Endovascular and open repair of visceral aneurysms: A retrospective single-center analysis

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Abstract. The aim of the present study was to analyze the outcome of open surgical and endovascular interventions for the treatment of visceral aneurysms. A retrospective review of a cohort of visceral aneurysm patients treated at a single tertiary referral center was conducted. STROBE guidelines were followed. The primary endpoint was post-operative in-hospital mortality. Secondary endpoints were major morbidity (Dindo-Clavien score, >3), the duration of the procedure, technical success and the length of hospital stay. As a result, 12 patients underwent open or endovascular surgery. No 30-day mortality or major morbidity were observed. The median aneurysm diameter was 2.0 cm (range, 1.5-5.0 cm). The median postoperative stay was four days for all procedures and significantly longer after open surgery compared with endovascular repair (ER) (7 vs. 3 days). Overall, the evidence from the present retrospective analysis shows no mortality and a shorter length of stay for patients undergoing ER for the treatment of a visceral aneurysm (VAA). Although the results are in line with the fact that ER is considered to be the first line treatment for VAA, this may be prone to selection bias.

Introduction

Visceral artery aneurysms are defined in this retrospective analysis as a true aneurysm in the celiac trunk (CT), superior mesenteric artery (SMA), inferior mesenteric artery, and/or their branches. Visceral artery aneurysms (VAAs) are rare and mostly asymptomatic., Rapid growth, size >2 cm, and pregnancy are risk factors associated with rupture. True visceral aneurysms are aneurysms are the result of weakening and thinning of the artery wall. Atherosclerosis, connective tissue disorders, infection (for example pancreatitis) and abdominal surgery are known risk factors for the development of VAA. Nowadays, conservative therapy, endovascular, and open surgery are the treatment options for patients with visceral aneurysms (VAA). During the last decade, endovascular repair of VAAs has been increasingly used (1-6). Catheter-based embolization or stent-graft placement are two major treatment options. Most VAAs originate from the splenic artery (SA) (60%) (Figs. 1 and 2), followed by the hepatic artery (HA) (20-50%) (Figs. 3 and 4). An origin from the superior mesenteric artery (SMA) (6%) (Figs. 5 and 6), the celiac trunk (CT) (4%) or other, smaller visceral arteries is considerably less common (7).

Mostly, VAAs are asymptomatic and incidental findings owing to the evolving and more frequently used imaging modalities. Risk factors associated with rupture are pancreatitis, rapid growth, size >2 cm, and pregnancy. The mortality associated with splenic artery aneurysm rupture has been reported at around 30%. In pregnancy, these rates are higher. Higher flow rate through the splenic artery because of distal compression of the aorta and iliac arteries by the pregnant uterus, portal congestion, and the progressive weakening of the basic structure of the arterial media are possible factors that explain this high mortality (8-16).

The aim of the present study is to compare the outcomes of patients undergoing open surgery (OS) or endovascular repair (ER) for the treatment of VAAs. We present our single center experience on the treatment of VAAs, reporting on 12 patients.

Patiends and methods

All patients 18 years or older at the time of surgery who were treated for VAAs and underwent endovascular or open surgery at the Department of Visceral, Vascular and Endocrine Surgery at the University Hospital Halle (Saale), Germany from 2014 to 2022 were included in the study. The STROBE statement (a checklist of items that should be addressed in articles reporting on the three main study designs of analytical epidemiology: cohort, case-control, and cross-sectional studies) was followed for reporting on observational data (17).

Anastomotic pseudoaneurysms and aortic aneurysms involving the visceral arteries were excluded. The decision to perform an open or endovascular repair was made after

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Figure 1. Angiography of an aneurysm of the splenic artery (black arrow) after positioning an 8F-Sheath in celiac trunk.

Figure 2. Angiography after endovascular treatment of a splenic artery aneurysm with a covered stentgraft (black arrow).

