TOTAL AORTIC ARCH REPLACEMENT AND FROZEN ELEPHANT TRUNK: MID TERM AND SECOND STAGE SURGERY OUTCOMES

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OUTLINE

Complex arch pathology

What are the options
- What is frozen elephant trunk?
- Why TAR + FET?

PWH experience
- Overall
- Special cases

Conclusion

AORTIC ARCH SURGERY

Open reconstruction of aortic arch has been one of the **most challenging** surgical **procedures**

- Locally: Complex arch and dissection anatomy
  - Segments of aorta involving supraaortic branches
- Systemically: Dynamic dissecting aneurysm pathology – perioperative malperfusion

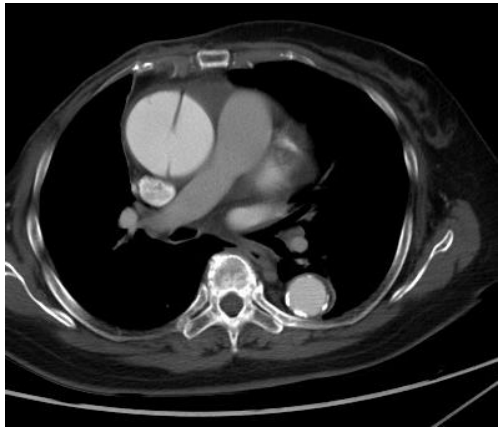
Optimal outcome requires well planned perioperative strategies to reconstruct and protect vital organs

IN PATIENT LIST

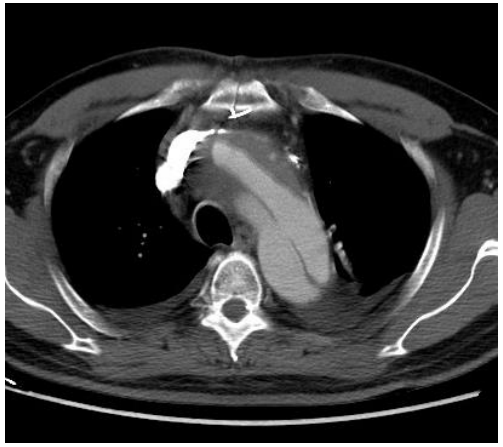
Range of aortic pathology is expanding

Options of management is also expanding

- Techniques for extensive aortic arch reconstruction



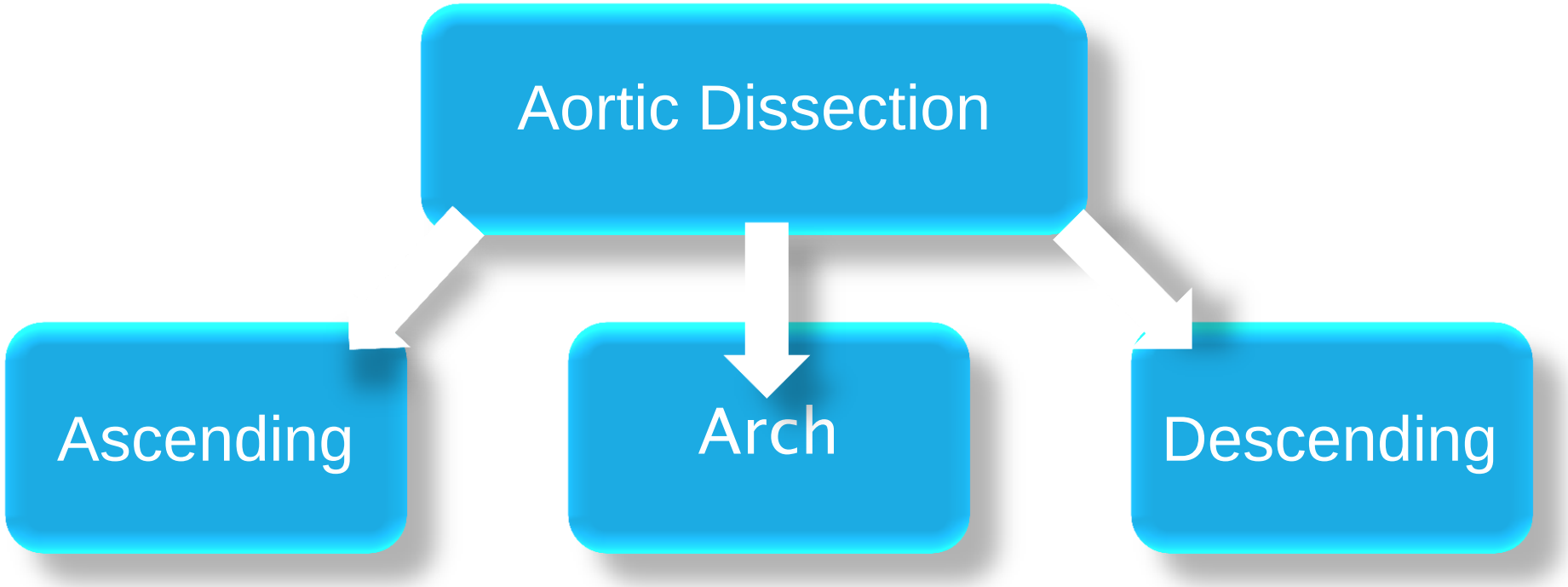
Chronic Type A



Residual Arch

Arch aneurysm

Arch dissection with malperfusion



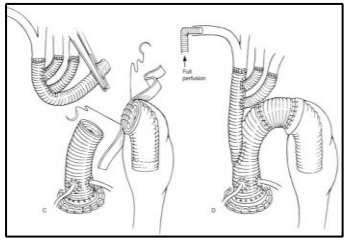
1. Open surgery is Gold standard
2. IRAD 17-24% Mortality
3. GERRAAD 17% Mortality
4. 20% Not fit for surgery

