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Extended versus limited arch replacement in acute Type A aortic dissection

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Abstract

OBJECTIVES: The recommended extent of surgical resection and reconstruction of the arch in acute DeBakey Type I aortic dissection is an ongoing controversy. However, several recent reports indicate a trend towards a more extensive arch operation in several institutions. We have analysed the recent data from the International Registry of Acute Aortic Dissection to assess the choice of procedure over time and to evaluate the surgical outcome in a 'real-world' database. Our aim was to compare short- and mid-term outcomes of limited repairs versus complete arch surgery.

METHODS: Of the 1241 patients included in the 'Interventional Cohort' of the International Registry of Acute Aortic Dissection from March 1996 to March 2015, 907 underwent ascending aortic or hemiarch replacement (Group A) and 334 had extended arch replacement (Group B). An extended resection was a surgeon's 'judgement call'. Logistic regression analysis, propensity-adjusted multivariable comparisons and Kaplan–Meier curves were used for analyses.

RESULTS: Overall in-hospital mortality was 14.2% with no difference between groups (Group A 13.1%, Group B 17.1%). Coma/altered consciousness (odds ratio 3.16, 95% confidence interval 1.60–6.25, $P = 0.001$), hypotension, tamponade or shock (2.03, 1.11–3.73, $P = 0.022$) and any pulse deficit (1.92, 1.04–3.54, $P = 0.038$) were predictors of in-hospital mortality in a propensity score-adjusted multivariable analysis. Overall 5-year survival was 69.4% in the ascending group and 73.1% in the total arch group ($P = 0.83$ by Kaplan–Meier analysis). For survivors of the index hospitalization, the 5-year freedom from death, aortic rupture and reintervention were 71.1% in Group A and 76.4% in Group B ($P = 0.54$ by Kaplan–Meier analysis).

CONCLUSIONS: Selective, or 'surgeon's choice', extended arch replacement had no discernible acute downside compared with less extensive surgery. Whether extended arch replacement improves the prognosis beyond 5 years remains to be settled.

Keywords: Aortic dissection • Aortic operation • Aortic arch • Outcomes

INTRODUCTION

Acute Type A aortic dissection (AAAD) is a challenging surgical emergency with in-hospital mortality just shy of 20% in recent series [1, 2]. Immediate surgery is required to prevent aortic rupture and counteract acute cardiac complications. The mainstay of management is replacement of the ascending aorta and, in selected cases, replacement or repair of the aortic valve. In more than 70% of patients with AAAD, the dissection extends beyond the ascending aorta (DeBakey Type I) [3]. In such a setting, a simple ascending aortic replacement leaves a dissected thoracic aorta with a patent false lumen in as many as 79% of patients [4]. The residual dissected aorta is prone to progressive dilation and aneurysmal development with a risk of rupture, and secondary surgical or endovascular treatment is necessary in 16–26% of patients within 10 years [5–7].

Traditionally, total arch replacement (TAR) during acute surgery for AAAD has been reserved for selected cases, such as those with extensive tears or aneurysms in the arch. Progress in operative and cerebral protection techniques has paved the way for elective arch replacement with acceptable risk. However, the risks of extensive surgery in the acute setting may outweigh potential long-term benefits.

As stated by Crawford more than 20 years ago, a randomized trial to determine the indications for arch replacement in AAAD is not likely to be conducted [8]. A potential benefit for extensive arch replacement demands a procedure-related morbidity and mortality at the level of a more limited ascending or hemiarch resection. We have used the data from a dedicated ‘Interventional Cohort’ subset of the International Registry of Acute Aortic Dissection (IRAD) to analyse ‘real-life’, contemporary and unselected patient data from aortic centres across the world. The ‘Interventional Cohort’ section of IRAD has recently been presented in detail [9]. The selection of the 1241 patients included in this arch analysis can be seen in Supplementary Material, Fig. S1. The aim of the study was to compare the outcomes of ascending aorta or hemiarch replacement to more extensive repairs involving aortic arch vessels.

