

# Prevalence and Predictive Factors of Severe Coronary Lesions in Algerian Patients Undergoing Coronary Angiography

Mourad Boukheloua<sup>1\*</sup> , Mohamed Berrehal<sup>2</sup>, Aziza Baali<sup>3</sup>, Souad Chelghoum<sup>4</sup>, Djamaledine Nibouche<sup>1</sup>

<sup>1</sup>Service de Cardiologie, Centre Hospitalier Universitaire Nafissa Hamoud, Algiers, Algeria

<sup>2</sup>Service de Cardiologie, Centre Hospitalier Universitaire, Sétif, Algeria

<sup>3</sup>Service de Radiologie, Centre Hospitalier Universitaire Nafissa Hamoud, Algiers, Algeria

<sup>4</sup>Service de Néphrologie, Centre Hospitalier Universitaire Mustapha Bacha, Algiers, Algeria

Email: \*boukheloua@gmail.com

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## Abstract

**Background:** The severity of coronary lesions in patients with coronary artery disease (CAD) has important prognostic and therapeutic consequences. Clinical symptoms not always reflect the disease severity and this study aimed to evaluate coronary lesions in the Algerian population where these data are scarce. **Methods:** It was a prospective cross-sectional study conducted in consecutive patients with an age  $\geq 20$  years who underwent clinically-indicated coronary angiography in our center. The objective of the study was to determine the prevalence of severe coronary lesions assessed with the Gensini score. The predictive factors of severity were evaluated in a multivariate analysis. **Results:** A total of 507 patients were included (male, 79.7%; mean age, 58.8 years). Coronary angiography was prescribed most frequently for ST-segment elevation myocardial infarction (STMI) (46.9%) and non-STMI (38.1%). The prevalence of severe coronary lesions was 69.6% (95% CI 65.5 - 73.5). In multivariate analysis, the independent predictive factors of severe coronary lesions were male sex (odds ratio [OR] 2.00;  $p = 0.0141$ ), diabetes (OR 1.92;  $p = 0.0070$ ), left ventricular dysfunction (OR 1.81;  $p = 0.0059$ ), age (OR 1.72;  $p = 0.0297$ ) and no lipid-lowering treatment (OR, 0.47;  $p = 0.0388$ ). **Conclusions:** Severe coronary lesions were present in two out three patients in this cohort of Algerian patients undergoing coronary angiography. Independent predictive factors of severe coronary lesions were male sex, diabetes, age, left ventricular dysfunction and no lipid-lowering treatment. It is important to identify these at-risk patients, as they should be explored at an asymptomatic stage before a cardiovascular event and receive prompt treatment with angioplasty or surgery.

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## Keywords

Coronary Artery Disease, Coronary Angiography, Gensini Score, Cardiovascular Risk Factors

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## 1. Introduction

Coronary artery disease (CAD) is a chronic and systemic inflammatory disease where atherosclerosis plays a central role [1]. CAD is the leading cause of death in Algeria [2] and in the world [3]. Severe coronary lesions (left main coronary artery or tritrunal lesions) must be identified because of their prognostic and therapeutic impact. Patients with severe coronary disease are at risk of higher mortality than patients with moderate disease, especially if there is an associated left ventricular dysfunction [4] [5]. These severe coronary lesions must be identified because of the need for early exploration at the asymptomatic stage before the event and the need of early treatment by angioplasty or surgery.

Coronary angiography is the gold standard for the diagnosis of coronary artery disease [6]. This method allows evaluating the localization and extent of the atherosclerosis in the coronary vessels. These parameters have been shown to be associated with cardiovascular events and mortality [7] [8] [9]. The probability of complete occlusion and myocardial infarction increases with the degree of coronary stenosis [7] [8] [9]. A correlation was found for Gensini score with age, sex, HDL, smoking and diabetes [10].

The Gensini score allows evaluating the severity of the lesions seen in coronary angiography, not simply as mono-, bi- or tritrunal coronary damages, but takes also into consideration the area which is perfused by the involved vessels [11]. According to Gensini, this method considers “*the geometrically increasing severity of lesions, the cumulative effects of multiple obstructions, the significance of their locations, the modifying influence of the collaterals, the size and quality of the distal vessels, and the importance of the status of myocardial function*” [11].

Despite the importance of the quantification of the lesions of coronary arteries, there are few data on the coronary lesions in Algerian CAD patients. The objective of this study was to determine the prevalence of severe coronary lesions assessed with the Gensini score and to assess the predictive factors of severity.

