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Original article

The Outcomes of Occlusive vs Non-Occlusive Culprit Coronary Artery in Non-ST-Segment Elevation Acute Coronary Syndrome (NSTEACS): A Descriptive Prospective Study in a Tertiary Cardiac Centre in Sudan

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Abstract

Background: Non-ST-segment elevation acute coronary syndrome (NSTEACS) is a common presentation of acute coronary syndrome. Revascularization as treatment for Acute Coronary syndrome in the republic of Sudan is free to all comers whether STEMI of NSTEMI. Urgent revascularization within the 24hrs mark, however, is only offered to patients with STEMI, as the ST segment elevation in the presenting ECG is believed to indicate an occluded culprit coronary artery and hence, the urgency to open the occluded culprit artery. This puts patients with NSTEMI categorically in a different lower risk stratum in terms of urgency for treatment. The frequency and outcomes of NSTEMI patients with occluded culprit coronary artery despite absence of ECG ST elevation in Africa, as general, are yet to be fully elucidated. ***Objectives:*** This prospective single study aimed to investigate the frequency and outcomes of NSTEMI (No ST segment elevation) Sudanese patients proven to have an occluded culprit coronary artery (TIMI flow 0). ***Methods:*** In this prospective single-center study, 100 NSTEACS conductive patients who were admitted to Al-Shaab Teaching Hospital Khartoum- Sudan from January to April 2022 were examined. Data regarding demographics, medical history, clinical presentations, laboratory investigation, electrocardiography (ECG) findings, echocardiogram, coronary angiography (CAG), management strategies, medications at discharge and follow up, 30-day outcomes, and 6-month mortality rates were collected. All patients underwent standard medical management and CAG within 24-48 hours of admission. ***Results:*** In total, 100 consecutive patients with NSTEACS were enrolled in this study, with 20% (n = 20) having occluded culprit artery (OCA) and 80% (n = 80) have no occluded culprit artery (non-OCA). Patients with OCA were younger (mean age 57.6 ± 10.7 years vs. 64.3 ± 11.1 years, p = 0.002) and predominantly male (70% vs. 48.8%, p = 0.06) as compared to those with non-OCA. Patients with OCA had a higher percentage of major cardiovascular risk factors (diabetes, hyperlipidemia, and smoking) than patients with non-OCA, except for hypertension, which was higher among patients with non-OCA (70% vs. 45%, p = 0.045). At admission, patients with OCA had a higher percentage of heart failure (20% vs. 7.5%, p = 0.05) and a lower ejection fraction (mean EF% 49.5 ± 13.7 vs. 54.3 ± 9.5, p = 0.04) as compared to patients with non-OCA. T-wave inversion was the most common ECG finding in both groups. With regard to the culprit coronary artery, the right coronary artery (RCA) was the most frequently involved in NSTEACS patients with OCA (60%), followed by the left circumflex artery (LCX) (20%), left anterior descending artery (LAD) (15%), and obtuse marginal artery (5%). In contrast, the LAD was the most involved vessel in NSTEACS patients with non-OCA (72%), followed by the RCA (49%) and the LCX (34%). The 30-day outcomes showed that the incidence of re-infarction, recurrent chest pain, and arrhythmias was higher among patients with OCA than those with non-OCA (15% vs. 5%, 25% vs. 11.3%, and 10% vs. 2.5%, respectively). However, no significant difference was noted in terms of the incidence of heart failure or death between the two groups. At 6-month follow-up, the mortality rate was noted to be higher in patients with OCA than in those with non-OCA (15% vs. 3.8%, p = 0.05). ***Conclusion:*** In this study, we can conclude that NSTEMI, in a considerable number of patients is the result of total occlusion of the culprit artery without showing ST elevation in the presenting ECG. These patients have a higher prevalence of major cardiovascular risk factors, worse clinical presentations, and worse outcomes than those with non-OCA. The RCA was the most frequently involved vessel in NSTEACS patients with OCA, while the LAD was the most involved vessel in those with non-OCA.

Keywords: ***Occlusive Myocadiac Infarction; Non-Occlusive Myocadiac Infarction; Non-ST-segment elevation acute coronary syndrome.***

Introduction

Non-ST-segment elevation acute coronary syndrome (NSTEACS) is a common type of acute coronary syndrome (ACS) that affects millions of people worldwide [1]. NSTEACS is characterized by the absence of ST-segment elevation (STE) on electrocardiography (ECG), otherwise it shares the same symptoms of STEMI of chest pain and elevation of cardiac biomarkers [2]. Since 1980, STE on the presenting ECG, in patient with typical chest pain is classically considered indictive of complete occlusion of the culprit coronary artery which indicates prompt revascularization. (DewoOCAPaper). NSTEMI patients are considered to have a critical stenosis defined as ≥70% stenosis of the culprit artery but not complete occlusion judging by the absence of STE in the presenting ECG and therefore have a favorable prognosis, albeit are at higher risk of adverse cardiovascular events, such as heart failure, and death [3].

