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WORD COUNT 2582
TIME SUBMITTED 29-AUG-2024 09:47AM
PAPER ID 111371448

AMALTEA MEDICAL PUBLISHING HOUSE

Words cont – 2,582

https://medscience.center/journals/

ORIGINAL ARTICLE

Correlation of peripheral arterial disease (PAD) with severity of heart failure in patients with type 2 diabetes mellitus

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Abstract

Background: Ankle Brachial Index (ABI) is a simple method to diagnose and assess the severity of peripheral arterial disease (PAD) and to evaluate cardiovascular prognosis in the general population. This study aims to determine the association between ABI value and the severity of heart failure in patients with type 2 diabetes mellitus. Type 2 diabetes concerns can manifest as macrovascular issues such as heart failure and microvascular issues such as peripheral arterial disease.

Methods: Cross-sectional study was conducted at Hasanuddin University Hospital and Dr. Wahidin Sudirohusodo Hospital. Patients diagnosed with type 2 diabetes mellitus and heart failure among the ages of 40 and 60 were included. Ankle Brachial Index was a comparison of ankle artery systolic blood pressure values with brachial artery systolic blood pressure. Data were analyzed using a Spearman and Chi-square tests.

Results: Of the 50 participants who fulfilled the study's eligibility criteria, the majority of them (60.0%) had a moderate ABI degree. The results of this study showed a moderate coefficient correlation (R=0.289) and a significant positive relationship (p<0.05) between ABI and heart failure. Furthermore, our study suggested that participants with HFrEF had significantly higher moderate ABI degrees (p<0.05).

Conclusion: This study found there was a significant association between moderate ABI degrees with severity of heart failure. The low level of ABI was proportional to the low level of Left Ventricle Ejection Fraction.

Keywords: PAD, heart failure, diabetes mellitus, ABI

INTRODUCTION

Hyperglycemia, a complication of type 2 diabetes mellitus (DM), is a metabolic disease caused by defects in insulin secretion, insulin function, or both. Concerns regarding type 2 diabetes can manifest either as microvascular problems like peripheral arterial disease (PAD) or macrovascular problems like heart failure [1,2]. Diabetes mellitus increases the risk of heart failure which leads directly to cardiomyopathy and significantly contributes to coronary heart disease [2,3]. Anoop et al. studied the association of type 2 diabetes mellitus with the incidence of cardiovascular events and discovered that diabetes is substantially related with an elevated risk of cardiovascular disease. It is further explained in their study that the two most prevalent early signs of cardiovascular disease in people with type 2 diabetes are peripheral arterial disease and heart failure [4].

Ankle Brachial Index (ABI) is a non-invasive screening test to detect the presence of PAD. The American Heart Association (AHA) also suggests the ABI test due to its sensitivity and specificity for PAD. Research that has been conducted over the past few decades indicates that ABI is not only a diagnostic tool but also a prognostic and systemic atherosclerotic marker predictor of cardiovascular events although in the absence of clinical manifestations of PAD [5,6]. In the Cardiovascular Health Study (CHS) an ABI <0.90 was linked to an elevated risk of heart failure in individuals without congestive heart failure (relative risk 1.61; 95% CI 1.14-2.29). In the Heart Outcomes Prevention Evaluation (HOPE) trial, the incidence of heart failure

was higher in those with clinical evidence of PAD or an ABI <0.9 (4.6%) compared to those with a normal ABI (2.6%) [7,8]. Therefore, we conducted this study to determine the association between ABI value and the severity of heart failure in patients with type 2 diabetes mellitus as an opportunity for early diagnosis of complications of type 2 diabetes mellitus.

METHODS

Patient population

This study worked with an analytic observational study with a cross-sectional design at Dr. Wahidin Sudirohusodo Hospital and Hasanuddin University Hospital from April 2024 until the minimum sample size was reached. Our minimum sample size was 47 patients. A total of 50 samples were collected met the inclusion and exclusion criteria.

Inclusion and exclusion criteria

Subjects were included in this study if they met the following criteria: inpatients and outpatients at Wahidin Sudirohusodo Hospital and Hasanuddin University Hospital who are 40–60 years old and have been diagnosed with heart failure and type 2 diabetes mellitus. All of the subjects agreed to complete a series of examinations and signed an informed consent. The exclusion criteria were Subjects with congenital heart disease, malignancy, and a history of vascular diseases such as thrombosis and peripheral arterial disease.

