A Systematic Review of In-situ Aortic Reconstructions for Abdominal Aortic Graft and Endograft Infections: Outcomes of Currently Available Options for Surgical Replacement

Elda Chiara Colacchio,[1] Mario D'Oria,[2] Beatrice Grando,[1,2] Alessandra Rinaldi Garofalo,[1] Alessia D'Andrea,[1,2] Silvia Bassini,[2] Sandro Lepidi,[2] Michele Antonello,[1] and Barbara Ruaro,[3] Padova and Trieste, Italy

Background: This review synthetizes recent literature about in-situ aortic reconstructions for abdominal aortic graft or endograft infections (AGEIs), aiming to report outcomes individually related to currently available vascular substitutes (VSs).

Methods: We performed a systematic review of all published literature from January 2005 to December 2022. We included articles reporting on open surgical treatment of abdominal AGEIs, with removal of the infected graft and in-situ reconstruction with biological or prosthetic material. Articles not distinguishing between abdominal and thoracic aortic-related outcomes were excluded, as well as studies reporting on cumulative in-situ and extra-anatomic reconstruction results.

Results: Of 500 records identified through database searching (Pubmed: 226; Embase: 274), 8 of them were included in the present review. Overall, 30-days mortality rate was 8.7% (25/285), while the most frequent early complications were respiratory adverse events (46/346, 13.3%) and renal function deterioration (26/85, 30%). In 250/350 cases (71.4%), a biological VS was utilized. In 4 articles, the outcomes of different types of VSs were presented jointly. Patients analyzed in the remaining 4 reports were sorted in a "biological" and a "prosthetic" group (BG and PG). The cumulative mortality rate of the BG and PG were 15.6% (33/212) and 27% (9/33), respectively, while graft reinfection was 6.3% (15/236) in the BG, and 9% (3/33) in the PG. The cumulative mortality rate reported in articles focused on autologous veins was 14.8% (30/202), while their 30-days reinfection rate was 5.7% (13/226).

Conclusions: Since abdominal AGEIs are uncommon conditions, literature focused on direct comparison between different types of VSs is scarce, particularly when related to materials other

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[1]*Department of Cardiac, Thoracic, Vascular Sciences and Public Health, Vascular and Endovascular Surgery Clinic, School of Medicine, Padova University, Padova, Italy.*

[2]*Division of Vascular and Endovascular Surgery, Cardiovascular Department, University Hospital of Cattinara, University of Trieste, Trieste, Italy.*

[3]*Pulmonology Unit, Department of Medical Surgical and Health Sciences, University Hospital of Cattinara, University of Trieste, Trieste, Italy.*

Correspondence to: Elda Chiara Colacchio, MD, Department of Cardiac, Thoracic, Vascular Sciences and Public Health, Vascular and Endovascular Surgery Clinic, School of Medicine, Padova University, Via Nicolò Giustiniani 2, 35128 Padova, Italy; E-mail: eldachiaracolacchio@gmail.com

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than autologous veins. Although we found a lower overall mortality rate in patients treated with biological material or with autologous veins only, in recent reports prosthesis provide promising results in terms of mortality and reinfection rate. However, none of the available studies distinguish and compares different types of prosthetic material. Large multicenter studies are advisable, especially focused on different types of VSs and their comparison.

INTRODUCTION

The real incidence of vascular graft and endograft infections (VGEIs) is difficult to determine due to the lack of population-based studies and larger cohorts,[1] and it depends on environmental, patient-related, surgical factors,[2] and graft location. VGEIs represent an important morbid condition, possibly leading to the most dramatic outcomes. For a long time, the incidence of aortic graft and endograft infections (AGEIs) has been considered to be very low,[3] yet in the last years the reported frequency is increasing, reaching 5% in some series[3,4] and 6% when the graft is also located in the groin.[4]

The clinical presentation is variable, mostly represented by fever, abdominal/back pain, weight loss or asthenia, and biological inflammatory syndrome. A less frequent manifestation is limb ischemia, with or without septic embolization. AGEIs may be associated to aortoenteric fistulas, whose frequency ranges from 0.5 to 1%, leading to a worsened prognosis.[3]

Radical infected graft excision, followed by extra-anatomic bypass (EAB), was considered the gold standard treatment in the past, because it avoids novel anastomosis and graft implant in a field still considered as ''infected''. Yet, the diffusion of several types of vascular substitutes (VSs) such as cryopreserved arterial allografts, autogenous veins, or antibiotic-soaked prosthesis, has modified the surgical approach. Current European and American guidelines[2,4] recommend, whenever possible, a surgical treatment with an in-situ reconstruction with autologous veins, obviously always following complete removal of the infected graft portion.