Coronary angiography (CAG) has been considered an essential tool for the diagnosis and management of NSTEACS. It helps to identify the location and severity of coronary artery disease (CAD), which is a major contributor to the pathophysiology of NSTEACS (Sara et al., 2020). NSTEACS patients with occlusive disease (OD), Non-ST-elevation myocardial infarction (NSTEMI), which is a type of acute coronary syndrome, has been defined as an ischemic event that results in the death of cardiomyocytes through necrosis and is typically accompanied by symptoms of acute myocardial ischemia, such as chest pain. To diagnose NSTEMI, a patient must present with a typical rise or fall in cardiac biomarkers (troponin) along with at least one of the following criteria: symptoms of ischemia, ECG changes not including STE, imaging evidence of new or presumed new loss of viable myocardium or regional wall motion abnormality, or the detection of intracoronary thrombus on angiography or autopsy [3].

NSTEMI is a result of an acute imbalance between myocardial oxygen demand and supply, most commonly due to a reduction in myocardial perfusion. Non-ST elevation ACS includes a clinical spectrum that ranges from unstable angina to NSTEMI. Nevertheless, it is recognized that this broad spectrum of clinical presentations and outcomes results from common underlying pathophysiology, with atherosclerotic plaque disruption and differing degrees of associated thrombosis and distal embolization[4].

The management of NSTEACS patients includes both medical and invasive strategies, depending on the severity of the disease and the patient's risk profile [5]. The choice of management strategy is often based on the extent of the coronary artery disease and the presence of symptoms, such as chest pain or dyspnea (Amsterdam et al., 2014). The goals of treatment in NSTEACS include relieving symptoms, reducing the risk of recurrent ischemic events, and improving the patient's long-term outcomes [6].

Several studies have investigated the frequency and outcomes of NSTEACS with occluded culprit artery (OCA). In these studies, patients with OCA were found to have a higher risk of adverse outcomes, including re infarction, heart failure, and mortality, as compared to patients with non-OCA [7].

Several studies have reported that NSTEACS patients with OCA are more likely to have a history of smoking, diabetes, and prior CAD compared to those with non-OCA [8,9]. In addition, patients with OCA may have a higher prevalence of left ventricular dysfunction, heart failure, and arrhythmias compared to those with non-OCA [2]. However, the results of these studies have been inconsistent, and the sample sizes have been relatively small. None of these were conducted in a sub-Saharan African population.

Therefore, there is a need for larger, prospective studies to investigate the frequency and outcomes of NSTEACS with occlusive and non-occlusive culprit coronary arteries. This present study aims to address this gap in the literature by prospectively enrolling a larger cohort of NSTEACS patients and collecting comprehensive clinical, laboratory, and angiographic data. The objectives of this study are to determine the frequency of occluded and non-occluded culprit coronary arteries in NSTEACS patients, to compare the clinical characteristics and outcomes of patients with occlusive and non-occlusive coronary arteries, and to identify predictors of adverse cardiovascular events in African patients.

Objectives

This study aimed to compare the occurrence and consequences of NSTEACS in patients with occluded versus patent, albeit significantly diseased, culprit coronary artery. Additionally, this research aims to evaluate and analyze the incidence, 30-day inpatient outcomes, and 60-day mortality rate of NSTEACS in patients with occluded and non-occluded culprit coronary artery.

Methodology

Study design

This is a cross-sectional observational study conducted in the adult emergency department of Al- Shaab Teaching Hospital from January 2022 to April 2022. All adult patients diagnosed with NSTEACS and underwent coronary angiography were included in this study.

Ethical consideration

This study received ethical approval from the Sudan Medical Specialization Board, the Internal Medicine Committee, and the Medical Educational Development Center. Written and verbal informed consent was obtained from each participant after explaining the nature and purpose of the study and their right to refuse participation. To protect their privacy and maintain confidentiality, coded questionnaires were used to collect data, and all information was gathered with strict confidentiality. The study ensured that participants were not harmed in any way during the study period.

