Spontaneous Coronary Artery Dissection

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40 y/o female transferred from OSH with ongoing chest pain

- 9 months post partum
- Sudden onset of throat and neck tightness while exercising
- Previously sedentary
- Admission ECG NSSTTC, Troponin 0.4
- Cath RCA lesion, negative rheumatologic and infections workup
- Ongoing symptoms
Discharged on DAPT, diltiazem, ranolazine, low dose metoprolol and low dose statin

- Persistent angina, managed conservatively
- Due to ongoing symptoms associated with increased activity repeat cardiac catheterization performed 7/2015
• ETT mibi performed 9/2015
• 10 minutes, 12 METS, no chest pain or ECG changes
• Small fixed anterior defect, minimal inferior ischemia
• Starting cardiac rehabilitation 10/2015
Cardiovascular Disease Death Trends for Males and Females in the United States 1979-2011
Annual Percentage Change in CHD Mortality among US adults by Sex

- Heart disease deaths have declined dramatically over the past 3 decades in people >65
- Improvements in death rates have slowed in people < 55 particularly in women
- obesity/diabetes effect vs novel risk factors vs both

Wilmot KA et al. Circulation 2015 (August)
Acute MI Mortality by Age and Sex

Source: Adapted from Vaccarino 1999
Gender differences in ACS

Women are less likely than men to experience chest pain

More likely to experience nausea and vomiting

Less likely to have these complaints and symptoms recognized as caused by ACS

Knowledge Gaps

Women ≠ Men
Case 2: Bias
Strategies to Avoid Diagnostic Errors

• **Knowledge**
  – Improved clinical decision making

• **Training**
  – Metacognition
The proportion of MI patients who presented without chest pain was significantly higher for women than men (42.0% vs 30.7% P < .001).

Significant interaction between age and sex with chest pain at presentation, young women less likely to have chest pain than older women.

The in-hospital mortality rate: 14.6% for women and 10.3% for men.

Younger women presenting without chest pain had greater hospital mortality than younger men without chest pain, and these sex differences decreased or even reversed with advancing age.
Myocardial Infarction in Young Women (Lichtman Circ Cardiovasc Qual Outcomes. 2015)

- 30 women (aged 30–55 years) w MI
- Five themes characterized their experiences:
  - Prodromal symptoms varied in both nature and duration
  - Inaccurate assessment of personal risk of heart disease and commonly attributed symptoms to non-cardiac causes
  - Abundant competing and conflicting priorities influenced decisions about seeking acute care
  - Inadequate response from the healthcare system resulting in delays in workup and diagnosis
  - Lack of routine utilization of primary care
WHY DO WE NEED A DIFFERENT APPROACH IN WOMEN?

Diagnostic Challenges:
- Lack of awareness
- Women present with atypical symptoms
- Less sensitivity and specificity of routine ETT in women

Treatment Challenges
- Women present later than men with acute MI
- Women are less likely to receive PCI, aggressive medical therapies following MI
- More co-morbidities
- Smaller hearts, smaller arteries.

Source: American Heart Association 2004
Progression of Coronary Artery Dissection

Normal Anatomy

- Tunica intima
- Tunica media
- Tunica adventitia

Direction of blood flow

Heart

Coronary artery

A. The tunica intima tears.

B. The tear gets larger and a thrombus forms.

C. The thrombus grows to where the vessel is completely blocked.
• SCAD may be the result of an intimal rupture with subsequent disruption of the vessel wall leading to a double lumen (true and false lumens).
• Bleeding of the vasa vasorum may result in an intramural hematoma.
• Progressive—pressure-driven—enlargement of the false lumen or intramural hematoma may cause further separation of the dissected layers, with true lumen compression resulting in myocardial ischemia or infarction.
• Coronary angio is unable to visualize the vessel wall and has a limited utility diagnostic accuracy.

