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Clinical Manifestations of Symptomatic Spontaneous Dissection of the Celiac and Superior Mesenteric Arteries

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Purpose: Spontaneous isolated dissection of the celiac artery (SID-CA) and superior mesenteric artery (SID-SMA) are rare vascular diseases with similar presentation, yet comparative studies have not been reported. In this study, we compared their characteristics with the aim of providing insights into their etiology.

Materials and Methods: Patients diagnosed with symptomatic SID-CA and SID-SMA between July 2009 and December 2018 were included. Demographics, clinical presentation, radiologic findings, treatment strategies, and outcomes were analyzed.

Results: Twenty-one patients with SID-CA and 40 patients with SID-SMA were compared. Demographics and initial abdominal pain characteristics were similar, but pain severity was significantly higher and associated mean fasting time was significantly longer in patients with SID-CA than in those with SID-SMA (fasting time 3.2 vs 2.1 days, P=0.001). Most patients were successfully treated conservatively without recurrent pain or aneurysmal dilatation, but 33.3% patients with SID-CA and 17.5% with SID-SMA required endovascular intervention. More favorable remodeling in terms of dissection regression on follow-up computed tomography was found after stenting, where patients with SID-CA showed better remodeling than those with SID-SMA. The overall median follow-up period was 22-31 months, while for patients with stent insertion, it was 55-77 months, and no stent occlusions were found during this period.

Conclusion: Patients with SID-CA presented with severer and longer-duration abdominal pain than those with SID-SMA. Stenting in both groups showed good long-term patency and favorable remodeling, with a higher regression rate for SID-CA. Based on our results, patients with SID-CA may benefit more from active endovascular intervention.

Key Words: Blood vessel dissection, Celiac artery, Superior mesenteric artery, Endovascular procedures

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INTRODUCTION

Spontaneous isolated dissection of the visceral artery (SID-VA) is a rare vascular disease that mainly affects the superior mesenteric artery (SMA) or the celiac artery (CA), without evidence of aortic dissection [1]. The pathophysiology or risk factors related to SID-CA or SID-SMA are not well known, but these diseases are known to be more prevalent in the Asian population [2,3]. With the increased use of imaging modalities, such as computed tomography (CT), SID-CA and SID-SMA are being more frequently diagnosed (including incidentally found cases).

The initial clinical presentation of both SID-CA and SID-SMA is similar in terms of symptoms and signs; typically, patients experience acute onset of diffuse abdominal pain, often associated with back pain, nausea, and vomiting. In SID-SMA, ischemia related to narrowed true luminal caliber can lead to decrease in bowel perfusion and consequent peritonitis or perforation in severe cases. In contrast, SID-CA is usually associated with hepatic and/or splenic ischemia, leading to end-organ infarction in severe cases. The prognosis of both SID-CA and SID-SMA varies widely, with most cases being self-limited, but can lead to life-threatening conditions depending on the severity of distal hypoperfusion and end-organ ischemia or necrosis.

Currently, there is no consensus regarding the treatment of SID-VA. Numerous studies, including the most recent European Society for Vascular Surgery guidelines, suggest conservative treatment for asymptomatic patients and conservative management to be the first line of treatment for symptomatic patients [4-7]. However, there is no consensus on the use of antithrombotic medications [8,9]. Additionally, there is controversy regarding the use of surgical or endovascular intervention in cases of severe end-organ ischemia [10,11].

Despite the increasing number of reports on SID-VA, most reports are associated with small sample sizes, and thus the quality of the evidence is low. Additionally, although the clinical presentation and treatment strategies of both disease entities are similar, there has been no head-to-head comparison between SID-CA and SID-SMA. In this study, we compared the clinical characteristics and demographic features of SID-CA and SID-SMA, with the aim of providing insights for understanding the etiology of SID-VA.

MATERIALS AND METHODS

1) Study design

A total of 21 patients were diagnosed with SID-CA and 40 patients were diagnosed with SID-SMA between July 2009 and December 2018 at Seoul National University Bundang Hospital. Medical records were retrospectively reviewed for demographic characteristics, laboratory findings, initial symptoms, including the severity of abdominal pain, CT images, and treatment strategies. The degree of pain was measured using the numeric pain rating scale (0-10) and categorized as mild (1-3), moderate (4-6), and severe (7-10) pain. Approval was obtained from the institutional research committee of Seoul National University Bundang Hospital (IRB No. B-2011/649-102), and the requirement for informed consent was waived due to the retrospective nature of the study.

