In the endovascular era, is elective open aortic arch surgery in elderly patients still justified?

Ourania Preventza, MD,^{a,b} Matt D. Price, MS,^{a,c} Hiruni S. Amarasekara, MS,^{a,c} Vicente Orozco-Sevilla, MD,^a Subhasis Chatterjee, MD,^a Qianzi Zhang, MPH,^a Kim I. de la Cruz, MD,^{a,b} and Joseph S. Coselli, MD^{a,b}

ABSTRACT

Objective: The data supporting performing elective aortic arch surgery in patients aged 75 years or older are equivocal. We evaluated short- and long-term outcomes after elective arch surgery in patients aged ≥ 75 years to determine whether complex arch operations are justified in such patients.

Methods: Over a 10-year period, 805 patients aged 50 to 89 years underwent elective proximal or total arch surgery. Composite adverse outcome was defined as operative mortality, persistent (ie, present at discharge) neurologic event, or persistent hemodialysis. Multivariable logistic regression was performed in the entire group.

Results: Multivariable analysis showed that age at admission independently predicted composite adverse outcome, operative mortality, and prolonged (>48 hours) ventilator support ($P < .0001$ for all), but not stroke. The same results were shown in a subgroup analysis in which older age (80-89 years) was associated with composite adverse outcome, operative mortality, and prolonged ventilator support. In a Cox proportional hazards regression model adjusted for antegrade cerebral perfusion time and prior history of renal disease, patients aged 50 to 74 years had significantly better overall survival than patients aged ≥ 75 years ($P < .001$).

Conclusions: As endovascular technology evolves, having benchmark data from likely endovascular-therapy candidates is critical. This study, among the few to focus on elective aortic arch surgery in elderly patients, suggests that surgical intervention carries risk and that novel endovascular therapies are needed. (J Thorac Cardiovasc Surg 2019;158:973-9)

Elective arch repair outcomes, distributed by decade of age.

Central Message

For elderly patients, benchmark analysis for complex aortic arch operations is important as we move toward less-invasive procedures. Gathering data on these patients' outcomes must continue.

Perspective

Although older age is not itself an absolute contradiction to open proximal aortic surgery, surgical intervention carries significant risk, and novel endovascular therapies are needed. We must minimize the invasiveness of the aortic arch procedure and, if possible, eliminate cardiopulmonary bypass by improving transcatheter aortic approaches and existing endovascular devices and stent grafts.

See Commentaries on pages 980 and 982.

From the ^aDivision of Cardiothoracic Surgery and ^cSurgical Research Core, Michael E. DeBakey Department of Surgery, Baylor College of Medicine, Houston, Tex; and ^bDepartment of Cardiovascular Surgery, Texas Heart Institute, Houston, Tex.

Read at the 98th Annual Meeting of The American Association for Thoracic Surgery, San Diego, California, April 28-May 1, 2018.

Received for publication April 27, 2018; revisions received Nov 5, 2018; accepted for publication Nov 6, 2018; available ahead of print Feb 6, 2019.

Address for reprints: Ourania Preventza, MD, Division of Cardiothoracic Surgery, Michael E. DeBakey Department of Surgery, Baylor College of Medicine, BCM 390, One Baylor Plaza, Houston, TX 77030 (E-mail: opsml01@aol.com).

0022-5223/\$36.00

Copyright © 2018 by The American Association for Thoracic Surgery

<https://doi.org/10.1016/j.jtcvs.2018.11.138>

As the population ages, aortic surgery is being considered for an increasing number of elderly patients. However, data supporting surgery for thoracic aortic aneurysm and dissection in these patients are equivocal. Aging-related changes in the cardiovascular system have been reported.^{1,2} Without doubt, elderly patients carry more risk factors than younger patients, and the independent effect

To view the AATS Annual Meeting Webcast, see the URL next to the webcast thumbnail.

