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Acute limb ischemia in the elderly: Determining the mortality factors

Yaşlılarda akut ekstremite iskemisi: Mortaliteye etkili faktörlerinin belirlenmesi

Kivanc Kacar, Tugra Gencpinar, Kivanc Metin, Baran Ugurlu

Department of Cardiovascular Surgery, Dokuz Eylül University Faculty of Medicine, İzmir, Türkiye

ABSTRACT

Background: The study aims to identify factors associated with mortality in elderly patients undergoing surgery for acute limb ischemia.

Methods: Between October 2010 and January 2024, a total of 205 patients (106 males, 99 females; mean age: 77.7±8.0 years; range, 65 to 98 years) who underwent embolectomy for acute limb ischemia were retrospectively analyzed. Postoperative mortality and one-year mortality were designated as primary outcome measures. Multiple regression analyses were performed for variables related to postoperative mortality, and cut-off values for numeric variables were determined. The Kaplan-Meier survival analyses were performed using one-year mortality data.

Results: Postoperative mortality rate was 35.1% and one-year mortality rate was 56.6%. A total of 52.8% of the patients who died postoperatively were functionally dependent and 72.2% had no history of atrial fibrillation. Multivariate analysis revealed that a neutrophil-to-lymphocyte ratio above 5.91 increased mortality by 9.1 times, functional dependency by 7.3 times, and absence of a history of atrial fibrillation by 3.3 times. Functional dependency, absence of atrial fibrillation, and neutrophil-to-lymphocyte ratio greater than 5.85 negatively affected one-year mortality.

Conclusion: Our study results indicate that absence of atrial fibrillation, functional dependency, and neutrophil-to-lymphocyte ratio can be used to predict postoperative mortality.

Keywords: Acute limb ischemia, elderly, embolectomy, mortality, risk.

ÖZ

Amaç: Bu çalışmada akut ekstremite iskemisi nedeniyle ameliyat edilen yaşlı hastalarda mortalite ile ilişkili faktörler belirlendi.

Çalışma planı: Ekim 2010 - Ocak 2024 tarihleri arasında akut ekstremite iskemisi nedeniyle embolektomi yapılan toplam 205 hasta (106 erkek, 99 kadın; ort. yaş: 77.7±8.0 yıl; dağılım, 65-98 yıl) retrospektif olarak incelendi. Ameliyat sonrası mortalite ve bir yıllık mortalite primer sonuç ölçümleri olarak belirlendi. Ameliyat sonrası mortalite ile ilişkili değişkenler için çoklu regresyon analizleri yapıldı ve sayısal değişkenler için kesim değerleri belirlendi. Bir yıllık mortalite verileri kullanılarak Kaplan-Meier sağkalım analizleri gerçekleştirildi.

Bulgular: Ameliyat sonrası mortalite oranı %35.1 ve bir yıllık mortalite oranı %56.6 idi. Ameliyat sonrası kaybedilen hastaların toplam %52.8'i fonksiyonel bağımlı iken, %72.2'sinde atriyal fibrilasyon öyküsü yoktu. Çok değişkenli analizde 5.91 üzeri nötrofil/lenfosit oranının mortaliteyi 9.1 kat, fonksiyonel bağımlılığın 7.3 kat ve atriyal fibrilasyon öyküsünün olmamasının 3.3 kat artırdığı saptandı. Fonksiyonel bağımlılık, atriyal fibrilasyon olmaması ve nötrofil/lenfosit oranının 5.85'ten büyük olması bir yıllık mortaliteyi olumsuz etkiledi.

Sonuç: Çalışma sonuçlarımız atriyal fibrilasyonun olmaması, fonksiyonel bağımlılık ve nötrofil/lenfosit oranının ameliyat sonrası mortaliteyi öngörmede kullanılabileceğini göstermektedir.

Anahtar sözcükler: Akut ekstremite iskemisi, ileri yaş, embolektomi, mortalite, risk.

Acute limb ischemia (ALI) is characterized by a sudden decrease in perfusion in the limb artery. It is a condition which requires emergency assessment and intervention, as it threatens the viability of the limb.[1] The diagnosis is typically made clinically and, despite treatment, the mortality and morbidity rates still remain high.[2] If the symptoms of limb ischemia have developed within the past two weeks, it is classified as ALI.[3] The underlying etiology can be explained in two ways: the embolization or *in-situ*

Corresponding author: Kivanc Kacar.
E-mail: kivanc.kacar@outlook.com

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thrombosis. Recently, a shift has been identified in age groups and etiology. Embolisms can be either cardiac or non-cardiac. Cardiac embolism may originate from left atrial thrombi associated with atrial fibrillation or from left ventricular thrombi following a myocardial infarction. Non-cardiac embolism frequently originates from atherosclerotic plaques or mural thrombi within the aorta.[4,5] *In-situ* thrombi can develop secondary to atherosclerotic occlusions, dissections, hypercoagulable states, vasospasm, or graft occlusions.[6,7]

