Original Article

DOI: 10.4274/haseki.galenos.2022.8094
Med Bull Haseki 2022;60:161-167

The Predictive Value of Nutritional Indexes for Developing Ascending Aortic Aneurysm in Elderly Patients with Hypertension

Umut Karabulut*, Kudret Keskin**

*Acibadem International Hospital, Clinic of Cardiology, Istanbul, Turkey

**Istanbul Sisli Hamidiye Training and Research Hospital, Clinic of Cardiology, Istanbul, Turkey

Abstract

Aim: Ascending aorta aneurysm (AsAA) is common in patients with hypertension. There is an increased rate of malnutrition in old age, which can be reliably examined with the Controlling Nutritional Status (CONUT) and Prognostic Nutritional Index (PNI) scoring systems. This study determined the predictive value of the nutritional indexes on the development of AsAA in elderly patients with hypertension.

Methods: This retrospective study included 302 patients with hypertension, aged 65 years and older, who presented at the cardiology outpatient clinic approximately 2019-2021. The patients were separated into AsAA developing (n=202) and non-developing (n=100). The nutritional status was determined by the CONUT and PNI scores.

Results: Of the 302 patients, 49% were male, the mean age was 72 years (68-77), and the AsAA (+) group was significantly older (p<0.01). The CONUT score was similar in both groups (p=0.06). The PNI score was found to be significantly lower in the AsAA (+) group than in the AsAA (-) group (p<0.001). Logistic regression analyses showed that the PNI score was an independent predictor of AsAAs in elderly patients with hypertension (Odds ratio: 0.92, 95% confidence interval: 0.87-0.98, p=0.01).

Conclusion: Low nutritional status (determined by PNI) increases the risk of developing AsAA in elderly hypertensive patients. Therefore, determining the nutritional status in elderly hypertensive patients may achieve better clinical outcomes.

Keywords: Ascending aorta aneurysm, nutritional index, hypertension, elderly

Introduction

Ascending aortic aneurysm (AsAA) is defined as an increase of more than 50% in the standard diameter of the thoracic aorta (1). AsAA is common in patients with hypertension, affecting approximately 15% of patients and is related to cardiovascular end-organ damage. Although AsAA progresses slowly, it can cause fatal complications such as aortic dissection (2).

Malnutrition increases at an older age according to several factors such as lower food intake, sarcopenia, and gastrointestinal tract problems (3,4). The Controlling Nutritional Status (CONUT) and the Prognostic Nutritional Index (PNI) scoring systems are reliable tools that are used to examine malnutrition in elderly patients (5).

Studies examining the effect of nutritional status on the prognosis of cardiovascular diseases have become more frequent recently. Nutritional status has been shown to be a predictor of short- and long-term mortality in elderly patients with acute heart failure, Type-A aortic dissection, and non-ST elevation myocardial infarction patients who have undergone percutaneous coronary intervention (6-8). Furthermore, it has been demonstrated that malnutrition in elderly patients affects embolic hemorrhagic processes due to atrial fibrillation and is a predictor of mortality in hypertensive patients. (9,10). However, studies examining the relationship between malnutrition and aortic aneurysm are limited. The relationship between malnutrition and prognosis has been shown in patients with arcus aortic aneurysm undergoing endovascular aneurysm repair (11). However, no study has been conducted on the relationship between ascending AsAA and malnutrition. Therefore, this study aimed to determine the predictive

Address for Correspondence: Umut Karabulut,
Acibadem International Hospital, Clinic of Cardiology, Istanbul, Turkey
Phone: +90 506 350 97 36 E-mail: umkarabulut@gmail.com ORCID: orcid.org/0000-0002-3947-9173
Received: 05.01.2022 **Accepted:** 10.03.2022

value of the nutritional indexes on the development of AsAAs in elderly patients with hypertension.

Methods

This retrospective study included 302 patients aged 65 years and older who presented at the cardiology outpatient clinic approximately 2019-2021 and were diagnosed with hypertension. Patients were excluded from the study if they were aged under 65 years, had diseases that cause malnutrition such as malignancy, heart failure with reduced ejection fraction (EF<40%), kidney failure, liver failure, or severe infection, or had diseases that caused AsAAs such as the bicuspid aorta, Marfan syndrome, Ehler-Danlos syndrome, and hypothyroidism, which may affect plasma albümin levels.

