Analysis of Risk Factors for Postoperative Mortality in Acute Type A Aortic Dissection Patients Under Different Critical Levels

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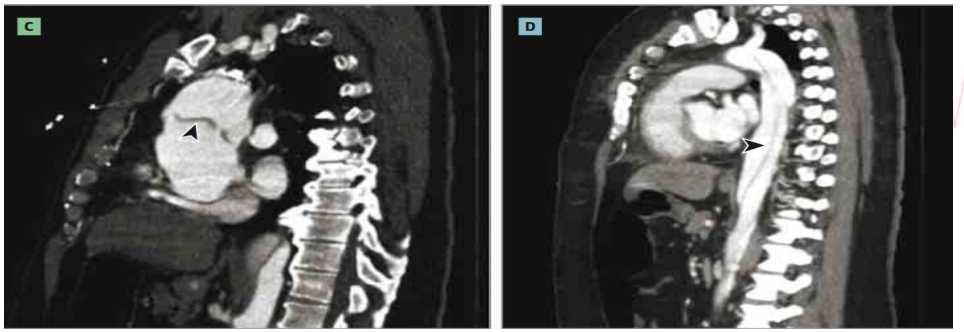
Acute Aortic Dissection



Aortic dissection, especially acute type A aortic dissection (aTAAD), is the most lethal cardiovascular disease.

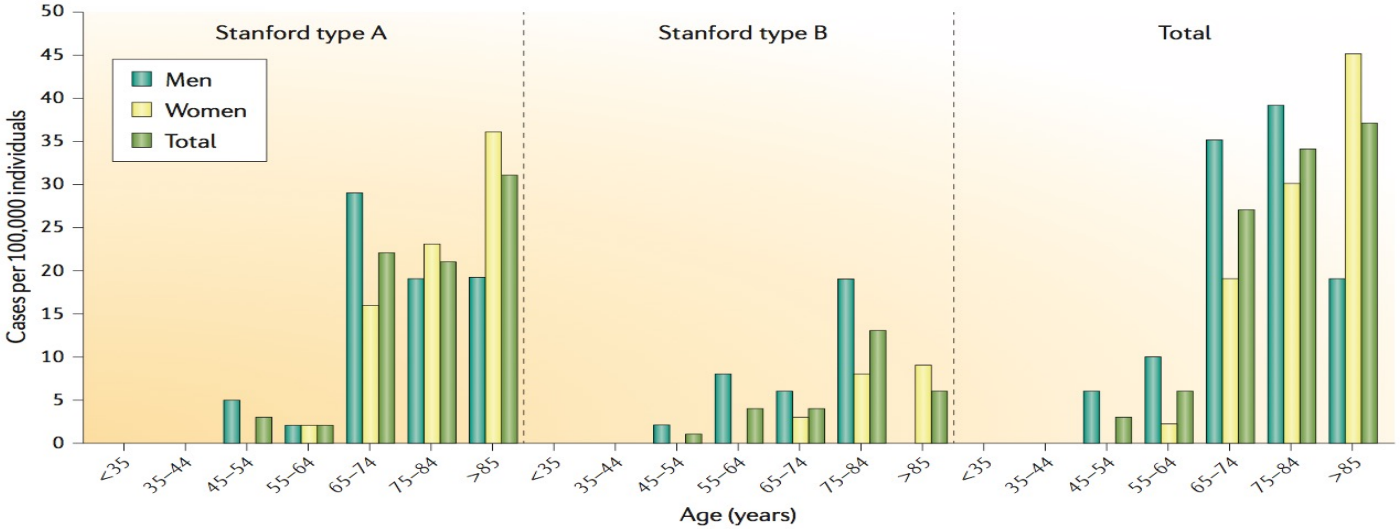
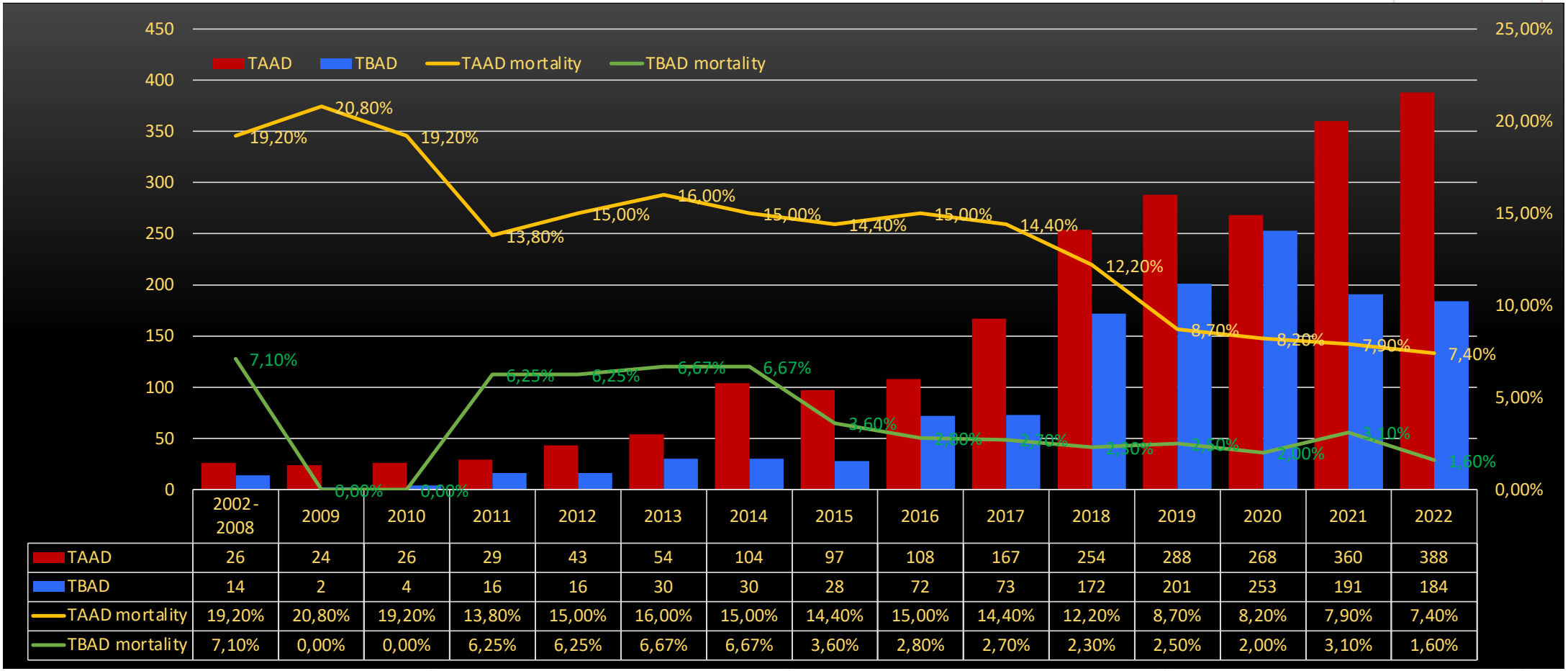


Figure 3 | **Incidence of aortic dissection.** Age-specific and sex-specific rates per 100,000 individuals for incidence of acute aortic dissection by subtype (2002–2012). Data from REF. 17.

