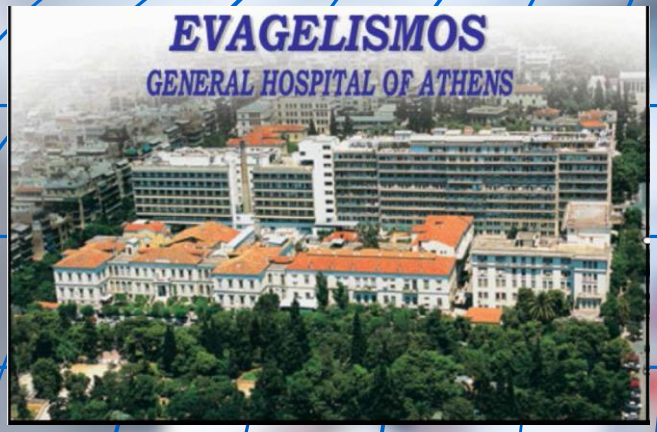
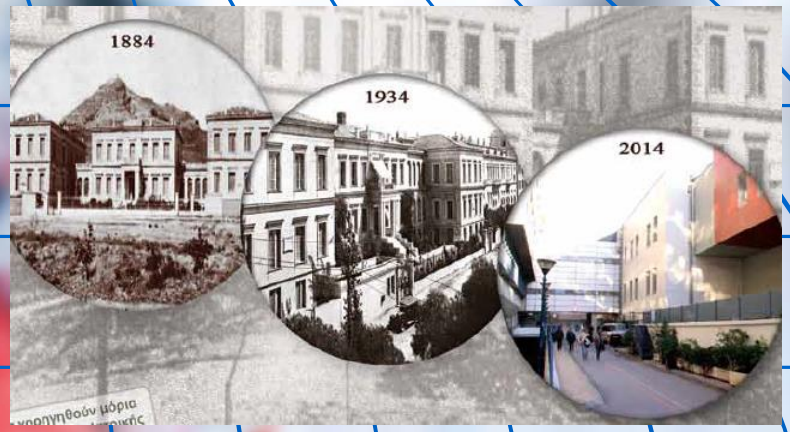




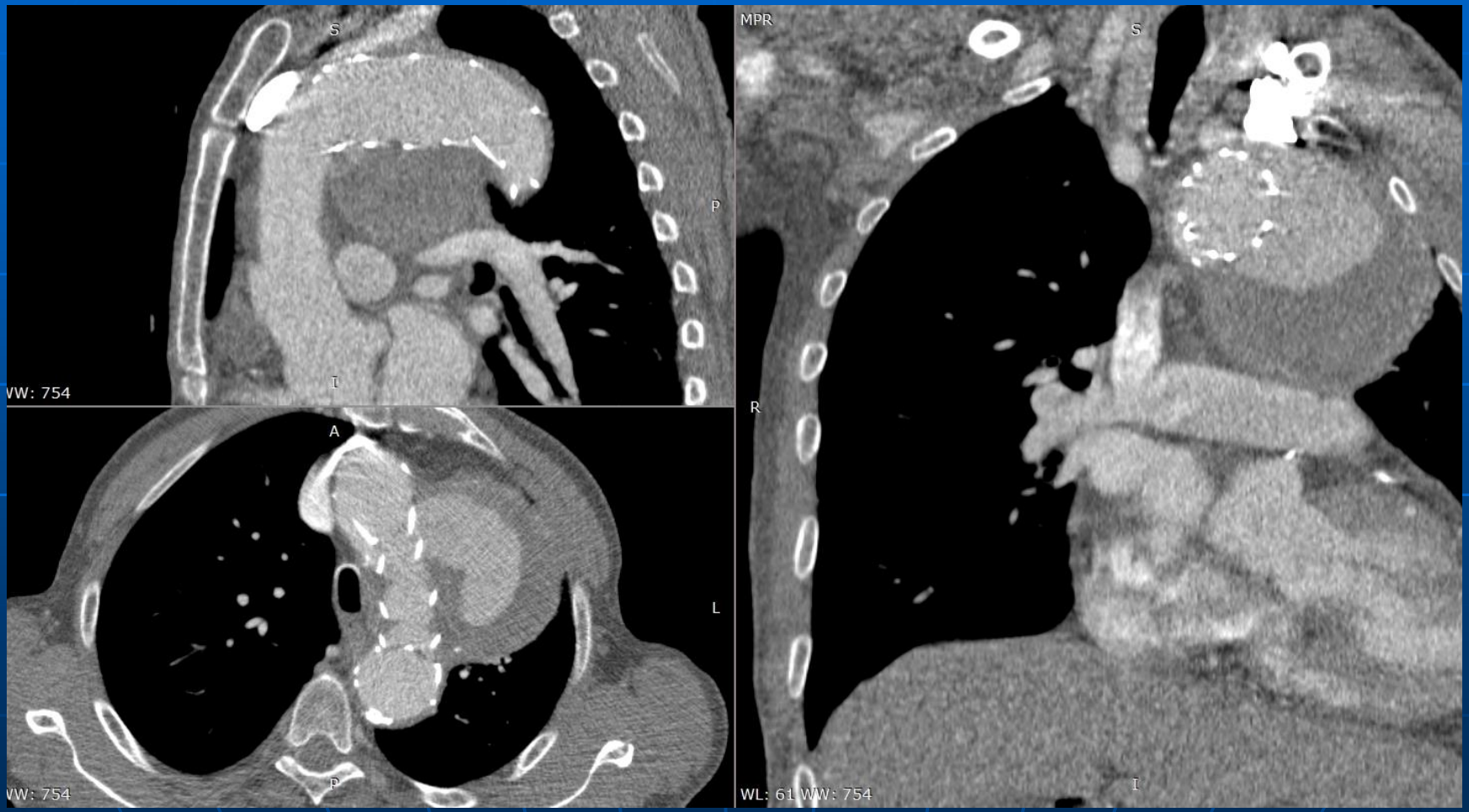
Υβριδική αντιμετώπιση Ραγέντος Ανευρύσματος Αορτικού Τόξου

Παναγιώτης Δεδεηλίας, MD, PhD, FECTS
Διευθυντής, Χειρ/κής κλινικής Καρδιάς, Θώρακος, Αγγείων
ΓΝΑ «Ο ΕΥΑΓΓΕΛΙΣΜΟΣ»

Παρουσίαση περίπτωσης

- 72 ετών ασθενής που 2 χρόνια πριν είχε υποβληθεί σε ενδοαυλική θεραπεία του αρχικού τμήματος της θωρακικής αορτής και στον οποίο τοποθετήθηκε επιτυχώς ενδοαυλικό μόσχευμα (stent-graft)
- Μετά απο πρόσφατο τροχαίο ατύχημα εμφανίζει θωρακικό άλγος με προοδευτική επιδείνωση.

