**Acta Cardiologia Indonesiana**

pISSN:2460-5700
eISSN:2579-4345

Web page: jurnal.ugm.ac.id/v3/jaci

# Ankle Brachial Index as Predictor of Coronary Artery Lesion Severity in Patients with Suspected Stable Coronary Artery Disease

Chandra Kurniawan*, Hariadi Hariawan, Nahar Taufiq

Department of Cardiology and Vascular Medicine, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia

**ARTICLE INFO**

*Corresponding author
Email:
chandrakardio@gmail.com
Address:
Department of Cardiology
and Vascular Medicine, Faculty of Medicine,
Public Health and Nursing,
Universitas Gadjah Mada,
Jalan Farmako Sekip, Yogyakarta,
Indonesia 55281

Keywords:
ABI;
SYNTAX Score;
Suspected SCAD

Manuscript submitted: February 05, 2019
Revised and accepted: October 28, 2019

**ABSTRACT**

*Background*: Atherosclerosis is a general process and can occur in coronary, peripheral, and aortic arteries. Traditional risk factors for atherosclerosis are gender, age, hypertension, diabetes, smoking, dyslipidemia, and family history. Atherosclerosis in the coronary arteries will develop into coronary artery disease (CAD). Angiography examination is the gold standard in CAD diagnosis. Lower extremity artery disease (LEAD) is part of peripheral artery disease (PAD) due to atherosclerosis and can be diagnosed using the ankle brachial index (ABI). The aim of this study was to predict the severity of coronary artery lesions in patients with suspected SCAD population with ABI.

*Method:* This was a analytical observational study using cross sectional research design. Data was taken consecutively from affordable populations at the polyclinic of RSUP Dr. Sardjito for 2 periods in May 2017-August 2017 and August 2018-October 2018. Examination of ABI was performed before patients underwent angiography and ABI was divided into low ABI (≤0.90) and normal ABI (0.91-1.40). SS measurements based on video angiography were divided into severe (SS> 22) and not severe (SS ≤22).Data were presented in categorical form and analyzed using SPSS 23. Confounding factors were then analyzed by bivariate test. If there was a confounding factor with a value of p <0.25, it was followed by a multivariate test.

*Result*: There were 35 subjects with low ABI and 71 subjects with severe lesions of 104 patients. The hypothesis test showed ABI increased the incidence of coronary lesion severity with PR 1.52 (1.21-1.93 with 95% CI) with a p value of 0.002. Bivariate tests show no confounding factors that increase the incidence of coronary lesion severity. Hypertension and dyslipidemia have a value of p <0.25 so multivariate analysis is performed. The results of multivariate analysis were only that ABI increase the incidence of coronary lesion severity (p= 0.004).

*Conclusion*: A low ABI value will increase the incidence of coronary atherosclerosis lesion by 1.52 times in patients with suspected SCAD.

**INTISARI**

*Latar Belakang:* Aterosklerosis adalah proses umum dan dapat terjadi pada arteri koroner, perifer, dan aorta. Faktor risiko tradisional untuk aterosklerosis adalah jenis kelamin, usia, hipertensi, diabetes, merokok, dislipidemia, dan riwayat keluarga. Aterosklerosis di arteri koroner akan berkembang menjadi penyakit arteri koroner (CAD). Pemeriksaan angiografi

adalah standar emas dalam diagnosis CAD. Penyakit arteri ekstremitas bawah (LEAD) adalah bagian dari penyakit arteri perifer (PAD) karena aterosklerosis dan dapat didiagnosis menggunakan ankle brachial index (ABI). Tujuan dari penelitian ini adalah untuk memprediksi keparahan lesi arteri koroner pada pasien yang diduga populasi SCAD dengan ABI.

*Metode*: Ini adalah penelitian observasional analitik menggunakan desain penelitian cross sectional. Data diambil secara berurutan dari populasi yang terjangkau di poliklinik RSUP Dr. Sardjito selama 2 periode pada Mei 2017-Agustus 2017 dan Agustus 2018-Oktober 2018. Pemeriksaan ABI dilakukan sebelum pasien menjalani angiografi dan ABI dibagi menjadi ABI rendah (≤0,90) ) dan ABI normal (0.91-1.40). Pengukuran SS berdasarkan video angiografi dibagi menjadi parah (SS> 22) dan tidak parah (SS ≤22). Data disajikan dalam bentuk kategorikal dan dianalisis menggunakan SPSS 23. Faktor perancu kemudian dianalisis dengan uji bivariat. Jika ada faktor perancu dengan nilai p <0,25, itu diikuti oleh uji multivariat.

