostium; of the remaining 6 patients, 3 also received energy delivery in the terminal coronary sinus, although it was unsuccessful. The last radiofrequency pulse that led to a successful result was set at 69±6 V (45±8 W) for 34±16 seconds. The local ECG features at the successful sites were as follows. The A:V ratio was 0.6±0.3. In patients with manifest preexcitation during sinus rhythm, discrete and high-frequency deflections (presumably AP potentials) were noted in 7 patients (Fig 3), and fractionated potentials between atrial and ventricular deflections were present in 3 patients. The earliest ventricular activation in group 1 patients was 18±5 milliseconds earlier than that recorded in the reference coronary sinus electrogram. The earliest atrial activation during orthodromic tachycardia was 7±5 milliseconds earlier than that recorded in the reference coronary sinus electrogram.

For group 2, a femoral venous approach was used in all patients. The successful ablation site was in the posteroseptal region of the tricuspid annulus in 12 patients and at the coronary sinus ostium in 4. The mean procedure time was 261±95 minutes, and mean fluoroscopy time was 35±26 minutes. In 2 patients, a single radiofrequency pulse successfully abolished the posteroseptal APs, and in the remaining 14 patients, a mean number of 8±5 radiofrequency pulses was delivered. The last successful pulse was set at 72±6 V (48±9 W) for 40±10 seconds. The local electrogram at the successful site showed the following characteristics. The A:V ratio was 0.6±0.3. Of the 10 patients with manifest preexcitation, 7 had high-frequency deflections (AP potentials). The earliest ventricular activation in these 10 patients was 19±11 milliseconds earlier than that recorded in the reference coronary sinus electrogram. The earliest atrial activation in the 16 group 2 patients with intact retrograde AP conduction occurred 13±8 milliseconds earlier than that recorded in the reference coronary sinus electrogram.

For group 3, the APs were successfully ablated in the posteroseptal region of the tricuspid annulus in 12 patients and at the coronary sinus ostium in 3. In the remaining patient (patient 40), the earliest ventricular activation was recorded within the terminal coronary sinus. The ablative attempts made at the posteroseptal tricuspid annulus and the coronary sinus ostium failed to eliminate the AP conduction. Because the placement of the diagnostic catheter inside the coronary sinus was technically difficult and time consuming and to avoid excessive radiation, insertion of an ablation catheter within the terminal coronary sinus was considered only as a last resort. Therefore, mapping of the posteroseptal region of the left ventricle adjacent to the AV junction was performed instead, which showed that ventricular activation via the AP was as early as that in the reference

