Left main percutaneous coronary intervention in acute and chronic coronary disease. A single center experience

Intervenção percutânea no tronco da coronária esquerda em doença coronariana aguda e crônica. Experiência de um centro

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ABSTRACT – Background: Improvements in percutaneous coronary intervention have reduced complications in the treatment of left main coronary artery disease. The objective of this study was to characterize percutaneous coronary intervention procedures in left main coronary artery, and evaluate patients' outcomes. **Methods:** A retrospective study performed from January 2015 to December 2018, in patients submitted to percutaneous coronary intervention in left main coronary artery for stable coronary artery disease or myocardial infarction, with second-generation drug-eluting stents. **Results:** A total of 82 patients were submitted to percutaneous coronary intervention in left main coronary artery. Among them, 26.8% had stable coronary artery disease, 50% had non-ST segment elevation myocardial infarction, and 23.2% had ST segment elevation myocardial infarction. Cardiogenic shock was present in 20.7% of them. Most patients were male, elderly, with cardiovascular risk factors, namely diabetes, hypertension and hyperlipemia. Among patients with stable coronary artery disease, patients had low to intermediate SYNTAX score. During hospitalization, patients did not develop any complications. During follow-up, cardiovascular death was of 4.5% (n=1). Regarding non-ST segment elevation myocardial infarction, during hospitalization, there were no registries of events. During follow-up, 9.1% of patients had cardiovascular-related hospitalizations. A patient died (3%) during the re-hospitalization from severe heart failure. Concerning ST segment elevation myocardial infarction patients, there was one case of acute stent thrombosis during hospitalization resulting in death. One patient was readmitted for percutaneous coronary intervention in left main coronary artery due to restenosis. Regarding the patients admitted in cardiogenic shock, in-hospital mortality was 58.8%. During follow-up, two patients experienced restenosis and were hospitalized (one underwent coronary artery bypass grafting, and the other, percutaneous coronary intervention). **Conclusion:** This is a real-world study in which we described our experience with percutaneous coronary intervention in left main coronary artery. In general, percutaneous coronary intervention in left main coronary artery in stable left main coronary artery disease, or in unstable disease with no cardiogenic shock, was a safe procedure. Further studies with extended follow-up are needed.

Keywords: Coronary artery disease; Percutaneous coronary intervention; Intravascular coronary imaging

RESUMO – Introdução: Avanços na intervenção coronária percutânea reduziram as complicações no tratamento de lesão do tronco da coronária esquerda. O objetivo deste estudo foi caracterizar os procedimentos de intervenção coronária percutânea no tronco da coronária esquerda e avaliar os desfechos dos pacientes. **Métodos:** Estudo retrospectivo realizado de janeiro de 2015 a dezembro de 2018 em pacientes submetidos à intervenção coronária percutânea no tronco da coronária esquerda por doença arterial coronariana estável ou infarto agudo do miocárdio com stents farmacológicos de segunda geração. **Resultados:** Foram submetidos à intervenção coronária percutânea no tronco da coronária esquerda 82 pacientes. Destes, 26,8% tinham doença arterial coronariana estável, 50% apresentaram infarto agudo do miocárdio sem supradesnívelamento do segmento ST, e 23,2% tiveram infarto agudo do miocárdio com supradesnívelamento do segmento ST. Choque cardiogênico estava presente em 20,7%. A maioria era do sexo masculino, idosa e com fatores de risco cardiovasculares (diabetes, hipertensão e hiperlipidemia). Entre os pacientes com doença arterial coronariana estável,

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o escore SYNTAX era baixo a intermediário. Durante a internação, os pacientes não apresentaram intercorrências. No seguimento, 4,5% (n=1) tiveram morte cardiovascular. Em relação ao infarto agudo do miocárdio sem supradesnivelamento do segmento ST, não houve registros de eventos durante a internação. Durante o acompanhamento, 9,1% dos pacientes foram hospitalizados devido a doenças cardiovasculares. Um paciente foi a óbito (3%) durante a reinternação devido à insuficiência cardíaca grave. Em relação aos pacientes com infarto agudo do miocárdio com supradesnivelamento do segmento ST, ocorreu um caso de trombose aguda do stent durante a internação, resultando em óbito. Um paciente foi readmitido para intervenção coronária percutânea no tronco da coronária esquerda devido à reestenose. Em relação aos pacientes admitidos em choque cardiogênico, a mortalidade intra-hospitalar foi de 58,8%. Durante o seguimento, dois pacientes apresentaram reestenose e foram hospitalizados (um foi submetido à revascularização do miocárdio e o outro à intervenção coronária percutânea). **Conclusão:** Este é um estudo do mundo real em que foi descrita a experiência com intervenção coronária percutânea no tronco da coronária esquerda. Em pacientes com doença estável, ou doença instável sem choque cardiogênico, a intervenção mostrou-se um procedimento seguro. São necessários mais estudos com seguimento prolongado.

