Pogostost restenoze in tromboze v stentu po vstavitvi žilne opornice v deblo leve koronarne arterije

In-stent restenosis and stent thrombosis rates after left main coronary artery stenting

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Izvleček

Namen: *V raziskavi smo ugotavljali, kako različne metode stentiranja, značilnosti posameznih bolnikov, pridružena bolezenska stanja in vrste lezij vplivajo na pogostost restenoze (ISR) in tromboze (ST) znotraj žilne opornice pri bolnikih, ki so imeli stentirano deblo leve koronarne arterije (LMCA). Ob tem smo ugotavljali tudi enomesečno in enoletno preživetje ter primerjali bolnike, ki so imeli elektiven poseg, in tiste, ki so potrebovali poseg zaradi akutnega koronarnega sindroma (AKS).*

Metode: *Dvesto sedemindevetdeset zaporednih pacientov z nezaščiteno LMCA je imelo opravljeno perkutano koronarno intervenco (PCI) v našem centru med januarjem 2008 in oktobrom 2016. Sto dvaintrideset bolnikov (50,8 %) je imelo opravljeno ponovno angiografijo. Večina (86,5 %) je imela vstavljeno opornico, obloženo z zdravilom (DES).*

Abstract

Purpose: *The aim of this study was to evaluate the in-stent restenosis (ISR) and stent thrombosis rates along with one-month and one-year survival rates in patients with left main coronary artery disease (LMCAD) with different methods of stenting, lesion characteristics, and clinical disease presentation.*

Methods: *A total of 297 consecutive patients with unprotected LMCAD were treated by percutaneous coronary intervention (PCI) at University Clinical Center Maribor between January 2008 and October 2016. One hundred and thirty-two (50.8%) eligible patients underwent angiographic follow-up. The majority of patients (86.5%) were treated with a single drug-eluting stent (DES).*

Results: *The overall prevalence of angiographic ISR in unprotected LMCA lesions was 33.3% (44 out of 132 patients with angiographic follow-up). The*

Rezultati: *Celokupna prevalenca angiografsko dokazane ISR pri nezaščiteni LMCA leziji je 33,3 % (44 bolnikov). V skupini bolnikov, ki so imeli vstavljen DES (123), je ta številka 31,7 % (39). Večina bolnikov z restenozo (63,6 %) je potrebovala ponovno PCI, pri 22,7 % bolnikov je bil potreben kirurški poseg, 13,6 % bolnikov je bilo zdravljenih konzervativno. V raziskavi se je kot pomemben dejavnik za ISR pokazala samo hipertenzija. Šest bolnikov (2,0 %) je doživelo stent trombozo. Enomesečna umrljivost po PCI je bila 12,5 %, enoletna pa 17,2 %. Bolniki, ki so bili obravnavani zaradi AKS, so imeli slabše izide.*

Zaključek: *V raziskavi smo ugotovili, da so bolniki, ki so bili sprejeti zaradi akutnega koronarnega sindroma, imeli slabše izide. Čeprav je pogostost ISR bila višja kot v drugih študijah, tovrstni podatki prikazujejo dejansko sliko bolnikov s prizadetostjo LMCA, ki potrebujejo PCI, in se kažejo z različnimi kliničnimi slikami.*

in-stent restenosis rate was 31.7% (39) in the group initially treated with DES (123). Most patients (63.6%) with ISR underwent repeated PCI, 22.7% had coronary artery bypass graft surgery, and 13.6% were treated conservatively. Only hypertension was shown to be statistically significant as a predictor of ISR in the present study. Stent thrombosis rate was 2.0% (six out of 297 patients). The mortality rate was 12.5% one month after the procedure on the left main coronary artery lesion, and 17.2 % after one year.

Conclusion: *Patients presenting with acute coronary syndrome had worse outcomes. While the numbers in the present study are higher compared to some other studies, they represent a real-world example of patients with different clinical presentations.*

INTRODUCTION

Significant left main coronary artery disease (LMCAD), defined as a > 50% narrowing of the lumen, is found in 4–6% of all patients that undergo coronary angiography (1). When present, it is associated with multivessel coronary artery disease in about 70% of patients (2,3). Current practice guidelines recommend coronary artery bypass grafting (CABG) as a standard revascularization procedure for patients with significant unprotected LMCAD. However, percutaneous coronary intervention (PCI) to treat unprotected LMCAD has increased in frequency, and is associated with improvements in interventional techniques and adjunctive drug therapy. For patients with lower complexity CAD (calculated using the SYNTAX score) who can undergo PCI at an acceptable risk and with reasonable probability for success, PCI may be an acceptable or even preferred option (4,5).

