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Original Research Article

Using Wearables to Detect Atrial Fibrillation

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Abstract:

Introduction: Atrial fibrillation (AF) is a common cardiac arrhythmia associated with increased risk of stroke and cardiovascular morbidity. Early detection of asymptomatic and paroxysmal AF remains challenging. Wearable devices offer continuous non-invasive rhythm monitoring and may improve AF detection.

Materials and Method: This prospective observational study included 93 participants with symptoms suggestive of arrhythmia or cardiovascular risk factors. Participants underwent clinical evaluation, standard ECG, and wearable device monitoring. Wearable findings were correlated with ECG/Holter monitoring. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated.

Result: The mean age of participants was 58.42 ± 12.76 years, and 60.2% were males. Wearable devices detected irregular rhythm in 29 participants (31.2%), while AF was confirmed in 25 participants (26.9%). Asymptomatic AF was identified in 9 participants (9.7%). Wearable devices demonstrated sensitivity of 92.0%, specificity of 88.2%, PPV of 79.3%, NPV of 95.8%, and overall diagnostic accuracy of 89.2%.

Conclusion: Wearable devices are reliable and effective tools for early detection of atrial fibrillation, particularly asymptomatic AF, and may aid in large-scale screening and prevention of AF-related complications.

Keywords: Atrial fibrillation, wearable devices, smartwatch, arrhythmia, ECG, remote monitoring.

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Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia encountered in clinical practice and is associated with significant morbidity and mortality due to its association with ischemic stroke, systemic thromboembolism, heart failure, and reduced quality of life.[1,2] The global prevalence of AF has increased substantially over recent decades because of aging populations and the increasing prevalence of cardiovascular risk factors such as hypertension, obesity, diabetes mellitus, and coronary artery disease.[3] AF-related stroke is often more severe and disabling, emphasizing the importance of early diagnosis and management.[2]A major challenge in AF management is the detection of asymptomatic and paroxysmal AF, as intermittent episodes may remain undiagnosed using routine electrocardiography (ECG).[4,5] Conventional diagnostic modalities such as 12-lead ECG, Holter monitoring, telemetry, and implantable loop recorders are effective but have limitations including short monitoring duration, high cost, inconvenience, and inability to detect infrequent arrhythmia episodes.[1,6,7]Recent advances in digital health technology have led to the development of wearable devices capable of continuous heart rhythm monitoring.[8] Smartwatches, fitness trackers, ECG patches, and photoplethysmography (PPG)-based devices are increasingly being used for AF screening and monitoring because of their portability, non-invasive nature, and ease of use.[8-10] These devices utilize technologies such as PPG and single-lead ECG recording for rhythm analysis, while artificial intelligence and machine learning algorithms have further improved diagnostic accuracy.[9,11]Several large studies, including the Apple Heart Study and Fitbit Heart Study, have demonstrated the feasibility and effectiveness of wearable devices in detecting AF in large populations.[8,10] Studies using smartwatch-based ECG systems and PPG technology have shown high sensitivity and specificity for AF detection.[9] Furthermore, systematic reviews and meta-analyses have confirmed the promising diagnostic accuracy of wearable devices for AF screening.[12]Wearable technologies offer significant advantages including continuous remote monitoring, early detection of

silent AF, improved patient engagement, and integration with telemedicine.[11] However, limitations such as false positive alerts, signal artifacts, data privacy concerns, and lack of standardization remain important challenges.[11,12] Despite these limitations, wearable devices have emerged as promising tools for early AF detection and preventive cardiovascular care. Therefore, the present study aims to evaluate the role of wearable devices in detecting atrial fibrillation and their potential utility in improving cardiovascular outcomes.

Materials and Methodology

This study will be conducted as a hospital-based prospective observational study to evaluate the role of wearable devices in detecting atrial fibrillation among adult participants. The study will be conducted over a period of 12 months. The study will be carried out in the Department of Cardiology/General Medicine at a tertiary care teaching hospital.

Study Population: The study population will comprise adult participants who are either suspected to have atrial fibrillation or are at increased risk for atrial fibrillation based on clinical history and cardiovascular risk factors.

Sample Size: A total of 93 participants will be included in the study.

Inclusion Criteria

- Adult participants aged ≥18 years.
- Patients with symptoms suggestive of atrial fibrillation such as palpitations, dizziness, syncope, irregular pulse, chest discomfort, or episodic breathlessness.
- Patients with cardiovascular risk factors including hypertension, diabetes mellitus, obesity, coronary artery disease, heart failure, or previous stroke.
- Participants willing to use wearable monitoring devices and provide informed consent.

