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Clinical outcome of graft removal versus preservation in abdominal aortic graft infection: a systematic review and meta-analysis

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Purpose: The purpose of this study was to compare the clinical outcomes of abdominal aortic graft infection (AGI) treated with removal of the graft *vs.* graft preservation.
Methods: The electronic databases PubMed, Embase, and Cochrane Library for studies that reported on AGI were searched. Observational studies and case series of at least 10 cases that reporting on the prevalence, microbiology, and outcomes of AGI were included.
Results: Our search identified 23 studies that met our inclusion criteria, reporting on a total of 873 patients who underwent open surgical repair (OSR) or endovascular aneurysm repair (EVAR). Of these patients, 833 received graft removal, and 40 received graft preservation. The prevalence of AGI was reported to be 1.0% (95% confidence interval [CI], 0.5%–1.8%) after OSR and 0.4% (95% CI, 0%–1.1%) after EVAR. The pooled estimates of 1-year, 2-year, and 5-year mortality were 28.7% (95% CI, 19.4%–38.8%), 36.6% (95% CI, 24.6%–49.5%), and 51.8% (95% CI, 38.4%–65.1%) in the graft removal group and 16.1% (95% CI, 4.1%–32.2%), 18.5% (95% CI, 5.7%–35.1%), and 50.0% (95% CI, 31.6%–68.4%) in the graft preservation group. The 30-day mortality rate's risk ratio (RR) for graft removal *vs.* preservation was 0.98 (95% CI, 0.40–2.38), while the 1-year mortality rate's RR was 3.44 (95% CI, 1.60–7.42).
Conclusion: The 30-day mortality rate of AGI treatment was found to be high, whether using graft removal or preservation. In selected patients, implementing antibiotics with graft preservation as an initial management may be helpful in reducing the mortality rate.
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Key Words: Prosthesis-related infection, Aortic aneurysm, Device removal, Treatment outcome

INTRODUCTION

Prosthetic aortic graft infection (AGI) is an infrequent but serious late complication that can occur in patients with abdominal aortic aneurysm or aortoiliac occlusive disease after open surgical repair (OSR) as well as endovascular aortic repair (EVAR) [1]. It is a potentially lethal condition, especially when treatment is delayed which can lead to life-threatening sepsis or massive hemorrhage [2-4]. Prosthetic graft infection is generally managed by graft removal with *in situ* graft replacement, graft removal with extra-anatomic bypass (EAB), or attempted graft preservation [3,4]. When the prosthetic graft is located in the

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aortoiliac segment, surgical removal of complete graft, with or without vascular reconstruction, is generally recommended to achieve complete eradication of the infection source [1]. When endograft is infected, explantation of the stent graft followed by *in situ* reconstruction yielded the best outcome [5]. However, surgical intervention for treating AGI in critically ill patients can be challenging [6]. For patients with severe comorbidities, preserving the graft has been proposed as an alternative treatment option, but its effectiveness is not well established [7]. Despite the release of clinical practice guidelines for vascular graft and endograft infection by the European Society for Vascular Surgery in 2020, there is still limited evidence on managing AGI [8]. Given the high morbidity and mortality associated with AGI and the lack of consensus on optimal management, a systematic review of the available literature is necessary to provide a comprehensive understanding of this condition. The aim of this review is to synthesize the existing evidence on the treatment outcomes of AGI, specifically regarding graft removal or preservation.

METHODS

This systematic review was conducted following the PRISMA-P (Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols) [9]. The review is registered in PROSPERO (No. CRD42022361214).

Criteria for considering studies for this review

Types of studies

Types of studies considered for this review included randomized controlled trials (RCTs), prospective studies, retrospective observational studies, and case series with at least 10 cases, reporting treatment outcomes of AGI after open or endovascular aortic surgery due to abdominal aortic aneurysm or aortoiliac occlusive disease. The outcome of interest was the 30-day mortality rate, as well as the mortality rate at 1, 2, and 5 years. In cases where there is duplication of patient data, only 1 study was included.

Interventions and comparators

The intervention considered in this review was graft removal, while graft preservation with graft preservation and antibiotics served as the comparator.

Outcome measurement

The study assessed primary outcomes, including 30-day mortality, as well as mortality rates at 1 year, 2 years, and 5 years. Additional outcomes examined were the prevalence of graft infection, secondary aortoenteric fistula (AEF), pathogen involvement, and rates of amputation or other complications.

Search methods for identification of studies

Electronic searches

The literature search strategy was developed by the review authors in collaboration with a clinical information specialist. The papers to be included in this systematic review and meta-analysis were sought in the PubMed, EMBASE, Clinicaltrials.gov, Web of Science, and Cochrane Library databases up to February 7, 2022, and updated the search on February 3, 2023. A combination of controlled vocabulary and free text terms was used to search the databases. Studies published as conference abstracts were also included. No language constraints were applied. The search strategy is presented in detail in Supplementary Material 1.