Coronary stents can still fail to maintain vessel patency after a successful procedure due to either restenosis or stent thrombosis. Restenosis is a gradual re-narrowing of the stented segment that occurs mostly between three and 12 months after stent placement. It usually presents as recurrent angina but can present as acute myocardial infarction in approximately 10% of patients. It can be managed by repeated percutaneous revascularization. In contrast, stent thrombosis is an abrupt thrombotic occlusion of a previously widely patent stent. It is a catastrophic complication that presents as sudden death or large myocardial infarction in most patients. Despite successful repeat revascularization, the six-month mortality is high. The availability of drug-eluting stents (DES) has significantly reduced the rates of restenosis and repeat revascularization compared to bare-metal stents or PTCA alone (6-8). However, the rate of in-stent restenosis (ISR) in DES has been reported to be between 3% and 20%, depending on which DES is evaluated, duration of follow-up, and complexity of lesions in which the stents were placed (9). DES restenosis benefits must be balanced against a slight but important increased risk for stent thrombosis beyond one year and the associated requirement for prolonged dual antiplatelet therapy.

The purpose of this study was to obtain data on ISR and stent thrombosis rates in real-life situations at our institution and to identify possible ISR predictors.

METHODS

Study population and angiographic follow-up

A total of 337 consecutive patients with LMCAD (defined as > 50% stenosis), 297 of which had unprotected LMCAD, were treated at University Medical Center Maribor, Slovenia and received PCI with stent implantation between January 2008 and October 2016. Patients presenting with acute coronary syndrome (ACS) were also included. The type of stent used was based on the judgment of the physician treating the individual patient. All patients were recommended routine angiographic follow-up 6–12 months after the procedure. However, patients with a high risk for periprocedural angiography complications, those with no symptoms or signs of ischemia, and patients who declined the recommendation did not undergo routine follow-up angiography, but had noninvasive stress tests (i.e., exercise treadmill test or radionuclide scan) or clinical follow-up.

Ethical approval of the study was provided by the institutional medical ethics committee.

Procedures and treatment strategy for LMCA-ISR lesions and stent thrombosis

All interventions were performed according to the current standard guidelines and the final interventional strategy was left entirely to the discretion of the operator. After each procedure, patients were maintained on dual antiplatelet therapy for at least six months or more. The duration of dual antiplatelet therapy and the type of medication were also chosen by a clinician based on clinical presentation, other medication use (e.g. previous anticoagulant therapy), and patient characteristics (i.e., age, gender, diabetes, ejection fraction, and other comorbidities).

Stent implantations for de novo LMCA lesions have been previously described (10-12). Angiographic ISR at LMCA lesions detected during either surveillance or clinically driven angiographic follow-up was treated by ischemia-driven (as documented by a positive functional test, ischemic changes on an electrocardiogram, or ischemic symptoms) repeat revascularization if stenosis was at least 50% of the target lesion diameter or at least 70% in the absence of documented ischemia. Asymptomatic patients with moderate stenosis (50% to 70%) and no evidence of inducible ischemia received optimal medical treatment with meticulous clinical follow-up. Patients requiring ischemia-driven repeat revascularization were treated with CABG or repeat PCI at the discretion of the individual physician after consideration of clinical or procedural factors, such as clinical overview, lesion anatomy, and repeat procedure complexity and after a discussion about patient's preferences.

Patients who underwent repeated PCI for LMCA-ISR lesions were treated either with balloon angioplasty alone, additional stenting, or drug-eluting balloon angioplasty. Surgical revascularization was performed with standard bypass techniques. Whenever possible, the internal mammary artery was preferred for revascularization of the left anterior descending artery. Primary percutaneous coronary intervention was performed in patients with possible stent thrombosis diagnosis.

Endpoints and definitions

The primary endpoints included the incidence of in-stent restenosis, stent thrombosis, and patient survival after one year since the initiation of the first LMCA intervention that included stenting.

Death was defined as death from any cause. Stent thrombosis was classified as acute, subacute, late, and very late if it occurred within 24 h, 30 days, 30 days to ≤ 1 year, or > 1 year, respectively (13). Binary angiographic restenosis was defined as ≥ 50% of luminal narrowing at follow-up angiography. The ISR patterns were classified as focal (Mehran ISR pattern I) or diffuse (Mehran ISR patterns II, III, and IV) according to geographic position of ISR in relation to a previously implanted stent (14).

Follow-up protocol and statistical analysis

After the LMCA lesion treatment, clinical follow-up was recommended after one month, six months, one year, and annually thereafter. Information on patient vital status and medical records were obtained from the hospital informational system. Patients undergoing

repeat PCI for LMCA-ISR lesion treatment were recommended repeated angiographic follow-up 6–12 months later to evaluate the incidence of recurrent ISR. The Medina classification was used to describe the location and distribution of restenosis. It is a binary classification system used in bifurcation lesions. By convention, the main bifurcation parent vessel was defined as LMCA into the left anterior descending artery (15).

Continuous variables were represented as the mean ± SD and compared using the t test. Categorical variables were presented as counts and valid percentages and compared using the chi-squared test. All p-values were two-sided and p-values < 0.05 were considered statistically significant. Statistical analysis was performed using the SPSS (version 23.0 for Windows, SPSS, Inc., Chicago, IL, USA).