PATIENTS AND METHODS

The IRAD is a multinational registry that collects consecutive and unselected cases of acute aortic dissection at 43 aortic centres in 13 countries. Participation in the registry does not *per se* imply treatment standardization. The details regarding the IRAD structure and data collection have been previously published [10]. Recently, records were supplemented with detailed information regarding surgical and endovascular treatment (Interventional Cohort, 20 centres). Of importance, this invasive case report form remains to be implemented in the entire IRAD network, and the number of patients included in this database is therefore lower than the total number of invasively treated patients in IRAD.

The study was approved by the institutional review board or ethics committee at each participating centre.

We analysed the data for all patients with AAAD enrolled in IRAD between March 1996 and March 2015. Patients managed exclusively with medication or for whom the invasive treatment form was lacking were excluded from the analysis. AAAD was defined as any non-traumatic dissection involving the ascending aorta and presenting within 14 days of symptom onset. Iatrogenic dissections were included. Patients were registered prospectively at presentation or retrospectively based on the discharge diagnoses. The diagnoses were based on imaging, intraoperative findings and/or autopsy.

‘Hemiarch’ replacement implies resection of the minor curvature of the aortic arch to various degrees, without reimplantation or deviation of any arch vessel. ‘Extended arch’ replacement was defined as the removal of parts or all of the aortic arch, with reimplantation of at least one of the arch vessels. The patients were stratified according to the extension of the aortic arch resection (Group A: none or just hemiarch and Group B: arch vessel reimplantation/arch replacement). Thus, the groups ‘complete arch’ and ‘partial arch’ from reference [9] have been combined as ‘extended arch’ or Group B in the present publication.

A standardized case report form was used to record demographics, medical history, presenting symptoms and clinical findings, imaging results, treatment and complications during the initial hospitalization. Follow-up data were obtained at 6 months and annually for up to 5 years using a standardized follow-up form to record clinical variables, imaging data, reinterventions and mortality with the date and cause of death where available. Our analyses were based exclusively on the standardized forms, as we have not independently reviewed patient charts or imaging studies.

Categorical variables were presented as frequencies and percentages. Continuous variables were presented as means and standard deviations or as medians and first and third quartiles (25th and the 75th percentiles) in cases of skewed data distributions. Differences between the 2 groups were analysed using the *t*-test or Mann–Whitney *U*-test for continuous variables and the χ^2 test or Fisher’s exact test for categorical variables, as appropriate. Missing values were not defaulted to negative; the presented values represent only those cases reported. Univariate analysis was first performed to select candidate variables (those with $P < 0.20$) to be introduced to a multivariable model. The relationship of clinical variables to in-hospital mortality was examined using binary logistic regression analysis utilizing a backward stepwise method. Propensity-adjusted multivariable analysis was used to assess risk factors for operative mortality. Kaplan–Meier survival curves were calculated for overall post-admission survival and post-discharge freedom from major adverse events (death, aortic rupture or aortic reintervention). Between-group differences were analysed using the log-rank test. All data analyses were performed using IBM SPSS Statistics for Windows, version 20.0. (IBM Corp., Armonk, NY, USA). A specified analysis can be found in the Supplementary Material.

RESULTS

A total of 1241 patients were identified from the Interventional Cohort; 907 (73%) patients underwent ascending aortic or hemiarch replacement (Group A) and 334 (27%) patients had extended arch replacement (Group B). Baseline patient characteristics, clinical presentation and imaging details are summarized in Table 1. Of notice, there were relatively more women in Group A, and significantly more patients in this group presented with syncope. The dissections were more extensive in Group B, and the maximal dimension of the aorta was marginally bigger in this group.

