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Percutaneous coronary intervention for unprotected left main coronary artery: radial vs. femoral access

Intervenção coronária percutânea em tronco de coronária esquerda não protegido: acesso radial vs. femoral

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ABSTRACT – Background: Percutaneous intervention for obstructive lesions of the unprotected left main coronary artery is complex. Choosing the vascular access can be decisive to a successful procedure. The objective of the present study was to describe the characteristics and hospital outcomes of patients with unprotected left main coronary artery disease and compare the radial and femoral access approaches. **Methods:** Clinical and angiographic data, access routes and hospital outcomes of patients that have undergone percutaneous coronary intervention of the unprotected left main coronary artery were collected from the *Central Nacional de Intervenções Cardiovasculares* (CENIC) between June 2006 and March 2016. **Results:** A total of 734 patients were included. Mean age was 66±12 years, 62% were male and 22% were diabetic. Acute coronary syndrome occurred in 47%. Cardiogenic shock was observed in 44% of patients with acute myocardial infarction. The procedure success rate was 90% and the hospital mortality rate was 8.5%. Femoral access was the most frequent approach. Regardless of the vascular approach used, there was no difference in the rate of major adverse cardiovascular events during hospital stay. **Conclusions:** High clinical complexity was observed in CENIC patients presenting with unprotected left main coronary artery lesions treated by percutaneous coronary intervention. Femoral access was the most frequent, especially for more complex cases. There was no difference between the procedure success rate and adverse event rate when comparing both vascular approaches.

Keywords: Coronary artery disease; Radial artery; Femoral artery; Angioplasty

RESUMO – Introdução: As lesões obstrutivas de tronco de coronária esquerda não protegido são de tratamento percutâneo complexo. A escolha da via de acesso pode ser decisiva para o sucesso do procedimento. O objetivo deste estudo foi descrever as características e os desfechos hospitalares de pacientes com lesão de tronco de coronária esquerda não protegido, comparando as vias de acesso radial e femoral. **Métodos:** Foram coletadas as características clínicas, angiográficas, vias de acesso e desfechos hospitalares dos pacientes submetidos à intervenção coronária percutânea de tronco de coronária esquerda não protegido do registro da Central Nacional de Intervenções Cardiovasculares (CENIC) entre junho de 2006 a março de 2016. **Resultados:** Foram incluídos 734 pacientes. A média de idade foi de 66±12 anos, 62% eram do sexo masculino e 22% diabéticos. Síndrome coronária aguda ocorreu em 47%. Choque cardiogênico foi observado em 44% dos pacientes com infarto agudo do miocárdio. A taxa de sucesso dos procedimentos foi de 90%. A mortalidade hospitalar foi de 8,5%. A via femoral foi o acesso mais frequente. Não houve diferença na taxa de eventos cardiovasculares adversos maiores intra-hospitalares em relação às vias de acesso. **Conclusões:** Os pacientes da CENIC com lesões de tronco de coronária esquerda não protegido tratados por intervenção coronária percutânea foram de alta complexidade clínica. A via de acesso femoral foi a mais frequente, especialmente em casos mais complexos. Não houve diferença na taxa de sucesso dos procedimentos e nem de eventos adversos, quando comparadas as vias de acesso.

Descritores: Doença da artéria coronariana; Artéria radial; Artéria femoral; Angioplastia

INTRODUCTION

Obstructive lesions of the unprotected left main coronary artery (LMCA), especially those involving its distal portion, are complex percutaneous procedures,

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requiring the use of multiple balloons and interventional techniques with two or more stents. The choice of vascular access may determine the success of the procedure in this setting.

The femoral approach allows using larger diameter catheters (7 and 8 Fr), providing greater support and facilitating the treatment of bifurcations, especially when using balloons and large diameter stents simultaneously. Despite presenting a shorter learning curve, the femoral technique is associated with a higher rate of vascular and hemorrhagic complications.^{1,2}

The radial approach is much safer, reducing the occurrence of complications related to the arterial puncture site, and also reducing mortality in the context of acute coronary syndromes.³ Nonetheless, it has a longer learning curve and limitations during complex cases that require more substantial support and larger diameter catheters.⁴⁻⁷

The objective of the present study was to describe clinical and angiographic characteristics and hospital outcomes of patients undergoing percutaneous coronary intervention (PCI) of the unprotected LMCA, comparing the radial and femoral access approaches.