Inclusion criteria: All consecutive adult patients with a confirmed diagnosis of NSTEACS who underwent coronary angiography within 48 hrs of the index admission, if presented with chest pain for > 10 minutes within the 24 hours mark and elevated troponin I or T, with normal ECG, T wave inversion or ST segment depression but no ST segment elevation.

Definition of occluded culprit artery: Patients with occluded culprit coronary artery are defined as those whose coronary angiogram in the index admission, shows a single 100% occluded coronary artery, with TIMI (Thrombolysis in Myocardial Infarction) study group (Brigham and Women's Hospital, Boston, Massachusetts) flow 0 -1 meaning no antegrade flow at all or contrast hanging up with failure to opacify the coronary artery distally with no other significant disease elsewhere in the coronary tree mounting to >70% stenosis.

Only patients with clear occluded culprit artery, as defined above were included in the analysis in the arm of OCA as judged by the judiciary panel of two blinded cardiologists independently.

Exclusion criteria: Included patients who did not undergo angiography in the index admission for any reason, patients with previous coronary artery bypass graft surgery, patients with evidence alluding to chronic total occlusion angiographically, and patients with multivessel vessels diseased if there is there is an artery with a significant stenosis more than 70% narrowing even in the presence of an occluded artery (TIMI flow 0-1) and absence of sings of chronic total occlusion. The sample size was estimated based on hospital statistics of 15-30 ACS patients per week and 60-120 patients per month. The principal investigator collected data through case report form, and the patients were followed up with clinical visits at 1 & 6 months to monitor possible outcomes.

Data management and analysis

Data analysis was performed using the Statistical Package for the Social Sciences version 21.0 by IBM Corp. in Armonk, NY. The results were presented in tables and figures created using Microsoft Excel 2010. The study variables consisted of dependent variables such as death, heart failure, arrhythmias, stroke, re-infarction, and re-admission, while independent variables included age, sex, co-morbidities, and type of occlusion.

Results

120 consecutive patients presenting with NSTEMI were screened, only 100 patients enrolled, of whom 20% (n = 20) had OCA and 80% (80) with no OCA. Of the 20 patients with OCA 12 had single artery which was 100% occluded with minor irregularities elsewhere or normal arteries but no significant occlusive disease. Eight patients with multi-vessels disease were included as well, as the occluded coronary artery was deemed the culprit by the panel of experts. Three patients had OCA plus one other vessel not > 70% stenosis (2 vessel disease group). Five patients had 3 vessel disease, OCA and other 2 vessels disease with or without minor irregularities elsewhere but no significant occlusive, not > 70% stenosis (3 vessel disease group).

Patients with OCA were between the ages of 20 and 60 and were generally younger than those with non-OCA. Most patients in both groups were male, which is, 70% of those with OCA and 68% of those with non-OCA. The major cardiovascular risk factors were hypertension, diabetes, dyslipidemia, smoking, and a history of ischemic heart disease (IHD). Patients with non-OCA had a slightly higher percentage of hypertension (57%), while patients with OCA had a higher percentage of diabetes (55%), history of IHD (30%), smoking (60%), and dyslipidemia (45%).

Table 1: Frequency of NSTEACS according to type of occlusion

Type	N	%
Occluded Culprit Artery (OCA)	20	20.0%
Non- Occluded Culprit Artery (NOCA)	80	80.0%

All patients in this study were offered CAG during their hospital stay, but only 83 patients had an echocardiography done during their hospital stay. At admission, most patients had a heart rate ranging from 60 to 100 bpm, a systolic blood pressure range of 90 to 150 mmHg, and a diastolic blood pressure range of 60 to 100 mmHg (88%). All patients had positive cardiac troponin.

All patient with OCA had an abnormal ECG at presentation in a way of T-wave inversion and ST depression 65% and 35%, respectively compared to patients with non-OCA, 58% and 36%, respectively, However, 6% of patients with non-OCA had a normal ECG.

