One-year clinical and angiographic outcomes after percutaneous coronary interventions in ostial versus distal left main lesions – a retrospective single center study

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Abstract

Background: Percutaneous coronary intervention (PCI) of left main coronary artery disease (LMD) is associated with appropriate clinical and angiographic outcomes, resulting in a class I recommendation in patients with less complex coronary anatomy. Due to higher SYNTAX scores and worse clinical outcomes, PCI in distal LMD is accomplished with a lower strength of recommendations for revascularization compared to ostial LM lesions. We compare angiographic and clinical outcomes of ostial/midshaft lesions versus distal lesion in LMD after PCI. Methods: This retrospective study included 176 patients with LMD undergoing PCI with drug-eluting stents. The study population was divided into 34 patients with ostial/midshaft LMD and 142 patients with distal LMD. Patients were routinely scheduled for 9 months of angiographic and 12 months of clinical follow-up. Quantitative coronary analysis (QCA) was performed for all lesions, using an 11-segment model. Primary outcome was MACE (major adverse cardiac events) defined as a composite of cardiac death, myocardial infarction and target lesion revascularization (TLR). Results: The primary outcome measure was comparable in both cohorts after 12 months follow-up (20.6% in ostial/midshaft LMD vs. 17.6% in distal LMD, P=0.71). As expected, TLR rates were increased in distal LM lesions compared to ostial LM lesions, but without reaching statistical significance (14.1% vs. 5.9%, P=0.15). Late lumen loss (LLL) in ostial/midshaft LMD was 0.42±0.33mm. In distal LM lesions value for LLL in the main vessel was 0.42±0.97 mm, with the highest values observed in segments adjacent to the bifurcation (0.37±1.13mm and 0.37±0.73 mm). On cox proportional regression analysis LLL in a bifurcation segment (P=0.03, HR 1.68 [1.1-2.7]) and diabetes mellitus (P=0.046, HR 2.77 [1.0-7.5] were independent correlates for occurrence of MACE. Conclusion: PCI of distal LM lesions result in comparable angiographic and clinical outcomes compared to ostial LM lesions. Highest rates for binary restenosis were observed in segments nearest to the bifurcation.

Background

Coronary artery bypass graft surgery (CABG) has been the standard of care for treatment of left main coronary artery disease (LMD) for nearly 40 years [1]. Nowadays, percutaneous coronary intervention (PCI) of LMD, using drug-eluting stents (DES), is associated with appropriate clinical results for the safety composite of death, myocardial infarction (MI) and stroke at long-term follow-up [1,2]. Therefore, recent guidelines indicate that PCI is a suitable alternative to CABG in LMD with less complex coronary anatomy, resulting in a class I level A recommendation for patients with low SYNTAX score (0-22) and a class IIa level A recommendation for patients with intermediate SYNTAX score (23-32) [3].

The left main coronary artery can be divided into three segments: ostial, midshaft, and distal bifurcations. Due to the anatomical complexity, distal LM lesions result in higher SYNTAX scores than ostial and midshaft LM lesions and consequently in lower levels of evidence for revascularization with PCI [3]. Previous studies have reported that PCI of lesions not involving the distal LM has better outcomes than PCI of distal LM lesions, largely because of a lower need for repeat revascularization [4]. However, limited data are available regarding angiographic outcomes after PCI with DES implantation at different LM segments.

The aim of the present study was to compare angiographic and clinical outcomes in ostial/midshaft and distal lesions in left main coronary artery disease after percutaneous coronary intervention.

Methods

176 patients with left main coronary artery disease of low or intermediate anatomical complexity and prohibitive surgical risk, undergoing percutaneous coronary intervention at our center between 2010 and 2014, were retrospectively included in the present study. Based on lesion location, the population was divided into two groups: the group with an ostial or midshaft LMD and the group with a distal LMD. Pre-procedural parameters, procedural data and post-procedural clinical and angiographic outcomes were evaluated for both groups. All patients gave written informed consent and were clinically followed up for at least one year after intervention. The study was approved by the local ethics committee and has been performed in accordance with the ethical standards laid down in the Declaration of Helsinki.

Treatment strategy was to cover the stenotic segment with one or more stents. High-pressure implantation with at least 14 atm was mandatory to ensure a proper alignment of stent struts at the vessel wall and to avoid any residual stenosis. Dual antiplatelet therapy was prescribed for at least 12 months. Patients were routinely scheduled for 9 months angiographic follow-up. Furthermore, 12 months clinical follow-up was completed for all patients in outpatient visits or phone calls. Primary point of interest was the occurrence of major adverse cardiac events (MACE), defined as the composite of cardiac death, any myocardial infarction and target lesion revascularization (TLR). Definite stent thrombosis was defined according to the ARC criteria [5]. Quantitative coronary angiography analysis (QCA) of the index procedure and the angiographic follow-up were performed with the current Cardiovascular Angiography Analysis System (CAAS 11.7, Pie Medical Imaging, Maastricht, The Netherlands), using the conventional single-vessel mode for ostial/midshaft lesions and the dedicated bifurcation algorithm for distal bifurcation lesions of the left main coronary artery [6]. Minimal lumen diameter (MLD) was measured in multiple projections, recording the results from the worst view. Late lumen loss (LLL) was defined as the difference between MLD post PCI and MLD at angiographic follow-up. LM bifurcation lesions were assessed according to the Medina classification [7].

