ELSEVIER

Check for updates

Visceral and Renal Vascular Disease

A Dedicated Algorithm for Endovascular Approach as a First-Line Treatment Option for Visceral Artery Aneurysms

Sara Pomatto,[1] Rodolfo Pini,[1,2] Gianluca Faggioli,[1,2] Carmine Poliseno,[1] Betti Shyti,[1] and Mauro Gargiulo,[1,2] Bologna, Italy

Objectives: Few data are reported in literature about visceral artery aneurysms (VAAs) management. The aim of the present study was to analyze VAAs management in a single institution, with a dedicated algorithm for endovascular approach as the first line treatment.

Methods: A single-center retrospective cohort study was performed. Patients with a VAA submitted to either endovascular repair or open surgery from 2016 to 2023 were included. A dedicated algorithm was used to evaluate the endovascular approach feasibility assessing on the preoperative computed tomography angiography the following parameters: (a) the tortuosity of the involved artery (<150°), (b) the healthy arterial diameter (>4 mm), (c) the VAA proximity to the hilum and/or the presence of a bifurcation of the aneurysmatic artery, and (d) the circumferential calcium presence. An endovascular approach was chosen if (a) and (b) criteria were satisfied without (c) and (d) ones. Otherwise, it was deemed a challenging anatomy, and an open surgical treatment was considered. In the absence of (a) and/or (b) criteria open surgery was the preferred option.

Results: Thirty-one asymptomatic aneurysms (28 patients) were treated electively. The most frequent VAA location was the splenic artery (18 cases; 58%), followed by the renal arteries (6 cases; 19%), the common hepatic artery (5 cases; 16%), the gastroepiploic artery (1 case, 3.2%) and the pancreatoduodenal artery (1 case; 3%). Twenty-two aneurysms (71%) were initially treated by an endovascular approach (stent-graft deployment and/or transcatheter embolization) with 3 (13%) of them needing a surgical conversion. Nine aneurysms (29%) were submitted directly to a surgical treatment (aneurysm resection with or without interposition bypass) with no peri-operative and long-term complications. Technical success was 90.3%.

Conclusions: Endovascular management as a first line approach is safe and effective in most cases. A preoperative dedicated algorithm is useful to identify suitable cases. Open surgery can be considered an alternative option in specific challenging anatomical situations or in case of endovascular failure.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

[1]Vascular Surgery, Department of Medical and Surgical Sciences (DIMEC), University of Bologna, Bologna, Italy.

[2]Vascular Surgery Unit, IRCCS Azienda Ospedaliero-Universitaria S. Orsola, Bologna, Italy.

Correspondence to: Gianluca Faggioli, Vascular Surgery, University of Bologna "Alma Mater Studiorum" - DIMEC, Policlinico S. Orsola, Via Giuseppe Massarenti 9, Bologna 40138, Italy; E-mail: gianluca.faggioli@unibo.it

Ann Vasc Surg 2025; 110PA: 197–204
https://doi.org/10.1016/j.avsg.2024.07.115

Manuscript received: June 28, 2024; manuscript accepted: July 17, 2024; published online: 1 October 2024

INTRODUCTION

Visceral artery aneurysms (VAAs) are a rare but clinically relevant condition with a reported incidence rate of 0.01−0.2%[1,2]; one of 4 of them may present with rupture, which can be life threatening.[3] The increasing use of intra-abdominal imaging modalities is occasionally disclosing an increasing number of asymptomatic VAAs allowing their elective treatment when indicated.[2]

Most commonly the VAAs affect the splenic artery (60%), with the other arteries involved less frequently (Table I).[4] Renal artery aneurysms are often considered as a separate entity, occurring in approximately 0.1% of the general population.[5]

The guidelines of the Society for Vascular Surgery recommend treatment when they are symptomatic or with a diameter greater of a determined value according to each artery (Table II), or if there is a growth rate >0.5 cm/year. The pancreaticoduodenal, gastroduodenal, superior mesenteric artery aneurysms, and the pseudoaneurysms should be treated regardless of their size.[3]

