ORIGINAL RESEARCH

Spontaneous Coronary Artery Dissection in Patients With a Provisional Diagnosis of Takotsubo Syndrome

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***Background*—**Takotsubo syndrome (TTS) mimics acute myocardial infarction in the absence of culprit coronary artery disease and is more common in women. Spontaneous coronary artery dissection (SCAD) shares a predilection for women, can result in left ventricular wall motion abnormalities similar to TTS, and may manifest subtle angiographic findings. The aim of this study was to determine the frequency of SCAD misdiagnosed as TTS.

***Methods and Results*—**Coronary angiograms of patients presenting with a provisional diagnosis of TTS were retrospectively reviewed by an independent expert blinded to left ventriculography and the specific purpose of the study to assess for SCAD. TTS was defined using European Society for Cardiology criteria. SCAD was categorized according to the Saw angiographic classification. Among 80 women with a provisional diagnosis of TTS, 2 (2.5%) met angiographic criteria for definite SCAD. Both dissections were located in the distal left anterior descending coronary artery and classified as type 2b. The wall motion abnormality was apical in both cases. An additional 7 patients (9%) had angiography that was indeterminate for SCAD. Clinical characteristics of patients with and without SCAD were similar.

***Conclusions*—**Among patients with a provisional diagnosis of TTS, definite SCAD in the left anterior descending coronary artery was present in 2.5% of cases, and coronary angiography was indeterminate for SCAD in an additional 9%. Careful review of coronary angiography may avoid missed diagnoses of SCAD in patients with myocardial infarction, nonobstructive coronary arteries, and wall motion abnormalities consistent with TTS. Intracoronary imaging maybe considered to establish a definitive diagnosis of SCAD when angiography is inconclusive. **(*J Am Heart Assoc*. 2019;8:e013581. DOI: 10.1161/JAHA.119.013581.)**

Key Words: coronary artery dissection • myocardial infarction • Takotsubo syndrome

Takotsubo syndrome (TTS) is characterized by transient left ventricular (LV) dysfunction with a clinical presentation that mimics acute myocardial infarction (MI).[1] LV wall motion abnormalities in TTS occur in the absence of culprit coronary artery disease and typically extend beyond a single coronary distribution. In a majority of TTS cases, a pattern of apical LV hypokinesis and ballooning with hyperdynamic basal LV segments is observed.[1] TTS disproportionately affects women, is often preceded by emotional or physical stressors, and is associated with outcomes that are similar to or more favorable than those of MI.[2,3]

Spontaneous coronary artery dissection (SCAD) is an underrecognized cause of MI that occurs due to an intimal disruption or intramural hematoma unrelated to atherosclerosis.[4] SCAD occurs in 2% to 4% of MIs and shares several clinical features with TTS.[5] As in TTS, SCAD has a predilection for women and is precipitated by emotional or physical triggers in up to 57% to 66% of cases.[4-10] SCAD is most often reported in women younger than 50 years,[4] whereas TTS tends to affect postmenopausal women.[1] The left anterior descending (LAD) coronary artery is most often affected by SCAD,[5,11] which may result in LV wall motion abnormalities similar to those observed in TTS. Wall motion abnormalities may be transient in patients with SCAD, depending on the extent of infarction, further obscuring the underlying diagnosis. Because SCAD may manifest subtle angiographic findings, meticulous review of coronary angiography and intracoronary imaging may be required to establish this diagnosis.

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An accompanying Table S1 is available at https://www.ahajournals.org/doi/suppl/10.1161/JAHA.119.013581

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Clinical Perspective

What Is New?

- Takotsubo syndrome (TTS) and spontaneous coronary artery dissection (SCAD) may present with similar clinical characteristics including symptoms of chest pain, elevated cardiac biomarkers, and similar wall motion patterns on echocardiography.
- At least 2.5% of patients presenting with a provisional diagnosis of TTS had angiographic evidence of SCAD.
- Angiography alone may be insufficient to definitively exclude a diagnosis of SCAD in up to 9% of patients presenting with a provisional diagnosis of TTS.