Searching other resources

The bibliographic lists of the selected studies were screened for relevant publications.

Study selection and data collection

Selection of studies

Two review authors (HK and NL) independently conducted pre-specified literature searches and evaluated the eligibility of studies for inclusion. Any disagreements between review authors were resolved through discussion.

Data extraction and management

Two review authors (HK and YK) extracted data from the selected studies. All study participants who underwent relevant treatment on AGI from the included studies were included in the analysis. The collected data were cross-checked by a second review author (NL). When mortality-related data were not described in the text, data were extracted from published Kaplan-Meier curves. Retrieved data were entered into a spreadsheet. The following types of data were extracted from the selected studies: study-related data; data related to the risk of bias assessment; demographics and clinical characteristics of the study populations; and mortality rate.

Assessment of risk of bias in included studies

The risk of bias tool developed by the Cochrane Collaboration was used to assess the risk of bias of selected non-RCTs [10]. The risk of bias assessment was performed independently by 2 review authors (HK, NL). A third review author (YK) acted as an adjudicator in the event of disagreement.

A summary of findings table was generated to present the main findings of this review and the quality of evidence was graded using the system developed by the Grades of Recommendation, Assessment, Development and Evaluation (GRADE) working group [11].

Data analysis

Measures of treatment effect

When the included study contained a single treatment result, pooled estimates of mortality data were described through narrative synthesis. When the study had comparators, outcomes that were dichotomous in nature were compiled into a meta-analysis to calculate risk ratios (RRs) with a 95% confidence interval (CI). Meta-analysis was performed using 4 studies that reported both treatment outcomes. We undertook comparisons of data using meta-analyses employing random-effect models unless the I^2 value for heterogeneity yielded a value less than 50%, in which case we used a fixed-effect model. A forest plot was created for each treatment effect. Analyses were conducted using the 'meta' package in R software ver. 4.1.2 (The R Foundation).

Unit of analysis issues

The individual patient was the unit of analysis.

Dealing with missing data

Although we attempted to contact the primary authors inquiring about missing data, we could not obtain the data.

Assessment of heterogeneity

A test for heterogeneity examines the null hypothesis that all studies are evaluating the same effect. We obtained the P-values comparing the test statistic with a chi-square distribution. Between studies, heterogeneity was examined with the Cochrane's Q (chi-square) test. Inconsistency was quantified by calculating I^2 and was interpreted using the following guide: 0%–40% might not be important; 30%–60% may represent moderate heterogeneity; 50%–90% may represent substantial heterogeneity; and 75%–100% may represent considerable heterogeneity [12].

Assessment of reporting biases

To assess reporting bias, we planned to create funnel plots for meta-analyses containing 10 or more included studies and publication bias was assessed by visually evaluating the symmetry of the funnel plot.

Meta-regression

Meta-regression models were formed to explore potential heterogeneity as a result of initial presentation as shock or AEF. The number of patients with shock or gastrointestinal (GI) bleeding or AEF and graft total removal were used as moderators, assuming that they reported all consecutive associated cases during their study period. The slope coefficient and P-value were calculated for each covariate against the outcome of interest. The P-value indicates the significance of a possible association, while the slope determines the strength of the association.

RESULTS

Included studies

After discarding irrelevant reports and excluding articles by the eligibility criteria, the literature search identified 22 non-RCTs and 1 case series that fulfilled the inclusion criteria (Fig. 1). The characteristics of the included studies and clinical characteristics of the study populations are presented in Table 1 [6,13-34]. A total of 873 patients were included; 176 patients after EVAR in 8 studies, 473 patients after OSR in 13 studies, and 168 patients after EVAR or OSR in 2 studies. A total of 833 patients received graft removal and 40 patients received graft preservation.

Risk of bias in included studies

The risk of bias in the included studies was low to serious. The risk of bias graph and summary are presented in Fig. 2. Important confounders regarding initial presentation, such as septic or hemorrhagic shock or AEF, and extent of infection were not adjusted or reported. For the rest of the domains, the risk of bias was judged to be low. Most of studies were retrospective observational designs and included all patients with AGI without selection, and the bias in measurement of outcomes was low because the outcome variables were dichotomous. The GRADE assessment is outlined in Table 2. The certainty of evidence was judged to be low to very low since the included studies were observational studies with low to serious risk of bias and a small sample size.