Their repair can be obtained by surgical or endovascular means according to the target artery anatomical features and the patient general clinical conditions. Endovascular techniques include transcatheter embolization (coils, plugs, embolic agents), self-expanding stent-grafts or flow-diverting stents placement and are usually considered the first line option given their less invasive nature.[1,2] Differently, surgical repair is mostly limited to challenging anatomies or endovascular repair failure, and include proximal and distal ligation of the aneurysm, aneurysmectomy with end-to-end anastomosis, arterial reconstruction using an autologous vein or prosthetic graft, and ex vivo repair.[2]

Nevertheless, randomized prospective trials comparing the 2 approaches are not yet available, and the best first line approach lacks evidence support. For this reason, we have analyzed the management of VAAs in a single institution, with an algorithm dedicated to a first line endovascular repair as a first line approach.

Table I. Visceral artery aneurysms distribution in the general population according to the involved visceral vessel[4]

Involved visceral vessel	%
Splenic artery	60
Hepatic artery	20
Gastroduodenal artery	6
Superior mesenteric artery	5.5
Celiac artery	4.5
Other arteries	4

Table II. Society for vascular surgery recommendations for treatment of true asymptomatic VAAs according to the involved artery[3]

Involved artery	Artery diameter (cm)
Celiac artery	>2
Hepatic artery	>2
Splenic artery	>3
Renal artery	>3

METHODS

Patients' Selection

All VAAs treated by endovascular or surgical means in a single center (Vascular Surgery Unit, Policlinico Sant'Orsola, Bologna) from 2016 to 2023 were prospectively collected and retrospectively analyzed and included all aneurysms with indication to repair affecting the celiac, superior mesenteric artery, inferior mesenteric artery or their branches or the renal arteries and/or their branches. Patients with arteriovenous fistula were excluded from the present study.

Patients' Characteristics

Demographic and clinical characteristics of the enrolled patients included the following: sex, age, hypertension (defined as systolic blood pressure>140 mm Hg or diastolic blood pressure>90 mm Hg), dyslipidaemia (defined as total cholesterol level >200 mg/dL or low intensity lipoprotein level >120 mg/dL or specific therapy), diabetes mellitus (prediagnosed in therapy with oral hypoglycaemic drugs or insulin), coronary artery disease (defined as history of angina pectoris, myocardial infarction or coronary revascularization), chronic obstructive pulmonary disease (defined as chronic bronchitis or emphysema), active smoking, chronic kidney disease (defined as glomerular filtration rate <30 ml/min), obesity (defined as BMI >30), and atrial fibrillation.

Data about possible concomitant aneurysms of other visceral, aorto-iliac, or lower limbs arteries were also collected. Clinical presentation (asymptomatic or with abdominal pain), and anatomical features of the aneurysm and the target artery were evaluated.

Treatment was performed in case of pseudoaneurysms of any diameter or true VAAs with a diameter >20 mm or a growth rate >0.5 cm/year.

Diagnosis and Preoperative Assessment

All the patients underwent a preoperative thoracoabdominal and iliac axis computed tomography angiography (CTA) to evaluate the morphology of the aneurysm (saccular or fusiform), its location (proximal, medium, or distal third of the involved visceral vessel), and the following parameters (Fig. 1).

a) tortuosity index of the involved artery (<150°) (Fig. 2),
b) healthy arterial diameter (>4 mm),
c) VAA proximity to the hilum and/or presence of a bifurcation of the aneurismatic artery,
d) circumferential calcium presence.

The tortuosity index (TI) was measured on preoperative CTA images by summing all the angles obtained between the axis of each arterial segment in relation to the main aortic axis. The mean TI used as a cutoff for endovascular treatment was 150°.

If (a) and (b) criteria were both satisfied in absence of (c) and (d) ones, the anatomy was deemed suitable for an endovascular treatment. Otherwise, it was defined a challenging anatomy, and a surgical treatment was considered an alternative option. If (a) and/or (b) criteria were not satisfied, surgical repair was the preferred treatment strategy.

Femoral-iliac and subclavian axes diameter and thrombosis and/or calcification amount were also preoperatively evaluated to plan an endovascular treatment.