*Hasil*: Ada 35 subjek dengan ABI rendah dan 71 subjek dengan lesi parah pada 104 pasien. Uji hipotesis menunjukkan ABI meningkatkan kejadian keparahan lesi koroner dengan PR 1.52 (1.21-1.93 dengan 95% CI) dengan nilai p 0,002. Tes bivariat tidak menunjukkan faktor perancu yang meningkatkan kejadian keparahan lesi koroner. Hipertensi dan dislipidemia memiliki nilai p <0,25 sehingga dilakukan analisis multivariat. Hasil analisis multivariat hanya bahwa ABI meningkatkan kejadian keparahan lesi koroner (p = 0,004).

*Kesimpulan*: Nilai ABI yang rendah akan meningkatkan kejadian lesi aterosklerosis koroner sebesar 1,52 kali pada pasien yang diduga SCAD.

## Background

Atherosclerosis is a systemic process and is a major cause of mortality and morbidity throughout the world. Atherosclerosis can occur in the coronary, cerebral, and extremity arteries, as well as in other arteries.[1] The traditional risk factors for atherosclerosis include gender, age, hypertension, diabetes, dyslipidemia, smoking, and hereditary. Atherosclerotic diseases are divided into aortic disease, coronary heart disease, and peripheral artery disease (PAD). PAD is classified into carotid artery disease, upper extremity artery disease (UEAD), mesenteric artery disease, renal artery disease, and lower extremity artery disease (LEAD).[2]

An ankle brachial index (ABI) examination is an inexpensive, easy to perform examination and has a high predictive value in LEAD detection under subclinical conditions.[2] According to Khoury et al. (1997), the presence of significant stenosis in the aorta, carotid artery and femoral artery suggest coexistence of significant lesions in the coronary arteries.[3,4]

Gold standard examination of atherosclerosis of coronary arteries is angiography. Severity of coronary lesions can be assessed objectively using several scores, such as SYNTAX, Gensini, and Oberman. Assessment of coronary atherosclerosis lesions can use many methods, but SS scoring better describes coronary artery function affected by atherosclerotic lesions and the results can be quantified.[5] Both ABI and SS values can describe the function of peripheral arteries of the lower extremities and coronary arteries due to the atherosclerosis process.[6]

ABI ability to estimate the severity of coronary lesions has not been widely studied. This study aimed to investigate ABI as a predictor of the severity of coronary lesions in a stable CAD population.

## Method

This study was an observational study using a cross sectional study design. The study was conducted at Dr. RSUP Sardjito Department of Cardiology and Vascular Medicine. The study was conducted in 2 periods, namely May 2017-August 2017 and August 2018-October 2018 in patients suspected of stable CAD. The study population was patients with suspected stable CAD in Dr. RSUP Sardjito in May 2017-August 2017 and August 2018-October 2018 and underwent coronary angiography. Data collection was carried out prospectively. The sample size was calculated, the value of the error used was 5%. The number of subjects determined in this study amounted to 104 patients. The following are the inclusion and exclusion criteria for the study.

Inclusion criteria:

a. Age over 18 years;
b. Suspected patients with stable CAD who underwent coronary angiography examination;
c. Patients suspected of stable CAD who have blood pressure measurements on all four extremities according to the standard;
d. Willing to participate in the study.

Exclusion criteria:

a. Patients who have underwent previous revascularization procedure in either or both coronary and peripheral arteries.
b. Patients with ABI> 1.4.

The independent variable in this study was ABI. The dependent variable in this study was the severity of coronary lesions measured using SS. The confounding factors taken into account in this study included gender, age, hypertension, diabetes mellitus, smoking history, and dyslipidemia.

