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【 CASE REPORT 】

Acalculous Ischemic Cholecystitis Caused by Spontaneous Celiac Artery Dissection

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Abstract:
We herein report a case of spontaneous isolated dissection of the celiac artery. A Japanese man in his 50s visited an emergency unit, complaining of sudden epigastralgia. Contrast-enhanced computed tomography indicated dissection of the celiac artery with patent false and true lumina, extending to the splenic and common hepatic arteries. On day 3 of hospitalization, the dissection progressed to the proper and right hepatic arteries. Progression of the dissection to the right hepatic artery provoked acalculous ischemic cholecystitis, and cholecystectomy followed. The resected gallbladder revealed extensive aseptic necrosis with little inflammatory reaction, and the gallbladder neck was spared from ischemia.

Key words: acalculous ischemic cholecystitis, spontaneous dissection of celiac artery, contrast-enhanced computed tomography

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Introduction

Spontaneous isolated dissection of the celiac artery (SIDCA) was first described by Bauersfeld in 1947 (1). Advances in diagnostic imaging modalities, such as the advent of ultrasound and contrast-enhanced computed tomography (CT), have greatly improved our recognition of SIDCA. However, there are no guidelines concerning the diagnosis or treatment of SIDCA, and no large-scale clinical trials have been performed.

SIDCA often occurs in middle-aged men with a history of smoking, hypertension and hyperlipidemia (2, 3). The major complaint is sudden abdominal pain without guarding or rigidity, but some patients remain asymptomatic. Elevated leukocyte counts and abnormal liver enzyme levels are commonly complicated (3). In a majority (80%) of cases, complete remission is reached with conservative treatment, including anti-hypertensive, anti-platelet and anti-coagulation therapy along with fasting and intravenous infusions (2, 3). Rupture and luminal obstruction of the celiac artery may provoke circulatory insufficiency, thereby necessitating surgical or endovascular treatments (3).

We herein report a middle-aged man with acalculous ischemic cholecystitis caused by SIDCA. The patient had a history of smoking, hypertension and hypercholesterolemia. Dissection of the celiac artery with patent false and true lumina extended to the splenic and common hepatic arteries. At the third day of hospitalization, dissection progressed to the proper and right hepatic arteries, and the occlusion of the right hepatic artery caused extensive ischemic necrosis of the gallbladder.

Case Report

A Japanese man in his 50s visited the emergency unit of Shimada Municipal Hospital, Shimada, Shizuoka, Japan, with a complaint of sudden epigastric pain, radiating to the

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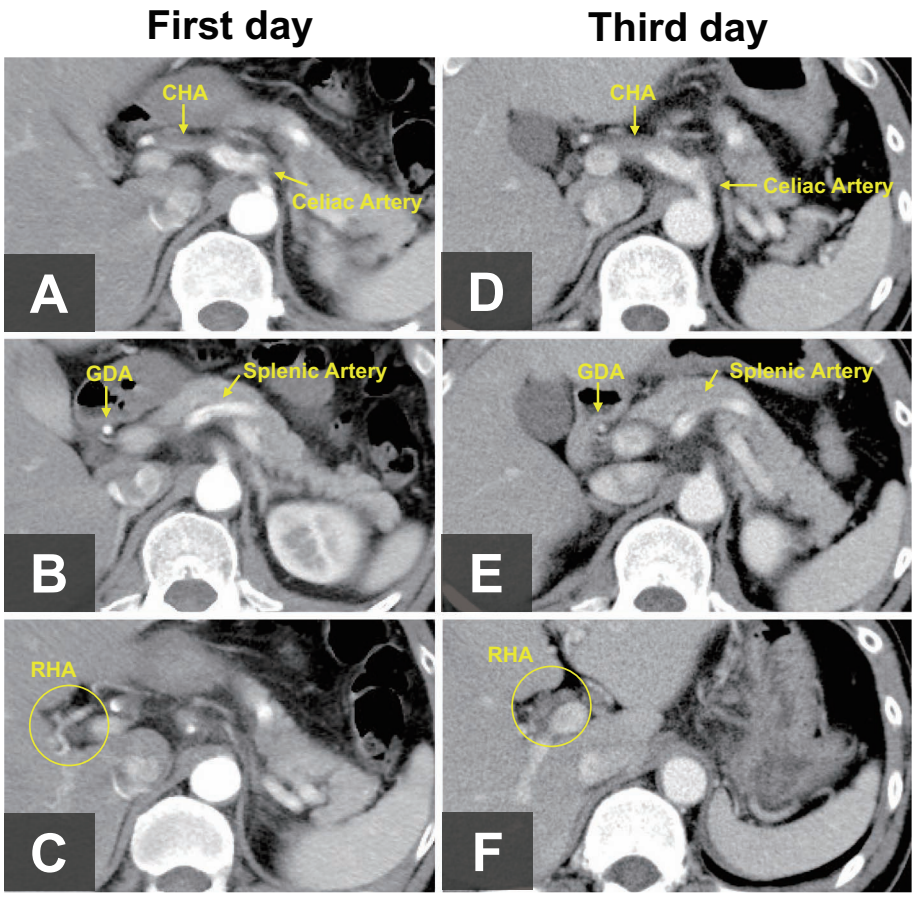

