JACC: CASE REPORTS VOL. 2, NO. 8, 2020

EDITORIAL COMMENT

Recognition of Anterior STEMI in Dextrocardia and the Importance of Right-Sided Chest Leads*

Jason Lee Winter, AEMT, DipECG

Dextrocardia situs inversus is a rare congenital condition in which the apex of the heart is located on the right side of the body (Figure 1). There are 2 main types of dextrocardia: dextrocardia of embryonic arrest (also known as isolated dextrocardia) and dextrocardia situs inversus, "which presents in approximately 1 per 10,000 individuals" (1).

NORMAL FINDINGS IN DEXTROCARDIA WITH LEFT-SIDED ELECTROCARDIOGRAPHY

The normal findings in dextrocardia with left-sided electrocardiography (ECG) include the following (Figure 2).

- Global negativity in lead I (a negative P-wave, QRS complex, and T-wave)
- Positively deflected QRS complex in aVR
- Negative P-wave in lead II
- Reverse R-wave progression in pre-cordial leads
- Right-axis deviation

LA/RA LEAD REVERSAL VERSUS DEXTROCARDIA

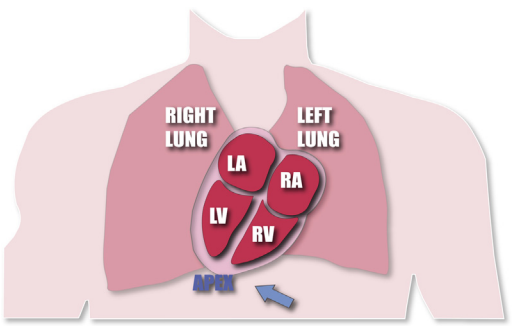
ECG is a useful diagnostic tool. However, errors in placement of ECG leads can create artifacts and mimic pathologies. One telltale sign is that, when there is P-QRS-T inversion in lead I, it is important to first check for LA/RA reversal, which is a common mistake; this is often referred to as *technical dextrocardia* and is far more common than seeing a patient with dextrocardia.

With reversal of the LA/RA electrodes in a patient without dextrocardia, what findings would be apparent on the ECG (Figure 3)? Einthoven's triangle flips 180° horizontally around an axis formed by lead aVF. This has the following effects on the ECG.

- Lead I becomes inverted.
- aVR and aVL are reversed.
- Leads II and III switch places.

Dextrocardia can be ruled out as a diagnosis by also noting normal R-wave progression in the pre-cordial leads, even in the context of an arm reversal. As dextrocardia will typically present with poor R-wave

FIGURE 1 The Anatomical Position of the Heart in Dextrocardia



Effects on the electrocardiogram from the accidental swapping of LA and RA electrodes. LA = left atrium; LV = left ventricle; RA = right atrium; RV = right ventricle.

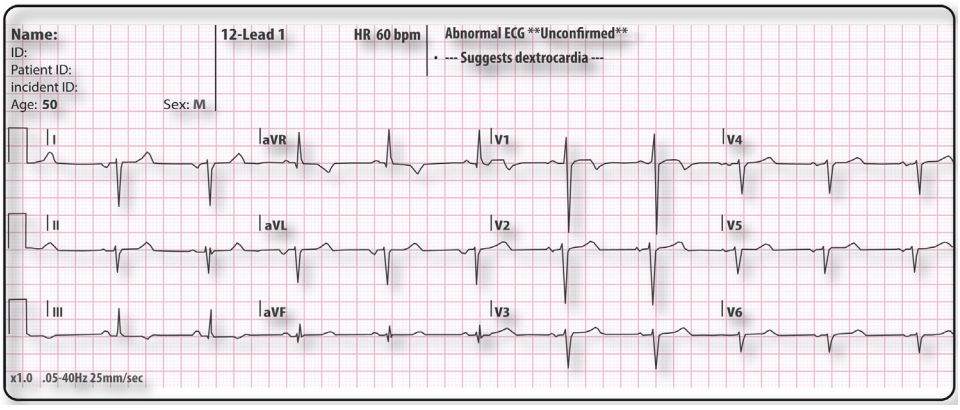
*Editorials published in *JACC: Case Reports* reflect the views of the authors and do not necessarily represent the views of *JACC: Case Reports* or the American College of Cardiology.