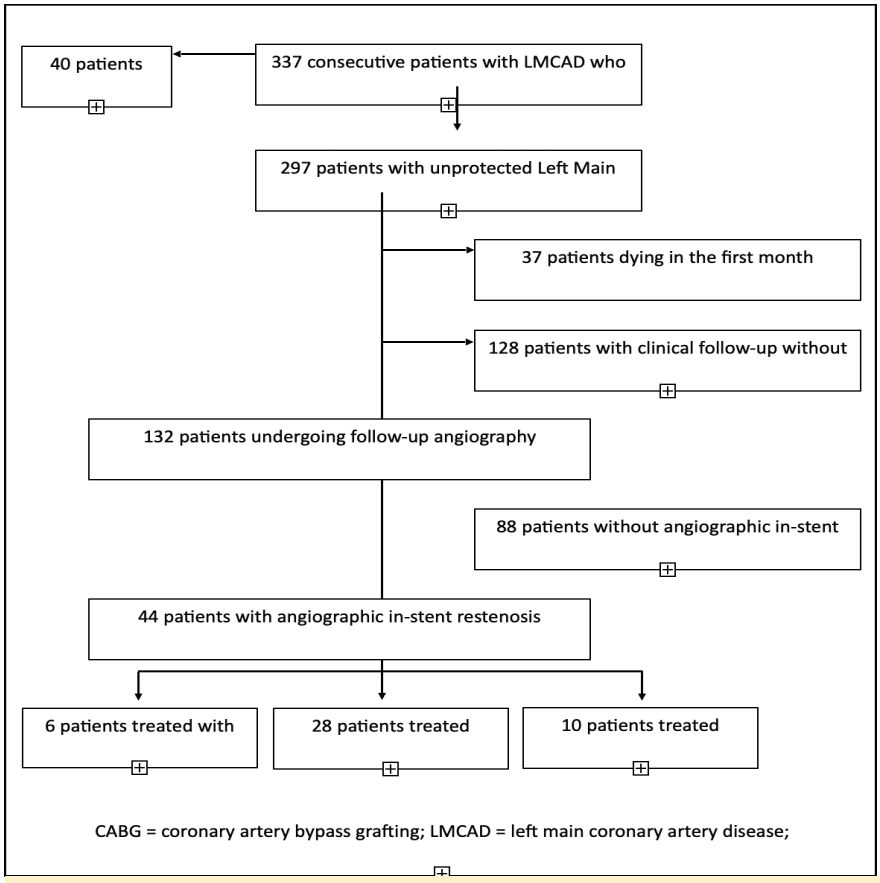

Figure 1. *Overall Study Profile*

RESULTS

LMCA-ISR incidence, pattern, and clinical presentation

A total of 337 consecutive patients with LMCAD were treated at University Clinical Center Maribor and received PCI with stent implantation between January 2008 and October 2016. Forty of them (11.9%) had protected LMCAD with at least one patent bypass graft to LAD and were therefore excluded from the study. The remaining 297 patients had unprotected left main coronary artery lesions. Figure 1 shows the overall study design. A total of 37 out of 297 patients (12.5%) did not survive the first month after LMCA stenting, mostly due to severity of their condition and complications that led to cardiogenic or septic shock with multiorgan failure. Four patients died because of stent thrombosis and two patients died due to gastrointestinal bleeding with consequent acute heart decompensation. Of the 260 eligible patients who survived the first month after stent implantation, 132 (50.8%) underwent angiographic follow-up.

Table 1 shows the clinical, lesion, and procedural characteristics of the overall population and of the patients who did and did not undergo angiographic follow-up. A DES was predominantly used for all stenting techniques. There were some baseline differences in patients who did or did not undergo angiographic follow-up. Follow-up patients were younger and more often experienced hypertension and hyperlipidemia, although diabetes was less frequent. They also less often presented with acute myocardial infarction.

Angiographic ISR at LMCA lesions was detected in 44 of the 132 patients who underwent angiographic follow-up. Of the 44 patients with ISR, 30 (68.1%) were diagnosed within one year, 13 (29.5%) were diagnosed after one to two years, and one (2.3%) was diagnosed after two or more years. The restenosis pattern was

Table 1. *Baseline Clinical, Angiographic and Procedural Characteristics of Overall Population and Patients Stratified by Angiographic Follow-Up*

