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Characteristics of Non-Obstructive Coronary Syndromes (Minoca, Inoca, Anoca): A Cross-Sectional Study in a First Interventional Cardiology Center in Central Africa

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Abstract

Introduction: Non-Obstructive Coronary Syndromes (NOCS), including MINOCA, INOCA, and ANOCA, represent a growing proportion of coronary syndromes still poorly documented in Sub-Saharan Africa. **Objective:** To describe the epidemiological, clinical, angiographic, and therapeutic characteristics of NOCS and compare them with Obstructive Coronary Syndromes (OCS) in patients managed in Yaoundé. **Methods:** This was a descriptive and analytical cross-sectional study conducted over a three-year period (November 2022-November 2025) at the Yaoundé General Hospital. All consecutive patients admitted for coronary syndrome who underwent coronary angiography were included. Patients were classified as NOCS or OCS based on the presence or absence of coronary lesions ≥ 50% via Quantitative Coronary Angiography (QCA). Statistical analysis was performed using SPSS 26.0. **Results:** Out of 111 patients presenting with coronary syndrome, 25 (22.5%) had NOCS. Patients with NOCS were significantly younger than those with OCS. Unstable angina was more frequent in the NOCS group. Dual Antiplatelet Therapy (DAPT) was less frequently utilized in these patients. **Conclusion:** NOCS constitutes a frequent and clinically relevant entity in Yaoundé. Their recognition necessitates an individualized diagnostic and therapeutic approach, even in the absence of significant coronary stenosis.

Keywords

Non-Obstructive Coronary Syndrome, MINOCA, INOCA, ANOCA,

Coronary Angiography, Cameroon

1. Introduction

These clinical presentations are now grouped under the term Non-Obstructive Coronary Syndromes (NOCS), which include MINOCA (Myocardial Infarction with Non-Obstructive Coronary Arteries), INOCA (Ischemia with Non-Obstructive Coronary Arteries), and ANOCA (Angina with Non-Obstructive Coronary Arteries) [1] [2]. Long regarded as benign or transient entities, NOCS are now recognized as distinct clinical conditions associated with significant cardiovascular risk and a substantial impairment of quality of life [2] [3].

The pathophysiological mechanisms of NOCS are multifaceted and complex. They notably include coronary microvascular dysfunction, coronary vasospasm, non-obstructive plaque rupture or erosion, transient thrombosis, spontaneous coronary artery dissection, and certain non-ischemic myocardial causes [4]. This heterogeneity explains the diagnostic challenges and the variability in therapeutic strategies observed in clinical practice.

Recent international guidelines, particularly those from the European Society of Cardiology, emphasize the need to better identify these entities, to no longer consider a "normal" coronary angiography as inherently reassuring, and to adopt an individualized diagnostic and therapeutic approach [5] [6]. Despite this, data from low- and middle-income countries, particularly in Sub-Saharan Africa, remain limited, even as the burden of cardiovascular disease in these regions continues to rise.

In this context, this study aimed to describe the epidemiological, clinical, angiographic, and therapeutic characteristics of non-obstructive coronary syndromes and to compare them with obstructive coronary syndromes in patients managed at the primary and only coronary angiography laboratory in Yaoundé.

2. Materials and Methods

2.1. Study Setting and Design

Yaoundé, the political capital of Cameroon, is home to the country's first and only cardiac catheterization laboratory. Functional since November 2022 at the Yaoundé General Hospital, the facility is operated by a single interventional cardiologist. We conducted a descriptive and analytical cross-sectional study over a three-year period, spanning from November 8, 2022, to November 8, 2025.

2.2. Data Source and Study Population

Data were obtained from the Yaoundé interventional cardiology registry, known as DéRICA (*yaounDé Registry of Interventional Cardiology Achievements*). This registry records all patients admitted to the cardiac catheterization unit within the Cardiovascular Exploration Department of the Yaoundé General Hospital. The

laboratory was equipped with a SIEMENS® Artis One coronary angiography system.

2.3. Eligibility Criteria

All consecutive adult patients referred to the catheterization laboratory between November 8, 2022, and November 8, 2025, who underwent coronary angiography for suspected coronary artery disease were eligible.

This included patients presenting with Acute Coronary Syndrome (ACS), defined as ST-Elevation Myocardial Infarction (STEMI), Non-ST-Elevation Myocardial Infarction (NSTEMI), or unstable angina, as well as patients with Chronic Coronary Syndrome (CCS), including stable angina or documented myocardial ischemia.