Figure 1. **Spontaneous isolated dissection of the celiac artery. A-C: The first day of hospitalization, D-F: the third day of hospitalization. A&D: Celiac artery and common hepatic artery (CHA), B&E: splenic artery and gastroduodenal artery (GDA), C&F: right hepatic artery (RHA). Contrast-enhanced CT shows dissection of the celiac artery without abdominal aortic dissection. The dissection extends to the common hepatic artery and splenic artery (A, B, D, E). The false lumen is patent, and the true lumen is not stenotic. Neither aneurysm formation nor rupture is observed. Enhancement effects of the spleen are maintained. Enhancement effects of RHA are observed on the first day of hospitalization (C, circle). The enhancement effects of RHA are lost on the third day of hospitalization (F, circle).**

left-sided back and lasting for 30 minutes. The pain happened while extending and stretching his back. He had a history of untreated hypertension and hypercholesterolemia. He had smoked 12 cigarettes/day for 18 years and drunken 1 cup of distilled spirits per day. His family history was unremarkable.

His body temperature was 37.2℃, blood pressure 135/91 mmHg, heart rate 76 beats per minute, respiratory rate 16 per minutes and oxygen saturation 95% while breathing ambient air. His weight was 62.0 kg with a body mass index of 21.2. No heart murmur was auscultated. The abdomen was soft with normal bowel sounds. There was tenderness on palpation on the epigastrium without guarding, rigidity or mass formation. The white blood cell count was elevated at 13,200/μL, and the C-reactive protein (CRP) level in the serum was elevated at 2.0 mg/dL, with D-dimer levels of 0.6 μg/dL. The calculated LDL cholesterol level was 158 mg/dL, HDL cholesterol was 64 mg/dL, and triglyceride level was 92 mg/dL. Other laboratory tests, including the levels of hepatobiliary enzymes, were within reference ranges.

An electrocardiogram showed a normal sinus rhythm with right axis deviation and no evidence of ischemia. The cardiothoracic ratio was 49%, and there was no pulmonary congestion on chest X-ray. Contrast-enhanced CT in the arterial phase indicated dissection of the celiac artery, expanding to the splenic and common hepatic arteries (Fig. 1A-C). Both the false and true lumina were patent, and effects of enhancement in the right hepatic and cholecystic arteries were observed (Fig. 1C, 2A). No abnormalities were noted in the aorta, liver, spleen or gallbladder (Fig. 1, 2). Based on the stable hemodynamics without ischemic changes in the abdominal organs, the patient was conservatively treated under strict blood pressure control, anti-coagulation therapy, fasting without water drinking and intravenous infusions.