Variable	Overall (n=297)	With angiographic follow-up (n=132)	Without angiographic follow-up (n=165)	p value
Demographic characteristics				
Age (years)	69.7 ± 11.5	67.1 ± 11.1	71.8 ± 11.4	**< 0.01**
Male	192 (64.6)	84 (63.6)	108 (65.5)	0.74
Cardiac or coexisting conditions				
Diabetes mellitus	92 (31.7)	32 (24.2)	60 (38.0)	**0.01**
Hypertension	236 (79.5)	114 (86.2)	122 (76.7)	**0.04**
Hyperlipidemia	219 (73.7)	120 (90.0)	99 (62.3)	**< 0.01**
Current smoker	33 (22.8)	18 (22.0)	15 (23.8)	0.79
Previous thrombotic events	84 (28.8)	38 (28.8)	46 (28.8)	0.99
Renal impairment	55 (19.4)	23 (17.4)	32 (20.2)	0.54
Clinical indication				**< 0.01**
Silent/stable angina	110 (37.0)	60 (45.5)	50 (30.3)	
Unstable angina	22 (7.4)	15 (11.3)	7 (4.2)	
Acute MI				
STEMI	49 (16.5)	17 (12.9)	32 (19.4)	
NSTEMI	116 (39.1)	40 (30.3)	76 (46.1)	
Lesion characteristics				
Location				0.48
Ostium	74 (24.9)	27 (20.5)	47 (28.5)	
Mid-shaft	18 (6.1)	9 (6.8)	9 (5.5)	
Distal bifurcation	146 (49.2)	68 (51.5)	78 (47.3)	
Diffuse	56 (18.6)	26 (19.7)	30 (18.2)	
Procedural characteristics				
Stent type				0.19
DES	226 (89.6)	123 (93.2)	143 (86.6)	
BAS	19 (6.4)	6 (4.5)	13 (7.9)	
Other	12 (4.0)	3 (2.3)	9 (5.5)	
DES				0.42
ZES	20 (7.5)	8 (6.6)	12 (8.5)	
EES	167 (63.0)	70 (58.3)	97 (68.3)	
SES	57 (21.5)	33 (12.7)	24 (16.9)	
BES	4 (1.5)	2 (1.5)	2 (1.4)	
Combination	17 (6.4)	10 (7.8)	7 (4.9)	
Total number of stents in LMCA lesion				**< 0.01**
Single	257 (86.8)	106 (80.3)	151 (92.1)	
≥ 2	39 (13.2)	26 (19.7)	13 (7.9)	
Total length of stents in LMCA lesion	25.4 ± 11.5	25.4 ± 13.3	25.4 ± 15.0	**1.0**
Average stent diameter in LMCA lesion	4.1 ± 1.4	4.4 ± 1.6	3.8 ± 1.1	< 0.01
Use of IABP	34 (11.4)	13 (9.8)	21 (12.7)	0.44
Kissing PTCA	109 (36.7)	67 (51.1)	42	**< 0.01**

Data are shown as mean ± SD or n (valid %). MI = myocardial infarction; STEMI = ST-elevation myocardial infarction; NSTEMI = non-ST-elevation myocardial infarction; DES = drug-eluting stent; BAS = bioactive stent ZES = zotarolimus-eluting stent; EES = everolimus-eluting stent; SES = sirolimus-eluting stent; BES = biolimus-eluting stent; LMCA = left main coronary artery disease; IABP = intra-aortic balloon pump; PTCA = percutaneous transluminal coronary angioplasty.

Table 2. *Clinical, Lesion, and Procedural Characteristics in Patients With or Without ISR Among Those Receiving Angiographic Follow-Up*

Variable	All Follow-Up Patients (n=132)	ISR (n=44)	Without ISR (n=88)	p value
Demographic characteristics				
Age (years)	67.1 ± 11.0	69.7 ± 11.0	65.8 ± 11.0	0.06
Male	84 (63.6)	25 (56.8)	59 (67.0)	0.25
Cardiac or coexisting conditions				
Diabetes mellitus	32 (24.2)	13 (29.5)	19 (21.6)	0.32
Hypertension	114 (86.4)	43 (97.8)	71 (80.7)	**< 0.01**
Hyperlipidemia	120 (90.9)	42 (95.5)	78 (88.6)	0.20
Current smoker	18 (22.0)	3 (11.1)	15 (17.0)	0.10
Previous thrombotic events	38 (28.8)	9 (20.5)	29 (33.0)	0.14
Renal impairment	23 (17.4)	7 (15.9)	16 (18.2)	0.75
Clinical indication				0.99
Silent/stable angina	60 (45.5)	19 (43.2)	41 (18.2)	
Unstable angina	15 (11.4)	5 (11.4)	10 (11.4)	
Acute MI				
STEMI	17 (12.9)	6 (13.6)	11 (12.5)	
NSTEMI	40 (30.3)	14 (31.8)	26 (29.5)	
Lesion characteristics				
Location				0.85
Ostium	27 (20.8)	9 (20.5)	18 (20.9)	
Mid-shaft	9 (6.9)	2 (4.5)	7 (8.1)	
Distal bifurcation	68 (52.3)	23 (52.3)	45 (52.3)	
Diffuse	26 (20.0)	10 (22.7)	16 (18.6)	
Procedural characteristics				
Stent type				0.21
DES	123 (93.2)	39 (88.6)	84 (95.5)	
BAS	6 (4.5)	4 (9.1)	2 (2.3)	
Other	3 (2.3)	1 (2.1)	2 (2.3)	
DES				0.40
ZES	8 (6.6)	2 (5.1)	6 (7.1)	
EES	70 (58.3)	22 (56.4)	48 (57.1)	
SES	33 (12.7)	9 (23.1)	24 (28.6)	
BES	2 (1.5)	0 (0.0)	2 (2.4)	
Combination	10 (7.8)	6 (15.4)	4 (4.8)	
Total number of stents in LMCA lesion				0.12
Single	106 (80.3)	32 (72.7)	74 (84.1)	
≥ 2	26 (19.7)	12 (27.3)	14 (15.9)	
Total length of stents in LMCA lesion	25.4 ± 13.3	28.5 ± 15.3	23.9 ± 12.1	0.06
Average stent diameter in LMCA lesion	4.3 ± 1.6	4.4 ± 1.8	4.4 ± 1.6	0.83
Use of IABP	13 (9.8)	7 (15.9)	6 (6.8)	0.10
Kissing PTCA	67 (50.8)	23 (52.3)	44 (50.0)	0.71
Time PCI to follow-up angiography	7.7± 5.3	9.9 ± 6.8	6.5 ± 3.9	**< 0.01**