The frequency of concomitant coronary artery bypass surgery was higher in Group A patients, and aortic valve procedures,

Table 1: Baseline patient characteristics, clinical presentation and diagnostic imaging

	All patients (*n* = 1241)	Group A (*n* = 907)	Group B (*n* = 334)	*P*-value
Baseline patient characteristics				
Age (years)	60.3 ± 14.0	60.8 ± 14.1	59.1 ± 13.6	0.058
Female gender	404/1241 (32.6)	323/907 (35.6)	81/334 (24.3)	<0.001
Year of surgery				0.001
1996–2002	170/1241 (13.7)	104/907 (11.5)	66/334 (19.8)	
2003–2008	391/1241 (31.5)	299/907 (33.0)	92/334 (27.5)	
2009–2015	680/1241 (54.8)	504/907 (55.6)	176/334 (52.7)	
Iatrogenic dissection	37/1223 (3.0)	32/894 (3.6)	5/329 (1.5)	0.062
Marfan syndrome	37/1182 (3.1)	24/868 (2.8)	13/314 (4.1)	0.230
Hypertension	892/1195 (74.6)	674/877 (76.9)	218/318 (68.6)	0.004
Diabetes mellitus	97/1178 (8.2)	79/863 (9.2)	18/315 (5.7)	0.057
Atherosclerosis[a]	195/1176 (16.6)	143/861 (16.6)	52/315 (16.5)	0.967
Aortic stenosis or insufficiency	124/1172 (10.6)	92/861 (10.7)	32/311 (10.3)	0.846
Bicuspid aortic valve	51/1158 (4.4)	37/851 (4.3)	14/307 (4.6)	0.876
Previous aortic dissection	45/1182 (3.8)	28/866 (3.2)	17/316 (5.4)	0.088
Known aortic aneurysm	133/1178 (11.3)	93/865 (10.8)	40/313 (12.8)	0.331
Current smoking	229/700 (32.7)	167/505 (33.1)	62/195 (31.8)	0.747
COPD	83/868 (9.6)	68/651 (10.4)	15/217 (6.9)	0.125
Chronic renal insufficiency	49/872 (5.6)	42/655 (6.4)	7/217 (3.2)	0.077
Previous invasive cardiac procedures				
Open-heart surgery	126/1168 (10.8)	93/856 (10.9)	33/312 (10.6)	0.889
Catheterization and/or PCI	118/1168 (10.1)	93/861 (10.8)	25/307 (8.1)	0.185
Clinical presentation				
Abrupt onset of pain	888/1138 (78.0)	641/830 (77.2)	247/308 (80.2)	0.283
Chest pain	996/1183 (84.2)	730/867 (84.2)	266/316 (84.2)	0.993
Back pain	447/1124 (39.8)	325/815 (39.9)	122/309 (39.5)	0.904
Abdominal pain	290/1125 (25.8)	212/816 (26.0)	78/309 (25.2)	0.801
Radiating pain	389/1075 (36.2)	269/783 (34.4)	120/292 (41.1)	0.041
Migrating pain	176/1064 (16.5)	125/775 (16.1)	51/289 (17.6)	0.553
Syncope	212/1173 (18.1)	168/858 (19.6)	44/315 (14.0)	0.027
Any pulse deficit	217/700 (31.0)	142/498 (28.5)	75/202 (37.1)	0.026
Coma/altered consciousness[b]	122/1127 (10.8)	90/829 (10.9)	32/298 (10.7)	0.955
Cerebrovascular accident	59/1111 (5.3)	45/820 (5.5)	14/291 (4.8)	0.658
Hypotension/shock/tamponade	282/1072 (26.3)	210/785 (26.8)	72/287 (25.1)	0.584
First systolic blood pressure (mmHg)	127.0 ± 37.7	126.8 ± 38.3	127.4 ± 36.2	0.810
First diastolic blood pressure (mmHg)	69.7 ± 21.8	69.9 ± 22.4	69.4 ± 20.0	0.747
Abnormal ECG	580/971 (59.7)	418/711 (58.8)	162/260 (62.3)	0.322
Diagnostic imaging				
Number of studies per patient[c]	2.0 (1.0–2.0)	2.0 (1.0–2.0)	2.0 (1.0–2.0)	0.759
Computed tomography	992/1239 (80.1)	720/905 (79.6)	272/334 (81.4)	0.463
Magnetic resonance imaging	22/1237 (1.8)	14/905 (1.5)	8/332 (2.4)	0.309
Transoesophageal echocardiography	806/1241 (64.9)	600/907 (66.2)	206/334 (61.7)	0.143
Arch vessel involvement[d]	387/837 (46.2)	252/602 (41.9)	135/235 (57.4)	<0.001
Aortic measurements (cm)[c]				
Widest diameter of ascending	5.0 (4.4–5.6)	5.0 (4.5–5.6)	5.0 (4.4–5.7)	0.585
Widest diameter of aortic arch	3.6 (3.1–4.1)	3.6 (3.1–4.1)	3.8 (3.3–4.4)	0.092
Widest diameter of descending aorta	3.2 (2.9–3.7)	3.2 (2.8–3.7)	3.4 (3.0–3.9)	0.019
Most distal extension of dissection				
Ascending aorta	117/968 (12.1)	99/708 (14.0)	18/260 (6.9)	0.003
Aortic arch	194/968 (20.0)	147/708 (20.8)	47/260 (18.1)	0.355
Left subclavian level	37/968 (3.8)	20/708 (2.8)	17/260 (6.5)	0.008
Descending thoracic aorta	166/968 (17.1)	123/708 (17.4)	43/260 (16.5)	0.760
Abdominal aorta	406/968 (41.9)	282/708 (39.8)	124/260 (47.7)	0.028
Intramural haematoma	38/1102 (3.4)	28/798 (3.5)	10/304 (3.3)	0.858

