What is Spontaneous Coronary Artery Dissection (SCAD) & Why is Cardiac Rehabilitation Important?

Marysia Tweet, MD
25th Annual MNACVPR State Conference
October 3rd, 2015

Goals:

• Learn about SCAD

• Review current SCAD research, patient resources, and recommended care

• Describe the role of cardiac rehabilitation

SCAD

• Causes myocardial infarction (MI) & sudden death

• Reported prevalence 0.07-1.1%

• Prevalence likely higher due to ↑ awareness & improved diagnostic techniques
  • We will see this more often!

• MI etiology in 10-30% F <50 yo

• Most common MI etiology during or shortly after pregnancy

Tweet et al. Circ 2012
Saw et al. Can Jour of Cardiol 2014
Elkayam et al. Circ 2014
Spontaneous coronary artery dissection (SCAD)

- Acute coronary syndrome without atherosclerosis
- Intramural hematoma +/− intimal dissection flap
- Diagnosed via: Coronary angiography, IVUS, OCT
Case 1: 37 yo F

• Delivered a baby 5 days ago
• Presents with CP and nausea
• STEMI on electrocardiogram

37 yo F with postpartum STEMI

Optical coherence tomography (OCT)
Case 2: 42 yo F with V. Fib Arrest

Intramural hematoma on OCT

Myocardial injury on cardiac MRI
Conservatively managed, Healing on follow-up

SCAD retrospective analysis 1979-2011
Baseline characteristics (N = 87)

- Mostly female (82%)
- Young (mean age 43 yrs)
- No or minimal typical risk factors
- Potential risk factors: postpartum/pregnancy, extreme emotion or extreme exercise, connective tissue disease, fibromuscular dysplasia, coronary tortuosity, family history

Tweet et al., Circulation 2012

SCAD presentation (n = 87)

STEMI n=43
• Single-vessel (34)  
• Multi-vessel (9)  
• V fib/tach (10)

NSTEMI n=38
• Single-vessel (29)  
• Multi-vessel (9)  
• V fib/tach (2)

Unstable angina n=6
• Single-vessel (4)  
• Multi-vessel (2)

Tweet et al., Circulation 2012
### Affected vessels (%)

<table>
<thead>
<tr>
<th>Distribution</th>
<th>Male</th>
<th>Female</th>
<th>Total population</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM</td>
<td>0</td>
<td>11</td>
<td>9</td>
<td>0.16</td>
</tr>
<tr>
<td>LAD</td>
<td>69</td>
<td>72</td>
<td>71</td>
<td>0.81</td>
</tr>
<tr>
<td>RCA</td>
<td>38</td>
<td>30</td>
<td>31</td>
<td>0.54</td>
</tr>
<tr>
<td>LCx</td>
<td>19</td>
<td>18</td>
<td>18</td>
<td>0.97</td>
</tr>
<tr>
<td>Multivessel</td>
<td>13</td>
<td>25</td>
<td>23</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Tweet et al., Circulation 2012

### Treatment and inpatient course

- SCAD N=87
  - PCI n=39
    - Conservative n=24
    - CABG n=5
      - Death n=1
  - CABG n=4
  - Fibrinolytics n=13
  - No Revascularization n=31

Tweet et al., Circulation 2012

### Long-Term Outcomes

**Major Adverse Cardiac Events (MACE) - Death, Recurrent SCAD, MI, CHF**

![Graph showing survival free of MACE (%)](image_url)

Tweet et al., Circulation 2012
Recurrence of SCAD

- Recurrence in 15/71 females, 0/16 males (p = 0.023)
- Median 2.8 yrs (3 days - 12 yrs)
- 3rd episode SCAD (n = 2) at 1 and 11 mos after prior event

Fibromuscular Dysplasia (FMD)