2) CT findings

Contrast-enhanced CT angiography images were obtained in all patients with SID-CA and SID-SMA for initial diagnosis, and follow-up CT scans were obtained within 6 months after initial treatment. Radiologic findings, such as thrombosis of the false lumen, aneurysmal change, and distal organ ischemia were collected. Morphological types of SID-CA and SID-SMA were defined according to the Sakamoto classification [12].

3) Initial treatment

All patients with SID-CA and SID-SMA were treated conservatively or underwent endovascular intervention. Initial conservative treatment consisted of fasting, hypertension management, anticoagulation with low molecular weight heparin (LMWH), and short-term CT angiography follow-up within 1 week. LMWH was used to prevent true luminal occlusion, which may arise from decreased true lumen caliber associated with false lumen thrombosis. Indications for endovascular intervention were distal hypoperfusion with consequent end-organ ischemia, uncontrollable pain, and persistent pain or progression of dissection despite conservative treatment. None of the patients underwent surgical intervention. After symptomatic relief and diet build-up, patients were discharged with oral antiplatelets, as well as antihypertensive medications, as necessary. Dual antiplatelets were prescribed for patients with stents for 3 to 6 months and switched to monotherapy afterwards, while patients treated conservatively were given single antiplatelet agent, unless the patients were on other antiplatelet regimens due to other underlying disease conditions.

4) Follow-up schedule

Basic follow-up protocols consisted of CT scans, laboratory tests, and physical examination of the patient. Patients treated conservatively were followed up 2 weeks after discharge, and in the case of improved symptoms, a CT scan was performed 3 to 6 months later. Additional CT scans were performed at 1 to 2 year intervals to evaluate the

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disease regression state. The criteria for the termination of follow-up were complete regression of the dissection, or asymptomatic stable disease on consecutive CT scans. Patients with endovascular stents were followed up at 6 and 12 months and subsequently at 1 to 2 year intervals to determine stent patency. Regression states on follow-up CT scans were classified as complete regression, partial regression, no change, or progression of disease. Complete regression was defined as complete disappearance of the false lumen thrombosis and healing of the intimal flap, while partial regression was defined as true luminal gain associated with improved but remnant false lumen thrombosis. Conversely, progression was defined as aggravation of false lumen thrombosis with decreased true lumen perfusion and/or extension of dissection to more distal parts of the artery, mostly found during short-term follow-up.

5) Statistical analysis

For comparison of the data, the chi-square test, Fischer's exact test, Student t-test, and Mann-Whitney test were used. Statistical analysis was performed using SPSS software (version 22.0; IBM Co., Armonk, NY, USA).

RESULTS

Symptomatic patients with SID-VA included 21 patients in SID-CA group and 40 patients in SID-SMA group. Demographic characteristics are shown in Table 1. In the SID-CA group, the median age was 49.5 years and 19 patients (90.5%) were male. Eight patients (38.1%) had hypertension, one (4.8%) had diabetes, and one (4.8%) had dyslipidemia. Six patients (28.6%) were smokers at the time of diagnosis. In the SID-SMA group, the median age was 50.6 years and 38 patients (95.0%) were male. Twenty patients (50.0%) had hypertension, three (7.5%) had diabetes, and seven (17.5%) had dyslipidemia. Twenty-six patients (65.0%) were smokers at the time of diagnosis. There was no significant difference between the two groups in demographic characteristics, and none of the patients had a history of connective tissue disorders. All patients with SID-CA and SID-SMA experienced abdominal pain, mostly presenting as epigastric/periumbilical pain (66.7% in SID-CA, 62.5% in SID-SMA). Of note, in patients with SID-CA, the severity of the abdominal pain tended to be moderate to severe (85.7%), whereas in those with SID-SMA the severity tended to be mild to moderate (77.5%) (P=0.01).

