OTJHS
Online Turkish Journal of Health Sciences

e-ISSN: 2459-1467

OTSBD
Online Türk Sağlık Bilimleri Dergisi

Online Turkish Journal of Health Sciences 2024;9(2):183-186 *Online Türk Sağlık Bilimleri Dergisi 2024;9(2):183-186*

Assessing the Diagnostic Accuracy of the Smartwatch ECG in Detecting Complete Atrioventricular Block: A Case Report

Tam Atriyoventriküler Bloğu Saptamada Akıllı Saat EKG'sinin Tanısal Doğruluğunun Değerlendirilmesi: Bir Olgu Sunumu

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ABSTRACT
This study aimed to assess the effectiveness of the smartwatch electrocardiogram (ECG) in detecting atrioventricular block. A case study was conducted to demonstrate the use of wearable technology, specifically the ECG, in monitoring cardiac health outside of traditional clinical settings. The patient in question was a 71-year-old woman who was hospitalized due to a complete atrioventricular (AV) block. Her ECG recordings were taken with an Apple Watch, which accurately displayed the complete AV block. After undergoing coronary angiography, the ECG recordings taken with the Apple Watch demonstrated that the complete AV block had been correct. These results indicate that wearable technology, such as smartwatches, holds great potential for monitoring third-degree AV block in non-clinical settings. The findings of this study can add to the growing body of evidence supporting the use of wearable technology in cardiac monitoring during emergencies.
Keywords: Atrioventricular block, coronary angiography, smartwatch

ÖZ
Bu çalışma, akıllı saat Elektrokardiyogramının (EKG) atriyoventriküler (AV) bloğu tespit etmedeki etkinliğini değerlendirmeyi amaçladı. Geleneksel klinik ortamların dışında kalp sağlığının izlenmesinde giyilebilir teknolojinin, özellikle de EKG'nin kullanımını göstermek için bir vaka çalışması yapıldı. Söz konusu hasta, tam AV blok nedeniyle hastaneye kaldırılan 71 yaşında bir kadındı. EKG kayıtları, tam AV bloğunu doğru bir şekilde görüntüleyen bir Apple Watch ile çekildi. Koroner anjiyografi sonrası Apple Watch ile çekilen EKG kaydında AV bloğunun tamamının düzeldiği görüldü. Bu sonuçlar, akıllı saatler gibi giyilebilir teknolojilerin, klinik dışı ortamlarda üçüncü derece AV bloğun izlenmesinde büyük potansiyel taşıdığını göstermektedir. Bu çalışmanın bulguları, acil durumlarda kardiyak izlemede giyilebilir teknolojinin kullanımını destekleyen giderek artan kanıtlara katkıda bulunabilir.
Anahtar Kelimeler: Atriyoventriküler blok, koroner anjiyografi, smartwatch

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Yayın Bilgisi / Article Info:
Gönderi Tarihi/ Received: 10/02/2024
Kabul Tarihi/ Accepted: 11/04/2024
Online Yayın Tarihi/ Published: 16./06/2024

Atıf / Cited: Yavuz YE and et al. Assessing the Diagnostic Accuracy of the Smartwatch ECG in Detecting Complete Atrioventricular Block: A Case Report. *Online Türk Sağlık Bilimleri Dergisi* 2024;9(2):183-186. doi: 10.26453/otjhs.1434820

INTRODUCTION

Smartwatches are used for various purposes in cardiovascular medicine. These encompass the computation of risk for both individuals in good health and patients, the screening and diagnosis of acute coronary syndrome and cardiac dysrhythmia, and the identification of prolonged QT. Additionally, they are used for cardiac telerehabilitation, identifying electrolytic disorders, managing heart failure, and drug titration.[1] The electrocardiogram (ECG) application on Apple Watch Series-4 or subsequent models generates an ECG similar to a single-lead (Lead I) ECG. A single-lead ECG can furnish information regarding heart rate and rhythm. It has been demonstrated that it is possible and reliable to detect atrial fibrillation (AF) by monitoring the heart rate using optical sensors on the Apple Watch.[2] The ECG feature of the Apple Watch (Apple Inc., Cupertino, CA, USA) has received approval from the Food and Drug Administration (FDA) for AF detection.

Studies have shown that smartwatches, including the Apple Watch, can detect a range of arrhythmias beyond AF, such as ventricular tachycardia, atrial flutter, and bradyarrhythmias.[3,4] Although it was not originally designed for AF patients, its intended use is becoming increasingly common.

The third-degree (complete) atrioventricular (AV) block exhibits a relatively distinctive appearance on

the ECG, characterized by the presence of atrial (P waves) and ventricular (QRS complexes) activities that occur independently of each other, along with an atrial rate that surpasses the ventricular rate. ECG findings are critical in guiding AV block therapy. In recent years, technological advancement has led to the development of portable ECG devices integrated into smartwatches, allowing for continuous heart rhythm monitoring outside of clinical settings.[5] This innovation has great potential for early detection and management of cardiac conditions, including AV block, improving patient care and outcomes.