Prevalence of aortic graft infection

Four papers described the prevalence and individual prevalence as 0.77% and 1.41% after OSR and 0.17% and 0.69% after EVAR. The pooled estimate of prevalence was 1.0% (95% CI, 0.5–1.8%) after OSR and 0.4% (95% CI, 0%–1.1 %) after EVAR (P = 0.140) (Fig. 3). Diagnosis was made by clinical, radiological including CT or radionuclide scan, or organisms recovered from blood, explanted graft or perigraft fluid. No study referred to published criteria such as Management of Aortic Graft Infection Collaboration (MAGIC) for making a diagnosis of AGI [35]. The mean time from aortic operation to AGI was 36.6 months (range, 10.3–72 months).

Procedure

In studies that reported graft removal, the aortic reconstruction method was EAB only in 6 studies, *in situ* bypass only in 4 studies, EAB and *in situ* bypass in 12 studies, and patch angioplasty in 1 study. Explant-only or aortic ligation was performed in 5 studies, in 6.7%–43.8% of the study population.

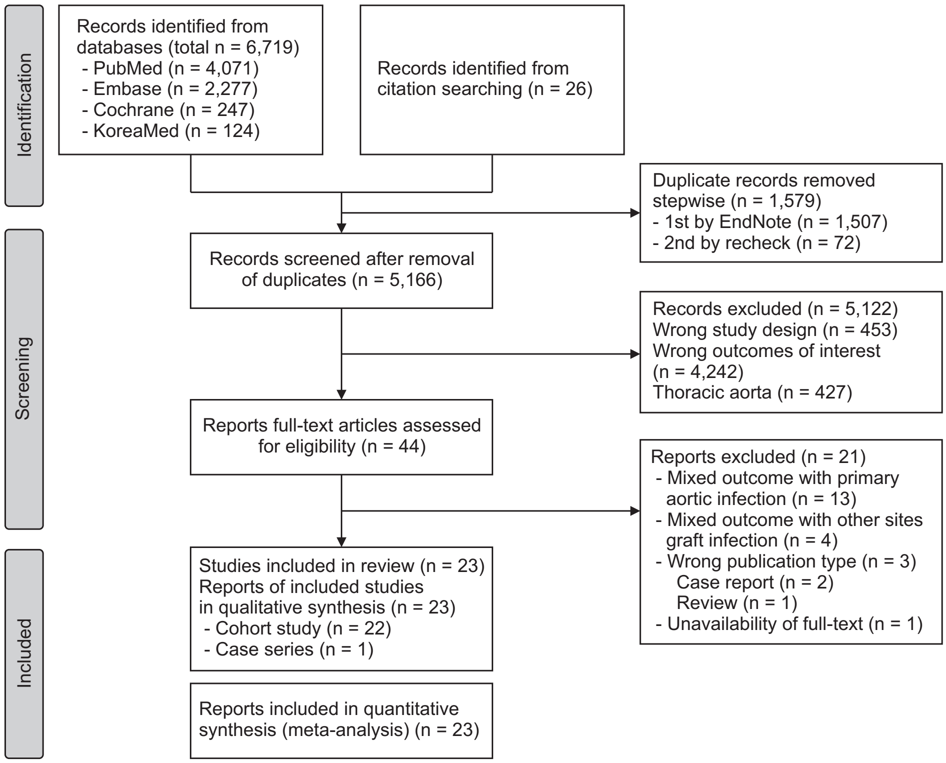

Fig. 1. Flow chart of the literature search for studies that reported mortality of treatment of aortic graft infection.

In studies that reported outcomes with graft preservation, additional or secondary procedures were performed. For initial treatment the following procedures were performed, aneurysmorrhaphy with omentum patching (n = 1) [32], EVAR (n = 1) [15], irrigation with omental or bovine patch (n = 2) [20], and percutaneous drainage (n = 7) [25]. Secondary procedures were performed in 2 studies; EVAR in a patient with rupture during antibiotics treatment (n = 1) [15] and complete graft removal with anatomic bypass (n = 2) or EAB (n = 2), percutaneous drainage (n = 1) or graft retention with EAB (n = 1) [25].

Microorganism

A total of 19 papers described the associated microorganism. The most commonly found species was *Staphylococcus* (17 studies, 8.3%–72.7%). Gram-positive bacteria were more commonly found (17 studies, 21.4%–100%) than gram-negative bacteria (1 study). Mixed flora was found in 10 studies (5.3%–53.3%). *Candida* species were found in 2.6%–15.4%.

