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Research Article

Clinical and Angiographic Features of Very Small Vessel Stenting in Current Drug Eluting Stent Era

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Abstract

Introduction: Very small vessel coronary artery disease represents a challenging entity for treatment with percutaneous coronary intervention. Plagued by high clinical restenosis rates, small vessel coronary stenting remains problematic even in the drug eluting stents (DES) era.

Materials and Methods: This study was conducted at our large tertiary referral center on all patients who underwent PCI for very small vessel stenting from January 2014 through April 2015. PCI was carried out in *de novo* lesion in a small vessel (diameter range = 2.25 mm, visual estimate) of a major coronary artery requiring treatment. Success was defined as a patent artery with TIMI 3 flow. The end points of the study were major adverse cardiac events (MACE) that is, death, acute stent thrombosis, non-fatal myocardial infarction (MI) and emergency coronary artery bypass graft surgery (CABG).

Results: Of the 100 patients, angiographic success was achieved in all patients. 19 patients developed coronary dissection after predilatation of the lesion treated with stenting successfully. One procedure (1%) was complicated by acute thrombus formation.

Discussion: This study reflects small vessel stenting in the 'real world', because the patients comprised a consecutive series with no exclusion or bias, and the procedures were performed by different operators in the same institution. Symptomatic benefit was achieved in 99% patients only one patient developed acute stent thrombosis.

Conclusion: Although very small vessels are considered challenging to treat and represent a higher risk for adverse outcomes, this analysis showed exceptionally low rates of device and patient oriented composite endpoints and stent thrombosis.

Keywords: *Drug Eluting Stents (DES); Major Adverse Cardiac Events (MACE); Myocardial Infarction (MI); Coronary Artery Bypass Graft Surgery (CABG)*

Introduction

Very small vessel coronary artery disease represents a challenging entity for treatment with percutaneous coronary intervention. Plagued by high clinical restenosis rates, small vessel coronary stenting remains problematic even in the drug eluting stents (DES) era. Risk of restenosis and adverse postprocedural outcomes bear an inverse correlation with vessel diameter [1-3]. Several studies have reported lower acute luminal gain with similar late loss when compared to large-vessel stents [4,5]. Thus, vessel size is an important determinant of subacute stent thrombosis and restenosis [6,7].

Previous evaluations of the impact of bare-metal stents (BMS) specifically designed for treatment of small coronary arteries have shown encouraging results [8]. Logically, the DES, with its attendant restenosis benefit, should be expected to improve results of small

vessel percutaneous coronary intervention (PCI). It has been demonstrated by randomized clinical trials of small vessel interventions that sirolimus-eluting stents (SES) is superior over BMS in rates of target lesion revascularization and restenosis [9,10]. These improvements are primarily attributable to decreased DES late loss. However, the factors influencing selection of stent platforms in these scenarios have not been elucidated. Several multicenter randomized trials have evaluated the efficacy of DES for the treatment of vessels with a RD less than 3 mm and shown a significant reduction in both restenosis and clinical events [11,12]. However, there is limited information on the relative safety and efficacy of SES compared to PES in patients with small vessel disease [13,14]. BMS implantation in small vessels had been previously cited as a risk factor for stent thrombosis [15], but improved techniques of optimal stent deployment and dual antiplatelet regimens appear to have largely resolved this problem. Very small vessels (VSV) with RVD ≤ 2.25 mm are often associated with diabetic and female patients and remain an important challenge in interventional cardiology. Because VSV are a key indication for DES in many countries, our aim was to analyse procedural and clinical outcomes in a large population of patients with at least one VSV treated with stenting.

Materials and Methods

This study was conducted at our large tertiary referral center on all patients who underwent PCI for very small vessel stenting from January 2014 through April 2015. Catheterization laboratory data regarding patients undergoing PCI were collected in a standardized fashion into a large database and included patient characteristics, indications for treatment, equipment, adjunct pharmacology, lesion characteristics, and adverse procedural events. All procedures were performed in accordance with standard techniques. The interventional strategy and use of glycoprotein IIb/IIIa inhibitors were left entirely to the discretion of the operator. All patients were advised to take aspirin lifelong (75 - 150 mg/day). A loading dose of 600 mg clopidogrel was given before the intervention. Postprocedural clopidogrel treatment (75 mg/day) differed within the group.

PCI was carried out using standard techniques. Procedural events, vessels treated and stent sizes and numbers were recorded. Success was defined as a patent artery with TIMI 3 flow. The end points of the study were major adverse cardiac events (MACE) that is, death, acute stent thrombosis, non-fatal myocardial infarction (MI) and emergency coronary artery bypass graft surgery (CABG). MI was defined as a new presentation with chest pain with either typical electrocardiographic findings or serum creatinine kinase level more than thrice the upper limit of normal. Enzymes were not routinely measured, so small subclinical infarcts may have been missed. Results are presented as mean (SD) or as percentage of the total unless otherwise stated.

The patient inclusion criteria were as follows:

1. Stable angina pectoris (Canadian Cardiovascular Society Classifications 2 - 4), unstable angina pectoris, or documented silent ischemia; or ST elevation myocardial infarction;
2. *De novo* lesion in a small vessel (diameter range = 2.25 mm, visual estimate) of a major coronary artery requiring treatment;
3. Target lesion stenosis > 70%;
4. Target lesion length 15 - 30 mm;
5. Coronary flow TIMI I-II;
6. Age 18 - 80 years.