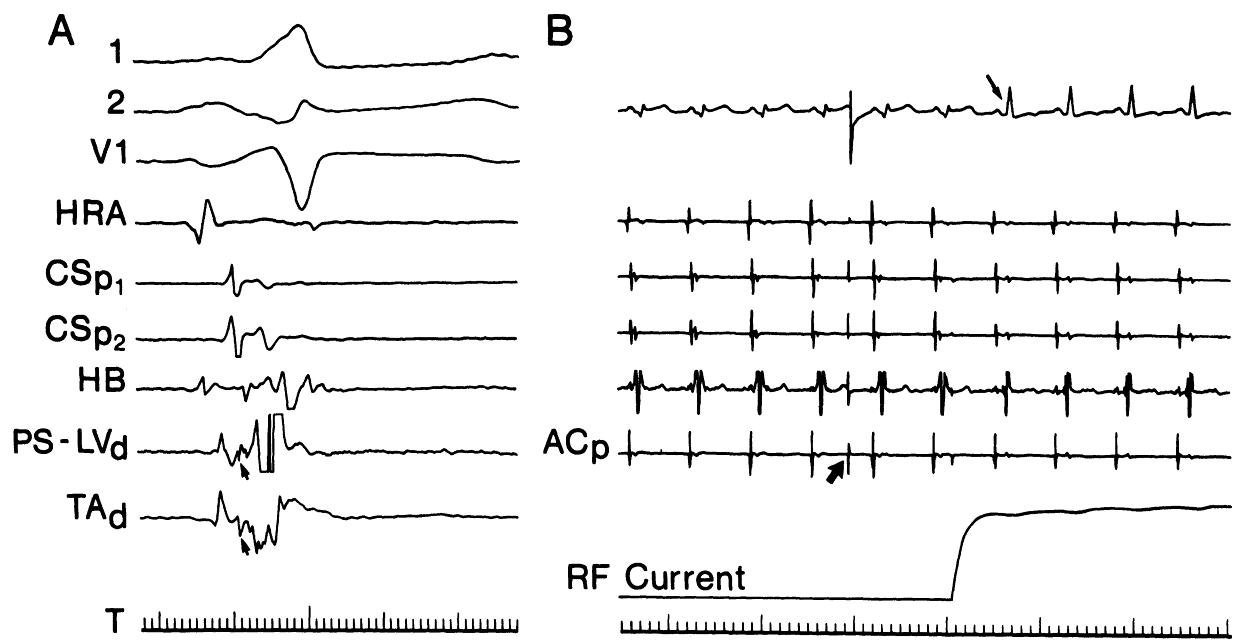


FIG 3. Mapping and ablation of a posteroseptal pathway (patient 10). During sinus rhythm with manifest preexcitation (A), the posteroseptal aspect of the left ventricle (PS-LV_d) adjacent to the AV junction and the atrial aspect of the tricuspid annulus (TA_d) are mapped. Note that both annular electrograms show an extra potential (arrows) between the atrial and ventricular electrograms, which are presumably accessory pathway potentials. These potentials occur simultaneously and 20 milliseconds earlier than the delta wave on the surface ECG. B, Effect of radiofrequency (RF) energy applied to the TA_d electrode. Note that in <1 second after the onset of RF delivery at 69 V, the delta wave disappears and the QRS complex normalizes (arrow in ECG lead 2). AC_p is the proximal electrogram obtained from the ablation catheter, and the arrow denotes the instant that the distal electrogram is switched from recording to ablation mode, producing an artifact in all electrograms.