Statistical analysis

Categorical parameters are presented as counts and percentages. Comparisons of proportions were carried out using the χ^2-test. Continuous variables are presented as mean ± one standard deviation. Continuous variables for two groups were compared with the unpaired U-test. Time-to-event analyses for one-year follow-up were performed using Kaplan-Meier estimates and were compared with the log-rank test. Kaplan-Meier survival curves were generated for time-to-event outcomes.

Multivariate Cox proportional-hazards regression (full-model) analysis was performed for probable influential variables ($P<0.20$) of univariate analysis. A two-sided P-value < 0.05 was considered to indicate statistical significance. All statistical analyses were performed using the Statistica software version 7.1 (Stat Soft, Inc., Tulsa, Oklahoma, USA) and MedCalc Software 17.9.2 (MedCalc Software bvba, Ostend, Belgium).

Results

Out of the 176 patients with left main coronary artery disease 19.3% of patients presented with ostial/midshaft lesions (N=34) and 80.7% with distal lesions (N=142 patients).

Baseline characteristics, including the logistic EuroSCORE (6.4±7 on average, P=0.68), were comparable for both groups (Table 1). As expected, the SYNTAX score was significantly higher in the distal LM group compared to the ostial/midshaft LM group (28.5±7.3 vs. 23.7±7.6, P<0.01).

Lesion characteristics and procedural data are displayed in Table 2. Ostial/midshaft LM lesions were predominantly treated with a single stent strategy (stents per lesion: 1.0±0.2). Medina classifications of distal LM lesions are also shown in Table 2. Leading treatment strategy of distal LM bifurcation lesions was the provisional T-stenting/reverse T-stenting technique (52.1%). In case of upfront two stent approach, the T-stenting was the leading strategy (29.6%). Kissing technique was performed in 62.7% of cases (68.1% in case of side brunch stenting). Total stent length was 32.0±13.7 mm in the distal LM group and 10.6±3.8 mm in the ostial/midshaft LM group (P<0.01). The rate of high pressure post-dilatation was 84.0% in total.

Clinical follow up after 12 months was completed for all 176 patients. Primary point of interest (MACE) was statistically comparable for both groups (20.6% in ostial/midshaft LMD vs. 17.6% in distal LMD, P=0.71, Figure 1). The clinical need for TLR in distal LM lesions was increased compared to ostial/midshaft LM lesions (14.1% vs. 5.9%, P=0.15, Figure 2). In contrast, patients with ostial/midshaft lesions had a four times increased risk for cardiovascular death than patients with distal lesions (12.2% vs. 2.9%, P=0.03, Figure 3*).* Rates of ST-elevating (2.9% in distal LMD vs. 0.0% in ostial/midshaft LMD, P=0.33) and non-ST-elevating myocardial infarction (3.6% vs. 8.8%, P=0.20) were similar between both groups (Figure 4 and 5). Detailed data about clinical follow-up are shown in Table 3.

Angiographic follow-up rate was 48.3% and comparable for both groups (ostial and distal lesions). Angiographic measures of ostial and distal LM lesions are presented in Table 4 and 5. In ostial/midshaft LMD late lumen loss (LLL) for in-stent segment was 0.42±0.33 mm, binary restenosis rate for in-stent segment was 0.0%. For distal LMD lowest values for LLL were seen in segments 1 (0.20±0.70 mm), 4 (0.20±0.66 mm) and 6 (-0.12±0.52 mm), while increased LLL was observed in segments adjacent to the bifurcation, with highest values in segment 7 (0.37±1.1 mm) and segment 11 (0.37± 0.7 mm) (Figure 6). Highest values for binary restenosis were observed in segment 7 (8.2%), segment 8 (6.8%) and segment 11 (6.8%).

On Cox proportional regression analysis late lumen loss for segment 11 (P=0.03, hazard ratio 1.68, confidence interval 1.1 to 2.7) and diabetes mellitus (P=0.046, hazard ratio 2.77, confidence interval 1.0 to 7.5) were independent correlates for occurrence of MACE during 12 months follow-up.

