HEALTHY HEART

VOLUME-10 | ISSUE-114 | MAY 05, 2019

Honorary Editor :
Dr. Vineet Sankhla

Lead aVR, 1 of 12 electrocardiographic leads, is frequently ignored in clinical medicine. It is also called as an “orphan” lead. 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 present article discusses instances with pictorial examples in which lead aVR provides valuable clinical information and makes a case for close attention being paid to this ‘forgotten lead’.

AVR - THE FORGOTTEN LEAD

information about the right ventricle outflow tract and basal part of the septum. It follows that all normally upright deflections on the ECG will, under normal circumstances, be negative in this lead. This makes aVR a valuable lead, which is discussed below.

AVR - THE FORGOTTEN LEAD

Lead aVR, 1 of 12 electrocardiographic leads, is frequently ignored in clinical medicine. It is also called as an “orphan” lead. 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. Lead aVR is the augmented unipolar right arm lead and may be considered as looking into the cavity of the heart from the right shoulder. It can provide specific

CLINICAL UTILITY OF AVR

AXIS DETERMINATION

Traditionally, the limb lead with the tallest R wave has been used to determine the electrical axis of the heart. Another method to determine the electrical axis of the heart involves seeking the lead with the deepest negative deflection or S wave. If aVR were noted to have the deepest S wave, it follows that the electrical axis should be directly opposite the hexiaxial reference system, ie, +30°

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ACUTE CORONARY SYNDROME

In Acute MI, the ECG is a useful tool to predict the likely LAD occlusion site. ST segment elevation in aVR strongly predicted LAD occlusion proximal to the first septal perforator. aVR ST segment elevation greater than the ST segment elevation in V1 (along with widespread ST depression > 6 leads) predicts LMCA occlusion with a sensitivity of 81% and a specificity of 80% **(Fig 1)** ST segment elevation that is greater in lead aVR than in lead V1 prompted early

(Fig 1)

Angiography, withholding of P2Y12 inhibitors and early referral to CABG, resulting in improved clinical outcomes. In patients with NSTEMI, ST segment elevation of 0.5 mm or greater in aVR was a useful predictor of LMCA or three-vessel coronary artery disease (sensitivity 78%, specifi- city 86%) **(Fig 2)**.

Also, aVR ST segment elevation was the strongest predictor of adverse events and higher rates of in-hospital death, recurrent ischemia and heart failure.

STRESS TESTING

Lead aVR is valuable in stress testing because it represents electrical forces oriented toward the cavity of the heart. It has been shown that exercise-induced ST depression in V5 and concomitant ST elevation in aVR may detect significant left anterior descending coronary artery stenosis in patients with single-vessel disease. Another study of more than 100 patients showed that exercise-induced ST segment elevation in lead aVR was useful in predicting LMCA disease (sensitivity 92.9%, specificity 48.6%). ST segment elevation in lead aVR during exercise testing was found to be more strongly correlated with positive tests such as nuclear imaging and coronary angiography, compared with right precordial lead changes. ST segment elevation in lead aVR is associated with a reversible defect in the anterior LAD territory regardless of the presence of ST segment depression in other leads.

Fig 2: ECG of a 71-year-old woman presenting with chest pain. Angiogram revealed high-grade stenosis of the distal LMCA involving the take-offs of the LAD and LCx. Note the ST elevation in aVR and the diffuse ST depressions

ACUTE PERICARDITIS

The ECG is frequently abnormal in cases of pericarditis, with diffuse ST segment elevations and PR segment depressions in most leads. Reciprocal ST segment depression and PR segment elevation ('knuckle' sign) in lead aVR are characteristic and help in supporting a diagnosis of acute pericarditis (ST-PR discordance) **(Fig 3)**

Fig 3: 12-lead ECG with ST-segment elevation in leads V1 to V6 and leads II, III, and aVF. Also note the PR-segment depression in leads II, III, and aVF as well as leads V4 to V6. A review of lead aVR reveals easily seen PR-segment elevation, a finding strongly suggestive of acute pericarditis.