Heart failure with reduced EF is defined as the inability to pump the heart to tissues and organs, which cause insufficiency to meet metabolic needs and left ventricular EF<40 (12).

Renal failure is defined as the presence of both of these factors [glomerular filtration rate (GFR) less than 60 mL/min and albumin greater than 30 mg per gram of creatinine] along with abnormalities of kidney structure or function for greater than three months signifies chronic kidney disease (13).

Ascending thoracic aortic aneurysm is defined as a dilatation of the ascending aorta producing a cross-sectional diameter more than 1.5 times its normal value (14). Ascending aorta diameter >38 mm in transthoracic echocardiography was accepted as the cut-off value for AsAA for this study cohort.

Study Design

The patients were separated into two groups those who developed AsAA [AsAA (+), n=202] and those who did not develop AsAA [AsAA (-), n=100]. Medical history, demographic data, height, body mass index, medications, and echocardiographic parameters were obtained from the hospital database. The patients who developed aortic dissection, cardiac death, and death were also recorded. The nutritional status of the patients was determined from the CONUT and PNI scores.

Ethical approval for this study was obtained from the Istanbul Bakirkoy Dr. Sadi Konuk Training and Research Hospital Regional Ethics Committee (approval no: 2022-15, date: 03.01.2022). All patient rights were protected, and written informed consent was obtained before the procedures, according to the Helsinki Declaration (2013).

Nutritional Score Systems

The CONUT score was calculated using the serum albumin, total cholesterol, and total lymphocyte count (Table 1) (15). The PNI score was calculated using the following formula: 10 x serum albumin value (g/dL) + 0.005 x total lymphocyte count (per mm^3). A score greater than 38 points was defined as normal (16).

Statistical Analysis

Data obtained in the study were analyzed statistically using SPSS 22.0 software (IBM, Armonk, NY, USA). The demographic, clinical, and laboratory values of the two groups were compared using the t-test or Mann-Whitney U test for continuous variables according to the distribution pattern of the data. A chi-square test was used to compare categorical data. The distribution of continuous variables was assessed using the Kolmogorov-Smirnov test. Univariate and logistic regression analyzes were used to determine the predictors of ascending aorta aneurysms. For all analyses, the statistical significance was set at 2-sided p<0.05.

Results

Of the 302 patients, 49% were male, and 51% were female. The mean age was 72 years (68-77), and the AsAA (+) group was significantly older (p<0.01). The mean aortic diameter was 42 mm (40-45) in the AsAA (+) group and 36 mm (35-37) in the AsAA (-) group (p<0.001). Age, height, the incidence of coronary artery disease, and atrial fibrillation values were significantly higher in the AsAA (+) group (p<0.01, p=0.001, p=0.001, and p=0.02, respectively).

Total platelet count, lymphocyte count, total protein, and albumin levels were significantly lower in the AsAA (+) group (p=0.001, p=0.002, p<0.001, and p=0.003, respectively). Demographic characteristics and laboratory results of the patients are summarized in Table 2.

Table 1. Assessment of malnutrition with the CONUT score

	Normal	Light	Moderate	Severe
Albumin (g/dL) -Score	3.5-4.5 **0**	3.0-3.49 **2**	2.5-2.9 **4**	<2.5 **6**
Total lymphocytes (10^9/L) -Score	>1.60 **0**	1.20-1.59 **1**	0.80-1.19 **2**	<0.80 **3**
Total cholesterol (mg/dL) -Score	>180 **0**	140-180 **1**	100-139 **2**	<100 **3**
Total score	**0-1**	**2-4**	**5-8**	**9-12**

CONUT: Controlling nutritional status

Patients with AsAA determined to have a larger left atrium (p=0.002), larger left ventricular diastolic dimension (p<0.001), lower ejection fraction (p<0.001), thicker interventricular septum and posterior wall (p=0.001, p=0.003) than the group without AsAA (Table 3).