Fasting was continued, and oral intake of water, including jelly beverages, was started on the third day of hospitalization without exacerbation of abdominal symptoms. Soon after drinking a jelly beverage, he complained of accelerated

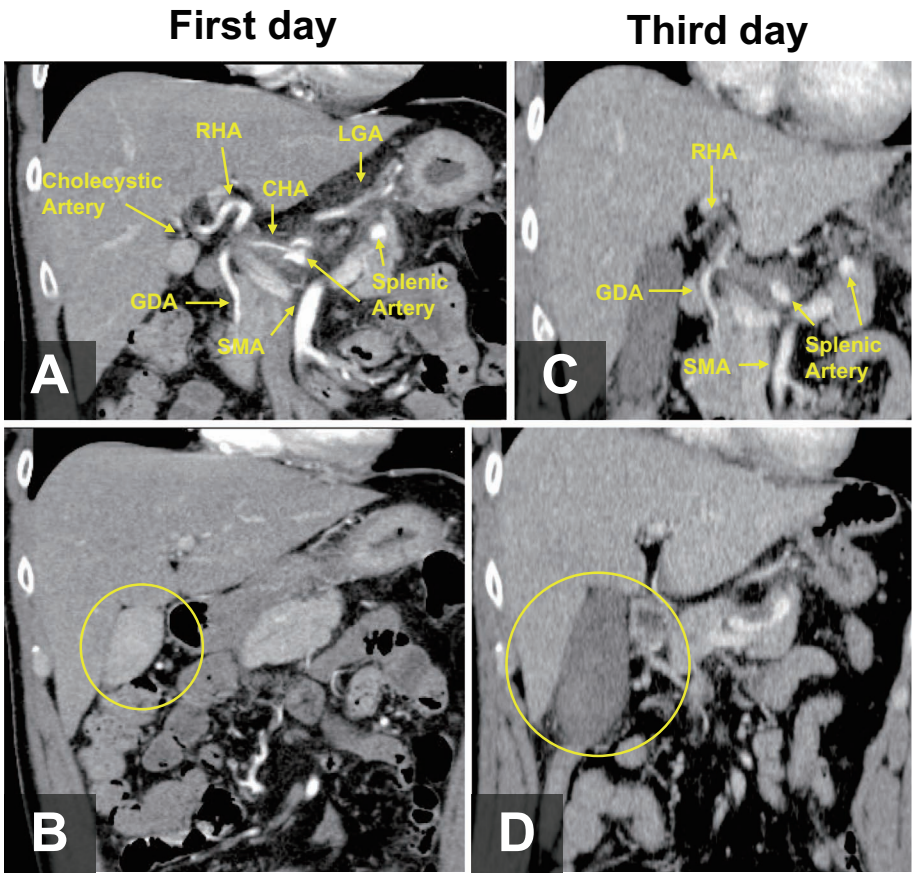

Figure 2. **Loss of enhancement effects of the right hepatic artery (RHA) and ischemic changes in the gallbladder on the third day of hospitalization. A&B: The first day of hospitalization, C&D: the third day of hospitalization, A&C: brunches of the celiac artery, left gastric artery (LGA) and superior mesenteric artery (SMA), B&D: The arterial phase of the gallbladder. A: The right hepatic artery (RHA) and cholecystic artery are patent on the first day of hospitalization. B: Enhancement effects of the gallbladder are maintained at the first day of hospitalization (circle). C: On the third day of hospitalization, when abdominal pain became exacerbated, contrast-enhanced CT shows the loss of the enhancement effects of the RHA. D: Dilatation of the gallbladder without enhancement effects of the cholecystic wall is observed by contrast-enhanced CT (circle).**

abdominal pain. There was tenderness at the epigastric and right subcostal regions with guarding and rigidity. The white blood cell count was elevated to 14,300/μL, and the serum CRP level had increased to 16.3 mg/dL, but the serum levels of hepatobiliary enzymes were not elevated. Contrast-enhanced CT showed that the dissection had progressed to the proper and right hepatic arteries in association with obstruction of the right hepatic artery, but neither aneurysm formation, rupture nor obstruction of the true lumen of the celiac, splenic and common hepatic arteries was seen (Fig. 1D-F, 2C). Dilatation of the gallbladder lumen was evident, and loss of enhancement effects of the gallbladder wall was noted (Fig. 2D). No gallstones were recognized.

