**Lead aVR – The Neglected Lead**

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**Abstract**

The aVR is often neglected lead. It is an unipolar lead facing the right superior surface. As all the depolarisations are going away from lead aVR, all waves are negative in aVR (P, QRS, T) in normal sinus rhythm. In dextrocardia, the p is upright in aVR. The lead aVR is a very important lead in localisation of Coronary Artery Disease. In the presence of anterior ST elevation, ST elevation in lead aVR and V1 denotes proximal LAD obstruction where ST elevation is more in lead V1, than in aVR. In the presence of anterior ST depression, ST elevation in lead aVR indicates Left Main Coronary Artery (LMCA) Disease where ST elevation is more in aVR than in V1. In wide QRS tachycardia, tall R wave in aVR indicates Ventricular Tachycardia rather than SVT with aberrancy. In the presence of QS complexes in inferior leads, the lead aVR helps to differentiate between inferior wall MI (IWMi) and left anterior fascicular block (LAFB). Initial R in aVR is suggestive of IWMi and terminal R is suggestive of LAFB. In pericarditis, lead aVR is most often the only lead which shows reciprocal ST depression where as in Acute Infarction, usually a group of leads shows reciprocal depression. In the presence of persistent ST elevation in anterior chest leads, the R in aVR is suggestive of left ventricular aneurysm (Goldburger’s sign). In acute pulmonary embolism, ST elevation in lead aVR is a bad prognostic sign. In Tricyclic antidepressant toxicity, R in aVR more than 3 mm is an adverse prognostic sign. So in variety of conditions, the aVR is proved to be a valuable lead not only in diagnosis but also in predicting the prognosis.

**Introduction**

Lead aVR, one of the 12 electrocardiographic leads, is frequently ignored in clinical medicine. In fact, many clinicians refer to the 12-lead electrocardiogram (ECG) as the 11-lead ECG, noting the commonly held belief that lead aVR rarely offers clinically useful information. The augmented limb leads were developed to derive more localised information than the bipolar leads I, II and III could offer. For this purpose from the existing limb electrodes, new leads aVR, aVF and aVL were constructed, being unipolar leads looking at the right, left and lower part of the heart with the reference electrode constructed from the other limb electrodes. Thus, the purpose of lead aVR was to obtain specific information from the right upper side of the heart, such as the outflow tract of the right ventricle and the basal part of the septum. In practice, however, most electro cardiographers consider lead aVR as giving reciprocal information from the left lateral side, being already covered by the leads aVL, II, V5 and V6. This has been the reason that lead aVR has become largely ignored. Moreover as all the depolarisations are going away from this lead, all waves are negative (P, QRS,T)in this lead (Figure 1).

**Electrocardiographic Significance of aVR**

1. **Coronary Artery Disease**

   a. **Localising the level of obstruction in Acute Coronary Syndrome (ACS)**: Lead aVR can be very useful in identifying Left Main Coronary Artery (LMCA) obstruction. Ischaemia of the basal part of the interventricular septum is the electrocardiographic explanation for the occurrence of ST-segment elevation in this lead. In this situation, owing to the dominance of the basal ventricular mass, the ST-segment vector in the frontal plane points in a superior direction, leading to ST-segment elevation in leads aVR and ST depression in the inferior leads (Figure 2). Lead aVR also helps in differentiating between LMCA and proximal Left Anterior Descending artery (LAD) disease. ST elevation in aVR more than in V1 is suggestive of LMCA disease and vice versa is suggestive of proximal LAD disease (Figure 3). In distal occlusion of the LAD, not involving the proximal septal area, no ST-elevation but rather depression in lead aVR is observed (Figure 4).

   b. **Atrial infarction**: In the presence of acute Inferior wall MI PR segment elevation in inferior leads and PR segment
d. **Left Anterior Fascicular Block (LAFB) and Inferior Wall MI (IWMI)**: When there is predominantly negative QRS in inferior leads, the dilemma is whether it is inferior MI or LAFB. If lead aVR shows initial 'r' it is inferior MI; if there is a terminal 'r' in lead aVR it is LAFB (Figures 7, 8).

### 2. Arrhythmias

Identification of the presence, configuration of the P wave and its relation to QRS is of particular importance in the diagnosis of tachycardias.

a. **Ventricular Tachycardia (VT)**: A dissociated negative P-wave in lead aVR is especially useful in the wide QRS tachycardia in diagnosing a ventricular origin of the arrhythmia. In VT there is a tall R in lead aVR (due to caudo cranial activation) – which is not usually seen in Supra Ventricular Tachycardia (SVT) with aberrancy (Figure 9).

b. **Supraventricular Tachycardia (SVT)**: During SVT lead aVR is helpful in determining the site of origin of the tachycardia or the tachycardia pathway. Any SVT with atrial activation in a caudo cranial direction, such as AV nodal tachycardia (AVRT), left atrial tachycardia or a circus movement tachycardia using a (para) septally located accessory pathway for ventriculo-atrial activation will typically show positive P waves in lead aVR.

