



# Guidance Directed Care of Spontaneous Coronary Artery Dissection: A Healthcare System-Based Experience

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## ABSTRACT

**Introduction:** Data on treatment of spontaneous coronary artery dissection (SCAD) has evolved with guidance from national societies beginning around 2018. Given emerging guidance and relatively uncommon presentation of SCAD, we hypothesized that a specialized SCAD clinic would improve guidance-based care.

**Methods:** We utilized a system-wide electronic medical record search to identify individuals with SCAD diagnosis from 2018 to 2023. All diagnostic angiograms were reviewed to verify diagnosis. We analyzed frequency of guidance-based care since 2018 system-wide. We also compared guidance-based care for individuals with index visits to the SCAD outpatient clinic as compared to non-SCAD clinic providers from initiation of specialty clinic in 2021.

**Results:** Differences were observed in pregnancy and contraception discussions (88 % vs 0 %,  $p < 0.001$ ) among pre-menopausal individuals in SCAD clinic compared to non-SCAD clinics. Safety of hormone replacement therapy (HRT) in menopausal women was addressed more by SCAD clinic providers (85 % vs 7 %,  $p < 0.001$ ). There was more fibromuscular dysplasia (FMD) screening in SCAD clinic (100 % vs 30 %,  $p < 0.001$ ). Among individuals with migraines, there was more discussion of triggering medications (triptans) in SCAD clinic (80 % vs 14 %,  $p = 0.008$ ). In individuals prescribed statins not by primary prevention guidelines and without atherosclerosis, there was a trend toward more discussion of statin use in SCAD clinic follow up vs non-SCAD clinic providers (63 % vs 17 %,  $p = 0.06$ ).

**Conclusions:** Individuals with follow up in SCAD clinic compared to non-SCAD clinics were more likely to have future pregnancy and contraception counseling, discussion of HRT safety, and FMD screening following index outpatient visit. Future quality improvement initiatives will target these aspects of guidance-based care among non-SCAD clinic providers with integration into cardiology fellow training.

## 1. Introduction

Treatment of individuals with spontaneous coronary artery dissection (SCAD) has evolved greatly in the last five years. This is in part due to the emergence of national and international publications on best practices for treatment at the time of and after a SCAD event, beginning in 2018 with the American Heart Association's Scientific Statement on SCAD.[1–4] Much of this guidance has come from SCAD registries. Prior work from a Canadian registry has shown beta blocker use and optimal hypertension control were associated with less SCAD recurrence. Both of

these recommendations are now included as expert recommendations in society consensus statements.[5] There remains a lack of randomized control trials assessing the benefits of any medication in SCAD treatment and recurrence. Optimal treatment strategies remain empiric, mostly based on large cohort data. Because SCAD is not related to atherosclerosis or hyperlipidemia, statin medications are only recommended in patients with SCAD if they are being used for primary prevention of other known atherosclerotic cardiovascular disease.[1,3] Underlying fibromuscular dysplasia (FMD) has been found in as many as 63 % of individuals with SCAD following screening after index event. Therefore,

**Abbreviations:** ACS, acute coronary syndrome; CABG, coronary artery bypass grafts; CTA, computed tomography angiography; EMR, electronic medical record; FMD, fibromuscular dysplasia; PCI, percutaneous coronary artery intervention; NSTEMI, non-ST elevation myocardial infarction; SCAD, Spontaneous coronary artery dissection; STEMI, ST elevation myocardial infarction.

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extracoronary vessel screening from brain to pelvis is recommended among all individuals following SCAD event.[2].

More nuanced management strategies include consideration of discontinuation of triptan medications as there is a well-established coprevalence of migraine among individuals with SCAD diagnosis and signal of index events around triptan use.[6,7] SCAD disproportionately impacts women, most commonly during time periods of hormonal fluctuation including perimenopause and postpartum.[3] Pregnancy-associated SCAD is also more severe and associated with more cardiac complications as compared to SCAD outside of pregnancy.[1,4,8] Informed, shared-decision making about risks of future pregnancies is imperative for all premenopausal women with prior SCAD. For peri- and postmenopausal women, counseling on avoidance of hormone replacement therapy is also recommended.[1,3] Management strategies regarding anti-platelet use for acute and long-term treatment for SCAD event have not been investigated by randomized trials, which has led to variable anti-platelet practices across institutions.[9].