Patients undergoing coronary angiography for non-ischemic indications (such as valvular heart disease, congenital heart disease, or pre-operative evaluation without suspected coronary disease) were excluded.

"No other clinical indications (such as isolated arrhythmia, preoperative assessment without ischemic suspicion, or structural heart disease) were included in the present analysis."

Patients were subsequently divided into two groups based on angiographic findings:

Non-Obstructive Coronary Syndrome (NOCS) was defined as the absence of any coronary stenosis ≥50% on Quantitative Coronary Angiography (QCA). All lesions less than 50% luminal diameter reduction were classified as non-obstructive. Lesions exactly 50% were classified as obstructive and therefore included in the OCS group.

Obstructive Coronary Syndrome (OCS) was defined as the presence of at least one coronary stenosis ≥50% on QCA.

Diagnostic classification within the NOCS group

MINOCA was defined according to the Fourth Universal Definition of Myocardial Infarction as:

- A rise and/or fall of cardiac troponin with at least one value above the 99th percentile upper reference limit;
- Clinical evidence of myocardial ischemia (ischemic symptoms, ECG changes, or imaging evidence);
- Absence of coronary stenosis ≥50% on angiography.

Alternative causes of troponin elevation such as myocarditis, takotsubo cardiomyopathy, pulmonary embolism, or severe supply-demand mismatch were evaluated based on clinical presentation, ECG findings, echocardiography, and laboratory data. However, systematic cardiac MRI was not available.

INOCA was defined as objective evidence of myocardial ischemia (positive stress testing or imaging) in the absence of coronary stenosis ≥50%.

ANOCA was defined as angina symptoms without troponin elevation or objective ischemia, in the absence of coronary stenosis ≥50%.

2.4. Variables Studied

The analyzed variables included:

- Socio-demographic data (age, sex);
- Medical history, cardiovascular risk factors, and comorbidities;
- Medical treatments prior to admission;
- Clinical characteristics at admission;
- Angiographic and procedural data.

Revascularization strategy and heart Team decision process

Revascularization decisions were made by the interventional cardiologist according to angiographic findings and clinical presentation.

Heart Team discussions were performed in selected cases of complex coronary anatomy (e.g., suspected multivessel disease or left main involvement) or uncertainty regarding optimal revascularization strategy.

These discussions occurred after diagnostic coronary angiography and were not based on pre-specified anatomical criteria but rather on operator discretion and local practice.

2.5. Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics version 26.0. Quantitative variables were expressed as mean ± standard deviation and compared using appropriate tests based on their distribution. Qualitative variables were expressed as frequencies and percentages and compared using chi-square tests or Fisher's exact test, as appropriate.

Associations were considered statistically significant at a value of $p < 0.05$. Due to the limited number of NOCS events (n = 25), multivariable logistic regression was not performed in order to avoid model overfitting and unstable estimates. Therefore, only univariate logistic regression analyses were conducted to identify factors associated with NOCS, with results expressed as Odds Ratios (OR) and 95% Confidence Intervals (CI).

3. Results

3.1. Study Population

A total of 115 patients were admitted to the coronary angiography laboratory for various indications. Of these, 111 patients presented with a coronary syndrome, including both Chronic Coronary Syndromes (CCS) and Acute Coronary Syndromes (ACS).

Twenty-five patients (22.5%) presented with Non-Obstructive Coronary Syndrome (NOCS), while 86 patients (77.5%) had Obstructive Coronary Syndrome (OCS).

Among those with NOCS, the distribution was as follows:

- Myocardial Infarction with Non-Obstructive Coronary Arteries (MINOCA): 11 cases (44%);
- Ischemia with Non-Obstructive Coronary Arteries (INOCA): 8 cases (32%);

- Angina with Non-Obstructive Coronary Arteries (ANOCA): 6 cases (24%).

3.2. Socio-Demographic Characteristics

The mean age of the overall population was 57.72 ± 11.29 years, with a range of 27 to 82 years. Patients presenting with NOCS were significantly younger than those with OCS, with a mean age of 50.29 ± 12.43 years versus 59.90 ± 10.01years ($p < 0.001$).