Descritores: Doença da artéria coronária; Intervenção coronária percutânea; Ultrassonografia de intervenção

INTRODUCTION

Unprotected left main coronary artery (LMCA) disease is found in approximately 5% to 7% of patients undergoing coronary angiography, and more than 80% of lesions include the bifurcation.^{1,2} Coronary artery bypass grafting (CABG) was the gold-standard treatment for LMCA disease for several years. Although percutaneous coronary intervention (PCI) in LMCA was previously reserved for patients with high surgical risk, or those requiring urgent treatment, the 2018 European Society of Cardiology (ESC) guidelines for myocardial revascularization stated that both PCI and CABG can be an appropriate alternative for stable LMCA disease, in patients with low to intermediate anatomical complexity.¹ On the other hand, it is important to distinguish between protected and unprotected LMCA disease, since PCI of unprotected lesions is associated with a poorest outcome as compared to protected lesions, especially in high-risk patients in whom PCI should only be considered in the absence of other revascularization options.^{2,3}

Therefore, we aimed to characterize percutaneous coronary intervention procedures in LMCA and evaluate patients' outcomes in different clinical scenarios.

METHODS

Registry design

A single-center, retrospective study performed from January 2015 to December 2018, in patients who underwent PCI in LMCA (Figure 1).

PCI: percutaneous coronary intervention; LMCA: left main coronary artery; NSTEMI: non-ST segment elevation myocardial infarction; STEMI: ST-segment elevation myocardial infarction; CS: cardiogenic shock.

Figure 1. Registry design. We enrolled 82 patients who underwent left main percutaneous coronary intervention, according to the clinical indication.

Population

Consecutive patients admitted for stable angina pectoris or acute coronary syndrome with a significant lesion (visually-assessed diameter of stenosis of >50%) in LMCA ostium, mid-shaft, or bifurcation, submitted to PCI. Participants were divided according to their clinical presentation into stable coronary artery disease (SCAD), non-ST segment elevation myocardial infarction (NSTEMI), ST segment elevation myocardial infarction (STEMI), and cardiogenic shock (CS). Both protected and unprotected LMCA lesions were included.

Procedures

Patients were submitted to PCI with second-generation drug-eluting stents. Reasons for PCI in case of LMCA disease were patient preference/inability of CABG due to patient instability, or refusal of the surgeon for technical or clinical reasons/decision made by interventional cardiologist and assistant cardiologist. Distal LMCA bifurcation lesions were treated with one or two-stent techniques, according to operator preference. For a two-stent strategy, the Culotte, DK crush, T and protrusion (TAP) or T-stent techniques were employed. Intravascular coronary imaging was used as per operator decision. Medical treatment after the procedure included 100mg of aspirin lifelong, and a P2Y12 inhibitor for 1 year.

Outcomes

Outcomes were in-hospital cardiovascular death, procedure-related myocardial infarction (MI), as per the fourth universal definition of MI, stroke, and target lesion failure, namely stent thrombosis and restenosis. The follow-up outcomes were evaluated at the last medical visit registered (minimum of 1 year) and comprised total number of deaths, non-cardiovascular and cardiovascular death, hos-

pitalization, MI, unplanned revascularization, heart failure, stroke and target lesion failure (stent thrombosis and restenosis).

