Original Article

Outcome of coronary angiography and percutaneous coronary intervention in Egyptian women with chronic stable angina

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Received 15 October 2010; accepted 22 November 2010
Available online 14 October 2011

Keywords  Coronary angiography; Women; Percutaneous coronary intervention;

Abstract  Background: A suboptimal degree of attention has focused on the detection and management of coronary artery disease (CAD) in women until recently. We sought out to study the anatomy of coronary arteries in women by the means of coronary angiography in comparison to men. The results of percutaneous coronary intervention (PCI) and in hospital outcomes were studied and compared to men.

Methods: The study included 488 female and 492 male patients with chronic stable angina undergoing coronary angiography ± PCI taken consecutively. The angiographic results, interventional details and procedural success, and related complications were collected and statistically analyzed.

Results: Female patients had similar coronary risk factors with higher incidence of diabetes mellitus and lower history of smoking. The likelihood of non-atherosclerotic affliction of the coronaries was 47% in women vs. 25.5% in men (P < 0.001). The prevalence of multivessel affliction and more complex lesions were significantly lower in the female patients compared to their male counterparts (P < 0.001). Female patients had lower rate of PCI procedures and lower number of stents implanted (P < 0.001) including drug eluting stents. The success rates were similar in both the sexes, with relatively higher complication rate in the female group.

Conclusion: Egyptian women have generally similar risk profile to male patients with CAD and tend to receive less aggressive therapy. They showed less severe coronary atherosclerosis than...
1. Introduction

A suboptimal degree of attention has focused on the detection and management of coronary artery disease (CAD) in women until recently. Despite the established benefits of PCI in reducing fatal and non-fatal complications in patients with ischemic heart disease, only an estimated 33% of annual PCIs are performed in women. In addition, women experience greater delays to intervention and are referred for diagnostic catheterization less frequently than men. In contrast, once women are referred for cardiac catheterization, revascularization rates, and practices are comparable to those in men. Some other studies showed that women consistently tend to have worse clinical outcomes than those of men; most of these worse outcomes are explained by the higher risk profile of women. It appears at least in some studies to represent a complex interplay of clinical factors such as delayed onset of disease, older age, smaller body surface area, and comorbidities at the time of presentation. We aimed with this work to the study of the anatomy of coronary arteries in Egyptian women with chronic stable angina in relation to their risk profile by means of coronary angiography in addition to assessment of the results of percutaneous coronary intervention (PCI) and in hospital outcomes in comparison to men.

2. Methods

2.1. Selection of subjects

Patients with chronic stable angina who were referred to the catheterization laboratory for coronary angiography with possible percutaneous coronary intervention were the elements of this study. Patients with recent acute coronary syndromes (less than 3 months), advanced serious systemic disease, e.g. malignancy or liver cell failure, were excluded from the current study. Patients of foreign nationality were not included in the present work. The reason for exclusion of foreign citizens was to typify the Egyptian patients.

2.2. Acquisition and analysis of the patients

This study was a prospective single center study including 488 female and 492 male patients referred for coronary angiography in Ain Shams University hospitals during the period from March 2008 to May 2010. All patients were subjected to:

(1) Detailed clinical history including age, sex, coronary risk factors (smoking, diabetes mellitus, hypertension, dyslipidemia, and family history of CAD). The present history of ischemic heart disease including functional class of angina and previous admissions for coronary events was analyzed. History of other comorbidities including chronic lung diseases, cerebrovascular stroke, peripheral arterial diseases and renal impairment, and detailed history of current medications was taken. Menstrual history of the female patients was taken including intake of oral contraceptive pills.

(2) Thorough clinical examination including general and cardiac examination.

(3) Baseline 12 lead electrocardiogram (ECG).

(4) Standard coronary angiography via transfemoral approach using Seldinger’s technique. The angiograms were done in all the standard views using right and left coronary catheters. The proximal width of the LMCA, LAD, LCx, and RCA were measured by quantitative coronary angiography (QCA). The vessels were also evaluated for ectatic segments and tortuosity. Measurements of the reference vessel diameter (RVD), minimal luminal diameter (MLD); and the percent of diameter stenosis were taken on end diastolic frames. Lesion length in millimeter was measured as the distance between proximal and distal shoulders of the lesion. According to Ryan et al. lesions were classified into type A, B; and C indicating anatomical difficulty and expected procedural success.

(5) Percutaneous coronary intervention (PCI): In the patients that required catheter based revascularization with acquisition of the following data:

- Procedural time is defined as the time interval between placement of the arterial sheath and removal of the guiding catheter.

- Technique used for each patient including balloon dilatation and use of stents with its data (manufacturer, type, length and deployment pressure).

