



Polycythemia and the Coronary Complications of Acute Coronary Syndrome Patients in Yemen

Mohammed Ali Al-Huthi*, Dhaifullah Jayed

Department of medicine, Medicine College, Dhamar University, Dhamar, Yemen

Email: *drmhuthi@yahoo.com

How to cite this paper: Al-Huthi, M.A. and Jayed, D. (2016) Polycythemia and the Coronary Complications of Acute Coronary Syndrome Patients in Yemen. *Open Access Library Journal*, 3: e3093.

<http://dx.doi.org/10.4236/oalib.1103093>

Received: September 26, 2016

Accepted: October 22, 2016

Published: October 26, 2016

Copyright © 2016 by authors and Open Access Library Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Background: A retrospective study was performed to study the effect of polycythemia on the severity of coronary artery occlusions and echocardiographic characteristics among acute coronary syndrome (ACS) patients in Yemen. **Methods:** Two hundred and four (204) ACS patients in Yemen who underwent coronary angiography were reviewed from January 2014 to December 2014. **Results:** The mean age of Polycythemia ACS patients was significantly lower than normal hemoglobin patients (54.59 years vs. 57.08 years; $p < 0.000$). The prevalence of hyperlipidaemia for Polycythemia ACS patients was significantly higher (55.1% and 39.9%; $p < 0.000$). Also the prevalence of history of coronary artery disease (CAD) for Polycythemia ACS patients was significantly higher (21.3% vs. 10.6%; $p < 0.000$). The prevalence of hypertension (HTN), diabetes mellitus (DM), and tobacco smoking were comparable at both groups. Left ventricle ejection fraction (LVEF) for Polycythemia ACS patients was significantly lower (47.9% and 52.8%; adjust; $p < 0.000$). Normal coronary angiography for non-Polycythemia ACS patients was non-significantly higher (9.6% vs. 7.6%). Single vessel occlusion for non-Polycythemia patients was higher (41.9% vs. 29.6%). Two vessel occlusions were comparable for patients at both groups. Three vessel occlusions for Polycythemia ACS patients were significantly higher (37.2% vs. 23.6%). **Conclusions:** Acute coronary syndrome occurs at a younger age for Polycythemia ACS patients. Polycythemia ACS patients are also more likely to have hyperlipidaemia and history of CAD. Impaired LVEF occurs more commonly in Polycythemia ACS patients. The ACS patients who have Polycythemia were associated with more coronary arteries occlusions. Three vessel occlusion and circumflex coronary artery occlusions occur more commonly among Polycythemia ACS patients. We noted association between high percentages of hemoglobin and coronary complications.

Subject Areas

Cardiology, Internal Medicine

Keywords

Acute Coronary Syndrome, Polycythemia, Coronary Angiography, Yemen

1. Introduction

Coronary Artery Disease (CAD) is one of the main causes of premature death in industrialized countries [1], even though its incidence and mortality have been falling for more than a decade in most of these countries [2]. Conversely, it appears to be increasing in many developing countries [3]. It has been shown that coronary stenosis may “grow” rapidly, leading to total vessel occlusion, particularly in patients who develop serious coronary events [4]. In fact acute coronary syndromes are most commonly precipitated when mild or moderate coronary stenosis becomes severely obstructive [5], and this transformation is usually associated with plaque fissuring, intramural hemorrhage, and occlusive thrombosis [6]. In 1980, angiographic studies by De Wood and coworkers revealed that occlusive thrombus was responsible for most cases of acute myocardial infarction [7]. Thrombus formation was subsequently implicated in the pathogenesis of unstable angina. At that time, the prevailing concept was that myocardial infarction resulted from occlusion at a site of high-grade stenosis. The establishment of coronary thrombosis as the most common cause of myocardial infarction led to the development and use of thrombolytic agents [8]. The subsequent mortality has been correlated with the severity of the initial arteriographic lesion [9].

The geographical variation observed in CAD mortality cannot be fully explained by differences in the prevalence of known risk factors [10]. Therefore, it has been postulated that the residual variation may be due to hematological factors. There are considerable geographical variations in the use of coronary angiography and revascularization within the United States and internationally, both in general populations [11] [12], and among patients who have had acute coronary syndrome [13].

However, many studies have examined risk factors profile for CAD in different geographical regions, but there have not been studies available at hand regarding comparing the severity of coronary arteries occlusions for ACS patients and hemoglobin levels. Besides, there have not been data to enable the study of the effect of high hemoglobin levels on the severity of coronary arteries occlusions in the Middle Eastern and Eastern Mediterranean ACS patients. The studies in this geographical area are essential. It is important to establish a causal relationship between risk factor for CAD, severity of coronary arteries occlusions, and variation of hemoglobin levels.

Polycythemia is a chronic myeloproliferative disorder, involving a multipotent hematopoietic progenitor cell, which causes in general an increased production of red cells, granulocytes and platelets, but most significantly in erythrocytes, which lead to hyperviscosity and an increased risk of thrombosis. Polycythemia Vera is a chronic myeloproliferative disorder, involving a multipotent hematopoietic progenitor cell, which causes in general an increased production of red cells, granulocytes and platelets,

but most significantly in erythrocytes. The occurrence of myocardial infarction in myeloproliferative disease is mostly attributed to coronary thrombosis due to hyperviscosity and thrombocytosis. Patients with polycythemia or essential thrombocythemia are at increased risk of arterial and venous thromboembolic events. Arterial ischemic complications occur in 24% to 43% of these patients, particularly those with cardiovascular risk factors (especially cigarette smoking) [14]. Myocardial infarction (MI) and heart failure is the most common cause of death. The pathophysiology of thromboembolic events in polycythemia Vera has not been elucidated, but many factors are involved: increases in hematocrit and blood hyperviscosity, stimulation of platelet aggregation and thrombogenesis, the presence of leukocytosis, rigidity of the membrane and intimal proliferation [15]. Hypoxia in patients with high levels of hemoglobin (polycythemia) is associated with increase in myocardial work. The effect of high levels of hemoglobin on the severity of coronary occlusion is posing a rise question. Is high levels of hemoglobin could be a risk for ACS, and must be taken into account when comparing cardiovascular risk for ACS?

