ORIGINAL ARTICLE

CARDIOVASCULAR SURGERY AND INTERVENTIONS

DOI: 10.4274/e-cvsi.2025.2060
Cardiovasc Surg Int 2026;13(1):27-30

Contrast-induced nephropathy after endovascular interventions in peripheral artery disease: Predictive value of the Mehran score

Ecem Gürses

Department of Cardiology, Bakırçay University Çiğli Training and Research Hospital, İzmir, Türkiye

Received: September 12, 2025 **Accepted:** September 20, 2025 **Epub:** February 24, 2026 **Publication Date:** March 02, 2026

ABSTRACT

Objectives: To evaluate the predictive value of the Mehran score for contrast-induced nephropathy (CIN) following peripheral transcatheter angioplasty (PTA) in patients with peripheral artery disease (PAD).

Patients and methods: We retrospectively analyzed 103 patients who underwent PTA at our center between January 2020 and July 2024. The Mehran score was calculated for all patients meeting inclusion criteria. CIN was defined as an absolute increase in serum creatinine ≥0.5 mg/dL or a relative increase ≥25% within 48-72 hours post-procedure. Receiver operating characteristic analysis was used to assess the predictive value of the Mehran score. Multivariate logistic regression identified independent risk factors for CIN.

Results: CIN occurred in 19 patients (18.4%). Patients who developed CIN received significantly higher contrast volumes (p<0.05). The optimal Mehran score cut-off for predicting CIN was 11.2, with an area under the curve of 0.712 (95% confidence interval: 0.612-0.826; sensitivity 69%, specificity 73%). Independent predictors of CIN included advanced age, diabetes mellitus, higher contrast volume, baseline glomerular filtration rate, and the Mehran score. Patients with CIN had longer hospital stays (3.9±1.7 *vs.* 1.9±0.7 days, p=0.002) and higher amputation rates (10.6% *vs.* 2.9%, p=0.004).

Conclusion: The Mehran score is a valuable tool for predicting CIN after PTA in PAD patients. Risk stratification using the Mehran score may guide preventive strategies, although PAD-specific models incorporating additional parameters are warranted.

Keywords: Peripheral artery disease, percutaneous transcatheter angioplasty, Mehran score, contrast-induced nephropathy.

Peripheral artery disease (PAD) is a prevalent vascular disorder associated with increased morbidity and mortality, with higher prevalence in older populations.[1,2] Untreated PAD carries a high risk of complications. Endovascular interventions, such as peripheral transcatheter angioplasty (PTA), have become preferred treatment options due to lower complication rates compared with medical therapy or surgical revascularization.[3]

However, contrast media used during these procedures may precipitate contrast-induced nephropathy (CIN), defined as an increase in serum creatinine ≥0.5 mg/dL or ≥25% within 48-72 hours post-procedure. CIN occurs more frequently in elderly or comorbid patients.[4-7]

Risk factors for CIN include advanced age, pre-existing renal impairment, diabetes mellitus (DM), anemia, heart failure, hemodynamic instability, and high contrast volume. The Mehran score, developed to predict post-coronary intervention CIN, incorporates both clinical and procedural parameters, including hypotension, intra-aortic balloon pump requirement, congestive heart failure, chronic kidney disease, diabetes, age >75 years, anemia, and contrast volume.[7,8]

The predictive value of the Mehran score in PAD patients undergoing PTA has not been extensively evaluated. This study aimed to assess the utility of the Mehran score for predicting CIN after PTA in this population.

Address for Correspondence: Ecem Gürses, MD, Department of Cardiology, Bakırçay University Çiğli Training and Research Hospital, İzmir, Türkiye
E-mail: eccemm_1988@hotmail.com **ORCID ID:** orcid.org/0000-0001-5325-6390
Cite this article as: Gürses E. Contrast-induced nephropathy after endovascular interventions in peripheral artery disease: predictive value of the Mehran score. Cardiovasc Surg Int. 2026;13(1):27-30

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PATIENTS AND METHODS

Study Design and Population

This retrospective, single-center cohort study was conducted with Local Ethics Committee of İzmir Bakırçay University (decision no: 1839, approval no: 2487, date: 07.11.2024) approval in accordance with the Declaration of Helsinki. Patients ≥18 years old who underwent PTA for PAD between January 2020 and July 2024 were included. Due to the retrospective design of the study, the requirement for written informed consent was waived.

