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Original Article

Re-catheterization in a young patient with acute myocardial infarction: is it preventable?

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Abstract: Coronary artery disease (CAD) is the leading cause of morbidity and mortality worldwide. The goal of our study was to determine the causes of re-catheterization in a young population who were admitted with myocardial infarction and previously underwent cardiac catheterization, and determine what measures can be applied to prevent their re-catheterization. A retrospective study was conducted at Tawam hospital for 6 years (2009-2014). 50 patients between 18 and 50 years of age admitted with acute coronary syndrome who had re-catheterization within a year from their first cardiac catheterization were included. Medical records were reviewed to gather demographic data, cardiac risk factors, laboratory data, hospital course, and angiographic findings. All data was analyzed using descriptive analysis. One third of study participants had been re-admitted electively for a staged PCI, while another third had been admitted and were found to have angina as they did not have significant lesions during re-catheterization; 12 of them had ballooning done while the remaining participants had no intervention. The final third of the participants had re-catheterization due to the development of a new infarction (STEMI/NSTEMI). Of those who had a new infarction, 14% had stent thromboses while 12% had stent restenosis. Stent thrombosis and stent restenosis were found to present as STEMI regardless of the diagnosis at first catheterization. Those with a bare metal stent were found to have a higher risk of ST/ISRS compared to those with a drug-eluting stent (DES). Among the cardiovascular risk factors, we determined that patients who had dyslipidemia (80%) presented the highest risk of having a re-catheterization, followed by those with hypertension or smoking (each 70%). No mortality was documented in the study population. Further research is warranted using accurate statistical analysis and a larger study population to determine the etiology and means of prevention of re-catheterization in the younger population.

Keywords: Acute coronary syndrome, myocardial infarction, young, re-catheterization, coronary risk factors

Introduction

Myocardial infarction is defined as the sudden termination of blood flow following thrombotic obstruction of a coronary artery that has been narrowed as a result of atherosclerotic plaque [1]. It remains a leading cause of mortality globally [2]. Advanced age has always been shown to be a risk factor with regards to acute myocardial infarction; however, the incidence of MI in young adults has increased due to the prevalence of known risk factors such as smoking, hypertension, elevated triglycerides, and low high density lipoproteins [3]. Patients below the age of 45 constitute an estimated 4.1% of the total number of myocardial infarctions [4].

The phenomenon of acute myocardial infarction in young adults has rapidly become a medical concern recently [5], even though younger patients have a better early and late prognosis compared to older patients when receiving appropriate intervention. One study showed that patients aged 55-64 years had an eight- to nine-times higher chance of sustaining an MI compared to patients aged 30-34 [6].

Adults aged up to 45 are typically in the most productive and industrious years of their lifetime. The rising prevalence of acute MI in this age group is projected to cause numerous psychological as well as socioeconomic implications, including an increased probability of sustaining a long term disability or in some cases, premature death [7].

The goal of this study was to elucidate the various etiologic factors contributing to repeated

cardiac catheterization in this young patient population at Tawam and subsequently form a viable plan for prevention. Multiple factors are known to serve as justification to repeat cardiac catheterization including staged percutaneous coronary intervention (PCI) in which patients undergo planned subsequent PCIs after the initial procedure to obtain revascularization [8].

Another reason for repeat cardiac catheterization is stent thrombosis, a known complication that arises after stent placement in which thrombotic obstruction of the stent occurs. Key factors that can lead to stent thrombosis include medication noncompliance, stent type, presence of patient comorbidities, lesion intricacies, or substandard stent deployment [9, 10].

Stent thrombosis differs from in-stent restenosis. Stent restenosis is typically a subacute event, whereas stent thrombosis is typically an acute phenomenon.

In-stent restenosis is a relatively common complication that occurs in patients who undergo bare metal stent placement (approximately 20%) [11]. The incidence has decreased with the advent of newer technologies such as utilization of drug eluding stents and drug eluding balloons; however, in-stent restenosis still remains a clinically challenging issue occurring in fewer than 10% of patients with drug eluding technology [12].

Materials and methods

A retrospective cross-sectional study was conducted at Tawam hospital over a period of 6 years (2009-2014) in an effort to discover the etiology of re-catheterization in younger patients admitted with acute myocardial infarction and to implement measures to prevent it. The study was approved by the ethics committee. The ethical approval of the study was CRD 10/60.