Abbreviation and Acronym

ACP = antegrade cerebral perfusion

of age itself adds to the risk of morbidity. Although overall advancements in cardiovascular care have reduced age-related cardiovascular mortality, hospital admissions due to cardiovascular disease are on the rise.³ In addition, prolonged hospital stay has been reported in older patients who undergo proximal aortic aneurysm surgery.⁴ In the present study, we reviewed our experience with proximal aortic surgery in patients aged 50 to 89 years to evaluate the effect of age on short- and long-term outcomes.

PATIENTS AND METHODS

Between January 2005 and June 2016, 805 patients aged 50 years or older underwent proximal aortic surgery. All but 3 of the procedures necessitated circulatory arrest: elective hemiarch (n = 595; 73.9%) or total arch surgery (n = 207; 25.7%). Of these patients, 218 (27%) were aged 50 to 59 years, 304 (38%) 60 to 69 years, 234 (29%) 70 to 79 years, and 49 (6%) 80 to 89 years. We focused some of our analyses on patients aged 75 years or older because this age cutoff was used in previous important studies of this topic.^{5,6}

A prospectively maintained database was used to review our data. Operative dictations, operative diagrams, and hospital records with admission and discharge summaries were reviewed to obtain data regarding patients'

preoperative characteristics (Table 1) and operative details (Table 2). Institutional review board approval was obtained from the Baylor College of Medicine, and informed consent or waiver of consent for data collection was obtained from all patients. Follow-up data were obtained from patients' clinic visits, telephone calls to the patient or the patient's family, and communication with the patient's family practice doctor or cardiologist.

Composite adverse outcome was defined as operative mortality, persistent (ie, present at discharge) neurologic event, or persistent hemodialysis. Definitions of other outcome variables and intraoperative times have been previously described.⁷

Surgical Technique

For ascending aneurysms involving the proximal or entire aortic arch, our technique has been previously described.⁷ Our method of establishing arterial inflow in elective cases is innominate artery cannulation, preferably with a side graft.⁸ Echocardiography is used in all elective cases by the anesthesia team, as are left and/or right arterial lines to monitor the perfusion pressure. Near-infrared spectroscopy is also used. We induce moderate hypothermia with active cooling to approximately 24°C. A hemiarch or total arch procedure is performed according to the patient's anatomy. In addition to moderate hypothermia, we use antegrade cerebral perfusion (ACP) for brain protection during the circulatory arrest period. Currently, our default strategy is to provide bilateral (rather than unilateral) ACP through a balloon-tipped 9F Pruitt catheter inserted into the left common carotid artery. For cases in which total arch replacement is performed with a trifurcated graft, we use the limb of the graft to provide ACP. We do not use retrograde cerebral perfusion, having abandoned this technique many years ago. Our techniques of complex total arch reconstruction and elephant trunk repair have been described previously.⁹

TABLE 1. Preoperative characteristics

Characteristic	Overall (N = 805)	Age (y)				P value
		50-59 (n = 218)	60-69 (n = 304)	70-79 (n = 234)	80-89 (n = 49)	
Age, y	66 (59-72)	55 (53-57)	65 (62-67)	74 (72-76)	82 (81-83)	<.001
Male	537 (66.7)	168 (77.1)	213 (70.1)	130 (55.6)	26 (53.1)	<.001
Smoking	472 (58.6)	112 (51.4)	187 (61.5)	144 (61.5)	29 (59.2)	.09
Redo sternotomy	236 (29.3)	71 (32.6)	96 (31.6)	55 (23.5)	14 (28.6)	.1
Hypertension	718 (89.2)	173 (79.4)	272 (89.5)	229 (97.9)	44 (89.8)	<.001
Prior pulmonary disease such as COPD, restrictive	187 (23.2)	38 (17.4)	77 (25.3)	65 (27.8)	7 (14.3)	.02
Preoperative cardiac disease*	223 (27.7)	59 (27.1)	96 (31.6)	58 (24.8)	10 (20.4)	.2
Congestive heart failure (NYHA class III or IV)	215 (26.7)	47 (21.6)	86 (28.3)	65 (27.8)	17 (34.7)	.2
Renal disease†	14 (1.7)	2 (0.9)	4 (1.3)	7 (3.0)	1 (2.0)	.3
History of stroke/TIA	99 (12.3)	25 (11.5)	35 (11.5)	32 (13.7)	7 (14.3)	.8
Diabetes mellitus	79 (9.8)	11 (5.0)	40 (13.2)	22 (9.4)	6 (12.2)	.02
Prior CABG surgery	53 (6.6)	6 (2.8)	20 (6.6)	21 (9.0)	6 (12.2)	.02
Prior proximal aortic surgery	149 (18.5)	48 (22.0)	68 (22.4)	27 (11.5)	6 (12.2)	.004
Aortic root	53 (6.6)	25 (11.5)	20 (6.6)	7 (3.0)	1 (2.0)	.002
Aortic valve	8 (1.0)	2 (0.9)	2 (0.7)	2 (0.9)	2 (4.1)	.2
Ascending aortic, with or without valve or root	108 (13.4)	28 (12.8)	53 (17.4)	22 (9.4)	5 (10.2)	.047
Prior thoracoabdominal aortic surgery	43 (5.3)	13 (6.0)	16 (5.3)	13 (5.6)	1 (2.0)	.7

