Eur J Vasc Endovasc Surg (2023) 66, 653—660

ORIGINAL ARTICLE

Editor's Choice – The VASCUNExplanT Project: An International Study Assessing Open Surgical Conversion of Failed Non-Infected Endovascular Aortic Aneurysm Repair

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WHAT THIS PAPER ADDS

This paper analysed data after open surgical conversion for failed endovascular aortic aneurysm repair from the VASCUNET international collaboration. It offers a unique insight into a large and real world case mix, in terms of indications, re-interventions, and techniques of open surgical conversion. Rupture and total graft explantation were significant predictors of 30 day death, while the overall 30 day mortality rate (6.1%) for elective procedures was not clinically insignificant. Greater efforts are needed to reconcile the indications and risk of elective conversion against the risk of delay and potential aneurysm rupture.

Objective: The need for open surgical conversion (OSC) after failed endovascular aortic aneurysm repair (EVAR) persists, despite expanding endovascular options for secondary intervention. The VASCUNExplanT project collected international data to identify risk factors for failed EVAR, as well as OSC outcomes. This retrospective cross sectional study analysed data after OSC for failed EVAR from the VASCUNET international collaboration.

Methods: VASCUNET queried registries from its 28 member countries, and 17 collaborated with data from patients who underwent OSC (2005 — 2020). Any OSC for infection was excluded. Data included demographics, EVAR, and OSC procedural details, as well as post-operative mortality and complication rates.

Results: There were 348 OSC patients from 17 centres, of whom 33 (9.4%) were women. There were 130 (37.4%) devices originally deployed outside of instructions for use. The most common indication for OSC was endoleak (n = 143, 41.1%); ruptures accounted for 17.2% of cases. The median time from EVAR to OSC was 48.6 months [IQR 29.7, 71.6]; median abdominal aortic aneurysm diameter at OSC was 70.5 mm [IQR 61, 82]. A total of 160 (45.6%) patients underwent one or more re-interventions prior to OSC, while 63 patients (18.1%) underwent more than one re-intervention (range 1 — 5). Overall, the 30 day mortality rate post-OSC was 11.8% (n = 41), 11.1% for men and 18.2% for women (p = .23). The 30 day mortality rate was 6.1% for elective cases, and 28.3% for ruptures (p < .0001). The predicted 90 day survival for the entire cohort was 88.3% (95% CI 84.3 — 91.3). Multivariable analysis revealed rupture (OR 4.23; 95% CI 2.05 — 8.75; p < .0001) and total graft explantation (OR 2.10; 95% CI 1.02 — 4.34; p = .04) as the only statistically significant predictive factors for 30 day death.

Conclusion: This multicentre analysis of patients who underwent OSC shows that, despite varying case mix and operative techniques, OSC is feasible but associated with significant morbidity and mortality rates, particularly when performed for rupture.

[†] A list of the collaborators in the collaborative study group is included in Appendix A.

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https://doi.org/10.1016/j.ejvs.2023.07.029

Keywords: Aortic aneurysm, Abdominal, Endovascular aneurysm repair, Device removal, Prosthesis failure, Conversion to open surgery
Article history: Received 23 February 2023, Accepted 18 July 2023, Available online 23 July 2023

INTRODUCTION

Since its introduction, endovascular aortic repair (EVAR) has become the first line treatment option for abdominal aortic aneurysms (AAA) in many patients with suitable anatomy and reasonable life expectancy, mainly owing to its reduced invasiveness compared with open surgical repair (OSR).[1,2] However, the long term durability of EVAR and need for secondary interventions still remain a concern that mandates lifelong follow up.[3] Although most re-interventions, when required, can usually be performed using endovascular methods, secondary open surgical conversion (OSC) is still required in some instances, and its incidence has been rising in recent years.[4] Previous research has demonstrated that OSC may be associated with significantly higher morbidity and mortality rates. It would be reasonable to assume that patients requiring OSC are often older and frailer compared with their counterparts undergoing primary OSR, and there are additional technical challenges that are imposed by the presence of a prior endograft. Large contemporary real world evidence needs to be accumulated in order to define risk factors associated with immediate and late prognosis following OSC.[5,6]

