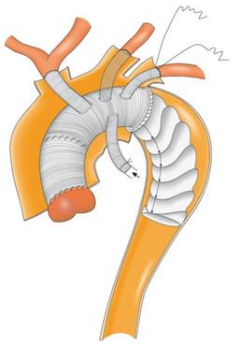
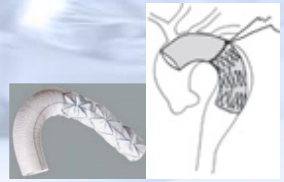


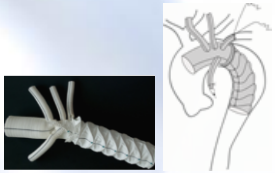
MHH

Cardiac, Thoracic, Transplantation
and Vascular Surgery

Total aortic arch replacement with the Thoraflex Hybrid Frozen Elephant Trunk Technique: The Hannover Experience.

Malakh Shrestha
Hannover Medical School





1983 Borst

2003 Karck

2005 Jakob

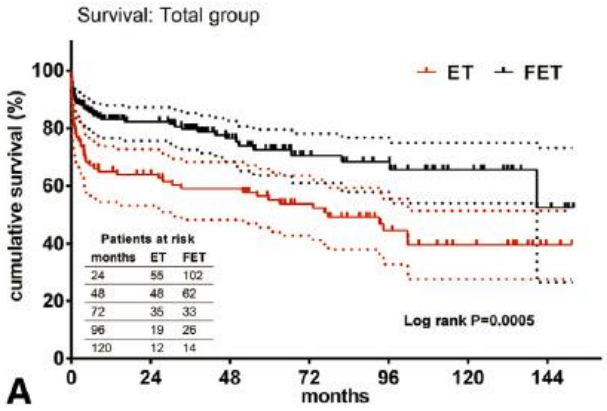
2013 Shrestha

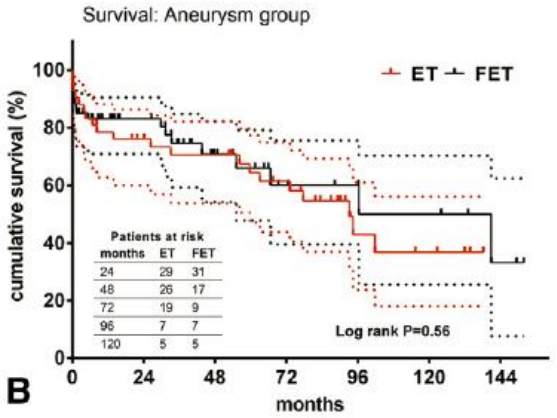
Disclosures

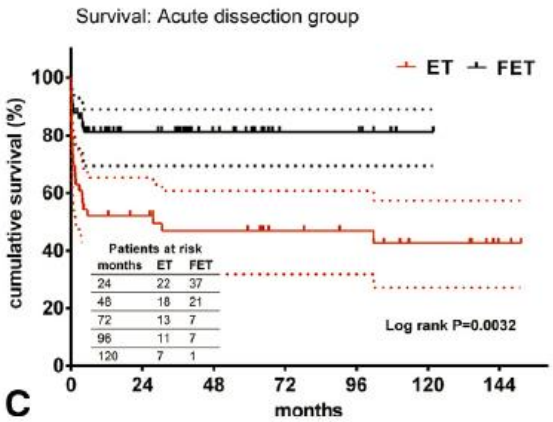
Consultant for Vascutek Terumo

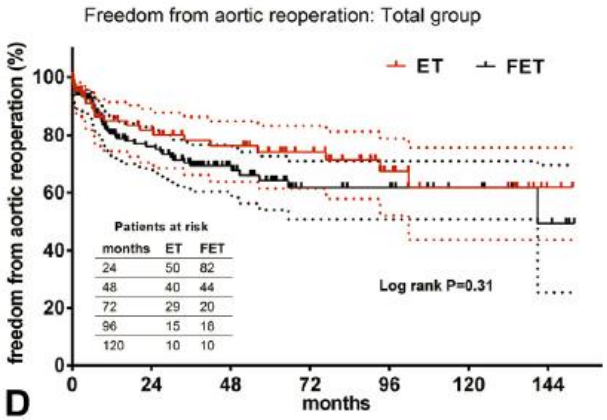
The elephant trunk is freezing: The Hannover experience

Malakh Shrestha, MBBS, Erik Beckmann, MD, Heike Krueger, RN, Felix Fleissner, MD, Tim Kaufeld, MD, Nurbol Koigeldiyev, MD, Julia Umminger, MD, Fabio Ius, MD, Axel Haverich, MD, Andreas Martens, MD