Data are shown as mean ± SD or n (valid %). MI = myocardial infarction; STEMI = ST-elevation myocardial infarction; NSTEMI = non-ST-elevation myocardial infarction; DES = drug-eluting stent; BAS = bioactive stent; ZES = zotarolimus-eluting stent; EES = everolimus-eluting stent; SES = sirolimus-eluting stent; BES = biolimus-eluting stent; LMCA = left main coronary artery disease; IABP = intra-aortic balloon pump; PTCA = percutaneous transluminal coronary angioplasty; PCI = percutaneous coronary intervention.

focal in 29 patients (65.9%) and diffuse in 15 (34.1%). The overall restenosis rate in non-bifurcation lesions was 27.4% (20 of 73 patients), and the rate of ISR in bifurcation lesions was 40.7% (24 of 59 patients).
Twenty-one patients (47.7%) presented with silent ischemia, seven (15.9%) presented with stable angina, four (9.1%) presented with unstable angina, and 12 (27.3%) presented with nonfatal myocardial infarction (all with NSTEMI).

Table 2 shows a comparison of clinical, lesion, and procedural characteristics between patients with and without ISR among those receiving angiographic follow-up. Patients with ISR were older and more often had hypertension, diabetes, and hyperlipidemia. They were more often implanted with a non-DES and had more bifurcation lesions and longer stent lengths. In addition, their follow-up angiography was performed at a later date. There were no differences in their initial clinical presentation.

LMCA-ISR treatment

Among the 44 patients with ISR in the LMCA, six (13.6%) received medical treatment only, 28 (63.6%) were treated with a repeated PCI (six with balloon angioplasty, seven with drug-eluting balloon angioplasty, and 15 with additional DES implantation), and ten (22.7%) underwent CABG. Table 3 shows the differences in clinical and angiographic LMCA-ISR features among the three groups of patients.
Figure 1 shows a Kaplan–Meier curve for patients who needed another procedure—either a repeat PCI, or CABG surgery in the first year after the LMCA stenting. In the first few months, the rate was low, but it increased steadily towards the year's end.

Table 3. *Clinical and Angiographic Characteristics of Patients With ISR According to Treatment Strategy*

Variable	Medical therapy (n=6)	Repeated PCI (n=28)	CABG (n=10)	p value
Clinical presentation of ISR				**0.67**
Silent	4 (66.7)	11 (39.3)	6 (60.0)	
Stable angina	1 (16.7)	5 (17.9)	1 (10.0)	
Unstable angina	0 (0.0)	4 (14.3)	0 (0.0)	
Acute MI	1 (16.7)	8 (28.6)	3 (30.0)	
Location of ISR (Medina)				**0.15**
LMCA only	0 (0.0)	4 (14.3)	2 (20.0)	
LAD ostium only	2 (33.3)	11 (39.3)	5 (50.0)	
LCX ostium only	4 (66.7)	9 (32.1)	0 (0.0)	
Multiple	0 (0.0)	4 (14.3)	3 (30.0)	
Type of ISR (Mehran)				**0.02**
Focal pattern	5 (83.3)	21 (75.0)	3 (30.0)	
Diffuse pattern	1 (16.7)	7 (25.0)	7 (70.0)	

Data are shown as or n (%).
ISR = in-stent restenosis; MI = myocardial infarction; LMCA = left main coronary artery; LAD = left anterior descending artery; LCX = left circumflex artery; PCI = percutaneous coronary intervention; CABG = coronary artery bypass grafting.

Stent thrombosis incidence and characteristics

The cumulative incidence of stent thrombosis was 2.0% (six patients; two acute, one subacute, one late, and two very late) in the overall unprotected LMCAD patients. All patients with stent thrombosis presented with acute coronary syndrome and experienced rapid deterioration. Four patients (66.7%) were unsuccessfully resuscitated and died. Two patients (33.3%) survived and underwent PCI with DES implantation. All cases of stent thrombosis occurred after the initial DES implantation at the left main

