



(CASE REPORT)



Electrocardiography: Double check your chest leads

Meenakshi Chenniappan ¹, Anshuman Gupta ², M. Hanumatha Rao ³, Amit Gupta ⁴ and Shweta Ghatge ^{4,*}

¹ Department of Cardiology, Ramakrishna Nursing Home, Thiruchirappalli, Tamil Nadu, India.

² Department of Cardiology, Hero Heart DMC Hospital, Ludhiana, Punjab, India.

³ Department of Cardiology, Care Hospital, Banjara Hills, Hyderabad, Telangana, India.

⁴ Scientific Services, USV Pvt Ltd, Mumbai, Maharashtra, India.

World Journal of Advanced Research and Reviews, 2024, 24(03), 1620-1624

Publication history: Received on 06 November 2024; revised on 14 December 2024; accepted on 16 December 2024

Article DOI: <https://doi.org/10.30574/wjarr.2024.24.3.3720>

Abstract

Electrocardiography (ECG) is a rapid, non-invasive and invaluable diagnostic tool which plays a pivotal role in emergency department (ED) to provide critical information that aids in the timely assessment and management of patients presenting with a variety of cardiac and non-cardiac conditions. The improper placement of the electrodes can cause artifacts which would alter the reading and thus affect the management. The findings of the ECG should be confirmed through an accurate physical examination because, in certain cases, they may result from anatomical irregularities that manifest as ECG alterations resembling cardiac abnormalities.

Keywords: Anterior Fascicular block; Chest electrodes; Electrocardiography; Emergency department; Pectus excavatum

1. Introduction

Electrocardiography (ECG) serves as a fundamental diagnostic tool used in the medical field to assess the electrical activity of the heart. It plays a pivotal role in emergency department (ED) as a rapid and invaluable diagnostic tool providing critical information that aids in the timely assessment and management of patients presenting with a variety of cardiac and non-cardiac conditions.

It plays a crucial role as a diagnostic evaluation for patients presenting with chest pain, dyspnea, neurologic symptoms, toxic ingestion, syncopal episode, multisystem trauma, cardiac arrhythmias, certain electrolyte imbalance and drug intoxication [1]. The accuracy of ECG recordings is highly dependent on the correct placement of electrodes on the patient's body, ensuring reliable data, aiding in the accurate interpretation of cardiac conditions, and is crucial for providing optimal patient care. Though ECG provides probable diagnosis, role of physical examination is irreplaceable. Below, we showcase a case series consisting of two cases highlighting the significance of correct placement of electrodes to prevent misinterpretation of results and emphasize the role of physical examination in confirming ECG findings, ultimately leading to a distinctive diagnosis.

1.1. Case 1

A 68-year-old male patient presented with a history of intermittent chest pain and shortness of breath for the past month. He had no history of hypertension or diabetes mellitus. On examination, the resting blood pressure was 150/100 mmHg and heart rate was 96 beats/min. An initial 12-lead ECG was obtained to evaluate the cardiac conduction system.

* Corresponding author: Shweta Ghatge

The ECG revealed sinus rhythm with characteristic findings of anterior fascicular block and PR interval in upper limit (Figure 1). Key features included left axis deviation greater than 45° , a small Q wave in lead I, and an R wave in lead III. These findings were indicative of an isolated anterior fascicular block. However, there was a sudden appearance of tall R wave in V3 ($>V4$) and sudden disappearance of R wave in V5 and the QRS complex looked completely different in V5 and V6.

- **Explanation of Ambiguous Alteration in ECG Pattern:** The unexpected appearance of R wave in one lead and sudden disappearance of R wave in another lead were suggestive of chest electrode malposition. Here electrode of V5 was placed in V3 position and electrode for V3 was placed in V5 position, resulting in this unusual appearance and disappearance of R wave. This type of ECG change cannot be explained by electrocardiographic terms because the configuration of QRS in V5 and V6 is most often similar in normal ECG.
- **Further Examination & Management:** Patient underwent further risk stratification, including a thorough medical history, assessment of co morbidities, and additional diagnostic tests, such as echocardiography and stress testing to identify potential ischemic heart disease or other contributing factors.