Values are presented as median (interquartile range) for continuous variables and n (%) for categorical variables. COPD, Chronic obstructive pulmonary disease; NYHA, New York Heart Association; TIA, transient ischemic attack; CABG, coronary artery bypass grafting. *Preoperative cardiac disease was defined as preoperative myocardial infarction, CABG, percutaneous transluminal coronary angioplasty, coronary artery disease, or pacemaker placement. †Serum creatinine level ≥ 1.5 mg/dL, history of hemodialysis, or history of renal insufficiency.

TABLE 2. Operative details

Characteristic	Overall (N = 805)	Age (y)				P value
		50-59 (n = 218)	60-69 (n = 304)	70-79 (n = 234)	80-89 (n = 49)	
Procedure						
Total arch replacement	207 (25.7)	55 (25.2)	80 (26.3)	69 (29.5)	3 (6.1)	.009
Hemiarch	595 (73.9)	162 (74.3)	223 (73.4)	164 (70.1)	46 (93.9)	.007
Concomitant procedures						
Aortic root procedure	223 (27.7)	91 (41.7)	92 (30.3)	35 (15.0)	5 (10.2)	<.001
Aortic valve repair or replacement	373 (46.3)	74 (33.9)	126 (41.4)	139 (59.4)	34 (69.4)	<.001
CABG	155 (19.3)	34 (15.6)	51 (16.8)	59 (25.2)	11 (22.4)	.03
Other cardiac*	93 (11.6)	23 (10.6)	28 (9.2)	37 (15.8)	5 (10.2)	.1
PRBC infusion, units	1 (0-3)	0 (0-3)	1 (0-3)	2 (0-4)	2 (0-3)	<.001
ACP						
Unilateral	265 (32.9)	68 (31.2)	108 (35.5)	76 (32.5)	13 (26.5)	.5
Bilateral	534 (66.3)	148 (67.9)	193 (63.5)	157 (67.1)	36 (73.5)	.5
Operative times, min						
CPB	131 (105-171)	139 (111-169)	31 (106-176)	127 (99-165)	122 (100-161)	.09
Myocardial ischemia	89 (67-117)	97 (74-122)	89 (68-118)	84 (67-111)	77 (58-107)	.001
Circulatory arrest	25 (18-44)	24 (18-45)	25 (18-44)	28 (19-47)	22 (17-32)	.01
	(N = 802)†	(n = 217)†	(n = 303)†	(n = 233)†		
ACP	24 (18-41)	23 (17-40)	24 (17-44)	27 (19-44)	22 (17-32)	.08
	(N = 801)†	(n = 217)†	(n = 302)†	(n = 233)†		

Data are presented as n (%) or median (interquartile range). CABG, Coronary artery bypass grafting; PRBC, packed red blood cells; ACP, antegrade cerebral perfusion; CPB, cardiopulmonary bypass. *Other cardiac: maze procedure, patent foramen ovale repair, mitral valve repair/replacement, tricuspid valve repair/replacement, or atrial septal defect repair. †Calculations for circulatory arrest and ACP times were adjusted for missing data as shown.