The lesion characteristics for both SID-CA and SID-SMA are shown in Table 2. The most common morphological type was type III (thrombosed false lumen with ulcer-like projection) in both SID-CA and SID-SMA. The mean dissection length was 48.3±13.6 mm in SID-CA, and 49.8±11.9 mm in SID-SMA (P=0.655). A comparison of morphologic type with pain severity showed no significant correlation (Supplementary Table 1).

Treatment patterns and outcomes are summarized in

Table 1. Demographic and clinical characteristics of patients with SID-CA and SID-SMA

Characteristic	SID-CA (n=21)	SID-SMA (n=40)	P-value
Mean age (y)	49.5 (35-67)	50.6 (38-73)	0.582
Sex, male	19 (90.5)	38 (95.0)	0.602
BMI (kg/m^2)	25.2	24.6	0.420
Coexisting medical condition			
Hypertension	8 (38.1)	20 (50.0)	0.427
Diabetes mellitus	1 (4.8)	3 (7.5)	>0.999
Dyslipidemia	1 (4.8)	7 (17.5)	0.243
Smoking	6 (28.6)	26 (65.0)	0.007
Pain at the initial presentation			
Mode of onset			0.405
Sudden	20 (95.2)	34 (85.0)	
Insidious	1 (4.8)	6 (15.0)	
Location			0.325
Epigastric/periumbilical pain	14 (66.7)	25 (62.5)	
Ill-defined location	7 (33.3)	12 (30.0)	
Back pain		3 (7.5)	
Severity			0.010
Mild	3 (14.3)	12 (30.0)	
Moderate	5 (23.8)	19 (47.5)	
Severe	13 (61.9)	9 (22.5)	

Values are presented as mean (range) or number (%).
SID-CA, spontaneous isolated dissection of the celiac artery; SID-SMA, spontaneous isolated dissection of the superior mesenteric artery; BMI, body mass index.

Table 2. Radiologic findings of SID-CA and SID-SMA

Anatomical feature	SID-CA (n=21)	SID-SMA (n=40)	P-value
Mean dissection length (mm)	48.3±13.6	49.8±11.9	0.655
Aneurysmal change	6 (28.6)	8 (20.0)	0.527
Morphologic type[a]			0.951
I	5 (23.8)	9 (22.5)	
II	0 (0.0)	0 (0.0)	
III	14 (66.7)	28 (70.0)	
IV	2 (9.5)	3 (7.5)	

Values are presented as mean±standard deviation or number (%).
SID-CA, spontaneous isolated dissection of the celiac artery; SID-SMA, spontaneous isolated dissection of the superior mesenteric artery.
[a]Sakamoto classification.

Table 3. Treatment and clinical outcome of patients with SID-CA and SID-SMA

Variable	SID-CA (n=21)	SID-SMA (n=40)	P-value
Treatment modality			0.206
Conservative care	14 (66.7)	33 (82.5)	
Intervention	7 (33.3)	7 (17.5)	
Mean fasting time (d)	3.2 (1-7)	2.1 (1-5)	0.001
Follow-up computed tomography findings			0.592
Intervention group			
Complete regression	5 (71.4)	3 (42.9)	
Partial regression	2 (28.6)	4 (57.1)	
No change	0	0	
Conservative care group			
Complete regression	5 (35.7)	9 (27.3)	
Partial regression	5 (35.7)	14 (42.4)	
No change	4 (28.6)	10 (30.3)	
Median follow-up period (mo)			
Overall	31.6 (0.4–118.9)	22.6 (1.1–106.9)	0.410
Intervention	77.6 (34–118.9)	55.7 (14.9–106.9)	0.374

Values are presented as number (%), mean (range), or median (range).
SID-CA, spontaneous isolated dissection of the celiac artery; SID-SMA, spontaneous isolated dissection of the superior mesenteric artery.