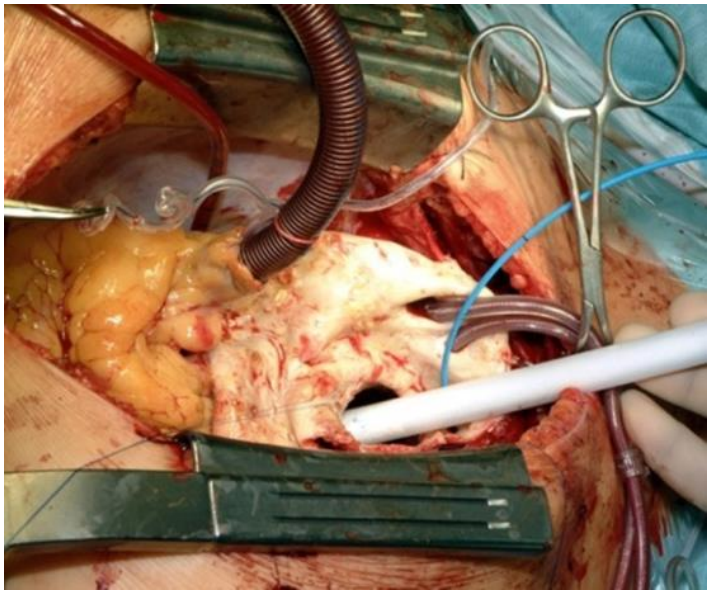


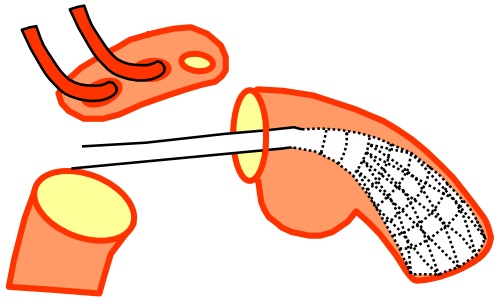


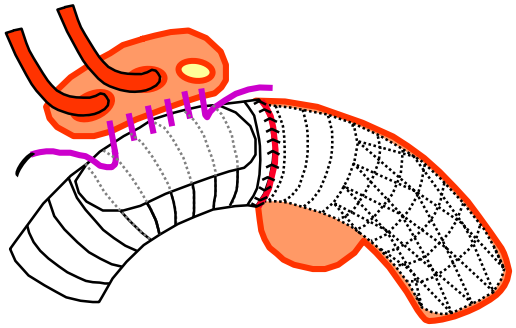


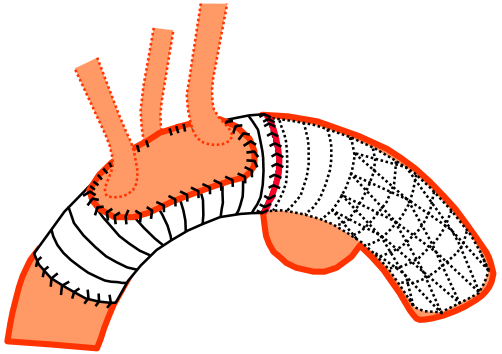


‘Frozen Elephant Trunk’ Procedure



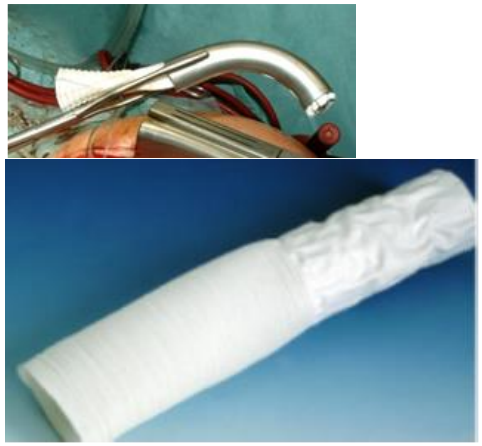




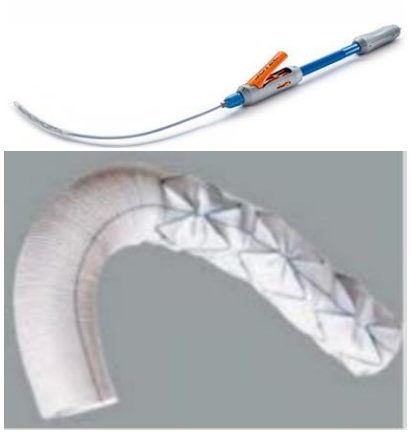


The frozen elephant trunk technique: a new treatment for thoracic aortic aneurysms.
Karck M, Chavan A, Hagl C, Friedrich H, Galanski M, Haverich A.
J Thorac Cardiovasc Surg. 2003 Jun;125(6):1550-3

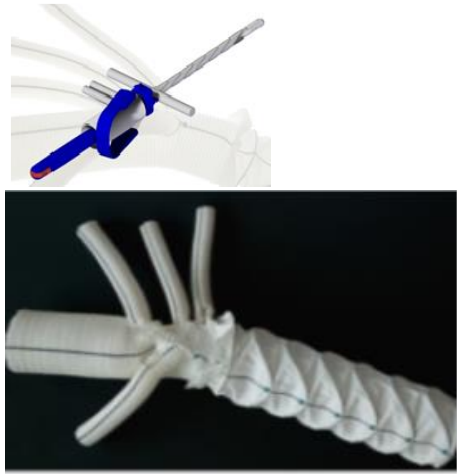
Hannover Medical School 08/2001- 4/2016, FET n= 251.



Chavan Haverich (n=66)



Jotec E-vita (n=31)



Vascutek Thoraflex (n=154)

Total aortic arch replacement with the frozen elephant trunk technique: 10-year follow-up single-centre experience†

Fabio Ius', Felix Fleissner', Maximilian Pichlmaier, Matthias Karck, Andreas Martens, Axel Haverich and Malakh Shrestha*

European Journal of Cardio-Thoracic Surgery 44 (2013) 949–957
doi:10.1093/ejcts/ezt229 Advance Access publication 9 May 2013

Total aortic arch replacement with a novel four-branched frozen elephant trunk graft: first-in-man results†

Malakh Shrestha*, Maximilian Pichlmaier, Andreas Martens, Christian Hagl, Nawid Khaladj and Axel Haverich

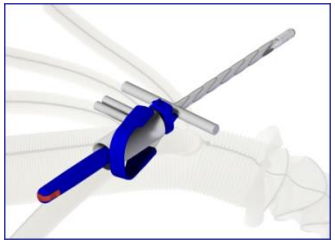
European Journal of Cardio-Thoracic Surgery Advance Access published May 31, 2012
European Journal of Cardio-Thoracic Surgery 0 (2012) 1–5
doi:10.1093/ejcts/ezs296
ORIGINAL ARTICLE