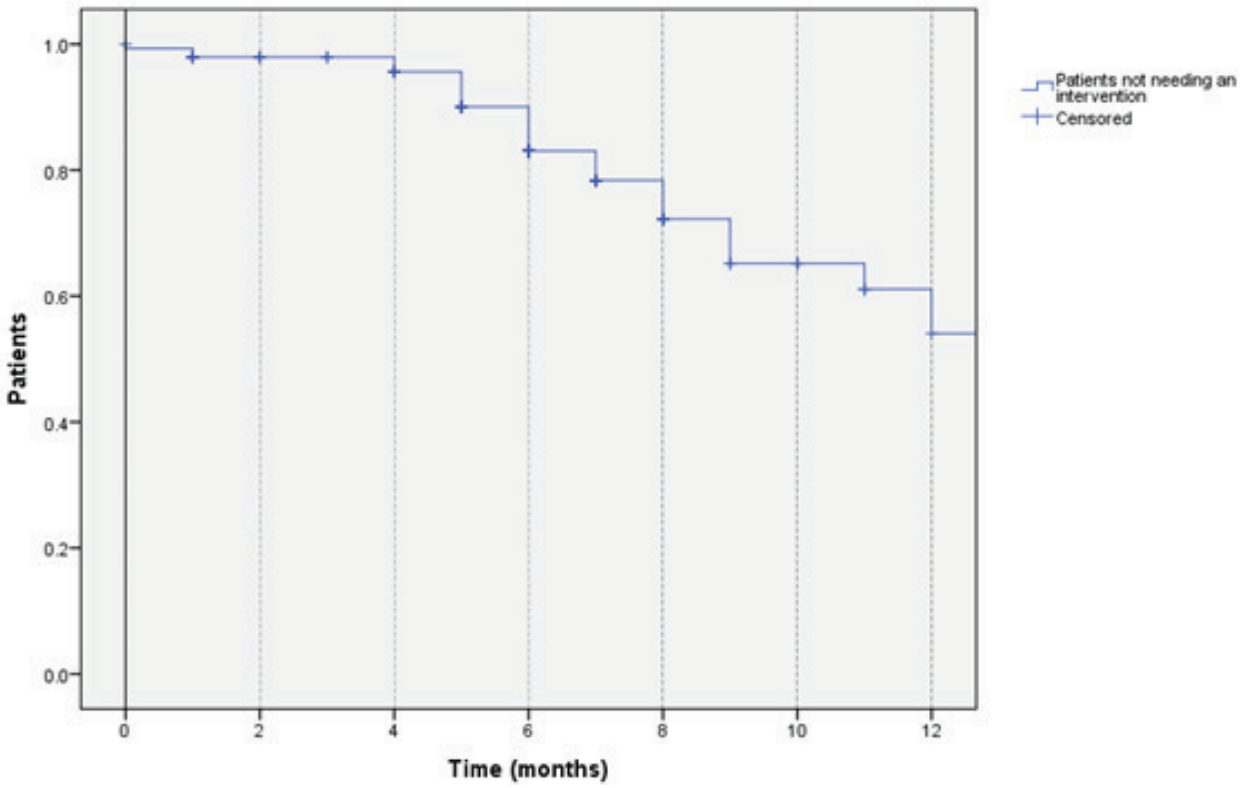

Figure 1. *Fraction of patients that needed a repeat PCI or a CABG surgery in the first year of LMCA stenting, who underwent a repeated angiography.*

position due to acute coronary syndrome. The incidence of very late thrombosis (after more than 12 months) was 0.6% (two patients).

Mortality rates after LMCA stenting

During the follow-up period (eight years and ten months, i.e., 106 months), 71 out of 297 patients died (23.9%). Among the patients who underwent angiographic follow-up, 17 patients (12.9%) died and among the patients with ISR, five patients (11.4%) died in total. The cause of death was cardiovascular in 64.8% of patients and due to multiorgan failure with sepsis in 19.7% of patients. Data regarding the cause of death were unavailable for the remaining 15.5% of patients. Table 4 shows one-month, one-year, and overall mortality rates for patients according to whether they underwent angiographic follow-up and whether they had ISR.

Of the 206 patients whose LMCAD first presented with acute coronary syndrome, 60 patients (29.1%) died during the observational period (37 patients within the first month), whereas of the 91 stable patients that were treated electively, 11 patients (12.1%) died.

Kaplan–Meier survival curves for patients with acute coronary syndrome are represented in figure 2. A large significant difference was present, mostly because of the initial high mortality in the ACS group ($p = 0.0001$). Figure 3 shows the survival of patients with angiographic follow-up depending on ISR occurrence. The curves appear to be similar ($p > 0.05$)

DISCUSSION

A cumulative ISR incidence of 33.3% was noted in the cohort of consecutive patients undergoing stent implantation for unprotected LMCA disease. ISR incidence was 31.7% in the group of patients treated with DES implantation, which might be higher than that reported in some other studies. (16-18)

The rates of angiographic restenosis after LMCA stenting with DES have been found to vary widely from 8% to 42% (6,16-24). The overall incidence of ISR over eight years was approximately 32%. This

Table 4. *One-month, one-year, and overall mortality rates of patients with unprotected LMCAD*

	1 month	1-year	overall
All patients with unprotected LMCAD (n=297)	37 (12.5)	57 (17.2)	71 (23.9)
patients without angiographic follow-up (n=165)	36 (21.8)	47 (28.5)	54 (32.7)
patients with angiographic follow-up (n=132)	1 (0.8)	4 (3.0)	17 (12.9)
patients without ISR (n=88)	1 (1.1)	3 (3.4)	12 (13.6)
patients with ISR (n=44)	0 (0.0)	1 (2.3)	5 (11.4)

Data are shown as n (%). LMCAD = left main coronary artery disease; ISR = in-stent restenosis.