Inclusion Criteria

Documented serum creatinine within 7 days prior to PTA and at least one post-procedure creatinine measurement within 48-72 hours.

Exclusion Criteria

End-stage renal disease on dialysis, acute kidney injury (AKI) at baseline, regular use of nephrotoxic medications (e.g., non-steroidal anti-inflammatory drugs), or incomplete clinical/laboratory data.

Demographic, clinical, and procedural data—including age, sex, body mass index, comorbidities (DM, hypertension, congestive heart failure, anemia, chronic kidney disease), procedure type, contrast type and volume, procedure duration, and hemodynamic parameters—were obtained from electronic medical records.

Mehran Score Calculation

The Mehran score was calculated using pre- and intra-procedural clinical and procedural variables. Patients were categorized into low (0-5), moderate (6-10), high (11-15), and very high (≥16) risk groups.

Definition of CIN

CIN was defined as an increase in serum creatinine ≥0.5 mg/dL or ≥25% within 48-72 hours post-PTA. For sensitivity analysis, KDIGO-AKI criteria were also applied.

Endpoints

The primary endpoint was CIN development. Secondary endpoints included hospital length of stay, acute dialysis requirement, and 30-day and 1-year all-cause mortality.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation or median (interquartile range) and compared using Student's t-test or Mann-Whitney U test. Categorical variables were expressed as frequencies (%) and compared using the chi-square test. Receiver operating characteristic (ROC) analysis determined the predictive value of the Mehran score for CIN. Variables with p<0.10 in univariate analysis or clinical relevance were included in multivariate logistic regression to identify independent CIN predictors. Statistical significance was set at p<0.05.

RESULTS

A total of 103 patients were included (mean age 62.6±10.1 years; 71% male). Comorbidities included smoking (74.7%), DM (55.3%), hypertension (52.4%), and chronic kidney disease (14.6%). The incidence of CIN was 18.4% (n=19), with a mean Mehran score of 8.9±2.1 (Table 1).

Mean procedure duration was 41.3±17.7 minutes, mean contrast volume was 141.7±41.3 mL, and mean hospital stay was 2.1±0.8 days.

Patients who developed CIN had longer hospital stays (3.9±1.7 *vs.* 1.9±0.7 days, p=0.002) and higher amputation rates (10.6% *vs.* 2.9%, p=0.004). Baseline glomerular filtration rate (GFR) was significantly lower in the CIN group (p=0.026). ROC analysis showed an area under the curve (AUC) of 0.712 (95% confidence interval [CI]: 0.612-0.826; sensitivity 69%, specificity 73%), with an optimal Mehran score cut-off of 11.2. Multivariate analysis identified anemia, high contrast volume, DM, baseline GFR, baseline creatinine, and Mehran score as independent predictors of CIN (Table 2). ROC curve analysis demonstrated that the Mehran score had good predictive accuracy for CIN (AUC: 0.712), as shown in Figure 1.