Discussion

The main findings of the present study can be summarized as follows: PCI of both ostial/midshaft and distal LM lesions show acceptable and comparable angiographic and clinical results up to 12 months follow-up. Distal LM lesions led to numerically but not to significantly higher rates of repeat revascularization compared to ostial/midshaft lesions with highest values for late lumen loss and binary restenosis occurring

in segments nearest to the bifurcation. Surprisingly, patients suffering from ostial/midshaft LM lesions had a four times increased rate of cardiac mortality as compared to patients with distal LM lesions. Finally, in distal LMD presence of diabetes mellitus as well as late lumen loss in a segment adjacent to the bifurcation were independent correlates for occurrence of MACE after PCI during 12 months follow-up.

Due to significant advances in device technology, increased operators´ expertise, and availability of improved antithrombotic therapy, PCI in left main coronary artery disease has emerged as a valid alternative technique to operative coronary artery bypass grafting [2,8-10]. Current European and American guidelines recommend both CABG and PCI for treatment of LMD with overall less complex anatomy [3,11]. This is strengthened by encouraging recent data, showing equivalent results in terms of 'hard' endpoints such as incidence of myocardial infarction, stroke, or cardiac and all-cause mortality at long-term follow-up. Early safety advantages of PCI are subsequently offset by higher rates of repeat revascularizations [1,2,12,13].

In a recent meta-analysis of 6 randomized trials, including 4.717 patients with LMD, one year results revealed rates for all cause death of 5.4%, myocardial infarction of 3.4% and repeat revascularization (TVR) of 8.7% in the PCI group (compared to 6.6%, 4.3% and 4.5% in the CABG group) [14]. In this meta-analysis, the entire population was in the 60^{th} decade with a rather lower SYNTAX score in most of the included trials (for example in the EXEL and NOBLE trial SYNTAX score was 20 and 22, respectively). In contrast to the mentioned analysis, we enrolled patients with a higher clinical risk profile. Patients in our study were older (mean age 72.3 years) and had a higher SYNTAX score with a mean of 28. In addition, mean EuroSCORE was 6.4 in the total cohort, 39.8% of patients had moderate to severe impairment of the left ventricular ejection fraction and 45.5% of patients were treated because of acute coronary syndrome. Especially due to these differences in baseline characteristics a comparison of the results with those of other trials is difficult. In our study 5.5% of patients died, rates of myocardial infarction and TLR were 6.8% and 12.5%, respectively. Nevertheless, the results from our study are comparable to those of previous trials and registries, considering an older population with poorer health status, which represent real-world conditions. These results are encouraging and confirm PCI in LMD as a safe and durable alternative revascularization option to operative revascularization treatment.

Comparing the results between ostial and distal left main lesions, we observed comparable MACE rates in both groups up to 12 months follow-up. However, in detail we detected a four times higher death rate in the ostial LM group (12.2% vs. 2.9%, P=0.03), whereas TLR rates were rather the other way round, but without reaching significance (5.9% vs. 14.1%, P=0.15). The largest study that addressed this issue was the analysis from the DELTA registry (Drug-Eluting Stent for Left Main Coronary Artery Disease), including 1.612 patients with LMD [4]. In this multicenter registry 482 patients with ostial LM lesions were compared to 1.130 patients with distal LM lesions for a median follow-up of 1.250 days. Again, the study population was younger than ours with an average age of 65.7 years, EuroSCORE and SYNTAX score were comparable to our study population. This trial demonstrated that PCI for ostial/midshaft lesions was associated with better clinical outcomes at long term follow-up than for distal lesions in LMD, largely because of a lower need for repeat revascularization. Noteworthy, no significant differences were observed in terms of all-cause death and the composite endpoint of all-cause death and MI. The trial confirmed the results of previous studies, reporting better outcomes of PCI for lesions not involving the distal LM [15,16]. These findings don´t completely

correspond to our results. Although baseline characteristics were equally distributed in both groups, death rates in ostial LMD were four times higher than in distal LMD. In detail four cardiac deaths occurred in both groups. One death in the ostial LM group occurred as a result of a target lesion non-ST-elevating myocardial infarction after 239 days. One patient died in the distal LM group because of a target lesion ST-elevating myocardial infarction after 244 days follow-up. The other 6 patients died due to decompensated heart failure without evidence for restenosis. In the end, these results might be a finding by chance and should not be overrated, but at least they disprove a tremendous clinical advantage for ostial lesions.

Altogether, our results are in line with the recommendations of recent guidelines on myocardial revascularization in LMD [3]. According to this, PCI has a class I level A recommendation for LMD with low SYNTAX score (0-22) and a class IIa level A recommendation for LMD with intermediate SYNTAX score (23-32). For patients with LMD and high anatomical complexity (SYNTAX score > 32) valid data are scarce due to the low number of patients studied in randomized controlled trials caused by exclusion criteria. Previous trials suggested a slightly trend towards better survival with CABG for this group [17]. Therefore, PCI in this setting cannot be endorsed in general by guidelines, as reflected by a class III level B recommendation. Due to the anatomical complexity, distal LM lesions result in higher SYNTAX scores than ostial and midshaft LM lesions and consequently in lower levels of evidence for revascularization with PCI. Our findings can possibly strengthen the role of PCI in distal LM lesions in the future, but further investigations are necessary.