Clinical data and sample collection

Sampling was carried out by consecutive sampling, subjects who met the inclusion and exclusion criteria were included in the study. The Criteria objectives of Diabetes mellitus in this study were patients who have been diagnosed with diabetes or a history of type 2 DM with HbA1C levels ≥6.5 or fasting blood levels ≥126 mg/dl and oral glucose tolerance test (OGTT) levels ≥200 mg/dl.

Ankle Brachial Index was a comparison of ankle artery systolic blood pressure values with brachial artery systolic blood pressure whose values are obtained by direct measurement on both arms and legs of the patient. ABI values are categorized into four interpretations: >1.4:

Calcification / stiff blood vessels, 0.9-1.4: Normal, 0.4-0.9: Moderate arterial disease, < 0.4: severe artery disease [6].

Heart failure is defined as a clinical syndrome with signs and symptoms caused by abnormalities in cardiac structure and/or function Classification of heart failure in this study based on Left Ventricular Ejection Fraction (LVEF) through Echocardiography examination Which is Categorized into three groups: HF with reduced EF (LVEF ≤40%), HF with mildly reduced EF (LVEF 41%–49%) and HF with preserved EF (LVEF ≥50%) [9].

Statistical analysis

Data were analyzed using Statistical Product and Service Solution (SPSS) version 25. The analysis method consists of descriptive methods and statistical tests. The statistical tests utilized were Spearman and Chi-Square tests. Statistical test results were considered significant if the p-value was <0.05. The results obtained will be presented in the narrative form which is complemented by tables and figures.

The Ethics Committee of the Faculty of Medicine, Universitas Hasanuddin, Makassar, South Celebes, has accepted our protocols. According to recommendation letter 396/UN4.6.4.5.31/ PP36/ 2024 with protocol number UH24050279.

RESULTS

This study consisted of 50 participants who met the study criteria. Thirteen participants (26%) were female, while 37 participants (74.0%) were male. The participants ranged in age from 36 to 77 years, with a mean age of 57.4±8.6 years. The range of ABI value was 0.42-1.30 with a mean of 0.90±0.20. Based on the ABI category, the degree of moderate ABI value was found to be higher in 30 subjects (60.0%) compared to normal ABI in 20 subjects (40%). The highest degree of heart failure was HFmrEF in 29 (58%) participants (Table 1).

Table 1. Subjects' characteristics (n 50)

Variable	N (50)	%
Sex		
Female	13	26,0
Male	37	74,0

Age		
<60 years	28	56,0
≥ 60 years	22	44,0
BMI		
Obese	26	52,0
Non-Obese	24	48,0
Hypertension		
Yes	36	72,0
No	14	28,0
ABI Degrees		
Moderate	30	60,0
Normal	20	40,0
Severity of HF		
HFrEF	10	20,0
HFmrEF	29	58,0
HFpEF	11	22,0
Lipid Fraction		
1 HDL	27	54,0
2 Trigliserida	14	28,0
3-4 LDL-Cholesterol total	9	18,0

BMI: Body Mass Index; ABI: Ankle Brachial Index; HF: Heart Failure; HFrEF: Heart Failure reduced Ejection Fraction; HFmrEF: Heart Failure mildly reduced Ejection Fraction HFpEF: Heart Failure preserved Ejection Fraction; HDL: High-Density Lipoprotein; LDL : Low-Density Lipoprotein

Our study found There was a significant positive correlation between ABI and heart failure ($p<0.05$) with a correlation coefficient (R) of 0.289 (Figure 1).

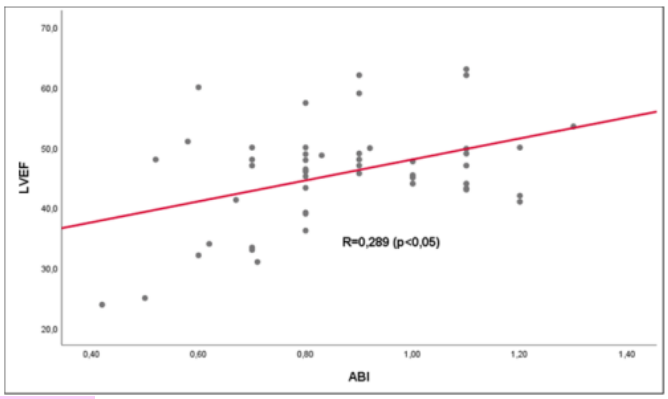

Figure 1: correlation between ABI and heart failure

Based on Table 2, subjects with HFrEF were found to be significantly higher in moderate ABI (33.3%) than in normal ABI (0%). Meanwhile, the proportion of subjects with HFmrEF and HFpEF was found to be significantly higher in normal ABI (75.0% and 25.0%) than in moderate ABI (46.7% and 20.0%). Based on Chi-Square results, a significant relationship was found between the degree of ABI and the severity of heart failure ($p<0.05$)

