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Endovascular Treatment of Mycotic Aortic and Iliac Aneurysms in a Tertiary Center: A 15-Year Experience

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Abstract

Objective This retrospective case series reports the 15-year experience of the endovascular management of mycotic aortic and iliac aneurysms (MAAs) at a tertiary referral center in the United Kingdom.

Materials and Methods The patients were identified through advanced searches in picture archiving and communication system (PACS) and electronic patient records. Data were retrieved and recorded in a structured spreadsheet including demographic details, symptoms and comorbidities, endovascular techniques employed and graft types, as well as treatment outcomes including 30-day mortality, 1-, 3-, and 5-year survival, aneurysm resolution percentage, and rates of re-intervention and complications.

Statistical Analysis Descriptive statistics summarized the demographic and clinical characteristics, presenting them as means for continuous variables and frequencies/percentages for categorical variables.

Results Of the 15 included patients, 73.3% (11/15) and 26.7% (4/15) were males and females, respectively, with a mean age of 64 years. Imaging revealed diverse anatomical involvement, with MAA in the descending thoracic (6/15), suprarenal and juxtarenal (5/15), infrarenal (3/15), and common iliac arteries (1/15). The 30-day mortality rate was 6.7% (1/15), while 1-, 3-, and 5-year survival rates from time of initial intervention were 57.1% (8/14), 38.5% (5/13), and 30.8% (4/13), respectively, with 1 case only just having undergone 1-month follow-up (performed in July 2023). The average mycotic aneurysm size was 47 mm (range: 19–80 mm), of which 33.3% (5/15) presented with rupture. The average sac size reduction following treatment was 31%, with 5/15 cases demonstrating complete resolution. Four cases required re-intervention due to persistent endoleak, sac re-expansion secondary to delayed endoleak, or stent occlusion. Persistent or recurrent graft infection was observed in 53.3% (8/15) of cases. Two cases required surgical re-intervention for stent occlusion.

Conclusion Our findings reinforce the role of endovascular interventions in MAA acute management, showcasing immediate survival benefits. Late complications and frequent re-interventions emphasize the importance of vigilant surveillance.

Keywords
- endovascular
- aortic aneurysm
- mycotic
- aortic graft

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Introduction

Mycotic aortic aneurysm (MAA) represents a heterogeneous disease entity of pathological infective dilatation of the aorta carrying a high risk of mortality and morbidity. It is traditionally thought of as primary or secondary, the latter relating to an antecedent source of infection often with a confirmed bacteremia. Immunosuppression, atherosclerosis, and preexisting aneurysms are all thought to be important risk factors.[1] Typical imaging findings on computed tomography (CT) include focal saccular dilatation often with a multilobulated appearance, peri-aortic fat stranding, gas-containing para-aortic collections, or adjacent septic foci such as paravertebral abscesses. Patients present chiefly with pyrexia or sepsis along with symptoms proportionate to the aortic segment involved: abdominal, chest, or back pain; shortness of breath; syncope; and hemoptysis. *Staphylococcus aureus*, *Salmonella*, and *Streptococcus pneumoniae* are among the most commonly identified causative organisms; however, the spectrum of infections has been found to be quite extensive.[2,3]

Traditional treatment consists of immediate and long-term intravenous antibiotic therapy with open surgical repair (OSR) and an extra-anatomic or in situ bypass. A growing body of evidence also supports the role for endovascular approaches such as endovascular aortic repair (EVAR), particularly in comorbid states precluding immediate surgery, as immediate risk mitigation or indeed as a palliative measure. Evidence is largely limited to case reports and a handful of cohort studies providing midterm outcomes such as Sörelius et al[4] and Lee et al[5] reporting on 130 and 82 MAA patients, respectively. A recent systematic review by Li et al found that early mortality rates for supra- and infrarenal MAAs managed endovascularly were lower (5.4 and 1.8%, respectively) compared to those managed by OSR (43.2 and 16.7%, respectively).[6] However, endovascular approaches were also found to be associated with higher rate of complications including re-infection and need for re-intervention, which constitute an ongoing concern. This study reports on a tertiary referral center's 15-year experience of endovascular management of abdominal and thoracic MAA.

