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Original Article

Accuracy of Cardiogoniometry in Diagnosing Acute Coronary Syndrome: A Cross-sectional Study

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ABSTRACT

Background: Ischemic heart disease (IHD) is the most common cause of mortality, and prompt treatment can be life-saving. Cardiogoniometry (CGM) is a noninvasive method that seems reliable for IHD diagnosis. This study aimed to determine the accuracy of CGM in IHD diagnosis in patients with suspected acute coronary syndrome (ACS), especially those with unstable angina or non–ST-elevation myocardial infarction (NSTEMI), whose diagnosis may be challenging.

Methods: This cross-sectional study was performed at Rajaie Cardiovascular Medical and Research Center, a tertiary public hospital. Forty-five patients with ACS in the emergency ward were enrolled. The patients underwent CGM about 24 hours before catheterization, and the results were compared with angiography as the gold standard for IHD diagnosis. The data were analyzed using the SPSS software and were reported separately for age, sex, and hypertension.

Results: The sensitivity and specificity of this method were 96.7% and 55.3%, respectively. The positive and negative predictive values were 80.6% and 88.9%, respectively.

Conclusions: CGM is a sensitive method for confirming or ruling out ACS. It is useful when the diagnosis is challenging, especially when ACS is suspected and electrocardiography or laboratory test results are unremarkable. Other studies are needed to confirm our conclusion. ***(Iranian Heart Journal 2023; 24(1): 39-44)***

KEYWORDS: Cardiogoniometry, Accuracy, Acute coronary syndrome, Coronary artery disease, Electrocardiogram

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Ischemic heart disease (IHD) is the principal cause of death the world over. [1] Early diagnosis is necessary, [2] and prompt management can limit the injured area of the heart damaged by acute coronary syndrome (ACS). [3] ACS is a situation in which myocardial ischemia occurs acutely. ACS comprises 3 different categories: ST-segment-elevation myocardial infarction (STEMI), non–ST-segment elevation myocardial infarction (NSTEMI), and unstable angina. [4]

In the routine practice in the emergency department, if a patient is suspected to have ACS, the diagnosis is made based on the patient's history, 12-lead electrocardiogram (ECG), biomarkers, and the stress test. [5] ECG is normal in 50% of patients with IHD, so its specificity is low in detecting IHD. [6] The exercise test is a useful method with sensitivity and specificity of 67% and 72%, respectively, in patients without prior MI. This method has several contraindications, including a history of a recent MI in the previous 2 days, unstable angina, uncontrolled cardiac arrhythmias, decompensated heart failure, and severe aortic stenosis causing symptoms. [7]

Cardiogoniometry (CGM) is a method to diagnose coronary artery disease (CAD). CGM was introduced by Sanz in 1983, and it is based on vector cardiography and 3D projections. CGM measures depolarization (QRS wave) and repolarization (T wave) in the frontal and oblique sagittal planes. Abnormal T waves in CGM appear long before they do in ECG. This method is noninvasive and useful for all patients with suspected ACS because it can be easily used in the emergency ward. Additionally, it causes no pain and has no contraindications. [8]

The aim of the present study was to determine the accuracy of CGM with a view to demonstrating its efficacy and promoting its use in the emergency department for a prompt diagnosis of ACS. Moreover, the roles of age, sex, and hypertension were evaluated.

METHODS

The present cross-sectional study was designed to determine the diagnostic accuracy of CGM in comparison with coronary angiography as the gold standard for IHD diagnosis. Forty-five patients were registered in this study, and the aim and the process of the study were explained to them. They were free to participate without paying any extra money for CGM. The study was approved by the institutional ethics committee.

The inclusion criteria were the suspected diagnosis of ACS, any indications for angiography, and negative results for troponin in the blood test. The exclusion criteria consisted of an ST-segment-elevation in ECG, an ST depression of <0.5 mm, positive results for troponin, a history of coronary artery bypass grafting, electrolyte abnormalities, and the diagnosis of drug toxicity. All the selected patients had suspected ACS, but the diagnosis had not been confirmed. The excluded patients were known cases of IHD or those whose diagnosis was confirmed by other methods, including laboratory tests and ECG.

Twenty-four hours before angiography, the patients underwent CGM using the Enverdis model. This study was interpreted as having a binary result. After angiography, the results were compared with the results of CGM for each patient. Cross-tab was used to compare the data and to determine the accuracy of CGM. Additionally, the Statistical Package for the Social Sciences (SPSS) for Microsoft Windows (SPSS Inc, Chicago Illinois) was used to analyze the data. Diagnostic accuracy contained 4 different indices: sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

RESULTS

The study population consisted of 48.9% females and 51.1% males. The mean age was 65±7 years. Further, 91% of the patients were hypertensive, and only 9% were non-

hypertensive. Concerning coronary artery stenosis, the left anterior descending artery had the highest frequency of stenosis (55.6%), followed by the right coronary artery (40%), the left circumflex artery (35.6%), and the left main (6.7%) (Fig. 1).