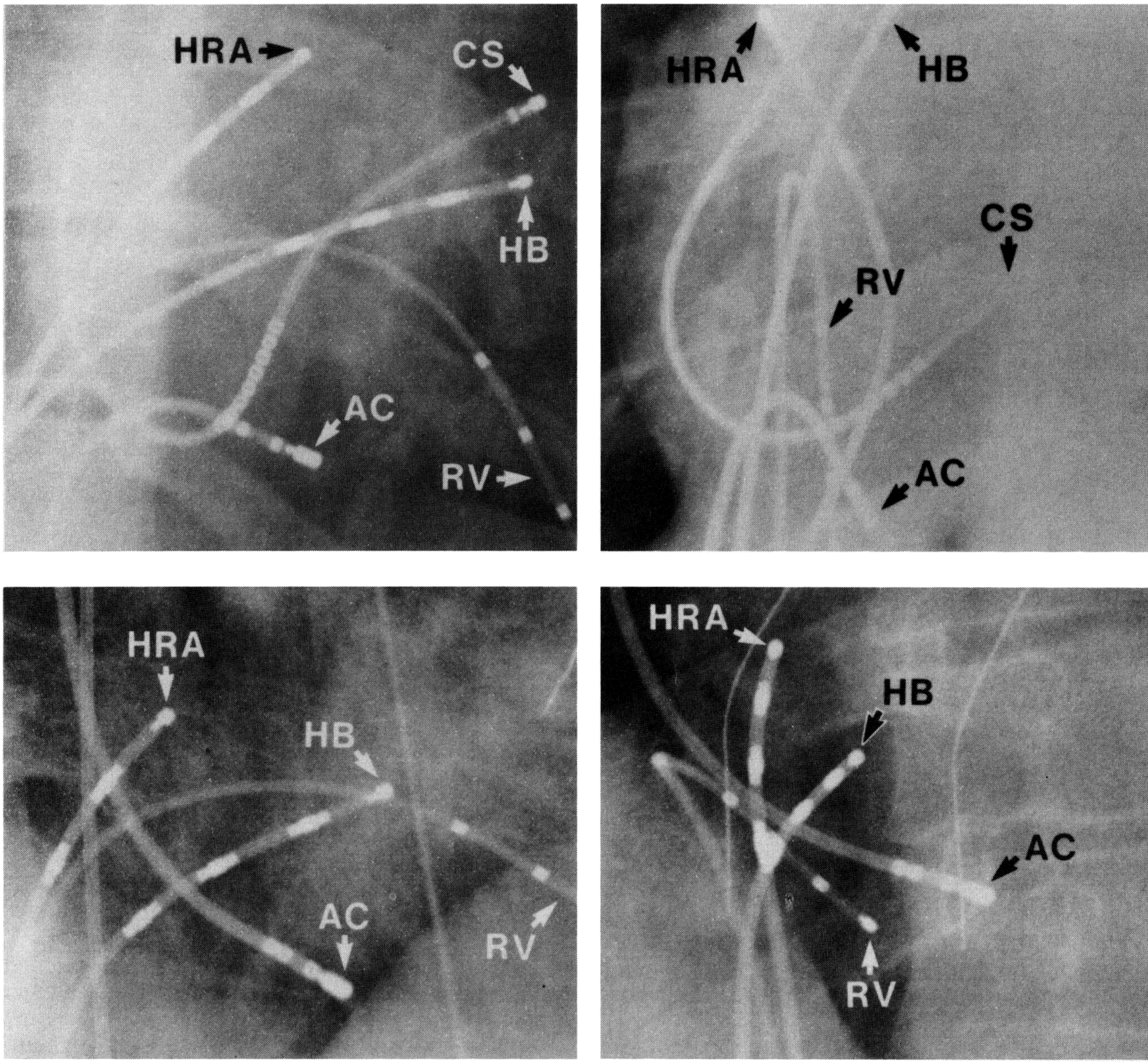
coronary sinus electrogram and 20 milliseconds earlier than the delta wave. The delivery of a single radiofrequency pulse at that site successfully ablated the AP. The mean procedure time was 298±135 minutes, and mean fluoroscopy time was 37±22 minutes. In 6 patients, a single radiofrequency pulse was sufficient to abolish AP conduction, and in the remaining 10 patients, a mean number of 7±5 pulses was delivered. The radiofrequency pulse was set at 72±7 V (48±9 W) for 38±12 seconds. The A:V ratio at the successful site was 0.5±0.3. In 12 patients with manifest preexcitation, high-frequency deflections or fractional electrograms (presumably AP potentials) were recorded at the successful sites in 7 patients. The local ventricular activation at the successful ablation sites was 20±9 milliseconds earlier than the delta wave. In 12 patients with intact retrograde AP conduction, the atrial activation at the successful sites was 16±11 milliseconds earlier than that recorded in the reference coronary sinus electrogram.

We compared several variables among the three groups. The cycle length of the orthodromic tachycardia was longer in group 3 than in groups 1 and 2 (342±50 milliseconds versus 300±23 milliseconds [P<.01] and 306±38 milliseconds [P<.05], respectively). The interval between the atrial activation recorded at the site of ablation and that in the reference coronary sinus electrogram during exclusive retrograde AP conduction (ie, Aac−Acs) was significantly shorter in group 1 than in groups 2 and 3 (P<.05 and P<.01, respectively). Although the total procedure time was longer in group 1 than in group 2 (P<.001), there was no significant statistical difference among the three groups in the fluoroscopic duration, number of radiofrequency pulses delivered, or voltage and duration of the last (successful) radiofrequency pulse. Furthermore, there was no significant difference among groups 1, 2, and 3 in the antegrade 1:1 AP conduction (291±30, 283±36, and 290±36 milliseconds, respectively), the antegrade AP effective refractory period (286±42, 281±40, and 288±44 milliseconds, respectively), the retrograde 1:1 AP conduction (271±25, 271±30, and 282±37 milliseconds, respectively), and the retrograde AP effective refractory period (275±22, 276±21, and 283±33 milliseconds, respectively).

