Unusual QRS Pattern in the Early Precordial Leads

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An asymptomatic, middle-aged man is found to have a QR pattern in lead V1 and a qR pattern in lead V2 of his ECG obtained during routine life insurance applicant screening. The risk assessment implication of this ECG finding is reviewed.

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HYPOTHETICAL CASE SCENARIO

A 40-year-old man is applying for a moderately large whole life insurance policy. The applicant has an engineering degree and an MBA. He works in his family's plumbing business where he is responsible for the financial side of the operation. The applicant is healthy and asymptomatic. Past health includes an episode of infectious mononucleosis while attending high school and a Colles' fracture as a result of a skiing accident. There is no family history of heart disease. His blood pressure is normal, and he takes no medications.

As part of the application process, he had an electrocardiogram (ECG), which was required for age and amount. The ECG was recorded by a paramed company (Figure).

ECG FINDINGS

Normal sinus rhythm is present with an average ventricular rate of 72 beats per minute. P waves are inverted in leads V1 and V2. The PR, QRS and QTc intervals are normal. There is left axis deviation with a mean QRS axis in the frontal plane of approximately −25 degrees. QRS voltage is normal. A QR pattern is present in lead V1, and a qR pattern is present in lead V2 accompanied by T wave inversion in both leads.

ECG INTERPRETATION

The major finding in the applicant's ECG is the presence of a QR/qR patterns in leads V1 and V2. This will be the focus in this ECG case study.

The finding of QR/qR complexes in leads V1 and V2 of an ECG raises several possibilities including: septal infarction, atypical right bundle branch block, Wolff-Parkinson-White syndrome, Brugada syndrome and chronic obstructive pulmonary disease. The insurance application context and lack of clinical findings would seem to rule out septal infarction and chronic obstructive pulmonary disease. The lack of additional diagnostic ECG features argues against right bundle branch block, Wolff-Parkinson-White syndrome and Brugada syndrome.