Table 3. The majority of patients underwent conservative management; however, seven patients (33.3%) underwent endovascular intervention in the SID-CA group, and seven patients (17.5%) underwent endovascular intervention in the SID-SMA group. The indication for endovascular intervention in the SID-CA group was the presence of severe end-organ hypoperfusion and/or aneurysmal dilatation in four patients, and intractable pain with progression of disease extent on short-term follow-up imaging in three patients. For SID-SMA, endovascular intervention was performed mainly in cases of severe bowel ischemia with a high risk of perforation in order to prevent surgical laparotomy. Stenting was performed mainly via a femoral approach and 6 to 8 mm (40 to 60 mm in length) bare-metal self-expanding stents were used in all cases. In conservatively treated patients, the mean fasting time was 3.2 days in the SID-CA group and 2.1 days in the SID-SMA group (P=0.001). On follow-up CT, regression (complete or partial) was found in approximately 70% of the patients after conservative management, but approximately 30% of the patients showed no change in dissection for both SID-CA and SID-SMA. Contrarily, patients with stents showed some degree of regression, with a higher percentage of complete regression in the SID-CA group than in the SID-SMA group (71.4% vs. 42.9%, respectively). Representative figures of complete and partial regression after endovascular stenting are shown in Fig. 1-4. The median follow-up period was 31.6 (0.41-118.9) months for the SID-CA group, and 22.6 (1.1-106.9) months for the SID-SMA group, and all patients reported symptomatic relief at their last follow-up. The median follow-up period in the patients with stents was longer (77.6 months for the SID-CA and 55.7 months for the SID-SMA groups), and all stents remained patent on CT during their last follow-up.

DISCUSSION

In this direct comparison of the clinical characteristics of SID-CA and SID-SMA, the basic demographic characteristics were not different between the two groups, except for a higher prevalence of smoking in patients with SID-SMA. The onset or location of initial abdominal pain was also similar; however, patients with SID-CA had severer pain, and the duration of pain was also longer, leading to a longer fasting time. A higher proportion of patients were treated conservatively in both groups, yet endovascular intervention was performed in up to 33.3% of patients with SID-CA and 17.5% of those with SID-SMA. On follow-up imaging, around 30% of patients managed conservatively had no regression of dissection in both SID-CA and SID-SMA, while in patients with stents, all cases showed either complete or partial regression. Of note, the median follow-up period was significantly longer in patients with stents, and patients with SID-CA had a higher rate of complete regression after stent insertion compared to those with SID-SMA.

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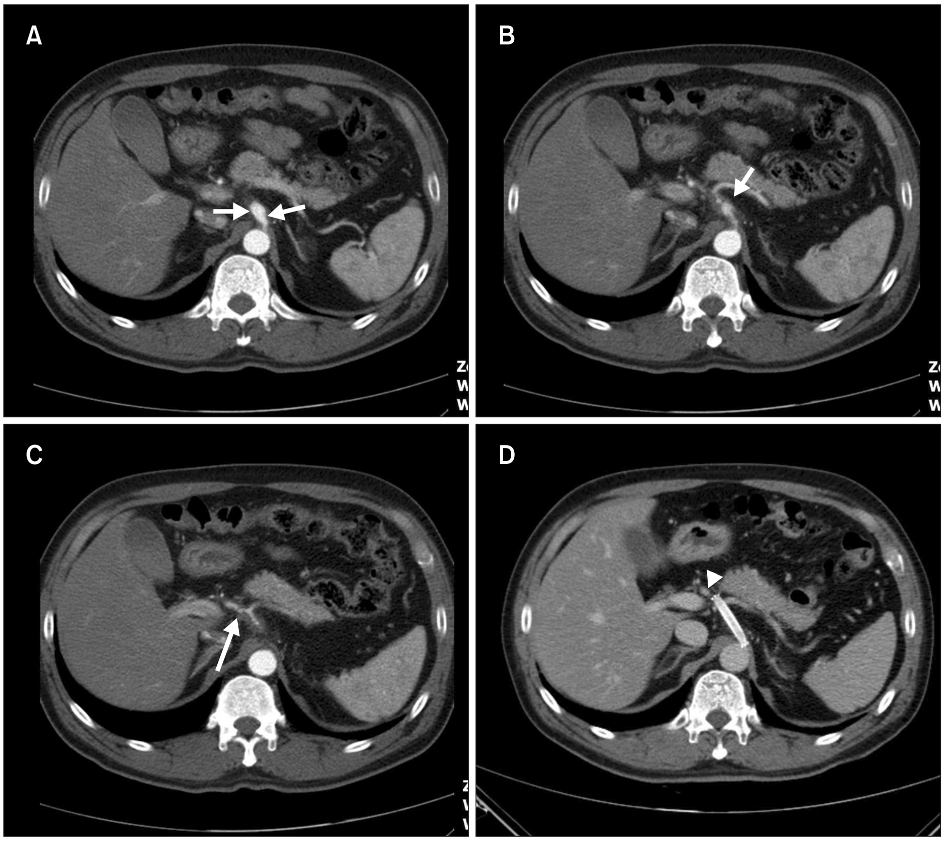

