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The Effect of Predilatation on Procedural Outcomes in Patients Undergoing Saphenous Vein Graft Percutaneous Coronary Intervention for Acute Coronary Syndrome

Akut Koroner Sendromla Başvuran ve Safen Ven Greftine Perkütan Koroner Girişim Yapılan Hastalarda Predilatasyonun İşlem Sonucuna Etkisi

ABSTRACT

Objective: Percutaneous coronary interventions (PCI) of saphenous vein grafts (SVG) are technically challenging due to friable plaques, high thrombus burden, and the risk of distal embolization. The impact of balloon predilatation on outcomes in patients presenting with acute coronary syndrome (ACS) remains unclear. This study aimed to evaluate the effect of predilatation in patients undergoing SVG PCI.

Method: In this single-center retrospective study, 202 patients with ACS and prior coronary artery bypass graft (CABG) surgery who underwent PCI to an SVG between 2007 and 2024 were analyzed. Patients were categorized according to whether predilatation was performed before stent implantation (predilatation group, n = 112; no predilatation group, n = 90). Coronary flow was assessed using the Thrombolysis in Myocardial Infarction (TIMI) classification. Logistic regression analysis was performed to identify independent predictors of inadequate post-procedural flow (TIMI < 3).

Results: Baseline demographic and clinical characteristics were comparable between the groups. Post-procedural TIMI 3 flow was achieved in 69.6% of the predilatation group and 55.6% of the non-predilatation group (P = 0.039). Predilatation (odds ratio [OR] = 0.51, P = 0.030) and the use of glycoprotein IIb/IIIa inhibitors (OR = 0.39, P = 0.003) were independently associated with a lower risk of inadequate flow. ST-segment elevation myocardial infarction (STEMI) was associated with a higher risk of inadequate TIMI flow (OR = 2.37, P = 0.039). Lipid parameters and statin use were not associated with TIMI flow outcomes.

Conclusion: In patients with ACS undergoing SVG PCI, predilatation before stent implantation was associated with improved reperfusion, as reflected by higher rates of post-procedural TIMI 3 flow. The use of glycoprotein IIb/IIIa (GP IIb/IIIa) inhibitors was associated with additional protection. Larger prospective studies are warranted.

Keywords: Acute coronary syndrome, percutaneous coronary intervention, predilatation, saphenous vein graft, Thrombolysis in Myocardial Infarction flow

ÖZET

Amaç: Safen ven greftlerine (SVG) uygulanan perkütan koroner girişimler (PCI), kırılgan plak yapısı, yüksek trombüs yükü ve distal embolizasyon riski nedeniyle teknik olarak zorludur. Akut koroner sendrom (ACS) ile başvuran hastalarda balon predilatasyonunun sonuçlar üzerindeki etkisi net değildir. Bu çalışmada, SVG PCI uygulanan hastalarda predilatasyonun etkisini değerlendirmeyi amaçladık.

Yöntem: Bu tek merkezli retrospektif çalışmada, 2007–2024 yılları arasında safen ven greftine PCI uygulanan, akut koroner sendromlu ve daha önce koroner arter baypas greft (CABG) cerrahisi geçirmiş 202 hasta analiz edildi. Hastalar, stent implantasyonundan önce predilatasyon uygulanıp uygulanmamasına göre iki gruba ayrıldı (predilatasyon yapılan, n = 112; predilatasyon yapılmayan, n = 90). Koroner akım, Thrombolysis in Myocardial Infarction (TIMI) sınıflamasına göre değerlendirildi. İşlem sonrası yetersiz akımın (TIMI < 3) bağımsız belirleyicilerini belirlemek için lojistik regresyon analizi yapıldı.

ORIGINAL ARTICLE
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Bulgular: Başlangıç demografik ve klinik özellikler gruplar arasında benzerdi. İşlem sonrası TIMI 3 akım, predilatasyon grubunda %69.6 ve predilatasyon yapılmayan grupta %55.6 oranında elde edildi (P = 0.039). Predilatasyon (OR = 0.51, P = 0.030) ve glikoprotein IIb/IIIa inhibitörü kullanımı (OR = 0.39, P = 0.003) yetersiz akım riskinin azalmasıyla bağımsız olarak ilişkili bulundu. ST-segment elevasyonlu miyokard enfarktüsü (STEMI), yetersiz TIMI akım riski ile ilişkili bulundu (OR = 2.37, P = 0.039). Lipid parametreleri ve statin kullanımı, TIMI akım sonuçlarıyla ilişkili değildi.

Sonuç: Akut koroner sendromlu ve SVG PCI uygulanan hastalarda, stentleme öncesi predilatasyon yapılması, işlem sonrası TIMI 3 akım oranlarını artırarak reperfüzyon başarısını iyileştirmiştir. GP IIb/IIIa inhibitörü kullanımı ek koruyucu etki sağlamıştır. Daha büyük, prospektif çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Akut koroner sendrom, perkütan koroner girişim, predilatasyon, safen ven grefti, Thrombolysis in Myocardial Infarction akımı

Cardiovascular diseases (CVDs) are among the leading causes of mortality and morbidity worldwide and frequently manifest clinically as acute coronary syndrome (ACS). Deaths due to ischemic heart disease (IHD) account for 38% of all CVD-related deaths in women and 44% in men.[1] Technological advances in revascularization techniques, including percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) have improved long-term survival rates and reduced the incidence of restenosis.[2]

Saphenous vein grafts (SVGs) have become one of the most commonly used graft types in coronary bypass surgery due to their technical ease of use and wide availability. However, both early and late SVG failure rates remain considerably high. Approximately 30% of SVGs occlude within the first year after CABG, and the rate of graft failure continues to increase over 5–10 years following surgery.[3] The treatment of SVG lesions poses significant challenges due to technical difficulties, increased mortality risk, and the potential for graft re-injury. In this setting, repeat surgical revascularization is often not a suitable option for many patients. Additionally, PCI targeting native coronary arteries often have limited success due to anatomical complexities such as chronic total occlusions (CTO), tortuosity, and severe calcification.[4]

Several studies have demonstrated that stent implantation in SVG lesions provides superior clinical and angiographic outcomes compared with balloon angioplasty in both the short and mid-to-long term.[5,6] However, PCI performed on SVGs using a stenting strategy following balloon lesion preparation has been reported to increase the incidence of periprocedural myocardial infarction (MI) and stent thrombosis compared with a direct stenting approach.[7] Conversely, other studies with long-term follow-up have reported no significant difference in clinical outcomes between these two treatment strategies.[8] Thus, the current literature provides conflicting evidence, and no studies have specifically evaluated patients presenting with ACS. Therefore, the present study aimed to investigate the impact of a predilatation strategy on procedural outcomes in patients with ACS undergoing PCI to an SVG.