Numerous clinical and preoperative laboratory parameters have been investigated in ALI to identify potential predictors of mortality and morbidity.[8] Of these, creatine kinase is the most frequently encountered.[9] The neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) have been the subject of investigation as potential inflammatory markers and predictors of mortality or morbidity in both acute and chronic limb ischemia.[10,11] Additionally, the aspartate to alanine aminotransferase ratio (De Ritis) and C-reactive protein (CRP)/albumin ratio have been shown to be particularly significant in critical limb ischemia.[12,13]

In the present study, we aimed to identify the factors associated with mortality in elderly patients undergoing surgery for ALI and to differentiate patients who truly benefited from surgical revascularization from those for whom the procedure was futile.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Dokuz Eylül University Faculty of Medicine, Department of Cardiovascular Surgery between October 2010 and January 2024. Patients who were operated for ALI within 24 h of admission to emergency department were reviewed. A total of 787 ALI episodes were identified in 749 patients. Episodes of recurrent ischemia in the same limb in 38 patients were excluded. Of 749 patients, only the first ischemic episode in 205 patients aged ≥65 (106 males, 99 females; mean age: 77.7±8.0 years; range, 65 to 98 years) was included in the study. Exclusion criteria were as follows: previous open or endovascular vascular surgery on the ipsilateral limb or inflow artery, traumatic ALI, and patients who did not undergo surgery. A written informed consent was obtained from each patient. The study protocol was approved by the Dokuz Eylül University Non-Interventional Research Ethics Committee (date: 20.02.2024, no: 2024/07-18). The study was conducted in accordance with the principles of the Declaration of Helsinki.

The primary outcome measures were one-year all-cause mortality and postoperative all-cause mortality. Postoperative mortality was defined as any death occurring within 30 days of surgery or before hospital discharge including death events that occurred during the hospitalization (even after 30 days) or after discharge, but within 30 days of the procedure. Mortality within one year following surgery was defined as one-year mortality. The data pertaining to mortality were extracted from the hospital's electronic health record system and subsequently cross-referenced with the Republic of Türkiye, Ministry of Health centralized database. The laboratory parameters were evaluated within a 24-h preoperative window. The glomerular filtration rate (GFR) was estimated utilizing the 2021 Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation, based on the preoperative creatinine level, and expressed in mL/min/1.73 m^2.[14] The time interval between the onset of ischemic symptoms and the surgical procedure was defined as the ischemic duration. A functional status assessment was conducted on all patients prior to the onset of symptoms. The patients were classified based on their functional status as follows: functionally independent (able to ambulate without assistance), partially dependent (requiring assistive devices for ambulation), and functionally dependent (unable to ambulate). The Rutherford classification was used to grade the severity of ischemia.[15] The patients were evaluated for a history of stroke, coronary artery disease, peripheral arterial disease, acute or chronic mesenteric ischemia, and carotid artery disease. All of these conditions were classified as primary vascular diseases. The study investigated whether the patient necessitated a second operation within 30 days postoperatively for revascularization of the same limb, which was defined as early reoperation. The study investigated postoperative complications, with a particular focus on renal, neurological, infectious, and cardiac events. In particular, the following were evaluated: renal replacement therapy (RRT), stroke, blood culture positivity, sepsis, acute decompensated heart failure, and life-threatening arrhythmias.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Continuous data were expressed in mean ± standard deviation (SD) or median (min-max), while categorical data were expressed in number and frequency. The normality of the continuous variables was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. In cases where the continuous ordinal variables did not follow a normal distribution, a non-parametric Mann-Whitney U test was employed. Conversely, for normally distributed continuous ordinal variables, the Student t-test was utilized. Categorical variables were compared using the chi-square and Fisher exact tests. Univariate and multivariate regression analyses were conducted to identify independent risk factors for postoperative mortality. The capacity of inflammatory prognostic markers to predict postoperative mortality and one-year mortality/survival was determined using receiver operating characteristic (ROC) analysis. Cut-off values were determined using the Youden index for parameters with a p value of <0.05, and sensitivity and specificity values were calculated for these cut-off values. The Kaplan-Meier survival analysis and log-rank test were used for one-year survival analyses. A p value of <0.05 was considered statistically significant with 95% confidence interval (CI).

