Procedural Results and Immediate Outcomes following De Novo Saphenous Venous Graft Interventions

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Abstract

Background Distal embolization is the detrimental factor in SVG intervention. There is no specific treatment for it except prevention. Guidelines have endorsed the use of embolic protection devices; however, their use is not without complications, and increases the procedural time and cost for the patient.

The objective of this study is to analyze the procedural results and immediate outcome in de novo SVG stenting.

Methods A retrospective observational study of patients who have undergone SVG-percutaneous coronary intervention at our institute. Baseline clinical, demographic data, intervention details, and in-hospital events are analyzed. Statistical analysis was done using Mini tab version 17. Chi-square testing, odds ratio, and 95% confidence intervals were calculated.

Results The study population included 96 lesions in 80 patients. Average age of the graft was 8.2 ± 4 years. Embolic protection devices were used only in 10%. Angiographic and clinical success was seen in 92.5%. Distal embolization was seen in 7.5%. Drug-eluting stent and shorter stents were associated with lesser distal embolization. Stent length (> 20 mm) proved to be an independent predictor of distal embolization. There was no correlation between distal embolization and age of patient, sex, hypertension, diabetes, and smoking, left ventricular function, age of graft, direct stenting, use of embolic device, and glycoprotein 2b/3a inhibitors.

Conclusion De novo SVG lesions can be stented with a high rate of angiographic and procedural success. Stent length is the only independent predictor of distal embolization. SVG interventions can be safely done in the absence of embolic protection devices irrespective of the graft age.

Keywords

- ▶ saphenous venous graft
- ▶ embolic protection device
- ▶ distal embolization
- ▶ slow flow
- ▶ no reflow
- ▶ periprocedural MI
- ▶ vein degeneration

Saphenous vein graft (SVG) degeneration and occlusion over time undermine the long-term benefits of coronary artery bypass graft (CABG) surgery. Percutaneous coronary intervention (PCI) is the preferred treatment of SVG stenosis.¹ SVG intervention is a challenge. The soft and friable plaque characteristics of graft lesions tend to embolize distally resulting in slow flow/ no reflow² and periprocedural myo-

cardial infarction (MI). A 10-fold increase in hospital mortality is reported.³ Distal embolization is difficult to predict.⁴ There is no specific treatment for it except its prevention. The only approved methodology to prevent distal embolization is the use of embolic protection devices (EPDs). However, use of EPDs is not without complications, and increases the procedural time and cost for the patient.

Materials and Methods

This is a retrospective observational study of post CABG patients who underwent stent deployment to stenosed SVG at our institution from June 2010 to June 2016. Baseline clinical, demographic data, and in-hospital events are obtained from hospital records. Only de novo SVG lesion was included. Patients with in-stent restenosis of the SVG graft were excluded. The type of lesion, location, and degree of degeneration were studied from diagnostic angiograms. The implantation technique, access site, details of hardware used, guide catheter, guide wires, balloon dilatation, type of stent, size, length, and deploying pressure of the stent were analyzed. Ancillary use of antiplatelets, anticoagulation especially glycoprotein 2b/3a (GP2b/3a) inhibitors was noted. The use of thrombus aspiration, EPDs, and any other device used was taken into consideration.

Angiographic success was defined as < 50% residual diameter stenosis with thrombolysis in myocardial infarction (TIMI) flow grade 3. Clinical success was defined as angiographic success without in-hospital complications (death, Q-wave MI, emergency CABG). Emergency CABG was defined as CABG performed within 24 hours of the index percutaneous procedure. Distal embolization was assumed when there was no reflow, slow flow, or an abrupt cut-off in one of the distal coronary artery branches. No reflow was defined as TIMI 0 to 1 flow and slow flow as TIMI 2 flow. Pre- and post-intervention 12-lead electrocardiogram and blood samples were acquired for creatine kinase (CK) and its myocardial band (MB) fraction enzyme estimation. Q-wave MI is defined as the presence of new Q waves on the postprocedure electrocardiography and a corresponding rise by at least threefold above normal limits of the serum CK-MB fraction. Non-Q-wave MI is defined as a rise by at least threefold above normal limits of the serum CK-MB fraction without the appearance of new Q waves.