During the rewarming period, other concomitant procedures, including coronary artery bypass grafting and aortic and mitral valve operations, are performed as needed. Intraoperative details are described in Table 2.

Statistical Analysis

Univariate comparisons were performed using the χ^2 test, Fisher exact test, or independent 2-sample *t* test, as appropriate. We built a multivariable logistic regression model with the following postoperative variables: composite adverse events, operative mortality, postoperative stroke, postoperative persistent stroke, ventilator support >48 hours, and renal dysfunction. We entered the preoperative and intraoperative variables (Tables 1 and 2) into the model and applied a backward selection method with removal *P* values of .05 to choose the final multivariable models. Areas under the receiver operating characteristic curve were used to evaluate discrimination, and the Hosmer-Lemeshow goodness-of-fit test and calibration curves assessed the applicability of the models.

Association between age group and overall survival was evaluated with a Cox proportional hazards regression model adjusted for ACP time and prior history of renal disease. The assumption of proportional hazards was examined with scaled Schoenfeld residuals.

RESULTS

Composite Adverse Outcome

In the multivariable analysis, age was an independent predictor of the composite adverse outcome (point estimate, 1.049; 95% confidence interval [CI], 1.027-1.071; *P* < .0001). In addition, age 80 to 89 years was associated with the composite adverse outcome (Table 3 and Figure 1). Other independent predictors of the composite adverse outcome are shown in Table 4.

Operative Mortality

In the multivariable analysis, age was an independent predictor of operative mortality (point estimate 1.049, 95% CI, 1.027-1.071; *P* < .0001). The same results were found in a subgroup analysis: Patients aged 80 to 89 years had a higher operative mortality rate (16.3%) than the younger groups of patients (4.1% for patients aged 50-59 years, 6.9% for patients aged 60-69 years, and 12.8% for patients aged 70-79 years; *P* = .001). The other independent risk factors were total arch repair, total cardiopulmonary bypass time, prior coronary artery bypass grafting surgery, and intraoperative red blood cell transfusion (Table 4).

Other Adverse Events

Age was not significant risk factor for stroke. In contrast, age predicted prolonged ventilator support (>48 hours) in the multivariable analysis (point of estimate, 1.049; 95% CI, 1.027-1.071; *P* < .0001). Age was also associated with postoperative renal dysfunction (odds ratio [OR], 1.074; 95% CI, 1.039-1.11; *P* < .0001) (Table 4).

Disposition and Readmission

Among the 121 survivors who were aged ≥ 75 years, 61 patients (50.4%) went home, and 60 (49.6%) were discharged to nursing homes (*n* = 24), long-term care facilities (*n* = 20), or rehabilitation centers (*n* = 16). In contrast,

TABLE 3. Outcomes

Outcome	All patients (N = 805)	Age (y)				P value
		50-59 (n = 218)	60-69 (n = 304)	70-79 (n = 234)	80-89 (n = 49)	
Composite adverse outcome*	94 (11.7)	13 (6.0)	32 (10.5)	40 (17.1)	9 (18.4)	.001
Operative mortality	68 (8.5)	9 (4.1)	21 (6.9)	30 (12.8)	8 (16.3)	.001
30-d mortality	47 (5.8)	8 (3.7)	13 (4.3)	22 (9.4)	4 (8.2)	.03
Total neurologic events, such as stroke and spinal cord ischemia	43 (5.3)	6 (2.8)	16 (5.3)	17 (7.3)	4 (8.2)	.1
Permanent total neurologic events	28 (3.5)	4 (1.8)	10 (3.3)	11 (4.7)	3 (6.1)	.3
Stroke	33 (4.1)	5 (2.3)	12 (3.9)	13 (5.6)	3 (6.1)	.3
Persistent stroke	26 (3.2)	4 (1.8)	9 (3.0)	10 (4.3)	3 (6.1)	.3
All renal dysfunction†	72 (8.9)	10 (4.6)	30 (9.9)	24 (10.3)	8 (16.3)	.03
Persistent renal failure‡	35 (4.4)	2 (0.9)	12 (3.9)	16 (6.8)	5 (10.2)	.003
Ventilator support >48 h	207 (25.7)	41 (18.8)	76 (25.0)	73 (31.2)	17 (34.7)	.01
Reoperation for bleeding	28 (3.5)	6 (2.8)	12 (3.9)	7 (3.0)	3 (6.1)	.6
Postoperative myocardial infarction	9 (1.1)	0	3 (1.0)	6 (2.6)	0	.06
Postoperative pulmonary embolism	9 (1.1)	1 (0.5)	2 (0.7)	5 (2.1)	1 (2.0)	.3
ICU length of stay (d)	3 (2-7)	2 (2-5)	3 (2-7)	4 (2-9)	5 (3-7)	.001
Hospital length of stay (d)	10 (7-15)	8 (7-12)	10 (7-16)	11 (8-19)	12 (9-17)	.001