Endovascular and Surgical Procedure

All the endovascular interventions were performed by vascular surgeons in a hybrid suite under spinal or general anesthesia. Endovascular procedures were performed using a surgical femoral and/or left brachial access. All the patients underwent intraoperative heparinization to maintain the activated clotting time > 200 sec. Self-expandable or balloon-expandable stent-grafts were used to preserve the patency of the vessel possibly in association with sac embolization. The sac-packing technique of saccular aneurysms with a narrow neck was also an option; conversely, the occlusion of the feeding artery with consequent organ hypoperfusion was not considered a primary endovascular strategy.

The open surgical repair was performed under general anesthesia with a transperitoneal approach. Open repair options included proximal and distal ligation of the aneurysm, aneurysmectomy with end-to-end anastomosis and arterial reconstruction using a prosthetic graft.

Statistical Analysis

All categorical variables were expressed as frequencies and percentage and compared using Fisher's exact test; continuous variables were expressed with median and interquartile range and compared using Mann−Withney *U*. In all the statistical tests, *P* values (2-tails) of 0.05 or less were considered statistically significant. The statistical analysis was performed using SPSS 23.0 for Apple (SPSS Inc, Chicago, Illinois, USA).

The database was filled in with information gathered from the electronic hospital records, where the data collected cannot be traced back to the individual patients, protecting their privacy. All patients have been contacted individually and got informed verbally about the research, while collecting data on their follow-up assessment. All data analyzed were collected as part of routine diagnosis and treatment. All patients had the right to withdraw from the study at any time.

RESULTS

Demographic, Clinical, and Anatomical Characteristics

A total of 31 asymptomatic VAAs (28 patients) underwent elective treatment in a single vascular center in the designated period. No symptomatic or ruptured cases were encountered. Thirty out of 31 (96.8%) VAAs were identified as true aneurysms.

Patients were predominantly males (20; 64.5%) with a mean age of 62 years (range 17−87). Ten (35.7%) patients had concomitant aneurysms. Among these, 5 patients had 2 different aneurysms in addition to the one that was managed.

Preoperative demographic and clinical characteristics are listed in Table III.

Eighteen (58%) VAAs affected the splenic artery, 6 (19.4%) the renal artery, 5 (16.2%) the common hepatic artery, 1 (3.2%) the pancreatoduodenal artery, and 1 (3.2%) the gastroepiploic artery. Most of the aneurysms (23; 74.2%) had a saccular morphology, while 7 (22.6%) were fusiform, and 1 (3.2%) was classified as a pseudoaneurysm. Imaging analysis revealed that about half of the aneurysms presented with thrombosis (48.4%) and/or

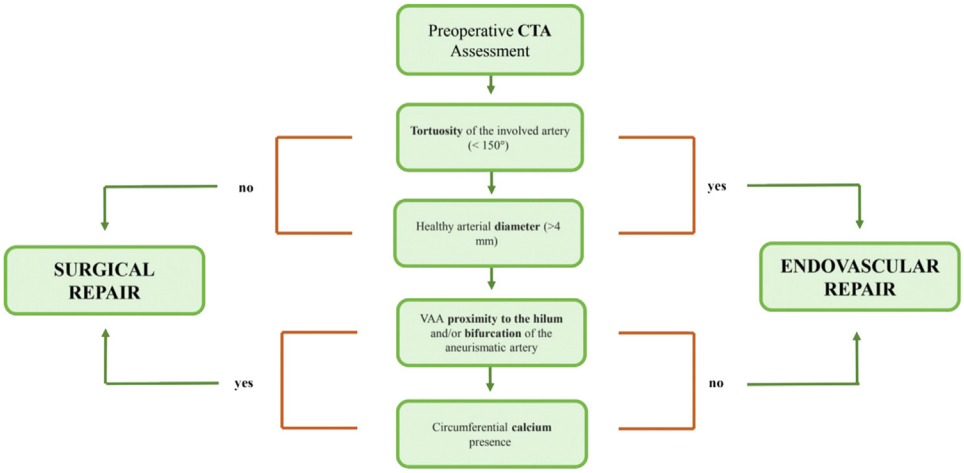

Fig. 1. Preoperative CTA assessment flow chart to define endovascular repair feasibility. CTA, computed tomography angiography; VAA, visceral artery aneurysms.