Objectives:

- 1) To compare the severity of coronary artery occlusions between Polycythemia ACS patients and non Polycythemia ACS patients in Yemen.
- 2) To assess echocardiographic characters of ACS Yemeni patients who have polycythemia and have not polycythemia.

2. Methodology

Study Design: A comparative retrospective study design was employed for this study.

Population Samples: Records of the ACS patients admitted in the Cardiac centre at Al-Thawrah Modern Teaching Hospital (Sana'a city), who had confirmed diagnosis of acute coronary syndrome and who underwent coronary angiography between from January 2014 to the December 2014, were evaluated.

Study Area:

Sana'a city: It is the capital of republic of Yemen.

Cases Selection: We retrospectively reviewed the angiographic, echocardiographic and clinical data of 204 consecutive patients who underwent coronary angiography for confirmed diagnosis of ACS in the Cardiac centre at Al-Thawrah General Teaching Hospital between January 2014 and December 2014 in order to assess the coronary complications of ACS patients among two groups of CS patients in Yemen The first group ACS patients who have increased hemoglobin levels (polycythemia). The second group ACS patients who have normal levels of hemoglobin.

All patients had diagnosis of ACS according to WHO criteria for the diagnosis of ACS.

Definition of Acute Coronary Syndrome: The World Health Organization (WHO) criteria for the diagnosis of ACS require at least two of the following three elements to be present: AMI with ST elevation (typical symptoms or electrocardiography (ECG)) with segment ST elevation and raised serum cardiac enzymes (CK-MB or troponin),

AMI without ST elevation (typical symptoms or ECG without ST-segment elevation and raised CK-MB or troponin), and unstable angina (symptoms or ECG indicative of ischemia, with normal enzymes), [16].

Inclusion Criteria: Age 30 - 69 years and diagnosed as ACS (clinical symptoms and or ECG and/or significant cardiac enzyme elevation).

Exclusion Criteria: Other cardiac disease (congenital heart disease, rheumatic heart disease and non coronary cardiac surgery, chronic medical illness (e.g. end stage liver/renal failure), and malignancies.

Sample Size Calculation: A total of two hundred and four (204) patients who had confirmed diagnosis of ACS admitted consecutively in the Cardiac centre, Al-Thawrah General Teaching Hospital, and underwent coronary angiography and echocardiography. One hundred and two (102) patients have increased levels of haemoglobin levels (Polycythemia) and equal numbers have normal levels of haemoglobin were included.

Investigations Protocol

1) General Clinical Examination: Measurement of blood pressure (BP), and heart rate (HR). Physical examination was performed for all patients, especially cardiac examination (signs of heart failure, arrhythmias etc.), and physical assessment was conducted for associated peripheral vascular disease.

2) Investigations and Procedures:

2.1) Electrocardiography (ECG):

A 12 lead ECG recording was made just before coronary angiography, where we stressed on the following; QMI (Q wave myocardial infarction), NQMI (Non-Q wave myocardial infarction), and arrhythmias.

2.2) Echocardiographic Examination

Echocardiographic studies were performed through a transducer system in the apical position while the patient was laid comfortably in the 45° left recumbent position. To acquire cross-sectional images for reconstruction, the operator must find the centre axis around which the imaging plane is rotated to encompass the entire Left ventricle (LV) cavity. Measurement of left ventricle ejection fraction (LVEF) was calculated from the M-mode under guidance of 2D dimension, obtained by use of Simpson's method according to the recommendations of the American Society of Echocardiography (ASE).

2.3) Coronary Arteriography

To establish the presence or absence of coronary occlusions, is by comparing the differences of coronary vessel occlusions among ACS Yemeni patients who have polycythemi versus ACS Yemeni patients who have normal levels of hemoglobin, and by comparing the severity and extent of coronary occlusions, such as one vessel disease (LAD, LCX, or RCA), two vessel disease, three vessel disease, or no vessel disease (normal coronary angiography).

2.3.1) Measurement of Coronary Artery Diameters:

Quantitative assessment: Each coronary arteriogram was assessed by two experienced cardiologists. Coronary diameters were measured through use of the Coronary Angiography Analysis System (CAAS) developed by Reiber [17], and validated by different

authors [18] [19].

2.3.2) Occlusion Definition:

In our study we have determined that the coronary artery occlusion was defined if the severity of coronary artery stenosis was of $\geq 50\%$ lumen diameter.

2.3.3) Coronary Angiography Protocol:

Preparation of the patients for coronary angiography: The cardiologist responsible for the procedure should fully explain it to the patients including its risk and benefits. Patients should be fasting, and an intravenous line should be established. Oral or intravenous sedation should usually be administered (e.g., benzodiazepine).

2.3.4) Coronary Arteriography Technique:

The Judkins Technique: This technique has become the most widely used technique for evaluation of the coronary arteriography. After local anesthesia with 1 percent lidocaine, percutaneous entry of the femoral artery is achieved by puncturing the vessel 1 to 3 cm below the inguinal ligament. A transverse skin incision is made over the femoral artery with a scalpel. Using a modified Seldinger's technique, an 18-gauge thin-walled needle is inserted at a 30 to 45 degree angle into the femoral artery, and a 0.035 or 0.038 inch J-tip Teflon-coated guide wire is advanced through the needle into the artery. The wire passes into the femoral artery and should pass freely up the aorta. It is generally recommended that the patient receives 3000 to 5000 units of heparin after access is obtained.

After coronary angiography has been completed, the catheters are removed and firm pressure is applied to the femoral area for 15 to 20 minutes, either by hand or by a mechanical clamp. The patient should be instructed to lie in bed for several hours, with the leg remaining straight to prevent hematoma formation.