Data are presented as median (interquartile range) for continuous variables and n (%) for categorical variables. ICU, Intensive care unit. *Composite adverse outcome was defined as operative mortality, persistent neurologic event, or persistent hemodialysis at discharge. †Postoperative renal dysfunction with or without temporary or permanent hemodialysis. ‡Hemodialysis-dependent at discharge.

among the 616 survivors who were aged 50 to 74 years of age, most (n = 502; 81.5%) were discharged home, whereas only 18.5% (n = 114) went to nursing homes

(n = 19), long-term care (n = 52), or rehabilitation centers (n = 42), and 1 patient left the hospital against medical advice ($P < .001$). The rate of unplanned readmission within

FIGURE 1. Elective arch repair outcomes, distributed by decade of age. Composite adverse event was defined as mortality, persistent stroke, and/or renal failure necessitating hemodialysis at discharge. Persistent stroke was defined as stroke that persisted to the time of discharge.

TABLE 4. Multivariable regression analysis (full cohort)

Outcome variable and predictors	Odds ratio (95% confidence interval)	P value
Composite adverse outcome		
Age (y)	1.07 (1.04-1.10)	<.0001
Renal disease*	5.09 (1.49-17.40)	.0094
Prior CABG surgery	3.15 (1.56-6.34)	.001
Total arch replacement	2.98 (1.79-4.93)	<.0001
History of stroke/TIA	1.86 (0.99-3.45)	.05
PRBC infusion (U)	1.10 (1.04-1.65)	<.0006
CPB time (min)	1.01 (1.01-1.01)	<.0001
(c = 0.818; HL test = 0.1)		
Operative mortality		
Age (y)	1.09 (1.05-1.13)	<.0001
Total arch replacement	2.85 (1.60-5.08)	<.00041
Prior CABG surgery	2.37 (1.07-5.33)	.03
PRBC infusion (U)	1.09 (1.02-1.15)	.005
CPB time (min)	1.01 (1.01-1.02)	<.0001
(c = 0.827; HL test = 0.1)		
Postoperative stroke		
Age (y)	1.04 (0.99-1.08)	.1141
Renal disease*	6.15 (1.51-25.04)	.01
History of stroke/TIA	4.13 (1.92-8.83)	<.00031
ACP time (min)	1.01 (1.00-1.02)	.02
(c = 0.729; HL test = 0.79)		
Ventilator support >48 h		
Age (y)	1.05 (1.03-1.07)	<.0001
Smoking	1.69 (1.16-2.45)	.006
Redo sternotomy	1.53 (1.03-2.25)	.034
Total arch replacement	1.55 (0.93-2.64)	.1
PRBC infusion (U)	1.006 (1.002-1.009)	<.001
CPB time (min)	1.006 (1.00-1.01)	.001
HCA time (min)	1.01 (1.00-1.02)	.03
(c = 0.771; HL test = 0.2)		

c, area under the curve; CABG, coronary artery bypass grafting; TIA, transient ischemic attack; PRBC, packed red blood cell; CPB, cardiopulmonary bypass; HCA, hypothermic circulatory arrest; HL, Hosmer-Lemeshow. *Serum creatinine level ≥ 1.5 mg/dL, history of hemodialysis, or history of renal insufficiency.