The CONUT score was similar in both groups. Although moderate and severe malnutrition was higher in the AsAA (+) group than in the AsAA (-) group, it did not reach statistical significance (p=0.06). The PNI score was found to be significantly lower in the ASAA (+) group than in the AsAA (-) group (p<0.001) (Figure 1) (Table 3).

Univariate and logistic regression analyses were performed for the predictors of AsAA (Table 4 and 5). Logistic regression analyses showed that the PNI score was an independent predictor of ascending aorta aneurysms in elderly patients with hypertension [Odds ratio (OR): 0.92, 95% confidence interval (CI): 0.87-0.98, p=0.01]. Age (OR: 1.09, 95% CI: 1.04-1.13, p<0.001), smoking (OR: 2.50, 95% CI: 1.36-4.57, p=0.003), and coronary artery disease (OR: 2.17, 95% CI: 1.14-4.13, p=0.01) were found to be independent predictors of the development of AsAA in elderly patients with hypertension (Table 5).

The median follow-up of the patients was 3.32 years (2.72-4.13). During the follow-up period, aortic dissection, percutaneous aortic intervention, surgery, and mortality did not develop in any case in the AsAA (-) group. In the AsAA (+) group, 4 (2.0%) patients developed aortic dissection, 6 (3%) patients underwent aortic surgery, and 8 (4%) patients died. Only two of the patients died from an aortic dissection.

Discussion

This study demonstrated that nutritional status determined by the PNI score was an independent predictor of the development of AsAA in elderly patients with hypertension.

The patients with AsAA in this study were found to be older and taller, with a greater frequency of atrial fibrillation and coronary artery disease, as expected. The use of antihypertensive and oral anticoagulant drugs was also higher in the AsAA (+) group. These results were compatible the findings of previous studies (17,18).

PNI is a practical, validated nutritional score, which objectively reveals the nutritional status according to lymphocyte count and albumin level. Several studies have demonstrated the relationship between PNI score and cardiovascular diseases (19-21). Studies on the relationship between aortic pathologies and nutritional status have been conducted on patients with aortic dissection and patients who had undergone percutaneous intervention or surgery to the aorta (7,11,22-24). In all of these studies, it has been shown that malnutrition adversely affects long-term survival and complications in patients undergoing intervention to the aorta. However, these data did not indicate clinical results regarding aneurysms that did not require intervention. The current study may be novel in demonstrating the role of nutritional status in AsAAs without percutaneous and surgical intervention.

Leone et al. (25) showed that AsAA significantly increased the frequency of cardiovascular events in hypertensive patients according to age, gender, and body surface area adjusted risk analysis. Therefore, diagnosing

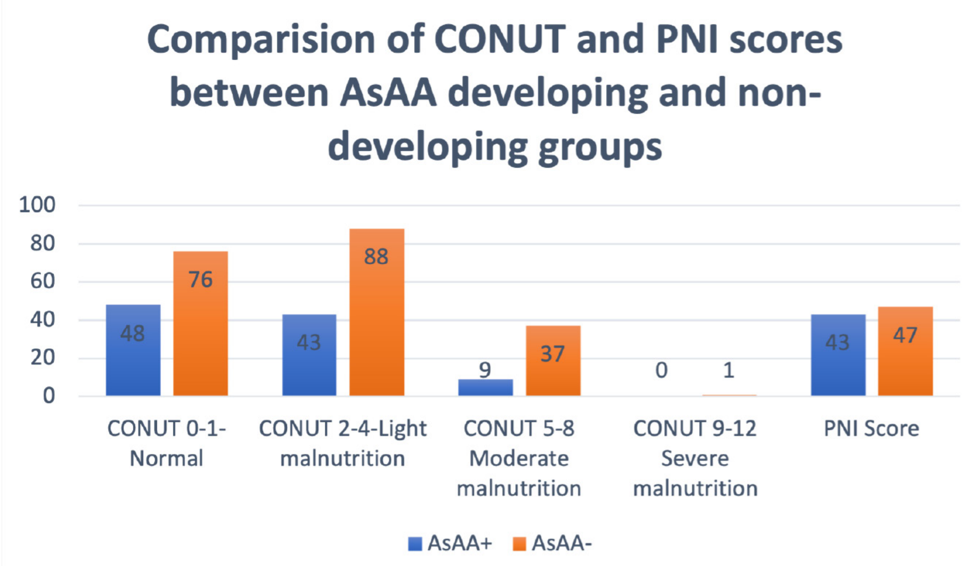

Figure 1. Comparision of CONUT and PNI scores between AsAA developing and non-developing groups

