Usefulness of three additional electrocardiographic chest leads (V_7, V_8 and V_9) in the diagnosis of acute myocardial infarction

LIBARDO J. MELENDEZ,* MD, FRCP[C], FACC; DAVID T. JONES,* MD, FRCP[C]; JUAN R. SALCEDO,† MD

Additional electrocardiographic chest leads (V_7, V_8 and V_9) were used in 117 persons consecutively admitted to a coronary care unit. Among the 46 (39%) with a proven acute myocardial infarction the electrocardiograms (ECGs) of 9 (20%) showed ST-segment elevation or abnormal Q-waves, or both, in the three additional leads. In six of the nine, such changes were associated with signs of anterolateral or inferior wall infarction (in three each) on the standard 12-lead ECG, but in the other three (7% of the 46) electrocardiographic changes diagnostic of acute myocardial infarction were found only on the additional chest leads; the last three had characteristic changes in serum enzyme concentrations.

This study showed that additional chest leads are helpful in detecting myocardial injury or necrosis in areas of the heart not properly reflected on the standard 12-lead ECG.

Des dérivations électrocardiographiques thoraciques additionnelles (V_7, V_8 et V_9) ont été utilisées chez 117 personnes hospitalisées consécutivement dans une unité de soins coronariens. Parmi les 46 (39%) ayant un infarctus aigu du myocarde reconnu les électrocardiogrammes (ECG) de 9 (20%) ont montré une élévation du segment ST ou des ondes Q anormales, ou les deux, dans les trois dérivations additionnelles. Chez six des neuf ces changements ont été associés à des signes d'infarctus antérolatéral ou d'infarctus de la paroi inférieure (dans trois cas chacun) sur l'ECG standard à 12 dérivations, mais dans les trois autres (7% des 46) les changements électrocardiographiques de l'infarctus aigu du myocarde n'ont été retrouvés que sur les dérivations thoraciques additionnelles; les trois derniers présentaient les changements caractéristiques des concentrations enzymatiques du sérum.

Cette étude a démontré que des dérivations thoraciques additionnelles sont utiles pour détecter une lésion ou une nécrose myocardique survenant dans des régions du coeur qui ne sont pas bien représentées sur l'ECG standard à 12 dérivations.

From the department of medicine, Victoria Hospital, London, Ont.

*Assistant professor of medicine, University of Western Ontario
†Cardiology resident, University of Western Ontario graduate program

Reprint requests to: Dr. Libardo J. Melendez, Victoria Hospital, 391 South St., London, Ont. N6A 4G5

The introduction of the unipolar lead concept by Wilson, Johnston and Rosenbaum[1] and its application in classic electrocardiography with six precordial leads[1,2] proved to be major steps in the development of clinical electrocardiography.[3] Although the concept has been disputed over the years, the practical use of unipolar lead recordings at various sites on the body surface has gained wide acceptability. More recently this concept has been applied in precordial mapping techniques that attempt quantification of myocardial injury or necrosis.[4,5]

Experience has shown that each of the six classic chest leads (V_1 to V_6) provides useful information for detecting and localizing myocardial injury or necrosis affecting the interventricular septum or the anterolateral wall of the heart, or both. On the basis of the postulates that underlie the use of these leads, one may speculate whether recordings from chest leads in positions V_7, V_8 and V_9 might not yield diagnostic information in patients suspected of having an acute myocardial infarction, particularly if the affected area was the far lateral portion of the left ventricle (Fig. 1). The purpose of the study described below was to determine the usefulness of these additional leads as part of the routine electrocardiographic examination of patients admitted to a coronary care unit.

