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Outcome after surgery for acute aortic dissection type A in patients over 70 years: data analysis from the German Registry for Acute Aortic Dissection Type A (GERAADA)☆

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Abstract

Objective: The number of elderly patients undergoing emergency surgery for acute aortic dissection type A (AADA) is rising. Published results report a higher risk for these patients compared with younger patients. The aim of our study was to analyse the surgical outcome of these patients and to identify those at risk. **Methods:** Between July 2006 and June 2009, 44 centres participating in the German Registry for Acute Aortic Dissection Type A (GERAADA) reported a total of 1558 patients. As many as 381 patients were between 70 and 80 years of age (septuagenarians), while 83 patients were 80 years and older (octogenarians). We compared the clinical features and events occurring 30 days after surgery. **Results:** On admission, 23% (n = 89) of septuagenarians had cardiac tamponade, compared with 31% (n = 26) of those age ≥80 years (p = 0.13). A little more than 13% (n = 48) of septuagenarians were intubated at admission compared with 21% (n = 17) of octogenarians (p = 0.06). The septuagenarians' 30-day postoperative mortality was 16% (n = 60), whereas that of patients aged over 80 years was 35% (n = 29) ($p < 0.001$). The mean hospital stay in the younger group was 18 days, of which 12 days were in the intensive care unit, compared with 18 and 13 days for octogenarians, respectively. **Conclusions:** Emergency surgery for septuagenarians with acute aortic dissection type A (AADA) resulted in acceptable mortality. Octogenarians revealed significantly higher 30-day mortality (odds ratio (OR) = 3.23, confidence interval (CI) = (1.81—5.72)), although it was lower than the mortality among patients without surgical treatment. A surgical approach should be considered in all patients on an individual basis.

Keywords: Aortic dissection; Octogenarians; Septuagenarians; GERAADA

1. Introduction

Untreated acute aortic dissection type A (AADA) remains a lethal aortic disease. Without surgical treatment, approximately 75% of patients die within 2 weeks of the onset of symptoms [1]. In our ageing society, the number of elderly patients undergoing emergency surgery for AADA has been steadily increasing. With advances in surgery, anaesthesia and perioperative medical management, surgical outcome continues to improve [2—4]; however, published case series report in-hospital mortality of even more than 80% in patients aged 80 years and older [5—7]. It therefore remains controversial whether emergency surgery is justified in elderly patients with AADA.

The German Registry for Acute Aortic Dissection Type A (GERAADA) is the largest registry worldwide documenting patients who underwent emergency surgery for AADA [8—10]. It gives us the opportunity to analyse a large cohort of elderly patients with AADA. We used the registry to evaluate differences in clinical presentation, management and surgical outcome between septua- and octogenarians.

2. Methods

2.1. Patient selection

We analysed patients with AADA enrolled in GERAADA from 1 July 2006 to 30 June 2009. The structure of this web-based registry has been described previously [8]. Patients were identified prospectively at presentation. AADA was defined by visualising an intimal flap separating two lumina in the ascending aorta; the acute stage was confined to the initial 14 days after symptom onset [11]. Patients were divided into two groups: those older than 70 years and younger than 80

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years of age (septuagenarians) and those aged 80 years and older (octogenarians).

2.2. Data collection

Data were acquired using a standard online questionnaire developed by the GERAADA principal investigator. Data collected included patient demographics, pre- and intra-operative status, postoperative complications, mid-term results and date and cause of death. Data forms were delivered via online access to the registry on the German Society for Thoracic and Cardiovascular Surgery (GSTCVS) homepage.