Emergency laparoscopic cholecystectomy was performed under the diagnosis of acalculous ischemic cholecystitis. Grossly, the surgical material displayed extensive necrosis throughout the gallbladder wall (Fig. 3A). The neck region of the gallbladder remained intact without ischemic changes. Microscopically, the body of the gallbladder showed transmural ischemic necrosis without infiltration of inflammatory cells (Fig. 3B, C). The intact gallbladder neck region was clearly demarcated from the ischemic gallbladder body. No abnormality was noted in the mural arterial branches.

Abdominal pain disappeared five days after cholecystectomy. At the postoperative day 6, contrast-enhanced CT revealed that the dissection of the celiac, splenic and common hepatic artery remained stable, and the right hepatic artery was reopened (Fig. 4). The patient was discharged 16 days after cholecystectomy without complications. The patient has been followed up with anti-hypertensive medication. The celiac arterial dissection has not recurred for more than six years.

Discussion

We herein report a case of acalculous ischemic cholecystitis caused by SIDCA. Stimulated gastrointestinal motility and accelerated bile excretion facilitated by drinking a jelly

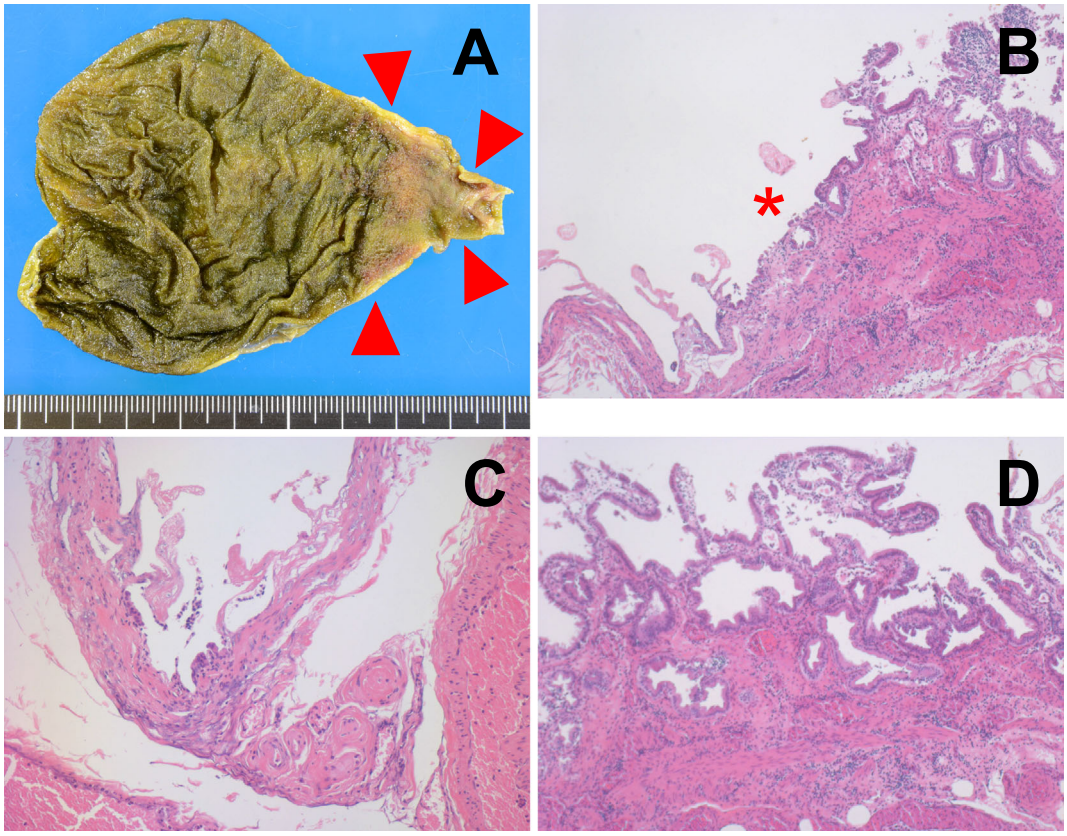

Figure 3. **Acalculous ischemic cholecystitis. A: Gross appearance, B-D: Hematoxylin and Eosin staining. A: Macroscopically, ischemic necrosis is extensively observed in the body of the gallbladder. There are no gallstones. The neck region of the gallbladder remains intact without ischemia (red arrowheads). B&C: Microscopically, the mucosa and submucosa reveal ischemic necrosis, while little inflammatory reaction is seen. The mucosa of the gallbladder neck remains intact histologically (B, asterisk and D).**

beverage on the third day of hospitalization might have induced increased oxygen consumption and intraluminal pressure of the gallbladder, provoking acalculous ischemic necrosis of the gallbladder. No gallstones were detected by contrast-enhanced CT or in the surgical specimen. Acalculous ischemic cholecystitis caused by SIDCA has been described in previous case reports (4). Acalculous ischemic cholecystitis has also been recorded in cases of acute aortic dissection (5-8). Acalculous cholecystitis is seen in 5%-14% of acute cholecystitis cases, while acute cholecystitis accompanies gallstones in around 90% of cases (9).

