Case Report
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Early Detection of Inferolateral Ischemia Using a Smartphone-Based ECG Device: A Case of Triple-Vessel Disease Confirmed by Coronary Angiography

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Abstract

Objective. This case report describes the capability of a smartphone-based electrocardiogram (ECG) in detecting multivessel coronary artery disease (CAD), with initial findings suggestive of double-vessel involvement, which was later confirmed as triple-vessel disease (TVD) by coronary angiography. **Case Report.** In this case report, we describe a 51-year-old woman with a known medical history of CAD, hypertension, TVD, and a prior episode of acute coronary syndrome who presented to Swami Rama Himalayan University, Dehradun, with complaints of chest pain. She had previously undergone percutaneous coronary intervention with stent placement. Conventional 12-lead ECG (Philips PageWriter ECG) indicated myocardial ischemia. Follow-up smartphone-based ECG (Spandan Pro) revealed inferolateral ischemia possibly affecting the left anterior descending artery (LAD) and left circumflex artery (LCX), with a possible diagnosis of double-vessel disease (DVD). Coronary angiography later confirmed the diagnosis of TVD with significant stenosis of the LAD, LCX, and right coronary artery, along with additional involvement of the left main coronary artery. Post-angiography, the patient was recommended for coronary artery bypass grafting as the first option and percutaneous transluminal coronary angioplasty as an alternative. **Conclusion.** This case illustrates the clinical efficacy of the smartphone-based ECG device in detecting inferolateral ischemia suggestive of DVD in patients with suspected or known CAD and highlights its diagnostic concordance with standard investigations, particularly coronary angiography.

Key Words: Inferolateral Ischemia ▪ Portable ECG ▪ Coronary Artery Disease ▪ Vessel Disease ▪ Coronary Angiography.

Introduction

Coronary artery disease (CAD) continues to be the leading cause of death worldwide (1). The severe form of CAD, known as triple-vessel disease (TVD), affects blood flow to the left anterior descending (LAD), left circumflex (LCX), and right coronary artery (RCA). An estimated 30% of individuals with CAD are thought to have TVD, which has a significant mortality risk and necessitates prompt risk stratification (2). The observation of ST deviations in patient electrocardiograms (ECGs) is a critical technique for diagnosing myocardial ischemia (3). The 12-lead ECG is a highly accepted diagnostic tool for diagnosing ischemia. Nevertheless, conventional 12-lead ECGs are typically utilized in hospital settings, thus limiting their application to regular monitoring and early detection in remote or developing regions (4). This highlights the need for a portable, readily available ECG device that can effectively augment diagnostic capabilities beyond conventional healthcare centers.

One such device is the Spandan Pro, a portable smartphone-based 12-lead ECG device developed by Sunfox Technologies Private Limited (Dehradun, India). Spandan Pro ECG is a medical

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device that has been certified and complies with important international and Indian regulatory standards. It holds certification under the Indian Medical Device Rules (MDR) as regulated by the Central Drugs Standard Control Organization (CDSCO) and maintains a certified Quality Management System (QMS) compliant with ISO 13485. Furthermore, the device adheres to critical international safety and performance standards: IEC 60601-1 (General requirements for basic safety and essential performance), IEC 60601-1-2 (Electromagnetic compatibility - EMC), and IEC 60601-2-25 (Particular requirements for the basic safety and essential performance of electrocardiographs). The device has a Computerized Algorithm for the detection of ST-Elevation Myocardial Infarction (STEMI) or Non-ST-Elevation Myocardial Infarction (NSTEMI), and Arrhythmia, and it is formally validated in accordance with the international standard for diagnostic electrocardiographs, IEC 60601-2-25. The Spandan's proprietary algorithm has been successfully validated against the CTS (Conformance Testing Services) Database and CSE (Common Standards for Quantitative Electrocardiography) Database, mandated by IEC 60601-2-25. The Spandan pro ECG algorithm was described in a previous paper, where Spandan was used to validate Decisions for Percutaneous Coronary Intervention (PCI) (5). This case report aims to highlight the ability of a smartphone-based ECG (Spandan Pro) device to detect multivessel CAD and its diagnostic concordance with coronary angiography.