Statistical Analysis

Categorical variables are expressed as counts and percentages. Continuous variables are presented as the mean $\pm$ standard deviation. Univariate analysis and binary logistic regression were done using Mini tab version 17 for all descriptive variables. The potential risk factors for distal embolization were analyzed further by chi-square testing; odds ratio and 95% confidence intervals were calculated. A *p* value of < 0.05 was considered significant.

Results

The study population included 80 patients with a mean age of 61 ± 9 years. Male sex constituted 84%. Hypertension was seen in 91%, diabetes mellitus in 61%, and smoking in 40%. Average age of the graft was 8.2 ± 4 years with the oldest graft being 22 years and the youngest ~ 1 year old. Indications for revascularization were stable angina in 48.75%, unstable angina in 43%, and acute MI in 6.25%. The baseline clinical and angiographic features with lesion characteristics and quantitative measurements are listed in ►Tables 1 and 2, respectively.

Table 1 Baseline clinical characteristics

Clinical characteristic	Number (%)
Patient age (years)	61 $\pm$ 9
Gender	
– Male	67 (83.7%)
– Female	13 (11.3%)
Hypertension	73 (91%)
Diabetes mellitus	49 (61%)
Cigarette smoking	32 (40%)
Age of graft (years)	8.2 $\pm$ 4
Indication for revascularization	
– Chronic stable angina	39(48.75%)
– Unstable angina/NSTEMI	36(43%)
– Acute STEMI	5(6.25%)

Abbreviations: NSTEMI, Non-ST elevation myocardial infarction; STEMI, ST elevation myocardial infarction.

Stent was deployed in 96 graft lesions. Access was femoral in 84% and radial in 16% patients. Judkin's Right was the most common guide catheter used followed by the Amplatzer Right irrespective of the vessel involved. The guide catheters used in different cases are listed in ►Table 3. A single guide wire was used in all cases. Balloon predilatation was done in 31% lesions and direct stenting in the rest. Thrombus aspiration was done in four patients. EPDs were used in eight patients. The GP2b/3a inhibitor was used in 16 patients.

Table 2 Baseline angiographic characteristics

Variable	Value (%)
Diseased vessel: SVG to	
– LAD/Diagonal	13 (16.25%)
– LCX/OM/LPDA	27 (33.75%)
– RCA/PDA	40 (50%)
Lesion location	
– Ostial/proximal	42 (52.5%)
– Body	22 (27.5%)
– Distal anastomosis	16 (20%)
Total occlusion	4 (5%)
Definite thrombus	6 (7.5%)
Pre procedure reference diameter (mm)	3.2 $\pm$ 0.4
Pre procedure diameter stenosis (%)	86.14 $\pm$ 7.4
Pre procedure MLD (mm)	0.45 $\pm$ 0.4
Average lesion length	14.5 $\pm$ 6.8

Abbreviations: LAD, Left anterior descending artery; LCX, left circumflex artery; LPDA, left posterior descending artery; MLD, minimum luminal diameter; OM, obtuse marginal artery; PDA, posterior descending artery; RCA, right coronary artery; SVG, saphenous venous graft.

Table 3 Guide catheters used in different cases

Vessel	Guide catheter	No. of patients
SVG to RCA/PDA/PLV	Judkins Right (JR)	21
	Amplatzer (AR/AL)	11 (10/1)
	Multipurpose (MP)	7
	LIMA	1
SVG to LCX/OM/LPDA	Judkins Right (JR)	24
	Amplatzer (AR/AL)	1
	Multipurpose (MP)	1
	EBU	1
SVG to LAD/D	Judkins Right (JR)	12
	Amplatzer (AR)	0
	Extra backup (EBU)	1

Abbreviations: D-diagonal; LAD, Left anterior descending artery; LCX, left circumflex artery; LIMA, left internal mammary artery catheter; LPDA, left posterior descending artery; OM, obtuse marginal artery; PDA, posterior descending artery; PLV, posterolateral vessel; RCA, right coronary artery; SVG, Saphenous venous graft.