Definitions

Periprocedural MI was characterized as coronary procedure-related MI within ≤ 48 hours after the index procedure is arbitrarily defined by a rise in cardiac troponin (cTn) values >5 -fold, with at least one of the following factors: new ischemic electrocardiogram (ECG) changes; development of new pathological Q waves; imaging evidence of loss of viable myocardium, which is presumed to be new and in a pattern consistent with an ischemic etiology; angiographic findings consistent with a procedural flow-limiting complication, such as coronary dissection, occlusion of a major epicardial artery or graft, side-branch occlusion due to thrombus, disruption of collateral flow, or distal embolization.

Stent thrombosis was defined if there were symptoms suggestive of an acute coronary syndrome, and angiographic or pathologic confirmation of stent thrombosis.

Target lesion failure was considered if stent thrombosis and restenosis were present.

Unprotected left main coronary artery was considered if patent graft to left anterior descending artery or left circumflex coronary artery was absent.

Statistical analysis

This is a descriptive study. Statistical analysis was carried out using the software Statistical Package for the Social Sciences (SPSS), version 22. Number of patients is described in absolute number and percentage. Continuous variables are reported as the mean $\pm$ standard deviation (SD).

RESULTS

The study enrolled 82 patients; in that, 26.8% presented with SCAD, 50% NSTEMI and 23.2% STEMI. Cardiogenic shock was present in 20.7% of patients. In figure 2, a survival analysis containing all patients included in the study is presented.

Figure 2. Survival analysis of the patients included in the study. The overall survival after approximately 1,200 days of follow-up was of nearly 60%.

Stable coronary artery disease

A total of 22 patients with SCAD underwent PCI in LMCA (Table 1). Most patients were male (14; 63.6%) with median age of 68.9 ± 7.7 years (range 51 to 78 years). Five (22.7%) patients were referred due to angina and a positive stress test. The remaining were referred to coronary angiography due to angina or left ventricular dysfunction, with no stress test. Diabetes was present in 54.5% ($n=12$) of patients, and 45.4% ($n=10$) had reduced ejection fraction. Twelve (54.5%) of patients had past history of coronary disease, nine (36.7%) had undergone PCI, and four (18.1%) were submitted to CABG. Most of the patients had unprotected LMCA (18; 81.8%) and the Synergy Between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery (SYNTAX) score was low to intermediate in all patients. A total of 77.3% of PCI in LMCA ($n=17$) were decided based on the patient, assistant cardiologist and interventional cardiologist opinions, considering comorbidities or coronary anatomy unsuitable to CABG. Surgeons refused to perform CABG in 22.7% ($n=5$) of patients, who were submitted to PCI in LMCA.

All PCIs in LMCA were performed with second-generation drug-eluting stents (everolimus: $n=15$, or 68.2%; zotarolimus: $n=7$, or 31.8%). The preferred vascular access was the right radial artery (17; 77.3%). The left radial artery was used in one patient (4.3%) with previous CABG, and in four (17.4%) patients a right femoral access was obtained (in three patients due to the operator preference and in one patient due to impossibility of obtaining a radial access). Nine (41%) patients had only LMCA disease, while four (18.2%) patients had lesions in LMCA and in another vessel, seven patients (31.8%) had lesion in LM and two vessels, and five (22.7%) patients had LM disease and three vessels. A total of 18 (81.8%) procedures were conducted on distal LMCA, four (18.2%) on the ostium. A one-stent technique was used in all PCIs in LMCA, except in one case of bifurcation lesion, in which a two-stent technique with DK-crush was employed. Pre and post-dilation were carried out in almost all cases ($n=21$, or 95.2%, and $n=20$, or 91.0%, respectively). Kissing balloon was performed in 11 (50%) patients, and proximal optimization technique (POT) in 16 (72.7%) patients. Regarding the use of intracoronary imaging, intravascular ultrasound (IVUS) was used in 11 (50%) patients. However, in the last 2 years of the study, the percentage of IVUS-guided procedures was 71.4%.

