Heliyon

Received:
7 January 2019
Revised:
7 February 2019
Accepted:
12 March 2019

Cite as: Jiale Ou, Hongyao Hu, Zhenzhong Wu, Hui Zhao, Chang Wang, Min Rao, Zhong Li, Jianwei Liu. A modified endovascular technique for treating spontaneous isolated superior mesenteric artery dissection and the early to medium-term outcomes. Heliyon 5 (2019) e01354. doi: 10.1016/j.heliyon.2019.e01354

A modified endovascular technique for treating spontaneous isolated superior mesenteric artery dissection and the early to medium-term outcomes

Jiale Ou*, **Hongyao Hu, Zhenzhong Wu, Hui Zhao, Chang Wang, Min Rao, Zhong Li, Jianwei Liu**

Division of Interventional Radiology, Department of Radiology, Renmin Hospital of Wuhan University, Wuhan, 430000, China

* Corresponding author.

E-mail address: eason.jiale.ou@gmail.com (J. Ou).

Abstract

Purpose: The spontaneous isolated dissection of superior mesenteric artery (SIDSMA) is a rare medical condition and the treatment remains controversial. This study is to present our refined technique with a Flexor introducer to facilitate stent advancement and its early to medium-term outcomes.
Methods: A total of 16 patients diagnosed with SIDSMA and repaired with endovascular stenting from January 2012 to December 2017 were retrospectively identified. All patients were male, and the average age was 56 years old (range from 48 to 72 years old). Diagnosis was preoperatively confirmed using computed tomography angiography and their morphologic features were measured. A long Flexor introducer was delivered to the true lumen of dissected superior mesenteric artery prior to coaxially advancing a stent. Patient

https://doi.org/10.1016/j.heliyon.2019.e01354

demographics, endovascular procedures and postoperative outcomes were collected for analysis.

Results: Total technical success was 87.5%. Endovascular attempt was unsuccessful in two patients with extensive thrombus, and the guidewire failed to pass through the true lumen. The remaining 14 SMA dissections were successfully repaired with the modified method. Four patients were repaired using bare stents and 10 with covered stents. The average operative duration was 44 ± 18 minutes. Abdominal pain was relieved postoperatively in all cases except one patient with no identified reasons. The median follow-up duration was 17 months (2−63 months). No procedure- or dissection-related symptoms was present during follow up, and postoperative computed tomography angiography showed all stented SMAs were patent.

Conclusions: Coaxial delivery of stents within the introducer can yield high technical success and good clinical outcomes in early to medium term. Extensive thrombus inside SIDSMA is the exclusive cause for endovascular failure with this technique.

Keyword: Surgery

1. Introduction

The spontaneous isolated dissection of superior mesenteric artery (SIDSMA) is a rare condition, previously estimated with the incidence of 60/100,000 per year [1]. However, with advanced imaging technique and better learning curve, the SIDSMA has been increasingly recognised and its classification and management have been described [2, 3, 4]. The incidence may not be as rare as previously reported, in particular in Asian population [5].

Current strategies for managing SIDSMAs include conservative observation with or without anticoagulant, endovascular access and surgical repair. Certain treatment algorithms have also been advocated [3, 6]. Increasing studies have suggested non-invasive therapies with or without anti-coagulant should be first considered [2, 3] as most SIDSMAs may progress with good prognoses, both clinically and morphologically [7]. However, clinical and morphologic courses have not been fully investigated due to limited cases. Furthermore, this disease may carry catastrophic potentials, such as arterial rupture and bowel infarction [8, 9, 10]. In this regard, there should be immediate options available to prevent severe consequences. Endovascular stenting, regarded as less invasive than open surgeries, has been a preferred solution.

There is no standard technique for treating SIDSMAs yet. Femoral access is routinely used. However, the delivery system sometimes is difficult to pass through the sharp angle between the arota and superior mesenteric artery (SMA), which

https://doi.org/10.1016/j.heliyon.2019.e01354

requires an extra access such as left brachial approach. Our study is to present a refined technique with the Flexor inducer to facilitate delivering a stent coaxially to the precise position, as well as early and medium-term outcomes with this technique.