Given the likely case mix between countries and centres regarding treatment indication and surgical modalities in patients undergoing OSC, this study aimed to: (1) describe clinical and technical features of failed EVAR before explantation; (2) report the procedural details of OSC; and (3) analyse the outcomes for this procedure and identify patterns of high risk patients for EVAR explantation. To achieve a contemporary, multinational, large perspective with the above aims, the VASCUNExplanT project was designed to leverage data from multinational and international vascular surgery centres.[7]

METHODS

Study design

This was a retrospective cross sectional study of AAA patients who underwent OSC after failed EVAR. The reporting of the current study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement.[8] The study protocol was distributed amongst members of the VASCUNET committee of the European Society for Vascular Surgery (ESVS) and published *a priori* (www.vascunet.org, accessed on 1 May 2022). Inclusion criteria were any patient who underwent a primary EVAR procedure between January 2005 and December 2020, in whom the subsequent OSC took place $>$ 30 days following the initial procedure. Open surgical conversion is defined as either complete or partial removal of the endograft or open surgical modification of the aneurysm, including banding of the aortic neck or ligation or clipping of lumbar or inferior mesentery arteries (IMA). The indication to proceed to OSC was based on the risks of the procedure weighed against the risks of rupture, depending on the size or growth of the aneurysm and the type of endoleak, if present. Those patients who underwent OSC for infection or who received EVAR therapy for an aortic dissection or a traumatic aortic transection were excluded. All study procedures were approved by ethics committee at each participating hospital according to local legislation.

Data were collected for six categories (see Supplementary Table S1 for detailed variable definitions), including demographic and comorbidity data, and procedural data from the primary treatment. The primary procedure data included maximum aneurysm diameter, the urgency of the procedure, the specific EVAR device used, adjunctive procedures, and the technical success of the procedure. The third category was specific to adherence to the particular device's instructions for use (IFU) and aspects of non-adherence. The fourth category addressed follow up, re-interventions and indications, as well as the technical success of these procedures. The fifth category was specific to the OSC procedure in terms of the indications and urgency of the repair, surgical technique employed, and 30 day mortality rate following the procedure. The surgical technique covered both anatomical clamp placement and the method of repair: complete explantation with surgical graft interposition, partial endograft explantation with surgical graft interposition, and those where the endograft was not explanted but modified by an open surgical cerclage, or ligation or clipping of the IMA or lumbar arteries. The technique used was not matched by any criteria, rather left to the discretion of the treating surgeons. Finally, post-operative data included complications and follow up living status.

The VASCUNET collaboration

VASCUNET is an international collaboration of more than 28 vascular surgery registries from around the globe.[1,9,10] All were queried, and 17 countries could provide multicentre data from 55 vascular units (see Supplementary Table S2).

Statistical analysis

Data were assessed for normality with quantile—quantile plots. Continuous data are presented with mean values and standard deviation (SD) or median values with interquartile range [IQR]. Normally distributed data were compared using *t* tests with 95% confidence intervals (CIs), while non-normally distributed data were compared using the Wilcoxon Rank Sum test. Categorical variables are reported as absolute numbers (%) and compared

Table 1. Baseline demographics of the 348 patients who underwent open surgical conversion after a previous EVAR, in addition to the deviating factors from the device specific instructions for use

Variable	Patients (n = 348)
Age − years	75 (70-80)
Female sex	33 (9.5)
Comorbidities	
Ischaemic heart disease	144 (41.5)
Hypertension	295 (85.0)
Diabetes mellitus	47 (13.5)
COPD	47 (13.5)
CKD	73 (21.0)
Hyperlipidaemia	46 (18.0)
CVD	6 (5.3)
Primary EVAR outside IFU	130 (37.4)
Iliac tortuosity	27 (20.8)
Insufficient proximal neck length	23 (17.7)
Severe proximal neck angle	17 (13.1)
Proximal neck thrombus or calcification	13 (10.0)
Iliac diameter	3 (2.3)
More than one factor	47 (36.2)

Data are presented as n (%). CKD = chronic kidney disease; COPD = chronic obstructive pulmonary disease; CVD = cerebral vascular disease; EVAR = endovascular aneurysm repair; IFU = instructions for use.