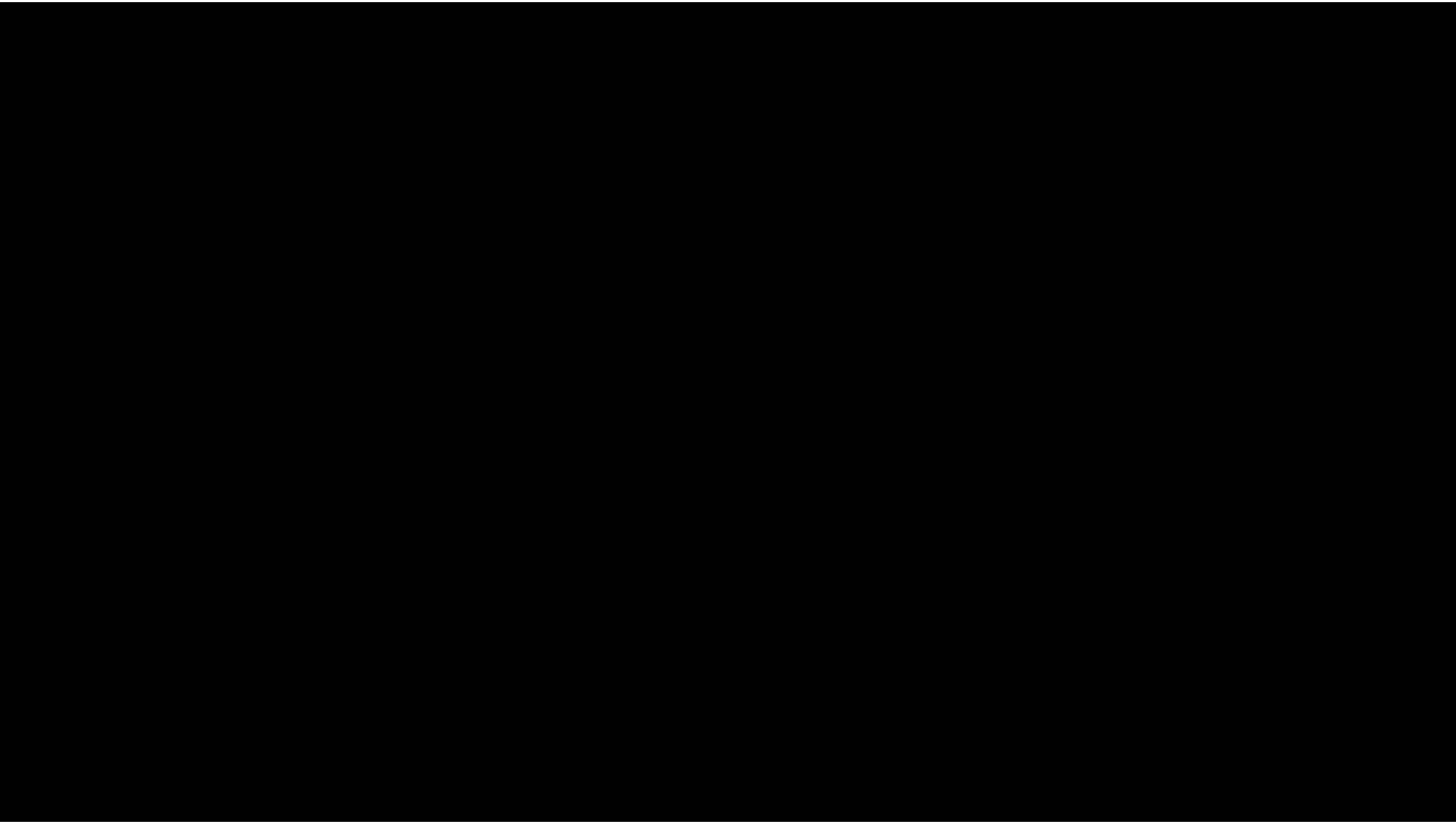
METHODS: From April 2010 to August 2011, 34 patients (25 males, age 60 ± 14 years) were operated on [14 aneurysms, 20 dissections (18 acute)]. Ten of these patients had undergone previous cardiac operations. The collapsed endoprosthesis was deployed in the descending aorta through the opened aortic arch. A sewing collar between the graft segments simplified the 'distal' anastomosis. The four-branched graft segment allowed the replacement of the aortic arch and supra-aortic vessels individually. Concomitant procedures were performed if necessary.

CONCLUSIONS: The graft adds to the 'frozen elephant trunk' concept for treating the arch and proximal descending aorta. Early experience demonstrates an excellent 30-day survival. Combining the frozen elephant with a four-branched arch graft increases the armament of the surgeon in the treatment of complex and diverse aortic arch pathology.

- Consists of unstented Dacron & a stented (polyester and nitinol stent) parts
- Un-stented part has 4 'fingers',
- The length of the stented part: 10 & 15 cms.
- The proximal unstented & distal stented parts are available in different sizes
- a sewing collar simplifies the suturing of distal anastomosis.
- Radio-opaque markers in the stented part.
- Fully Sealed Device

Product Development Collaboration
Hannover Medical School, Germany
+ Vascutek Terumo





Preoperative Data	All	Chavan-Haverich	Jotec	Thoraflex	*P value*
Patients	251	66	31	154	0.232
male gender	175 (70%)	48 (73%)	25 (81%)	102 (66%)	0.232
Age, y	63 (50-70)	63 (49-70)	64 (54-70)	62 (50-70)	0.847
Diagnosis					
Aneurysm	82 (33%)	19 (29%)	11 (35%)	52 (21%)	0,723
AADA	100 (40%)	18 (27%)	15 (48%)	67 (44%)	0,046
CADA	69 (27%)	29 (44%)	5 (16%)	35 (23%)	0.002
Marfan-Syndrome	21 (8%)	9 (14%)	2 (6%)	10 (6%)	0.247
Redo	67 (27%)	25 (38%)	7 (23%)	35 (23%)	0.061
Malperfusion	35 (14%)	4 (6%)	5 (16%)	26 (17%)	0.302
cerebral	17 (7%)	0	4 (13%)	13 (8%)	0.106
Abdominal	11 (4%)	0	1 (3%)	10 (6%)	0.474
lower limb	22 (9%)	4 (6%)	2 (6%)	16 (10%)	0.693