- FMD of external iliac artery on 8 of 16 femoral angiograms
- Carotid FMD (n = 2), both with dissection
- All female
- FMD prevalence likely underestimated since no routine vascular screening
- 4/10 pts with FMD recurred including both carotid dissection pts
Prompted the Mayo Clinic SCAD Virtual Registry and DNA Registry

1. Identify subjects via a disease-specific support group on a social networking site
2. Confirm disease status
3. Obtain detailed records and surveys for data collection
4. Follow-up

Prospective research, DNA studies, multicenter registry

Advance Rare Disease Research through Social Networking

Mayo Clinic SCAD Virtual and DNA Registry

United States
Mayo Clinic SCAD Virtual and DNA Registry

Nearly 500 enrollees with confirmed SCAD

Mayo SCAD Clinic

• Approximately 10 SCAD patients each month

Patient Engagement
Excoronary Vascular Imaging
Consecutive Series

- 115 Mayo Clinic SCAD outpatients
- Vascular abnormalities:
  - Fibromuscular dysplasia
  - Dissection
  - Aneurysm
  - Dilatation
  - Tortuosity
  - Undulating aorta

Overall Vascular Abnormalities 66%
Overall FMD 45%

Prasad et al., Am J Cardiol, 2015

Original Research Article
A novel application of CT angiography to detect extracoronary vascular abnormalities in patients with spontaneous coronary artery dissection

Jackson J. Liang DO, Myha Prasad MD, Marysia S. Tavet MD, Sharonee N. Meyro MD, Zojir Gordon MD, PNG, Jerome F. Brem MD, Shuai Leng PNG, Terri J. Vrtiska MD

*Department of Internal Medicine, Mayo Clinic, Rochester, MN, USA

Journal of Cardiovascular Computed Tomography 6 (2015) 112-115

Abstract
Fibromuscular dysplasia (FMD) is associated with extracoronary vascular abnormalities, which depending on type and location may warrant treatment. In this retrospective study, we provide additional diagnostic or prognostic information about this uncommon entity. Fibromuscular dysplasia (FMD), aortitis, and dissection have been described in multiple vascular territories by magnetic resonance angiography (MRA). The aim of this study was to assess the proportion of extracoronary vascular abnormalities in women. We highlight the techniques and features of novel CTA protocols to detect extracoronary vascular abnormalities in women.
**Iliac FMD**

---

**SCAD Coronary Tortuosity**

- A. Intravessel symmetry
- B. Multivessel symmetry
- C. Corkscrew sign
- D. Coronary artery microaneurysm
- E. Coronary fibromuscular dysplasia

Eleid et al., Circ Cardiovasc Interv 2014

---

**Prevalence of SCAD Coronary Tortuosity**

![Graph showing prevalence of SCAD coronary tortuosity](image)

Eleid et al., Circ Cardiovasc Interv 2014

- P<0.0001 for all

SCAD (N=346)

Controls (N=313)
**SCAD Coronary Tortuosity**

- Recurrent SCAD (n=40) usually occurred in segments of tortuosity (80%)
- ↑ recurrence risk if severe tortuosity
- Vascular abnormalities & FMD associated with corkscrew & multivessel symmetrical tortuosity (P<0.05 for both)

Eleid et al., Circ Cardiovasc Interv 2014

**How Should Acute SCAD Be Managed?**

**AHA/ACC Guidelines for ACS**

- Revascularization by balloon and/or stent
  - Class I, Level of Evidence A
- Atherosclerotic ACS
- Revascularization outcomes for SCAD are unknown

**Spontaneous Coronary Artery Dissection**

- 45 consecutive SCADs
- Included pts with associated CAD (40%)
- 35% required early PCI/CABG due to ischemia
- 54% (7/13) complete healing

Alfonso et al., JACC Imaging, 2012
SCAD Acute Management
Retrospective review (N = 189)

- 95 treated with balloon, stent(s) or bypass
- 94 conservatively managed
- Mean age 44 yrs, 95% female
- Presentation:
  - STEMI 49%, NSTEMI 44%, UA 7%