2. Methods

2.1. Patients

This study was approved by the Ethics Committee of Renmin Hospital of Wuhan University and consents were obtained from patients. A total of consecutive 28 patients diagnosed with SMA dissection were retrospectively identified from our hospital electronic data pool between January 2012 and December 2017. The inclusion criteria for endovascular stenting included rupture or peritonitis, aneurysmal dissection, suspected bowel ischemia and constant abdominal pain lasting over five days with true lumen (TL) compression rate >50%. Those with trauma and aortic dissection were excluded. In this study, 16 patients met the criteria and received endovascular treatment. Of these 16 patients, the average age was 56 ± 7 years old (rang from 48 to 72 years), and all of them were male.

2.2. Imaging and classification

Computed tomography angiography (CTA) was performed in all patients prior to endovascular repair. CTA images were reconstructed and analyzed on the advanced processing platform (Advantage Windows Workstation, Version 4.6 with CardIQ Software, GE Healthcare, USA). Other findings, such as free peritoneal air, abdominal effusion or ascites and hematoma were excluded on CT scan. The morphologic features, including the location and length of dissection, and the compression or occlusion of the true lumen, were evaluated. In our study, the location was defined as the length from the SMA origin to the dissection entry. We defined the compression percentage as the ratio between diameter of the TL at the site of maximal stenosis and the proximal diameter of the SMA. Aneurysmal dilatation was defined as 50% enlargement of the SMA lumen compared with its corresponding normal caliber of the SMA [11]. The measurements were performed by two physicians using the centerline technique (Fig. 1).

We used Yun's classification [2] to classify the SIDSMAs into the following groups (Fig. 2): TypeⅠ, patent true and false lumen revealing entry and re-entry sites; Type Ⅱ, patent true lumen but no re-entry flow from the false lumen; Type Ⅱa, visible false lumen but not visible re-entry site; Type Ⅱb, not visible false luminal flow (thrombosed false lumen) which usually causes true lumen narrowing; Type Ⅲ, SMA dissection with occlusion of SMA.