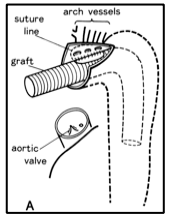
1. Open TAR is Gold standard but most are done by specialized center
2. Total debranching +TEVAR is less invasive and not require CPB

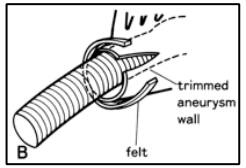
1. **TEVAR is the standard for "complicated" type B**
2. **Open surgery has good outcome is highly specialized center**

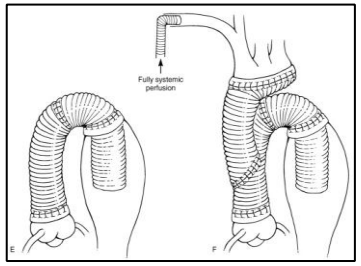
Persistently Perfused Descending Thoracic False Lumen

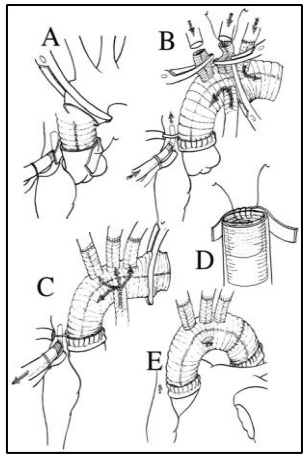
APPROACHES TO ARCH – MODIFICATIONS FOR PROBLEMS

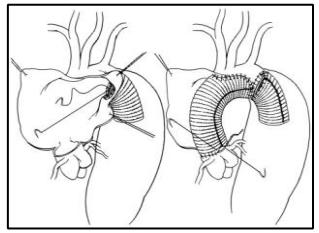


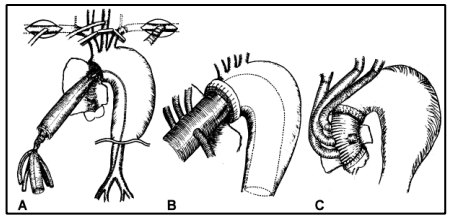


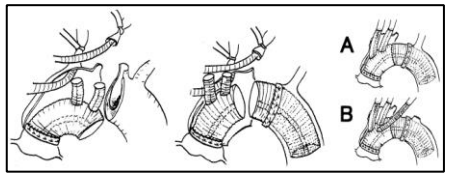


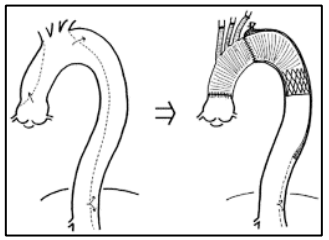












Courtesy from Prof Eugenio Neri

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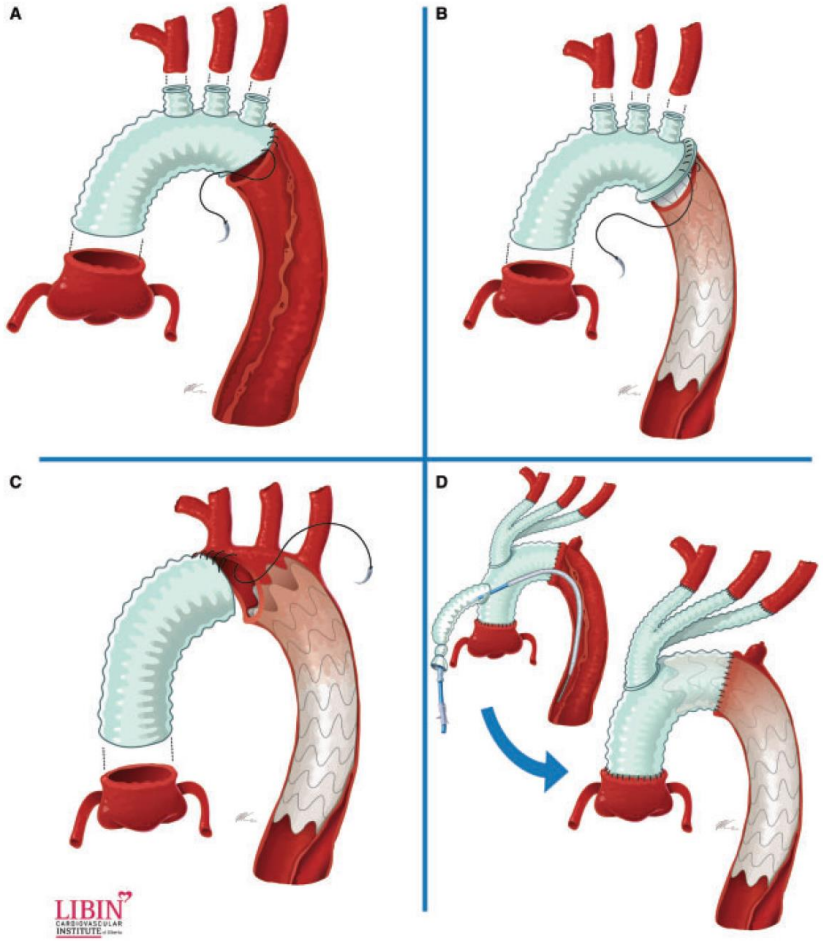