Statistical Analysis:

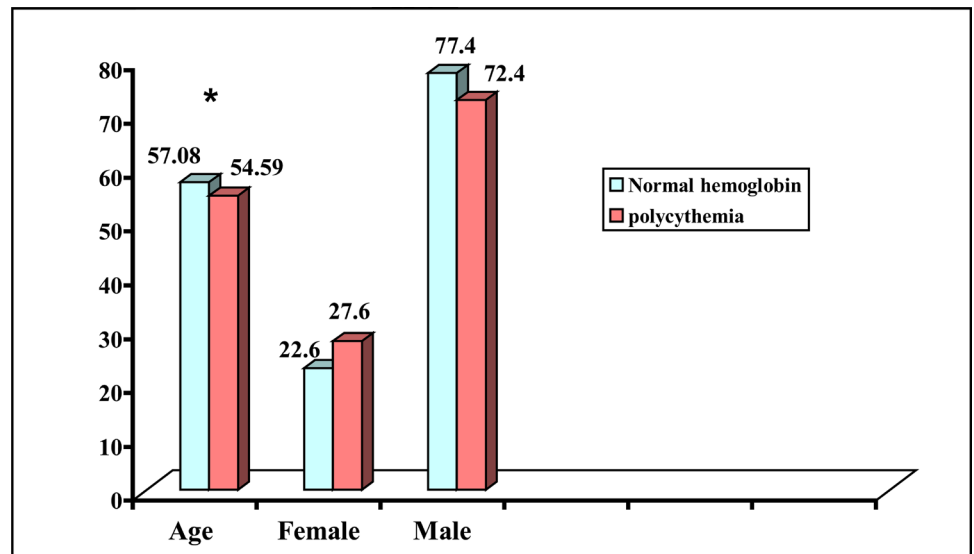
All statistical analyses were conducted through use of the SPSS statistical package version 11.5. Data were expressed as mean \pm SD or proportion. The χ^2 test or t test used to compare the difference between groups. We set the level of the statistical significance at a p value of <0.05 . Statistical tests with $p < 0.10$ and >0.05 were considered to be of borderline significance.

3. Results

From January 2014 to December 2014, coronary angiography performed on 204 patients had a confirmed diagnosis of ACS. The ACS Yemeni patients were aged 30-69 years. We gathered all ACS patients (polycythemic and non polycythemic patients), who were admitted consecutively at the Cardiac Centre at Al-Thawrah Modern Teaching Hospital and underwent coronary angiography.

1) Age, sex and diagnosis of ACS Yemeni patients with high and normal levels of hemoglobin:

Figure 1 gives the mean age of all ACS patients which was (55.8 ± 6.8) years. The mean age of ACS patients who have polycythemia was significantly lower than non polycythemic patients (54.59 years [SD = 7.56] vs. 57.08 years [SD = 6.21]; $p < 0.000$).



*Significant difference

Figure 1. The mean age and sex differences for ACS Yemeni patients at both groups, reaching 204 patients.

Table 1. Summarizes the risk factors for CAD among ACS Yemeni patients for both groups reaching 204 patients.

ACS patients groups	History of hyperlipidaemia	History of smoking	History of HTN	History of DM	History of CAD	Family History of CAD
Polycythemia	55.1%	62.1%	48.2%	32.6%	21.3 %	14.0%
Normal hemoglobin	39.9%	55.5%	42.9%	26.2%	10.6%	20.6%
Chi-square	14.095	2.743	1.715	2.889	12.690	4.649
<i>P</i>	0.000*	0.058	0.110	0.054	0.000*	0.020

*Significant difference;

HTN: Hypertension;

DM: Diabetes Mellitus;

CAD: Coronary Artery Disease.

Acute coronary syndrome among females at both groups was comparable; 27.6% vs. 22.6%.

2) Risk factors for ACS among Yemeni patients Polycythemia and non Polycythemia patients:

Table 1 summarizes the risk factors for ACS among patients at both groups in Yemen. The prevalence of hyperlipidaemia among ACS patients was significantly higher for ACS Polycythemia patients than non polycythemic ACS patients (55.1% and 39.9% respectively; $p < 0.000$). Also reported history of CAD for polycythemic ACS patients was significantly higher (21.3% vs.10.6%; $p < 0.000$).

The prevalence of smoking in polycythemic ACS patients non-significantly higher (62.1% and 55.5%; $p = 0.058$). The prevalence of hypertension in Polycythemia ACS patients was non-significantly higher (48.2% and 42.9%; $p = 0.110$).

3) Echocardiographic and coronary angiographic complications among Polycythemia and non Polycythemia ACS Yemeni patients:

Table 2 shows the mean left ventricular ejection fraction (LVEF) detected by echocardiography before coronary artery angiography for ACS patients, which was significantly lower for Polycythemia patients (47.9% and 52.8%; $p < 0.000$).

Coronary Artery Angiography:

Table 3 summarizes the severity of coronary artery occlusions among polycythemic and non Polycythemia ACS patients in Yemen. Normal coronary angiography for patients with normal hemoglobin levels was non-significantly higher (9.6% vs. 7.6%). Single vessel occlusion was significantly higher among normal hemoglobin patients (41.9% vs. 29.6%; $p < 0.001$). Two vessel occlusions were comparable among both groups (25.6% vs. 24.9%). Three vessel occlusions for Polycythemia patients were significantly higher (37.2% vs. 23.6%).

Figure 2 summarizes the anatomical locations of coronary arteries occlusions for Polycythemia and non Polycythemia ACS patients in Yemen. Left anterior descending artery occlusion (LAD) was non-significantly higher among Polycythemia patients (75.1% vs. 66.8%; adjusted OR = 1.499; $p = 0.16$). Circumflex coronary artery occlusion (CX) was significantly higher among Polycythemia ACS patients (53.8% vs. 42.2%; adjusted OR = 1.597; $p < 0.003$). Right coronary artery occlusion (RCA) was higher among Polycythemia ACS patients (56.1% vs. 47.2%; OR = 1.434; $p = 0.017$). Left main coronary artery occlusion (left main) for ACS patients was comparable at both groups (7.3% vs. 5.6%; OR = 1.317; $p = 0.254$).

4. Discussion

To our knowledge, the association between ACS and high levels of hemoglobin has lit-

Table 2. The mean Ejection Fraction (EF) for Polycythemia and non Polycythemia ACS patients in Yemeni 204 patients.