Incidence

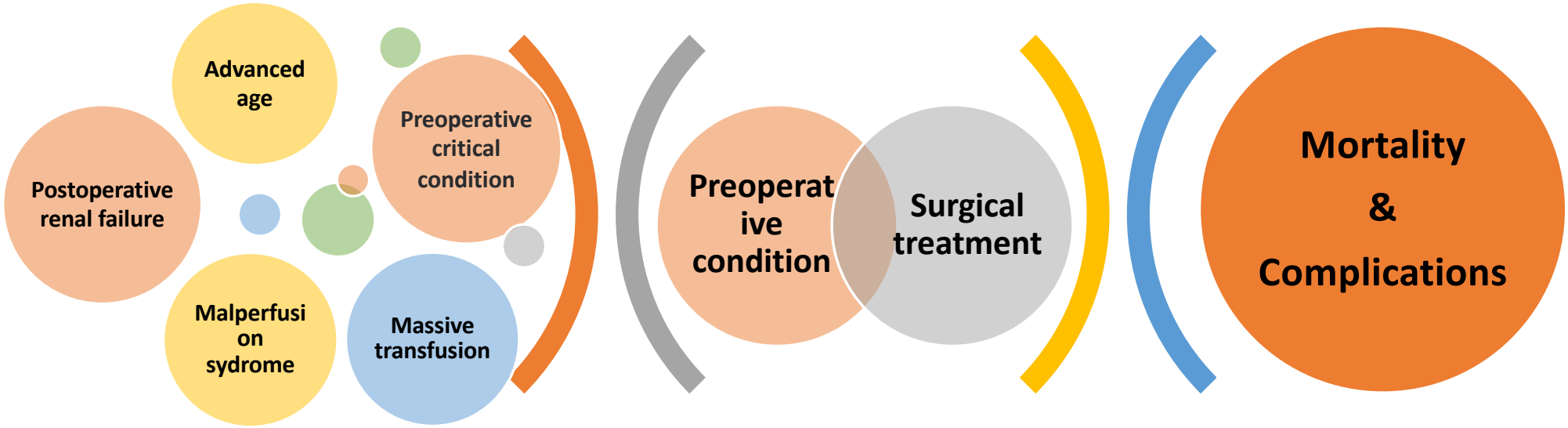
- In hospital patients incidence：3-5/100 thousands per year
- Pre-hospital death included: 15/100 thousands per year
- People over 64 yrs old: 35/100 thousands per year

Aortic Dissection. ***Nature Reviews Disease Primers*** **2. 2016.**



	2002-2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TAAD	26	24	26	29	43	54	104	97	108	167	254	288	268	360	388
TBAD	14	2	4	16	16	30	30	28	72	73	172	201	253	191	184
TAAD mortality	19,20%	20,80%	19,20%	13,80%	15,00%	16,00%	15,00%	14,40%	15,00%	14,40%	12,20%	8,70%	8,20%	7,90%	7,40%
TBAD mortality	7,10%	0,00%	0,00%	6,25%	6,25%	6,67%	6,67%	3,60%	2,80%	2,70%	2,30%	2,50%	2,00%	3,10%	1,60%

Background



Perioperative mortality

It is necessary to build up a scoring system to make the critical classification as soon as possible after admission.

Background

Researcher	Year	Count	Variables	AUROC	Mortality
Tan et al.	2001	252	preoperative CPR, iatrogenic AD, preoperative pericardial drainage	NA	0.56 (0.49-0.63)
Spirito et al.	2001	108	preoperative MI, preoperative RF, shock, over 70 yrs old	NA	0.70 (0.63-0.76)
Mehta et al.	2002	547	advanced age, female, acute chest pain, abnormal ECG, pulseless, renal failure, cardiac tamponade	0.74	0.69 (0.62-0.75)
Santini et al.	2007	311	advanced age, cardiac tamponade, hypotension, AMI, intestinal ischemia, acute renal failure, CNS injury	0.77	0.74 (0.67-0.80)
Leontyev et al.	2016	534	preoperative critical status, malperfusion of myocardia and intestinal, CAD	0.77	0.74 (0.68-0.80)
Mejare-Berggren et al.	2017	509	preoperative critical status, CAD	0.66	0.73 (0.67-0.79)
Ghoreishi et al.	2018	269	increased lactate and creatinine, liver failure	0.75	0.77 (0.71-0.83)

Background

1. **The limited sample size**
2. **The variables are heterogeneous**
3. **Organ perfusion status is not taken into consideration in most studies**

Different surgical techniques have been reported alternative and effective to patients under stable condition.