What Are the Clinical Implications?

- SCAD should be considered as a differential diagnosis in patients presenting with TTS.
- Careful review of angiography for patients presenting with TTS is required to avoid a missed diagnosis of SCAD.
- Intracoronary imaging may be warranted in patients with provisional TTS among whom angiography cannot definitively rule out SCAD.

Because of the overlapping clinical presentations in these mechanistically distinct syndromes, SCAD may be easily misdiagnosed as TTS, and in theory the 2 syndromes may occur simultaneously.[12–16] The aim of this study was to determine the prevalence of SCAD in a large cohort of patients assigned a diagnosis of TTS in routine clinical practice.

Methods

All data and supporting materials have been provided with the published article.

We retrospectively reviewed medical records of adults aged ≥18 years who were hospitalized at NYU Langone Health or Bellevue Hospital Center and were referred for consideration in the NYU Takotsubo Registry Study between February 2004 and May 2018 based on a physician-assigned provisional diagnosis of TTS (n=103). Among these, 80 patients had coronary angiographic images available for review. Patients were eligible for inclusion in this study if LV wall motion abnormalities occurred in a pattern consistent with TTS and there was no evidence of causative obstructive coronary artery disease, consistent with ESC diagnostic criteria for TTS.[1]

Clinical coronary angiograms were retrospectively reviewed by a cardiologist who is an independent, international expert in spontaneous coronary dissection (J.S.) and who was blinded to LV imaging and clinical data. The independent expert was asked to review angiograms for evidence of SCAD, without being aware of the purpose of this study. Specifically, the provisional diagnosis of TTS was not disclosed and left ventricular angiograms were not provided for review. Any suspected SCAD was defined according to the Saw angiographic classification, as previously described.[17] Briefly, type 1 SCAD was assigned when contrast staining and a linear radiolucency suggestive of a dissection flap were present. A diagnosis of type 2 SCAD was assigned when there was an abrupt decrement in arterial caliber with diffuse narrowing, either bounded by normal artery segments (type 2A) or extending to the distal branches of the vessel (type 2B). Type 3 SCAD was characterized by a focal tubular stenosis in a vessel otherwise free of atherosclerotic disease. If angiographic imaging diagnostic for SCAD was present, cases were classified as "definite SCAD." Suspected cases of SCAD were classified as "indeterminate" when further testing with intracoronary imaging or repeat angiography would have been necessary to confirm the diagnosis. Following an initial blinded review, the SCAD expert reviewer was unblinded and asked to rereview the angiograms with the left ventriculography included to ensure that the wall motion patterns corresponded to the territory of the vessel affected by SCAD.

Full medical record review was performed to abstract demographics, clinical comorbidities, and key laboratory findings. The presence of any emotional or physical triggers preceding a provisional diagnosis of TTS was ascertained from patient report as documented in the medical record. All 12-lead ECGs were reviewed to identify ST-segment–elevation MI; the remaining cases were designated as non–ST-segment–elevation MI. Patterns of LV wall abnormalities were classified based on the InterTAK diagnostic criteria using LV imaging from echocardiography and/or invasive ventriculography.[3]

Statistical Analyses

Continuous measures following a normal distribution are shown as means and SDs; continuous variables with a nonnormal distribution are displayed as medians and interquartile ranges. All statistical tests were performed in SPSS 25.0 (IBM, Armonk, NY). The study was approved by the New York University School of Medicine Institutional Review Board. Because this was a retrospective analysis, patients were not contacted, and requirement for informed consent was waived.

Results

A total of 80 patients with a clinical provisional diagnosis of TTS who were referred for consideration in the NYU Takotsubo Registry Study were included. The mean age was

71.3±11.5 years and 78 (98%) were women. The majority of patients had the apical wall motion pattern (95%) and presented with an initial diagnosis of non–ST-segment–elevation MI (69%). See Table 1 for clinical characteristics of all study patients.