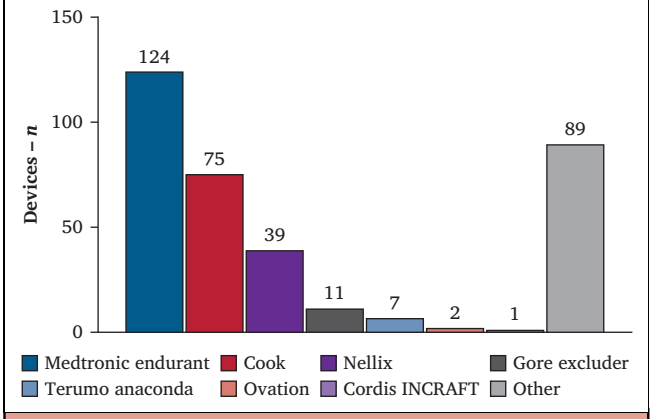

Figure 1. Bar chart demonstrating the number and manufacturer of the endovascular aneurysm repair endografts used in the primary aneurysm repair procedure. Other includes: Vanguard, Quantum, Renu, Seal, EVT, AneuRx, Powerlink, Treovance, Stentor, Ancure, Fortron, Lifepath, AFX, Homemade Endografts, and combinations.

using the χ^2 test. Binary logistic regression was used for the univariable and multivariable analysis to calculate odds ratios (ORs) with 95% CIs. Notably, variables with a p value $< .20$ in the univariable analyses were subsequently included in the multivariable analysis. No correction for multiple hypothesis testing was applied. Missing data were handled by case wise exclusion. Time to event analyses were performed using Kaplan—Meier curve estimates. A p value $< .05$ was considered statistically significant. All data analysis and graphical presentation were carried out using Stata/SE, version 16.1 (StatCorp 2019; Stata Statistical Software: Release 16. College Station, TX, USA: StataCorp LP).

RESULTS

A total of 348 individual patients who underwent OSC were identified from 55 centres; 33 (9.5%) were women and 315 (90.5%) were men. The median AAA diameter at the time of the original aneurysm exclusion procedure was 60 mm (IQR 55, 68). Further baseline characteristics and patient comorbidities are given in Table 1. Twenty-one patients (6.0%) were initially treated for AAA rupture, the majority underwent EVAR as an elective procedure. Data on the proportion of conversions (i.e., number of OSCs over the total number of EVARs performed) were unavailable. There were 329 (94.5%) bifurcated EVAR devices, 13 (3.7%) aorto-uni-iliac devices, supplemented with a femorofemoral crossover bypass, and six (1.7%) tube endografts were used. The number and type of devices are displayed in Figure 1. Notably, there were 39 Nellix devices. Of all the devices, 130 (37.4%) were placed outside of the specific device IFU (Table 1) with most (36.2%, n = 47) involving more than one exclusion factor. Furthermore, peri-operative adjunctive procedures were performed in 67 patients (19.2%), which included: embolisation (3.5%), femorofemoral bypass (3.7%), proximal cuff extension (3.7%), Palmaz stent placement (1.4%), and endo-anchor placement (1.2%). Of all the devices implanted, 92 (26.4%) had an identifiable endoleak on the completion angiogram and were specified as follows: Type I, n = 30 (32.6%); Type II, n = 56 (60.9%); Type III, n = 5 (5.4%); and Type V, n = 1 (1.1%).