## 2. Materials and Methods

### 2.1. Type of Study

This was a single-center prospective cross-sectional study in patients referred to the cardiology department of Hussein Dey University Hospital Center (Algiers) for a coronary angiography examination.

The primary objective of the study was to assess the prevalence of severe coronary lesions in patients who underwent coronary angiography. The secondary objective was to identify the predictive factors of severe coronary lesions.

From March 1, 2017 to March 31, 2018, consecutive patients aged  $\geq 20$  years who underwent clinically indicated coronary angiography (coronary artery disease, positive myocardial ischemia test, preoperative cardiac surgery workup or myocardial or rhythmic pathology) were enrolled. Patients with a history of coronary angioplasty or coronary bypass surgery were not included (Gensini score not valid in these patients).

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the CHU Nafissa Hamoud (ex-Hôpital Parnet), Hussein Dey, Alger (July 3, 2016). Written informed consent was obtained from each patient.

## 2.2. Data Collected

For each patient, the following data were collected in a case report form: demographics data, anthropologic data, risk factors of cardiovascular diseases (smoking, arterial hypertension, diabetes, history of ischemic coronary disease, dyslipidemia, familial history of coronary disease, menopause, stroke or transient ischemic attack, peripheral arterial disease, chronic kidney disease, asthma and chronic obstructive pulmonary disease), clinical symptoms, electrocardiogram, biological workup and echocardiography (diameter of left ventricle, left ventricular ejection fraction, pulmonary artery pressure). The 10-year risk of cardiovascular disease was calculated according to Framingham risk score [12] and European risk score [13].

## 2.3. Score of Gensini for Severity of Coronary Lesions

The angiographic cinematograph obtained by intracoronary injection of a contrast medium was viewed. The removal of a possible coronary arterial spasm or spontaneous vasoconstriction or induced by instrumental manipulation was necessary for a good analysis and was obtained by direct intracoronary injection of isosorbide dinitrate before angiography.

Measurements were performed by quantitative analysis using angiographic calculation software integrated into the imaging system of the GE INNOVA 2100 and PHILIPS (Philips Inturis CardioView, QCA version 3.3). The calculation was performed by two different experienced interventional cardiologists. The stenoses were evaluated in two different angles and the minimum diameter was taken into consideration. At the time of the calculation, all investigators were blinded to the clinical data. In case of disagreement, the opinion of a third analyst was sought and the final decision was obtained by consensus.

The severity of atherosclerosis of coronary vessels was graded using the Gensini score [11]. The most severe coronary stenosis of each coronary vessel was quantified according to its degree (diameter reduction 1% - 25%, 1 point; 26% -

50%, 2 points; 51% - 75%, 4 points; 76% - 90%, 8 points; 91% - 99%, 16 points; total occlusion, 32 points). The number of points of each lesion was multiplied by a coefficient depending on the anatomic localization of the lesion: left common artery  $\times 5$ , proximal interventricular artery  $\times 2.5$ , circumflex branch  $\times 2.5$ , middle interventricular artery  $\times 1.5$ , right coronary artery  $\times 1$ , distal interventricular artery  $\times 1$ , posterolateral artery  $\times 1$ , marginal artery  $\times 1$  and all other segments  $\times 0.5$ . The total Gensini score is the sum of the points of all lesions. Patients with a GENSINI score of 20 points or more were considered to have severe coronary lesions [14] [15].

## 2.4. Statistical Analysis

The primary endpoint was the rate of patients with severe coronary lesions (Gensini score  $\geq 20$  points).

The sample size was calculated based on a retrospective analysis performed at the cardiology department of the University Hospital Center of Hussein Dey during 2015. Out of 560 coronary angiographies, 233 presented severe coronary lesion corresponding to a rate of 41.6%. With an estimated first-order risk of 5% and a precision level of at least 5%, a minimum of 374 patients were to be included in the study.

A multivariate logistic regression analysis to determine the independent factors for severe coronary lesions was performed. Significant factors ( $p < 0.10$ ) after univariate analysis were included in the logistic model.

Statistical analyzes were performed using Epi-info version 7.2.2.6 (Center for Disease Control, Atlanta, GA, USA).