Clinical outcomes

Mortality rate

The pooled estimate of the mortality rate at 30 days was 17.4% (95% CI, 12.9%–22.3%) in the graft removal group and 7.1% (95% CI, 0%–31.5%) in the graft preservation group (P = 0.390) (Supplementary Fig. 1A). The pooled estimates of 1-year, 2-year, and 5-year mortalities were 28.7% (95% CI, 19.4%–38.8%), 36.6% (95% CI, 24.6%–49.5%), and 51.8% (95% CI, 38.4%–65.1%) in the graft removal group and 16.1% (95% CI, 4.1%–32.2%), 18.5% (95% CI, 5.7%–35.1%), and 50.0% (95% CI, 31.6%–68.4%) in the graft preservation group, respectively (Supplementary Fig. 1B–D). When excluding results after partial removal from the graft removal group, the pooled estimate of mortality rate at 30 days, and 1, 2, and 5 years was 18.3% (95% CI, 14.7%–22.1%), 29.6% (95% CI, 20.2%–39.7%), 36.9% (95% CI, 24.2%–50.4%) and 45.5% (95% CI, 39.6%–51.4%) (Supplementary Fig. 2).

Four papers that reported outcomes for both graft removal and graft preservation were included in the meta-analysis. The RR of 30-day mortality rate with graft removal *vs.* graft preservation was 0.98 (95% CI, 0.40–2.38) (Fig. 4). The RR of death at 1 year was 3.44 (95% CI, 1.60–7.42).

To investigate whether the center's treatment strategy is linked to the outcome, we compared the mortality rate of graft removal between 2 groups of studies. Group A reported outcomes of graft removal only, while group B reported outcomes after both graft removal and preservation (Supplementary Fig. 3). The 30-day mortality rate of graft removal was 18.1% (95% CI, 14.0%–22.6%) in group A and 33.5% (95% CI, 12.5%–20.4%) in group B (P = 0.070). The 1-year mortality rate was 27.3% (95% CI, 18.4%–37.1%) in group A and 71.1% (95% CI, 28.1%–99.9%) in group B (P = 0.080).

Outcome of patients with aortoenteric fistula

A total of 18 studies described 300 patients with secondary

Table 1. Summary of included studies

Study	Country	Study type	Population	Study period	No. of patients	Age (yr)	M/F	Initial presentation			Graft removal	
								AEF	GI bleeding	Shock	Total	Partial
Graft removal												
Armstrong 2005 [13]	United States	Retrospective observational study	Secondary AEF after open aortic surgery due to aneurysm or AIOD	1991–2004	29	70 (58–80)	19/10	29	25	10	29	0
Arya 2013 [14]	United States	Retrospective observational study	Endograft explantation due to infection or endoleak	2002–2012	12	71.9 (46–88)	11/1	2			11	1
Capoccia 2016 [15]	Italy	Retrospective observational study	Graft infection after EVAR	2012.6–2013.10	20			6[a)]	6		20	0
Chaufour 2017 [16]	France	Retrospective observational study	Graft infection after EVAR	1998.1–2015.1	33	69 (57–87)	33/0	12	3	1	33	0
Chen 2021 [17]	Taiwan	Retrospective observational study	Graft infection after EVAR	2006.1–2020.4	31	69.1 ± 9.9 (58–80)	25/6				31	0
Darling 1997 [18]	United States	Retrospective observational study	Graft infection after open aortic surgery due to aneurysm or AIOD	1987–1995	16	62 (47–73)	11/5	8	4	1	16	0
Davila 2015 [19]	United States	Retrospective observational study	Graft infection after EVAR	1997–2014	36	69 (54–80)	30/6	1	2		34	2
Dominguez-Cainzos 2023 [20]	Spain	Case series	Graft infection after EVAR	2010–2019	6	71 (59–81)	NA	1	0		5	1
Dorigo 2003 [21]	Italy	Retrospective observational study	Secondary AEF after open aortic surgery due to aneurysm or AIOD	1990.1–2002.3	30	70 ± 10	28/2	30	21		30	0
Filiberto 2021 [22]	United States	Retrospective observational study	Graft infection after Endo or open aortic surgery	2002–2019	142	66.6 ± 11	98/44	55				
Hayes 1999 [23]	United Kingdom	Retrospective observational study	Graft infection after open AAA repair	1992.1–1997.12	11	66 (49–78)	8/3	4	4	1	11	0
Jicha 1995 [24]	United States	Retrospective observational study	Graft infection after open aortic surgery	1980–1991	78	69.7	48/30	32			69	9
Maze 2013 [25]	New Zealand	Retrospective observational study	Graft infection after open aortic surgery	1999.1–2010.12	1	71 (48–85)	16/2				1	0
Mirzaie 2007 [26]	Germany	Retrospective observational study	Graft infection after open aortic surgery	2002.1–2004.1	11	72 (56–85)	8/3				0	11
O'Hara 1986 [27]	United States	Retrospective observational study	Graft infection after open aortic surgery	1961–1985.2	84	61	71/13	33	31		67	17
Quiñones-Baldrich 1991 [28]	United States	Retrospective observational study	Graft infection after open aortic surgery	1970.1–1988.6	45	63 (30–84)	34/11	7				
Reilly 1987 [29]	United States	Retrospective observational study	Graft infection after open aortic surgery	NA	101	64.4 ± 8.6	73/28	43			43	0

