CORRELATION OF ANKLE - BRACHIAL INDEX (ABI) AND LOW - DENSITY LIPOPROTEIN (LDL) WITH DIABETIC FOOT SEVERITY DEGREE

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Abstract: Diabetic foot is a complication of diabetes mellitus which is characterized by ulceration in the legs. *The severity of the diabetic foot can be determined by the Wagner-Meggit system which in this study uses 5 categories namely degrees 1 - 5 degrees. ABI (Ankle-Brachial Index) is an evaluation of peripheral arterial disease in diabetic foot patients. LDL is the main factor of atherosclerosis which causes macrovascular disorders in diabetic foot. The purpose of this study was to determine the correlation between ABI and LDL on the severity of diabetic foot based on the Wagner-Meggit classification. The method used is observational analytic with cross sectional approach. A total of 35 samples were obtained by consecutive sampling. Data analysis was performed using the Spearman test and logistic regression. A significant correlation was obtained between ABI and the severity of diabetic foot (p = 0.06; r = -0.424), there was no correlation between LDL and the severity of diabetic foot (p = 0.09; r = -0.395). The results of logistic regression analysis found no correlation between ABI (p = 0.163; OR = 0.008) and LDL (p = 0.69; OR = 0.984) with the severity of the diabetic foot. Obtained Negelkerke R Square value of 0.095.*

Keywords: *Diabetic foot, ABI, LDL, Wagner-Meggit classification*

INTRODUCTION

Diabetic foot with ulcers is a common complication of diabetes. Diabetic foot ulcer is a chronic wound in the area below the ankle, which increases morbidity, mortality, and reduces the quality of life of patients. Diabetic foot ulcers are caused by peripheral neuropathy, peripheral arterial disease, or a combination of both.[1]

The 2013 RISKESDAS results of diabetes mellitus patients for South Kalimantan, based on a doctor's diagnosis was 1.4% and based on a diagnosis or symptoms was 2.0%.[2] According to research by Fajar Apriansyah in 2014 it was found that the number of diabetic foot patients in Ulin General Hospital Banjarmasin each year had increased; based on the number of visits in 2011 there were 1468 people, in 2012 there were 2194 people, in 2013 there were 2892 people, and in 2014 there were 2704 people until October.[3]

Ankle-Brachial Index (ABI) is a simple and economical test with good reproducibility in peripheral arterial diseases such as diabetic foot, Leriche syndrome, thromboangitis obliterans, fibromuscular dysplasia, Raynaud's phenomenon, and other peripheral arterial diseases.[4] ABI is a ratio between ankle-high systolic blood pressure with the right or left brachial artery. In several studies found that the measurement results are useful in early detection of peripheral arterial disease and an indicator of general atherosclerosis which is believed to be one of the pathogenicity of diabetes feet.[5]

According to Antonio Tuttolomondo in 2015 it was stated that LDL or Low Density Lipoprotein is trusted to be a marker for the incidence of diabetic foot where LDL levels (> 130 mg / dL), hypercholesterolemia, hypertrigliceridemia are higher prevalence in diabetic patients with foot ulcers than those without. LDL is a major factor in the formation of atherosclerosis which is one of the causes of macrovascular disorders in diabetic feet.[6]

A study by Kristiani et al in 2015 at P Dr. R. D Kandou General Hospital concluded that there was a significant relationship between ABI and the severity of the ulcer. The lower ABI makes ulcer severity increased.[7]

Ahmeti et al's research in 2012 showed that high LDL levels were one of the factors that had a significant effect on the incidence of diabetic foot ulcers and an increase in the severity score of diabetic legs.[8]

Until now there has been no research on the correlation of LDL and ABI with the severity of diabetes foots in Banjarmasin, especially Ulin General Hospital. Thus, this research needs to be done.

RESEARCH METHOD

This research used cross sectional with observational analytic method. The population was diabetic foot patients in Diabetic Foot Polyclinic of Ulin General Hospital Banjarmasin. The subject was the part of its population which presented all of the population. Samples were taken using inclusion and exclusion criteria. The inclusion criteria was diabetic foot patients who were getting treatment in Diabetic Foot Polyclinic of Ulin General Hospital Banjarmasin and agreed to be a research subject signing the informed consent. Exclusion criteria was patient with wound or disability in one of body part that would be used for ABI measurement; and patient with extremities edema and thrombophlebitis.