2.3. Statistical analysis

Statistics are summarised as frequencies and percentages for categorical variables, and as mean and standard deviation for continuous variables. The two age groups (septua- and octogenarians) were compared with the χ^2 test for categorical variable and the unpaired *t*-test for continuous variables. The *p*-values are not presented for $n \leq 10$ in the subgroup. As several tests were performed, they should be considered as an exploratory mean. The descriptive statistics and tests have been analysed referring to the cases without missing values (complete case analysis). Time in-hospital was censored if a patient died during the hospital stay. The influence of age ($\geq$70 and $<$80 years vs $\geq$80 years) on 30-day-mortality was analysed using logistic regression using the co-variables below: preoperative cardiopulmonary resuscitation, respirator dependence on admission, cardiac tamponade, hemiplegia or hemiparesis, paraplegia or paraparesis and various operative techniques such as ascending aortic replacement, composite graft implantation, hemi- and total arch replacement and David and Yacoub procedures. The influence of those factors on length of stay in the intensive care unit (ICU) and in hospital was measured using linear regression. The influence of circulatory arrest time on mortality was measured using logistic procedure. This is an exploratory study, which is why the term 'statistically significant' should not be taken literally, as we did not adjust for the number of tests carried out.

3. Results

3.1. Demographics and aetiology

Between July 2006 and June 2009, 44 centres participating in GERAADA reported a total of 1558 patients. A total of 381 patients were between 70 and 80 years of age (septuagenarians), while 83 patients were 80 years and older (octogenarians). Men constituted 48% (184/381) of the younger age group, but only 31% (26/83) of the older age group.

Connective-tissue disorders such as Marfan and Ehlers–Danlos syndrome were rare and were observed only in the younger patient cohort (1% (4/381) and 0.4% (2/381), respectively). The frequency of hypertension, atherosclerosis, aortic aneurysm and iatrogenic dissection were similar in both groups (Table 1).

3.2. Clinical presentation

Clinical presentations are reported in Table 1. Octogenarians were more likely to present with a relevant

Table 1. Demographics, aetiology, clinical presentation and diagnostic imaging of patients with acute aortic dissection type A (AADA).[a]

Variable	Overall, *n* = 464	≥70 and <80 years, *n* = 381	≥80 years, *n* = 83	*p* values
Clinical characteristics				
Age (years)	75.3 (SD: 4.4)	73.7 (SD: 2.8)	82.8 (SD: 2.3)	
Gender: male	210 (45%)	184 (48%)	26 (31%)	
Aetiology				
Marfan syndrome	4 (0.9%)	4 (1.1%)	0 (0%)	
Ehlers–Danlos syndrome	2 (0.4%)	2 (0.4%)	0 (0%)	
Arterial hypertension	266 (57.3%)	219 (57.5%)	47 (56.6%)	0.89
Atherosclerosis	149 (32.1%)	128 (33.6%)	21 (25.3%)	0.14
Iatrogenic dissection	36 (7.8%)	29 (7.6%)	7 (8.4%)	0.80
Aortic aneurysm	170 (36.6%)	140 (36.8%)	30 (36.1%)	0.92
Clinical presentation				
Cardiac tamponade	115 (24.8%)	89 (23.4%)	26 (31.3%)	0.13
Cardiopulmonary resuscitation	32 (6.9%)	30 (7.9%)	2 (2.4%)	
Intubated by admission	65 (14.0%)	48 (12.6%)	17 (20.5%)	0.06
Hemiplegia or hemiparesis	22 (4.7%)	18 (4.7%)	4 (4.8%)	
Paraplegia or paraparesis	12 (2.6%)	9 (2.4%)	3 (3.6%)	
Aphasia	8 (1.7%)	7 (1.8%)	1 (1.2%)	
Diagnostic imaging				
Computed tomography	381 (82.1%)	317 (83.2%)	64 (77.1%)	0.19
Echocardiography	244 (52.6%)	198 (52.0%)	46 (55.4%)	0.57
Angiography	55 (11.9%)	49 (12.9%)	6 (7.2%)	0.15
Magnetic resonance	7 (1.5%)	6 (1.6%)	1 (1.2%)	0.80
Diagnostic imaging findings				
Involvement of:				
Arch	344 (74.1%)	284 (74.5%)	60 (72.3%)	0.67
Supra-aortic vessels	132 (28.5%)	104 (27.3%)	28 (33.7%)	0.24
Descending aorta	186 (40.1%)	149 (39.1%)	37 (44.6%)	0.36
Abdominal aorta	135 (29.1%)	103 (27.0%)	32 (38.6%)	0.04
Pelvic arteries	82 (17.7%)	64 (16.8%)	18 (21.7%)	0.29

[a] Categorical variables are presented as frequencies and percentages, continuous variables are presented as mean and standard deviation.