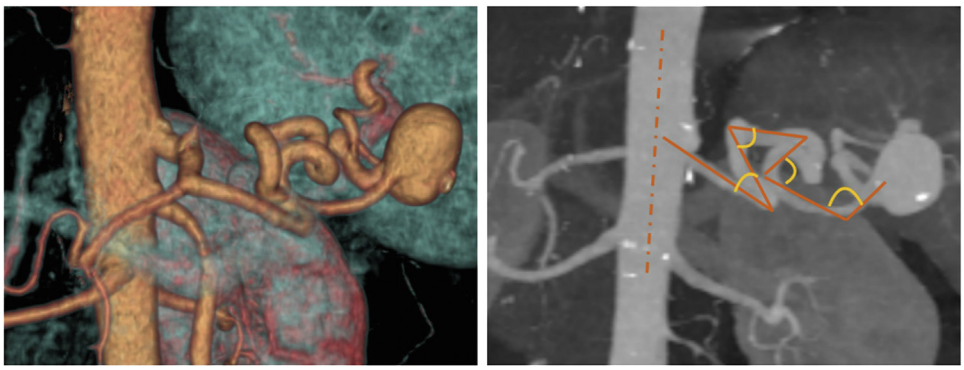

Fig. 2. Tortuosity index (TI) measurement.

calcifications (45.2%), while 9 (29%) showed neither of these characteristics. The 31 asymptomatic VAAs were distributed as provided in Table IV.

Operative Details

All interventions were performed electively. Twenty-two (71%) VAAs underwent an endovascular repair, while 9 (29%) were surgically treated. The proportion of endovascular or surgical repair performed according to the involved visceral artery is reported in Figure 3.

Endovascular repair was the first-line treatment modality for VAAs management. In 15 cases (68.2%), a stent was deployed. GORE® VIABAHN Endoprosthesis (W.L. Gore & Associates, Inc., Newark, Delaware, United States) self-expandable stent-graft was the most frequently employed one (13; 86.7%). Advanta (Atrium Medical Corporation, Merrimack, NH) balloon-expandable stent-graft was deployed in 4 (26.7%) procedures, and in 2 of them it was used in combination with GORE VIABAHN Endoprosthesis. Furthermore, a combined approach using both stent-grafts and embolizing materials was adopted in 6 (27.3%) procedures.

Four (18.2%) saccular VAAs with a narrow neck involving a tortuous artery were treated using embolizing materials with preservation of the vascularization of the involved organ (sac-packing technique). Coils were employed in all 4 (100%) procedures, using MReye Embolization Coils (Cook Medical, Bloomington, U.S.A.) in 2 procedures (50%), Concerto Detachable Coil System (Medtronic, Minneapolis, United States) in 4 procedures (100%), and once (25%) AZUR™ CX Peripheral Coil System (Terumo, Shibuya, Tokyo,

Table III. Preoperative demographic and clinical characteristics of the enrolled patients

	n (%)
Male	20 (64.5%)
Age	62 (17–87)
Hypertension	25 (80.6%)
Dyslipidemia	18 (58.1%)
Diabetes	2 (6.5%)
Ischemic heart disease	2 (6.5%)
Chronic obstructive pulmonary disease	4 (12.9%)
Smoking	12 (51.6%)
Chronic kidney disease	13 (41.9%)
Body mass index (kg/m^2)	25.8[a]
Atrial fibrillation	4 (12.9%)
Patients with oncomitant aneurysms	10 (35.7%)

[a]Mean.

Table IV. VAAs characteristics

	n (%)
Anatomical location	
Splenic artery	18 (58%)
Renal artery	6 (19.4%)
Common hepatic artery	5 (16.2%)
Pancreatoduodenal artery	1 (3.2%)
Gastroepiploic artery	1 (3.2%)
Morphology	
Saccular	23 (74.2%)
Fusiform	7 (22.6%)
Pseudoaneurysm	1 (3.2%)
Arterial Location	
Proximal third	7 (22.6%)
Middle third	6 (19.4%)
Distal third	9 (29%)
Bifurcation	3 (9.7%)
Hilar	6 (19.4%)
Size (mm)[a]	
Splenic AA	29 (16–90)
Renal AA	25.5 (12–44)
Hepatic AA	34 (15–52)
Pancreatoduodenal AA	30
Gastroepiploic AA	40
Thrombosis	15 (48.4%)
Calcification	14 (45.2%)
Symptomatic	0 (0%)
Ruptured Aneurysm	0 (0%)

AA, artery aneurysm.
[a]Mean.

