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Saphenous Venous Graft PCI Registry: A Single Centre Experience

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Abstract

Background: During coronary artery bypass grafting (CABG), the treatment of coronary artery disease by grafting saphenous vein is a common practice. However, within 10 years of SVG intervention due to degeneration and occlusion of grafted artery, the failure rate of SVG is observed to be as high as 50%. The repeat vascularisation with PCI has increased in clinical practice; however, the data on clinical outcome in Indian population is limited.

Methods: A retrospective observational analysis of 30 post-CABG patients with SVG-PCI in single centre between April 2010 and July 2020 was conducted.

Results: The average age of patient was 62.7 ± 9.9 years and majority were male patients (87%) with history of diabetes mellitus (63%), hypertension (73%) and habit of tobacco (83%). After 11.0 ± 4.1 years of CABG with an average of 2 SVGs, the PCI of SVG to OM vessel was performed with drug eluting stents in 97% of cases. PCI of native vessel was performed in only 30% of cases. In majority of SVG-PCI cases (63%) one stent with an average length of 23.2 ± 7.3 mm and diameter of 3.5 ± 0.50 mm was implanted. Patients were discharged on DAPT regimen and in 80% DPDs were used on a routine basis. At 1 year follow-up, 97% of cases had no complications during follow-up, but one case had undergone redo CABG.

Conclusion: The PCI of SVG lesions had positive clinical outcomes as revealed by fewer incidences of post procedural and post-discharge complications.

Keywords: Coronary artery • Antiplatelet therapy • Saphenous venous graft • Drug eluting stent • Coronary intervention

Abbreviations: CABG: Coronary Artery Bypass Graft; PCI:Percutaneous Coronary İntervention; DAPT: Dual Antiplatelet Therapy; DPD: Distal Protection Device

Introduction

Invasive coronary revascularization, in particular, saphenous venous graft (SVG) is a common type of graft in the management of multi-vessel disease in patients with coronary artery bypass grafting (CABG) [1]. Still, within 10 years of SVG intervention the failure rate of SVG is known to accelerate from 25% to 50% [2]. The failure of SVG is related to co-morbidities like smoking, diabetes mellitus, surgery-related factors and many more [3]. Besides, the patho-physiological reasons for the degeneration and progressive occlusion of SVG includes neo-intimal growth, accelerated atherosclerosis, distal embolization, plaque embolization, and inflammation and so on [4] which are resolved either by repeat CABG or by percutaneous coronary intervention (PCI). Repeated CABG increases the risk of mortality when compared to PCI alone [5]. In the context of PCI, different types of stents like bare metal stents (BMS), drug-elution stents (DES) of first and second generation, covered stents are implanted for the revascularisation of occluded artery and to reduce restenosis of target lesions [3]. When compared with the PCI of native vessel, SVG-PCI has poor long-term outcomes like peri-procedural MI, no-reflow, target vessel revascularization, in-stent restenosis [6]. To minimize the complications multiple approaches such as use of embolic protection devices (EPDs) and drug therapy including use of vasodilators, anti-platelets are recommended [4]. Intervention of SVG has remained a challenge and depends on patients anatomy, nevertheless the benefit of this technique in long-term can be maximized by analyzing the existing clinical data on PCI of SVGs. The aim of this study is (i) to evaluate the clinical profile in post-CABG patients who underwent PCI in SVG interventions, interventional techniques used and adjunctive drug therapy used; (ii) to determine the role played by co-morbidities in predicting the outcomes of SVG-PCI intervention.

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Literature Review

The common problem of atherosclerosis of lesion or clot in pre-existing graft is mainly resolved by revascularization. In many CABG patients, the repeat CABG is not an option because of advancing age and increased risk of mortality. Thus, PCI is widely recommended due to reduced morbidity and mortality when compared to repeat CABG [7]. In patients with history of CABG, the PCI can be performed to a native vessel as well as a graft vessel; however, the PCI of graft vessel is a difficult task and have poor long-term clinical outcomes. Higher risk of morbidity and mortality are associated with occurrence of restentoic lesion and multiple stents, thereby indicating poor survival benefit [8]. According to Behboudi et al. [7] chronic total occlusion increases the risk of SVG failure. There is no definite solution to optimal target for revascularization. Inferior long term outcome and adverse events is associated with post-SVG PCI when compared to native vessel PCI [9]. Bundhoo et al. [10] found higher number of existing grafts and higher rate of target vessel revascularization (TVR) in SVG PCI patients, whereas Alidoosti et al. [11] found that outcome in terms of major adverse cardiovascular events (MACE) was no different between PCI on SVG and native vessels. In a primitive observations study, Islam et al. [12] found that on an average 11 years after CABG, the PCI of SVG was very effective with 93.5% survival rate. The revascularisation of SVG graft or native vessel is still debatable. Overall, the choice of intervention to revascularize the type of vessel depends on patient's health-related characteristics.