Table 1. Continued

Study	Country	Study type	Population	Study period	No. of patients	Age (yr)	M/F	Initial presentation			Graft removal	
								AEF	GI bleeding	Shock	Total	Partial
Ricotta 1991 [30]	Italy, United States	Retrospective observational study	Graft infection after open aortic surgery	NA	32	66 ± 7	26/6	8	6		20	12
Schaefers 2019 [6]	Germany	Retrospective observational study	Graft infection after EVAR or open AAA repair	2008.1–2016.12	26	69.9 (55–90)	20/6	9	4	17	26	0
Seeger 2000 [31]	United States	Retrospective observational study	Graft infection after open aortic surgery	1989.1–1999.7	36	61.8 ± 2.3	27/9				36	0
Shukuzawa 2019 [32]	Japan	Retrospective observational study	Graft infection after EVAR	2006.7–2014.12	2	77 (63–85)	2/0	2	1	0	2	0
Turney 2014 [33]	United States	Retrospective observational study	Graft infection after EVAR	1999–2012	13	NA	NA				13	0
Yeager 1990 [34]	United States	Retrospective observational study	Graft infection after open aortic surgery	1975.1–1989.10	38			15	14		38	0
Graft preservation												
Capoccia 2016 [15]	Italy	Retrospective observational study	Graft infection after EVAR	2012.6–2013.10	6	NA	NA					
Dominguez-Cainzos 2023 [20]	Spain	Case series	Graft infection after EVAR	2010–2019	4	71 (64–80)	NA	1	0			
Maze 2013 [25]	New Zealand	Retrospective observational study	Graft infection after open aortic surgery	1999.1–2010.12	17	71 (48–85)	16/2					
Shukuzawa 2019 [32]	Japan	Retrospective observational study	Graft infection after EVAR	2006.7–2014.12	13	70.5 (67–74)	12/1	2	1	1		

M/F, male/female; GI, gastrointestinal; AEF, aortoenteric fistula; AIOD, aortoiliac occlusive disease; EVAR, endovascular abdominal aneurysm repair; AAA, abdominal aortic aneurysm; NA, not available.

[a]Patients with AEF were reported together without distinction between graft removal and conservative treatment groups.