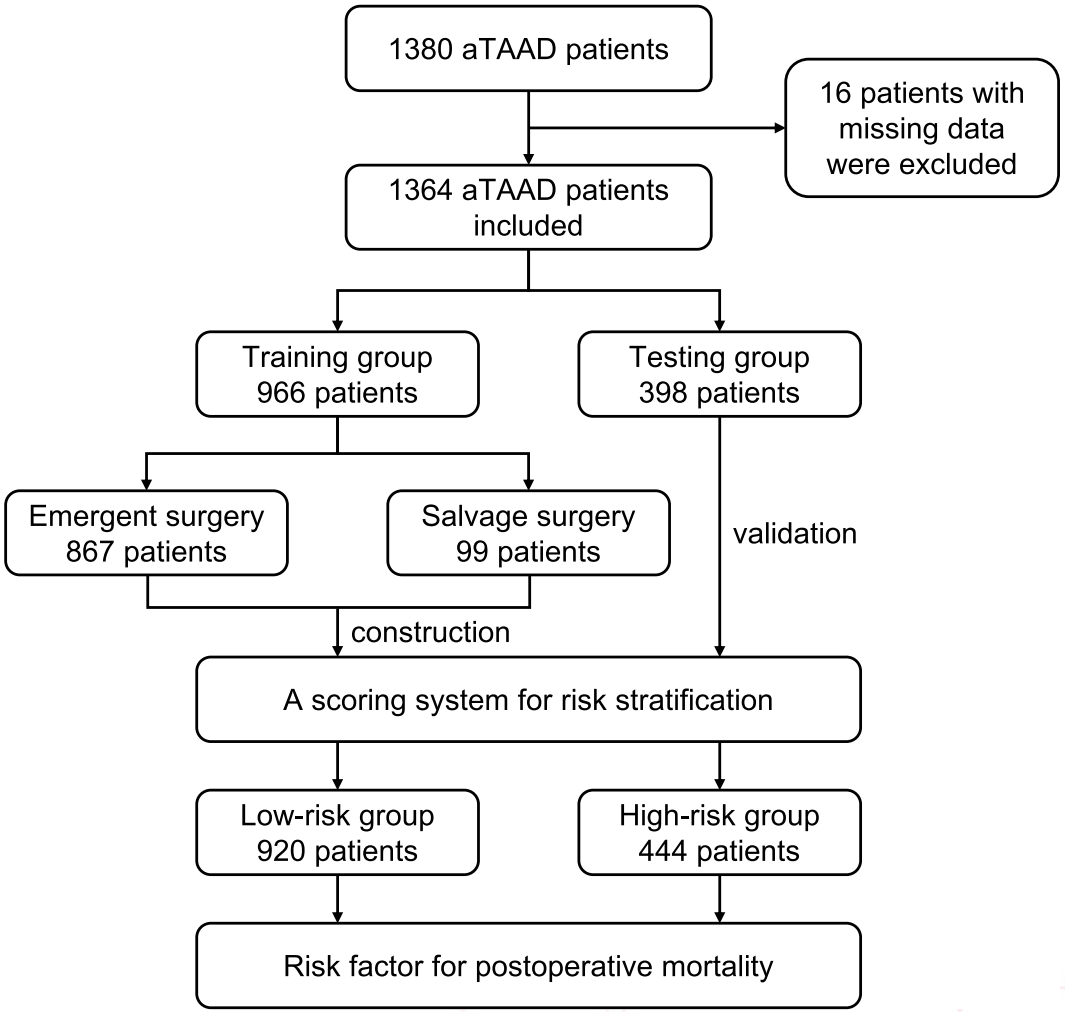
Whether these techniques are also suitable for critically ill patients?

Purpose

1. Construct a new scoring system for aTAAD patients

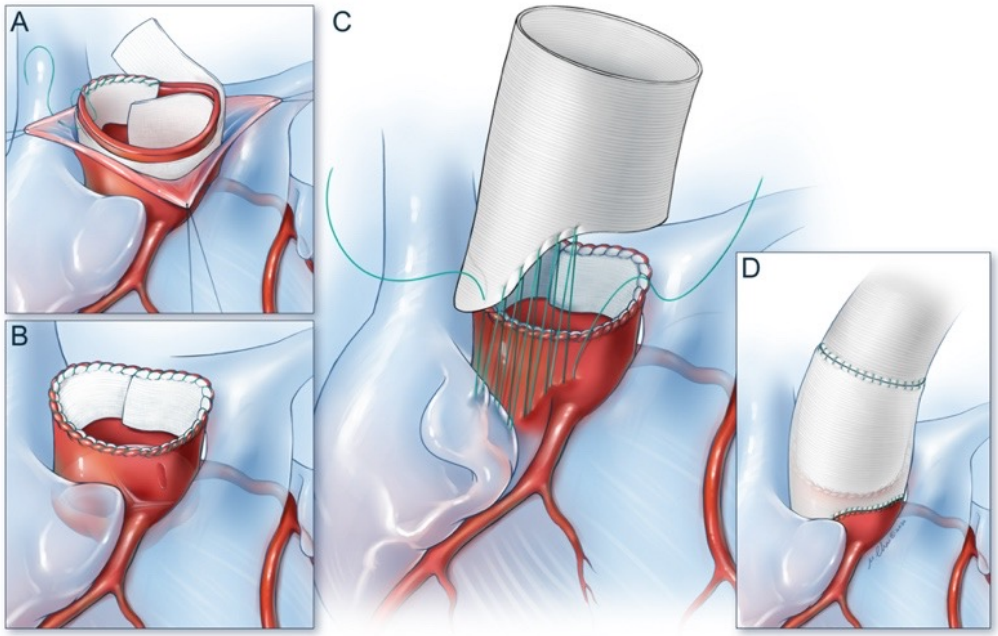
2. Risk factors of mortality in different preoperative status patients

Method



- ✓ Clinical data of 1380 aTAAD patients were collected since 2010 to 2020;
- ✓ Data of 1364 aTAAD patients were used for further analysis;
- ✓ All patients were divided into the ratio of 7:3 in training group and testing group;
- ✓ A scoring system was built up for risk stratification;
- ✓ Risk factors for postoperative mortality were analyzed in low- and high-risk patients separately.

Surgical treatments in our center

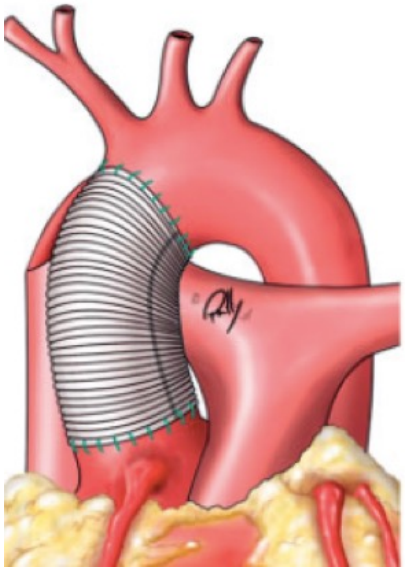


Root procedure

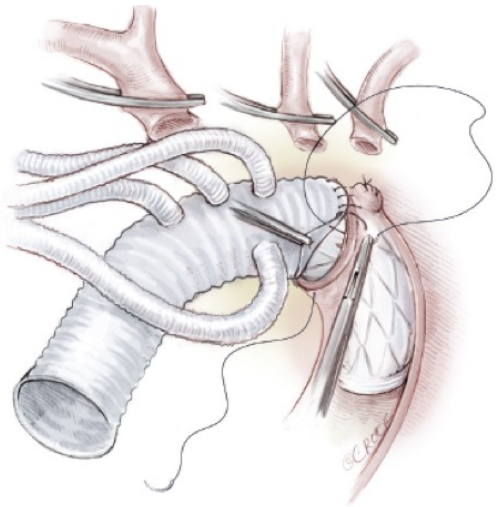
Double jacket wrapping technique based on the root reconstruction procedure

Xue YX et al. Ann Thorac Surg. 2020.