Case Description

A 51-year-old woman presented to the Swami Rama Himalayan University (SRHU) Hospital (Dehradun, India) on 20 February 2024, with complaints of chest pain. At the time of presentation, the patient did not exhibit symptoms such as shortness of breath, syncope, palpitations, or gastrointestinal symptoms. She had a medical history of CAD, hypertension (HTN), TVD, and a prior episode of acute coronary syndrome (ACS). She had undergone PCI with stent placement on 29 January 2023. The patient did not present with comorbid conditions such as diabetes mellitus, and her social history revealed that she was a non-smoker. The patient's anthropometric measurements revealed a height of 155 cm and a weight of 60 kg, resulting in a body mass index (BMI) of 24.97 kg/m^2, which is within the normal range.

The patient was compliant with her medications. Her medications included dual antiplatelet agents (aspirin and ticagrelor), atorvastatin (a high-potency statin used as lipid-lowering therapy), isosorbide nitrate (a long-acting nitrate), low molecular weight heparin, pantoprazole (a proton pump inhibitor), and metoprolol succinate (a beta-blocker frequently prescribed for CAD, HTN, and ACS). On physical examination, the patient was alert and oriented to time, person, and place. At the time of presentation, her blood pressure was 110/70 mmHg. She was clinically stable, with no signs of hemodynamic compromise.

The initial assessment of the patient involved a conventional 12-lead ECG (Philips PageWriter ECG) on 20/02/24 at 3:48 PM. The conventional 12-lead ECG showed significant ST-segment depression in lead AVF, along with T wave inversion in lead III. These findings can suggest myocardial ischemia. These findings were interpreted as non-specific but indicative of possible wall ischemia (Figure 1A). The next morning at 8:57 AM on 21/02/24, a comprehensive 12-lead ECG was recorded using the smartphone-based ECG device. The smartphone-based ECG detected ST-segment depression in multiple leads: V4, V5, V6, AVL, II, III, and AVF. This pattern was consistent with inferolateral ischemia, potentially involving the LAD and LCX arteries, suggesting double-vessel disease (DVD) (Figure 1B).

The same evening (21/02/24), diagnostic coronary angiography was performed at 4:30 PM to clarify the extent and severity of CAD. The angiogram revealed the following findings:

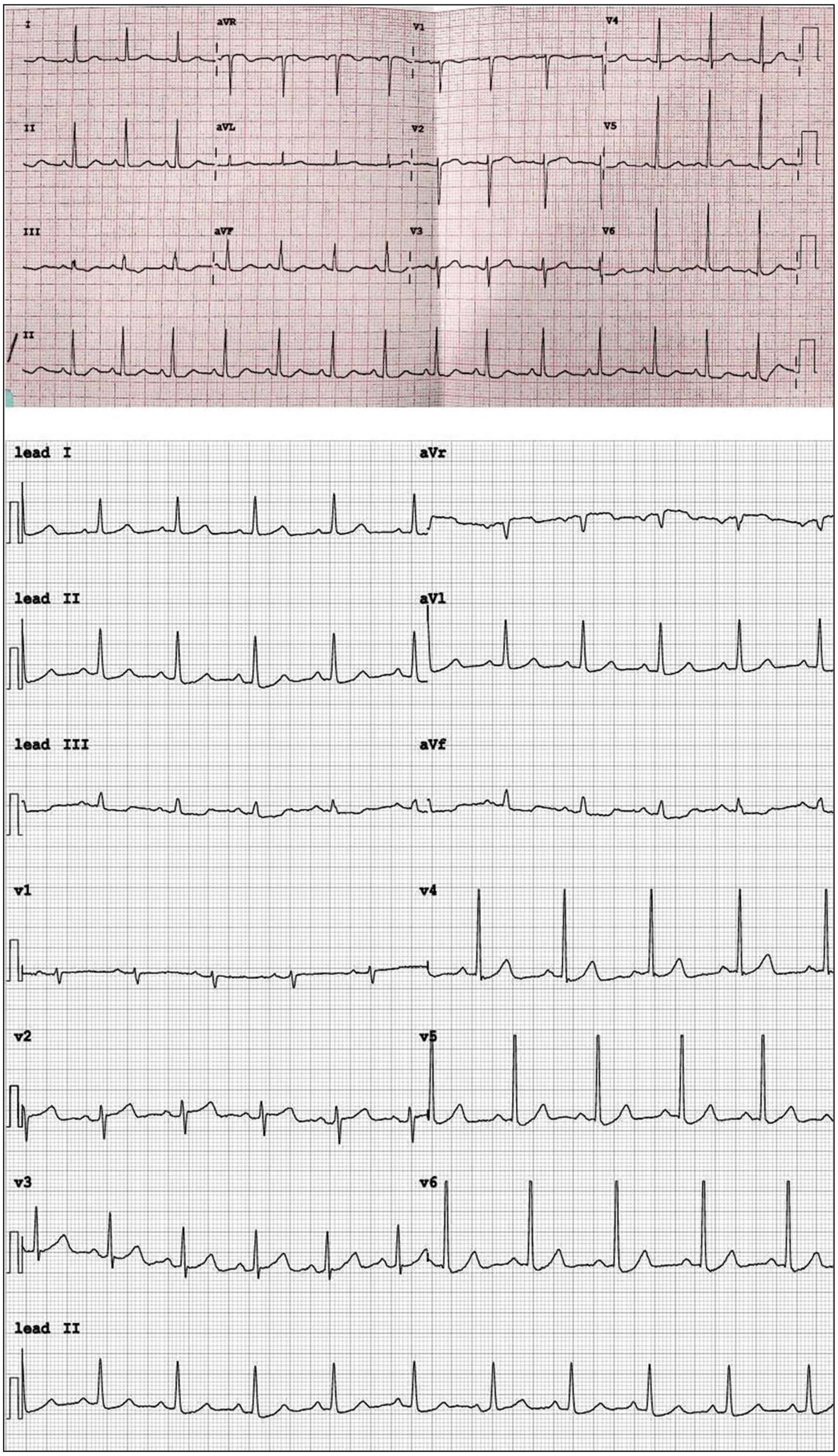

Figure 1. ECG report. (A) A conventional 12-lead ECG test report showing ST elevation of lead AVF and T wave inversion of lead III. (B) Spandan ECG test report showing ST-segment depression in leads V4, V5, V6, AVL, II, III, and AVF.

LMCA: Proximal 30-40% lesion, mid normal, distal 50% lesion. LAD: Type III artery, ostial 70% lesion, mid 70% lesion, distal normal. D1: Normal. LCX: Non-dominant, ostial 70% lesion, mid 90% lesion, distal normal. OM1: Normal. RCA/PDA: Dominant, proximal normal, mid 90% lesion.

The final impression of the coronary angiography confirmed TVD involving the LAD, LCX, and RCA, as well as additional involvement of the left main coronary artery (LMCA) (Figure 2). Based on the angiographic findings of TVD, the cardiology team recommended surgical vascularization through coronary artery bypass grafting (CABG) as the first approach. Percutaneous transluminal coronary angioplasty (PTCA) was advised as an alternative approach because of the nature and extent of the disease. Unfortunately, the patient was lost to follow-up after discharge, and further details are not available.