Although several authors have reported on outcomes of surgical treatment of AGEIs, articles often also include native aorta infections, and combine multiple arterial segments (i.e., thoracic and abdominal aorta) or in-situ and EABs outcomes. Furthermore, outcomes of employed VSs are often presented jointly, making it difficult to understand which one provides better results.

The aim of this review is to systematically analyze recent literature, selecting studies reporting on in-situ abdominal aortic reconstruction for AGEIs, ideally distinguishing between different types of VSs outcomes.

MATERIALS AND METHODS

Search Strategy and Eligibility Criteria

A systematic research and articles selection was independently conducted on December 2022 by two different researchers (E.C.C. and B.G.), according to the principles of the Preferred Reporting Items for Systematic review and Metanalyses guidelines[5] (Fig. 1). Discrepancies and disagreements were discussed and thus resolved. Pubmed and Embase databases were used to perform an electronic search, using the terms ''abdominal aorta,'' ''graft infection,'' ''endograft infection,'' ''in-situ replacement,'' and ''aortic graft replacement.'' In the initial selection, we only included articles in English and a time-lapse beginning in 2005.

Records were imported in a dedicated software (Mendeley Desktop 1.19.8, © Mendeley Ltd.) that allowed duplicates removal and articles screening by title and abstract.

Inclusion criteria were articles about surgical treatment of abdominal AGEIs, with complete removal of the graft and in-situ reconstruction with biologic or prosthetic material. Considering the paucity of literature, articles without a direct comparison between different types of VSs were also included. We excluded studies only reporting on extra-anatomic aortic reconstruction, articles reporting on both in-situ and extra-anatomic reconstruction, yet presenting overall results without distinguishing between the two types of interventions, records only reporting on native aorta infections or not separating outcomes of surgical treatment on native aorta and on graft/endograft infections. We also excluded studies only presenting data on diagnosis, clinical presentation and/or medical/conservative treatment, without mentioning surgical treatment, articles on thoracic aorta, case reports with less than 5 cases, and comments to other articles, reviews, systematic reviews, and metanalysis.

Data Extraction

Baseline and key information were schematized in two tables (Tables I and II), and included authors' names, year of publication, overall number of patients, number of patients who actually underwent