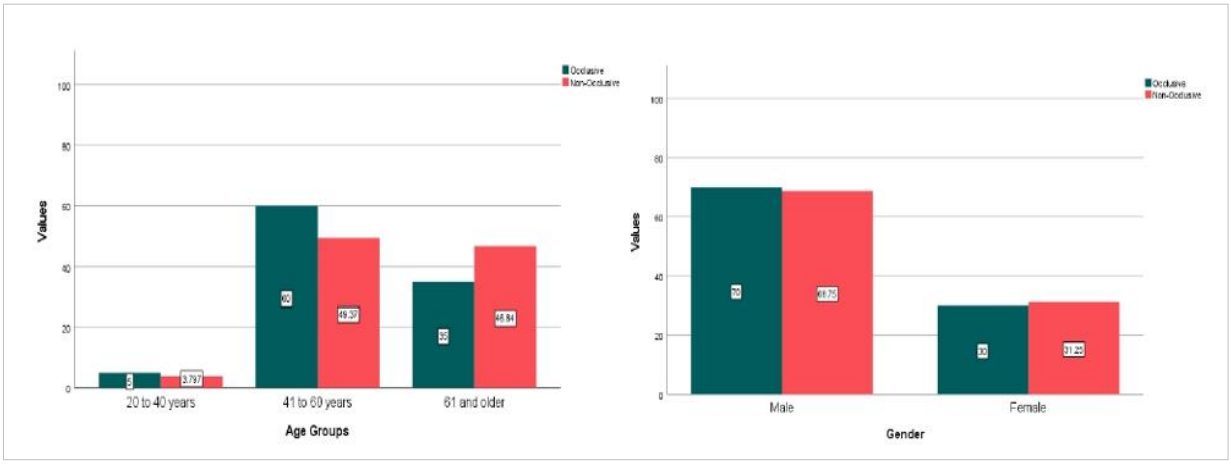

Figure 1: Distribution of age groups by type of occlusion in NSTEACS patients. Figure 2: Distribution of gender according to type of occlusion in NSTEACS patients

Moreover, 20% of patients with OCA presented with heart failure (HF), as compared to 16% of patients with non-OCA, and one patient (5%) with OCA died of tachyarrhythmia during hospital stay. Additionally, 10% of patients with OCA developed arrhythmias during their hospital stay, compared to 3.75% of patients with non-OCA. RCA (n = 12, 60%) was the most culprit coronary artery in NSTEACS with OD, followed by Lcx (n = 4, 20%), LAD (n = 3, 15%), and OM (n = 1, 5%). However, LAD (72%) was the most involved vessel among patients with non-OCA, followed by RCA (49%) and LCX (34%). Meanwhile, 80% of patients with OCA had a preserved ejection fraction, while 20% had reduced ejection fraction, and six (30%) of them had regional wall motion abnormality (RWMA) as per echocardiography, with the inferolateral wall being the most affected (83%). On the other side, 60% of patients with non-OCA a had preserved ejection fraction, while 18% had reduced ejection fraction; 27% of them with had RWMA, with the anterior wall being the most affected (45%).

Table 2: Distribution of HTN according to type of occlusion in NSTEMI patients

HTN	Type of occlusion				Total		P-Value
	Occlusive		Non-Occlusive				
	N	%	N	%	N	%	
No	9	45.0%	34	42.5%	43	43.0%	0.840
Yes	11	55.0%	46	57.5%	57	57.0%	
Total	20	100.0%	80	100.0%	100	100.0%	

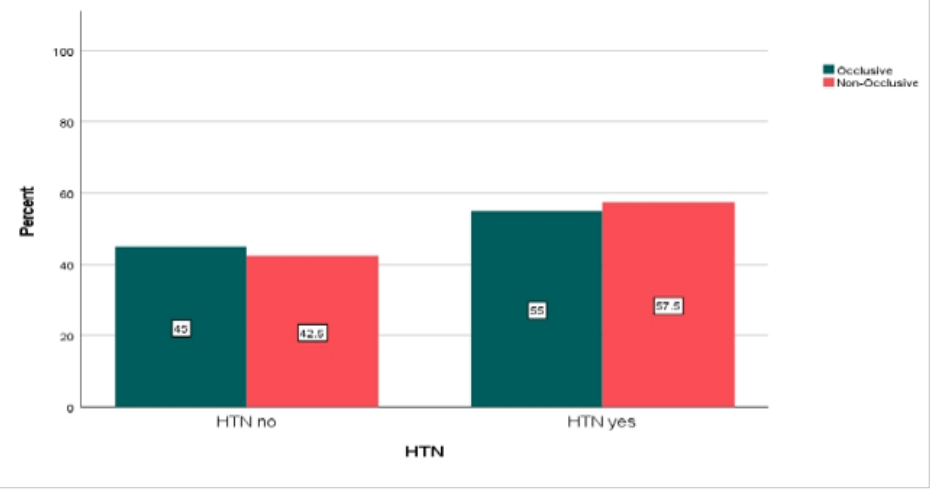

Figure 3: Distribution of HTN according to type of occlusion in NSTEACS patients

With regard to data on 30-day outcomes, no deaths were reported in both groups. However, 10% and 11% of patients with OCA and non-OCA developed HF within the 30-day observation, respectively. However, among patients with OD, one patient (5%) was re-admitted for HF; meanwhile, in patients with non-OCA, seven (8.75%) had to be re-admitted, that is, five patients with HF, one (1.3%) patient with bleeding complications, and one (1.3%) patient with tachyarrhythmias. All patients with OCA and 50 patients with non-OCA had repeated echocardiography at 30 days. As per the echocardiography findings, 35% of patients with OCA had decreased EF as compared to their EF at admission, 30% had static EF, and 35% had increased EF.