Acalculous cholecystitis may be caused by dysmotility of the gallbladder that increases the intracholecystic pressure to induce ischemia, inflammation and overgrowth of bacteria (10). Dysfunction of gallbladder contraction may result from diabetes mellitus, hypertension, heart failure, renal failure, vasculitis, embolism, acquired immunodeficiency syndrome, infection, surgery, trauma, burn and parental nutrition (10). The reduction in the blood supply from the celiac artery caused by median arcuate ligament syndrome and arteriosclerosis is insufficient for inducing ischemic changes in the abdominal organs, such as the stomach, pancreas, spleen, liver and gallbladder, due to the abundance of collateral blood flow (11-14). The pancreatic arcade anastomosing the gastroduodenal artery with the first jejunal artery is the most important blood supply for abdominal organs in cases of celiac arterial obstruction (12-14). In localized celiac artery dissection, the blood flow of the proper hepatic artery is maintained through the pancreatic arcade. The cholecystic artery, typically branching from the anterior right hepatic artery, comprises the main vessel feeding the gallbladder, which also receives numerous arterial twigs from the right hepatic artery via the gallbladder bed on the liver side (15). In the present case, the dissection of the celiac artery progressed to the right hepatic artery, hampering the blood supply to the cholecystic artery, which was not recovered through the pancreatic arcade system. Of note, the transmural ischemic changes in the body of the gallbladder showed a clear border with the normal-looking (non-ischemic) mucosa located at the neck of the gallbladder. The present findings indicate that the gallbladder neck had a collateral blood supply in the present case. The pattern of vascular supply to the biliary tract and neck region of the gallbladder reportedly show some degree of variation (16).

It has been suggested that a rapid increase in the arterial pressure after intense exercise may be a causative factor for SICDA, since SICDA occurred during weight-lifting or weight training in three cases (17-19). Mechanical stress