During hospitalization, there were no registries of stroke, MI, heart failure, or death due to any cause. Upon discharge, all patients were treated with dual antiplatelet therapy, 81.8% with statin, 9.1% with ezetimibe, 63.6% with beta-blocker, and 40.9% with angiotensin-converting enzyme inhibitor (ACEI). The follow-up was 498.7 ± 167.4 days (Table 2). Four (18.2%) patients were readmitted; one (4.5%) patient had a type-2 MI and a stroke and was medically managed; the remaining were admitted due to heart failure, and one (4.5%) of these patients died (a patient

Table 1. Characterization of patients and procedures according to the clinical presentation

Variable	SCAD	NSTEMI	STEMI	CS
Demographic characteristics				
Age, years				
Mean	68.9	72.3	69	70.7
Standard deviation	7.7	9.1	10.1	8.7
Male, n (%)	14 (63.6)	27 (81.2)	7 (70)	10 (58.2)
BMI, kg/m ²				
Mean	38.2	26.5	24.6	28.4
Standard deviation	18.0	3.1	1.8	5.3
Comorbidities				
Diabetes mellitus, n (%)				
Treated with oral glucose-lowering drugs	12 (54.5)	20 (60.6)	2 (20)	4 (23.5)
Insulin-treated	1 (4.5)	0	0	1 (5.9)
Hypertension, n (%)	16 (72.7)	28 (84.8)	6 (60)	11 (64.7)
Hyperlipidemia, n (%)	14 (63.6)	22 (66.7)	4 (40)	11 (64.7)
Smoker, n (%)				
Former smoker (>30 days)	7 (31.8)	10 (30.3)	2 (20)	3 (17.6)
Current smoker	2 (9.1)	3 (9.1)	1 (10)	3 (17.6)
Previous coronary angioplasty, n (%)	8 (36.7)	7 (21.2)	1 (10)	0
Previous coronary artery bypass grafting, n (%)	4 (18.2)	11 (33.3)	0	1 (5.9)
Previous myocardial infarction, n (%)	10 (45.6)	15 (45.5)	1 (10)	1 (5.9)
History of coronary artery disease, n (%)	12 (54.5)	18 (54.5)	3 (30)	3 (17.6)
History of heart failure, n (%)	0	1 (3.0)	0	2 (11.8)
Significant valvular heart disease, n (%)	0	0	0	1 (5.9)
History of cerebrovascular disease, n (%)	1 (4.5)	6 (18.2)	0	2 (11.8)
Peripheral vascular disease, n (%)	0	3 (9.1)	0	3 (17.6)
Chronic kidney disease, n (%)	1 (4.5)	3 (9.1)	0	2 (11.8)
Ejection fraction, n (%)				
Normal (>50%)	12 (54.5)	22 (66.7)	4 (40)	1 (5.9)
Mild decrease (41%-50%)	2 (9.1)	5 (15.2)	1 (10)	2 (11.8)
Moderate decrease (31%-40%)	6 (27.3)	4 (12.1)	5 (50)	3 (17.6)
Severe decrease (<30%)	2 (9.1)	2 (6.1)	0	11 (64.7)
Medications upon discharge, n (%)				
Aspirin	22 (100)	32 (100)	9 (100)	7 (100)
Clopidogrel	13 (59.1)	13 (40.6)	2 (22.2)	4 (57.1)
Ticagrelor	9 (40.9)	18 (56.6)	7 (77.7)	3 (42.9)
Beta-blocker	14 (63.6)	23 (71.2)	5 (55.6)	6 (85.7)
ACEI	9 (40.9)	19 (59.4)	5 (55.6)	5 (71.2)
Statins	18 (81.8)	25 (78.1)	8 (88.8)	7 (100)
Ezetimibe	2 (9.1)	2 (6.3)	0	0
Angiographic characteristics				
Lesion location, n (%)				
Ostium, proximal, midshaft, and/or diffuse	4 (18.2)	5 (15.2)	2 (20)	2 (11.8)
Distal and/or bifurcation	18 (81.8)	28 (84.8)	8 (10)	15 (88.2)
Unprotected LMCA	18 (81.8)	22 (66.7)	10 (100)	16 (94.1)
Anatomical complexity (% patients)				
Low SYNTAX	13 (59.1)	14 (42.4)	6 (60)	4 (23.5)
Intermediate SYNTAX	5 (22.7)	7 (21.2)	2 (20)	6 (35.3)
High SYNTAX	0	1 (3.0)	2 (20)	6 (35.3)
Complementary diagnostic devices				
IVUS	11 (50)*	12 (36.7)†	2 (20)	2 (11.8)
FFR	0	0	0	0
OCT	0	1 (3.0)	0	0
Follow-up, days				
Mean	498.7	614.9	633.5	619.1
Standard deviation	167.4	237.6	185.4	242.5
Death causes, n (%)				
Cardiovascular-related	1 (4.5)	1 (3.0)	10 (58.8)	
Non-cardiovascular related	3 (13.6)	3 (9.0)	0	
Unknown			1 (5.8)	

* After 2016, the intracoronary imaging guided procedures were performed in 71.4% of cases; † before 2016, intracoronary imaging guided procedures were carried out in 58.8% of cases.

