

Electrocardiographic Limb Leads Placement and Its Clinical Implication: Two Cases of Electrocardiographic Illustrations

Robert T. Tung, M.D., FACC

Department of Veterans Affairs, Eastern Kansas HealthCare System, Cardiology Section, Topeka, KS

Received March 14, 2021; Accepted for publication May 3, 2021; Published online Sept. 1, 2021
<https://doi.org/10.17161/kjm.voll4i5259>

INTRODUCTION

Since its introduction, the electrocardiography (ECG) has become the most commonly performed cardiac diagnostic procedure and a fundamental tool of clinical practice.^{1,2} It is indispensable for the diagnosis and prompt treatment of patients with acute coronary syndromes and is an accurate, noninvasive tool for diagnosing cardiac conduction disturbances and arrhythmias. Proper, standard ECG leads placement is essential in providing accurate information from the recordings. Modified limb leads placement on the torso has the important advantages of ease and speed of application, particularly in emergent situations and has become commonplace. However, modified limb placement was reported to have unwanted abnormal ECG findings.³ Clinically significant abnormal ECG findings due to this modified, non-standard limb placement are illustrated by two cases.

CASE REPORT

ECG Illustration 1. A 74-year-old patient with known severe ischemic cardiomyopathy was admitted for congestive heart failure and atrial fibrillation with type 2 myocardial ischemia. The initial 12-lead ECG (Figure 1A) was obtained with limb leads placed on the torso position and reported as “ST elevation and possible acute inferior wall myocardial infarction (MI)”. Repeat ECG with limb leads placed in standard, distal limb positions showed resolution of “ST elevation” in the inferior leads (Figure 1B).

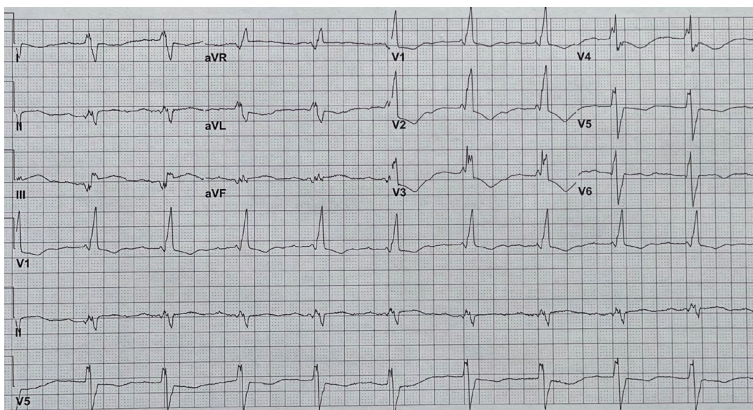


Figure 1A. ECG Illustration 1 with torso limb leads placement showed ST elevation in leads III, mimicking acute MI.

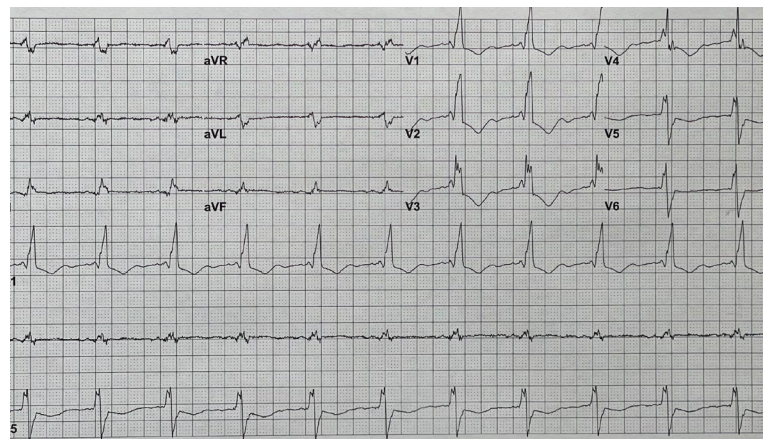


Figure 1B. ECG Illustration 1 with standard limb leads placement showed no ST elevation in lead III.