Japan). Additionally, Amplatzer Vascular Plug (Abbott, North Chicago, U.S.A.) was deployed in one procedure (25%).

Intraoperative conversion from an endovascular procedure to surgery was necessary in a single patient (4.5%), due an intraoperative bleeding during attempts to embolize a tortuous splenic artery using a vascular plug. The artery was secured through open surgery and the aneurysm was excluded by ligation. A postoperative CTA revealed the exclusion of the aneurismal sac with good spleen perfusion by collateral arteries. As an accessory find, it was detected an asymptomatic pulmonary embolism. Deep venous thrombosis and cardiac alterations were excluded, and the patient was discharged in good clinical conditions on the 13th postoperative day on its usual oral anticoagulant therapy.

Three aneurysms (9.7%), involving a tortuous splenic artery, could not be successfully excluded using an endovascular approach due the impossibility of advancing and deploying materials within the target artery. These procedures were halted to prevent possible iatrogenic ruptures. In all 3 instances, a final angiography revealed the absence of complications, such as vascular dissection or rupture. These splenic artery aneurysms (SAA) underwent an elective surgical intervention within a week, and they were treated with ligation and aneurysmectomy.

Nine (29.0%) VAAs underwent first-line open surgical repair. Five (55.6%) were treated with ligation of the involved artery, while in 3 (33.3%) VAAs — one splenic, one hepatic, and one renal — an aneurysmectomy and end-to-end anastomosis was performed to preserve the vessel integrity. A single (11.1%) SAA was treated with aneurysmectomy and Dacron Silver vascular graft interposition.

The technical success rate was 90.3% (28 cases), with 3 aneurysms (9.7%) that could not be successfully excluded by endovascular repair and needed a surgical reintervention.

There were no intraoperative deaths neither cases of ruptured aneurysms.

Early Results

The mean hospital stay was 8 days. No perioperative death occurred.

Twenty-five (80.6%) cases underwent postoperative imaging assessment to detect any potential postoperative complication. Among these, 20 (80.0%) underwent CTA, 3 (12%) Doppler Ultrasound, and 2 (8%) both imaging modalities concurrently. No postoperative surgical or endovascular procedure related complication occurred. In 3 cases, a surgical elective re-intervention was performed 1 week after the first endovascular procedure due its failure to treat a tortuous SAA.

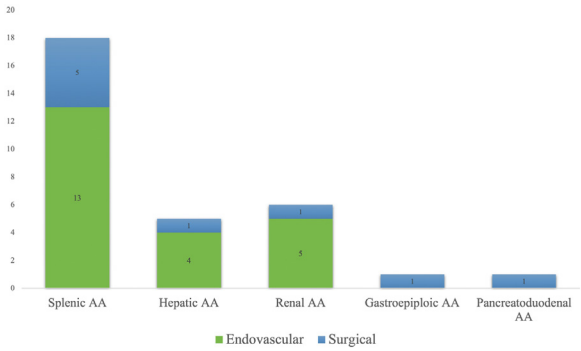

Fig. 3. Endovascular versus surgical approach according to the involved visceral artery. AA, artery aneurysm.

Follow-up Results

The mean follow up was 28 months.

The survival rate was 90.3%. Three deaths occurred during the follow-up period, and they were not related to the vascular intervention. All 3 cases experienced neither intraoperative nor postoperative complications, nor did they require reintervention.

During the follow-up period, a total of 3 (9.7%) complications were documented at CTA. These complications were persistent aneurysm perfusion, type 1 endoleak and asymptomatic stent-graft thrombosis, respectively.

The persistent aneurysm perfusion was monitored through CTA studies, and over time, the aneurysm underwent complete thrombosis, resulting in exclusion. The type 1 endoleak was managed through endovascular relining, utilizing a covered stent. Stent-graft thrombosis in the context of a hepatic artery aneurysm did not require reintervention due its asymptomatic nature; adequate blood perfusion to the liver was maintained through collateral vessels.