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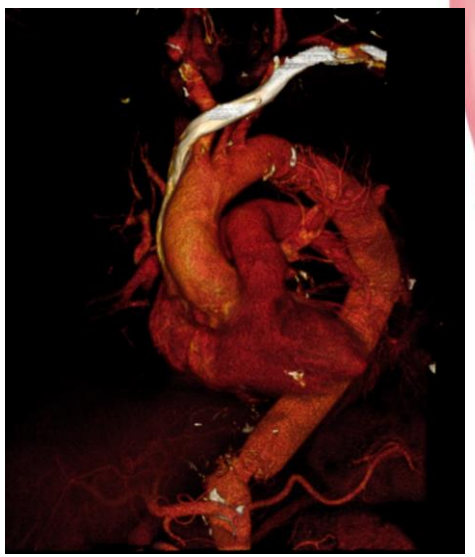
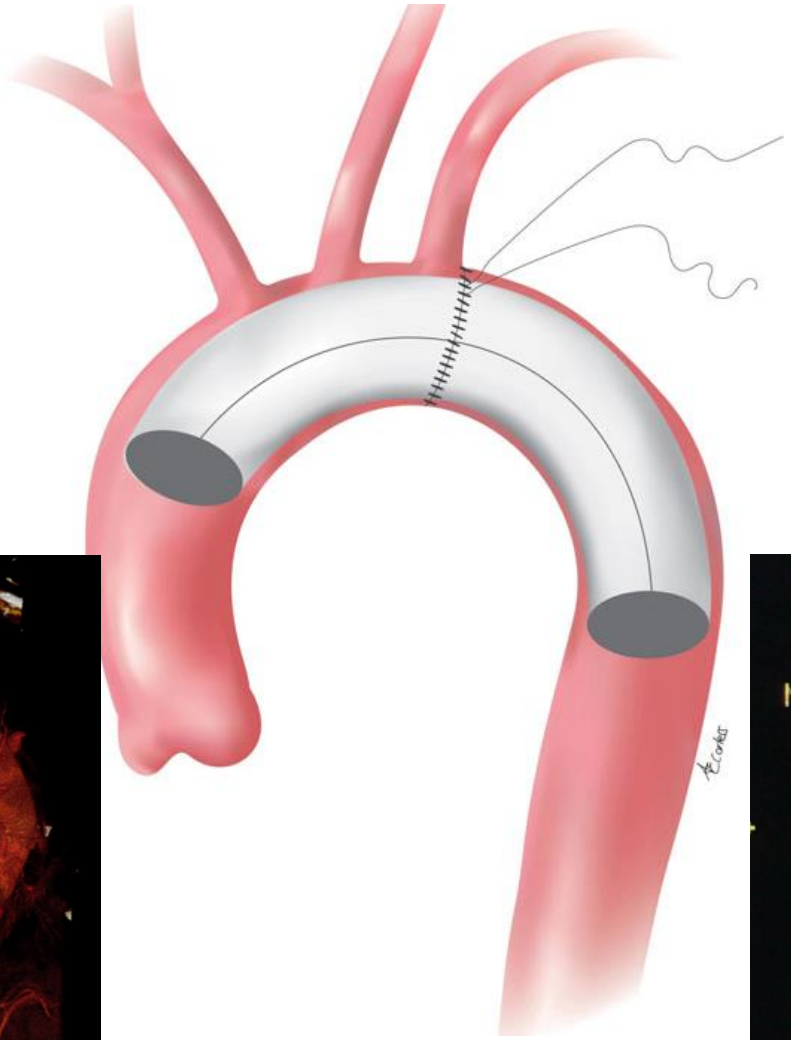
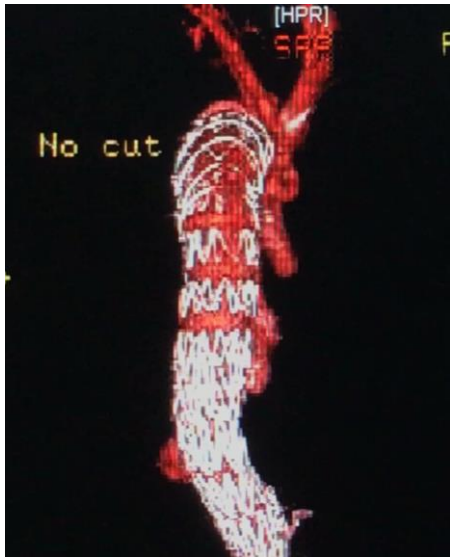
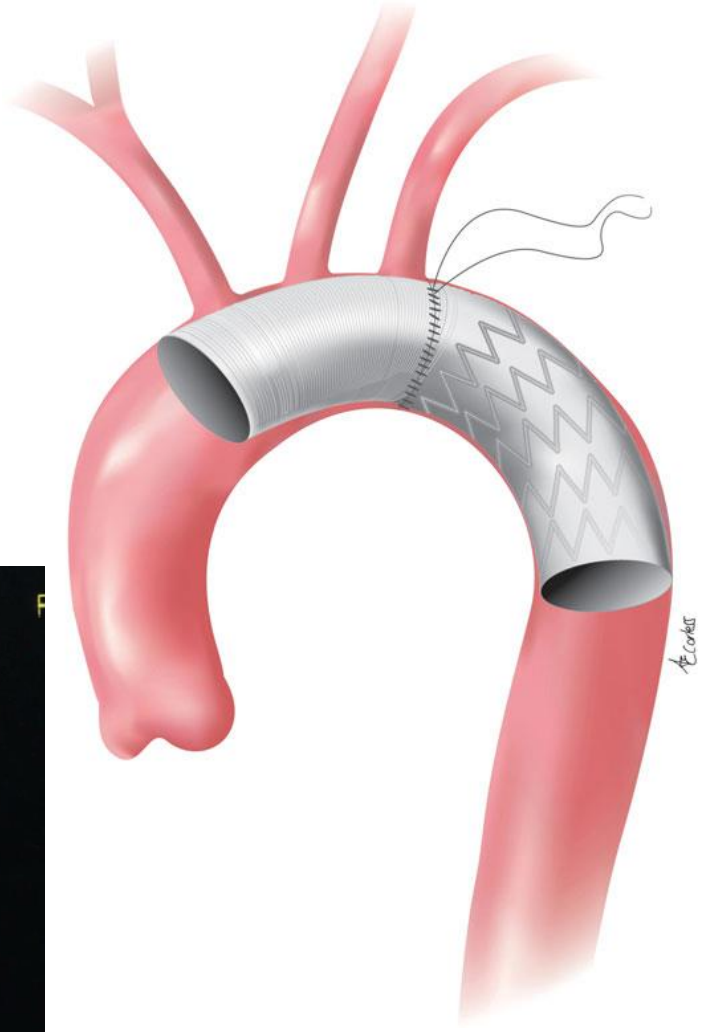
Floating versus Frozen