CONUT: Controlling Nutritional Status, PNI: Prognostic nutritional, AsAA: Ascending aorta aneurysm

Table 2. Demographic characteristics and laboratory results of the patients				
	Total n=302	**Normal aorta n=100 (33.1%)**	**Aortic aneurysm 202 (66.9%)**	**p-value**
Sex (male)	148 (49.0%)	45 (45.0%)	103 (51.0%)	0.32
Age (years) (median- Q1-Q3)	72 (68-77)	71 (63-73)	74 (69-79)	**<0.01***
Height, cm, (median)	166 (161-172)	163 (159-170)	167 (162-172)	**0.001***
Body mass index (kg/m^2), (SD)	25.5 (2.1)	25.3 (1.7)	25.6 (2.2)	0.15
Diabetes mellitus, n%	102 (33.8%)	38 (38.0%)	64 (31.7%)	0.27
Smoking, n%	104 (34.4%)	27 (27.0%)	77 (38.1%)	0.056
Hyperlipidemia, n%	157 (52.0%)	46 (46.0%)	111 (55.0%)	0.14
Coronary artery disease	89 (29.7%)	17 (17.3%)	72 (35.6%)	**0.001****
CABG, n%	34 (11.3%)	8 (8.0%)	26 (12.9%)	0.20
PCI	45 (14.9%)	15 (15.0%)	30 (14.9%)	0.97
Heart failure, n%	32 (10.6%)	8 (8.0%)	24 (11.9%)	0.30
CVE	25 (8.3%)	5 (5.0%)	20 (9.9%)	0.14
Atriyal fibrillation, n%	105 (34.8%)	26 (26.0%)	79 (39.1%)	**0.02**
Peripheral vascular disease, n%	15 (5.0%)	3 (3.0%)	12 (5.9%)	0.26
Medications				
Beta blocker, n%	253 (83.8%)	72 (72.0%)	181 (89.6%)	**<0.001****
Calcium channel blocker, n%	110 (36.4%)	24 (24.0%)	86 (42.6%)	**0.002****
ACEI, n%	92 (30.7%)	35 (35.0%)	57 (28.5%)	0.25
ARB, n%	139 (46.0%)	55 (55.0%)	84 (41.6%)	**0.02****
Diuretic, n%	124 (41.1%)	50 (50.0%)	74 (36.6%)	**0.02****
Spiranolactone, n%	36 (11.9%)	7 (7.0%)	29 (14.4%)	0.06*
Alfa blocker, n%	19 (6.3%)	2 (2.0%)	17 (8.4%)	**0.03****
OAD-Insulin, n%	90 (29.8%)	34 (34.0%)	56 (27.7%)	0.26
Statin, n%	145 (48.0%)	51 (51.0%)	94 (46.5%)	0.46
ASA, n%	131 (43.4%)	43 (43.0%)	88 (43.6%)	0.92
Clopidogrel, n%	24 (8.0%)	6 (6.0%)	18 (9.0%)	0.37
Oral anticoagulant, n%	82 (27.2%)	17 (17.0%)	65 (32.2%)	**0.005****
Monotherapy, n%	63 (20.9%)	20 (20.0%)	43 (21.3%)	0.79
Dual therapy, n%	79 (26.2%)	29 (29.0%)	50 (24.8%)	0.40
Triple therapy, n%	102 (33.8%)	32 (32.0%)	70 (34.7%)	0.64
More, n%	49 (16.2%)	15 (15.0%)	34 (16.8%)	0.68
Laboratory				
Hemoglobin, (g/dL)	13.5 (12.1-14.6)	13.6 (12.8-14.1)	13.3 (11.9-14.6)	0.09
Platetelet (x10^3/mm^3)	246 (216-281)	259 (231-287)	239 (201-269)	**0.001*****
Leukocyte (x10^3/mm^3)	7.5 (1.9)	7.6 (1.7)	7.4 (1.9)	0.60
Neutrophil (x10^3/mm^3)	4.5 (1.5)	4.4 (1.4)	4.5 (1.6)	0.57
Lymphocyte (x10^3/mm^3)	1.9 (1.5-2.4)	2.2 (1.6-2.5)	1.9 (1.4-2.3)	**0.002*****
Monocyte (x10^3/mm^3)	0.6 (0.8)	0.7 (1.4)	0.6 (0.2)	0.08
Total protein, (mg/dL)	6.6 (6.1-7.0)	6.9 (6.5-7.1)	6.5 (6.0-6.8)	**<0.001*****
Albumin, (mg/dL)	3.4 (3.0-3.9)	3.6 (3.3-4.1)	3.4 (2.9-3.8)	0.003***
AST, (mg/dL)	27.6 (11.2)	27.1 (9.9)	27.9 (11.8)	0.56
ALT, (mg/dL)	21.8 (9.6)	21.2 (7.8)	22.1 (10.4)	0.46
Glucose, (mg/dL)	114.4 (36.5)	111.6 (22.7)	115 (41.7)	0.35
Creatinine, (mg/dL)	0.9 (0.7-1.1)	0.8 (0.6-1.0)	0.9 (0.8-1.2)	<0.001***