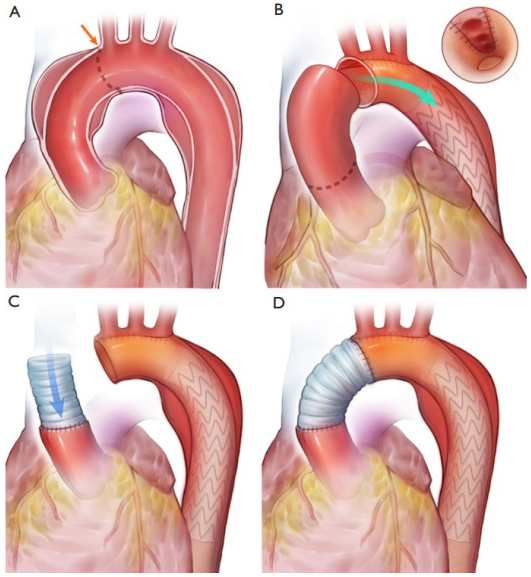
Surgical treatments in our center



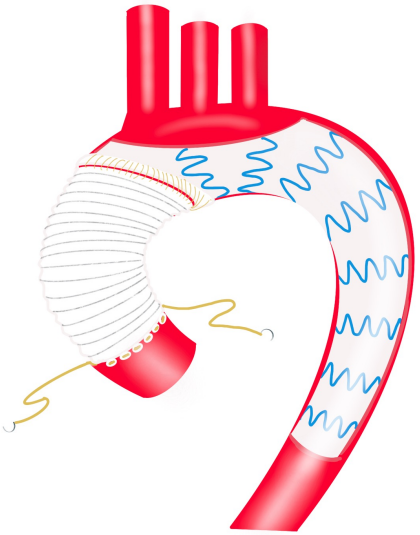
As only
or
As+Hemi-arch



Total arch+FET



Modified “in situ” total arch +FET

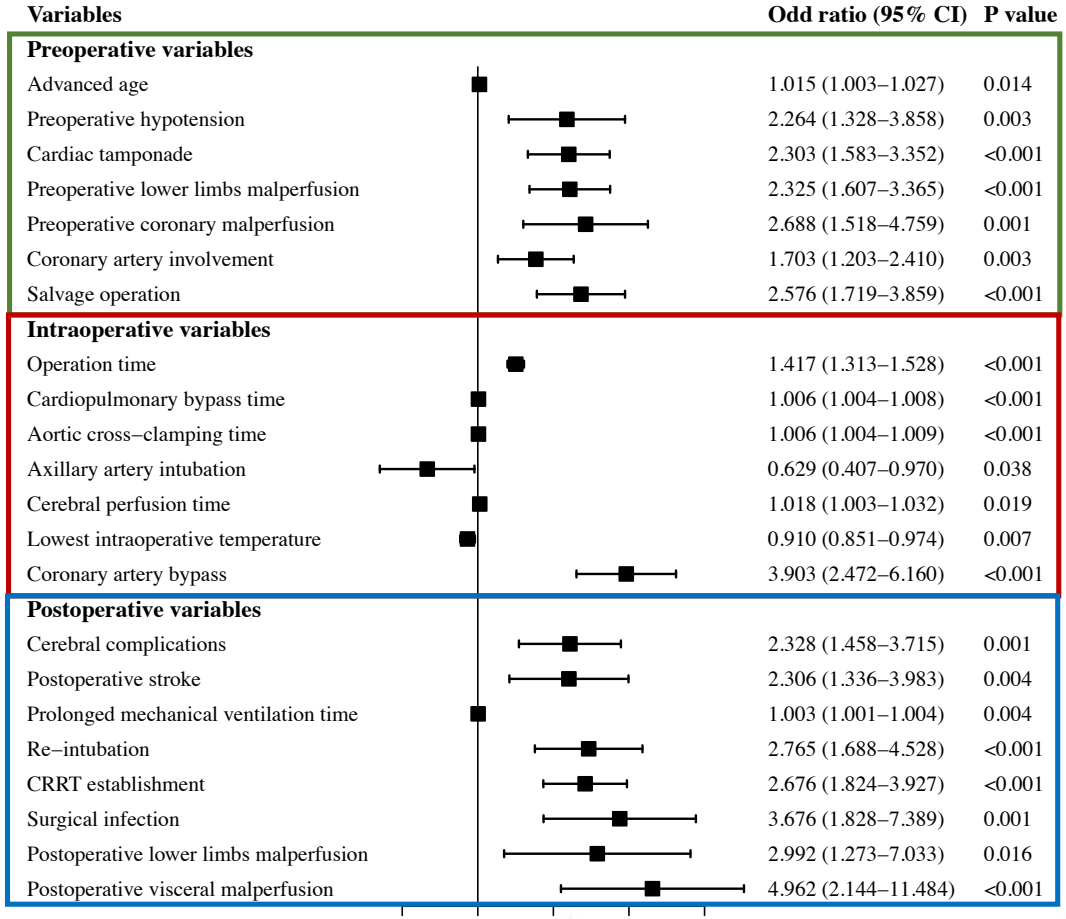


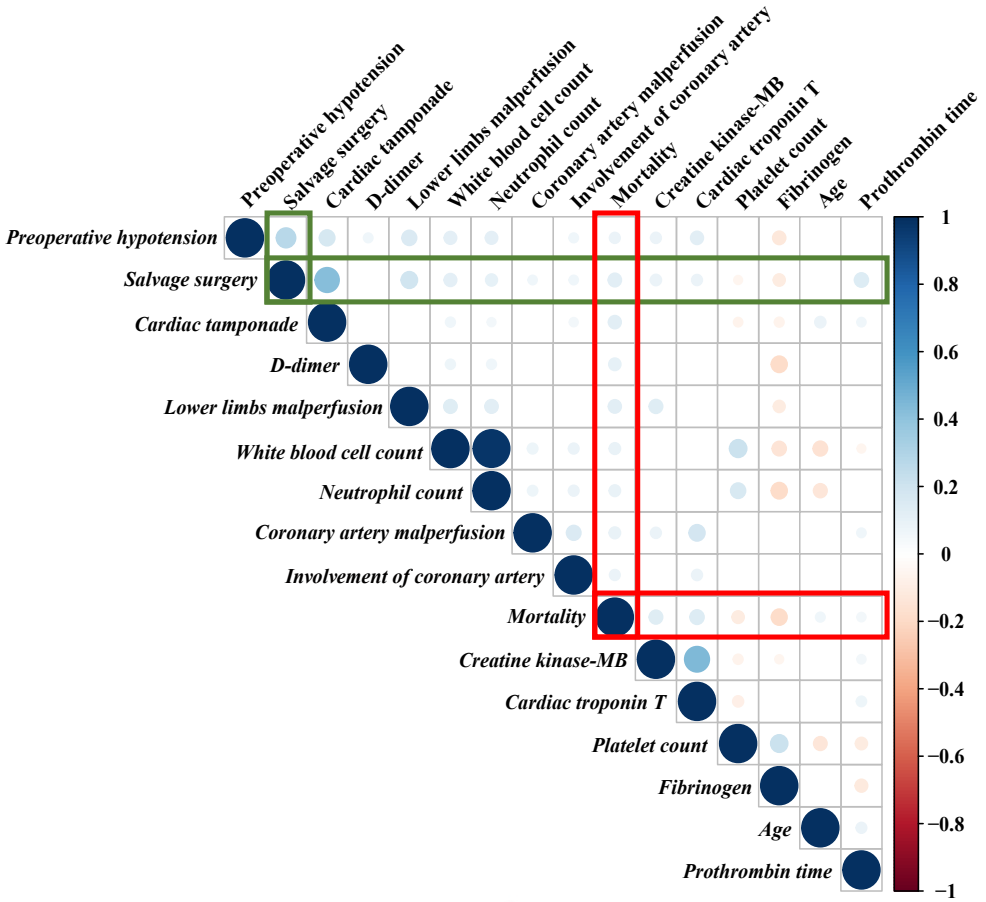
Fenestrated stent