THE FROZEN ELEPHANT TRUNK

Development between 1996–2003 for complex aortic arch pathologies

Aneurismal or dissecting pathologies from the ascending or the aortic arch extending into the descending thoracic aorta

- Replacing the aortic arch
- Antegrade distal stenting to proximal descending thoracic aorta

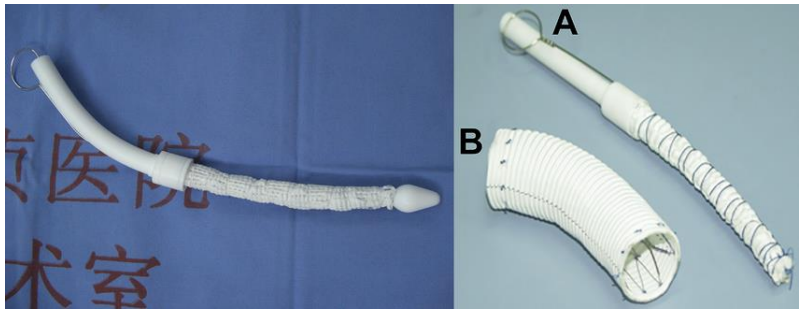
Advantages:

- Sealing of the descending aorta, allowing single staged surgery
- Stent graft promote false lumen thrombosis and aortic remodelling
- “frozen” stent allows subsequent stenting procedure

EVIDENCE ON FET

Two commercially available FET system in HK

No current guideline for the FET use
- **Position statement available**

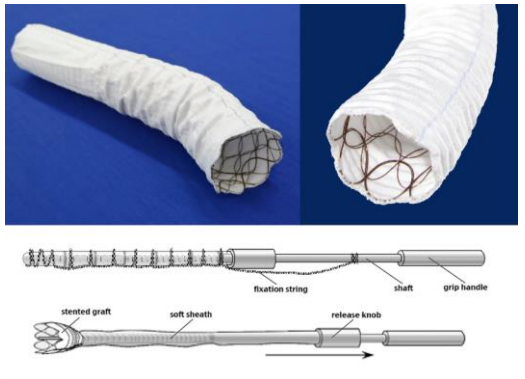


Cronus Stent graft

JOTEC E-VITA

Accumulating evidence
- Candian thoracic aortic collaborative (CTAC) investigators meta-analysis (2018) – FET favours vs cET in arch surgery
- All Literature Investigation of CV Evidence (2016) – FET acceptable in ATAD
- Kreibich (2017) – FET favourable alternative for complicated Type B without landing zone
- Hannover group

Thoraflex



J Graft

POSITION STATEMENT OF VASCULAR DOMAIN OF EACTS

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POSITION STATEMENT

Cite this article as: Shrestha M, Bachet J, Bavaria J, Carrel TP, De Paulis R, Di Bartolomeo R *et al.* Current status and recommendations for use of the frozen elephant trunk technique: a position paper by the Vascular Domain of EACTS. Eur J Cardiothorac Surg 2015;47:759–69.

REPORT

Current status and recommendations for use of the frozen elephant trunk technique: a position paper by the Vascular Domain of EACTS†

Malakh Shrestha[a], Jean Bachet[b], Joseph Bavaria[c], Thierry P. Carrel[d], Ruggero De Paulis[e], Roberto Di Bartolomeo[f], Christian D. Etz[g], Martin Grabenwöger[h], Michael Grimm[i], Axel Haverich[a], Heinz Jakob[j], Andreas Martens[a], Carlos A. Mestres[k,l], Davide Pacini[f], Tim Resch[m], Marc Schepens[n], Paul P. Urbanski[o] and Martin Czerny[p,q,*]

(i) The FET technique or an alternative method to close the primary entry tear should be considered in patients with acute type A aortic dissection with a primary entry in the distal aortic arch or in the proximal half of the descending aorta to treat associated malperfusion syndrome or to avoid its postoperative development. Class of recommendation IIa—Level of evidence C [23, 55]

(ii) The FET technique may be considered for use in patients undergoing surgery for acute type A aortic dissection to prevent mid-term aneurysmal formation in the downstream aorta. Class of recommendation IIb—Level of evidence C [19, 47–49]

(iii) The FET technique should be considered in patients with complicated acute type B aortic dissection when primary TEVAR is not feasible or the risk of retrograde type A aortic dissection is high. Class of recommendation IIa—Level of evidence C [50]

(iv) The FET technique should be considered in patients with extensive thoracic or thoraco-abdominal aortic disease when a second procedure, either open surgical or endovascular in downstream aortic segments, can be anticipated. Class of recommendation IIa—Level of evidence C [42, 64]