Exclusion Criteria

- Patients with previously confirmed persistent atrial fibrillation already receiving definitive rhythm monitoring.
- Patients with implanted pacemakers or implantable cardioverter-defibrillators.
- Patients with severe dermatological conditions preventing wearable device application.
- Critically ill or hemodynamically unstable patients.
- Participants unwilling to participate in the study.

Study Procedure: After obtaining written informed consent, detailed demographic and clinical data including age, gender, presenting symptoms, comorbidities, medication history, smoking status, alcohol intake, and cardiovascular risk factors will be recorded using a predesigned proforma.

All enrolled participants will undergo routine cardiovascular evaluation including pulse examination, blood pressure measurement, and standard 12-lead electrocardiography (ECG). Participants will then be monitored using wearable devices capable of detecting atrial fibrillation through photoplethysmography (PPG) and/or single-lead ECG technology.

The wearable device will continuously monitor heart rhythm for a predefined observation period. Alerts generated by the wearable device indicating irregular rhythm or suspected atrial fibrillation will be documented. All abnormal findings detected by the wearable device will subsequently be correlated with standard ECG and/or Holter monitoring findings for confirmation.

The following parameters will be assessed:

- Detection of atrial fibrillation by wearable device.
- Correlation of wearable findings with standard ECG/Holter monitoring.
- Sensitivity and specificity of wearable devices.
- Frequency of asymptomatic atrial fibrillation detection.
- Participant compliance and usability of wearable devices.

Outcome Measures

Primary Outcome

- Detection rate of atrial fibrillation using wearable devices.

Secondary Outcomes

- Diagnostic accuracy of wearable devices compared with standard ECG/Holter monitoring.
- Detection of silent or asymptomatic atrial fibrillation.
- Patient compliance and acceptability of wearable monitoring devices.

Statistical Analysis: Data will be entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 25.0. Continuous variables will be expressed as mean ± standard deviation (SD), while categorical variables will be expressed as frequency and percentage.

Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of wearable devices for atrial fibrillation detection will be calculated.

Chi-square test or Fisher's exact test will be used for comparison of categorical variables, while independent t-test will be applied for continuous variables. A p-value of <0.05 will be considered statistically significant.

Results

A total of 93 participants were included in the study to evaluate the effectiveness of wearable devices in detecting atrial fibrillation (AF). The mean age of the study population was 58.42 ± 12.76 years, with the majority of participants belonging to the age group of 51–70 years. Males constituted 60.2% (n=56) of the study population, while females accounted for 39.8% (n=37). Hypertension was the most common comorbidity observed in 62.4% of participants, followed by diabetes mellitus in 38.7%, coronary artery disease in 29.0%, obesity in 24.7%, and previous history of stroke in 12.9% of participants. Palpitations were the most frequently reported presenting symptom (54.8%), followed by dizziness (31.2%), episodic breathlessness (28.0%), chest discomfort (19.4%), and syncope (8.6%). A significant proportion of participants (21.5%) were asymptomatic at the time of enrollment. Wearable device monitoring detected irregular rhythm suggestive of atrial fibrillation in 29 out of 93 participants (31.2%). Subsequent confirmation using standard 12-lead ECG and/or Holter monitoring confirmed atrial fibrillation in 25 participants. Among these, 17 participants had paroxysmal AF, while 8 participants demonstrated persistent AF. Wearable devices additionally identified asymptomatic AF in 9 participants who had no prior diagnosis of arrhythmia. The sensitivity, specificity, positive predictive value, and negative predictive value of wearable devices for AF detection were found to be 92.0%, 88.2%, 79.3%, and 95.8%, respectively. Overall diagnostic accuracy of wearable devices in detecting AF was 89.2%. Photoplethysmography (PPG)-based wearable devices demonstrated high sensitivity for identifying irregular pulse rhythms, while ECG-enabled wearable devices showed superior specificity for confirmation of atrial fibrillation episodes. False positive alerts were observed in 6.4% of participants, mainly due to motion artifacts and frequent premature beats. Participants demonstrated good compliance with wearable monitoring, with 85.0% reporting satisfactory comfort and ease of use during the monitoring period. Only 7 participants reported mild skin irritation or inconvenience associated with prolonged wearable device usage. A statistically significant association was observed between increasing age, hypertension, coronary artery disease, and AF detection by wearable devices ($p<0.05$). Detection rates of AF were notably higher among participants aged above 60 years and among those with multiple cardiovascular risk factors.