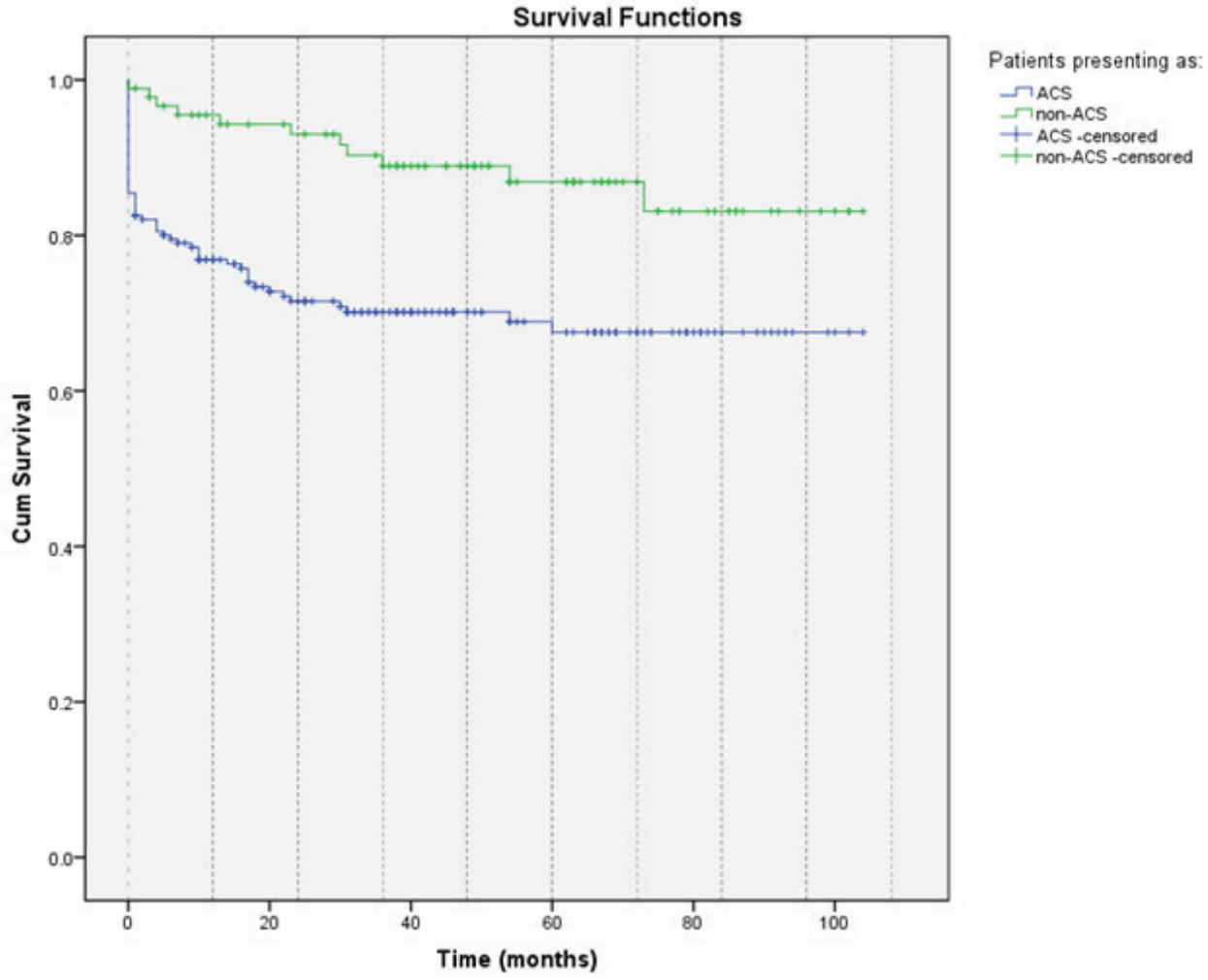

Figure 2. *Kaplan Meier survival plot of patients presenting with acute coronary syndrome (ACS). Vertical dotted lines represent years.*