Diagnosis	Perioperative Data	All n=82	Thoraflex n=52
Aneurysm 	Operation time, min	315 (267-360)	310 (267-355)
	Cardiopulmonary Bypass time, min	196 (165-248)	196 (163-235)
	Cardiac ischemia time, min	100 (65-127)	81 (58-112)
	SACP, min	64 (50-89)	78 (56-92)
	Beating heart	37 (45%)	37 (71%)
	concomitant procedure	42 (51%)	26 (50%)
	CABG	23 (28%)	15 (29%)
	AV Replacement	10 (12%)	5 (10%)
	AV Reconstruction	12(15%)	8 (15%)
	David	11 (13%)	8 (15%)

Aneurysm

Postoperative Data	All n=82	Thoraflex n=52
prolonged ventilation (>96h)	14 (17%)	6 (12%)
ICU stay, d	4 (2-9)	4 (3-11)
Rethoracotomy (bleeding)	13 (16%)	7 (13%)
Recurrent nerve palsy	13 (16%)	5 (10%)
Acute Kidney Injury	16 (20%)	12 (23%)
Dialysis	13 (16%)	10 (19%)
permanent	1 (1%)	1 (2%)
Paraparesis	5 (6%)	5 (10%)
permanent	3 (4%)	3 (6%)
Stroke	11 (13%)	7 (13%)
In hospital mortality	14 (17%)	8 (15%)

Aneurysm

Follow-up data	All n=82	Thoraflex n=52
Patients in follow-up	72 (87.8%)	47 (90.4%)
follow-up, y	2.26 (0.37-5.19)	0.71 (0.13-2.48)
Aortic reoperation	21 (26%)	12 (23%)
Time to reoperation, d	151 (13-289)	129 (16-282)
Open surgical	9 (11%)	5 (10%)
Thoracoabdominal	3 (4%)	2 (4%)
Descending Aorta	1 (1%)	1 (2%)
Abdominal/iliac	4 (5%)	4 (8%)
Endovascular	12 (15%)	7 (13%)
Reoperation Status		
planned	1 (1%)	1 (2%)
unplanned	20 (24%)	11 (21%)

Diagnosis	Perioperative Data	All n=100	Thoraflex n=67
 **AADA**	Operation time, min	375 (314-436)	389 (334-436)
	Cardiopulmonary Bypass time, min	261 (208-293)	267 (216-295)
	Cardiac ischemia, min	118 (75-164)	102 (60-146)
	SACP, min	85 (63-103)	95 (77-116)
	Beating heart	43 (43%)	43 (64%)
	concomitant procedure	72 (72%)	52 (78%)
	Aortic root Reconstruction	28 (28%)	18 (17%)
	CABG	11 (11%)	8 (12%)
	AV Replacement	20 (20%)	11 (16%)
	AV Reconstruction	48 (48%)	38 (57%)
	David	31 (31%)	26 (39%)
	Yacoub	6 (6%)	3 (4%)

	Postoperative Data	All n=100	Thoraflex n=67
 AADA	prolonged ventilation (>96h)	27 (27%)	18 (17%)
	ICU stay, d	5 (3-10)	5 (3-10)
	Rethoracotomy (Bleeding)	19 (19%)	13 (19.5%)
	Recurrent nerve palsy	17 (17%)	13 (19.5%)
	Acute Kidney Injury	21 (21%)	11 (16%)
	Dialysis	17 (17%)	11 (16%)
	permanent	3 (3%)	2 (3%)
	Paraparesis	6 (6%)	3 (4%)
	permanent	1 (1%)	0
	Stroke	18 (18%)	3 (4%)
	In hospital mortality	12 (12%)	6 (9%)

AADA

Follow-up data	All n=100	Thoraflex n=67
Patients in follow-up	90 (90%)	62 (93%)
follow-up, y	2.12 (0.50-4.65)	1.33 (0.46-2.84)
Aortic reoperation	12 (12%)	7 (10%)
Time to reoperation, d	218 (92-521)	218 (92-361)
Open surgical	10 (10%)	5 (7%)
Thoracoabdominal	2 (2%)	1 (2%)
Descending Aorta	1 (1%)	1 (2%)
Abdominal/iliac	3 (3%)	2 (3%)
Endovascular	5 (5%)	3 (4%)
Reoperation Status		
planned	1 (1%)	1 (2%)
unplanned	12 (12%)	6 (9%)