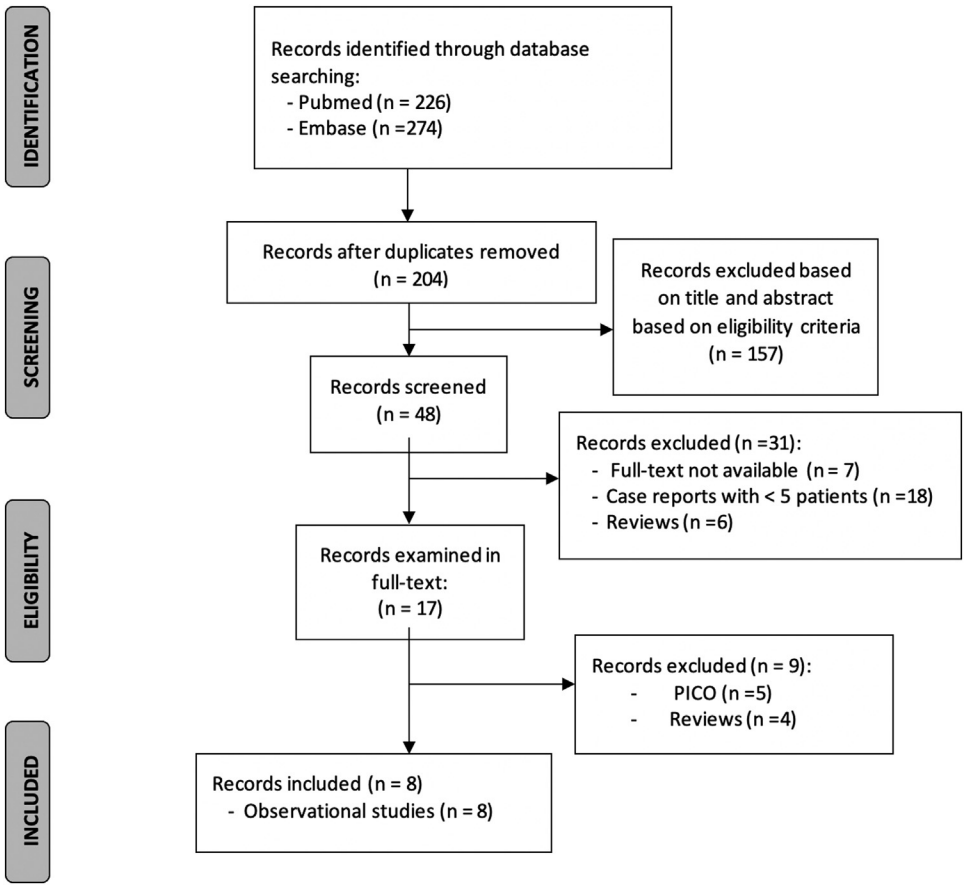

Fig. 1. Flow-chart of articles screening according to the Preferred Reporting Items for Systematic review and Metanalyses (PRISMA) guidelines.[5] PICO, population, intervention, comparison, outcome.

graft removal, and in-situ reconstruction, and thus included in the present review. We also registered the time lapse included by each author and the subgroups of patients included in each study.

Follow-up examination modalities and intervals were registered for each article, as well as primary and secondary outcomes, including 30-days or procedure-related mortality, overall survival during follow-up, procedure-related surgical or medical complications, VS reinfection rate, overall reinterventions, amputation-free survival, primary and secondary patency.

Diagnosis of graft/endograft infection relied on the MAGIC (Management of Aortic Graft Infection Collaboration) criteria[14] in almost all studies. We reported clinical presentation of patients, particularly the presence of abdominal/back pain, fever, and constitutional symptoms such as weight loss, asthenia, or anorexia. Cases of biological inflammatory syndrome were also registered, particularly hyperleukocytosis and elevation of C-reactive protein (CRP). Percentage of early and late graft infections was not reported in all the articles; furthermore, it did not have a standard definition. In fact, Cernohorsky et al.[7] and Gavali et al.[1] did not specify the cutoff between early or late infection timing, while Betz et al. set the cut-off to 4 months, according to European guidelines.[2]

We registered microbiological findings from intraoperative sampling or hemocultures, dividing them in gram-positive or gram-negative cocci or bacilli, and fungal infections. We reported on perioperative and postoperative antibiotic therapy, whose extent was extremely variable from report to report.

Intraoperative details were the selected type of VS and adjunctive procedures, when specified, going from field irrigation with hypochlorous acid solution to small intestine suture or resection. Employed VSs were the femoral-popliteal vein (FPV) or deep femoral vein used to perform a neo-aortoiliac system (NAIS) procedure,[15] plain or

Table I. Baseline characteristics of the selected studies.

Study	Year	Article type	Time lapse	Subgroups	Follow-up technique
Ali et al.[6]	2009	Observational multicentric	1990–2006	Surgical grafts	DUS/CTA
Cernohorsky et al.[7]	2011	Observational multicentric	1996–2009	Endografts	CTA, abdominal X-rays, DUS, serum creatinine
Davila et al.[8]	2015	Observational multicentric	1997–2014	Endografts	not specified
Han et al.[9]	2018	Observational singlecenter	2001–2015	Native aorta infections; surgical grafts; endografts	Blood test; CT
Gavali et al.[10]	2021	Observational multicentric	1995–2017	Surgical graft; endograft	not specified
Betz et al.[11]	2022	Observational single-center	2015–2020	Surgical grafts	clinical and laboratory examination; DUS
Mufty et al.[12]	2022	Observational single-center	2005–2021	Endograft	CTA
Khalid et al.[13]	2023	Observational single-center	2008–2020	Endograft	PET/CT; CT