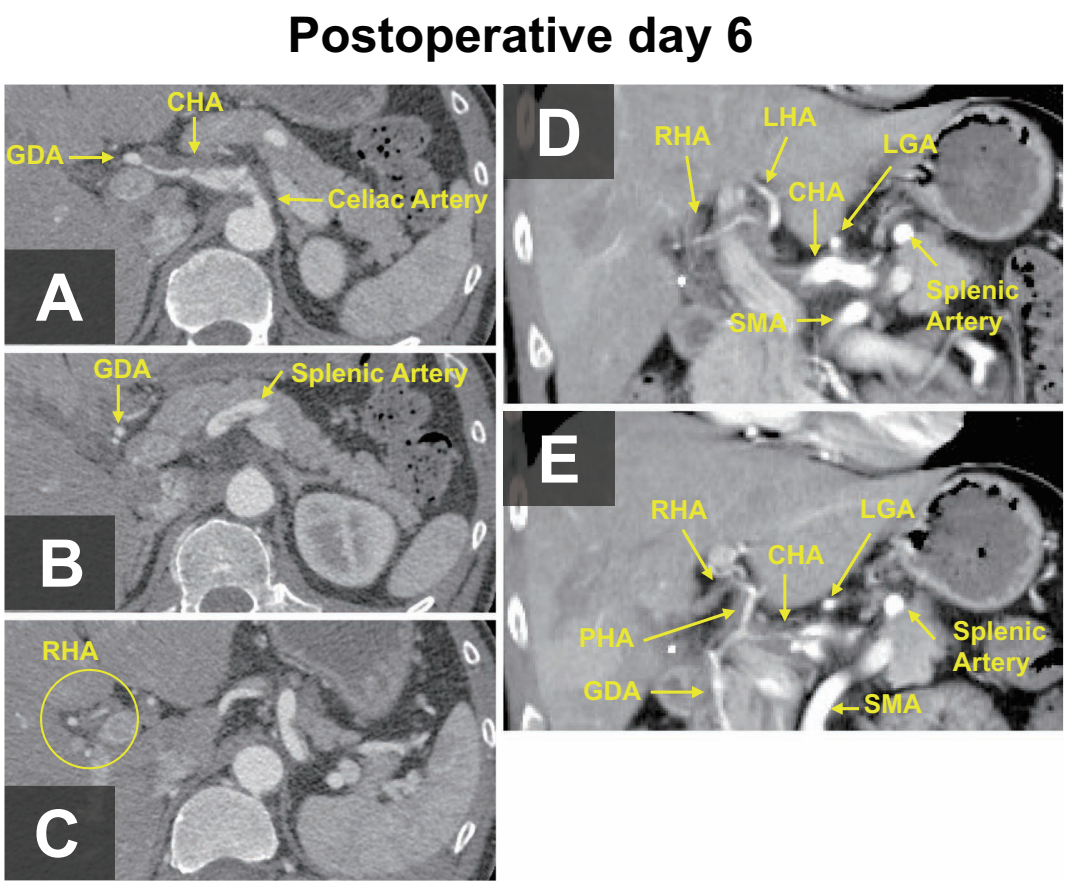

Figure 4. **Reopening of right hepatic artery (RHA) on postoperative day 6. A&B: The dissection of the celiac, splenic and common hepatic arteries remains stable on contrast-enhanced CT. C-E: Enhancement effects of RHA are observed. The proper hepatic artery (PHA), left hepatic artery (LHA), common hepatic artery (CHA), left gastric artery (LGA), gastroduodenal artery (GDA) and superior mesenteric artery (SMA) are enhanced.**

may cause dissection of the vertebral artery (20). In the present case, epigastric pain occurred during extending and stretching movements of the patient's back, which might have induced mechanical stress on the celiac artery, thereby provoking SICDA.

Causatively, SIDCA may be correlated with fibromuscular dysplasia, Marfan syndrome, Ehlers-Danlos syndrome, vasculitis syndrome, arteriosclerosis and pregnancy (21-23). Segmental arterial mediolysis (SAM) should also be considered as a potential cause of SICDA (22, 23). In 1976, Slavin and Gonzalez-Vitale (24) first reported three autopsy cases of SAM that had formed in the abdominal muscular arteries. The medial smooth muscle layer revealed segmental necrosis, typically causing intraabdominal hemorrhaging. In an animal model, α1 or β2 adrenergic agonists accelerated the release of noradrenaline from the sympathetic nerve, which induced the apoptosis of smooth muscle cells of the tunica media (25, 26). The outer arterial medial layer resulted in vacuolization and lysis, representative microscopic features of SAM. The most commonly affected vessels are the superior mesenteric (53%), hepatic (45%), celiac (36%), renal (26%) and splenic (25%) arteries, and SAM results in aneurysm formation (76%), dissection (61%) and arterial rupture (46%) (27). Risk factors for SAM include an older age, hypertension and smoking, all of which are common with SIDCA (3, 27). Uchiyama et al. (28) proposed clinical criteria of SMA, including a sudden onset of intraabdominal bleeding, middle to elderly patient age, a lack of vasculitis or arteriosclerosis and beading and narrowing signs on angiography. In the present case, a histopathological evaluation of the involved artery was not performed, so the possibility of celiac arterial dissection secondary to SAM cannot be excluded.