As the patient did not exhibit signs of acute myocardial infarction or hemodynamic instability, a conservative approach was chosen. Medications such as a cardio-selective beta-blocker (Metoprolol 50mg) and angiotensin-receptor blocker (Telmisartan 40 mg) were initiated to manage associated cardiovascular risk factors and improve overall cardiac function. The patient was counseled on the importance of lifestyle modifications, including smoking cessation, dietary changes, and regular exercise, to address modifiable risk factors and promote cardiovascular health.

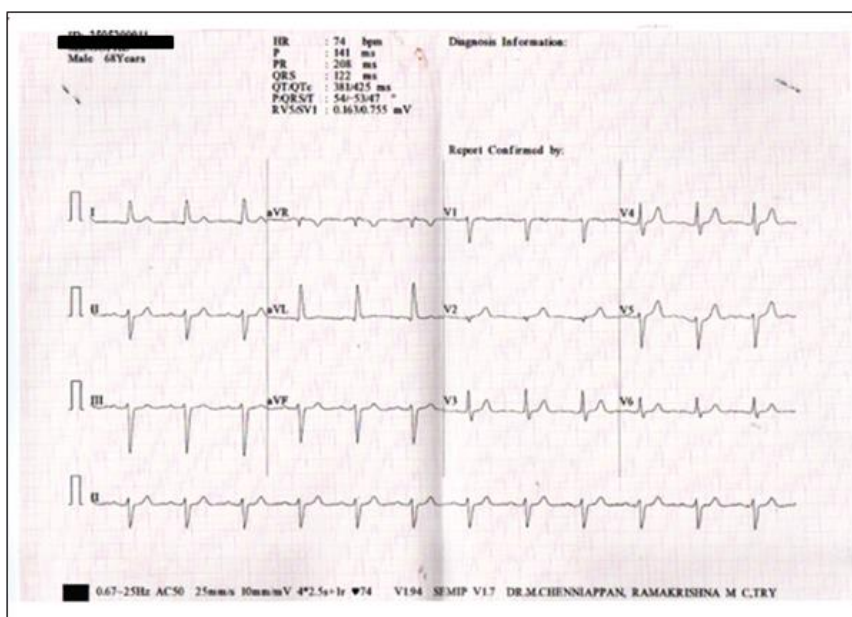


Figure 1 ECG showing left axis deviation greater than 45° , a small Q wave in lead I, and an R wave in lead III. There is a tall R wave in V3 ($>V4$) and sudden disappearance of R wave in V5 and in V5 and V6, the QRS complex was looking completely different

1.2. Case 2

A 70-year-old male presented with complaints of occasional palpitations and mild chest discomfort during physical activity. On examination, the patient had a noticeable chest deformity characterized by a sunken appearance, consistent with pectus excavatum. His ECG findings revealed poor R wave progression in the anterior chest leads. His ECG showed non progression of R wave in V1-V4 (Figure 2).

- **Explanation of Ambiguous Alteration in ECG Pattern:** Non progression of R wave or poor prognosis of R wave in chest leads is a vague term. Physical examination showed posterior depression of sternum and costal cartilages suggestive of pectus excavatum. With this criterion of ECG showing poor prognosis of R wave, further investigations, including echocardiography and chest imaging, confirmed the diagnosis of pectus excavatum. The chest imaging revealed a significant depression of the sternum, causing a displacement of the heart and altering the electrical vectors in the anterior chest wall.

- Further Management:** Initial management focused on optimizing cardiovascular risk factors. Medications such as antiplatelet agents (Aspirin 81mg daily), statins (Rosuvastatin 20mg daily), and beta-blockers (metoprolol extended release 50mg daily) were prescribed to alleviate myocardial stress and manage ischemic risk. However, due to persistent symptoms and the significant impact on ECG findings, surgical intervention was deemed necessary. The patient underwent a modified Ravitch procedure to address the pectus excavatum deformity, thereby relieving compression on the heart and improving cardiac electrical vectors. Postoperatively, the patient exhibited notable improvement in symptoms, and a follow-up ECG revealed a significant enhancement in R-wave progression.