CT αγγειογραφία

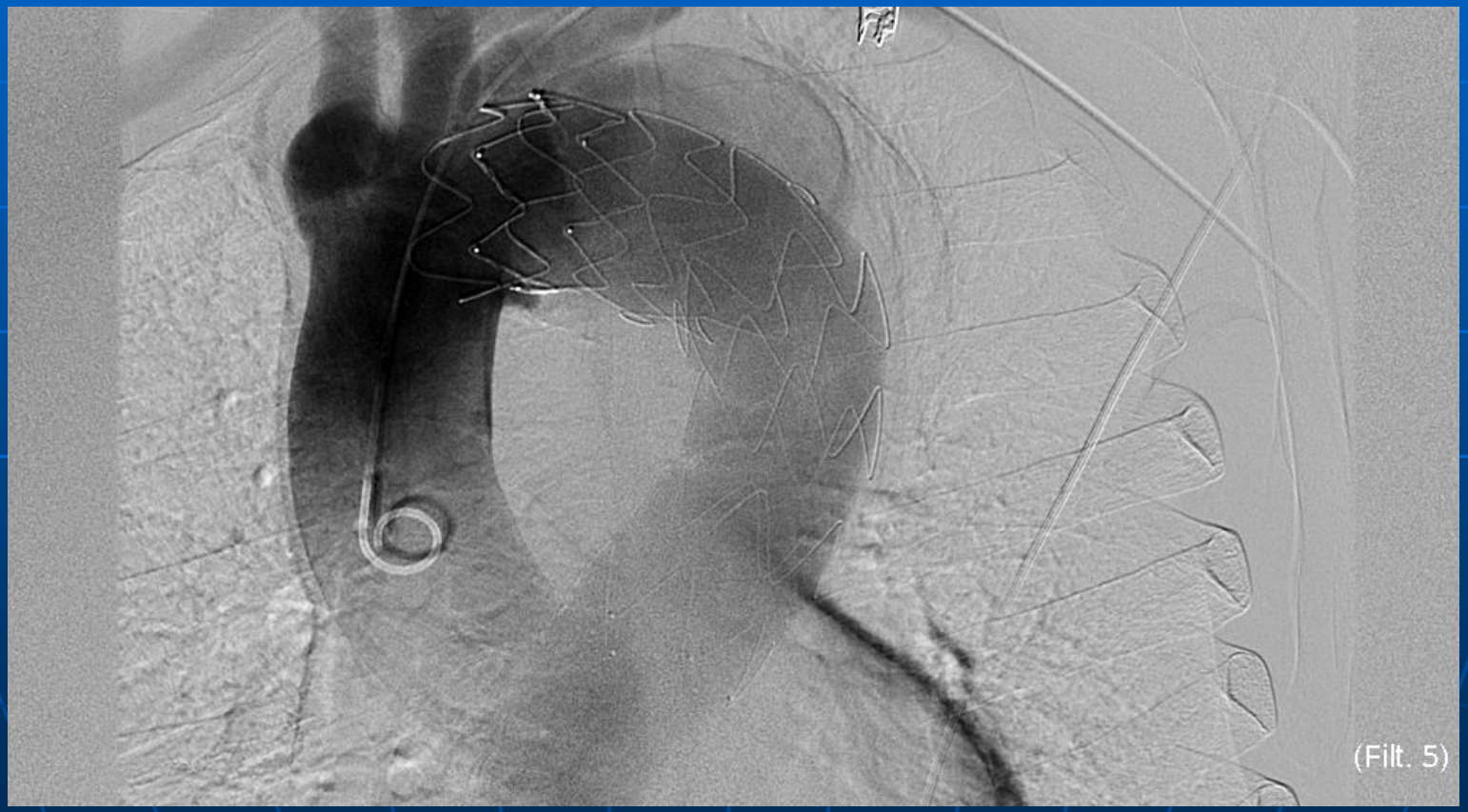


Αγγειογραφία-1

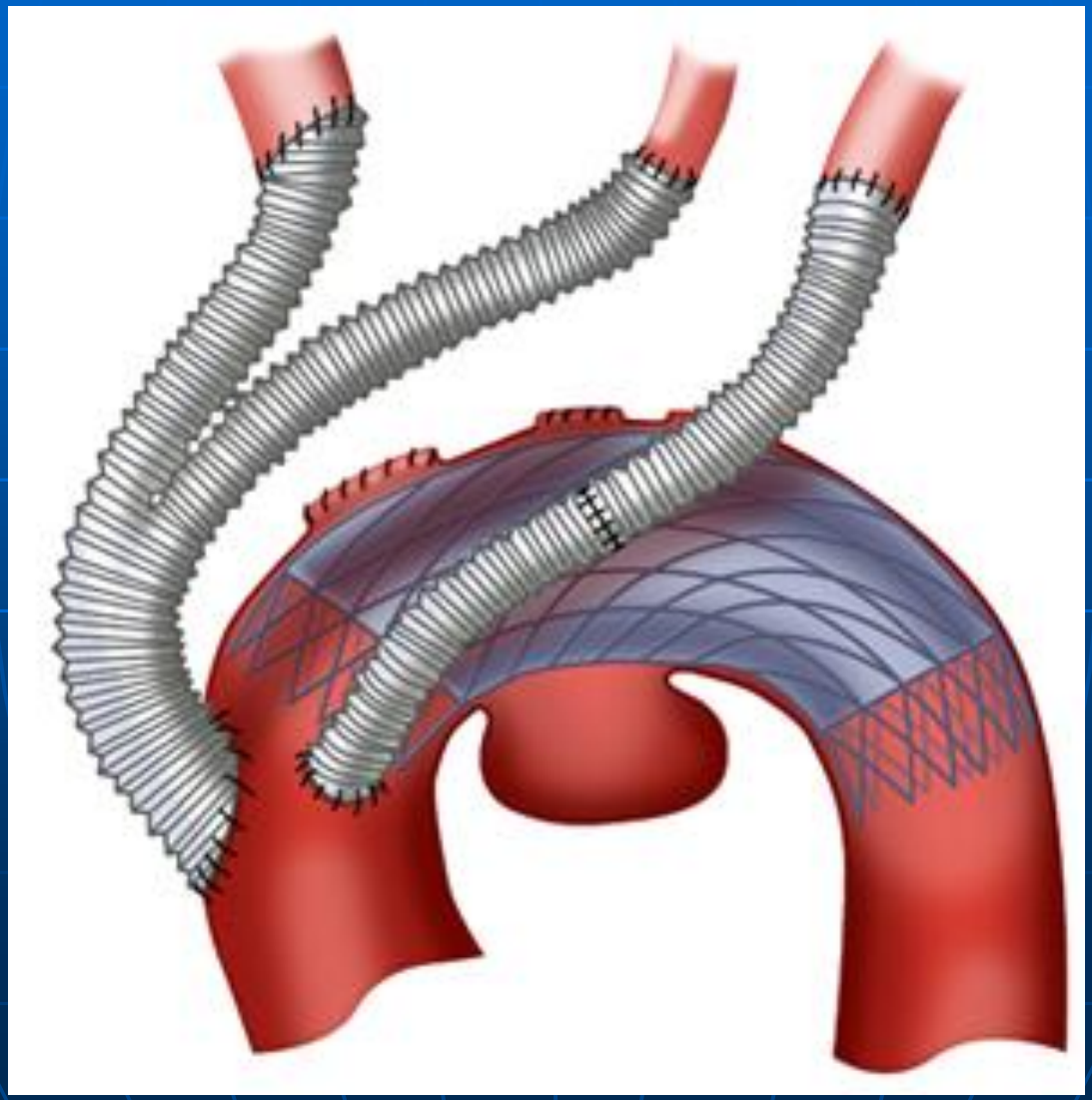
Ψευδοανεύρυσμα/ρήξη άπω τόξου

Σημείο ρήξης: έκφυση αρ. καρωτίδος

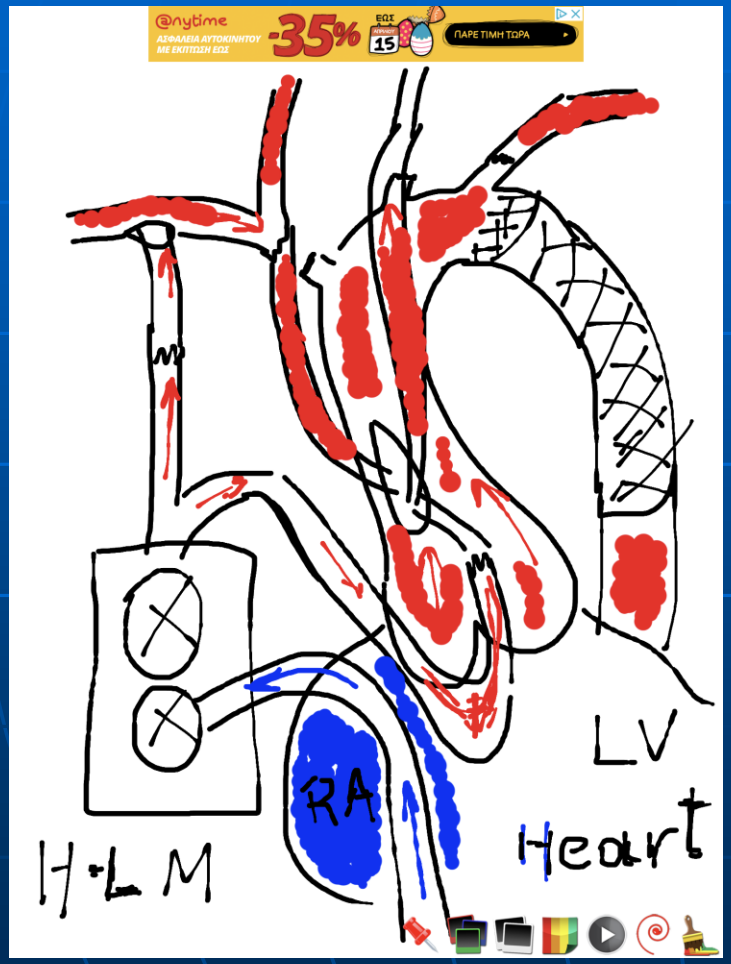
Αγγειογραφία-2

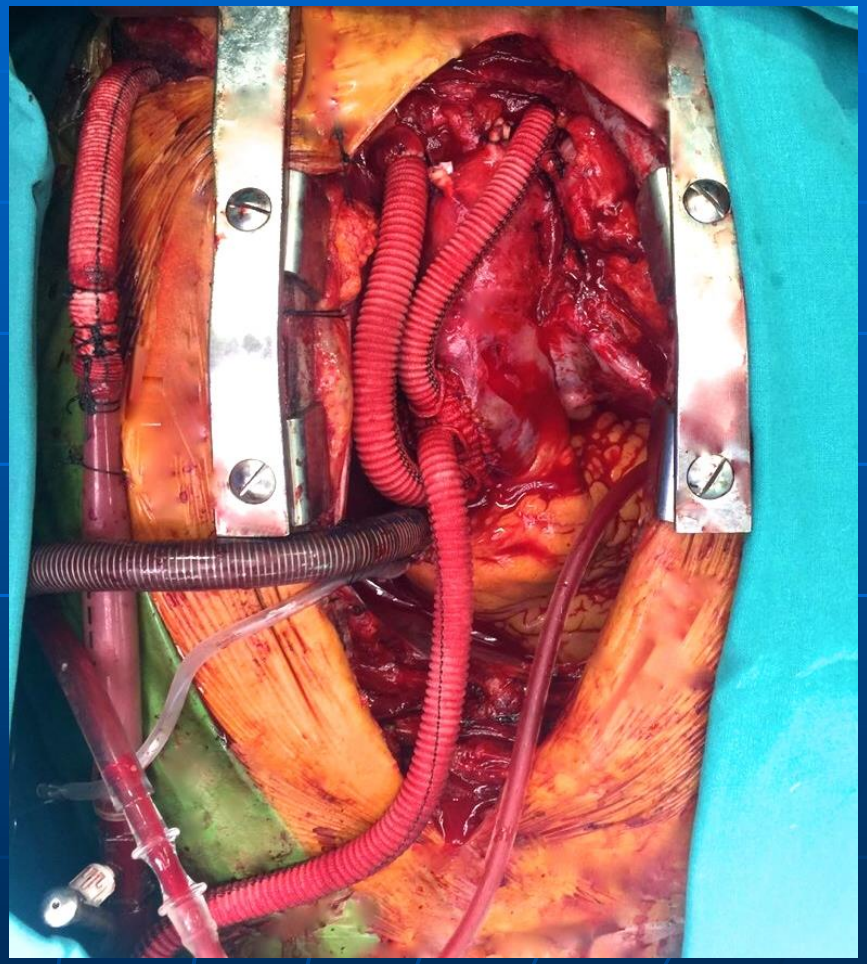


Υβριδική Αντικατάσταση Τόξου

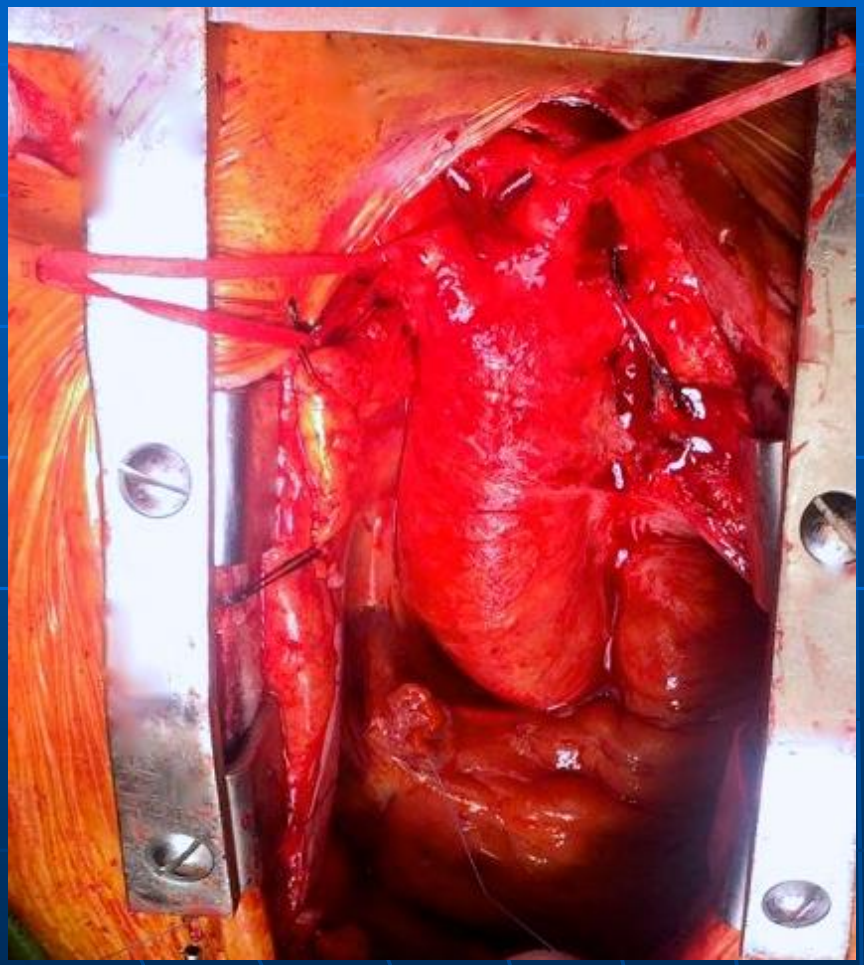


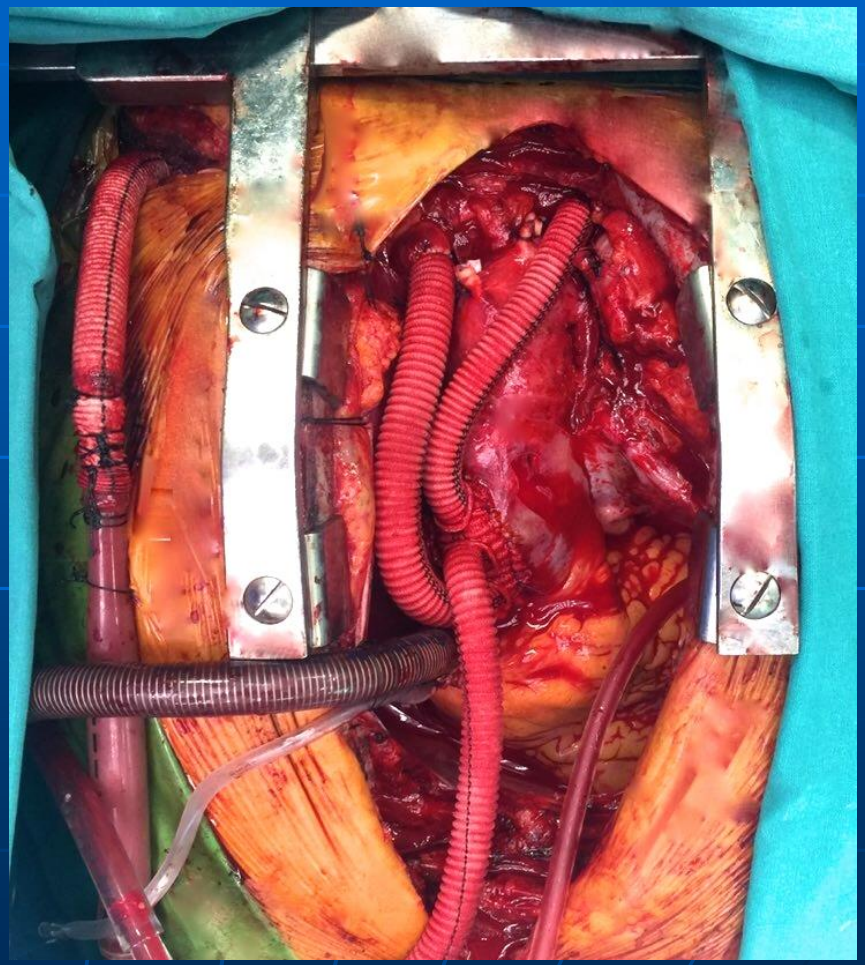
Κύκλωμα εξωσωματικής κυκλοφορίας



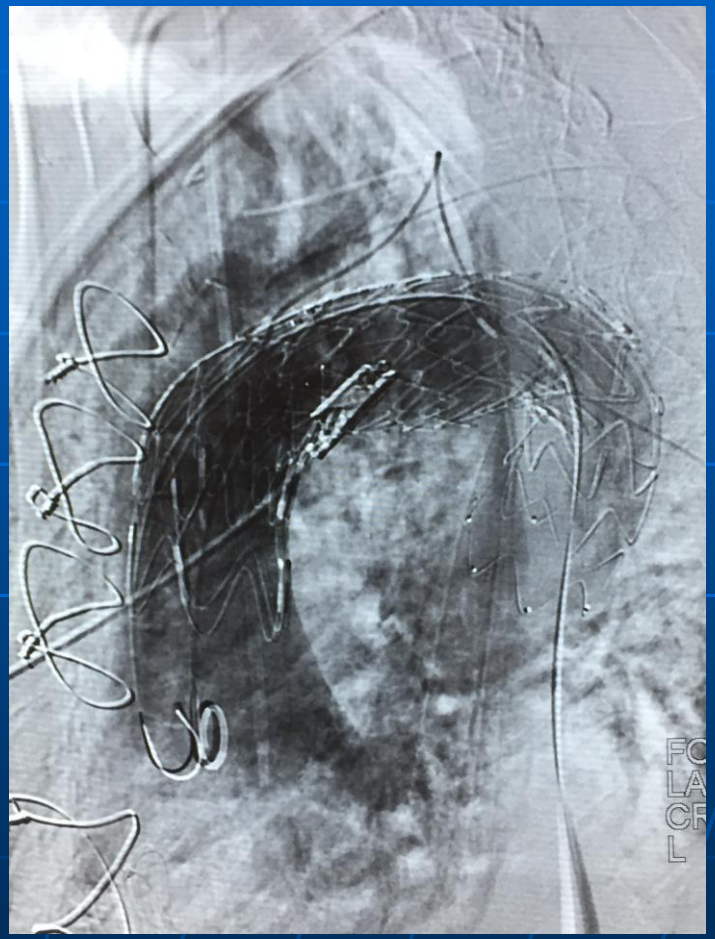


Διεγχειρητικές εικόνες υβριδικής αντικατάστασης αορτικού τόξου τύπου-Ι

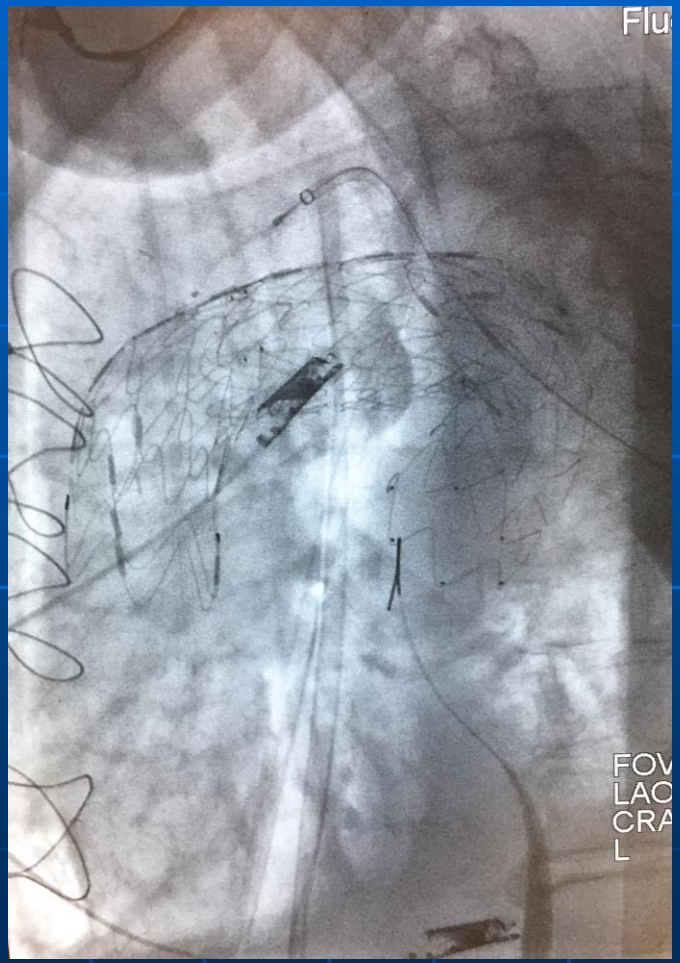




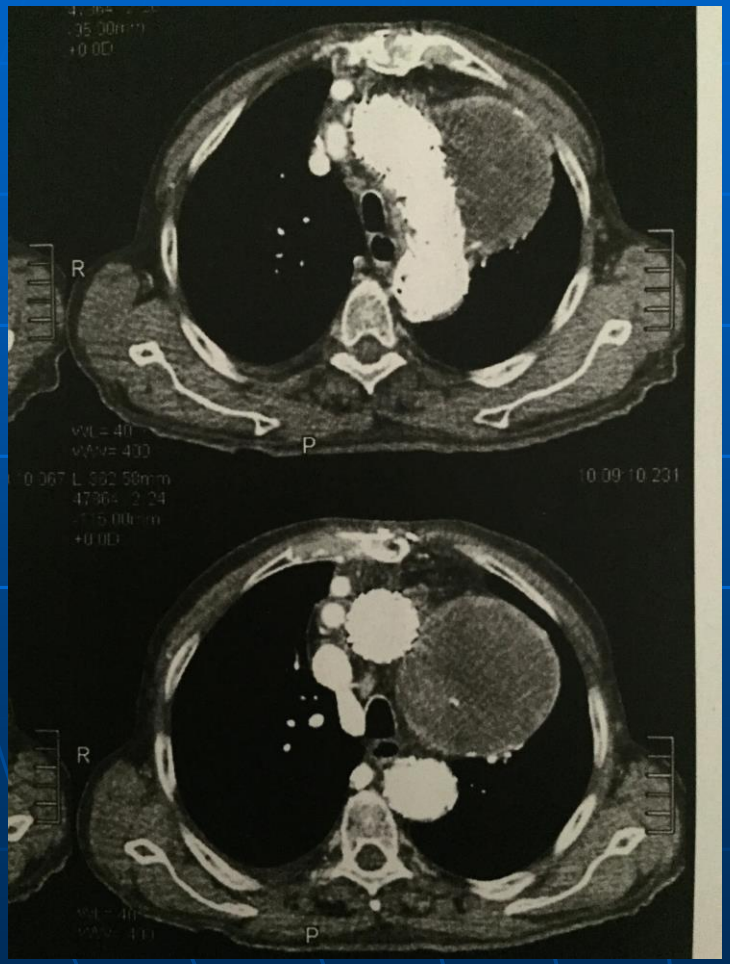
Μετεγχειρητική Αγγειογραφία και ενδοαυλική αντιμετώπιση ανιούσης αορτής και αορτικού τόξου.