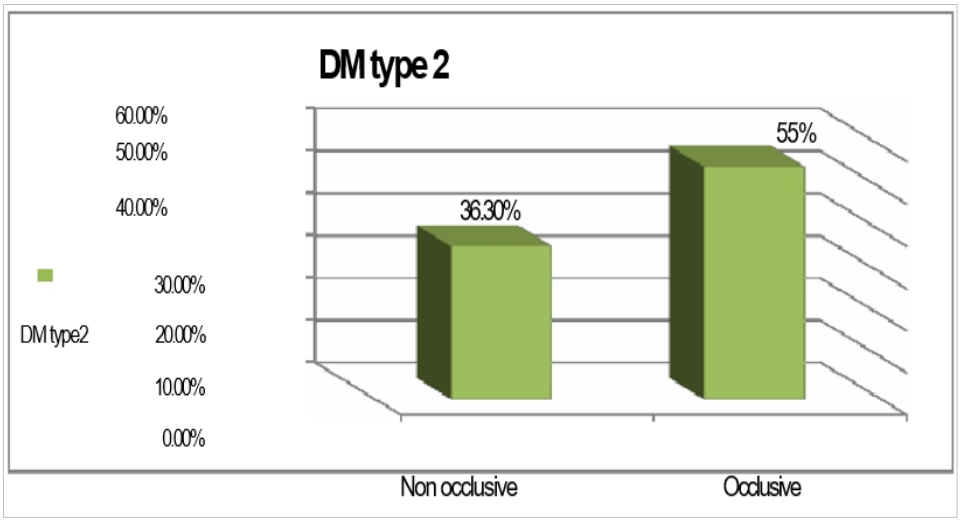

Figure 4: Distribution of DM type 2 according to type of occlusion in NSTEACS patients.

Discussion

This present study aimed to compare the clinical and angiographic characteristics, echocardiographic findings, and 30-day outcomes between patients with non-OCA and those with OCA in the setting of NSTEACS. The results showed that patients with OCA were mostly younger than those with non-OCA and had a higher prevalence of diabetes, smoking, dyslipidemia, and a history of ischemic heart disease. These findings are consistent with previous studies that have reported a higher prevalence of cardiovascular risk factors in patients with OCA compared to those with non-OCA [13,14].

In terms of angiographic findings, the RCA was the most frequently involved vessel in patients with OD, followed by the Lcx, LAD, and OM. On the other hand, the LAD was the most frequently involved vessel in patients with non-OCA, followed by the RCA and Lcx. These results are consistent with previous studies that examined patients with NSTEACS [9,11,15]. The echocardiographic findings showed that patients with OCA had a higher prevalence of regional wall motion abnormality (RWMA) as compared to those with non-OCA, and the inferolateral wall was the most frequently affected region. These findings are consistent with previous studies that have reported a higher prevalence of RWMA in patients with OCA compared to those with non- OCA [9,10,14].

The 30-day outcomes showed that no deaths occurred in either group, but patients with OCA had a higher prevalence of heart failure compared to those with non-OCA. However, the number of patients re-admitted for HF was higher in the non-OCA group. These results are consistent with previous studies that have reported a higher incidence of HF in patients with OCA compared to those with non-OCA [13,14]. The repeated echocardiographic findings showed that a higher proportion of patients with OCA had an increased ejection fraction compared to those with non- OD, which could be attributed to the better perfusion of the myocardium after successful revascularization. In total, the study enrolled 100 NSTEACS consecutive patients; 20% (n = 20) of the NSTEACS patients had OD, while 80% had non-OCA. A similar percentage of 20% was reported in the randomized Acute Catheterization and Urgent Intervention Triage Strategy Trial study, while a higher percentage of 30% was reported at the Tabba Heart Institute, Karachi.

Regarding baseline demographics, patients with OCA were younger, and males represented a higher percentage than females among the two groups. Another study reported that NSTEACS is more common among patients older than 55 years with a male predominance.