Fig. 1. Representative computed tomography (CT) images of complete regression after endovascular intervention for spontaneous isolated dissection of the celiac artery. CT images before intervention (A-C) and 33 months after intervention (D). White arrows, dissection; arrowhead, complete regression.

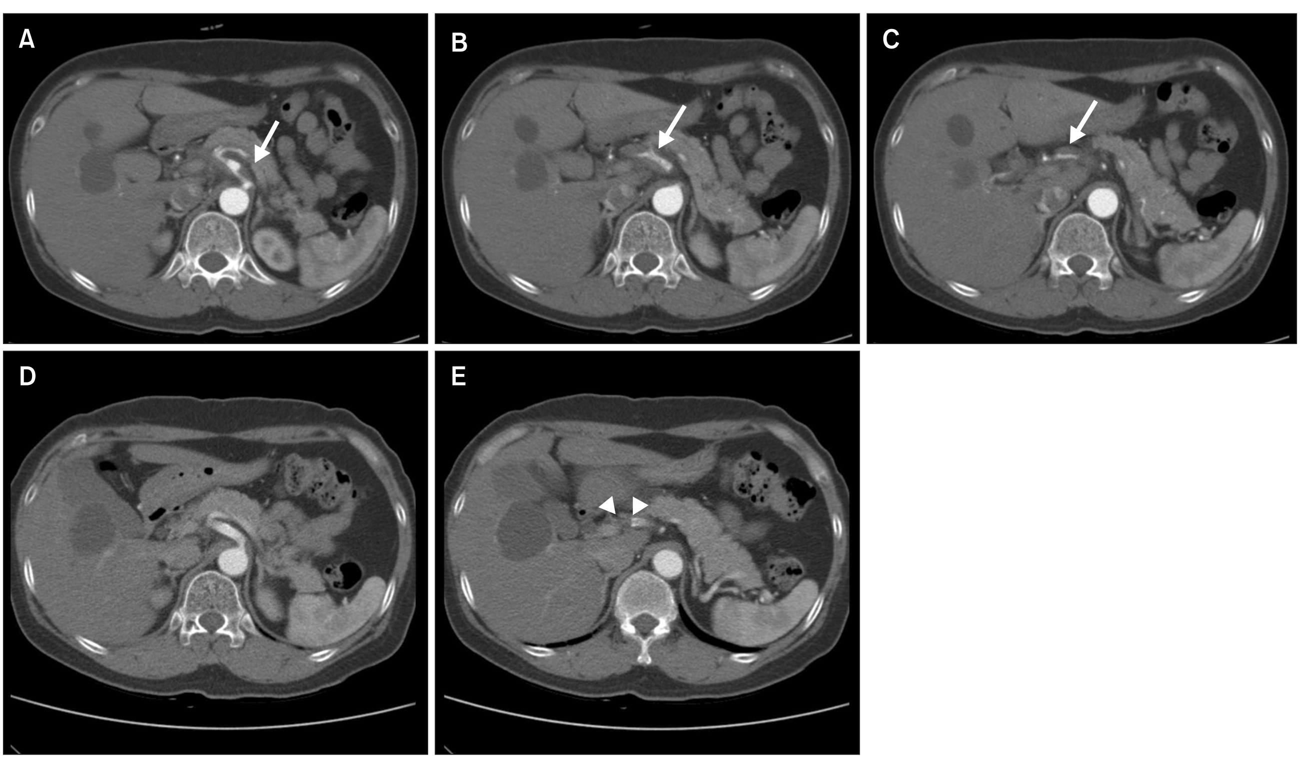

Fig. 2. Representative computed tomography (CT) images of partial regression after endovascular intervention for spontaneous isolated dissection of the celiac artery. CT images before intervention (A-C) and 24 months after intervention (D, E). White arrows, dissection; arrowhead, partial regression.