There were 16 patients (4.6%) who underwent a re-intervention within 30 days following their EVAR procedure, of which 12 (75.0%) were considered technically successful. The indication for these early re-interventions included: 10 (62.5%) for Type I or Type III endoleaks, five (31.3%) for an occluded iliac limb, and one (6.3%) for access vessel bleeding. A total of 160 (45.6%) patients underwent at least one re-intervention, while 63 patients (18.1%) underwent more than one re-intervention (range 1 − 5) during follow up. The final indications for OSC are given in Table 2, as are the percentage of those patients who underwent at least one re-intervention prior to their OSC. Notably, patients with Type II endoleaks represent the highest proportion (78%). The most common indication for OSC was endoleak (n = 143, 41.1%), followed by aneurysm sac growth with no identifiable leak (n = 111, 31.9%). Ruptures accounted for 60 (17.2%) of the procedures. Of the 39 Nellix devices, 17 were treated for a Type I endoleak, while nine were treated for rupture. There were 27 patients who underwent OSC for limb thrombosis, of which 11 (40.7%) were Cook devices.

At the time of OSC, the median age of the entire cohort was 75 [IQR 69, 80] years. The female median age of 80 [IQR 73, 85] years was greater than the male median age of 75 [IQR 69, 80] years ($p < .001$). The median time from the primary EVAR to OSC was 48.6 months [IQR 29.7, 71.6],

Table 2. Final indications for the 348 open surgical conversions and the numbers and percentages of these patients who had undergone at least one previous re-intervention

Indication	Patients (n = 348)
Type I endoleak	79 (22.7)
Previous re-intervention	27 (34.2)
Type II endoleak + growth	50 (14.4)
Previous re-intervention	39 (78.0)
Type III endoleak	14 (4.0)
Previous re-intervention	6 (42.9)
Graft migration	7 (2.0)
Previous re-intervention	0
Aneurysm growth, no leak	111 (31.9)
Previous re-intervention	51 (46.0)
Limb thrombosis	27 (7.8)
Previous re-intervention	14 (51.9)
Rupture	60 (17.2)
Previous re-intervention	23 (38.3)

Data are presented as n (%).

while the median AAA diameter at the time of OSC was 70.5 mm [IQR 61, 82]. The median overall follow up from the time of OSC was 240 [IQR 30, 957] days.

The OSC technique consisted of the following: complete explantation with surgical graft interposition, 60.1%; partial explantation with surgical graft interposition, 29.3%; preservation of endograft with ligation of lumbar or IMA vessels, 8.4%; and cerclage or banding of the proximal neck with preservation of the EVAR device, 2.2%. Most (88.5%, $n = 308$) aortic exposures were transperitoneal, as opposed to retroperitoneal. Infrarenal clamping was performed in 35.6% ($n = 104$) of the procedures, while placement above specific visceral vessels was as follows: coeliac artery (20.5%, $n = 66$), superior mesenteric artery (1.9%, $n = 6$), and most proximal renal artery (36.0%, $n = 116$). There were 30 (9.3%) procedures in which no aortic clamping was performed. The median length of stay following OSC was 10 days [IQR 7, 15].

The overall OSC 30 day mortality rate was 11.8% ($n = 41$), 11.1% for men and 18.2% for women ($p = .23$). There were 102 acute procedures, of which 60 were for rupture. The remaining cases were for pain (i.e., symptomatic, and aneurysm growth or endoleak), while six patients were operated on acutely for limb occlusion. For elective cases, the 30 day mortality rate was 6.1%, whereas for non-elective cases it was 25.5% ($p < .001$). The 30 day mortality rate for those patients who ruptured was 28.3% ($n = 17$). For those procedures in which total or partial graft explantation was performed, the 30 day mortality rate was 11.9%, compared with 8.1% for those in whom the graft was preserved ($p = .60$). Univariable and multivariable analyses (Tables 4 and 5) revealed both rupture (OR 4.23; 95% CI 2.05 − 8.75; $p < .001$) and total graft explantation (OR 2.10; 95% CI 1.02 − 4.34) as statistically significant predictive factors of death within 30 days. The estimated 90 day survival, based on Kaplan−Meier curves, for the entire cohort was 88.3% (95% CI 84.3 − 91.3).