Materials and Methods

Case Selection and Data Collection

This retrospective case series aimed to comprehensively analyze the radiological features and outcomes of patients with MAAs who underwent imaging evaluation and endovascular treatment at a tertiary level regional vascular center in London, United Kingdom, between 2009 and 2024. Patients were identified through advanced searches in picture archiving and communication system (PACS) and electronic patient records. The inclusion criteria comprised cases with confirmed MAAs based on clinical, laboratory, and imaging findings that were treated with endovascular repair. Exclusion criteria included cases with incomplete or inadequate imaging data and cases with MAA that were treated with OSR. Radiological evaluation of screened cases was performed by interventional radiologists including detailed measurement and descriptions of aneurysm size, location, and morphology. The presence of associated findings, such as peri-aortic changes, thrombus, or vascular complications, was also documented.

Statistical Analysis

Descriptive statistics were used to summarize demographic and clinical characteristics. Continuous variables were presented as means and categorical variables were expressed as frequencies and percentages. When performing survival analyses for the 1-, 3-, and 5-year intervals, patients were included in these if they were alive at the relevant intervals. If patients were operated recently and are still alive but have not reached this interval, they were excluded from the relevant analysis. For example, of the 15 patients, 9 patients were treated between 2009 and 2019 and have therefore had up to 5-year follow-ups and included in all analyses (1, 3, and 5 years). Of the remaining six patients treated between 2019 and 2023, four are deceased and have been included in the 1-, 3-, and 5-year survival analyses, but two patients are still alive and yet to have their 3- and 5-year follow-ups, so they have been excluded from these.

Ethical Considerations

This study was conducted in accordance with the principles of the Declaration of Helsinki and an institutional review board approval was secured before initiating the data collection process. Patient confidentiality and privacy were strictly maintained throughout the study.

Results

Patient Demographics

A total of 15 patients were included in the analysis, of which 11 (73.3%) were males and 4 (26.7%) were females. The mean age of the included patients was 64 years (range: 41–89 years). Most patients were diagnosed with MAA after presenting in the emergency department with symptomatology as described in ►**Table 1**, while some were long-standing diagnoses and chronic symptoms. The main clinical findings of these patients were pain (73.3%), shortness of breath (53.3%), and pyrexia (53.3%).

Comorbidities

The comorbidities of the included patients are summarized in ►**Table 1**. Heart disease was defined as either echocardiographic reduced ejection fraction, known coronary artery disease, or previous percutaneous coronary intervention. Two patients (13.3%) suffered from chronic kidney disease, one was human immunodeficiency virus (HIV) positive, and two (13.3%) had latent/active tuberculosis (TB). One (6.7%) patient had systemic lupus erythematosus (SLE) with a kidney transplant.

Causative Pathogen

Proven bacteremia was confirmed in 46.7% (7/15) of cases either at presentation (20.0%, $n = 3$) or during their in-

Table 1 Summary of demographics, presentation, and comorbidities

	n	%
Gender		
Male	11	73.3
Female	4	26.7
Age (y)	64	
Symptomatology		
Pain	11	73.3
Shortness of breath	8	53.3
Fever at presentation	8	53.3
Shock	3	20.0
Hemoptysis	1	6.7
Comorbidities		
Diabetes	4	26.7
Hypertension	10	66.7
Dyslipidemia	8	53.3
Heart disease	8	53.3
Chronic kidney disease	2	13.3
Venous thromboembolism	1	6.7
Immunocompromise	2	13.3
HIV	1	6.7
TB	2	13.3

Abbreviations: HIV, human immunodeficiency virus; TB, tuberculosis.

hospital stay (26.7%, $n = 4$). Five (33.3%) had *S. aureus* and/or *Escherichia coli* (13.3%) or streptococcal bacteremia (6.7%). Of the 15 patients, 14 (90.9%) had been treated with immediate antibiotics (within 24 hours) due to either presumed mycotic aneurysm or secondary sepsis. Long-term intravenous antibiotics was ensured on discharge of at least 6 weeks, variably extended according to clinical condition, microbiology advice, and culture and sensitivity results. Concurrent steroid treatment was used in the SLE patient with kidney transplant and only later (2 days postadmission) were antibiotics started as the differential changed to favor infection.

