Atrial pacing at multiple sites in the Wolff-Parkinson-White syndrome¹

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Atrial pacing at multiple sites was used in an attempt to predict the site of pre-excitation in 5 patients with Wolff-Parkinson-White syndrome with 5 different anomalous pathway locations (right anterior, right posterior, septal, left posterior, and left lateral). At least 3 atrial pacing sites were tested in each patient. Pacing sites tested included high right atrium, low lateral right atrium, low septal right atrium, proximal coronary sinus, and distal coronary sinus. Atrial stimulation sites with shortest and longest stimulus-delta intervals could be identified in each patient, the shortest stimulus-delta interval in each case ranging from 60 to 80 ms. The difference between the shortest and longest stimulus-delta interval in each case ranged from 60 to 110 ms. It was suggested that the site with the shortest stimulus-delta interval corresponded to a site close to the atrial insertion of the anomalous pathway. This hypothesis was confirmed in all cases (3 with epicardial mapping and 2 with retrograde atrial activation data). In conclusion, atrial pacing at multiple sites is helpful in predicting the site of anterogradely conducting anomalous pathways, and appears particularly useful for differentiation of right posterior, left posterior, and septal pre-excitation.

Cure of Wolff-Parkinson-White syndrome is now possible using epicardial mapping for delineating the site of pre-excitation, and surgical transection of anomalous AV connections (Sealy and Wallace, 1974; Gallagher *et al.*, 1975). Anomalous pathway location plays a role in determining the success of operation (Sealy and Wallace, 1974; Gallagher *et al.*, 1975; Tonkin *et al.*, 1975). Right anterior, lateral, and posterior as well as left lateral anomalous AV connections appear readily accessible to surgical cure. Left posterior and septal anomalous pathways are less accessible to the surgeon. Since, therefore, the surgical cure of pre-excitation appears to be partly related to anomalous pathway location, the accurate preoperative localisation of these pathways has assumed considerable importance.

The means of predicting anomalous pathway locations include surface electrocardiography and vectorcardiography, as well as electrophysiological evaluation in the catheterisation laboratory (Wellens

et al., 1971; Touboul *et al.*, 1972; Coumel and Attuel, 1974; Denes *et al.*, 1974; Spurrell *et al.*, 1974; Svenson *et al.*, 1974, 1975; Wellens and Durrer, 1974, 1975; Wyndham *et al.*, 1974; Zipes *et al.*, 1974; Gallagher *et al.*, 1975; Neuss *et al.*, 1975; Denes *et al.*, 1976a, b). Electrophysiological techniques include lateralisation of the anomalous pathway by noting the effects of functional bundle-branch block on the cycle length of circus movement tachycardia or on retrograde anomalous pathway conduction time (Coumel and Attuel, 1974; Spurrell *et al.*, 1974; Zipes *et al.*, 1974; Neuss *et al.*, 1975; Wellens and Durrer, 1975); intracardiac catheter electrode mapping of retrograde atrial activation during circus movement tachycardia and/or with ventricular pacing (Svenson *et al.*, 1974, 1975; Wellens and Durrer, 1974, 1975; Zipes *et al.*, 1974; Gallagher *et al.*, 1975; Neuss *et al.*, 1975; Denes *et al.*, 1976a, b), and evaluation of atrial pacing at multiple sites with observation of QRS morphology and stimulus-delta intervals (Wellens *et al.*, 1971; Touboul *et al.*, 1972; Denes *et al.*, 1974; Gallagher *et al.*, 1975; Svenson *et al.*, 1975; Denes *et al.*, 1976a).

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Although all these techniques appear to be of value in localisation of anomalous pathways, major emphasis has been placed upon the use of retrograde atrial activation sequences in the prediction of anomalous pathway location (Zipes *et al.*, 1974; Wellens and Durrer, 1974, 1975; Gallagher *et al.*, 1975; Neuss *et al.*, 1975; Svenson *et al.*, 1975; Denes *et al.*, 1976a). The use of atrial pacing at multiple sites has received less attention. In the present study, we describe the results of atrial pacing studies at multiple sites in 5 patients with anterogradely conducting anomalous pathways in different locations. Our results confirm the value of multiple atrial pacing sites in anomalous pathway localisation. In addition, criteria are developed for using the information obtained with this technique in predicting the site of pre-excitation.