ABBREVIATIONS

ACS	Acute coronary syndrome
AF	Atrial fibrillation
ASA	Acetylsalicylic acid
CABG	Coronary artery bypass graft
CK-MB	Creatine kinase–myocardial band
CTO	Chronic total occlusions
CVD	Cardiovascular disease
ECG	Electrocardiography
HDL	High-density lipoprotein
HIMS	Hospital Information Management System
ICA	Invasive coronary angiography
IHD	Ischemic heart disease
IV	Intravenous
LDL	Low-density lipoprotein
LVEF	Left ventricular ejection fraction
MACE	Major adverse cardiac events
NSTEMI	Non–ST-elevation myocardial infarction
PCI	Percutaneous coronary interventions
STEMI	ST-segment elevation myocardial infarction
SVG	Saphenous vein grafts
TIMI	Thrombolysis in Myocardial Infarction
TVF	Target vessel failure
USAP	Unstable angina pectoris
WBC	White blood cell

Materials and Methods

Study Population

In this retrospective, single-center study, patients with a history of CABG who were admitted with ACS between 2007 and 2024 were screened through the Hospital Information Management System (HIMS). Patients who underwent percutaneous coronary intervention to a saphenous vein graft during the procedure were included in the study.

According to the predefined exclusion criteria, individuals younger than 18 years of age, patients with chronic liver failure, those with chronic kidney failure, patients who underwent intervention

only to native coronary arteries, and cases in which more than one coronary vessel was treated simultaneously were excluded. Additionally, patients who underwent post-dilatation or sequential predilatation, those in whom distal embolic protection devices were used during the procedure, cases in which graft dissection occurred during the intervention, and patients with multiple sequential lesions in the same SVG were also excluded. Furthermore, patients using oral anticoagulants for any indication were excluded from the analysis. Patients whose invasive coronary angiography (ICA) procedural images were not accessible and those without available laboratory data recorded in the HIMS within ±7 days of the ICA date were also excluded. Ultimately, 202 patients were included in the final analysis. Regardless of procedural outcome, patients were classified into two subgroups according to whether predilatation was performed.

All patients underwent selective left and right coronary angiography, as well as CABG angiography, using the Judkins technique. A transfemoral or transradial approach was used for ICA. When necessary, aortic root angiography was performed to assess graft patency. The degree of stenosis was determined using angiographic images with vessel calibration techniques. Stenosis > 70% in the SVG was considered severe, and PCI was performed in these patients. Before PCI, patients received a loading dose of clopidogrel, ticagrelor, or prasugrel. For patients not already taking acetylsalicylic acid (ASA), a 300 mg chewable loading dose was administered prior to the procedure. During the intervention, intravenous (IV) unfractionated heparin (70–100 U/kg) was administered. In cases of high thrombus burden or the development of no-reflow, a glycoprotein IIb/IIIa inhibitor was administered as an IV bolus at the operator's discretion. The type of stent used was also determined by the operator.

Coronary angiographic images were obtained in at least two orthogonal projections using the Philips Allura Xper FD10 cardiovascular X-ray system (Philips Healthcare, Philips Medical Systems). Coronary flow status was assessed independently by two cardiologists using the Thrombolysis in Myocardial Infarction (TIMI) flow grading system. Cases with TIMI flow grades of 0, 1, or 2 were classified as having impaired coronary flow, whereas those with a TIMI grade of 3 were categorized as having normal coronary flow.

In addition, patient files and hospital archive records were reviewed, and the following data were collected: demographic characteristics (age, sex, smoking status, date of CABG, statin use, medical history, antiplatelet therapy, etc.), electrocardiographic (ECG) findings, laboratory parameters (lipid profile, complete blood count indices, liver function tests, etc.), and echocardiographic measurements.

Written informed consent was obtained from all patients prior to the procedure. The study protocol was approved by the Sivas Cumhuriyet University Non-Interventional Clinical Research Ethics Committee (Approval Number: 2024-02/32, Date: 22.02.2024) and conducted in accordance with the Declaration of Helsinki.

Statistical Analysis

Descriptive statistics were expressed as mean ± standard deviation or median (minimum–maximum) for numerical variables and as frequency and percentage [n (%)] for categorical variables. The normality of data distribution was assessed using the Kolmogorov–Smirnov test and histogram plots. The Mann–Whitney U test was used to compare non-normally distributed (nonparametric) continuous variables between two groups, while differences between categorical variables were analyzed using the chi-square test. The degree of correlation between variables was evaluated using Pearson or Spearman correlation analyses, depending on data distribution. Logistic regression analysis was performed to identify independent predictors of TIMI flow. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). Covariates included in the multivariable model were selected a priori based on clinical relevance, previous literature, and potential confounding effects. To avoid overfitting and unstable estimates, not all recorded variables were entered simultaneously into the final model. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA), and a P-value < 0.05 was considered statistically significant. Graphs were generated using GraphPad Prism version 10.6.0.

Results

Among patients who underwent ICA between 2007 and 2024 and had a prior history of CABG, a total of 202 individuals diagnosed with ACS met the inclusion criteria for the study. These patients were divided into two groups according to whether predilatation was performed during the procedure (predilatation group, n = 112; no predilatation group, n = 90). Demographic data, laboratory findings, ECG records, echocardiographic results, and ICA images of all patients were reviewed. The baseline demographic and clinical characteristics of the study population are presented in Table 1.

