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Acil Servise Göğüs Ağrısı ile Başvuran Hastalarda Perfüzyon İndeksi ve Pleth Variability Index'in Diagnostik Etkinliği

Diagnostic Efficacy of Perfusion Index and Pleth Variability Index in Patients Admitted to the Emergency Department with Chest Pain

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Öz

Giriş ve Amaç: Akut koroner sendrom (AKS) dünya çapında ölümlerin en önemli sebebidir. Bu nedenle acil servise göğüs ağrısı ile başvuran hastalarda hızlı bir şekilde ayırıcı tanı ve tedavinin yapılması gerekmektedir. Hızlı tanı ve tedavinin hayat kurtarıcı olduğu bu patolojide her geçen gün yeni tanı yöntemleri öne sürülmektedir. Bu çalışma ile göğüs ağrısı ile acil servise başvuran hastaların değerlendirilmesinde Perfusion Index (PI) ve Pleth Variability Index (PVI) ölçümlerinin katkısının ortaya konulması amaçlanmaktadır.

Gereç ve Yöntemler: Acil servise göğüs ağrısı ile 01/04/2019-01/10/2019 tarihleri arasında başvuran bütün erişkin hastalara rutin klinik işleyiş sırasında çalışmaya kör olan eğitimli bir triaj hemşiresi tarafından Masimo Radical 7 Pulse Oksimetre Cihazı ile PI and PVI ölçümü yapıldı. Hastaların demografik özellikleri, PI, PVI, HEART skoru, EKG bulguları ve troponin değerleri kayıt edildi.

Bulgular: Çalışmamıza 96 (%62,3)'sı erkek, toplam 154 hasta dahil edildi. Yaş ortalaması erkeklerde 55.1 ±18.2, kadınlarda 56,8 ±20,2, toplamda 56,3±18,9 yıl olarak hesaplandı. Hastaların 66 (%42,8)'sının AKS tanısı ile hastaneye yatırıldığı, 88(%57,2) hastanın ise taburcu edildiği saptandı. AKS tanısı alan hastalar ile taburcu edilen hastalar karşılaştırıldığında; yatan hastaların istatistiksel olarak daha yüksek Troponin, HEART skoru ve yaş ortalaması sahip olduğu görüldü. İki grup arasında PI ve PVI açısından bir farklılık saptanmadı.

Sonuç: PI ve PVI'nın acil serviste AKS şüphesi ile değerlendirilen hastaların yönetiminde acil hekimlerine katkısının sınırlı olacağı görüşündeyiz.

Anahtar Kelimeler: Akut koroner sendrom, Göğüs ağrısı, Perfüzyon indeksi, Pleth variability index

Abstract

Objective: Acute coronary syndrome (ACS) is the leading cause of death worldwide. Therefore, rapid differential diagnosis and treatment is required in patients who present to the emergency department (ED) with chest pain. In this disorder, in which rapid diagnosis and treatment are life-saving, novel diagnostic methods are being proposed every day. This study aimed to reveal the contributions of the Perfusion Index (PI) and the Pleth Variability Index (PVI) measurements to management of patients with chest pain.

Materials and Methods: PI and PVI measurements were carried out during routine clinical procedure by a trained triage nurse who was blinded to the study using the Masimo Radical 7 Pulse Oximetry Device in all adult patients who were admitted to the ED with the complaint of chest pain between April 1st, 2019 and October 1st, 2019. The demographic characteristics, PI, PVI, HEART score, ECG findings, and troponin levels were recorded.

Results: A total of 154 patients, 96 (62.3%) of whom were males, were included in our study. The mean age was calculated as 55.1 ±18.2 years in men, 56.8 ±20.2 years in women, and 56.3±18.9 years in total. Of all patients, 66 (42.8%) were hospitalized with ACS diagnosis, and 88 (57.2%) were discharged from ED. The hospitalized patients had statistically higher values for Troponin, HEART score, and mean age. There was no difference between the two groups regarding PI and PVI.
Conclusion: We think that the contributions of PI and PVI to emergency physicians in the management of patients who are evaluated with suspicion of ACS in the ED will be limited.

Keywords: Acute coronary syndrome, Chest pain, Perfusion Index, Pleth Variability Index

1.Introduction

Acute Coronary Syndrome (ACS) is the most important cause of death worldwide and one of the most critical disorders that need to be diagnosed rapidly in patients who present to the emergency department (ED) with chest pain. For this reason, guidelines have recommended that electrocardiography (ECG) should be performed within the first ten minutes of admission, and an investigation for the cardiac enzymes should be performed immediately after obtaining a focused story in patients presenting to the ED with chest pain [1,2]. In this disorder, in which rapid diagnosis and treatment are life-saving, new diagnostic methods are being proposed day by day.