Table 3. Details of the 110 post-operative complications and 50 patients who returned to the operating theatre within 30 days after operation for open surgical conversion

	Patients (n = 348)
Complication	110
Renal failure	32 (29.1)
Myocardial infarction	17 (15.5)
Abdominal compartment syndrome	20 (18.2)
Stroke	9 (8.2)
Re-intubation	25 (22.7)
Other, unspecified	39 (35.5)
More than one	15 (13.6)
Return to operating theatre < 30 days	50
Intra-abdominal bleeding	20 (40.0)
Bowel ischaemia	10 (20.0)
Abdominal compartment syndrome	9 (18.0)
Wound dehiscence	3 (6.0)
Lower extremity ischaemia	6 (12.0)
Sepsis or infection	1 (2.0)
Anastomotic pseudoaneurysm	1 (2.0)

Data are presented as n (%).

There were 110 patients (31.6%) who experienced at least one of the post-operative complications as shown in Table 3, where renal failure was the most frequent (29.1%, $n = 32$), and 15 patients (13.6%) had more than one. There were 50 patients (14.4%) who returned to the operating theatre within 30 days; the most common indication was intra-abdominal bleeding (40.0%, $n = 20$) followed by bowel ischaemia (20.0%, $n = 10$). There were no significant predictors of return to the operating theatre within 30 days.

DISCUSSION

Despite its reduced invasiveness and better short term results, an increasing rate of complications requiring secondary procedures has been associated with EVAR compared with OSR of AAA.[11] This renders the effective

Table 4. Univariable and multivariable analyses of risk factors for 30 day death

	OR (95% CI)	p value
Univariable analysis		
Age − per year	1.04 (0.99−1.09)	.09
Aneurysm diameter − per 5 mm	1.07 (0.97−1.18)	.20
Rupture	4.35 (2.16−8.76)	<.001
Female sex	1.78 (0.69−4.61)	.24
At least one previous re-intervention	0.81 (0.42−1.57)	.54
Suprarenal clamp	1.18 (0.56−2.45)	.67
Total graft explantation	1.85 (0.93−3.71)	.08
Multivariable analysis		
Age − per year	1.03 (0.99−1.07)	.28
Rupture	4.23 (2.05−8.75)	<.001
Total graft explantation	2.10 (1.02−4.34)	.04

OR = odds ratio; CI = confidence interval

Table 5. Univariable and multivariable analyses of risk factors for return to the operating theatre < 30 days

Variable	OR (95% CI)	*p* value
Univariable analysis		
Age − per year	1.01 (0.97−1.05)	.71
Aneurysm diameter − per 5 mm	1.02 (0.92−1.13)	.68
Rupture	1.43 (0.69−3.00)	.34
Female sex	0.57 (0.17−1.94)	.37
At least one previous re-intervention	1.10 (0.60−2.00)	.76
Suprarenal clamp	0.69 (0.37−1.29)	.25
Total graft explantation	1.86 (0.98−3.51)	.06
Multivariable analysis		
Rupture	1.48 (0.71−3.11)	.30
Total graft explantation	1.88 (0.99−3.56)	.05

OR = odds ratio; CI = confidence interval

overall benefit of endovascular techniques in terms of mid- and long term survival to remain controversial. While many of these complications can be effectively managed by endovascular means, OSC may be needed in specific circumstances, such as repeated failure despite multiple endovascular procedures. Open conversion after EVAR is not without its challenges, as many patients are initially offered EVAR because of reduced physical fitness, and the embedded endograft particularly in the suprarenal renal aortic segment may increase the complexity of the surgical procedure.[12,13] Since patients with aortic disease are surviving longer with advances in healthcare, maintaining consistent long term outcomes following EVAR is a contemporary priority, while understanding patterns of EVAR failure represents an area of ongoing research.