Methods

Included in this study were 117 persons admitted consecutively to the coronary care unit of Victoria Hospital, London, Ont. A 15-lead electrocardiogram (ECG) was obtained, either in the emergency room or at the time of arrival at the coronary care unit. For the three additional leads the electrode was placed over the posterior axillary line (V_7), over the midscapular line (V_8) and half-

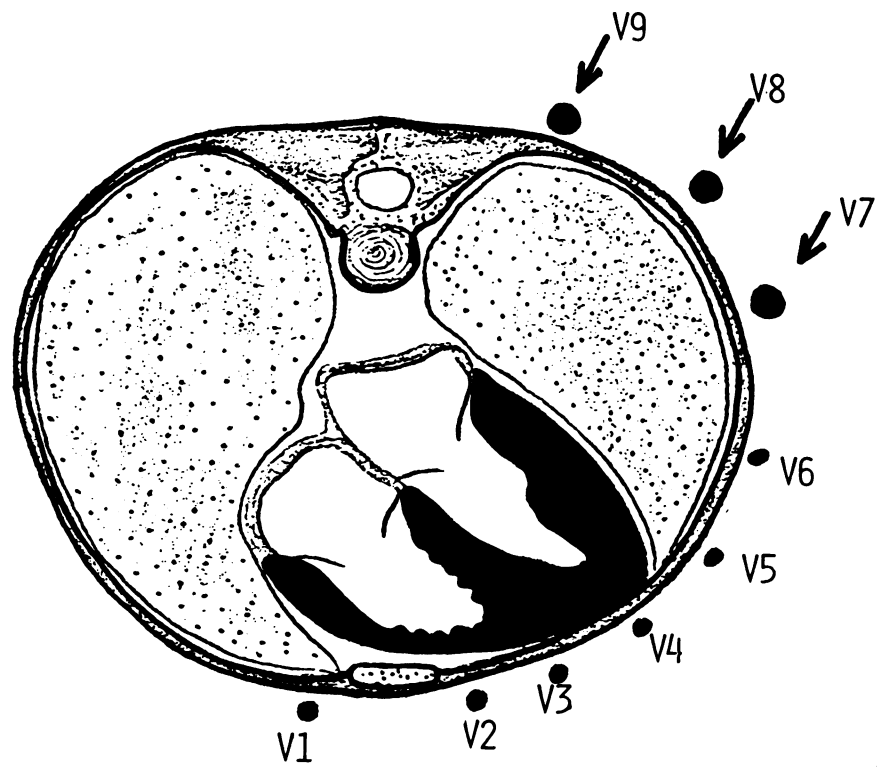

FIG. 1—Cross-sectional view of thorax showing relation of electrocardiographic chest leads to heart.

way between the midscapular line and the spine (V_9), all at the same level as V_6. Skin markings for the electrode locations of all nine precordial leads were made at the time the first ECG was done to ensure that the same position was used for subsequent recordings. In a few instances double standardization (2 cm = 1 mV) was used for recording the additional chest leads, but in no instances were voltage criteria considered for diagnostic purposes. A similar ECG was made daily for 3 consecutive days, and concentrations of serum enzymes (serum glutamic oxaloacetic transaminase [SGOT], lactate dehydrogenase [LDH], LDH_1 and creatine phosphokinase [CPK]) were determined daily for 3 days.

A diagnosis of myocardial infarction was established on the basis of a suggestive history (severe anterior chest pain lasting longer than half an hour) plus a typical 12-lead ECG (with an evolving current of injury pattern or the development of abnormal Q-waves) or characteristic changes in serum enzyme concentrations (rise and fall in the concentrations of SGOT, LDH or CPK for which no other cause was evident) or both.[6] Electrocardiographic localization of myocardial injury or infarction was established according to the leads that showed characteristic changes, as follows: V_1 to V_3, anteroseptal; V_4 to V_6, anterolateral; and II, III and aVF, inferior.

Twenty individuals (mean age 51 years) without evidence of heart disease were studied by means of a similar 15-lead ECG so that the normal morphology for leads V_7, V_8 and V_9 could be defined.

Observations

None of the ECGs in the 20 healthy individuals showed Q-waves lasting at least 40 ms on the additional chest leads. The T-wave was upright in V_7 in all the ECGs, flat in V_8 in one individual and flat in V_9 in three individuals. Inversion of the T-wave was never seen in the additional chest leads.

Among the 117 persons admitted to the coronary care unit acute myocardial infarction was eventually diagnosed with the use of the above-mentioned criteria in 46 (39%). The diagnosis was established from the history plus a typical 12-lead ECG or characteristic changes in serum enzyme concentrations, or both, in 36 (78%) of the 46; from the history plus characteristic changes in serum enzyme concentrations with a nonspecific ECG in 7 (15%); and from the history plus typical acute and evolving electrocardiographic changes without diagnostic changes in serum enzyme concentrations in 3 (7%).