The study was conducted by interviewing and measuring ABI in diabetic foot patients in the Diabetic Foot Polyclinic of Ulin General Hospital accompanied by a nurse on duty and data from the Clinical Pathology Laboratory of Ulin Regional Hospital. The data was recorded in the research data base and was input into the research tabulation. Data analysis in this

study used statistical software. The data obtained would conducted by the Spearman test and logistic regression test to see the correlation between the independent and dependent variables.

RESULTS AND DISCUSSION

Based on table 1, there are more male patients than women, in addition to the Wagner-Meggit classification which is higher, 4 and 5, which are characterized by the presence of gangrene, there are more men than women as much as 3: 1. This is in accordance with the research of Misbah Mehraj et al in 2018 at the Institute of Medical & Health Sciences, Uttarakhand, India; men have a greater prevalence of 66% than women at 34%.[9] On the basis of the theory of this study also explained this can occur due to several things such as joint mobility in men who are lower and also self-care habits in women which is very influential on the incidence of diabetes feet.[10]

The greatest number of diabetic foot ulcers were found in the age range of 46-55 years or the age of the early elderly with 16 patients (45.7%) and the age range of 56-65 years or the final elderly period with 12 patients (34.3%). Patients in the age range 36-45 years were 5 patients (14.3%), while patients in the age range> 65 years were only

2 patients (5.7%). The average age of diabetic foot patients in this study was 53.8 ± 8.27. These results are in accordance with the research of Misbah Mehraj et al in 2018 at the Institute of Medical & Health Sciences, Uttarakhand, India. Diabetic foot patients have a high prevalence in the age group 40-59 years.[9] This is due to a decrease in joint mobility which is compounded by neuropathy, peripheral arterial disease, and worsening condition of diabetes mellitus in patients in that age group.[11]

Diabetic foot patients in Ulin General Hospital Banjarmasin with the Wagner-meggit 1st classification were the most, 15 patients (43%), followed by the Wagner-Meggit 2nd and 3rd classification with 11 and 5 patients (31% and 14%); while the Wagner-Meggit 4th and 5th classification is the least where there are only 2 patients each (6%). In Nurhanifah's research at Ulin General Hospital Banjarmasin in 2017 also found data in accordance with the results of this study in which patients with Wagner-Meggit 1st classification were the most which were 18 subjects (36%) out of 50 subjects.[12] This can happen because Ulin General Hospital is a referral hospital so that patients who come are patients who have undergone initial treatment at lower health care facilities.

Table 1. Characteristics of research data for correlation of ankle-brachial index (ABI) and low density lipoprotein (LDL) with the severity of diabetes foot in patients with type 2 diabetes mellitus in Ulin General Hospital Banjarmasin.

Characteristics (N=35)	n(%)
Gender	
Man	18(51%)
Woman	17(49%)
Age	
36-45 y.o	5(14,3%)
46-55 y.o	16(45,7%)
56-65 y.o	12(34,3%)
>65 y.o	2(5,7%)
Mean ± SD	53,8 ± 8,27
Wagner-Meggit Classification	
1	15(43%)
2	11(31%)
3	5(14%)
4	2(6%)
5	2(6%)

Table 2. Research data for the correlation of ankle-brachial index (ABI) and low density lipoprotein (LDL) with the severity of diabetes foot in patients with type 2 diabetes mellitus in Ulin General Hospital Banjarmasin.