In the present analysis revascularization rates were statistically not different in distal LM lesions as compared to ostial/midshaft LM lesions. According to this, the quantitative coronary analysis (QCA) revealed a comparable late lumen loss for ostial and distal LM lesions (0.42±0.33 mm and 0.42±0.97 mm in the main vessel, respectively). A trend toward higher rates of binary restenosis after PCI of distal LM lesions was already suggested in former analyses [4]. In our study, distal LM lesion segments nearest to the bifurcation showed the highest values for late lumen loss with highest values in segment 7 (0.37±1.13) and 11 (0.37± 0.73). This may be explained by involving the left anterior descending and left circumflex coronary arteries in case of distal LMD, being technically more challenging and associated with increased intra- and post-procedural complications [16,18]. Moreover, the development of atherosclerosis in the left main coronary artery has been linked to flow hemodynamics, with atherosclerotic plaques described at areas of low endothelial shear stress in the lateral wall of the bifurcation, opposite of the carina [19]. On the other hand, a lower lesion complexity often offers the use of shorter and larger stents, which are associated with better outcomes [4].

D'Ascenzo and colleagues revealed in a propensity score matched analysis with 440 patients that a planned angiographic follow-up after PCI of LMD results in more TLR, but may reduce mortality [20]. Up to date, the optimal choice for follow up these patients is still largely debated. While angiographic restenosis has been linked to mortality [21], angiographic control was associated with higher rates of revascularization without affecting mortality [22]. Consequently, routine angiographic follow-up for LMD is actually not recommended by guidelines [23]. However, high risk patients need close clinical follow-up after PCI, as they may have a higher need for repeat revascularization. Nowadays, the recommendation of angiographic follow-up after PCI is based on patient-associated factors, lesion-specific characteristics and procedural variables. Distal LM lesion segments nearest to the bifurcation showed the highest values for late lumen loss in our trial. It has

been shown that angiographic LLL seems to correlate with the occurrence of important clinical events such as binary restenosis and TLR [24-26]. Especially LLL in segment 11 was an independent predictor for the occurrence of MACE in distal LM lesions in our study. Hence, our findings may simplify the indication of angiographic follow-up in future, but further investigations are necessary.

The multivariate analysis resulted in findings that besides late lumen loss for segment 11, diabetes mellitus is a predictor of MACE. This is not surprising, as cardiovascular risk factors, especially diabetes mellitus, are generally considered as markers of poorer prognosis even in non-PCI populations. A more diffuse and accelerated form of atherosclerosis, accompanied by small vessels size, long lesions and greater plaque burden are well documented in these patients [27].

Conclusion

PCI of distal LM lesions result in comparable angiographic and clinical outcomes compared to ostial LM lesions up to 12 months follow-up. In distal LM lesions segments nearest to the bifurcation show the highest values for late lumen loss and binary restenosis. Presence of diabetes mellitus as well as late lumen loss in segments close to the bifurcation are independent correlates for occurrence of MACE during 12 months follow-up.

Limitations

The present study is not a randomized trial. Nevertheless, the work reflects conditions and clinical outcomes from a real-world setting. We did not include intravascular imaging or optical coherence tomography at follow-up to measure neointimal proliferation. Lastly, angiographic follow-up rate was only 48.3%.

List Of Abbreviations

CABG	Coronary artery bypass graft surgery
PCI	Percutaneous coronary intervention
LMD	Left main coronary artery disease
SYNTAX	Synergy between PCI with Taxus and Cardiac Surgery
QCA	Quantitative coronary analysis
TLR	Target lesion revascularization
LLL	Late lumen loss
MACE	Major adverse cardiac events
DES	Drug-eluting stents
LM	Left main

MLD	Minimal lumen diameter
EuroSCORE	European System for Cardiac Operative Risk Evaluation

Declarations

Ethics approval and consent to participate

The study was approved by the local ethics committee (ethics committee of University of Ulm, reference number 192/17).

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SM, TS, WR, NG, MR made substantial contributions to conception and design, data acquisition as well as data analysis and interpretation. SM, TS, WR, JW, NG, and MK are been involved in drafting the manuscript or revising it. SM, TS, WR, NG, DF, JW and MR given final approval to the version to be published.