Implantation of stents during SVG intervention is a common practice. The superiority of different stents in the treatment of SVG-PCI has been conflicting. Behboudi et al. [7] associated hypertension and use of BMS to increased risk of cardiac events. On the contrary, at 1 year, the use of second generation DES stents over BMS had no superior outcomes in terms of TVR, stroke, stent thrombosis or death; however, the DES stent length of >20 mm significantly predicted MACE [13]. Brikalis et al. [14] in their double-blind randomized study found similar clinical outcomes between DES and BMS, but encouraged use of BMS owing to their low cost compared to DES. Yet in another study, the number and length of stents had no influence on clinical outcome like no-reflow [15].

Various factors increase the risk of SVG failure and multiple strategies are employed to mitigate the failure rate. Slow-flow/no-reflow is one of the risk factors of failure of SVG-PCI. Thrombus, acute coronary syndromes, presence of ulcer and degenerated vein graft are associated to no-flow phenomenon [16]. Hashemi-Jazi et al. [15] associated high DBP, lesion of location to proximal and presence of degenerated SVG to occurrence of no-reflow. The assessment of probable cause of no-reflow helps to select strategies to avoid complications. For example, Verma et al. [17] suggested use of thrombus aspiration device prior to stent deployment in SVG to reduce the thrombus burden thereby reducing the risk of no-flow phenomenon. Another factor of SVG failure is distal embolization, which is resolved by routine use of EPDs [18], but the anatomic difficulty, in particular the lesion location and complexity of EPDs device has led to underutilization of this device [19]. Additionally, the use of this device in SVG-PCI has also produced conflicting results. Paul et al. [20] in their meta-analytic study involving more than 50,000 SVG patients found that use of EPDs during SVG had no apparent benefit with respect to mortality, MACE, TVR or periprocedural myocardial infarction (MI). Similarly, Mahmood et al. [19] found limited benefit from use of EPDs. Besides these, drug therapy including use of antiplatelets, vasodilators and others are also used to reduce the complications of SVG-PCI.

Research gap

The assessment of clinical outcomes is essential to identify the risk factors and to develop improved interventions. Among Indian population, limited data is available on examining the outcome and on optimal SVG-PCI in patients with CABG. Also, there is lack of guidelines on treatment and prevention of SVG-PCI failure. The objectives of this study will help to fill the identified research gap.

Research Methodology

A retrospective observational analysis was conducted of total 30 post-CABG patients with SVG-PCI who were treated at Departments of Cardiology at KLES Dr. Prabhakar Kore Hospital, Belagavi between April 2010 and July 2020. Demographic data (age, sex and co-morbidities) and SVG-PCI procedural characteristics were obtained for each patient. The end point of this study was the incidences of complications at 1 year follow-up. The collected data was statistically analyzed using SPSS 24.0 and presented in the form of frequency and percentage.

Results

An abnormality in ROS production and imbalance of endothelium-derived nitric oxide (NO) production has been long suggested to be the key pathogenic mechanism of the endothelial dysfunction [5,10] involving dysfunctional mitochondria that results in the development of clinical events, including vascular diseases and stroke. Therefore, the effective protection of endothelial cells and reducing oxidative stress is beneficial in many experimental and clinical settings of CVD. In this study, we demonstrated that alpha-lipoic acid (ALA) protects HUVECs from Ang II-induced endothelial dysfunction (Table 1).

Post CABG LIMA grafting was found in 77% (23/30) with majority to LAD and all patients had undergone SVG (100%) with maximum 2 number (53%) of SVG graft. RIMA graft was performed in only 2 patients (Table 2).

In order to minimize the complication, after discharge patients were orally treated with anti-platelet therapy comprising aspirin and clopidogrel (66%) or aspirin and ticagrelor (34%). Further, to reduce the risk of distal embolization, distal occlusion/potential device was used in 80% of patients (Table 3).