• In this setting, novel tomographic techniques, such as intravascular ultrasound (IVUS), optical coherence tomography (OCT), or multislice CTA may offer imaging advantage
Spontaneous Coronary Artery Dissection
Tweet et al.
Circulation. 2012;126:579-588

- Retrospective cohort of 87 patients
- Mean age 42.6, 82% women
- 18% postpartum, mean age 33, mean 38 days postpartum
- Presentation was ST-elevation myocardial infarction in 49%.
- Multivessel SCAD was found in 23%.
- Median follow-up 47 months, 17% recurrence all female
- 10 year mortality 7.7% and MACE 47%
Table 1. Patient Characteristics, Presentation, and Angiographic Distribution at the Initial Spontaneous Coronary Artery Dissection Event

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Male Patients (n=16)</th>
<th>Female Patients (n=71)</th>
<th>Total Population (n=87)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (SD) [range], y</td>
<td>46.3 (12) [19–68]</td>
<td>41.7 (9.5) [18–78]</td>
<td>42.6 (10.1) [18–78]</td>
<td>0.10</td>
</tr>
<tr>
<td>BMI (SD), kg/m²</td>
<td>27.9 (5.9)</td>
<td>26.2 (5.7)</td>
<td>26.5 (5.8)</td>
<td>0.30</td>
</tr>
<tr>
<td>White race, n (%)</td>
<td>12 (75)</td>
<td>60 (85)</td>
<td>72 (83)</td>
<td>0.36</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>3 (19)</td>
<td>13 (18)</td>
<td>16 (18)</td>
<td>0.97</td>
</tr>
<tr>
<td>Diabetes mellitus, n (%)</td>
<td>0 (0)</td>
<td>2 (3)</td>
<td>2 (2.2)</td>
<td>0.49</td>
</tr>
<tr>
<td>Hyperlipidemia, n (%)</td>
<td>5 (31)</td>
<td>7 (10)</td>
<td>12 (14)</td>
<td>0.025</td>
</tr>
<tr>
<td>Tobacco use, n (%)</td>
<td>9 (56)</td>
<td>18 (25)</td>
<td>27 (31)</td>
<td>0.016</td>
</tr>
<tr>
<td>Oral contraceptives, n (%)</td>
<td>NA</td>
<td>9 (13)</td>
<td>9 (10)</td>
<td></td>
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<tr>
<td>Presentation</td>
<td></td>
<td></td>
<td></td>
<td>0.23</td>
</tr>
<tr>
<td>STEMI, n</td>
<td>11 (60)</td>
<td>32 (45)</td>
<td>43 (49)</td>
<td></td>
</tr>
<tr>
<td>NSTEMI, n</td>
<td>4 (25)</td>
<td>34 (48)</td>
<td>38 (44)</td>
<td></td>
</tr>
<tr>
<td>Unstable angina, n</td>
<td>1 (6)</td>
<td>5 (7)</td>
<td>6 (7)</td>
<td></td>
</tr>
<tr>
<td>Life-threatening ventricular arrhythmia, n</td>
<td>2 (13)</td>
<td>10 (14)</td>
<td>12 (14)</td>
<td></td>
</tr>
<tr>
<td>Left ventricular EF (SD), %*</td>
<td>46 (18)</td>
<td>52 (13)</td>
<td>51 (14)</td>
<td>0.21</td>
</tr>
<tr>
<td>Distribution, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>LM</td>
<td>0 (0)</td>
<td>8 (11)</td>
<td>8 (9)</td>
<td>0.16</td>
</tr>
<tr>
<td>LAD, n</td>
<td>11 (69)</td>
<td>51 (72)</td>
<td>62 (71)</td>
<td>0.81</td>
</tr>
<tr>
<td>RCA, n</td>
<td>6 (38)</td>
<td>21 (30)</td>
<td>27 (31)</td>
<td>0.54</td>
</tr>
<tr>
<td>LCx, n</td>
<td>3 (19)</td>
<td>13 (18)</td>
<td>16 (18)</td>
<td>0.97</td>
</tr>
<tr>
<td>Multivessel, n</td>
<td>2 (13)</td>
<td>18 (25)</td>
<td>20 (23)</td>
<td>0.27</td>
</tr>
</tbody>
</table>

BMI indicates body mass index; STEMI, ST-segment–elevation myocardial infarction; NSTEMI, non–ST-segment–elevation myocardial infarction; EF, ejection fraction; LM, left main artery; LAD, left anterior descending artery; RCA, right coronary artery; and LCx, left circumflex artery.