In the 9 patients (3, 11, 13, 21, 26, 27, 30, 43, and 45) with inducible AV nodal reentrant tachycardia at baseline, the same tachycardia remained inducible after successful AP ablation. These patients required further attempts at a slow pathway ablation[14] during the same setting, which successfully abolished the AV nodal reentrant tachycardia. None of these 9 patients developed AV block.

Follow-up

All patients underwent a 24- to 48-hour follow-up electrophysiological evaluation before discharge. There was no evidence of a functioning AP in any of these patients. Six patients (5, 11, 17, 29, 41, and 48) had a recurrence of AP conduction. In 5 of these 6 patients, a repeat ablation was performed within 4 weeks after the initial attempt. During the repeat procedure, a successful ablation was accomplished using a venous approach and a single radiofrequency pulse. The successful sites were the same as (in patients 11 and 48) or adjacent to (in patients 17, 29, and 41) the regions in which a loss of AP conduction had been accomplished during the initial



attempt. The remaining patient (patient 5), who had not returned for a late follow-up evaluation, developed a recurrence of orthodromic tachycardia approximately 5 months after the initial ablation, and a repeat ECG revealed the resumption of manifest preexcitation. A repeat electrophysiological evaluation showed that both antegrade and retrograde AP conduction properties were modified and the AP effective refractory period was markedly longer than that at the initial study. During the repeat ablative attempt, the coronary sinus could not be entered beyond the ostium, a problem that was also encountered during the first procedure. A transesophageal echocardiogram verified that the coronary sinus was markedly small in diameter throughout its course. The timing of ventricular or atrial activation via the AP conduction could not be determined within the coronary sinus and beyond its ostium. The mapping of the left ventricular posteroseptal region, as well as the atrial and ventricular aspects of the mitral annulus, failed to detect any sites being activated earlier than the ostial coronary sinus electrograms. Several pulses of radiofrequency current delivered at the coronary sinus ostium and the left ventricular posteroseptal region failed to eliminate the AP conduction. This patient was, therefore, treated medically with 120 mg sotalol BID and has had no clinical recurrence for the past 4 months.

Thirty-five patients underwent a late follow-up electrophysiological evaluation 2 to 3 months after the final successful ablation and were found to have no conduction over the AP or inducible supraventricular tachycardia. In addition, 4 patients with a unidirectional AP only capable of antegrade conduction had a 6- to 8-week follow-up 12-lead ECG, which revealed a normal sinus rhythm, PR interval, and QRS duration. During a mean 12±9 months of follow-up after the final successful ablation in 49 patients, all have remained asymptomatic.

Complications

Three patients (5%) experienced complications associated with the 56 ablative procedures, including the six repeat ablations. One patient (patient 11) developed transient, high-degree (2:1) AV block during radiofre-