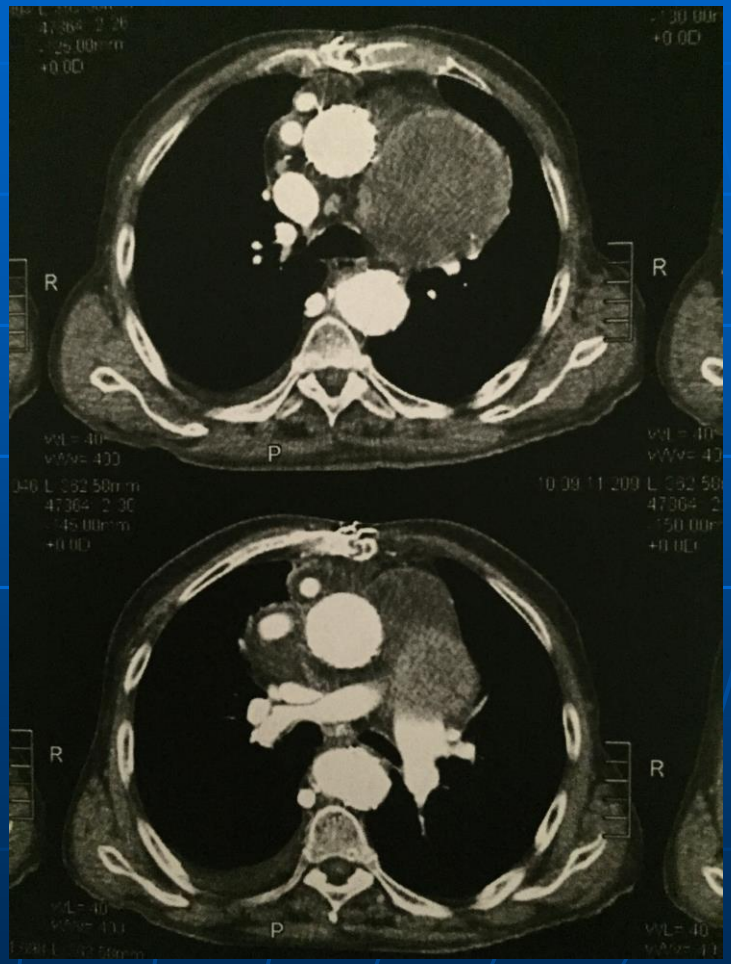


Διακαθετηριακός αποκλεισμός αριστερής υποκλειδίου αρτηρίας



Μετεγχειρητική CT αγειογραφία Υβριδικής αντικατάστασης αορτικού τόξου τύπου-Ι





3D ανασύσταση της υβριδικής τύπου-Ι αντμετώπισης

1η Ερώτηση

Για ποιόν λόγο χρησιμοποιήθηκε η εξωσωματική κυκλοφορία;

- α) Για καλύτερο έλεγχο των αναστομώσεων και καλύτερο χώρο πρόσφυσης του μοσχεύματος.
- β) Για την καλύτερη προστασία του εγκεφάλου
- γ) Για διατήρηση χαμηλότερης πίεσης
- δ) Για όλα τα ανωτέρω

Για ποιο λόγο προτιμήθηκε η εξωσωματική κυκλοφορία;

- Έλεγχος αρτηριακής πίεσης καθόλη τη διάρκεια της επέμβασης
- Αναστόμωση σε πολύ κεντρικό τμήμα της ανιούσας αορτής ώστε να δημιουργηθεί καλύτερη επιφάνεια πρόσφυσης στο μόσχευμα.
- Βελτιωμένη εγκεφαλοπροστασία (υψηλή ροή)
- Ευκολότερος μερικός αποκλεισμός αορτής
- Αποφυγή καρδιακής καταπόνησης(LVvent)

Ορισμός

- Υβριδική αντικατάσταση του αορτικού τόξου είναι ο συνδυασμός της ανοικτής χειρουργικής αντιμετώπισης ενός τμήματος της πάσχουσας αορτής και ταυτόχρονα η προετοιμασία για την ολοκλήρωση της υπόλοιπης παθολογίας ενδοαυλικά.
- 398 δημοσιεύσεις στο pubmed σχετικές με την υβριδική αντιμετώπιση του τόξου από το 2010-σήμερα
- 7 τράπεζες και ομιλίες γύρω από την υβριδική αντιμετώπιση του τόξου στο EACTS 2019

Εξέλιξη της χειρουργικής του τόξου

Conventional open total arch repair, "Elephant trunk", Borst 1983

- ✓CPB and DHCA
- ✓2-stage procedure
- ✓(7-17)% mortality rate
- ✓(4-12)% neurological injury rate
- ✓interval mortality
- ✓not all patients fit for open surgery

Endovascular repair, Volodos, 1991

- ✓but aortic arch anatomy?
- ✓adequate landing zone?

Hybrid approaches

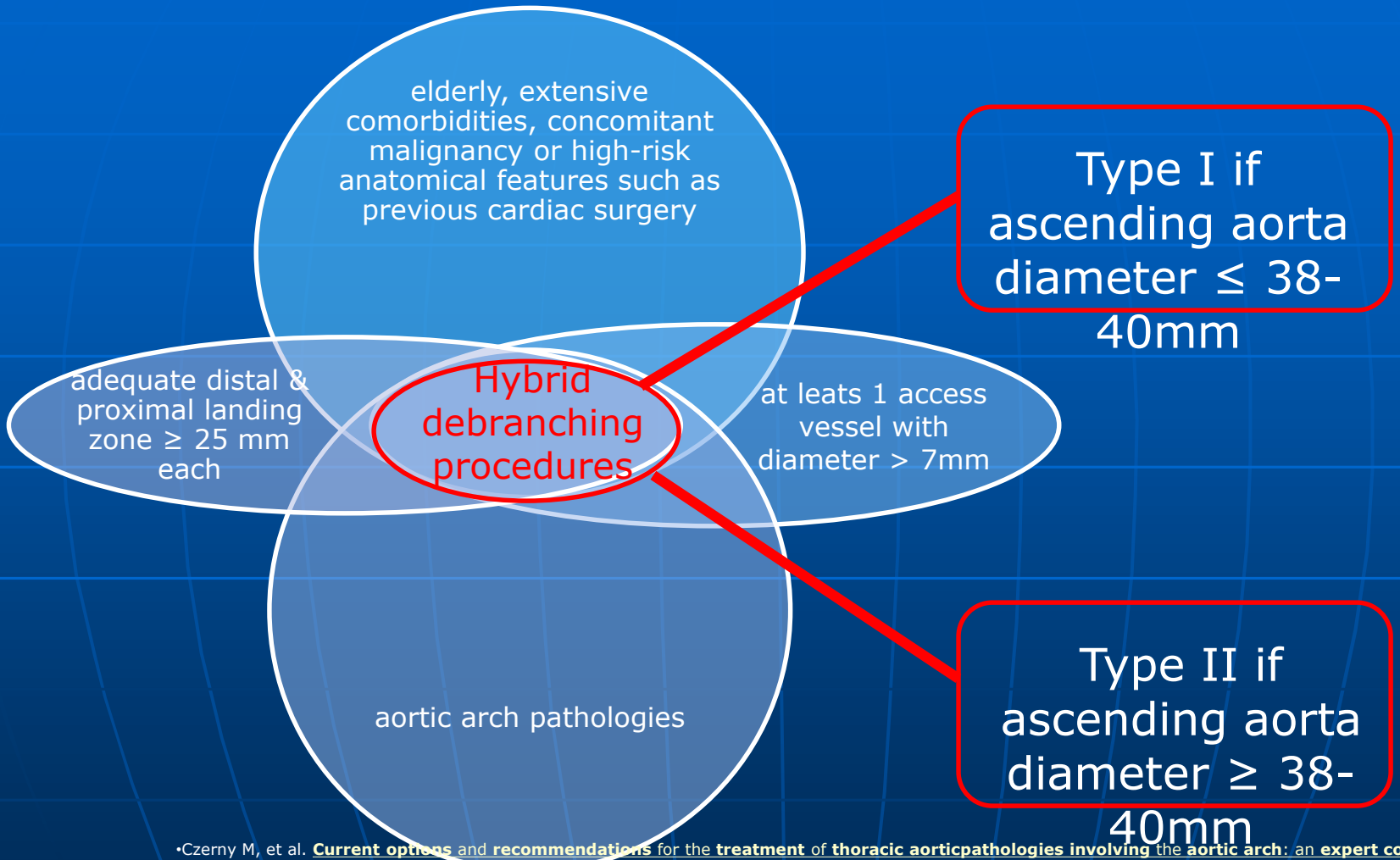
- ✓combination of tools
- ✓extend the envelope
- ✓high risk patients unfit for open repair
- ✓acceptable mortality and morbidity rates

•Younes HK[1], et al. Hybrid thoracic endovascular aortic repair: pushing the envelope. J Vasc Surg. 2010;51(1):259-66.
•Moulakakis KG, et al. A systematic review and meta-analysis of hybrid aortic arch replacement. Ann Cardiothorac Surg. 2013;2(3):247-60.
•Borst HG, et al. Extensive aortic replacement using "elephant trunk" prosthesis. Thorac Cardiovasc Surg 1983;31:37-40.
•Bavaria J, et al. Hybrid approaches in the treatment of aortic arch aneurysms: postoperative and midterm outcomes. J Thorac Cardiovasc Surg. 2013 Mar;145(3 Suppl):S85-90.
•Westaby S, et al. Arch and descending aortic aneurysms: influence of perfusion technique on neurological outcome. Eur J Cardiothorac Surg 1999;15:180–5.
•Papakonstantinou NA[1], et al. Cardiac surgery or interventional cardiology? Why not both? Let's go hybrid. J Cardiol. 2017;69(1):46-56.
•Oskowitz AZ[1], et al. Hybrid treatment of aortic arch aneurysms. J CardiovascSurg (Torino). 2015 Oct;56(5):719-28.
•Zerwes S, et al. Clinical outcomes in hybrid repair procedures for pathologies involving the aortic arch. Vascular. 2015 Feb;23(1):9-16.

Ενδείξεις υβριδικής αντιμετώπισης: Υψηλού κινδύνου ασθενείς με:

- Οξύ αορτικό σύνδρομο: Οξύς διαχωρισμός, Αθηρωματικό έλκος, Ενδαγγειακό αιμάτωμα, Ιατρογενής διαχωρισμός.
- Εκφυλιστικά ανευρύσματα
- Σύνδρομο μεγάλης αορτής
- Χειρουργική ανατομία «μη φιλική» για ανοικτή κλασσική θεραπεία

INDICATIONS-NECESSITIES



•Czerny M, et al. **Current options** and **recommendations** for the **treatment** of **thoracic aorticpathologies involving** the **aortic arch**: an **expert consensus document** of the**European Association** for **Cardio-Thoracic Surgery** (**EACTS**) and the **EuropeanSociety** for **Vascular Surgery** (**ESVS**). Eur J Cardiothorac Surg. 2019 Jan 1;55(1):133-162.

•Moulakakis KG, et al. A systematic review and meta-analysis of hybrid aortic arch replacement. Ann Cardiothorac Surg. 2013;2(3):247-60.

•Bavaria J, et al. Hybrid approaches in the treatment of aortic arch aneurysms: postoperative and midterm outcomes. J Thorac Cardiovasc Surg. 2013 Mar;145(3 Suppl):S85-90.

•Vallabhajosyula P[1], et al. Type I and Type II hybrid aortic arch replacement: postoperative and mid-term outcome analysis. Ann Cardiothorac Surg. 2013;2(3):280-7.

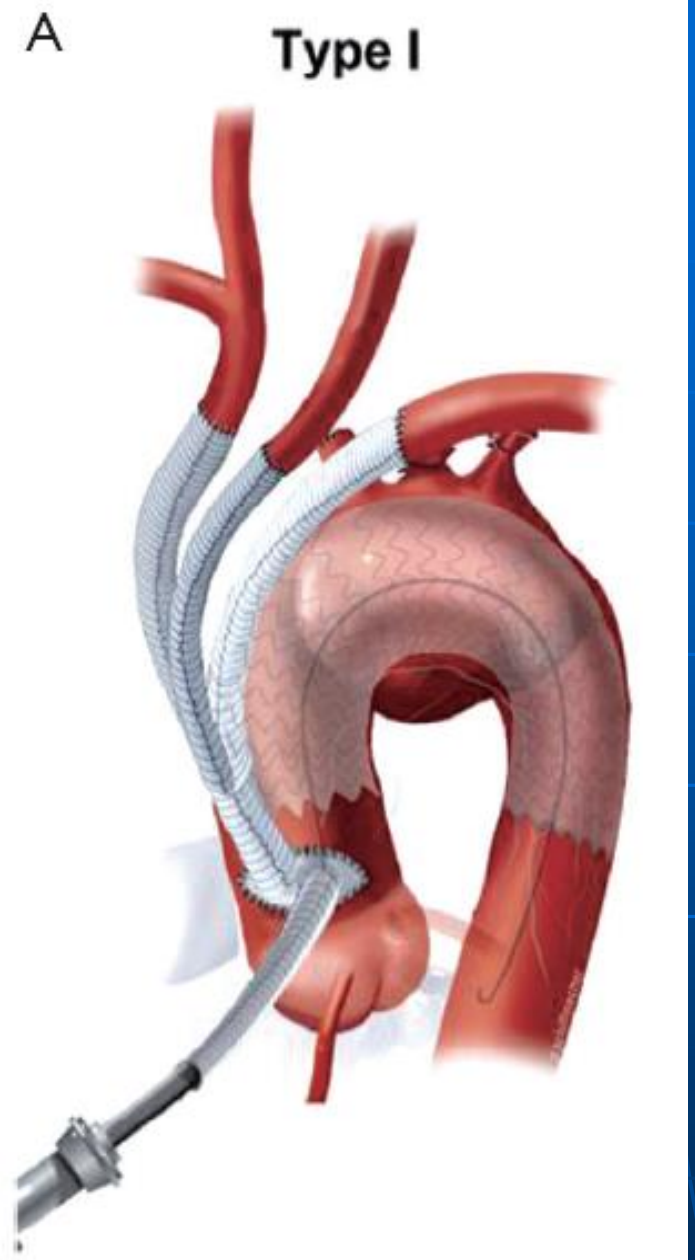
•Canaud L[1], et al. Hybrid Aortic Repair of Dissecting Aortic Arch Aneurysm after Surgical Treatment of Acute Type A Dissection. Ann Vasc Surg 2016;30:175-80.

•Shirakawa Y, et al. The efficacy and short-term results of hybrid thoracic endovascular repair into the ascending aorta for aortic arch pathologies. Eur J Cardiothorac Surg. 2014;45(2):298-304; discussion 304.

•Vallabhajosyula P, et al. Type II arch hybrid debranching procedure. Ann Cardiothorac Surg 2013;2(3):378-86.

•Brechtel K[1], et al. Hybrid debranching and TEVAR of the aortic arch off-pump, in re-do patients with complicated chronic type-A aortic dissections: a critical report. J Cardiothorac Surg 2013;8:188.

•Mizuno T[1], et al. Easy and Safe Total Debranching of Arch Aneurysms Using Axiloaxillary Arterial Bypass. Ann Thorac Surg. 2015;100(4):1476-8.

