CASE REPORT

Pathological ECG that seemed normal following electrode misplacement

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SUMMARY

We report the case of a 57-year-old woman found at home who received an ECG after having recovered from a seizure, without any clinical cardiac anomaly. The ECG revealed an elevation of the ST segment from the V1 to V5 leads and negative T waves from V1 to V5 leads. At her hospital admission, the emergency care unit (ECU) nurse performed another ECG. It no longer showed any repolarisation anomaly. However, the ECU nurse had put the precordial electrodes 3 cm too low, probably due to the patient's voluminous breasts. In the end, the pathological trace reappeared after we returned the electrodes to their initial positions. Malpositioning of the electrodes caused a seemingly normal ECG result with life-threatening consequences.

Figure 2 ECG 2 performed at the emergency care unit: note the pseudonormal repolarisation from V1 to V5 leads.

BACKGROUND

The ECG is a very common diagnostic tool. Many different clinical situations require its immediate implementation (thoracic pain, discomfort for patients with diabetes, bradycardia or tachycardia, dyskalaemia, etc). An ECG can be conducted by nurses, paramedics or physicians, with different levels of competence, knowledge and training.

The literature has frequently reported pathological traces, but few papers have underlined the importance of following the guidelines for the standardisation of the ECG.¹

In many clinical situations, an ECG is part of the basic paraclinical tests, thanks to its ease of realisation. Normal and pathological traces do not have the same consequences in terms of treatment, orientation and medical supervision. False negative traces may induce an additional delay in cardiovascular treatments and endovascular procedures, enhancing functional and life-threatening complications.

CASE PRESENTATION

An ECG (figure 1) was performed by a prehospital medical emergency team at the home of a 57-year-old woman with no medical history or cardiovascular

risk factors. A trace was recorded after the patient recovered from a convulsive seizure. Clinical exams were normal. In particular, there was no chest pain nor neurological deficit. The vital parameters were normal, the patient had no fever and her capillary glycaemia was 10 mmol/L. The ECG showed a sinus rhythm with ST segment elevation from leads V1 to V5 without reciprocal changes. The T waves were negative from the V2 to V5 leads (figure 1).

Immediately after the patient was admitted at the emergency care unit (ECU), the nurse performed a second ECG, though after repositioning the electrodes quite differently (figure 2). The precordial repolarisation then appeared as normal. Given the difference between the prehospital and in-hospital traces, a third ECG was carried out while respecting the initial prehospital precordial electrode positions (figure 3): this ECG displayed its initial abnormalities.

Figure 3 ECG 3 performed after correction of the leads' misplacement at the emergency care unit: note the ST-segment elevation and T-negative waves from leads V1 to V5.

Figure 1 ECG 1 performed at home: note the ST-segment elevation and T-negative waves from leads V1 to V5.

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Figure 4 Electrode positioning sites associated with the successive ECGs. Note the importance of the ribs references to avoid lead misplacement: breast tissues are fake friends and definitively not a good point of reference.

INVESTIGATIONS

Cardiac enzymes were elevated: myoglobin=174 µg/L (n<85), troponin=212 µg/L (n<0.6). On the same day, echocardiography showed hypokinesia of the middle septum, the anterior and inferior walls. The ventricular ejection fraction was estimated at 42%. There was no valvulopathy or no pericardial effusion; filling pressures were normal. A coronary angiography was performed, resulting in no abnormality. No electroencephalogram was performed due to the absence of seizure recurrence. Finally, the diagnosis was stress cardiomyopathy.

DIFFERENTIAL DIAGNOSIS

A subarachnoid haemorrhage was called to mind, thanks to the association of the seizure with the ECG repolarisation anomalies. However, this diagnosis was rejected given the absence of headache and a normal CT scan. Intoxication by cocaine was also evoked, but this hypothesis was invalidated through a urinary screening.

TREATMENT

The patient was treated with verapamil 240 mg/j for 3 months.

OUTCOME AND FOLLOW-UP

The patient left the hospital after a 10-day-long hospitalisation, during which both the echocardiography and ECG returned to normal. The troponin peak was at 752 µg/L on the fourth day.

DISCUSSION

The first question in this case is which electrode position was the correct one: the on-the-breast position of ECG 1 and 3 or the under-the-breast position of ECG 2?

First of all, there is very little doubt about the final diagnosis of stress myocardopathy: the myocardial hypokinesia (echocardiography), the absence of obstructive coronary disease, the absence of myocarditis and the highly elevated troponin levels are all elements that point to this direction, referring to Mayo Clinic's definition of cardiomyopathy stress.² The spontaneously favourable evolution with a normalisation of the cardiac enzymes, the ultrasound and the ECG also point in this direction. Thereafter, this ischaemic pathology was described well on ECG 1 and 3 using the on-the-breast electrode position (ST segment elevation from leads V1 to V5, T waves negative from the V2 to V5 leads) but was not visualised on ECG 2, which used an under-the-breast electrode position

(pseudonormal repolarisation). Without the third ECG, the diagnosis of ischaemia would probably have been missed.

On ECG 2, V3 to V6 leads were positioned too low on the thorax due to the ECU nurse's failure to respect the international standards (figure 4). The recommendation is that V4 should be placed in the fifth intercostal space on the mid-clavicular line, and V5 should be equidistance from V4 to V6 rather than at the anterior axillary line. Likewise, it is more important to respect a horizontal plane from V4 to V6 than to respect the fifth intercostal space.¹

As a result, ECG 1 and 3, which follow the recommendations and find a pathological trace that aligns with the final diagnostic are well done, contrary to ECG 2, which does not follow the international standard and is a false negative.

Although electrical signals recorded by an electrode located on a breast are slightly modified by the mammary volume, these modifications concern mainly the R wave progression in precordial leads.³ In McCann *et al's* series, the ECU teams tended to place V4 under the breast, especially in the case of large ones, breast implants or obesity. A vertical misplacement over or equal to 25 mm was observed in 20.0% of women for V4, 40.0% for V5 and 34.3% for V6; a horizontal misplacement over or equal to 25 mm was observed in 45.7% of women for V4, 40.0% for V5 and 37.1% for V6.⁴ Moreover, the majority of women preferred to have an electrode on the breast instead of under (less manipulation and feels less intrusive) and did not mind a

Learning points

- ▶ The ECG diagnosis may depend on the quality of its acquisition.
- ▶ A malposition of electrodes can lead to false negatives or false positives.
- ▶ The result of an ECG should be rechecked when it is inconsistent with the patient's clinical presentation or with previous ECG's.
- ▶ The guidelines about performing an ECG emphasise continuous practice.
- ▶ For patients with large breasts, the electrodes must be placed, ensuring that they are positioned at the level of the optimal intercostal space. This latter constitute the anatomical reference for the placement of the electrodes, despite the apparent mammary mass.

realisation by a man or a woman.⁵ Despite these observations, the international guidelines recommend electrodes be placed under the breast, but the medical community expects complementary studies.² Our case contributes to knowledge in the field by showing how electrode positions on or under the breast can induce T wave variations, thus causing false negatives. In the end, the correct placement of the V5 (fifth intercostal space) electrode is more important than the on-breast or under-breast electrode position; in people with large breasts, the respect of intercostal spaces usually requires placement of V4 and V5 over the breast. Some technical solutions have been developed and seem to resolve the problem of electrode misplacement.⁶

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