From the Yorkshire Ambulance Service National Health Service Trust, Wakefield, United Kingdom. Mr. Winter has reported that he has no relationships relevant to the contents of this paper to disclose.

The author attests they are in compliance with human studies committees and animal welfare regulations of the author's institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the *JACC: Case Reports* author instructions page.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2020.06.009

FIGURE 2 Left-Sided ECG of a 50-Year-Old Man With Dextrocardia Situs Inversus



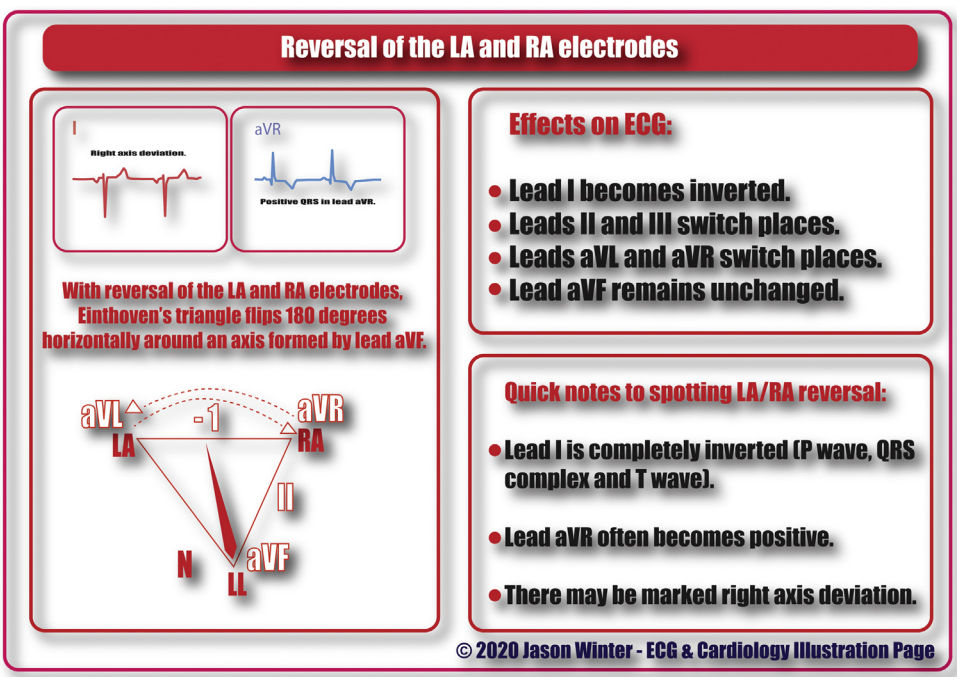
ECG shows normal findings in dextrocardia with the classic findings of right-axis deviation, aVR shows a positive QRS (with upright P-wave). Lead I shows inversion of the P-wave and negative QRS. In the precordial leads, we see absent R-wave progression (dominant S waves throughout), often with smaller-amplitude complexes in the left-sided chest leads (V_4 to V_6). bpm = beats/min; ECG = electrocardiography; HR = heart rate; ID = identification.

progression in the pre-cordial leads, because ventricular depolarization occurs in the opposite direction (2).

By thinking in the other way, a diagnosis of dextrocardia can be easily missed in the context of this common technical error (Figure 4).