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Tables

Table 1 Baseline clinical characteristics

	Total	Distal LMD	Proximal LMD	P-value
Number of patients	176	142	34	
Age (years)	72.3±10.6	72.3±10.6	72.0±11.0	0.83
Sex (male)	136 (77.3)	113 (79.6)	23 (67.7)	0.15
Hypertension	151 (85.8)	121 (85.2)	30 (88.2)	0.64
Hyperlipidemia	117 (66.5)	97 (68.3)	20 (58.8)	0.30
History of smoking	51 (30.0)	42 (29.6)	9 (26.5)	0.72
Diabetes mellitus	60 (34.1)	50 (35.2)	10 (29.4)	0.52
Renal insufficiency	30 (17.0)	25 (17.6)	5 (14.7)	0.68
Body mass index (kg/m□)	27.1±4.4	27.3±4.6	26.9±4.5	0.80
Number of diseases vessels	2.8±0.5	2.8±0.5	2.7±0.5	0.29
SYNTAX score	27.6±7.6	28.5±7.3	23.7±7.6	< 0.01
EuroSCORE II	6.4±7.3	6.3±7.3	5.7±7.1	0.68
Stable angina	96 (54.5)	78 (54.9)	18 (52.9)	0.83
Unstable angina	80 (45.5)	64 (45.1)	16 (47.1)	0.83
5 (3.1)				

Data are presented as mean ± SD or n (%). LMD = Left main disease.

Table 2 Lesion characteristics and procedural data

	Total	Distal LMD	Proximal LMD	P-value
Number of lesions	176	142	34	
Medina Class				
1-1-1	63 (35.8)	63 (44.4)	0 (0.0)	< 0.01
1-0-1	21 (11.9)	21 (14.8)	0 (0.0)	0.02
0-1-1	1 (0.6)	1 (0.7)	0 (0.0)	0.51
Calcification	14 (8.0)	12 (8.5)	2 (5.9)	0.61
Thrombus burden	5 (2.8)	4 (2.8)	1 (5.9)	0.97
Total stent length (mm)	27.8±15.4	32.0±13.7	10.6±3.8	< 0.01
Stents per lesion	1.77±1.03.	1.97±1.1	1.0±0.2	< 0.01
Maximal inflation pressure (atm)	15.5±3.4	15.6±3.4	15.3±3.6	0.68
High pressure postdilatation	148 (84.0)	123 (86.6)	25 (73.5)	0.08
Bifurcation treatment strategy				
Single stent strategy	71 (50.0)	71 (50.0)	-	
Crush /mini crush	8 (5.6)	8 (5.6)	-	
Culotte	3 (2.1)	3 (2.1)	-	
Provisional T /reverse T	74 (52.1)	74 (52.1)	-	
T-stenting	42 (29.6)	42 (29.6)	-	
V-stenting	4 (2.8)	4 (2.8)	-	
5 (3.1)	89 (62.7)	89 (62.7)	-	
Kissing				

Data are presented as mean ± SD or n (%). LMD = Left main disease.

Table 3 Clinical follow-up

	Total	Distal LMD	Proximal LMD	P-value
Stent thrombosis				
acute	0 (0)	0 (0)	0 (0)	-
subacute	0 (0)	0 (0)	0 (0)	-
late	2 (1.1)	2 (1.4)	0 (0)	0.35
MACE	32 (18.2)	25 (17.6)	7 (20.6)	0.71
MACE within 4 weeks	2 (1.1)	2 (1.4)	0 (0)	0.35
Cardiac death	8 (4.5)	4 (2.9)	4 (12.2)	0.03
MI, target vessel related				
STEMI	4 (2.3)	4 (2.9)	0 (0.0)	0.33
NSTEMI	8 (4.5)	5 (3.6)	3 (8.8)	0.20
TLR	22 (12.5)	20 (14.1)	2 (5.9)	0.15

Data are presented as mean ± SD or n (%). The percentages in the subgroups are Kaplan-Meier estimates at the specific time point and do not equal the number of patients divided by the total number in the treatment group.

LMD = Left main disease; MACE = Major adverse cardiac events; MI = Myocardial infarction; STEMI = ST-elevation myocardial infarction, NSTEMI = Non-ST-elevation myocardial infarction, TLR = Ischemia-driven target lesion revascularization.

Table 4 Angiographic measures pre- and post PCI and at follow-up: ostial lesions

	Pre PCI	Post PCI	FUP
Minimal lumen diameter (mm)			
Total segment	1.80±0.56	3.47±0.53	3.3±0.5
In-stent segment	1.80±0.57	3.72±0.48	3.5±0.4
Distal segment	3.35±0.59	3.61±0.57	3.5±0.5
Reference vessel diameter (mm)			
Total segment	3.89±0.54	3.81±0.41	4.0±0.5
In-stent segment	3.89±0.54	4.16±0.39	4.0±0.5
Distal segment	3.89±0.54	4.16±0.39	4.0±0.5
Stenosis of luminal diameter (%)			
Total segment	54.0±12.9	16.58±9.75	16.9±8.0
In-stent segment	53.9±12.9	10.7±7.4	13.5±7.4
Distal segment	14.0±9.1	13.6±10.8	13.2±8.2
	Acute gain (mm)	Late loss (mm)	BNR (%)
Total segment	1.67±0.62	0.28±0.34	0.0
In-stent segment	1.91±0.61	0.42±0.33	0.0
Distal segment	0.26±0.43	0.18±0.49	0.0

Data are presented as mean ± SD or n (%). LMD = Left main disease; FUP = Follow-up; BNR = binary restenosis.

