

Endovascular treatment with stenting of celiac artery aneurysms

Fu-Kang Yuan, MD^a, Hai-Lin Xi, MD^a, Rui-Hao Qin, MD^a, Zhi-Long Tian, MD^a, Cui Li, MD^b, Fei Lu, MD^{c,*} 

Abstract

This study aimed to detail the clinical outcomes of patients suffering from celiac arterial aneurysm (CAA) that underwent treatment via stent occlusion.

This is a single-center, retrospective study. A total of 8 consecutive CAA patients were treated via stent occlusion from March 2014 to September 2018 at our hospital. Follow-up computed tomography was conducted after stenting at 1, 3, 6, and 12-month time points and every year thereafter. Both short- and long-term outcomes were assessed.

In total, 8 stents were inserted into these 8 patients, with 2 being uncovered and 6 being covered stents. In 2 patients, stents were positioned in the celiac artery, while in the remaining 6 patients they were placed in the celiac and common hepatic arteries. The median operative duration was 66 minutes. No patients exhibited procedure-associated complications, and the median follow-up duration was 39 months (range: 18–72). Abdominal contrast-enhanced CT analyses of these patients exhibited stent and distal artery patency in 100% of patients, together with CAA obliteration. Visceral necrosis did not occur in any patients over the follow-up period.

Stent occlusion can be safely and effectively used to treat CAA patients.

Abbreviations: CAA = celiac arterial aneurysm, CT = computed tomography, VAA = visceral arterial aneurysm.

Keywords: celiac arterial aneurysm, endovascular, stent occlusion

1. Introduction

More widespread use of abdominal contrast-enhanced computed tomography (CT) imaging has revealed visceral arterial aneurysm (VAA) to be a more common disease than was previously recognized.^[1–3] Between 4.8% and 6.3% of VAA cases present as celiac arterial aneurysm (CAA) cases, which must be urgently

treated as their rupture is typically associated with patient death.^[4,5]

A wide range of approaches have been employed to conduct endovascular repair in VAA patients, including ultrasound-guided injection of thrombin, coil embolization, and stent occlusion.^[3–6] These endovascular options are less invasive and less expensive than open surgery, making them preferable in the vast majority of patients. Of these strategies, stent occlusion is the most commonly reported approach to VAA treatment in the literature.^[6–10] In contrast, there have been relatively few studies reporting on stent occlusion and associated outcomes in CAA patients.^[4,5]

In the present study, we discuss clinical outcomes in CAA treatments that underwent stent occlusion treatment at our hospital.

2. Patients and methods

This was a retrospective single-center study that received hospital Institutional Review Board approval. Written consent requirements were waived for this study as a result of its retrospective nature.

2.1. Patients

A total of 8 consecutive CAA patients underwent stent occlusion in our hospital between March 2014 and September 2018 (Table 1). These patients (3 female, 5 male) had a median age of 58.5 years (range: 43–65). Five patients had been suffering from abdominal pain, whereas the other three were asymptomatic, with CAA having been discovered incidentally.

Six patients had hypertension and 3 patients had undergone prior abdominal surgery. No patient experienced abdominal infection.

Editor: Wilhelm Mistiaen.

Natural Science Foundation of Jiangsu Province, China (BK20161168 & BK20150211); the social development project of Xuzhou, China (KC17109& KC15SH098).

The authors declare no conflicts of interest.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

^aXuzhou Institute of Cardiovascular disease; Department of Vascular Surgery, Xuzhou Clinical School of Xuzhou Medical University, 199 Jiefang Road,

^bPhysiology Department of Basic Medical College, Xuzhou Medical University,

^cXuzhou Central Hospital; Department of Critical Care Medicine, The Xuzhou School Of Clinical Medicine Of Nanjing Medical University, 199 Jiefang Road, Xuzhou, Jiangsu, China.

* Correspondence: Fei Lu, Xuzhou Central Hospital, Department of Critical Care Medicine, The Xuzhou School Of Clinical Medicine Of Nanjing Medical University, 199 Jiefang Road, Xuzhou 221009, Jiangsu, China (e-mail: haomengzhen8888@163.com).

Copyright © 2020 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial License 4.0 (CCBY-NC), where it is permissible to download, share, remix, transform, and buildup the work provided it is properly cited. The work cannot be used commercially without permission from the journal.

How to cite this article: Yuan FK, Xi HL, Qin RH, Tian ZL, Li C, Lu F. Endovascular treatment with stenting of celiac artery aneurysms. *Medicine* 2020;99:48(e23448).