All patients received dual antiplatelet therapy: Aspirin with either clopidogrel/prasugrel/ticagrelor. Conventional heparin was the routine anticoagulation.

Angiographic success was achieved in 92.5% of the patients. Distal embolization occurred in 7.5% patients. No reflow was observed in two patients and slow flow in four patients. Ten patients had periprocedural minor elevation of cardiac enzymes, while three patients had periprocedural non-Q-MI. There were no cases of in-hospital mortality or emergency CABG. Procedural details and outcome are summarized in ►Table 4. Access site minor complications were detected in two patients (femoral hematoma) which resolved with conservative management. Hemoglobin drop of ~1 g was seen in three patients but none required transfusion. Contrast-induced nephropathy was seen in three patients which recovered without the need for dialysis. There were no cases with coronary perforation/dissection or cardiac tamponade.

Descriptive variable between the two groups, that is, group with distal embolization and group with no distal embolization, has been compared (►Table 5). Factors contributing to distal embolization in the form of slow flow/no reflow and periprocedural MI were analyzed for their significance by univariate (►Table 6) and multivariate analysis (►Table 7). Univariate analysis showed distal embolization to be associated with acute coronary syndrome, femoral access, reduced hemoglobin, increased stent length, and reduced stent diameter. Multivariate analysis showed lower incidence of distal embolization with the use of drug-eluting stent (DES) over bare metal stent (BMS), shorter stent length, and greater stent size. When further analyzed by 2 table chi-

Table 4 Procedural details and outcome

Variable	Value (%)
No. of stents implanted	96
Access site	
– Femoral	67 (83.75%)
– radial	13 (16.25%)
Angiographic success	92.5%
Type of stent	
– DES	85 (88.5%)
– BMS	11 (11.5%)
Stent deployment	
– Direct	66 (68.75%)
– Predilatation	30 (31.25%)
Average stent length	19.5 ± 7.4 mm
Average stent diameter	3.2 ± 0.44 mm
Embolic protection device	8 (10%)
– Angioguard	5
– Filter wire	1
– Embosticid	2
GP2b/3a inhibitor	16 (20%)
Complications	
– No reflow/slow flow	6 (7.5%)
– Periprocedural MI	3 (3.7%)
– In hospital mortality	0

Abbreviations: BMS, bare metal stent; DES, drug-eluting stents; GP2b/3a, glycoprotein 2b/3a.

square testing and proportional 2 test, only stent length (length > 20 mm) was an independent predictor of distal embolization. A scatter plot of distal embolization with suspected risk factors has been shown in ►Fig. 1. We could not detect any relationship between distal embolization and age of patient, sex, hypertension, diabetes, smoking, and left ventricular function either by multivariate or univariate analysis. Age of graft, direct stenting, use of embolic devices, and GP2b/3a inhibitors correlation with distal embolization were also nonsignificant even by chi-square test.

Discussion

SVG interventions accounts for ~5% to 10% of all PCIs.⁵ In view of the natural history of SVG patency rate, repeat intervention would be required in ~4% of patients by 5 years, 19% of patients by 10 years, and 31% of patients by 12 years after initial bypass surgery.⁶ The decision to intervene in a diseased SVG is guided by the patient's clinical status, noninvasive demonstration of ischemia, and presence of significant stenosis angiographically (ACC/AHA recommendations). Saphenous vein graft failure is defined as SVG occlusion (100% occlusion) or ≥ 75% stenosis of the graft vein.⁷ SVG is considered degenerative when characterized by luminal irregularities and ectasia