Patients with the following conditions were excluded:

1. Unprotected left main coronary artery disease with > 50% stenosis;
2. Significant stenosis (> 50%) proximal or distal to the target lesion;
3. Heavily calcified lesion;
4. Documented left ventricular ejection fraction < 30%;
5. Excessively tortuous target lesion;
6. Co morbid conditions like, malignancy, lung disorders, renal dysfunction, liver dysfunction.

Results

Patients: Of the 100 PCIs in the study period, 100% included placement of an SV stent and these patients made up the study group. Baseline characteristics of the 100 were: 74 male (74%); age 57 + 9.6 years; 51 hypertensive (51%); 54 diabetic (54%); 61 hypercholesterolemia (61%); 72 smokers (72%); and one with documented cerebrovascular disease (1%). 60% patients had chronic stable angina, 22% had unstable angina/Non ST elevation myocardial infarction and 18% had ST elevation myocardial infarction.

Age	57 + 9.6
Male	74
Female	26
Diabetes mellitus	54
Hypertension	51
Dyslipidemia	61
Smoking	72
Stable angina	60
Unstable angina/NSTEMI	22
STEMI	18

Table 1: *Baseline characteristics.*

SVD	28
DVD	44
TVD	28
Stenting to LAD	48
Stenting to LCX	12
Stenting to RCA	27
Stenting to D1	3
Stenting to OM	10

Table 2: *Vessel characteristics*

Stent diameter	2.25 mm
Stent size	22.9 ± 6.9
DES	96%
BMS	4%
Predilatation	83%
Postdilatation	91%
Aspirin	100%
Clopidogrel	95%
GP IIb/IIIa inhibitors	16%
Statin	100%

Table 3: *Procedural characteristics.*

Stent size			
Sex	**Mean**	**N**	**Std. Deviation**
Male	22.3462	74	6.94766
Female	24.5556	26	6.71453
Total	22.9143	70	6.90881

Table 4: *There is no difference between the size of stent in both sexes.*

Procedural outcomes

Of the 100 patients, angiographic success was achieved in 100%. 19 patients developed coronary dissection after pre dilatation of the lesion treated with stenting successfully. One procedure (1%) was complicated by acute thrombus formation. In this case, in a 49-year-old man, thrombus was noted proximal to the stent of ramus which led to complete occlusion of LMCA and treated with PTCA from LMCA to LAD. One patient got type one coronary perforation which was treated conservatively.

Coronary dissection	19
Coronary perforation	1
Slow flow	11
No reflow	0
Acute stent thrombosis	1
Death	0
Emergency CABG	0
MI	1

Table 4: *There is no difference between the size of stent in both sexes.*

Discussion

This study shows small vessel stenting in the 'real world'. Procedures were performed by different operators in the same institution. The main findings were that all 100 patients underwent successful stenting of very small vessel disease, with complication rates similar to large vessel stenting as demonstrated by previous large trials [16]. Majority patients are male (74%) with mean age of 57 + 9.6 years; 51 hypertensive (51%); 54 diabetic (54%); 61 hypercholesterolemia (61%); 72 smokers (72%); and one with documented cerebrovascular disease (1%). 60% patients had chronic stable angina, 22% had unstable angina/Non ST elevation myocardial infarction, 18% had ST elevation myocardial infarction.

PCI in diabetic patients with small reference diameter vessels remain an important challenge in interventional cardiology, as it is associated with increased complications and restenosis rates [17,18]. Moreover, continued tobacco abuse exacerbates target lesion revascularization rates after SVS implantation [19]. The DES holds a promise as a means of reducing late lumen loss and clinical restenosis in small vessels [13]. In our study 54% patients were diabetic and had multivessel disease, stenting were done successfully in these patients with no major complication. The present study further confirms the diabetic prevalence in SVS. Additionally, fewer small vessel stenoses present as STEMI, likely reflective of the limited territory at risk, as well as lack of transmural vessel distribution. The small vessel lesions are different from their larger counterparts in the sense that the small vessels are usually distal or are branch vessel locations, along with greater lesion complexity (type B2 and C classifications). These features result in longer procedure times, involving more contrast and radiation exposure. Our data also suggest that the development of DES has spurred an increase in the numbers of small vessels being treated.

Symptomatic benefit was achieved in 99% patients, only one patient developed acute stent thrombosis and acute anterior wall myocardial infarction, fortunately treated timely with PCI and stenting to LMCA to LAD. This patient was a 49 years old male with significant history of smoking, but no history of DM2, or Hypertension. He underwent stenting of RAMUS in view of stable angina CCS class III. After 12 hours of procedure he developed acute onset chest pain with anterior wall MI. Beside this in our study, no major complication happened.

In our study 87% of lesions were in the left anterior descending, circumflex or right coronary artery. The remaining 13% of lesions were in significant branches (diagonal, marginal or posterior descending arteries). This suggests that most SV lesions are being considered for PCI using the same criteria as non-SV lesions, and only a minority are part of a multivessel procedure in which SV stenting is an 'adjunct' treatment of small branches.

One weakness of this study is lack of long-term clinical or angiographic follow-up. However, the focus of our study was to delineate patient and lesion characteristics, as well as procedural variables, in a real-world population in the era of DES to hopefully provide further insight into the treatment of these challenging cases.

Conclusion

Although very small vessels are considered challenging to treat and represent a higher risk for adverse outcomes, this analysis showed exceptionally low rates of device and patient oriented composite endpoints and stent thrombosis.

Key Messages

- Definitions of very small vessels vary: we chose = 2.25 mm.
- 100% of PCI procedures involve small vessel stenting.
- 87% of small vessel stents are placed in the three main coronary arteries (rather then small branches).
- Procedural and in hospital outcomes are excellent.

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