TAAD with tear at distal arch
Or Distal Mal-perfusion

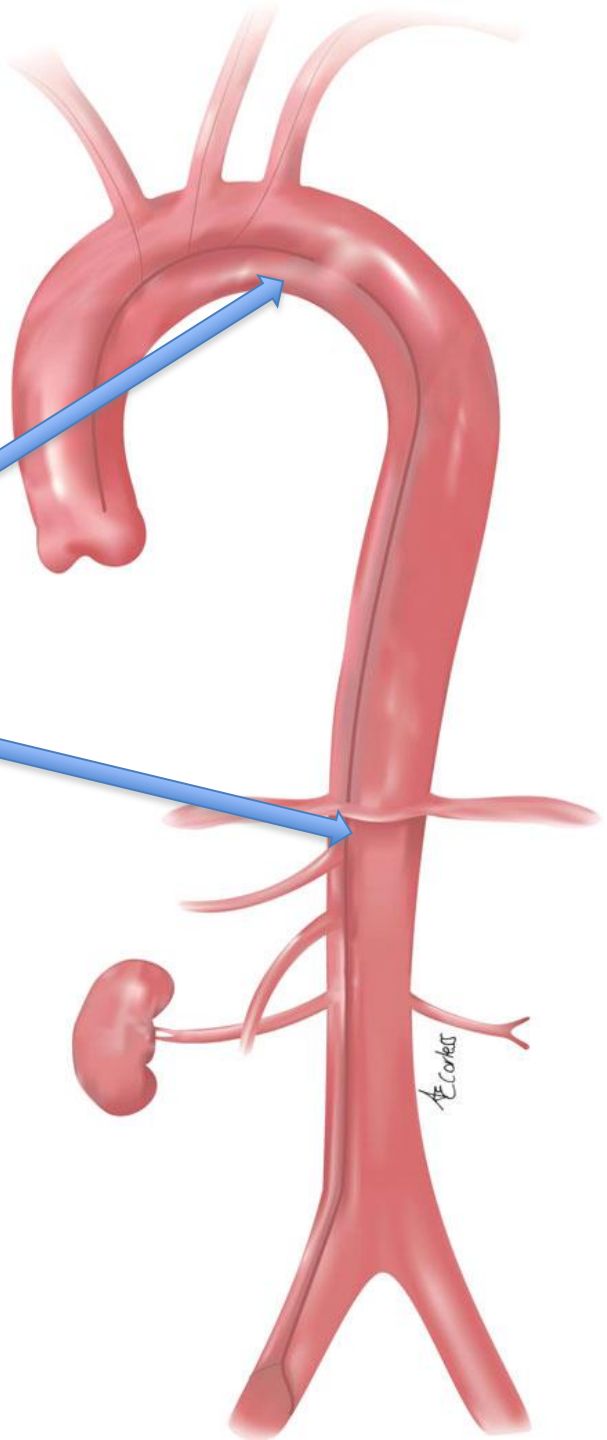
TAAD patients to prevent mid term aneurysmal change

TBAD without good Landing zone or high risk of RTAD

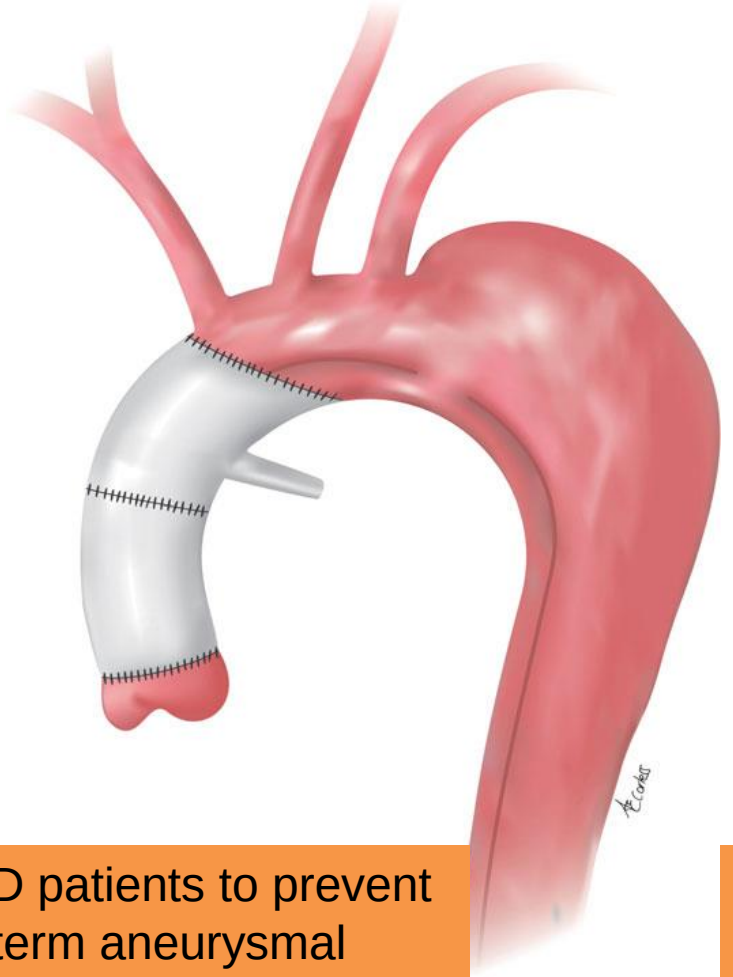
Extensive pathology Involving multiple Segments of aorta