Methods

Five patients with pre-excitation were selected for presentation in this report. All patients had typical surface electrocardiographic findings of Wolff-Parkinson-White syndrome including a short PR interval (less than 0.12 s), wide QRS complexes (0.12 s or greater), delta waves, and documented supraventricular tachyarrhythmias. These 5 patients were selected because: (1) technically adequate multiple atrial pacing site data were obtained for analysis, and (2) the anomalous pathway location was reasonably well documented, so that the predictive value of multiple atrial pacing sites could be examined. (3) The patients represented 5 different anomalous pathway locations.

Electrophysiological studies were performed in the supine, non-sedated state. Informed written consent was obtained from all patients before the study. All cardioactive drugs were discontinued 48 hours before the study. Catheter techniques for recording and stimulation were similar to those previously described (Wyndham *et al.*, 1974; Denes *et al.*, 1976a, b). Electrocardiographic leads I, II, III, and V1, atrial and His bundle electrograms were recorded using a paper speed of 100 mm/s. Intervals were measured by averaging 10 consecutive beats. Tripolar and quadripolar catheters (with interelectrode distances of 1 cm) were placed under fluoroscopic control.

The following atrial pacing sites were used: (1) high right atrium, at the superior vena cava-right atrial junction, (2) low lateral right atrium, at the inferior vena cava-right atrial junction, (3) low septal right atrium (using the His bundle recording catheter) at the most distal site on pull-back from the ventricle, where stable atrial capture with an atrial depolarisation preceding the QRS complex

could be obtained, (4) right atrial appendage, (5) proximal coronary sinus (just inside the os of the coronary sinus), (6) distal coronary sinus (at the most distal site in the coronary sinus where atrial capture could be obtained, usually close to the left heart border).

The atria were stimulated from the tested sites at rates slightly faster than sinus and then in 10 beats/minute increments until total pre-excitation was achieved. The stimulus-delta remained constant at increasing pacing rates. For purposes of comparison results in each case were compared at an identical cycle length between 460 and 600 ms. Epicardial mapping techniques were similar to those previously described by our laboratory (Wyndham *et al.*, 1974; Denes *et al.*, 1976a, b).

DEFINITIONS

Pre-excitation was classified electrocardiographically during maximal pre-excitation. The electrocardiographic classification of pre-excitation was based on the work of Boineau *et al.* (1973).

Anterior right ventricular pre-excitation (type B) was defined by the presence of a QS or rS in V1 and an R in I and III. Posterior right ventricular pre-excitation (type AB) was defined by the presence of a QS or rS in V1, an R in I, and a QS in III. Posterior left ventricular pre-excitation (type A) was defined by the presence of an R or RS in V1, an R in I, and a QS or rS in III. Lateral left ventricular pre-excitation (type C) was defined by the presence of an R or RS in V1, a QS or rS in I, and an R in III.

Stimulus-delta intervals were measured from the onset of the stimulus artefact to the earliest onset of the delta wave on simultaneous surface electrocardiographic leads. This interval represented the atrial and anomalous pathway conduction times from the site of atrial stimulation.

Total or maximal pre-excitation referred to a QRS complex resulting from ventricular activation exclusively through the anomalous atrioventricular connection.

Results

CASE 1

The patient was a 25-year-old woman with symptomatic recurrent paroxysmal supraventricular tachycardia and recurrent paroxysmal atrial fibrillation with rapid ventricular response. Electrocardiograms revealed type B pre-excitation (Fig. 1). Basic conduction intervals were recorded during sinus rhythm at a cycle length of 610 ms and revealed a PA interval of 30 ms. AH and HV intervals could not be measured since the His bundle electrograms were buried within the ventricular electrogram. The P delta interval was of 75 ms.

Fig. 1 The effect of atrial pacing at multiple sites on stimulus-delta intervals in case 1 with type B pre-excitation. Shown in each panel from top to bottom are surface electrocardiographic leads I, II, III, and V1. HRA represents high right atrial pacing; LLRA low lateral right atrial pacing; LSRA low septal right atrial pacing; RAA right atrial appendage pacing. Cycle length was 500 ms. Stimulus-delta intervals are listed and expressed in ms. Time lines are at 1 second and paper speed is 100 mm/s in this and subsequent illustrations. Note that the shortest stimulus-delta interval (60 ms) is obtained with right atrial appendage pacing (panel D).