https://doi.org/10.1016/j.heliyon.2019.e01354

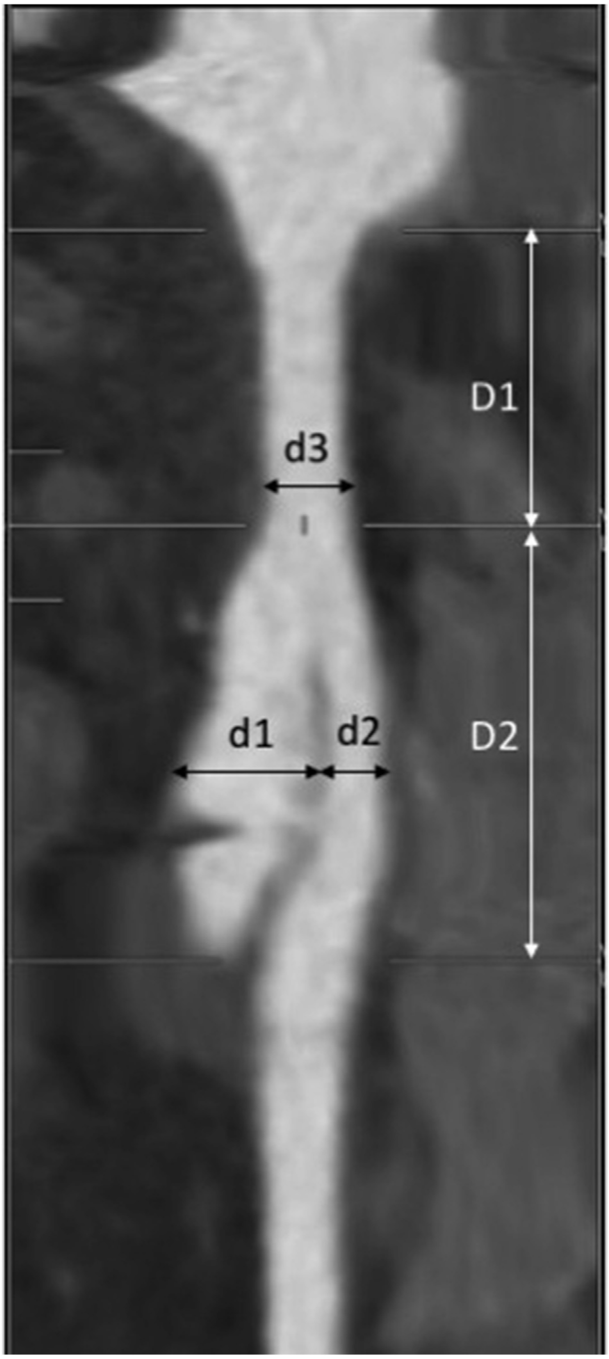

Fig. 1. Measurements of SIDSMA. D1: distance from entry site of dissection to SMA orifice; D2: dissection length; d1: diameter of false lumen (FL); d2: diameter of true lumen (TL); d3: normal SMA diameter. Aneurysmal dissection/dilatation: when ((d1+d2)/d3-1)*100% > 50%; compression rate: (1-d2/d3) *100%.

https://doi.org/10.1016/j.heliyon.2019.e01354

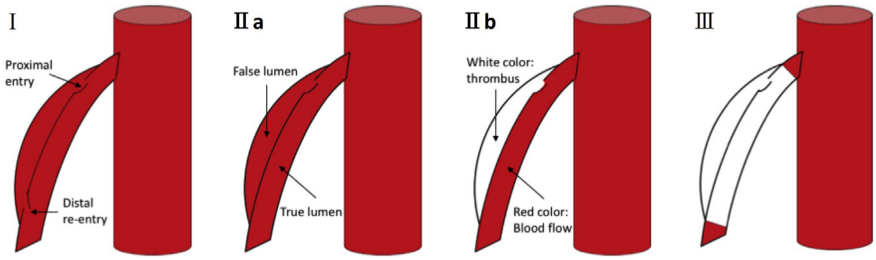

Fig. 2. Classification of spontaneous isolated dissection of superior mesenteric artery: type I, IIa, IIb, and III

2.3. Endovascular procedure

All patients received endovascular stenting under an angiographic suite with a fixed digital substraction angiography (DSA) platform (Artis Zee, Siemens, Muenchen, Germany). The endovascular repair was performed by the same interventional team under local anaesthesia. The right femoral artery was routinely accessed. After a 5F sheath was inserted into the right femoral artery, a bolus of 5000U heparin was administered. A pigtail catheter was advanced to above the celiac trunk to have a general DSA imaging of the abdominal aorta and its visceral branches as to detect potential collateral perfusion into the SMA. Meanwhile, DSA imaging of celiac trunk was routinely obtained to evaluate the gastroduodenal artery (GDA). The catheter was then exchanged to Cobra (C2, Cook, Bloomington, In., USA), or Yashiro catheter (Yashiro type, Terumo Co., Tokyo, Japan) to selectively perform the SMA angiography.

The nature of the lesion, the distal blood supply and the collateral perfusion were evaluated on the DSA imaging. The stent size and length were determined based on the measurement of the diameter of normal SMA and the length of the lesion. A 7 or 8F sheath was then exchanged. With the Cobra or Yashiro catheter in situ, a 0.035" guidewire or stiff guidewire (Radifocus, Terumo Co., Tokyo, Japan; or Amplatz Super Stiff, Boston Scientific, Heredia, COSTA RICA) was delivered to distal SMA true lumen, bypassing the primary dissection entry. If the true lumen was completely occluded or nearly compressed by the false lumen causing the guidewire unable to be advanced into the distal true lumen, the plan was converted to conservative management. With the guidewire in situ, a 7F or 8F introducer (Flexor, Cook Medical, Bloomington, In., USA) was advanced along the stiff guidewire into distal SMA true lumen. Subsequently, a stent was coaxially delivered within the introducer, and then deployed after the introducer was retrieved backward to the proximal SMA or orifice (Fig. 3).

Completion angiography was performed to evaluate the patency of the stented SMA as well as the distal blood supply. Technical success indicated accurate deployment of the stent at the planned position without any procedural complications. Operative duration was the period between the aortic artery angiography and the completion