Characteristics	Amount (n)	Mean ± SD	Median	Modus
LDL				
≤100 mg/dL	12(34,3%)	130,68	124	102
>100 mg/dL	23(65,7%)	(±57,48)		
ABI				
<0,91	11(31,4%)			
0,91-1,3	23(65,7%)	0,983(±0,220)	0,96	1
>1,3	1(2,9%)			

The results were obtained among 35 diabetic foot patients with mean and SD LDL levels at 130.68 (± 57.48) accompanied by LDL levels distribution data of 12 patients with LDL levels ≤100 mg / dL (34.3%) and 23 patients with levels LDL> 100 mg / dL (65.7%). The agreed normal LDL level is below 130 mg / dL, but according to the National Cholesterol Education Program in the ATP III At-A-Glance Quick Desk Reference Guidelines 2002 states that patients with diabetes are considered to be in agreement with patients at risk of CHD (Coronary Heart Disease) so the target LDL level is <100 mg / dL.

The mean and SD values of ABI values from 35 diabetic foot patients was found at 0.983 (± 0.220) accompanied by distribution data of ABI values for 11 patients (31.4%) with ABI values < 0.91, 23 patients (65.7%) with an ABI value of 0.91 -1.3, and 1 patient (2.9%) with an ABI value > 1.3.

Table 3. Distribution of patients based on ABI values, LDL levels, and Wagner-Meggit classification in the study of the correlation of ankle-brachial index (ABI) and low density lipoprotein (LDL) with the degree of severity of diabetes foot in patients with type 2 diabetes mellitus at Ulin Hospital Banjarmasin.

		Severity Degree absed on Wagner-Meggit Classification				
		1st Degree n=15	2nd Degree n=11	3rd Degree n=5	4th Degree n=2	5th Degree n=2
ABI	<0,91 n(%)	2(13,3%)	4(36,36%)	2(40%)	1(50%)	2(100%)
	0,91-1,3 n(%)	13(86,7%)	6(54,54%)	3(60%)	1(50%)	-
	>1,3 n(%)	-	1(9,09%)	-	-	-
LDL	<100 mg/dL n(%)	2(13,33%)	5(45,45%)	2(40%)	2(100%)	1(50%)
	>100 mg/dL n(%)	13(86,67%)	6(54,45%)	3(60%)		1(50%)

Based on table 3, it can be seen that patients who are in the Wagner-Meggit 1st classification mostly have a normal ABI value at <0.91 by 13 subjects (86.7%), whereas LDL levels tend to be above the optimal level at 13 subjects (86.67%). Patients who were in the Wagner-Meggit 2 classification mostly had normal ABI values at 6 subjects (54.54%), whereas for LDL levels most had LDL levels above optimal with 6 subjects (54.45%). Patients who were in the Wagner-Meggit 3rd classification mostly had normal ABI values with 3 subjects (60%), whereas LDL levels mostly had optimal above-LDL levels with 3 subjects (60%). Patients with the Wagner-Meggit 4th classification each had 1 patient (50%) who had a normal ABI value and <0.98. LDL levels of patients with Wagner-Meggit 4th classification all have normal LDL levels, whereas patients with Wagner-Meggit 5th classification all have ABI values below normal and there are 1 subject (50%) for each with optimal LDL levels and above optimal LDL levels.

Table 4. The bivariate analysis results of ABI variables in the study of the correlation between ABI and LDL with the severity of diabetes foot in type 2 diabetes mellitus patients at Ulin General Hospital Banjarmasin.

