Correlation between Localization of Accessory Conduction Pathway and Body Surface Maps in the Wolff-Parkinson-White Syndrome

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Body surface maps were recorded in 26 patients with Wolff-Parkinson-White syndrome, who underwent successful localization and interruption of the accessory conduction pathway. Five types of body surface maps were classified according to the location of the potential maximum and minimum in the delta wave. These 5 types were left free wall type, left posterior septal type, right posterior septal type, right anterior septal type and right free wall type. Each type correlated well with the location of the accessory pathway, which was determined intraoperatively through epicardial and/or endocardial maps or surgical interruption. The potential minimum zone at 40 msec after the onset of the delta wave appeared at limited areas on the body surface, and this zone was divided into 7 areas which correspond to the location of the accessory pathway.

In the surgical interruption of the W-P-W syndrome, the location of the accessory conduction pathway is decided by performing epicardial mapping. There are many useful methods to determine the location of accessory conduction pathways, i.e., ECG, UCG, electrophysiological study with catheter electrodes and body surface isopotential maps. Especially, body surface isopotential map is one non-invasive method helpful in diagnosing the location of the accessory conduction pathway and in reflecting the characteristic patterns of potential distribution in each stage of ventricular excitation. These non-invasive methods shorten the time of catheter electrode study and help the surgeon to choose the most appropriate access to the heart. This report deals with the location of the potential minimum and the maximum in body surface maps and the location of accessory conduction pathways decided by means of epicardial mapping.

METHODS

Body surface isopotential maps were recorded in 26 out of 31 patients who underwent surgical interruption of the WPW syndrome in our department from Dec. 1973 to Feb. 1980. These 26 patients consisted of 18 males and 8 females aged one year 6 months to 67 years. For the construction of body surface maps, 112 lead points were applied to the anterior and posterior chest walls. Employing Mingograph 82, the lead II and 5 unipolar lead ECGs were recorded together at one time with Wilson's central terminal as the reference point. Body surface isopotential maps were constructed at 20 msec, 40 msec, 80 msec and 120 msec after the onset of the delta wave in lead II (Figs. 1 and 2).

RESULTS

The patients exhibited a great variety of surface potential patterns. We considered that the potential minimum and maximum during the delta wave must be closely correlated with the location of the accessory conduction pathway.

Key Words: Wolff-Parkinson-White syndrome
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Fig.1. Positions of unipolar leads and procedure used for the construction of body surface isopotential maps.

Fig.2. Body surface isopotential map at 40 msec after the onset of the delta wave. Case 27 shows the left anterior wall type. The potential minimum (−) was located on the upper back and the maximum (+) was located on the anterior chest.

No 27 BSPM DURING THE DELTA WAVE (40MSEC)

(+)= Maximum, (−)= Minimum

Fig. 3. The left free wall type. The potential minimum was located on the back and the maximum was located on the anterior chest.

Fig. 5. The right anterior septal type. The potential minimum was located on the upper anterior chest wall and the maximum in the left axillary area. The minimum was located higher than the maximum.

Fig. 4. The left posterior septal type. The potential minimum was located on the right anterior axillary line and the maximum was located on the left anterior chest wall.

Fig. 6. The right posterior septal type. The potential minimum was located on the right anterior chest wall and the maximum in the left axillary area. The minimum was located at the same level or lower than the maximum.

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Five types were classified according to the location of the potential minimum and maximum at 40 msec after the onset of the delta wave. These types were the left free wall type, the left posterior septal type, the right anterior septal type, the right posterior septal type and the right free wall type.

1) Left Free Wall Type

Twelve patients were enclosed in this type. In all these patients, the potential minimum was located on the back and the maximum located on the left anterior chest or median line (Fig. 2). Comparing the location of the potential minimum to the location of the accessory pathway decided using epicardial mapping, we could see that when the minimum was in a position higher than the maximum, the accessory pathway was located on the left anterior wall or lateral wall and when the minimum was lower than the maximum, the accessory pathway located on the left posterior wall (Fig. 3).

In these patients, the ECG showed the characteristic feature of type A WPW syndrome except Case 14. Her ECG showed rS in precordial lead V1 and RS in lead V2. But under atrial pacing of 150/min, both leads V1 and V2 turned to the Rs pattern, so that this patient was considered to have type A WPW syndrome.

2) Left Posterior Septal Type

Only one patient belonged to this type. Forty msec after the onset of the delta wave, the potential minimum was located on the right anterior axillar line and the maximum on the left anterior chest wall (Fig. 4). During late QRS wave, the maximum still remained on the left anterior chest, and also the negative area remained on the back and upper abdominal area. This suggests early excitation of the posterior wall and delayed excitation of the right ventricular wall.

The initial force of the ECG in this patient
was positive in leads V₁ and V₂, so this patient was considered to have type A WPW syndrome.