Aneurysm Anatomical Location and CT Findings

All admitted patients underwent CT imaging as an index scan to look for the cause of symptoms, which prior to the CT were often assumed to be due to respiratory or urosepsis. Additional dedicated aortic imaging in the arterial phase was performed if not performed on the initial CT scan. Six cases involved the thoracic aorta (40.0%), five (33.3%) aneurysms involved the suprarenal or juxtarenal aorta (►**Figs. 1** and **2**), and three cases (20.0%) the infrarenal aorta (►**Fig. 3**). One case (6.7%) was limited to the common iliac and common femoral arteries. Most cases (73.3%) demonstrated either CT features of collections adjacent to the aneurysm with or without gas loculations or perivascular fat stranding or fluid. None underwent adjunctive drainage. The average aneurysm size was 47 mm (range: 19–80 mm), and 33.3% (5/15) patients presented with rupture and clinical sequelae associated with this.

Technical Details

►**Table 2** provides a summary of the graft devices utilized in the included cases. The average length of time from presumed diagnosis to intervention was 7 days with nonimmediate intervention (over 7 days) attributed to unstable patients (1/15, 6.7%; treated with antibiotics and intensive care), stent unavailability (1/15, 6.7%), and chronic/known aneurysm under monitoring (2/15, 13.3%).

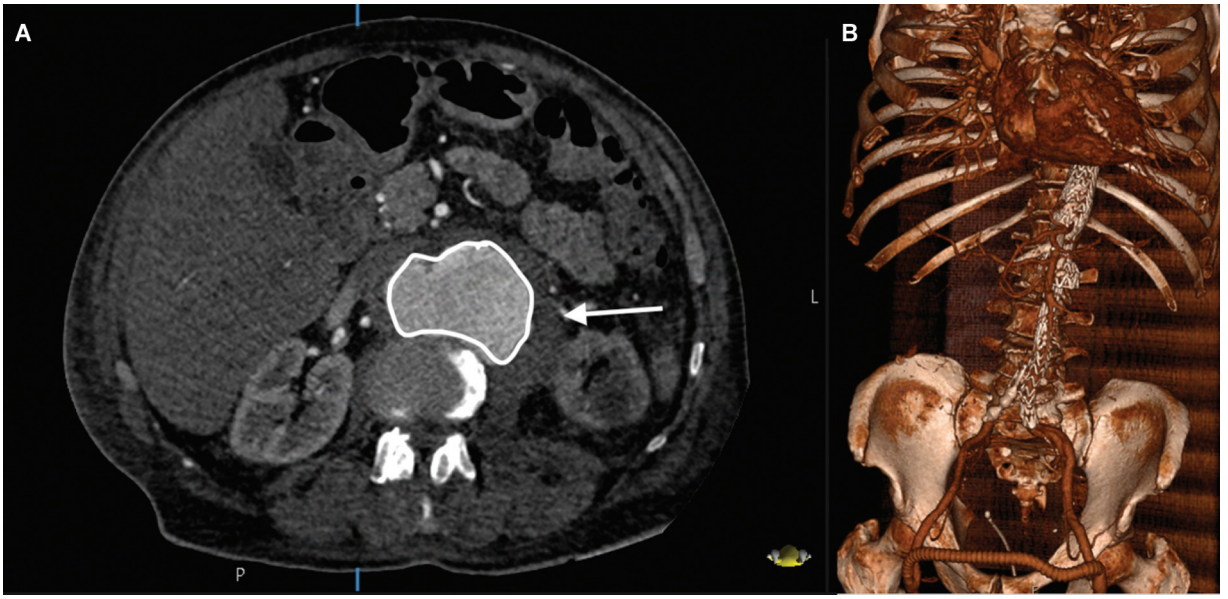

Fig. 1 Juxtarenal mycotic aortic and iliac aneurysm (MAA) on computed tomography (CT) angiographic imaging with (**A**) peri-aneurysmal collection/stranding (*arrow*) with (**B**) postendovascular management in three-dimensional reconstruction.