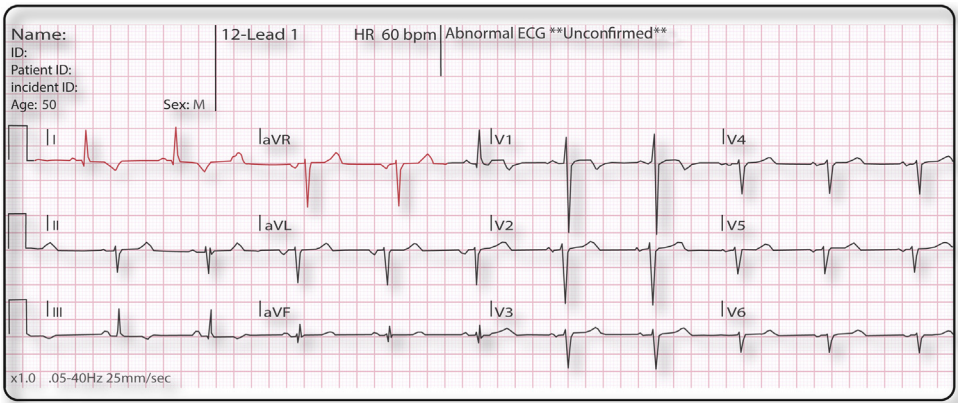
We should also be able to interpret normal findings on the ECG in a patient with situs inversus dextrocardia. Dextrocardia can be easily detected in a standard 12-lead ECG. An alerting sign is a P and QRS inversion in lead I. If you encounter this, first check your limb leads to assess proper limb lead placement.

FIGURE 3 Effects on the ECG From the Accidental Swapping of LA and RA Electrodes



Abbreviations as in Figures 1 and 2.

FIGURE 4 A Technical Error Switching LA/RA, Causing a Negative aVR



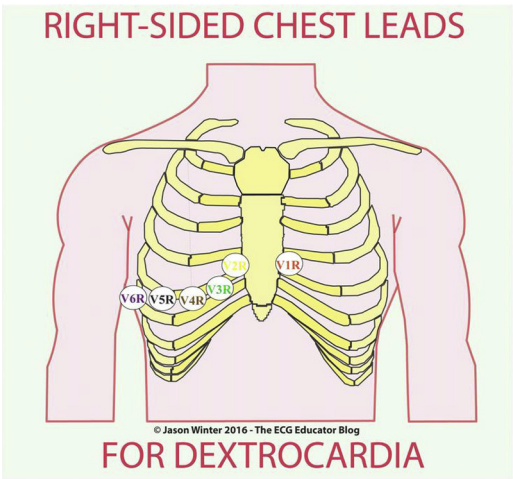
This error may lead to missing the diagnosis of a dextrocardia. With careful examination, other findings will help with reaching the correct diagnosis, including the poor R-wave progression at the chest leads and the switched II/III limb leads, which indicates the dextrocardia hidden by the switched leads. Abbreviations as in Figures 1 and 2.

Remember that aVR is generally negative, referring to Einthoven's equilateral triangle. aVR may be positive in patients with a heart on the right side of their chest (dextrocardia/dextroposition).

DEXTROCARDIA AND ACUTE ANTERIOR MYOCARDIAL INFARCTION

Dextrocardia imposes a great challenge in diagnosing acute myocardial infarction (MI) on ECG. Both limb and pre-cordial leads should be reversed to reveal all ECG changes, showing the extent of MI in patients with dextrocardia, which may be underestimated or even undiagnosed unless dextrocardia can be recognized in a timely manner and the chest leads reversed, along with accurate recording of a right-sided ECG (Figure 5).

FIGURE 5 Correct Precordial Lead Positioning on a Patient With Dextrocardia



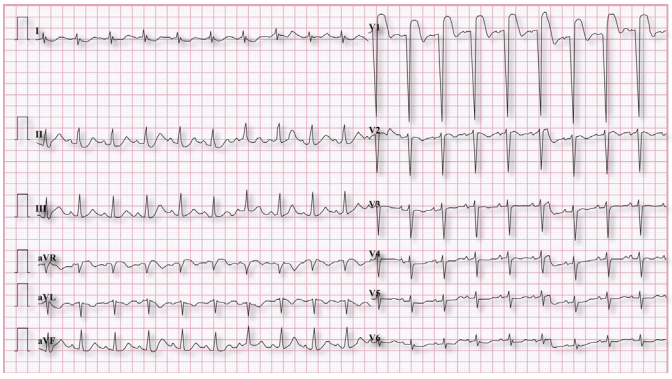
Right-sided electrocardiograms are not just for right ventricular wall myocardial infarctions.