INDICATIONS

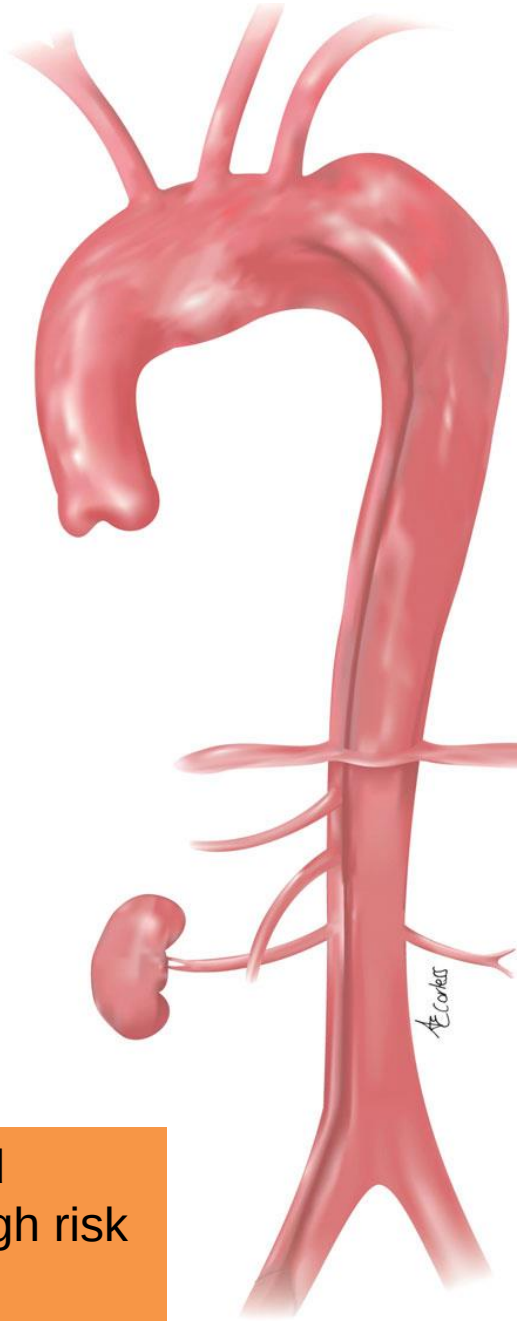
TAAD with tear at distal arch
Or Distal Mal-perfusion



INDICATIONS



TAAD patients to prevent mid term aneurysmal change



TBAD without good Landing zone or high risk of RTAD

INDICATIONS

Extensive pathology
Involving multiple
Segments of aorta

PWH: INDICATIONS OF TAR+FET

Acute

- Type A Dissection / DeBakey Type I dissection / IMH
  - Intimal tear in *distal* arch or *proximal* descending
  - PAU in *distal* arch or *proximal* descending
  - "Small"/ "Slit-like" true lumen in descending (Pseudo-Coarctation)
- Complicated Type B dissection with aneurysmal arch/ascending

Chronic

- Aortic aneurysm involving ascending, arch and descending
- Chronic dissection involving ascending, arch and descending

PWH EXPERIENCE

- Retrospective review of prospectively collected data
  - August 2014 to April 2020
  - 41 patients with Thoraflex™ Hybrid device implantation at PWH Hospital
    - Patients demographics
    - Intra-operative parameters
    - Post-operative clinical and radiological outcomes were collected and analyzed

PWH EXPERIENCE - DEMOGRAPHICS

Table 1 Preoperative characteristics	
Demographics	n=41
Age, yr; mean ± SD	60 ± 11
Male, n (%)	34 (83%)
Aortic disease	
Acute Type A aortic dissection/ intramural hematoma, n (%)	15 (36.6%)
Debakey Type 1 aortic dissection	13 (31.7%)
Acute complicated Type B Aortic dissection	3 (7.3%)
Thoracic aortic aneurysms, n (%)	9 (22%)
Chronic aortic dissections, both Type A and B, n (%)	13 (31.7%)
Coarctation of aorta with aortic regurgitation	1(2.7%)
Previous surgery	
Ascending aortic replacement	6(14.6%)
Presentation	
Acute chest pain, n (%)	10 (24.4%)
Chronic back pain, n (%)	7 (17%)
Incidental findings	2 (4.9%)
Malperfusion syndrome^, n (%)	8 (19.5%)
Radiological progression, n (%)	14 (34.1%)

PWH EXPERIENCE - OPERATIVE DATA

Table 2 Operative data	
Variables	n=41
Operative time (min)	417±121
Cardiopulmonary bypass time (min)	251±77
Aortic cross-clamp time (min)	147±40
Moderate hypothermic circulatory arrest time (min)	89±28
Antegrade cerebral perfusion time (min)	154±43
Intraoperative blood products	
Packed red blood cells (units)	4±4
Platelet concentrate (units)	9±4
Plasma (units)	7±4
Cyroprecipitate (units)	8±4
Operative priority	
Emergency, n (%)	16 (39%)
Elective, n (%)	25 (61%)
Concomitant procedures	10 (24%)
AVR*	3
Bentall procedure	1
CABG*	6
TEVAR	1
Postoperative ECMO	1

PWH EXPERIENCE - POSTOPERATIVE DATA

Mortality

Stroke/ Spinal cord injury

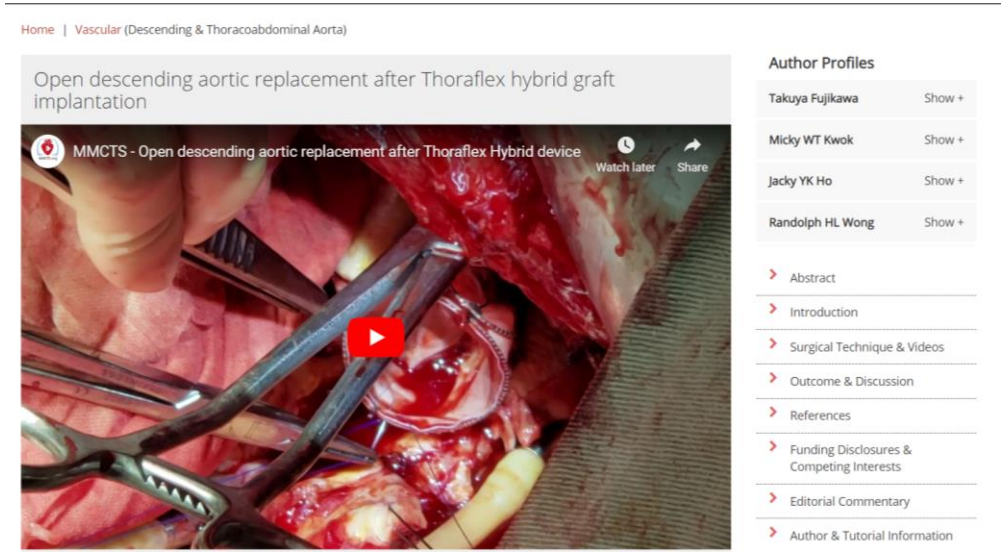
Mortality after discharge mean follow up of 3.3 years