Received: 7 April 2020 / Received in final form: 20 August 2020 / Accepted: 23 October 2020

<http://dx.doi.org/10.1097/MD.00000000000023448>

Table 1**Baseline data.**

No./Gender/Age (y)	Surgery history	Involvement	Maximum diameter of CAA (mm)	Symptom
1/Male/65	Yes	CA; CHA	40	Abdominal pain
2/Female/55	No	CA; CHA	32	None
3/Male/43	No	CA; CHA	45	Abdominal pain
4/Male/44	Yes	CA	12	None
5/Female/52	No	CA	29	Abdominal pain
6/Male/62	Yes	CA	14	Abdominal pain
7/Male/62	No	CA	27	None
8/Female/48	No	CA; CHA	28	Abdominal pain

CA = celiac artery, CAA = celiac artery aneurysm, CHA = common hepatic artery.

2.2. CAA diagnosis

Abdominal contrast-enhanced CT imaging was used to diagnose CAA (Fig. 1a). CAA size, shape, and vascular involvement was evaluated prior to stent insertion

2.3. Stent insertion

Fluoroscopic guidance and local anesthesia were used during all stent insertion procedures in this study. All procedures were performed in the digital subtraction angiography room.

The treatment was performed via a right femoral approach. A 5F vascular sheath was inserted into the right femoral artery, a 0.035-inch soft guide wire (Terumo, Tokyo, Japan) and a 4F angiographic catheter (Cordis, NJ, USA) were inserted to the vascular sheath, and the angiographic catheter was placed at the ostium of the celiac artery.

CAA was confirmed via celiac angiography, after which the guide wire was exchanged for 0.035-inch stiff guide wire (Cook, IN, USA). This guide wire was then used to insert a metal stent which was used to seal the CAA (Fig. 1b). Stent selection criteria were: (a) stents had to fully cover the CAA neck (a minimum of 5 mm on both sides), and (b) the stent had a diameter that was 1.1–1.2 times the celiac artery diameter. After stent insertion was complete, patency was confirmed and CAA was reevaluated via celiac angiography.

For 6 months following intervention, all patients underwent dual anti-platelet treatment (aspirin 100 mg/day + clopidogrel 75 mg/day), after which daily aspirin intake was maintained for life.

2.4. Follow-up

Patient follow-up via contrast-enhanced CT was conducted at 1, 3, 6, and 12 months post-operation, and once per year thereafter.

2.5. Definitions

CAA obliteration was defined as no contrast-medium entered into CAA sac on follow-up contrast-enhanced CT. Stent patency was defined as contrast-medium fully flowed through the stent on follow-up contrast-enhanced CT. Re-stenosis was defined as there was a filling defect in stent on the follow-up contrast-enhanced CT.

3. Results

3.1. Treatment

In total, 8 stents were implanted into these 8 patients. Covered stents (Bard, NJ, USA) were used for 6 patients with larger CAAs size (≥ 20 mm), whereas uncovered stents (Medtronic, MN, USA) were used in the 2 remaining patients (Table 2). Both of the 2



Figure 1. A 62-year-old man with CAA underwent stent insertion. (A) CAA as detected via pre-operative abdominal contrast-enhanced CT imaging. The size of the CAA was 14 × 11 mm. (B) CAA stent insertion using an uncovered stent. There was some contrast-medium flow into the CAA after stent insertion. (C) CT follow-up revealing CAA obliteration and stent patency.

Table 2**Treatment and outcomes.**

	Type of stent	Follow-up (mo)	Patency of stent	CAA size (before)	CAA size (after)
1	Covered	72	Yes	40 mm	32 mm
2	Covered	56	Yes	32 mm	26 mm
3	Covered	50	Yes	45 mm	35 mm
4	Uncovered	40	Yes	12 mm	11 mm
5	Covered	38	Yes	29 mm	16 mm
6	Uncovered	32	Yes	14 mm	12 mm
7	Covered	25	Yes	27 mm	26 mm
8	Covered	18	Yes	28 mm	19 mm

CAA = celiac artery aneurysm.

patients (No. 4 and 6) had the smaller CAA size (< 20 mm). Furthermore, for patient No. 4, another reason for the choice of uncovered stent was the asymptomatic nature. While for patient No. 6, another reason for the choice of uncovered stent was the narrow CAA neck (3 mm).

The stents used in this study were 8 mm in diameter and 20 to 60 mm in length. The 6 covered stents were self-expandable stents and the 2 uncovered stents were balloon-expandable stents.