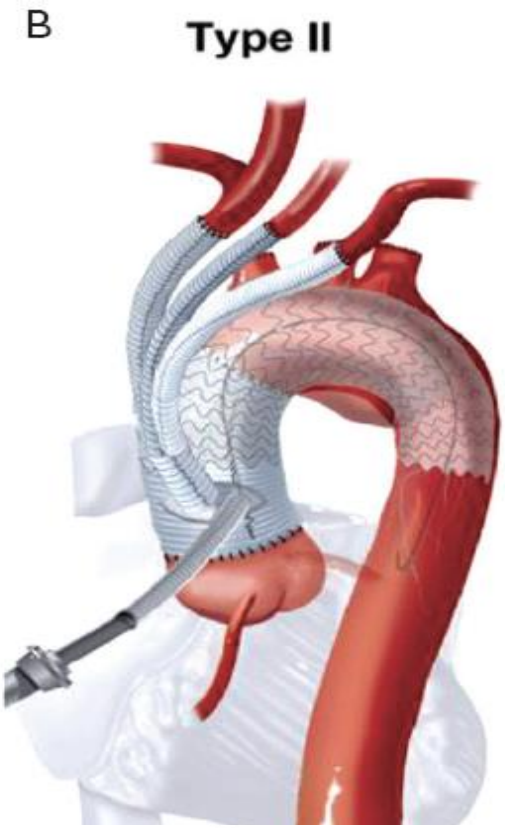


Hybrid arch procedures

Type I arch hybrid

Transposition of branches so that landing zone on Z0 of the aorta is available.

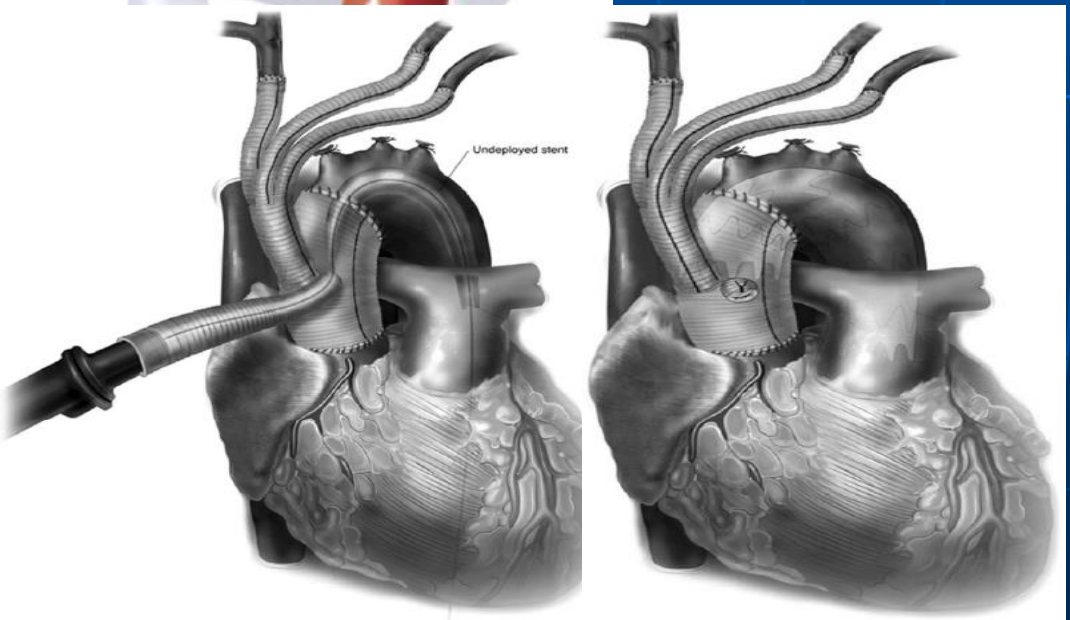
Followed by simultaneous or in second stage TEVAR



Hybrid arch procedures

Type II arch hybrid repair

1. The type II is recommended in Aortic aneurysms of ascending aorta and arch with acceptable Z3/Z4 and good peripheral LZ .
2. In this type replacement of ascending aorta in addition to transposition of the branches is required .
3. A short time of extracorporeal circulation is needed.



4. The fourth branch of the graft is used for the insertion of the stent-graft and is transfixed afterwards.

Hybrid arch procedures

Type III arch hybrid repair

More complex cases such as mega aorta syndrome or dissections with a lot of communications between true and false lumen require hybrid type III replacement .

In cases like this there is no acceptable proximal or distal LZ.

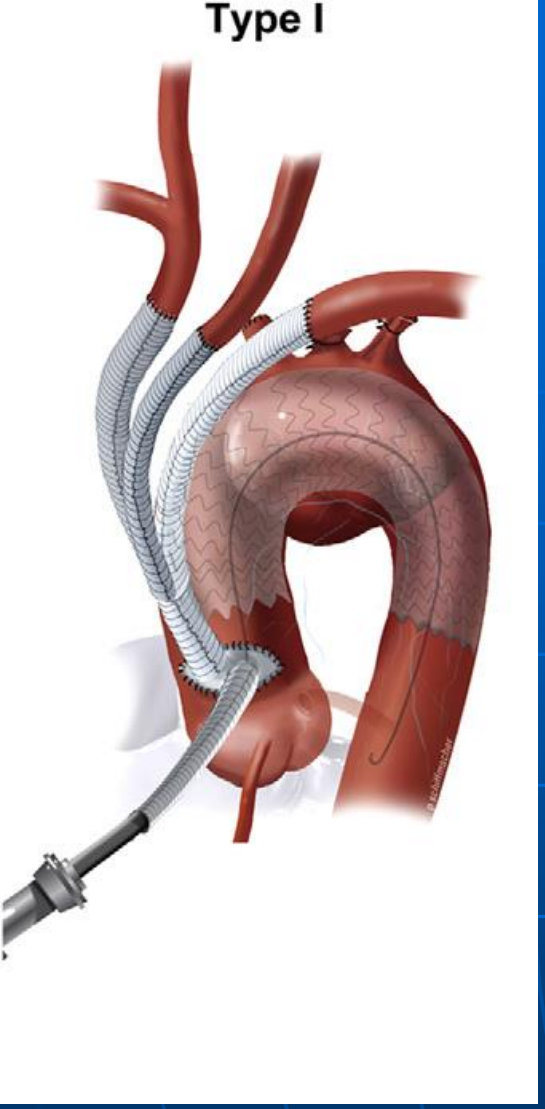
A total ascending aorta and arch replacement is needed : Elephant trunk or Frozen elephant trunk.

When extensive coverage of the descending aorta is to be performed CSF drainage should be provided.

2η Ερώτηση

Ποιά άλλη τεχνική μπορούσε να χρησιμοποιηθεί;

- α) Υβριδική τύπου ΙΙ
- β) Frozen elephant trunk (Υβριδική τύπου ΙΙΙ)
- γ) Συνέχιση ενδοαυλικής θεραπείας με Fenestrated graft.
- δ) Καμμία απο τις παραπάνω.



Pros

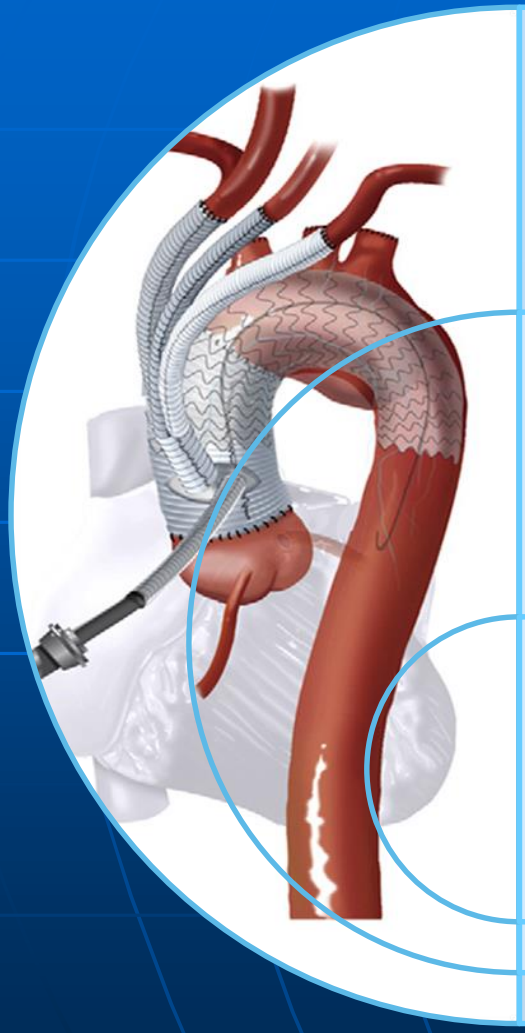
- no aortic cross clamping, no cardioplegia
- no DHCA
- no CPB

Cons

- retrograde aortic dissection possibility
- no concomitant cardiovascular procedures
- high endoleak rate
- neurologic complications, atheromatous or air embolism

•Younes HK[1], et al. Hybrid thoracic endovascular aortic repair: pushing the envelope. J Vasc Surg. 2010;51(1):259-66.
•Leacche M, et al. Surgical update: hybrid procedures, do they have a role? Circ Cardiovasc Interv. 2010;3(5):511-8.
•Bavaria J, et al. Hybrid approaches in the treatment of aortic arch aneurysms: postoperative and midterm outcomes. J Thorac Cardiovasc Surg. 2013 Mar;145(3 Suppl):S85-90.
•Faulds J, et al. Minimally Invasive Techniques for Total Aortic Arch Reconstruction. Methodist Debakey Cardiovasc J. 2016;12(1):41-4.
•Canaud L[1], et al. Hybrid Aortic Repair of Dissecting Aortic Arch Aneurysm after Surgical Treatment of Acute Type A Dissection. Ann Vasc Surg 2016;30:175-80.
•Kollias VD[1], et al. Single-stage, off-pump hybrid repair of extensive aneurysms of the aortic arch and the descending thoracic aorta. Hellenic J Cardiol 2014;55(5):355-60.

Type II Hybrid advantages



risks of retrograde type A dissection and endoleak are eliminated

less invasive than total open arch replacement

less bleeding

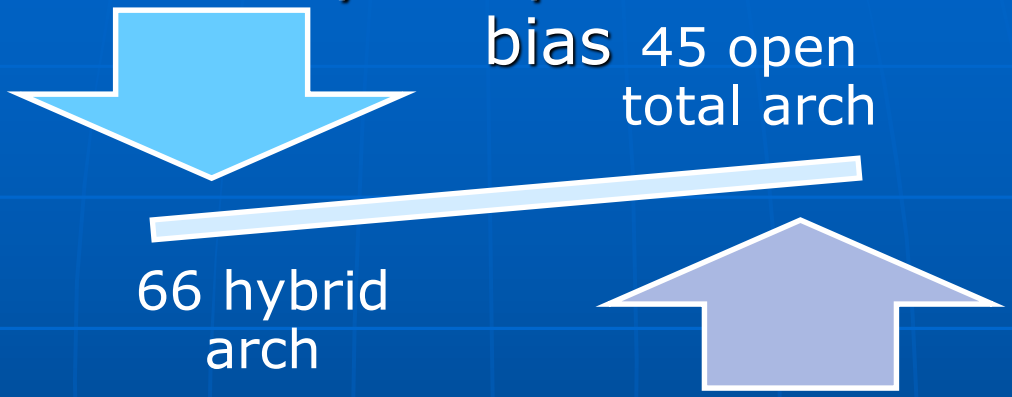
•Kollias VD[1], et al. Single-stage, off-pump hybrid repair of extensive aneurysms of the aortic arch and the descending thoracic aorta. Hellenic J Cardiol 2014;55(5):355-60.

•nt WD[1], et al. Results of type II hybrid arch repair with zone 0 stent graft deployment for complexaortic arch pathology. J Thorac Cardiovasc Surg 2014;148(6):2951-5.

Ke

OPEN TOTAL AORTIC ARCH REPAIR vs HYBRID APPROACH

Cannot be directly compared due to selection bias



- ✓no significant difference in in-hospital mortality (16% open vs 11% hybrid)
- ✓no significant difference in transient neurologic complications (11% both)
- ✓no significant difference in permanent neurologic complications (9% open vs 13% hybrid)

- ✓9% mortality in patient<75 y.o. whereas 36% mortality in patients>75y.o.
- ✓no significant difference in hybrid group
- ✓when >75y.o. 11% mortality in hybrid group vs 36% mortality in open group

Milewski RK, et al. Have hybrid procedures replaced open aortic arch reconstruction in high-risk patients? A comparative study of elective open arch debranching with endovascular stent graft placement and conventional elective open total and distal aortic arch reconstruction. J Thorac Cardiovasc Surg 2010;140:590-7.

Interactive CardioVascular and Thoracic Surgery (2019) 1–8
doi:10.1093/icvts/ivz027

ORIGINAL ARTICLE

Cite this article as: Seike Y, Matsuda H, Fukuda T, Hori Y, Inoue Y, Omura A *et al.* Is debranching thoracic endovascular aortic repair acceptable as the first choice for arch aneurysm in the elderly? Interact CardioVasc Thorac Surg 2019; doi:10.1093/icvts/ivz027.

Is debranching thoracic endovascular aortic repair acceptable as the
Interactive CardioVascular and Thoracic Surgery (2019) 1–8
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Is debranching thoracic endovascular aortic repair acceptable as the first choice for arch aneurysm in the elderly?†

Yoshimas kuda[b], Yo ura[a], Sasaki[a] ar

[a] Department of Car r Center, Osak
[b] Department of Rad ka, Japan

* Corresponding autl bral and Card 5, Japan.
Tel: +81-6-6833501 l. Matsuda).

Key question

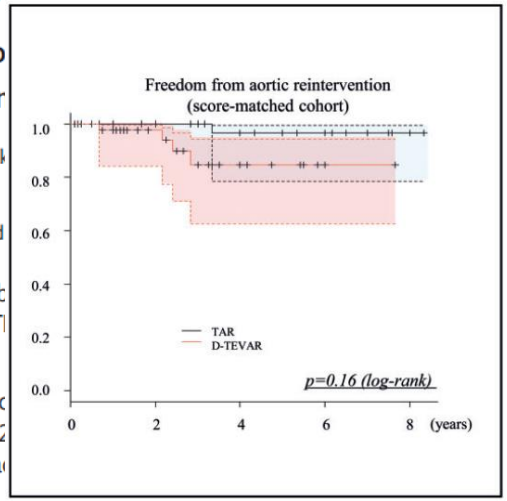
Is debranching thoracic endovascular aortic repair (d-TEVAR) acceptable as the first choice for aortic arch aneurysm in the elderly (>75 years old)?

Key finding(s)

Propensity score matching yielded similar rates of survival (85% in TAR vs 71% in d-TEVAR) and of freedom from reintervention (97% vs 90%) at 4 years.

Take-home message

d-TEVAR is acceptable as the first choice of procedure for repair of aortic arch aneurysm in the elderly (>75 years old).



OBJECTIVES: This outcomes b nching tho-racic endovascula idity of d-T arch aneu-rysm in the elderly

METHODS: We r ad undergc 21 patients who had undergc) between 2 group were matched based or atient chara

RESULTS: Rates of freedom from all-cause mortality at 2 and 4 years were similar between the 2 groups (88% and 77% in the TAR group vs 82% and 64% in the d-TEVAR group, $P = 0.11$), but rates of freedom from reintervention at 2 and 4 years were significantly higher in the TAR group (100% and 96%) than in the d-TEVAR group (97% and 88%) ($P = 0.004$). Propensity score matching yielded similar survival rates of 88% and 85% for TAR vs 86% and 71% for d-TEVAR ($P = 0.53$) and comparable freedom from reintervention rates (100% and 97% in TAR, 98% and 90% in d-TEVAR, $P = 0.16$) at 2 and 4 years. Cox regression analysis identified previous cerebral infarction [hazard ratio (HR) 3.9; $P = 0.005$ in TAR/HR 3.1; $P = 0.002$ in d-TEVAR] as an independent positive predictor of overall mortality in both groups.