RESULTS

A review of the localizations of ischemia revealed that 163 cases were observed in the lower limbs, while 42 cases were observed in the upper limbs (79.5% *vs*. 20.5%). A functional dependency assessment of the patients revealed that 53 were dependent, 68 were partially independent, and 84 were fully independent (25.9%, 33.2% *vs*. 41.0%). The most common comorbidities were analyzed, revealing that hypertension (HT) was present in 133 (64.9%) patients, congestive heart failure (CHF) in 109 (53.2%) patients, atrial fibrillation in 93 (45.4%) patients, and primary vascular disease in 119 (58.0%) patients. According to the Rutherford classification, 17 (8.3%) patients were classified as Grade 1, 144 (70.2%) patients as Grade 2a, and 44 (21.5%) patients as Grade 2b.[15] During the postoperative period, early reoperation was performed in 35 (17.1%) patients, RRT was required in 16 (7.8%) patients, cardiac complications were observed in 29 (14.1%) patients, cerebrovascular events were observed in 23 (11.2%) patients, sepsis developed in 15 (7.3%) patients. Postoperative mortality was observed in 72 (35.1%) patients, while one-year mortality was observed in 116 (56.6%) patients. Amputation was performed in 37 (18.0%) patients within three months of surgery.

Demographic and clinical data were compared between 72 patients who died postoperatively and 133 patients who survived. The median age was 80.0 (range, 65.0 to 98.0) years in non-survivors, compared to 76.0 (range, 65.0 to 97.0) years in survivors (p=0.007). The proportion of functionally dependent patients was higher in non-survivors (11.3% *vs*. 52.8%; p<0.001). Conversely, atrial fibrillation as baseline rhythm was significantly higher among survivors (54.9% *vs*. 27.8%; p<0.001). The rate of malignancy history was found to be significantly higher in non-survivors compared to survivors (8.3% *vs*. 19.4%; p=0.020). No statistically significant differences were observed between survivors and non-survivors regarding sex, duration of ischemia, location of ischemia, HT, CHF, diabetes mellitus (DM) and primary vascular disease (Table 1). A statistically significant difference was observed between survivors and non-survivors in the mean and median values of the following immune-inflammatory markers: CRP/albumin ratio, NLR, PLR, and De Ritis ratio (Table 1). The ROC curves were generated for age, GFR, CRP/albumin ratio, NLR, PLR, and De Ritis ratio and cut-off values were determined for these numerical variables to identify potential predictors of postoperative mortality (Table 2).

The results of the multivariate regression analysis indicated that functional dependence (OR=7.3, 95% CI: 2.3-23.1; p=0.001), the absence of atrial fibrillation (OR=3.3, 95% CI: 1.4-7.9; p=0.007), and an NLR >5.91 (OR=9.1, 95% CI: 3.2-25.9; p<0.001) were the most significant risk factors for postoperative mortality. The results of the univariate and multivariate regression analyses are presented in Table 3.

At the end of the one-year follow-up, 116 patients died, while there were 89 survivors. The median age was 78.0 (range, 65.0 to 98.0) years in non-survivors and 76.0 (range, 65.0 to 92.0) years in survivors. The incidence of lower limb ischemia was higher in non-survivors compared to survivors (71.9% *vs*. 85.3%; p=0.018). Patients who did not survive at the end of one year were mostly functionally dependent patients at the initial presentation. The proportion of functionally dependent patients was higher in non-survivors compared to the survivors (3.4% *vs*. 43.1%; p<0.001). There were no significant differences in sex, HT, DM, CHF, history of malignancy, primary vascular disease, or early reoperation between survivors and non-survivors at the end of one-year follow-up. The presence of atrial fibrillation at the initial