Photoplethysmography is commonly used in patient monitoring as a noninvasive method based on the absorption of infrared light by tissues. Due to pulsatile blood flow in peripheral tissues, the amount of light absorbed varies with each heartbeat. Perfusion Index (PI) is a parameter determined by comparing the amount of infrared light recorded by the photoplethysmograph in both the pulsatile and non-pulsatile periods in a specific region (e.g., the hand finger or foot) and believed to be a reliable indicator of peripheral perfusion [3]. Pleth Variability Index (PVI) is a parameter that measures the changes in PI due to the ventilatory cycle and is considered to be an indicator of cardiac output and intravascular volume [3]. Due to their properties, it is evident that both PI and PVI are closely associated with cardiac function.

This study aimed to reveal the contributions of the PI and PVI to the rapid assessment and diagnosis of patients with chest pain, a significant and common indicator of cardiac dysfunction.

2.Materials and Methods

This study was a prospective, cross-sectional, single-center study conducted in patients admitted to the ED of Suleyman Demirel University Hospital, Isparta. Ethical approval was obtained from the local ethics committee (protocol# 2018/206). This study was supported by Suleyman Demirel University Scientific Research Projects Coordination Unit (project no: TTU-2019-6951)

PI and PVI measurements were performed by a trained triage nurse, blinded to the study, using the Masimo Radical-7 Pulse Oximetry Device (Masimo Corporation, Irvine, CA) during the routine clinical evaluation process such as anamnesis, physical examination, and ECG in all adult patients (age>18 years) who presented to the ED with acute-onset chest pain between April 1st, 2019 and October 1st, 2019. The oximeter probe used for measuring PI and PVI was placed at the index fingertip of the right hand, and the value was recorded after a fixed value was observed on the monitor or after waiting for 60 seconds. Triage nurses working in the ED are regularly trained on using the device for measurement. Then, the patients whom emergency physicians followed up with the preliminary diagnosis of ACS were included in the study. All patients included in this study were diagnosed and treated according to the American Heart Association's guideline for managing ACS in adults [1,2]. The patients' demographic characteristics (age, gender), systolic/diastolic blood pressures (SBP/DBP), Heart Rate (HR), PI, PVI measured at admission, the HEART score, ECG findings (ST-elevation/non-specific changes/normal) and high-sensitivity cardiac troponin T (hs-cTnT) values were recorded.

Patients who did not have a preliminary diagnosis of ACS at the initial evaluation and did not undergo cardiac follow-up, who were diagnosed with ACS in a peripheral center and referred to cardiology, those with a history of peripheral artery disease, a chest trauma within the last week, a non-cardiac diagnosis such as pneumonia or pneumothorax that explained the chest pain, and pregnant patients were excluded from the study.

2.1.Statistical Analysis

The study's data were evaluated for statistical analysis using the Statistical Package for Social Sciences (SPSS) for Windows, version 22 software. The Kolmogorov-Smirnov test assessed the normalization of numerical data distribution. Since numerical data did not have a normal distribution, the Mann-Whitney U test was used for statistical analysis, and descriptive statistics were shown as mean ±standard deviation and median (min-max). The Chi-square test was used to make statistical analyses for categorical variables, and descriptive statistics were shown as frequency (%). $p<0.05$ was considered statistically significant.

3.Results and Discussion

3.1. Results

A total of 154 patients, 96 (62.3%) of whom were males, were included in our study. The average age was 55.1 ± 18.2 years in males, 56.8 ± 20.2 years in females, and 56.3 ± 18.9 years in general. The

demographic, clinical, and laboratory values of the patients were presented in detail in Table 1.

Table 1. Demographic, clinical, and laboratory data of patients

Gender (n)	**Male**	**96 (%62.3)**
	Female	58 (%37.7)
Age (year)	Male	55.1 ±18.2
	Female	56.8 ±20.2
	Total	56.3 ±18.9
Blood pressure (mmHg)	Systolic	136.7 ±24.4
	Diastolic	80.3 ±14.2
Pulse (beats/min)		81.5 ±17.7
ECG (n)	ST elevation	15 (%9.4)
	Non-specific change	44 (%27.3)
	Normal	95 (%63.3)
Intermediate Outcome (n)	Hospitalization	66 (%42.8)
	Discharge	88 (%57.2)
High-sensitivity cardiac troponin T (ng/ml)		0.068 ±0.217
HEART score		4.8 ±2.3
PI		4.4 ±3.0
PVI		21.7 ±11.2

ECG: Electrocardiography, PI: Perfusion Index, PVI: Pleth Variability Index

It was found that the cardiology department hospitalized 66 (42.8%) patients with ACS diagnosis. When the patients diagnosed with ACS and the discharged patients were compared, it was found that the hospitalized patient group had statistically significantly higher hs-cTnT value, HEART score, and average age. There were no significant differences between the two groups regarding PI and PVI values (Table 2).