50 patients below age 50 years who were admitted to the hospital with an acute myocardial infarction (based on electrocardiogram findings and cardiac enzymes) and had cardiac re-catheterization within a year of their first catheterization were included in the study patients aged <18 years and >50 years. Patients who presented with cardiac arrest to ED, patients with congenital cardiac and vascular disease, and patients who developed MI after surgery or secondary to underlying illness such as sepsis were excluded from the study.

Medical records of patients who met the inclusion criteria were reviewed for demographic data, including age, gender, ethnic group, and cardiovascular risk factors such as diabetes, hypertension, dyslipidemia, obesity, family history of coronary artery disease (CAD), and smoking. Labs were reviewed to stratify patients as controlled or uncontrolled diabetes and to stratify for the presence of dyslipidemia and anemia, as well as troponin level and its correlation to the extent of the infarct. Vital signs were reviewed to stratify patients as having uncontrolled hypertension or controlled if taking prescription medications for hypertension. The collected data were analyzed using descriptive analysis.

Risk factors evaluated in this study included

Hypertension: Hypertension was recorded in patients who were prescribed antihypertensive medications at admission or had been previously diagnosed with hypertension and in those whose blood pressure (Bp) was persistently elevated during their hospital stay (defined as Bp >130/80 mmHg). Hypertension was further classified into controlled (Bp = or <140/90) and uncontrolled (Bp >140/90).

Diabetes mellitus: Diabetes mellitus was recorded in patients who were prescribed hypoglycemic medications prior to admission or those who were previously diagnosed with diabetes, and those whose HbA1c was checked during their hospital stay and it was found to be elevated (>6.5%). Diabetes was further classified into controlled (HbA1c <7) and uncontrolled (HbA1c = or >7).

Dyslipidemia: Dyslipidemia was recorded in patients who were on anti-dyslipidemia agents or those who were previously diagnosed with dyslipidemia and those who had their lipid profile checked during hospital stay and met the criteria for diagnosis (Low density lipoprotein (LDL) >2.6 mmol/l). Dyslipidemia was further classified into controlled (LDL <1.8 mmol/l) and uncontrolled (LDL >2.6 mmol/l).

Table 1. Demographic data and risk factors

Demographic data	
Age	Mean 39 years +/-5
Gender	Male (46)
	Female (4)
Ethnic group	Emirati (15)
	Non-Emirati (35)
Insurance holder	30
Risk factors	
Diabetes Mellitus	65% (20% controlled)
Hypertension	70% (60% controlled)
Dyslipidemia	80% (40% controlled)
Tobacco use	70% (16% were ex-smoker)
Family history of CAD	20%
Compliance	40% non-compliant

Smoking: Smoking history was assessed and those who were current smokers or ex-smokers were further evaluated as to the mode of smoking, the amount and the duration.

Obesity: Obesity of the participants was evaluated by calculating their BMI and assigning them in normal (BMI 20-24.9), overweight (BMI 25.0-29.9), or obese (BMI >/= 30) weight categories.

Cardiac catheterization findings during the first cardiac catheterization, and during the cardiac re-catheterization were reviewed. We also investigated the reasons for cardiac re-catheterization, including in-stent restenosis, stent thrombosis or new myocardial infarction, and we evaluated the role of noncompliance in new myocardial infarctions. We also reviewed data on in hospital complications, including tachyarrythmia and bradyarrhythmia (Supraventricular and ventricular), congestive heart failure, cardiogenic shock, cardiac arrest, and death.

Results

Table 1 summarizes the risk factors and demographic data of the study population (50 participants). The mean age of the participants was 39 years. The majority of the participants were male (92%) and non-local (70%). 60% of the participants were insured. Three quarters of the study population were found to have dyslipidemia followed by hypertension and smoking. Out of 70% of those who consumed tobacco, 54% were actively smoking while 16% had completely quit smoking. 65% of the study group were diagnosed with diabetes and only 20% were well controlled while the rest had uncontrolled diabetes (HbA1c = or >7). Surprisingly, out of 70% of those diagnosed with hypertension, 60% had their blood pressure under control (Goal: <130/80). 40% of those who were diagnosed with dyslipidemia had their lipid profile at or below the goal (Goal: LDL <1.8). Only 20% of our participants had a positive family history of CAD. Less than half of the participants were found to be non-compliant with their medications and the majority of those were men from non-local communities with financial issues who were not capable of accessing their medication. Of the 40% of participants who were non-compliant, 50% had no health insurance.