When leads V_7, V_8 and V_9 were analysed, a current of injury pattern, ST-segment elevation or the development of Q-waves lasting at least 40 ms, or a combination of these features, was found in nine persons. In six individuals these changes were associated with signs of acute myocardial infarction (anterolateral in three and of the inferior wall in the other three) in the standard 12-lead ECG, but in three individuals they were the only definite electrocardiographic evidence of myocardial injury or necrosis. In Fig. 2 is the 15-lead ECG of a person with a typical history and serum enzyme changes diagnostic of acute myocardial infarction, in whom only the chest leads V_7, V_8 and V_9 show electrocardiographic changes characteristic of acute injury or infarction. Prominent R-waves in leads V_1 to V_3 were not seen in the ECGs of the three individuals in whom changes of myocardial infarction were noted in the additional chest leads as well as in the standard 12 leads in association with acute (two patients) or old (one patient) anteroseptal infarction. In one patient with diagnostic changes in the additional chest leads but no evidence of acute or old anteroseptal infarction in the standard 12-lead ECG the R-waves were prominent in leads V_1 and V_2 (Fig. 3), a change that has been considered highly suggestive of "true posterior" or "dorsal" wall infarction.[7]

Discussion

These observations suggested the following conclusions:

1. The QRS-ST-T pattern of leads V_7, V_8 and V_9 in healthy individuals is qualitatively similar to that of leads V_5 and V_6 (Q-waves lasting less than 40 ms, isoelectric ST-segments and upright T-waves).
2. Persons with diagnostic changes

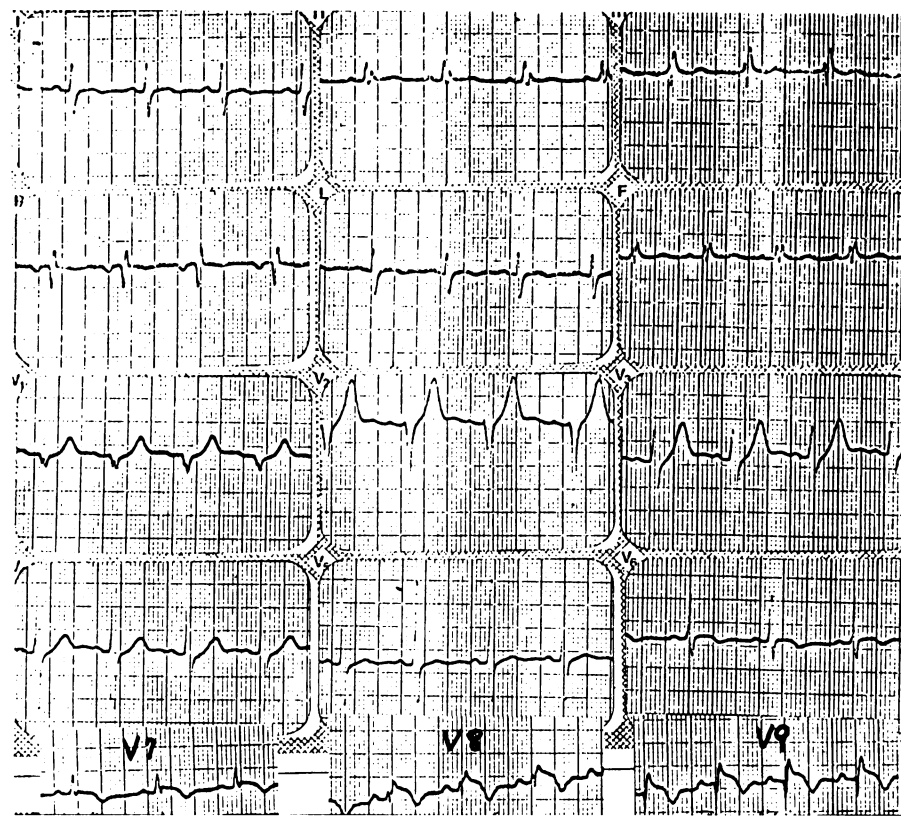

FIG. 2—Evidence of old anteroseptal infarction in 12-lead electrocardiogram. While V_6 pattern suggests myocardial ischemia, clearer injury pattern is seen in leads V_8 and V_9. Serial changes in serum enzyme concentrations were characteristic of acute myocardial infarction.