Four atrial pacing sites were studied at a cycle length of 500 ms. The stimulus-delta intervals and QRS durations from these sites were as follows: (1) high right atrium, with a stimulus-delta of 100 ms and QRS duration of 180 ms (Fig. 1A); (2) low lateral right atrium, with a stimulus-delta of 130 ms and a QRS duration of 150 ms (Fig. 1B); (3) low septal right atrium with a stimulus-delta of 110 ms and QRS duration of 130 ms (Fig. 1C); (4) right atrial appendage, with a stimulus-delta of 60 ms and QRS duration of 180 ms (Fig. 1D).

Curative surgery was attempted because of recurrent tachyarrhythmias. Epicardial mapping revealed earliest ventricular activation on the anterior right ventricle adjacent to the right atrial appendage (Fig. 2). The epicardial ventricular electrograms preceded the onset of the delta wave by 38 ms. After epicardial mapping, the right atrium was entered during cardiopulmonary bypass. A transmural atrial incision was made parallel to the AV ring and adjacent to the area of earliest ventricular activation. All subsequent electrograms have revealed normal PR intervals without pre-excitation. Arrhythmias have not recurred (6-month follow-up).

Comment

Electrocardiograms before surgery suggested a right anterior anomalous pathway. Atrial pacing studies at multiple sites provided strong evidence of an anterior right AV connection with demonstration of the shortest stimulus-delta interval (60 ms) and

maximum pre-excitation from the right atrial appendage pacing site. The predicted site of pre-excitation was confirmed at cardiac surgery.

CASE 2

This was a 15-year-old youth with recurrent paroxysmal supraventricular tachycardia. Electrocardiograms during total pre-excitation revealed type AB pre-excitation. This case has been previously reported because of bilateral anomalous pathways (a manifest right posterior anterograde pathway, and a left lateral concealed retrograde pathway), and will, therefore, be described only briefly here (Denes *et al.*, 1976a).

Three atrial pacing sites were studied at a cycle length of 600 ms (Fig. 2 of Denes *et al.* (1976a)). The stimulus-delta intervals and QRS duration from these sites were as follows: (1) high right atrium, with a stimulus-delta of 140 ms and QRS duration of 120 ms; (2) low lateral right atrium, with a stimulus-delta of 80 ms and QRS duration of 180 ms; (3) proximal coronary sinus, with a stimulus-delta of 115 ms and QRS duration of 170 ms. Epicardial mapping revealed early activation of the posterior right ventricle contiguous to the intra-ventricular groove, with early activation coinciding with the onset of the delta wave (Fig. 6 of Denes *et al.* (1976a)). A transmural right atrial incision parallel to the AV ring adjacent to the site of earliest ventricular activation resulted in cure of antero-grade pre-excitation.

Comment

In this patient, the electrocardiogram during total pre-excitation suggested a posterior right ventricular connection. The atrial pacing site study showed the shortest stimulus-delta and widest QRS complex from the low lateral right atrium suggesting a lateral right atrial connection. The posterior right atrium was not tested. Epicardial mapping studies and surgery localised the anterogradely conducting anomalous connection to the right posterior ventricle.

CASE 3

This was a 37-year-old man with recurrent paroxysmal supraventricular tachycardia. Electrocardiograms during total pre-excitation indicated type AB pre-excitation (Fig. 3).

Basic conduction intervals were recorded during sinus rhythm at a cycle length of 870 ms and were as follows: P delta of 100 ms and PA of 30 ms. AH and HV intervals could not be measured since the H potential was buried within the ventricular electrogram.

Four atrial pacing sites were selected for pacing at a cycle length of 460 ms. The stimulus-delta intervals and QRS duration from these sites were as follows: (1) High right atrium, with a stimulus-delta of 110 ms and QRS duration of 170 ms (Fig. 3A). (2) Low lateral right atrium, with a stimulus-delta of 110 ms and QRS duration of 170 ms (Fig. 3B). (3) Low septal right atrium, with a stimulus-delta of 70 ms and QRS duration of 170 ms (Fig. 3C). (4) Distal coronary sinus, with a stimulus-delta of 140 ms and QRS duration of 170 ms (Fig. 3D).

Retrograde atrial activation sequences were determined during right ventricular pacing. Low right atrial septal electrograms preceded high right atrial, lateral right atrial, and right atrial appendage electrograms by 30, 40, and 50 ms, respectively. The retrograde conduction time measured from the onset of the QRS to the low septal right atrial electrogram was 90 ms and was constant at all ventricular paced cycle lengths.