SCAD: stable coronary artery disease; NSTEMI: non-ST segment elevation myocardial infarction; STEMI: ST segment elevation myocardial infarction; CS: cardiogenic shock; BMI: body mass index; ACEI: angiotensin-converting-enzyme inhibitors; LMCA: left main coronary artery; SYNTAX: Synergy Between Percutaneous Coronary Intervention with Taxus and Cardiac; IVUS: intravascular ultrasound; FFR: fractional flow reserve; OCT: optical coherence tomography.

with severely depressed left ventricular function). Non-cardiovascular deaths were registered in three (13.6%) patients. There were no registries of target lesion failure.

Table 2. Patients' outcomes according to the clinical presentation

Event	SCAD	NSTEMI	STEMI	Cardiogenic shock
MACE				
All-cause deaths	4 (18.2)	4 (12.1)	2 (20.0)	11 (64.7)
Cardiovascular death	1 (4.5)	1 (3.0)	1 (10.0)	10 (58.8)
Stroke	1 (4.5)	0	0	0
Myocardial infarction	1 (4.5)	1 (3.0)	0	2 (28.6)
Revascularization	0	0	1 (10.0)	2 (28.6)
Target lesion failure	0	0	2 (20.0)	2 (28.6)
PCI	0	0	0	1 (14.3)
CABG	0	0	1 (10.0)	1 (14.3)
Hospital admission, driven by cardiac-related symptoms	4 (18.2)	3 (9.0)	1 (10.0)	2 (28.6)

Results expressed as n (%).

SCAD: stable coronary artery disease; NSTEMI: non-ST segment elevation myocardial infarction; STEMI: ST segment elevation myocardial infarction; MACE: major adverse cardiovascular events; PCI: percutaneous coronary intervention; CABG: coronary artery bypass grafting.

Non-ST segment elevation myocardial infarction

Forty-one PCIs in LMCA were performed in patients admitted for NSTEMI. Eight of these patients were in CS. Most patients were male (27; 81.2%) and the median age was of 72.3±9.1 years. Most patients had cardiovascular risks factors, namely diabetes (20; 60.6%), hypertension (28; 84.8%), hyperlipidemia (22; 66.7%), past history of smoking (10; 30.35%) or current smoking (3; 9.1%). In addition, 18 (54.5%) patients had a past history of coronary disease; in that, seven patients had undergone PCI (21.2%), and 11 (33.3%), CABG. Therefore, 22 (66.7%) patients had unprotected LMCA, and the SYNTAX score was low to intermediate in most patients (only one patient had high SYNTAX score). Coronary artery bypass grafting was rejected by four patients, and the PCIs in LMCA performed were based in patient's preference, and discussion with assistant cardiologist and interventional cardiologist.

Regarding the procedural aspects, all PCIs used second-generation drug-eluting stents (everolimus: n=21, or 63.6%, zotarolimus: n=12, or 36.7%). A right radial access was obtained in most cases (21; 63.6%); a right femoral approach was done in eight patients (in three cases due to impossible radial access); in four patients a left radial access was used, and in one patient, a right cubital access. Most patients had multivessel disease (LMCA and three vessels: n=18, or 54.5%; LMCA and two vessels: n=8, or 24.2%; LMCA and one vessel: n=5, or 15.1%; LMCA disease alone: n=2, or 6.1%). Left main coronary artery lesions were

mainly distal (n=28, 84.8%; ten involving the bifurcation, including one patient in CS) and the remaining were ostial. A one-stent technique was preferred, but in five cases a two-stent technique was employed (four Culotte and one TAP), and pre- and post-dilation, POT and kissing-balloon were always used. In general, pre-dilatation was performed in 31 (93.9%) patients, post-dilation in 30 (90.9%) patients, POT in 22 (66.7%), and kissing balloon in eight (24.2%). Intravascular ultrasound was used in 12 (36.4%) patients and optical coherence tomography (OCT) in one patient. Nevertheless, in the last 2 years of the study, intracoronary imaging guided procedures were performed in 58.8% of cases.