https://doi.org/10.1016/j.heliyon.2019.e01354

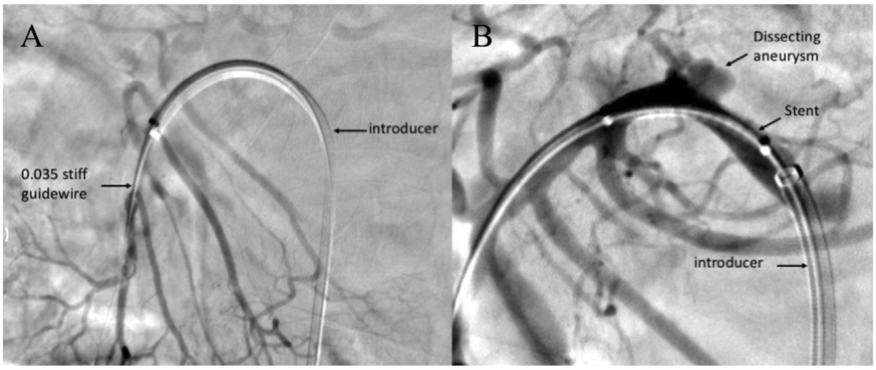

Fig. 3. A: an introducer delivered passing though the dissected SMA to distal TL; B: a stent deployed and the introducer retrieved backward.

angiography. After the endovascular treatment, antiplatelet therapy (aspirin and clopidogrel) was administered and continued for 6−12 months.

2.4. Follow-up protocol

Postoperative follow up was conducted at 1, 6, and 12 months, and yearly thereafter. Clinical presentations, such as pain relief or recurrence, gastrointestinal bleeding or any other complications were recorded. All patients received CTA review within 6 months after discharge or when clinically necessary. Imaging features, including stent patency, stent stenosis or occlusion, and false lumen patency, were evaluated as well.

3. Results

The demographics of 16 patients receiving endovascular repair were shown in Table 1. There were 50% of them with hypertension, 46.9% with hypercholesterolemia, and 43.8% with smoking. Fourteen patients presented with abdominal pain (including two with hematochezia), and two with back pain. Severity of pain was graded from 0 to 10 using a visual analogue scale.

Of the 16 patients attempted with endovascular treatment, six patients had aneurysmal dilation with morphologic concerns, and 10 cases suffered non-decreasing symptoms over 5 days with compression rate >50%. Based on Yun's classification of SIDSMA, 62.5% patients (n = 10) were categorized into type IIa, 25% (n = 4) were type IIb, and 12.5% (n = 2) were type III (Table 2). The distance from the entry site to the SMA orifice was 23.8 ± 7.4 mm, and the average length of the dissection was 26.1 ± 13.3 mm. One patient with typeIIb SMA dissection also had a 22 mm-diameter pseudoaneurysm in the right colic artery. Coils (MicroNester, Cook Co., Bloomington, Indiana, USA) were used to embolize the pseudoaneurysm prior to repair of the SMA dissection.

https://doi.org/10.1016/j.heliyon.2019.e01354

Table 1. Patient demographic and clinical features.

Features (n = 16)	No. (%)
Mean age (range) (years)	56 ± 7 (48−72)
Gender, male (%)	16 (100%)
Initial presentations	
Pain	
Abdominal pain	14 (87.5%)
Back pain	2 (12.5%)
Concurrent symptoms	
Vomiting	4 (25.0%)
Bloody stool	2 (12.5%)
Other medical conditions	
Smoking	7 (43.8%)
Hypertension	8 (50.0%)
Diabetes mellitus	3 (18.6%)
Hypercholesterolemia	6 (46.9%)
Ischemic heart disease	2 (12.5%)

There was no surgical conversion and the overall technical success was 87.5%. Two unsuccessful type Ⅲ cases were attributed to the extensive thrombus inside the true lumen of the dissected SMA and the guidewire failed to cross the occluded lesion. The treatment was converted to conservative observation with anticoagulant therapy. Abdominal pain was improved gradually before discharge in 7 days and 12 days respectively. CTA or DSA imagings were repeated and reviewed prior to discharge. Remodeling in one type III dissection with conversion to typeⅡb was identified (Fig. 4) in CTA in 5 days, while the other had the dissection flap developing into distal SMA trunk. However, the pain was significantly improved in 7 days and completely resolved in a month during follow-up.

Table 2. Morphologic features of SMA pathologies.