56% of the participants had STEMI on initial presentation for their initial cardiac event, while 20% of them had NSTEMI and the rest were diagnosed with angina (24%). Angiographic data of those with STEMI diagnosed prior to their first cardiac catheterization showed 7 with an anterior STEMI and partial occlusion of the LAD, 19 with an inferior STEMI and partial occlusion of the right coronary artery (RCA) and 2 with a lateral STEMI and partial occlusion of the left circumflex artery (LCx). **Table 2** summarizes catheterization finding during first catheterization, re-catheterization, and type of stent used.

Angiographic data of those diagnosed with NSTEMI prior to their first cardiac catheterization showed 5 participants diagnosed with an anterior NSTEMI and partial occlusion of the LAD followed by lateral NSTEMI in 4 patients and partial occlusion of the LCx and inferior NSTEMI in 1 patient with partial occlusion of the RCA.

Of the 50 participants, 14% were found to have single vessel disease involving only the LAD. Participants who had intervention (Percutaneous coronary intervention-PCI) during first cardiac catheterization included 6 who had a bare metals stent (BMS) stent inserted, and the remaining participants had a drug-eluting stent (DES) placed. 5 of the participants were found to have no significant lesion and therefore no stent placements. 2 others were found to have significant lesions but had unsuccessful attempts at stent insertion. These 7 participants

Table 2. Findings during first catheterization and re-catheterization as well as the type of used stent

First catheterization	
STEMI	56% (28)
NSTEMI	20% (10)
Angina	24% (12)
Re-catheterization	
STEMI	12% (6)
NSTEMI	18% (7)
Angina	38% (19)
Stage PCI	32% (16)
Stent thrombosis	14%
In-stent restenosis	12%
Stent type	
BMS	17%
DES	83%

STEMI: ST Elevation Myocardial Infarction; NSTEMI: Non-ST Elevation Myocardial Infarction; PCI: Percutaneous Coronary Intervention; BMS: Bare Metal Stent; DES: Drug Eluting Stent.

who did not have a stent placed, alternatively received intensive medical treatment. 1 other patient had successful thrombus de-clotting and also had no stent inserted.

About one third of the participants were re-admitted within one week to the hospital, electively for a staged PCI. Another third of the participants were subsequently admitted with a diagnosis of angina. Cardiac re-catheterization showed no significant lesion, and no intervention was done in 40% (7 patients) while ballooning was done for 60% (12 patients) of those admitted with angina. One of the participants was found to have triple-vessel disease and was referred to a cardiothoracic surgeon for CABG.

All of the participants who had stent thrombosis and in-stent restenosis (ISRS) were found to be non-compliant with their cardiac medications. ST and ISRS were found to be common in those with a BMS compared to a DES. One (1) patient was diagnosed with Prinzmetal angina. The overall inn hospital mortality was 0%.

Chart review (**Table 3**) revealed that none of the participants had anemia and the mean hemoglobin level during first catheterization and re-catheterization were not significantly different. It is expected for participants to have better control of their LDL cholesterol and blood pressure during second admission when they had cardiac re-catheterization compared to their first catheterization due to being prescribed lipid lowering agents and antihypertensive agents, but our chart review showed similar levels in the mean value of LDL cholesterol, and an unexpected increase of 12% in the percentage of participants who had uncontrolled blood pressure. This is probably explained by noncompliance to the prescribed medication. Evaluation of the medical records revealed a significant weight reduction during the cardiac re-catheterization admission compared to the first cardiac catheterization admission with a 4% and 6% reduction in those stratified as obese or overweight, respectively.

Overall complications post-MI in younger patients were found to be minimal. Only 2% of the participants developed atrial fibrillation after their first catheterization and another 2% after their re-catheterization; however, there was an increase in heart failure rate after the second catheterization from 2 to 4% (**Table 4**).

Discussion

Our study included patients below age 50 who had acute myocardial infarction and underwent cardiac re-catheterization within a year from their first cardiac catheterization. Acute myocardial infarction is common in the elderly population and rare in the younger population; however, in the past decade, the incidence of acute myocardial infarction in the younger population has increased significantly [4, 13]. Recognition of the etiology of this increase and taking measures to reduce it will benefit society as well as each individual patient. Young patients with CAD initially treated with catheterization and stent placement are returning in increasing numbers with recurrent symptoms leading to cardiac re-catheterization. Mitigating the risk factors to reduce the risk for recurrent symptoms and re-catheterization is necessarily a top priority for those treating them, yet prior studies on this are nonexistent.