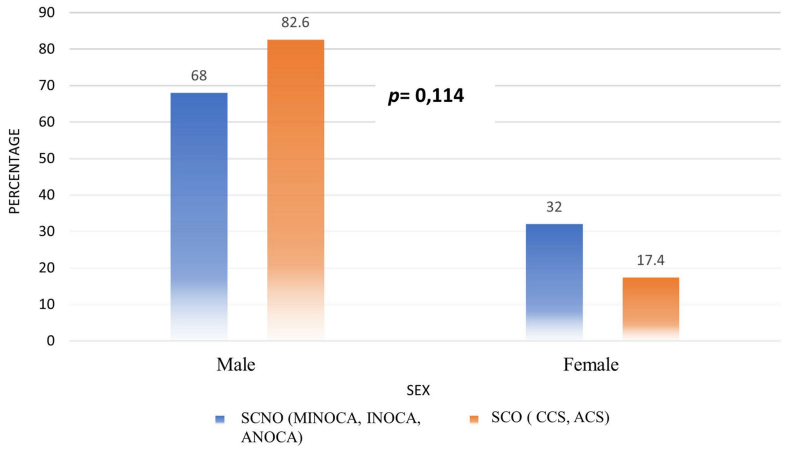
The age groups ≤40 years and 41 - 50 years were more frequent among NOCS patients, showing statistically significant associations. Conversely, the 61 - 70 age group was less represented in the NOCS group. Table 1 below details these socio-demographic characteristics.

Table 1. Socio-demographic characteristics of NOCS patients compared to OCS patients.

Variables	NOCS (n = 25)	OCS (n = 86)	p-value	OR (95% CI)
Mean Age ± SD	50.29 ± 12.43	59.90 ± 10.01	**< 0.001**	Mean Diff = −9.66 (−14.23 - −4.89)
Age Groups (years)				
≤ 40	5 (20)	3 (3.5)	**0.014**	6.92 (1.52 - 31.38)
[41 - 50]	7 (28)	9 (10.5)	**0.048**	3.33 (1.09 - 10.13)
[51 - 60]	9 (36)	33 (38.4)	1.00	0.90 (0.36 - 2.28)
[61 - 70]	2 (8)	29 (33.7)	**0.011**	0.17 (0.04 - 0.78)
> 70	2 (8)	12 (14)	0.732	0.54 (0.11 - 2.57)

NOCS: Non-Obstructive Coronary Syndrome; **OCS**: Obstructive Coronary Syndrome; **SD**: Standard Deviation; **OR**: Odds Ratio; **CI**: Confidence Interval.

The sex distribution showed a male predominance in both groups, with no statistically significant difference between NOCS and OCS ($p = 0.114$). Figure 1 below illustrates the distribution of NOCS and OCS according to age.



SCNO: Non-Obstructive Coronary Syndrome; SCO: Obstructive Coronary Syndrome.

Figure 1. Distribution of NOCS and OCS patients by sex.

3.3. Medical History, Comorbidities, and Cardiovascular Risk Factors

Prior coronary history was more frequent among NOCS patients compared to those with OCS (16% vs. 3.5%), with a statistically significant difference (p = 0.044).

Hypertension was significantly less frequent in the NOCS group compared to the OCS group (56% vs. 79.1%, p = 0.021). The prevalence of diabetes, dyslipidemia, and smoking did not differ significantly between the two groups.

Heart failure was less common in NOCS patients (4% vs. 26.7%, p = 0.015).

Regarding associated heart diseases, ischemic heart disease was significantly less represented in the NOCS group (12% vs. 53.5%, p < 0.001). Hypertensive heart disease showed a comparable frequency in both groups.

Elevated lipoprotein(a) concentrations were less frequent among NOCS patients (25% vs. 50.8%, p = 0.043). An impaired left ventricular ejection fraction (LVEF < 50%) was also less frequent in the NOCS group (20% vs. 56.5%, p = 0.001). These data are summarized in Table 2 below.

3.4. Medical Treatments Prior to Admission

Dual Antiplatelet Therapy (DAPT) was less utilized in NOCS patients compared to those with OCS (80% vs. 96.5%, p = 0.014). The use of Optimal Medical Therapy (OMT) showed no statistically significant difference between the two groups. Table 2 below describes these medication histories.

Table 2. Medical history, comorbidities, cardiovascular risk factors, and prior treatments in NOCS and OCS patients.