The main finding of this international multicentre study of 348 patients who underwent OSC for EVAR failure is that, despite the intervention being technically feasible using different surgical approaches and techniques, it was associated with significant morbidity and mortality. These results must be compared with those from prior studies that have shown peri-operative death rates ranging five − 25%, largely attributable to the urgency of presentation.[5,14,15] The present report also found that the odds ratio of early death was more than four fold higher in those cases presenting with rupture. Clearly, efforts to identify or perhaps act on indications for OSC need improving, at the least to avoid the occurrence of symptoms or rupture. Defining the indication for OSC is not always clear, particularly when further endovascular options are not exhausted. Almost half of the current cohort underwent at least one re-intervention, while 18% underwent more than one. These numbers must also be considered in light of the almost 20% of patients who had already undergone adjunctive procedures at the primary operation. This rate of re-intervention is somewhat higher than the 29.7% of secondary endovascular salvage procedures reported by Goudeketting *et al.*[16] It is not surprising that patients with Type II endoleaks were most likely to undergo a re-intervention, while those with Type I endoleaks or endograft migration were more likely to undergo OSC directly. Limb thrombosis, while uncommon (7.8%), is a troublesome yet clear indication for re-intervention. More than half of these 27 patients underwent some form of re-intervention prior to OSC. The finding that 11 (40.7%) of the OSC procedures for this indication were performed for Cook devices is a worrisome signal that echoes recent reports.[9] Given that 17% of OSC procedures ultimately took place because of rupture, the admonishment for earlier OSC seems warranted.

Elective OSC is not without risk, as mortality figures at 30 days were > 6%, which are significantly higher than reports for primary OSR.[6] Post-operative morbidity and death have previously been shown to be driven by both patient and procedure related factors, including age, urgency of the procedure, and duration of suprarenal aortic cross clamping.[17] The technical challenges posed by OSC are related to difficulties in stent removal of endografts with suprarenal fixation. A partial explantation with a surgical graft interposition (29% of the present series) is one alternative, in which the proximal stent of the endograft is used as a "neo neck" and troublesome aortic clamping can be avoided.[18] Similar techniques can be used distally, where the endografts can be left *in situ* as "neo limbs".[19] It is interesting to note in this series that total graft extraction was indeed predictive of worse outcomes, while suprarenal aortic clamp placement was not statistically significant.

Intuitively, any re-intervention should be goal directed, and a failing EVAR can sometimes be difficult to diagnose. The most frequent indication for OSC in the present series was endoleak, followed by sac expansion with no identifiable endoleak, a finding which is confirmed in prior reports.[16,17] Persistent Type II endoleaks have recently been shown to increase AAA related mortality after EVAR,[20] although the evidence may be mixed.[21] Treating or reducing their incidence might decrease the risk of late rupture. It is apparent from the present report that Type I endoleaks are not uncommon, and there are concerns as to whether more liberal use of EVAR over recent years has played a role in the increase in late EVAR failure for various reasons. It is well documented that EVAR performed in hostile aortic anatomy and or outside the manufacturer's IFU is linked to increased rates of secondary interventions during follow up, including OSC.[22−24] It is indeed sobering that as many as 37% of the entire cohort were initially treated outside of the device IFU, a number not unique amongst previous reports regarding adherence to IFU.[25] Policies and compliance regarding surveillance of the patients included in this analysis were unavailable, yet this in no way mitigates the importance of adherence to post-operative follow up protocols, perhaps more so in patients at high risk of late EVAR failure, as also advocated by current clinical practice guidelines.[26] It may be that some patients would have been better served by more complex repair, including open, in the first instance, in order to avoid the need for subsequent procedures during follow up. Additionally, the failures of the Nellix devices resulted in device recall and subsequent recommendations that included enhanced surveillance and explantation.[27]