Table 5 Comparison of descriptive variables between both groups

Descriptive feature	Distal embolization group No: 6 (%)	No distal embolization group No: 74 (%)
Patient age (years)	60 ± 9.7	61 ± 9
Female gender	1 (17)	12 (16)
Hypertension	5 (83)	68 (92)
Diabetes mellitus	4 (67)	43 (58)
Cigarette smoking	2 (33)	30 (41)
Age of graft (years)	9.1 ± 4.5	8.2 ± 4.7
Acute coronary syndrome	4 (67)	37 (50)
LV dysfunction	4 (66)	26 (35)
Radial access	2 (22)	13 (18)
DES	3 (50)	61 (82)
Direct stenting	4 (67)	46 (62)
Post dilatation	3 (50)	11 (15)
Average stent length >20	7 (78)	38 (53)
Average stent diameter ≤3	1 (11)	56 (78)
Embolic protection device	0	08 (11)
GP2b/3a inhibitor	2 (33)	14 (19)
Hemoglobin (avg)	12.7	12.3
Creatinine	1.15	1.1

Abbreviations: avg, average; DES, drug-eluting stent; GP2b/3a, glycoprotein 2b/3a; LV, left ventricular; No, number.

compromising > 50% of lumen on angiography. SVG disease occurs in three phases: *early* (before hospital discharge), intermediate (1 month to 1 year), and (3) *late* (beyond 1 year). In the present study, average age of the graft was 8.2 ± 4 years, which indicates that the predominant pathophysiology was atherosclerosis. The atherosclerotic plaque of vein graft is diffuse, concentric, and friable, characterized by foam cells and inflammatory cells in abundance, poorly developed/absent fibrous cap, and little calcification.⁷⁻⁹ This nature of the plaque is responsible for the distal embolization resulting in no reflow after PCI. No reflow is associated with worse clinical outcomes including high postprocedural MI (17.7% versus 3.5%) and death (7.4% versus 2%).¹⁰

Bhargava et al¹¹ reported distal embolization in 09% to 3.4% patients undergoing SVG stenting and Kuroda et al¹² observed distal embolization in 13.6%. In our study, distal embolization was seen in 7.5% patients in par with previous data. Periprocedural CK-MB elevation after successful SVG intervention is common ranging from 15% to 47%.¹³ In this study, periprocedural elevated cardiac enzymes was seen in 12.5%, while MI was seen in 3.7%, relatively lesser than previous reports.

Table 6 Univariate analysis

Parameter	p Value	95% CI
Female sex	0.54	−0.15, 0.29
Hypertension	0.45	−0.45, 0.19
Diabetes	0.38	−0.49, 0.19
Smoking	0.47	−0.22, 0.47
Acute coronary syndrome	0.08	−0.56, 0.03
LV dysfunction	0.29	−0.15, 0.54
Femoral access	0.06	−0.16, 0.41
Balloon predilatation	0.29	−0.15, 0.54
Post dilatation	0.18	−0.14, 0.49
Stenting	0.02	−0.60, 0.02
DES	0.002	−0.83, −0.19
Stent diameter	0.000	−2.16, −1.92
Stent length	0.000	−22.98, −19.07
Hemoglobin	0.000	−11.38, −10.69
Creatinine	1.00	−0.09, 0.09
EPD	0.98	−0.19, 0.19
GP2b/3a inhibitors	0.18	−0.09, 0.52

Abbreviations: CI, confidence interval; DES, drug-eluting stent; EPD, embolic protection device; GP2b/3a, glycoprotein 2b/3a; LV, left ventricle.

There are no definite predictors for distal embolization. Female sex is a significant predictor of poor outcomes after SVG intervention with higher vascular complications, acute renal failure, and high 30-day mortality.¹⁴ However, no study has demonstrated any relationship between gender and distal embolization and this holds true in our study also. No relation could be detected between distal embolization and age of patient, presence of hypertension, diabetes, and smoking. Sdringola et al² and Primary Angioplasty in Myocardial Infarction Trial trial¹⁵ support thrombus and acute coronary syndrome as predictors of distal embolization. In our study, distal embolization was associated with thrombus and acute coronary in univariate analysis but not in multivariate analysis. Age of the graft did not matter in this aspect unlike angiographic graft degeneration shown in previous studies.¹⁶⁻¹⁸ Kuroda et al¹² reported that lesion length was an independent predictor of distal embolization in SVG intervention. In this study, we did not consider lesion length as it is prone for subjective and objective variation being a QCA measurement. Instead we considered the stent length which was a more definitive measurement not prone to any variation or error. Stent length proved to be an independent predictor for distal embolization, with length >20 mm associated with increased incidence of distal embolization. Chronic renal insufficiency is a significant predictor of 1 year major adverse cardiac event, target vessel revascularization, and death, but its relation to distal embolization is