ECG Illustration 2. This ECG (Figure 2A) with torso limb leads placement was obtained in a 76-year-old patient which showed the presence of a Q wave in lead aVL suggestive of an old lateral wall MI. When the limb leads were moved from torso position to standard distal limb positions, a repeat ECG (Figure 2B) showed resolution of Q waves in lead aVL.

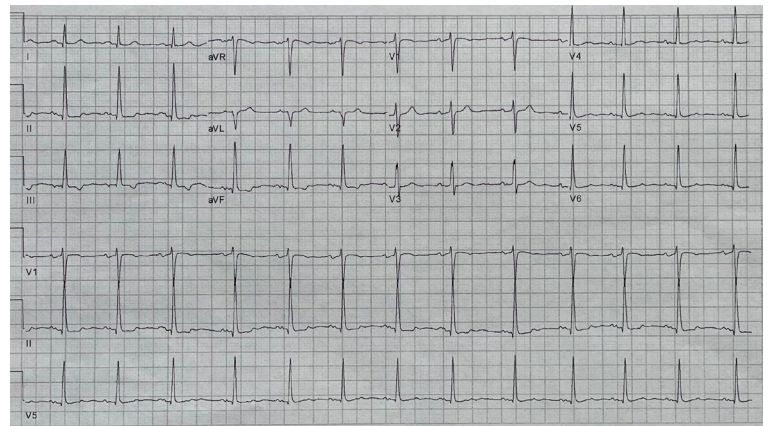


Figure 2A. ECG Illustration 2 with torso limb leads placement showed Q waves in lead aVL, suggestive of prior lateral MI.

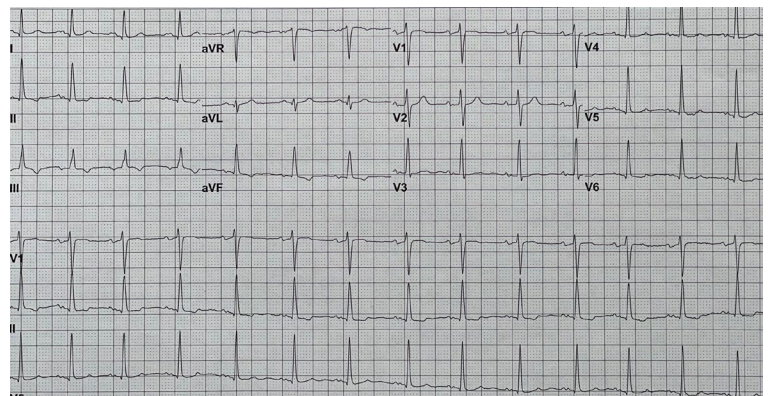


Figure 2B. ECG Illustration 2 with standard limb leads placement showed normal QRS morphology in lead aVL.

DISCUSSION

Because of its broad applicability, the accurate recording and precise interpretation of the ECG is critical. The establishment of, and adherence to, professionally developed and endorsed evidence-based standards for all phases of the ECG procedure is an important step in ensuring the high level of precision required and expected by clinicians and their patients.^{4,5} The standard 12-lead ECG consists of three limb leads (leads I, II, and III), three augmented limb leads (leads aVR, aVL, and aVF), and six precordial leads (V1 through V6).⁴

Historically, limb lead electrodes have been attached at the wrists and the ankles with the patient in the supine position. For routine 12-lead recording, the American Heart Association (AHA) statement of 1975 recommended placement of the four limb lead electrodes on the arms and legs distal to the shoulder and hips,⁴ and not necessarily on the wrists and ankles. Different placement of lead electrodes on the limbs can alter the ECG.⁶ Clinically, recording of the ECG from the upper arm rather than from the wrist to reduce motion artifact has become popular and is facilitated by the development of disposable tab electrodes. However, it affects ECG voltages and durations, most importantly in the limb leads.