Arch procedure

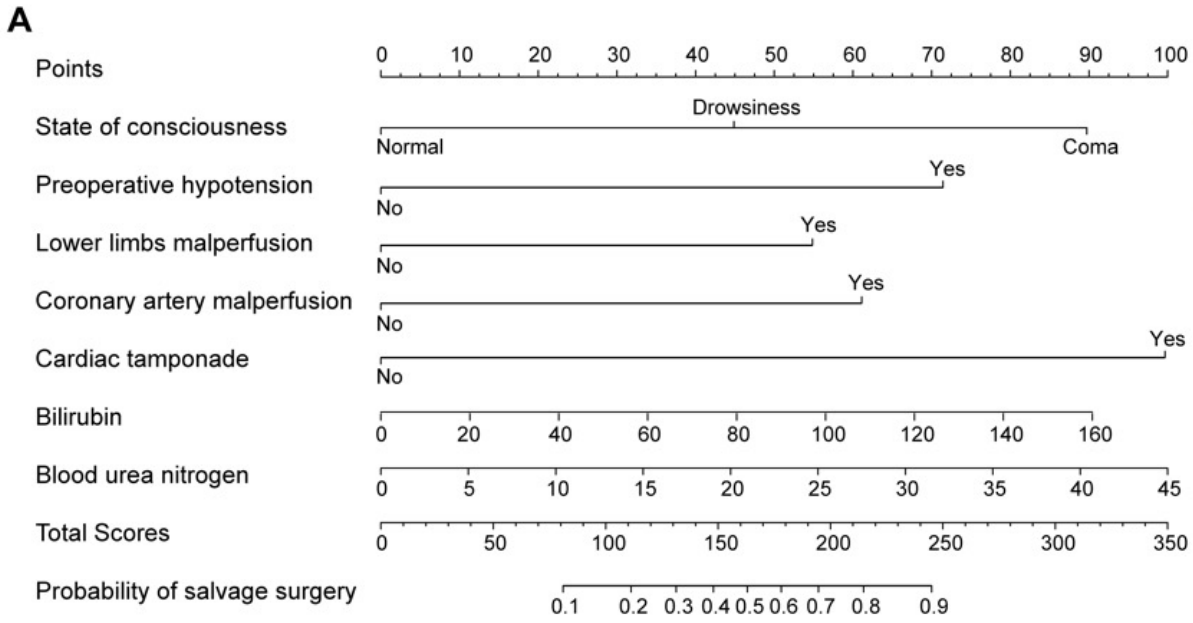
Xue YX et al. J Thorac Dis. 2021
Zhou Q et al. Interact Cardiovasc Thorac Surg. 2018
Sun LZ et al. Ann Cardiothorac Surg. 2013

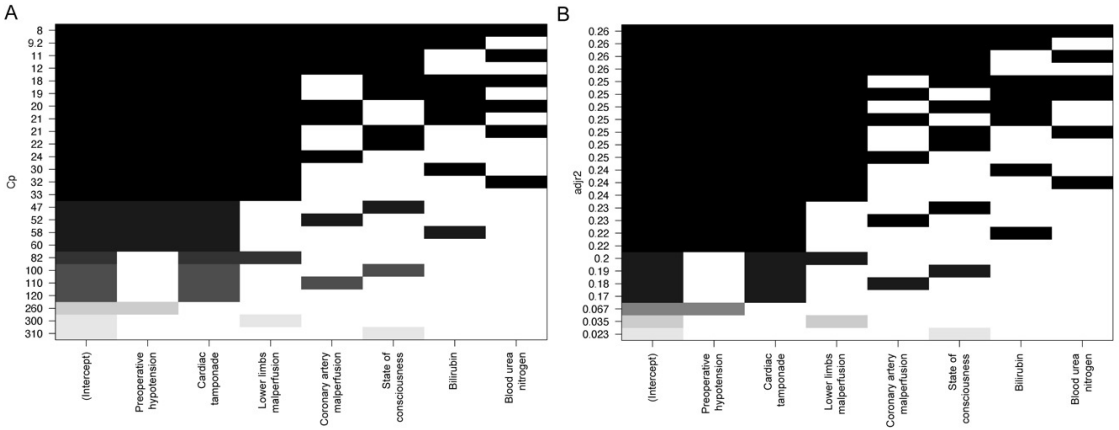
Result one: Risk factor for postoperative mortality in aTAAD patients (all data set)