Table 7 Multivariate analysis of significant factors

Parameter	p Value	95% CI
Acute coronary syndrome	0.18	0.57–20.07
LV dysfunction	0.25	0.03–2.47
Hemoglobin	0.07	
Radial access	0.11	0.05–1.96
Stenting	0.14	0.52–100.8
DES	0.03	7.5–6472.55
Stent size diameter	0.04	0.00–0.82
Stent length	0.02	0.57–0.96

Abbreviations: CI, confidence interval; DES, drug-eluting stent; LV, left ventricle.

Goodness-of-Fit Tests

Method	Chi-Square	DF	p
Pearson	142.373	36	0.000
Deviance	29.205	36	0.782
Hosmer–Lemeshow	7.227	8	0.512

Stent length ≤ 20 to > 20 mm

Chi square (χ^2) = 6.103, p = 0.013 (OR = 0.104, 95% CI = 0.005–0.905, RR = 0.121, 95% CI = 0.006 to 0.913)

Proportional 2 Test: Significance 0.017.

Fischer 2 test: 0.02.

not established.^{19,20} In the present study, renal insufficiency was not associated with distal embolization. Reduced hemoglobin contributed to no reflow/slow flow in the present study both by univariate and multivariate analysis. This is contrary to the fact that hyper viscosity is a plausible cause for slow flow and not anemia. Anemia is definitely associated with poor outcome following intervention and acute coronary syndrome, but its role in slow flow/no reflow needs to be ascertained in further studies.

Percutaneous treatment of the SVG lesions is a challenge for any interventional cardiologist and several techniques have been tested to prevent the occurrence of distal embolization. Though several pharmacological methods and devices have been tried to ensure distal protection during PCI, none is fool proof.

Balloon angioplasty: Balloon angioplasty of SVGs is currently considered as only a palliative procedure.²¹ Implantation of stents in SVG lesion is recommended (SAVED trial) to improve short- and long-term outcomes.^{22,23} In the present study, we excluded cases where only balloon angioplasty was done.

Type of stent: There is no role for covered stents for the prevention of distal embolization except to bail out (SYM-BIOT III trial, RECOVERS trial, BARRICADE trial). Meta-analysis of recent randomized and observational studies (RRISC, SOS, ISAR-CABG, BASKET-SALVAGE, DIVA) has shown that DES scores over BMS in terms of lower target vessel revascularization and target lesion revascularization. However, only one study has shown DES to be associated with improved short term which was attributed to increased stent thrombosis in BMS group. Our study shows that implantation of DES in SVG lesions scores over BMS in terms of reduced distal embolization.

Direct stenting: Stenting without preliminary balloon dilatation or preparation was proposed to reduce the risk of distal embolization in SVG interventions. The hypothesis was that the stent would act as scaffold to trap the friable tissue of the plaque before balloon dilatation and reduce its fragmentation. Leborgne et al²⁴ and Lozano et al²⁵ proposed that direct stenting should be preferred whenever feasible in SVG stenting especially when a distal protection device cannot be used as direct stenting scored in terms of distal embolization. The present study failed to show that direct

Fig. 1 Scatter plot of distal embolization with risk factors. Abbreviations: HB, haemoglobin; LDH, lactate dehydrogenase; CPK, creatinine phosphokinase.

stenting scores over conventional stenting in terms of preventing distal embolization in SVG lesions.