*Ejection fraction was not available for 13 patients.
Associated Factors

- The most common association in women was postpartum status (18%), with a mean maternal age of 33, mean postpartum period of 38 days.
- In about 30% of SCAD patients an underlying cause other than pregnancy can be identified – most frequently an atherosclerotic plaque rupture.
- Hormonal, vascular, or shear-stress–related factors, present in 48 patients (55%).
- Extreme physical activity was the principal precipitant in men (44% versus 2.8% in women, $P<0.001$).
Differential Diagnosis- Chest Pain in Young Woman

- *Exclude cardiac diagnosis before assuming non-cardiac etiology*

- ACS: plaque rupture, plaque erosion, SCAD, coronary embolus (SLE, OCP’s/smoking, hypercoag, ASD/PFO)

- Myocarditis, pericarditis

- Aortic dissection (post-partum, Turner’s, Ehler’s Danlos, Loeys-Dietz Marfan syndrome, FMD)

- Microvascular ischemia

- Takatsubo uncommon in pre-menopausal women

- Pulmonary embolus
MI in Non-Obstructive CAD (Reynolds Circulation 2011)

- Results—Women with myocardial infarction were enrolled prospectively, before angiography, if possible.
- Women with >50% angiographic stenosis or use of vasospastic agents were excluded.
- IVUS was performed during angiography; cardiac magnetic resonance imaging was performed within 1 week.
- Fifty women (age, 57 ± 13 years) had median peak troponin of 1.60 ng/mL; 11 had ST-segment elevation.
• 15 patients (30%) had normal angiograms.
• Plaque disruption was observed in 16 of 42 patients (38%) undergoing IVUS.
• Abnormal CMRI findings in 26 of 44 patients (59%) late gadolinium enhancement (LGE) in 17 patients, and T2 signal hyperintensity indicating edema in 9 additional patients.
• The most common LGE pattern was ischemic (transmural/subendocardial).
• Nonischemic LGE patterns (midmyocardial/subepicardial) were also observed.
Fig. 1 – Representative IVUS image showing plaque rupture in a normal segment. The site of plaque rupture is marked with an arrow on the angiogram. The middle panel shows the outline of the lumina border (yellow) and external elastic lamina (red) corresponding to the IVUS image in the right panel. (Adapted with permission from Reynolds et al., 2011.)
MGH SCAD Registry

- 66 patients with SCAD (89.4% women and 10.6% men).
- Mean age at first event was 47 ± 10 (range 22-65) years.
- The majority (39.4%) of cases occurred at rest. Precipitating factors included physical stress (27.3%), emotional stress (19.7%), multiple stressors (10.6%) and peripartum status (3%).
- All presented with myocardial infarction (MI); 49.2% non-ST-segment elevation MI and 50.8% ST-segment elevation MI.
• 50.8% had single vessel SCAD while 49.2% had multi vessel SCAD.
  – In those with single vessel SCAD, the most commonly involved vessel was the left anterior descending artery or one of its branches (63.6%).
  – Most patients (88.7%) demonstrated evidence of coronary artery tortuosity with 54.5% being severely tortuous.
  – 3.0% percent underwent CABG, 39.4% PCI and 57.6% were managed conservatively.
– A total of 47 patients were seen by a geneticist. Amongst patients who underwent genetic testing (n=22) for underlying connective tissue disorders only 4.5% had positive test results and the remainder were inconclusive or negative.

– Vascular imaging (non-invasive and/or invasive) revealed that only 23.2% (13 of 56) had extracoronary fibromuscular dysplasia (FMD).
• 38 patients had LVG in setting of cardiac cath
• Twenty-seven (71%) patients had LVG findings characteristic of Takotsubo cardiomyopathy
• No difference in vessel involved
• Lower LVEF in TCM/SCAD
Psychological Stress Post SCAD-MGH Registry

- STAI administered to 54 patients
- Mean age at time of first SCAD event was 47 ± 9 (range 27-64) years.
- Mean time from SCAD event to STAI completion was 2 ± 3 (range 0-9) years.
- Mean STAI-S score was 38 ± 13 (range 20-71) and the mean STAI-T score was 36 ± 9 (range 22-53).
- A total of 37.0% of the group had STAI-S scores ≥ 40.
• In our SCAD registry the prevalence of symptoms of anxiety is high

• Many of the patients seen at our clinic report high levels of anxiety as well as difficulty managing their personal and professional lives as a result of SCAD.