CONCLUSIONS: Midterm outcomes after TAR and d-TEVAR were satisfactory and propensity score matching-based evaluation revealed no significant differences in outcomes, implying that d-TEVAR is an acceptable first-choice procedure for aortic arch aneurysm in patients older than 75 years.

Keywords: Elderly • Aortic arch aneurysm • Total arch replacement • Debranching thoracic endovascular aortic repair • Propensity score matching

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doi:10.1016/j.jacc.2010.02.015

PRACTICE GUIDELINE: FULL TEXT

2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM Guidelines for the Diagnosis and Management of Patients With Thoracic Aortic Disease

9.2.2.2.1. Open Surgery. At present, endovascular stent grafts have not been approved by the US Food and Drug Administration for treatment of aneurysms or other conditions of the aortic arch. For patients with large aneurysms who are not candidates for conventional open operation, experience is accumulating with operative procedures that involve translocation of the brachiocephalic arteries from the aortic arch using branch grafts from the proximal ascending aorta, and placement of an endovascular graft into the distal ascending aorta, the entire aortic arch, and a segment of the adjacent descending thoracic aorta (371,460,461).

European Heart Journal (2014) **35**, 2873–2926
doi:10.1093/eurheartj/ehu281

ESC GUIDELINES

2014 ESC Guidelines on the diagnosis and treatment of aortic diseases

Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult

The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC)

Authors/Task Force members: Raimund Erbel* (Chairperson) (Germany), Victor Aboyans* (Chairperson) (France), Catherine Boileau (France), Eduardo Bossone (Italy), Roberto Di Bartolomeo (Italy), Holger Eggebrecht (Germany), Arturo Evangelista (Spain), Volkmar Falk (Switzerland), Herbert Frank (Austria), Oliver Gaemperli (Switzerland), Martin Grabenwöger (Austria), Axel Haverich (Germany), Bernard Iung (France), Athanasios John Manolis (Greece), Folkert Meijboom (Netherlands), Christoph A. Nienaber (Germany), Marco Roffi (Switzerland), Hervé Rousseau (France), Udo Sechtem (Germany), Per Anton Sirnes (Norway), Regula S. von Allmen (Switzerland), Christiaan J.M. Vrints (Belgium).

**ESC Committee for Practice Guidelines (CPG): Jose Luis Zamorano (Chairperson) (Spain), Stephan Achenbach (Germany), Helmut Baumgartner (Germany), Jeroen J. Bax (Netherlands), Héctor Bueno (Spain), Veronica Dean (France), Christi Deaton (UK), Çetin Erol (Turkey), Robert Fagard (Belgium), Roberto Ferrari (Italy), David Hasdai (Israel), Arno Hoes (The Netherlands), Paulus Kirchhof (Germany/UK), Juhani Knuuti (Finland), Philippe Kolh

Arch vessel transposition (debranching) and TEVAR might be considered as an alternative to conventional surgery in certain clinical situations, especially when there is reluctance to expose patients to hypothermic circulatory arrest; however, especially after total arch vessel transposition, as well as in patients with the underlying diagnosis of acute Type B AD, the risk of retrograde Type A AD as a direct consequence of the procedure is elevated and should be weighed against the remaining risk of conventional surgery.[105,117,324,325]

European Journal of Cardio-Thoracic Surgery 55 (2019) 133–162
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POSITION STATEMENT

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Current options and recommendations for the treatment of thoracic aortic pathologies involving the aortic arch: an expert consensus document of the European Association for Cardio-Thoracic surgery (EACTS) and the European Society for Vascular Surgery (ESVS)

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Writing Committee: Sabine Adler[c,‡], Jos C. van den Berg[d,e,‡], Luca Bertoglio[f,‡], Thierry Carrel[b,†], Roberto Chiesa[f,‡], Rachel E. Clough[g,‡], Balthasar Eberle[h,†], Christian Etz[i,†], Martin Grabenwöger[j,†], Stephan Haulon[k,‡], Heinz Jakob[l,†], Fabian A. Kari[a,†], Carlos A. Mestres[m,†], Davide Pacini[n,†], Timothy Resch[o,†], Bartosz Rylski[a,†], Florian Schoenhoff[b,†], Malakh Shrestha[p,†], Hendrik von Tengg-Kobligk[q,‡], Konstantinos Tsagakis[l,†] and Thomas R. Wyss[b,‡]

Recommendation 23: TEVAR in zone 0 after previous debranching may be considered in patients unfit for open repair and suitable anatomy [180, 191].	Class IIB	Level B
Recommendation 24: TEVAR in zones 1 and 2 should be considered in patients with suitable anatomy [4	Class IIA	Level B
Recommendation 25: stent-graft deployment is not recommended in patients with a proximal and/or distal landing zone length less than 25 mm or 38 mm [4	Class III	Level B
Recommendation 26: zones 0–2 TEVAR are not recommended in patients with connective tissue dise native aor		Level C
Recomm should be considered in patients with concomitant aortic valve pathology or at high risk for retrograde type A aortic dissection (ascending aorta >38 mm, bicuspid aortic valve, arch abnormalities, lost sinutubular junction, extensive ascending aortic length) [175, 191].	Class IIA	Level B

6.3 Transposition (debranching) of supra-aortic vessels and thoracic endovascular aortic repair and the importance of the subclavian arteries in maintaining the blood supply to the spinal cord

thoracic aortic pathology (zone 0 proximal neck). For patients at a higher risk of stroke, open aortic arch surgery remains the best therapeutic option because extensive manipulation during debranching as well as during TEVAR might cause embolization [178, 180, 181]. Patients presenting with distal arch pathology

ELSEVIER CrossMark

Canadian Journal of Cardiology 32 (2016) 703–713

Society Position Statement

Canadian Cardiovascular Society/Canadian Society of Cardiac Surgeons/Canadian Society for Vascular Surgery Joint Position Statement on Open and Endovascular Surgery for Thoracic Aortic Disease

Jehangir J. Appoo, MDCM (Co-chair),[a] John Bozinovski, MD,[b] Michael W.A. Chu, MD,[c] Ismail El-Hamamsy, MD, PhD,[d] Thomas L. Forbes, MD,[e] Michael Moon, MD,[f] Maral Ouzounian, MD, PhD,[g] Mark D. Peterson, MD, PhD,[h] Jacques Tittley, MD,[i] and Munir Boodhwani, MD, MMSc (Co-chair);[j] on behalf of the CCS/CSCS/CSVS Thoracic Aortic Disease Guidelines Committee

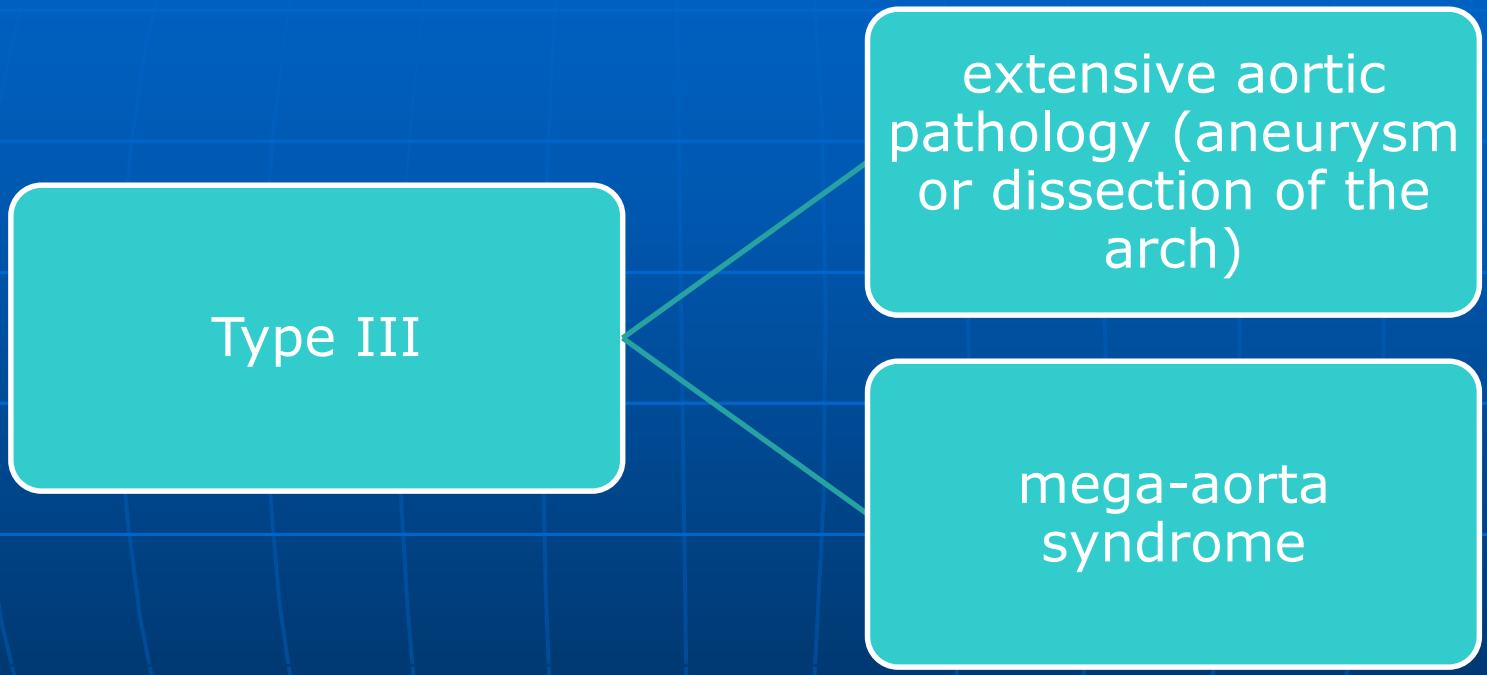
RECOMMENDATION

13. We suggest that hybrid arch repair be considered in patients deemed too high-risk for conventional open repair who meet specific anatomic criteria (Weak Recommendation, Low-Quality Evidence).

Values and preferences. Stroke is a significant risk in conventional and hybrid techniques. Creation of an optimal straight landing zone in Dacron or native aorta is desirable for stent graft technology available today. Ascending aortic diameter ≥ 4 cm is a risk factor for retrograde type A dissection. Hybrid arch repair should be avoided in patients with known or suspected connective tissue disorders unless proximal and distal landing zones are in Dacron replaced aorta.

14. We suggest that hybrid arch techniques might be considered for single-stage repair in patients with diffuse aneurysms involving the ascending, arch and descending aorta (mega aorta) (Weak Recommendation, Low-Quality Evidence).

INDICATIONS FOR FROZEN ELEPHANT TRUNK



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INDICATIONS FOR FET

Recommendation 19: the FET technique or TEVAR 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 DTA to treat associated malperfusion syndrome or to avoid its postoperative development.	**Class IIA**	**Level C**

The FET is potentially indicated for all pathologies of the aortic arch, aneurysm and dissection [159–161]. Different from endovascular aortic repair, the fixation of the FET is performed by a circumferential suture, which eliminates the risk of a proximal endoleak. The endoluminal sealing of the surgical suture line by the stent graft improves haemostasis and makes FET ideal to fix

Recommendation 22: the FET technique should be considered in patients with concomitant distal thoracic and thoraco-abdominal aortic disease that, in a later stage, will or is likely to require either surgical or endovascular treatment.	**Class IIA**	**Level C**

DTA: descending thoracic aorta; FET: frozen elephant trunk; TEVAR: thoracic endovascular aortic repair.

Current options and **recommendations** for the **treatment** of **thoracic aorticpathologies involving** the **aortic arch**: an **expert consensus document** of the**European Association** for **Cardio-Thoracic surgery** (**EACTS**) and the **EuropeanSociety** for **Vascular**

European Heart Journal (2014) 35, 2873–2926
doi:10.1093/eurheartj/ehu281

2014 ESC Guidelines on the diagnosis and treatment of aortic diseases

Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult

The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC)

Authors/Task Force members: Raimund Erbel* (Chairperson) (Germany), Victor Aboyans* (Chairperson) (France), Catherine Boileau (France), Eduardo Bossone (Italy), Roberto Di Bartolomeo (Italy), Holger Eggebrecht (Germany), Arturo Evangelista (Spain), Volkmar Falk (Switzerland), Herbert Frank (Austria), Oliver Gaemperli (Switzerland), Martin Grabenwöger (Austria), Axel Haverich (Germany), Bernard Iung (France), Athanasios John Manolis (Greece), Folkert Meijboom (Netherlands), Christoph A. Nienaber (Germany), Marco Roffi (Switzerland), Hervé Rousseau (France), Udo Sechtem (Germany), Per Anton Sirnes (Norway), Regula S. von Allmen (Switzerland), Christiaan J.M. Vrints (Belgium).

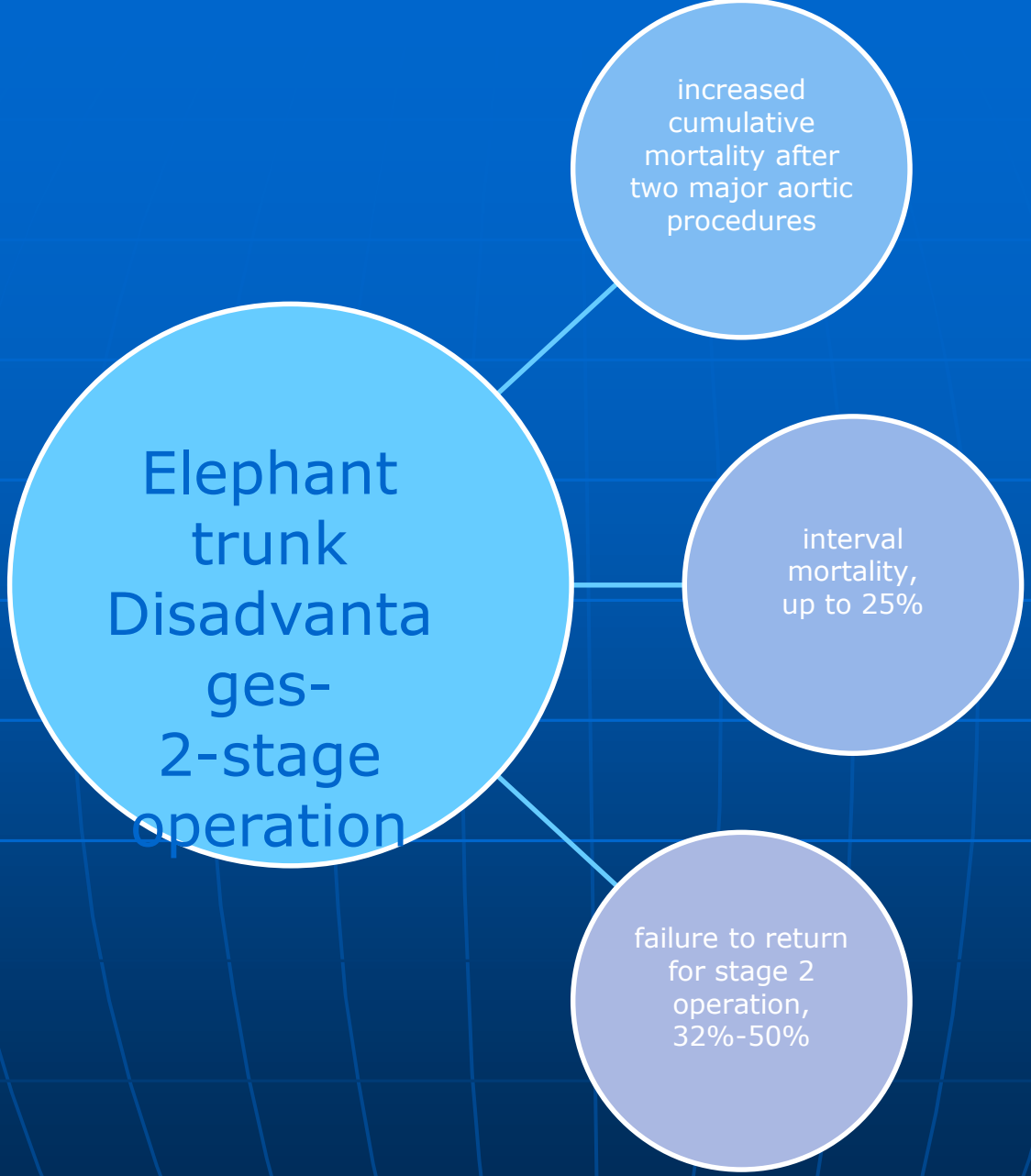
**ESC Committee for Practice Guidelines (CPG): Jose Luis Zamorano (Chairperson) (Spain), Stephan Achenbach (Germany), Helmut Baumgartner (Germany), Jeroen J. Bax (Netherlands), Héctor Bueno (Spain), Veronica Dean (France), Christi Deaton (UK), Çetin Erol (Turkey), Robert Fagard (Belgium), Roberto Ferrari (Italy), David Hasdai (Israel), Arno Hoes (The Netherlands), Paulus Kirchhof (Germany/UK), Juhani Knuuti (Finland), Philippe Kolh