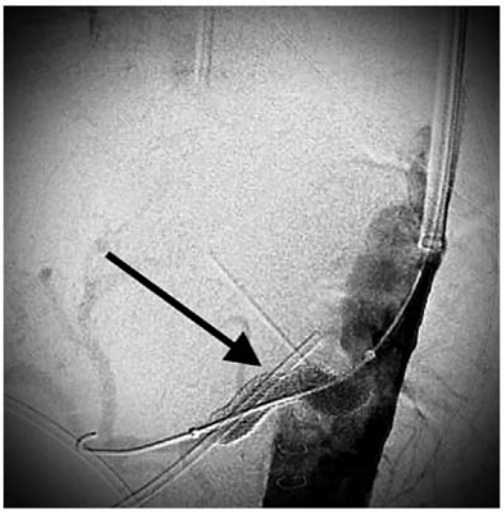

Figure 3. Angiography of an aneurysm of the common hepatic artery after endovascular treatment with a covered stentgraft (black arrow).

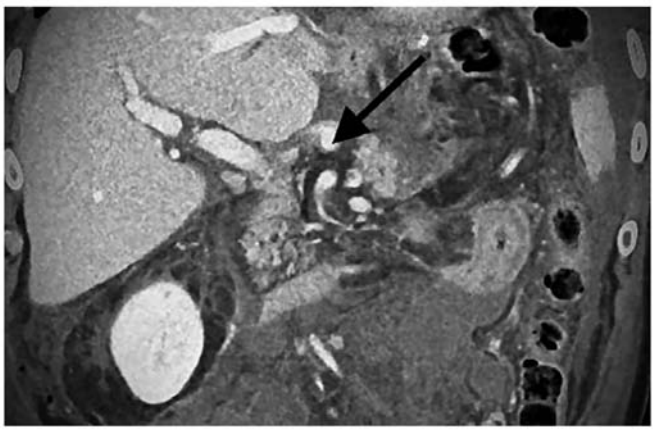

Figure 4. Computed tomography scan of a common hepatic artery aneurysm (black arrow) before endovascular treatment.

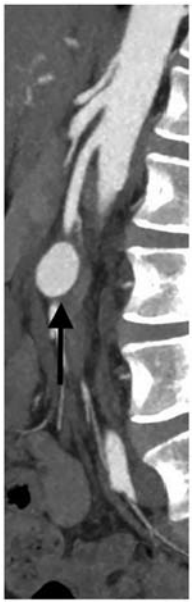

Figure 5. Computed tomography scan from an aneurysm of the superior mesenteric artery (black arrow) (sagittal plane).

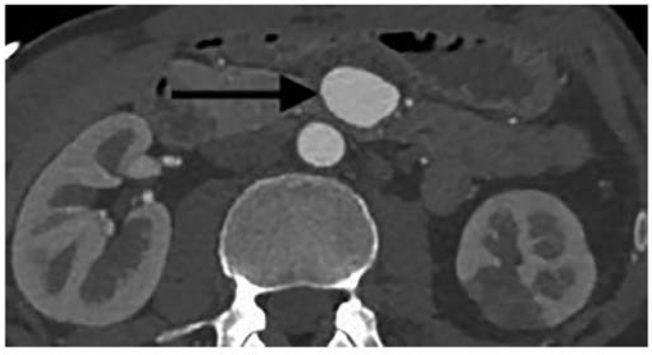

Figure 6. Computed tomography scan from an aneurysm of the superior mesenteric artery (black arrow) (axial plane).

discussion in a multidisciplinary meeting (angiology, radiology and vascular surgery). All ruptured VAAs underwent intervention. Open repair was performed in general anesthesia

as an aneurysmorrhaphy with or without vascular reconstruction by (direct end-to- end anastomosis or using a vein graft interposition). Endovascular treatment was performed in local anesthesia and consisted either of coilembolization or covered stent placement. If a stent graft placement was technically possible it was performed in order to maintain the vessel patency. If not, a coilembolization was performed.