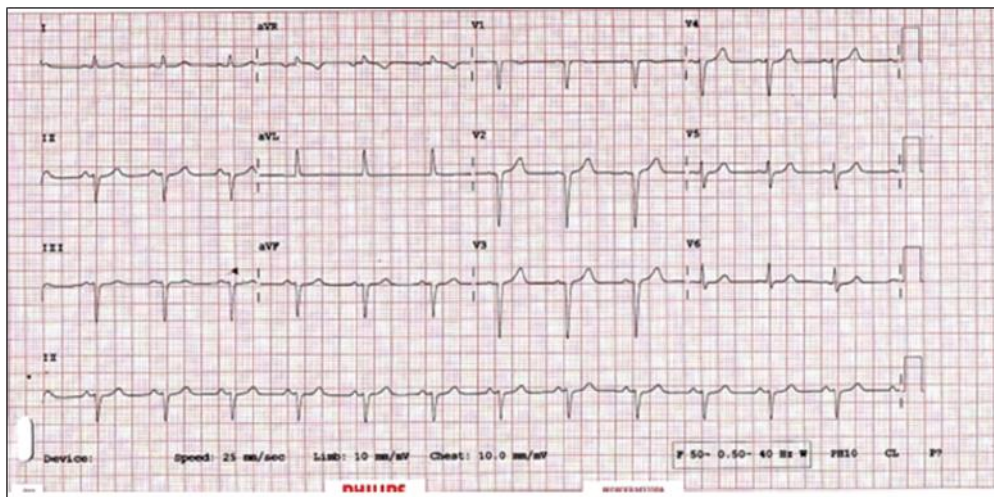


Figure 2 ECG showing non progression of R wave in V1-V4

2. Discussion

ECG continues to remain one of the best tools for identifying and accurately diagnosing several cardiovascular diseases or conditions. Due to its low cost and easy availability, clinicians rely on ECG as an initial diagnostic tool. However, misplacement of ECG leads poses a major challenge to healthcare providers, as it can result in serious outcomes such as misdiagnosis and inappropriate treatment. According to a study data, the misplacement of ECG leads by nurses is almost 64% while only <20% physicians place the V1 and V2 lead correctly [2].

The misplacement of V1 and V2 leads may mimic acute anterior ST elevation MI or incomplete right bundle branch block [3]. Thorough recognition of ECG patterns indicative of incorrect lead positioning can help detect the fault and minimize the chance of incorrect diagnosis and treatment, which would otherwise be unnecessary [4,5].

Certain important findings on ECG can aid physician in identifying the signs of incorrect electrode placement. Several tools, such as REVERSE mnemonic can identify these abnormal ECG findings.

ECG technicians most often make errors by misplacing electrodes, either in limb leads or chest leads. To avoid this error, chest electrodes can be color-coded so that the technician remembers the assigned colors for specific electrodes and can place them correctly.

The colors for the chest electrodes are red (V1), yellow (V2), green (V3), brown (V4), orange (V5) and purple (V6). These colors can be remembered easily by the following method. Electrodes V1 – V3 can be remembered as traffic signal (red, yellow, green), and electrodes V4-V6 can be remembered as a mnemonic “BOP” (brown, orange, purple). In this simple way, technicians can identify the chest electrodes and place them in the correct positions without needing to look at the letter on the electrode like V1, V2, etc.

The ECG technician/paramedics who record the ECG should be well trained to connect the electrodes in the limbs as well as placement of chest electrodes in the correct positions. If they are taught the positioning of the chest electrodes as well as the limb electrodes through the colors it will be easy for them to place the electrodes in a correct position.

Sometimes wrongly recorded ECGs may give a wrong diagnosis like dextrocardia, myocardial Infarction, ventricular enlargement etc. and the patient may get inappropriate and incorrect treatment. So, educating the technicians in a

simple way through color coding of electrodes is an efficient method of making sure that the ECG is recorded properly [4]. Constant efforts should be taken to identify lead reversals to minimize errors in diagnosing.