PCI characteristics

PCI was performed in all the patients with higher number of proximal (43%) followed by mid (27%) lesion location. Other lesion locations were ostial (13%), anastomosis (10%), distal (3%) and mid-distal (3%). The coronary lesion of

Table 1. Clinical characteristics.

Variables	N (%)
Age (years)	62.7 ± 9.9
Gender	
Male	26 (87)
Female	4 (13.3)
Tobacco	
Yes	25 (83)
No	5 (17)
Others Comorbidity	
Yes	7 (23)
No	23 (77)
Hypertension	
Yes	22 (73)
No	8 (27)
Diabetes Mellitus	
Yes	19 (63)
No	11 (37)
Complaints	
Chest pain	16 (53)
Dyspnea- NYHA Class 2	7 (23)
Chest pain, Dyspnea	4 (13)
Dyspnea-NYHA Class 2,Syncope	2 (7)
Dyspnea-NYHA, Class 3	1 (3)
Previous MI	
Yes	14 (47)
No	16 (53)
CABG interval (years)	11.0 ± 4.1
Diagnosis	
IWMI	2 (7)
NSTEMI	11 (37)
Unstable Angina	17 (57)
LV Function	
Normal	13 (43)
Mild	6 (20)
Moderate	3 (10)
Border line	8 (27)

Table 2. Post CABG grafting technique.

Grafting technique	
LIMA graft	N (%)
Diagonal	3 (10)
LAD	18 (60)
LAD, Diagonal	1 (3)
OM	1 (3)
No	7 (23)
Grafting technique	
SVG	
Number of SVG graft	
1	8 (27)
2	16 (53)
3	5 (17)
4	1 (3)
RIMA	
Yes	2 (6)
No	28 (94)

Table 3. Strategies to minimize complications.

Drug therapy	
Aspirin+Clopidogrel	20 (66)
Aspirin+Ticagrelor	10 (34)
Distal potential device	
Yes	24 (80)
No	06 (20)

type C lesion was predominant (43%). The type A and B lesion corresponded to 33% and 23%, respectively. PCI of native vessel (proximal-LAD, proximal-mid, left main LAD and LCX, and RCA) was performed in only 30% of patients. PCI of SVG to OM was performed in larger number (47%) followed by SVG-LAD (23%) and SVG-RCA (13%). SVG-PDA, SVD-RAMUS and SVG-RCA along with SVG-OM were performed in 10%, 3% and 3% of patients, respectively. In 97% of patients drug eluting stent (DES) were implanted; only one patient had bare metal stent (BMS) implanted. In 63% patient's only one stent was implanted. About 23% of patients had 2 stents, 10% had 3 stents and only 3% had 5 stents. The average length and diameter of stent was 23.2 ± 7.3 mm and 3.5 ± 0.50 mm, respectively (Table 4).

Follow-up was performed at one month and after one year of SVG-PCI procedure, and the majority of patients had no complications (97%). The incidence of post procedure complications included no-reflow complication in one patient. Further, out of 30 patients only one patient with no complication had to undergo Redo- CABG during the follow-up period (Table 5).

Discussion

In patients with multi-vessel coronary artery disease CABG is the standard treatment which provides survival benefit. Multiple reasons like comorbidities, degeneration of grafts and atherosclerosis makes the CABG patients to undergo angiographic evaluation in majority of symptomatic patients. In treatment of coronary artery disease the coronary revascularization is achieved by multiple grafting techniques like right internal mammary artery (RIMA), left internal mammary artery (LIMA) and SVG [21]. In this study, 77% of patients received LIMA; LIMA to LAD after CABG is the gold standard for surgical revascularization and is more preferred than SVG [22]. In this study, in particular all CABG patients had undergone SVG and though SVG is distinct but has its own degeneration pattern and failure over a period of time thereby increasing the risk of MACE [23]. The main aim of this study was to measure the outcome in terms of post-discharge complication at 1 year in CABG patients who underwent PCI of SVG.