Table 5 Angiographic measures pre- and post PCI and at follow-up: distal lesions

	Pre PCI	Post PCI	FUP
Minimal lumen diameter (mm)			
Main vessel	1.70±0.69	3.31±0.76	2.97±0.95
Segment 9	4.10±1.03	4.49±0.72	4.28±0.71
Segment 1	2.44±0.91	4.01±0.63	3.80±0.65
Segment 2	1.77±0.77	3.47±0.76	3.12±1.02
Segment 7	2.99±9.84	3.42±0.60	3.10±0.86
Segment 11	2.06±0.89	3.19±0.64	2.92±0.87
Segment 3	2.66±0.69	3.09±0.65	2.98±0.72
Segment 4			
Side branch	1.91±1.12	2.77±2.24	2.32±0.71
Segment 10	2.01±0.98	2.79±0.69	2.52±0.81
Segment 8	1.91±1.03	2.66±0.65	2.42±0.76
Segment 5	2.44±0.79	2.66±0.64	2.81±2.50
Segment 6			
Reference vessel diameter (mm)			
Main vessel	3.76±0.92	4.02±0.84	3.92±0.75
Segment 9	4.29±0.77	4.57±0.69	4.43±0.62
Segment 1			4.43±0.60

Segment 2	4.30±0.76	4.55±0.69	3.81±0.82
Segment 7	3.91±2.88	4.03±0.84	3.48±0.48
Segment 11	3.10±0.63	4.26±4.94	3.43±0.51
Segment 3	3.12±0.65	3.59±0.63	3.37±0.52
Segment 4	3.06±0.62	3.50±0.64	
Side branch			2.83±0.68
Segment 10	2.82±1.08	3.00±0.72	2.95±0.74
Segment 8	2.87±0.88	3.08±0.73	2.87±0.71
Segment 5	2.77±0.73	3.01±0.71	2.82±0.67
Segment 6	2.73±0.7	2.94±0.68	

Stenosis of luminal diameter (%)			23.8±20.0
Main vessel	54.2±16.7	19.8±30.4	3.3±8.7
Segment 9	5.8±14.7	2.5±11.3	14.0±10.7
Segment 1	42.9±19.9	11.3±8.6	19.0±19.2
Segment 2	52.0±18.7	13.7±9.1	11.0±20.5
Segment 7	30.7±23.4	5.84±7.1	14.6±21.1
Segment 11	34.5±22.9	10.0±7.9	11.6±16.6
Segment 3	12.8±14.5	11.7±10.2	
Segment 4			20.3±21.7

Side branch	35.4±28.0	15.4±15.1	16.6±22.6
Segment 10	30.4±26.6	11.4±17.0	18.2±21.8
Segment 8	34.2±29.1	13.1±15.1	14.4±22.4
Segment 5	12.5±19.9	11.5±15.6	
Segment 6			BNR (%)

	Acute gain (mm)	Late Loss (mm)		
Main vessel			8.2	
Segment 9	1.61±0.87	0.42±0.97	0.0	
Segment 1	0.43±0.98	0.20±0.70	0.0	
Segment 2	1.58±0.98	0.25±0.65	8.2	
Segment 7	1.70±0.94	0.37±1.13	6.8	
Segment 11	0.43±9.89	0.37±0.73	8.2	
Segment 3	1.14±0.88	0.35±0.88	2.7	
Segment 4	0.43±0.68	0.20±0.66	8.2	
Side branch			6.8	
Segment 10	0.87±2.50	0.32±0.58	6.8	4.1
Segment 8	0.78±0.97	0.30±0.66		
Segment 5	0.76±0.96	0.26±0.58		
Segment 6	0.22±0.62	-0.12±2.52		

Total lesions length (mm)	
Main vessel	28.9±9.8
Segment 9	1.2±2.1
Segment 1	8.9±4.6
Segment 2	4.3±0.8
Segment 7	3.0±0.0
Segment 11	10.0±9.1
Segment 3	4.7±0.7
Segment 4	
Side branch	13.6±9.8
Segment 10	2.9±0.4
Segment 8	9.5±9.3
Segment 5	4.1±1.5
Segment 6	129.2±31.2
Angle proximal side	84.6±34.2
Angle distal side	

Data are presented as mean ± SD or n (%). LMD = Left main disease; FUP = Follow-up; BNR = binary restenosis.