The two groups were generally comparable with respect to demographic and clinical characteristics. However, when the target SVGs were evaluated, 43.1% of the interventions were performed on saphenous vein grafts to the right coronary artery (RCA–SVGs), 37.1% on saphenous vein grafts to the circumflex/obtuse marginal arteries (Cx/OM–SVGs), and 19.8% on saphenous vein grafts to the left anterior descending/diagonal arteries (LAD/D–SVGs). Interventions targeting RCA grafts were significantly more frequent than those targeting other grafts (P = 0.011).

The rate of statin use prior to ACS presentation was 78.6% in the predilatation group and 62.2% in the no predilatation group, with this difference reaching statistical significance (P = 0.011). In contrast, no significant differences were observed between the two groups in terms of anticoagulant or antiplatelet therapy use (P = 0.116 and P = 0.269, respectively).

One of the main outcomes of the study, post-procedural TIMI 3 flow, was observed in 63.4% of the overall patient population. The rate of TIMI 3 flow was 69.6% in the predilatation group and 55.6% in the no predilatation group, indicating a significantly higher proportion among patients who underwent predilatation (P = 0.039).

Laboratory parameters were generally comparable between the two groups. However, white blood cell (WBC) levels, although within normal clinical limits, were significantly higher in the predilatation group (P = 0.037). In the lipid profile analysis, both

Table 1. Baseline demographic and clinical characteristics

Variables	Without predilatation (n = 90)	With predilatation (n = 112)	All patients (n = 202)	*P*
Female, n (%)	21 (23.3)	24 (21.4)	45 (22.3)	0.746
Mean age, years	66.8 ± 8.0	67.9 ± 8.3	67.4 ± 8.2	0.339
STEMI, n (%)	12 (13.3)	20 (17.9)	32 (15.8)	0.573
SVG location				0.011*
RCA, n (%)	49 (54.4)	38 (33.9)	87 (43.1)	
Cx/OM, n (%)	25 (27.8)	50 (44.6)	75 (37.1)	
LAD/D, n (%)	16 (17.8)	24 (21.4)	40 (19.8)	
Number of grafts	1.9 ± 0.7	1.7 ± 0.7	1.8 ± 0.7	0.105
SGV age, years	9.3 ± 5.0	10.2 ± 4.6	9.8 ± 4.8	0.193
Diabetes mellitus, n (%)	48 (53.3)	65 (58.0)	113 (55.9)	0.503
Hypertension, n (%)	85 (94.4)	104 (92.9)	189 (93.6)	0.866
COPD, n (%)	23 (25.6)	22 (19.6)	45 (22.3)	0.315
Smoking, n (%)	7 (7.8)	10 (8.9)	17 (8.4)	0.970
Malignancy, n (%)	4 (4.4)	6 (5.4)	10 (5.0)	1.000
Atrial fibrillation, n (%)	8 (8.9)	14 (12.5)	22 (10.9)	0.554
LVEF (%)	46 ± 9	46 ± 9	46 ± 9	0.678
GP IIb/IIIa inhibitor use, n (%)	30 (33.3)	36 (32.1)	66 (32.7)	0.858
Adenosine use, n (%)	0 (0.0)	2 (1.8)	2 (1.0)	0.503
Nitrate use, n (%)	0 (0.0)	5 (4.5)	5 (4.5)	0.067
Adrenaline use, n (%)	0 (0.0)	1 (0.9)	1 (0.5)	1.000
Statin use, n (%)	56 (62.2)	88 (78.6)	144 (71.3)	0.011*
Antiplatelet use, n (%)	87 (96.7)	103 (92.0)	190 (94.1)	0.269
Insulin use, n (%)	32 (35.6)	43 (38.4)	75 (37.1)	0.678
TIMI 3 flow, n (%)	50 (55.6)	78 (69.6)	128 (63.4)	0.039*
Hemoglobin, g/dL	13.7 ± 2.2	13.5 ± 1.7	13.6 ± 1.9	0.601
Hematocrit, %	39.3 ± 6.3	40.8 ± 5.0	40.7 ± 5.6	0.822
WBC (×10³/L)	8.5 ± 3.1	9.5 ± 3.6	9.0 ± 3.4	0.037*
Platelet count (×10³/L)	212 ± 56	228 ± 71	221 ± 65	0.086
Creatinine, mg/dL	1.15 ± 0.48	1.15 ± 0.49	1.15 ± 0.49	0.910
TSH (mIU/L)	0.94 (0.47–1.68)	1.09 (0.69–1.79)	1.04 (0.56–1.76)	0.113
T3 (pg/mL)	2.68 ± 0.55	2.61 ± 0.47	2.64 ± 0.51	0.334
T4 (pg/mL)	1.19 ± 0.26	1.23 ± 0.28	1.22 ± 0.27	0.269
CRP (mg/L)	4.94 (2.32–10.75)	7.44 (3.30–14.62)	6.74 (2.93–13.99)	0.241
Troponin T (ng/L)	168 (16–649)	262 (36–882)	223 (28–827)	0.131
Triglycerides (mg/dL)	139 (96–221)	132 (94–196)	134 (96–204)	0.409
Total cholesterol (mg/dL)	181 ± 49	167 ± 44	173 ± 47	0.043*
HDL (mg/dL)	36 ± 8	36 ± 10	36 ± 9	0.941
LDL (mg/dL)	117 ± 40	105 ± 38	110 ± 39	0.028*
Albumin, g/L	38.1 ± 5.2	38.1 ± 4.7	38.1 ± 4.9	0.988
Uric acid, mg/dL	6.0 ± 1.8	6.3 ± 1.9	6.2 ± 1.8	0.311
ALT (U/L)	21 (15–31)	19 (13–25)	20 (14–27)	0.171
AST (U/L)	26 (20–43)	24 (19–34)	25 (19–37)	0.721
Potassium (mEq/L)	4.3 ± 0.5	4.4 ± 0.5	4.4 ± 0.5	0.245
Sodium (mEq/L)	137 ± 4	137 ± 4	137 ± 4	0.934
Calcium (mEq/L)	8.98 ± 0.59	8.97 ± 0.52	8.97 ± 0.55	0.894