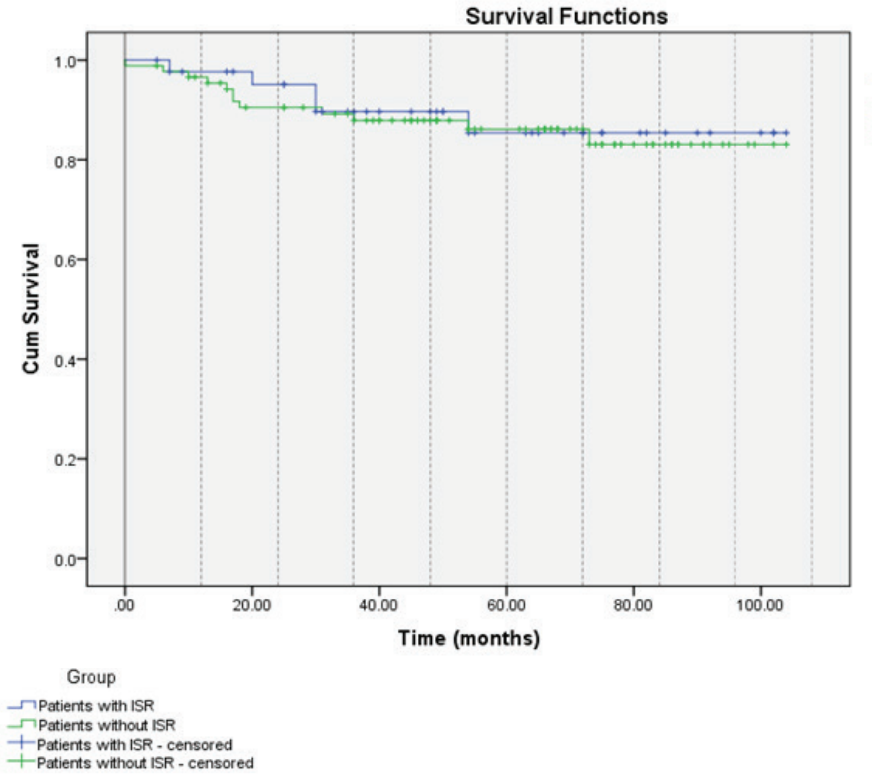

Figure 3. *Kaplan Meier survival plot of patients with and without in-stent restenosis (ISR). Vertical dotted lines represent years.*

disparity in the incidence of LMCA-ISR among studies might be due to the differences in patient selection and exclusion criteria, relative frequency of distal bifurcation lesions, interventional techniques, and completeness and timing of surveillance angiography. Only hypertension was shown to be a statistically significant predictor of ISR in the present study. The predictive values of diabetes mellitus, ostial lesion location, or total stented length could not be confirmed (25-27).

The choice of treatment strategy (medical treatment, repeated PCI, or CABG) for LMCA-ISR lesions depends primarily on several clinical and angiographic factors, making optimal patient selection crucial for the appropriate treatment of LMCA-ISR lesions and achievement of favorable long-term outcomes. The present study found that treatment strategies were dependent on lesion characteristics, procedural complexities, patient clinical characteristics, and patient/physician preference.

Cohort mortality rate was relatively high as 23.9% of patients with unprotected LMCAD after stenting died during the observational period. Mortality was dependent on age, patient characteristics, clinical disease presentation, and lesion complexity. There are limited data on the use of PCI in patients with acute myocardial infarction due to left main disease. The present study showed a large and significant difference in survival of patients presenting with acute coronary syndrome. These patients were less stable and more complex. Based on the study population, there were no significant differences in mortality of patients with or without ISR, both showing similar survival profiles. It should be noted that all patients with ISR were treated, but using different options.

Older studies noted in-hospital mortality rates of 30–35% following PCI with or without stenting (28,29). Not surprisingly, the outcomes in patients presenting with acute myocardial infarction were worse than in those with left main disease who underwent elective PCI (28,29). The reported cases represent a select group that survived to reach the cardiac catheterization laboratory. More observational studies have reported lower in-hospital mortality rates ranging from 11–21% and lower (30,31).

The total occurrence of stent thrombosis in the present study was 2.0% and very late thrombosis occurred in < 1% after DES implantation. In other studies, stent thrombosis rate varied from < 1 to 3% (32-39). However, we were unable to predict when a patient might be prone to acute sudden stent thrombosis and angiography might be associated with a risk that must not be ignored in patients who have undergone left main stent placement (20,21).

Study limitations

The present work was a retrospective single-center observational study. No exclusion criteria were used

and all consecutive patients with LMCAD and treated with PCI and stent implantation were included. This also includes the patients presenting with critical conditions and/or those who developed irreversible shock in the next hours or days. Therefore, mortality rate was higher and these patients could not undergo clinical or angiographic follow-up. In addition, angiographic follow-up was not systematically performed in all remaining patients either. There were also differences in the groups that had and did not have an angiographic follow-up. Moreover, the treatment strategy for LMCA-ISR was at the discretion of a treating physician and/or patient. Finally, the number of patients treated at our institution was relatively small and there might be too few patients with ISR that were too dissimilar to compare and to use to draw any firm conclusions.

CONCLUSIONS

The incidence of ISR after successful stent implantation in consecutive real-world patients with unprotected LMCAD and angiographic follow-up was approximately 33%. Hypertension was shown to be a predictor of a higher stent in-stenosis rate. The stent thrombosis rate was 2.0% with the incidence of very late thrombosis of 0.7%. The overall one-year mortality rate was 17.2%. It was 3% in the group of patients who underwent angiographic follow-up and 2.3% in the group of patients with ISR.

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