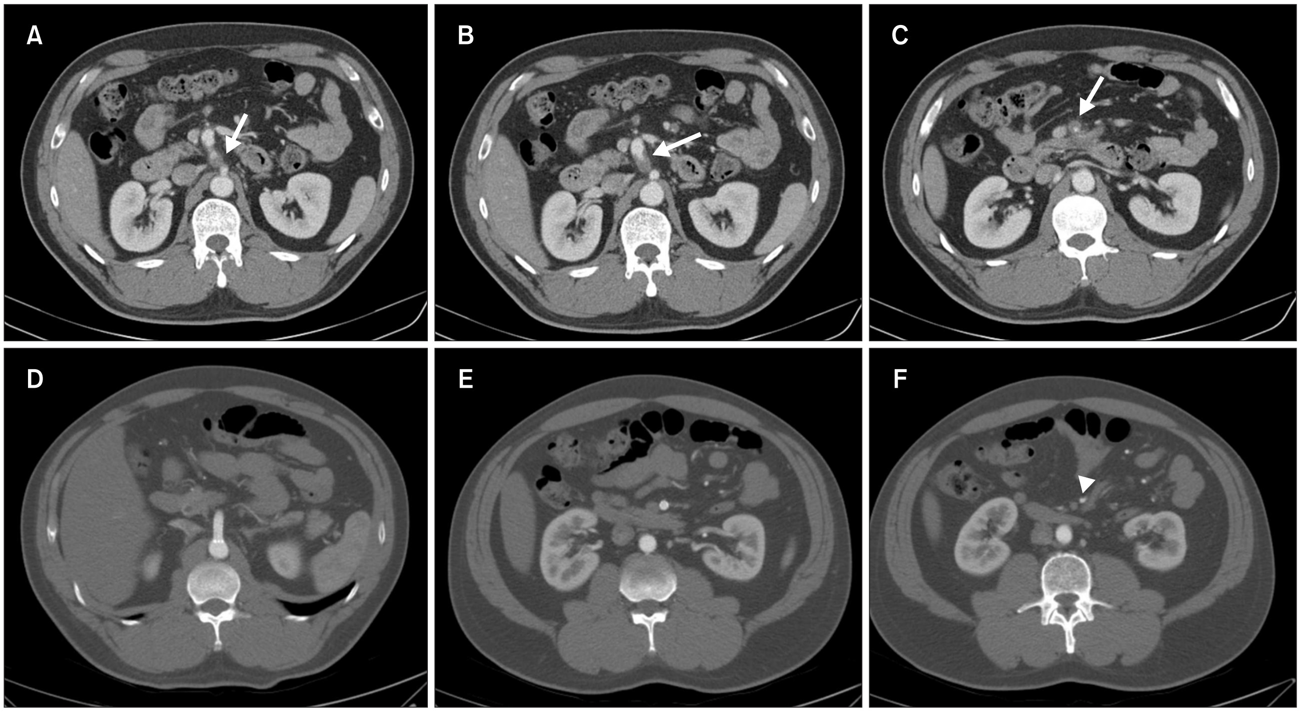

Fig. 3. Representative computed tomography (CT) images of complete regression after endovascular intervention for spontaneous isolated dissection of the superior mesenteric artery. CT images before intervention (A-C) and 12 months after intervention (D-F). White arrows, dissection; arrowhead, complete regression.