Figures

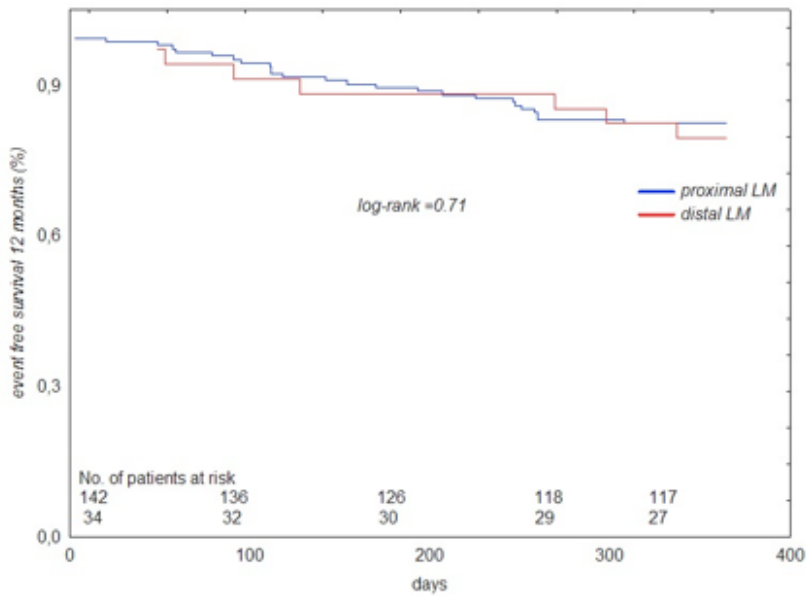

Figure 1

Kaplan-Meier curves of one-year event-free survival among patients with ostial/midshift and distal left main (LM) disease.

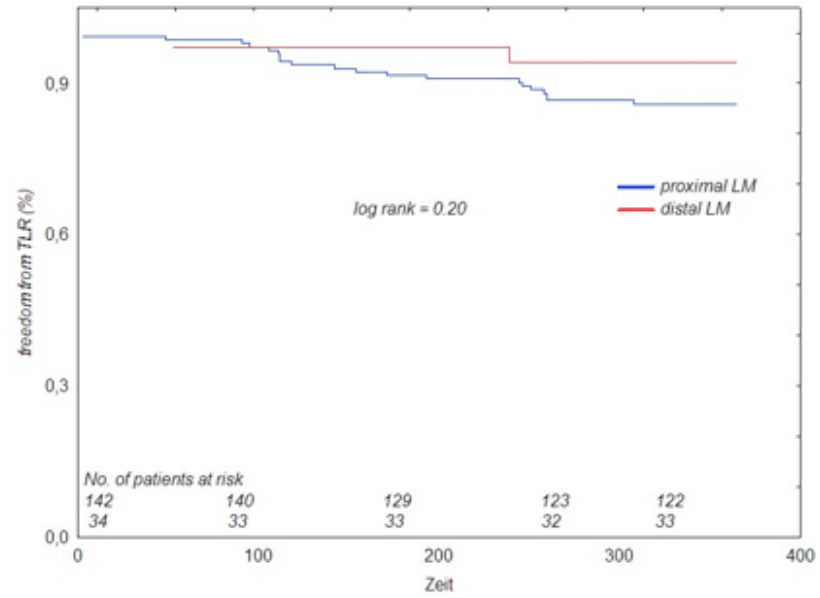

Figure 2

Kaplan-Meier curves of one-year target lesion revascularization (TLR) among patients with ostial/midshift and distal left main (LM) disease.

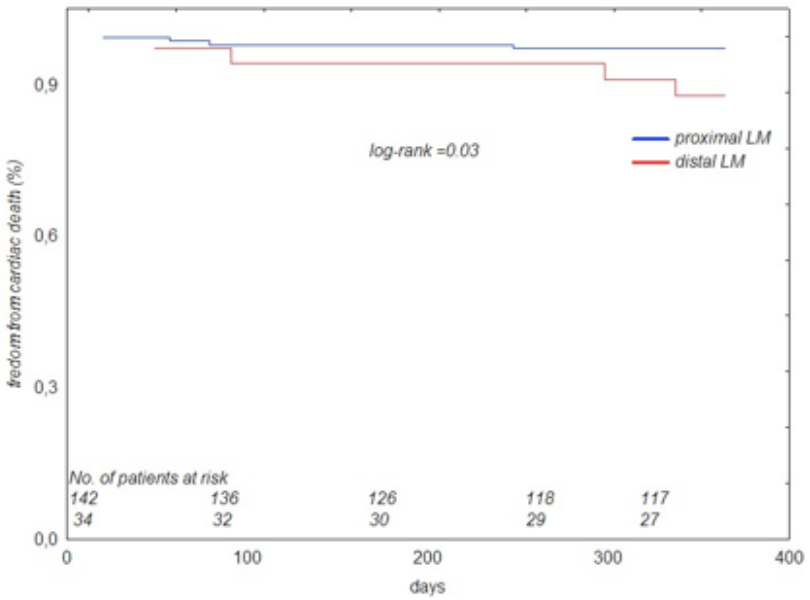

Figure 3

Kaplan-Meier curves of one-year cardiovascular death among patients with ostial/midshift and distal left main (LM) disease.