PET, positron-emission tomography.

silver-coated polyester, with or without triclosan soaking, polytetrafluoroethylene (PTFE), arterial allografts, and biosynthetic collagen prosthetic grafts. Five studies reported on multiple materials,[1,7,8,13] while three concentrated on 1 single type of VS.[6,11,12] Two of the five studies on multiple materials also presented outcomes of biological VSs only,[13] or of a single material (i.e., FPV with NAIS configuration).[1] We managed to sort a portion of patients[6,9,12,13] in 2 groups: a ''biological'' group (BG) and a ''prosthetic'' group (PG), aiming to distinguish outcomes between different types of materials. Biosynthetic collagen prosthetic grafts were not included in the 2 groups because we believe they could have intermediate features.

RESULTS

Study Selection and Overall Features

Of 500 records identified through database searching (Pubmed: 226; Embase: 274), 204 were screened for title and abstract after duplicates removal. Seventeen articles were examined in full-text, and 8 of them were included in the present review. Articles were published from 2009[6] to 2022[13] (Fig. 1).

All studies were observational, 4 of them (50%) were multicentric[6–8,10] and the analyzed period went from five[11] to 22 years.[10] Two studies[6,11] only presented results on infected surgical graft replacement, 4 articles analyzed surgical treatment of infected endografts,[7,8,12,13] 2 reports analyzed both.[9,10] Han et al.[9] also included primary infected abdominal aortic aneurysms, yet authors distinguished outcomes of native aorta and AGEIs. Of 457 cases analyzed in the selected articles, 350 underwent graft/endograft removal and in-situ reconstruction with biologic or prosthetic graft, and were thus included in the present review. Three groups of authors reported on 1 single VS type: Ali et al.[6] and Mufty et al.[12] utilized the FPV, while Betz et al.[11] employed a biosynthetic collagen prosthetic graft. Overall, in 250/350 cases (71.4%) a biological VS was utilized.

Clinical Presentation and Microbiological Findings

Five studies detailed initial clinical presentation of patients undergoing infected graft/endograft removal and in-situ reconstruction.[6,8,11–13] Open groin wounds were present in 84/291 (40.8%) patients, while femoral pseudoaneurysm were present in 68/187 (36%), constitutional symptoms (asthenia, weight loss, and anorexia) in 61/187

Table II. Focus on results of included studies.

Study	Patients undergoing ISR for AGEI ($n°$)	VS	Biological VS	Outcomes
Ali et al.[6]	187	FPV: 187 (100%)	187	30d mortality: 19 (10%); procedure related mortality: 27 (14%); 30d limb loss: 14 (7.4%); 30-days graft disruption: 10 (5%); 30-days pulmonary failure: 25 (13%); 72m PP: 81%; 72m SP: 91%; 7y limb salvage 89%; 5y overall survival: 52%
Cernohorsky et al.[7]	4	Silver-coated polyester graft: 2 (50%); autologous deep femoral vein: 1 (25%); polyester + vein: 1 (25%)	1	Mortality: 3/12 (25%)
Davila et al.[8]	27	Rifampin-soaked polyester: 14 (39%), non-antibiotic treated polyester: 2 (6%), PTFE: 2 (6%), FPV: 4 (11%), combination FPV and cryopreserved graft: 1 (3%); cryopreserved graft: 4 (11%)	9	30d ISR mortality: 2/27 (7.4%); overall ISR mortality: 6/27 (22%)
Han et al.[9]	9	PTFE/Dacron: 9 (100%)		In-hospital mortality: 1 (11.1%); anastomosis dehiscence: 2 (22.2%); graft reinfection: 3 (33.3%)
Gavali et al.[10]	55	NAIS: 24 (43.6%); silver-impregnated graft: 10 (18.2%); rifampicin-soaked antibiotic graft: 10 (18.2%); arterial autografts: 4 (7.3%); miscellaneous: 7 (12.7%)	28	Overall: 30d dialysis: 4 (8%); 30d respiratory complications: 11 (22%); overall reinterventions: 13 (25%); recurrent graft infection: 9 (17%); anastomotic dehiscence: 5 (9%); 90d, 1y and 5y survival: 76.4%, 72.7%, 49.9%. NAIS: reinfection: 3/24 (13%), anastomosis dehiscence: 4/24 (17%), reintervention: 7/24 (30%); 5y survival: 44%
Betz et al.[11]	19	Biosynthetic collagen prosthetic grafts: 19 (100%)	0	Freedom from reinfection: 94.4% at 1y and 3y; 30d mortality: 1 (5.3%); 30d pneumonia: 3 (15.7%); survival: 83.4% at 1y, 63.2% at 3y; graft occlusion rate: 15.7% at 1y, 21.1% at 3y; major amputation rate: 5.6% at 1y, 10.5% at 3y;
Mufty et al.[12]	15	FPV: 15 (100%)	15	30d: 1 (6.6%); overall mortality: 3 (20%); survival at 1, 2 and 3y: 85.6%, 74.9%, 74.9%; early AKI: 7 (46.7%); early pneumonia: 1 (6.7%); reinfection: 0 (−)