30 days was 5.8% (n = 7) for patients aged ≥ 75 years and was 5.7% (n = 35) for the patients aged 50 to 74 years ($P = 1.0$).

Follow-up and Survival

Among all patients who survived to discharge (n = 737), mean postoperative follow-up time was 2.8 ± 2.6 years. Mean follow-up time was 2.9 ± 2.6 years for survivors aged 50 to 74 years (n = 616) and 2.3 ± 2.4 years for survivors aged ≥ 75 years (n = 121).

After adjustment for ACP time and prior history of renal disease, Cox proportional hazards regression model patients aged 50 to 74 years had significantly better overall survival than patients aged ≥ 75 years ($P < .001$) (Figure 2).

DISCUSSION

Advances in cardiac and aortic surgery have allowed successful transcatheter interventions and open surgical procedures in elderly patients. But age and frailty are associated with prolonged hospital and intensive care unit stays and greater mortality in cardiac surgery patients.¹⁰ Even isolated coronary artery bypass surgery poses a higher risk of adverse events for older patients¹¹; the early mortality rate is 5.8% in octogenarians.¹² Also, evidence suggests that endovascular repair of descending thoracic pathology is more beneficial than open repair in patients older than age 75 years.⁶ Hybrid or endovascular total exclusion of atherosclerotic or dissected arch aneurysm has not yet become mainstream treatment,¹³ and the results are equivocal, but new devices are being developed that could make this treatment approach advantageous.

As endovascular technology advances and targets the ascending aorta and the aortic arch, it is important to provide contemporary data from elderly patients who undergo open arch repair and are considered to be at higher risk because of their age. To decrease the amount of extraneous variability in our data, our study included only elective cases of open aortic arch repair in patients aged ≥ 50 years. The study found significant outcome differences that favored the younger group, and older age appeared to be associated with adverse composite outcome, operative mortality, renal insufficiency, and prolonged ventilator support.

In a population-based study of thoracic aortic surgery patients, the odds of early mortality increased with every 5 years of age (OR, 1.22; 95% CI, 1.14-1.31), and survival was poorer in patients older than 65 years.¹⁴ In an older but excellent study by Okita and colleagues,¹⁵ patients aged 70 years or older who required surgery for thoracic aortic aneurysm had less satisfactory results than patients younger than age 70 years. Patel and colleagues,¹⁶ in an elegant study of 721 patients who underwent proximal and total arch surgery, found advancing age to be associated with early and late mortality ($P < .05$). The authors suggest that endovascular therapies should be considered first for patients who are considered high risk, such as those with advanced age.

On the other hand, multiple other studies appear to justify performing not only elective but also emergency aortic operations in elderly patients, which makes advanced age itself not an absolute contraindication to open operation.^{17,18} Kilic and colleagues,⁵ in their review of data from 629 patients (of all ages) who underwent elective hemiarch operations, found that age ≥ 75 years was not an independent predictor of risk-adjusted operative mortality. However, only 95 of these patients were aged ≥ 75 years. Furthermore, no patient in the study underwent a total arch operation; in our study, total arch (vs hemiarch) procedure predicted operative mortality.

FIGURE 2. Association between age group and overall survival after elective arch repair, as shown by a Cox proportional hazards regression model.

Our results with regard to mortality are similar to those reported by Safi and colleagues.¹⁹ In their study of 1193 patients (including 317 patients aged ≥ 72 years) who underwent hemiarch and total arch procedures, including emergency operations, age was associated with a higher risk of death and stroke, and advanced age was also associated with stroke, with an OR of 1.04 ($P = .008$). On the other hand, in a European study of 524 patients treated for acute and chronic proximal aortic pathology, older age was not associated with a higher risk of mortality or neurologic injury.²⁰ In our study, although advanced age was associated with composite adverse outcome and mortality, it was not associated with stroke.