Table 2. Comparison of the hospitalized and discharged patients

	Hospitalized (n:66)	**Discharged (n:88)**	**p-value**
Age (years)	63.20 ±13.79	51.35 ±20.61	**<0.001**
Gender (m/f)	46/20	50/38	0.077
Systolic blood pressure (mm Hg)	140.0 ±25.1	134.3 ±23.7	0.223
Diastolic blood pressure (mmHg)	81.2 ±13.1	79.6 ±15.1	0.599
Pulse (beats/mın)	81.6 ±17.7	81.4 ±17.7	0.716
High-sensitivity cardiac troponin T (ng/ml)	0.138 ±0.310	0.010 ±0.014	**<0.001**
HEART score	6.64 ±1.72	3.57 ±1.83	**<0.001**
PI	4.81 ±3.09	4.11 ±2.92	0.140
PVI	23.26 ±13.84	20.53 ±8.80	0.445

PI: Perfusion Index, PVI: Pleth Variability Index

3.2. Discussion

Our study revealed that the PI and PVI values measured at admission in patients with chest pain who were followed up with suspicion of ACS in the ED were not effective in diagnosing ACS. PI and PVI measurements, which are considered objective indicators of peripheral circulatory disorders, have been investigated in many clinical disorders [3-6]. On the other hand, to the best of our knowledge, there is no study in the literature investigating PI and PVI measurements' effectiveness in ACS patients. In this respect, our study is important because it is the first study in the literature. Our study showed that the patient group hospitalized with ACS diagnosis had a higher age, hs-cTnT value, and HEART score as expected. These results were valuable since they showed that our study was compatible with the literature and that our results could be generalized.

PI has been an increasingly commonly used method for peripheral perfusion measurement in recent years. Various studies have shown that a PI value above 1.4 was an indicator of impaired peripheral perfusion [4]. On the other hand, controversial results have been reported in studies on PI in the ED. While Pirneskoski et al. suggested that pulse photoplethysmography wave amplitude could be used for patient assessment in the emergency room, Oskay et al. reported that PI was an insignificant parameter to predict the hospitalization and mortality status in the ED [7,8]. Even though only patients with chest pain were studied in our study, PI was an insignificant

parameter to decide for hospitalization in the ED or diagnosing ACS. Besides, both PI and PVI were previously shown to be affected by sympathetic activity [9,10]. In this respect, the fact that there were no differences between the two groups regarding hemodynamic parameters (SBP, DBP, HR) supports the absence of any difference between the groups regarding PI and PVI values.

PVI is a new parameter based on measuring dynamic changes in PI due to the ventilatory effect. Even though its use has been suggested to be limited in patients with spontaneous breathing due to difficulties in keeping the ventilatory pressures fixed, it has been considered that PVI provided information about the intravascular volume and cardiac functions to the clinicians [9]. Keller et al. reported in patients with spontaneous breathing that while cardiac output increased with passive leg raising, PVI decreased significantly, and the other hemodynamic parameters did not change significantly [11]. We hypothesized that PVI might have a role in diagnosing ACS in patients with chest pain, considering that myocardial infarction would affect cardiac output and thus, would cause a change in PVI, but our study revealed no significant difference between patients diagnosed with ACS and those who were discharged.

Study Limitations

Our study involved various limitations besides being primarily single-centered. A detailed comparison of ACS types could not be made in the patients included in our study. The cause of this situation was the relatively small number of patients with ST-segment elevation myocardial infarction (STEMI), and more importantly, this study aimed to investigate the effectiveness of PI and PVI in ACS diagnosis.

5. Conclusion

In conclusion, PI and PVI have been promising as easily applicable, repeatable, and objective parameters that clinicians would benefit from in many fields such as peripheral perfusion, cardiac function, and cardiac output in recent years. On the other hand, even though we think that PI and PVI will have limited contributions to emergency physicians while evaluating their patients with suspicion of ACS in the ED, it is evident that more comprehensive studies with more cases are needed.

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