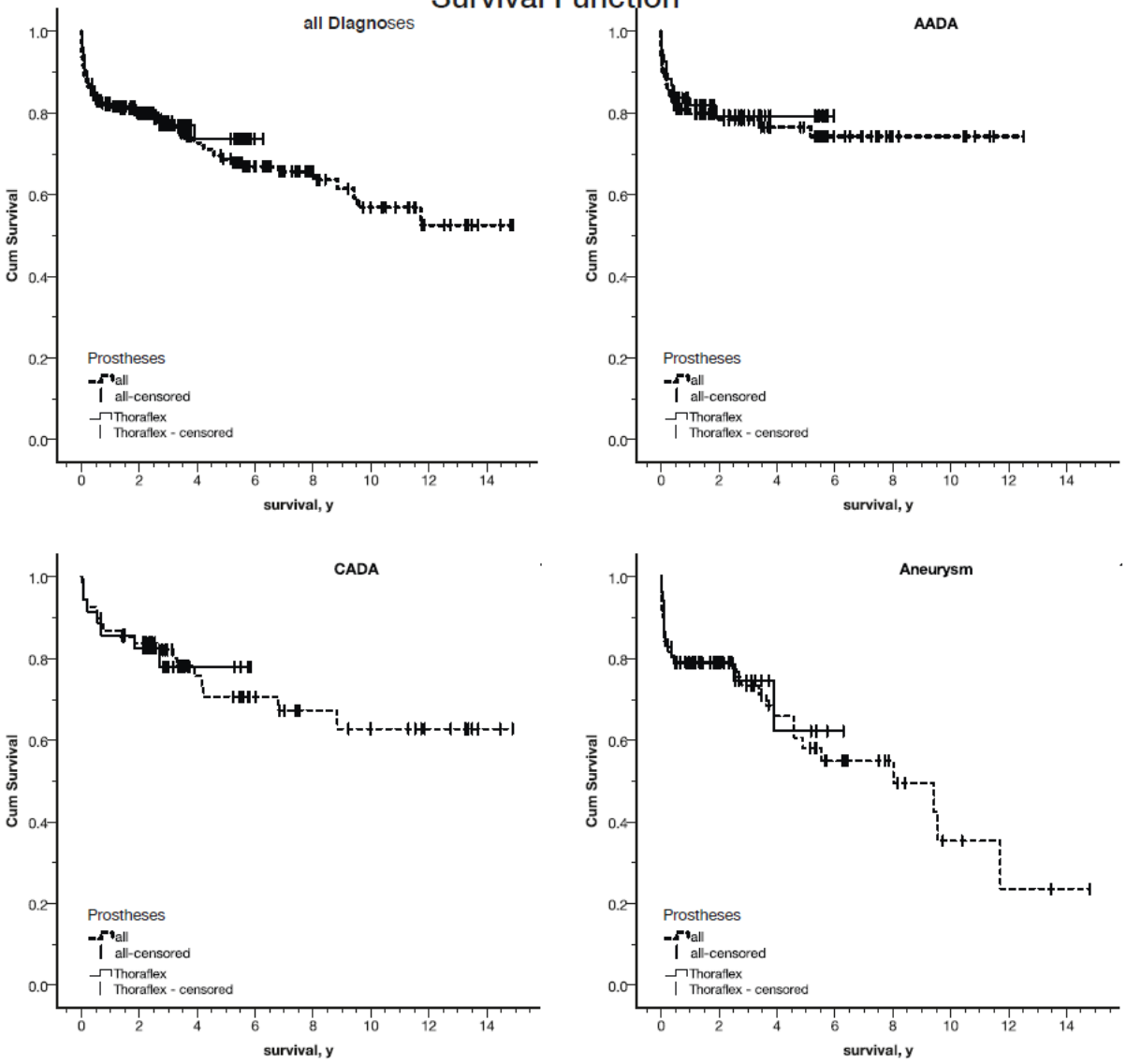
Diagnosis	Perioperative Data	All n=69	Thoraflex n=35
 **CADA**	Operation time, min	397 (336-441)	410 (332-449)
	Cardiopulmonary Bypass time, min	234 (193-283)	234 (204-289)
	Cardiac ischemia time, min	129 (95-184)	120 (80-179)
	SACP, min	79 (61-102)	100 (83-118)
	Beating heart	20 (29%)	20 (57%)
	concomitant procedures	30 (43%)	15 (43%)
	Aortic root Reconstruction	4 (6%)	1 (3%)
	CABG	8 (12%)	2 (6%)
	AV Replacement	16 (23%)	6 (17%)
	AV Reconstruction	7 (10%)	4 (11%)
	David	6 (9%)	3 (9%)
	Yacoub	1 (1%)	1 (3%)

CADA

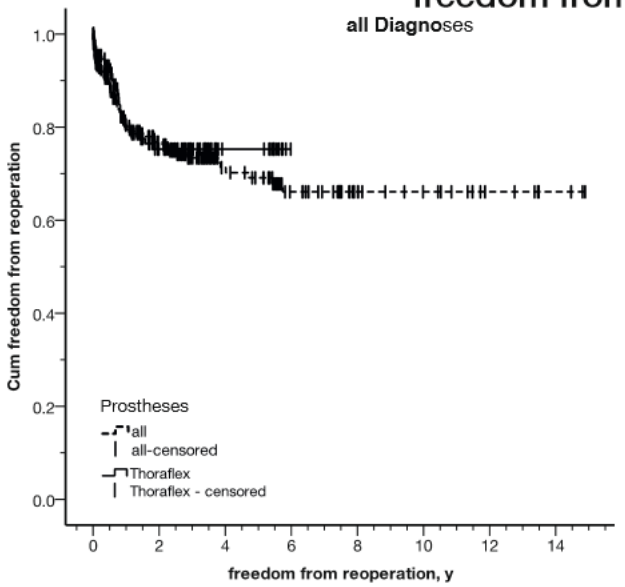
Postoperative Data	All n=69	Thoraflex n=35
prolonged ventilation (>96h)	18 (26%)	8 (23%)
ICU stay, d	6 (3-13)	6 (3-13)
Rethoracotomy (Bleeding)	14 (20%)	5 (14%)
Recurrent nerve palsy	18 (26%)	12 (34%)
Acute Kidney Injury	15 (22%)	9 (26%)
Dialysis	14 (20%)	8 (23%)
permanent	1 (1%)	1 (3%)
Paraparesis	3 (4%)	3 (9%)
permanent	0	
Stroke	7 (10%)	3 (9%)
In hospital mortality	3 (4%)	1 (3%)