Table 1. General characteristics of the study population

	CIN (n=19)	NKF (n=84)	p-value
Age,years	64.5±9.9	62.2±10.7	0.568
Male gender, %	13 (68.4%)	61 (72.6%)	0.212
Systolic BP, mmHg	128.8±17.4	129.6±18.3	0.656
Diastolic BP, mmHg	74.7±13.5	81.4±19.9	0.046*
Diabetes mellitus, %	14 (73.6%)	43 (51.1%)	0.012*
Hypertension, %	13 (68.4%)	41 (48.8%)	0.008*
CAD, %	9 (47.3%)	27 (32.1%)	0.032*
CKD, %	5 (26.3%)	10 (11.9%)	0.062
Iliac-femoral, %	2 (10.5%)	11 (13.1%)	0.468
SFA,%	11 (57.8%)	53 (63.1%)	0.282
BTK, %	5 (26.3%)	20 (23.8%)	0.404
LVEF, %	52.5±8.8	56.2±9.2	0.108
Creatinine (baseline), mg/dL	1.29±0.28	1.12±0.24	0.044*
GFR, mg/dL/1.73 m^2	57±10.2	68±13.1	0.002*
Mehran score	11.5±3.5	9.8±2.8	0.001*
Hemoglobin conf, mg/dL	11.7±2.7	12.6±2.4	0.033*
Contrast volume, mL	204±48	174±33	<0.001*
In-hospital stay, days	3.9±1.7	1.8±0.9	<0.001*
Mortality, 1 year	2 (10.5%)	4 (4.7%)	0.256
BARC >2 bleeding, %	2 (10.5%)	6 (7.1%)	0.542

*: p<0.05 was considered statistically significant; BARC: Bleeding academic research consortium; BP: Blood pressure; BTK: Below the knee; CAD: Coronary artery disease; CIN: Contrast induced nephropathy; GFR: Glomerular filtration rate; LVEF: Left ventricle ejection fraction; NKF: Normal kidney function; SFA: Superficial femoral artery.

Table 2. Univariate and multivariate analysis of contrast induced nephropathy predictors

	Univariate analysis		Multivariate analysis	
	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value
Age	1.2 (0.4-1.6)	0.042	ns	ns
Contrast volume	3.3 (1.6-6.1)	<0.001	2.2 (1.2-3.5)	<0.001*
GFR	4.2 (2.0-6.9)	<0.001	2.5 (1.7-3.6)	<0.001*
Baseline creatinine	2.1 (1.1-3.8)	0.004	1.5 (0.9-2.9)	0.030*
Mehran score	2.7 (1.4-4.9)	<0.001	1.8 (1.1-3.2)	0.007*
DM	1.8 (0.9-3.3)	0.014	1.2 (0.6-2.2)	0.049*
Anemia	1.9 (0.7-3.7)	0.008	1.2 (0.8-2.0)	0.041*
LVEF	1.1 (0.3-1.8)	0.048	ns	ns

*: p<0.05 was considered statistically significant; CI: Confidence interval; DM: Diabetes mellitus; GFR: Glomerular filtration rate; LVEF: Left ventricle ejection fraction.

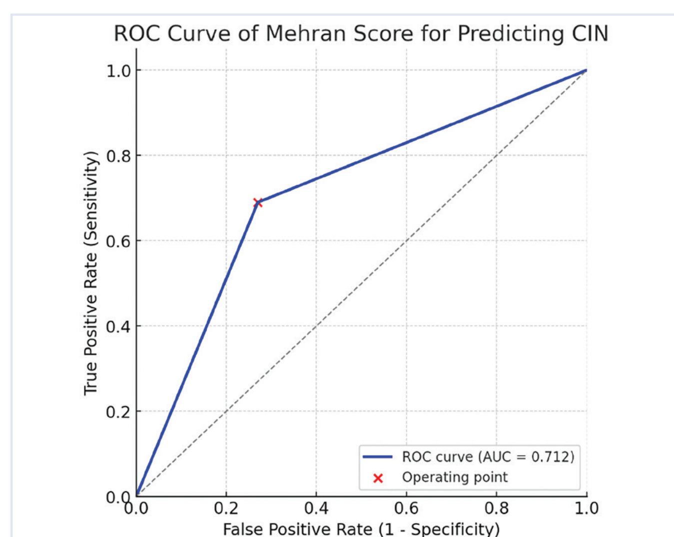

Figure 1. The ROC curve of the Mehran score predicting the development of contrast-induced nephropathy. (AUC; 0.712, sensitivity 69%; specificity 73%)

AUC: Area under the curve; ROC: Receiver operating characteristic; CIN: Contrast-induced nephropathy.