ACUTE PULMONARY EMBOLISM

Acute PE distorts right heart hemodynamics and gives rise to a variety of ECG findings including the classic S1Q3T3 pattern (S wave in lead I, Q wave in lead III and T wave inversion in lead III). ST segment elevation in aVR is believed to be due to acute right ventricular overload, transient hypoxia from impaired coronary flow or increased myocardial oxygen demand **(Fig 4)**

Fig4: ECG of a 54-year-old woman presenting with an acute pulmonary embolus. Note the 'SIQ3T3' pattern. Additional findings include atrial fibrillation, right axis deviation, incomplete right bundle branch block, and ST elevation in aVR and V1

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ARRHYTHMIAS

The morphology of the P wave in lead aVR can be used to differentiate atrial tachyarrhythmias. A positive P wave in aVR during tachycardia favours atrioventricular nodal re-entry tachycardia **(Figure 5).**

A negative P wave in aVR suggests a focal right atrial tachycardia **(Figure 6).**

ST segment elevation in aVR during narrow QRS complex tachycardia suggests atrioventricular re-entry through an accessory pathway as the mechanism of the tachycardia. The morphology of the R wave in lead aVR has been used to risk-stratify patients with Brugada syndrome (BS). In patients with BS, a prominent R wave in lead aVR – also known as the 'aVR sign' – portends a greater risk for arrhythmic events

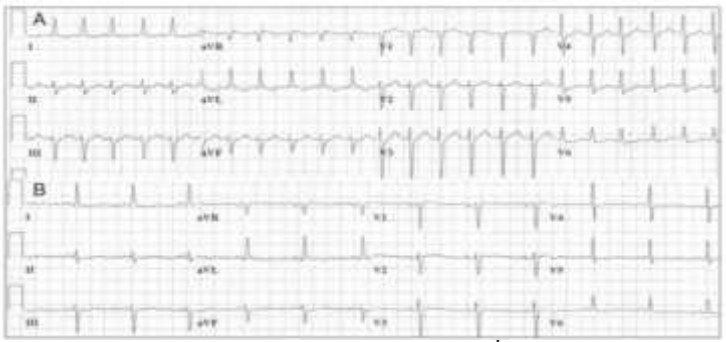


Fig 5: Electrocardiograms from a patient during atrioventricular nodal reentry tachycardia (AVNRT) (a) and while in sinus rhythm (b). Note the positive P wave in aVR at the end of the QRS complex during AVNRT that is not present while in sinus rhythm

Fig 6: Electrocardiogram showing atrial tachycardia with 2:1 conduction. Note the negative P waves in aVR

Fig 7: ECG of a 46-year-old man with multiple syncopal episodes who was found on electrophysiological testing to have indu- cible ventricular fibrillation. Note the Brugada pattern in V1 and V2, and the 'aVR sign' (prominent R wave) in aVR

(Figure 7)

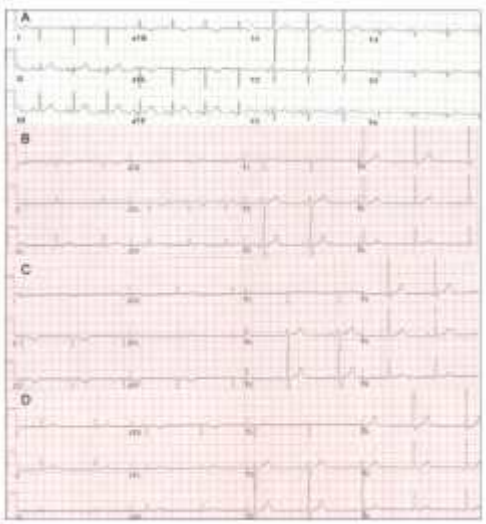
TRICYCLIC ANTIDEPRESSANTS (TCA) POISONING

Overdose of TCA is a leading cause of death in the USA. QRS duration is the cardiac parameter mostly followed in cases of TCA overdose, because it has been shown that a QRS duration of 100 ms or greater is predictive of seizures and arrhythmia. The amplitude of the terminal R wave (3 mm or greater) in aVR and the ratio of the R wave to the S wave in aVR are better predictors of seizures and arrhythmias in these patients, than QRS interval **(Figure 8)**

Fig 8: Electrocardiogram from a 39-year-old woman with a tricyclic antidepressant overdose. Note the sinus tachycardia, the QRS wid- ening, the corrected QT prolongation and the 'terminal R wave' (R wave 3 mm or greater) in aVR

DEXTROCARDIA AND LEAD REVERSAL

With dextrocardia, the heart is situated in the right chest due to a primary reversal of the primitive cardiac loop. Here, the P wave, QRS complex and T wave are all directed inferiorly and to the right, and the ECG has an appearance of the arm leads being reversed. In both



dextrocardia and lead reversal due to incorrect lead placement, the P wave and QRS complex are upright in lead aVR. In case of lead reversal, the precordial pattern (V1 to V6) is normal **(Figures 9A, B and C)**. With dextrocardia **(Figure 9D),** the QRS voltage gradually diminishes

from V1 through V6 as the leads are placed further left away from the heart in the right chest.