Comment

The electrocardiogram in this patient was similar to that of case 2 and suggested a posterior right ventricular connection. However, atrial pacing site studies strongly suggested a septal anomalous pathway, because of the very short stimulus-delta with low right atrial septal pacing. Though this anomalous pathway location was not confirmed with epicardial mapping and surgery, the retrograde activation data provided strong confirmatory evidence for this predicted site of pre-excitation

Fig. 2 Diagram of epicardial activation during pre-excitation in case 1. Isochronous lines are drawn at 10 to 20 ms intervals with reference to the onset of delta wave. Inferior (upper), anterior (lower left), and left lateral (lower right) views of the heart are shown. The earliest area of epicardial activity is on the posterolateral left ventricle.

(Gallagher *et al.*, 1975). These electrophysiological findings led to a decision not to attempt surgical cure of the pre-excitation.

CASE 4

This was an 18-year-old youth with paroxysmal atrial fibrillation. Electrocardiograms revealed type A pre-excitation (Fig. 4). Basic conduction intervals at a cycle length of 765 ms revealed a P delta of 120

Fig. 3 The effect of atrial pacing at multiple sites on stimulus-delta intervals in case 3 with type AB pre-excitation. In each panel surface electrocardiographic lead I, II, III, and V1 are shown. Abbreviations are similar to Fig. 1. DCS represents distal coronary sinus pacing. Note that the shortest stimulus-delta interval (70 ms) is obtained with low septal right atrial pacing.

ms, PA of 24 ms, AH of 53 ms, and an HV of 38 ms.

Six atrial pacing sites were selected for pacing at a cycle length of 460 ms. The stimulus-delta intervals and the QRS duration from these sites were as follows: (1) High right atrium, with a stimulus-delta of 130 ms and QRS duration of 120 ms (Fig. 4A). (2) Low lateral right atrium, with a stimulus-delta of 140 ms and QRS duration of 120 ms. (3) Low septal right atrium, with a stimulus-delta of 100 ms and QRS duration of 100 ms (Fig. 4C). (4) Proximal coronary sinus, with a

stimulus-delta of 60 ms and QRS duration of 140 ms (Fig. 4D). (5) Midcoronary sinus, with a stimulus-delta of 80 ms and QRS duration of 140 ms (Fig. 4E). (6) Distal coronary sinus with a stimulus-delta of 100 ms and QRS duration of 130 ms (Fig. 4F).

Retrograde atrial activation sequences were determined during ventricular pacing. The proximal coronary sinus atrial electrogram preceded the low septal right atrial, high right atrial, low lateral right atrial, and distal coronary sinus activation by 5, 20, 60, and 30 ms, respectively. The retrograde

Fig. 4 The effect of atrial pacing at multiple sites on stimulus-delta intervals in case 4 with type A pre-excitation. In each panel, surface electrocardiographic leads I, II, III, and V1 are shown. Abbreviations are similar to Fig. 1 and 3. PCS and MCS represent proximal and mid coronary sinus pacing. Note that the shortest stimulus-delta interval (60 ms) is obtained with proximal coronary sinus pacing.

conduction time to the proximal coronary sinus site was 60 ms with ventricular pacing at all tested cycle lengths.

Comment

In this patient, the electrocardiogram suggested a left posterior connection. The atrial pacing site study revealed the shortest stimulus-delta and widest QRS complex from the proximal coronary sinus, suggesting a posterior left atrial connection. Though this anomalous pathway location was not confirmed with epicardial mapping and surgery, retrograde activation data provided strong confirmatory evidence for the predicted site of pre-excitation (Gallagher *et al.*, 1975).

CASE 5

This was a 53-year-old man with primary myocardial disease, subacute pericarditis, and recurrent paroxysmal atrial flutter with 1:1 anomalous pathway conduction. Electrocardiogram revealed type C pre-excitation (Fig. 5). Basic conduction intervals were recorded during sinus rhythm at a cycle length of 980 ms and revealed a P delta interval of 130 ms, and a PA of 25 ms. AH and HV intervals could not be measured since the H potential was buried within the ventricular electrogram.