*P < 0.05; ALT, Alanine aminotransferase; AST, Aspartate aminotransferase; COPD, Chronic obstructive pulmonary disease; CRP, C-reactive protein; Cx, Circumflex artery; D, Diagonal; GP IIb/IIIa, Glycoprotein IIb/IIIa; HDL, High-density lipoprotein; LAD, Left anterior descending artery; LDL, Low-density lipoprotein; LVEF, Left ventricular ejection fraction; OM, Obtuse marginal artery; RCA, Right coronary artery; STEMI, ST-elevation myocardial infarction; SVG, Saphenous vein graft; TIMI, Thrombolysis in Myocardial Infarction; TSH, Thyroid-stimulating hormone.

Table 2. Distribution of patients by diagnosis, troponin levels, and percentages of coronary artery lesions causing acute coronary syndrome

Diagnosis	Number of patients (n = 202)	Percentage (%)	Vessel stenosis (%)			Troponin		
			25th percentile	Median	75th percentile	25th percentile	Median	75th percentile
USAP	70	34.7	80	95	99	3.00	12.50	33.00
NSTEMI	100	49.5	90	95	99	239.00	388.50	975.50
STEMI	32	15.8	95	99	100	230.50	1027.00	3458.50

NSTEMI, Non–ST-elevation myocardial infarction; STEMI, ST-elevation myocardial infarction; USAP, Unstable angina pectoris. High-sensitivity cardiac troponin T (hs-cTnT) laboratory reference values: 0–13 ng/L, normal; 14–50 ng/L, intermediate risk (repeat testing recommended); > 50 ng/L, high risk.

total cholesterol and low-density lipoprotein (LDL) levels were above target ranges in both groups but were significantly lower in the predilatation group (P = 0.043 and P = 0.028, respectively). High-density lipoprotein (HDL) levels were below target ranges in both groups, with no significant differences observed between the groups in terms of HDL or triglyceride levels (P = 0.941 and P = 0.409, respectively).

The distribution of patients according to diagnosis, troponin levels, and the percentages of culprit vessel stenoses leading to ACS are presented in Table 2. Approximately half of the patients who underwent intervention (49.5%) were diagnosed with non–ST-elevation myocardial infarction (NSTEMI), representing the largest subgroup within the study population. When patients with unstable angina pectoris (USAP) and NSTEMI were considered together, they accounted for 84.2% of the entire cohort. When the stenosis rates detected by ICA were evaluated, the median degree of stenosis was 95% in both the USAP and NSTEMI groups. In contrast, patients diagnosed with ST-elevation myocardial infarction (STEMI) had a significantly higher median stenosis rate of 99%. Evaluation of high-sensitivity cardiac troponin T (hs-cTnT) levels showed that the median troponin concentration in the USAP group was 12.50 ng/L, which was within the normal reference range. In the NSTEMI and STEMI groups, troponin levels were markedly elevated, with the highest median value observed in the STEMI group at 1027.00 ng/L (230.50–3458.50). The laboratory reference ranges for hs-cTnT were as follows: 0–13 ng/L, normal; 14–50 ng/L, intermediate risk (repeat testing recommended); and > 50 ng/L, high risk.

Table 3 presents a comparative analysis of the diameters and lengths of balloons and/or stents used in patients with and without predilatation. The mean stent diameter was 3.0 ± 0.5 mm in the predilatation group and 3.2 ± 0.5 mm in the no predilatation group, with no statistically significant difference between the groups (P = 0.187). In contrast, the mean stent length was significantly greater in patients who underwent predilatation (20.2 ± 6.0 mm) than in those who did not (18.0 ± 4.6 mm), demonstrating a statistically significant difference (P = 0.010).

According to the correlation analysis presented in Table 4, a statistically significant positive correlation was observed between patient age and SVG age (P < 0.01). Similarly, creatinine levels were found to increase significantly with age (P < 0.01).

Predilatation was associated with significantly improved post-procedural TIMI flow (P < 0.05). A statistically significant positive correlation was also observed between troponin levels and patient age (P < 0.05). Additionally, troponin levels showed a strong positive association with the diagnosis of STEMI (P < 0.01). In contrast, the relationship between STEMI diagnosis and TIMI flow was negative, as patients diagnosed with STEMI exhibited significantly lower TIMI flow levels (P < 0.01). Although not statistically significant, a weak negative correlation was observed between SVG age and balloon diameter. Similarly, a nonsignificant positive correlation was found between LDL levels and balloon length, while a negative correlation was observed between creatinine levels and balloon length.

Table 3. Balloon and/or stent sizes

Variables	Without predilatation (n = 90)	With predilatation (n = 112)	All patients (n = 202)
Stent diameter (mm)	3.2 ± 0.5	3.0 ± 0.5	0.187
Stent length (mm)	18.0 ± 4.6	20.2 ± 6.0	0.010*
Balloon diameter (mm)	-	2.6 ± 0.5	-
Balloon length (mm)	-	17.2 ± 4.8	-

*P < 0.05.

According to logistic regression analysis, insufficient TIMI flow was not significantly associated with SVG age, smoking status, atrial fibrillation (AF), statin use, or uric acid levels (P = 0.784, P = 0.132, P = 0.253, P = 0.239, and P = 0.228, respectively). Likewise, sex, hypertension, antiplatelet use, nitrate therapy, and the presence of chronic obstructive pulmonary disease (COPD) were not significantly associated with insufficient TIMI flow (P = 0.304, P = 0.367, P = 0.800, P = 0.423, and P = 0.209, respectively). Similarly, patient age, diabetes mellitus, left ventricular ejection fraction (LVEF), LDL levels, and creatinine concentration were not significantly associated with the development of insufficient TIMI flow (P = 0.337, P = 0.840, P = 0.788, P = 0.199, and P = 0.562, respectively).