Tweet et al., Circ Cardiovasc Interv 2014

SCAD Acute Management
Retrospective review (N = 189)

- Treated with balloon and/or stent(s):
  - 53% failure
  - 50% failure rate in those with preserved distal coronary flow, 6 (13%) emergency CABG
- Conservative therapy:
  - Uneventful hospital course
  - 73% of 59 with repeat CA showed healing
  - 9 (10%) early SCAD progression requiring stent or bypass surgery (mean 4 days, 2-7)

Tweet et al., Circ Cardiovasc Interv 2014

Final loss of flow

Final loss of flow

Failure to cross lesion (7/23)
Final loss of flow (8/23)
Residual stenosis >30% (8/23)

Tweet et al., Circ Cardiovasc Interv 2014
**Target Vessel Revascularization**

Revascularization vs Conservative Management

![Graph showing comparison between revascularization and conservative management for target vessel revascularization.](Image)

Tweet et al., Circ Cardiovasc Interv 2014

**Recurrent SCAD**

Revascularization vs Conservative Management

![Graph showing comparison between revascularization and conservative management for recurrent SCAD.](Image)

Tweet et al., Circ Cardiovasc Interv 2014

**Proposed Algorithm for Acute SCAD Management**

- Acute SCAD on angiography:
  - Yes: TIMI flow assessment
    - TIMI 0-1 OR clinically unstable
      - Revascularize
    - TIMI 2-3 AND clinically stable
      - Conservative management, inpatient monitoring for 5 days
  - No: OCT/IVUS: False lumen or intramural hematoma?
Outpatient SCAD Clinic
Standard Evaluation

• Detailed history of SCAD, risks
• Extensive review of records & imaging
• Routine labs, CRP, Lpa, homocysteine, TSH
• Exam – added focus on extracoronary findings
• CTA protocol- base of skull to pelvis (FMD, aneurysms)
• Other testing as indicated-Stress, CCTA
• Medical Genetics consultation

Why Medical Genetics?

• 5 familial cases among 412 patient enrollees
  • Mother-Daughter
  • Identical twin sisters
  • Sisters
  • Aunt-niece
  • First cousin pairs
• Implicates both recessive and dominant modes of inheritance

Monogenic disorders associated with SCAD

• Vascular Ehlers Danlos syndrome (Type IV) – COL3A1
• Marfan Syndrome – FBN1
• Loeys-Dietz Syndrome – TGFBR1, TGFBR2, SMAD3, TGFB2
• Pseudoxanthoma Elasticum (PXE) – ABCC6
Moving Beyond Known Disorders: Mayo Clinic SCAD DNA biorepository

- Pilot study: 28 unrelated SCAD patients
- Whole exome sequencing & comparative variant filtering of proband-parent trios
- Ruled out a common disease gene but identified 8 plausible candidate genes

Theis et al., presented at the Individualized Medicine Conference and the American Society of Human Genetics, 2014

Anxiety and Depression

Prevalence and Predictors of Depression and Anxiety Among Survivors of Myocardial Infarction Due to Spontaneous Coronary Artery Dissection

Jackson J. Sieg, DO; Marilyn S. Tweet, MD; Sarah E. Hayes, BA; Ralf Gutai, MD, PhD; Rebecca V. Hayes, MD

Cardiac Rehabilitation (CR) and SCAD

- Young
- Predominantly women
- Minimal risk factors
- Current CR studies & guidelines following MI primarily based on atherosclerosis pts
Baseline Functional Capacity in SCAD

- Treadmill stress testing for 18 female SCAD pts vs female all-comers <55 yrs
- SCAD pts:
  - Mean age 46 yrs
  - Mean duration 9.8 min
  - Mean METs 10.6
- Controls:
  - Mean age 49 yrs (p=0.19)
  - Mean duration 6.2 min
  - Mean METS 6.8 (p value <0.001)