• The results from this study highlight the incredible need for health care professionals to carefully screen this unique patient population for symptoms of anxiety and refer for psychological evaluation and treatment as needed.

• The impact of such treatment on recurrent cardiac events will need to be assessed.
Women with Spontaneous Coronary Artery Dissection May Be More Fit than the Average Patient Referred for Exercise Stress Testing
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Massachusetts General Hospital Department of Cardiovascular Medicine; Massachusetts General Hospital Department of Vascular Medicine; Harvard Medical School; Massachusetts General Hospital Department of Pediatrics

Introduction
- Spontaneous Coronary Artery Dissection (SCAD) patients represent a rare subgroup presenting with acute coronary syndrome (ACS) who are often younger with fewer comorbidities than the average coronary artery disease patient.
- It is also a condition that disproportionately affects women who appear to be more physically fit than the average woman, although this has never been investigated.
- Current cardiac rehabilitation programs appear to be inadequate in preparing patients to return to their functional baseline prior to the SCAD event.

Aims
- We sought to determine the functional capacity of SCAD patients in order to better inform development of cardiovascular rehabilitation programs and exercise recommendations for these patients.

Methods
- Data from patients diagnosed with SCAD collected for the Massachusetts General Hospital registry.
- Results of treadmill stress testing (ETT) for 17 female SCAD patients were compared to that of female patients with all-comers and coronary artery disease under the age of 55 presenting for ETT at our institution in 2015.
- A 2:1 age and gender matched case-control study was conducted comparing the 17 female SCAD patients with all-comers who received an ETT between 2005 and 2015. The controls were randomly assigned using a SAC macro from Mayo Clinic named "Smash".
- Descriptive analyses were conducted to evaluate differences in patient characteristics and ETT stress test results between cases and controls. The chi-square test was used to compare dichotomous and categorical variables, and the t-test was used to compare continuous variables.

Results
Table 1: Baseline Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>SCAD Patients (N=17)</th>
<th>Control (N=34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean)</td>
<td>45±9</td>
<td>65±6</td>
</tr>
<tr>
<td>Risk Factors (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>7 (41)</td>
<td>12 (35)</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>4 (24)</td>
<td>8 (24)</td>
</tr>
<tr>
<td>Obesity</td>
<td>1 (6)</td>
<td>12 (35)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0 (0)</td>
<td>3 (9)</td>
</tr>
<tr>
<td>Family History</td>
<td>0 (0)</td>
<td>15 (44)</td>
</tr>
<tr>
<td>Smoking</td>
<td>1 (6)</td>
<td>7 (21)</td>
</tr>
<tr>
<td>Reproductive History</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscarriage</td>
<td>4 (24)</td>
<td>2 (6)</td>
</tr>
<tr>
<td>Pre-Eclampsia/Gestational Hypertension</td>
<td>3 (18)</td>
<td>1 (3)</td>
</tr>
</tbody>
</table>

Table 2: Comparison of Functional Capacity of Female SCAD Patients and Age and Gender Matched Controls

<table>
<thead>
<tr>
<th>Case (N=17)</th>
<th>Control (N=34)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Risk Factors (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>7 (41)</td>
<td>7 (21)</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>4 (24)</td>
<td>8 (24)</td>
</tr>
<tr>
<td>Obesity</td>
<td>1 (6)</td>
<td>12 (35)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0 (0)</td>
<td>3 (9)</td>
</tr>
<tr>
<td>Family History</td>
<td>0 (0)</td>
<td>15 (44)</td>
</tr>
<tr>
<td>Smoking History</td>
<td>1 (6)</td>
<td>7 (21)</td>
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<tr>
<td>History of CAD</td>
<td>0 (0)</td>
<td>2 (6)</td>
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<tr>
<td>ETT Results</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise Duration (min)</td>
<td>9.1±2.8</td>
<td>8.2±3.0</td>
</tr>
<tr>
<td>Metabolic Equivalents Achieved</td>
<td>10±2</td>
<td>9±3.4</td>
</tr>
<tr>
<td>Duke Treadmill Score</td>
<td>8.8±3.6</td>
<td>7.3±4.3</td>
</tr>
</tbody>
</table>