## 3. Results

### 3.1. Patient Characteristics

A total of 507 patients meeting eligibility criteria were included in our department. Patients were male in majority (79.7%) and had a mean age of 58.8 years (Table 1). Risk factors of cardiovascular diseases were frequent: smoking (40.0%), diabetes (53.9%), arterial hypertension (44.8%), low HDL-cholesterol (61.1%) and high LDL-cholesterol (52.4%). The Framingham score was  $>20\%$  (high risk) in 16.4% of patients, more frequently in men than in women (19.1% vs. 5.8%, respectively). The European risk score was high in 63.6% of patients.

Coronary angiography was prescribed most frequently in 46.9% of patients for myocardial infarction (with ST-segment elevation (STMI) and in 38.1% for non-ST-segment elevation (NSTMI).

### 3.2. Severity of Coronary Lesions and Risk Factors

The lesions of coronary arteries are described in Table 2. They were most frequently monotruncular (27.4%), tritruncular (27.0%) or bitruncular (18.9%) and involved most frequently the left anterior descending artery (71.0%), left circumflex artery (52.7%) and right coronary artery (51.7%). A total of 236 (58.4%)

**Table 1.** Patient characteristics.

	<b>Analysis population (N = 507)</b>
Age, years, mean (SD)	58.8 (10.7)
Male sex, n (%)	404 (79.7)
Body mass index $\geq 30$ kg/m <sup>2</sup> (obesity), n (%)	115 (22.7)
Smoking, n (%)	203 (40.0)
Arterial hypertension, n (%)	227 (44.8)
Diabetes, n (%)	273 (53.9)
Renal failure, n (%)	89 (17.6)
LDL-cholesterol > 1 g/L, n (%)	266 (52.4)
Low HDL-cholesterol, n (%)	310 (61.1)
Dyslipidemia, n (%)	54 (10.7)
Lipid-lowering treatment (statins), n (%)	42 (8.3)
History of coronary disease, n (%)	
Stable angor	36 (7.1)
Myocardial infarction	25 (4.9)
Unstable angor	8 (1.6)
Family history of early coronary artery disease, n (%)	57 (11.2)
History of stroke/transient ischemic attack, n (%)	9 (1.8)
Left ventricular dysfunction, n (%)	192 (47.5)
Framingham score > 20%, n (%)	83 (16.4)
High risk European score, n (%)	222 (63.6)
Reasons for coronary angiography, n (%)	
Acute coronary syndrome	
ST-segment elevation myocardial infarction (STMI)	238 (46.9)
Non-ST-segment elevation myocardial infarction (NSTMI)	193 (38.1)
Post-myocardial infarction	23 (4.5)
Exploration	
Exercise-induced angina	33 (6.5)
Positive ischemia test	41 (8.0)
Preoperative workup	8 (1.5)
Dilated or obstructive cardiomyopathy	6 (1.1)
Silent ischemia	1 (0.2)

patients had lesions of left main coronary artery or bi- or tritroncular lesions which are anatomically considered as severe lesions.

The mean Gensini score was 47.0 (95% CI 43.7 - 50.3) and the rate of severe

**Table 2.** Localization of coronary lesions and severity according to Gensini score.

	<b>Analysis population (N = 507)</b>
Type of coronary lesions, n (%)	
Healthy	25 (4.9)
No significant lesions	52 (10.3)
Monotroncular	139 (27.4)
Bitroncular	96 (18.9)
Tritroncular	137 (27.0)
Left main coronary artery-monotroncular	7 (1.4)
Left main coronary artery-bitroncular	11 (2.2)
Left main coronary artery-tritroncular	40 (7.9)
Anatomical localization, n (%)	
Left main coronary artery	58 (11.5)
Left anterior descending artery	360 (71.0)
Left circumflex artery	267 (52.7)
Right coronary artery	262 (51.7)
Gensini score	
Mean	47.0
95% CI	43.7 - 50.3
Gensini score $\geq$ 20 (severe lesions), n (%)	
All	353 (69.6)
Men	295 (73.0)
Women	58 (56.3)

coronary lesions (score  $\geq$  20) was 69.6% (95% CI 65.5 - 73.5). This rate was higher in men compared to women (73.0% vs. 56.3%).