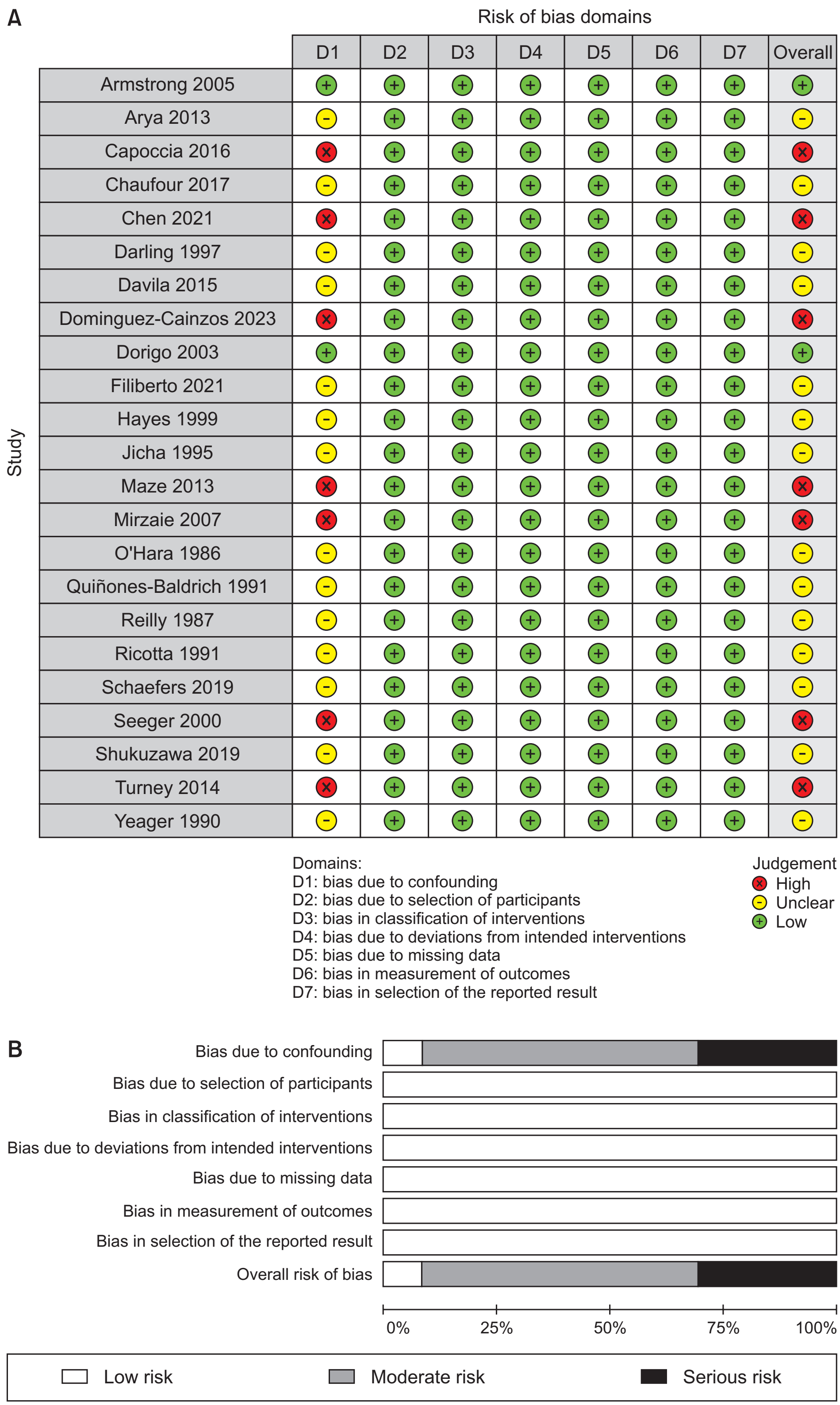

Fig. 2. Risk of bias graph (A) and summary (B) of included studies.

AEF (39.6%; range, 2.8%–100%). The reported mortality rate in patients with AEF was 29.5% (range, 0%–26.7%), 43.4% (range, 0%–100%), 51.5% (range, 0%–100%), and 69.6% (range, 39.0%–100%).

Additional outcomes

For the major amputation rate, a direct comparison could not be made because the time point at which the amputation rate was observed was not the same for each study. The reported

Table 2. Summary of findings table

Graft removal compared to graft preservation with antibiotics for aortic graft infection

Patient or population: aortic graft infection
Setting: perioperative mortality
Intervention: graft removal
Comparison: graft preservation

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with graft preservation	Risk with graft removal				
Thirty-day mortality	High 500/1,000	 490/1,000 (200–1,000)	RR, 0.98 (0.40–2.38)	29 cases 40 controls 11/29 exposed 4/40 unexposed (4 observational studies)	⊕○○○ Very low[a,b]	The evidence suggests that graft removal results in no difference in 30-day mortality
1-yr mortality	Low 118/1,000 High 250/1,000	 406/1,000 (189–876) 860/1,000 (400–1,000)	RR, 3.44 (1.60–7.42)	9 cases 34 controls 6/9 exposed 6/34 unexposed (3 observational studies)	⊕○○○ Very low[a,c]	The evidence suggests that graft removal results in increased 1-yr mortality

*The risk in the intervention group (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
CI, confidence interval; RR, risk ratio.

GRADE working group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Explanations
a. Confounding variables, including patients' condition at the diagnosis such as shock or gastrointestinal bleeding and age, were not addressed or adjusted.
b. There was a study with no event in both intervention and comparator and the results were inconsistent between studies with wide CI.
c. The confidence intervals of RR from 2 studies were wide and included 1.

major amputation rate ranged from 0% to 27%.

Thirty-day cause of death was described in detail in 12 studies. The most common cause of death was multiple organ failure from sepsis, aortic stump disruption, massive bleeding, or myocardial infarction.

Reinfection during the follow-up period was reported in 8 studies. In graft removal studies, the reinfection rate was 3.4%–36%. Two studies on graft preservation reported reinfection, with 1 study having a rate of 58.8% [25] and the other reporting none [32].

Meta-regression

Meta-regression analysis did not reveal any association between the 30-day mortality following AGI and the initial presentation with AEF or total removal of the aortic graft (P = 0.968 and P = 0.636, respectively) (Supplementary Fig. 4A, B). Due to limited data availability, further evaluation for GI bleeding or shock was not possible, as only 13 and seven studies, respectively, provided relevant data.

DISCUSSION

Traditionally, the standard treatment for AGI is based on 2 principles: early and effective elimination of the infection source, and successful vascular reconstruction [1,3,8]. Previous systematic reviews have been conducted under the premise that graft removal is the standard treatment for AGI [36-38]. However, this review raises the question of whether graft removal is the most effective treatment method for ensuring patient survival with AGI. To determine the outcomes of AGI, it is crucial to consider the availability of surgeons skilled in treating this condition, as well as selecting patients who are best suited for graft preservation or monitoring, based on their overall health status, frailty, and severity of symptoms. In the studies that discussed the reasons for choosing to preserve the graft, removal was not possible due to the high operative risk