Table 1. Demographic data and postoperative mortality data

	All patients (n=205)				Postoperative mortality (n=72)				No postoperative mortality (n=133)				
Variables	n	%	Mean±SD	Median	n	%	Mean±SD	Median	n	%	Mean±SD	Median	*p*
Age (year)			77.0±8.0	77.7			80.0±8.2	79.8			76.0±7.7	76.6	0.007
Sex													0.946
Male	106	51.7			37	51.4			69	51.9			
Female	99	48.3			35	48.6			64	48.1			
Ischemia duration (h)			18.0±50.3	38.3			24.0±34.6	33.9			16.0±57.0	40.6	0.444
Rutherford classification													<0.001
Grade 1	17	8.3			1	1.4			16	12.0			
Grade 2a	144	70.2			45	62.5			99	74.4			
Grade 2b	44	21.5			26	36.1			18	13.5			
Functional dependence													<0.001
Independent	84	41.0			12	16.7			72	54.1			
Partially independent	68	33.2			22	30.6			46	34.6			
Dependent	53	25.9			38	52.8			15	11.3			
Comorbidities													
Atrial fibrillation	93	45.4			29	40.3			77	54.9			<0.001
Diabetes mellitus	92	44.9			31	43.1			61	45.9			0.699
Hypertension	133	64.9			41	56.9			92	69.2			0.080
Primer vascular disease	119	58.0			43	59.7			76	57.1			0.721
Malignancy	25	12.2			14	19.4			11	8.3			0.020
Re-operation	35	17.1			13	18.1			22	16.5			0.783
Amputation in 3 months	37	18			N/A				N/A				
Laboratory data													
Serum Cr (mg/dL)			1.1±1.3	1.4			1.3±1.9	1.8			1.0±0.7	1.2	0.026
GFR (mL/min/1.73 m^2)			59.9±26.4	59.7			51.5±28.6	52.5			63.6±24.4	63.5	0.008
CRP/albumin			14.9±34.6	29.9			34.5±43.2	47.2			8.8±24.4	20.5	<0.001
NLR			6.6±9.6	9.5			11.1±12.2	15.0			5.0±6.0	6.6	<0.001
PLR			165.0±179.9	217.3			197.1±200.6	253.9			152.5±165.1	197.5	0.008
De Ritis			1.9±2.0	2.3			2.2±2.9	2.8			1.8±1.3	2.1	0.038

SD: Standard deviation; GFR: Glomerular filtration rate (mL/min/1.73 m^2); CRP: C-reactive protein; NLR: Neutrophil to lymphocyte ratio; PLR: Platelet to lymphocyte ratio; De-Ritis: aspartate to alanine aminotransferase ratio.

Table 2. Postoperative mortality prediction (ROC analysis)

Variables	AUC	95% CI Limit	*p*	Cut-off	Sensitivity	Specificity
Age	0.615	0.533-0.696	0.007	82.50	44.4	74.4
GFR	0.613	0.529-0.697	0.008	45.09	45.8	76.7
CRP/albumin	0.721	0.649-0.792	<0.001	26.49	62.5	70.7
NLR	0.777	0.710-0.844	<0.001	5.91	84.7	60.9
PLR	0.612	0.532-0.692	0.008	158.60	69.4	54.9
De Ritis	0.588	0.505-0.671	0.038	2.63	36.1	78.9

ROC: Receiver operating characteristic; AUC: Area under the curve; CI: Confidence interval; GFR: Glomerular filtration rate (mL/min/1.73 m^2); CRP: C-reactive protein; NLR: Neutrophil to lymphocyte ratio; PLR: Platelet to lymphocyte ratio; De-Ritis: Aspartate to alanine aminotransferase ratio.

Table 3. Univariate and multivariate analysis for postoperative mortality

	All patients (n=205)		Postoperative mortality (n=72)		Univariate analysis			Multivariate analysis		
	n	%	n	%	OR	95% CI	*p*	OR	95% CI	*p*
Male	106	51.7	37	51.4	1.0	0.6-1.7	0.946	N/A	N/A	
Lower extremity	163	79.5	62	86.1	2.0	0.9-4.3	0.089	0.6	0.2-2.0	0.451
No atrial fibrillation	112	54.6	52	72.2	3.2	1.7-5.9	<0.001	3.3	1.4-7.9	0.007
History of malignancy	25	12.2	14	19.4	2.7	1.1-6.3	0.023	2.8	0.9-8.9	0.081
Partially independent	68	33.2	22	30.6	2.8	1.3-6.4	0.009	2.1	0.7-6.0	0.169
Dependent	53	25.9	38	52.8	15.2	6.5-35.7	<0.001	7.3	2.3-23.1	0.001
Rutherford Grade 2a	144	70.2	45	62.5	7.3	0.9-56.5	0.058	4.1	0.3-47.9	0.262
Rutherford Grade 2b	44	21.5	26	36.1	23.1	2.8-190.2	0.003	7.9	0.6-106.1	0.120
Age >82.5	66	32.2	32	44.4	2.3	1.3-4.3	0.006	1.9	0.8-4.7	0.146
GFR <45.09	65	31.7	33	45.8	2.9	1.5-5.1	0.001	0.5	0.2-1.1	0.093
CRP/albumin ratio >26.49	84	41.0	45	62.5	4.0	2.2-7.4	<0.001	1.7	0.7-4.3	0.223
NLR >5.91	118	57.6	61	84.7	8.6	4.2-17.9	<0.001	9.1	3.2-25.9	<0.001
PLR >158.60	110	53.7	50	69.4	2.8	1.5-5.1	0.001	0.5	0.2-1.3	0.131
De Ritis >2.63	54	26.3	26	36.1	2.1	1.1-4.0	0.021	1.3	0.5-3.0	0.566