In this study, male patients (87%) of a mean age of 62.7 ± 9.9 years with hypertension (73%), diabetes mellitus (63%), tobacco habit (83%), lower rate of previous MI (47%) and normal EF (43%) had undergone PCI of SVG at an average of 11.0 ± 4.1 years after CABG. Similar observation was made by Islam et al. [12] wherein after 11.5 ± 5.4 years of CABG, occlusion of graft vessel was performed in patients of an average age of 62.1 ± 10.8 years with history of diabetes mellitus, hypertension and dyslipidemia. Likewise, other report also found PCI of SVG in elderly male patients after 9 years of grafting [24] indicating poor outcome of SVG in long-term. The PCI of SVG grafts involves implantation of stents to prevent the SVG failure [23]. In the present study there was no comparison of outcome between DES and BMS stents because only one patient received BMS and remaining patients got DES. Further, out of 29 cases, there was only one case of post-discharge

Table 4. PCI characteristics.

PCI variables	N (%)
Lesion location	
Anastomosis	3 (10)
Mid	8 (27)
Distal	1 (3)
Mid,distal	1 (3)
Ostial	4 (13)
Proximal	13 (43)
Type of Lesion	
Type A	7 (23)
Type B	10 (33)
Type C	13 (43)
Native Vessel PCI	
Left main- PROX LAD	1 (3)
Left main- LCX	1 (3)
Proximal LAD	4 (13)
Proximal -MID RCA	1 (3)
RCA	2 (7)
SVG PCI	
SVG-LAD	7 (23)
SVG-PDA	3 (10)
SVG-OM	14 (47)
SVG-RAMUS	1 (3)
SVG-RCA	4 (13)
SVG-RCA,SVG-OM	1 (3)
Stent Type	
Bare metal	1 (3)
Drug Eluting	29 (97)
Number of Stents	
1	19 (63)
2	7 (23)
3	3 (10)
5	1 (3)
Stent characteristics	
Stent Length (mm)	23.2 ± 7.3
Stent Diameter (mm)	3.50 ± 0.50

Table 5. Post procedure complications.

Variables	
Post procedure complication	N (%)
No complication	29 (97)
No reflow , Ventricular fibrillation	1 (3)
1 month follow-up	
Yes	30 (100)
1 year follow-up	
Yes	29 (97)
No	1 (3)

complications associated with DES. Few clinical studies have shown improved outcomes as revealed by lower incidences of revascularization of target lesions in patients implanted with DES than BMS. Better outcome in terms of reduced MACE and low mortality was observed with newer generation of DES than BMS [25]. On the contrary, Brilakis et al. [14] found that in patients with *de-novo* SVG lesions the implantation of DES or BMS did not show any difference in long-term outcome like target vessel revascularization, cardiac death and target vessel myocardial infarction, except that in few patients target vessel failure was observed. Similarly, meta-analytic review also showed no difference in mortality and MI between the group using DES and BMS [26]. Overall, it can be said that besides the price of DES which is higher compared to BMS, the benefits associated with both the stents could not be distinguished in clinical outcomes, nevertheless, the findings of the present study is suggestive of largely favourable outcome of DES. Further, in Mazhar et al.'s observational study [13] the average length of stent in DES group was >20 mm and mean number of stents per patient was 1.6 ± 0.090. The stent length of >20 mm was identified as the predictor of major adverse cardiovascular events and increased target vessel revascularization., whereas in the present study occurrence of complication was least with an average stent length and number of stents of 23.2 ± 7.3 mm and 1.7, respectively. It was proposed that use of DES with longer length depends on the longer lesions which possibly reduce the incidence of restenosis in future.

The comparison of PCI of native vessel and graft vessel revealed higher incidences of restenosis and occlusion in PCI of graft vessel than native vessel [9,27]. The findings of this study was in contrast to j-Cypher registry where risk of complications like cardiac death, myocardial infarction, target vessel revascularization and stent thrombosis was higher in CABG patients who underwent PCI for more than one SVG than PCI of native vessel [28]. In this study all patients (100%) had PCI of SVG and very few patients (30%) had undergone PCI of native vessel and complications were found in only 3% of total population. Additionally, it can also be inferred that PCI of SVG was an effective procedure as revealed by lower number of complications in spite of larger number of Type B and Type C lesions. With a similar frequency of Type B and C lesions in older patients, [29] predicted 90% success rate of PCI of SVG.