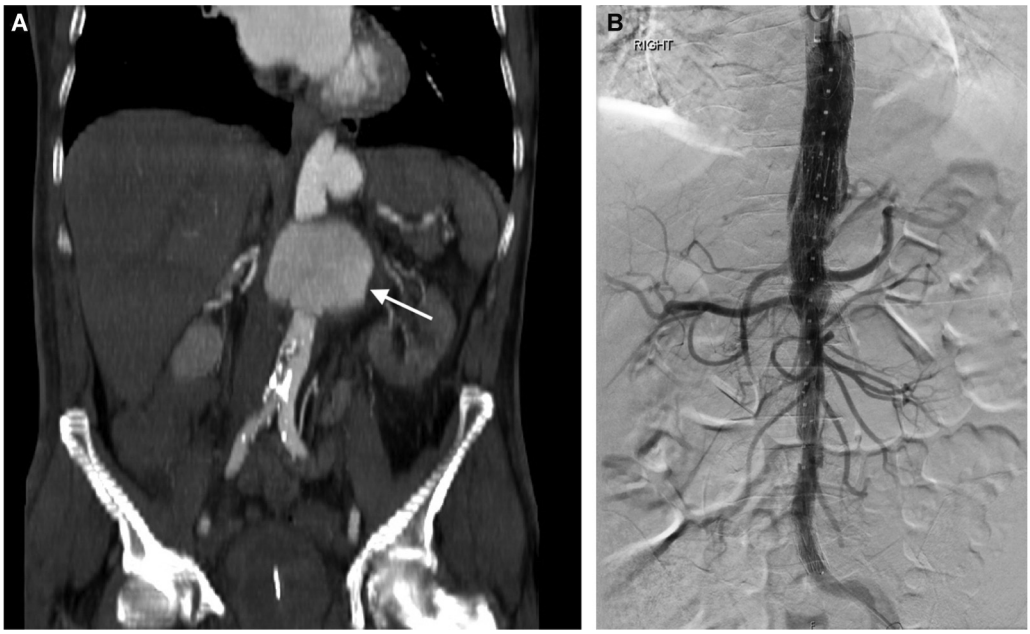

Fig. 2 (**A**) Pre-endovascular treatment maximum-intensity projection computed tomography (CT) angiographic image of the mycotic aortic and iliac aneurysm (MAA; *arrow*) with (**B**) post–endovascular aortic repair (post-EVAR) digital subtraction angiographic appearance.

