American Journal of Emergency Medicine 36 (2018) 865–870

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Diagnostic

Misplacing V1 and V2 can have clinical consequences☆,☆☆

Brooks Walsh, MD

Bridgeport Hospital, Department of Emergency Medicine, 267 Grant St, Bridgeport, CT 06610, USA

ARTICLE INFO

Article history:
Received 11 December 2017
Received in revised form 3 February 2018
Accepted 7 February 2018

Keywords:
Electrocardiography/standards
Electrodes
ECG
EKG
Diagnostic errors

ABSTRACT

The precordial electrocardiogram (ECG) leads V1 and V2 are often misplaced. Such misplacement usually involves placing these leads too high on the chest. The resulting ECG may generate erroneous ECG patterns: e.g. incomplete right bundle branch block, anterior T wave inversion, septal Q waves, ST-segment elevation. These features may falsely suggest acute or old cardiac ischemia, pulmonary embolism, or a type-2 Brugada pattern. On rare occasion, conversely, high placement of V1 and V2 may reveal a true type-1 Brugada pattern. The emergency clinician needs to be aware of the possibility of lead misplacement, and should know how to suspect it based on unusual P wave morphology in V1 and V2.

1. Introduction

The electrocardiogram (ECG) is an essential tool for identifying myriad cardiac and non-cardiac disorders quickly, cheaply, and non-invasively. Nonetheless, it can also be performed improperly, and thus interpreted incorrectly.

In particular, the precordial leads must be placed in the appropriate locations. V1 is placed in the 4th intercostal space (ICS) along the right margin of the sternum, V2 along the left margin of the sternum in the 4th ICS as well. V4 is placed in the 5th ICS, in the mid-clavicular line, with V3 placed midway between V2 and V4. V5 and V6 are then placed in the anterior axillary line and axillary line, respectively, at the same level as V4.

This convention has been standard for almost 80 years [1]. Nevertheless, moving V1 and V2 upwards to the 3rd or 2nd ICS has proven to be a consistent and persistent error [1,2]. Despite the common occurrence of this misplacement, there may not be awareness of the potential impact on the patient's clinical course.

In the following five cases V1 and V2 were placed too high. This misplacement, in turn, directly lead to a change in the patient's clinical course. In four of these cases, an acute cardiopulmonary process was incorrectly suspected initially. In the fifth case, a type 1 Brugada pattern was recognized only because of the high placement of V1 and V2, and appropriate identification and referral was made possible because of lead misplacement.

2. Case presentations

2.1. Case 1

A young adult woman presented to the emergency department (ED) with mild and atypical chest pain, and an ECG was obtained (Fig. 1a). The physician noted the incomplete right bundle branch block (IRBBB) pattern in V2, and considered this to be concerning for pulmonary embolus (PE). A D-dimer was marginally elevated, and so a CT angiogram (CTA) of the chest was ordered. Care of the patient was transferred to a second physician at shift change, who wondered if the IRBB was due to lead placement, as suggested by the biphasic P wave in V2. He asked for a repeat ECG, and placed the leads himself (Fig. 1b). No IRBBB was seen. The CTA had already been performed, and was negative for PE.

2.2. Case 2

A 50-year-old woman was seen at her primary care physician's office for a routine visit. She was noted to be hypertensive, despite apparent compliance with her anti-hypertensive medications. She had no chest pain, shortness of breath, or other potentially ischemic symptoms, but an ECG was obtained (Fig. 2a). The precordial leads demonstrated apparent changes (rSr' in V1, and T wave inversions in V1–V3) from a prior ECG. She was sent to the emergency department, based on concern for acute ischemia. The emergency physician felt that this change likely represented lead misplacement, and so an ECG was repeated with careful attention to the chest leads (Fig. 2b). Lastly, to rule out "silent" dynamic ischemic changes, a third ECG was performed with V1 and V2 placed where the patient recalled them being done in the office. The ECG obtained with this deliberate misplacement (Fig. 2c) was

☆ These cases have not been previously published, submitted for publication, presented at conference, either in oral or poster format.

☆☆ The author received no financial assistance from any source.

E-mail address: Brooks.Walsh@bpthosp.org.