The unexpected finding of QR or qR complexes in leads V1 and V2 in an asymptomatic life insurance applicant should also raise the possibility of a technical error. In this case,
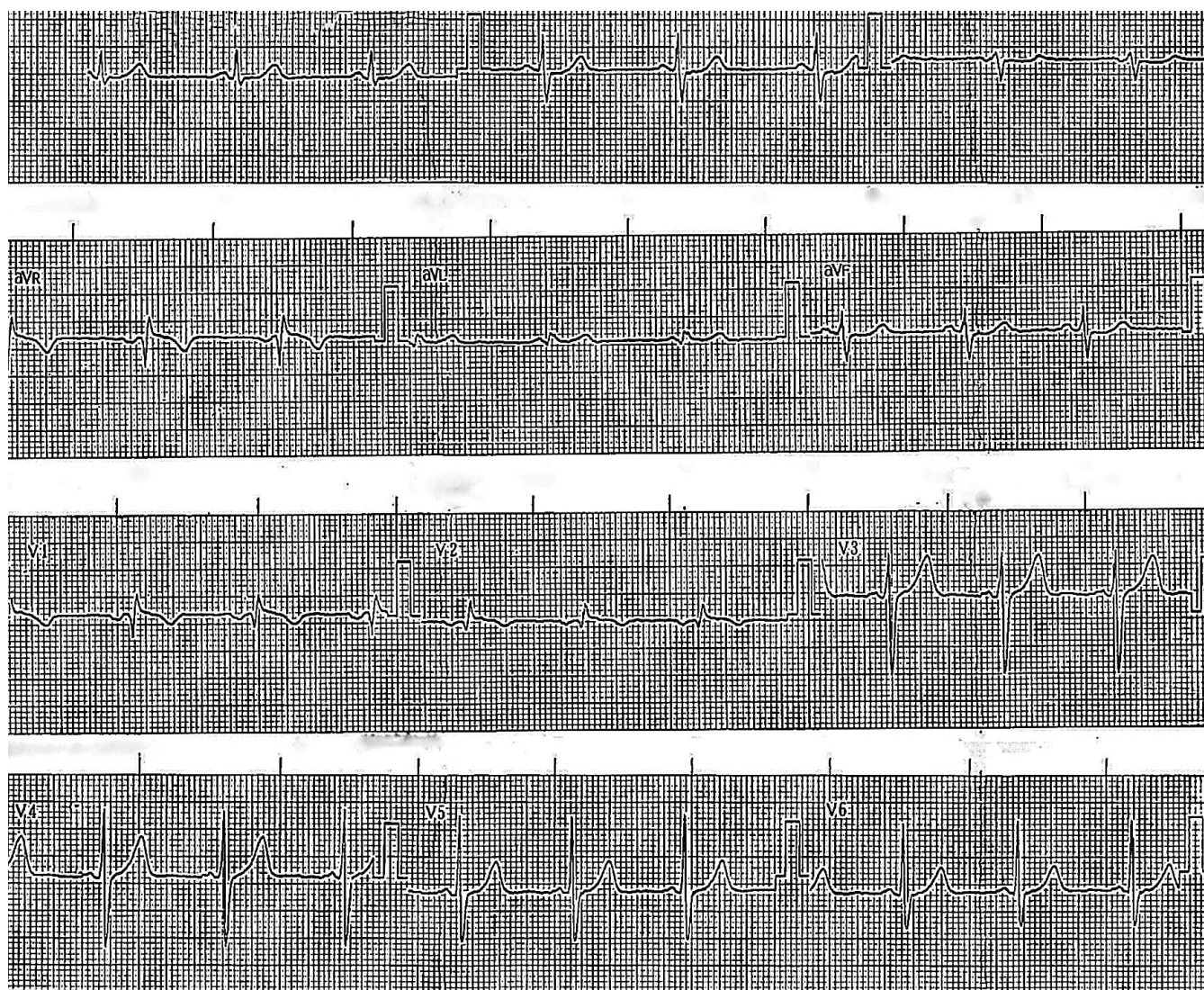
Figure. *Applicant's Electrocardiogram.*

misplacement of the right precordial leads would be our main suspect.

The correct position of these leads is: V1- fourth intercostal space right sternal margin and V2- fourth intercostal space left sternal margin. Placing parasternal electrodes V1 and V2 at chest positions superior to these correct positions is a common ECG technical error.

As the V1 and V2 electrodes are displaced to successively higher locations on the chest, changes occur in the P waves and QRS complexes in these leads. Such a technical error can potentially yield recorded wave- forms that mimic the ECG diagnosis of the conditions associated with increased mortality such as those mentioned above. These changes have been discussed and nicely illustrated in a paper by Ilg and Lehmann,[1] and I will borrow from their narrative for the discussion of this ECG case.

Atrial electrical activation begins in the sinus node (located in the high lateral right atrium) from which it proceeds anteriorly/inferiorly (to the rest of the right atrium) and leftward (to the left atrium), producing a mean P wave vector that points anteriorly, inferiorly and left- ward. When correctly situated in the fourth intercostal space, the V2 lead lies directly in the advancing path of this vector and an upright P wave is typically produced.

When lead V2 is displaced to successively higher locations on the chest (and more perpendicular to the mean P wave vector), the P wave amplitude becomes diminished and then biphasic or isoelectric (ie, flattened). With even further superior displacement; a level is reached at which V2 now faces a receding mean P wave vector, resulting in an inverted P wave. By contrast, when V2 is correctly positioned at the fourth intercostal space, a fully inverted P wave is relatively rare.[1]

Thus a valuable clue to a possible misplacement of the right precordial leads superior to the fourth intercostal space is the absence of an upright P wave in lead V2 with frank inversion of the P wave being an even more suggestive sign.[1-4]