The independent expert performed a review of all coronary angiography blinded to the provisional diagnosis of TTS and to left ventriculography. Two patients (2.5%) with a provisional diagnosis of TTS were retrospectively assigned a diagnosis of definite type 2b SCAD involving the LAD coronary artery based on the angiographic review. In both cases there was diffuse narrowing and tapering of the distal LAD, extending to the terminal vessel (Figure). The diagnosis of SCAD was supported by the absence of concomitant atherosclerosis in the proximal LAD or in other coronary vessels. Demographics and clinical data for these patients are presented in Table 2. Both patients had apical wall motion abnormalities suggestive of TTS.

An additional 7 patients (9%) were assigned a diagnosis of "indeterminate SCAD" in the LAD based on expert angiographic review. These cases would have required additional angiographic views, intracoronary imaging, or repeat coronary angiography at follow-up to confirm or exclude SCAD. In all of these cases LAD segments were suspicious for SCAD. Indeterminate cases included possible type 2a SCAD in 4 cases, type 2b SCAD in 1 case, and type 3 SCAD in 1 case. In 1 case the patient had tortuous arteries concerning for coronary fibromuscular dysplasia, and intracoronary imaging would have been required for diagnostic confirmation. In 6/7 (86%) cases the wall motion abnormalities included the apex. In the remaining case the wall motion pattern was midventricular without apical involvement; thus, it did not correspond to the arterial segment affected by possible type 3 SCAD and was unlikely to be the cause of wall motion abnormalities in this case. In 3 of the 6 remaining possible SCAD cases, the LV wall motion abnormalities extended beyond the territory expected to correspond to the affected coronary segment, such as to the mid–inferior wall. Clinical characteristics of patients with definite or indeterminate SCAD and patients with TTS without SCAD were compared and were not significantly different between groups (Table S1).

Table 1. Clinical Characteristics of All Study Patients

	Study Patients (n=80)
Demographics	
Age (y), mean±SD	71.3 ± 11.5
Female sex, %	78 (98%)
Race	
White, %	62 (78%)
Black, %	1 (1%)
Asian, %	5 (6%)
Unknown/other, %	12 (15%)
Ethnicity	
Hispanic, %	7 (9%)
Comorbidities	
Hypertension, %	42 (53%)
Hyperlipidemia, %	41 (51%)
Diabetes melltius, %	10 (13%)
Depression, %	11 (14%)
Anxiety, %	11 (14%)
TTS trigger	
Physical	34 (43%)
Emotional	28 (35%)
None	20 (25%)
Presentation	
ST-segment elevation	25 (31%)
No ST-segment elevation	55 (69%)
Peak troponin (ng/mL), median (IQR)	1.75 (0.79-3.69)
LVEF, %, median (IQR)	35% (30% to 40%)
TTE wall motion type	
Apical	76 (95%)
Midventricular	3 (4%)
Focal	1 (1%)
Basal	0 (0%)

IQR indicates interquartile range; LVEF, left ventricular ejection fraction; TTE, transthoracic echocardiogram; TTS, Takotsubo syndrome.

Discussion

Takotsubo syndrome and SCAD are distinct clinical entities characterized by chest pain, elevated troponin, and/or ECG changes. Both syndromes share a predilection for women and an association with predisposing emotional or physical stressors. In 52% of SCAD cases the LAD is affected, which may result in apical wall motion abnormalities that are indistinguishable from those characteristically observed in TTS.[8] In the present study we identified that 2.5% of patients with a provisional diagnosis of TTS based on characteristic regional wall motion abnormalities in the absence of severe coronary stenoses had definite angiographic evidence of SCAD on expert angiographic review.