In other studies, prolonged ventilator support after cardiac surgery procedures has been associated with advanced age.^{5,21} Likewise, in our study, multivariable analysis showed that age was a risk factor for prolonged ventilator support. This may be because aging is associated with decreased vital capacity, increased residual volume, and decreased respiratory muscle strength, all of which diminish pulmonary reserve in older people.²²

The main concern raised by performing a complex aortic arch operation in older patients is postoperative quality of life. In a study by Kurazumi and colleagues,¹⁷ among 47 consecutive patients older than age 80 years, 20 underwent

surgical treatment for aortic arch disease, and 27 were treated medically. The results appear to indicate acceptable outcome for the surgical patients in terms of postoperative quality of life. Although our study did not examine quality of life directly, in our older patients, similar numbers of patients went home versus being discharged to another facility. A significant difference was found, as expected, between the younger and older groups in the percentage of patients who were discharged home (47.3% vs 80.5%). In contrast, the readmission rate within 30 days did not differ between the groups. In addition, survival rates were better in the younger group.

The limitations of our study include its retrospective design, although the sample size is quite large for a single-institution study. Also, we did not use the frailty concept, which has been used extensively to evaluate aged patients undergoing percutaneous aortic valve replacement. In addition, unlike other studies, we did not evaluate quality of life, which is important to elderly patients.¹⁷ However, we did analyze disposition and readmission rates, both of which are indirect indicators of quality of life.

CONCLUSIONS

The rates of composite adverse outcomes, mortality, and prolonged ventilator support were significantly higher in

older patients and especially in patients older than age 80 years. Benchmark analyses such as this for complex operations in elderly patients are important as we move into less invasive procedures. Without a doubt, efforts must continue to gather data regarding outcomes of thoracic aortic surgery in elderly patients. Considerations specifically targeting these patients include minimizing the invasiveness of the aortic arch procedure and, if possible, eliminating cardiopulmonary bypass by improving transcatheter aortic approaches and the existing endovascular devices and stent grafts.

Webcast

You can watch a Webcast of this AATS meeting presentation by going to: https://aats.blob.core.windows.net/media/18May01/28ABC%20Aortic%20Endovascular/S86%20-%20Part%20/S86_6.MP4.

Conflict of Interest Statement

Dr Coselli participates in clinical research trials conducted by Edwards Lifesciences and Bolton Medical; consults for, receives royalties and a departmental educational grant from, and participates in clinical trials for Vascutek Terumo; and consults and participates in clinical trials for Medtronic Inc and W.L. Gore & Associates. Dr Preventza consults for Medtronic Inc and W.L. Gore & Associates, and has received travel expenses from Cook Medical Inc. All other authors have nothing to disclose with regard to commercial support.

Stephen N. Palmer, PhD, ELS, contributed to the editing of the manuscript.