Univariate analysis showed that some factors were significantly associated ( $p < 0.10$ ) to severe coronary lesions: age (odds ratio [OR] 2.31;  $p < 0.001$ ), history of acute coronary syndrome (2.12,  $p = 0.09$ ), male sex (OR 2.10,  $p < 0.001$ ), left ventricular dysfunction (OR 1.93,  $p = 0.001$ ), renal failure (OR 1.90,  $p = 0.02$ ), diabetes (OR 1.89,  $p = 0.001$ ), high Framingham risk score (OR 1.69,  $p = 0.05$ ), diabetes duration (OR 1.63,  $p = 0.05$ ), high European risk score (OR 1.54,  $p = 0.08$ ), smoking (OR 1.39,  $p = 0.09$ ), dyslipidemia (OR = 0.59,  $p = 0.08$ ) and lipid-lowering treatment (OR 0.55,  $p = 0.06$ ) (**Table 3**).

In multivariate analysis, the independent predictive factors of severe coronary lesions were male sex (OR 2.00;  $p = 0.0141$ ), diabetes (OR 1.92;  $p = 0.0070$ ), left ventricular dysfunction (OR 1.81;  $p = 0.0059$ ), age (OR 1.72;  $p = 0.0297$ ) and no lipid-lowering treatment (OR, 0.47;  $p = 0.0388$ ) (**Table 4**).

**Table 3.** Factors associated with severe coronary lesions (univariate analysis).

	Severe lesions n (%)	Odds ratio	95% CI	P-value
Age, years (>50 for men; >60 for women)	283 (74.3)	2.31	1.52 - 3.15	<0.001
History of acute coronary syndrome	28 (82.3)	2.12	0.86 - 5.24	0.09
Male sex	295 (73.0)	2.10	1.34 - 3.28	<0.001
Left ventricular dysfunction	162 (45.9)	1.93	1.29 - 2.88	0.001
Renal failure	71 (20.1)	1.90	1.09 - 3.32	0.02
Diabetes	207 (75.8)	1.89	1.28 - 2.77	0.001
High Framingham risk score	68 (19.3)	1.69	0.98 - 2.93	0.05
Diabetes duration	82 (77.4)	1.63	0.99 - 2.70	0.05
High European risk score	84 (23.8)	1.54	0.94-2.50	0.08
Smoking	149 (42.2)	1.39	0.94 - 2.06	0.09
Elevated triglycerides	139 (39.4)	1.35	0.90 - 2.01	0.13
Low HDL	219 (62.0)	1.13	0.76 - 1.66	0.53
Pulmonary arterial hypertension	86 (24.4)	1.09	0.69-1.71	0.69
Arterial hypertension	157 (44.5)	0.96	0.65 - 1.40	0.83
Abdominal obesity	212 (60.1)	0.86	0.58 - 1.27	0.44
Obesity	73 (20.7)	0.70	0.45 - 1.08	0.11
History of coronary disease	35 (9.9)	0.66	0.37 - 1.16	0.15
Dyslipidemia	32 (9.1)	0.59	0.33 - 1.06	0.08
Lipid-lowering treatment	24 (6.8)	0.55	0.28 - 1.04	0.06

**Table 4.** Independent predictive factors of severe coronary lesions (multivariate analysis).

	Adjusted odds ratio	95% CI	P-value
History of coronary disease	2.07	0.80 - 5.35	0.1327
Male sex	2.00	1.15 - 3.49	0.0141
Diabetes	1.92	1.19 - 3.10	0.0070
Left ventricular dysfunction	1.81	1.18 - 2.76	0.0059
Age	1.72	1.05 - 2.81	0.0297
Renal failure	1.68	0.91 - 3.09	0.0924
Smoking	1.53	0.96 - 2.45	0.0709
Diabetes duration	1.22	0.65 - 2.26	0.5263
Low HDL	1.19	0.78 - 1.82	0.4132
High Framingham risk score	1.15	0.63 - 2.10	0.6372
High European risk score	0.98	0.56 - 1.70	0.9611
Lipid-lowering treatment	0.47	0.23 - 0.96	0.0388

## 4. Discussion

This study is the first to our knowledge to evaluate severity and risk factors of coronary lesions in patients with CAD in a Maghreb country. The mean Gensini score was at 47.0 with severe coronary lesions defined as Gensini score  $\geq 20$  being present in about two patients out of three. The patients included in our study were mainly male and had frequently expected risk factors of CAD. Thus, almost half of patients reported smoking, arterial hypertension, mellitus diabetes or elevated LDL-cholesterol. These rates of risk factors are high, but were expected. In a comparable recent study performed in Israel by Charach *et al.*, high rates of risk factors were also reported in 417 patients with CAD-related symptoms who underwent clinically indicated coronary angiography: hypertension (73.6%), dyslipidemia (71.7%), diabetes (44.2%) and smoking (31.8%) [16]. Mean Gensini score was 66.7; the lower age of patients in our study is a possible explanation for this difference in the Gensini score (58.8 vs. 67.8 years).