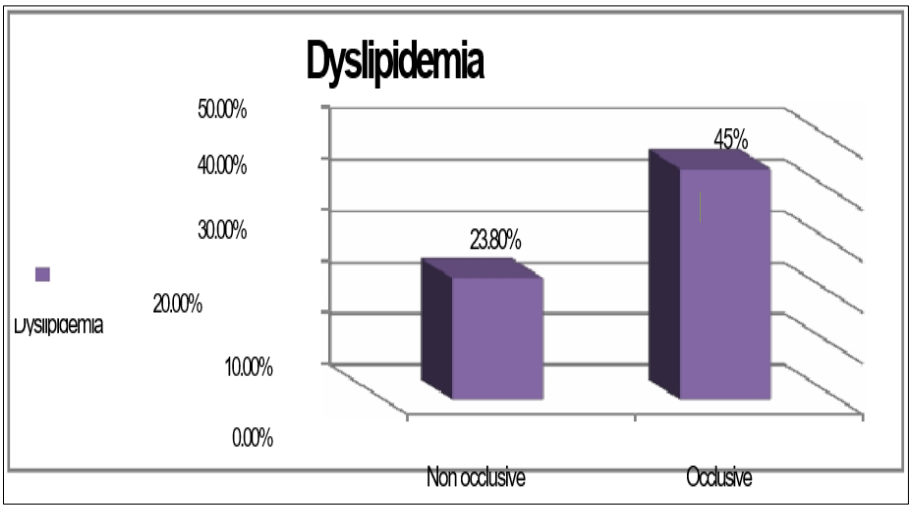

Figure 5: Distribution of dyslipidemia according to type of occlusion in NSTEACS patients.

Regarding major cardiovascular risks, patients with OCA had a higher percentage of cardiovascular risks than patients with non-OCA except for hypertension (57%), which was noted to be slightly higher among patients with non-OCA (55%).

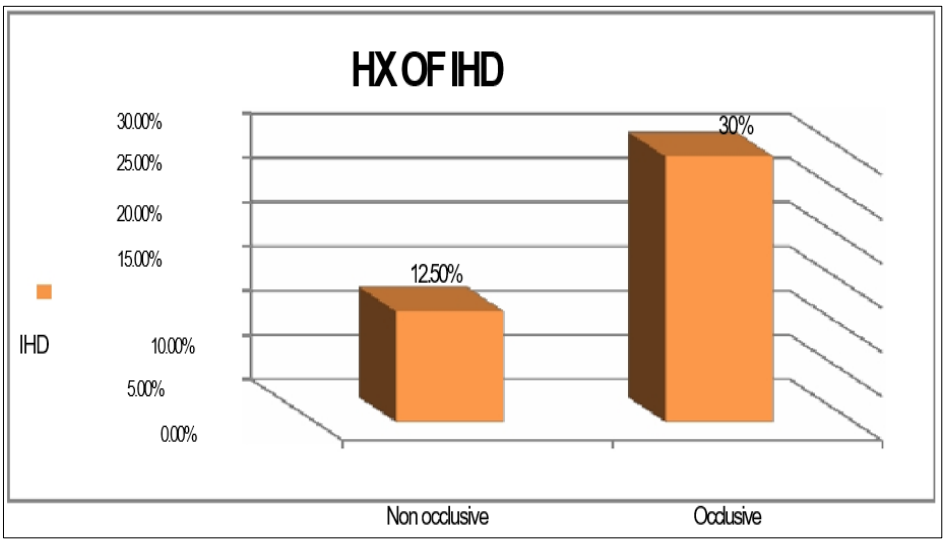

Figure 6: IHD history according to type of occlusion in NSTEACS patients.

In hospital events and outcomes, patients with OCA had a higher percentage of HF at admission (20%) and reduced EF% (30%) compared to patients with non-OCA (16% and 18%, respectively). Cardiac arrhythmias (10%) and deaths (5% each) were higher among patients with OCA compared to patients with non-OCA (3.75% and 0%, respectively). The T-wave inversion was the most prominent ECG finding among the two groups. Compared to previous studies, one study reported a higher percentage of HF and a greater drop in EF and cardiac arrhythmias among patients with OD, while another study showed no differences in terms of inpatient outcomes among the two groups.