Table 2. Surgical procedures and outcomes of patients with acute aortic dissection type A (AADA).[a]

Variables	Overall, $n = 464$	≥70 and <80 years, $n = 381$	≥80 years, $n = 83$	p values
Surgical procedures				
Mean operating time (min)	317.0 (99.8)	322.1 (100.4)	293.3 (94.1)	0.02
Mean circulatory arrest time (min)	29.6 (20.0)	29.7 (20.3)	29.0 (18.7)	0.79
Degree of hypothermia (°C)	24.3 (4.4)	24.4 (4.3)	24.1 (4.5)	0.61
Selective cerebral perfusion	344 (74.14%)	289 (75.85%)	55 (66.27%)	0.07
Ascending aortic replacement	367 (79.1%)	298 (78.2%)	69 (83.1%)	0.32
Composite graft implantation	65 (14.0%)	56 (14.7%)	9 (10.8%)	0.36
Proximal or hemiarch replacement	240 (51.7%)	199 (52.2%)	41 (49.4%)	0.64
Total arch replacement	62 (13.4%)	54 (14.2%)	8 (9.4%)	
David operation	12 (2.6%)	11 (2.9%)	1 (1.2%)	
Yacoub operation	7 (1.5%)	6 (1.6%)	1 (1.2%)	
CABG	77 (16.6%)	69 (18.1%)	8 (9.4%)	
Aortic valve replacement	38 (8.2%)	28 (7.4%)	10 (12.1%)	0.18
Aortic valve reconstruction	57 (12.3%)	44 (11.6%)	13 (15.7%)	0.18
Outcomes				
Re-operation	97 (20.9%)	78 (20.5%)	19 (22.9%)	0.62
Prolonged intubation >48 h (n)	224 (52.8%)	189 (54.5%)	35 (45.5%)	0.15
New incidence of:				
Hemiplegia or hemiparesis	48 (10.3%)	38 (10.0%)	10 (12.1%)	0.57
Paraplegia or paraparesis	9 (1.9%)	6 (1.6%)	3 (3.6%)	
Aphasia	10 (2.2%)	8 (2.1%)	2 (2.4%)	
ICU length of stay (days)	10.6 (16.1)	10.2 (16.0)	12.5 (16.1)	0.26
Hospital length of stay (days)	17.9 (18.4)	18.0 (18.5)	17.7 (18.1)	0.90
30-day mortality	89 (19.2%)	60 (15.8%)	29 (34.9%)	<0.0001

ICU – intensive care unit; CABG – coronary artery bypass graft.
[a] Categorical variables are presented as frequencies and percentages, continuous variables are presented as mean and standard deviation.

haemodynamic cardiac tamponade (31% vs 23%, $p = 0.13$). However, only two patients (2%) in the older patient group required preoperative cardiopulmonary resuscitation, compared with 30 (8%) in the younger cohort. Furthermore, 21% ($n = 17$) of octogenarians were intubated at admission, compared with 13% ($n = 48$) of septuagenarians ($p = 0.06$). Incidences of neurologic deficits did not differ between the two age groups.

3.3. Diagnostic imaging findings

All patients underwent some form of imaging study. The most common diagnostic tool in both groups was computed tomography (octogenarians 77% vs septuagenarians 83%, $p = 0.19$). Aortic dissection extended to the supraaortic vessels (34% vs 27%, $p = 0.24$) and abdominal aorta (39% vs 27%, $p < 0.05$) more frequently in the octogenarians.