METHODS

This is a retrospective study with information collected from data registered in the *Central Nacional de Intervenções Cardiovasculares* (CENIC; <http://www.corehemo.net/>), of the *Sociedade Brasileira de Hemodinâmica e Cardiologia Intervencionista* (SBHCI), created in 1991. The registry has information on PCI procedures gathered on a dedicated database, entered voluntarily by member physicians from various Brazilian institutions. The study was approved by the *Hospital Leforte* Ethics and Research Committee, as CAEE 90669318.2.0000.5485.

Data for the study were collected from 734 patients presenting unprotected LMCA disease treated with PCI, from June 2006 to March 2016. Patients were divided into two groups, radial and femoral, according to the access site chosen by the physician performing the procedure. Groups were compared in relation to clinical characteristics (age, sex, systemic arterial hypertension, diabetes mellitus, dyslipidemia, previous PCI, previous myocardial infarction, clinical presentation and Killip classification), angiographic data (extent of coronary artery disease, anatomical complexity, pre-procedure Thrombolysis in Myocardial Infarction – TIMI flow, presence of left ventricular dysfunction and presence of collateral circulation), and procedure data (frequency of stent use; percentage of drug-eluting stent use; length, diameter and number of stents per patient; type of intervention performed; use of thromboaspiration; use of glycoprotein IIb/IIIa inhibitors; post-procedure TIMI flow; degree of pre- and post-procedure stenosis; and procedure success rate). Clinical hospital outcomes analyzed were death, emergency coronary artery bypass graft sur-

gery (CABG), acute myocardial infarction (MI) and major adverse cardiovascular events (MACE).

The patient was considered as the sample unit for the analysis of clinical variables. Some patients underwent more than one procedure. In these cases, the procedure to be considered was randomly selected. The Chi-square test was used to compare categorical variables. The odds ratio was used whenever necessary. Analysis of variance (ANOVA) was used to compare continuous variables. The Bonferroni correction was used for multiple comparisons. To verify the influence of variables of interest on mortality of patients treated with PCI of unprotected LMCA, simple and multiple logistic regression models (*forward*) were used. A significance level of 5% (p-value <0.05) was set for all analyses.

RESULTS

A total of 734 patients (576 femoral and 158 radial approaches) were included in the study. A total of 739 procedures were performed, with a mean of 1.01 per patient. A total of 769 vessels were treated, 725 (94.3%) of which with stents, totaling up 764 stents. There were significant differences between the groups regarding clinical characteristics (Table 1). The group with femoral access had a higher percentage of smokers and older patients. Regarding clinical status, stable angina and asymptomatic patients prevailed in the group with radial access, while acute MI and non-ST

Table 1. Clinical characteristics

Characteristic	Access		Total (n=734 patients)	p-value
	Femoral (n=576 patients)	Radial (n=158 patients)		
Age, years	66.7 (12.5)	63.8 (12.0)	66.1 (12.4)	0.007
Male	357 (62.0)	101 (63.9)	458 (62.4)	0.654
Smoking	115 (20.0)	17 (10.8)	132 (18.0)	0.007
HTN	445 (77.3)	126 (79.7)	571 (77.8)	0.504
Dyslipidemia	317 (55.5)	74 (47.4)	391 (53.8)	0.072
Diabetes mellitus	113 (21.9)	24 (22.6)	137 (22.1)	0.874
Previous acute MI	69 (13.4)	16 (15.1)	85 (13.7)	0.643
Previous PCI	110 (19.3)	31 (20.7)	141 (19.6)	0.700
Clinical presentation				
Stable angina	229 (39.8)	79 (50.0)	308 (42.0)	0.026
Silent ischemia	60 (10.4)	21 (13.3)	81 (11.0)	
Acute MI	112 (19.4)	19 (12.0)	131 (17.8)	
NSTE-ACS	175 (30.4)	39 (24.7)	214 (29.2)	
Killip				
1	40 (35.7)	7 (36.8)	47 (35.9)	0.979
2	14 (12.5)	2 (10.5)	16 (12.2)	
3	9 (8.0)	2 (10.5)	11 (8.4)	
4	49 (43.8)	8 (42.1)	57 (43.5)	