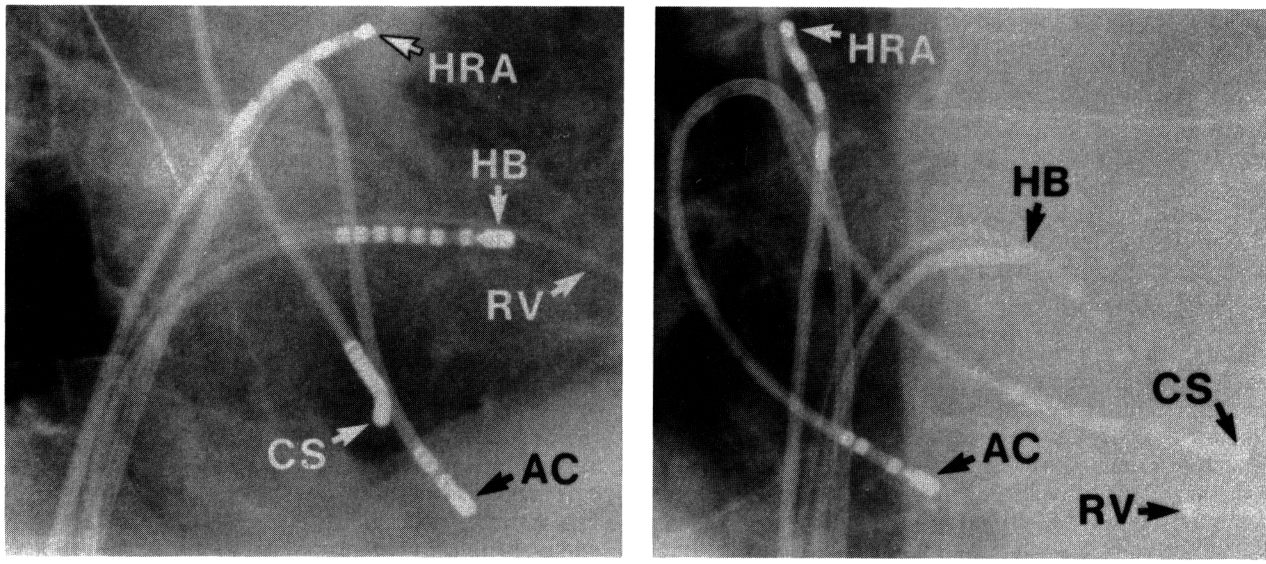


FIG 4. This page and facing page. Radiographic views of successful ablation sites. Radiograms are obtained from three different patients. For each patient, the right anterior oblique view is shown on the left and the left anterior oblique view is shown on the right. The intracardiac catheters are positioned in the high right atrium (HRA), His bundle region (HB), right ventricular apex (RV), and coronary sinus (CS). The ablation catheter (AC) is shown at the successful sites, which are the posteroseptal aspect of the tricuspid annulus (facing page, top), the coronary sinus ostium (facing page, bottom), and the inferomedial aspect of the right atrium posterior to the coronary sinus ostium (above). Note that the AC is introduced to the targeted areas using a femoral vein (facing page, top; above) or right internal jugular vein (facing page, bottom).

quency delivery to the coronary sinus ostium. A 1:1 AV conduction over the normal pathway spontaneously returned within 10 minutes of ablation. Two patients developed pericardial effusions. This was of no hemodynamic significance in 1 patient (patient 8) whose serial echocardiographic studies over several weeks showed a complete resolution of the effusion. The source of pericardial effusion in this patient was believed to be the coronary sinus in which several radiofrequency currents were applied. The other patient (patient 4) developed echocardiographic and hemodynamic signs of cardiac tamponade shortly after successful ablation. Because of a rapid pericardial fluid reaccumulation, she underwent surgical drainage and was found to have a small tear at the right ventricular apex, which was successfully repaired.

Echocardiographic examination of the remaining 48 patients performed 24 to 48 hours after ablation revealed no newly developed abnormalities related to the ablation procedure.

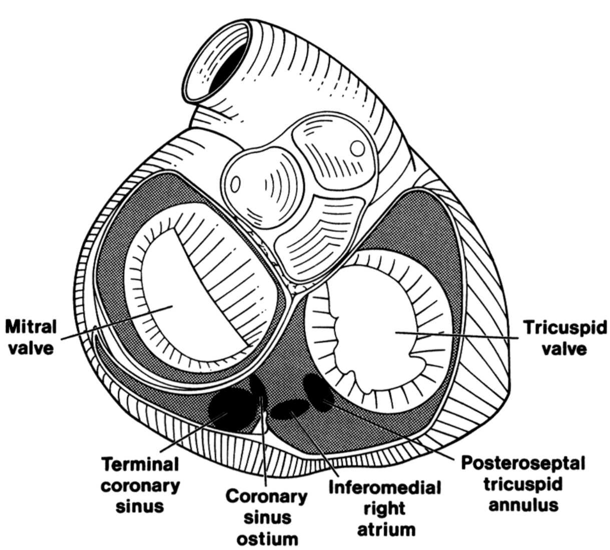


FIG 5. Sites of successful ablation using a venous approach. This schema is a cranial view of a cross section of the heart at the atrioventricular junction. The sites of successful ablation were the posteroseptal aspect of the tricuspid annulus (30 patients), the terminal 1 cm of the coronary sinus (4 patients), the coronary sinus ostium (12 patients), and the inferomedial aspect of the right atrium (2 patients).

