

Case Report

Apple Watch for Pulse Rate Assessment Detects Unidentified Paroxysmal Atrial Fibrillation

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Abstract: Consumer rhythm-monitoring devices, such as the Apple Watch, are becoming more readily available. Irregular pulses can be detected using an optical sensor built into the wearable device. The Apple Watch (Apple Inc., Cupertino, CA, USA) is a class II medical device with pulse rate and electrocardiography (ECG) monitoring capabilities. Here we report a case in which an arrhythmia that was conventionally perceived but undiagnosed was identified as atrial fibrillation by self-acquisition of ECG data using an Apple Watch.

Keywords: Apple Watch; wearable sensor; pulse rate; arrhythmia; atrial fibrillation; case report

1. Introduction

The Apple Watch (Apple Inc., Cupertino, CA, USA) is a class II medical device with pulse rate and electrocardiography (ECG) monitoring capabilities [1,2]. Consumer rhythm-monitoring devices, such as the Apple Watch, have become increasingly accessible. The Apple Watch detects pulse waves on the wrist using an optical heart rate sensor and measures fluctuations in the pulse interval at rest. The system notifies the user when an irregular pulse is detected [3,4]. Here we report a case in which arrhythmia, of which the patient was aware but had not yet received a definitive diagnosis, was identified as paroxysmal atrial fibrillation (AF) using an Apple Watch.

2. Case Presentation

A 59-year-old man taking medication for hypertension and hyperlipidemia had experienced occasional short-lasting arrhythmias for approximately 15 years. However, a 12-lead electrocardiogram, part of his annual physical examination, indicated no arrhythmia. The patient's awareness of arrhythmia had ceased in the previous five years. The patient also had untreated sleep apnea syndrome. And finally, he had been aware of an irregular heartbeat for approximately three months.

The patient was working on his personal computer in his office when he became aware of arrhythmia and simultaneously received a notification from his Apple watch that he was experiencing tachycardia exceeding 120 bpm (Figure 1). The patient's pulse rate exceeded 150 bpm, and he activated the ECG app on his Apple watch to obtain a series of ECG tracings (Figure 2: 30-sec ECG collected during an arrhythmic attack; Figure 3: 30-sec ECG collected at the time of the arrhythmia; Figure 4: 30-sec ECG collected 30 min after the arrhythmic attack). The patient was aware of the arrhythmia for approximately 3 minutes. Loss of consciousness did not occur. The arrhythmia resolved without intervention such as the Valsalva maneuver or carotid massage.

The ECG charts, which were converted to PDF files, were submitted to a cardiologist, who diagnosed the patient with paroxysmal AF.



Figure 1. Pulse rate chart recorded in iPhone.



Figure 2. Paroxysmal atrial fibrillation was detected during the arrhythmic attack (a) The first 1 min of an electrocardiogram collected immediately after notification of the tachycardic episode. 25 mm/s, 10 mm/mV, iOS 15.4.1, Apple Watch 4.2, algorithm ver. 1.



Figure 3. Paroxysmal atrial fibrillation was detected during the arrhythmic attack. Electrocardiogram collected during the second minute after notification of the tachycardic episode. 25 mm/s, 10 mm/mV, iOS 15.4.1, Apple Watch 4.2, algorithm ver. 1.



Figure 4. Electrocardiogram collected at 30 min after cessation of the arrhythmia. 25 mm/s, 10 mm/mV, iOS 15.4.1, Apple Watch 4.2, algorithm ver. 1.

3. Discussion

The Apple Watch has a background check function for high and low pulse rates, and the irregular pulse rate notification feature checks for an irregular pulse, which is indicative of AF [5,6]. The irregular pulse notification function uses an optical pulse rate sensor to detect pulse waves at the wrist and measure fluctuations in the resting pulse rate interval. When the algorithm detects repeated irregular pulse rates, a possible sign of AF, the user receives a notification and the date, time, and heart rate are recorded in the healthcare application of the paired iPhone. The ECG app, available on Apple Watch Series 4 and later, records a single-lead ECG similar to the I-lead ECG using an electric pulse rate sensor in the digital crown and a crystal on the back of Apple Watch Series 4 and later. The electrical signals acquired by the watch are transmitted to the paired iPhone, and a 30-s continuous ECG is made available as a PDF file. The single-lead ECG provides information on heart rate and heart rhythm and can be used to classify AF [1]. In the prospective single-group Apple Heart Study, 34% of individuals who received an arrhythmia notification were later diagnosed with AF, with a positive predictive value of 0.84. These estimates may help providers better understand the implications of irregular pulse notifications when patients present for clinical care [1,6-8].

Upon complaining of symptoms or the awareness of arrhythmia, the patient is subjected to Holter ECG testing for 24–48 hours for objective diagnosis or hospitalized for several days to monitor whether the symptom is considered to be caused by a dangerous arrhythmia that could result in loss of consciousness or death. However, hospitalization and wearing a Holter ECG for 48 hours is extremely burdensome for patients of working age, and in many cases, the diagnosis is not made due to a lack of time for monitoring. However, there are many cases in which the diagnosis is not made because the patient is asymptomatic during the test period. Failure to reach a diagnosis may result in missed opportunities for appropriate therapeutic intervention and, consequently, sudden death. Since the diagnosis of arrhythmia and the subsequent treatment plan depend entirely on symptomatic ECG findings, the use of an Apple Watch, which enables the diagnosis of arrhythmia in the symptomatic state during normal life, may significantly impact the future treatment of arrhythmia. The problem with apple watch at present is that the operation of recording is somewhat complicated for those who are not familiar with it. However, this will be easily resolved by the future refinement of the device.

The data from test results that we can see as healthcare professionals are limited to data collected during a patient's hospital visit. However, devices such as smartwatches and smartphones continue to accumulate data outside the hospital while being worn. The significant difference is that healthcare data still lack unified medical meaning and interpretation, while ECG tracings can be treated as established data. Sudden death is becoming an increasing problem in today's aging society. This sudden death is usually

preceded by loss of consciousness, and loss of consciousness while driving can cause serious accidents involving many surrounding vehicles and people. These are most often caused by cardiovascular disease, such as myocardial infarction and associated ventricular arrhythmias. However, it is extremely difficult to determine the risk of sudden death especially when the people has never been aware of the symptom. If wearable devices have the ability to detect and automatically record dangerous arrhythmias or significant ST-T changes, it will be possible to diagnose potential cardiovascular diseases in advance. In the near future, it is possible that the wearable device such as Apple watch will become an indispensable piece in medical diagnosis, and may even lead to a diagnostic revolution.

4. Conclusions

We reported a case in which an arrhythmia that was conventionally perceived but undiagnosed was identified as atrial fibrillation by self-acquisition of ECG data using an Apple Watch.

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