To that end, fenestrated and branched EVAR (F-BEVAR) procedures have emerged as a safe and effective treatment modality for both the primary procedure in cases of dubious anatomy,[26,28] and also in addressing proximal EVAR failures.[29–31] Similarly, iliac branch devices can be successfully used to manage distal EVAR failures.[28,32] Since these procedures can maintain the minimal invasiveness of the original endovascular treatment, their use seems justified, given appropriate anatomic eligibility. However, potentially successful redo endovascular procedures should not justify pushing the boundaries of the initial infrarenal EVAR devices, as the goal for AAA patients must remain for the first operation to be the right one, including open aortic surgery. Secondary endovascular procedures can also be technically demanding and not without associated risks.[37] In addition, the success of a re-intervention can also be difficult to define. As intimated above, many patients underwent multiple re-interventions, and a rupture rate of 17% suggests that either too few re-interventions, or perhaps one too many prior to OSC, were performed before considering conversion.

A key lesson from this paper is to be responsible with EVAR. The large numbers of patients treated outside device IFU and the number of peri-procedural endoleaks cannot be ignored, many of which were left untreated. These must be weighed against the intangible variables of patient choice and true informed consent regarding risks of re-intervention, OSC, and death. Furthermore, this study represents the value of international collaboration of vascular registries. To drive quality improvement and patient safety, registries must report on procedures and devices, and record outcomes.

Study limitations

The major limitation of this study was the strong patient selection bias. Due to its retrospective and voluntary nature from selected centres, the analysis was limited to those patients deemed fit for OSC and who were entered into this study, and lacked patients who were turned down for explantation of failing endografts for valid reasons including fitness for open surgery. Furthermore, these data are not validated, including for case numbers. These factors along with others in this section could potentially contribute to these results being superior to those obtained from a prospective registry based or population based study.

As indications for OSC are not well established, the interpretation and strategies employed amongst centres may have varied, thus rendering the analysis at high risk of selection bias. These patients are complex, as are the multiple variables of interest, and it is difficult to balance the desire for increased granularity against the willingness and feasibility of comprehensive data capture. For example, the distinction between a Type Ia and Type Ib endoleak would have added further value, but this distinction was not made on the database query. A large number of patients had to be excluded due to incorrect and insufficient data, and larger numbers may have allowed for identification of other potentially significant factors such as patient sex or operative technique.

It should also be noted that OSCs performed for infection were deliberately excluded, as these patients represent a different pathological entity and are more difficult to predict than an otherwise failing EVAR. How these patients were excluded was up to the individual centres, and it is possible that some undiagnosed infections were included in the cohort; some of the complications noted in Table 3 include sepsis and pseudoaneurysm formation, which may represent a manifestation of previous underlying infection.

A clear record of the EVAR surveillance programs among centres was also not possible. All centres claim to have an established follow up program, using both ultrasound and computed tomography at various times, but the heterogeneity limited any useful analysis. Harmonisation of variables across international registries for aortic pathology along with accurate recording of outcomes may lead to early reporting of adverse outcomes and drive quality improvements for patients with AAA.

Finally, this study was unable to establish a denominator (i.e., the number of primary endovascular or open procedures undertaken by the participating centres) with which to estimate the incidence of endograft failures leading to OSC. Capture of all OSCs was assured by participating centres, but no external and internal validity process was carried out, primarily due to issues of data protection compliance. It is hoped in the future, with accurate re-coding of aortic procedures, devices, and re-interventions on international registries, that the true incidence of endograft failures, re-interventions, and OSCs can be accurately estimated, high risk patients can be identified, and measures can be taken to reduce patient harm. While the multicentre nature of the study population is a strength, in terms of real world data, it can only be underscored that further research and recommendations are needed in this field.