Abnormal serum levels of liver enzymes are reportedly seen in 25% (5/20) of patients with SICDA (3). In the present case, the hepatobiliary enzyme levels were within the reference ranges before and after acalculous ischemic cholecystitis. In the liver, 70% of the blood supply is maintained by the portal vein and 30% by the hepatic artery. The left and right hepatic arteries communicate with each other in the hilar plate (29). Occlusion of the right hepatic artery might have been rescued by the left hepatic artery in the present case.

Arterial dissection can be restricted to the celiac artery, or it may extend from the celiac artery to the splenic and/or proper hepatic arteries. Kim et al. (2) reviewed a total of

164 SIDCA patients and evaluated the risk of surgical treatments. Aneurysm formation and extended dissection to the arterial branches were associated with an increased risk of invasive treatment. In the present case, the dissection extended to the splenic and common hepatic arteries, thereby assigning the patient a greater risk of invasive surgery.

Conservative treatments are sufficient to manage SICDA in most cases (2, 3), but careful monitoring of the dissection of the celiac artery is necessary, as gastrointestinal motility induced by oral intake might accelerate the extended dissection to the right hepatic artery, thus causing acalculous ischemic cholecystitis. Further studies are needed to clarify the pathological mechanisms and therapeutic strategies of SIDCA.

The authors state that they have no Conflict of Interest (COI).

References

1. Bauersfeld SR. Dissecting aneurysm of the aorta; a presentation of 15 cases and a review of the recent literature. Ann Intern Med **26**: 873-889, 1947.

2. Kim B, Lee BS, Kwak HK, Kang H, Ahn JH. Natural course and outcomes of spontaneous isolated celiac artery dissection according to morphological findings on computed tomography angiography: STROBE compliant article. Medicine (Baltimore) **97**: e9705, 2018.

3. Tanaka H, Miwa T, Fukuoka T, Oshima K, Kimura Y, Nakao A. A case of isolated spontaneous celiac artery dissecton. J Jpn Surg Assoc **74**: 2406-2411, 2013.

4. Inomata Y, Sato Y, Iwabuchi T, et al. A case of emergency surgery for acalculous gangrenous cholecystitis due to celiac artery dissection. Nihon Shokakibyo Gakkai Zasshi (Jpn J Gastroenterol) **116**: 428-433, 2019 (in Japanese with English abstract).

5. Nemoto M, Hosaka A, Takayama Y, Yoshimi F. Acute type B aortic dissection associated with acute pancreatitis, pancreatic pseudocysts, and acalculous cholecystitis. Ann Vasc Dis **12**: 392-394, 2019.

6. Inagaki FF, Hara Y, Kamei M, Tanaka M, Yasuno M. Acute and chronic acalculous cholecystitis associated with aortic dissection. J Surg Case Rep **8**: rjv101, 2015.

7. Söğütlü G, Işik B, Yilmaz M, et al. Acute acalculous cholecystitis induced by aortic dissection: report of a case. Ulusal Travma Acil Cerrahi Derg **16**: 283-285, 2010.

8. Roth T, Mainguene C, Boiselle JC. Acute acalculous cholecystitis associated with aortic dissection: report of a case. Surg Today **33**: 633-635, 2003.