Table 2. Continued

	Total n=302	Normal aorta n=100 (33.1%)	Aortic aneurysm 202 (66.9%)	p-value
Na, (mg/dL)	138.9 (3.6)	138.8 (3.8)	139.0 (3.6)	0.59
K, (mg/dL)	4.2 (3.9-4.5)	4.1 (3.9-4.4)	4.3 (4.0-4.5)	**0.004*****
CRP, (mg/dL)	0.3 (0.1-0.9)	0.3 (0.1-0.8)	0.3 (0.1-1.1)	0.34
Uric acid, (mg/dL)	5.8 (5.0-6.7)	5.5 (4.9-6.5)	6.0 (5.1-6.9)	0.01***
Total cholesterol, (mg/dL)	202 (40)	206 (38)	200 (40)	0.19
HDL cholesterol, (mg/dL)	50 (16)	53 (17)	49 (15)	0.052
LDL cholesterol, (mg/dL)	127 (36)	131 (42)	125 (33)	0.14
Triglyceride, (mg/dL)	164 (74)	165 (61)	164 (80)	0.87

*Mann-Whitney U test, **Chi-square, ***t-test
CABG: Coronary artery bypass grafting, PCI: Percutaneous coronary intervention, CVE: Cerebrovascular event, OAD: Oral antidiabetic, ACEI: Angiotensin-converting enzyme inhibitor, ARB: Angiotensin receptor blocker, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, HDL: High-density lipoprotein, LDL: Low-density lipoprotein

and controlling AsAA in hypertensive elderly patients is crucial for protection against organ damage. The results of the current study support the view that improving nutritional status may be effective in preventing aortic and vascular damage in elderly hypertensive patients.

A striking result of this study was that, unlike the PNI score, there was no significant difference between the groups in the CONUT score. It was thought that the possible reason for this was the relatively small number of patients. Moderate-severe malnutrition determined by the CONUT score was higher in the AsAA group, and this difference would probably have reached a statistically significant level with more patients.

In this study, age, smoking, and coronary artery disease were other independent predictors of AsAA. These results are compatible with a similar study by Otaki et al. (26).

Study Limitations

The main limitation of this study was the single-center, retrospective, and cross-sectional design. Additionally, the change of AsAA in the echocardiography could not

Table 3. Nutritional status, echocardiographic findings, and long-term clinical outcomes of the patients