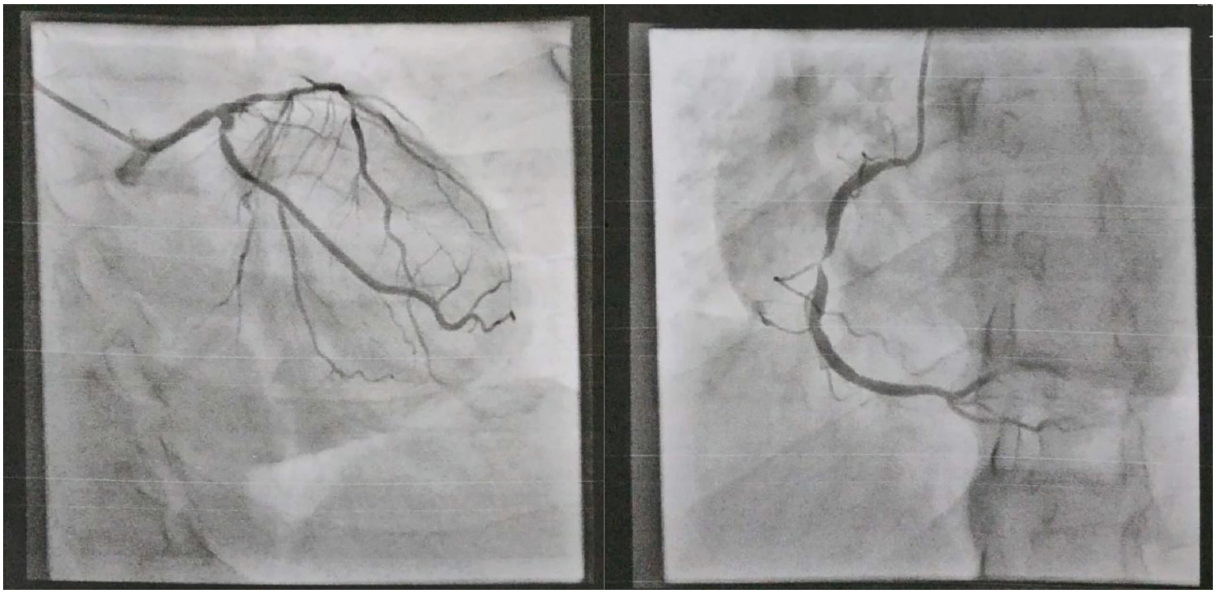

Figure 2. Coronary angiography report showing TVD involving the LAD, LCX, and RCA, with additional LMCA involvement.

Discussion

This case presents the diagnostic concordance between smartphone-based ECG and coronary angiography in detecting severe ischemic heart disease. Conventional 12-lead ECG results suggested myocardial ischemia. The smartphone-based ECG device identified ST depression in various leads, indicative of inferolateral ischemia and DVD possibly involving the LAD and LCX arteries. There was good concordance between these findings and the angiographic findings of TVD involving the LAD, LCX, and RCA, with additional LMCA involvement. Although coronary angiography remains the ultimate gold standard for identifying anatomical occlusions, the conventional 12-lead ECG remains a potent tool for predicting the culprit vessel and guiding early triage. This case illustrates that smartphone-based ECG can detect ischemic changes suggestive of vessel involvement. While it cannot replace the anatomical detail provided by angiography, it can at least identify significant ischemia and provide a preliminary indication of the territories that may be involved. Its portability, relatively low cost, and ease of use make it particularly valuable in ambulances, remote centers, or pre-hospital settings, enhancing early detection and supporting timely clinical decision-making.

An increasing number of studies support the use of smartphone-based ECGs to detect ischemia and arrhythmias, especially in ambulatory settings and resource-constrained locations. Mahajan et al. conducted a study to validate the accuracy of Spandan ECG interpretation in detecting ischemia compared to conventional 12-lead ECG interpretation. They reported a sensitivity of 87.4%, specificity of 97.4%, positive predictive value (PPV) of 87.4%, and Negative Predictive Value (NPV) of 89.85% (6). Another study used Spandan Pro ECG to evaluate its diagnostic efficacy for the detection of ST elevation against conventional 12-lead ECGs, thereby aiding cardiologists' decisions to perform PCI. The device showed excellent concordance with conventional 12-lead ECGs, particularly in leads II, III, and AVF, with Pearson correlation coefficients of almost 1. The ST elevations observed in the Spandan pro ECG devices did not show a significant statistical difference from those of the conventional 12-lead ECG. The device had 94% sensitivity and a 94% positive predictive value for ST-elevation detection, thus supporting its role in decision-making for PCI (5). Another study employed the Spandan pro ECG device to evaluate the diagnostic performance of smartphone ECG devices in Cardiac Care Units and Cardiac Intensive Care Unit-admitted patients regarding the presence of STEMI or NSTEMI.The diagnosis was made by a team of cardiologists after a thorough examination of ECG records, which showed 100% specificity, 93% sensitivity, 80% negative predictive value, and 100% positive predictive value, yielding an F-score of 0.96 and a Matthews correlation coefficient of 0.86 (7). Studies highlighted the capability of the Spandan smartphone-based ECG in identifying myocardial ischemia. Similarly, in the study by Muhlestein et al., another ECG device (AliveCor™ Heart Monitor) was used, and the study confirmed the potential of smartphone ECGs for the evaluation of acute ischemia (8).