Conclusion

Using contemporary and international multicentre data from 348 patients who underwent OSC for EVAR failure, this study found that, despite the intervention being technically feasible using different approaches, it was associated with significant morbidity and mortality rates, especially among patients presenting with rupture. The most frequent indication for OSC in the present series was endoleaks, while as many as 37% of the entire cohort had received EVAR outside the manufacturers' IFUs. Future studies on risk features for late OSC are needed to identify patients at highest risk of EVAR failure who may benefit from intensified surveillance as well as well powered trials to compare effectiveness of different techniques.

CONFLICT OF INTEREST STATEMENT AND FUNDING

None to declare.

APPENDIX A. SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejvs.2023.07.029.

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COUP D'OEIL

Azygos Vein Mimicking Aortic Dissection

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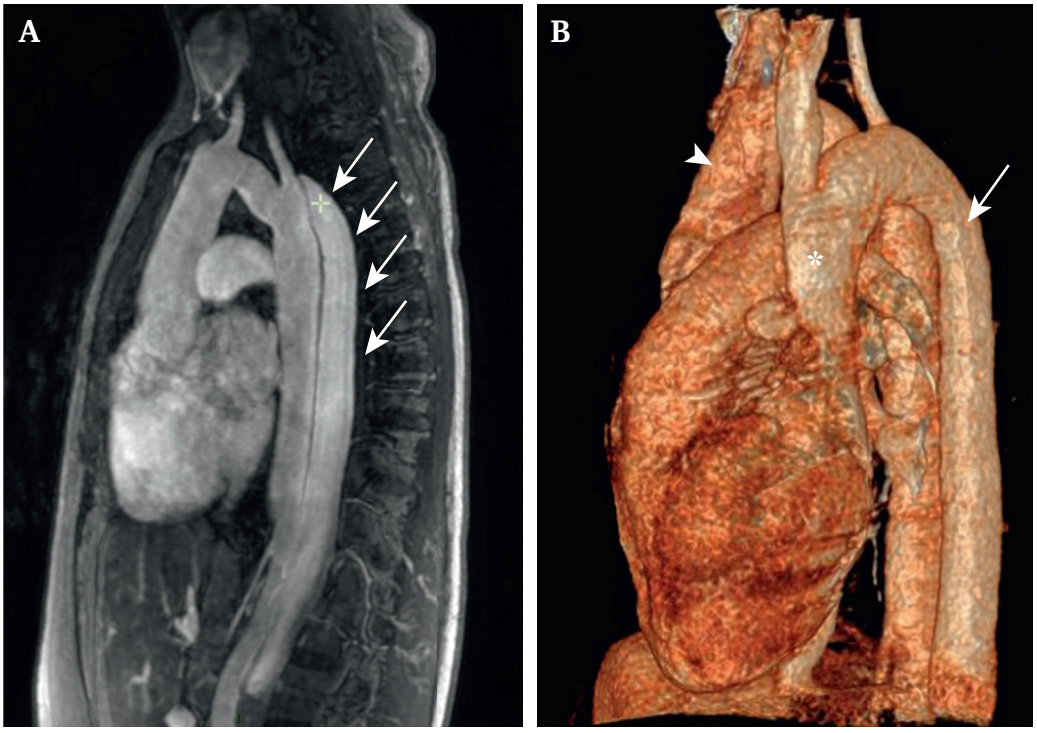

An asymptomatic 45 year old woman who underwent open surgical correction of a coarctation 25 years ago was under cardiac surveillance. Due to increased blood pressure, thoracic magnetic resonance angiography (MRA) was performed. The initial MRA reading described a type B aortic dissection (A, arrows) according to the Stanford classification. However, the final protocol showed that the initial false lumen was not the aorta (B, arrowhead) but an enlarged azygos vein (B, arrow), draining into the left superior vena cava (B, asterisk), due to inferior vena cava aplasia and an abdominal situs inversus.

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https://doi.org/10.1016/j.ejvs.2023.08.009