Results expressed as mean ± standard deviation or n (%). HTN: systemic arterial hypertension; PCI: percutaneous coronary intervention; MI: myocardial infarction; NSTE-ACS: non-ST segment elevation acute coronary syndrome.

segment elevation acute coronary syndrome (NSTEMI-ACS) were more prevalent in the femoral group. Patients in the Killip 4 class were more frequent in the femoral approach.

Regarding angiographic characteristics (Table 2), patients in the femoral access group had a higher percentage of calcified, long lesions, with a higher thrombus load and a pre-procedure TIMI coronary flow grade 0/1. There was no significant difference in the extent of coronary disease between groups. It is noteworthy that in 44 patients with

femoral access and in 40 with radial access, there was no record of the extent of the coronary disease.

Regarding the characteristics of the procedure (Table 3), patients in the femoral access group had a higher proportion of vessels treated per patient, and also of primary and rescue PCI than those with radial access. The radial approach patients had a higher stent-to-patient ratio, higher use of drug-eluting stents and longer devices than those with femoral access.

Table 2. Angiographic characteristics

Characteristic	Access		Total (n=739 procedures/ n=769 vessels)	p-value
	Femoral (n=580 procedures/ n=608 vessels)	Radial (n=159 procedures/ n=161 vessels)		
Extension of coronary disease*				
Multivessel LMCA	279 (52.1)	72 (60.5)	156 (23.8)	0.094
Isolated LMCA	257 (47.9)	47 (39.5)	304 (46.4)	
Type B2/C lesions	128 (77.1)	12 (80.0)	140 (77.3)	0.797
Calcified lesions	160 (26.4)	26 (16.1)	186 (24.3)	0.007
Thrombotic lesions	86 (14.1)	9 (5.6)	95 (12.4)	0.003
Long lesions (>20mm)	72 (11.8)	10 (6.2)	82 (10.7)	0.039
Bifurcations	221 (36.3)	71 (44.1)	292 (38.0)	0.071
Occlusions	75 (12.4)	15 (9.4)	90 (11.7)	0.297
pre TIMI flow				
0/1	130 (21.4)	17 (10.6)	147 (19.1)	0.001
2/3	478 (78.6)	144 (89.4)	622 (80.9)	
Left ventricular dysfunction	201 (60.2)	33 (45.8)	234 (57.6)	0.025
Collateral circulation	46 (12.6)	11 (15.5)	57 (13.1)	0.508

Results expressed n (%). *The extension of the coronary disease was not reported in the registry of some patients. LMCA: left main coronary artery; TIMI: Thrombolysis in Myocardial Infarction.

Table 3. Characteristics of procedures

Characteristic	Access		Total (n=739 procedures/ n=769 vessels)	p-value
	Femoral (n=576 patients/n=580 procedures/n=589 stents)	Radial (n=158 patients/n=159 procedures/n=175 stents)		
Treated vessels/patient	1.1±0.2	1.0±0.1	1.0±0.2	0.019
Use of stent	543 (94.3)	148 (93.7)	691 (94.1)	0.776
Stent/patient ratio	1.1±0.3	1.2±0.4	1.1±0.3	0.005
Drug-eluting stents	238 (40.5)	104 (59.4)	342 (44.8)	<0.001
Stent diameter, mm	3.49±0.61	3.47±0.65	3.49±0.61	0.675
Stent length, mm	17.6±7.8	19.7±9.7	18.0±8.3	0.005
Type of intervention				0.016
Primary PCI	94 (16.2)	12 (7.5)	106 (14.3)	
Rescue PCI	7 (1.2)	1 (0.6)	8 (1.1)	
Glycoprotein IIb/IIIa inhibitors	40 (6.9)	8 (5.0)	48 (6.5)	0.397
Thromboaspiration	4 (0.68)	0	4 (0.52)	0.579
Post TIMI				
0/1	48 (8.1)	8 (4.6)	56 (7.3)	0.110
2/3	541 (91.9)	167 (95.4)	708 (92.7)	
Stenosis grade				
Pre	82.9 (15.9)	82.8 (49.7)	82.9 (27.5)	0.971
Post	5.3 (13.9)	3.9 (11.4)	5 (13.4)	0.220
Success of the procedure	521 (89.8)	143 (89.9)	664 (89.9)	0.967