Given the publication of these best practices, we assessed SCAD related care within our large, multi-hospital healthcare system. We hypothesized that care by clinicians in a specialized SCAD clinic would be more aligned with published guidance after an index SCAD event when compared to care provided by non-SCAD clinicians within our healthcare system. Since our institution has an established SCAD clinic with care provided by practitioners well versed in SCAD, the above hypothesis would be expected. The study's aim is to highlight the existing knowledge gap in providing guideline directed care for SCAD in the community.

## 2. Methods

This study was approved by the University of Pittsburgh Medical Center Institutional Review Board (STUDY23010210). We performed a system-wide electronic medical record (EMR) search across the entire University of Pittsburgh Medical Center, a large healthcare network with a shared electronic medical record among 40 hospitals and 600 + outpatient centers scattered throughout Pennsylvania. We identified all individuals age > 18 years of age with diagnosis by ICD-10 code or term "coronary artery dissection" used in coronary angiography or computed tomography angiography (CTA) reports between 2018–2023. To verify diagnosis of spontaneous coronary dissection (vs traumatic or iatrogenic dissection), all angiograms and admission notes were individually reviewed by a general cardiologist who specializes in management of SCAD and borderline cases were adjudicated with an interventional cardiologist.

We excluded individuals prior to the publication of major societal guidelines beginning in 2018 and individuals without definitive diagnosis of SCAD on review of coronary angiography or coronary CTA. We also excluded individuals with iatrogenic, atherosclerotic, or traumatic coronary artery dissection. Data was retrospectively extracted from individual records by manual chart review. Variables extracted include demographic information, type of acute coronary syndrome (ACS) at initial SCAD presentation, length of index SCAD hospitalization, type of intervention for SCAD (if any), timing and location of index outpatient cardiology visit, medications at time of discharge and at outpatient visits (including beta blockers, antiplatelets, and statins), completion of FMD screening, documentation of blood pressure control, documentation of migraine history with counseling on medications, and counseling on contraception or hormone replacement therapy at outpatient visits. Guidance-based care outcomes that involved counseling were only scored as discussed vs not discussed if the patient had history of the relevant conditions. For example, if the patient did not have a prior history of chronic hypertension or migraine in their medical history, this outcome was not counted toward or against counseling outcomes. Guidance-based care outcomes that included hospitalization details, like days hospitalized, were only included in analysis if adequate notation on days hospitalized was available. In this way, outcomes would not be

influenced by the availability of electronic medical records. Further, providers would not be penalized for failing to document counseling on conditions not included in patient's medical history. As such, denominators reflect of total number of participants for which variables were available and applicable in each subgroup.

Baseline characteristics and implementation of guidance-based care were analyzed in a system-wide cohort of individuals from 2018 to 2023. We further compared guidance-based care following index SCAD event for individuals seen in the SCAD outpatient clinic (21 individuals) as compared to individuals who saw other cardiology providers in the system (24 individuals) from 2021 to 2023, as the SCAD clinic was implemented in 2021. Our EMR only collected data on sex assigned at birth during these years; we denote sex as "women" and "men" in this manuscript. We do not have sufficient EMR data on gender identity, so this is not included in the baseline demographics. Individuals were placed in the SCAD clinic group if they were seen in the SCAD clinic any time after 2021 following their SCAD event. For analysis, Fisher's exact test was used to compare categorical variables between groups, and student's two tailed *t*-test (if normally distributed) or Wilcoxon Rank sum (if non-normally distributed) was used to compare continuous variables. We considered a *p*-value of less than 0.05 to be statistically significant.

## 3. Results

### 3.1. Baseline demographics

There were no significant differences in baseline demographics between individuals seen in SCAD clinic as compared to non-SCAD clinics within the UPMC system (Table 1). Most individuals were women (SCAD clinic: 100 % vs non-SCAD clinic: 96 %, *p* = 0.18), self-identified as white (SCAD clinic: 96 % vs non-SCAD clinic: 90 %, *p* = 0.47) and presented at a mean age of  $49 \pm 11$  years for their index SCAD event.