Table 3: Distribution of IHD history according to type of occlusion in NSTEACS patients

HD			
Count			
	Type of non-STEMI		**Total**
	Non-occluded culprit	**Occluded culprit**	
I	69	14	83
H History of angina	1	1	2
D Previous MI	4	2	6
Previous PCI	3	1	4
Unknown	3	2	5
Total	80	20	100
P-value =0.385			

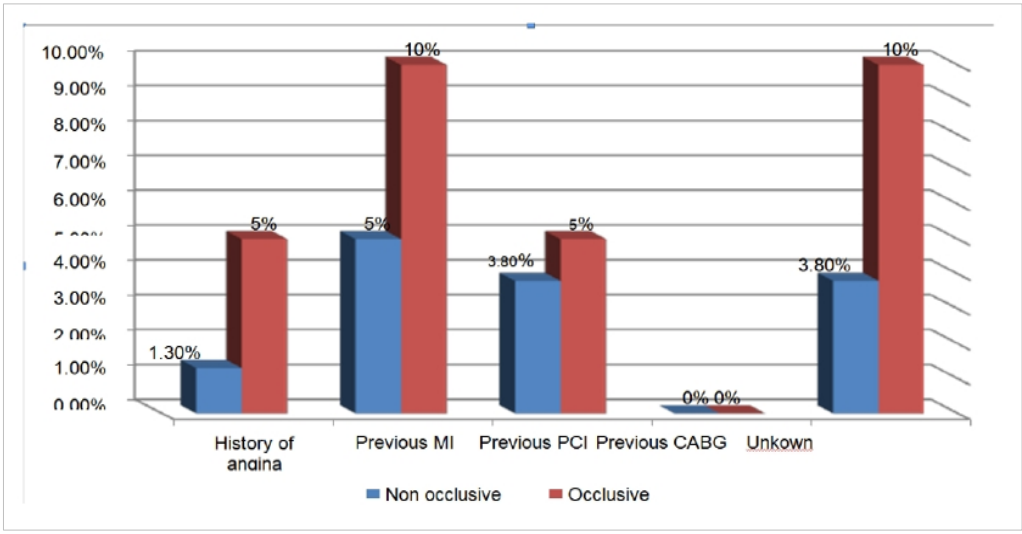

Figure 7: Distribution of IHD history according to the type of occlusion in patients with NSTEACS

RCA (n = 12, 60%) was the most common culprit coronary artery in NSTEACS with OD, followed by Lcx (n = 4, 20%), LAD (n = 3, 15%), and OM (n = 1, 5%). However, LAD (72%) was the most involved vessel in non-OCA, followed by RCA (49%) and LCX (34%). The randomized Acute Catheterization and Urgent Intervention Triage Strategy trial study showed the same results (the incidence of coronary occlusion was 28.4%, 19.3%, and 12.6% in patients with NSTEMI due to right coronary, left circumflex, and left anterior descending artery disease, respectively).

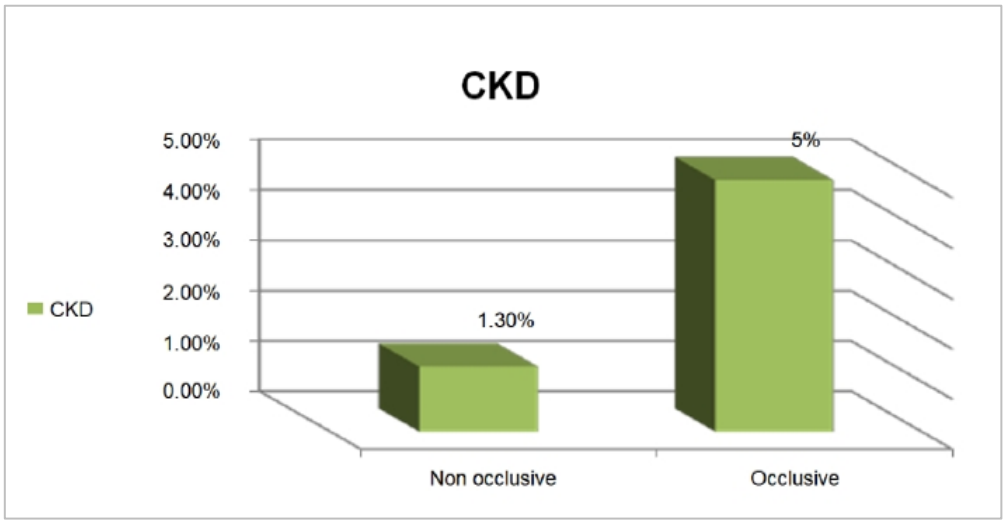

Figure 8: Distribution of CKD according to the type of occlusion in patients with NSTEACS.