Recommendations for treatment of aortic dissection

Recommendations	Class[a]	Level[b]	Ref.[c]
In all patients with AD, medical therapy including pain relief and blood pressure control is recommended.	I	C	
In patients with Type A AD, urgent surgery is recommended.	I	B	1,2
In patients with acute Type A AD and organ malperfusion, a hybrid approach (i.e. ascending aorta and/or arch replacement associated with any percutaneous aortic or branch artery procedure) should be considered.	IIa	B	2,118, 202–204, 227
In uncomplicated Type B AD, medical therapy should always be recommended.	I	C	
In uncomplicated Type B AD, TEVAR should be considered.	IIa	B	218,219
In complicated Type B AD, TEVAR is recommended.	I	C	
In complicated Type B AD, surgery may be considered.	IIb	C	

Extensive repair including graft replacement of the ascending aorta and aortic arch and integrated stent grafting of the descending aorta[108] ('frozen elephant trunk') was introduced as a single-stage procedure.[103,105] The 'frozen elephant trunk' is increasingly applied for this disease entity if complete ascending-, arch-, and descending AD are diagnosed in otherwise uncomplicated patients.[113–117] Originally designed for repair of chronic aneurysm, the hybrid approach, consisting of a single graft, is also applied, more often now in the setting of acute dissection (*Web Figures 10 and 11*).[118–121]

and peripheral arteries. In particular clinical situations, the 'frozen elephant trunk' technique might also be considered in the treatment of complicated acute Type B AD without a proximal landing zone, as it also eliminates the risk of retrograde Type A AD.[226]



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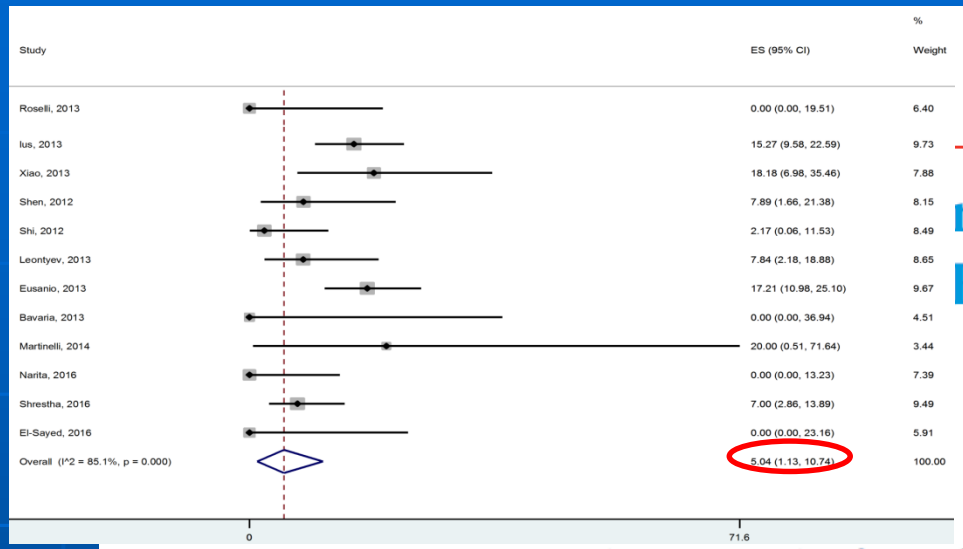
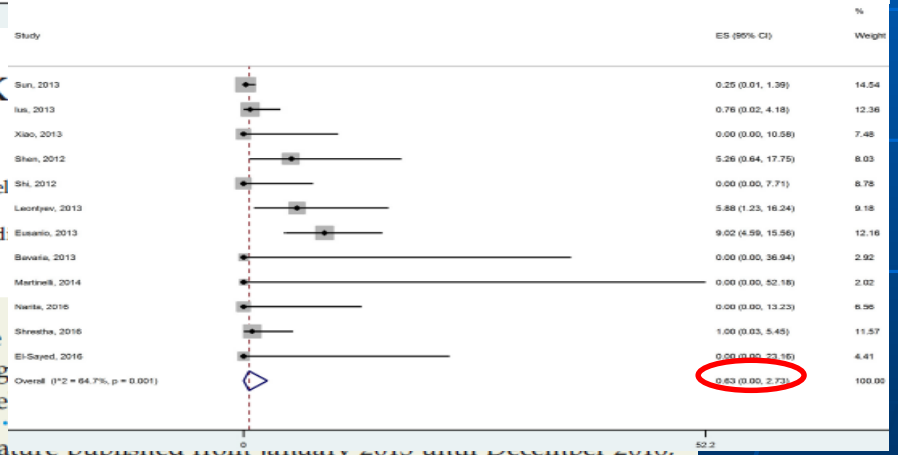
Our meta-analysis





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Background Conventional open total arch replacement is the
However, it is a two-stage procedure related to hig
aortic arch reconstruction, the so-called "frozen e

Methods A meta-analysis and detailed review of the literature published from January 2013 until December 2016, concerning frozen elephant trunk hybrid approach was conducted and data for morbidity and mortality rates were extracted.

Results Among 989 patients included, the pooled 30-day or in-hospital mortality rate was 5.04% (95%CI = 1.13–10.74), stroke rate was 2.38% (95%CI = 0.13–6.30), and the irreversible paraplegia due to spinal cord injury rate was 0.63% (95%CI = 0.00–2.73). Finally, the pooled cumulative survival at 1 year was remarkably high (86.7%, 95%CI = 81.08–92.90).

Conclusions Frozen elephant trunk is a safe alternative to conventional elephant trunk repair for extensive aortic arch pathologies with acceptable short- and mid-term results, avoiding the interval mortality hazard.

Keywords Hybrid procedures • Aortic arch • Frozen elephant trunk

European Journal of Cardio-Thoracic Surgery 44 (2013) 1076–1083
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ORIGINAL ARTICLE

Experience with the conventional and frozen elephant trunk techniques: a single-centre study†

Sergey Leontyev*‡, Michael A. Borger‡, Christian D. Etz, Monica Moz, Joerg Seeburger, Farhard Bakhtiary, Martin Misfeld and Friedrich W. Mohr

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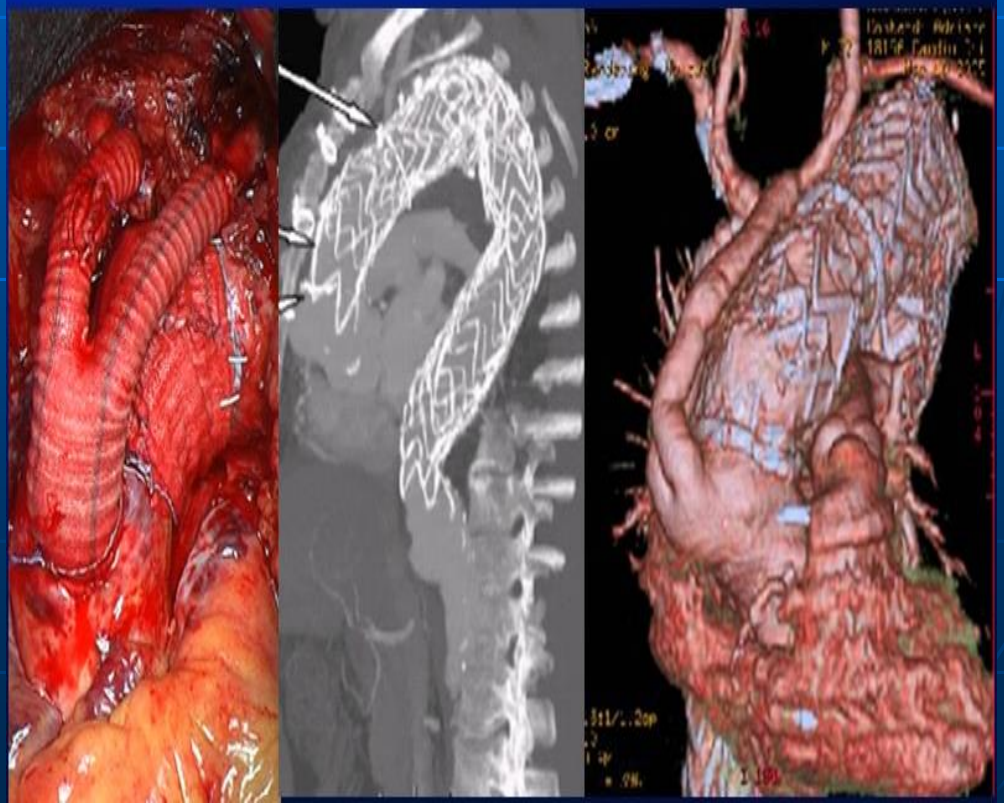
Table 4: Postoperative clinical characteristics for cET vs FET patients and for patients with and without Type A aortic dissection

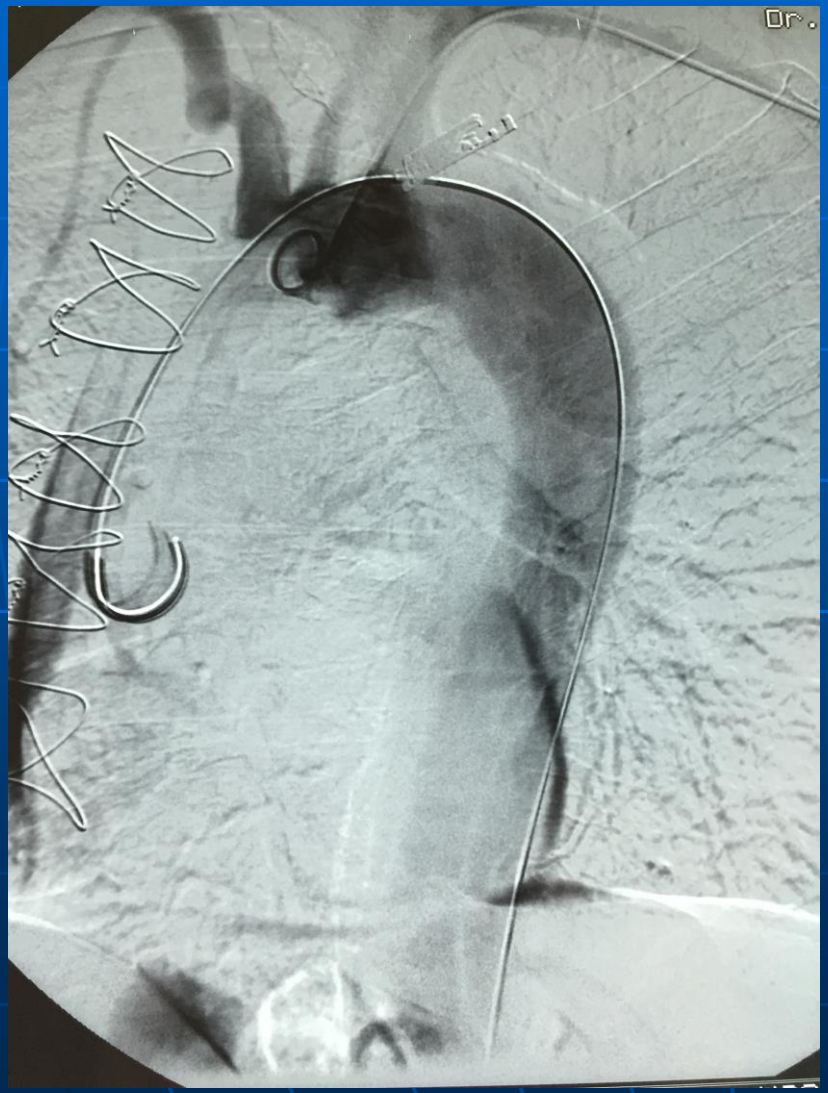
	Total $n = 171$	cET $n = 125$	FET $n = 46$	P
Postoperative outcome				
PND	26 (15.2)	20 (16.0)	6 (13.0)	0.6
TND	27 (15.8)	23 (18.4)	4 (8.7)	0.1
Paraplegia	15 (8.8)	5 (4.0)	10 (21.7)	<0.001
Respiratory failure	76 (44.4)	57 (45.6)	19 (41.3)	0.6
Renal failure	34 (19.9)	23 (18.4)	11 (23.9)	0.4
Reoperation for bleeding	30 (17.5)	24 (19.2)	6 (13.0)	0.3
30-day mortality	28 (16.4)	24 (19.2)	4 (8.7)	0.1
In-hospital mortality	31 (18.1)	27 (21.6)	4 (8.7)	0.053

Hybrid type II repair

Debranching with reinforcement of landing zone with graft material to enhance seal and prevent future dilatation of landing zone



Υβριδική αντιμετώπιση ανιούσης και τόξου σε δύο χρόνους



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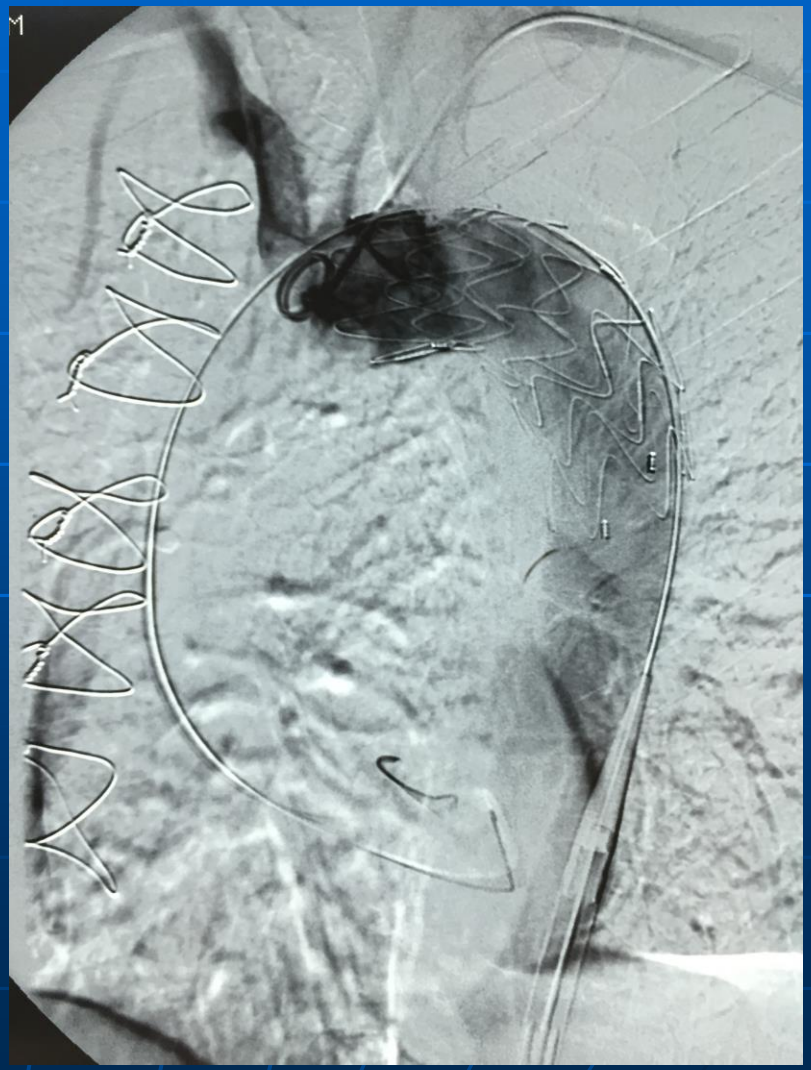