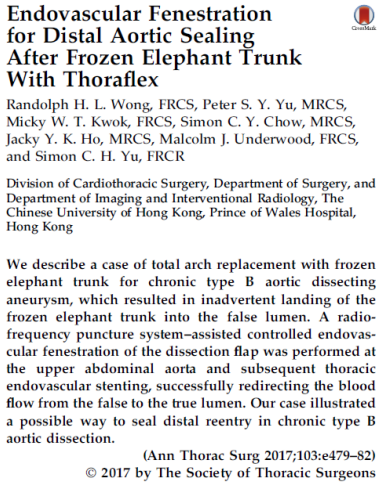
Table 3 Postoperative data, complications and mortality	
Variables	PWH Cohort (n=41)
Inhospital mortality, n (%)	4 (9.8%)
Intraoperative mortality, n (%)	1 (2.4%)
Emergency surgery mortality	2/16 (12.5%)
Type A Aortic dissection mortality	1/15 (6.7%)
Elective surgery mortality	2/25 (8%)
Overall post discharge survival *	36/37 (97%)
Intensive care unit stay (days)	4±5
Resternotomy for hemostasis	2 (4.9%)
Stroke	2 (4.9%)
Spinal cord injury	
Permanent	1 (2.4%)
Transient	1 (2.4%)
Vocal cord paralysis, n (%)	3 (7.3%)
Stent mal-deployment	1 (2.4%)
Sternal wound infection	2 (4.9%)

SECOND STAGE OPERATION AND OUTCOME

- Second stage operation happened in 1/3 of patients
- Experience in both open and endovascular techniques

Table 4 Second stage operation data and mortality	
Second stage operation	12/37 (32.4%)
Open descending replacement^	4/37 (10.8%)
TEVAR	9/37 (24.3%)
Distal SINE and Type Ib endoleak	7/37 (19%)
Overall mortality of second stage operation#	1/12 (8.3%)





Endovascular Fenestration for Distal Aortic Sealing After Frozen Elephant Trunk With Thoraflex

Randolph H. L. Wong, FRCS, Peter S. Y. Yu, MRCS, Micky W. T. Kwok, FRCS, Simon C. Y. Chow, MRCS, Jacky Y. K. Ho, MRCS, Malcolm J. Underwood, FRCS, and Simon C. H. Yu, FRCR

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We describe a case of total arch replacement with frozen elephant trunk for chronic type B aortic dissecting aneurysm, which resulted in inadvertent landing of the frozen elephant trunk into the false lumen. A radiofrequency puncture system–assisted controlled endovascular fenestration of the dissection flap was performed at the upper abdominal aorta and subsequent thoracic endovascular stenting, successfully redirecting the blood flow from the false to the true lumen. Our case illustrated a possible way to seal distal reentry in chronic type B aortic dissection.

(Ann Thorac Surg 2017;103:e479–82)

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SURGICAL TECHNIQUE

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Open descending aortic replacement after Thoraflex™ hybrid graft implantation

Takuya Fujikawa[a], Jacky Y.K. Ho[a], Henry M.K. Wong[b] and Randolph H.L. Wong[a,*]

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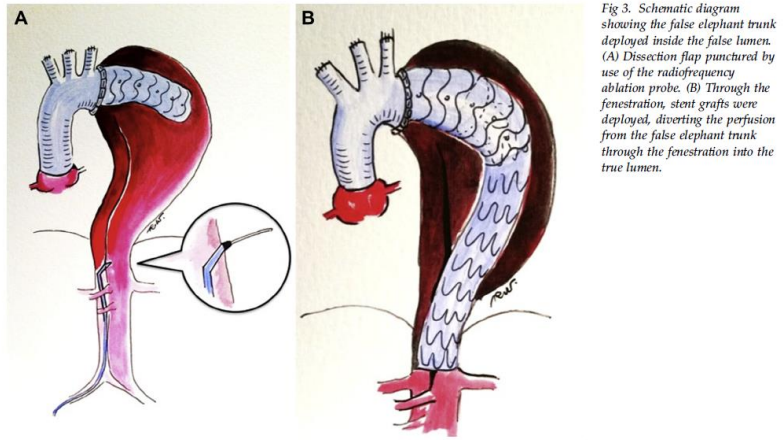


Fig 3. Schematic diagram showing the false elephant trunk deployed inside the false lumen. (A) Dissection flap punctured by use of the radiofrequency ablation probe. (B) Through the fenestration, stent grafts were deployed, diverting the perfusion from the false elephant trunk through the fenestration into the true lumen.

DISCUSSION

Mid-term outcome from our institute was acceptable with overall mortality of 9.7%