In 2 patients, stents were placed in the celiac artery, whereas they were positioned in the celiac and common hepatic arteries in the remaining 6 patients. The median operative duration was 66 minutes (range: 60–90 min), and there were no instances of procedure-associated complications.

CAA obliteration was observed via celiac angiography in the 6 patients treated using covered stents, while reductions in CAA blood flow were evident in the 2 patients treated with uncovered stents.

3.2. Long-term outcomes

The patients in this study were followed for a median of 39 months (range: 18–72). Follow-up abdominal contrast-enhanced CT images confirmed 100% stent and distal artery patency as well as CAA obliteration in all patients (Fig. 1c). All CAAs shrank in size after stent insertion (Table 2). There were no cases of visceral necrosis within the follow-up period.

4. Discussion

Herein, we evaluated the clinical efficacy and long-term outcomes associated with stent insertion for the treatment of CAA. Our results were positive, with patients exhibiting promising short- and long-term outcomes.

While a range of different treatment strategies have been employed to treat VAA and CAA, all of these approaches share

the goal of reducing blood flow into the VAA/CAA sac in an effort to prevent its subsequent rupture.^[1–6] Tulsyan et al found that they were able to achieve high rates of technical success (98%) when used coil- or medical glue-mediated embolization to treat 48 VAA patients, while maintaining low rates of postoperative mortality.^[6] Jhajharia et al, in contrast, have reported the use of endoscopic ultrasound-guided thrombin injection to aid in the management of three visceral artery pseudoaneurysm patients, achieving complete pseudoaneurysm closure.^[3] Embolization strategies, however, are only appropriate for the treatment of VAAs with a narrow neck, as a wide neck can lead to leakage of the embolization agent and off-target embolization in other arteries. Certain solid embolic agents additionally have the potential to cause intraoperative aneurysm rupture.

Stent occlusion can be more easily used to treat CAA relative to embolization, and it is associated with lower treatment costs and a reduced risk of intraoperative rupture.^[4,5] Our results demonstrate a 100% technical success rate when using stent occlusion to treat CAA, consistent with previous reports.^[4,5]

These prior studies (Table 3) all utilized covered stents,^[4,5,11–14] whereas in the present study we treated 2 patients with uncovered stents owing to the relatively small (< 20 mm) diameter of the CAA neck. Although instant CAA obliteration was not achieved in these patients, long-term follow-up confirmed that CAA obliteration did still eventually occur in both cases. This suggests that uncovered stents can sufficiently slow the flow velocity within the aneurysm sac, thereby creating an environment that is more conducive to thrombus deposition.^[15] Li et al^[16] reported on outcomes in 8 patients that exhibited incompletely sealed aneurysms following stent occlusion. In all 8 of these cases, however, the authors found upon follow-up CT examination that residual endoleak was absent or markedly decreased.^[16]

Table 3**Previous studies regarding stent repair of CAA.**

No.	Year	Patients number	Treatment with stent			CAA shrinkage or obliteration
			Median CAA size	Type of stents	Median duration	
Atkins et al ^[11]	2003	1	10 cm	Covered	Not given	Yes
Atar et al ^[12]	2004	1	60 mm	Covered	Not given	Yes
Basile et al ^[13]	2007	1	25 mm	Covered	Not given	Yes
Carrafiello et al ^[14]	2010	1	Not given	Covered	Not given	Yes
Zhang et al ^[4]	2016	10	39 mm	All covered	60.5 min	Yes
Xia et al ^[5]	2019	11	38 mm	All covered	63.2 min	Yes

CAA = celiac artery aneurysm.

Both covered and uncovered stents have their advantages and limitations. Covered stents can provide an instant obliteration of the CAA, and therefore, the covered stents were usually used for the large CAA.^[11–14] Compared to the covered stents, bare stents have the mild radial strength and good compliance with the vascular wall.^[17] However, the bare stents cannot completely seal the CAA, and therefore, bare stents were only suitable for the small CAA with a narrow neck.

We observed a long-term stent patency rate of 100% in this study, in line with prior findings.^[4,5] This high patency rate is potentially attributable to the regular administration of antiplatelet treatments to these patients following stent insertion.

Even though stents were placed in the celiac and common hepatic arteries in 6 patients in the present study, splenic infarction was not detected in any of these patients upon follow-up evaluation. This suggests that there was sufficient collateral circulation in these patients, thus ensuring that an adequate blood supply was available to the spleen and other abdominal organs.^[18]

There are certain limitations to the present analysis. For one, this was a retrospective study and it is thus inherently susceptible to selection bias. Secondly, this study had a limited sample size making it more challenging to draw any definitive conclusions, particularly as only 2 patients were treated via uncovered stent insertion. Future studies with large sample sizes are thus warranted.