In contrast, the use of glycoprotein IIb/IIIa (GP IIb/IIIa) inhibitors and the performance of predilatation during the procedure were identified as significant factors associated with a reduced risk of insufficient TIMI flow (P = 0.003 and P = 0.030, respectively). Conversely, patients who underwent the procedure for STEMI had a significantly higher likelihood of developing insufficient TIMI flow (P = 0.039). These findings are illustrated in Figure 1.

Among patients who underwent predilatation, TIMI 3 flow was achieved in 78 cases, which were classified as having no flow limitation. In the same group, 34 patients exhibited TIMI flow grades of 0, 1, or 2, indicating impaired flow. In the no

Table 4. Correlation analysis of variables

Variables	TIMI flow	Age	SGV age	Balloon diameter	Balloon length	Creatinine	LDL	Troponin	Predilatation	STEMI
TIMI flow	1									
Age	0.004	1								
SGV age	0.057	0.244**	1							
Balloon diameter	0.004	-0.177	-0.059	1						
Balloon length	-0.047	-0.102	0.017	0.065	1					
Creatinine	-0.051	0.305**	0.105	0.004	0.052	1				
LDL	0.001	-0.094	-0.089	0.166	0.031	-0.043	1			
Troponin	-0.116	0.212*	0.098	-0.177	0.050	0.119	0.124	1		
Predilatation	0.153*	0.058	0.107	-	-	0.039	-0.146*	0.096	1	
STEMI	-0.184**	0.019	0.054	0.073	0.041	-0.004	0.014	0.363**	0.062	1

*P < 0.05, **P < 0.01; LDL, Low-density lipoprotein cholesterol; STEMI, ST-elevation myocardial infarction; SVG, Saphenous vein graft; TIMI, Thrombolysis in myocardial infarction.

predilatation group, TIMI 3 flow was observed in 50 patients, whereas 40 patients demonstrated TIMI flow grades of 0, 1, or 2. Comparison between the groups showed that the rate of TIMI 3 flow was significantly higher in the predilatation group (P = 0.039). These findings, along with the distribution of SVGs according to their corresponding native vessels, are illustrated in Figure 2.

Discussion

In this study, we evaluated the effect of predilatation on coronary flow during PCI of SVGs in patients presenting with ACS and a prior history of CABG. Our results demonstrated that patients who underwent predilatation before stent implantation had significantly higher rates of TIMI 3 flow. This finding suggests that predilatation may help preserve distal flow and improve procedural success, particularly in graft interventions. Moreover, the more frequent occurrence of impaired TIMI flow among patients with STEMI may be attributed to a higher thrombus burden and the graft characteristics. Additionally, the observed improvement in TIMI flow with the use of GP IIb/IIIa inhibitors supports the role of antiplatelet therapy in achieving successful reperfusion.

Despite increasing recognition of their limited long-term patency, saphenous vein grafts remain widely used in the surgical treatment of obstructive coronary artery disease. Reported patency rates for SVGs vary considerably in the literature, with graft failure rates reaching up to 61% in follow-up periods exceeding 10 years.[9] In patients with prior CABG, current guidelines recommend PCI of the native coronary artery as the preferred revascularization strategy whenever feasible, whereas PCI of SVGs is considered a secondary option because of its higher risk of adverse events.[10] Furthermore, as the time elapsed after CABG increases, the incidence of diffuse atherosclerosis, calcified lesions, and CTOs in native coronary arteries also rises. The development of de novo CTOs even in initially patent vessels has been documented, further contributing to the need for graft interventions.[11] Consequently, PCI of SVG may become unavoidable in certain clinical scenarios. However, it should be recognized that graft PCI carries an increased risk of complications, including friable plaque, high thrombus burden, distal embolization, and the no-reflow phenomenon. Therefore, interventional strategies should be planned with particular caution.[9] Considering these technical challenges and the potential to improve long-term outcomes in interventions targeting SVG lesions, our study evaluated factors influencing coronary flow during the procedure, with particular emphasis on the role of predilatation.

In interventions involving SVGs, whether stent implantation should be performed directly or after predilatation remains a matter of debate in the literature. Direct stenting may reduce the risk of distal embolization by minimizing plaque manipulation, whereas predilatation facilitates lesion preparation and may promote optimal stent expansion and full apposition to the vessel wall.[12] However, studies evaluating the effects of these two strategies on clinical outcomes have yielded heterogeneous results.

Among studies comparing different strategies in SVG-PCI, a subgroup analysis of the DIVA trial (Drug-Eluting Stents vs Bare-Metal Stents in Saphenous Vein Graft Angioplasty) conducted by Latif et al.[7] evaluated stenting with and without predilatation and found no significant difference in 12-month target vessel failure (TVF).[13] Moreover, during long-term follow-up, the direct stenting group demonstrated lower incidences of stent thrombosis and target vessel myocardial infarction. Similarly, Leborgne et al.[14] compared a direct stenting strategy with predilatation followed by stenting in patients with SVG stenosis, evaluating outcomes including creatine kinase–myocardial band (CK-MB) release, major adverse cardiac events (MACE), and long-term clinical outcomes. The authors reported that direct stenting may reduce the risk of distal embolization and limit long-term MACE rates compared with predilatation. However, both of these studies primarily focused on long-term clinical outcomes. In contrast, our study evaluated a more selective population consisting exclusively of patients presenting with ACS, and coronary flow was directly assessed using the TIMI flow system. Our findings demonstrated significantly higher rates of TIMI 3 flow in the predilatation group, highlighting the role of predilatation in improving acute procedural success during SVG-PCI.