Embolic protection devices: EPDs are currently accepted as standard therapy for the prevention of distal embolization during percutaneous treatment of SVG disease (SAFER,²⁶ FIRE,²⁷ SPIDER,²⁸ PROXIMAL).²⁹ In accordance with the current guidelines, every effort should be made to use EPD in SVG interventions whenever technically feasible. The high costs of these devices, the need for a learning curve, and the potential complications associated with the use of these additional devices in the atherothrombotic milieu and the disadvantages associated with individuals EPDs are major hindrances to their use in daily practice. In the American College of Cardiology National Cardiovascular Data CathPCI Registry,³⁰ embolic protection was only used in 23% of patients. In the present study, distal EPD was used in eight patients. Though no incidence of no reflow/slow flow was observed in these 10% patients, no statistically significant correlation with distal embolization protection could be established with their use. Unfortunately, no reflow is still seen despite the use of protection devices which could be the result of emboli during primary crossing, incomplete capture or during device retrieval due to injury at deployment site, small particles, or filter overload.³¹

GP2b/3a inhibitors: The EPIC trial³² first favored the use of abciximab therapy during percutaneous treatment of SVG lesions. However, a pooled analysis of five randomized trials of intravenous GP2b/3a inhibitor in SVG proved no benefit in terms of individual or combined end points either at 30 days or at 6 months. They were associated with an increased incidence of major and minor bleedings.^{4,33} Their use in combination with EPDs was associated with superior performance with reduced occurrence of no reflow periprocedural ischemia and distal embolization in a few studies,^{26,27} but this requires further clarification. GP2b/3a inhibitor was infused in 20% patients in the present study but proved no benefit in terms of prevention of no reflow/slow flow.

Prophylactic administration of intragraft adenosine does not decrease the risk of slow or no reflow, though multiple high doses can reverse it.³⁴ Prophylactic intragraft administration of verapamil tends to reduce the occurrence of no reflow compared with placebo.³⁵ Intracoronary nicardipine has shown to be promising in preventing no reflow in SVG interventions in the absence of distal embolic protection.³⁶ In our study, intravenous nitroglycerine was used periprocedural in 28 cases but failed to show any correlation with prevention of distal embolization.

Conclusion

Stent implantation in patients with de novo SVG lesions can be achieved with a high rate of angiographic and clinical success. The risk of distal embolization is present but can be minimized by choosing DES and shorter stents. In the Indian population, SVG interventions can be safely done in the absence of EPDs irrespective of the graft age. In the current era of better stents, improvised PCI hardware, favorable

natural history of SVG disease due to improved vein harvesting techniques, and medical therapy, the role of distal protection devices in SVG intervention needs to be redefined. Further large-scale randomized trials need to reassess the use of EPDs in SVG intervention.

Limitation of the study

The limitations typically encountered with retrospective studies are applicable here. No follow-up data are considered to study the restenosis rate which is another limitation of SVG lesions.