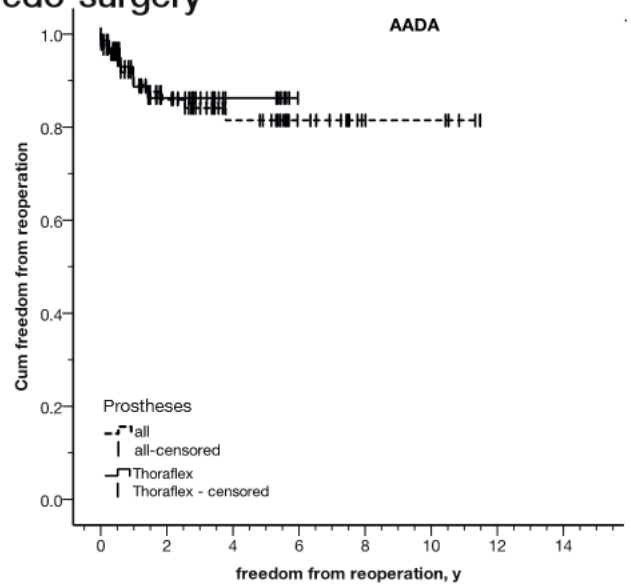
	Follow-up data	All n=69	Thoraflex n=35
 **CADA**	Patients in follow-up	67 (97.1%)	35 (100%)
	follow-up, y	2.92 (1.24-6.84)	1.82 (0.67-2.83)
	Aortic reoperation	26 (38%)	11 (31%)
	Time to reoperation, d	281 (124-666)	281 (209-345)
	Open surgical	17 (25%)	6 (17%)
	Thoracoabdominal	11 (16%)	3 (9%)
	Descending Aorta	3 (4%)	2 (6%)
	Abdominal/iliac	2 (3%)	2 (6%)
	Endovascular	9 (13%)	5 (14%)
	Reoperation Status		
	planned	1 (1%)	1 (3%)
	unplanned	25 (36%)	10 (29%)