Five stimulation sites were selected for pacing at a cycle length of 460 ms. The stimulus-delta

intervals and QRS duration from these sites were as follows: (1) High right atrium, with a stimulus-delta of 170 ms and QRS duration of 180 ms (Fig. 5A). (2) Low lateral right atrium, with a stimulus-delta of 180 ms and QRS duration of 180 ms (Fig. 5B). (3) Low septal right atrium, with a stimulus-delta of 140 ms and a QRS duration of 140 ms (Fig. 5C). (4) Proximal coronary sinus, with a stimulus-delta of 80 ms and QRS duration of 190 ms (Fig. 5D). (5) Distal coronary sinus, with a stimulus-delta of 70 ms and QRS duration of 190 ms (Fig. 5E).

Because of pericarditis and medically intractable recurrent atrial flutter with hypotension necessitating frequent cardioversions, surgical ablation of the anomalous connection was attempted. After pericardectomy, the ventricular epicardium was mapped. The earliest area of ventricular activation was on the posterolateral left ventricle adjacent to the AV ring, preceding the onset of the delta wave by 25 ms (Fig. 6). After epicardial mapping, the left atrium was entered during cardiopulmonary bypass. A transmural atrial incision was made parallel to the AV ring and adjacent to the earliest site of ventricular activation, which resulted in normalisation of the electrocardiogram with loss of the delta wave. During surgical repair, the left circumflex artery was damaged with development of intraoperative myocardial infarction. The patient expired with postoperative cardiogenic shock.

Fig. 5 The effect of atrial pacing site on stimulus-delta intervals in case 5 with type C pre-excitation. In each panel, surface electrocardiographic leads I, II, III, and V1 are shown. Abbreviations are similar to Fig. 1 and 4. Note that the shortest stimulus-delta interval (70 ms) is obtained with distal coronary sinus pacing.

Fig. 6 Diagram of epicardial activation in case 1 during pre-excitation. Isochronous lines are drawn at 10 to 20 ms intervals with reference to the earliest onset of delta wave on multiple surface electrocardiographic leads. Anterior (upper), left lateral (lower left), and inferior (lower right) views of the heart are shown. The earliest area of epicardial activity is on the anterior right ventricle preceding the onset of the delta wave by 38 ms.

Comment

The electrocardiogram during total pre-excitation suggested a left lateral anomalous connection. Multiple pacing site study strongly suggested a left lateral bypass, because of the shortest stimulus-delta (70 ms) with distal coronary sinus pacing. Epicardial mapping and surgery confirmed the presence of a left lateral anomalous connection.

Discussion

The success of surgery in the Wolff-Parkinson-White syndrome is partially determined by anomalous pathway location. In a recent report by Tonkin *et al.* (1975) cure of pre-excitation was achieved in 91 per cent of patients with anomalous pathways located in the free wall of the mitral or tricuspid annulus. In contrast, cure of pre-excitation was achieved in only 36 per cent of cases with septal anomalous pathways (Tonkin *et al.*, 1975). Thus, the ability to predict the site of anomalous

pathway before operation is of major importance in the presurgical evaluation of patients with pre-excitation.

Electrophysiological studies in the catheterisation laboratory may allow localisation of anomalous pathway location. The means for achieving this localisation are as follows: (1) Recording of retrograde atrial activation sequences from multiple sites during AV re-entrant tachycardia or ventricular pacing, (2) observations of changes in retrograde atrial activation time during the occurrence of functional bundle-branch block, allowing lateralisation of the anomalous pathway, and (3) measurement of stimulus-delta intervals and QRS duration from multiple atrial stimulation sites.

The use of retrograde atrial sequence and of functional bundle-branch block has been described in detail in recent publications (Coumel and Attuel, 1974; Spurrell *et al.*, 1974; Zipes *et al.*, 1974; Svenson *et al.*, 1974; Wellens and Durrer, 1974; Gallagher *et al.*, 1975; Neuss *et al.*, 1975; Tonkin

et al., 1975). The use of atrial stimulation at multiple sites has received less attention. Wellens *et al.* (1971) noted that left atrial pacing produced more pre-excitation than right atrial pacing in one patient with type A pre-excitation. Touboul *et al.* (1972) made similar observations in 2 patients with type A Wolff - Parkinson - White syndrome. Recently, Svenson *et al.* (1975) reported on the electrophysiological evaluation of 25 patients with Wolff-Parkinson-White syndrome and commented that the degree of ventricular pre-excitation was greatest and the stimulus-delta interval was shortest when atrial pacing was performed from the site at which earliest atrial activation was recorded during AV re-entrant tachycardia. However, the atrial sites tested and their stimulus-delta intervals were not reported.