References

- 1 Vermeersch P, Agostoni P, Verheye S, et al. Randomized double-blind comparison of sirolimus-eluting stent versus bare-metal stent implantation in diseased saphenous vein grafts: six-month angiographic, intravascular ultrasound, and clinical follow-up of the RRISC Trial. *J Am Coll Cardiol* 2006;48(12):2423–2431
- 2 Sdringola S, Assali AR, Ghani M, et al. Risk assessment of slow or no-reflow phenomenon in aortocoronary vein graft percutaneous intervention. *Catheter Cardiovasc Interv* 2001;54(03):318–324
- 3 Abbo KM, Dooris M, Glazier S, et al. Features and outcome of no-reflow after percutaneous coronary intervention. *Am J Cardiol* 1995;75(12):778–782
- 4 Carter LI, Golzar JA, Cavendish JJ, Dixon SR. Embolic protection of saphenous vein graft percutaneous interventions. *J Interv Cardiol* 2007;20(05):351–358
- 5 Lee, Park S-J, Kandzari DE, et al. SVG intervention. *J Am Coll Cardiol* 2011;4(08):31–43
- 6 Motwani JG, Topol EJ. Aortocoronary saphenous vein graft disease: pathogenesis, predisposition, and prevention. *Circulation* 1998;97(09):916–931
- 7 Alexander JH, Hafley G, Harrington RA, et al; PREVENT IV Investigators. Efficacy and safety of edfoligide, an E2F transcription factor decoy, for prevention of vein graft failure following coronary artery bypass graft surgery: PREVENT IV: a randomized controlled trial. *JAMA* 2005;294(19):2446–2454
- 8 Murphy GJ, Angelini GD. Insights into the pathogenesis of vein graft disease: lessons from intravascular ultrasound. *Cardiovasc Ultrasound* 2004;2:8
- 9 Nguyen T, Pham L, Cheem TH, Douglas JS, Hermiller J, Grines C. Approach to the patient with prior bypass surgery. *J Interv Cardiol* 2004;17(05):339–346
- 10 Habibzadeh MR, Thai H, Movahed MR. Prophylactic intragraft injection of nicardipine prior to saphenous vein graft percutaneous intervention for the prevention of no-reflow: a review and comparison to protection devices. *J Invasive Cardiol* 2011;23(05):202–206
- 11 Bhargava B, Kornowski R, Mehran R, et al. Procedural results and intermediate clinical outcomes after multiple saphenous vein graft stenting. *J Am Coll Cardiol* 2000;35(02):389–397
- 12 Kuroda Y, Hara K, Nakajima H, Ikari Y. Short-term outcome of stent implantation in saphenous vein grafts: predictors of distal embolization and restenosis. *Jpn Circ J* 2001;65(04):265–270
- 13 Hong MK, Mehran R, Dangas G, et al. Are we making progress with percutaneous saphenous vein graft treatment? A comparison of 1990 to 1994 and 1995 to 1998 results. *J Am Coll Cardiol* 2001;38(01):150–154
- 14 Ahmed JM, Dangas G, Lansky AJ, et al. Influence of gender on early and one-year clinical outcomes after saphenous vein graft stenting. *Am J Cardiol* 2001;87(04):401–405
- 15 Stone GW, Brodie BR, Griffin JJ, et al for the Second Angioplasty in Myocardial Infarction Trial (PAMI-2) Investigators. Clinical and angiographic outcomes in patients with previous coronary artery bypass graft surgery treated with primary balloon angioplasty for acute myocardial infarction. *Second Primary Angioplasty in*