Upon discharge, all patients were on dual antiplatelet therapy, and most of them were treated with statin (25; 78.1%), beta-blocker (23; 71.2%) and ACEI (19; 59.4%). During hospitalization, total mortality was of 9.75% (n=4) and was restricted to patients in CS. There were no registries of MI, stroke, acute renal failure, or death. Among patients in CS who survived hospitalization, there were no registries of death during follow-up (mean of 619.17±242.2 days). However, a patient was re-admitted due to acute coronary syndrome related to LMCA stent restenosis. The patient underwent CABG. Excluding CS patients, the remaining had a mean follow-up of 614.9±237.6 days. During this period, three (9.1%) patients had cardiovascular-related hospitalizations, and one of them had a MI which was medically managed, and two patients were admitted due to heart failure. There was no record of unplanned revascularization, target lesion failure, or stroke. One (3%) patient died during the re-hospitalization from severe heart failure (known before the PCI in LMCA), and three (9%) patients died from non-cardiovascular causes. All outcomes described were observed in patients with unprotected LMCA, and those with protected LMCA experienced no unfavorable outcome.

ST-segment elevation myocardial infarction

A total of 19 patients with STEMI underwent PCI in LMCA, and nine of them were admitted in CS (their data will be presented separately). Among the STEMI patients admitted with no CS, 70% were male and mean age was 69±10.1 years. Out of these, two (20%) presented diabetes, six (60%) hypertension, and four (40%) hyperlipidemia. Furthermore, 30% of patients had a past history of coronary disease, and one patient had undergone PCI. As to left ventricular ejection fraction, 60% of patients presented mild to moderate drop, whereas 40% had preserved values. All patients had an unprotected LMCA, and most patients had low to intermediate SYNTAX score (only two had high score). Lesions in LMCA and one more vessel were observed in 30% of patients; in LMCA and two vessels in 40% of cases; and in LMCA and three vessels, in 33%. Only four (40%) patients had a reperfusion time less than 120 minutes, mainly due to patient delay in contacting the health-

care services. Before PCI, Thrombolysis in Myocardial Infarction (TIMI) 2 flow was present in three (30%) patients, and seven (70%), TIMI 3 flow. After PCI, all patients had a TIMI 3 flow.

Percutaneous coronary interventions in LMCA were performed only with second-generation drug-eluting stents (everolimus: n=6, or 60%; zotarolimus: n=4, or 40%). In 90% of patients, a right radial access was used; only one patient required right femoral access since radial access was not possible. Eight (80%) lesions were distal, and two (20%) ostial. A one-stent technique was used in all patients. Predilation was used in 70%, postdilatation in 90%, POT in 70%, and kissing balloon in 30% of procedures. Intravascular ultrasound was employed in 20% of cases.

A patient presented acute stent thrombosis during hospitalization and died. During hospitalization, the remaining patients had no registries of events, namely MI, stroke, acute renal failure, or death. Total mortality (including patients in CS) was of 31.6% (six patients, five admitted in CS). Upon discharge, all patients were on dual antiplatelet therapy and most of them were treated with statin (8; 88.8%), beta-blocker (5; 55.6%) and an ACEI (5; 55.6%). The mean follow-up was 633.5 ± 185.4 days. A patient was readmitted for suspected progression of coronary artery disease (with no infarction), and a restenosis in LMCA submitted to PCI was found. Patient was referred to CABG. Another patient died for unknown reasons.