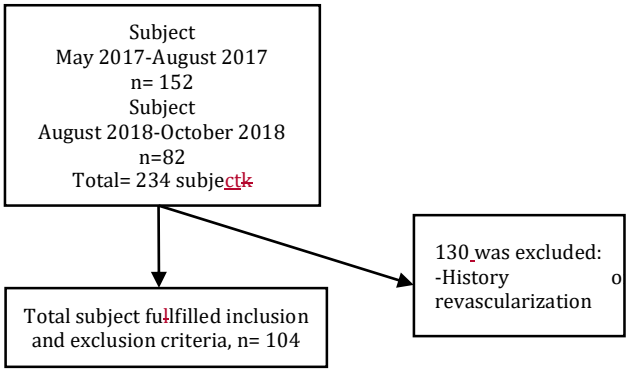
An ABI examination is performed before the patient underwent cardiac catheterization procedure and was willing to participate in the study. Examination using OMRON HEM-7121 digital sphygmomanometer from RSUP Dr. Sardjito was calibrated periodically and L size cuffs was used (for arm circumference 32-42 cm). The video from the angiography was in CD and played back using the RadiAnt DICOM viewer software. The severity of coronary lesions was calculated using the SYNTAX I calculator accessible online through the website www.SYNTAXscore.com.

The ABI measurement and SS assessment were carried out by conformity test using inter-observer Kappa test with SPSS 23 software for ABI and intra-observer for SS. The ABI was measured by professional technician and SS was calculated by cardiologist-interventionist. Suitability was considered good if the value was more than 0.80.

This study has received approval from the Ethics Commission of the Faculty of Medicine, Public Health and Nursing, Gadjah Mada University, and Dr. Sardjito General Hospital. Yogyakarta.

## Result

The total population obtained during the 2 periods were 234 subjects. A total of 104 subjects became the study sample because they met the inclusion criteria. The following is the sampling flow of the research subject.




As many as 104 subjects of patients with suspected stable CAD were included in the analysis of basic characteristics, which were dominated by male patients amounting 84 subjects (80.8%). Subjects obtained, ranged from 33-75 years of age, was divided into 2 categories, namely geriatrics (over 60 years old) and non-geriatrics (less than 60 years old). There were 37 diabetes patients (35.6%), 49 geriatrics patients (47,1%), 64 hypertension patients (61.5%), 57 smokers (54.8%), and 57 dyslipidemia patients (54.8%). The ABI score was divided into low ABI and normal ABI, with a number of low ABI samples of 35 (33.7%) subjects and normal ABI patients as many as 69 (66.3%) subjects. The severity of SS-based coronary lesions was divided into high and low SS, with the number of subjects with high SS being 71 (68.2%) and low SS as many as 33 (31.8%) subjects. The following is a table of the basic characteristics of study subjects (table 1).

**Table 1.**
Basic characteristics of the research subject

| Variable | Value (n=104) |
|---|---|
| Sex | |
| Male; n(%) | 84 (80.8%) |
| Female; n(%) | 20 (19.2%) |
| Age | |
| Geriatric (>60 years); n(%) | 49 (47.1%) |
| Non-geriatric; n(%) | 55 (52.9%) |
| Risk Factor | |
| Diabetes Mellitus; n(%) | 37 (35.6%) |
| Hypertension; n(%) | 64 (61.5%) |
| Smoker; n(%) | 57 (54.8%) |
| Dyslipidemia; n(%) | 57 (54.8%) |
| ABI | |
| ABI low (≤0,90) | 35 (33.7%) |
| ABI normal (>0,90) | 69 (66.3%) |
| Coronary lesion severity | |
| Severe (SS>22) | 71 (68.2%) |
| Not severe (SS≤22) | 33 (31.8%) |

ABI: ankle brachial index; SS: SYNTAX Score, n: sample size

We found low prevalence ratio of ABI to the incidence of coronary lesion severity of 1.52 (95% CI: 1.21-1.93; p <0.05) (table 2).

**Table 2.**
Test the ABI hypothesis for the severity of coronary lesions

| | Severe | Not severe | Total | PR (95% CI) |
|---|---|---|---|---|
| ABI low | 31 | 4 | 35 | 1,52 (1,21-1,93 |
| ABI normal | 40 | 29 | 69 | p 0,002* |
| Total | 71 | 33 | 104 | |

ABI: ankle brachial index; ABI low: ≤0.90; ABI normal: 0.91 1.40; CI: confidence interval; severity lesion (Severe: SS>22, No severe: SS≤22); PR:prevalence ratio; SS: SYNTAX Score
*significant with p<0.05

Bivariate tests on confounding factors were performed to look for other variables that are thought to be influential. The following is a bivariate test table for confounding factors for the severity of coronary lesions (table 3).