OR: Odds ratio; CI: Confidence interval; GFR: Glomerular filtration rate (mL/min/1.73 m^2); CRP: C-reactive protein; NLR: Neutrophil to Lymphocyte ratio; PLR: Platelet to lymphocyte ratio; De-Ritis: Aspartate to alanine aminotransferase ratio.

presentation had a significant impact on one-year survival. The incidence of atrial fibrillation as a baseline rhythm was higher among survivors (60.7% *vs*. 33.6%; p<0.001). While comparing Rutherford grades, the proportion of Grade 1 patients was significantly higher in the one-year survivors (12.4% *vs*. 5.2%; p<0.001), while the proportion of Grade 2b patients was higher in non-survivors (9.0% *vs*. 31.0%; p<0.001). In addition, there were significant differences in the median and mean values of the immune-inflammatory markers CRP/albumin ratio, NLR, PLR and De Ritis ratio between survivor and non-survivors. The mean CRP/albumin ratio was higher in non-survivors (17.3 *vs*. 22.0, p<0.001). The mean NLR was higher in non-survivors (6.5 *vs*. 11.8; p<0.001). The mean PLR was higher in non-survivors (201.1 *vs*. 229.7; p=0.017). The mean De Ritis ratio was higher in non-survivors (1.95 *vs*. 2.60; p=0.027) Data for the one-year survivors and non-survivors are presented in Table 4. The ROC curves were generated for age, GFR, CRP/albumin ratio, NLR, PLR, and De Ritis

Table 4. One-year mortality and survival analysis (n=205)

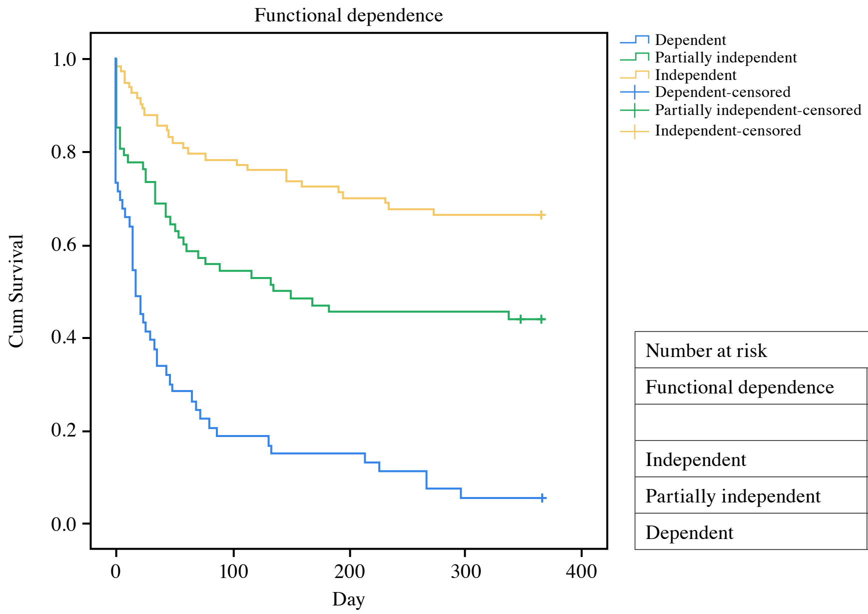
	One year survival (n=89)				One year mortality (n=116)				
Variables	n	%	Mean±SD	Median	n	%	Mean±SD	Median	*p*
Age (year)			76.0±7.5	76.0			78.0±8.2	79.0	0.011
Sex									0.401
Male	48	55.1			57	49.1			
Female	40	44.9			59	50.9			
Ischemia duration (h)			12.0±55.8	35.7			24±45.8	40.3	0.019
Extremity									0.018
Lower extremity	64	71.9			99	85.3			
Upper extremity	25	28.1			17	14.7			
Rutherford classification									<0.001
Grade 1	11	12.4			6	5.2			
Grade 2a	70	78.7			74	63.8			
Grade 2b	8	9.0			36	31.0			
Functional dependence									<0.001
Independent	56	62.9			28	24.1			
Partially independent	30	33.7			38	32.8			
Dependent	3	3.4			50	43.1			
Comorbidities									
Atrial fibrillation	54	60.7			39	33.6			<0.001
Diabetes mellitus	40	44.9			52	44.8			0.987
Hypertension	62	69.7			71	61.2			0.209
Primer vascular disease	47	52.8			72	62.1			0.183
Malignancy	7	7.9			18	15.5			0.097
Laboratory data									
Serum Cr (mg/dL)			1.05±0.46	1.14			1.2±1.6	1.6	0.046
GFR (mL/min/1.73 m^2)			65.5±22.5	65.5			53.5±28.3	55.1	0.006
CRP/albumin			5.9±22.0	17.33			29.4±39.3	22.0	<0.001
NLR			4.2±6.8	6.49			8.5±10.7	11.8	<0.001
PLR			142.2±184.7	201.13			182.4±175.9	229.7	0.017
De Ritis			1.7±1.0	1.95			2.1±2.5	2.6	0.027

SD: Standard deviation; GFR: Glomerular filtration rate (mL/dk/1.73 m^2); CRP: C-reactive protein; NLR: Neutrophil to lymphocyte ratio; PLR: Platelet to lymphocyte ratio; De-Ritis: aspartate to alanine aminotransferase ratio.