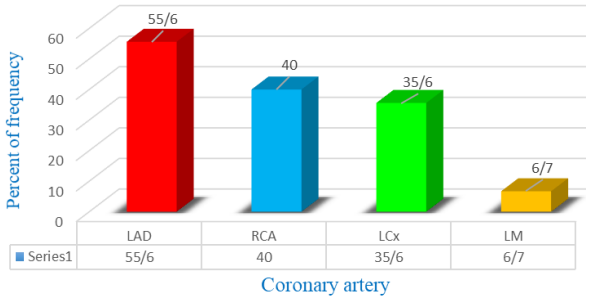

Figure 1: The image presents the amount of stenosis in the coronary arteries.

LAD, Left anterior descending artery; RCA, Right coronary artery; LCx, Left circumflex artery; LM, Left main coronary artery

The results included the accuracy of CGM in different groups based on sex, age, and hypertension.

1. Accuracy of CGM in males and females: Sensitivity was 100% in females and 94.7% in males. Specificity was 45.5% in females and 75% in males. PPV was 64.7% in females and 94.7% in males. In addition, NPV was 100% in females and 75% in males (Fig. 2).

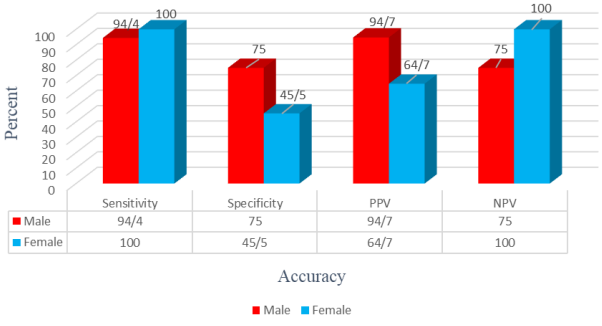

Figure 2: The image depicts the accuracy of CGM in males and females.

CGM, Cardiogoniometry; PPV, Positive predictive value; NPV, Negative predictive value

2. Accuracy of CGM with regard to age: The patients were divided into 2 age groups: ≥65 years and <65 years. Sensitivity was 100% in the younger and 96.4% in the older groups. Specificity was 50% in the younger and 66.7% in the older groups. PPV was 25% in the younger and 96.4% in the older groups. NPV was 100% in the younger and 66.7% in the older individuals (Fig. 3).

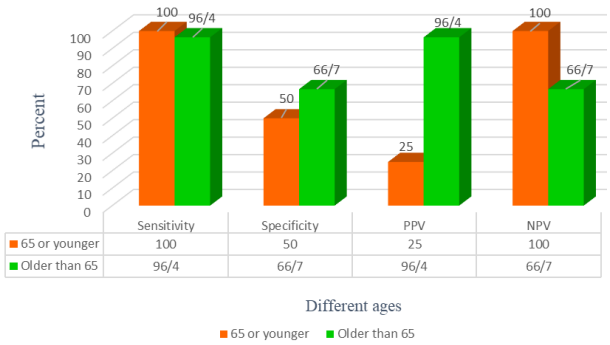

Figure 3: The image depicts the accuracy of CGM with regard to age.

CGM, Cardiogoniometry; PPV, Positive predictive value; NPV, Negative predictive value

3. Accuracy of CGM concerning hypertension: Sensitivity, specificity, PPV, and NPV were 100% in the non-hypertensive group. In the patients with hypertension, sensitivity and specificity were 96.6% and 41.7%, respectively. Additionally, in the hypertensive patients, PPV and NPV were 80% and 83.3%, respectively (Fig. 4).

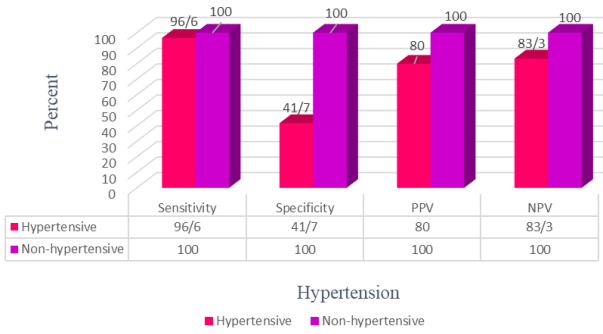

Figure 4: The image presents the accuracy of CGM with regard to hypertension.

CGM, Cardiogoniometry; PPV, Positive predictive value; NPV, Negative predictive value

4. The final results: The sensitivity and specificity of CGM were 96.7% and 53.3%, respectively. PPV and NPV were 80.6% and 88.9%, respectively (Fig. 5 & Table 1).
Moreover, the accuracy index (95% confidence interval [CI]) was 82.2% (68%–92%).