3.4. Surgical procedures

The diagnosis of aortic dissection was confirmed in all patients during surgery. All patients underwent a standard median sternotomy and total cardiopulmonary bypass. Most procedures consisted of supracoronary replacement of the ascending aorta (octogenarians 83% vs septuagenarians 78%, $p = 0.32$) or composite graft implantation (octogenarians 11% vs septuagenarians 15%, $p = 0.36$). Half of the patients in each group underwent proximal or hemiarch replacement, according to the Borst classification. Septuagenarians were more likely to undergo total replacement of the aortic arch (14% vs 9%, $p = 0.21$). The David operation was carried out in 11 patients (3%) in the younger cohort and in only one patient (1%) in the older cohort. Octogenarians more frequently received additional aortic valve procedures (replacement 12% vs 7%; reconstruction 16% vs 12%, $p = 0.18$). Surgical coronary revascularisation was carried in 18% of septuagenarians and 9% of octogenarians. The mean time of surgery was significantly higher in the younger cohort (322 ± 100 min vs 293 ± 94 min, $p = 0.02$). Mean circulatory arrest time did not differ between groups. Surgical procedures are summarised in Table 2.

3.5. Outcomes

Postoperative complications were similar in the two groups (Table 2). About 20% of the patients in each group required re-operation due to postoperative bleeding. A little more than half (55%) of the younger patients required prolonged intubation (>48 h), compared with 46% of octogenarians ($p = 0.15$). New postoperative neurological complications occurred more frequently in the octogenarians, although

Table 3. Logistic regression analysis of influence of clinical presentation and operative techniques on 30-day mortality in septua- and octogenarians.

Variables	Septua- and octogenarians, $n = 464$		
	OR	95% CI	p values
Clinical presentation			
Age	3.23	1.82–5.73	<0.0001
Cardiac tamponade	0.93	0.51–1.70	0.82
Cardiopulmonary resuscitation	5.23	2.20–12.45	<0.001
Intubated by admission	2.40	1.22–4.73	0.01
Hemiplegia or hemiparesis	1.08	0.35–3.34	0.89
Paraplegia or paraparesis	3.40	0.99–11.68	0.05
Surgical procedures			
Ascending aortic replacement	3.87	0.45–33.00	0.21
Composite graft implantation	3.24	0.35–30.20	0.30
Proximal or hemiarch replacement	1.07	0.61–1.87	0.81
Total arch replacement	0.95	0.40–2.23	0.91
David operation	1.48	0.07–31.00	0.80
Yacoub operation	3.23	0.15–67.21	0.45

OR – odds ratio; CI – confidence intervals.

those differences were not statistically significant. Hospital length of stay did not differ between the two groups. Average hospital stay was 18 days in octogenarians, of which 13 days were in the ICU, compared to septuagenarians' 18 and 12 days, respectively. The 30-day mortality was higher among the older patients (35% vs 16%, $p < 0.001$). Circulatory arrest time influenced the mortality rate significantly ($p < 0.001$) in both groups. Age $\geq$80 years was an independent predictor of 30-day mortality ($p < 0.001$).

The logistic regression analysis of clinical presentation and influence of operative techniques on 30-day mortality revealed that only age ($p < 0.0001$), preoperative cardiopulmonary resuscitation ($p < 0.001$) and respirator dependence on admission ($p < 0.05$) significantly raised the rate of patients dying within 30 days after surgery (Table 3) when considering patients over 70 years old. Furthermore, neither clinical presentation nor operative techniques influenced significantly the length of stay on the ICU or in hospital.

4. Discussion

Indications for emergency surgery for AADA in the elderly have risen in recent years due to the increasing age of the general population and to technical improvements in perioperative management and postoperative care. However, most articles consistently report that advanced age remains a significant determinant of mortality after surgery for aortic dissection [5–7,12]. This fact and the absence of practice guidelines for elderly patients with AADA (and no endovascular alternative) [14] make the therapy decision of these patients problematic.