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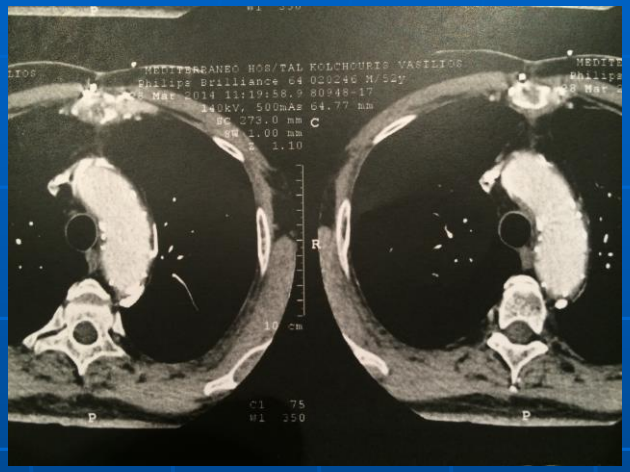

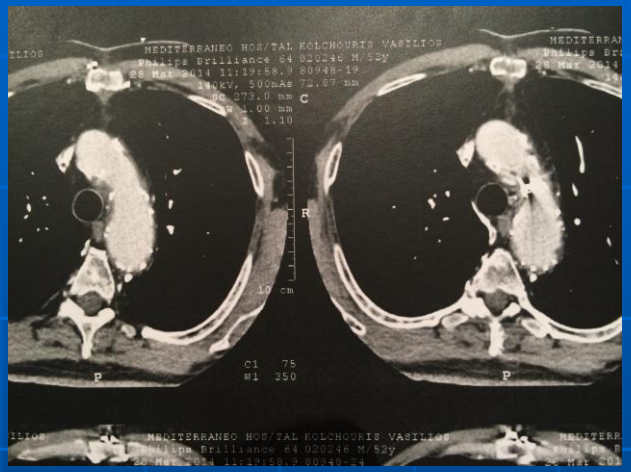

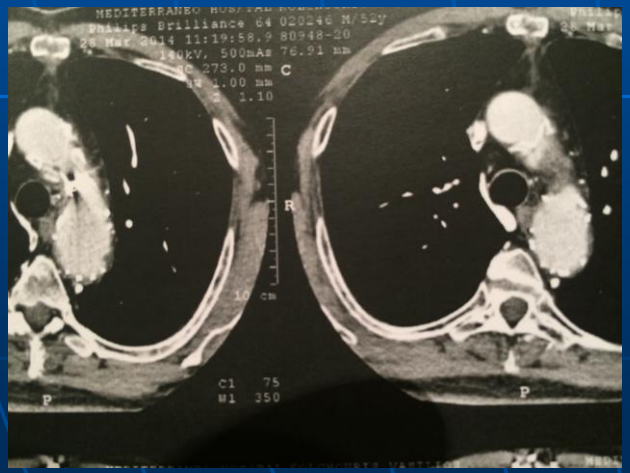

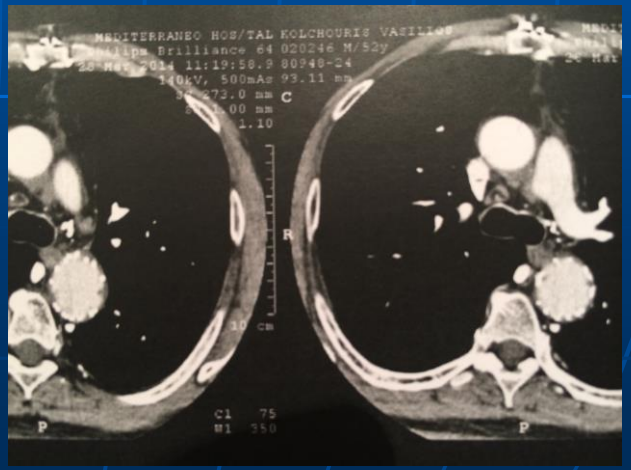

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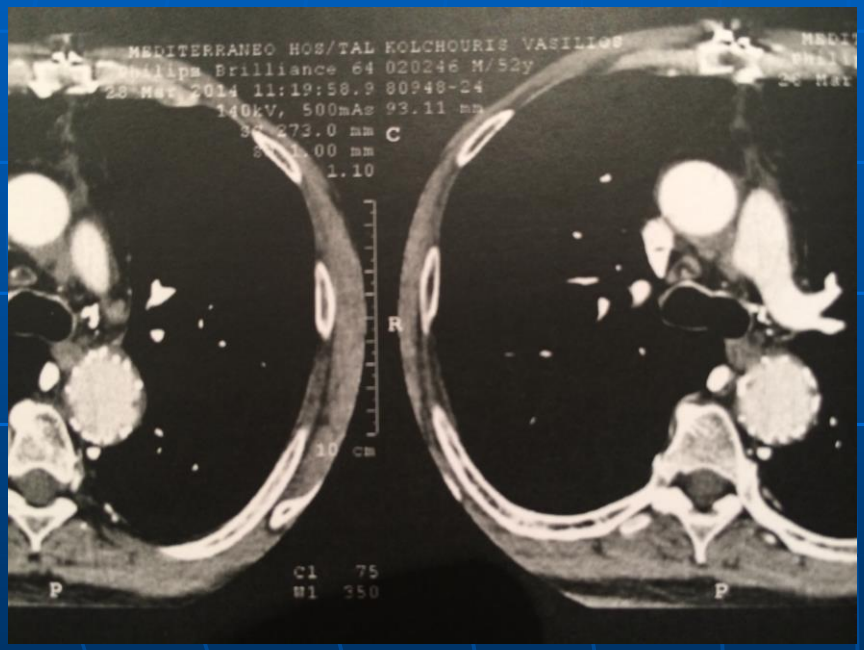