TENSION PNEUMOTHORAX

The postulated causes for ECG changes associated with tension pneumothorax include displacement of the heart, rotation of the heart, acute right ventricular dilation and air in the thoracic cavity. PR segment elevation in inferior ECG leads and PR segment depression in lead aVR have been reported in left-sided pneumothorax.

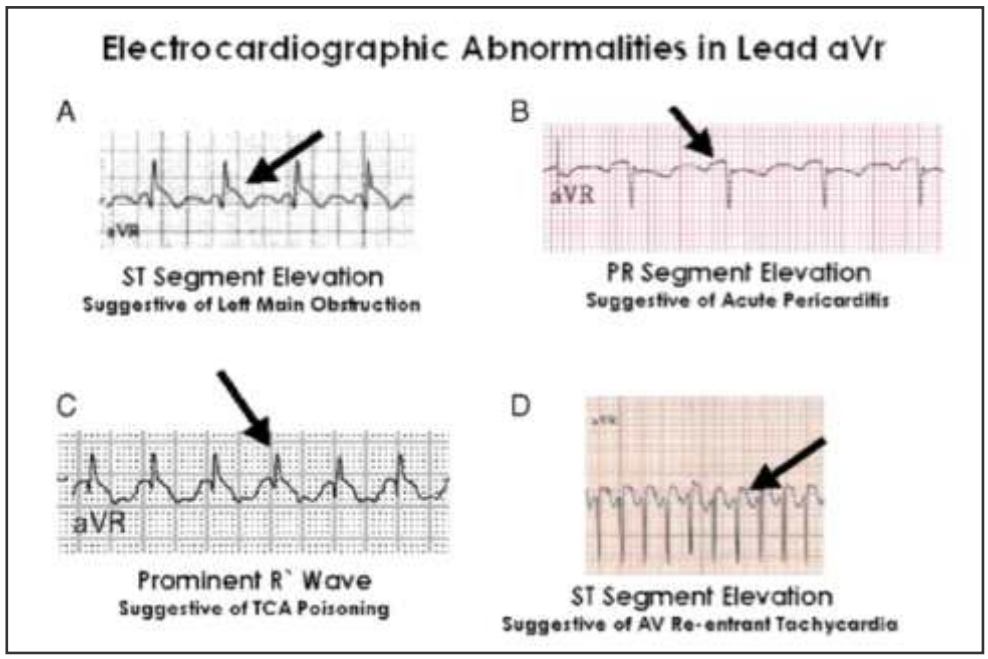
TAKOSUBO SYNDROME

Stress-induced cardiomyopathy, also known as takotsubo or apical ballooning syndrome, has been reported to result in transient ST segment elevation in lead aVR, along with ST segment elevation in leads I, II, III, aVF and V2 to V6. Reversible diffuse impairment of coronary microcirculation leading to transient global myocardial ischemia, possibly due to a catecholamine surge, is generally accepted as the mechanism producing this acute MI picture

CONDUCTION ABNORMALITIES

A new and improved ECG criteria for the diagnosis of LAHB using criteria based on the fact that the peak of the terminal R wave in lead aVR occurs later than the peak of the terminal R wave in lead aVL, compared with using frontal plane QRS axis criteria **(Figure 10).**

Fig 10: Demonstrating a left anterior fascicular block. Note, the terminal R wave in aVR occurs later than in aVL



CONCLUSION

Lead aVR has multiple clinical applications and is a useful tool for interpreting ECGs. However, it is often overlooked, even by experienced ECG readers. Careful attention to this lead during evaluation of the ECG can aid in the diagnosis of acute LMCA or proximal LAD occlusion, affecting timing and type of therapy, and predicting prognosis in patients with acute myocardial infarction. Noting changes in aVR can aid in the diagnosis in clinical scenarios, including pulmonary embolism, TCA overdose, dextrocardia and lead reversal. Clinical training curriculums need to impart the importance of systematic evaluation of all leads while interpreting the ECG. aVR – the forgotten lead can be a useful tool in the diagnosis and prognosis of many clinical syndromes.

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Printed, Published and Edited by Dr. Keyur Parikh on behalf of the CIMS Hospital
Printed at Hari Om Printery, 15/1, Nagori Estate, Opp. E.S.I. Dispensary, Dudheshwar Road, Ahmedabad-380004.
Published from CIMS Hospital, Nr. Shukan Mall, Off Science City Road, Sola, Ahmedabad-380060.