- Immediate Angiographic success: It is defined as less than 20% residual stenosis and a normal arterial blood flow TIMI flow grade III.

- Primary success is defined as an immediate angiographic success without first 24 h in hospital adverse events; including death, myocardial infarction, or target lesion revascularization.

2.3. Data management and statistical analysis

All data were collected and subjected to the following tests:

(1) X mean, SD standard deviation: to measure the central tendency of data and the distribution of date around their mean.

(2) Student’s t-test: for testing statistical significant difference between means of two samples.

(3) Median: is a measure of central tendency when extremes of values are found in data.

(4) \( \chi^2 \) test (chi square test) to test statistical significant relation between different variables or grades (qualitative data) or percentages.
(5) Spearman’s correlation test (correlation coefficient \( r \)) to test a positive or negative linear relationship between two variables (one dependent and the other is independent variable).

Significant result is considered if \( P \)-value was < 0.05. Highly significant result is considered if \( P \)-value was < 0.01.

3. Results

It took around 78 weeks to recruit 492 male patients, while it took 112 weeks to include 488 female patients in the present study.

3.1. Clinical characteristics

The mean age of the female patients was 59.18 ± 8.62 years, while the mean age of the male patients group was 57.4 ± 6.23 years and this was statistically non significant (Table 1). Among the clinical characteristics and coronary risk factors of the studied patients, there were no significant statistical differences regarding hypertension, dyslipidemia, and family history of ischemic heart disease. The presence of diabetes mellitus was significantly higher in the female patients (\( P = 0.05 \)), while the history of smoking (ex or current) was significantly higher in male patients in comparison to female patients (\( P < 0.001 \)). The mean weight of both groups was similar, but the females had a smaller body surface area than the males (\( P < 0.001 \)).

In our study, recent exacerbation of the chronic stable angina was the most common indication of coronary angiography in female patients, but history of previous acute coronary syndrome (ACS) and previous revascularization procedure was more common among male patients (\( P < 0.001 \)) (Table 2). Women had more comorbid conditions than men; as regards cerebrovascular disease and chronic pulmonary disease, but this was not statistically significant. However, the prevalence of peripheral vascular disease in males was statistically significant (\( P = 0.05 \)). Both groups had similar incidence of chronic renal insufficiency.

As regards baseline medications; there was no significant statistical difference between Egyptian males and females in their baseline medications including aspirin, \( \beta \) blockers, nitrates, calcium channel blockers, ACE inhibitors, and statins. The Egyptian females were less likely on clopidogril than their male counterparts (\( P = 0.05 \)). As 85% of the female patients were menopausal, 4.5% of the female patients were on hormonal replacement therapy (HRT). Of the 73 still menstruating patients, 25 patients were taking oral contraceptive pills (OCP) (Fig. 1).

3.2. Coronary angiographic findings

The results of coronary angiography are listed in Tables 3 and 4 and Figs. 2-4. As for the presence of ectatic vessels in both sexes, all the results are statistically insignificant except that of the ectatic RCA, which was higher in male patients (\( P = 0.019 \)). Female patients had statistically higher incidence of the presence of tortuous vessels than their male counterparts (\( P < 0.001 \))

4. Number of diseased vessels

Normal coronaries were found in 47% of the female patients and 25.5% of the male patients. The percentages of single vessel affliction were similar in both groups. But, the incidence of multivessel affliction was less in the females in comparison to

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**Table 1** Coronary risk factors of the studied patients.

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Female ( (n = 488) )</th>
<th>Male ( (n = 492) )</th>
<th>( P )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>59.18 ± 8.62</td>
<td>57.4 ± 6.23</td>
<td>0.28</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>249 (51%)</td>
<td>187 (38%)</td>
<td>0.05</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>214 (43.9%)</td>
<td>236 (48%)</td>
<td>0.072</td>
</tr>
<tr>
<td>Hypertension</td>
<td>278 (57%)</td>
<td>295 (60%)</td>
<td>0.08</td>
</tr>
<tr>
<td>Family history</td>
<td>96 (19.6%)</td>
<td>89 (18%)</td>
<td>0.68</td>
</tr>
<tr>
<td>History of smoking</td>
<td>43 (8.8%)</td>
<td>241 (49%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>80.9 ± 14.2</td>
<td>82.4 ± 8.5</td>
<td>0.17</td>
</tr>
<tr>
<td>Body surface area (m²)</td>
<td>1.82 ± 0.162</td>
<td>1.92 ± 0.126</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

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**Table 2** Clinical history and comorbidities of Egyptian patients.