In summary, while further research is required, our results suggest that stent occlusion is a safe, simple, and effective approach to the treatment of patients with CAA.

Author contributions

Data curation: Hai-Lin Xi, Cui Li.

Funding acquisition: Zhi-Long Tian.

Methodology: Fu-Kang Yuan, Rui-Hao Qin, Zhi-Long Tian.

Supervision: Fei Lu.

Writing – original draft: Fu-Kang Yuan.

Writing – review & editing: Fei Lu.

References

- [1] Shukla AJ, Eid R, Fish L, et al. Contemporary outcomes of intact and ruptured visceral artery aneurysms. *J Vasc Surg* 2015;61:1442–7.

- [2] Hosn MA, Xu J, Sharafuddin M, et al. Visceral artery aneurysms: decision making and treatment options in the new era of minimally invasive and endovascular surgery. *Int J Angiol* 2019;28:11–6.
- [3] Jhahharia A, Wanjari S, Ashdhir P, et al. Endoscopic ultrasound-guided thrombin injection for management of visceral artery pseudoaneurysm: a novel approach. *Indian J Gastroenterol* 2018;37:271–5.
- [4] Zhang W, Fu YF, Wei PL, et al. Endovascular repair of celiac artery aneurysm with the use of stent grafts. *J Vasc Interv Radiol* 2016;27:514–8.
- [5] Xia FF, Fan ZQ, Huo XB, et al. Endovascular stent repair of celiac arterial aneurysm. *Medicine (Baltimore)* 2019;98:1–4.
- [6] Tulsyan N, Kashyap VS, Greenberg RK, et al. The endovascular management of visceral artery aneurysms and pseudoaneurysms. *J Vasc Surg* 2007;45:276–83.
- [7] Venturini M, Marra P, Colombo M, et al. Endovascular repair of 40 visceral artery aneurysms and pseudoaneurysms with the viabahn stent-graft: technical aspects, clinical outcome and mid-term patency. *Cardiovasc Intervent Radiol* 2018;41:385–97.
- [8] Herzog T, Suelberg D, Belyaev O, et al. Treatment of acute delayed visceral hemorrhage after pancreatic surgery from hepatic arteries with covered stents. *J Gastrointest Surg* 2011;15:496–502.
- [9] Larson RA, Solomon J, Carpenter JP. Stent graft repair of visceral artery aneurysms. *J Vasc Surg* 2002;36:1260–3.
- [10] Zhang Y, Lu Q, Zhao Z, et al. Multiple overlapping uncovered stents as an alternative flow-diverting strategy in the management of peripheral and visceral aneurysms. *J Vasc Surg* 2014;60:1209–17.
- [11] Atkins BZ, Ryan JM, Gray JL. Treatment of a celiac artery aneurysm with endovascular stent grafting—a case report. *Vasc Endovascular Surg* 2003;37:367–73.
- [12] Atar E, Feldman G, Neyman H, et al. Percutaneous treatment of a celiac artery aneurysm using a stent graft. *Isr Med Assoc J* 2004;6:370–1.
- [13] Basile A, Lupattelli T, Magnano M, et al. Treatment of a celiac trunk aneurysm close to the hepato-splenic bifurcation by using hepatic stent-graft implantation and splenic artery embolization. *Cardiovasc Intervent Radiol* 2007;30:126–8.
- [14] Carrafiello G, Rivolta N, Fontana F, et al. Combined endovascular repair of a celiac trunk aneurysm using celiac-splenic stent graft and hepatic artery embolization. *Cardiovasc Intervent Radiol* 2010;33:352–4.
- [15] Zhang Y, Lu Q, Jing Z. Multilayer stents, a new progress in the endovascular treatment of aneurysms. *Chin Med J (Engl)* 2013;126:536–41.
- [16] Li MH, Leng B, Li YD, et al. Comparative study of covered stent with coil embolization in the treatment of cranial internal carotid artery aneurysm: a nonrandomized prospective trial. *Eur Radiol* 2010;20:2732–9.
- [17] Fu YF, Cao C, Shi YB, et al. Endovascular bare stenting for isolated superior mesenteric artery dissection. *Vasc Endovascular Surg* 2020;54:12–6.
- [18] Waldenberger P, Bendix N, Petersen J, et al. Clinical outcome of endovascular therapeutic occlusion of the celiac artery. *J Vasc Surg* 2007;46:655–61.