DISCUSSION

The present study reports an 8-years monocentric experience in the elective treatment of visceral arteries aneurysms using a dedicated preoperative algorithm. Patients were treated by endovascular repair when technically feasible according to the above-mentioned flow chart (Fig. 1). Open surgery was considered a first line option in the remaining cases. Thirty-one asymptomatic aneurysms were treated: 22 (71%) of them endovascularly (stent-graft deployment and/or transcatheter embolization) and 9 (29%) surgically (aneurysm resection with or without bypass). This preoperative algorithm allowed us to reach a 90.3% technical success rate.

Few data are available in the literature about VAAs management and postoperative outcomes.

In the last years, endovascular repair has been usually considered the first-line option for VAAs treatment because of its lower invasiveness than open surgery, shorter hospital stays, and better patient's acceptance, but the type of treatment should be individualized according to the anatomy and general clinical conditions of the single patient.[3,6] Specifically, patient fitness and comorbidities and preoperative CTA must be carefully evaluated to plan the best treatment strategy for the single patient. Target visceral vessel and aneurysm anatomical features (diameter, angle of emergence, tortuosity, bifurcation and calcification of the target artery, aneurysm size, proximity to the hilum and risk of target organ ischemia) and femoral-iliac or subclavian-axillary access evaluation are necessary.[7] In our practice, the following parameters are usually evaluated on the preoperative CTA: tortuosity of the involved artery (<150°), healthy arterial diameter (>4 mm), VAA proximity to the hilum and/or bifurcation of the aneurismatic artery, and circumferential calcium presence, in order to assess the suitability of a first-line endovascular approach. In the literature, there is a lack of data regarding the assessment of the tortuosity index (TI) of visceral vessels, unlike iliac axes or carotid arteries.[8,9]

The aneurysm treatment was performed in most cases by stent-graft deployment with or without coil embolization of the aneurysmal sac, and in few cases of saccular VAAs with a narrow neck involving a tortuous artery by transcatheter embolization alone using the sack-packing technique. When a challenging anatomy (high tortuosity of the target artery, small arterial diameter, proximity to the hilum, high calcification) was found at preoperative CTA, and the patient was considered fit for surgery, a first-line surgical repair was preferred.

A recent systematic review and metanalysis by Barrionuevo et al.[10] showed that there is no significant difference between open and endovascular repair, with low short-term and long-term mortality in both arms. However, it is unclear if this finding could be related to the small sample size of the available studies.[10,11] In our experience, no perioperative death occurred after either the endovascular or surgical treatment. Long-term survival was 90.3%, and the 3 late deaths occurred during the follow-up period were not VAA related.

Complications such as respiratory and cardiac ones and wound infections are more likely to occur with a surgical approach, therefore if the

endovascular approach warrants similar efficacy in terms of VAA treatment it should be reasonably preferred.[10]

Covered stents allow to repair the arterial wall yet preserving the vessel patency and minimizing target organ ischemic risks. In line with our experience, Venturini et al.[7] suggest the use of self-expandable stent-grafts (GORE VIABAHN Endoprosthesis) for VAAs endovascular repair, given their good flexibility and adaptability to the arterial sinuosity. However, in case of tortuous visceral vessels, stent-graft deployment is often not feasible.

In those cases, transcatheter embolization remains the only endovascular option. This technique allows the aneurysm exclusion, but it can lead to target organ ischemia. When the VAA involves only the artery side wall and it has a narrow neck, the sac-packing technique allows to embolize only the aneurysmal sac without target artery occlusion.[7] In our experience, all the few cases of embolization alone were performed using such a technique to exclude the VAA arising from a tortuous artery preserving the target organ perfusion. Many different materials (coils, plugs, embolic agents) are available for transcatheter embolization, but coils embolization remains the most used technique.[7] Our practice is in line with these data, as coils were the preferred material for transcatheter embolization.

Dorigo et al.[6] reported a non-negligible rate (3/26 patients; 11.5%) of technical failure of the endovascular approach in patients with difficult anatomies (tortuous arteries, small-caliber arteries). As many others, they underlined the importance of a tailored approach based on the site and anatomy of the involved vessels.[6,11] In our experience, 3 endovascular procedures were halted because of an impossible material navigation inside the target artery. These patients underwent a subsequent elective surgical repair of the aneurysm. Even if all of them had a highly tortuous splenic artery, a first-line endovascular treatment was attempted because of the patients' preference. One more patient needed an intraoperative surgical conversion due an intraoperative bleeding during attempts to embolize a tortuous splenic artery using a vascular plug; this occurrence should be considered when planning the endovascular treatment and should prevent to exaggerate with the endovascular maneuvers.