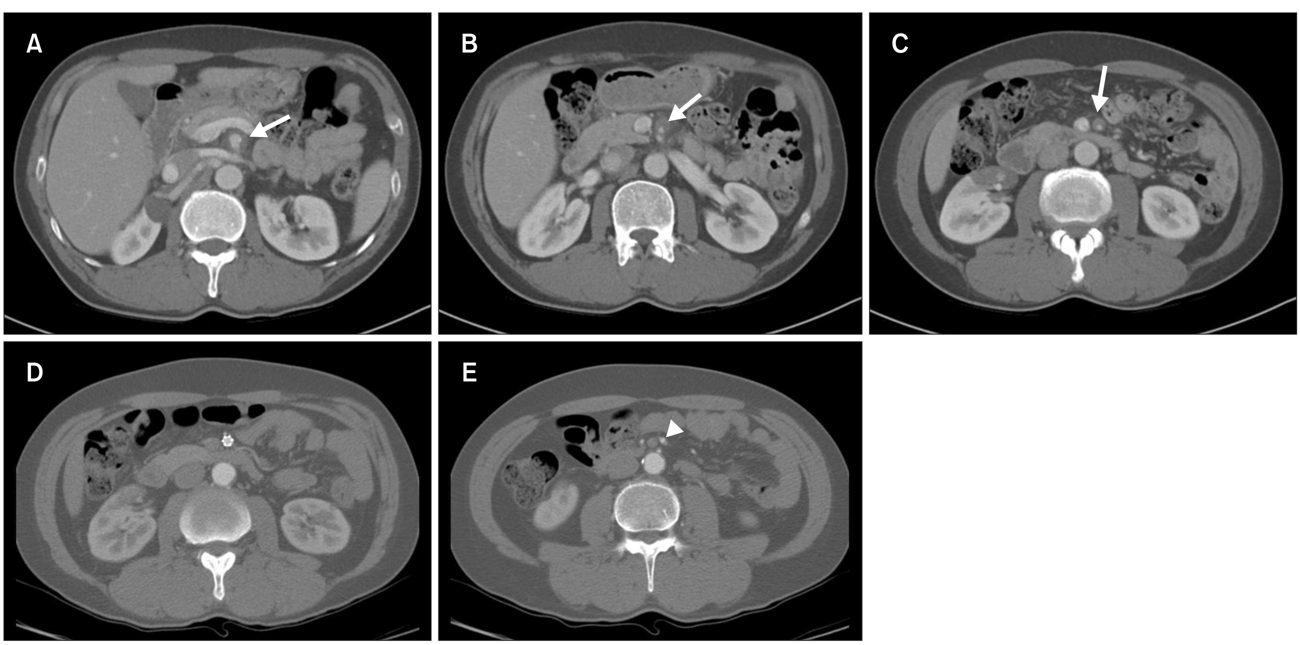

Fig. 4. Representative computed tomography (CT) images of partial regression after endovascular intervention for spontaneous isolated dissection of the superior mesenteric artery. CT images before intervention (A-C) and 3 months after intervention (D, E). White arrows, dissection; arrowhead, partial regression.

The best treatment option for SID-VA remains unknown. Most of the recent studies reporting the natural history of SID-VA have shown that conservative management is still the preferred option, and in many cases, the course is benign. We recently reported a series of patients with SID-CA, where we demonstrated that active endovascular interven-

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tion in patients with distal hypoperfusion showed good outcomes in the long-term with rapid resolution of symptoms [13]. In response to a letter to the editor of this previous report, we explained that one of our rationales for such active intervention was that from our clinical experience, patients with SID-CA tended to present with more severe abdominal pain and longer time was needed for pain relief [14]. The current study supports our clinical impression that patients with SID-CA show more severe abdominal pain and for a longer period of time compared to those with SID-SMA. This, in turn, leads to a longer fasting time and longer hospitalization. Endovascular intervention can allow for rapid resolution of pain, which translates to improved patient satisfaction and early return to daily activities. Stent patency was found to be excellent, without any stent occlusions, during a relatively long follow-up period (more than 6 years). Previous studies, including our own, showed that in some conservatively-managed patients, perfusion was maintained through collaterals with complete obliteration of the initially dissected artery; thereby, indicating that stenting allows for favorable remodeling [6]. This can lead to unfavorable outcomes, including recurrent abdominal pain, as shown by Heo et al. [11], where 20% of patients with SID-SMA initially managed conservatively showed recurrent abdominal pain. Stenting for SID-CA also showed higher rates of complete regression compared to SID-SMA (71.4% vs. 42.9%, respectively) despite the lesion length (and stent length) being similar between the two groups. In this respect, despite the many similarities between SID-CA and SID-SMA in terms of clinical presentation and progression, more active endovascular intervention for SID-CA may be warranted based on the more severe clinical manifestations and superior post-stenting outcomes. However, these advantages must be weighed against the drawbacks associated with endovascular intervention, mainly increased risk of periprocedural complications, longer use of antiplatelet medications, and increased radiation/contrast exposure associated with more active imaging surveillance. Fortunately, in our series, there were no periprocedural or antiplatelet medication-related complications.