ST-segment elevation myocardial infarction in a patient with dextrocardia is an extremely rare finding, with <100 cases ever reported worldwide. An acute MI is a potentially life-threatening diagnosis that should not be missed on ECG interpretation. It is recommended that both chest and limb leads be reversed in patients with known or suspected dextrocardia and situs inversus presenting with chest pain, specifically to rule out MI.

If the ECG interpreter fails to recognize dextrocardia on the ECG, he/she may feel no incentive to record a right-sided ECG, especially if, for example, an obvious acute inferior MI is not identified. Therefore, one telltale sign that appears in the ECG in the case of anterior MI is ST-segment elevation in V_1 only. This alone should suggest the need for a right-sided ECG. Importantly, a misplaced V_1 lead on recording a left-sided ECG, "which is common especially with a chest deformity" would cause undiagnosed anterior MI in patients with dextrocardia; however, ST-segment elevation can be noted in aVR, also often seen in case reports in patients with dextrocardia having acute anterior MI (Figures 6 and 7) (3).

In dextrocardia, reversal of the arm leads results in a normal P-wave and QRS axis in the limb leads in addition to reorientation of the chest leads into the right side (annotated as V_1R-V_6R); this results in a

FIGURE 6 Left-Sided Electrocardiogram of Dextrocardia Patient



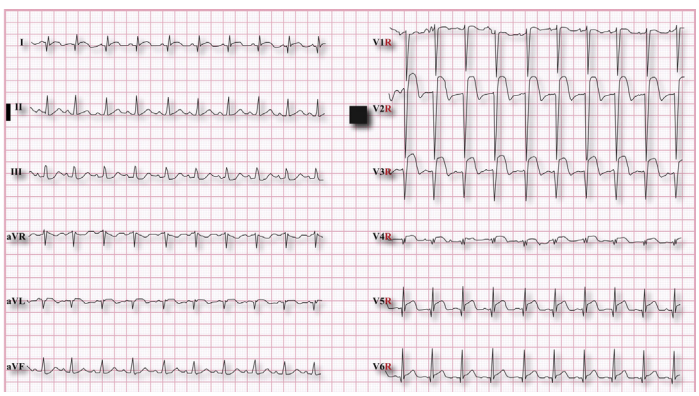
A left-sided electrocardiogram shows one lead ST-segment elevation only at V1, mimicking a right ventricle infarction. Reprinted with permission from Rathore et al. (3).

typical pattern of septal depolarization and R-wave progression on the 12-lead ECG (4).

The case report by Celik et al. (5) represents what has been discussed previously, and the positive point is that the diagnosis of extensive anterior MI was not missed or confused with just anteroseptal infarction. Their diagnosis of the patient having dextrocardia led to a right-sided ECG, which led them to uncover this extensive anterior MI (**Figures 8** and **9**), which now is correctly labeled V_1R through V_6R; it is important that any reversal of leads be clearly identified on the ECG itself. Additionally, one important fact with the right-sided ECG is that both limb and all chest leads, V_1R through V_6R, were reversed, not unlike what is commonly done to reverse just V_3R through V_6R; this shows clearly septal depolarization and normal R-wave progression.

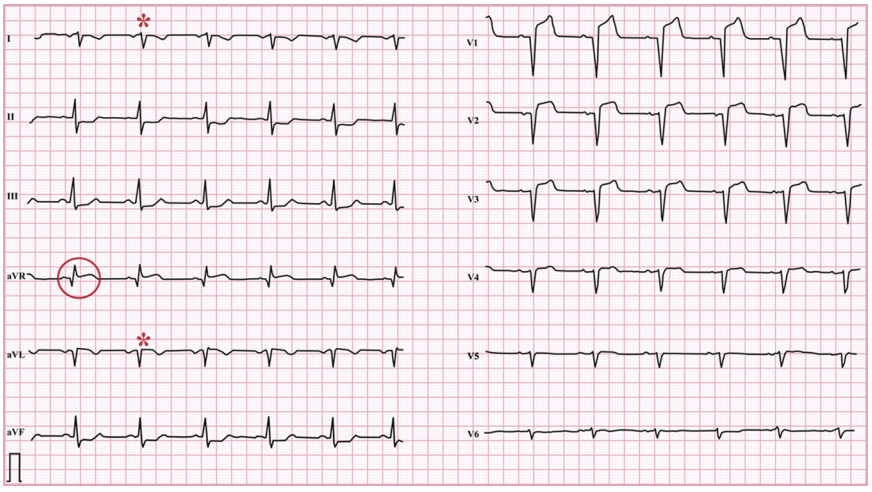
ADDRESS FOR CORRESPONDENCE: Mr. Jason Lee Winter, Yorkshire Ambulance Service NHS Trust, Trust Headquarters, Brindley Way, Wakefield 41 Business Park, Wakefield WF2 0XQ, United Kingdom. E-mail: ECG.Educator@gmail.com.