Cardiogenic shock

Percutaneous coronary interventions in LMCA were performed in 17 patients in CS (20.1% of total PCI in LMCA performed). Nine (52.9%) of these patients had STEMI and eight (47.1%) NSTEMI. Decision to perform PCI in LMCA was made by the interventional cardiologist and the assistant team, due to patient's clinical instability and no availability of a heart surgery team at the center studied. Patients in CS were predominantly male (10; 58.2%). Mean age was of 70.7 ± 8.7 years. Most patients had hypertension and hyperlipidemia (11; 64.7%). Diabetes was present in five patients (29.4%). Three (17.6%) patients had a past history of coronary artery disease, and one patient had a history of CABG. Regarding the left ventricle function, more than half of patients had a severe left ventricular function decrease, and lesions in LMCA and three vessels (11; 64.7%). Unprotected LMCA was observed in 16 (94.1%) patients, and the SYNTAX score was intermediate to high in most patients. All procedures were made using second-generation drug-eluting stents (everolimus: n=10, or 58.8%; zotarolimus: n=7, or 41.2%). The right radial access was used in nine (53%) patients, and the right femoral access in eight (47.1%) – in half of these patients, radial access was not possible. Only two (11.6%) patients presented with LMCA ostial lesions, while most patients had distal lesions (15; 88.2%). A one-stent technique was preferred in all patients. All lesions were predilated, while 14 (82.4%) were postdi-

lated. Proximal optimization technique was used in nine (52.9%) patients, and kissing-balloon in eight (47.1%). Intravascular ultrasound was used in two (11.6%) procedures.

Regarding the patient's outcomes, in-hospital mortality was 58.8% (n=19), but there were no signs of MI related with procedure or stroke. Upon discharge, all patients were on dual antiplatelet therapy and most were treated with statin (7; 100%), beta-blocker (6; 85.7%) and ACEI (5; 71.2%). During follow-up, two patients experienced restenosis and were hospitalized (one presenting with NSTEMI and another with asymptomatic ischemia); one underwent CABG and the other, PCI. One patient died for unknown reasons.

DISCUSSION

Our study aimed to understand the characteristics, clinical presentations and outcomes of patients submitted to PCI in LMCA at our center. Our population comprised mostly elderly patients, with relevant cardiovascular risk factors, such as diabetes, hypertension and hyperlipidemia, and patients with unprotected LMCA. SCAD patients had no in-hospital events, and during follow-up, 18.2% of patients were readmitted for cardiovascular symptoms that were unrelated to PCI in LMCA. The only cardiovascular death recorded was a patient with previous severely decreased ejection fraction, who died from heart failure. Therefore, we believe, for our SCAD patients, PCI in LMCA is a good alternative to CABG. Although the decision to perform PCI in LMCA was made by the Cardiology team in most cases, our population comprised only patients with low to intermediate SYNTAX score. Another factor that may have contributed to our decision is the fact our center does not provide cardiac surgery services. Intracoronary imaging was used in only 50% of patients, but analyzing the period after starting using IVUS and OCT, this percentage raised to 71.4%, which can be considered an improvement. Previous studies also demonstrated the role of PCI in LMCA stable disease. The results from the SYNTAX study and, more recently, the EXCEL and NOBLE trials, showed PCI in LMCA can be an effective, durable and non-inferior treatment in patients with low anatomical complexity, in whom complete revascularization may be achieved with PCI (low to intermediate SYNTAX score) when compared to CABG.^{3,4} However, a more recent study, in which an independent angiographic core laboratory was blinded to the randomization arm and outcomes of the EXCEL trial, mentioned approximately one-quarter of randomized patients had a high SYNTAX score; nonetheless, according to EXCEL trial design, only patients with low and intermediate scores were enrolled. In these patients, the 4-year difference in major adverse cardiac and cerebrovascular events (MACCE) between PCI and CABG would likely have been even more pronounced than what was reported. However, the study also stated the 4-year outcomes of composite index inclu-

ding death, MI, or stroke, in PCI and CABG were consistent across the range of anatomic complexity enrolled in the EXCEL trial.^{5,6} A 10-year follow-up of the PRECOMBAT trial of patients with LMCA disease, randomized to PCI or CABG, was recently published and did not demonstrate significant difference in the incidence of MACCE.⁷ A systematic review and meta-analysis carried out in 2020 also demonstrated long-term mortality after PCI with drug-eluting stent compared with CABG, in patients with LMCA disease, was not different in cardiac death, stroke, or MI, between PCI and CABG.⁸