https://doi.org/10.1016/j.ajem.2018.02.006
0735-6757/

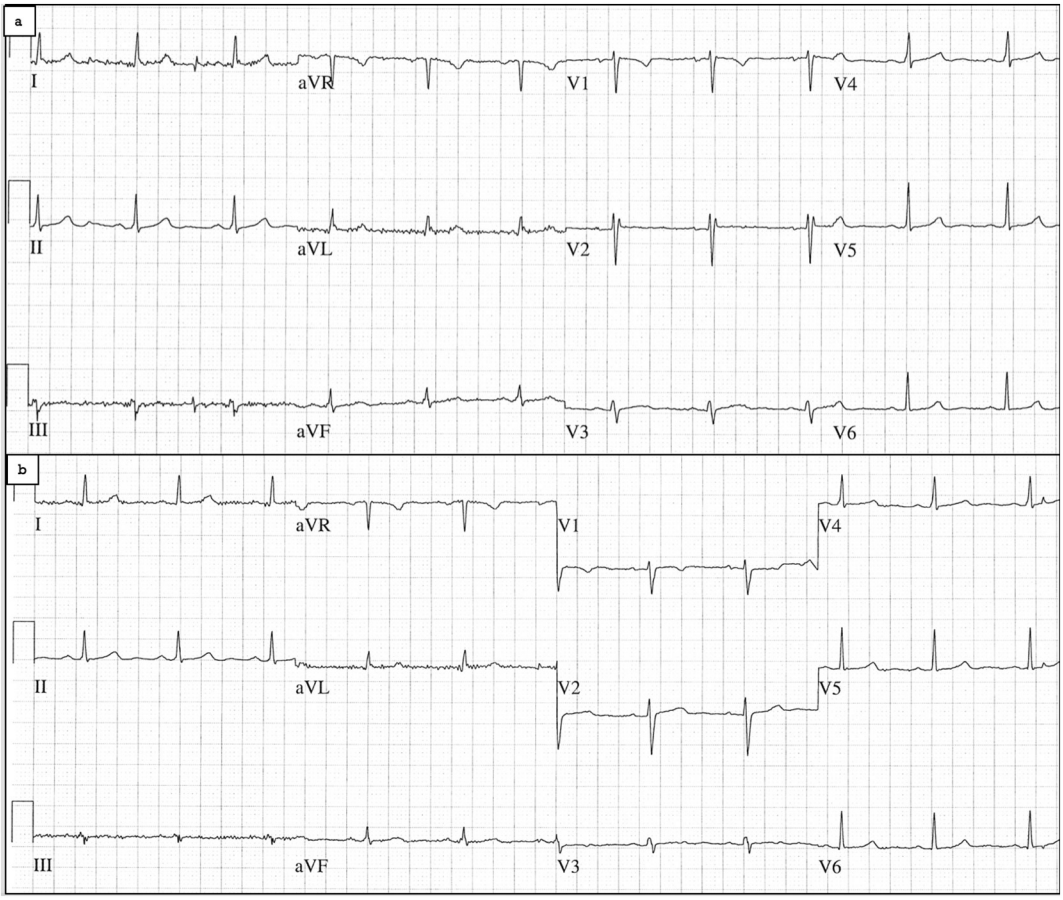

Fig. 1. ECGs from Case 1. Initial ECG (a), and after proper placement of precordial leads (b): ECG, Electrocardiogram.

similar to that obtained in the office. Further evaluation for ischemia was deferred, and the patient referred back to their physician.

2.3. Case 3

A 20-year-old man had an ECG performed during his annual medical evaluation to renew his commercial driver's license (Fig. 3a). The computer interpretation noted "Right-precordial ST elevation, consider acute ischemia." Despite the absence of any symptoms, he was sent immediately to the emergency department. The emergency physician doubted cardiac ischemia, and repeated the ECG after placing the precordial leads personally (Fig. 3b). Given the thin, muscular habitus of the patient, the ST elevation was felt to be normal male variant. When asked where the clinic staff had placed the precordial leads, he pointed to just below his clavicles. No further testing was required, and his paperwork for his commercial driver's license was signed.

2.4. Case 4

A 41-year-old man was seen by his primary care physician for an annual exam, and an ECG was obtained for unclear reasons (Fig. 4a). The patient reported excellent health, with no symptoms to suggest cardiac disease. Nonetheless, because of the computer interpretation of acute ST segment elevation MI (STEMI), 911 was called, and the patient was transferred to the emergency department by ambulance. The emergency physician thought that ischemia was unlikely, and repeated the ECG after placing the precordial leads (Fig. 4b). No further testing was performed.

2.5. Case 5

A 20-year-old man presented to the emergency department with fevers, chills, and occasional dizziness. An ECG was obtained to evaluate for syncope (Fig. 5a).

The emergency physicians noted an apparent type 1 Brugada pattern in V1, and type 2 Brugada pattern in V3. The evolution of the QRS and T waves, however, suggested both lead misplacement and lead switch problems. (The progression of the R wave suggested V2 had been switched with V3.) The physician ordered a repeat ECG, and placed the precordial electrodes himself (Fig. 5b). This confirmed that V2 and V3 had been switched in the first ECG (V3 in Fig. 5b is identical to V2 in Fig. 5a), but the Brugada pattern is significantly attenuated. Nonetheless, despite the likely high placement of V1 and V2 in the first ECG, cardiology agreed this was very likely Brugada.

3. Discussion

Precordial leads have been applied with poor technique for over half a century [3]. Despite this long-standing recognition, lead misplacement remains a concern [1,4]. In particular, V1 and V2 are commonly misplaced [5-7] usually too high (although there can be a great deal of variability) [2].

This misplacement is likely due to multiple factors: e.g. poor initial training, patient obesity, not removing clothing. Misplacement may be more common in women [8], perhaps due to concerns with preserving patient modesty [9]. Lastly, examples of lead placement obtained from the Internet are often incorrect, and may not include illustrations of placement on women or people with different body types [10].