Our study cohort included patients who received a provisional diagnosis of TTS at the time of their index presentation. Patients identified with SCAD in this series were older than previously reported in small cohorts (mean age 45-53 years).[5,13] In contrast, the mean age of patients with SCAD in the National Inpatient Sample (N=7347) was 62±15 years, suggesting that SCAD may frequently affect

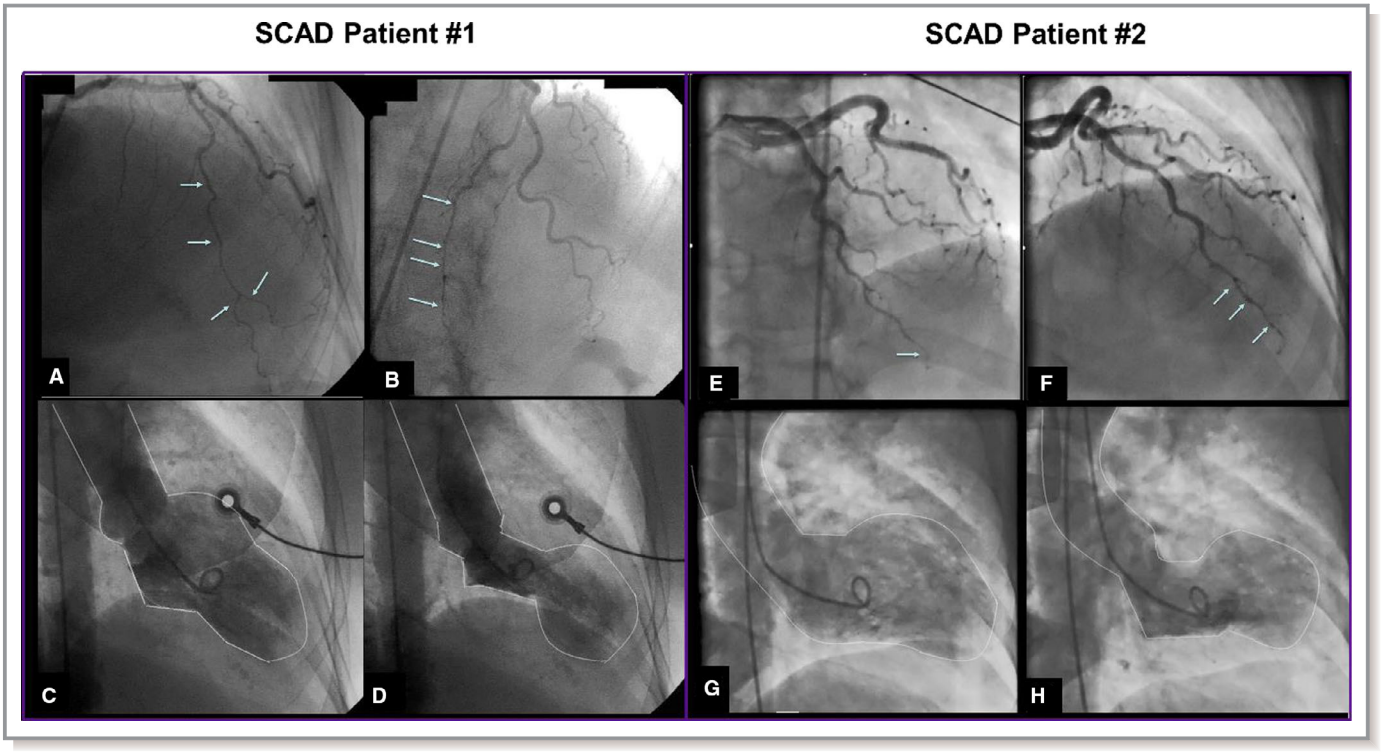

Figure. Coronary angiography and left ventriculography demonstrating type 2b SCAD in 2 patients with a provisional diagnosis of TTS assigned at the time of hospital discharge. **A** and **B,** Diffuse tapering of the mid- and distal LAD (arrows) in patient #1 consistent with type 2b SCAD. Left ventriculography in patient #1 during diastole (**C**) and systole (**D**) demonstrates severe anterior apical, apical, and inferior apical hypokinesis with hyperdynamic basal LV segments. **E** and **F**, Diffuse narrowing of the distal LAD (arrows) in patient #2, diagnostic for type 2b SCAD. Left ventriculography during diastole (**G**) and systole (**H**) in patient #2 also revealed a severe anterior apical and apical wall motion abnormality. LAD indicates left anterior descending; SCAD, spontaneous coronary artery dissection; TTS, Takotsubo syndrome.

older adults.[18] Furthermore, SCAD frequently occurred in patients with cardiovascular comorbidities, including hypertension (64%), dyslipidemia (64%), and diabetes mellitus (24%).[18] Thus, it is important to consider a diagnosis of SCAD even in older women with cardiovascular risk factors.