Results expressed as mean±standard deviation or n (%). PCI: percutaneous coronary intervention; TIMI: Thrombolysis in Myocardial Infarction.

There was no significant difference in clinical hospital outcomes (Table 4). Occurrence of acute MI, need for revascularization, death and MACE were similar between the groups. In the simple logistic regression model (Table 5), some variables were associated with death: clinical presentation of acute MI, primary PCI, use of glycoprotein IIb/IIIa inhibitor, presence of left ventricular dysfunction, Killip 4

Table 4. Clinical outcomes during hospital admission

Outcome	Access		Total (n=734 patients)	p-value
	Femoral (n=576 patients)	Radial (n=158 patients)		
Acute MI	7 (1.4)	1 (0.9)	8 (1.3)	0.729
Emergency CABG	2 (0.6)	1 (1.3)	3 (0.7)	0.455
Death	45 (8.5)	10 (8.4)	55 (8.5)	0.966
MACE	51 (8.9)	11 (7.0)	62 (8.4)	0.448

MI: myocardial infarction; CABG: coronary artery bypass surgery; MACE: major adverse cardiovascular events.

Table 5. Determinants of mortality by simple logistic regression

Determinants	Estimate	p-value	OR	95%CI
Access, femoral vs. radial	0.02	0.966	1.02	0.5-2.08
Age, years	0.00	0.710	1.00	0.97-1.02
Sex, female vs. male	0.04	0.900	1.04	0.59-1.83
Smoking, no vs. yes	0.23	0.543	1.26	0.6-2.65
HTN, no vs. yes	0.79	0.007	2.20	1.23-3.91
Dyslipidemia, no vs. yes	0.94	0.001	2.55	1.42-4.56
Diabetes mellitus, yes vs. no	-0.25	0.516	0.78	0.37-1.65
Previous acute MI, yes vs. no	0.05	0.899	1.06	0.46-2.43
Previous PCI, no vs. yes	1.34	0.027	3.80	1.16-12.44
Clinical presentation, stable angina vs. acute MI	-2.92	<0.001	0.05	0.02-0.13
Clinical presentation, silent ischemia vs. acute MI	-3.35	0.001	0.04	0-0.26
Clinical presentation, NSTEMI vs. acute MI	-2.34	<0.001	0.10	0.04-0.21
Killip, 1 vs. 4	-1.62	0.001	0.20	0.08-0.5
Killip, 2 vs. 4	-2.67	0.012	0.07	0.01-0.56
Killip, 3 vs. 4	-1.54	0.062	0.21	0.04-1.08
Extension of coronary disease, multivessel LMCA vs. isolated LMCA	2.28	<0.001	9.76	4.18-22.81
Left ventricular dysfunction, yes vs. no	2.26	0.002	9.57	2.23-41.06
Collateral circulation, yes vs. no	0.29	0.543	1.33	0.53-3.35
Type of intervention, Primary PCI vs. others	2.81	<0.001	16.55	8.84-30.99
Type of intervention, Rescue PCI vs. others	1.47	0.180	4.34	0.51-37.31
Glycoprotein IIb/IIIa inhibitors, yes vs. no	1.38	0.001	3.98	1.89-8.37

OR: odds ratio; 95%CI: 95% confidence interval; HTN: systemic arterial hypertension; MI: myocardial infarction; PCI: percutaneous coronary intervention; NSTEMI: non-ST segment elevation acute coronary syndrome; LMCA: left main coronary artery.

class, and extension of coronary disease. Arterial hypertension, dyslipidemia and history of previous PCI were predictors of death. Vascular access (radial or femoral) was not associated with the mortality outcome. Variables with incomplete data (Killip, ventricular dysfunction and collateral circulation) were excluded from the multivariate logistic regression analysis (Table 6). The independent variables most associated with death were extension of coronary disease and type of procedure performed (primary PCI).