Features (n = 13)	n (%), or mm
Dissection	16
Type I	0 (0%)
Type IIa	10 (62.5%)
Type IIb	4 (25.0%)
Type III	2 (12.5%)
Entry site to SMA orifice	23.8 ± 7.4
Dissection length	26.1 ± 13.3
Compression rate	72% (56−100%)

https://doi.org/10.1016/j.heliyon.2019.e01354

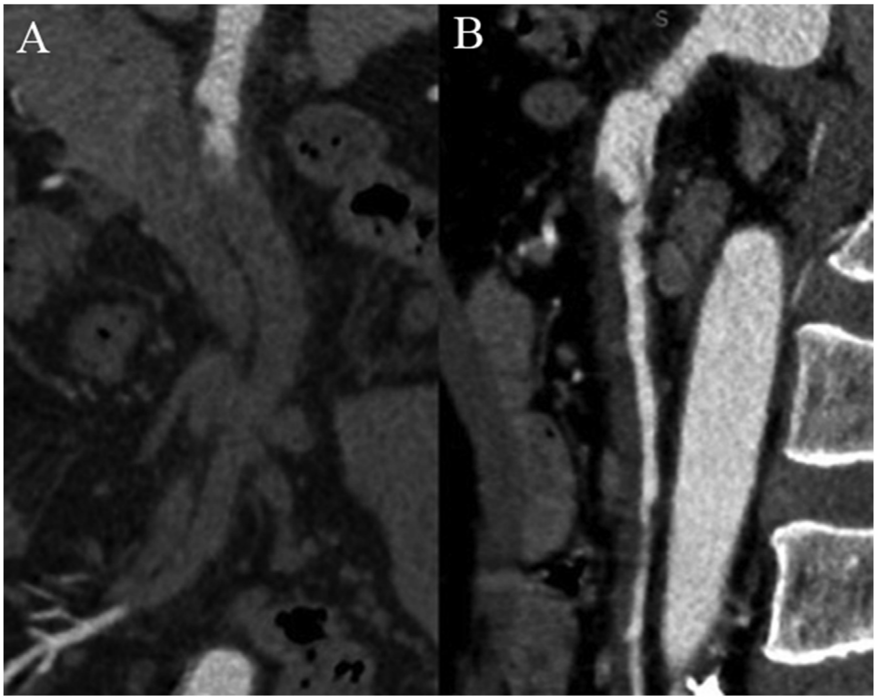

Fig. 4. Conversion of Type III SMA dissection (A) to type IIb dissection (B) after conservative treatment.

Of the 14 cases, the average operative duration was 44 ± 18 minutes. All dissections were isolated with either bare stents (Protégé EverFlex, ev3, MN, USA (n = 4)) or covered stents (Jostent, Abbott Vascular, Abbott Park, Illinois, USA (n = 2); Fluency, Bard, AZ, USA (n = 1); Viabahn, W.L.Gore, Flagstaff, Arizona, USA (n = 7)). The choice of stent types was determined according to physicians' preference, stent availability and the morphology or classification of SMA dissection. Completion angiography revealed patency of all stented SMAs and complete isolation of false lumens.

One patient presented with severe abdominal pain and consequent neurogenic shock in three hours after stenting. Urgent DSA confirmed patency of the stented SMA, and following abdominal CT scan excluded critical complications, such as ascites, intestinal perforation, and obvious ischemia. Conservative managements including anti-hypotension, analgesia, anticoagulant, and intensive care monitoring for one day were applied. The pain was improved gradually and completely disappeared in one week.

The median follow-up duration was 17 months (2−63 months). Two patients were lost during follow up after one year. During follow up, no dissection or procedure-related symptoms was reported. One patient with repeated abdominal pain in 2 months was scanned with CTA and the stented SMA was confirmed patent. Other abdominal CTAs were performed within six months showing patency of all stented SMAs.

https://doi.org/10.1016/j.heliyon.2019.e01354

4. Discussion

We presented a potentially better solution than using routine guiding sheath to coaxially deliver a stent into the dissected SMA. This solution is achieved by deploying a Flexor introducer into the distal true lumen prior to stent delivery. This relatively flexible sheath could be advanced through the vault-shaped SMA without difficulty, and serve as a "tunnel" to protect the fragile dissection while delivering a relatively stiffer stent. All endovascular stents were successfully deployed in our study provided the guidewire was in position. Two unsuccessful type III cases were attributed to the failure of passing the guidewire through the occluded lesion due to extensive thrombus. This was also the major preclusion for endovascular stenting in Dong et al.'s study [12].