Table 5. One-year survival prediction (ROC analysis)

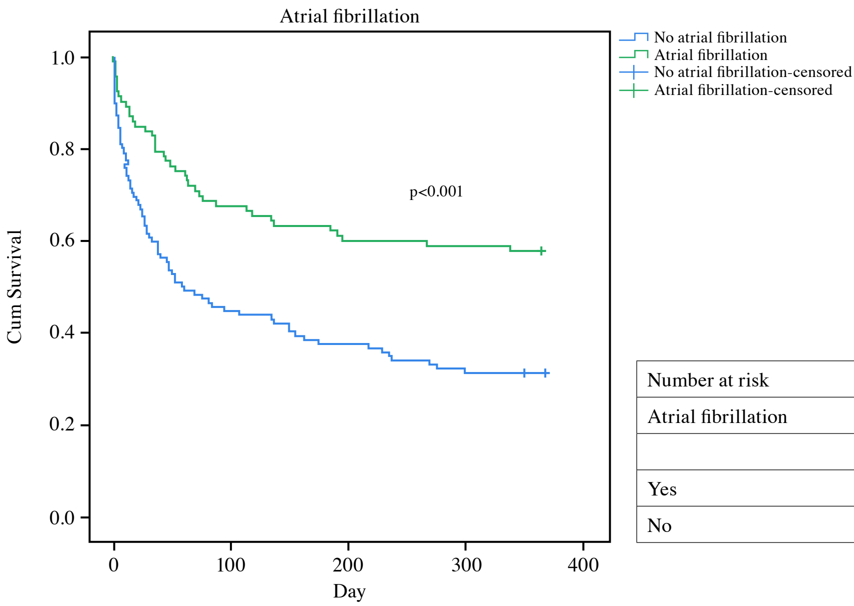
Variables	AUC	95% CI	*p*	Cut-off	Sensitivity	Specificity
		Limit				
Age	0.604	0.527-0.682	0.011	82.5	79.8	41.4
GFR	0.611	0.535-0.688	0.006	45.09	83.1	42.2
CRP/albumin	0.698	0.627-0.770	<0.001	14.37	68.5	65.5
NLR	0.715	0.644-0.787	<0.001	5.85	66.3	72.4
PLR	0.597	0.517-0.677	0.017	119.3	44.9	79.3
De Ritis	0.590	0.513-0.668	0.027	1.90	60.7	58.6

ROC: Receiver operating characteristic; AUC: Area under the curve; CI: Confidence interval; GFR: Glomerular filtration rate (mL/min/1.73 m^2); CRP: C-reactive protein; NLR: Neutrophil to lymphocyte ratio; PLR: Platelet to lymphocyte ratio; De-Ritis: Aspartate to alanine aminotransferase ratio.



Number at risk						
Functional dependence	0	100	200	300	1 year survival	
					n	%
Independent	84	66	59	56	56	66.7
Partially independent	68	37	31	31	30	44.1
Dependent	53	10	8	3	3	5.7

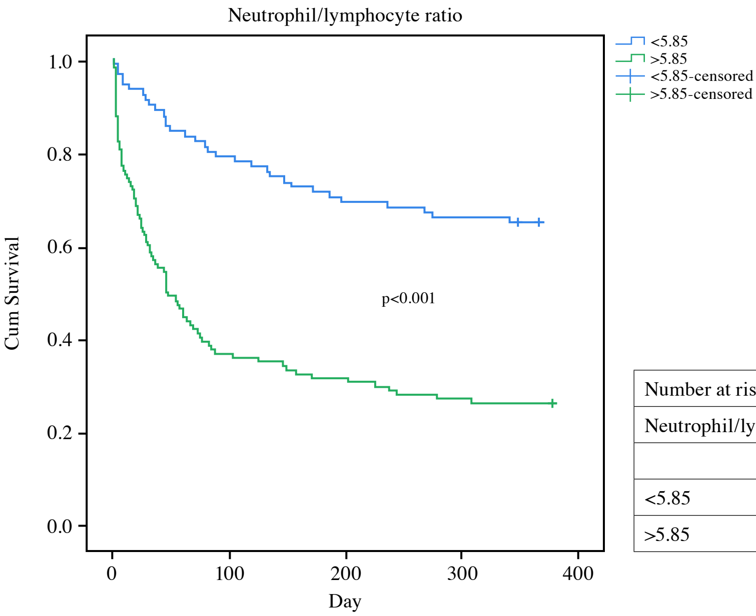
Figure 1. Kaplan-Meier survival analyses and number at risk tables for functional dependence.