Data was extracted and presented in a tabular fashion. The following descriptive patient and operation characteristics were documented: sex, age at diagnosis, use of diagnostic imaging techniques, aneurysm localization, aneurysm size and symptoms and therapy. The following predefined outcomes were also extracted: in-hospital mortality, major morbidity (when defined as Dindo-Clavien >III) (18), length of hospital stay and technical success (complete aneurysm occlusion in the postoperative CT-Scan). The Clavien Dindo Classification was used to rank the severity of surgical complications. This classification consists in a scale of several grades (Grade I, II, IIIa, IIIb, IV and V). Grade I complications consists in any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions. Grade II include complications requiring pharmacological treatment. Grade III refers to complications requiring surgical, endoscopic or radiological intervention (IIIa not under general anesthesia and IIIb under anesthesia). Grade IV regards life-threneting complications and Grade V represents the death of the patient (18). Descriptive statistics from our patient collective are reported as numbers or mean.

Results

From 2014 to 2022, 12 patients with VAAs, 11 females and one male were treated at the University Hospital Halle (Saale).

The median age was 59 years (range 40 to 87 years). Only one patient was male, and all were diagnosed by a CT-scan. The detailed patient and operative characteristics are given in Tables I and II.

There were eight patients with an aneurysm of the SA, two patients with aneurysms of the SMA, one patient with an aneurysm of the HA and one patient with an aneurysm of the CT. Only one patient was symptomatic and presented with signs of bleeding. All patients received a contrast-enhanced CT-scan.

The median aneurysm diameter was 2 cm (range 1.5 cm to 5 cm) for all aneurysms, 3.75 cm for aneurysms of the SMA, 2 cm for aneurysms of the SA and for aneurysms of the CT and 1.5 for the aneurysm of the HA.

Six aneurysms of SA, one aneurysm of the CT and one aneurysm of the HA were treated with ER (eight patients). Seven patients were treated with covered stents and one with coiling embolization. In total eight covered stents were implanted. Two patients with SA aneurysms and two patients with SMA aneurysms underwent OS. No allogeneic grafts were required. Three patients needed direct suture only and one a vein graft.

There was no in-hospital mortality and no major postoperative complications (Clavien-Dindo grade ≥3). Technical success was achieved in all patients. The median postoperative stay was four days for all procedures and significantly longer after OS when compared with ER (seven days vs. three days).

Table I. Patients and preoperative characteristics.

No.	Sex	Age	Year	Imaging	Location	Size, cm	Symptoms related to the aneurysm	Atherosclerosis	Connective tissue disorders	Infection	Previous abdominal surgery	Diabetes Mellitus Type II	Smoker
1	F	50	2019	CTA	SA	2.5	N	N	N	N	N	N	N
2	F	69	2017	CTA	SA	2	N	N	N	N	N	Y	N
3	F	61	2014	CTA	SMA	5	N	Y	N	N	Y	N	N
4	F	33	2021	CTA	SMA	2, 5	N	N	Y	N	N	N	Y
5	F	52	2020	CTA	SA	2	N	N	N	N	N	N	N
6	F	74	2021	CTA	SA	3.5	N	N	N	N	N	N	N
7	M	67	2020	CTA	HA	1.5	Bleeding	N	N	Y	Y	Y	N
8	F	64	2022	CTA	CT	2	N	Y	N	N	N	N	Y
9	F	54	2021	CTA	SA	2.2	N	N	N	N	N	N	N
10	F	57	2021	CTA	SA	1.5	N	N	N	N	N	N	N
11	F	53	2021	CTA	SA	2	N	N	N	N	N	N	N
12	F	87	2022	CTA	SA	2	N	N	N	N	N	N	N

M, male; F, female; SA, splenic artery; SMA, superior mesenteric artery; CT, celiac trunk; HA, hepatic artery; CTA, computed tomography angiography; Y, Yes; N, No.

Table II. Surgical characteristics and postoperative outcomes.