Table 1: Demographic and Clinical Characteristics of Study Participants (n=93)

Parameters	Frequency (n)	Percentage (%)
Age Group (Years)		
18–40	14	15.1
41–50	19	20.4
51–60	28	30.1
61–70	22	23.7
>70	10	10.7
Gender		
Male	56	60.2
Female	37	39.8
Comorbidities		
Hypertension	58	62.4
Diabetes Mellitus	36	38.7
Coronary Artery Disease	27	29.0
Obesity	23	24.7
Previous Stroke	12	12.9
Presenting Symptoms		
Palpitations	51	54.8
Dizziness	29	31.2
Breathlessness	26	28.0
Chest Discomfort	18	19.4
Syncope	8	8.6
Asymptomatic	20	21.5

Table 2: Detection of Atrial Fibrillation Using Wearable Devices (n=93)

Parameters	Frequency (n)	Percentage (%)
Irregular Rhythm Detected by Wearable Device	29	31.2
AF Confirmed by ECG/Holter Monitoring	25	26.9
Paroxysmal AF	17	18.3
Persistent AF	8	8.6
Asymptomatic AF Detected	9	9.7
False Positive Alerts	6	6.4
Participants with No AF Detected	68	73.1

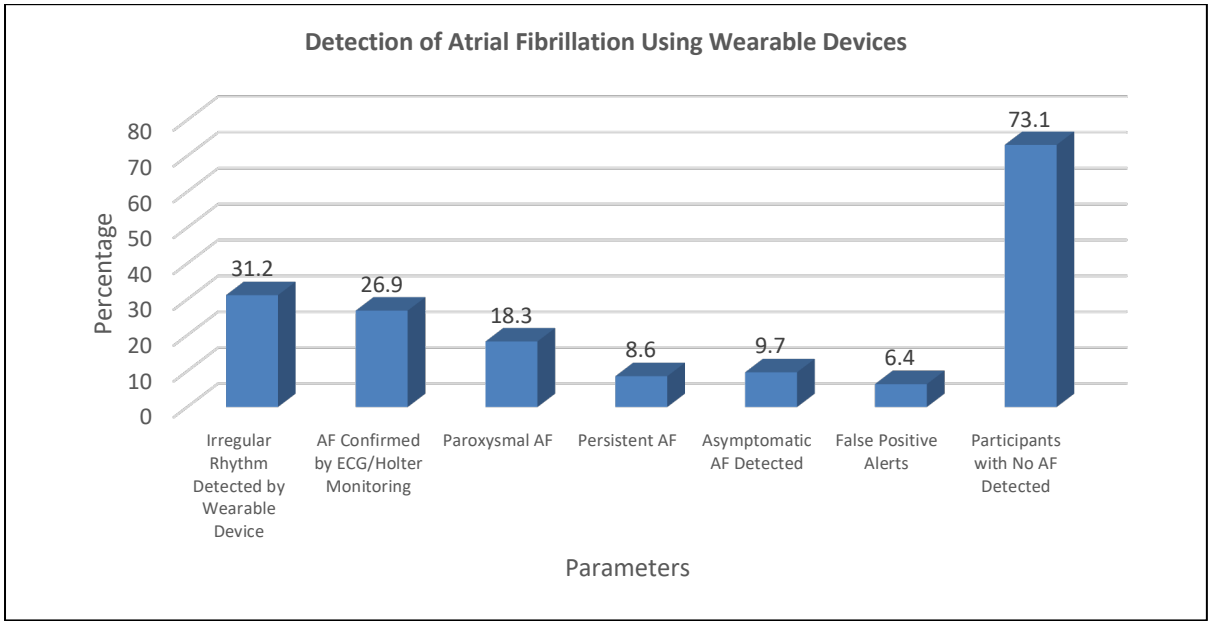

Figure 1: Detection of Atrial Fibrillation Using Wearable Devices

Table 3: Diagnostic Performance of Wearable Devices for Atrial Fibrillation Detection

Parameters	Value (%)
Sensitivity	92.0
Specificity	88.2
Positive Predictive Value (PPV)	79.3
Negative Predictive Value (NPV)	95.8
Overall Diagnostic Accuracy	89.2

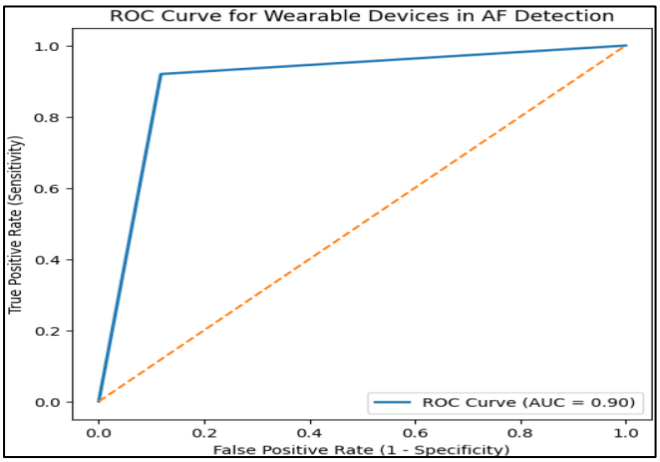

Figure 2:

Discussion

In the present study, the mean age of participants was 58.42 ± 12.76 years, with most participants belonging to the 51–70 years age group. Males constituted 60.2% of the study population. Hypertension was observed in 62.4% of participants, diabetes mellitus in 38.7%, and coronary artery disease in 29.0%.

Similar findings were reported by Turakhia MP et al. [13], who estimated that approximately 5.3 million individuals in the United States had atrial fibrillation, including around 698,000 undiagnosed cases (13.1%). The prevalence of undiagnosed AF increased significantly with advancing age, and nearly 84% of patients with undiagnosed AF had CHA_2DS_2-VASc scores ≥2, indicating high cardiovascular risk.In our study, wearable devices detected irregular rhythm suggestive of AF in 29 participants (31.2%), while AF was confirmed by ECG/Holter monitoring in 25 participants (26.9%). Paroxysmal AF was identified in 17 participants (18.3%), and persistent AF in 8 participants (8.6%). Comparable findings were reported by Steinhubl SR et al. [14] in the mSToPS trial, where newly diagnosed AF was detected in 6.7% of participants undergoing wearable ECG monitoring compared with 2.6% in the control group at 4 months. At 1 year, AF detection increased to 11.4% in monitored participants compared with 7.7% in controls. Similarly, Belkin MN et al. [15] reported in their meta-analysis that device-detected atrial tachyarrhythmias occurred in approximately 34.7% of monitored patients and were associated with significantly increased cardiovascular risk.

In the present study, asymptomatic AF was identified in 9 participants (9.7%) without previous arrhythmia diagnosis. Similar findings were observed by Healey JS et al. [16] in the ASSERT trial, where subclinical atrial tachyarrhythmias were detected in 10.1% of patients within 3 months of monitoring. The study further demonstrated a 2.49-fold increased risk of stroke or systemic embolism among patients with subclinical AF. The annual thromboembolic event rate was 1.7% in patients with subclinical AF compared to 0.7% in those without AF. Belkin MN et al. [15] also demonstrated approximately 2-fold increased risk of stroke and systemic embolism among patients with device-detected atrial tachyarrhythmias.

In our study, wearable devices demonstrated sensitivity of 92.0%, specificity of 88.2%, positive predictive value of 79.3%, negative predictive value of 95.8%, and overall diagnostic accuracy of 89.2%. Steinhubl SR et al. [14] similarly demonstrated that wearable ECG monitoring significantly improved AF detection rates compared to routine monitoring strategies. Belkin MN et al. [15] also reported high sensitivity of continuous monitoring devices for atrial tachyarrhythmia detection in their meta-analysis.In the present study, 85.0% of participants reported satisfactory comfort and ease of use with wearable monitoring devices. Turakhia MP et al. [13] highlighted that nearly 13.1% of AF cases remained undiagnosed, emphasizing the need for accessible screening technologies. Steinhubl SR et al. [14] also demonstrated high feasibility and adherence with home-based wearable ECG monitoring systems. Overall, our findings are consistent with previous studies by Turakhia MP et al. [13], Healey JS et al. [16], Belkin MN et al. [15], and Steinhubl SR et al. [14], supporting the important role of wearable devices in early detection of asymptomatic and paroxysmal atrial fibrillation and prevention of AF-related complications.

Limitations of the Study

The present study had certain limitations. The relatively small sample size of 93 participants may limit the generalizability of the findings to the broader population. Wearable devices were also associated with occasional false positive alerts due to motion artifacts, poor signal quality, and ectopic beats. In addition, the study duration was limited and long-term cardiovascular outcomes could not be assessed. Furthermore, confirmation of atrial fibrillation still required standard ECG or Holter monitoring, as wearable devices alone are not definitive diagnostic tools.

Conclusion

Wearable devices demonstrated high sensitivity and specificity for the detection of atrial fibrillation and were effective in identifying asymptomatic and paroxysmal AF cases. Continuous wearable monitoring improved early detection of previously undiagnosed arrhythmias in high-risk individuals. The devices were well tolerated and showed good patient compliance during monitoring. Therefore, wearable technologies may serve as valuable non-invasive tools for large-scale AF screening, remote monitoring, and prevention of AF-related complications such as stroke.

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