In the first case presented, the unexpected appearance of R wave in one lead and sudden disappearance of R wave in another lead were suggestive of chest electrode malposition. Here electrode of V5 was placed in V3 position and electrode for V3 was placed in V5 position resulting in this unusual appearance and disappearance of R wave.

The second case highlighted the importance of physical examination, which can sometimes rule out major cardiac ailments suggested by an ECG. Pectus excavatum, a congenital deformity of the chest wall, can impact cardiac anatomy and lead to atypical ECG findings. It is prevalent in 1/300 to 1/1000 persons with 3-5 times more occurrences in males [5]. In this case, the poor R wave progression was attributed to the altered positioning of the heart within the chest cavity, affecting the normal depolarization pattern.

Poor R wave progression can be caused by anterior myocardial infarction, chronic obstructive pulmonary disease (COPD), obesity, dextrocardia, pregnancy, left bundle branch block (LBBB) or improper placement of chest electrodes.

The ECG signs produced by pectus excavatum which results in compression and leftward displacement of heart include nonspecific ST-T changes and poor prognosis of R in V1-V4, mimicking coronary artery disease (CAD). Additionally, other ECG changes such as incomplete blockade of His, ventricular premature depolarization (VPDs) and MVP are present in more than 90% of cases.

It is imperative to record ECGs one space above or below depending upon the condition when poor R progression is present to rule out organic causes. In cases of obesity, ascites and pregnancy it is one space above while in tall lean individuals and those with emphysema it is one space below. If R wave progresses in repositioned leads, it is unlikely due to organic causes such as anterior wall myocardial infarction (AWMI). Data from few studies have highlighted ECG abnormalities in patients with pectus excavatum and the common finding of cardiac axis deviation and changes in the P and T waves [4,5].

The importance of taking utmost caution while placing the electrodes and the role of physical examination before initiating treatment based on ECG are crucial. The cases highlight the need for timely training and education on the proper technique and interpretation of data obtained from ECG. This would save time in emergencies and prevent wrong or inadequate treatment for these patients.

3. Conclusion

The correct placement of ECG electrodes is of great importance to obtain an accurate reading. The correct positioning of the electrodes; ensuring optimal quality of signal and minimizing artifacts can improve the reliability of the ECG findings and help serve faster in emergency cases. Regular training on electrode placement facilitates prompt result interpretation and appropriate patient treatment.

It is also crucial to confirm ECG findings through accurate physical and laboratory tests, as this can also help identify uncommon conditions such as pectus excavatum. The series also emphasizes the impact of pectus excavatum on ECG patterns.

Compliance with ethical standards

Acknowledgements

Authors thank Triveni Bangera (Sqarona Medical Communications LLP, Pune) for medical writing assistance.

Disclosure of conflict of interest

Amit Gupta and Shweta Ghatge are employees of USV Pvt Ltd. All other authors have no conflict of interest to declare.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

- [1] Harrigan RA, Chan TC, Brady WJ. The electrocardiogram. In: Roberts JR, Hedges JR, editors. Clinical procedures in emergency medicine. 4th ed. Philadelphia (Pa)7 Mosby-Saunders-Elsevier; 2003.
- [2] Hadjiantoni A, Oak K, Mengi S, Konya J, Ungvari T. Is the correct anatomical placement of the electrocardiogram (ECG) electrodes essential to diagnosis in the clinical setting: a systematic review. *Cardiology and Cardiovascular Medicine*. 2021;5(2):182-200
- [3] Abobaker A, Rana RM. V1 and V2 pericordial leads misplacement and its negative impact on ECG interpretation and clinical care. *Annals of Noninvasive Electrocardiology*. 2021;26(4).
- [4] Baranchuk A, Shaw C, Alanazi H. Electrocardiography pitfalls and artifacts: The 10 commandments. *Crit Care Nurse*. 2009 Feb;29(1):67-73.
- [5] Sharma G, Carter YM. Pectus Excavatum. 2020 Aug 26. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan28613668.