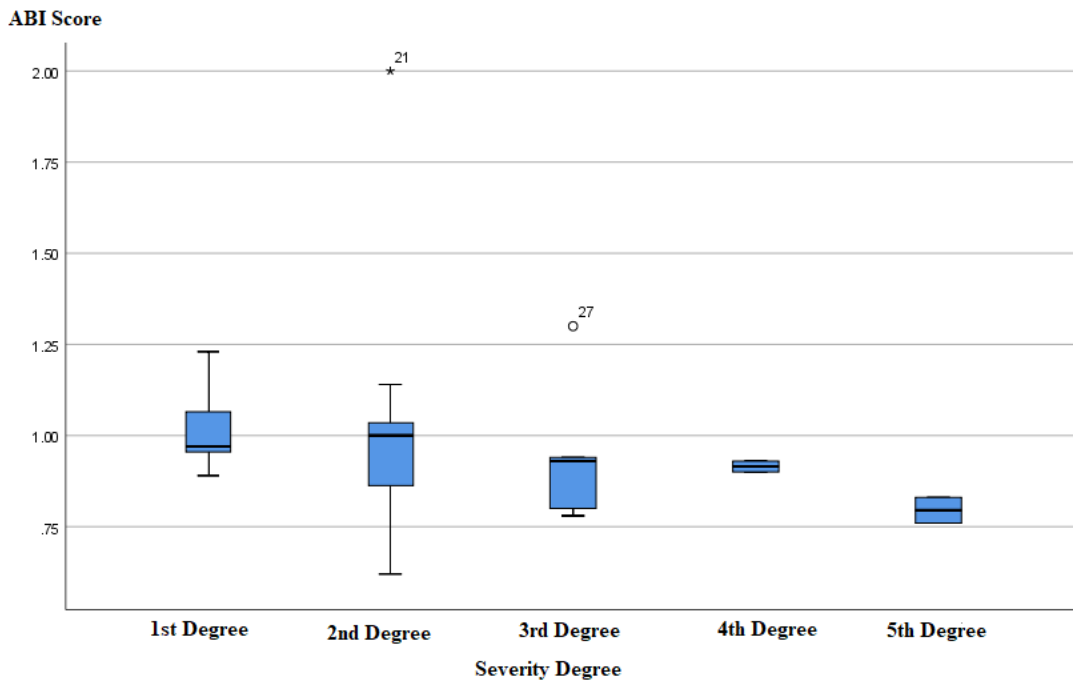| Severity Degree of Diabetes Foot	N	ABI Mean $\pm$ SD	R	P
Wagner Meggit I	15	1,008 $\pm$0,093		
Wagner Meggit II	11	1,0295 $\pm$ 0,35104		
Wagner Meggit III	5	0,95 $\pm$ 0,208	-0,424	0,006
Wagner Meggit IV	2	0,915$\pm$0,021		
Wagner Meggit V	2	0,795 $\pm$ 0,049		

Figure 1. Scatter Plot of the Correlation between ABI Value and Severity Degree of Diabetes Foot in Patients with Diabetes in Diabetes Foot Polyclinic at Ulin General Hospital Banjarmasin.

After testing through the Spearman test, it was found that the correlation between ABI and the severity of the diabetic foot obtained P value = 0.006 or smaller than 0.05, which means there was a significant correlation between the ABI value and the severity of diabetes foot. In table 4 can be seen the value of r = -0.424 which means the correlation between the ABI value and the degree of severity of diabetes legs has an inverse direction with a sufficient correlation value.

These results are in accordance with research from Rahmat Taufik et al in 2015 at RS.D dr. Dr. Padang Padang, where a significant non-directional relationship was found with a value of p = 0.00 (<0.05) between a decrease in ABI value and the severity of diabetes foot according to Wagner-Meggit classification.[13] In a study by Kristiani et al in 2015 at RSUP Dr. R. D Kandou about the relationship of ABI and the severity of the ulcer analyzed by Spearman's

correlation coefficient. The obtained results are r = - 0.388 with P = 0.008 which states there is a significant relationship between ABI and the severity of the ulcer. The lower ABI, the more severe the ulcer.[7]

The relationship between ABI value and the severity of diabetes foot can be explained by one of the pathoprogressive factors in diabetes feet, which is PAD or peripheral arterial disease, which is an indicator of ABI value.

Peripheral artery disease has an important influence on patients with diabetes. There is a prediction of PAD to mainly involve the tibia arteries and peroneal. Patients with diabetes will experience micro-arterial non-occlusive dysfunction disorders involving arterioles and capillaries. In addition, an increase in micro-arterial pressure and stream leading to endothelial injury together with sclerosis results in a decrease of capillary capacity with impaired automatic regulation functions including

removal of the vasoconstrictor response. It also causes leukocyte migration and oxygen diffusion to be disrupted. So that in the end the progression of foot ulcers in diabetic patients is caused by poor response to injury even though only a minor trauma is exacerbated by the presence of peripheral neuropathy and infection of the ulcer.[14]

Table 5. The results of bivariate analysis of LDL variables in the study of the correlation between ABI and LDL with the severity of diabetes foot in type 2 diabetes mellitus patients at Ulin General Hospital Banjarmasin.