Table 6. Determinants of mortality by multiple logistic regression

Constant	Estimate	p-value	OR	95%CI
Extension of coronary disease, multivessel LMCA vs. isolated LMCA	1.97	0.001	7.15	2.34-21.85
Type of intervention, Primary PCI vs. others	2.99	<0.001	19.80	9.3-42.16
Type of intervention, Rescue PCI vs. others	2.18	0.055	8.87	0.95-82.97

OR: odds ratio; 95%CI: 95% confidence interval; LMCA: left main coronary artery; PCI: percutaneous coronary intervention.

DISCUSSION

There are few studies comparing radial and femoral approaches for PCI of unprotected LMCA. Our work compared both vascular access sites retrospectively, using the CENIC database, which reflects the national scenario. Femoral access was the most common access site for the treatment of unprotected LMCA in the Brazilian registry. Patients with more severe clinical characteristics (elderly, Killip 4 functional class and with acute coronary artery disease) were predominantly treated by the femoral approach. The radial approach had a higher proportion of young patients, asymptomatic patients or those with stable angina, and functional class 1/2.

Although the radial approach is safer, with less hemorrhagic and vascular complications, it has a longer learning curve, being reserved initially for less complex cases and stable patients.^{6,7} Stronger scientific evidence showing reduction of bleeding and mortality, and recommendations in guidelines encouraging the use of the radial approach are relatively recent.^{1,2} These factors may have influenced this approach to be less used for treating unprotected LMCA lesions in the CENIC registry, during the investigation period. In addition, although the technical limitations imposed by the radial approach (smaller caliber, less support) can be overcome with the use of techniques (buddy wire, buddy balloon and anchorage) and dedicated devices (guide catheters with greater support and mother and child catheter), these devices are often not widely available in Brazilian cath labs.

The angiographic characteristics of the lesions reflected the clinical profile of each vascular access group. Long lesions

with a marked degree of calcification were more frequently treated by the femoral approach; lesions with a high thrombotic load and pre-procedure coronary TIMI flow grade 0/1, as well as interventions, such as primary and rescue PCI, prevailed in the femoral group, and may be explained by the higher percentage of ACS and acute MI in this group.

Our analysis of the procedures showed that a small number of stents per procedure was used, suggesting low use of techniques with multiple devices. The proportion of drug-eluting stents was higher when using the radial technique, which may be explained by the higher percentage of elective cases treated in this access route.

Our study did not find significant differences between the radial and femoral groups in relation to clinical outcomes (acute MI, emergency CABG, death and MACE), similar to what was observed in other studies.⁸⁻¹¹ The multivariate logistic regression model showed that coronary artery disease and primary PCI were significantly associated with death, corroborating findings in the literature.¹²

Our study has important limitations. It is a retrospective, non-randomized analysis with operator selection bias. The hemorrhagic and vascular complications, amount of contrast used, dose of radiation, length of hospital stay and crossover rate between the vascular approaches were not accounted for; neither were the frequency of multiple stent techniques nor success in the final kissing balloon in procedures with two or more stents.

CONCLUSIONS

Patients on the CENIC registry with unprotected left main coronary artery lesions treated with percutaneous coronary intervention were of high clinical complexity. Femoral access was the most frequent, especially in more complex cases. There was no difference in the success rate of the procedures or in major adverse cardiovascular events when the radial and femoral access routes were compared.

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CONFLICTS OF INTEREST

The authors declare there are no conflicts of interest.

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