- Myocardial Infarction Trial (PAMI-2) Investigators. *J Am Coll Cardiol* 2000;35(03):605–611
- 16 Coolong A, Baim DS, Kuntz RE, et al. Saphenous vein graft stenting and major adverse cardiac events: a predictive model derived from a pooled analysis of 3958 patients. *Circulation* 2008;117(06):790–797
 - 17 Kirtane AJ, Heyman ER, Metzger C, Breall JA, Carrozza JP Jr. Correlates of adverse events during saphenous vein graft intervention with distal embolic protection: a PRIDE substudy. *JACC Cardiovasc Interv* 2008;1(02):186–191
 - 18 Giugliano GR, Kuntz RE, Popma JJ, Cutlip DE, Baim DS; Saphenous Vein Graft Angioplasty Free of Emboli Randomized (SAFER) Trial Investigators. Determinants of 30-day adverse events following saphenous vein graft intervention with and without a distal occlusion embolic protection device. *Am J Cardiol* 2005;95(02):173–177
 - 19 Lee MS, Hu PP, Aragon J, et al. Impact of chronic renal insufficiency on clinical outcomes in patients undergoing saphenous vein graft intervention with drug-eluting stents: a multicenter Southern Californian Registry. *Catheter Cardiovasc Interv* 2010;76(02):272–278
 - 20 Gruberg L, Weissman NJ, Pichard AD, et al. Impact of renal function on morbidity and mortality after percutaneous aorto-coronary saphenous vein graft intervention. *Am Heart J* 2003;145(03):529–534
 - 21 de Feyter PJ. Percutaneous treatment of saphenous vein bypass graft obstructions. A continuing obstinate problem. *Circulation* 2003;107(18):2284–2286
 - 22 Hong MK, Mehran R, Dangas G, et al. Comparison of time course of target lesion revascularization following successful saphenous vein graft angioplasty versus successful native coronary angioplasty. *Am J Cardiol* 2000;85(02):256–258
 - 23 Savage MP, Douglas JS Jr, Fischman DL, et al; Saphenous Vein De Novo Trial Investigators. Stent placement compared with balloon angioplasty for obstructed coronary bypass grafts. *N Engl J Med* 1997;337(11):740–747
 - 24 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(03):501–506
 - 25 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(03):270–277
 - 26 Baim DS, Wahr D, George B, et al; Saphenous vein graft Angioplasty Free of Emboli Randomized (SAFER) Trial Investigators. Randomized trial of a distal embolic protection device during percutaneous intervention of saphenous vein aorto-coronary bypass grafts. *Circulation* 2002;105(11):1285–1290
 - 27 Stone GW, Rogers C, Hermiller J, et al; FilterWire EX Randomized Evaluation Investigators. Randomized comparison of distal protection with a filter-based catheter and a balloon occlusion and aspiration system during percutaneous intervention of diseased saphenous vein aorto-coronary bypass grafts. *Circulation* 2003;108(05):548–553
 - 28 Dixon SR. Saphenous vein graft protection in a distal embolic protection randomized trial. Paper presented at: Transcatheter Cardiovascular Therapeutics 2005; October 18, 2005; Washington, DC
 - 29 Mauri L, Cox D, Hermiller J, et al. The PROXIMAL trial: proximal protection during saphenous vein graft intervention using the Proxis Embolic Protection System: a randomized, prospective, multicenter clinical trial. *J Am Coll Cardiol* 2007;50(15):1442–1449
 - 30 Brilakis ES, Wang TY, Rao SV, et al. Frequency and predictors of drug-eluting stent use in saphenous vein bypass graft percutaneous coronary interventions: a report from the American College of Cardiology National Cardiovascular Data CathPCI registry. *JACC Cardiovasc Interv* 2010;3(10):1068–1073
 - 31 Dash D. An update on coronary bypass graft intervention. *Heart Asia* 2014;6(01):41–45
 - 32 Mak KH, Challapalli R, Eisenberg MJ, Anderson KM, Califf RM, Topol EJ. Effect of platelet glycoprotein IIb/IIIa receptor inhibition on distal embolization during percutaneous revascularization of aortocoronary saphenous vein grafts. EPIC Investigators. Evaluation of IIb/IIIa platelet receptor antagonist 7E3 in Preventing Ischemic Complications. *Am J Cardiol* 1997;80(08):985–988
 - 33 Roffi M, Mukherjee D, Chew DP, et al. Lack of benefit from intravenous platelet glycoprotein IIb/IIIa receptor inhibition as adjunctive treatment for percutaneous interventions of aortocoronary bypass grafts: a pooled analysis of five randomized clinical trials. *Circulation* 2002;106(24):3063–3067
 - 34 Sdringola S, Assali A, Ghani M, et al. Adenosine use during aortocoronary vein graft interventions reverses but does not prevent the slow-no reflow phenomenon. *Catheter Cardiovasc Interv* 2000;51(04):394–399
 - 35 Michaels AD, Appleby M, Otten MH, et al. Pretreatment with intragraft verapamil prior to percutaneous coronary intervention of saphenous vein graft lesions: results of the randomized, controlled vasodilator prevention on no-reflow (VAPOR) trial. *J Invasive Cardiol* 2002;14(06):299–302
 - 36 Fischell TA, Subraya RG, Ashraf K, Perry B, Haller S. “Pharmacologic” distal protection using prophylactic, intragraft nicardipine to prevent no-reflow and non-Q-wave myocardial infarction during elective saphenous vein graft intervention. *J Invasive Cardiol* 2007;19(02):58–62