In many cases SCAD is angiographically subtle, particularly when distal vessels are affected or nonobstructive luminal narrowing is present. The diagnosis of SCAD is reinforced by the absence of angiographic evidence of atherosclerosis in nonaffected epicardial coronary vessels. Although type 1 SCAD may be easily recognized based on the presence of a radiolucent intra-arterial dissection flap, this represents only a minority of SCAD cases.[5,8] In contrast, types 2 and 3 SCAD are thought to be missed frequently.[4,5,19] This is consistent with the current analysis, in which both cases of type 2b SCAD affecting the distal LAD were not identified by clinical providers at the time of coronary angiography. To establish a diagnosis of type 2b SCAD, careful review of angiography by experienced operators may be necessary. In some cases angiography alone may be insufficient to diagnose SCAD. The American Heart Association and European Society of Cardiology position statements on the diagnosis of SCAD highlight the importance of intracoronary imaging with intravascular ultrasound or optical coherence tomography in indeterminate cases to avoid missed diagnoses of SCAD.[5,20] Cardiac magnetic resonance imaging with late gadolinium enhancement in the territory of the affected artery also supports a diagnosis of MI from SCAD instead of TTS.[21]

Although catecholaminergic states have been implicated in the pathophysiology of both TTS and SCAD, mechanisms of disease differ significantly, with direct myocardial effects often proposed as a mechanism of TTS and increased shear stress precipitating vascular damage postulated in SCAD.[1,4,5] In addition, based on the Fourth Universal Definition of MI,[22] TTS is categorized as a non-MI myocardial injury, whereas SCAD is considered to be a subset of type 2 MI. The clinical management of TTS and SCAD also differs substantially, with implications for follow-up diagnostic imaging, medical therapy, and post-event monitoring. After SCAD, treatment with β-blockers is recommended to decrease the shear stress and limit propagation of coronary dissection and has been associated with better outcomes.[4] Although dual antiplatelet use is controversial, single antiplatelet use is generally recommended long-term. Patients with SCAD are also recommended to undergo screening for predisposing arteriopathies such as fibromuscular dysplasia, occult aneurysms,

Table 2. Clinical Characteristics of Patients With Definite SCAD

	SCAD Patient #1	SCAD Patient #2
Age, y	83	66
Sex	Female	Female
Race/ethnicity	Non-Hispanic white	Hispanic
Comorbidities		
Hypertension	Present	Absent
Hyperlipidemia	Present	Present
Diabetes mellitus	Absent	Absent
Depression	Absent	Absent
Anxiety	Absent	Present
TTS Trigger	Emotional trigger	Physical trigger
ECG presentation	STEMI	NSTEMI
Peak troponin, ng/mL	3.61	1.30
LVEF, %	28%	45%
Wall motion type	Apical	Apical
Vessel affected by SCAD	LAD	LAD
SCAD type	Type 2b	Type 2b

LAD indicates left anterior descending coronary artery; LVEF, left ventricular ejection fraction; NSTEMI, non–ST-segment–elevation myocardial infarction; SCAD, spontaneous coronary artery dissection; STEMI, ST-segment–elevation myocardial infarction; TTS, Takotsubo syndrome.

and dissections that may require surveillance or treatment.[5] Given the risks of dissection propagation or worsening intramural hematoma, close monitoring is indicated early after presentation. In contrast, in patients with TTS, angiotensin-converting enzyme inhibitors have been associated with better outcomes in observational studies.[3] There is no apparent role for antiplatelet therapy or β-blockers in TTS.