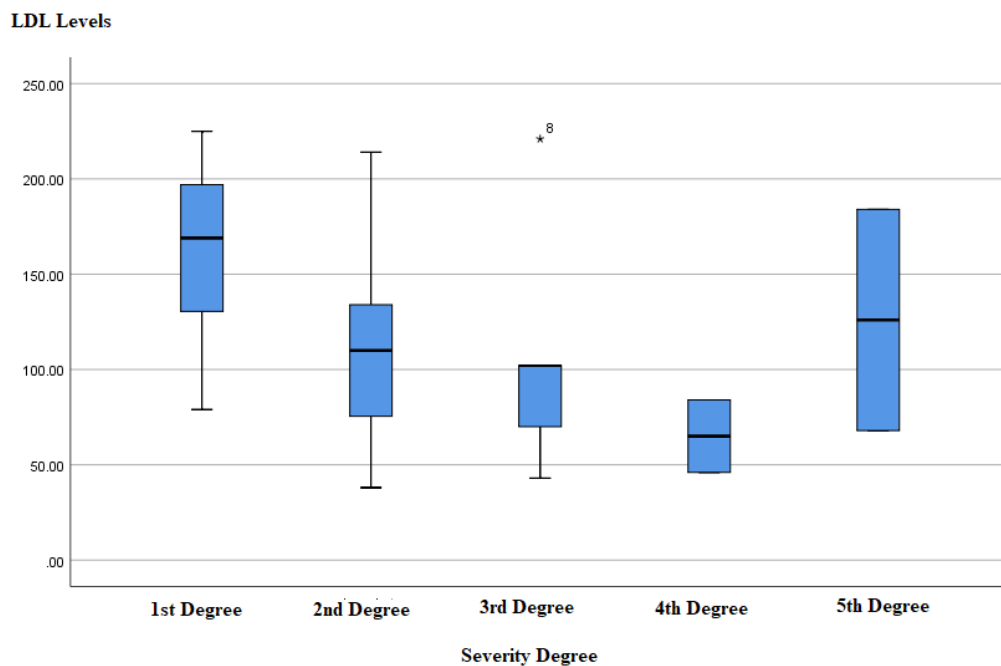| Severity Degree of Diabetic Foot	N	LDL Level with Mean $\pm$ SD	r	P
Wagner Meggit I	15	163,5 $\pm$ 44,8		
Wagner Meggit II	11	109,1 $\pm$ 59,3		
Wagner Meggit III	5	107,6 $\pm$ 67,4	-0,395	0,09
Wagner Meggit IV	2	42 $\pm$5,65		
Wagner Meggit V	2	126 $\pm$ 82,02		

Figure 2 Scatter Plot Correlation of LDL Levels with Severity of Diabetes Feet in Patients with Diabetes Foot in Diabetes Foot Polyclinic at Ulin General Hospital Banjarmasin.

In the test using the Spearman test to see the correlation of LDL and the severity of diabetes legs obtained p value = 0.09 (> 0.05) and the value of r = -0.395 which means there is no significant correlation with the inverse direction and low correlation values between LDL levels with the severity of the diabetes foot. Similar results to this study were found in a study by Arum Dessy Rahmasari in 2016 in Surakarta stated that there was no significant correlation between high LDL levels and the severity of diabetes legs with a p value of 0.457 (r = 0.14).[15] In another study by Ahmed O Al-Mubarak et al in 2017 at

Milton Kenyes University Hospital where the value of p = 0.998 was obtained which means there is no significant relationship between LDL levels and the incidence of diabetes feet.[16] The results that are not in accordance with the hypothesis in this study are most likely due to the lack of treatment control data that has been received by patients, especially drugs that can affect LDL levels that can cause bias in this study. Most patients have experienced treatment even before coming to the diabetic polyclinic of Ulin Regional Hospital so that there is a possibility that the patient has a history of medication consumption including cholesterol-lowering due to cholesterol control which is one of the screening efforts for complications suggested by PERKENI in the Consensus on Management and Prevention of Type 2 Diabetes Mellitus In Indonesia.[1] In addition, according to Ahmeti et al, the lipid profile is worth checking as a whole considering that total cholesterol, triglycerides, HDL, and LDL are multiple factors which are interrelated and influence each other in the incidence of diabetes foot.[8]

The limitation of this study is the time of research and data taken by researchers manually so that there is a risk of errors in writing data. The lack of variety of variables examined also influenced the results of this study. The absence of patient medical history data can cause bias in the study results.