Parameter	Odds Ratio (OR)	95% Confidence Interval (CI)	P Value
Age	1.00	0.96–1.04	0.337
Sex (Females)	0.64	0.27–1.50	0.304
SVG Age	1.01	0.94–1.08	0.748
Hypertension	0.50	0.11–2.26	0.367
Diabetes Mellitus	1.07	0.54–2.13	0.840
Atrial Fibrillation	2.30	0.55–9.59	0.253
COPD	1.64	0.76–3.54	0.209
Smoking	2.75	0.74–10.25	0.132
STEMI	2.37	1.04–5.39	0.039*
LVEF	1.00	0.96–1.03	0.788
Antiplatet Use	0.82	0.18–3.80	0.800
Statin Use	0.64	0.30–1.35	0.239
GP IIb/IIIa Inh. Use	0.39	0.21–0.73	0.003*
Nitrate Use	0.42	0.05–3.51	0.423
Predilatation	0.51	0.28–0.94	0.030*
LDL	1.01	1.00–1.02	0.199
Creatinine	0.81	0.40–1.66	0.562
Uric Acid	1.13	0.93–1.37	0.228

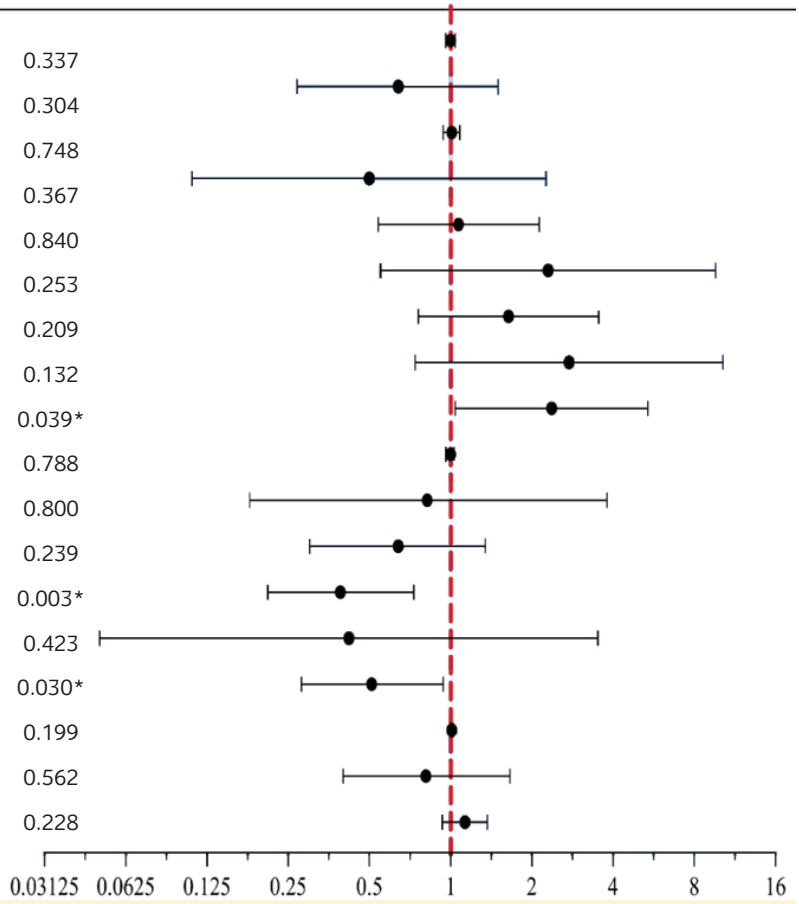


Figure 1. Logistic regression analysis of factors associated with inadequate Thrombolysis in Myocardial Infarction (TIMI) flow after saphenous vein graft percutaneous coronary intervention (SVG-PCI). The forest plot demonstrates odds ratios (ORs) with 95% confidence intervals (Cis) for each parameter.

***P < 0.05; COPD, Chronic obstructive pulmonary disease; GP Iib/IIIa inh., Glycoprotein Iib/IIIa inhibitor; LDL, Low-density lipoprotein cholesterol; LVEF, Left ventricular ejection fraction; STEMI, ST-elevation myocardial infarction; SVG, Saphenous vein graft; TIMI, Thrombolysis in Myocardial Infarction.**

Lee et al.[15] suggested that, in SVG lesions, direct stenting may represent a more advantageous strategy than predilatation because it may reduce vascular wall injury and the risk of distal embolization associated with repeated balloon dilatations. However, in our study, patients who underwent postdilatation or multiple sequential predilatations were excluded. Therefore, the favorable outcomes observed were likely associated with an effective and controlled predilatation approach. This finding highlights the crucial role of appropriate patient selection and meticulous lesion preparation in procedural success and, when interpreted alongside the results of comparative studies,[7,14] provides a clinically meaningful perspective.

In our cohort of patients presenting with ACS, the most frequently involved graft was the RCA–SVG, whereas the least commonly affected was the LAD/D–SVG. The mean interval between CABG and the ACS event was approximately 10 years, which corresponds to the period when graft degeneration typically becomes clinically evident. Vessel-based analysis demonstrated that the best procedural TIMI flow was observed in Cx/OM–SVG. These findings suggest that the hemodynamic performance of grafts may vary depending on the target coronary artery segment, flow demand, and the quality of the surgical anastomosis. Consistent with our findings, previous studies have reported lower long-term patency rates for RCA grafts and variable TIMI flow outcomes depending on distal vessel bed characteristics and flow requirements.[16,17]

In our study, factors associated with impaired TIMI flow were evaluated. Predilatation (OR = 0.51, P = 0.030) and the use of GP IIb/IIIa inhibitors (OR = 0.39, P = 0.003) were identified as protective factors, whereas the presence of STEMI was significantly associated with impaired flow (OR = 2.37, P = 0.039). This finding is consistent with previous studies reporting that periprocedural complications and inadequate distal flow during SVG-PCI are particularly common in STEMI cases and are closely related to a high thrombus burden.[13,18] Similarly, Keeley et al.[19] demonstrated that impaired flow in SVG lesions is frequently