Table 1: Accuracy of cardiogoniometry

True positive	True Negative	False Positive	False Negative	Total
29	8	7	1	45
Sensitivity: 96.67% (CI, 82.78% to 99.92%) Specificity: 53.33% (CI, 26.59% to 78.73%) Positive predictive value: 80.56% (CI, 70.61% to 87.72%) Negative predictive value: 88.89% (CI, 52.38% to 98.31%)				

CI, Confidence interval

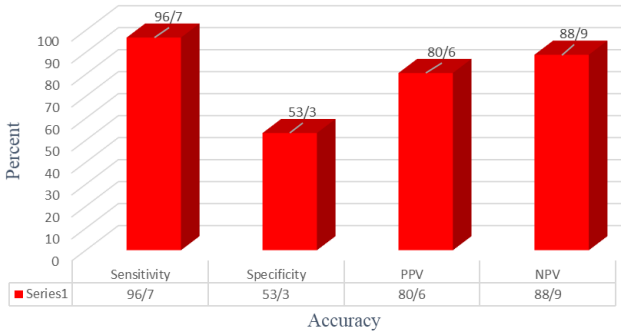

Figure 5: The image presents the final results.

PPV, Positive predictive value; NPV, Negative predictive value

DISCUSSION

Based on the results of the current study, the sensitivity of CGM is high (96.7%); accordingly, it is very sensitive for the diagnosis of CAD. This method can be used for patients who demonstrate the risk factors of IHD but whose ECG is unremarkable. Moreover, CGM is useful for patients who have contraindications for the exercise test or in situations where the exercise test is not available. Because of the low level of specificity, other differential diagnoses for ACS should be considered. On the strength of its good PPV, CGM can be considered a reliable method for IHD diagnosis. Given the acceptable level of NPV, CGM is a good method of ruling out ACS.
The sensitivity and specificity of CGM have been assessed in several studies. Its sensitivity ranges from 79% to 89%, and its specificity ranges from 64% to 82%. [6, 9-13] In several studies, the accuracy of CGM was compared with that of ECG. In most of them, CGM was superior to ECG, [11-13] but in 1 study, the specificity of ECG was higher. [6]
CGM in physical stress was studied by Weber et al. [14] The sensitivity and specificity at rest were 39% and 63%, respectively, and the sensitivity and specificity after stress were 42% and 57%, respectively.
In the current investigation, in addition to the final results, sensitivity, specificity, PPV, and NPV were determined with regard to age, sex, and hypertension.
We divided the study population into 2 age groups, as mentioned above. Sensitivity in both groups was good and almost similar. Specificity was lower in younger patients. PPV was higher in older individuals, and NPV was higher in the younger group. Based on these data, CGM can be reliably used in both age groups for CAD diagnosis, but it is better for ruling out CAD in patients aged <65 years.
We also divided our patients into 2 groups based on sex. Sensitivity was high in both groups. In the female group, specificity and PPV were lower, and NPV was higher. Based on the obtained data, CGM is sensitive in both groups. In women presenting with ACS, other differential diagnoses of CAD should be considered. CGM is also more useful for ruling out CAD in females.
All the accuracy indices were 100% among our non-hypertensive patients. Although the results were different in the presence of hypertension, most of our patients were hypertensive. The difference between the number of hypertensive and non-

hypertensive patients renders a comparison between these 2 groups unreliable.

Limitations

Confidence intervals (CI) were wide, suggesting that a larger sample size is needed. Although the results were acceptable, more studies are needed to replicate and confirm them and to achieve definite results.

Hypertension was the other limitation of this study. Most of our patients were hypertensive, and a reliable comparison between patients with and without hypertension was not possible. Consequently, more reliable results require further studies to compare CGM results between hypertensive and non-hypertensive patients with equal participants in each group. Moreover, it may be useful to conduct other studies to compare CGM between diabetic and nondiabetic patients or to compare smokers and nonsmokers.

CONCLUSIONS

CGM was sensitive in the diagnosis of IHD. Furthermore, PPV and NPV were acceptable. Therefore, this technique could be used to confirm or rule out IHD. CGM is painless, can be used in the emergency ward or the patient's room, and does not harm the patient in any way.

CGM should be added to ECG in order to obtain better results for the early management of patients. Additionally, it can be an economical method by making extra laboratory tests unnecessary.

In conclusion, CGM is recommended to be used alongside ECG in the emergency wards or clinics for patients with suspected IHD. It can be used in challenging patients who show risk factors of IHD but whose ECG is negative, in patients who may have contraindications for the exercise test, or in patients for whom the exercise test is not available. Other studies are needed to confirm our conclusion.

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