An older study conducted in Tunisia reported clinical and coronary angiography data among 157 patients with a mean age of 60 years who had a primary postero-diaphragmatic infarction and a right coronary artery which was the most frequently stenotic artery (76%) [17]. In these patients, the most frequent risk factors were smoking (83%), followed by diabetes (37%), arterial hypertension (30%) and dyslipidemia (21%) [17]. Patients with 3 or more risk factors had much more tritruncal (50%) than monotruncal (16%) or bitruncal (12%) involvement.

Many other studies performed worldwide tempted to establish a relationship between one or more risk factors and the severity of coronary lesions. The study of Raichlen *et al.* performed in the United States evaluated the progression of CAD in patients who had undergone two coronary angiography examinations with a time interval of at least 2 years [18]. Blood pressure, cigarette smoking, diabetes mellitus and physical activity were identified as important risk factors in the progression of CAD [18]. Horimoto *et al.* showed in a multivariate analysis that age, male gender, Apo B/Apo A-I, diabetes, arterial hypertension and smoking were independent predictive factors of the severity of coronary atherosclerosis in Japanese CAD patients [19]. In the Greek study of Koliaki *et al.* in 1228 patients, smoking was the most important predictive factor for angiographically significant CAD, followed by dyslipidemia, diabetes, family history and hypertension [20].

The classical cardiovascular risk factors are major predictors of the prevalence of CAD. However, the relationship between these factors and the severity of lesions documented by coronary angiography could be more complex. In addition, the association of the risk factors with lesion severity may differ from population to population. Our multivariate analysis performed in an Algerian cohort indicates that the up-to-date risk factors of severe coronary lesions for this population are male sex, diabetes left ventricular dysfunction, age and the absence of lipid-lowering treatment. These results will enable us to better manage



coronary patients in our cardiology department of Hussein Dey University Hospital Center. Indeed, it is important to investigate the severity of coronary artery disease, not only because of its prognostic impact, but also because of the therapeutic consequences. Severe lesions can occur despite pauci-symptomatic or asymptomatic CAD. It is therefore important to identify these at-risk patients, as they should be explored at the asymptomatic stage before the event and receive prompt treatment with angioplasty or surgery.

Our study was based on the Gensini score which is used for quantifying the severity of CAD since its first description in 1975 [11]. The Gensini score was developed to consider in a unique parameter the complexity of the main characteristics of each coronary lesion: severity score, region multiplying factor and collateral adjustment factor [11]. Many methods have been developed to score coronary lesions, Gensini score and CASS-70 being the most widely used [6]. These two scores have been shown to be strongly correlated ( $r = 0.90$ ;  $p < 0.0001$ ) in 3600 CAD patients to quantify the severity of coronary lesions in CAD [6].

The recent study of Cheng *et al.* opened interesting perspectives in the prediction of severe coronary lesions [6]. Considering that CAD is an inflammatory disease, these authors have studied serum interferon as a possible risk factor of severe coronary lesions. In 155 CAD patients diagnosed by coronary angiography, the degree of stenosis was positively correlated with serum interferon- $\gamma$  (IFN- $\gamma$ ), monokine induced by IFN- $\gamma$  (MIG) and IFN- $\gamma$ -inducible protein 10 (IP-10) levels. MIG and IP-10 were independent predictors of Gensini score. Combined with classical risk factors of coronary lesion severity, such noninvasive biomarkers could help to screen patients at risk of coronary stenosis before the cardiovascular event.

Our study has some limitations. It was performed in a single center and therefore our cohort could be not representative of the population of Algerian CAD patients who undergo clinically-indicated coronary angiography. Patients who did not sign the consent have not been described and this is another possible bias. Some of the data collected such as comorbidities or medical history relied on patients' memory, which is also a limitation of the study.

## 5. Conclusion

Severe coronary lesions were present in two out three patients in this cohort of Algerian patients undergoing coronary angiography. Predictive factors of severe coronary lesions were male sex, diabetes, age, left ventricular dysfunction and no lipid-lowering treatment. It is important to identify these at-risk patients, as they should be explored at an asymptomatic stage before a cardiovascular event and receive prompt treatment with angioplasty or surgery.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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