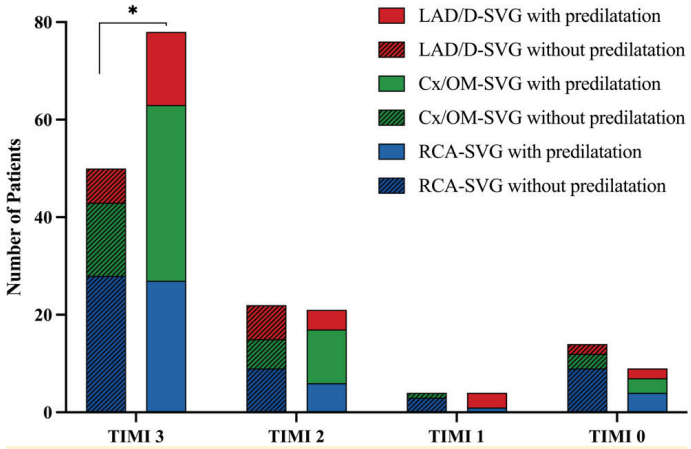


Figure 2. Distribution of Thrombolysis in Myocardial Infarction (TIMI) flow grades in patients with and without predilatation.

*** P < 0.05, Cx, Circumflex artery; D, Diagonal; LAD, Left anterior descending artery; OM, Obtuse marginal artery; RCA, Right coronary artery; SVG, Saphenous vein graft.**

associated with thrombotic occlusion and the no-reflow phenomenon. The identification of STEMI as an independent predictor of impaired TIMI flow in our study is therefore consistent with these observations. Conversely, the protective effect of GP IIb/IIIa inhibitors is well supported by the literature, as these agents have been shown to significantly increase the rate of TIMI 3 flow by reducing microvascular thrombus formation.[20] De Luca et al.[21] demonstrated that early administration of GP IIb/IIIa inhibitors significantly improves reperfusion success, particularly in STEMI patients with a high thrombus burden. These findings further support the protective role of GP IIb/IIIa inhibitors against impaired TIMI flow observed in our study.

Although LDL cholesterol levels were significantly lower in the predilatation group in our study, LDL values in both groups remained above guideline-recommended targets. The low rate of statin use observed in both groups is also noteworthy. However, in the logistic regression analysis, neither LDL levels nor statin use were significantly associated with impaired TIMI flow. Several explanations may account for this finding. First, lipid parameters in the setting of ACS are often influenced by the acute-phase response, which may prevent LDL levels from accurately reflecting the true chronic burden of dyslipidemia.[22-24] Moreover, in the acute phase, the primary determinants of TIMI flow, such as thrombus burden, distal embolization, and microvascular reperfusion impairment, are more closely related to procedural hemodynamic and thrombotic factors than to lipid levels. The well-established anti-inflammatory, endothelial-protective, and plaque-stabilizing effects of statins are known to become more evident over the long term, particularly in reducing restenosis, lowering the need for repeat revascularization, and maintaining graft patency, rather than influencing acute outcomes.[25,26] This observation is consistent with the lack of a significant association between LDL levels or statin use and impaired TIMI flow in our study, which focused on the acute phase.

In summary, among patients presenting with ACS who underwent SVG-PCI, our findings demonstrate that predilatation not only facilitates mechanical lesion preparation but may also contribute to preserving post-procedural coronary flow. Considering the dynamic thrombus burden and microvascular reperfusion impairment characteristic of ACS, these results indicate that a careful and selective predilatation strategy may be critical for optimizing procedural success. Furthermore, the observed protective effect of GP IIb/IIIa inhibitors against impaired TIMI flow underscores the importance of optimizing antiplatelet therapy in ACS patients. By focusing specifically on ACS cases treated with SVG-PCI, our study provides a modest yet meaningful contribution to the limited data on this challenging clinical subset.

Study Limitations

This study was conducted at a single center and had a retrospective design. The relatively limited number of patients may have increased the potential for bias in patient selection and data recording processes. Furthermore, information regarding statin use, as well as antiplatelet and anticoagulant therapies, was obtained from electronic medical records; therefore, regular medication adherence could not be verified. The lack of access to detailed surgical data related to CABG and technical factors that might have affected graft patency constitutes another limitation. Additionally, data regarding the patency status of native coronary arteries at the time of index ICA were not available. Cases with graft dissection during the procedure were excluded, which may have introduced selection bias and limited the generalizability of the findings. Coronary flow was evaluated solely using the TIMI flow classification, which represents a methodological limitation for the assessment of microvascular reperfusion with more sensitive parameters. Nevertheless, TIMI flow is one of the fundamental indicators of reperfusion success in ACS, and its clinical significance should not be overlooked.

Conclusion

In this study, the impact of predilatation on post-procedural coronary flow was evaluated in patients presenting with ACS who underwent PCI to SVGs. The findings indicate that predilatation may improve reperfusion success in the acute phase by increasing the rate of post-procedural TIMI 3 flow. Moreover, the protective effect observed with the use of GP IIb/IIIa inhibitors highlights the importance of optimized antiplatelet strategies. Conversely, the presence of STEMI was associated with impaired distal flow. Although our study provides valuable insights, the generalizability of these findings is limited. Larger randomized controlled trials are warranted to confirm these results.

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Informed Consent: Written informed consent was obtained from all patients prior to the procedure.