Limitations

This retrospective observational study included patients with a physician-assigned diagnosis of TTS at 2 affiliated academic medical centers who were referred for inclusion in the NYU Takotsubo Registry. We cannot exclude a referral bias to the registry, which may affect the reported prevalence of SCAD and limit study generalizability. The independent expert performed blinded reviews of angiographic images without the clinical context suggestive of TTS. It is unknown whether clinical data and/or review of left ventriculography would have impacted the final diagnoses. The question arises as to whether the SCAD is etiologic for TTS and the wall motion abnormalities observed. Tapering of the vessel due to SCAD can limit angiographic visualization of the terminal portion of the affected vessel. Therefore, it is challenging to determine the area of the LV that best corresponds to the vascular territory affected. In the first definite case of SCAD identified in this study, the extent of SCAD was judged to match the observed wall motion abnormalities, but the relationship in the second case was less clear. Similarly, wall motion abnormalities appeared to extend beyond the affected territory in 3 of 6 cases with angiography that was indeterminate for SCAD and did not correlate with the location of possible SCAD in 1 other case. Unfortunately, intracoronary imaging and cardiac magnetic resonance imaging were not performed as part of clinical care for patients in this cohort. In the absence of confirmatory intracoronary imaging, we cannot exclude alternative diagnoses such as MI with nonobstructing coronary arteries due to occult atherosclerotic plaque rupture and/or thrombosis. Because we were unable to establish a definitive diagnosis of SCAD in 6 cases in this series, the prevalence of SCAD among patients with a provisional diagnosis of TTS may be underestimated and could be as high as 10%.

Conclusions

Among patients with a provisional diagnosis of TTS, SCAD was present in at least 2.5% of cases, and an additional 7.5% of cases had coronary angiography that was indeterminate for SCAD with a wall motion abnormality in the territory of the possible SCAD. Careful review of coronary angiography and intracoronary imaging may be necessary to avoid missed diagnoses of SCAD as the cause of an apparent TTS presentation, even in patients in whom clinical suspicion of SCAD might otherwise be low.

Disclosures

None.

References

1. Ghadri JR, Wittstein IS, Prasad A, Sharkey S, Dote K, Akashi YJ, Cammann VL, Crea F, Galiuto L, Desmet W, Yoshida T, Manfredini R, Eitel I, Kosuge M, Nef HM, Deshmukh A, Lerman A, Bossone E, Citro R, Ueyama T, Corrado D, Kurisu S, Ruschitzka F, Winchester D, Lyon AR, Omerovic E, Bax JJ, Meimoun P, Tarantini G, Rihal C, S YH, Migliore F, Horowitz JD, Shimokawa H, Luscher TF, Templin C. International expert consensus document on Takotsubo syndrome (Part I): clinical characteristics, diagnostic criteria, and pathophysiology. *Eur Heart J*. 2018;39:2032–2046.
2. Smilowitz NR, Hausvater A, Reynolds HR. Hospital readmission following Takotsubo syndrome. *Eur Heart J Qual Care Clin Outcomes*. 2019;5:114–120.
3. Templin C, Ghadri JR, Diekmann J, Napp LC, Bataiosu DR, Jaguszewski M, Cammann VL, Sarcon A, Geyer V, Neumann CA, Seifert B, Hellermann J, Schwyzer M, Eisenhardt K, Jenewein J, Franke J, Katus HA, Burgdorf C, Schunkert H, Moeller C, Thiele H, Bauersachs J, Tschope C, Schultheiss HP, Laney CA, Rajan L, Michels G, Pfister R, Ukena C, Bohm M, Erbel R, Cuneo A, Kuck KH, Jacobshagen C, Hasenfuss G, Karakas M, Koenig W, Rottbauer W, Said SM, Braun-Dullaeus RC, Cuculi F, Banning A, Fischer TA, Vasankari T, Airaksinen KE, Fijalkowski M, Rynkiewicz A, Pawlak M, Opolski G, Dworakowski R, MacCarthy P, Kaiser C, Osswald S, Galiuto L, Crea F, Dichtl W, Franz WM, Empen K, Felix SB, Delmas C, Lairez O, Erne P, Bax JJ, Ford I, Ruschitzka F, Prasad A, Luscher TF. Clinical features and outcomes of Takotsubo (stress) cardiomyopathy. *N Engl J Med*. 2015;373:929–938.