<table>
<thead>
<tr>
<th>Clinical presentation</th>
<th>Female ( (n = 488) )</th>
<th>Male ( (n = 492) )</th>
<th>( P )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerating angina</td>
<td>302 (62%)</td>
<td>185 (37.6%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Previous CABG</td>
<td>34 (7%)</td>
<td>78 (15.8%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Previous PCI</td>
<td>107 (22%)</td>
<td>216 (44%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Previous ACS</td>
<td>59 (12%)</td>
<td>177 (36%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chronic pulmonary disease</td>
<td>21 (6.35%)</td>
<td>25 (5.1%)</td>
<td>0.08</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>10 (2.05%)</td>
<td>8 (1.63%)</td>
<td>0.06</td>
</tr>
<tr>
<td>Peripheral arterial disease</td>
<td>8 (1.64%)</td>
<td>23 (4.69%)</td>
<td>0.05</td>
</tr>
<tr>
<td>Chronic renal insufficiency</td>
<td>17 (3.48%)</td>
<td>20 (4.1%)</td>
<td>0.1</td>
</tr>
</tbody>
</table>
their male counterparts \((P < 0.001)\). The results are displayed in Fig. 2.

### 5. Lesion characteristics

Females had more type A lesions than males while males had more type C lesions than females \((P < 0.001)\) (Figs. 3 and 4).

#### 5.1. Interventional procedural characteristics

Among the patients who underwent coronary angiography, more men (31.5%) were referred for PCI than women (16%) \((P < 0.001)\), and there was no statistically significant difference in the percentage of target vessels to be stented between both groups (Table 5).

Our study also focused on how many vessels were targeted for revascularization. We found that men were more likely to undergo multivessel intervention than women \((P < 0.05)\) (Fig. 5).

During intervention, the number of stent per patient was statistically higher in male patients \((1.76 \text{ vs. } 1.25)\) \((P = 0.01)\), and drug eluting stents were less likely to be used in female patients in comparison to their male counterparts \((8.5% \text{ vs. } 24.7%)\) \((P < 0.001)\).

Our study found no significant difference in the procedural success rate between females and males \((99.2% \text{ vs. } 98.4% \text{ respectively, } P = 0.8)\).

Regarding procedure related complications, the female patients were more likely to suffer from complications like hematoma, dissection, spasm, pseudoaneurysms, and arrhythmias, while male patients had higher incidence of bleeding complications \((P < 0.001)\) (Table 6).

### 6. Discussion

Several studies have reported that there is an unequal distribution in the use of resources between women and men, implying that the observed differences in outcome may in part relate to resource utilization. Women have been reported to undergo cardiac catheterization and consequently revascularization

<table>
<thead>
<tr>
<th>Female patients</th>
<th>Male patients</th>
<th>(P)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMCA 0 ((0%))</td>
<td>1 ((0.2%))</td>
<td>0.315</td>
</tr>
<tr>
<td>LAD 7 ((1.4%))</td>
<td>15 ((3%))</td>
<td>0.155</td>
</tr>
<tr>
<td>LCx 5 ((1.02%))</td>
<td>11 ((2.24%))</td>
<td>0.407</td>
</tr>
<tr>
<td>RCA 6 ((1.23%))</td>
<td>24 ((4.9%))</td>
<td>0.019</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Female patients</th>
<th>Male patients</th>
<th>(P)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAD 26 ((5.3%))</td>
<td>13 ((2.6%))</td>
<td>0.001</td>
</tr>
<tr>
<td>LCx 28 ((5.7%))</td>
<td>12 ((2.4%))</td>
<td>0.001</td>
</tr>
<tr>
<td>RCA 34 ((7%))</td>
<td>14 ((2.8%))</td>
<td>0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Females</th>
<th>Males</th>
<th>(P)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients for PCI 78 ((16%))</td>
<td>155 ((31.5%))</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Target vessels for stenting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAD 19.4</td>
<td>30.1</td>
<td>0.161</td>
</tr>
<tr>
<td>Lt Cx 5.4</td>
<td>11.8</td>
<td>0.274</td>
</tr>
<tr>
<td>RCA 6.5</td>
<td>15</td>
<td>0.681</td>
</tr>
</tbody>
</table>
patients had higher incidence of previous acute coronary syndromes and revascularization procedures than females. This may be explained by the reluctance of Egyptian women to undergo coronary angiography and revascularization procedures until they have severe symptoms signifying significant myocardial ischemia.

In our study, it took 112 weeks to acquire the 488 female patients referred for coronary angiography; while it took only 78 weeks to acquire the slightly higher number of male patients. These kinds of findings show a prevalence of CAD in males more than in females and the suggestions of gender bias in cardiac care decision making.

According to Miller et al., more men \( (n = 1.418; \ 17\% \text{ of the male study population}) \) than women \( (n = 487; \ 8\% \text{ of the female population}) \) were referred for coronary angiography \( (P < 0.001) \).