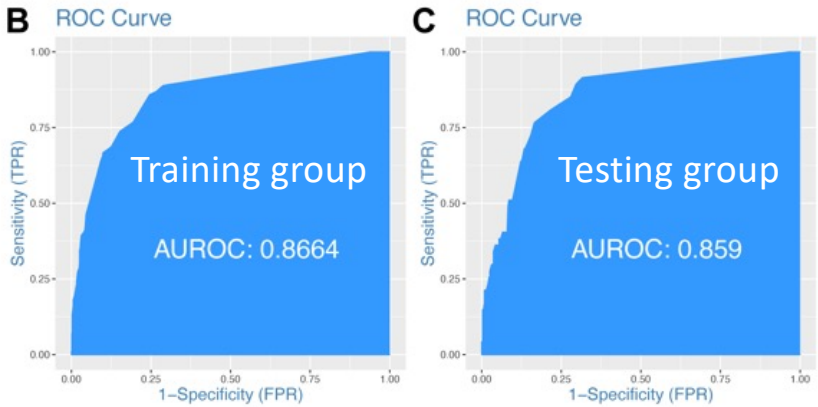


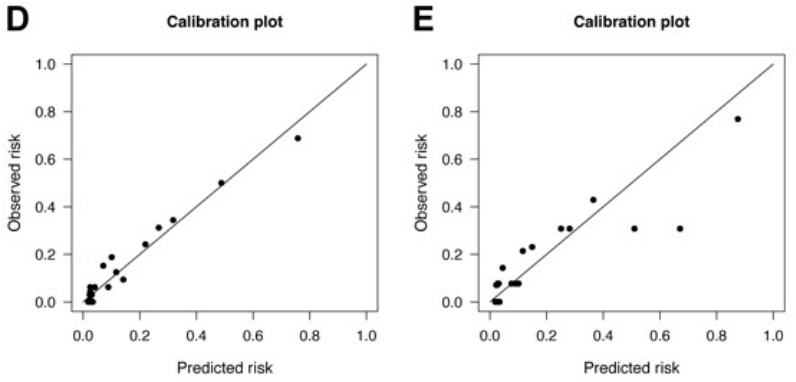


Result two: Model construction

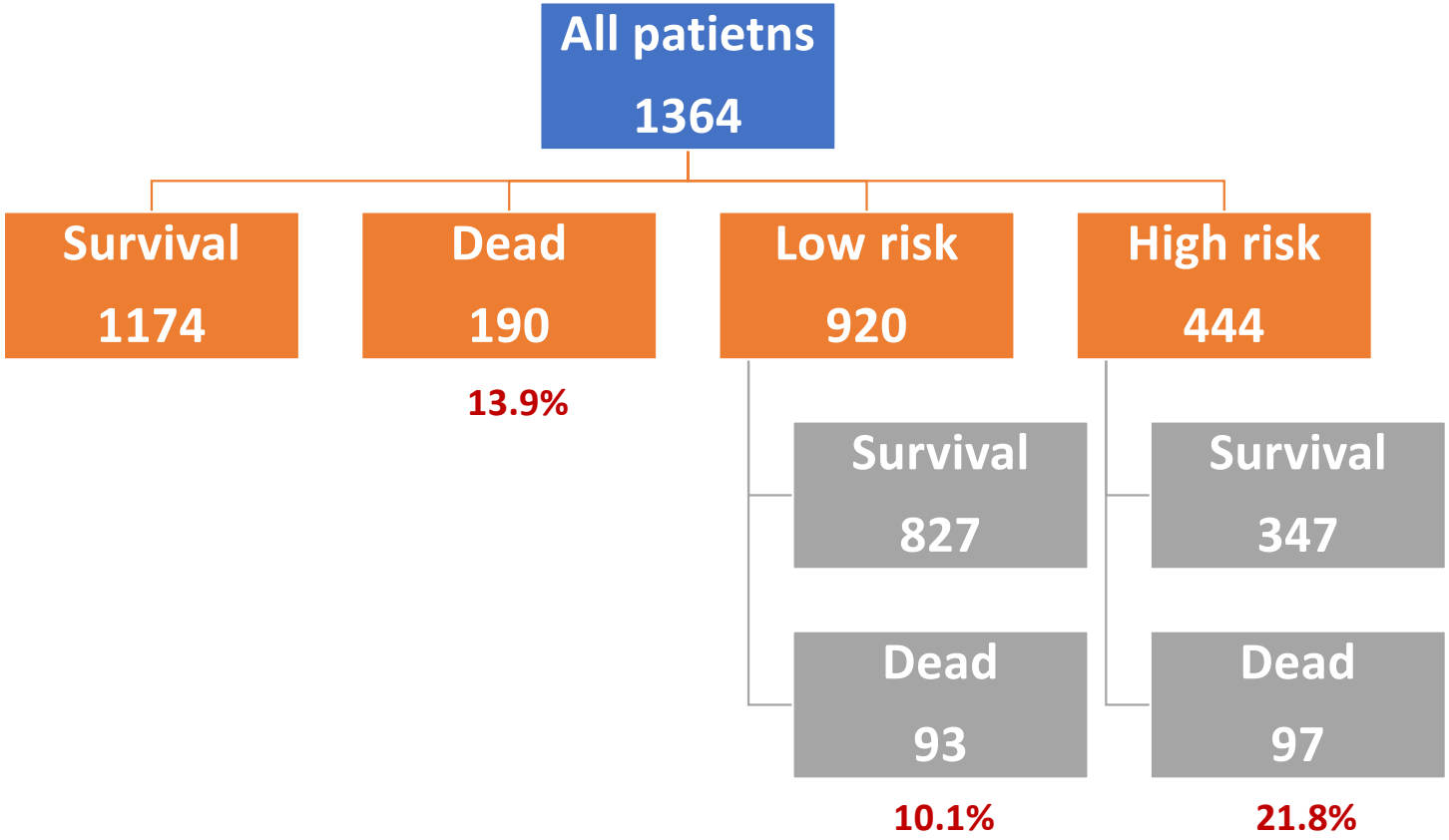








- Total score of specific aTAAD patient over 70 pts will be considered as high risk.
- Salvage surgery will be performed for these high-risk patients.