(*Continued*)

Table II. Continued

Study	Patients undergoing ISR for AGEI (*n*°)	VS	Biological VS	Outcomes
Khalid et al.[13]	34	Biological: tubularized bovine pericardium: 1/10 (10%), FPV: 5/10 (50%); arterial allograft: 4 (40%), miscellaneous: 2/10 (20%); Prosthetic: silver-coated polyester: 1/24 (4.1%), silver and triclosan-coated polyester: 23/24 (95.9%)	10	Overall mortality: 12 (35%); overall mortality (biological): 3/10 (30%); overall mortality (prosthetic): 9/24 (37.5); reinfections (biological): 2/10 (20%); reinfections (prosthetic): 0 (0%); reinterventions (biological): 4/10 (40%); re-interventions (prosthetic): 6/24 (25%); early overall AKI: 7 (21%); early overall pneumonia: 6 (18%)

ISR, in situ reconstruction; PP, primary patency; SP, secondary patency; PTFE, polytetrafluoroethylene; AKI, acute kidney injury.

(32%), abdominal/back pain in 47/104 (45.2%), and fever in 52/104 (50%). A biological inflammatory syndrome was reported in 4 studies,[8,9,12,13] particularly leukocytosis appeared in 40% of cases (45/113), while elevation of CRP appeared in 22% (25/113). In a study by Han et al.[9], a CRP elevation was present in all cases of graft/endograft infection.

The study by Cernohorsky et al. showed a 26% rate of early infections in the overall cohort,[7] while the study by Gavali et al. had a 20% infection rate,[10] and Betz et al. in their study had a 31.6% infection rate.[11]

Gram-positive cocci or bacilli were found in 251/350 (71.7%) cases, and represented the most detected microorganism among intraoperative findings and hemocultures. Gram-negative cocci or bacilli were the second most frequently detected bacteria, and they were found in 154/350 cases (44%). Fungal infections were always secondary to Candida spp. colonization, and were detected in 70/350 cases (20%). Most patients presented with a polymicrobial colonization, and in 14% of cases (49/350) no microorganism was found.

Intraoperative Details

The intervention setting was described in 3 articles[6,8,13]: 27/257 (10%) patients underwent emergent surgery. In all analyzed cases, patients underwent graft/endograft removal and aortoiliac or aortofemoral replacement with in-situ surgical reconstruction. Graft-enteric fistulae were found in 46/236 patients (19.5%). Adjunctive procedures were detailed in 5 reports, and consisted of small intestine suture or resection,[7,11,13] graft wrapping in retrocolically transposed great omentum,[9,12,13] ureter resection,[11] and field irrigation with hypochlorous acid solution.[11] Khalid et al. also performed coverage of the VS with Gerota's fascial flap, and carried out laparostomy after a gastrointestinal reconstruction or when the bowel viability was not certain. Employed VSs were FPV in 232/350 cases (66.3%), silver-coated polyester graft in 13/350 patients (3.7%), rifampin-soaked polyester graft in 24/350 (6.8%), silver and triclosan-coated polyester in 23/350 (6.5%), arterial grafts in 8/350 (2.3%), and biosynthetic collagen prosthetic grafts in 19/350 (5.4%). Han et al. used a polyester or PTFE nonantibiotic treated graft, without distinguishing between the 2 types.[9]