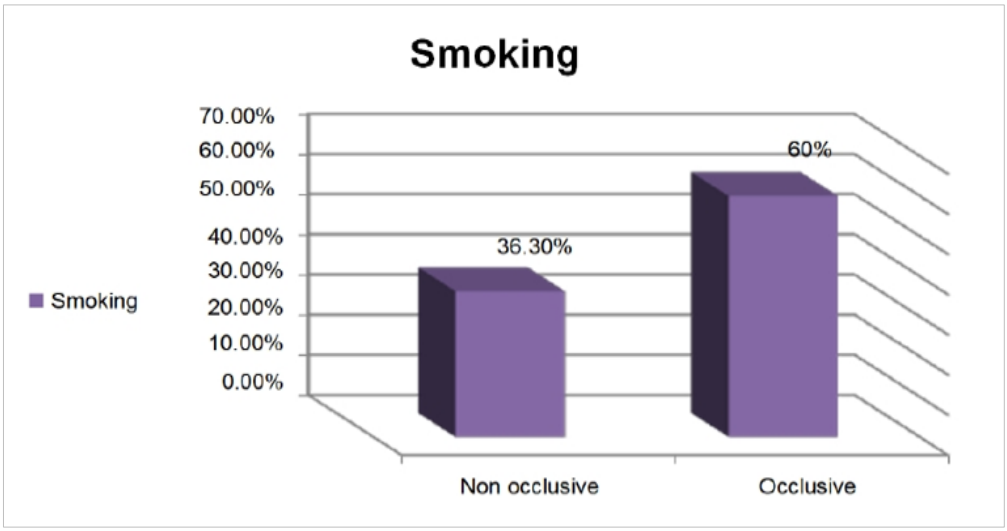

Figure 9: Distribution of smoking status according to the type of occlusion in NSTEACS patients

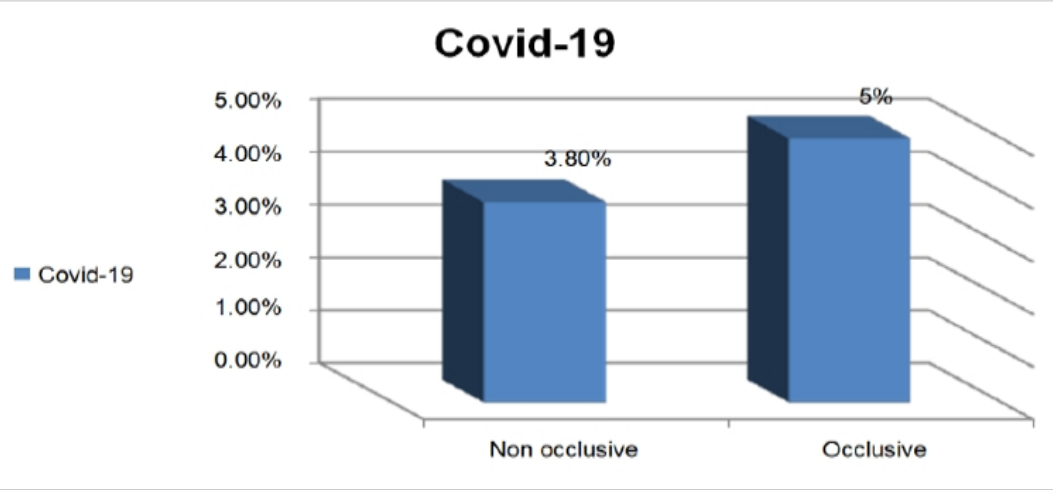

Figure 10: Distribution of COVID-19 status according to the type of occlusion in NSTEACS patients.

No deaths were reported in both groups after 30 days. No significant difference was noted with regard to HF (10% and 11%). Re-admission is higher among patients with non-OCA. More reductions in EF% were reported among patients with OD. Moreover, 6-month mortality was slightly higher among patients with non-OCA.

Conclusion

In this present study, it was demonstrated that patients with OCA had a higher prevalence of cardiovascular risk factors, more severe angiographic findings, and a higher prevalence of RWMA and HF compared to those with non-OCA. These findings highlight the importance of prompt diagnosis and management of OCA in patients with NSTEACS, which could improve their clinical outcomes. However, further studies are needed to confirm these findings and explore the potential underlying mechanisms of these differences between the two groups.

Ethics approval and consent to participate

Ethical approval was obtained from Sudan Medical Specialization Board (SMSB). Hospital administration's approval and informed consent from patients were obtained as well. Data used anonymously by using identity numbers instead of names is ordered to protect the patient's identity and kept secure in a separate file. No reference to any individual participant was made in study reports. Subject identities were known only by the study staff.

Data Availability

All data are available in the article and further details can be requested directly from the corresponding author.

Conflicts of Interest

"The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper."

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