The bivariate test results show that none of the confounding factors studied have statistical significance values. The bivariate test results show hypertension and dyslipidemia have p values <0.25, so that hypertension and dyslipidemia will be carried out by multivariate tests together with ABI.

The results of multivariate test with logistic regression test showed that the ABI only affected the severity of coronary lesions.

**Table 3.**
Bivariate tests for confounding factors for the severity of coronary lesions

| Variable | Severe (n=71) | Not Severe (n=33) | PR (CI 95%) | p |
|---|---|---|---|---|
| *Sex* | | | | |
| Male; n (%) | 58 (81.7%) | 26 (78.8%) | 1.06 (0.74-1.51) | 0.727 |
| Female; n (%) | 13 (18.3%) | 7 (19.2%) | | |
| *Age* | | | | |
| Geriatric, n (%) | 34 (47.9%) | 15 (45.5%) | 1.03 (0.79-1.34) | 0.817 |
| Non-geriatric, n (%) | 37 (52.1%) | 18 (54.4%) | | |
| Risk Factors | | | | |
| DM, n (%) | 27 (38.0%) | 10 (30.3%) | 1.11 (0.85-1.44) | 0.444 |
| Hipertension, n (%) | 48 (67.6%) | 16 (48.5%) | 1.30 (0.96-1.76) | 0.062 |
| Smoker, n (%) | 39 (54.9%) | 18 (54.5%) | 1.00 (0.77-1.30) | 0.971 |
| Dyslipidemia, n (%) | 42 (59.2%) | 15 (45.5%) | 1.19 (0.90-1.57) | 0.191 |

CI: confidence interval;
DM: diabetes mellitus;
PR: prevalence ratio;
SS: SYNTAX Score
*significant with p<0.05

**Table 4.**
Multivariate tests for the severity of coronary lesions

| Variable | P |
|---|---|
| ABI | 0.004* |
| Hypertension | 0.055 |
| Dyslipidemia | 0.279 |

ABI: ankle brachial index; CI: confidence interval
*significant with p<0.05

## Discussion

Low ABI values have been shown to have 1.52 times (1.21-1.93 with 95% CI) higher prevalence ratio, with a p value <0.05, compared to normal ABI. This was consistent with previous studies using ABI as a predictor of high Gensini scores in coronary heart disease.[7]

Bivariate tests were performed on confounding factors of gender, age, diabetes, hypertension, smoking, and dyslipidemia. The study sample was mostly male. This study showed male patients dominated the study population, but it was not proven to increase the incidence of coronary lesion severity. This was similar to previous studies that gender did not increase the incidence of coronary lesions.[8] This can be caused because women are still exposed to estrogen which prevents atherosclerosis, and men are more likely to be exposed to metabolic stress.[9,10]

The age in this study did not affect the severity of coronary lesions. Coronary age begins after the fourth decade. Evidently, almost all subjects were > 40 years old. The severity of coronary lesions is a result of a complex process of atherosclerosis. Several studies have also shown to have no effect on the severity of coronary lesions.[8]

Other confounding factors, such as DM, hypertension, smoking, and dyslipidemia were not shown to increase the incidence of coronary lesions in this study. Previous study had suggested that DM is an independent risk factor for the severity of coronary lesions. In this study, hypertension, smoking, and dyslipidemia were also not shown to increase the incidence of coronary lesions.[8]

Post-mortem studies explained patients with a history of smoking have more involvement in coronary lesions and more narrowing areas were found compared to non-smoking populations.[11] Other studies have shown angiography showing lesions that are more complex, calcified and widespread in stable CAD patients with hypertension compared to stable CAD without hypertension.[4]

The limited number of subjects with DM, hypertension, smoking, and dyslipidemia may make the data not strong enough to see the prevalence ratio which is statistically significant.

The significant independent variable bivariate test results with SS was ABI. P value <0.25 in the confounding factor test for SS was only hypertension. The variable was then carried out by multivariate test. The multivariate test showed that ABI had a value of p <0.05 for severity of coronary lesions. Hypertension and dyslipidemia in the multivariate test did not show statistical significance with a value of p> 0.05. The multivariate test in this study showed that ABI was an independent variable on the severity of coronary lesions.