Values are expressed as number/total number (%) or mean ± standard deviation, unless otherwise specified. Aortic diameters are all measured after occurrence of dissection.

COPD: chronic obstructive pulmonary disease; PCI: percutaneous coronary intervention; ECG: electrocardiography.

[a]Any history of PCI, coronary artery bypass grafting or catheterization demonstrating >70% stenosis in the coronary, cerebral or peripheral vasculature.

[b]Complete or partial mental unresponsiveness (beyond that expected from anaesthesia) or no evidence of psychological or physiologically appropriate responses to stimulation.

[c]Values are median (interquartile range).

[d]Any imaging modality showing dissection extending into the brachiocephalic trunk, left common carotid artery or left subclavian artery.

although not aortic valve replacement, were more dominant in Group B. Furthermore, biological valves were used more frequently in Group B and mechanical valves in Group A. Elephant trunks were constructed in 9.6% of the total arch patients (Group B), and the Group B patients had longer cardiopulmonary bypass times, longer cross-clamp time and slightly higher temperatures during bypass. Further details on surgical procedures are presented in Table 2. There was no increase in the relative number of TAR procedures in the later time period.

The in-hospital mortality was 14.2%, similar between groups. Table 3 summarizes postoperative complications. Group B had a higher frequency of fatal bleedings and acute post-procedure renal failure. Univariate predictors of in-hospital mortality are presented in Table 4, and Table 5 presents that patients with arch vessel involvement and/or later year of surgery were more likely to get a total arch resection. In the propensity-adjusted multivariable analysis coma at presentation, hypotension/tamponade/shock and any pulse deficit were significantly associated with in-hospital mortality (Table 6).

Follow-up was available for 534 of those 1065 patients who survived the index hospitalization (49% of survivors). Kaplan–Meier curves for overall survival and freedom from major adverse events are presented in Figs 1 and 2, respectively.

DISCUSSION

In the German Registry for Acute Aortic Dissection Type A (GERAADA), a recent analysis compared hemiarch with extensive replacement of the arch in 658 patients [1]. This analysis did not show a difference in the overall 30-day mortality, the presence of neurologic deficits or malperfusion, which is in concert with our study. However, an analysis from GERAADA presented at the American Association for Thoracic Surgery Aortic Symposium 2014 (Karck et al.) based on 2137 patients operated on between 2006 and 2010 suggests that even fair risk subgroups may have an unfavourable outcome from extensive surgery, as TAR in patients with DeBakey Type I aortic dissection with an intimal tear in the ascending aorta and no pre-existing neurological deficit resulted in a 70% higher mortality (14% vs 24%) compared with ascending repair only. Furthermore, analysis of the complete IRAD database (1995 patients operated from January 1996 to January 2013) identified arch replacement as an independent risk factor for in-hospital mortality [11]. Thus, both the IRAD and the GERAADA data indicate that arch replacement is a significant, albeit small, risk factor for increased operative mortality in high-powered analyses. These data seen together therefore document the clinical suspicion that there is a procedure-related increased