3) Right Anterior Septal Type
   Also, only one patient belonged to this type. Forty msec after the onset of the delta wave, the potential minimum was located on the upper anterior chest wall and the maximum in the left axillary area (Fig. 5). The minimum was located higher than the maximum. The initial force of the ECG in this patient (Case 22) showed (-) in leads V₁, II, III and aVF. So this patient was considered to have type C W-P-W syndrome.

4) Right Posterior Septal Type
   Six patients belonged to this type. In this type, the potential minimum was located on the right anterior chest wall and the potential maximum in the left axillary area. Although the maximum was located in the same area, the minimum positioned lower than the right anterior septal type. The minimum was located at the same level or lower than the maximum (Fig. 6).

   Five ECGs of these 6 patients showed type C W-P-W syndrome and one patient (Case 6) showed type B W-P-W syndrome. Of these 6 patients, Case 6 had the accessory conduction pathway nearest to the right posterior wall (Fig. 6).

5) Right Free Wall Type
   Ten patients belonged to this type. Forty msec after the onset of the delta wave, the potential minimum was located on the right anterior chest wall or median line and the maximum on the left anterior chest wall (Fig. 7). Comparing the location of the accessory pathways diagnosed through epicardial mapping to the position of the potential minimum and maximum, we could see that when the minimum was located higher than the maximum, the accessory pathway was found in the anterior wall and when the minimum was located lower than the maximum, the accessory pathway was found on the right lateral or posterior wall. Of these 10 patients, the ECG showed type B WPW syndrome in 9 cases. In one case, the ECG exhibited type C WPW syndrome. In this patient (Case 18), the accessory pathway was located nearest to the right anterior septal wall (Fig. 7).

DISCUSSION
   Yamada et al.¹¹ and Taccardi et al.¹² have classified body surface maps in the WPW syndrome. Yamada classified body surface maps into 3 types (Types I, II and III) by analyzing the characteristic patterns of potential distribution at each stage of ventricular excitation. Using Ueda's¹⁰ ECG classification for the WPW syndrome, he recorded the ECG of type A WPW syndrome in Type I body surface maps, type C WPW syndrome

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in Type III maps and type B WPW syndrome in Type I or Type II maps.

Taccardi attempted to group body surface maps according to the location of the potential maximum and minimum during the delta wave\textsuperscript{12,13} He divided the patients into 6 types, and suggested the probable location of the accessory conduction pathway of each type.

Spach\textsuperscript{44} constructed body surface maps in the WPW syndrome experimentally mimicking stimulating 7 different ectopic sites in intact chimpanzees. His experimental results indicated the essential accuracy of the classifications of both Yamada and Taccardi.

Our classification was obtained from the position of the potential minimum and maximum 40 msec after the onset of the delta wave. It was confirmed with the location of accessory conduction pathways decided through epicardial or endocardial mapping and surgical interruption. So we considered this classification the most reasonable and accurate one.

We have some disagreement with Taccardi’s classification. In our experience with the left free wall type, the potential minimum has always been located on the back. This is in contrast to the experience of Taccardi who recorded type 4 (the potential minimum in the upper sternal area) and type 5 (the potential minimum in the left axillary region) of the left cardiac type. Our experience of the left anterior type (Cases 14 and 27) and the left lateral wall type (Cases 2, 8, 10, 21, 24 and 29) indicated the potential minimum on the back, and also Spach et al. recorded the minimum on the back in early QRS wave of the left anterior type. So it is interesting to know where the accessory conduction pathways are really located in types 4 and 5 of Taccardi’s classification.

From our experience, now, we can classify the left posterior septal type in the left cardiac type. This is the intermediate type between the left free wall type and the right posterior septal type. We agree with the right anterior wall type 3, but it seems better to suggest a accessory pathway in the right posterior or the right posterior septal wall in type 2.

Although we hope to pinpoint more accurately the location of the accessory pathway through body surface isopotential maps, the potential minimum could not be localized in that way. This is probably because 1) in our early cases, we decided the lead points of body surface maps case by case, 2) the lead intervals might be too wide\textsuperscript{15} and 3) the heart may rotate or locate differently case by case.

We considered that the potential minimum 40 msec after the onset of the delta wave must appear on the limited area of the body surface. This is because the early excitation area can be seen only along the atrioventricular groove. So we can suggest the potential minimum zone on the body surface. This zone starts from the anterior chest wall and continues to the left upper axillary area, then goes downward on the back and finally returns to the anterior chest passing the right lower axillary area (Figs. 8 and 9). Furthermore, like Fig. 9, it may be possible to divide this zone into several areas which correspond to the left anterior wall, left lateral wall, left posterior wall, left posterior septal wall, right anterior septal wall, right lateral wall and right posterior septal wall.

REFERENCES
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