DISCUSSION

In this cohort of PAD patients undergoing PTA, CIN incidence was 18.4%, consistent with previously reported rates of 10-30%. The Mehran score demonstrated significant predictive value, with a cut-off of 11.2 (AUC 0.712), aligning with prior studies in coronary interventions and TAVI procedures.[8-10]

CIN is primarily attributed to contrast-induced renal toxicity and ischemia, with patient-related factors (age, DM, heart failure, impaired renal function) and procedural factors (contrast volume, hemodynamic instability) contributing to risk. In our study, CIN patients had higher prevalence of DM, reduced left ventricle ejection fraction (LVEF), and lower baseline renal function. PAD patients often have high rates of DM, smoking, and concomitant renal and coronary disease, potentially explaining increased heart failure prevalence and poorer outcomes.[8,10-13]

Higher contrast volume was associated with CIN, while procedure-related hypotension or blood loss was not significantly associated. Lower hemoglobin levels were observed in the CIN group. CIN remains a leading cause of hospital-acquired renal failure.[14-16] Post-procedural renal dysfunction has been linked to increased morbidity and mortality, although one-year mortality was not statistically different in our cohort. Amputation rates were higher in the CIN group, likely reflecting higher comorbidity burden.

In this study, the incidence of CIN was 18.4%, and affected patients experienced prolonged hospitalization, higher amputation rates, and worse baseline renal function. ROC analysis identified a Mehran score cut-off of 11.2 with good predictive accuracy, while multivariate analysis confirmed anemia, high contrast volume, DM, baseline GFR, creatinine, and Mehran score as independent predictors of CIN. These findings are consistent with previous reports highlighting the prognostic impact of mo difiable risk factors and validated risk scores in predicting CIN after cardiac and transcatheter interventions.[7,17-19] Early identification of high-risk patients and optimization of preventable risk factors remain crucial to improve outcomes.

Consistent with previous studies, Karakişi et al.[20] reported that the incidence of AKI following coronary artery bypass grafting was 7.6%, with previous myocardial infarction and postoperative creatinine increase as independent predictors of AKI. Similarly, Yurdam et al.[21] demonstrated that in patients undergoing PCI for chronic total occlusion, higher contrast volume, elevated blood glucose levels, reduced baseline renal function, and lower left ventricular ejection fraction were independent predictors of CIN. These findings underscore the importance of careful pre-procedural risk assessment and optimization of modifiable factors to minimize CIN incidence.

The Mehran score is a validated tool for predicting CIN and future adverse outcomes after percutaneous interventions. In our study, anemia, DM, baseline GFR, baseline creatinine, contrast volume, and Mehran score independently predicted CIN. These findings support its utility in risk stratification for PAD patients undergoing PTA. Preventive strategies—including contrast minimization and pre-procedural intravenous hydration—should be considered in high-risk patients.

Given the high prevalence of diabetes, smoking, and chronic kidney disease in PAD patients, the application of established coronary risk models such as the Mehran score may require recalibration or modification for peripheral interventions. Future multicenter studies with larger cohorts are needed to develop PAD-specific CIN risk models incorporating procedural complexity and lesion characteristics.

This study is limited by its retrospective, single-center design, small sample size, variability in hydration protocols, heterogeneity in contrast type and volume, and incomplete long-term renal follow-up. The Mehran score is a valuable tool for predicting CIN in PAD patients undergoing endovascular interventions. While it can guide risk stratification and preventive strategies, PAD-specific risk models incorporating additional parameters are warranted.

Ethics

Ethics Committee Approval: This retrospective, single-center cohort study was conducted with Local Ethics Committee of İzmir Bakırçay University (decision no: 1839, approval no: 2487, date: 07.11.2024) approval in accordance with the Declaration of Helsinki.

Informed Consent: Due to the retrospective design of the study, the requirement for written informed consent was waived.

Footnotes

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

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