Younger patients presenting with an acute MI have a different risk factor profile, clinical presentation, and prognosis compared to the older patient population, which deserves consideration when treating them. The increased prevalence of risk factors for CAD in this younger age

Table 3. Data during first catheterization and re-catheterization

	First Cath	Re-Cath
Troponin	88.3+/-23	76.4+/-22.5
Hemoglobin (Hgb)	14+/-0.9 g/l	13+/-0.7 g/l
Low density lipoprotein (LDL)	2.43+/-1 mmol/l	2.48+/-0.7 mmol/l
High density lipoprotein (HDL)	0.85+/-0.1 mmol/l	0.9+/-0.1 mmol/l
Body mass index (BMI)	25.4+/-2.5 kg/m^2	24.14+/-2.3 kg/m^2
Normal BMI	44%	54%
Overweight	46%	40%
Obesity	10%	6%
Blood pressure		
Normal	32% (16)	28% (14)
Controlled	40% (20)	32% (16)
Uncontrolled	28% (14)	40% (20)

Table 4. Complications during first catheterization and re-catheterization

Complications	First Cath	Re-Cath
Arrhythmia	2%	2%
Heart failure	2%	4%
Cardiac arrest	None	None
Pericarditis	2%	None

group should alarm all physicians [13]. It is well known that diabetes, hypertension, dyslipidemia, positive family history of acute myocardial infarction, smoking, and male gender are the main risk factors for CAD [14, 15], and this study is no different except for the age of the participants. One of the most common non-modifiable risk factors that leads to developing acute myocardial infarction at any age is male gender. In our study 92% of the participants were male and similar findings haves been demonstrated in multiple previous studies [14, 15]. Of the modifiable risk factors, smoking has been demonstrated to be the most common among young patients with CAD [15]. 70% of our study population were also found to be smokers. Only 3 out of 50 patients in our study were found to have no risk factors except for smoking, and all 3 presented with STEMI. Family history has also been found to contribute to CAD in young patients [16]. Positive family history of CAD is one of the most common risk factors in the younger population, as reported in the literature, ranging from 14% to 69% [17-19] with this study finding that only 20% of the participants had a positive family history of CAD. The other well-known risk factors that contribute to CAD are hypertension and diabetes. While a review of the literature [14, 15] demonstrates a lower incidence of diabetes in younger patients developing CAD of 28% and 35% in respective studies, our study found that 70% of study participants had diabetes. This difference can be explained by dietary habits, the high prevalence of obesity, and ethnicity as our study population is primarily comprised of Arabic and Asian ethnic groups. Hypertension was detected in 70% of our study population, which is higher compared to the literature where its prevalence ranged from only 14% to 30% [17-19].

In the younger population postmyocardial infarction, mortality in the hospital and one year after the first catheterization was not significant (0%) both in our study and in literature review (1.9%) [12, 20].

No prior study has been conducted to analyze the reason for re-catheterization in younger patients. This is the first study to analyze the decision strategy for re-catheterization in younger patients. One third of our participants had re-catheterization electively for staged PCI while another third of the participants had re-catheterization due to the development of a new infarction. The most significant cause was found to be ST and ISRS, which arose primarily due to noncompliance with medications especially dual antiplatelet agents, and it primarily occurred in patients who had a BMS inserted.

It is important to have additional studies on this subject to help guide physicians to understand the cause of re-catheterization in younger patients, and to take appropriate measures to prevent their occurrence.

We acknowledge the limitations of our study including the small sample size, the incomplete documentation of risk factors and family history of the participants, and that it is a retrospective study.

Conclusion

Young men are at risk to have re-catheterization after their first myocardial infarction. In our

study, smoking history, uncontrolled cardiac risk factors including weight, hypertension, hyperlipidemia, and diabetes, and noncompliance to cardiac medications were all contributing factors. The type of stent also contributed to re-catheterization, with those patients with a BMS at a higher risk of developing ST and ISRS compared to those with a DES. Some of our participants were found to have significant lesions with zero mortality.

To our knowledge no studies have been conducted investigating the etiology of re-catheterization in a younger population. Larger case control studies are warranted to determine the most common contributing factors for re-catheterization in younger patients with MI.

Disclosure of conflict of interest

None.

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