Discussion

All posteroseptal APs in this series were initially targeted for ablation using a venous approach. This approach was effective in the vast majority (94%) of patients. The successful sites (Fig 5) were at the posteroseptal region of the tricuspid annulus (30 patients), at the terminal portion of the coronary sinus including its ostium (15 patients), and at the inferomedial aspect of the right atrium posterior to the coronary sinus ostium (2 patients). The posteroseptal region of the left ventricle was the site of successful ablation in only 2 patients. The results of this study suggest that the vast majority of posteroseptal APs can be successfully ablated using a right atrial approach even though the delta wave polarity on the ECG or the VA prolongation during orthodromic tachycardia with functional left bundle-branch block indicates a left ventricular insertion site.

Anatomic Considerations

Anatomically, the posteroseptal area of the heart corresponds to a region known as the crux.[2,13] The term "crux" refers to the area where the four cardiac chambers reach their maximal proximity posteriorly. Three distinctive features of the crux are as follows. First, the right atrium and the coronary sinus form a unit that wraps around the left atrium. Second, the interatrial

sulcus is to the far left of the interventricular sulcus. Third, the right AV sulcus is markedly depressed below that of the left. The anatomic conformation of this region allows the right atrium to lie directly on the posterosuperior process of the left ventricle. The latter corresponds to a portion of the left ventricle that connects the mitral annulus to the muscular septum. The medial and inferior walls of the right atrium merge posteriorly to form the coronary sinus ostium. Because of its close proximity to the crux, the terminal portion of the coronary sinus should be regarded as a component of the right atrio–left ventricular complex.

Based on the surgical experience,[2,5] the vast majority of APs coursing through the posteroseptal region share a common feature, ie, their right atrio–left ventricular connections. Our data are compatible with such an anatomic orientation of AP fibers as indicated by the following observations. First, mapping the atrial aspect of the mitral annulus in 10 group 1 patients revealed that left atrial activation during retrograde AP conduction was consistently later than that recorded on the right side. Similarly, during antegrade AP conduction, ventricular activation recorded from the atrial aspect of the mitral annulus occurred later than the onset of the delta wave. Second, mapping the posteroseptal aspect of the left ventricle in seven group 1 patients demonstrated the earliest ventricular activation occurring simultaneously with that recorded in the posteroseptal aspect of the tricuspid annulus or the terminal coronary sinus. These two observations made in these patients strongly suggested that APs were anomalous connections in the right atrio–left ventricular complex. Finally, in 17 of 18 group 1 patients with AP characteristics suggestive of left ventricular AP insertion, successful ablation was accomplished using a right atrial approach. Therefore, dividing these APs into right- or left-sided pathways may be useful in describing their ECG or electrophysiological characteristics; however, such a classification may have little (if any) value in predicting the site of successful posteroseptal AP ablation.

The posteroseptal region is surrounded by three anatomically distinct areas: midseptal (anterosuperior border), right posterior paraseptal (right lateral border), and left posterior paraseptal (left lateral border). The APs located in these areas should be distinguished from posteroseptal APs. Midseptal APs are situated between the anterior portion of the posterosuperior process of the left ventricle, posterior to the right fibrous trigone and the right atrium. The right and left posterior paraseptal APs are actually free-wall pathways, connecting the right and left ventricles to the right and left atria, respectively. Although these APs are frequently distinguishable from posteroseptal APs on the basis of their ECG features or electrophysiological characteristics, the mapping and ablative results were the most reliable techniques for separating posteroseptal APs from the other locations in this cohort of patients.

Ventricular Activation Characteristics of the Posteroseptal Region

Of 22 patients with a positive delta wave in lead V_1, 15 patients had functional left bundle-branch block inducible during orthodromic tachycardia, which resulted in VA prolongation in 10 group 1 patients. In contrast, of 14 patients with a negative or biphasic delta wave in lead V_1, only 2 of the 9 patients with inducible functional left bundle-branch block demonstrated VA interval prolongation. Furthermore, the presence of a uniphasic R wave or R>S in lead V_1 was consistently associated with VA prolongation during orthodromic tachycardia with functional left bundle-branch block (when inducible). Therefore, there appears to be a correlation between the ECG pattern and the effect of functional left bundle-branch block on the VA interval, and both are most likely influenced by the activation pattern of the left ventricular posteroseptal region as discussed below.