Usually repeat CABG increases the risk of mortality likely because the co-morbidities or weakening of system progresses with increasing age. In the present study only one 59 year old patient with PCI of SVG to RCA and OM, without PCI of native vessel and with three stents of length 26 mm had to undergo CABG again. It could probably be due to increased severity and diffused nature of SVG disease wherein PCI of even native vessel would not have served the purpose as observed by Miyoshi et al. [30] wherein 72 year old patient was rescued by redo-CABG due to occlusion of both native and SVG coronaries. Further, a case report of 62 year old patient undergoing redo-CABG and SVG-PCI together highlighted the possible risk of both surgical and PCI procedures, and suggested to consider the patients clinical characteristics, age and scoring of risk factor in EuroSCORE system before optimizing the medical procedure [31].

To prevent the failure of SVG after CABG, oral antiplatelet drugs are administered. In the present study aspirin in combination with clopidogrel or ticagrelor were recommended. The meta-analytic review of 20 randomised controlled clinical trials has revealed that combination of either clopidogrel or ticagrelor with aspirin has superior benefit than administration of aspirin alone. Among different combinations including rivaroxaban and aspirin, Vitamin K antagonists, aspirin alone, the use of aspirin and clopidogrel combination drug was associated with fewer incidences of major bleeding. To obtain improved outcome, the authors recommend tailoring the drug combination based on patient's clinical profile [32]. Besides the use of DPDs are routinely used to reduce the adverse event associated with SVG. In a 30-day study, lower risk of MI and no-reflow phenomenon was observed when DPD was used Paul et al., [20]. In the context of outcome, in the present study, the no-reflow phenomenon was found in only one male patient of 72 years with normal LV function and with history of diabetes mellitus and tobacco habit. In this particular patient, post CABG four SVG graft of lesion at mid was performed and further PCI of SVG to RCA with two drug-eluting stents of length 17 mm and diameter 3.5 mm was performed. After PCI of SVG, risk of no reflow is high

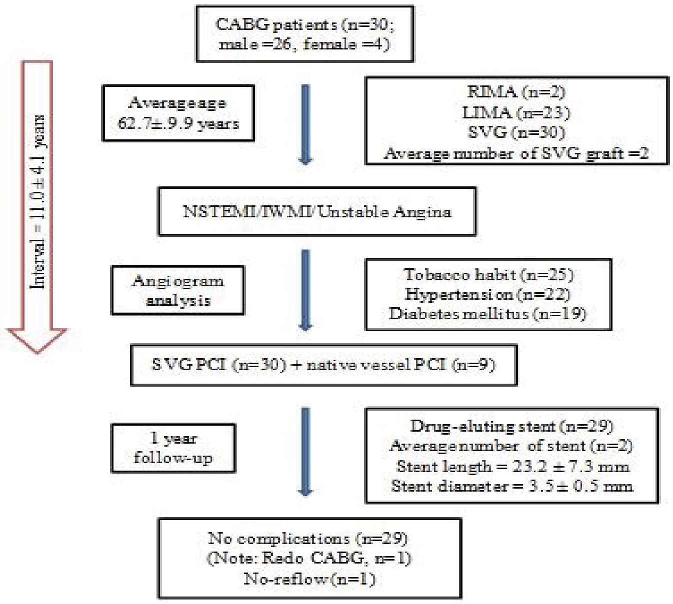

Figure 1. Approach to SVG-PCI.

probably due to athero-thromboembolism [33]. In a cross-sectional study, no-reflow phenomenon was significantly and positively associated with factors like high DBP, degenerated SVG, lesions at proximal site, whereas more than one stent with length of >30 mm was the negative predictor [15]. It can be inferred that risk of no-reflow depends on preoperative conditions and the intervention techniques. The approach to SVG-PCI is presented in Figure 1. The limitation of this study includes single-centered study and small sample size. The control group without PCI was not included in this study. Further, the clinical outcomes like mortality and other major adverse cardiac events were not measured as outcomes.

Conclusion

PCI of SVG graft is a challenging procedure and demands the involvement of cardiologist with both experience and expertise, and immediate intervention to obtain long-term positive clinical outcomes. To conclude, in this study on an average of 11.0 ± 4.1 years after CABG with an average of 2 SVGs, the PCI of SVG to OM graft was performed with drug eluting stents of average length of 23.2 ± 7.3 mm and diameter of 3.5 ± 0.50 mm. The risk of PCI of SVGs was higher in patients with diabetes mellitus, hypertension and with the habit of tobacco. Overall, PCI of SVG lesions using drug eluting stents have delivered positive clinical outcomes in terms of a fewer number of complications including dissection and no-reflow during the follow-up.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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