4. Saw J, Mancini GBJ, Humphries KH. Contemporary review on spontaneous coronary artery dissection. *J Am Coll Cardiol*. 2016;68:297–312.
5. Hayes SN, Kim ESH, Saw J, Adlam D, Arslanian-Engoren C, Economy KE, Ganesh SK, Gulati R, Lindsay ME, Mieres JH, Naderi S, Shah S, Thaler DE, Tweet MS, Wood MJ; American Heart Association Council on Peripheral Vascular Disease, Council on Clinical Cardiology, Council on Cardiovascular and Stroke Nursing, Council on Genomic and Precision Medicine, and Stroke Council. Spontaneous coronary artery dissection: current state of the science: a scientific statement from the American Heart Association. *Circulation*. 2018;137:e523–e557.
6. Saw J, Ricci D, Starovoytov A, Fox R, Buller CE. Spontaneous coronary artery dissection: prevalence of predisposing conditions including fibromuscular dysplasia in a tertiary center cohort. *JACC Cardiovasc Interv*. 2013;6:44–52.
7. Saw J, Aymong E, Sedlak T, Buller CE, Starovoytov A, Ricci D, Robinson S, Vuurmans T, Gao M, Humphries K, Mancini GB. Spontaneous coronary artery dissection: association with predisposing arteriopathies and precipitating stressors and cardiovascular outcomes. *Circ Cardiovasc Interv*. 2014;7:645–655.
8. Saw J, Starovoytov A, Humphries K, Sheth T, So D, Minhas K, Brass N, Lavoie A, Bishop H, Lavi S, Pearce C, Renner S, Madan M, Welsh RC, Lutchmedial S, Vijayaraghavan R, Aymong E, Har B, Ibrahim R, Gornik HL, Ganesh S, Buller C, Matteau A, Martucci G, Ko D, Mancini GBJ. Canadian spontaneous coronary artery dissection cohort study: in-hospital and 30-day outcomes. *Eur Heart J*. 2019;40:1188–1197.
9. Nakashima T, Noguchi T, Haruta S, Yamamoto Y, Oshima S, Nakao K, Taniguchi Y, Yamaguchi J, Tsuchihashi K, Seki A, Kawasaki T, Uchida T, Omura N, Kikuchi M, Kimura K, Ogawa H, Miyazaki S, Yasuda S. Prognostic impact of spontaneous coronary artery dissection in young female patients with acute myocardial infarction: a report from the Angina Pectoris-Myocardial Infarction Multicenter Investigators in Japan. *Int J Cardiol*. 2016;207:341–348.
10. Saw J, Aymong E, Mancini GB, Sedlak T, Starovoytov A, Ricci D. Nonatherosclerotic coronary artery disease in young women. *Can J Cardiol*. 2014;30:814–819.
11. Tweet MS, Hayes SN, Pitta SR, Simari RD, Lerman A, Lennon RJ, Gersh BJ, Khambatta S, Best PJ, Rihal CS, Gulati R. Clinical features, management, and prognosis of spontaneous coronary artery dissection. *Circulation*. 2012;126:579–588.
12. Bakhit A, Bin Abdulhak A. Spontaneous coronary dissection misdiagnosed as Takotsubo's cardiomyopathy. *Int J Cardiol*. 2016;225:384–386.
13. Chou AY, Sedlak T, Aymong E, Sheth T, Starovoytov A, Humphries KH, Mancini GB, Saw J. Spontaneous coronary artery dissection misdiagnosed as Takotsubo cardiomyopathy: a case series. *Can J Cardiol*. 2015;31:1073.e5–1073.e8.
14. Y-Hassan S, Böhm F. The causal link between spontaneous coronary artery dissection and Takotsubo syndrome: a case presented with both conditions. *Int J Cardiol*. 2016;203:828–831.
15. Y-Hassan S, Henareh L. Spontaneous coronary artery dissection triggered post-ischemic myocardial stunning and Takotsubo syndrome: two different names for the same condition. *Cardiovasc Revasc Med*. 2013;14:109–112.
16. Y-Hassan S. Spontaneous coronary artery dissection and Takotsubo syndrome: an often overlooked association; review. *Cardiovasc Revasc Med*. 2018;19:717–723.
17. Saw J. Coronary angiogram classification of spontaneous coronary artery dissection. *Catheter Cardiovasc Interv*. 2014;84:1115–1122.
18. Mahmoud AN, Taduru SS, Mentias A, Mahtta D, Barakat AF, Saad M, Elgendy AY, Mojadidi MK, Omer M, Abuzaid A, Agarwal N, Elgendy IY, Anderson RD, Saw J. Trends of incidence, clinical presentation, and in-hospital mortality among women with acute myocardial infarction with or without spontaneous coronary artery dissection: a population-based analysis. *JACC Cardiovasc Interv*. 2018;11:80–90.
19. Saw J, Mancini GB, Humphries K, Fung A, Boone R, Starovoytov A, Aymong E. Angiographic appearance of spontaneous coronary artery dissection with intramural hematoma proven on intracoronary imaging. *Catheter Cardiovasc Interv*. 2016;87:E54–E61.
20. Adlam D, Alfonso F, Maas A, Vrints C, Writing C. European Society of Cardiology, acute cardiovascular care association, SCAD study group: a position paper on spontaneous coronary artery dissection. *Eur Heart J*. 2018;39:3353–3368.
21. Tan NY, Hayes SN, Young PM, Gulati R, Tweet MS. Usefulness of cardiac magnetic resonance imaging in patients with acute spontaneous coronary artery dissection. *Am J Cardiol*. 2018;122:1624–1629.
22. Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, White HD; Executive Group on Behalf of the Joint European Society of Cardiology/American College of Cardiology/American Heart Association/World Heart Federation Task Force for the Universal Definition of Myocardial Infarction. Fourth universal definition of myocardial infarction (2018). *Glob Heart*. 2018;13:305–338.