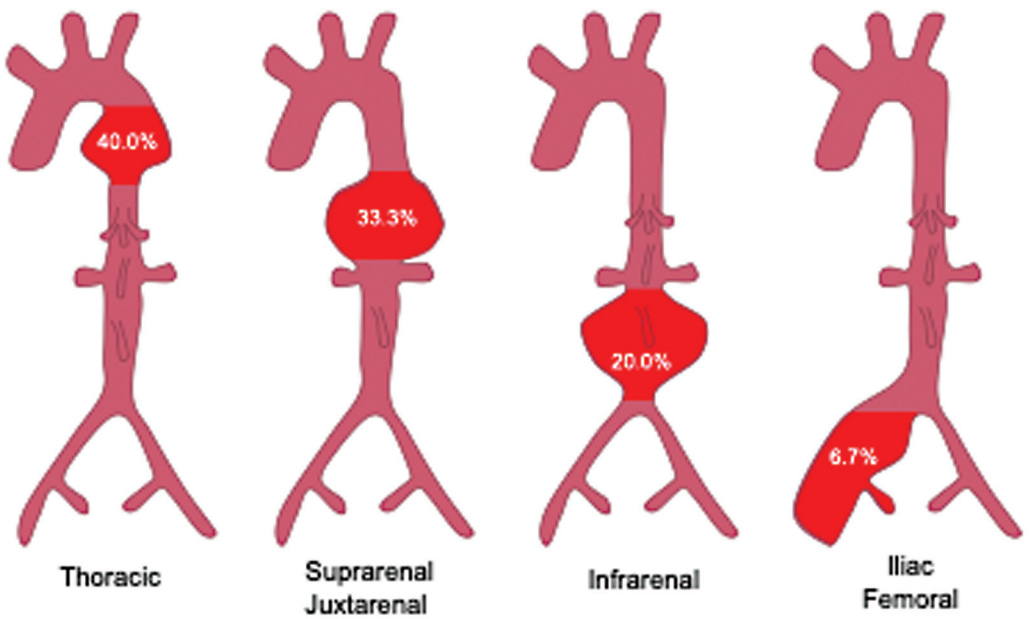

Fig. 3 Anatomical location of mycotic aneurysms.

Table 2 Summary of graft systems used

	N	Main body stents	Chimney stents		
			Coeliac axis	SMA	MRA
Descending thoracic	6	GORE TAG	–	–	–
Suprarenal, juxtarenal	5	GORE TAG	GORE VIABAHN	GORE VIABAHN	GORE VIABAHN Protégé GPS
Infrarenal	3	INCRAFT AAA Stent GORE EXCLUDER Stent	–	–	–
Common Iliac	1	GORE VIABAHN VBX	–	–	–

Abbreviations: MRA, main renal artery; SMA, superior mesenteric artery.

Table 3 Summary of 30-year mortality and 1-, 3-, and 5-year survival per aortic segment

	N	30-d mortality	1-y survival	3-y survival	5-y survival
Descending thoracic	6	0.0% (0/6)	66.7% (4/6)	66.7% (4/6)	33.3% (2/6)
Suprarenal/juxtarenal	5	20.0% (1/5)	60.0% (3/5)	25.0% (1/4)	25.0% (1/4)
Infrarenal	3	0.0% (0/3)	33.3% (1/3)	0.0% (0/2)	0.0% (0/2)
Combined abdominal	8	12.5% (1/8)	50.0% (4/8)	16.7% (1/6)	16.7% (1/6)

Follow-Up and Outcomes

The 30-day mortality of all treated cases was 6.7% (1/15) with 14 patients (93.3%) achieving satisfactory clinical progress leading to their eventual discharge following intervention.

Follow-up of almost all patients was conducted with repeat CT or MR angiographic imaging with variable surveillance at 1-, 6-, and 12-month intervals. Surveillance imaging beyond this stage was highly variably and unavailable partly due to some patients repatriating to referring hospitals and/or lost follow-ups.

The 1-, 3-, and 5-year survival rates from time of initial intervention were 57.1% (8/14), 38.5% (5/13), and 30.8% (4/13), respectively (►**Table 3**). Of the 13 patients who underwent surveillance scans at our institution, there was an average sac size reduction of 31%, with 5 cases (33.3%) demonstrating complete resolution and 3 (20.0%) endoleak cases showing re-expansion.

Six (40.0%) patients underwent at least one re-intervention. These were due to the following:

- Unsuccessful exclusion of the aneurysm secondary to a type I endoleak.
- Aortic occlusion requiring thrombectomy of an occluded Aorto-uniiliac (AUI).
- Type II endoleak, sac expansion, and an aorto-enteric fistula.
- Superior mesenteric artery (SMA) occlusion secondary to compression of the SMA chimney stent requiring relining of stents.

Postoperative aneurysm rupture was seen in two cases, both of which were fatal and both of which were re-intervened on. There was evidence of persistent/recurrent graft infection in 53.3% (8/15) of cases as demonstrated by subsequently performed avidity on positron emission tomography (PET) scans or worsening sepsis. Aorto-enteric fistula formation was observed in one case and new dialysis dependence in another case. Use of PET scans was limited to problem-solving in two cases. Subsequent surgical procedure was performed in two infrarenal cases with occluded stents: one femoral–femoral bypass for aortic occlusion and one bilateral axillo-profunda bypass.