Haris et al. (2018) have proven atherosclerosis in the carotid artery to be associated with severity of coronary lesions. This study had also proven that LEAD is associated with severity of coronary lesions. Atherosclerosis in the carotid and peripheral arteries had been proven to be a predictor of atherosclerosis in coronary arteries.[12]

This study showed low ABI is correlated with increased incidence of coronary lesion severity, but cannot be used as a diagnostic test for CAD detection which replaces the examination of other diagnostic tools. This study was still limited to the assessment of the probability that patients with low ABI have a risk of severe coronary lesions that are heavier than normal ABI values. One of the results of this study can support education of patients suspected of SCAD.

## Conclusion

A low ABI value will increase the incidence of coronary atherosclerosis lesion by 1.52 times in patients with suspected SCAD.

## References


1. Caro, J., Migliaccio-Walle, K., Ishak, K.J. and Proskorovsky, I., 2005. The morbidity and mortality following a diagnosis of peripheral arterial disease: Long term follow-up of a large database. *BMC Cardiovascular Disorders*, 5, pp.1–8.

2. Aboyans, V. et al., 2018. Questions and Answers on Diagnosis and Management of Patients with Peripheral Arterial Diseases: A Companion Document of the 2017 ESC Guidelines for the Diagnosis and Treatment of Peripheral Arterial Diseases, in collaboration with the European Society fo. *European Journal of Vascular and Endovascular Surgery*, 55(4), pp.457–464.

3. Benchimol, D., Pillois, X., Benchimol, A., Houitte, A., Sagardiluz, P., Tortelier, L. and Bonnet, J., 2009. Accuracy of ankle-brachial index using an automatic blood pressure device to detect peripheral artery disease in preventive medicine. *Archives of Cardiovascular Diseases*, 102(6–7), pp.519–524.

4. Khoury, Z., Schwartz, R., Gottlieb, S., Chenzbraun, A., Stern, S. and Keren, A., 1997. Relation of coronary artery disease to atherosclerotic disease in the aorta, carotid, and femoral arteries evaluated by ultrasound. *American Journal of Cardiology*, 80(11), pp.1429–1433.

5. Sianos, G., Morel, M.-A., Kappetein, A.P., Morice, M.-C., Colombo, A., Dawkins, K., van den Brand, M., Van Dyck, N., Russell, M.E., Mohr, F.W. and Serruys, P.W., 2005. The SYNTAX Score: an angiographic tool grading the complexity of coronary artery disease. *EuroIntervention : journal of EuroPCR in collaboration with the Working Group on Interventional Cardiology of the European Society of Cardiology*, 1(2), pp.219–227.

6. Kalkan, K., Hamur, H., Yildirim, E., Ipek, E., Ermis, E., Ozturk, M., Karal, H., Korkmaz, A.F., Bayantemur, M. and Demirelli, S., 2018. The Comparison of Angiographic Scoring Systems With the Predictors of Atherosclerosis. *Angiology*, 69(2), pp.158–163.

7. Al, H.B., Saffar, H.B. Al, Ghizzi, H.J. Al and Muhammed, S.M., 2009. The Ankle- Brachial Pressure Index AS A Predictor of Coronary Artery Disease Severity. , 51(3), pp.254–258.

8. Bhattacharyya, P.J., et. al., 2016. A Study of cardiovascular risk factors correlation with the angiographic severity of coronary artery disease usV. A.ing Syntax score. *Indian journal of medical sciencesOSR Journal of Dental and Medical Sciences*, 15(1), pp.21–28.

9. Glagov, S., Zarins, C., Giddens, D.P. and Ku, D.N., 1988. Hemodynamics and atherosclerosis. Insights and perspectives gained from studies of human arteries. *Archives of pathology & laboratory medicine*, 112(10), pp.1018–1031.

10. Touboul, P.J. et al., 2007. Mannheim carotid intima-media thickness consensus (2004-2006): An update on behalf of the advisory board of the 3rd and 4th Watching the Risk Symposium 13th and 15th European Stroke Conferences, Mannheim, Germany, 2004, and Brussels, Belgium, 2006. *Cerebrovascular Diseases*, 23(1), pp.75–80.

11. Leone, 2014. Relation between Coronary Lesions and Cigarette Smoking of Subjects Deceased from Acute Myocardial Infarction . A Histopathological Study. , 2(2).

12. Haris, M., Hariawan, H., Ismail, M.T. and Wahab, A.S., 2018. Correlation between Carotid Intimal-Media Thickness and Coronary Artery Disease Severity in Stable Coronary Artery Disease Patients. *Acta Cardiologica Indonesia*, 3(2), pp.81–88.