Table 6. The results of multivariate analysis of LDL variables in the study of the correlation of ankle-brachial index (ABI) and low density lipoprotein (LDL) with the severity of diabetes foot in type 2 diabetes mellitus patients in Ulin General Hospital Banjarmasin.

	P	OR(95%CI)	*Lower*	*Upper*
ABI	0,166	0,0008	0,000	7,245
LDL	0,63	0,984	0,968	1,001

Nagelkerke R Square : 0,246

In table 1 can be seen that an increase in 1 unit of ABI reduces the severity of diabetes foot by 99.2% (OR = 0.0008, 95% CI 0.000-7.245) and an increase of 1 mg / dL LDL decreases the risk of diabetes foot severity by 1.6% (OR = 0.984, 95% CI 0.968-1.001). However, this relationship is not statistically significant because the p value is greater than 0.05 due to the lack of the samples used in this study which is very limited. From the Nagelkerke R Square calculation results obtained by 0.246 which means that the two independent variables according to the analysis by logistic regression where the severity of diabetes foot is divided into two categories namely 1-2 (lower grade) and 3-5 (higher grade) at greater severity high has a greater risk, 24.6%. Severity degrees are divided into two categories based on research by Quraysh Shabbir Sadriwala et al in 2018 in Maharashtra, India.

CONCLUSIONS

Based on the results of this study it was concluded the results of measurements of LDL levels, from 35 diabetic foot patients with the mean of LDL level and SD LDL were 130.68 (± 57.48) mg / dL with 12 LDL levels distribution data with LDL levels ≤100 mg / dL (34.3%) and 23 patients with LDL levels> 100 mg / dL (65.7%). The results of measurement of ABI levels, from 35 diabetic foot patients obtained mean and SD values of 0.983 (± 0.220) accompanied by data distribution of ABI values of 11 patients (31.4%) with ABI values < 0.91, 23 patients (65.7%) with an ABI value of 0.91-1.3, and 1 patient (2.9%) with an ABI value > 1.3. The 35 diabetic foot patients who met the

inclusion and exclusion criteria, most diabetic foot patients were in category 1 with a data distribution of 15 patients with Wagner-Meggit I degrees (43%), 12 patients with Wagner-Meggit II degrees (31%), 5 patients with Wagner-Meggit III degrees (14%), 2 patients with Wagner-Meggit IV degrees (6%), and 2 patients with Wagner-Meggit V degrees (6%). There was a significant relationship between the value of ABI with the severity of diabetes foot in the Diabetes Foot Polyclinic at Ulin General Hospital Banjarmasin with a p value of 0.006 and a value of r = -0.424, which means having a correlation that is opposite to sufficient strength. There was no significant relationship between LDL levels with the severity of Diabetes Foot in the Diabetes Foot Polyclinic of Ulin Hospital Banjarmasin with a p value of 0.09 and a value of r = -0.395, which means having a correlation that is the opposite of weak strength. Correlation between the ABI index value and LDL levels with the severity of diabetes foot based on Wagner-Meggit classification with the Nargekerkel r square value of 0.246 which means that at a higher severity has a greater risk that is equal to 24.6%.

Suggestion in this study is that ABI examination should be done as early as possible in order to avoid further complications of diabetic foot ulcers. Further research needs to be done with more variable variables with a longer time and a larger number of samples. Need to control drugs that can affect cholesterol levels that can cause bias the results of LDL levels. It is necessary to check the lipid profile other than LDL so that the meaningful results of the research are better.

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