All patietns
1364
Survival
1174
Dead
190
13.9%
Low risk
920
High risk
444
Survival
827
Dead
93
10.1%
Survival
347
Dead
97
21.8%

Result three: Risk factors of postoperative mortality for different critical level patients

Low risk patients	All	Survival	Dead	P value
Operation time (hour)	7.8±1.9	7.7±1.7	9.3±2.4	<0.001
CPB time (min)	231.7±72.3	228.0±67.8	264.6±99.8	0.001
ACC time (min)	161.4±52.1	159.3±51.2	180.2±56.6	<0.001
Arterial intubation approach				
Ascending aorta	15 (1.6%)	13 (86.7%)	2 (13.3%)	
Femoral artery	211 (22.9%)	193 (91.5%)	18 (8.5%)	0.610
Axillary artery	190 (20.7%)	173 (91.1%)	17 (8.9%)	
Axillary-Femoral artery	504 (54.8%)	448 (88.9%)	56 (11.1%)	
DHCA	907 (98.6%)	815 (98.5%)	92 (98.9%)	1.000
Cerebral perfusion (CP)	792 (86.1%)	708 (85.6%)	84 (90.3%)	
None	128 (13.9%)	119 (93.0%)	9 (7.0%)	
Anterograde CP	744 (80.9%)	666 (89.5%)	78 (10.5%)	0.423
Retrograde CP	48 (5.2%)	42 (87.5%)	6 (12.5%)	
CP time (min)	29.7±10.9	29.5±11.0	32.1±10.0	0.043
Lowest temperature (℃)	21.0±2.4	21.0±2.4	20.5±2.4	0.058
Root treatment				
Untreated	9 (1.0%)	8 (88.9%)	1 (11.1%)	
Root repair	699 (76.0%)	631 (90.3%)	68 (9.7%)	0.693
Root replacement	212 (23.0%)	189 (89.2%)	23 (10.8%)	
Arch treatment				
Untreated	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Hemi-arch replacement	166 (18.0%)	151 (91.0%)	15 (9.0%)	
Island replacement	108 (11.7%)	96 (88.9%)	12 (11.1%)	0.757
Total arch replacement	335 (36.4%)	296 (88.4%)	39 (11.6%)	
Branch stent implantation	32 (3.5%)	29 (90.6%)	3 (9.4%)	
F-stent implantation	279 (30.3%)	255 (91.4%)	24 (8.6%)	
CABG	54 (5.9%)	39 (4.7%)	15 (16.1%)	<0.001
Planned CABG	37 (68.5%)	32 (86.5%)	5 (13.5%)	0.001
Unplanned CABG	17 (31.5%)	7 (41.2%)	10 (58.8%)	
MV replacement	6 (0.7%)	4 (0.5%)	2 (2.2%)	0.116
MV repair	15 (1.6%)	12 (1.5%)	3 (3.2%)	0.187
TV repair	18 (2.0%)	15 (1.8%)	3 (3.2%)	0.415
AFRA	5 (0.5%)	4 (0.5%)	1 (1.1%)	0.414

High risk patients	All	Survival	Dead	P value
Operation time (hour)	7.9±2.2	7.6±2.0	9.0±2.6	<0.001
CPB time (min)	240.5±80.6	230.0±66.9	278.5±109.7	0.001
AAC time (min)	168.6±59.6	164.4±53.8	183.9±75.4	0.045
Arterial intubation approach				
Ascending aorta	5 (1.1%)	3 (60.0%)	2 (40.0%)	
Femoral artery	118 (26.6%)	86 (72.9%)	32 (27.1%)	0.048
Axillary artery	86 (19.4%)	75 (87.2%)	11 (12.8%)	
Axillary-Femoral artery	235 (52.9%)	183 (77.9%)	52 (22.1%)	
DHCA	438 (98.6%)	341 (98.3%)	97 (100.0%)	0.347
Cerebral perfusion (CP)	354 (79.7%)	283 (81.6%)	71 (73.2%)	0.086
None	90 (20.3%)	64 (71.1%)	26 (28.9%)	
Anterograde CP	334 (75.2%)	268 (80.2%)	66 (19.8%)	0.166
Retrograde CP	20 (4.5%)	15 (75.0%)	5 (25.0%)	
CP time (min)	30.2±11.3	29.9±11.1	31.4±12.0	0.281
Lowest temperature (℃)	21.5 (20.0, 23.0)	22.0 (20.0, 24.0)	20.0 (18.0, 22.0)	0.007
Root treatment				
Untreated	5 (1.1%)	4 (80.0%)	1 (20.0%)	
Root repair	335 (75.5%)	257 (76.7%)	78 (23.3%)	0.377
Root replacement	104 (23.4%)	86 (82.7%)	18 (17.3%)	
Arch treatment				
Untreated	5 (1.1%)	5 (1.4%)	0 (0.0%)	
Hemi-arch replacement	107 (24.1%)	83 (77.6%)	24 (22.4%)	
Island replacement	52 (11.7%)	43 (82.7%)	9 (17.3%)	
Total arch replacement	127 (28.6%)	97 (76.4%)	30 (23.6%)	<0.001
Branch stent implantation	8 (1.8%)	6 (75.0%)	2 (25.0%)	
F-stent implantation	145 (32.7%)	113 (77.9%)	32 (22.1%)	
CABG	39 (8.9%)	21 (6.1%)	18 (18.6%)	<0.001
Planned CABG	28 (71.8%)	18 (64.3%)	10 (35.7%)	0.072
Unplanned CABG	11 (28.2%)	3 (27.3%)	8 (72.7%)	
MV replacement	1 (0.2%)	1 (0.3%)	0 (0.0%)	1.000
MV repair	3 (0.7%)	2 (0.6%)	1 (1.0%)	0.524
TV repair	4 (0.9%)	4 (1.2%)	0 (0.0%)	0.581
AFRA	0 (0.0%)	0 (0.0%)	0 (0.0%)	-

Result four: Univariate analysis of postoperative mortality in low- and high-risk patients