Table 2: Relationship between ABI and Severity of heart failure

ABI degrees		Severity of Heart Failure			Total	p
		HFrEF	HFmrEF	HFpEF		
Moderate	n	10	14	6	30	0,015
	%	33,3%	46,7%	20,0%	100,0%	
Normal	n	0	15	5	20	
	%	0,0%	75,0%	25,0%	100,0%	
Total	n	10	29	11	50	
	%	20,0%	58,0%	22,0%	100,0%	

DISCUSSION

This study involved 50 subjects who met the study criteria. Subjects in this study were predominantly male with a total of 37 (74%) subjects. The age range of the subjects was 36-77 years. The average ABI value was 0.90±0.20 with most of the participants (60.0%) having a moderate ABI degree. The LVEF value of the subjects was between 23.9% - 63.0% with the highest degree of heart failure being HFmrEF in 29 (58%) participants.

We examined the relationship between ABI and heart failure in this study and discovered that there was a moderate (R=0.289) but statistically significant positive connection ($p <0.05$). This suggests that the lower LVEF value was correlated with lower ABI values. This outcome is consistent with other studies; Gupta et al. found a significant correlation between an elevated risk of heart failure and a low ABI value ($p <1.00$) of one randomly selected lower extremity [7]. The same results were also presented by the Cardiovascular Health Study which demonstrated that ABI <0.90 was independently associated with an increased risk of heart failure [10].

In addition, our research also analyzed the relationship between the degree of ABI value and the severity of heart failure and found that participants with HFrEF had significantly higher moderate ABI degrees than those with normal ABI values (p <0,05). Sadeghi et al. have discovered that ABI <0.90 increases the risk of heart failure which concluded that ABI can be a useful method in assessing risk factors for atherosclerosis and the degree of coronary involvement in patients who have risk factors [11]. Another study by Prasada et al. also revealed that low ABI values are also associated with heart failure, especially in HFrEF [12]. According to research by Marc et al., participants with heart failure and symptomatic PAD are more likely to experience vascular disease events [13].

The Ankle-Brachial Index is linked to vascular atherosclerosis and cardiovascular disease risk factors, and it acts as a marker of systemic atherosclerosis. Numerous cardiovascular risk factors are linked to a low ABI, such as smoking history, dyslipidemia, hypertension, diabetes mellitus, and some recent cardiovascular risk factors (e.g., C-reactive protein, interleukin-6, homocysteine, and chronic kidney disease) [14]. In this study we investigated confounding variables to the severity of heart failure and degrees of ABI value, we found that participants with comorbid hypertension had a significant association with the degree of ABI value and the severity of heart failure (p<0.05). Padron et al have reported that ABI values less than 0.9 were associated with hypertension and HDL values [15]. A different study conducted by Khukhua et al. suggested that Patients with blood pressure more than 140/90 mmHg were shown to have a considerably lower ABI value [16].

CONCLUSIONS

This study found there was a significant association between moderate ABI degrees with severity of heart failure. The low level of ABI was proportional to the low level of Left Ventricle Ejection Fraction Furthermore, it is also suggested that a larger number of samples can be investigated and not only conducted in one health service center.

Acknowledgement: This research was supported by the Department of Internal Medicine, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics Committee approval: The Ethics Committee of the Faculty of Medicine, Universitas Hasanuddin, Makassar, South Celebes, has accepted our protocols. According to recommendation letter 396/UN4.6.4.5.31/ PP36/ 2024 with protocol number UH24050279.

Conflict of interest: All authors declare that they have no commercial relationships (e.g. consultancy, shareholding, equity interests, patent/licensing arrangements, etc.) that could create a conflict of interest in connection with the submitted article

Authors' contribution: ISB (Concept, Design, Sources, Materials, Data Collection and Processing, Analysis and Interpretation, Literature Search, Manuscript Writing). MA (Concept, Design, Supervision, Analysis and Interpretation, Literature Search). PT (Concept, Design, Supervision, Analysis and Interpretation, Literature Search). SB (Concept, Design, Supervision, Analysis and Interpretation, Literature Search). HR (Concept, Design, Supervision, Analysis and Interpretation, Literature Search). AS (Concept, Design, Analysis and Interpretation, Critical Review). The manuscript was written by all authors, who also contributed to its revisions and content assessment. They have all read and given their approval to the paper, verifying to the accuracy and validity of the study findings.

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