Number at risk						
Atrial fibrillation	0	100	200	300	1 year survival	
					n	%
Yes	93	63	56	55	54	58.1
No	112	50	42	35	35	31.2

Figure 2. Kaplan-Meier survival analyses and number at risk tables for atrial fibrillation.

ratio to determine cut-off values for predicting one-year mortality. The results are presented in Table 5. The Kaplan-Meier survival analysis showed that age, ischemia localization, functional dependency (Figure 1), malignancy history, atrial fibrillation (Figure 2), Rutherford classification, GFR, CRP/albumin ratio, NLR (Figure 3), PLR, and De Ritis ratio were significant predictors of survival ($p<0.05$). The effects of the identified variables on one-year mortality are shown in Table 6.



Number at risk						
Neutrophil/lymphocyte	0	100	200	300	1 year survival	
					n	%
<5.85	91	72	63	60	59	64.8
>5.85	114	41	35	30	30	26.3

Figure 3. Kaplan-Meier survival analyses and number at risk tables for neutrophil-to-lymphocyte ratio.

DISCUSSION

In the present study, we identified the factors associated with mortality in elderly patients who underwent surgery for ALI. Our study results demonstrated that an age of 82.5 years was a significant predictor of both postoperative mortality and one-year survival. Consistent with the literature, univariate regression analysis revealed that patients aged >82.5 years had a 2.3-fold increased risk of postoperative mortality.[16] In elderly patients, the increased number and severity of comorbidities, decreased functional capacity, and higher rates of perioperative complications are anticipated to result in poorer outcomes. The lack of significant differences in ischemia times may be due to the dependence of elderly patients on carers for access to healthcare. This dependence often results in delayed presentation, obscuring the relationship between symptom severity and time to presentation.

Furthermore, the multivariate regression analysis in the current study demonstrated that functionally dependent patients had a significantly higher risk of postoperative mortality, with 7.3-fold increased odds, and a significantly lower one-year survival rate of 5.7%. These results are consistent with the literature.[17] It is thought that functionally dependent patients have higher postoperative and one-year mortality rates due to difficulties in expressing their complaints, delays in seeking medical care, reduced participation in diagnostic and therapeutic processes during the perioperative period, inability to mobilize, and inability to return to their daily active life.

Atrial fibrillation plays a significant role in the etiology of ALI. In our study, patients with atrial fibrillation had lower postoperative mortality and higher one-year survival rates. The absence of atrial fibrillation was significantly associated with a 3.3-fold increased risk of postoperative mortality in the multivariate regression analysis. On the other hand, a previous study showed that atrial fibrillation was associated with increased postoperative mortality.[16] Another study also found that atrial fibrillation was a major cause of thromboembolic events in the elderly and that open surgery resulted in superior outcomes, including lower amputation rates, in this patient population.[18] The favorable outcomes observed in elderly patients with atrial fibrillation in our study may be attributed to the high rates of surgical success in the treatment of ischemia following thromboembolic events. In patients without atrial fibrillation, the management of acute ischemia can be considerably more challenging due to the presence of additional factors that complicate the situation. These include systemic events such as agonal thrombi, severe primary vascular disease, general deterioration, acute renal failure, impaired oral intake, hypotension, shock, systemic infection, and sepsis. These complications, as opposed to those seen in patients with atrial

Table 6. Factors affecting one-year mortality

		1 year mortality		
Variables	n	n	%	*p*
Age (year)				0.001
<82.5	139	68	48.9	
>82.5	66	48	72.7	
Extremity				0.018
Upper	42	17	40.5	
Lower	163	99	60.7	
Functional dependence				<0.001
Dependent	53	50	94.3	
Partially independent	68	38	55.9	
Independent	84	28	33.3	
Atrial fibrillation				<0.001
No	112	77	68.8	
Yes	93	39	41.9	
Malignancy				0.097
No	180	98	54.4	
Yes	25	18	72.0	
Rutherford classification				<0.001
Grade 1	17	6	35.3	
Grade 2a	144	74	51.4	
Grade 2b	44	36	81.8	
GFR				<0.001
<45.09	64	49	76.6	
>45.09	141	67	47.5	
CRP/albumin				<0.001
<14.37	101	40	39.6	
>14.37	104	76	73.1	
NLR				<0.001
<5.85	91	32	35.2	
>5.85	114	84	73.7	
PLR				<0.001
<119.3	64	24	37.5	
>119.3	141	92	65.2	
De Ritis				0.006
<1.9	102	48	47.1	
>1.9	103	68	66.0	