This study aimed to assess the effectiveness of the smartwatch ECG in detecting atrioventricular block.

CASE REPORT

The patient/relatives have signed an informed consent form, and the study was conducted following the international declaration. Ethics committee approval is not required.

A 71-year-old female patient, who has a medical background of hypertension and hyperlipidemia but lacks any established presence of coronary artery disease, was admitted to the emergency department due to experiencing symptoms of dizziness and weakness over three days. Bradycardia was noticed in the patient's first evaluation. Later, we were consulted on the ECG recordings taken after the AV complete block was seen. At the time of assessment, the hemodynamics was stable except for bradycardia. Cardiac and lung auscultation was not remarkable. Transthoracic echocardiography performed at admission showed that the left ventricular ejection fraction (LVEF) was 60%. Blood pressure was 142/88mmHg; pulse was between 30-35/min, respiratory rate was 26, and SaO2 was 98. Afterwards, the patient was admitted to the coronary intensive care unit for additional examination and therapy. Coronary angiography was planned when the patient's troponin values exceeded the upper limit. There was no evidence of chest pain, hypotension, signs of shock, altered cognitive condition, persistent chest pain due to ischemia, or sudden onset of pulmonary oedema, which were among the signs and symptoms of hemodynamic instability. Since the patient's complaints were relatively moderate, temporary intravenous pacemaker implantation was not considered. The patient was continuously monitored with on-site transcutaneous pacing pads. In this process, the patient's ECG was recorded three times for 30 seconds using an Apple Watch-6 (Figure 1A). It was compared with the patient's standard 12-lead ECG (Figure 1B).

The ECG recording taken with the Apple Watch-6 showed the AV complete block accurately. Later, the patient underwent coronary angiography with a preliminary diagnosis of NSMTI. Coronary angiography of the patient revealed critical stenosis in RCA (Figure 2A). There was no significant stenosis in the other coronary vessels (CX and LAD). The patient's rhythm returned to normal sinus rhythm within the first hour after recanalizing the RCA acute lesion (Figure 2B).

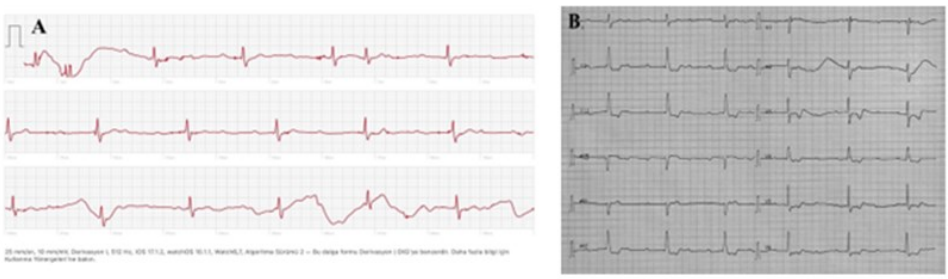

Figure 1. Apple Watch ECG single-lead (Lead I) recording before coronary angiography. A: Third-degree (complete) atrioventricular (AV); B: Traditional ECG recording before coronary angiography: Third-degree (complete) atrioventricular (AV).

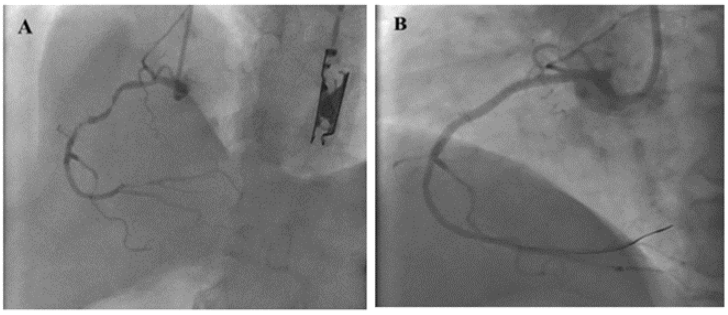

Figure 2. Coronary angiography baseline (A) and final images after revascularization (B).

After taking another ECG recording with the Apple Watch, it was confirmed that the complete block had been corrected (Figure 3A and Figure 3B).
During his hospital stay, both the conventional 12-lead ECG and continuous ECG monitoring using the Apple Watch 6 provided parallel and supporting data on his cardiac status. The patient's clinical condition, devoid of any complications, stabilized significantly, and she was discharged after two days of hospitalization.