### 3.2. SCAD presentation

Concerning presentation of ACS event, a total of 24/78 (31 %) individuals presented with an ST-elevation myocardial infarction (STEMI), which did not significantly differ between clinic types (SCAD clinic: 61 % vs non-SCAD clinic: 46 %, *p* = 0.66). There were no differences between interventional vs conservative therapy (SCAD clinic with intervention: 24 % vs non-SCAD clinic 25 %, *p* = 0.93). Cardiac complications including cardiac arrest occurred in 8 % (10/78) of the overall cohort and more frequently among individuals presenting to the SCAD clinic (SCAD clinic: 19 % vs. non-SCAD clinic: 8 %, *p* = 0.29). Similarly, more individuals presented to SCAD clinic with pregnancy associated SCAD vs to non-SCAD clinic (SCAD clinic: 19 % vs 8 %, *p* = 0.29). (Table 1).

### 3.3. Guidance-Based care

Regarding guidance for recurrence prevention, beta blocker use (SCAD clinic: 95 % vs non-SCAD clinic 96 %, *p* = 0.92) and discussion of hypertension (SCAD clinic: 82 % vs non-SCAD clinic 67 %, *p* = 0.28) were not significantly different between individuals seen in SCAD clinic compared to those seen in non-SCAD clinics. (Table 2).

For counseling among premenopausal patients, pregnancy planning and contraception were addressed significantly more in SCAD clinic as compared to non-SCAD clinics (SCAD clinic: 88 % vs. non-SCAD clinic: 0 %, *p* < 0.001). Similarly, safety of hormone replacement therapy in peri- or post-menopausal patients was addressed more in SCAD clinic as compared to non-SCAD clinics (SCAD clinic: 85 % vs non-SCAD clinics 7 %, *p* < 0.001). Among those with a history of migraines, there was more discussion of discontinuing potential event triggering medications (triptans) in SCAD clinic (80 % vs 14 %, *p* = 0.008). (Table 2).

In terms of follow-up extracoronary vascular screening, individuals

**Table 1**

Baseline demographics on individuals diagnosed with spontaneous coronary artery dissection (SCAD) among all individuals in healthcare system since 2018 (total cohort) and among individuals seen at the SCAD vs non-SCAS clinics from clinic inception (6/1/2021–12/31/2023). Values are expressed as n(%) or mean  $\pm$  standard deviation depending on variable. \*P<0.05 considered significant. CABG: coronary artery bypass grafts, PCI: percutaneous coronary artery intervention, NSTEMI: non-ST elevation myocardial infarction, STEMI: ST elevation myocardial infarction.

	Total Cohort (n = 79)	Non-SCAD Clinic (n = 24)	SCAD Clinic (n = 21)	P-value
Dates of data extraction	2018–2023	2021–2023	2021–2023	
Sex				0.18
Women	73/79 (92 %)	22/24 (92 %)	21/21 (100 %)	
Men	6/79 (8 %)	2/24 (8 %)	0/21 (0 %)	
Age at time of SCAD (years)	49 $\pm$ 11	50 $\pm$ 11	46 $\pm$ 11	0.29
Fibromuscular Dysplasia (if screened)	9/46 (20 %)	3/13 (23 %)	4/20 (20 %)	0.83
Self-Identified Race				0.47
White	75/79 (95 %)	23/24 (96 %)	19/21 (90 %)	
Black	4/79 (5 %)	1/24 (4 %)	2/21 (10 %)	
ACS Presentation				0.66
NSTEMI	54/78 (69 %)	13/24 (54 %)	12/31 (39 %)	
STEMI	24/78 (31 %)	9/24 (46 %)	8/21 (61 %)	
Intervention (PCI/CABG)	16/78 (21 %)	6/24 (25 %)	5/21 (24 %)	0.93
Days hospitalized	4 $\pm$ 5	6 $\pm$ 7	5 $\pm$ 5	0.56
Complications				
Cardiac Arrest	10/78 (8 %)	2/24 (8 %)	4/21 (19 %)	0.29
Recurrent SCAD	7/78 (9 %)	2/24 (8 %)	2/21 (10 %)	0.89
Pregnancy associated SCAD	9/77 (12 %)	2/24 (8 %)	4/21 (19 %)	0.29

that were seen in SCAD clinic had a higher rate of FMD screening prior to their index clinic visit compared to those individuals seen in non-SCAD clinics (33 % vs 4 %,  $p = 0.01$ ) (Table 1). Following index outpatient clinic visit, FMD screening rates remain significantly higher among individuals seen in SCAD clinic as compared to non-SCAD clinics (SCAD clinic: 100 % vs non-SCAD clinic: 30 %,  $p < 0.001$ ). (Table 2).