Postoperative Course and Outcomes

Five reports expressed the duration of postoperative antibiotic therapy, going from a minimum of 9 days

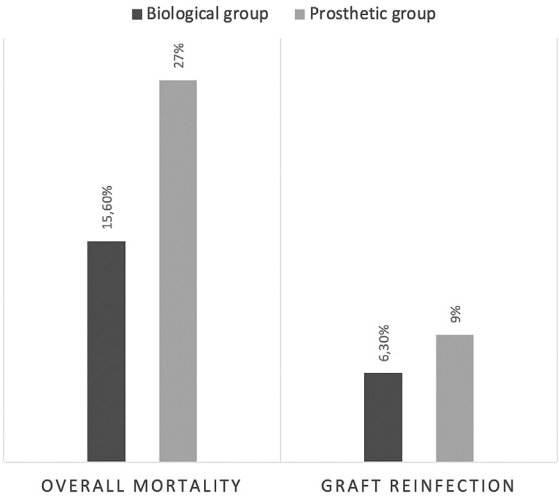

Fig. 2. The bar graph represents the percentages of overall mortality and graft reinfection in the biological and prosthetic groups.

in Mufty et al. report,[12] to a lifelong treatment in 19 cases described by Davila et al.[8]

The median follow-up ranged from 201 days[7] to 3.1 years.[10] Ali et al.[6] performed duplex ultrasound (DUS) or computed tomography angiography (CTA) every 4 months for 1 year, and every 6−12 months thereafter, while Cernohorsky et al. performed CTA at discharge and then at 1, 3, 6, 12 months and yearly thereafter from 1996 to 1999, and a CTA after 4−6 weeks, and DUS and abdominal X-rays every 6 months thereafter[7] from 1999 to the end of the study. Other authors added a blood test every 3 months for 1 year and every 6 months thereafter,[9,11] while others performed positron emission tomography/CT scans at 6 months.[13]

Postoperative outcomes are outlined in Table II. Thirty-days mortality was 8.7% (25/285), while the most frequent early complications were respiratory adverse events (46/346, 13.3%) and renal function deterioration (26/85, 30%). Ali et al. only used FPVs, reporting a 30-days graft disruption rate of 5% (10/187), with a 5-years overall survival of 52%.[6] Mufty et al.[12] also reported their experience with FPVs use, with a 30-days mortality rate of 6%, an overall mortality of 20%, and no cases of reinfection. Gavali et al.[10] described an overall reintervention rate of 25% (13/55) and a recurrent graft infection of 17% (9/55), while these data were higher in Han et al. study[9] (33.3%) with the solely use of prosthetic material. Han et al. also reported an in-hospital mortality of 11.1% (1/9) and an anastomosis dehiscence rate of 22% (2/9).[9] Freedom from reinfection was 94.4% at 1 and 3 years in Betz et al. study[11] with the use of biosynthetic collagen prosthetic grafts, and major amputation rate was 5.6% and 10.5% at 1 and 3 years, respectively. Gavali et al. also calculated outcomes for surgical reconstruction with FPVs, with a graft infection rate of 13% (3/55), an anastomosis dehiscence in 17% (4/55) of patients, and a reintervention rate of 30% (7/55).[10] Khalid et al.[13] reported an overall mortality of 30% (3/10) and 37.5% (9/24) for patients undergoing aortic reconstruction with a biological material and a prosthesis, respectively; furthermore, reinfections only occurred in the group of patients undergoing ''biological'' reconstruction (2/10, 20%), who also presented a 40% reintervention rate (4/10); the latter lowered to 25% (6/24) in the group of ''prosthetic'' reconstruction.

We managed to sort a portion of patients in 2 groups, BG and a PG, whose overall mortality rate was 15.6% (33/212)[6,12,13] and 27% (9/33),[9,13] respectively. Graft reinfection was 6.3% (15/236) in the BG,[6,10,12,13] and 9% (3/33) in the PG (Fig. 2). The cumulative mortality rate described by Ali et al.[6] and Mufty et al.,[12] both reporting on FPVs, was 14.8% (30/202), while the cumulative 30-days reinfection rate, also including Gavali et al.[10] work, was 5.7% (13/226).