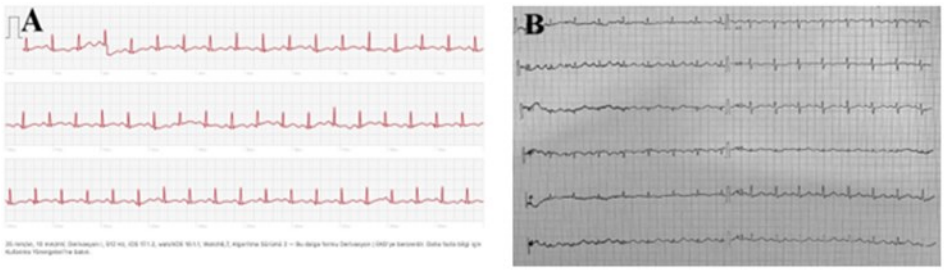

Figure 3. Apple Watch ECG single-lead (Lead I) recording after coronary angiography. A: Sinus rhythm; B: Traditional ECG recording after coronary angiography: Sinus rhythm.

DISCUSSION AND CONCLUSION

The comparative analysis between the Apple Watch ECG and the traditional 12-lead ECG demonstrated notable accuracy in the detection of complete AV block. Before the coronary angiography, the smartwatch ECG and the traditional 12-lead ECG both displayed a complete AV block, with matching characteristics in heart rhythm and rate. Following the revascularization of the RCA, both ECG methods showed a return to normal sinus rhythm within the first-hour post-procedure. This rapid normalization of the heart rhythm, consistently detected by both the smartwatch and traditional ECGs, highlights the potential of smartwatch technology in post-intervention monitoring. These results underscore the potential of wearable technology, such as the Apple Watch, to complement traditional diagnostic methods in detecting and monitoring significant cardiac events.
The core of our methodology revolves around the use of an Apple Watch equipped with the capability to perform an ECG comparable to a single-lead (Lead I) ECG. The choice of this device was influenced by its FDA approval for detecting arrhythmias such as atrial fibrillation, which underscores its reliability and potential utility in a clinical setting.
Smartwatches are experiencing a growing surge in popularity due to their ability to detect alterations in heart rhythm at a premature stage, thus aiding the individual in obtaining an early recommendation for admission to a medical facility in the presence of potentially severe ailments.[6]
The FDA has approved the ECG and irregular rhythm notification features of the Apple Watch, which are increasingly being used to detect arrhythmias.[7] Earlier research indicated that identifying premature atrial contractions and premature ventricular contractions through a 15-second single-lead ECG in middle-aged individuals without any cardiovascular disease is linked to a higher probability of developing atrial fibrillation and heart failure.[8] In another study, the smart device was placed in different body positions for recording. Multi-lead ECGs were recorded. After the data was combined, the Smartwatch ECG was consistent with the standard ECG for diagnosis. The precision of the smartwatch ECG in detecting ST segment alterations was excellent. The sensitivity of the smartwatch ECG to normal ECG was 84%, the sensitivity to ST elevation was 93%, and the sensitivity to NSTMI ECG changes was 94%.[9] In another study, bradyarrhythmias and tachyarrhythmias were accurately detected. Due to the limitations of the smartwatch, the diagnosis of atrial rhythms was made less accurate, while for ischemic heart disease, it resulted in high specificity but poor sensitivity. Multiple Apple Watch ECG recordings taken from different suitable locations have been shown to improve diagnostic accuracy.[5]
Smart devices, which can provide very important results in diagnosis and follow-up, particularly in arrhythmia, can accurately show vital rhythm disorders, as shown in our study. As a result, we think that the following points reflected in our practice are important. Unlike traditional ECGs, which record heart activity briefly during a clinic visit, Apple Watch provides continuous monitoring. This feature is particularly useful in catching intermittent heart abnormalities that may not be present during a doctor's visit but may occur occasionally in a home environment. Early diagnosis facilitates rapid medical intervention, which can prevent the progression of the current clinical condition and reduce the risk of complications.
Our study's findings should be viewed in the context

of the limitations of smartwatch ECG technology, which restricts the depth of cardiac analysis compared to a standard 12-lead ECG. While our results are promising, they should not replace traditional diagnostic tools in all clinical scenarios. As a case report, our research offers valuable insights but cannot definitively establish causality or generalize findings to a broader population. Further investigation through larger-scale research is needed to validate and extend our findings.

In conclusion, AV complete block, a type of life-threatening arrhythmia that may not show any obvious symptoms for a long time, was followed with a smart device comparatively. The observed consistency between Apple Watch and traditional 12-lead ECG in detecting and monitoring important cardiac events, such as complete AV block, highlights their potential to enhance clinical diagnosis and patient management at home or in routine care settings.

Ethics Committee Approval: The patient/relatives have signed an informed consent/consent form, and the study was conducted following the international declaration. Ethics committee approval is not required.

Conflict of Interest: No conflict of interest was declared by the authors.

Author Contributions: Concept – YEY, SG; Supervision – YEY, MA; Materials – YEY, EB; Data Collection and/or Processing – EB, MA; Analysis and/or Interpretation – YEY, MA, EB; Writing –YEY.

Peer-review: Externally peer-reviewed.

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