JACC Vol. 10, No. 5
November 1987:1022–23

Editorial Comment

Has Clinical Application of Dipole Analysis Reached a Turning Point?*

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The 12 lead electrocardiogram (ECG) often fails to detect myocardial infarction in the presence of left bundle branch block (sensitivity 44%, specificity 43% and predictive value 50%) (1). The vectorcardiogram is more sensitive than the ECG (2–6) (sensitivity 89% and predictive value 62%), but its specificity is low (17%). Thallium scintigraphy has replaced both the ECG and the vectorcardiogram in diagnosing myocardial infarction in the presence of left bundle branch block. Recently, as more experience has accumulated in the evolving field of myocardial scanning, it has become apparent that patients with left bundle branch block may have a perfusion defect on thallium scintigraphy, even in the absence of coronary artery disease, thus indicating the need for improved diagnostic techniques.

Dipolarity and "residue" of the body surface potentials. The vectorcardiographic spatial current dipole has a fixed location (7), and it uses a limited number of recording electrodes. On the other hand, the single moving dipole uses many electrodes (up to several hundred) for mapping the body surface potential. Real progress has been made possible only by the introduction of recent advances in mathematical methods and computer application. Studies in animal preparations (8,9) and in humans (10–12) have demonstrated the usefulness of dipole analysis in diagnosing ischemic heart disease, conduction disturbances and cardiac arrhythmias (13). The study by Tsunakawa et al. (1) in this issue of the Journal contributes significantly to the detection and quantification of dipolar analysis of the body surface potentials in myocardial infarction in the presence of left bundle branch block. In short, the position and the moment of an equivalent dipole and the nondipolarity were calculated at intervals of 2 ms (14). The concept of "residue" introduced by this group was obtained from the average ratio of the nondipolar component to the measured body surface potentials. Sixteen patients with left bundle branch block were classified into two groups based on the presence (Group A) or absence (Group B) of a perfusion defect on thallium-201 scintigraphy. The maximal residue value of Group A during the initial QRS complex was significantly greater than that of Group B (40.9 ± 10.9% versus 23.4 ± 5.4%, $p < 0.01$).

Advantage of the method. The proposed technique has eliminated complicated and imprecise mathematical calculations currently used by several investigators (15). By eliminating sampling of the back of the torso, the method has been significantly simplified without interfering with the accuracy of the results. Another advantage of the technique is its use of 60 electrodes, thereby reducing artifacts to a minimum. The reduced number of electrodes seems to be technically adequate and could be used in future studies; we believe that it has a reasonable chance to be considered for standardization.

Confirmation of activation patterns in left bundle branch block and ischemic heart disease. The diagnosis of pure left bundle branch block is frequently unreliable by conventional methods because of its association with fascicular blocks mimicking or masking myocardial infarction (16). Significant diagnostic improvements have been obtained by designing appropriate body surface maps (17), but such techniques require elaborate and tedious studies. The simplified technique herein reported supports the concept that relates early left ventricular activation in left bundle branch block first to intramyocardial activation, and only later to engagement of the specialized system (18). Hence, ventricular depolarization is more dipolar in patients with left bundle branch block than in subjects with normal conduction.

It is also fair to assume that the nondipolar component (residue) becomes larger because, whenever the excitation front reaches an infarcted area, the electric dipole moment fails to develop. More nondipolarity is found in patients with a thallium perfusion defect (Group A) than in patients with normal perfusion (Group B). This could be easily explained by the irregular fronts of activation in myocardial infarction. One may also postulate that the maximal residue value occurring in Group A at approximately 22 ms from the onset of the QRS complex is related to the localization of the perfusion defect on the anterior wall and septum—precisely where activation occurs during the initial stage of the QRS complex.

Limitations. Assessment of the nondipolar fraction (residue) is most useful in evaluating depolarization and of lesser value in studying repolarization. There was no significant difference in the mean residue value during the T wave in all three groups (infarction [A], noninfarction [B], and nor-

*Editorials published in *Journal of the American College of Cardiology* reflect the views of the authors and do not necessarily represent the views of JACC or the American College of Cardiology.

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0735-1097/87/$3.50

mal subjects). The ST segment has not been evaluated because of apparent lack of reliability caused by variations in the magnitude of the segment. Previous studies (19), however, have stressed the significance of the ST segment by identifying the dipole loci compatible with the anatomic position of the infarcted area. Other limitations relate to the imperfection of the basic standard of comparison—thallium-201 myocardial scintigraphy—and to the older age of the patients studied. More perfusion defects unrelated to ischemic heart disease could be expected to be present in the older age group. The usefulness of the method should be improved by introducing better standards of comparison and by including younger patients in future studies.

Conclusions. Clearly, continual reassessment, simplification and other technical improvements in dipolar analysis will result in its wider employment—not only in the specialized hospital-based department (20), but also in cardiac ambulatory stations. The encouraging results reported by others and the significant contribution made by Tsunakawa et al. (1) appear to support acceptance of the dipole analysis as a valuable, noninvasive clinical technique.

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