Ali et al.[6] performed a multivariate analysis to identify predictive factors of perioperative and 12 months mortality. Factors influencing perioperative mortality were graft colonization by *Candida glabrata*, *Klebsiella pneumoniae* and *Bacterioides fragilis*, perioperative sepsis, and intraoperative blood loss ≥3 liters; factors influencing 12 months mortality were age ≥64 years old, initial presentation with proximal or distal anastomosis bleeding, chronic kidney disease (CKD), fungal infection, and American Society of Anesthesiologists score ≥4. Gavali et al. identified age, CKD and coronary disease[10] as factors influencing overall mortality, while Khalid et al. pointed out emergency management and diabetes in a univariate analysis.[13]

DISCUSSION

Abdominal AGEIs are uncommon yet serious conditions, with a mortality rate ranging from 15% to 50%.[16] The incidence of endograft infection reaches 5%,[17] while surgical graft infection rate can raise to 6%[3] when a groin incision is involved in the first intervention. In a recent report, aortic endograft infection represented 24.6% among reasons of open surgical conversion after a failed endovascular aortic repair.[18] For patients considered ''fit'' for surgery, treatment involves the total explant of the infected graft. Formerly, EAB had been considered

the gold standard for reconstruction, aiming to reestablish the arterial flow without leaving material in the same infected site. However, if these interventions for AGEIs carry an overall substantial risk of major lower limb amputation, this seems to be even higher with EAB, ranging from 1 to 30%.[19,20] Furthermore, this type of reconstruction presents an 8.8% risk of septic aortic stump rupture.[21] Therefore, indications for treatment have progressively changed, and the most recent European and American guidelines[2,4] recommend a complete removal of the infected graft portion, followed by in-situ reconstruction. The range of available VSs is relatively large, and nowadays surgeons can choose between biologic and synthetic materials. Biological grafts have traditionally been considered as the most resistant to reinfection, and a classic example of autologous and homologous tissues are veins (FPV or great saphenous) respectively, and cryopreserved arterial allografts. FPVs are ideal conduits for aortoiliac reconstruction (i.e., NAIS)[15] for reasons of diameter, yet they are not always available (e.g., patients with deep vein thrombosis) and their dissection and harvest extend operative time. Arterial allografts are often not promptly available, especially in emergency, and sometimes there is a diameter discrepancy between the allograft and the arterial segment.[13] To overcome accessibility issues, bovine pericardium aortic tubes have been proposed, with promising early results even in infected fields.[22,23] Nevertheless, follow-up is still limited even in recent series, with a low number of cases.[24] Available prosthesis for in-situ replacement are multiple, ranging from rifampin-soaked polyester to PTFE, to silver-coated polyester, with or without triclosan addition. Finally, a recent article reported on biosynthetic collagen prosthetic grafts,[11] with acceptable midterm outcomes. Although the prompt availability of prosthesis is undoubted, their resistance to reinfection is less certain,[21] and recent European guidelines suggest their use only if autologous veins are not available.[2]

Many authors have presented their experience with AGEIs, yet articles often mix surgical treatment outcomes of various districts, such as thoracic and abdominal aorta, or native aorta and aortic graft infections, or in-situ repair and EABs. We focused our research on in-situ reconstructions, performed for AGEIs in the abdominal district. The eligibility criteria of this review were relatively strict, excluding articles reporting on AGEIs of multiple arterial districts, but not making a distinction between their outcomes, and again excluding reports not separating native aortic infection repair and AGEI surgery. Our ultimate goal was to analyze the outcomes of each VS described in screened literature. Because only a limited number of reports met our eligibility criteria, we performed a narrative synthesis of our findings. Of course, abdominal AGEIs are uncommon, and in all selected reports authors investigated a wide period of time in order to collect a satisfying number of patients, or performed multicenter studies.[6–8,10] Thus, in the majority of cases it was not possible to analyze outcomes of a single material. Nevertheless, Khalid et al.[13] also reported separated results for biological or prosthetic material, while Gavali et al.[10] also presented outcomes of NAIS reconstruction with autologous veins. Furthermore, Ali et al.[6] only analyzed FPVs, as well as Mufty et al.,[12] Betz et al.[11] presented results with biosynthetic collagen prosthetic grafts use, while Han et al.[9] only used prosthesis (polyester or PTFE), always performing graft wrapping in retrocolically transposed great omentum. However, the majority of patients (69%) were treated with a biological substitute, in particular 64% of FPVs and 2.2% of arterial allografts, as suggested by current guidelines.[2]