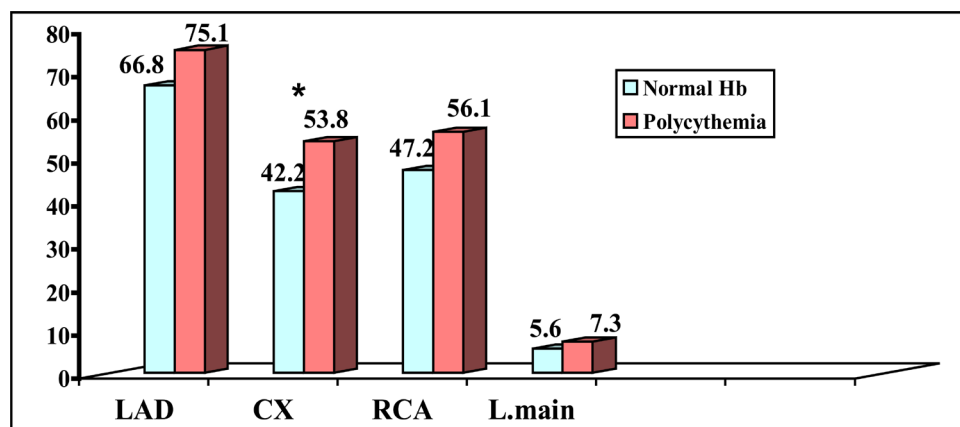
ACS patients groups		Nº	Mean	Std. Deviation	T	p
Ejection	Polycythemia	102	47.9	8.381	-6.681	*0.000
Fraction (EF)	Normal	102	52.8	9.724	-6.681	

*Significant deference.

Table 3. The coronary arteries (normal or coronary vessel occlusion) among Polycythemia and non Polycythemia ACS Yemeni patients in Yemen 204 patients.

ACS Patients groups	Coronary Stenosis (occlusions)			
	Normal coronaries Nº percent	single vessel Nº percent	Two vessel Nº percent	Three vessel Nº percent
Normal Hb	11 9.6%*	43 41.9%	25 24.9%	23 23.6%
Polycythemia	8 7.6%	30 29.6%	26 25.6%	38 37.2%*

*Significant deference.



*Significant difference

LAD: Left anterior descending artery

CX: Left circumflex artery

RCA: Right coronary artery

L. main: Left main coronary artery

Figure 2. Anatomical locations of coronary arteries occlusions among Polycythemia and non Polycythemia ACS Yemeni patients, reaching 204 patients.

the studies which described some correlation, while the association of ACS complications and high levels of hemoglobin at different levels of hemoglobin was still controversial.

Of 204 ACS consecutive Yemeni patients presented with a confirmed diagnosis of ACS, underwent coronary angiography. The mean age of all ACS Yemeni patients was 55.8 ± 6.8 years. The mean age for non Polycythemia ACS patients was significantly higher. Occurrence of ACS among females was comparable at both altitudes.

Our results revealed that the mean age of ACS Yemeni patients was lower than the mean age of the patients in developed countries such as in ACS European patients, where the mean age was 65 years [20], and it was similar to the mean age of ACS patients in some Arab countries such as Saudi Arabia where it was 57 years [21], and Lebanon where it was 60 years [22]. The mean age of ACS Yemeni patients was also similar to the mean age of the Malaysian ACS patients [23].

Prevalence of risk factors for Acute Coronary Syndrome and variation of hemoglobin levels:

Our study provides some important information regarding the effect of elevated hemoglobin levels on the prevalence of risk factors for ACS Polycythemia patients that will assist in providing appropriate knowledge about high levels of hemoglobin as a risk for ACS patients. Prevalence of hyperlipidaemia among ACS patients was significantly higher among Polycythemia ACS patients, ($p < 0.000$). There is ample evidence to suggest that the process of atheroma is triggered by hyperlipidaemia, with deposition of lipids in the arterial wall [24] [25] [26] [27]. Hyperlipidaemia and DM are independent risk factors for CAD severity and extent. Hyperlipidaemia was associated with more severe CAD, and had a greater influence [28]. Hyperlipidaemia correlated significantly with progression of atherosclerosis [29].

The prevalence of smoking in ACS patients was comparable among both groups in

Yemen. The prevalence of smoking among ACS Saudi patients was 76.9% [19], higher than the prevalence in our study (62.1%), while the prevalence of smoking among ACS European ACS patients was lower (48%) [18]. Among the ACS patients, coronary occlusions extent and severity was greater among smoker group than non-smoker group [30]. Smoking causes endothelial dysfunction and is associated with increased platelet thrombus formation [31].

The prevalence of hypertension in polycythemic and normal hemoglobin ACS patients was comparable, and which was similar to European ACS patients (48%) [18].

Hypertension is a strong independent risk factor for the development of cardiovascular disease and strongly predicts mortality across populations [32].

The prevalence of DM among ACS patients at high and low altitude regions was comparable, with mean prevalence of 29.4%. However, our prevalence of DM was 23% higher than those reported by the major European survey among European ACS patients [18].

Diabetes mellitus is associated with platelet and endothelial dysfunction resulting in accelerated atherosclerosis and plaque instability [33]. Diabetic patients presented with an ACS are more likely to have a larger culprit lesion with associated plaque ulceration and intra-coronary thrombus [34].

Multivariate analysis in coronary artery surgery study showed a modest independent association between the presence of DM and increased severity of CAD [35]. Two European studies reported increased severity of CAD and increased vessel disease severity in diabetic patients [36] [37].

Also reported history of CAD among Polycythemia ACS patients was significantly higher ($p < 0.000$), while the prevalence of family history for ACS patients with normal hemoglobin was significantly higher. A family history of CAD is an independent risk factor for MI, and that the number of relatives and the age at which they were affected is related to the strength of the association. There is a multiplicative effect on relative risk factors among family histories [38].