The pathogenesis or risk factors associated with SID-VA are not well understood. In our comparison, we found that smoking was more frequent in patients with SID-SMA, yet it is unclear whether this has any clinical significance. Previous reports failed to show any correlation between smoking and SID-VA [6,7]. Additionally, there was no evidence of calcification or atherosclerotic changes in either group. We found that type III was the most prevalent form in both SID-CA and SID-SMA, but we did not find any positive correlation between the morphological type and clinical outcomes (data not shown) or pain severity. There are several theories about the etiology of SID-CA and SID-SMA. For SID-SMA, a previous study using fluid dynamics inferred that the abrupt curvature of the SMA after branching from the aorta, and the transition of the SMA from a fixed retropancreatic portion to a mobile segment are potential sites for dissection [15]. In contrast, the CA is adjacent to the median arcuate ligament, and the position of the ligament in relation to the celiac axis is known to have respiratory and positional variability. It has been previously reported that stenotic compression of the celiac axis by the median arcuate ligament can cause celiac axis dissection and formation of pancreaticoduodenal arcade aneurysms [16]. This is the reason why in clinical practice, the dissection starts closer to the ostium in the celiac artery, while for the SMA, it can be found to start in relatively more distal parts. Regarding the cause of pain related to dissection, it is unclear whether the pain results from the ischemia itself, since the end-organs involved in SID-VA, mainly the liver and the small bowel, have an abundant blood supply from collaterals. Additionally, the location of the pain in many cases is at the epigastric or periumbilical area and not at the site of organ ischemia. Therefore, there have been suggestions that pain may originate from the perivascular inflammation that arises from the dissection, which stimulates the surrounding nerves. This may explain the more severe pain in patients with SID-CA, since the celiac axis is surrounded by abundant nerve plexuses and ganglia. Conversely, SID-SMA tends to occur more distal to the ostium of the SMA, where the presence of nerves is relatively low.

This study has several limitations, including the retrospective nature of the study design and the small number of patients included in each group. However, SID-VA itself is a rare disease with a low incidence, and it is noteworthy that a direct comparison between SID-CA and SID-SMA has not been reported in the literature. This study has shown that there are some differences in the clinical manifestations between SID-CA and SID-SMA, which can aid in clinical decision-making for the treatment of patients with SID-VA. Further studies with larger number of cases are required to delineate the pathophysiology of SID-VA, and considering that most of the reports of SID-VA are from the Asian population, an Asian version of the Vascular Low Frequency Disease Consortium may be the next step.

CONCLUSION

Despite the similarities in the presentation of SID-CA and SID-SMA, this study showed that patients with SID-CA have more severe and longer-duration abdominal pain than those with SID-SMA. In selected cases of endovascular intervention, both SID-CA and SID-SMA showed favorable results in terms of good long-term patency and favorable remodeling, with a higher regression rate for SID-CA compared to that of SID-SMA after stenting. Although conservative management still plays a major role in the treatment of SID-VA, based on our results, patients with SID-CA may benefit more from active endovascular intervention, which can be taken into consideration when making clinical decisions.

SUPPLEMENTARY MATERIALS

Supplementary data can be found via https://doi.org/10.5758/vsi.200071.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

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AUTHOR CONTRIBUTIONS

Concept and design: JWK, HSP, TL. Analysis and interpretation: JWK, HSP, KLK. Data collection: JWK, KLK. Writing the article: JWK, HSP. Critical revision of the article: JWK, HSP, CSS, TL. Final approval of the article: JWK, HSP. Statistical analysis: JWK, KLK. Obtained funding: none. Overall responsibility: JWK, HSP, TL.

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