In terms of managing SIDSMAs, current strategies include conservative observation with or without anticoagulants, endovascular stenting and surgical repair. Increasing reports have shown a good clinical and morphological prognosis treated with conservative management, with or without anticoagulants [10, 13, 14, 15]. Moreover, recent studies have revealed that some SIDSMAs could achieve complete remodelling in symptomatic patients [10, 16], regardless of the compression rate. In this regard, conservative observation is recommended as the first choice, even with the abdominal pain and tenderness. In our study, all symptomatic patients were initially treated conservatively, unless there was morphologic concern, such as aneurysmal dilation. Urgent surgery may be regarded as the last resort, which is indicated for the presence of bowel infarction [17, 18]. However, no surgical repair was required in our centre and there has been no SIDSMA-related decease reported.

Endovascular stenting has been recommended for those with >80% compression of true lumen, or >2.0 cm aneurysm or suspected bowel ischemia [19]. In our study, the TL compression rate was less stringent. Those with consistent symptoms over 5 days despite conservative treatment were considered suitable candidates. Likewise, aneurysmal dissection, or suspected bowel infarction were regarded as endovascular candidates in our study, which was in agreement with Kimura et al.'s study [16]. Our study demonstrated good early and medium-term outcomes of treating SIDSMAs with endovascular stenting and this less invasive procedure could also shorten the fasting time and length of stay [19, 20]. Therefore, endovascular stenting would be a safe and preferred alternative compared to surgical repair.

Two unsuccessful type III cases in our cohort of study were converted to conservative management and the symptoms were clinically improved, despite morphologic exacerbation in one patient. However, another occluded SIDSMA achieved partial remodelling shown in CTA after one-week anticoagulant therapy. A similar morphological progression was reported in Tomita et al.'s study [10], who further concluded that the proportion of TL stenosis might not correlate with remodelling. Therefore,

 https://doi.org/10.1016/j.heliyon.2019.e01354

failure of stenting the SIDSMA may not require urgent surgical conversion, and conservative management would be more justified despite longer symptomatic duration and length of stay. In this regard, we recommend that the conservative therapy for type III SIDSMA should be both considered prior to intervention or after the failure of endovascular stenting.

There are no specific stents for the SMA pathologies yet. Lu et al. [21] reported a high success rate and good clinical outcomes using bare stent implantation to treat SIDSMA. Min et al. [19] were concerned that covered stent might obliterate multiple side branches and therefore did not recommend it. In our small number of patients, 68.75% dissected FLs were completely isolated with covered stents and no evidence of bowel ischemia was present or confirmed postoperatively. One patient who suffered severe abdominal pain was presumably attributed to blockage of small blanches, but neither repeated DSA nor CT imaging could identify ischemia contributing to the worsening symptoms. In our experience, we suggest that covered stent might be considered for type IIa dissection, given its generally proximal and local properties, while bare stent is recommended for type IIb and type III dissections as there is no blood flow in the false lumen (FL).

To better describe the morphology of SIDSMA, several classifications have been put forward. The first classification was described by Sakamoto et al. [22], which did not involve complete thrombotic occlusion of SMA true lumen. Luan's et al. proposed a classification based on the location and dissection length, which has been reported to be associated with the pain severity [23]. However, both schemes are not suitable for management decision. In our study, we adopted Yun's classification [2] which can not only better describe the morphologic pathology but provide a guidance for management. More specifically, type I SIDSMA in our centre does not require endovascular or surgical intervention, presumably due to progressive morphologic remodelling and good clinical improvement in our observation. The majority of endovascular stentings were performed for type IIa and type IIb modalities, mainly because of the compression of TL causing continuous symptoms. Endovascular attempt failed to revascularize the occluded SMA in two type III patients.

In this regard, we integrate classification into the management algorithm (Fig. 5) for SIDSMA in our centre based on previous suggestions. Conservative management is considered a first choice for those symptomatic patients without rupture or bowel infarction. While symptoms persist 5−7 days despite ongoing medical treatment, endovascular repair should be performed, in particular for Type II and III dissections. However, we recommend ongoing medical therapy first for type I dissection, given its good morphologic and clinical outcomes in our observation. For type III pathology, conversion to conservative management can be considered whilst endovascular attempt fails, given the possibility of positive remodelling and clinical improvement. Nevertheless, surgical repair is the last resort for the treatment of SIDSMA.