Most of our patients were admitted for NSTEMI. Patient's characteristics were similar to those with SCAD, although NSTEMI patients had a higher percentage of previous CABG and protected LMCA. Nevertheless, all events were observed in patients with unprotected LMCA. Outcomes were also optimistic, even in the SCAD population, since there was only one cardiovascular death registered during follow-up, in a patient with history of severely decreased ejection fraction. All these patients were clinically stable, and those in CS were analyzed separately. Intravascular ultrasound was used in 12 (36.4%) patients, and OCT in one. Intracoronary imaging guided procedures were performed in 58.8% of cases, in the last 2 years of the study, and show an increasing tendency. Results of the STEMI patients demonstrated this population had less known cardiovascular risk factors, and almost half of the patients were in CS. Excluding these patients, our results revealed the presence of two cases of target lesion failure: an acute stent thrombosis that resulted in patient's death during hospitalization, and a restenosis during follow-up, which led the patient to CABG. Intravascular coronary imaging was not used in these cases. Intravascular ultrasound was only used in 20% of patients with STEMI, probably due to their unstable picture. ST-segment elevation myocardial infarction patients with or without CS, and NSTEMI patients with ongoing instability, within our area of referral, are transferred to our center for emergent PCI. This can explain the high number of patients treated in critically-ill conditions. Mortality due to STEMI was 20% (n=2), and to cardiovascular causes, 10% (n=1), but it is important to remember the low number of patients of this population. In-hospital mortality of patients in CS was 58.8% (n=17). Therefore, in-hospital mortality was mainly due to presence of CS, and all patients who died had unprotected LMCA. Myocardial infarction complicated by CS, or cardiac arrest due to LMCA lesions, is generally accepted to be treated with PCI, for CABG is also associated with a too high mortality risk. A 2013 meta-analysis studied patients who underwent primary PCI due to LMCA culprit lesions, and assessed 13 studies. It concluded patients in CS had a substantially higher mortality at 30 days, than patients without shock, regardless of the stent used.⁹ Patients with LMCA disease and CS usually account for more than 50% of deaths, which is in agreement with CS generic mortality and our results. In our case series, stent restenosis

occurred in three patients (which presented as two cases of NSTEMI and one case of asymptomatic ischemia); in that, two were referred to CABG and one was treated with PCI. In patients who had target lesion revascularization detected, intracoronary imaging was not used during procedure. This can be a key point for our future procedures. The European Bifurcation Club (EBC) recommends the use of IVUS during most LMCA interventions.^{10,11} Intravascular ultrasound can be used before stent implantation to assess the risk of side branch involvement, particularly in patients with a vulnerable carina or with significant calcifications identified by IVUS longitudinal reconstruction. Moreover, it is used to assess stent length and diameter, and provide reference measurements that can be used to plan the size and length of POT balloon.¹⁰ On the other hand, IVUS is an excellent tool after stent implantation to optimize the results; in other words, to rule out residual edge stenosis or edge dissection; to evaluate stent expansion and apposition; to rule out accidental abluminal rewiring; to ensure minimal luminal areas; and to assess complications. Ye et al. performed a meta-analysis of ten studies, and showed IVUS guidance in PCI in LMCA reduced the risk of all-cause death by 40%, and cardiac death by 53%. Intravascular ultrasound was also associated with lower risk of target lesion failure, and definite or probable stent thrombosis, but not with MI or target vessel revascularization.¹⁰ We have increasingly employed IVUS, but we aim nowadays to improve our value, since it is known that IVUS should not be considered only for diagnosis (class of recommendation IIa, Level of Evidence B, according to the ESC myocardial revascularization guidelines of 2018, to assess severity of unprotected LM lesions), but also for the previously mentioned reasons.¹

CONCLUSION

In our cohort, in patients with low anatomical complexity who underwent elective percutaneous coronary intervention, there was not record of death. During follow-up, excluding patients in cardiogenic shock, most non-cardiovascular deaths may reflect the age and comorbidities of the patients treated. In-hospital deaths were mainly due to cardiogenic shock. Moreover, target lesion failure was not a prominent phenomenon in our center, probably due to increasing expertise, use of new-generation drug-eluting stents, potent dual antiplatelet therapy, and despite not being ideal yet, the increasing use of intravascular imaging.

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None.

CONFLICTS OF INTEREST

The authors declare there are no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: CCO, CGB, JC and JM; data collection: CCO; data interpretation: CCO, CGB, JC and JM; text writing: CCO; approval of the final version to be published: CCO, CGB, JC and JM.

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