Variables	Low-risk patients				High-risk patients			
	Odd ratio	95% Confidence Interval		P Value	Odd ratio	95% Confidence Interval		P Value
		Lower	Upper			Lower	Upper	
Intraoperative variables								
Operation time	1.512	1.353	1.689	<0.001	1.322	1.192	1.467	<0.001
CPB time	1.005	1.003	1.008	<0.001	1.007	1.004	1.010	<0.001
ACC time	1.007	1.003	1.011	<0.001	1.005	1.002	1.009	0.005
Axillary artery cannulation	-	-	-	-	0.464	0.236	0.914	0.029
Lowest hypothermia temperature	-	-	-	-	1.122	1.021	1.233	0.016
CABG	3.116	2.026	4.792	<0.001	3.537	1.799	6.953	<0.001
Postoperative variables								
Cerebral complications	2.041	1.024	4.070	0.048	2.341	1.204	4.551	0.013
Mechanical ventilation time	-	-	-	-	1.005	1.002	1.008	0.003
Re-intubation	3.080	1.619	5.857	0.001	2.646	1.185	5.910	0.019
CRRT establishment	3.704	2.192	6.257	<0.001				
Surgical infection	3.878	1.564	9.614	0.007	3.747	1.181	11.894	0.028
Postoperative lower limbs malperfusion	-	-	-	-	3.809	1.391	10.431	0.011
Postoperative visceral malperfusion	-	-	-	-	5.109	1.728	15.102	0.004

Discussion——artery cannulation

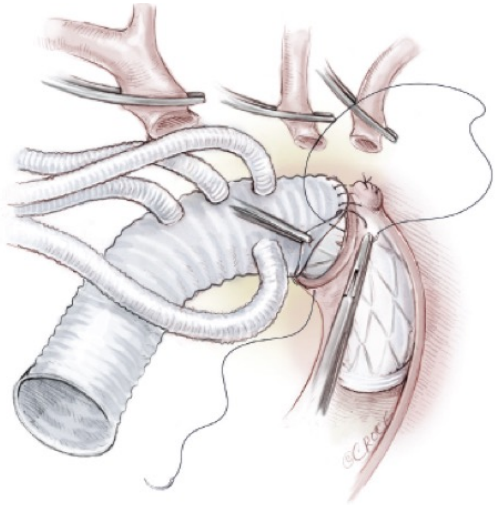
2021 The American Association for Thoracic Surgery expert consensus document: Surgical treatment of acute type A aortic dissection

- Axillary artery cannulation is commonly performed in the Europe and the North America and can decrease the postoperative mortality in aTAAD patients.
- Femoral artery cannulation is more efficient approach to establish CPB and has been widely used around the world, however, the retrograde blood flow would increase the incidence of stroke and intraoperative organ malperfusion.

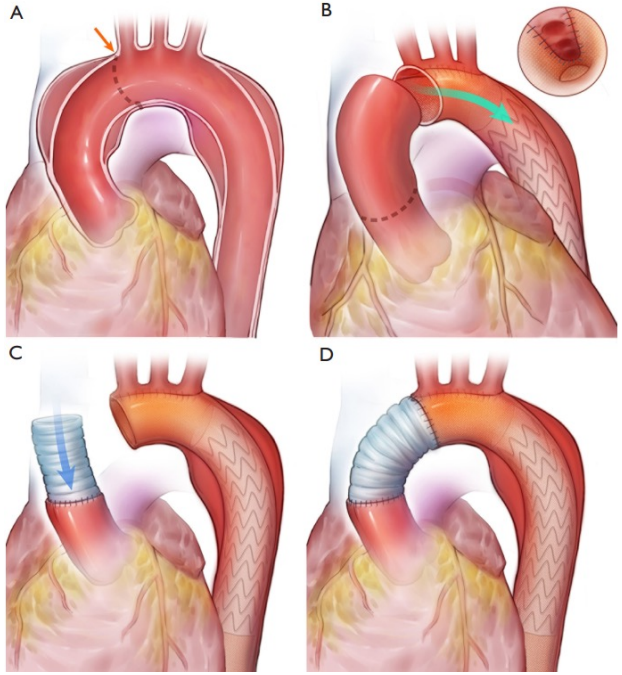
Variables	Axillary artery N=86	Femoral artery N=118	Axillary-Femoral artery N=235	P1 value	P2 value
Cerebral complications	6 (7.0%)	12 (10.2%)	24 (10.2%)	0.466	0.402
Postoperative stroke	3 (3.5%)	7 (5.9%)	19 (8.1%)	0.524	0.212
Postoperative hemiplegia	2 (2.3%)	5 (4.2%)	4 (1.7%)	0.701	0.661
CRRT establishment	8 (9.3%)	20 (16.9%)	43 (18.3%)	0.150	0.058
Postoperative lower limbs malperfusion	1 (1.2%)	5 (4.2%)	10 (4.3%)	0.404	0.300
Postoperative visceral malperfusion	1 (1.2%)	2 (1.7%)	11 (4.7%)	1.000	0.193
Postoperative gastrointestinal bleeding	2 (2.3%)	3 (2.5%)	2 (0.9%)	1.000	0.292

De Paulis, R et al. EJCTS 2015
Lee TC et al. Journal of cardiac surgery 2018
Helder K et al. The Annals of thoracic surgery 2019

Discussion——arch treatments



High risk patients
Usage ratio from 36.4% to 28.6%
Mortality rate 11.6% to 23.6%



- Avoiding supra-arch vessels isolation and anastomosis could decrease operation time, CPB time, AAC time, DHCA time and intraoperative bleeding compared to TAR surgery.
- Combined using of the FET would be helpful of early aortic remodeling.

Arch treatment	All	Survival	Dead	
Untreated	5 (1.1%)	5 (1.4%)	0 (0.0%)	
Hemi-arch replacement	107 (24.1%)	83 (77.6%)	24 (22.4%)	
Island replacement	52 (11.7%)	43 (82.7%)	9 (17.3%)	<0.00
Total arch replacement	127 (28.6%)	97 (76.4%)	30 (23.6%)	1
Branch stent implantation	8 (1.8%)	6 (75.0%)	2 (25.0%)	
F-stent implantation	145 (32.7%)	113 (77.9%)	32 (22.1%)	

Limitations

- This is a retrospective and single center cohort study with limited sample size
- After incorporating more clinical variables, the predictive model will have higher sensitivity and specificity
- External validation from other centers is needed
- Further researches are important to evaluate the influences of different surgical procedures and cannulation approaches on specific patients

Summary

- It is useful to quickly recognize high-risk patients after admission ASAP, especially for those MPS patients.
- For low-risk patients, there are no difference among different root procedures or arch procedures. Combined CABG procedure could increase the postoperative mortality.
- For high-risk patients, the extended arch procedure, femoral artery cannulation and combined CABG procedure would increase the postoperative mortality.
- Increased operation time, CPB time and ACC time are risk factors in all patients.

Thanks for your attention

Aortic Disease Center of Jiangsu Province

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