- ATAAD mortality of 13.3% with > 50% with malperfusion on presentation

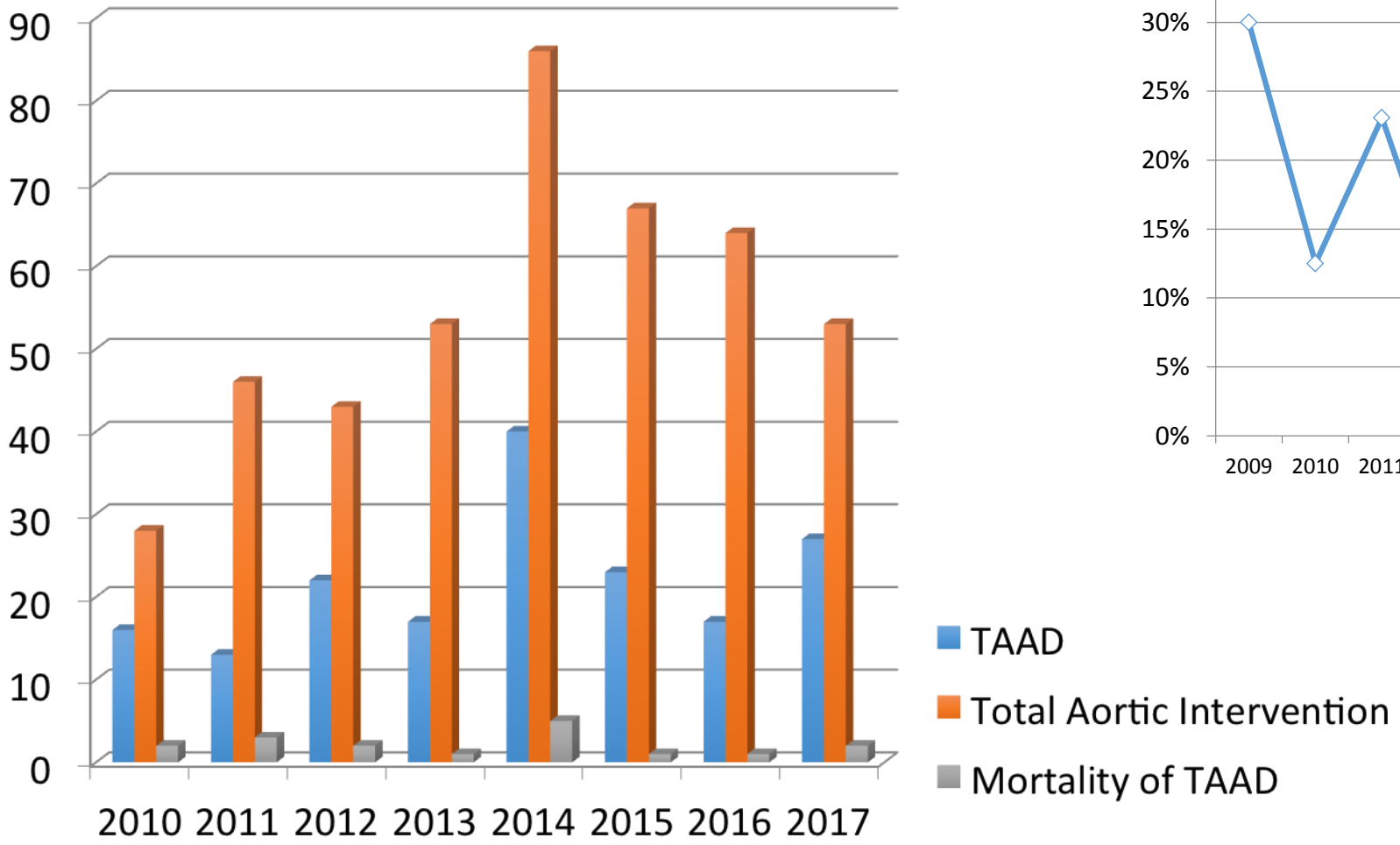
Second stage procedure is not uncommon (30%) and dSINE was noted in 20% of patients

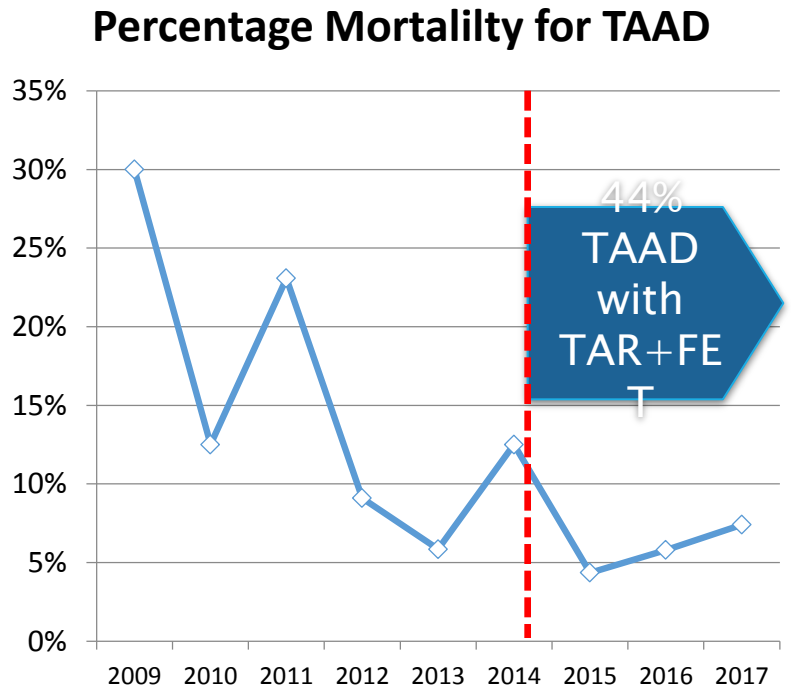
- Mechanism needs to be further delineated
- Outcome for second stage procedure is acceptable 8% (1/12) mortality

- Extending experience of TAR + FET
  1. Endovascular salvage of mal-deployment
  2. TEVAR salvage for TAR + FET that was done in China
  3. Coaractation of aorta as an indication of TAR+FET with concomitant AVR and CABG
  4. Open replacement of descending post FET

PWH:TAAD OPERATIVE MORTALITY

Total 440 cases of Thoracic Aortic Interventions in 2010-2017





CONCLUSION

Total arch replacement with FET is a safe and effective in complex aortic pathologies

Both endovascular and open second stage procedures are possible and with acceptable post-discharge survival

- Surveillance is crucial

Further study is warranted to evaluate its impact on survival and disease progression in descending thoracic aorta

- Particularly Distal SINE phenomenon

TEAM EFFORT TO ACHIEVE GOOD OUTCOME

Cardiothoracic Surgery team lead by **Dr Takuya Fujikawa and Dr Randolph Wong**

AORTIC MDT with radiologists and vascular surgeons

Perfusionist team

OT nurses

ICU colleagues

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