Regarding medications other than beta-blockers, there was a trend toward higher statin prescription at hospitalization discharge among individuals who were seen at the SCAD clinic for outpatient care. Among individuals with SCAD but without atherosclerosis or statin indicated by primary prevention guidelines, there was more discussion of discontinuing statin in SCAD clinic (SCAD clinic: 63 % vs non-SCAD clinic: 17 %,  $p = 0.06$ ). Dual anti-platelet therapy (DAPT) was prescribed in 54 % of all individuals in the study at hospital discharge. Following the index outpatient clinic visit, there was less DAPT continuation among clinicians in the SCAD clinic as compared to those in the non-SCAD clinics (SCAD clinic: 44 % vs non-SCAD clinic 83 %,  $p = 0.06$ ). (Table 2).

#### 4. Discussion

This study sought to analyze the use of guidance-based SCAD care in our large multi-hospital healthcare system. In addition, we analyzed differences in guidance-based care following creation of a SCAD clinic as compared to care in a non-SCAD clinic. The results of this study showed that guidance-based care remains suboptimal across multiple categories including: interventions to prevent SCAD recurrence, pregnancy and HRT counseling, FMD screening, and appropriate use of statin

**Table 2**

Guidance-based care post-SCAD index event for all individuals system-wide since 2018. Variables for individuals seen in SCAD clinic and in community providers from clinic inception (6/1/2021–12/31/2023) are also shown. Values are expressed as n(%) or mean  $\pm$  standard deviation depending on variable. P<0.05 considered significant. CAD: coronary artery disease, DAPT: dual anti-platelet therapy, HRT: hormone replacement therapy.

	Total Cohort (n = 79)	Non-SCAD Clinic (n = 24)	SCAD Clinic (n = 21)	P-value
Dates of data extraction	2018–2023	2021–2023	2021–2023	
<b>Recurrence prevention</b>				
Hypertension addressed	43/70 (61 %)	14/21 (67 %)	14/17 (82 %)	0.28
Beta-blockers	70/77 (91 %)	23/24 (96 %)	20/21 (95 %)	0.92
<b>Counseling</b>				
HRT (age > 45)	13/47 (28 %)	1/14 (7 %)	11/13 (85 %)	<0.001
Future pregnancy/Contraception (age < 45)	8/25 (32 %)	0/8 (0 %)	7/8 (88 %)	<0.001
Migraine meds addressed	11/23 (48 %)	1/7 (14 %)	8/10 (80 %)	0.008
<b>FMD Screening</b>				
Pre-Clinic	17/78 (22 %)	1/24 (4 %)	7/21 (33 %)	0.01
Post-Clinic	25/61 (41 %)	7/23 (30 %)	14/14 (100 %)	<0.001
<b>Medications</b>				
<b>Statin</b>				
At hospital discharge	56/77 (73 %)	20/24 (83 %)	12/21 (57 %)	0.05
Statin for primary prevention or CAD	26/56 (46 %)	8/20 (40 %)	4/12 (33 %)	0.71
If not indicated, discussed during clinic visit	20/28 (71 %)	2/12 (17 %)	5/8 (63 %)	0.06
<b>DAPT (conservative treatment)</b>				
At hospital discharge	33/61 (54 %)	6/17 (35 %)	8/16 (50 %)	0.39
Continued following index outpatient clinic visit	29/60 (48 %)	10/12 (83 %)	4/9 (44 %)	0.06

medications. A SCAD dedicated clinic achieved greater implementation of guidance-based care. Specifically, clinicians in the SCAD clinic had higher rates of counseling about contraception (among pre-menopausal women) and HRT (among peri- and postmenopausal women) as well as FMD screening. Similar to prior studies, our healthcare system showed heterogeneous practices regarding prescription of DAPT both following hospital discharge as well as maintaining DAPT follow index outpatient clinic visit.

Similar to the recommendations in the AHA scientific statement in 2018, the initial management of index SCAD event in this patient cohort mirrors the adoption of conservative management recommendations for stable patients. [1] This is reflected in the fact that only 21 % individuals in the study underwent PCI or CABG. FMD prevalence was lower in our total cohort (20 %) as compared to other reported cohorts, and is likely reflective of suboptimal screening (only 41 % of individuals ever received screening). Overall, the demographics of our population are reflective of national registry cohorts. The percent of individuals who self-identify as Black was low (5 %), like other registries. [10–12] We hypothesize this incidence may be under-representative of the true occurrence, in part due to racial disparities in equity regarding ACS presentation and diagnosis as well as management. Moving forward, the SCAD community should emphasize the need to improve diagnosis of SCAD during ACS presentation across all populations, including those of

minority races and ethnicities.