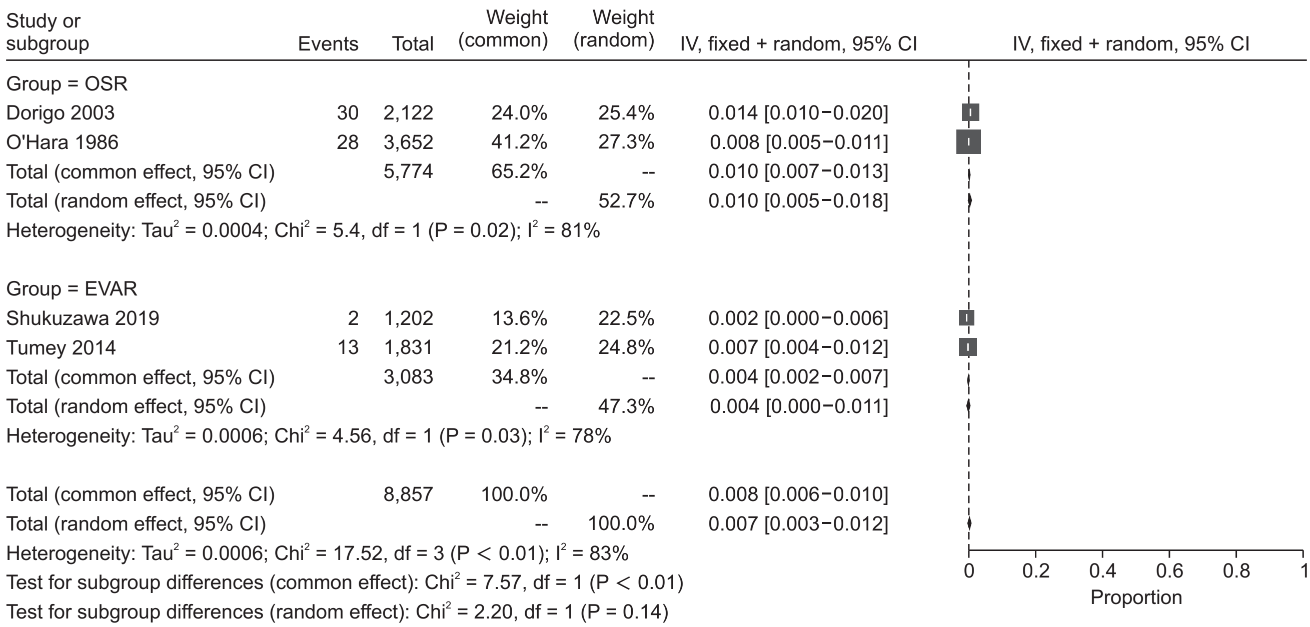

Fig. 3. Pooled estimate of prevalence of aortic graft infection after open surgical repair (OSR) or endovascular aneurysm repair (EVAR). IV, inverse variance; CI, confidence interval; df, degree of freedom.