Clinical presentation was in line with current literature, being fever and abdominal/back pain the most frequent symptoms.[3,21,25] CRP elevation was variable, since the cumulative rate was 22%, yet some authors found it in all cases.[7,9] Graft-enteric fistulae were found in 19.5% of patients, ranging from 14% in Ali et al. article[6] to 50% in 2 other reports.[10,13] The reported incidence of this complication is extremely variable in literature, and we have found a higher rate compared to other works.[21] The majority of infections had a late onset;[2] however, this was reported only in 3 studies[7,10,11]; in fact, most authors presented the median timing of infection onset, without distinguishing between early and late. Furthermore, only 1 group of authors[10] specified what was the cutoff (4 months), suggesting that the reported literature incidence of early and late infection onset could present some imprecisions. Microbiological findings were in line with literature,[2,3,21] and fungal and gram-negative infections appeared to be related to a worsened outcome in multivariate analysis.[6] Absence of colonization ranged from 12%[13] to 33% of cases[7]: the hypothesis related to this last finding are multiple, from the onset of an empirical antibiotic therapy prior to microbiological sampling, to the biofilm protecting bacteria and hampering a correct specimen collection.[21]

Early mortality rate reported in literature ranges between 16% and 22%,[2] and this was in line with our reports. In fact, we managed to sort a group of patients in a BG and a PG, with an overall mortality of 15.6% and 27%, respectively, while mortality

obtained from studies only reporting on FPVs was 14.8%, with a 30-days reinfection rate of 5.7%. We believe cumulative mortality was superimposable between the BG and the patients undergoing reconstruction with FPV also because most biological VSs were FPVs. Although the mortality rate in the PG was higher, we succeeded in extrapolating information about prosthesis only in 33 cases, while 202 patients belonged to the BG. Khalid et al.[13] reported results using silver-coated or triclosan-soaked silver-coated, that were similar to patients undergoing biological reconstruction, with a 37.6% rate of mortality (vs. 30% in the BG), and no reinfections (vs. 20% in the BG). Han et al.[9] found an in-hospital mortality rate of 11.1%, and an overall reinfection rate of 33% with the solely use of prosthetic grafts. However, no distinction was made between the 2 different types of prosthesis; thus, it is impossible to define which 1 raises or reduces morbidity and mortality rates. Promising initial results are also presented by Betz et al.,[11] who reported on biosynthetic collagen prosthetic grafts, with contained mortality and morbidity rates; yet, follow-up is limited and current guidelines do not make any recommendation regarding this type of material, due to the lack of evidence.[2]

The main limitation of this review is related to the extreme variety of results reported in literature. In fact, being a rare condition, the evidence is limited, and studies often include multiple VSs outcomes, without making a distinction between 1 or the other. Analyzing the current literature, we feel that the choice between VSs often depends on the availability of material and the surgeon's preference. All selected studies are observational and burdened by selection bias. As an instance, only patients ''fit'' for surgery, particularly in-situ reconstruction, were included in the selected articles. Probably, the mortality would have been higher if also patients undergoing EAB or conservative treatment were included. Finally, even if is well-known that the incidence of graft infection raises with a groin access, most articles do not mention whether the type of initial surgical procedure was aortoiliac or aortofemoral, or do not specify which of them had the worst or better outcomes.

CONCLUSIONS

Abdominal AGEIs are uncommon yet life-threatening conditions, and always require a multidisciplinary approach to select the best combination of medical and surgical treatment. In-situ reconstruction after infected graft removal is nowadays the suggested primary treatment, and first-line VSs are FPVs. Although overall mortality rate was lower in patients treated with biological material or with FPVs only, results related to prosthetic material use are promising in terms of mortality and reinfections, although none of the selected reports distinguish between different types of prosthesis. Given the incidence of AGEIs and the current paucity of specific literature, large multicenter studies are advisable, focusing on different types of VSs and their comparison.

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