Table 2: Surgical details

	All patients (n = 1241)	Group A (n = 907)	Group B (n = 334)	P-value
Time from presentation to surgery (h)	7.0 (4.0–19.0)	7.0 (4.0–18.0)	7.0 (4.0–20.0)	0.761
Concomitant coronary artery bypass grafting	105/1074 (9.8)	86/766 (11.2)	19/308 (6.2)	0.012
Aortic valve procedure	844/1241 (68.0)	595/907 (65.6)	249/334 (74.6)	0.003
Prosthetic valve implantation	296/845 (35.0)	208/601 (34.6)	88/244 (36.1)	0.688
Type of prosthesis				0.011
Biological prosthesis	133/287 (46.3)	81/201 (40.3)	52/86 (60.5)	0.002
Mechanical prosthesis	151/287 (52.6)	119/201 (59.2)	32/86 (37.2)	0.001
Homograft	3/287 (1.0)	1/201 (0.5)	2/86 (2.3)	0.215
Resuspension	396/1045 (37.9)	277/747 (37.1)	119/298 (39.9)	0.391
Aortic valve sparing technique[a]	189/1044 (18.1)	134/740 (18.1)	55/304 (18.1)	0.995
Mitral valve procedure	15/1241 (1.2)	12/907 (1.3)	3/334 (0.9)	0.771
Replacement	7/1057 (0.7)	7/749 (0.9)	0/308 (0.0)	0.114
Repair	8/1056 (0.8)	5/747 (0.7)	3/309 (1.0)	0.699
Elephant trunk[b]	32/1013 (3.2)	3/712 (0.4)	29/301 (9.6)	<0.001
Use of surgical glue	636/1044 (60.9)	469/746 (62.9)	167/298 (56.0)	0.041
Type of glue				0.460
Biologic	565/611 (92.5)	414/450 (92.0)	151/161 (93.8)	
Synthetic	46/611 (7.5)	36/450 (8.0)	10/161 (6.2)	
Teflon felt reinforcement of anastomosis	962/1102 (87.3)	689/790 (87.2)	273/312 (87.5)	0.898
Arterial cannulation site				
Axillary	427/1241 (34.4)	293/907 (32.3)	134/334 (40.1)	0.010
Femoral	531/1241 (42.8)	387/907 (42.7)	144/334 (43.1)	0.888
Aorta	134/1241 (10.8)	101/907 (11.1)	33/334 (9.9)	0.527
Other	52/1241 (4.2)	43/907 (4.7)	9/334 (2.7)	0.111
Unknown	130/1241 (10.5)	106/907 (11.7)	24/334 (7.2)	0.022
Systemic circulatory arrest time (min)	42.0 (28.3–59.0)	37.0 (26.0–50.0)	75.0 (48.5–97.0)	<0.001
Total cardiopulmonary bypass time (min)	195.0 (153.0–242.0)	188.0 (147.0–233.8)	218.5 (178.0–267.0)	<0.001
Cooling time (min)	54.0 (40.0–64.0)	52.0 (40.0–63.0)	55.0 (43.0–66.5)	0.164
Minimum temperature (°C)	22.0 (18.0–26.0)	20.3 (18.0–25.8)	24.0 (18.0–27.0)	0.007
Cerebral perfusion during circulatory arrest	793/948 (83.6)	514/650 (79.1)	279/298 (93.6)	<0.001
Cerebral perfusion strategy				<0.001
Antegrade	608/892 (68.2)	376/607 (61.9)	232/285 (81.4)	
Retrograde	284/892 (31.8)	231/607 (38.1)	53/285 (18.6)	

Values are expressed as number/total number (%) or median (interquartile range).