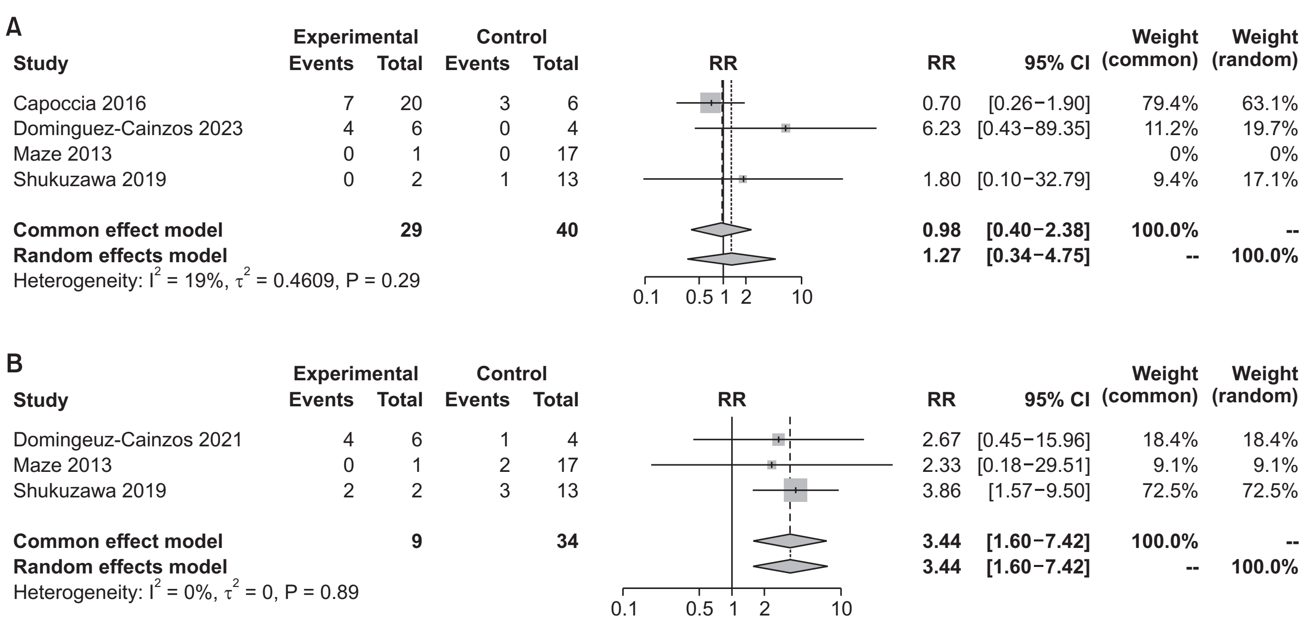

Fig. 4. Relative risk of 30-day mortality (A) and 1-year mortality (B) of graft removal (experimental) *vs*. graft preservation (control) in patients with aortic graft infection. RR, risk ratio, CI, confidence interval.

from the patient's poor condition. Nevertheless, the outcome of early treatment in these studies was not inferior to those of the group where the graft was removed and even showed a lower mortality rate at 1 year. The most common cause of 30-day mortality was sepsis in both groups. Considering that sepsis may not be controlled even though total graft removal is attempted to achieve eradication of the infection source, recovery of the host's defense capability is also an important factor to consider in AGI treatment. In 2 studies, a secondary procedure was performed during follow-up, suggesting that graft preservation can be an effective initial management option for selected patients. However, it should be noted that the evidence on the effectiveness of graft preservation is limited by the small sample size and retrospective nature of the studies. Further research is necessary to identify which patient groups will benefit from graft preservation.

To account for differences in patients' baseline conditions and treatment outcomes between centers, the mortality rate after graft removal was compared between studies that only reported outcomes for removal and studies that reported outcomes for both removal and preservation. In papers that reported results for both treatments, the mortality rate tended to be higher, although it did not reach statistical significance. This suggests that the outcome may be biased by factors such as the severity of the patient's initial presentation or the level of experience of the center. However, it is believed that this reflects real-world conditions. Meta-regression was conducted to determine whether the initial presentation, such as AEF or total removal of the graft, influenced the heterogeneity of the analysis results. Both AEF and total removal were not sources of heterogeneity. Further studies are needed to evaluate the association between mortality and other initial presentations, including GI bleeding or shock.

Another secondary finding was that the prevalence of AGI in our study was even lower, ranging from 0.17% to 1.41%, compared to prior reports which ranged from 0.5% to 5% [1]. This variability may be due in part to differences in study design, patient populations, and diagnostic criteria. In addition, the microbiology of AGI can vary depending on the location and type of the graft, as well as the timing of infection. The MAGIC proposed a definition for AGI in 2016 [35]. In this study, 9 out of 23 included studies met the MAGIC criteria, while 10 papers did not provide the diagnostic criteria of AGI. Moreover, none of the papers reviewed in this study referred to these criteria. To create an optimal treatment algorithm, the case definition of AGI should be clearly provided in the papers discussing AGI.

The study found that *Staphylococcus* was the most commonly isolated microorganism in cases of AGI, with gram-positive bacteria being more prevalent than gram-negative bacteria. These results are in line with previous studies that identified *Staphylococcus aureus* as the most common causative organism of AGI. Therefore, when AGI is suspected, empiric antibiotics should cover gram-positive bacteria, particularly *Staphylococcus* species.

Our study has some limitations. Firstly, due to the scarcity of relevant studies on AGI, the eligibility criteria had to be flexible. Secondly, the low number of available studies resulted in the use of low-quality studies with limited populations in the meta-analysis, reducing the overall strength of the evidence. There were also reports of graft infections in both the thoracic and abdominal aorta, but removing thoracic aortic grafts carries a higher risk of surgery-related morbidity and mortality than abdominal aortic graft removal. To reduce bias, the study excluded thoracic grafts from the eligibility criteria, resulting in a smaller number of included studies. Despite its limitations, the present study provides valuable insights into the prevalence, clinical features, management, and outcomes of AGI. Despite the limited number of high-quality papers available for analysis, the calculated RR through meta-analysis revealed that the direction of risk remained consistent with the pooled estimates. This congruence in the direction of risk among the available studies adds considerable credibility to our results. Our review is significant as AGI is a rare disease with potentially serious consequences. This study suggests that graft removal may not always be the best option for all patients with AGI. Further research is necessary to better understand and develop effective treatment strategies for AGI, which could improve patient survival outcomes.

SUPPLEMENTARY MATERIALS

Supplementary Material 1 and Supplementary Figs. 1–5 can be found via https://doi.org/10.4174/astr.2023.105.4.207.

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Conflict of Interest
No potential conflict of interest relevant to this article was reported.

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