Echocardiographic and Coronary Angiographic complications among Polycythemia ACS patients and ACS patients with normal hemoglobin levels in Yemen:

Echocardiography has a diagnostic, prognostic value, and detects complications in ACS patients [39]. The mean left ventricular ejection fraction (LVEF) detected by echocardiography before coronary angiography for ACS Yemeni patients was significantly higher among normal hemoglobin ACS patients ($p < 0.000$). Left ventricular ejection fraction is an important prognostic variable after acute myocardial infarction [40]. Left ventricle ejection fraction (LVEF), is a strong predictor of early and long-term outcome after myocardial infarction [41].

Coronary Arteries Angiography Findings: Coronary arteriography permits a precise anatomic description of the morphology, distribution, and severity of any significant atherosclerotic lesions present [42].

We studied the variations in the coronary arteries occlusion detected by coronary angiography among Polycythemia ACS patients and ACS patients with normal hemog-

lobin levels in Yemeni. Our study revealed that the use of coronary angiography among ACS patients was much higher in male than in female. Many studies in the past have shown that women are less likely than men to be referred for coronary angiography [43]. In our study, (204) patients were evaluated. We found that the occurrence of coronary vessel disease among Polycythemia ACS patients, indicated 8 patients (7.6%) had normal coronary arteries, 30 patients (29.6%) had single vessel disease, 26 patients (25.6%) had two vessel disease, and 38 patients (37.2%) had three vessel disease. Whereas we found among non Polycythemia ACS patients, that 11 patients (9.6%) had normal coronary arteries, 43 patients (41.9%) had single vessel disease, 25 patients (24.9%) had two vessel disease, and 23 patients (23.6%) had three vessel disease. Predictors of coronary artery disease in an Arab population had not been well defined well. Coronary artery disease detecting by coronary angiography in Syria (Arab country), was present in 80% and normal in 20% patients [44]. Compared to the other non-Arab developing country, such as India, an Indian study on ACS patients at high altitude regions revealed that 5% had normal coronaries, 26% had single vessel, 30% had two vessel, and 39% had three vessel disease [45]. These findings were similar to our findings at Polycythemia ACS patients. Two and three vessel disease occurrence among non Polycythemia ACS patients was non-significantly lower than Polycythemia ACS patients Yemen and India.

Our findings compared other developed country such as England. British study showed coronary occlusion in 48% had one-vessel disease, 38.3% had two-vessel disease, and 12.7% had three-vessel disease [46]. Our study revealed that three vessel occlusions was higher than the British findings, and single vessel occlusion was lower than the British findings.

Our study found that the prevalence of normal coronary angiography, single vessel disease and two vessel disease were comparable among Polycythemia and non Polycythemia ACS patients. The three vessel occlusion occurrence among Polycythemia was more common.

The location of circumflex coronary artery occlusion (CX) was significantly higher among Polycythemia ACS Yemeni patients ($p = 0.003$). The issue is even more troublesome in those situations where the CX is affected. The CX is the dominant vessel in only about 10% of humans [47], and is the least frequently affected vessel in myocardial infarction [48]. The location of LAD, RCA, and left-main occlusions were comparable among ACS patients at both groups. Among Polycythemia ACS patients, 75.1% had LAD occlusion, 53.8% had CX occlusion, 56.1% had RCA occlusion, and 7.3% had left main occlusion. Among non Polycythemia ACS patients, 66.8% had LDA occlusion, 42.2% had CX occlusion, 47.2% had RCA occlusion, and 5.6% had left main occlusion.

German study showed that coronary artery stenosis found 39% in the LAD, 29% in the CX and 33% in the RCA [49].

Polycythemia ACS patients in Yemen have significantly an angiographic infarct-related lesion in the right coronary or left circumflex artery (CX) than the non Polycythemia ACS patients in Yemen. Non Polycythemia ACS patients were less likely

to have site of occlusion in left anterior descending (LAD), and left main coronary artery (Left-main) than Polycythemia ACS patients. Non Polycythemia ACS Patients compared with Polycythemia ACS patients were less likely to have multivessel disease, particularly among those where the circumflex was the infarct-related artery. The majority of Polycythemia ACS patients had multi vessel disease with significant stenoses (>50%) of the LAD, CX and RCA.

Polycythemia ACS patients had significantly lower global left ventricular function, as indicated by greater median left ventricular ejection fraction, than did non Polycythemia patients. The decreased EF and increased risk factor for CAD such as hyperlipidaemia and reported history of CAD among Polycythemia ACS patients may partially explain the increased coronary occlusions than non Polycythemia ACS patients. However, further researches are necessary and are recommended for better clarification of interaction between Polycythemia and coronary artery occlusions among ACS patients.

4. Conclusion

Acute coronary syndrome patients who have Polycythemia were significantly younger. Those Polycythemia ACS patients in Yemen have higher risk factors for CAD, especially hyperlipidaemia and history of CAD, contrary to ACS patients with normal levels of hemoglobin. ACS patients with normal levels of hemoglobin had significantly better global left ventricular function, as indicated by greater median left ventricular ejection fraction, than what Polycythemia ACS patients had. Quantitatively, there is progression of coronary artery disease with a decrease in LVEF. The Polycythemia ACS patients in Yemen were associated with more coronary artery occlusions. The Polycythemia ACS patients have significantly an angiographic infarct-related lesion in the right coronary or left circumflex artery (CX) than the ACS patients with normal levels of hemoglobin. ACS patients with normal levels of hemoglobin were less likely to have site of occlusions in left anterior descending (LAD) and left main coronary artery (Left-main) than Polycythemia ACS patients. We noted that the presence of coronary occlusions among ACS Yemeni patients was higher than that in developed countries. However, the pattern of coronary occlusions and the pattern of LVEF had a negative relationship among ACS patients with single, double, and triple vessel disease and high levels of hemoglobin. Three-vessel disease and circumflex coronary occlusion were more common among Polycythemia ACS patients. There is association between increased levels of hemoglobin and coronary complications. However, further researches are important and are recommended for better clarification of interaction between increased levels of hemoglobin and coronary artery complications among ACS patients.