[a]Reimplantation or remodelling (*ad modum* Yacoub or David).

[b]Some patients in International Registry of Acute Aortic Dissection had isolated descending stent grafts placed during circulatory arrest.

Table 3: Postoperative complications

	All patients (n = 1241)	Group A (n = 907)	Group B (n = 334)	P-value
Mortality	176/1241 (14.2)	119/907 (13.1)	57/334 (17.1)	0.077
Cause of death				
Neurologic	17/176 (9.7)	11/119 (9.2)	6/57 (10.5)	0.788
Tamponade	4/176 (2.3)	2/119 (1.7)	2/57 (3.5)	0.596
Visceral ischaemia	11/176 (6.3)	7/119 (5.9)	4/57 (7.0)	0.749
Rupture	26/176 (14.8)	20/119 (16.8)	6/57 (10.5)	0.272
Bleeding	14/176 (8.0)	6/119 (5.0)	8/57 (14.0)	0.039
Major organ failure	27/176 (15.3)	19/119 (16.0)	8/57 (14.0)	0.739
Cardiac	36/176 (20.5)	24/119 (20.2)	12/57 (21.1)	0.892
Unknown/other	41/176 (23.3)	30/119 (25.2)	11/57 (19.3)	0.385
New cerebrovascular accident	73/1152 (6.3)	49/837 (5.9)	24/315 (7.6)	0.273
Coma	7/1151 (0.6)	6/837 (0.7)	1/314 (0.3)	0.681
Spinal cord ischaemia	5/1149 (0.4)	3/837 (0.4)	2/312 (0.6)	0.617
Myocardial ischaemia/infarction	37/809 (4.6)	28/570 (4.9)	9/239 (3.8)	0.476
Acute renal failure	238/1187 (20.1)	159/863 (18.4)	79/324 (24.4)	0.022
Cardiac tamponade	97/1181 (8.2)	68/858 (7.9)	29/323 (9.0)	0.557
Mesenteric ischaemia/infarction	36/1186 (3.0)	28/865 (3.2)	8/321 (2.5)	0.507
Limb ischaemia	51/1185 (4.3)	35/862 (4.1)	16/323 (5.0)	0.500

Values are expressed as number/total number (%). Mortality indicates in-hospital mortality.

Table 4: Univariate predictors of in-hospital mortality

Variables	OR	95% CI	P-value
Age ≥70 years	1.51	1.07–2.12	0.019
Male gender	0.75	0.54–1.05	0.092
Partial or total arch replacement	1.36	0.97–1.92	0.077
Previous aortic aneurysm	1.81	1.15–2.86	0.009
Previous aortic dissection	1.15	0.51–2.62	0.739
Chronic renal insufficiency	1.56	0.73–3.30	0.246
Previous cardiac surgery	2.43	1.56–3.78	<0.001
Any pulse deficit	1.85	1.19–2.88	0.006
Cerebrovascular accident	2.48	1.34–4.59	0.003
Coma or altered consciousness at admission	3.57	2.32–5.49	<0.001
Hypotension/shock/tamponade at admission	2.03	1.42–2.90	<0.001
Arch vessel involvement	0.84	0.57–1.26	0.401
Concomitant CABG	3.02	1.86–4.89	<0.001
Total CPB time	1.01[a]	1.01–1.01	<0.001
Systemic circulatory arrest time	1.01[a]	1.00–1.01	0.009

OR: odds ratio; CI: confidence interval; CABG: coronary artery bypass grafting; CPB: cardiopulmonary bypass.
[a]Per 1-min increment.

Table 5: Multivariable logistic regression analysis for receiving a complete arch repair

Variables	Odds ratio	95% CI	P-value
Female gender	0.722	0.501–1.039	0.080
Later year of surgery	2.987	1.998–4.466	<0.001
Any arch vessel involvement	1.822	1.311–2.530	<0.001
Distal extent at the left subclavian	2.139	0.996–4.595	0.051

C-statistic = 0.651; Hosmer–Lemeshow $P = 0.904$.
CI: confidence interval.

mortality with TAR in AAAD, but the neutral results from the present study indicate that this must be small in a strategy of surgeon-determined use of arch resection.