Variables	NOCS (n = 25)	OCS (n = 86)	p value	OR (CI 95%)
Medical History				
Prior coronary history	4 (16)	3 (3.5)	**0.044**	5.27 (1.09 - 25.37)
Hypertension	14 (56)	68 (79.1)	0.021	0.34 (0.13 - 0.86)
Diabetes	5 (20)	27 (31.4)	0.268	0.55 (0.19 - 1.61)
Dyslipidemia	9 (36)	46 (53.5)	0.124	0.49 (0.19 - 1.23)
Smoking	2 (8)	7 (8.1)	1.00	0.98 (0.19 - 5.05)
Heart failure	1 (4)	23 (26.7)	**0.015**	0.11 (0.02 - 0.89)
Heart Diseases				
Hypertensive heart disease	13 (52)	45 (52.5)	0.977	0.99 (0.41 - 2.41)
Ischemic heart disease	3 (12)	46 (53.5)	<0.001	0.12 (0.03 - 0.43)
Mixed heart disease	2 (8)	22 (25.6)	0.060	0.25 (0.06 - 1.16)
Comorbidities				
HIV infection	1 (4)	4 (4.7)	1.00	0.85 (0.09 - 8.01)
Elevated LP(a) (≥50 mg/dl), n = 85	5 (25)	33 (50.8)	**0.043**	0.32 (0.11 - 0.99)
Impaired LVEF (< 50%)	5 (20)	48 (56.5)	**0.001**	0.19 (0.07 - 0.56)

Continued

Medical Treatments Prior to Admission				
DAPT	20 (80)	83 (96.5)	**0.014**	0.15 (0.03 – 0.66)
OMT	14 (56)	63 (73.3)	0.099	0.46 (0.18 – 1.17)

NOCS: Non-Obstructive Coronary Syndrome; **OCS**: Obstructive Coronary Syndrome; **Lp (a)**: Lipoprotein (a); **LVEF**: Left Ventricular Ejection Fraction; **DAPT**: Dual Antiplatelet Therapy; **OMT**: Optimal Medical Therapy; **OR**: Odds Ratio; **CI**: Confidence Interval.

3.5. Clinical, Angiographic, and Procedural Characteristics

The time delay before admission did not differ significantly between the NOCS and OCS groups. The presence of chest pain at admission was comparable in both groups.

The indications for coronary angiography were dominated by ACS in both groups, with no significant difference between NOCS and OCS. Among the types of ACS, unstable angina was significantly more frequent in NOCS patients, whereas STEMI was more frequent in the OCS group.

Right coronary dominance was the most common in both groups. No left dominance was observed among NOCS patients, in contrast to the OCS group, where it was present in 16.3% of cases.

3.6. Baseline Clinical and Biological Presentation

Among patients classified as MINOCA, all fulfilled the biological criteria for myocardial infarction with elevated cardiac troponin levels consistent with the Fourth Universal Definition of Myocardial Infarction. ST-segment elevation was less frequent in the NOCS group compared to OCS, whereas unstable angina predominated.

Echocardiographic evaluation showed a lower prevalence of regional wall motion abnormalities and impaired Left Ventricular Ejection Fraction (LVEF < 50%) in the NOCS group, consistent with the lower burden of myocardial necrosis observed in these patients.

No systematic intracoronary imaging (IVUS or OCT) or coronary functional testing was performed to further characterize the underlying mechanisms.

The radial approach was the most frequently used access site in both groups, with no statistically significant difference.

3.7. Treatment Patterns in NOCS vs OCS

Pre-admission therapy was more frequently recorded for patients with OCS, reflecting established cardiovascular risk management. During hospitalization, antithrombotic therapy (dual antiplatelet therapy or single antiplatelet) and guideline-recommended medical therapy (beta-blockers, statins, ACE inhibitors/ARBs) were administered according to ACS presentation and standard protocols.

At discharge, most NOCS patients received Optimal Medical Therapy (OMT)

including antiplatelets, statins, and renin-angiotensin-aldosterone system inhibitors, tailored to the presumed mechanism of myocardial injury. DAPT was prescribed primarily in patients with suspected plaque-related events, while OMT alone was preferred for those with likely microvascular dysfunction or spasm, acknowledging the lack of intracoronary imaging to definitively identify the underlying mechanism.

This stratification highlights that treatment decisions were guided by clinical suspicion of pathophysiological mechanisms, ensuring that NOCS patients received appropriate secondary prevention despite diagnostic limitations. Table 3 below describes these angiographic and procedural characteristics.