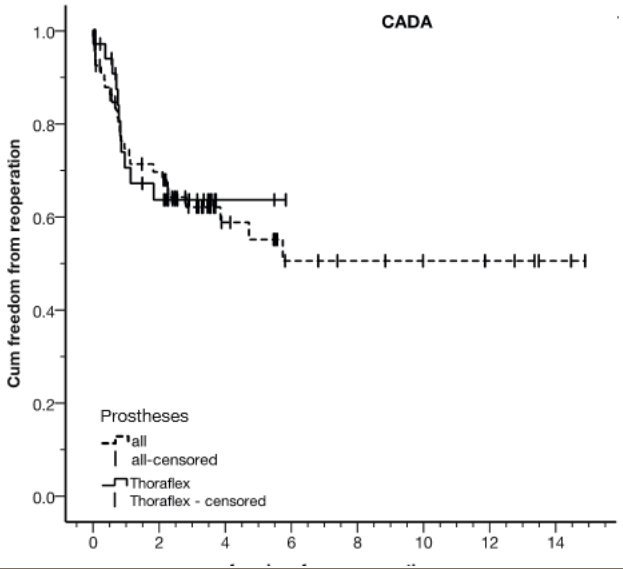
Survival Function

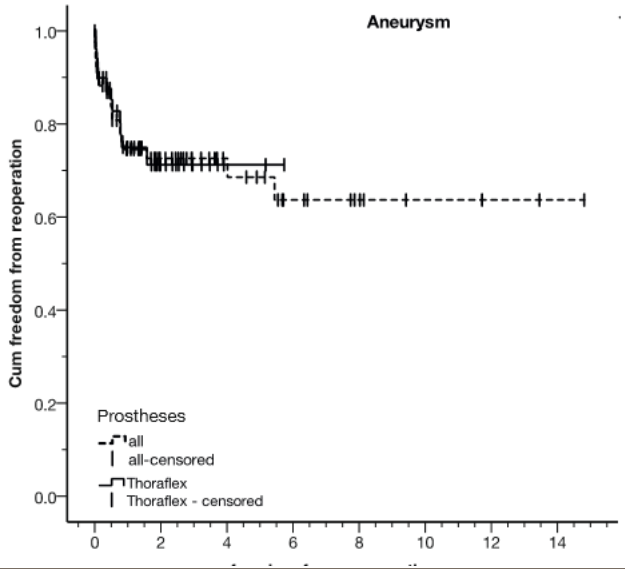


freedom from redo-surgery

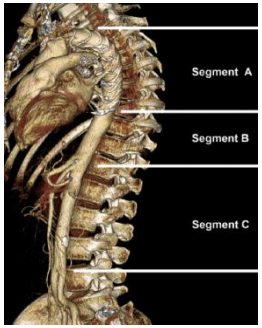


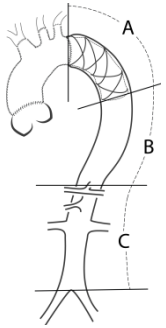


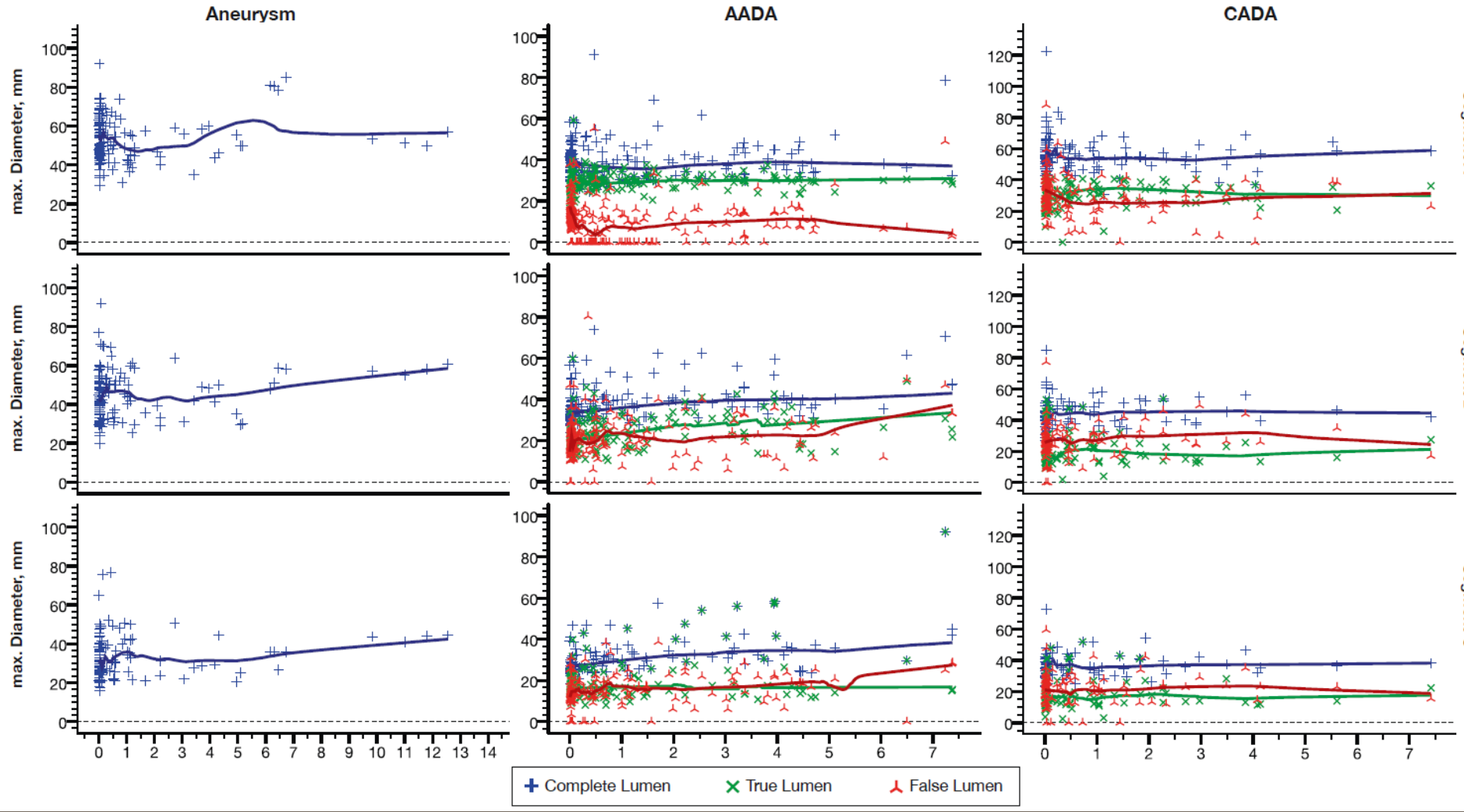


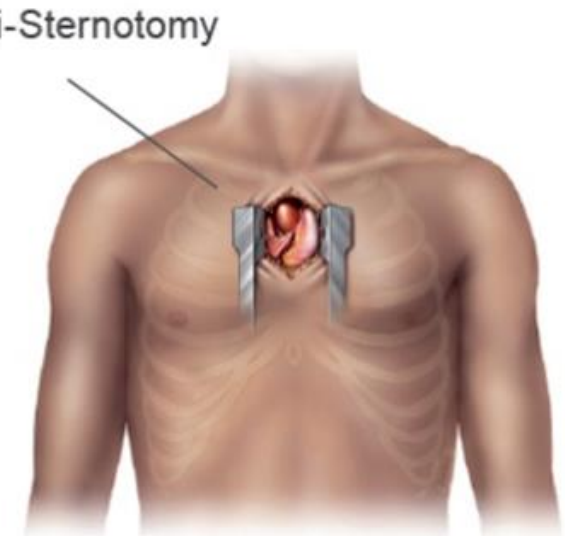


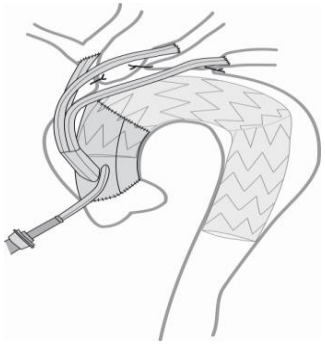
Follow-up Aortic imaging

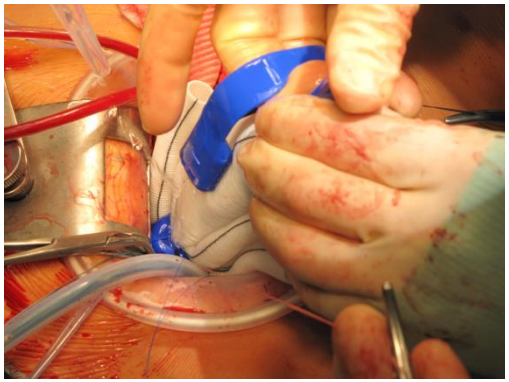


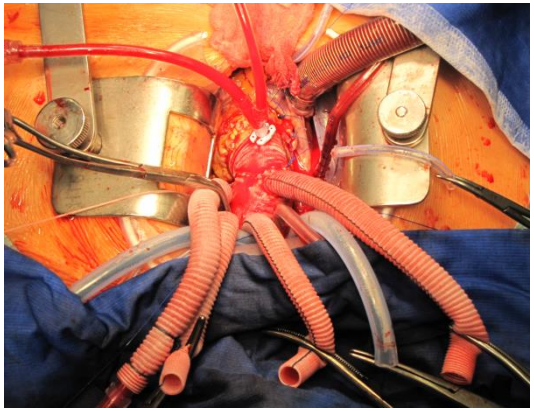


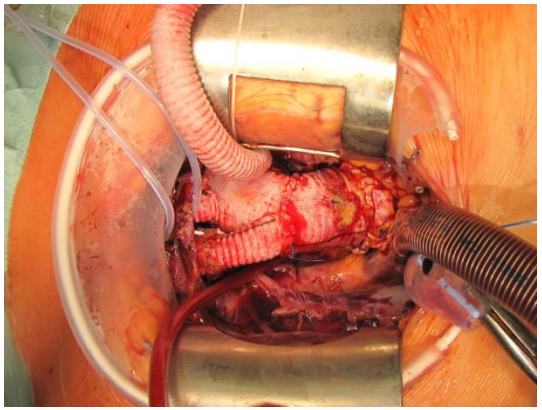



Mini-Sternotomy









Good judgment comes from experience and experience comes from bad judgment.