The likelihood of non-atherosclerotic affliction of the coronaries was more in women with slightly lower incidence of coronary ectasia, but with significantly higher incidence of the presence of tortuous coronary vessels than their male counterparts \( (P < 0.001) \). In a study involving serial IVUS studies of coronary plaque progression, women had smaller and more tortuous vessels, \( P = 0.002 \), while Cantor et al. found a very poor correlation between sex, BSA and vessel reference diameter, even after stratification by lesion location.

As regards coronary atherosclerosis, the prevalence of single vessel affection is relatively the same while two, three or more vessel affection were significantly less in the female patients in comparison with their male counterparts \( (P < 0.001) \). In addition, our study showed that women had more type A lesions \( (29.8\%) \) than men \( (20.5\%) \) while men had more type C lesions than women \( (43.1\% \text{ vs. 35.1\%}) \) \( (P < 0.001) \). These results are consistent with the data obtained by Hochman et al. who enrolled the angiographic data of 4638 men and 1768 women and showed that women in all subgroups were significantly more likely than men to have less severe stenosis.

Of the 488 females referred for coronary angiography, intervention was done for only 78 cases \( (16\%) \). In contrast, PCI was done for 155 males \( (31.5\%) \) \( (P < 0.001) \). We also focused on how many vessels were targeted for revascularization, and we found that clinically men were more likely to undergo multivessel intervention than women \( (P < 0.05) \). The use of drug eluting stents was more in males as male patients tend to have worse lesions.

Women consistently tend to have worse outcomes and lower success rate than men; most of these worse outcomes are explained by the higher risk profile of women. However, our study found no significant difference in the procedural success rate between both sexes.

The continuing refinement of the interventional techniques has impacted greatly on the morbidity and mortality of both sexes following PCI. Advancements in equipment such as intra-coronary stents, along with smaller balloons, catheters, and sheaths, have revolutionized the field. Women may particularly benefit from these changes as they generally have smaller coronary vessels with a reported greater tendency for dissection during PCI. Our study showed that the females were more likely to suffer from hematomas, pseudoaneurysm, and a greater tendency for dissection \( (P < 0.001) \). Male patients in our study tend to have more bleeding complications \( (P < 0.001) \) in contrast to the findings of Cho et al. who demonstrated higher incidence of previous acute coronary syndromes and revascularization procedures than females.

In addition, the results of revascularization procedures have been reported to be less favorable in women than in men. In contrast to prior reports, which showed relatively older female patients, the presenting ages of both female and male patients referred for coronary in our study were similar. We attribute this finding to the relatively small number of patients done in this study compared to other registries as well as to the reluctance of Egyptian physicians’ to refer older female patients for coronary angiography. Consistent with these reports, women in our study had lower body weight and BSA, more often had diabetes, and were less often smokers and presented with significantly more comorbidities than men.

In our study, 85% of the female patients were menopausal in concordance with the traditional point of view. The relatively small number of female patients using hormonal therapy is not popular among Egyptian females attributed to the random selection of the cases and that the usage of hormonal therapy is not popular among Egyptian females as it is in the West.

Unlike some studies who showed higher tendency of male patients to have more acute indication for coronary procedures and similar history of previous revascularization procedures (PCI or CABG), the presenting indication for coronary angiography in our study showed higher prevalence of exacerbation of anginal symptoms in female patients, while male procedures less often than men. In addition, the results of revascularization procedures have been reported to be less favorable in women than in men.

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incidence of vascular access complications and bleeding was among women. This can be explained in part by the higher tendency of the use of dual antiplatelet agents by males in our study population. Similarly, female patients were prone to a higher occurrence of spasm and arrhythmia, while the incidence of a cerebrovascular incident was equal in both sexes.

7. Limitations

Limitations of this study include the observational nature of the analysis. All patient data were collected from a tertiary referral center, relatively small number of patients studied compared to larger studies and the statistical need to include larger numbers to be applicable to the general population. However, the results provide reassurance that women do well after referral for PCI. Lastly, HRT and OCP were used by a small percentage of female patients; therefore their roles as risk factors were not significant.

8. Conclusions and recommendations

Egyptian women have generally similar risk profile to male patients with CAD and tend to receive less aggressive therapy. They showed less severe coronary atherosclerosis than men and potentially have lower PCI procedures with similar acute success rates and relatively higher procedure-related complications.

Better attention is advised to be given to women with chest pain to exclude CAD by non-invasive testing and include proper medical therapy before referral to invasive coronary procedures.

The high success rate of coronary interventional procedures among females encourages referral of patients suspected to have CAD with better precautions to avoid noticeably higher complications.

References