ECG Features

Based on the delta wave polarity in lead V_1 of the surface ECG, posteroseptal APs have traditionally been categorized as either right- or left-sided pathways.[10] The two distinct patterns of the delta wave and the QRS complex polarity in lead V_1 are most likely due to different activation patterns of the interventricular septum and the left ventricular posterosuperior process. If the right side of the septum is activated earlier than the left side, a right-to-left septal depolarization will give rise to a negative or biphasic delta wave and a predominantly negative QRS complex. On the other hand, if the left side of the septum is activated first, a left-to-right septal depolarization will result in a positive delta wave and a predominantly positive QRS complex.

VA Response to Functional Left Bundle-Branch Block

In 18 patients (group 1), functional left bundle-branch block resulted in a 10- to 30-millisecond VA interval prolongation during orthodromic tachycardia. This phenomenon indicates that ventricular depolarization at the site of the AP insertion was normally (ie, during narrow QRS tachycardia) via the left bundle. We have previously shown that VA interval lengthening in patients with posteroseptal APs was only demonstrable with a complete left bundle-branch block and not with an isolated functional left posterior fascicular block, indicating that activation of the left ventricular posteroseptal region was perhaps provided by the left septal fascicle.[15]

The exact reason for the lack of VA interval prolongation in response to functional left bundle-branch block in group 2 patients is not well understood. However, two possibilities are worthy of mention. First, it is possible that the ventricular activation at the insertion site of the AP occurs via both right and left bundle branches (ie, double supply) and, therefore, the posteroseptal activation during a unilateral functional bundle-branch block remains undisturbed via the contralateral bundle branch. Second, epicardial mapping has shown that during normal AV conduction in some individuals, the latest activation of the left ventricle occurs in its posteroseptal (crux) area.[16] Therefore, it seems conceivable that, in some cases, despite a significant activation delay in the bulk of left ventricular myocardium, the occurrence of functional left bundle-branch block causes no further delay in the posteroseptal activation. In other words, the time interval between the onset of ventricular depolarization (ie, beginning of the QRS complex) and the posteroseptal activation occurring antegradely via the left bundle (ie, during normal AV

conduction) or transseptally via the right bundle (ie, with functional left bundle-branch block) is exactly the same.

Prior Studies

Jackman et al[7] reported 43 patients with posteroseptal APs undergoing catheter ablation. During 51 ablative procedures, a complete eradication of AP conduction was accomplished in 41 of 43 patients (95%). The following areas were targeted for ablation: (1) the posteroseptal region of the tricuspid annulus or around the margin of the coronary sinus ostium, (2) underneath the mitral annulus close to the septum, and (3) the middle cardiac vein. Subsequently, the investigators from the same laboratory reported their preliminary results in a larger series of 65 patients with posteroseptal accessory pathways (not including 9 patients with midseptal pathways) in whom successful results could be accomplished.[17,18] Successful sites were right posteroseptal (35%), terminal coronary sinus including the ostium (33%), left ventricular posteroseptal (23%), and middle cardiac vein (9%). Furthermore, the same group attempted to correlate the site of successful ablation with the polarity of the delta wave in ECG leads I, II, aVL, and aVF in 55 posteroseptal accessory pathways (not including seven midseptal pathways).[19] There were two striking findings. First, among 40 patients with a positive or biphasic delta wave in lead II, 32 (80%) were successfully ablated in the right posteroseptal region. Second, in 15 patients with a negative delta wave in lead II, the successful ablation site was in the coronary sinus (including the middle cardiac vein) in 8 patients (53%). The results of the present study are comparable with those mentioned above. Among 11 patients with a positive or biphasic delta wave in lead II, 9 (82%) were ablated in the posteroseptal region of the tricuspid annulus; and of 25 patients with a negative delta wave in lead II, 13 (52%) were successfully ablated within the terminal coronary sinus including the ostium. Schluter et al[9] performed catheter ablations in 21 posteroseptal APs that were designated as left-sided in 14 patients and right-sided in 7. In patients with left-sided posteroseptal APs, the ablation was attempted from the coronary sinus (10 patients) or the left ventricle (4 patients). Seventeen patients (81%) had a successful ablation and the remaining 4 with unsuccessful ablations of left-sided APs had ablative attempts made only from the coronary sinus. Calkins et al[20] reported on 44 patients with posteroseptal APs in whom the left ventricular approach was used in 22%. Forty-one of 44 patients (93%) had successful results.