https://doi.org/10.1016/j.heliyon.2019.e01354

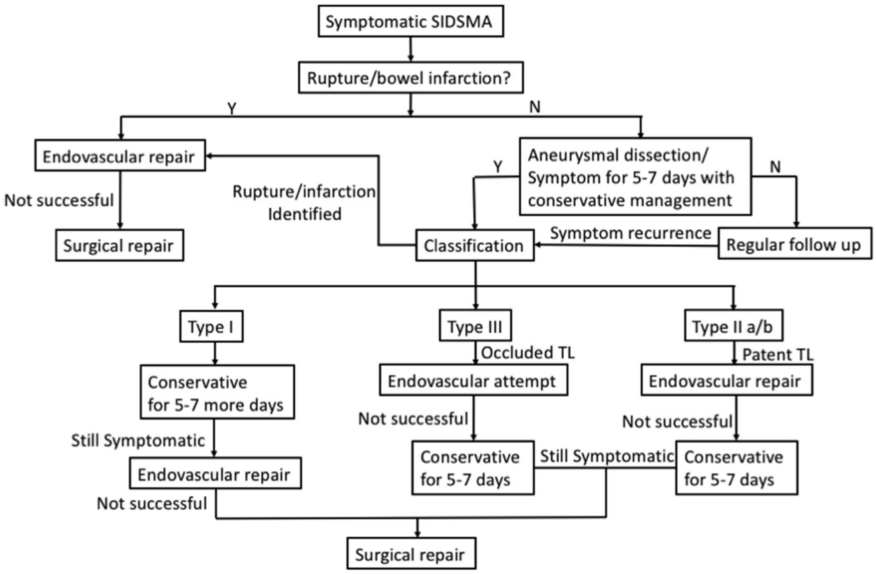

Fig. 5. Management algorithm for symptomatic isolated dissection of superior mesenteric artery (SIDSMA). TL: True Lumen.

Our study was first limited by a small number of patients, which could be a major restriction to provide a good recommendation for the endovascular treatment of SMA pathologies. Second, the morphologic follow-up duration was not long enough, with only 6 months postoperatively. Further follow-up imaging could provide more details about the stented SMA consequences. Third, the cause for severe abdominal pain in one patient after successful stenting could not be identified. This could be a significant factor to refine our endovascular technique and choice of stent. Last, comparison with conservative management or open surgical repair was not performed and therefore, the superiority among them could not be verified. Further clinical evidence is required to validate our primary results.

5. Conclusions

Delivery of stents inside the introducer pre-deployed into the SMA can achieve high technical success. Endovascular stenting could be a safe and effective alternative for treating SMA pathologies, with excellent early and mid-term outcomes. Type III SIDSMA with extensive thrombus is the major cause for endovascular failure.

Declarations

Author contribution statement

Jiale Ou: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

https://doi.org/10.1016/j.heliyon.2019.e01354

Hongyao Hu: Conceived and designed the experiments; Wrote the paper.

Zhenzhong Wu: Performed the experiments; Wrote the paper.

Hui Zhao, Chang Wang: Analyzed and interpreted the data.

Min Rao, Zhong Li, Jianwei Liu: Contributed reagents, materials, analysis tools or data.

Funding statement

This work was partially supported by the National Natural Science Foundation of China (81701791).

Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

References

[1] A.G. Foord, R.D. Lewis, Primary dissecting aneurysms of peripheral and pulmonary arteries: dissecting hemorrhage of media, Arch. Pathol. 68 (1959) 553–577.

[2] W.S. Yun, Y.W. Kim, K.B. Park, et al., Clinical and angiographic follow-up of spontaneous isolated superior mesenteric artery dissection, Eur. J. Vasc. Endovasc. Surg. 37 (5) (2009) 572–577.

[3] H.K. Kim, H.K. Jung, J. Cho, et al., Clinical and radiologic course of symptomatic spontaneous isolated dissection of the superior mesenteric artery treated with conservative management, J. Vasc. Surg. 59 (2) (2014) 465–472.

[4] S.H. Heo, Y.W. Kim, S.Y. Woo, et al., Treatment strategy based on the natural course for patients with spontaneous isolated superior mesenteric artery dissection, J. Vasc. Surg. 65 (4) (2017) 1142–1151.

[5] J.Y. Luan, X. Guan, X. Li, et al., Isolated superior mesenteric artery dissection in China, J. Vasc. Surg. 63 (2) (2016) 530–536.