To further clarify the indications for TAR in the acute management of AAAD, one must consider the natural course of post-repair AAAD. The survivors of surgically treated AAAD have significantly higher long-term mortality than the normal population [12]. In a recent publication from Sweden, it was found that the cause of late deaths was due to aortic events in at least 27% of patients and possibly as many as 42% [13]. Reintervention rates vary with the 10-year freedom from aortic reoperation following AAAD repair ranging between 74% and 98% [5–7, 14–16]. Some of these procedures are proximal reoperations that cannot be prevented by a more radical primary distal aortic resection. The risk connected with distal aortic reoperation also varies considerably, with mortality rates ranging from 0% to 31% [5, 17]. Thus, identification of the patients at risk for future aortic complications before initial surgery is highly desirable.

The patient cohort in our analysis consisted of 1241 patients treated at 20 aortic centres in 9 countries. Of these patients, more than 60% underwent surgery during the last 6-year period, and 90% underwent surgery in the last 12 years. This represents a 'real-world' current reflection of aortic dissection management. Our results suggest that the conservative approach is sufficient for many patients in the short and intermediate postoperative period. Nevertheless, in select cases, an extensive procedure may be performed without prohibitive risk. Of interest, the TAR patients were more likely to receive cerebral perfusion during systemic circulatory arrest, this perfusion was more likely antegrade, and arterial cannulation site was in most cases axillary. As the IRAD data reflect 'surgeon's preference', approximately 1 in 4 patients were deemed in need of a complete arch resection during this period, and such a selection process resulted in similar hospital and 5-year mortality.

Coma at admission, circulatory instability and signs of malperfusion (pulse deficits) were independent risk factors for

Table 6: Propensity-adjusted multivariable logistic regression analysis for in-hospital mortality

Variables	Odds ratio	95% CI	*P*-value
Propensity for complete arch	4.62	0.41–51.51	0.214
Female gender	1.17	0.61–2.25	0.630
Age	1.81	0.94–3.49	0.076
Complete arch repair	1.14	0.59–2.19	0.701
Any pulse deficit	1.92	1.04–3.54	0.038
Coma/altered consciousness	3.16	1.60–6.25	0.001
Hypotension, shock or tamponade at presentation	2.03	1.11–3.73	0.022

C-statistic = 0.710; Hosmer–Lemeshow *P* = 0.731.
CI: confidence interval.

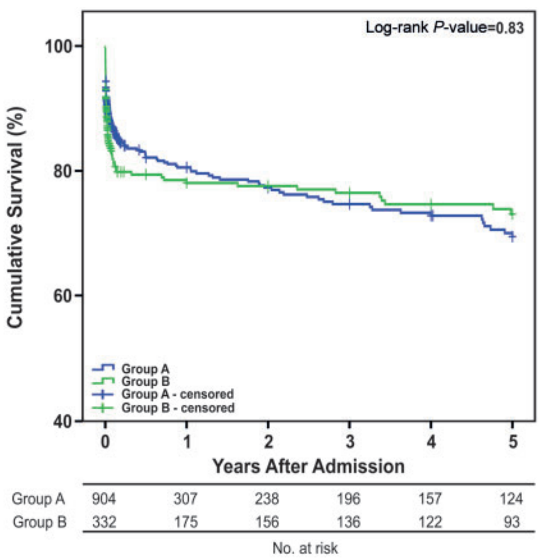

Figure 1: Kaplan–Meier post-admission survival curves stratified according to the extent of surgery.