References

- [1] Gandhi, M.M., Lampe, F.C. and Wood, D.A. (1995) Incidence, Clinical Characteristics, and Short-Term Prognosis of Angina Pectoris. *British Heart Journal*, **73**, 193-198.
<http://dx.doi.org/10.1136/hrt.73.2.193>
- [2] Tunstall-Pedoe, H., Kuulasmaa, K., Mähönen, M., *et al.* (1999) Contribution of Trends in Survival and Coronary Event Rates to Changes in Coronary Heart Disease Mortality:

- Ten-Year Results from 37 WHO MONICA Project Populations. *Lancet*, **353**, 1547-1557. [http://dx.doi.org/10.1016/S0140-6736\(99\)04021-0](http://dx.doi.org/10.1016/S0140-6736(99)04021-0)
- [3] Husten, L. (1998) Global Epidemic of Cardiovascular Disease Predicted. *Lancet*, **352**, 1530. [http://dx.doi.org/10.1016/S0140-6736\(05\)60342-X](http://dx.doi.org/10.1016/S0140-6736(05)60342-X)
 - [4] Moise, A., Theroux, P., Taeymans, Y., Descoings, B., Lesperance, J., Waters, D., Pelletier, G.B. and Bourassa, M.G. (1983) Unstable Angina and Progression of Coronary Atherosclerosis. *New England Journal of Medicine*, **309**, 685-689. <http://dx.doi.org/10.1056/NEJM198309223091201>
 - [5] Ambrose, J.A., Tannenbaum, M.A., Alexopoulos, D., Hjemdahl-Monsen, C.E., Leavy, J., Weiss, M., Borrico, S., Gorlin, R. and Fuster, V. (1988) Angiographic Progression of Coronary Artery Disease and the Development of Myocardial Infarction. *Journal of the American College of Cardiology*, **12**, 56-62. [http://dx.doi.org/10.1016/0735-1097\(88\)90356-7](http://dx.doi.org/10.1016/0735-1097(88)90356-7)
 - [6] Falk, E. (1985) Unstable Angina with Fatal Outcome: Dynamic Coronary Thrombosis Leading to Infarction and/or Sudden Death—Autopsy Evidence of Recurrent Mural Thrombosis with Peripheral Embolization Culminating in Total Vascular Occlusion. *Circulation*, **71**, 699-708. <http://dx.doi.org/10.1161/01.cir.71.4.699>
 - [7] DeWood, M.A., Spores, J., Notske, R., Mouser, L.T., Burroughs, R., Golden, M.S., *et al.* (1980) Prevalence of Total Coronary Occlusion during the Early Hours of Transmural Myocardial Infarction. *New England Journal of Medicine*, **303**, 897-902. <http://dx.doi.org/10.1056/NEJM198010163031601>
 - [8] Ambrose, J.A., Winters, S.L., Stern, A., Eng, A., Teichholz, L.E., Gorlin, R., *et al.* (1985) Angiographic Morphology and the Pathogenesis of Unstable Angina Pectoris. *Journal of the American College of Cardiology*, **5**, 609-6016. [http://dx.doi.org/10.1016/S0735-1097\(85\)80384-3](http://dx.doi.org/10.1016/S0735-1097(85)80384-3)
 - [9] Amsterdam, E.A., Most, A.S., Wolfson, S., Kemp, H.G. and Gorlin, R. (1970) Relation of Degree of Angiographically Documented Coronary Artery Disease to Mortality. (Abstr) *Annals of Internal Medicine*, **72**, 780. http://dx.doi.org/10.7326/0003-4819-72-5-780_4
 - [10] Gyllerup, S., Lanke, J., Lindhom, L.H. and Schersten, B. (1991) Smoking Habits, Sales of Fat and Antihypertensives Fail to Explain the High Coronary Mortality in Cold Regions of Sweden. *Scottish Medical Journal*, **36**, 165-168.
 - [11] Anderson, G.M., Grumbach, K., Luft, H.S., Roos, L.L., Mustard, C. and Brook, R. (1993) Use of Coronary Artery Bypass Surgery in the United States and Canada: Influence of Age and Income. *JAMA*, **269**, 1661-1666. <http://dx.doi.org/10.1001/jama.1993.03500130075035>
 - [12] Whittle, J., Conigliaro, J., Good, C.B. and Lofgren, R.P. (1993) Racial Differences in the Use of Invasive Cardiovascular Procedures in the Department of Veterans Affairs Medical System. *New England Journal of Medicine*, **329**, 621-627. <http://dx.doi.org/10.1056/NEJM199308263290907>
 - [13] Guadagnoli, E., Hauptman, P.J., Ayanian, J.Z., Pashos, C.L., McNeil, B.J. and Cleary, P.D. (1995) Variation in the Use of Cardiac Procedures after Acute Myocardial Infarction. *New England Journal of Medicine*, **333**, 573-578. <http://dx.doi.org/10.1056/NEJM199508313330908>
 - [14] Crassard, I., Woimant, F. (2005) Affections hematologiques et accidents vasculaires cérébraux. *EMC-Neurologie*, **2**, 339-348. <http://dx.doi.org/10.1016/j.emcn.2005.04.001>
 - [15] Hermanns, B., Handt, S., Kindler, J. and Füzesi, L. (1998) Coronary Vasculopathy in Polycythemia Vera. *Pathology & Oncology Research*, **4**, 37-39. <http://dx.doi.org/10.1007/BF02904693>
 - [16] Gomes, S., Pereira, D., Oliveira, R., Faria, P., Freitas, A., Pereira, E., Alve, C. and Cardoso,