The present study systematically presents multiple site data in 5 patients with the Wolff-Parkinson-White syndrome. In each of our cases, an atrial stimulation site with shortest stimulus-delta interval could be identified, as could a site with longest stimulus-delta. Several assumptions were made in evaluating our data. First, it was assumed that anomalous pathway conduction time was constant and independent of atrial stimulation during pre-excitation. Secondly, it was assumed that atrial conduction velocity was constant and independent of the site of atrial pacing. We did recognise that the anomalous pathway may respond in an all-or-none fashion depending upon the site of stimulation (Svenson *et al.*, 1975). Accepting these assumptions, differences in stimulus-delta intervals between different stimulation sites should reflect varying distances between atrial stimulation site and the atrial insertion of the anomalous pathway. The atrial pacing site with the shortest stimulus-delta interval should correspond to a location closest to the atrial insertion of the anomalous pathway. Conversely, the longest stimulus-delta interval should be obtained from the most distant atrial pacing site.

In the present study, the shortest observed stimulus-delta interval in each of the patients was between 60 and 80 ms. In all patients, the difference between shortest and longest stimulus-delta interval was always between 60 and 110 ms. The hypothesis that the site with shortest stimulus delta reflected the atrial insertion of the anomalous pathway appeared to be confirmed. In 3 of our patients, one each with right anterior, right posterior, and left lateral anomalous pathway locations, this confirmation was obtained by epicardial mapping and anomalous pathway surgery. In 2 of our patients, though epicardial maps were not obtained (surgery being avoided in these patients because of the results of pacing site studies), strong supportive

evidence for the predicted site of pre-excitation was obtained by use of retrograde activation data. The latter technique has been previously confirmed to be of value in predicting anomalous pathway location with epicardial mapping (Svenson *et al.*, 1974, 1975; Gallagher *et al.*, 1975). It should also be pointed out that multiple stimulation site studies allowed differentiation of the site of anomalous pathways in patients with similar electrocardiographic findings.

CLINICAL IMPLICATIONS

The present study suggests that atrial pacing at multiple stimulation sites provides useful information in the electrophysiological assessment of patients with Wolff-Parkinson-White syndrome who are being considered for pre-excitation surgery. The demonstration of a stimulation site with shortest stimulus-delta interval, particularly if that interval is less than 80 ms, is strong evidence for that site being close to the atrial insertion of the anomalous pathway. The simultaneous demonstration of maximum pre-excitation at a relatively slow-paced rate from the same site provides additional supportive evidence. However, if normal pathway time is rapid from the site of the short stimulus delta, then maximum pre-excitation might not be noted (Amat-y-Leon *et al.*, 1975).

The use of multiple pacing site data appears to be particularly useful in detecting patients with septal anomalous pathways. In this group of patients, electrocardiograms do not reveal pathognomonic findings of septal pre-excitation, but usually suggest either left or right posterior pre-excitation (Tonkin *et al.*, 1975). Studies of retrograde conduction in these patients (either with ventricular pacing, or during paroxysmal tachycardia) show early activation of the low septal right atrium (Svenson *et al.*, 1975). Previous studies have shown that the normal sequence of retrograde atrial activation in patients without pre-excitation is characterised by earliest activation of the low right atrial septum (Amat-y-Leon *et al.*, 1976). This is also true in patients with AV nodal re-entrant paroxysmal tachycardia, when examining the activation sequence of AV nodal re-entrant atrial echo beats (Amat-y-Leon *et al.*, 1976). On theoretical grounds, one would also expect a similar retrograde activation pattern from a retrogradely conducting James tract (atrionodal connection) or atriofascicular tract (Anderson *et al.*, 1975). Thus, demonstration of early retrograde activation of low septal right atrium would not be pathognomonic of septal pre-excitation. Demonstration of the shortest stimulus-delta interval with low right atrial septal pacing would provide strong evidence for the

presence of an anterogradely conducting septal anomalous pathway bypassing the AV node.

The present study thus indicates that atrial pacing at multiple sites is useful in the evaluation of patients with Wolff-Parkinson-White syndrome, and supplements the other methods used for prediction of site of pre-excitation. The use of atrial sites provides relatively direct information concerning the location of anterogradely conducting anomalous pathways.

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