Regarding guidance-based care, we found no significant difference in certain aspects of care between SCAD and non-SCAD clinics, including use of beta-blocker and addressing hypertension control among those with history of hypertension. This could be attributed to adopting an approach to managing SCAD as ACS from atherosclerotic plaque, rather than guideline adherence. This is further supported by the maintenance of DAPT following ACS hospitalization and index outpatient clinic visit among 83 % of non-SCAD clinics on conservatively managed patients. While there is lack of randomized trials to guide anti-platelet management, a recent French registry noted that those patients prescribed with DAPT had a significantly higher rate of major adverse cardiac event at 12 months as compared to those on single antiplatelet therapy (SAPT). [13] We await results of ongoing randomized trials to further inform guidance-based care with regard to antiplatelet management. [14].

Despite guidance for FMD screening among all individuals following presentation of SCAD, we noted suboptimal implementation of this in our cohort (41 % of cohort ever screened since 2018), which was significantly improved among those seen in the SCAD clinic (SCAD clinic: 100 %, non-SCAD clinic 30 %). [2] While this represents some of the more definitive guidance in patients with SCAD, conditions like FMD and SCAD remain uncommon as compared to ACS and vascular disease secondary to atherosclerosis, which highlights the power of a dedicated SCAD clinic to improve care.

A relatively novel and major finding of our study was the stark differences in counseling regarding future pregnancy/contraception and HRT use among this predominantly young female cohort. Sex hormones are thought to play a role in triggering SCAD given the most common time periods of presentation during a women's lifespan include perimenopause and postpartum. [15,16] Pregnancy-associated SCAD is further associated with more serious initial presentations including more STEMI, greater dissection of proximal and multivessel involvement, greater rates of clinical shock and left ventricular systolic dysfunction. This underscores the importance of discussion surrounding future pregnancy and contraceptive management as part of management for SCAD among premenopausal individuals.

This study has limitations. As the initial EMR search was dependent on the presence of adequate ICD-10 coding or "coronary artery dissection" being noted in cardiac catheterization or CTA reports, SCAD diagnoses at subsequent healthcare visits may have been missed. Given the search criteria, we did adjudicate all studies for presence of SCAD, including unclear cases with an interventional cardiologist, which represents a strength in our dataset. Counseling variables were limited to manual data extraction from EMR documentation and may have been underestimated if this was not adequately documented in outpatient clinic notes. Additionally, the sample size for this study is small, predominantly due to the fact that SCAD is a fairly rare disease that can be difficult to diagnosis angiographically. Our overall cohort numbers were relatively small compared to larger registry databases, as this represents a healthcare system cohort, not a SCAD dedicated registry, and our SCAD clinic was implemented only 3 years prior to this analysis. However, we feel this represents a unique perspective of real-world data regarding implementation of guidance-based care. As the SCAD dedicated clinic is situated in a Women's Cardiac Clinic, we hypothesized baseline characteristics including female sex (denoted as women in this manuscript), pregnancy-associated SCAD and more complex SCAD cases (ie. cardiac arrest complication or recurrent SCAD) would be over-represented in the SCAD specialty clinic. While female sex, pregnancy-associated SCAD and recurrent SCAD had greater percentages of patients presenting to the specialty clinic, these differences did not reach significance. (Table 1) As such, we do not believe these differences impacted overall outcomes.

## 5. Conclusions

Our study is among the first to highlight real-world data after

adoption of guidance-based management of SCAD in a large, multi-hospital healthcare system. Optimal care occurred more frequently in a dedicated SCAD clinic when compared to non-SCAD clinic care. It is still unknown if this management strategy affects quality of life or clinical outcomes among SCAD patients, and this remains an area of future study. A multipronged approach, including SCAD education starting at a fellowship level will equip cardiology fellows with the knowledge to diagnose and manage SCAD based on current guidelines, ultimately improving patient outcomes. This will set the stage to enhance the culture of managing SCAD in the future when fellows transition into independent cardiologists. Furthermore, implementation of a SCAD center with clinicians trained to counsel on topics including contraception and hormone replacement therapies, are important initiatives toward advancing the cardiovascular care of these individuals.

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## CRediT authorship contribution statement

**Eleanor Christenson:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Deeksha Acharya:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Kathryn Berlacher:** . **Agnes Koczo:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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