Table 3: Comparison of Functional Capacity of Female SCAD Patients and Females Age 50 and Under with CAD

<table>
<thead>
<tr>
<th>Case (N=17)</th>
<th>Control (N=19)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Mean)</td>
<td>45±9</td>
<td>45±6</td>
</tr>
<tr>
<td>Traditional Risk Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>7 (41)</td>
<td>17 (87)</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>4 (24)</td>
<td>14 (74)</td>
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<tr>
<td>Obesity</td>
<td>1 (6)</td>
<td>4 (21)</td>
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<tr>
<td>Diabetes</td>
<td>0 (0)</td>
<td>5 (26)</td>
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<tr>
<td>Family History</td>
<td>0 (0)</td>
<td>6 (32)</td>
</tr>
<tr>
<td>Smoking</td>
<td>1 (6)</td>
<td>10 (53)</td>
</tr>
<tr>
<td>ETT Results</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise Duration</td>
<td>9±2</td>
<td>6.6±2.5</td>
</tr>
<tr>
<td>Metabolic Equivalents Achieved</td>
<td>10±2.9</td>
<td>7.9±2.7</td>
</tr>
<tr>
<td>Duke Treadmill Score</td>
<td>8±3.6</td>
<td>4.2±4.1</td>
</tr>
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</table>

Conclusions
- The majority of women in our cohort are younger and have fewer comorbidities than the average coronary artery disease (CAD) patient. The vast majority of our SCAD patients present with acute coronary syndrome, with one third with ST elevation myocardial infarction.
- Women presenting with SCAD appear to have less risk factors than the average female referred for stress testing, although this did not reach statistical significance given the small number of patients in our cohort.
- Women with SCAD appear to have similar or perhaps slightly better functional capacity than the average patient who presents for stress testing. They also have comparable Duke Treadmill Scores, suggesting similar prognosis as the average patient in terms of ischemic heart disease risk.
- Women with SCAD appear to have fewer comorbidities than younger women with traditional CAD. They also appear to have greater functional capacity than women with traditional CAD, although this did not reach statistical significance. Women with SCAD also have a better Duke Treadmill Score as compared to women with traditional CAD, although this did not reach statistical significance.
- Further patients need to be gathered in order to determine the statistical significance of these findings. Clinically, women with SCAD do appear to be a healthy cohort than the average woman with CAD.
SCAD

- Does not behave like typical atherosclerotic CAD
- Young men and women with few traditional cardiac risk factors
- Not rare just rarely diagnosed
- High index of suspicion required
- Improved training of community first responders, ER teams and cardiologists
Acute Management

- Cath or CTA
- Caution with angiography
- If > TIMI 2 flow manage conservatively
- IVUS/OCT in experience/ed hands
- Short term DAPT/Statin/anticoagulation on a case by case basis
SCAD Long Term Management

- Slow introduction to physical activity
- Manage psychosocial stressors
- Cardiac rehab a must, individualized approach may be required
- Issues: Return to work, contraception, future events, impact on family
- Vascular screening, genetics
- Integrated approach critical
Summary

• SCAD is a serious clinical condition with significant initial morbidity mainly related to a presentation as acute MI
• Once the diagnosis of SCAD is established, a “conservative” management strategy, defined as selecting revascularization only for patients with ongoing or recurrent ischemia, is associated with an excellent long-term prognosis;
• In patients with strong clinical suspicion of SCD, angiography fails to provide an accurate diagnosis, and additional imaging techniques are required
Summary

• Cardiovascular disease can occur in young individuals
  – ECG, biomarkers, echocardiogram, CTA/MRI, cath w IVUS/OCT

• Young women can present with typical and atypical symptoms in the setting of coronary artery disease

• Increased vigilance is required on the part of physicians and nurses

• Further research is required to better understand the risk factors for and pathophysiology of coronary artery dissection in order to develop possible preventive therapies