Nutritional Indexes				
CONUT score				
	Total	**Normal Aorta**	**AsAA**	
Normal (0-1)	124 (41.2%)	48 (48.0%)	76 (37.8%)	0.06
Light malnutrition (2-4)	131 (43.5%)	43 (43.0%)	88 (43.8%)	
Moderate & severe malnutrition (5-8)	46 (15.3%)	9 (9.0%)	37 (18.4%)	
Severe malnutrition (9-12)	1 (0.3%)	0	1 (0.5%)	
PNI score (>38=normal nutrition)	44.7 (7.4)	47.1 (8.0)	43.5 (6.7)	**<0.001*****
Echocardiographic findings		**Normal Aorta**	**AsAA**	
LA, mm	40.0 (38.0-43.0)	39.0 (38.0-41.0)	41.0 (39.0-43.0)	**0.002*****
LVEDD, mm	49.0 (48.0-51.0)	49.0 (46.0-50.7)	50.0 (48.0-52.0)	**<0.001*****
EF %	55.0 (50.0-55.0)	55.0 (55.0-60.0)	51.0 (50.0-55.0)	**<0.001*****
IVS, mm	12.8 (1.2)	12.5 (1.0)	12.9 (1.2)	**0.001*****
PW, mm	12.1 (0.7)	11.9 (0.6)	12.1 (0.7)	**0.003*****
Aortic annulus, mm	24.0 (23.0-26.0)	23.0 (22.0-24.0)	25.0 (24.0-27.0)	**<0.001*****
Sinus valsalva, mm	32.0 (30.0-36.0)	30.0 (29.0-31.0)	34.0 (31.0-36.0)	**<0.001*****
Ascending aorta, mm	40.0 (37.0-43.0)	35.0 (33.0-37.0)	42.0 (40.0-45.0)	**<0.001*****
Long-term clinical outcomes				
Aortic disssection	4 (1.3%)	0	4 (2.0%)	0.15
Aortic surgery/percutaneous intervention	6 (2.0%)	0	6 (3.0%)	0.08
All-cause mortality	8 (2.7%)	0	8 (4.0%)	**0.04***

CONUT: Controlling Nutritional Status, PNI: Prognostic Nutritional Index, LA: Left atrium, LVEDD: Left ventricle end-diastolic dimension, IVS: Interventricular septum, EF: Ejection fraction, PW: Posterior wall, AsAA: Ascending aorta aneurysm
*Mann-Whitney U test, ***t-test

Table 4. Univariate regression analysis for the predictors of ascending aorta aneurysm

	OR	95% CI	p-value
PNI score	0.93	0.89-0.96	**<0.01**
CONUT score	2.59	1.15-5.85	**0.02**
Gender	1.27	0.78-2.05	0.32
Age	1.07	1.04-1.11	**<0.01**
Smoking	1.66	0.98-2.81	**0.04**
Coronary artery disease	2.63	1.45-4.79	**<0.01**

CONUT: Controlling Nutritional Status, PNI: Prognostic Nnutritional, CI: Confidence interval, OR: Odds ratio

Table 5. Logistic regression analysis for the predictors of ascending aorta aneurysm

	OR	95% CI	p-value
PNI score	0.92	0.87-0.98	**0.01**
CONUT score	0.59	0.16-2.06	0.40
Gender	1.41	0.82-2.41	0.21
Age	1.09	1.04-1.13	**<0.001**
Smoking	2.50	1.36-4.57	**0.003**
Coronary artery disease	2.17	1.14-4.13	**0.01**

CONUT: Controlling Nutritional Status, PNI: Prognostic nutritional, CI: Confidence interval, OR: Odds ratio

be obtained. This valuable finding shows the aneurysm expansion rate and prognosis. Finally, the relationship between morbidity, mortality, and nutritional status could not be demonstrated because the AsAA-related morbidity and mortality rates were very low.

Conclusion

Low nutritional status increases the risk of developing AsAA in elderly hypertensive patients. Therefore, determining nutritional status by risk scores and supporting with natural dietary complements or medically the high-risk elderly hypertensive patients may achieve better clinical outcomes in AsAA patients. Nevertheless, there is a need for further multicenter studies with larger patient numbers and longer follow-up periods to confirm these results.

Ethics

Ethics Committee Approval: Ethical approval for this study was obtained from the Istanbul Bakirkoy Dr. Sadi Konuk Training and Research Hospital Regional Ethics Committee (approval no: 2022-15, date: 03.01.2022).

Informed Consent: All patient rights were protected, and written informed consent was obtained before the procedures, according to the Helsinki Declaration (2013).

Authorship Contributions

Concept: U.K., Design: U.K., Data Collection and/or Processing: U.K., Analysis and/or Interpretation: K.K., Literature Research: K.K., Writing: U.K.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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