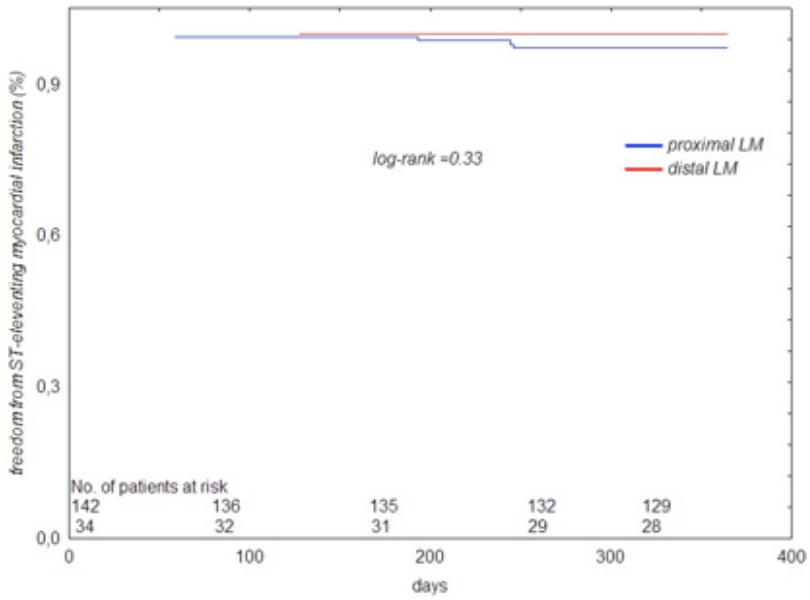

Figure 4

Kaplan-Meier curves of one-year non-ST-segment elevation myocardial infarction among patients with ostial/midshift and distal left main (LM) disease.

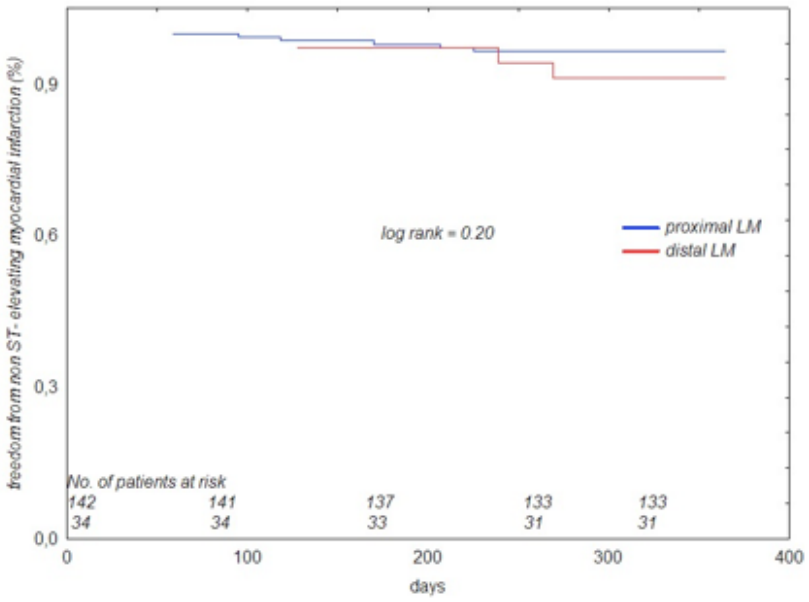

Figure 5

Kaplan-Meier curves of one-year ST-segment elevation myocardial infarction among patients with ostial/midshift and distal left main (LM) disease.

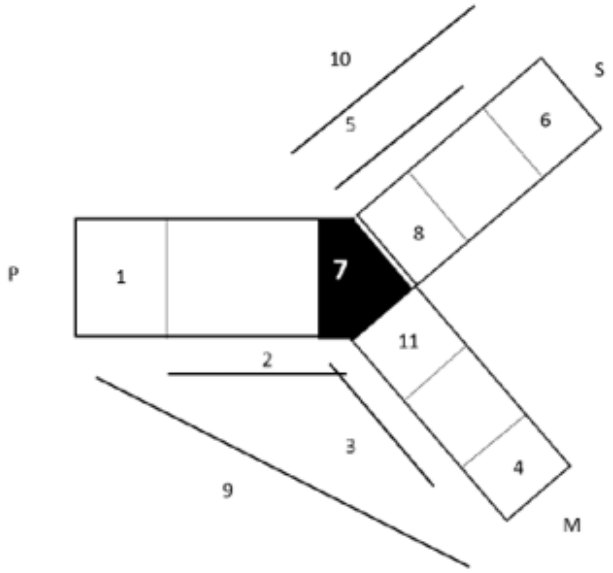

Figure 6

Diagramm of left main bifurcation with detailed segments. P = proximal side; M = main vessel; S = side branch