Table 3. Clinical, angiographic, and procedural characteristics of NOCS patients compared to OCS patients.

Variables	NOCS (n = 25)	OCS (n = 86)	p-value	OR (CI 95%)
Time to admission				
<24 hrs	2 (8)	6 (7)	1.00	1.16 (0.22 - 6.13)
[1 - 30] days	14 (56)	51 (59.3)	0.768	0.87 (0.36 - 2.15)
[1 - 3] months	2 (8)	12 (14)	0.732	0.54 (0.11 - 2.57)
>3 months	7 (28)	17 (19.8)	0.379	1.58 (0.57 - 4.39)
Chest pain at the admission				
Yes	11 (44)	43 (50)	0.597	0.44 (0.32 - 1.92)
No	14 (56)	43 (50)		1.27 (0.52 - 3.12)
Indications				
SCA	20 (80)	65 (75.6)	0.646	1.29 (0.43 - 3.87)
SCC	5 (20)	21 (24.4)		0.77 (0.26 - 2.32)
Types of ACS				
STEMI	8 (32)	43 (50)	0.112	0.47 (0.18 - 1.21)
NSTEMI	3(12)	15 (17.4)	0.759	0.64 (0.17 - 2.44)
Unstable Angina	9 (36)	5 (5.8)	< 0.001	9.11 (2.69 - 30.79)
n = 110				
Right	19 (79.2)	54 (62.8)	0.133	2.25 (0.76 - 6.62)
Left	0	14 (16.3)	**0.037**	
Balanced	5 (20.8)	18 (20.9)	0.992	0.94 (0.31 - 2.86)
Access				
Femoral	7 (28)	32 (37.2)	0.396	0.66 (0.25 - 1.74)
Radial	18 (72)	54 (62.8)		1.52 (0.57 - 4.05)

NOCS: Non-Obstructive Coronary Syndrome; **OCS**: Obstructive Coronary Syndrome; **OR**: Odds Ratio; **CI**: Confidence Interval.

4. Discussion

In this series of patients undergoing coronary angiography, 22.5% presented with a Non-Obstructive Coronary Syndrome (NOCS). This rate is higher than the

prevalence of MINOCA reported in several registries of patients undergoing angiography for myocardial infarction (approximately 6% - 8%), potentially reflecting a broader inclusion that encompasses INOCA and ANOCA entities in addition to classic MINOCA [2]. Our NOCS patients were significantly younger than those with obstructive coronary artery disease, which aligns with observations that non-obstructive forms often affect younger patients or those with a different risk profile [3].

NOCS patients exhibited a lower prevalence of hypertension, less left ventricular dysfunction, and less associated ischemic heart disease compared to patients with coronary obstruction. This profile is consistent with the heterogeneous pathophysiology of NOCS, which frequently relies on non-atherosclerotic mechanisms such as microvascular dysfunction, coronary spasms, transient thrombosis, or spontaneous coronary artery dissection [7]. Indeed, MINOCA is not a benign form of infarction but a multifaceted entity where angiography may appear normal despite profound pathophysiological lesions [8].

In our cohort, the male predominance in NOCS was not statistically different from that observed in obstructive disease; this may diverge from international data suggesting a higher prevalence of MINOCA among women in certain populations [3]. This discrepancy could be attributed to our small sample size, as despite the lack of statistical significance, a higher proportion of NOCS was observed in women with a p-value approaching significance ($P = 0.114$).

The search for atherosclerosis not visible on standard angiography (for example, via intracoronary imaging) was not systematic in this study. However, data suggest that phenomena such as underlying plaque rupture or erosion, transient thrombosis, or microembolization may be present even when angiography shows non-obstructed coronary arteries [7]. Similarly, in INOCA and ANOCA forms, microvascular dysfunction and spasm are major mechanisms explaining myocardial ischemia in the absence of macroscopic obstruction [2].

Regarding management, our results show a lower utilization of dual antiplatelet therapy in NOCS compared to obstructive coronary artery disease, reflecting persistent uncertainty and variability in clinical practices. Current guidelines recommend an individualized approach based on the identification of the underlying mechanism (e.g., antithrombotic therapy if a thrombotic mechanism is suspected, or vasodilator therapy for spasms), although high-quality evidence is still lacking for certain specific therapeutic options [9].