Niaderi et al., presented as poster at ACC, 2015

CR in SCAD: Mayo Clinic SCAD Registry Data

- Reviewed 412 enrollees in the ongoing Mayo Clinic SCAD Registry (2010-2013)
- 354 (86%) completed CR survey questions
- Mean age at time of SCAD 46 ± 10 yrs
- 95% female

Krittanawong et al., presented as poster at AHA QCOR, 2015
CR in SCAD: Mayo Clinic SCAD Registry Data

• 76% participated in at least one cardiac rehab session
• Those users averaged 18±12 sessions

Krittanawong et al., presented as poster at AHA QCOR, 2015

Perceived CR Benefits

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional benefits</td>
<td>75%</td>
</tr>
<tr>
<td>Physical health benefits</td>
<td>82%</td>
</tr>
<tr>
<td>Today I am still experiencing the benefits of participating in cardiac rehab</td>
<td>45%</td>
</tr>
</tbody>
</table>

Krittanawong et al., presented as poster at AHA QCOR, 2015

Reasons for Not Participating in CR

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too little energy to engage in a rehab program</td>
<td>2%</td>
</tr>
<tr>
<td>Too ill to do any physical activities</td>
<td>2%</td>
</tr>
<tr>
<td>My healthcare providers did not recommend rehab program</td>
<td>67%</td>
</tr>
<tr>
<td>No insurance coverage for rehab program</td>
<td>8%</td>
</tr>
<tr>
<td>Too expensive</td>
<td>2%</td>
</tr>
<tr>
<td>Too far to travel or no way to get to rehab facility</td>
<td>12%</td>
</tr>
</tbody>
</table>

Krittanawong et al., presented as poster at AHA QCOR, 2015
### Regular Exercise

<table>
<thead>
<tr>
<th>CR n=269</th>
<th>No CR n=85</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic exercise &gt;30 min (duration)</td>
<td>54%</td>
<td>40%</td>
</tr>
<tr>
<td>Aerobic exercise at &gt; 1/wk (frequency)</td>
<td>80%</td>
<td>66%</td>
</tr>
</tbody>
</table>

Krittanawong et al., presented as poster at AHA QCOR, 2015

---

### Mayo Clinic SCAD CR Experience

- Nine SCAD pts in Mayo Clinic CR
- Average of 12.3 days (7-21) after SCAD
- Completed average of 28 CR sessions (5-39)

- Standard CR program:
  - Supervised & independent flexibility, stretching, aerobic, strength training
  - Counseling regarding nutrition, weight & stress management

Silber et al., JCRP, 2015

---

### Mayo Clinic SCAD CR Experience

- CR was well received
- No reported cardiac symptoms or adverse events during exercise testing or training
- Peak O2 uptake ↑18% (n=4)
- 6-min walk distance ↑22% (n=4)
- Depression & stress scores ↑2.3 & 1.3 pts, respectively

Silber et al., JCRP, 2015
CR Summary

- Most SCAD pts find CR to be beneficial
- Lack of referral most common reason for no CR
- Standard CR 1 to 2 wks after SCAD seems feasible and safe
- CR observed to improve aerobic capacity, body composition, measures of depression & stress in SCAD

CR Summary

- Recommend CR for SCAD pts
- May have high functional ability so need to tailor CR to the patient
- Continue to study SCAD & determine appropriate recommendations as much remains uncertain!

SCAD Take Home Points

- SCAD primarily affects young women
- Presentation is heart attack, unstable angina, cardiac arrest
- No atherosclerosis
- Associated conditions: extreme emotion or extreme exercise, peripartum status, connective tissue disease, non-CAD vasculopathy & FMD, coronary tortuosity, genes
- Will see more (↑awareness, intravascular imaging)
- Important to diagnose because management is different than guidelines!!!
- Cardiac rehab is important!!!
- Study referrals remain significant to the Mayo Clinic SCAD Virtual and DNA registries (thank you)!
Thank you!
Questions & Discussion
tweet.marysia@mayo.edu