A high position of the V1 and V2 electrodes may also cause the R wave amplitude in these leads to decrease by approximately 0.1 mV per intercostal space. Placement of these precordial electrodes in the third intercostal space (only one space higher than the normal position) will often result in poor R wave progression or frank QS waves suggestive of septal infarction. Placement of recording electrodes V1 and V2 even higher will sometimes produce a Qr complex in lead V1 associated with a QS or Qr pattern in lead V2. In the latter case, the terminal "r" wave in V1 also is usually greater than in lead V2.[1, 3-6] Occasionally, V1 and V2 may resemble AVR when placed too superiorly (rSr′ pattern with T wave inversion).[7,8]

Based on the above comments, let's return to our applicant's ECG, where there are several clues to the possibility of misplaced precordial leads V1 and V2. The first is the presence of negative P waves in V1 and V2. The qR pattern in these same leads reinforces this possibility. The rSr′ pattern in V1 with a negative T wave resembling the QRS pattern in lead AVR suggests that leads V1 and V2 have been placed significantly superior to their correct position, probably close to the second intercostal space.

DISCUSSION

The electrocardiogram has a long history as a risk assessment tool in the application process for life insurance. There are many factors that can affect the ECG examination results including physiological inter-individual variability and the performance of the technical procedure itself. One of the most common technical mistakes is inaccurate ECG electrode placement vs correct anatomical landmarks, eg, in proper intercostal spaces.[9]

Variation in the placement of the precordial electrodes is a common source of error. Wenger et al[10] determined the differences in placement of the precordial electrodes among 30 experienced technicians compared with their correct placement. In over 50% of cases, the V1 and V2 electrodes were placed above the fourth intercostal space. A recent survey of 119 medical personnel involved in cardiac care (at 6 UK hospitals) revealed that 10% of cardiac technicians, approximately 50% of nurses and approximately 75% of physicians failed to identify the correct vertical location of these leads.[11]

These errors are not trivial. These electrodes are the "guide" electrodes for the other precordial leads in the horizontal plane. Pseudo-infarction, bundle branch block and Brugada patterns can be generated leading to inaccurate risk assessment or postponement of insurance offers as a result of medical director or automated computerized ECG misinterpretation.

REFERENCES

1. Ilg KJ, Lehmann MH. Importance of recognizing pseudo-septal infarction due to electrocardiographic lead misplacement. *Am J Med.* 2012;125:23–27.
2. García-Niebla J, Rodríguez-Morales M, Valle-Racero JI, Bayés de Luna A. Negative P wave in V1 is the key to identifying high placement of V1-V2 electrodes in non-pathological subjects. [Letter to Editor] *Am J Med.* 2012;125:e9–e10.
3. Zema MJ. Pseudo-septal myocardial infarction due to electrocardiographic lead misplacement. [Letter to Editor] *Am J Med.* 2012;125:e11.

4. Marafioti V and Variola A. Pseudoinfarction pattern by misplacement of electrocardiographic precordial leads. [Letter to Editor] *Am J Emerg Med.* 2004;22:62.

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

6. García-Niebla J. Morphologies suggestive of V1 and V2 lead misplacement. *Rev Esp Cardiol.* 2008;61:1100–1109.

7. Bayés de Luna A. *Basic electrocardiography: normal and abnormal patterns*. Boston: Blackwell; 2007: 24–26.

8. Nickson C. ECG artifacts. *Life in the fast lane.* Accessed June 21, 2015. http://lifeinthefastlane. com/ecg-library/basics/ecg-artifacts/

9. Kania M, Rix H, Fereniec M, et al. The effect of precordial lead displacement on ECG morphology. *Med Biol Eng Comput.* 2014:52:109–119.

10. Wenger W, Kligfield P. Variability of precordial electrode placement during routine electrocardiography. *J Electrocardiol*. 1996;29:179–184.

11. Rajaganeshan R, Ludlam C L, Francis DP, et al. Accuracy in ECG lead placement among technicians, nurses, general physicians and cardiologists *Int J Clin Pract.* 2008,62:65–70.