GERAADA is currently the largest registry worldwide for patients who underwent emergency surgery for AADA [8]. Using this database, we analysed differences in demographics, clinical characteristics, surgical approach and outcomes of a large cohort of elderly patients with AADA. To identify patients at risk and evaluate the influence of advanced age, we divided the cohort into septua- and octogenarians.

The aetiology of AADA varied between the younger and older groups. Connective-tissue disorders such as Marfan or Ehlers–Danlos syndrome were presented exclusively in the younger patient cohort, whereas the incidence of atherosclerosis, hypertension, aortic aneurysm and iatrogenic dissection was similar in both groups. There were significantly fewer men with AADA in the older group. This gender difference may be explained by the shorter life expectancy of males.

The surgical approaches between the two age groups differ, revealing a higher incidence of more complex surgery in the younger group. The older patients were more likely to undergo supracoronary replacement of the ascending aorta than composite graft implantation. However, both groups underwent proximal or hemiarch replacement equally often, while younger patients underwent more total aortic arch replacements. The David operation was carried out almost exclusively in the younger cohort, as the David technique's complex valve-sparing aortic root reconstruction in septuagenarians was recently proved superior to mechanical and biological composite graft methods [15]. Yet, octogenarians more frequently underwent additional aortic valve procedures. Nevertheless, the mean operating time was lower in the older group. The discrepancy between more severe aortic pathology and less complex surgery for aortic dissection in octogenarians may be explained by the new commonly held belief that less-invasive surgery in octogenarians with AADA is safer and more effective than complex surgery. This hypothesis was recently confirmed by Hata and colleagues [13], who reported an impressive success rate in a series of octogenarians, who underwent quick replacement of the ascending aorta with minimum invasive stress. Our data reinforce this position.

The mortality of patients with AADA without surgical treatment rises to 75% within 2 weeks of the onset of symptoms, a finding reported by other investigators. [1] Emergency surgery for septuagenarians with AADA resulted in an acceptable 30-day-mortality of 16%. Although 30-day mortality was significantly higher in the octogenarians, it was still not prohibitive. The fact that almost 35% of octogenarians died within 30 days after surgery is not surprising [16]; however, it requires deep analysis of risk factors for such high surgical mortality. First of all, we know that among old patients with AADA, the characteristic symptoms (abrupt onset of pain) and signs (murmur of aortic regurgitation or pulse deficits) are significantly less common [16], suggesting that the time between the dissection event and surgery may correlate with patient age. This factor may significantly increase mortality among octogenarians. Second, octogenarian patients tend to experience more preoperative complications. The older group presented relevant haemodynamic cardiac tamponade more frequently. Twice as many octogenarians were intubated upon admission as were septuagenarians. The incidences of neurologic deficits did not differ between the two groups; however, patients aged $\geq$80 years presented a higher frequency of supraaortic branch vessel involvement as well as significantly more frequent dissections extending to the abdominal aorta and iliac arteries. In summary: octogenarians arrive at the hospital in more serious condition, which may result in poorer prognosis for these patients.

The strength of our study is its large number of patients, the many centres that participated and the clear rules for 30-day follow up. Limitation is certainly the fact that this is an observational study where confounding by other risk factors cannot be ruled out. In addition, referral criteria may cause a small bias (e.g., decision: surgery or no surgery is made by different surgeons). Furthermore, data from patients who died on the way to hospital are not retrievable from our registry. We presume that there is also a subgroup of old and very ill patients which, because of very poor condition, is not treated at a hospital with a cardiac surgery team. These patients are preoperatively 'selected' in external hospitals on an individual basis and usually after consultation with the family.

Our study supports the hypothesis that surgical therapy for AADA should not be denied on the basis of advanced age alone. The 35% mortality among octogenarians after surgical repair for AADA is not prohibitive, as the mortality of patients with AADA without surgery reaches 75% [2]. We believe that an aggressive surgical approach should be considered in all

patients on an individual basis. Physicians should also offer octogenarians with AADA the chance to benefit from surgical therapy.