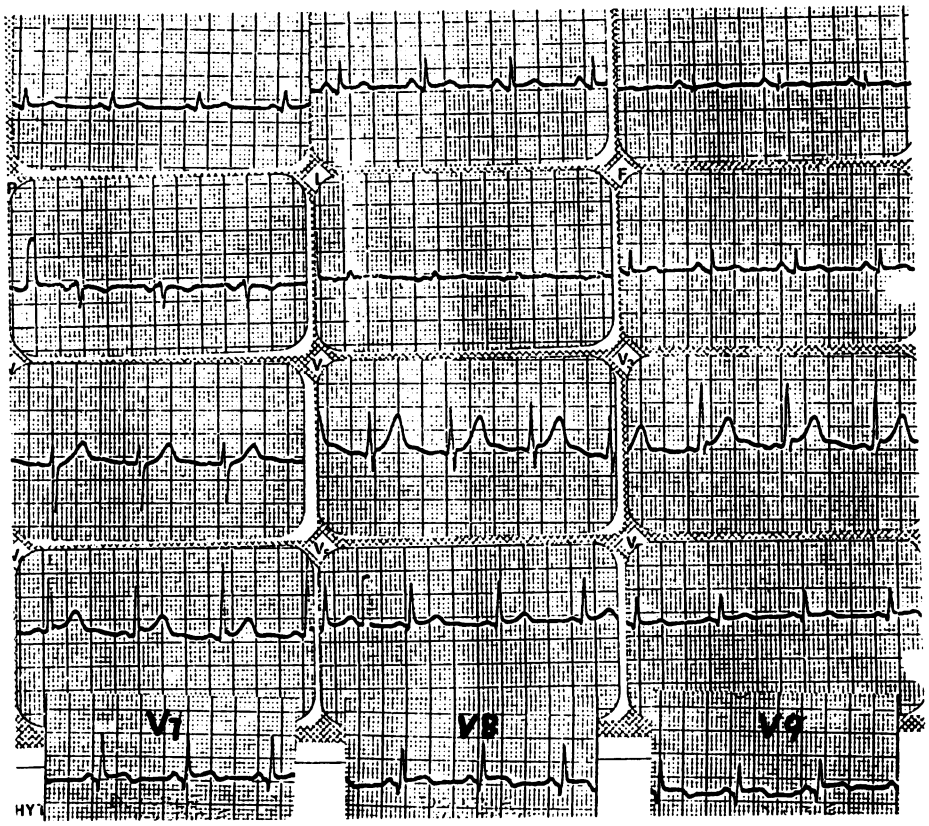

FIG. 3—Abnormal Q-waves and ST-segment elevation in leads V_7, V_8 and V_9, and conspicuous R-waves in leads V_2 and V_3. Patient presented with severe retrosternal chest pain, and serial determinations of serum enzyme concentrations showed changes characteristic of acute myocardial infarction.