Supplemental Material

Table S1. Clinical characteristics of patients with definite and indeterminate SCAD versus takotsubo syndrome.

	SCAD (Definite N=2, Indeterminate N=6)	**Takotsubo (N=71)**
Demographics		
Age (yrs), mean (STD)	71.5 ±7.5	69.35 ±10.40
Female Sex (%)	8 (100%)	68 (96%)
Race		
White (%)	5 (63%)	56 (79%)
African American (%)	0 (0%)	1 (1%)
Asian (%)	1 (13%)	4 (6%)
Unknown /Other (%)	2 (25%)	10 (14%)
Ethnicity		
Hispanic (%)	2 (25%)	6 (8%)
Comorbidities		
Hypertension (%)	6 (75%)	36 (51%)
Hyperlipidemia (%)	4 (50%)	36 (51%)
Diabetes (%)	1 (13%)	9 (13%)
Depression (%)	0 (0%)	11 (15%)
Anxiety (%)	0 (0%)	10 (14%)
TTS Trigger		
Physical	4 (50%)	30 (42%)
Emotional	1 (13%)	25 (35%)
None	3 (38%)	21 (30%)
Presentation		
ST-elevation	2 (25%)	22 (31%)
No ST-elevation	6 (75%)	49 (69%)
Peak Troponin (ng/mL), median (IQR)	1.44 (1.25-3.29)	1.89 (0.82-3.65)
LVEF, %, median (IQR)		
TTE Wall motion type		
Apical	8 (89%)	68 (96%)
Midventricular	0 (0%)	2 (3%)
Focal	0 (0%)	1 (1%)
Basal	0 (0%)	0 (0%)

TTE= transthoracic echocardiogram, TTS= takotsubo syndrome, LVEF= left ventricular ejection fraction