Study Limitations

First, functional left bundle-branch block was not induced in any of the group 3 patients. Some of these patients would have been included in group 1 or group 2 if this type of aberrancy had been demonstrated. Therefore, the number of patients included in groups 1 and 2 might not have reflected the true ratio of patients with "right-sided" and "left-sided" posteroseptal APs in a series of consecutive patients. Second, in 38 patients, >1 radiofrequency pulse (mean, 8±6 pulses) was delivered. Although the last ablation site that led to complete abolition of AP conduction was considered as a successful site, it is conceivable that some (if not all) of these 38 patients had a broad band of AP fibers in the posteroseptal region, which necessitated the radiofrequency energy delivery at multiple adjacent sites. Third, coronary sinus venography was not performed in any of these patients. It is possible that in those patients requiring radiofrequency delivery within the terminal coronary sinus for successful results, the ablation catheter tip was, indeed, inside a branch (eg, middle cardiac vein) or diverticulum of the coronary sinus. Although the knowledge of detailed coronary sinus anatomy in these cases might have been useful for a precise determination of the site of AP ablation, successful results were achieved in the absence of such an intervention. Finally, the mapping data obtained from the atrial aspect of the mitral annulus did not support a left atrio–left ventricular connection in any of the 10 group 1 patients undergoing such detailed mapping. Nevertheless, due to the relatively small sample size in this series, the existence of posteroseptal APs confined to the left atrio–left ventricular region cannot be entirely excluded.

Clinical Implications

Based on the results of this study, several issues may be worthy of mention. It seems advisable to make an effort to induce functional bundle-branch block during orthodromic tachycardia and analyze the effect of such aberrancy on the VA interval. Any prolongation of the VA interval in response to right bundle-branch block strongly argues against a posteroseptal location of the AP. On the other hand, lengthening of the VA interval by ≤30 milliseconds in response to left bundle-branch block is compatible with a posteroseptal AP location. Depending on delta polarity, the R/S ratio in lead V_1, and the magnitude of VA interval prolongation in response to functional bundle-branch block, the initial mapping and ablation attempts can be focused on certain regions. For example, the posteroseptal aspect of the tricuspid annulus may be targeted first when the delta wave is negative or the R/S ratio is <1 in the ECG lead V_1 and when there is no VA interval prolongation in response to functional left bundle-branch block during orthodromic tachycardia. If the delta wave is negative in lead II or the R/S ratio is >1 in lead V_1 and the VA interval is prolonged by functional left bundle-branch block, the terminal coronary sinus including its ostium should be the focus of the initial attempts. Mapping of the left ventricle may be considered as the last approach when initial attempts at the posteroseptal aspect of the tricuspid annulus and the terminal coronary sinus are futile.

Conclusions

This study demonstrates that successful ablation of posteroseptal APs is feasible using a venous approach. This was accomplished in 47 patients even though the electrophysiological characteristics of the APs were suggestive of left-sided pathways in 18 patients. It seems reasonable, therefore, to attempt the transcatheter ablation of these APs from the right atrium regardless of their ECG pattern or the VA interval response to functional left bundle-branch block during orthodromic tachycardia. This may minimize or obviate the need for a left-sided heart catheterization and delivery of radiofrequency pulses inside the left ventricular cavity in the vast majority of patients.

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