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References

1. Timmis A, Vardas P, Townsend N, et al.; Atlas Writing Group, European Society of Cardiology. European Society of Cardiology: cardiovascular disease statistics 2021. *Eur Heart J*. 2022;43(8):716-799. Erratum in: *Eur Heart J*. 2022;43(8):799. [CrossRef]
2. Bansal A, Hiwale K. Updates in the Management of Coronary Artery Disease: A Review Article. *Cureus*. 2023;15(12):e50644. [CrossRef]
3. Goldman S, Zadina K, Moritz T, et al.; VA Cooperative Study Group #207/297/364. Long-term patency of saphenous vein and left internal mammary artery grafts after coronary artery bypass surgery: results from a Department of Veterans Affairs Cooperative Study. *J Am Coll Cardiol*. 2004;44(11):2149-2156. [CrossRef]
4. Brilakis ES, Banerjee S, Burke MN. A New Treatment Strategy for Saphenous Vein Graft Lesions?: Letting it Go. *J Am Coll Cardiol*. 2018;71(18):1983-1985. [CrossRef]
5. Hanekamp CE, Koolen JJ, Den Heijer P, et al.; Venestent Study Group. Randomized study to compare balloon angioplasty and elective stent implantation in venous bypass grafts: the Venestent study. *Catheter Cardiovasc Interv*. 2003;60(4):452-457. [CrossRef]
6. Savage MP, Douglas JS Jr, Fischman DL, et al. Stent placement compared with balloon angioplasty for obstructed coronary bypass grafts. Saphenous Vein De Novo Trial Investigators. *N Engl J Med*. 1997;337(11):740-747. [CrossRef]
7. Latif F, Uyeda L, Edson R, et al. Stent-Only Versus Adjunctive Balloon Angioplasty Approach for Saphenous Vein Graft Percutaneous Coronary Intervention: Insights from DIVA Trial. *Circ Cardiovasc Interv*. 2020;13(2):e008494. [CrossRef]
8. Lozano I, López-Palop R, Pinar E, et al. Direct stenting in saphenous vein grafts. Immediate and long-term results. *Rev Esp Cardiol*. 2005;58(3):270-277. Spanish. [CrossRef]
9. Back L, Ladwiniec A. Saphenous Vein Graft Failure: Current Challenges and a Review of the Contemporary Percutaneous Options for Management. *J Clin Med*. 2023;12(22):7118. [CrossRef]
10. Xenogiannis I, Zenati M, Bhatt DL, et al. Saphenous Vein Graft Failure: From Pathophysiology to Prevention and Treatment Strategies. *Circulation*. 2021;144(9):728-745. [CrossRef]
11. Çoner A, Akıncı S, Akbay E, Budak AB, Saba T, Müderrisoğlu H. Development of De Novo Chronic Total Occlusion in Native Coronary Arteries of Coronary Artery Bypass Grafting Surgery Patients. *Acta Medica Alanya*. 2020;4(3):230-235. [CrossRef]
12. Lee M, Kong J. Current State of the Art in Approaches to Saphenous Vein Graft Interventions. *Interv Cardiol*. 2017;12(2):85-91. [CrossRef]
13. Ergelen M, Uyarel H, Gül M, et al. Efficacy and outcome of primary percutaneous coronary intervention in patients with ST-elevation myocardial infarction due to saphenous vein graft occlusion. *Turk Kardiyol Dern Ars*. 2010;38(8):531-536. Turkish.
14. Leborgne L, Cheneau E, Pichard A, et al. Effect of direct stenting on clinical outcome in patients treated with percutaneous coronary intervention on saphenous vein graft. *Am Heart J*. 2003;146(3):501-506. [CrossRef]
15. Lee MS, Park SJ, Kandzari DE, et al. Saphenous vein graft intervention. *JACC Cardiovasc Interv*. 2011;4(8):831-843. [CrossRef]
16. Nakajima H, Iguchi A, Tabata M, et al. Predictors and prevention of flow insufficiency due to limited flow demand. *J Cardiothorac Surg*. 2014;9:188. [CrossRef]
17. Porto I, Belloni F, Niccoli G, et al. Filter no-reflow during percutaneous coronary intervention of saphenous vein grafts: incidence, predictors and effect of the type of protection device. *EuroIntervention*. 2011;7(8):955-961. [CrossRef]
18. Januszek RA, Dziewierz A, Siudak Z, Rakowski T, Dudek D, Bartuś S. Predictors of periprocedural complications in patients undergoing percutaneous coronary interventions within coronary artery bypass grafts. *Cardiol J*. 2019;26(6):633-644. [CrossRef]
19. Keeley EC, Velez CA, O'Neill WW, Safian RD. Long-term clinical outcome and predictors of major adverse cardiac events after percutaneous interventions on saphenous vein grafts. *J Am Coll Cardiol*. 2001;38(3):659-665. [CrossRef]
20. de Lemos JA, Antman EM, Gibson CM, et al. Abciximab improves both epicardial flow and myocardial reperfusion in ST-elevation myocardial infarction. Observations from the TIMI 14 trial. *Circulation*. 2000;101(3):239-243. [CrossRef]
21. De Luca G, Gibson CM, Bellandi F, et al. Early glycoprotein IIb-IIIa inhibitors in primary angioplasty (EGYPT) cooperation: an individual patient data meta-analysis. *Heart*. 2008;94(12):1548-1558. [CrossRef]
22. Balci B. The modification of serum lipids after acute coronary syndrome and importance in clinical practice. *Curr Cardiol Rev*. 2011;7(4):272-276. [CrossRef]
23. Rosenson RS, Brewer HB, Rader DJ. Lipoproteins as biomarkers and therapeutic targets in the setting of acute coronary syndrome. *Circ Res*. 2014;114(12):1880-1889. [CrossRef]
24. Yılmaz C, Üngan İ, Arslan E, et al. The HALP Score's Prognostic Value for the Elderly (≥75 years) Patients Following Percutaneous Coronary Intervention for Acute Myocardial Infarction. *Turk Kardiyol Dern Ars*. 2025;53(6):388-397. [CrossRef]
25. Olsson AG, Schwartz GG, Szarek M, et al. High-density lipoprotein, but not low-density lipoprotein cholesterol levels influence short-term prognosis after acute coronary syndrome: results from the MIRACL trial. *Eur Heart J*. 2005;26(9):890-896. [CrossRef]
26. Ridker PM, Danielson E, Fonseca FA, et al.; JUPITER Study Group. Rosuvastatin to prevent vascular events in men and women with elevated C-reactive protein. *N Engl J Med*. 2008;359(21):2195-2207. [CrossRef]