GFR: Glomerular filtration rate (mL/min/1.73 m^2); CRP: C-reactive protein; NLR: Neutrophil to lymphocyte ratio; PLR: Platelet to lymphocyte ratio; De-Ritis: aspartate to alanine aminotransferase ratio.

fibrillation, contribute to the increased difficulty in managing acute ischemia. Consequently, the absence of atrial fibrillation in elderly patients is believed to adversely affect one-year survival. Other predictors in our study, such as postoperative complications, malignancy, Rutherford classification, and age, are consistent with the findings of prior study.[18]

In the present study, elevated NLR values were found to be associated with both increased postoperative mortality and reduced one-year survival. The results of the multivariate regression analysis revealed that NLR values exceeding 5.91 were associated with a 9.1-fold increased risk of postoperative mortality. Several studies have indicated that elevated NLR values are associated with a higher risk of amputation and death in patient with ALI or critical limb ischemia. However, there is no association between NLR values and postoperative vascular patency.[11,19,20] The findings of our study indicate that elevated NLR may be associated with severe atherosclerosis, widespread systemic inflammation, sepsis, and end-of-life complications. Furthermore, our results suggest that the relationship between NLR and postoperative mortality can be explained by these factors. A markedly elevated NLR, a standard and cost-effective laboratory test, was identified as an independent risk factor for postoperative mortality.

Elevated PLR values were significantly associated with reduced one-year survival and a 2.8-fold increased risk of postoperative mortality in our study. Previous studies have demonstrated an association between elevated PLR values and higher rates of mortality and amputation.[11] Elevated PLR levels can be attributed to increased blood viscosity or *in-situ* thrombi. Given the higher prevalence of *in-situ* thrombi and agonal thrombi in the elderly, further studies are needed to elucidate the relationship between age and PLR levels.

The search for a reliable model to predict mortality in ALI is ongoing. The designed model must be reliable, fast enough to avoid delaying treatment, and cost-effective. Similar studies have identified age, male sex, functional dependency, and comorbidities such as chronic obstructive pulmonary disease and CHF as risk factors for mortality.[17] Our study corroborates these findings, particularly for functional dependency in the elderly population. Furthermore, we observed that a significantly elevated NLR was an independent predictor of postoperative mortality. More interestingly, among elderly patients, ALI secondary to atrial fibrillation was associated with improved surgical outcomes, while those without atrial fibrillation had lower success rates and higher mortality. In patients without atrial fibrillation, agonal thrombi and *in-situ* thromboses resulting from atherosclerosis are etiologies associated with relatively lower surgical success rates and higher postoperative mortality.

Predicting postoperative mortality in patients using a model based on the identified parameters can guide surgeons toward conservative interventions in high-risk patients, such as catheter-directed thrombolysis or percutaneous mechanical thrombectomy technique. Catheter-directed thrombolysis is a less invasive alternative to open surgical procedures.[21] This technique can be employed in viable or marginally threatened limbs (Rutherford Class I and IIa). Catheter-based lytic therapy is administered over a 24 to 48-h period. However, it may not be suitable for limbs requiring a more emergent intervention.[21] Several studies have demonstrated that percutaneous mechanical thrombectomy devices and combined catheter-directed thrombolysis exhibit lower mortality and amputation rates at both a month and one year compared to open surgical procedures.[22] However, it is essential to note the higher incidence of distal embolization in infrapopliteal lesions associated with these endovascular techniques.[21] This approach may result in a reduction in postoperative mortality rates among high-risk patient groups. The desired model can also contribute to better preoperative informed consent, allowing patients and their families to be more accurately informed and aligning their expectations with potential outcomes. The outcomes may be influenced by whether the patient is admitted from home, a nursing home, a care facility, or a hospital. Further studies are needed to examine whether the outcomes of ALI with atrial fibrillation etiology differ according to age groups.

The main limitations to this study include the relatively small sample size and the single-center, retrospective design based on patient data extracted from hospital records. Further large-scale, prospective studies using additional parameters are warranted to confirm these findings.

In conclusion, in elderly patients, elevated neutrophil-to-lymphocyte ratio, functional dependency, and the absence of atrial fibrillation are significant predictors indicating that the disease may be of systemic origin or may present as an end-of-life issue. This condition is thought to severely impact surgical success and the planning of postoperative medical treatment.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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