FIGURE 7 Right-Sided Electrocardiogram of Dextrocardia Patient



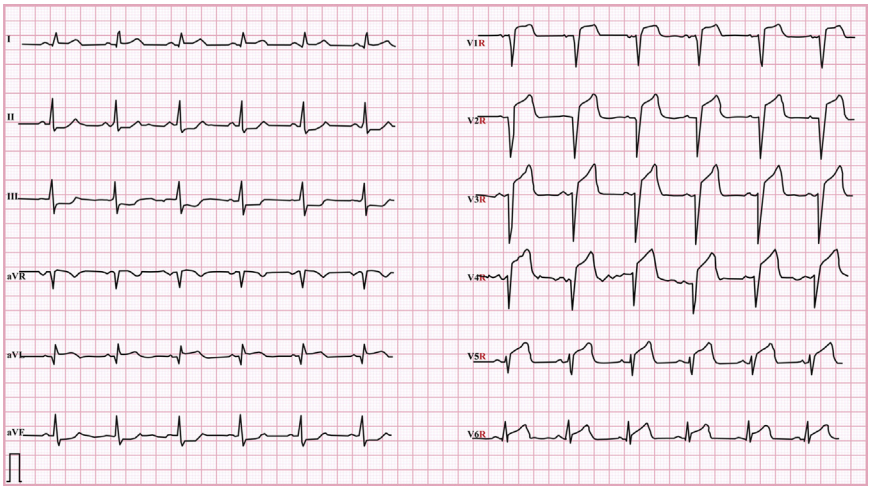
A right-sided electrocardiogram of the same patient, showing an extensive anterior myocardial infarction instead. Reprinted with permission from Rathore et al. (3).

FIGURE 8 **A Left-Sided Electrocardiogram Showing ST-Segment Elevation in a Patient With Dextrocardia**



The standard 12-lead electrocardiogram showing typical features of dextrocardia characterized by a reversal of polarity in leads I and aVL, QS and rS patterns in the precordial leads, and positive polarity in aVR **(red circle and red asterisks)**. ST-segment elevation was seen in leads aVR and V_1 through V_4, and ST-segment depression was detected in the inferior leads.

FIGURE 9 **A Right-Sided Electrocardiogram Showing Extensive Anterior MI in the Same Patient**



REFERENCES

1. Abbott ME, Meakins JC. On the differentiation of two forms of congenital dextrocardia. Bull Int Assoc Med Museums 1915;(5):134–8.

2. Rosen AV, Koppikar S, Shaw C, Baranchuk A. Common ECG lead placement errors. Part II: precordial misplacements. Int J Med Students 2014;2:99–100.

3. Rathore A, Gowda Somashekar CM, Sadananda KS, Manjunath CN. Acute myocardial infarction in dextrocardia: a diagnostic and therapeutic challenge. Can dextrocardia be a risk factor? J Cardiol Cases 2017;17:48–51.

4. Neki NS, Shergill GS, Singh A, Kaur S, Tyagi P, Singh T. ECG in dextrocardia. World J Pharm Med Res 2017;3:219–20.

5. Celik AI, Karaaslan MB, Ikikardes MF, Meral F, Cahliyan CE. Acute anterior myocardial infarction in a patient with dextrocardia and situs inversus: an unusual coexistence. J Am Coll Cardiol Case Rep 2020;2:1220–1.

KEY WORDS anterior myocardial infarction, dextrocardia, situs inversus, ST-segment elevation