c. **Pre-excitation syndrome-related narrow complex tachycardia**: In a report, Ho et al reported that ST-segment elevation in lead aVR assists in the ultimate identification of the mechanism of these narrow QRS complex tachycardias, including atroventricular nodal reentrant tachycardia (AVNRT, ie, typical paroxysmal supraventricular tachycardia), AVRT (i.e. WPW-related narrow complex tachycardia), and atrial tachycardia (AT). Atrioventricular reciprocating tachycardia (WPW-related tachycardia) was differentiated from AVNRT and AT with a sensitivity of 71% and a specificity of 70%—ST-segment elevation in lead aVR was found to be strongly suggestive of WPW-related narrow complex tachycardia (Figure 10).

d. **Left Atrial tachycardia and rhythm**: During Atrial tachycardias and ectopic atrial rhythm, a positive ‘p’
4. Tricyclic antidepressant ingestion
Early electrocardiographic findings in tricyclic overdose include sinus tachycardia, QRS complex widening greater than 100 milliseconds, right axis deviation, and characteristic R-wave changes in lead aVR.14 The R wave changes in lead aVR that are indicative of tricyclic poisoning include an increased amplitude of the terminal R wave and an increased R wave to S wave ratio.15 QTc prolongation in this condition is primarily due to QRS widening. Progressive QRS widening identifies high risk patients for Torsade de Pointes.

5. Mal positions and Technical Errors
a. Dextrocardia: Dextrocardia is a type of cardiac malposition in which the major axis of the heart (base to apex axis) points to the right. Hence, the P wave and QRS complex in lead aVR would be positive and there is non progression of ‘R’ from V1 to V6 on left side and progression r waves in right sided chest leads (Figure 13).

b. Dextroversion or shifting of Mediastinum: In dextroversion or in shifting of mediastinum the heart is pushed to the right with the chambers in their normal positions (LV on the left and RV on the right). Here lead aVR shows negative ‘p’ and negative QRS with non progression of R from V1 to V6.

c. Technical Dextrocardia: When the limb placement is wrong (right arm - left arm lead reversal) it can cause technical dextrocardia in the ECG. Lead aVR will show positive ‘P’ and positive QRS but there will be normal progression of R from V1 to V6 (Figure 14).

6. Tension Pneumothorax
The electrocardiographic changes are more common in left pneumothorax, with or without tension, including a right QRS axis deviation, low QRS voltage, reduced precordial R-wave voltage, and anterior T-wave inversion.17 Marked PR-segment elevation in inferior leads and reciprocal PR-segment depression in lead aVR had been reported
7. Acute pulmonary embolism

Although most patients with pulmonary embolism present with only sinus tachycardia or normal finding, it is well known that acute pulmonary embolism may give rise to certain electrocardiographic changes, including arrhythmias, alteration in conduction, a shift in axis of the QRS complex, and changes in morphology of the P wave, QRS complex, ST segment, and T wave as well as the “classical” SIQ3T3 electrocardiographic pattern. Acute right ventricular overload could also manifest as ST-segment elevation in lead aVR and terminal r wave (Figure 15).

Predictive Value of STE in aVR

In the context of widespread ST depression + symptoms of myocardial ischaemia:

- STE in aVR ≥ 1mm indicates proximal LAD / LMCA occlusion or severe 3VD
- STE in aVR ≥ 1mm predicts the need for CABG
- STE in aVR ≥ V1 differentiates LMCA from proximal LAD occlusion
- Absence of ST elevation in aVR almost entirely excludes a significant LMCA lesion

In the context of anterior STEMI:
• STE in aVR ≥ 1mm is highly specific for LAD occlusion proximal to the first septal branch

In patients undergoing exercise stress testing:
• STE of ≥ 1mm in aVR during exercise stress testing predicts LMCA or ostial LAD stenosis

Magnitude of ST elevation in aVR is correlated with mortality in patients with acute coronary syndromes:
• STE in aVR ≥ 0.5 mm was associated with a 4-fold increase in mortality
• STE in aVR ≥ 1mm was associated with a 6- to 7-fold increase in mortality
• STE in aVR ≥ 1.5 mm has been associated with mortalities ranging from 20-75%

Conclusion
Since its entering in the late 19th century, the ECG has emerged into a clinical tool provides valuable diagnostic information in many situation which help the physician not only in diagnosis but also to plan appropriate management in acute and chronic situations. Many physicians are turned to look at routine things, but suitable changes in the most neglected aVR gives a crucial information in many situation which otherwise are not evident in the routine leads. So, in addition to routine evaluation of ECG, one should pay a careful attention to lead aVR which provides essential diagnostic and prognostic information in not only cardiac situation but also in many non cardiac situation.

References