Contemporary international guidelines emphasize that revascularization decisions in patients with complex coronary anatomy [10], particularly those with multivessel disease, left main coronary artery involvement [11], or diabetes [12], should rely on a structured multidisciplinary Heart Team approach. In patients with diabetes and multivessel coronary artery disease, surgical revascularization is frequently favored over percutaneous coronary intervention due to improved long-term cardiovascular outcomes [13]. These recommendations highlight the importance of individualized decision-making and reinforce the need for struc-

tured evaluation pathways, even in resource-limited settings where interventional cardiology services are emerging.

In the absence of systematic intracoronary imaging or functional testing, the choice of therapy in NOCS patients was guided by clinical suspicion of the underlying mechanism. Patients with features suggestive of plaque-related events (e.g., elevated troponin with ECG changes consistent with myocardial infarction) were preferentially prescribed Dual Antiplatelet Therapy (DAPT) in addition to guideline-recommended medical therapy (beta-blockers, statins, ACE inhibitors/ARBs).

For patients in whom microvascular dysfunction, vasospasm, or non-plaque-related mechanisms were more likely, single antiplatelet therapy or Optimal Medical Therapy (OMT) alone was favored. This approach allowed tailored secondary prevention despite diagnostic uncertainty, ensuring that each patient received therapy aligned with the most probable pathophysiological mechanism. While the absence of definitive intracoronary characterization limits the precision of treatment attribution, this pragmatic, mechanism-based strategy reflects current expert recommendations for the management of NOCS/MINOCA.

These results have several clinical implications. First, the recognition of NOCS must be systematic in patients presenting with ischemic symptoms or myocardial infarction without significant angiographic obstruction, as these patients are not free from cardiovascular risk and require a thorough evaluation of the underlying mechanisms. Second, functional exploration (e.g., provocation tests, intracoronary imaging, microvascular assessment) should be encouraged to refine the diagnosis and tailor treatment [9]. Finally, our results emphasize the importance of optimizing secondary prevention even in patients without obstruction, as they remain at risk for subsequent cardiovascular events.

5. Limits

This study presents several limitations. The cross-sectional design of this study limits causal inference. Our findings support associations rather than a causalty effect relationships. Furthermore, a single-center study based on a coronary angiography population, may introduce selection bias by including primarily patients referred for invasive evaluation, potentially over-representing higher-risk ACS cases.

The retrospective nature of the study and its small sample size limit the statistical power, robust multivariable adjustment, and the generalizability of the findings. The lack of systematic intracoronary imaging (such as IVUS or OCT) or functional testing for all NOCS patients restricts the ability to precisely define the underlying pathophysiological mechanisms. As a result, mechanisms such as microvascular dysfunction and ccoronary vasospasm weren't assessed in our cohort. We carefully applied standardized diagnostic algorythms; some cases of MINOCA or other NOCS subtypes may remain misclassified due to incomplete testing. The long-term impact of the various therapeutic strategies was not evaluated in this study. Detailed information regarding diabetes type, duration, treatment modal-

ity, and glycemic control (HbA1c) was not systematically available in the registry and therefore could not be analyzed in this study.

6. Conclusions

Non-obstructive coronary syndromes represent a non-negligible proportion of coronary syndromes managed in the catheterization laboratory in Yaoundé. In this study, they primarily affected younger patients with a generally less pronounced cardiovascular risk profile, including a lower prevalence of hypertension, left ventricular dysfunction, and associated ischemic heart disease compared to obstructive coronary syndromes. Unstable angina was strongly associated with NOCS patients, highlighting the diversity of clinical presentations.

These results confirm that the absence of significant coronary stenosis does not exclude clinically relevant coronary pathology. They underscore the need for systematic recognition of NOCS and an individualized diagnostic and therapeutic approach based on the underlying pathophysiological mechanisms. Strengthening functional diagnostic capabilities and developing local registries could improve the management and understanding of these entities in resource-limited settings.

Author Contributions

All authors contributed to the study conception, analysis, interpretation, and drafting of this work. Consequently, all authors assume responsibility for all aspects of the manuscript.

Ethical Considerations

All patients provided free, informed, and written consent prior to coronary angiography. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

The study was reviewed and approved by the Ethics and Pharmacovigilance Committee of the Yaoundé General Hospital prior to initiation. Formal reference numbering was not systematically assigned at the time of approval, but written institutional authorization was obtained and archived locally.

This study was reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for cross-sectional studies.

Conflicts of Interest

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

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