[6] Z. Dong, W. Fu, B. Chen, et al., Treatment of symptomatic isolated dissection of superior mesenteric artery, J. Vasc. Surg. 57 (2 Suppl) (2013) 69S–76S.

 https://doi.org/10.1016/j.heliyon.2019.e01354

[7] K. Tomita, H. Obara, Y. Sekimoto, et al., Evolution of computed tomographic characteristics of spontaneous isolated superior mesenteric artery dissection during conservative management, Circ. J. 80 (6) (2016) 1452–1459.

[8] S. Suzuki, S. Furui, H. Kohtake, et al., Isolated dissection of the superior mesenteric artery: CT findings in six cases, Abdom. Imag. 29 (2) (2004) 153–157.

[9] E.M. Ham, B.S. Cho, J.B. Ye, et al., The endovascular treatment of a ruptured aneurysm of the middle colic artery combined with an isolated dissection of superior mesenteric artery: report of a case, Vasc. Endovasc. Surg. 48 (4) (2014) 352–355.

[10] M. Aimi, C. Amano, R. Yoshida, et al., Isolated superior mesenteric artery dissection with small intestine ischemia, Case Rep. Gastroenterol. 9 (3) (2015) 341–346.

[11] R.M. Gobble, E.R. Brill, C.B. Rockman, et al., Endovascular treatment of spontaneous dissections of the superior mesenteric artery, J. Vasc. Surg. 50 (6) (2009) 1326–1332.

[12] Z. Dong, J. Ning, W. Fu, et al., Failures and lessons in the endovascular treatment of symptomatic isolated dissection of the superior mesenteric artery, Ann. Vasc. Surg. 31 (2016) 152–162.

[13] H. Funahashi, N. Shinagawa, T. Saitoh, et al., Conservative treatment for isolated dissection of the superior mesenteric artery: report of two cases, Int. J. Surg. Case Rep. 26 (2016) 17–20.

[14] M. Jibiki, Y. Inoue, T. Kudo, Conservative treatment for isolated superior mesenteric artery dissection, Surg. Today 43 (3) (2013) 260–263.

[15] K. Okamura, S. Morizumi, M. Kawata, et al., Conservative therapy as a primary treatment for spontaneous isolated dissection of the superior mesenteric artery, Ann. Vasc. Surg. 28 (8) (2014) 1939–1945.

[16] Y. Kimura, T. Kato, K. Nagao, et al., Outcomes and radiographic findings of isolated spontaneous superior mesenteric artery dissection, Eur. J. Vasc. Endovasc. Surg. 53 (2) (2017) 276–281.

[17] P. Zerbib, C. Perot, M. Lambert, et al., Management of isolated spontaneous dissection of superior mesenteric artery, Langenbeck's Arch. Surg. 395 (4) (2010) 437–443.

[18] Z. Li, H. Ding, Z. Shan, et al., Initial and middle-term outcome of treatment for spontaneous isolated dissection of superior mesenteric artery, Medicine (Baltim.) 94 (45) (2015) e2058.

 https://doi.org/10.1016/j.heliyon.2019.e01354

[19] S.I. Min, K.C. Yoon, S.K. Min, et al., Current strategy for the treatment of symptomatic spontaneous isolated dissection of superior mesenteric artery, J. Vasc. Surg. 54 (2) (2011) 461−466.

[20] P. Pang, Z. Jiang, M. Huang, et al., Value of endovascular stent placement for symptomatic spontaneous isolated superior mesenteric artery dissection, Eur. J. Radiol. 82 (3) (2013) 490−496.

[21] P.H. Lu, X.C. Zhang, L.F. Wang, et al., Percutaneous endovascular reconstruction with bare stent implantation for isolated superior mesenteric artery dissection, Vasc. Endovasc. Surg. 48 (5-6) (2014) 406−411.

[22] I. Sakamoto, Y. Ogawa, E. Sueyoshi, et al., Imaging appearances and management of isolated spontaneous dissection of the superior mesenteric artery, Eur. J. Radiol. 64 (1) (2007) 103−110.

[23] J.Y. Luan, X. Li, Computed tomography imaging features and classification of isolated dissection of the superior mesenteric artery, Eur. J. Vasc. Endovasc. Surg. 46 (2) (2013) 232−235.

 https://doi.org/10.1016/j.heliyon.2019.e01354