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Appendix A. Conference discussion

Dr J. Bachet (*Abu Dhabi, United Arab Emirates*): I would like to commend the group, and Dr Weigang in particular, for having set up and developed the German Registry of Acute Aortic Dissection. In only 3 years you were able to gather more than 1500 patients from 44 centres and collect a large amount of data. This is a remarkable achievement, and I hope that it will serve as a model for the development of a larger European registry in which all the European centres will be as eager to participate as our German colleagues.

The controversy about the indication for surgery in acute dissection in the elderly is still running. In this regard you bring us useful information. The fact that 85% of the septuagenarians survived surgery indicates, for sure, as we imagined before, that emergency surgery should not be denied to this group of patients because of their age. This is a certainty, thank you for confirming it.

But, considering the spontaneous mortality of the disease, the good and comforting news is that two-thirds of the octogenarians survived the surgical procedure. Your study also confirms the predominant common sense of the surgical community. Sophisticated procedures such as valve-sparing procedures, arch replacements, were rare, and indeed their indication at this age can be questioned. So we certainly share your conclusion that, particularly after the age of 80, surgery must be considered on an individual basis.

This brings me to my first question. Do you know how many octogenarians referred to the participating centres were denied surgery and for what reasons? And what would be your criteria to deny surgery in this group of patients?

Last, your study does not provide us with any information about the mid term or late survival of the patients. So do you know what has been the average survival in the operated on octogenarians? Indeed, if the survival is limited, do you think that emergency surgery should still be carried out?

Dr Rylski: Of course, every registry has its advantages and disadvantages. The problem common to all of them is the long-term follow-up, and examining the patient's transport from an external hospital to the hospital where the patient underwent his surgery. These data are not retrievable from our registry. We include only those acute aortic dissection type A patients who underwent surgery. We don't know how many patients died, for example, on the way to the hospital.

You asked me what our criteria were for operating on 80-year-old patients. We analysed the preoperative risk factors that these patients presented at admission. We detected no correlation between preoperative malperfusion syndrome or neurological events and the 30-day mortality rate. Perhaps we had too few patients in that subgroup to analyse these factors. It's not always possible to speak with the patient or to talk with the family to find out whether the patient wants surgery or not. I believe that it should be up to the surgeon to decide whether the patient should undergo surgery or not when he or she is 80 years old and presents with acute aortic dissection type A.

Dr Bachet: Let me be more specific. If you see an acute dissection in a gentleman of 55, for instance, with a stroke, most surgeons would agree that despite the stroke he should undergo surgery. Would you have the same criteria if you see a gentleman of 83 with acute dissection and a stroke? Would you operate on him? That is my question.

Dr Rylski: If I find that this patient has a 75% risk of dying without surgery and, with a preoperative stroke, 90% risk of dying, I would attempt to perform surgery to give him or her a chance of survival.

Dr M. Grabenwoger (*Vienna, Austria*): We are only looking for some factors influencing bad outcome in patients over 80 out of this analysis. Is this preoperative stroke, or do you have this data out of the database, the risk factors for death?

Dr E. Weigang (*Mainz, Germany*): In a different analysis of the entire registry, we detected a preoperative risk factor for death when the patient was already suffering from neurological dysfunction; this factor correlated with a mortality rate of 32%. Preoperative malperfusion syndrome also increases the mortality risk in the same analysis.

The subgroup analysis with patients over 80 years was statistically underpowered, thus we could not confirm those preoperative risk factors in that group either.

There are many conservative clinicians around the world who still believe that this type of complicated surgery in an emergency setting is not feasible in elderly patients. However, patients over 80 years in our registry have shown an acceptable outcome after surgery, and this is the message of our paper. Therefore, I maintain that our conclusions are sound.