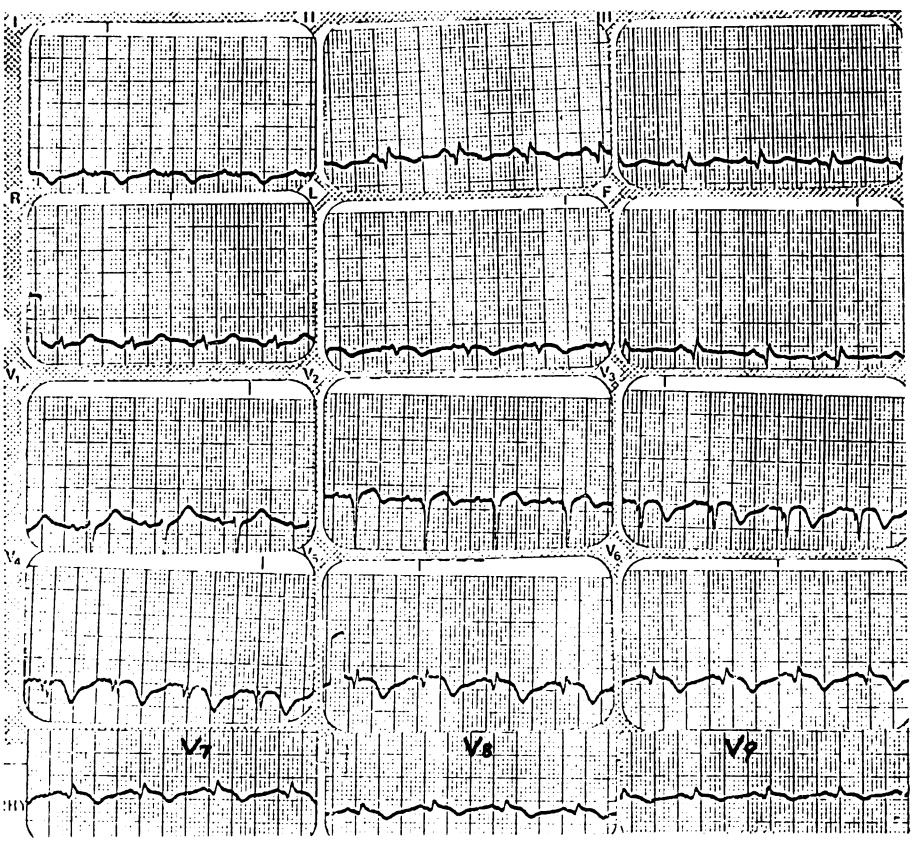

FIG. 4—Extensive acute myocardial infarction. True posterior wall involvement is suggested by appearance of leads V_7, V_8 and V_9. Simultaneous occurrence of anteroseptal infarction may abolish the prominent R-waves in leads V_1 and V_2, which are usually associated with true posterior wall necrosis.

of acute myocardial infarction in the 12-lead ECG may or may not show similar changes in leads V_7, V_8 and V_9. As a corollary, the presence of changes of myocardial injury or infarction in leads V_7, V_8 and V_9 may suggest a larger area of involvement than the classic 12-lead ECG appears to indicate.

3. In some patients with acute myocardial infarction diagnosed from a typical history and characteristic changes in serum enzyme concentrations who have a normal 12-lead ECG, changes indicative of myocardial injury or necrosis may be found in the additional chest leads. The fact that in three of our patients with acute myocardial infarction the only diagnostic electrocardiographic changes were seen in the additional chest leads appears to indicate that these leads reflect areas of the heart that are not properly explored by any of the standard 12 leads.

For leads V_7, V_8 and V_9 the electrodes seem to face the far lateral portion of the left ventricular wall, which is very likely the portion that has been referred to as the true posterior or dorsal wall of the heart. This suggestion is supported by the observation of the development of changes of acute infarction in leads V_7, V_8 and V_9 in a person whose ECG developed prominent R-waves in leads V_1 and V_2 (Fig. 3), a change that has been considered highly suggestive of infarction of the true posterior wall of the heart.[7] However, the failure of R-waves to become prominent in lead V_1 or V_2 in the presence of infarction of the dorsal wall of the heart may be expected when anteriorly directed vectors are abolished because of the previous or simultaneous occurrence of an anteroseptal infarction, as is illustrated in Fig. 4; the features of this ECG suggest that the patient's extensive involvement included the far lateral or dorsal wall of the heart, but that the old anteroseptal wall damage prevented the development of prominent R-waves in leads V_1 and V_2.

At the time of this study we did not have facilities for recording from orthogonal lead systems. Although such systems may reflect these changes in a simpler form, they are not yet available in many hospitals. We have shown that recording from three additional chest leads, V_7, V_8 and V_9, which can be done with little

additional expenditure or effort, is helpful for electrocardiographic disclosure of myocardial injury or necrosis involving portions of the myocardium that may not be clearly reflected on the routine 12-lead ECG. These additional chest leads may show changes of injury or necrosis associated with infarction of the anterolateral or inferior wall, perhaps reflecting a greater extension of damage, or may, in about 7% of all cases of infarction, reveal the only electrocardiographic abnormality indicative of myocardial injury or necrosis.

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