9. Indar AA, Beckingham IJ. Acute cholecystitis. Br Med J **325**: 639-643, 2002.

10. Balmadrid B. Recent advances in management of acalculous cholecystitis. F1000Research **7**: F1000 Faculty Rev 1660, 2018.

11. Charnsangavej C, Chuang VP, Wallace S, Soo CS, Bowers T. Angiographic classification of hepatic arterial collaterals. Radiology **144**: 485-494, 1982.

12. Mulder DS, Rubush J, Lawrence MS, Ehrenhaft JL. Celiac axis compression syndrome. Can J Surg **14**: 122-126, 1971.

13. Harjola PT. A rare obstruction of celiac artery. Ann Chir et Gynaecol Fenn **52**: 547-550, 1963.

14. Brandt LJ, Boley SJ. Celiac axis compression syndrome. A critical review. Am J Dig Dis **23**: 633-640, 1978.

15. Ellis H. Anatomy of the gallbladder and bile ducts. Surgery (Oxford) **29**: 593-596, 2011.

16. Ramesh Babu CS, Sharma M. Biliary tract anatomy and its relationship with venous drainage. J Clin Exp Hepatol **4**: S18-S26, 2014.

17. Zhang WW, Killeen JD, Chiriano J, Bianchi C, Teruya TH, Abou-Zamzam AM. Management of symptomatic spontaneous isolated visceral artery dissection: is emergent intervention mandatory? Ann Vasc Surg **23**: 90-94, 2009.

18. Riles TS, Lin JC. Celiac artery dissection from heavy weight lifting. J Vasc Surg **53**: 1714-1715, 2011.

19. González W, Altieri PI, Alvarado E, et al. Celiac trunk and branches dissection due to energy drink consumption and heavy resistance exercise: case report and review of literature. Bol Aso Med P R **107**: 38-40, 2015.

20. Park KW, Park JS, Hwang SC, Im SB, Shin WH, Kim BT. Vertebral artery dissection: natural history, clinical features and therapeutic considerations. J Korean Neurosurg Soc **44**: 109-115, 2008.

21. Zeebregts CJ, Schepens MA, Hameeteman TM, Morshuis WJ, de la Riviere AB. Acute aortic dissection complicating pregnancy. Ann Thorac Surg **64**: 1345-1348, 1997.

22. Hosaka A, Nemoto M, Miyata T. Outcomes of conservative management of spontaneous celiac artery dissection. J Vasc Surg **65**: 760-765, 2017.

23. Glehen O, Feugier P, Aleksic Y, Delannoy P, Chevalier JM. Spontaneous dissection of the celiac artery. Ann Vasc Surg **15**: 687-692, 2001.

24. Slavin RE, Gonzalez-Vitale JC. Segmental mediolytic arteritis: a clinical pathologic study. Lab Invest **35**: 23-29, 1976.

25. Slavin RE. Segmental arterial mediolysis: a clinical-pathologic review, its role in fibromuscular dysplasia and description and differential diagnosis of the masquerader-muscular artery cystic necrosis. World J Cardiovasc Dis **3**: 64-81, 2013.

26. Slavin RE, Leifsson PS. Segmental arterial mediolysis with mesangial cell hyperplasia; a review with supplementary comments concerning its pathogenesis. Interv Cardiol **9**: 181-190, 2017.

27. Skeik N, Olson SL, Hari G, Pavia ML. Segmental arterial mediolysis (SAM): systematic review and analysis of 143 cases. Vasc Med (London, England) **24**: 549-563, 2019.

28. Uchiyama D, Koganemaru M, Abe T, et al. A case of successful transcatheter arterial embolization for intraabdominal hemorrhage due to suspected segmental mediolytic arteriopathy. Jpn J Interv Radiol **20**: 278-281, 2005.

29. Tohma T, Cho A, Okazumi S, et al. Communicating arcade between the right and left hepatic arteries: evaluation with CT and angiography during temporary balloon occlusion of the right or left hepatic artery. Radiology **237**: 361-365, 2005.