No.	Therapy	Implants	Morbidity (Dindo-Clavien)	In-Hospital Mortality	Duration of postoperative stay (Days)
1	OS; aneurysm resection, direct suture	-	0	N	6
2	OS; aneurysm resection, direct suture	-	0	N	4
3	OS; aneurysm Resection, Vein graft	-	0	N	19
4	OS; aneurysm resection, direct suture	-	0	N	8
5	ER; covered stentgraft	Viabahn 5x50 mm	0	N	1
6	ER; covered stentgraft	Viabahn 8x57 mm	0	N	3
7	ER; two covered stentgrafts	Gore Viabahn 5x50 mm and Bentley Begraft 6x18 mm	0	N	7
8	ER; covered stentgraft	Bentley Begraft 6x27 mm	0	N	3
9	ER; covered stentgraft	Bentley Begraft 6x37 mm	0	N	4
10	ER; covered stentgraft	Bentley Begraft 6x27 mm	0	N	3
11	ER; covered stentgraft	Viabahn 5x50 mm	0	N	2
12	ER; coiling	Platinum embolization coils	0	N	5

N, none; ER, endovascular; OS, open surgery.

Discussion

In this retrospective study we reported on our single center experience on the treatment of VAAs, both with endovascular and open surgery.

In our small patient collective, no mortality was observed. This may be due to the almost total absence of emergency repairs. Considerable mortality is described in the treatment of these patients in an emergency setting (19). In a retrospective study reporting on 185 aneurysms, 46% of the patients were symptomatic with bleeding or rupture. Despite 98% technical success on treating symptomatic patients, 30-day overall and aneurysm-related mortality was 6.2 and 3.4%, respectively. On the other hand, no deaths were observed in patients undergoing elective treatment (20). In another report of 217 splenic artery aneurysms, operative mortality was 5% in the elective group and 20% in the emergency group (8). In another study an operative mortality rate of 37.5% for ruptured superior mesenteric artery aneurysms was described. Also in this study, no mortality was observed for elective repair (21). In another large retrospective study, morbidity (19% vs. 4%; P=.003), 30-day mortality (13% vs. 0% P=0.001), 1-year (32.5% vs. 4.1%, P<.001), and 3-year mortality rates (36.4% vs. 8.3%; P<.001) were significantly higher for ruptured aneurysms than for intact aneurysms. Open surgery had higher 30-day mortality rates thanendovascular repair (28% vs. 7%; P= .06) (22). In our retrospective patient cohort, length of stay was shorter in the ER group (mean difference -4.25 days, 95% CI [-5.52; -2.98], P<0.00001; seven vs. four days). Comparable results regarding the length of stay were reported in a previous meta-analysis (23). The technical success of 100% when using endovascular stentgrafts or coiling observed in our patient collective may reflect the bias inherent in the analysis of a very small patient collective. In a systematic review and meta-analysis from 2016 comprising 22 studies reporting on endovascular treatment of VAAs, a 93.2% technical success rate was reported (24).

This study has limitations. The main limitation is that it is exclusively based on retrospective data, which could represent a problem in terms of selection bias. The long inclusion period does not necessarily reflect contemporary surgical and endovascular techniques. Another limitation is the small number of patients. The STROBE guidelines were followed to ensure transparency and standardized reporting. Nevertheless, the findings of this work may provide useful information, as it reports a case series of a rare disease with outcomes on open and endovascular treatment.

In conclusion, evidence from this retrospective small case series shows no mortality and a shorter length of stay for patients undergoing ER for the treatment of VAA. Although the results are in line with the fact that ER is nowadays considered the first line treatment for VAA, they may be prone to selection bias.

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Availability of data and materials

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

Authors' contributions

AR outlined, wrote and drafted the manuscript. AR, UR, JP, JK, EJ and JU performed analysis or interpretation of data for the work. All authors critically revised the manuscript and read and approved the final version of the manuscript. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. AR and JP confirm the authenticity of all the raw data.

Ethics approval and consent to participate

A fully anonymized retrospective evaluation of the study data was conducted, and so the need for an ethical vote and patient consent was waived, according to section 17 of the Hospital Act of the Federal State of Saxony-Anhalt and section 15 of the Saxony-Anhalt Medical Association's professional code of conduct.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests

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