Noise from motion of the arms and legs during ambulatory and exercise ECG can be reduced by placement of the limb leads on the torso position. This is described as the Mason-Likar lead position, in which the arm electrodes are placed in the infraclavicular fossae medial to the deltoid insertions and the left leg electrode is placed midway between the costal margin and iliac crest in the left anterior axillary line.⁷ Torso limb leads placement sometimes is used to reduce motion artifact during recording in infants. This modified lead placement may affect QRS morphology more than repolarization compared with standard ECG, including false-negative and false-positive infarct criteria.^{3,6,8}

The torso limb leads placement is a very common practice. This non-standard modification has the important advantages of ease and speed of application, especially in an emergency. The limb movement artifact also is reduced. This application was promoted by ECG manufacturers with diagram of such limb lead positions posted on their ECG machines (Figure 3). Present ECG illustrations showed that clinically significant ECG findings could be observed with the modified leads placement. Such abnormalities could lead to unnecessary investigations, procedures, and worries for the patients. Thus, ECGs recorded with torso placement of the extremity electrodes cannot be considered equivalent to standard ECG for all purposes and should not be used interchangeably with standard ECGs for serial comparison, according to guideline recommendations,^{4,5} with exception for situations that torso limb lead placement may be appropriate. In the latter situation, these ECGs should be marked with “torso limb leads position” to alert the clinician to its limitations and repeat ECG with standard lead position is warranted for confirmation when abnormal findings are encountered.

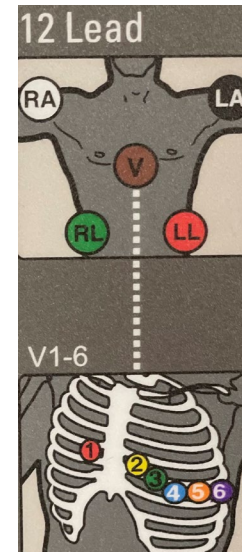


Figure 3. Diagram of ECG leads placement posted on a commercial ECG machine.

CONCLUSIONS

In summary, the ECG is the most widely used cardiac diagnostic tool in the clinical practice. Standard lead electrode placement according to guideline recommendations⁵ should be observed closely to avoid abnormal findings which might lead to further, unnecessary testing, or procedures and worries for patients. All ECG with torso limb lead placement during exercise testing, urgent acquisition, or in other appropriate situations should be marked as such to alert clinician of its limitation. When abnormal findings are encountered, ECG with standard lead placement should be repeated for confirmation.

REFERENCES

- 1 Kligfield P. The centennial of the Einthoven electrocardiogram. *J Electrocardiol* 2002; 35 (Suppl):123-129. PMID: 12539109.
- 2 Fye WB. A history of the origin, evolution, and impact of electrocardiography. *Am J Cardiol* 1994; 73(13):937-949. PMID: 8184849.
- 3 Pipberger HV, Arzbaecher RC, Berson AS, et al. Recommendations for standardization of leads and of specifications for instruments in electrocardiography and vectorcardiography: Report of the Committee on Electrocardiography. *Circulation* 1975; 52:11-31.
- 4 Jowett NI, Turner AM, Cole A, Jones PA. Modified electrode placement must be recorded when performing 12-lead electrocardiogram. *Postgrad Med J* 2005; 81(952):122-125. PMID: 15701746.
- 5 Kligfield P, Gettes LS, Bailey JJ, et al. Recommendations for the standardization and interpretation of the electrocardiogram: Part I: The electrocardiogram and its technology – A scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society. *J Am Coll Cardiol* 2007; 49(10):1109-1127. PMID: 17349896.
- 6 Pahlm O, Haisty WK, Edenbrandt L, et al. Evaluation of changes in standard electrocardiographic QRS waveforms recorded from activity-compatible proximal limb lead positions. *Am J Cardiol* 1992; 69(3):253-257. PMID: 1731468.
- 7 Mason RE, Likar I. A new system of multiple-lead exercise electrocardiography. *Am Heart J* 1966; 71(2):196-205. PMID: 5902099.
- 8 Sevilla DC, Dohrmann ML, Somelofski CA, Wawrzynski RP, Wagner NB, Wagner GS. Invalidation of the resting electrocardiogram obtained via exercise electrode sites as a standard 12-lead recording. *Am J Cardiol* 1989; 63(1):35-39. PMID: 2909158.

Keywords: ECG, myocardial infarction, cardiac electrophysiologic technique