- A. (2005) New Diagnostic Criteria for Acute Myocardial Infarction and In-Hospital Mortality. *Revista Portuguesa de Cardiologia*, **24**, 231-237.
- [17] Reiber, J.H.C. (1988) Morphologic and Densitometric Quantitation of Coronary Stenoses: An Overview of Existing Quantitation Techniques. In: Reiber, J.H.C. and Serruys, P.W., Eds., *New Developments in Quantitative Coronary Arteriography*, Martinus-Nijhoff, Dordrecht, 34. http://dx.doi.org/10.1007/978-94-009-1309-7_4
- [18] Waters, D., Craven, T. and Lesperance, J. (1993) Prognostic Significance of Progression of Coronary Atherosclerosis. *Circulation*, **87**, 1067-1075. <http://dx.doi.org/10.1161/01.CIR.87.4.1067>
- [19] Kaski, J., Tousoulis, D., Pereira, W.L., Crea, F. and Maseri, A. (1992) Progression of Complex Coronary Artery Stenosis in Patients with Angina Pectoris: Its Relation to Clinical Events. *Coronary Artery Disease*, **3**, 305-312. <http://dx.doi.org/10.1097/00019501-199204000-00007>
- [20] Rosengren, A., Wallentin, L., Gitt, A.K., Behar, S., Battler, A. and Hasdai, D. (2004) Sex, Age, and Clinical Presentation of Acute Coronary Syndromes. *European Heart Journal*, **25**, 663-670. <http://dx.doi.org/10.1016/j.ehj.2004.02.023>
- [21] Ashouri, K., Ahmed, M.E., Kardash, M.O., Sharif, A.Y., Adbalsattar, M. and Al-Ghozeim, A. (1994) Acute Myocardial Infarction at High Altitude: The Experience in Asir Region, Southern Saudi. *Ethnicity & Disease*, **4**, 82-86.
- [22] Dakik, H.A., Koubeissi, Z., Kleiman, N.S., Nasrallah, A., Sawaya, J., Gharzuddine, W., Tamim, H., Shaar, K. and Alam, S. (2004) Acute Myocardial Infarction: Clinical Characteristics, Management and Outcome in a University Medical Centre in a Developing Middle Eastern Country. *Canadian Journal of Cardiology*, **20**, 789-793.
- [23] Dhanjal, T.S., Lal, M., Haynes, R. and Lip, G. (2001) A Comparison of Cardiovascular Risk Factors among Indo-Asian and Caucasian Patients Admitted with Acute Myocardial Infarction in Kuala Lumpur, Malaysia and Birmingham, England. *International Journal of Clinical Practice*, **55**, 665-668.
- [24] Temte, J.L. (1996) Elevation of Serum Cholesterol at High Altitude and Its Relationship to Hematocrit. *Wilderness & Environmental Medicine*, **7**, 216-224. [http://dx.doi.org/10.1580/1080-6032\(1996\)007\[0216:EOSCAH\]2.3.CO;2](http://dx.doi.org/10.1580/1080-6032(1996)007[0216:EOSCAH]2.3.CO;2)
- [25] Al-Tahan, B.J., Elkhasky, F., Ogunniyi, A., Al-Rajeh, S., Larbi, E., Daif, A. and Bamgboye, E. (1998) Risk Factors of Stroke at High and Low Altitude Areas in Saudi Arabia. *Archives of Medical Research*, **29**, 173-177.
- [26] Mahfouz, A.A. and Al-Erian, R.A. (1993) Hypertension in Asir Region, Southwestern Saudi Arabia: An Epidemiologic Study. *Southeast Asian Journal of Tropical Medicine and Public Health*, **24**, 284-286.
- [27] Sharma, S. (1990) Clinical, Biochemical, Electrocardiographic and Noninvasive Hemodynamic Assessment of Cardiovascular Status in Natives at High to Extreme Altitudes (3000 m - 5500 m) of the Himalayan Region. *Indian Heart Journal*, **42**, 375-379.
- [28] Fujimoto, N., Matsubayashi, K., Miyahara, T., Murai, A., Mastuda, M., Shio, H., Suzuki, H., et al. (1989) The Risk Factors for Ischemic Heart Disease in Tibetan Highlanders. *Japanese Heart Journal*, **30**, 27-34. <http://dx.doi.org/10.1536/ihj.30.27>
- [29] De Mendoza, S., Nucete, H., Ineichen, E., Salazar, E., Zepa, A. and Glueck, C.J. (1979) Lipids and Lipoproteins in Subjects at 1,000 and 3,500 Meter Altitudes. *Archives of Environmental Health*, **34**, 308-311. <http://dx.doi.org/10.1080/00039896.1979.10667422>
- [30] Kasaoka, S., Okuda, F., Satoh, A., et al. (1997) Effect of Coronary Risk Factors on Coronary Angiographic Morphology in Patients with Ischemic Heart Disease. *Japanese Circulation*