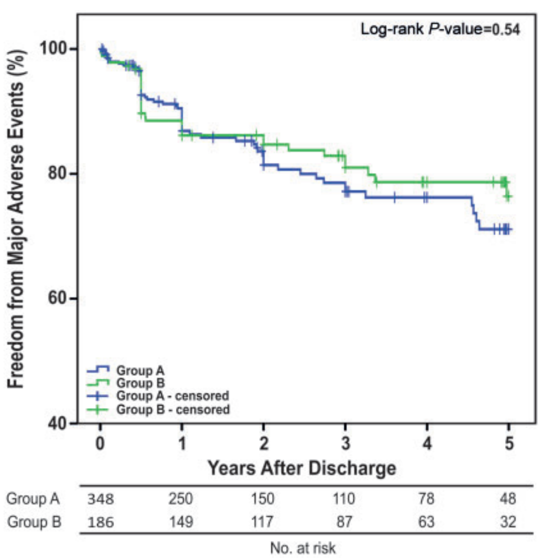

Figure 2: Kaplan–Meier curves of post-discharge freedom from major adverse events (all-cause mortality, aortic rupture and reoperation, including endovascular repair), stratified according to the extent of surgery.

in-hospital death after propensity adjustment. This is consistent with previous findings, as cerebral malperfusion with fixed deficits or coma carries poor postoperative prognosis, particularly if surgery is delayed [18, 19].

This was not a randomized trial, and several factors can for the surgeon be decisive in choosing arch replacement over the somewhat simpler ascending or hemiarch replacement. The 2 groups in our study were relatively homogenous, although there were some differences in clinical presentation and imaging characteristics. The proportion of patients with arch vessel dissection was highest in Group B, whereas the number of patients presenting with syncope was highest in Group A. In Group A, a higher proportion of patients had a dissection confined to the ascending aorta, as judged by preoperative imaging. There is considerable overlap between the 2 groups with respect to arch vessel involvement and dissection propagation, and therefore, other aspects must account for different resection strategies. There is a definite possibility that patients in Group B had a more malignant aortic pathology, which is not accounted for by the IRAD registry forms or conventional imaging techniques. Intraoperative decisions and circumstances that can mandate more extensive procedures are not recorded in the IRAD forms. Surgeon's preference, experience and institution protocols also play a role, as IRAD includes patients from aortic referral centres worldwide.

There are most likely subgroups for which arch replacement can be beneficial, such as patients with the primary entry located in the aortic arch and patients with a pre-existing aneurysm of the aortic arch or proximal descending aorta. However, identification of a differentiated treatment and outcome of such subgroups cannot be done from the IRAD database in its present state of development. High-quality registry data with diligent follow-up are of the utmost importance in the future identification of these patients. IRAD has initiated an interventional working group, which is gathering more detailed data on these types of variables to further our understanding of optimal therapies.

Limitations

The study has several limitations. The most significant limitation to observational studies is the potential for selection bias. IRAD has included more than 3500 patients with AAAD, but adequate surgical details in the new invasive report form were available for only 1241 patients. Our results may therefore not be representative of the entire IRAD patient population but be limited to centres with a particular engagement in the surgical cohort.

Of importance, and essential to evaluate our study, 5-year follow-up does not give the complete overview of a potential prophylactic benefit of TAR, as aneurysms in the downstream aorta can develop slowly. Also, since the majority of patients were operated in the last few years, follow-up is still incomplete and lacking for half of the patients.

In most cases of in-hospital mortality, the cause of death was recorded. However, we did not have sufficient information to decipher the cause of death during follow-up to perform a relevant analysis of aortic-specific death.

Data about intimal tear location as judged by imaging were not available in a large portion of cases. Furthermore, the IRAD registry case report forms do not collect information on whether the primary entry tear is found and excised during surgery.

CONCLUSION

In conclusion, based on existing data, it does not seem justified to 'routinely' add additional complexity to an already challenging procedure (TAR), with the intent to reduce the risk of future complications. However, a strategy of individual and aortic-specific assessments as a basis for TAR still remains crucial in decision-making processes to select the optimal surgical strategy for patients with AAAD. A longer follow-up from both GERAADA and IRAD will hopefully enlighten us on the long-term effect of extensive arch surgery in aortic dissection.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *EJCTS* online.

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