The patient in our study complained of chest pain, which is the most typical clinical manifestation of CAD. According to Chowdhary et al., 62.16% of patients experienced chest pain (9), and according to Haider et al., 96% of patients had chest pain (10). The patient in our study had a history of recognized HTN. According to Takieddin et al., 61.46% of patients had HTN (11), and according to Tsega et al., HTN was the most prevalent comorbid condition, occurring in 47.3% of patients (12). Patients with HTN may have an increased risk of MI and heart failure due to cardiac hypertrophy, and they may also contribute to the development of atherosclerosis through mechanical stress. Overall, HTN is one of the most common comorbidities in patients with CAD.

The availability of basic ECG remains low in many remote primary care settings in developing countries, including India. For patients presenting with chest pain, early identification of STEMI is crucial for timely stabilization and referral. A smartphone-based ECG enables the early and accurate detection of significant ischemia, allowing remote healthcare workers to initiate essential medications, coordinate urgent transport, and alert receiving hospitals in advance. This early identification can help avoid harmful delays in accessing appropriate care, which is particularly relevant in conditions such as myocardial ischemia. It also helps prioritize limited resources and reduces avoidable patient referrals by distinguishing non-life-threatening cases. Compared with other portable ECG devices, the Spandan platform leverages the smartphone's high-resolution display, provides advanced on-device algorithms for real-time interpretation of 12+ arrhythmias and 14+ types of myocardial infarction/ischemia, and supports a seamless digital workflow for instant report sharing and teleconsultation. Battery-free, highly portable, and paperless, it is easy to deploy in wards, triage areas, or community health camps. This case highlights the clinical utility of smartphone-based ECG in triaging chest pain and the early detection and risk assessment of patients with known cardiovascular risk factors, even outside tertiary centers. Despite these promising findings, this case report has several limitations. As this is a single case report, the generalizability of Spandan's diagnostic accuracy cannot be assumed without large-scale validation studies. Importantly, this case is part of an ongoing clinical trial with a substantial sample size, which will allow for a comprehensive assessment and confirmation of these preliminary observations.

Conclusion

In this case, smartphone-based ECG demonstrated ischemic changes suggestive of DVD, which were later confirmed as TVD with LMCA involvement on coronary angiography. This case report supports the use of smartphone-based ECG devices as a valuable adjunct to conventional 12-lead ECG for the early detection and risk assessment of patients with chest pain and known cardiovascular risk factors.

What Is Already Known on This Topic:

Early diagnosis of CAD is important for early intervention and better outcomes, particularly in patients who have experienced ACS or undergone PCI. Standard 12-lead ECG and coronary angiography are standard methods for assessing ischemia and vessel involvement. However, these modalities may not be readily available in resource-constrained or remote areas. Smartphone-derived ECG devices have shown promise in detecting arrhythmias and monitoring rhythms; however, their application in diagnosing ischemia and multivessel disease is still being explored.

What This Study Adds:

This case demonstrates the potential of a smartphone-based ECG device to detect inferolateral ischemia indicative of DVD, which was later confirmed as TVD through coronary angiography. This underscores the ability of portable ECG technology to aid in the early identification of multivessel coronary involvement, supporting its role in preliminary screening and triage, especially in patients with complex CAD.

Conflict of Interest: NC, DA, SYPS, and MP are currently employed by Sunfox Technologies. The other authors have no conflicts of interest.

Ethical Approval and Patient Consent: The patient described in this case report was enrolled in a broader clinical trial that received ethical approval from the Swami Rama Himalayan University Institutional Ethics Committee (Approval No. SRHU/HIMS/E-1/2024/07) with CTRI No. CTRI/2024/07/071055. Written informed consent was obtained from the patient for the publication of this study.

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Standard of Reporting: CARE guidelines and methodology were followed.

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Supplementary Table: Timeline of The Case Report

Date	Time	Event
29/01/2023	-	The patient underwent PCI with stent placement (the exact vessel stented was not recorded).
20/02/2024	3:48 PM	A conventional 12-lead ECG was performed following complaints of chest pain.
21/02/2024	8:57 AM	Spandan smartphone-based ECG was performed, which showed inferolateral ischemia potentially involving the LAD and LCX, with a probable diagnosis of DVD.
21/02/2024	4:30 PM	The patient underwent coronary angiography, which confirmed the presence of TVD along with LMCA involvement.
21/02/24	-	Post-angiography, the patient was recommended for CABG as the first option and PTCA as an alternative option.