- Journal*, **61**, 390-395. <http://dx.doi.org/10.1253/jcj.61.390>
- [31] Bemis, C.E., Gorlin, R., Kemp, H.G. and Herman, M.V. (1973) Progression of Coronary Artery Disease: A Clinical Arteriographic Study. *Circulation*, **47**, 455-464. <http://dx.doi.org/10.1161/01.CIR.47.3.455>
 - [32] Manofroi, W.C., Zago, A.J., Leitao, C.B., Ordovas, K.G., Ribeiro, L.W., De Souza, J., Kirschnick, L., Candiago, R.H., Cruz, R., Goellener, A. and Dias, I. (1998) Comparison of Coronary Arteriosclerosis in Patients with Myocardial Infarction and Angina Pectoris. *Arquivos Brasileiros de Cardiologia*, **71**, 25-29.
 - [33] Hung, J., Lam, J.Y.T., Lacoste, L. and Letchacovski, G. (1995) Cigarette Smoking Acutely Increases Platelet Thrombus Formation in Patients with Coronary Artery Disease Taking Aspirin. *Circulation*, **92**, 2432-2436. <http://dx.doi.org/10.1161/01.CIR.92.9.2432>
 - [34] Lewington, S., Clarke, R., Qizilbash, N., *et al.* (2002) Age-Specific Relevance of Usual Blood Pressure to Vascular Mortality: A Meta-Analysis of Individual Data for One Million Adults in 61 Prospective Studies. *Lancet*, **360**, 1903-1913. [http://dx.doi.org/10.1016/S0140-6736\(02\)11911-8](http://dx.doi.org/10.1016/S0140-6736(02)11911-8)
 - [35] Moreno, P.R., Murcia, A., Palacios, I.F., *et al.* (2000) Coronary Composition and Macrophage Infiltration in Atherectomy Specimens from Patients with Diabetes Mellitus. *Circulation*, **102**, 2180-2184. <http://dx.doi.org/10.1161/01.CIR.102.18.2180>
 - [36] Gyongyosi, M., Yang, P., Hassan, A., *et al.* (1999) Coronary Risk Factors Influence Plaque Morphology in Patients with Unstable Angina. *Coronary Artery Disease*, **10**, 211-219. <http://dx.doi.org/10.1097/00019501-199906000-00002>
 - [37] Alderman, E.L., Corley, S.D., Fisher, L.D., *et al.* (1993) Five-Year Angiographic Follow-Up of Factors Associated with Progression of Coronary Artery Disease in the Coronary Artery Surgery Study (CASS). CASS Participating Investigators and Staff. *Journal of the American College of Cardiology*, **22**, 1141-1154. [http://dx.doi.org/10.1016/0735-1097\(93\)90429-5](http://dx.doi.org/10.1016/0735-1097(93)90429-5)
 - [38] Pajunen, P., Nieminen, M.S., Taskinen, M.R., *et al.* (1997) Quantitative Comparison of Angiographic Characteristics of Coronary Artery Disease in Patients with Noninsulin-Dependent Diabetes Mellitus Compared with Matched Nondiabetic Control Subjects. *American Journal of Cardiology*, **80**, 550-556. [http://dx.doi.org/10.1016/S0002-9149\(97\)00420-7](http://dx.doi.org/10.1016/S0002-9149(97)00420-7)
 - [39] Pajunen, P., Taskinen, M.R., Nieminen, M.S., *et al.* (2000) Angiographic Severity and Extent of Coronary Artery Disease in Patients with Type 1 Diabetes Mellitus. *American Journal of Cardiology*, **86**, 1080-1085. [http://dx.doi.org/10.1016/S0002-9149\(00\)01163-2](http://dx.doi.org/10.1016/S0002-9149(00)01163-2)
 - [40] Zorris, R.W., Whincup, P.H., Lampe, F.C., *et al.* (2001) Geographical Variations in Incidence of Coronary Heart Disease in Britain: The Contribution of Established Risk Factors. *Heart*, **86**, 277-283. <http://dx.doi.org/10.1136/heart.86.3.277>
 - [41] Vincelj, J. (2004) Echocardiography in Acute Coronary Syndrome. *Acta Medica Croatica*, **58**, 95-99.
 - [42] McClements, B.M., Weyman, A.E., Newell, J.B. and Picard, M.H. (2000) Echocardiographic Determinants of Left Ventricular Ejection Fraction after Acute Myocardial Infarction. *American Heart Journal*, **140**, 284-289. <http://dx.doi.org/10.1067/mhj.2000.107543>
 - [43] The Multicenter Postinfarction Research Group (1983) Risk Stratification and Survival after Myocardial Infarction. *New England Journal of Medicine*, **309**, 331-336. <http://dx.doi.org/10.1056/NEJM198308113090602>
 - [44] Forsberg, S., Bijure, A., Haggendahl, E., Paulin, S., Varnauskas, S.E. and Werko, L. (1971) Post Mortem, Coronary Arteriographic, Clinical and Electrocardiographic Findings in 80 Patients Investigated with Coronary Arteriography. *Acta Medica Scandinavica*, **189**, 463-

470. <http://dx.doi.org/10.1111/j.0954-6820.1971.tb04406.x>
- [45] Heller, L.I. (1995) Diagnostic Evaluation of Women with Suspected Coronary Artery Disease. *Cardiology*, **86**, 318-323. <http://dx.doi.org/10.1159/000176896>
- [46] Al-Kateb, H., Zarzzour, W., Shameah, M. and Juoma, M. (1998) Coronary Risk Factors of Angiographically Assessed Patients from Syria. *Journal of Cardiovascular Risk*, **5**, 31-35. <http://dx.doi.org/10.1097/00043798-199802000-00004>
- [47] Calton, R., Satiga, T., Dhanoa, J., Jaison, T.M. and David, T. (1998) Correlation of Braunwald's Clinical Classification of Unstable Angina Pectoris with Angiographic Extent of Disease, Lesion Morphology and Intra-Luminal Thrombus. *Indian Heart Journal*, **50**, 300-306.
- [48] Kaski, J.C., Chester, M.R., Chen, L. and Katritsis, D. (1995) Rapid Angiographic Progression of Coronary Artery Disease in Patients with Angina Pectoris. *Circulation*, **92**, 2058-2065. <http://dx.doi.org/10.1161/01.CIR.92.8.2058>
- [49] Bittl, J.A. and Levin, D.C. (1997) Coronary Arteriography. In: Braunwald, E., Ed., *Heart Disease*, WB Saunders, Philadelphia, 240-272.

Abbreviations

ACS: Acute Coronary Syndromes,
ASE: American Society of Echocardiography,
BP: Blood Pressure,
CAD: Coronary Artery Disease,
DM: Diabetes Mellitus,
ECG: Electrocardiography,
FBG: Fasting Blood Glucose,
HA: High Altitude,
Hb: Hemoglobin,
HDL: High-Density Lipoprotein,
HF: Heart Failure,
HT: Hypertension,
IHD: Ischemic Heart Disease,
LA: Low Altitude,
LDL: Low-Density Lipoprotein,
LVEF: Left Ventricle Ejection Fraction,
MI: Myocardial Infarction,
Non-QMI: None Q wave Myocardial Infarction,
OR: Odds Ratio,
QMI: Q wave Myocardial Infarction,
RHD: Rheumatic Heart Disease,
RBG: Random Blood Glucose,
SD: Stander Deviation,
TG: Triglycerides,
WHO: World Health Organization.



Open Access Library

Submit or recommend next manuscript to OALib Journal and we will provide best service for you:

- Publication frequency: Monthly
- 9 [subject areas](#) of science, technology and medicine
- Fair and rigorous peer-review system
- Fast publication process
- Article promotion in various social networking sites (LinkedIn, Facebook, Twitter, etc.)
- Maximum dissemination of your research work

Submit Your Paper Online: [Click Here to Submit](#)

Or Contact service@oalib.com