References

- Izzo C, Carrizzo A, Alfano A, Virtuoso N, Capunzo M, Calabrese M, et al. The impact of aging on cardio and cerebrovascular diseases. *Int J Mol Sci*. 2018; 19(2).
- Lakatta EG. Arterial and cardiac aging: major shareholders in cardiovascular disease enterprises: part III: cellular and molecular clues to heart and arterial aging. *Circulation*. 2003;107:490-7.
- Nichols M, Townsend N, Scarborough P, Rayner M. Cardiovascular disease in Europe: epidemiological update. *Eur Heart J*. 2013;34:3028-34.
- Preventza O, Coselli JS, Garcia A, Akvan S, Kashyap S, Simpson KH, et al. Aortic root surgery with circulatory arrest: predictors of prolonged postoperative hospital stay. *J Thorac Cardiovasc Surg*. 2017;153:511-8.
- Kilic A, Arnaoutakis GJ, Bavaria JE, Sultan I, Desai ND, Vallabhajosyula P, et al. Outcomes of elective aortic hemiarch reconstruction for aneurysmal disease in the elderly. *Ann Thorac Surg*. 2017;104:1522-30.
- Patel HJ, Williams DM, Upchurch GR Jr, Dasika NL, Passow MC, Prager RL, et al. A comparison of open and endovascular descending thoracic aortic repair in patients older than 75 years of age. *Ann Thorac Surg*. 2008;85:1597-603.
- Preventza O, Coselli JS, Garcia A, Kashyap S, Akvan S, Simpson KH, et al. Moderate hypothermia at warmer temperatures is safe in elective proximal and total arch surgery: results in 665 patients. *J Thorac Cardiovasc Surg*. 2017;153: 1011-8.
- Preventza O, Price MD, Spiliotopoulos K, Amarasekara HS, Cornwell LD, Omer S, et al. In elective arch surgery with circulatory arrest, does the arterial cannulation site really matter? A propensity score analysis of right axillary and innominate artery cannulation. *J Thorac Cardiovasc Surg*. 2018;155:1953-60.e4.
- Preventza O, Garcia A, Cooley DA, Haywood-Watson RJ, Simpson K, Bakaeen FG, et al. Total aortic arch replacement: a comparative study of zone 0 hybrid arch exclusion versus traditional open repair. *J Thorac Cardiovasc Surg*. 2015;150:1591-8.
- Buth KJ, Gainer RA, Legare JF, Hirsch GM. The changing face of cardiac surgery: practice patterns and outcomes 2001-2010. *Can J Cardiol*. 2014;30:224-30.
- Nicolini F, Fortuna D, Contini GA, Pacini D, Gabbieri D, Zussa C, et al. The impact of age on clinical outcomes of coronary artery bypass grafting: long-term results of a real-world registry. *Biomed Res Int*. 2017;2017:9829487.
- Nicolini F, Molardi A, Verdichizzo D, Gallazzi MC, Spaggiari I, Cocconcelli F, et al. Coronary artery surgery in octogenarians: evolving strategies for the improvement in early and late results. *Heart Vessels*. 2012;27:559-67.
- Cochennec F, Tresson P, Cross J, Desgranges P, Allaire E, Becquemin JP. Hybrid repair of aortic arch dissections. *J Vasc Surg*. 2013;57:1560-7.
- Higgins J, Lee MK, Co C, Janusz MT. Long-term outcomes after thoracic aortic surgery: a population-based study. *J Thorac Cardiovasc Surg*. 2014;148:47-52.
- Okita Y, Ando M, Minatoya K, Tagusari O, Kitamura S, Nakajima N, et al. Early and long-term results of surgery for aneurysms of the thoracic aorta in septuagenarians and octogenarians. *Eur J Cardiothorac Surg*. 1999;16:317-23.
- Patel HJ, Nguyen C, Diener AC, Passow MC, Salata D, Deeb GM. Open arch reconstruction in the endovascular era: analysis of 721 patients over 17 years. *J Thorac Cardiovasc Surg*. 2011;141:1417-23.
- Kurazumi H, Mikamo A, Kudo T, Suzuki R, Takahashi M, Shirasawa B, et al. Aortic arch surgery in octogenarians: is it justified? *Eur J Cardiothorac Surg*. 2014;46:672-7.
- Tang GH, Malekan R, Yu CJ, Kai M, Lansman SL, Spielvogel D. Surgery for acute type A aortic dissection in octogenarians is justified. *J Thorac Cardiovasc Surg*. 2013;145:S186-90.
- Safi HJ, Miller CC III, Lee TY, Estrera AL. Repair of ascending and transverse aortic arch. *J Thorac Cardiovasc Surg*. 2011;142:630-3.
- Czerny M, Krahenbuhl E, Reineke D, Sodeck G, Englberger L, Weber A, et al. Mortality and neurologic injury after surgical repair with hypothermic circulatory arrest in acute and chronic proximal thoracic aortic pathology: effect of age on outcome. *Circulation*. 2011;124:1407-13.
- Gumus F, Polat A, Yektas A, Totoz T, Bagci M, Erentug V, et al. Prolonged mechanical ventilation after CABG: risk factor analysis. *J Cardiothorac Vasc Anesth*. 2015;29:52-8.
- Sprung J, Gajic O, Warner DO. Review article: age related alterations in respiratory function - anesthetic considerations. *Can J Anaesth*. 2006;53:1244-57.

Key Words: aortic surgery, age, open repair, stent graft