European Journal of Cardio-Thoracic Surgery Advance Access published February 10, 2015

European Journal of Cardio-Thoracic Surgery (2015) 1–9
doi:10.1093/ejcts/ezv009

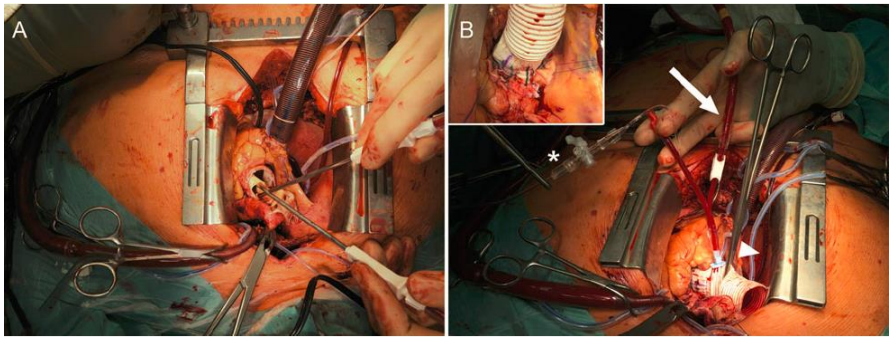
ORIGINAL ARTICLE

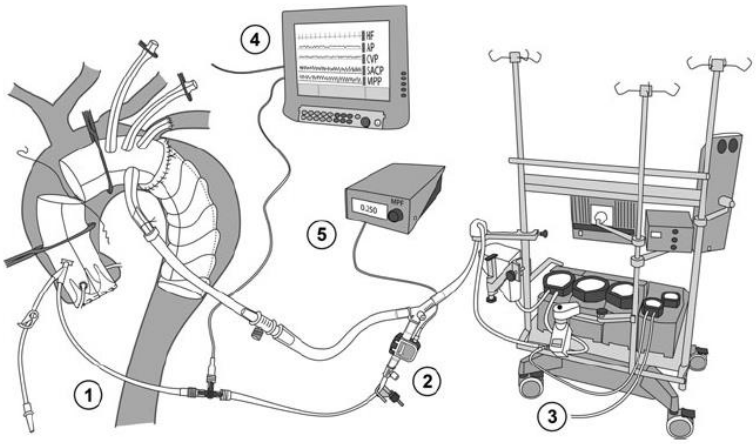
AORTIC SURGERY

Do not leave the heart arrested. Non-cardioplegic continuous myocardial perfusion during complex aortic arch repair improves cardiac outcome†

Andreas Martens*, Nurbol Koigeldiyev, Erik Beckmann, Felix Fleissner, Tim Kaufeld, Heike Krueger, Detlev Stanelle, Jakob Puntigam, Axel Haverich and Malakh Shrestha

10/2010 – 10/2014, 144 patients





	CMP	CA	*P*-value
Total operation time (min)	363 ± 61	395 ± 87	0.0016
Cardiopulmonary bypass time (min)	242 ± 50	264 ± 68	0.046
Cardiac ischaemia time (min)	49 ± 32	149 ± 56	<0.0001
Visceral ischaemia time (min)	55 ± 20	54 ± 31	0.847
Minimal oesophageal temperature (°C)	25 ± 1	25 ± 2	0.491
Selective antegrade cerebral perfusion time (min)	101 ± 29	101 ± 43	0.967

	CMP	CA	*P*-value
30-day mortality (*n*, %)	2 (6%)	23 (21%)	0.040
New onset PND (*n*, %)	3 (8%)	11 (10%)	1.000
SCI (*n*, %)	2 (6%)	5 (5%)	0.670
Recurrent nerve palsy (*n*, %)	5 (14%)	14 (13%)	1.000
Myocardial infarction (MI) (*n*, %)	0 (0%)	3 (3%)	0.573
Low cardiac output (*n*, %)	1 (3%)	24 (22%)	0.0052

Conclusions I

- In selected patients with multi-segment aortic aneurysms, FET allows for a ‘single stage ‘ therapy.
- In acute DeBakey type I aortic dissections, FET stabilizes the dissecting membrane and favours true lumen expansion.
- This can be “life-saving” in patients with malperfusion.
- FET graft favours false lumen thrombosis in both acute and chronic DeBakey type I aortic dissections.
- It offers an ideal landing zone for trans-femoral endovascular completion at a later stage.

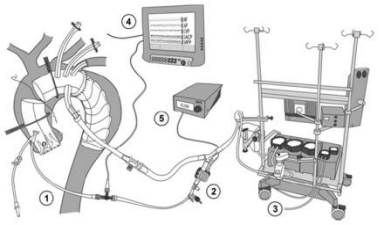
In acute and chronic aortic dissections, “excessively long” FET may increase the risk of spinal cord injury.

FET graft infection is extremely complex to treat and has dismal results.

FET technique is just one of the tools available to the surgeon to treat complex aortic arch disease.

Conclusion II

Modern peri-operative management techniques such as replacing the aortic arch on continuous perfused myocardium (‘beating heart’) reduces the peri-operative risks.



•In Dissections, FET length of 10 centimeters beyond the left subclavian origin is sufficient to stabilize the intimal flap and to promote false lumen thrombosis.

•All patients after FET implantation warrant a strict follow-up including serial CT Scans.

•All necessary precautions should be undertaken to avoid FET graft infection.

The peri-operative risks after surgery of the aortic arch is mainly procedure dependent.

Thank you!