Lifelong follow up imaging is of paramount importance after VAAs repair, especially for those treated with an endovascular approach. Many authors report higher reintervention rates for the endovascular repair if compared to open surgery.[10,11] It is mostly due to late aneurysm recanalization or persistent aneurysm perfusion. Risk factors are the large aneurysm size and, once more, the high tortuosity of the target artery.[11] In our experience, only one patient underwent reintervention following the detection of a type 1 endoleak during follow-up imaging. An endovascular relining with stent-graft deployment was successfully performed. A case of persistent aneurysm perfusion was monitored through CTA studies, and it did not need any intervention because the aneurysm underwent complete thrombosis over time. At the follow-up imaging, it was also observed an asymptomatic hepatic artery stent-graft thrombosis, which did not require further intervention, as collateral vessels ensured adequate blood perfusion to the liver.

The present study has certain limitations, including its retrospective analysis and the low number of patients, due the rarity of the pathology. An additional limitation is the absence of an available cutoff value in the literature for the TI of visceral arteries, leading us to use a TI value from another anatomical district.

CONCLUSIONS

Data about VAAs management are limited. Endovascular management as a first line approach is usually safe and effective and a dedicated preoperative algorithm is useful to identify suitable cases. Open surgery can be considered an alternative first line option in challenging anatomical situations (tortuous visceral arteries, small caliber arteries, and proximity to the hilum) or in case of endovascular failure.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Sara Pomatto: Investigation, Writing — original draft. **Rodolfo Pini:** Conceptualization, Formal analysis, Supervision, Writing — review & editing. **Gianluca Faggioli:** Conceptualization, Supervision, Writing — review & editing. **Carmine Poliseno:** Investigation. **Betti Shyti:** Investigation. **Mauro Gargiulo:** Supervision, Writing — review & editing.

REFERENCES

1. Obara H, Kentaro M, Inoue M, et al. Current management strategies for visceral artery aneurysms: an overview. Surg Today 2020;50:38–49.
2. Wolk S, Distler M, Radosa C, et al. Management and outcome of true visceral and renal artery aneurysm repair. Langenbecks Arch Surg 2021;406:623–30.
3. Chaer RA, Abularrage CJ, Coleman DM, et al. The Society for Vascular Surgery clinical practice guidelines on the management of visceral aneurysms. J Vasc Surg 2020;72:3S–39S.

4. Berek P, Kopolovets I, Dzsinich C, et al. Interdisciplinary management of visceral artery aneurysms and visceral artery pseudoaneurysms. Acta Med 2020;63:43–8.
5. Silingardi F, Gennai S. Visceral and renal artery aneurysms. Torino, Italy: Edizioni Minerva Medica S.p.A., 2021.
6. Dorigo W, Pulli R, Azas L, et al. Early and intermediate results of elective endovascular treatment of true visceral artery aneurysms. Ann Vasc Surg 2016;30:211–8.
7. Venturini M, Marra P, Colarieti A, et al. Covered stenting and transcatheter embolization of splenic artery aneurysms in diabetic patients: a review of endovascular treatment of visceral artery aneurysms in the current era. Pharmacol Res 2018;135:127–35.
8. Fenelli C, Gargiulo M, Prendes CF, et al. Effect of iliac tortuosity on outcomes after iliac branch procedures. J Vasc Surg 2022;76:714–723.e1.
9. Faggioli G, Ferri M, Gargiulo M, et al. Measurement and impact of proximal and distal tortuosity in carotid stenting procedures. J Vasc Surg 2007;46:1119–24.
10. Barrionuevo P, Malas MB, Nejim B, et al. A systematic review and meta-analysis of the management of visceral artery aneurysms. J Vasc Surg 2019;70:1694–9.
11. Keschenau PR, Kaisaris N, Jalaie H, et al. Management strategies for true and dissecting visceral artery aneurysms. J Cardiovasc Surg 2020;61:340–6.