Discussion

The findings of this 15-year retrospective case series on the endovascular treatment of MAAs offer valuable insights into the evolving landscape of MAA management. It also revisits the nuances and challenges associated with this complex patient population from the very diagnosis to patient selection for endovascular management and their onward surveillance.

Patient presentations and imaging findings in our chosen cohort are no different to what has been reported in previous studies, classically presenting with signs and symptoms of acute aortic syndrome and an element of sepsis. Distinguishing true embolic mycotic aneurysms from secondary infections of existing aneurysms remains a diagnostic challenge; however, the clinical significance of this is unclear as all patients are started on the same treatment algorithm.

Our reported outcomes align well with previous studies, for example, the systematic review by Li et al reporting satisfactory early mortality rates for both supra- and infrarenal MAAs managed endovascularly[6] with our reported 30-day all-cause mortality of 6.7% providing further evidence of the short-term benefits of this intervention. The significance of these results is augmented further when placed alongside surgical hesitation to operate on this complex, often comorbid and fragile patient group, which in itself goes against traditionally held beliefs of OSR being the gold standard. In addition, our 30-day mortality of 6.7% compares well with Clough et al's 30-day mortality of 11%,[7] while our higher 3-year survival in patients with thoracic aneurysm repairs (66.7%) versus abdominal aneurysms (16.7%) contradicts the recently published results from Lee et al[5] reporting better short-term and worse long-term outcomes in relation to this patient group.

This may be secondary to the comorbid state of the abdominal aortic patients, some of whom underwent delayed intervention either due to septic state and/or hemodynamic instability. In addition, despite achieving favorable early outcomes, our findings also reiterate concerns about late complications requiring re-interventions in the form of graft infection, failure to fully exclude the aneurysm sac, or occlusion of stents resulting in ischemic sequelae. The use of baseline PET/CT scanning to establish infection-related avidity in "presumed mycotic" aneurysms was very limited. This was used only once in an otherwise stable and nonseptic patient as a problem-solving tool to ascertain the nature of CT findings (infective or otherwise).

Chimney stenting of splanchnic branches was included as standard in our treatment of juxtarenal and suprarenal aneurysms and is reflective of the noninferior performance of chimney EVAR (Ch-EVAR) in emergency treatment compared to OSR in non-MAA cases.[8] Off-the-shelf branched

stent grafts (BEVAR grafts), commonly known as T-grafts, with directional branches have also been described in the literature reportedly accommodating common anatomical variations with relative technical ease of implantation.[9–11] Although the two techniques, Ch-EVAR and BEVAR/FEVAR (fenestrated grafts), demonstrate similar success rates,[12] the former remains the favorite for emergent repairs. In addition, while Ch-EVAR is thought to carry a higher risk of endoleaks, especially type 1 "gutter leaks" and as shown in one of our cases, fenestrated endovascular aortic repair (FEVAR) requires precise preoperative planning and customization, potentially increasing procedural complexity and delaying emergent treatment.

Conclusion

Our 15-year retrospective analysis of MAAs adds to the growing evidence of the crucial role of endovascular approaches in the acute management of this complex patient group, highlighting the immediate survival benefits. Distinguishing true mycotic aneurysms from secondary infections of preexisting aneurysms appears a semantic distinction at first, but can be crucial when stratifying patients into those who need emergency intervention. Concerns persist about late complications (including those from complex chimney stenting) necessitating re-interventions, highlighting the importance of strict surveillance. Ongoing research, diagnostic standardization, and long-term follow-up studies are imperative for refining treatment strategies in this challenging patient population.

Note

The article was presented earlier at PAIRS 2024, Dubai, February 2024.

Ethical Approval Statement

An institutional review board approval by the Clinical Effectiveness unit at the Trust was secured before initiating the data collection process.

Authors' Contribution

I.T., M.R.A., and A.E. conceived the research idea and designed the study. I.T. gathered the data, performed the statistical analysis of the data, and drafted the initial manuscript. O.J., M.M., D.L., I.R., M.R.A., and A.E. provided critical revisions and intellectual input and supervised the overall research process. All authors reviewed and approved the final version of the manuscript.

Conflict of Interest

None declared.

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