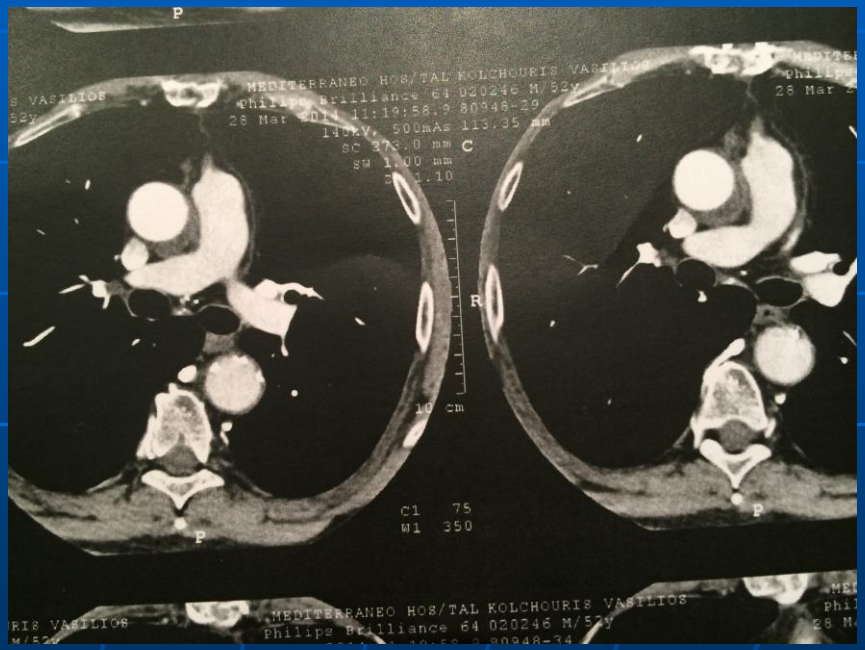

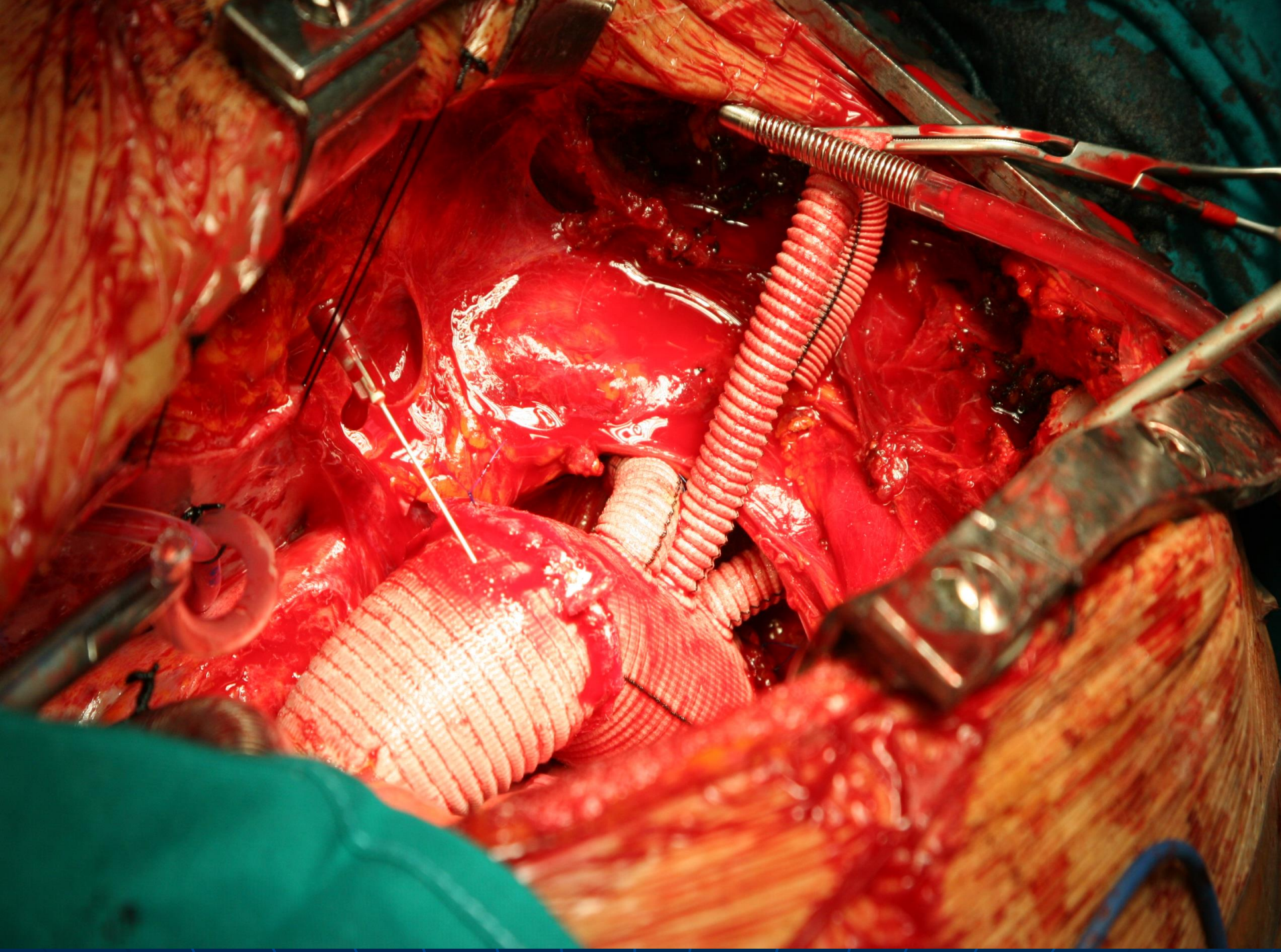

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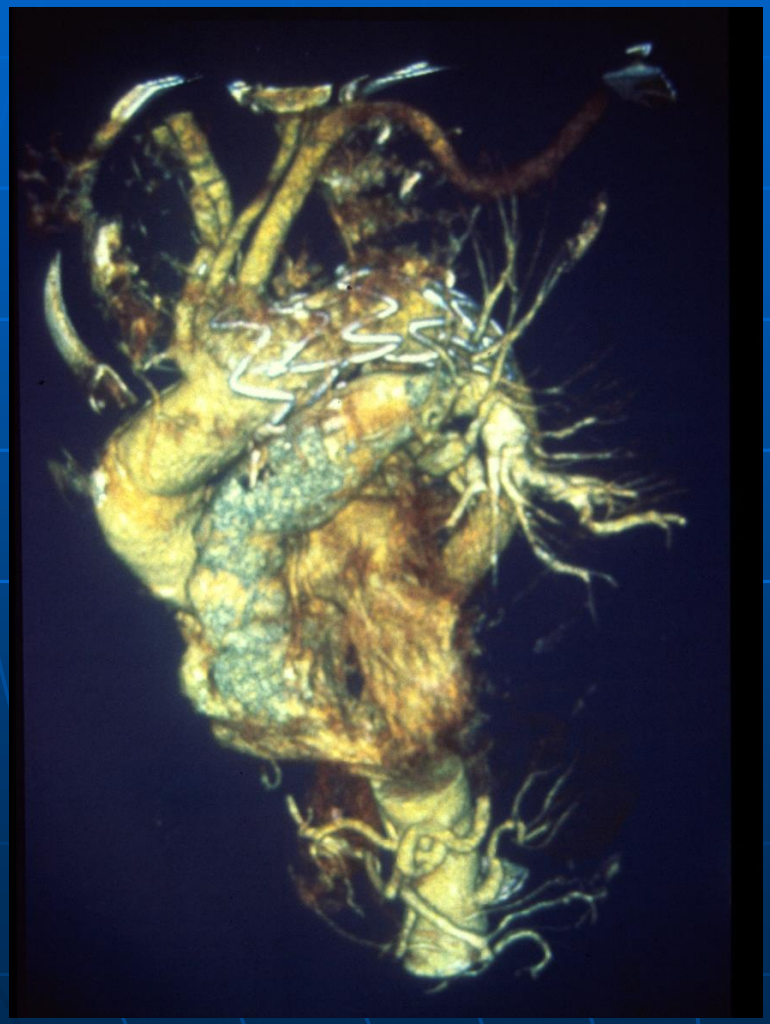
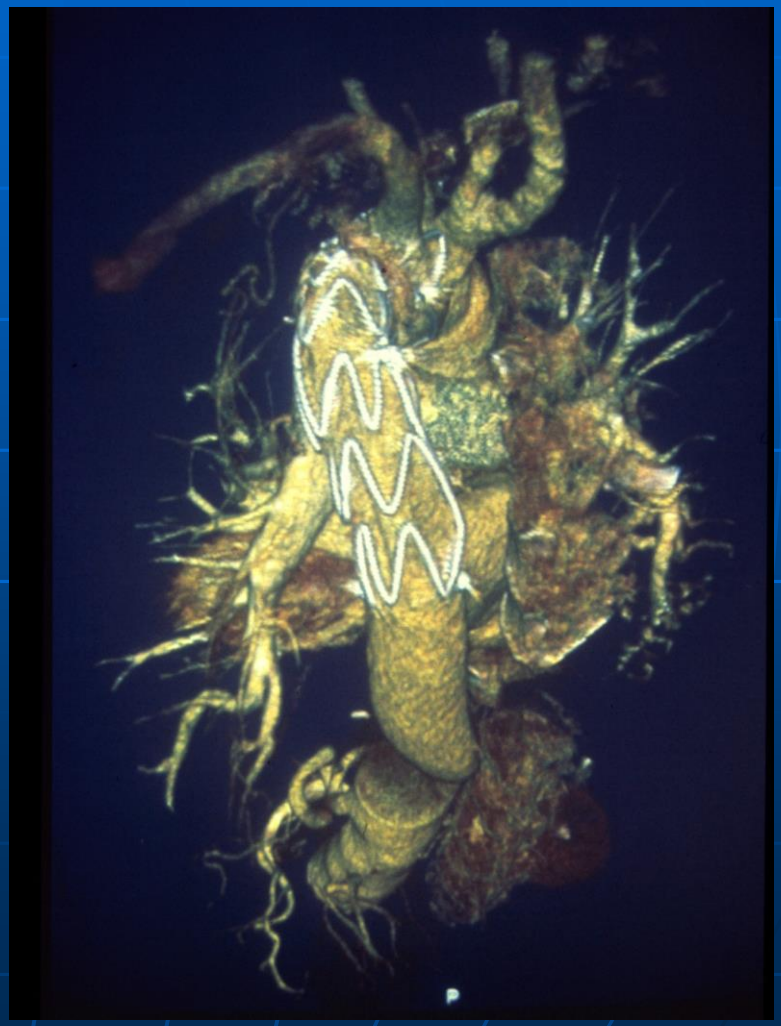
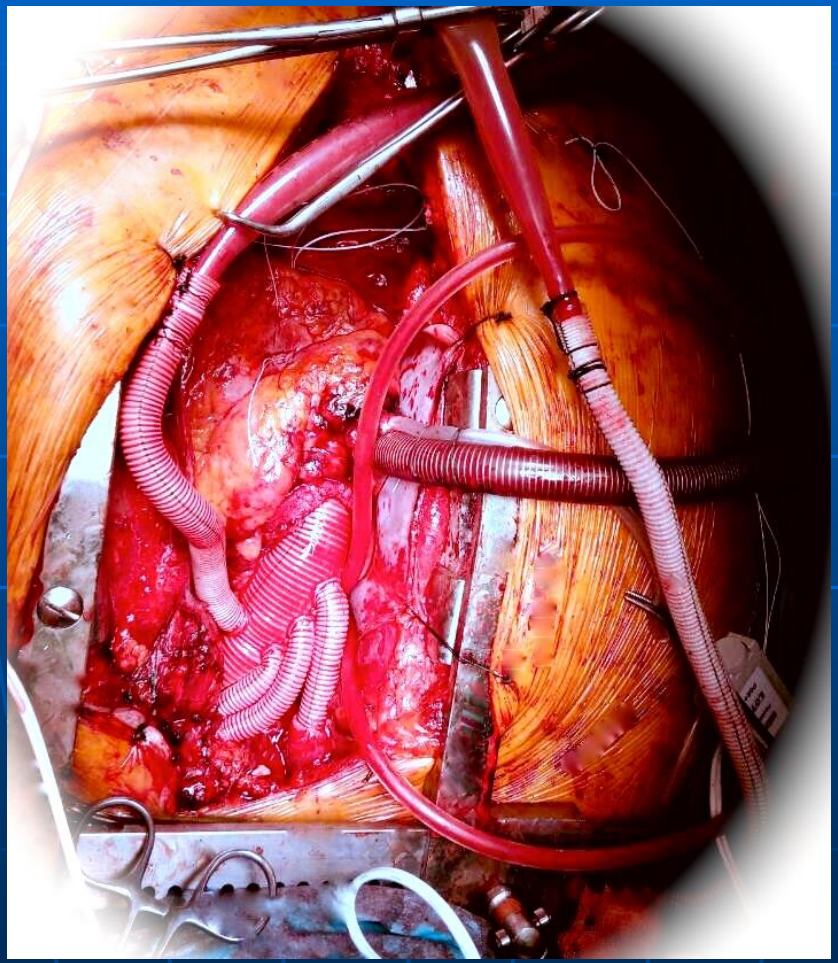
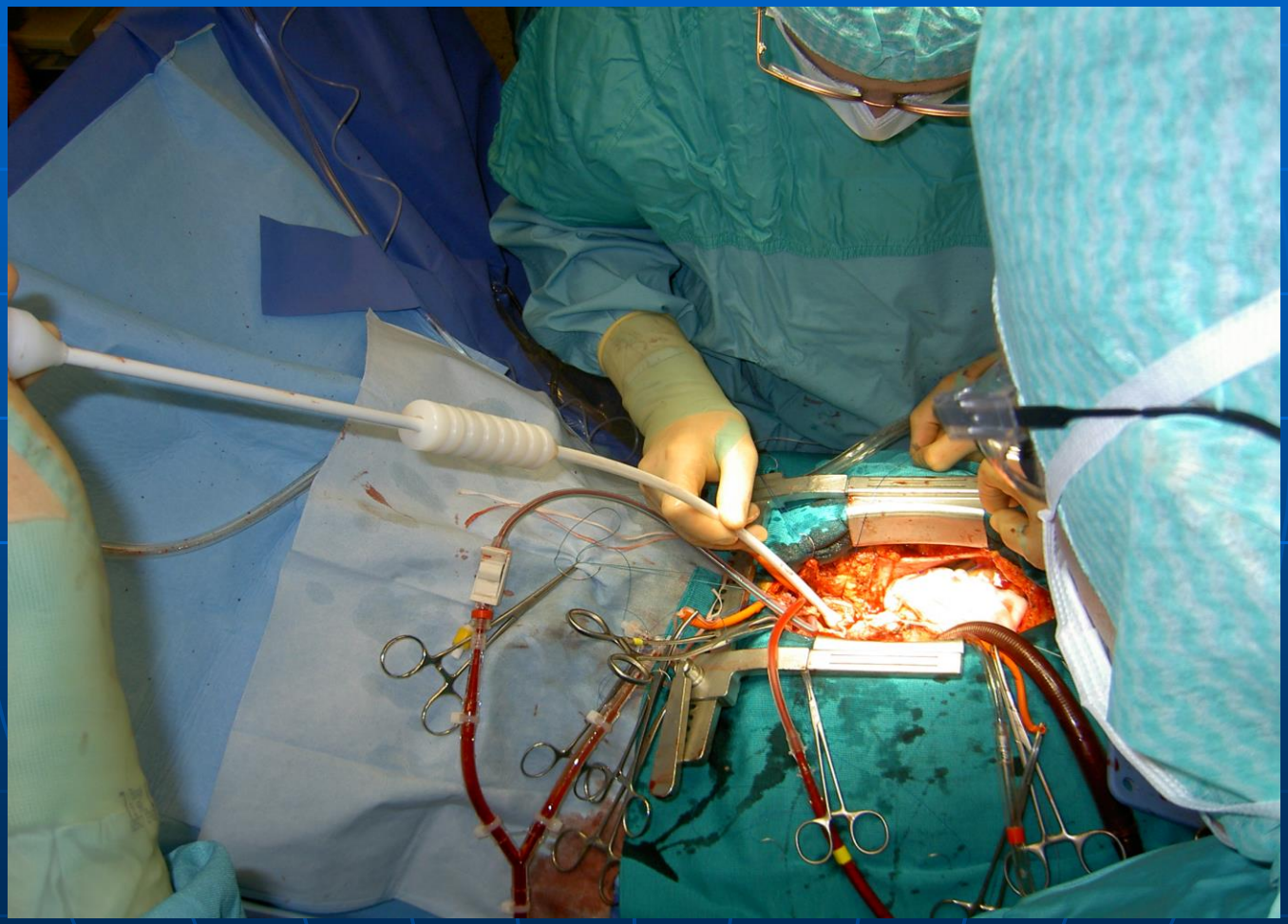




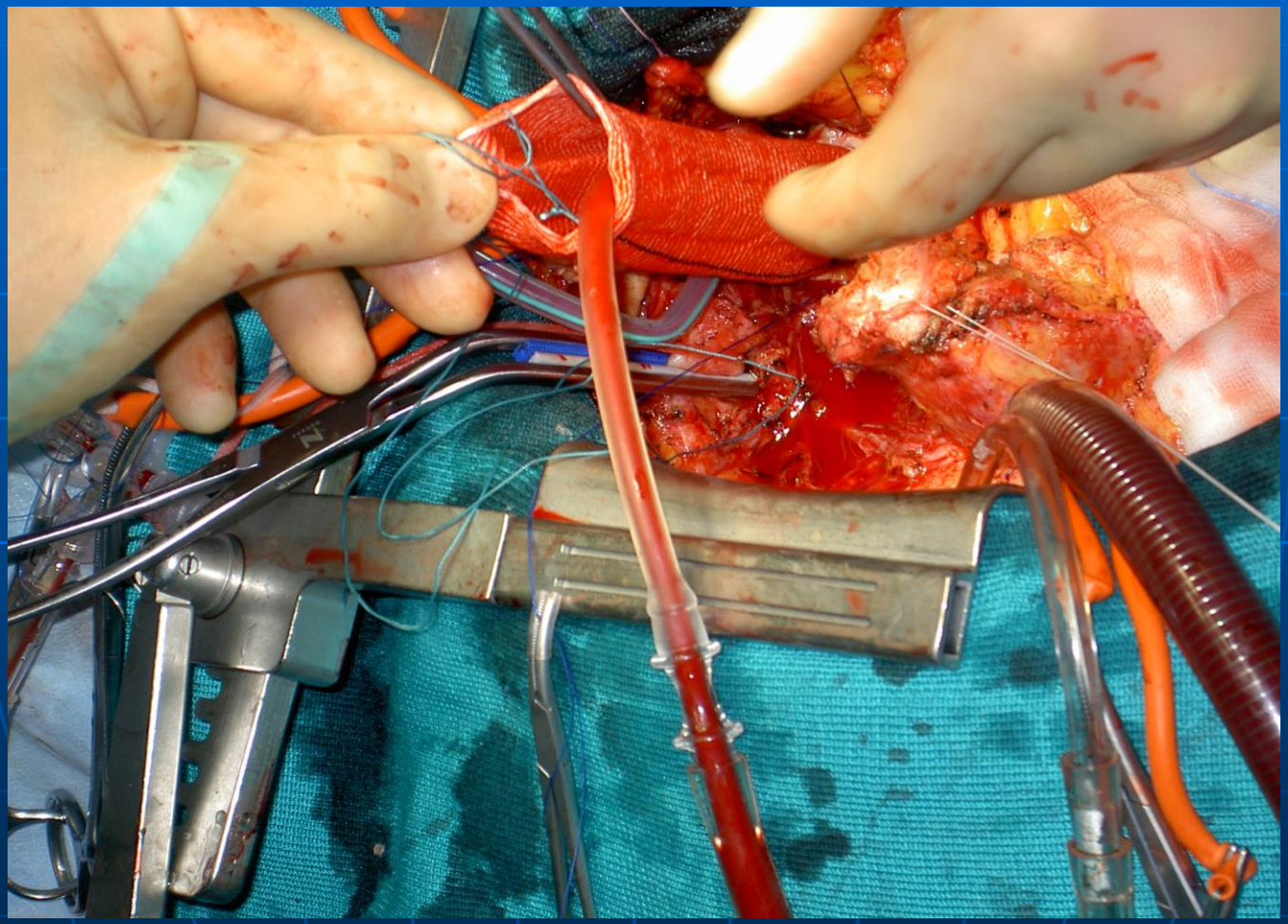
Acsending aorta and arch replacement with tetrabranch graft



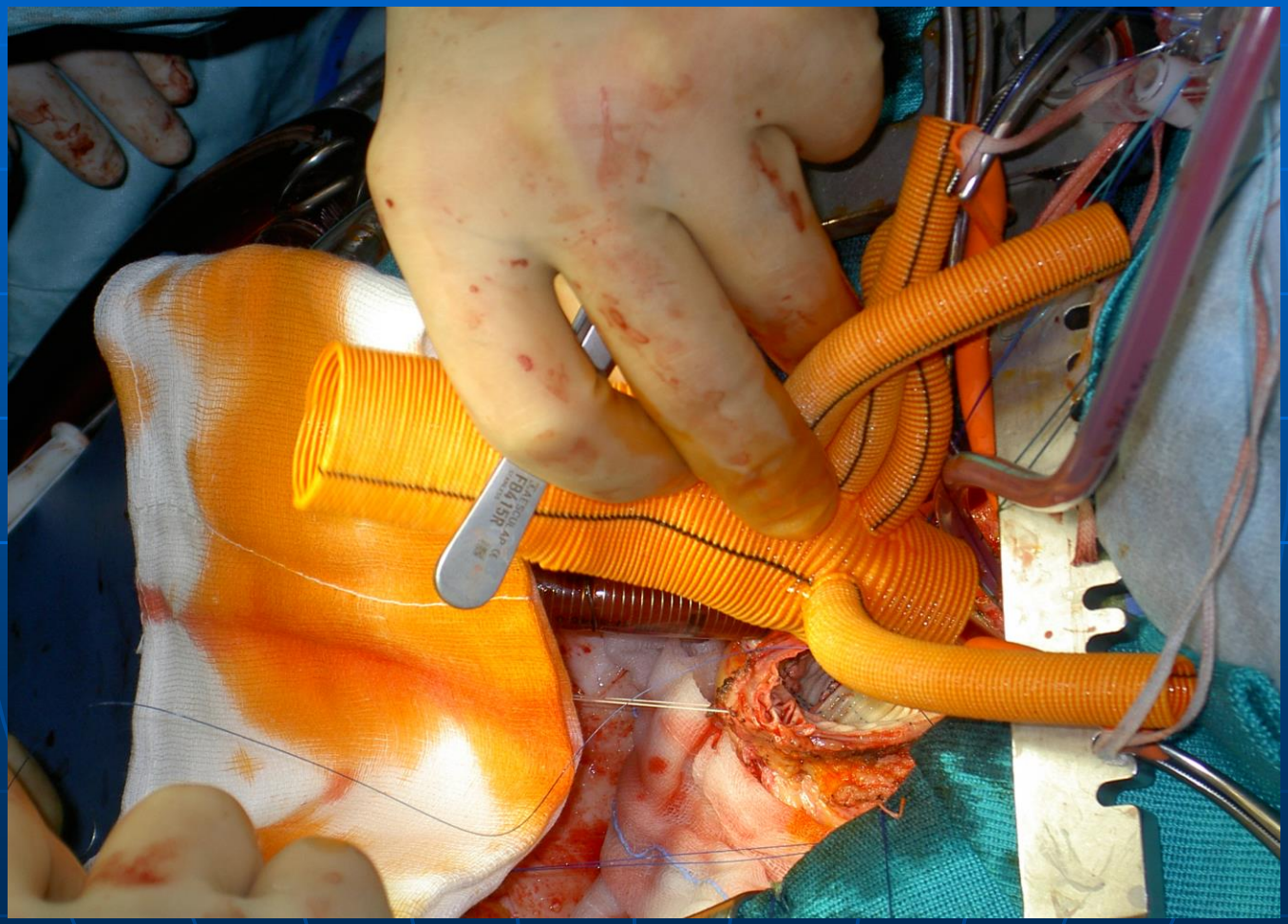
Insertion of the e-vita open graft to the descending thoracic aorta



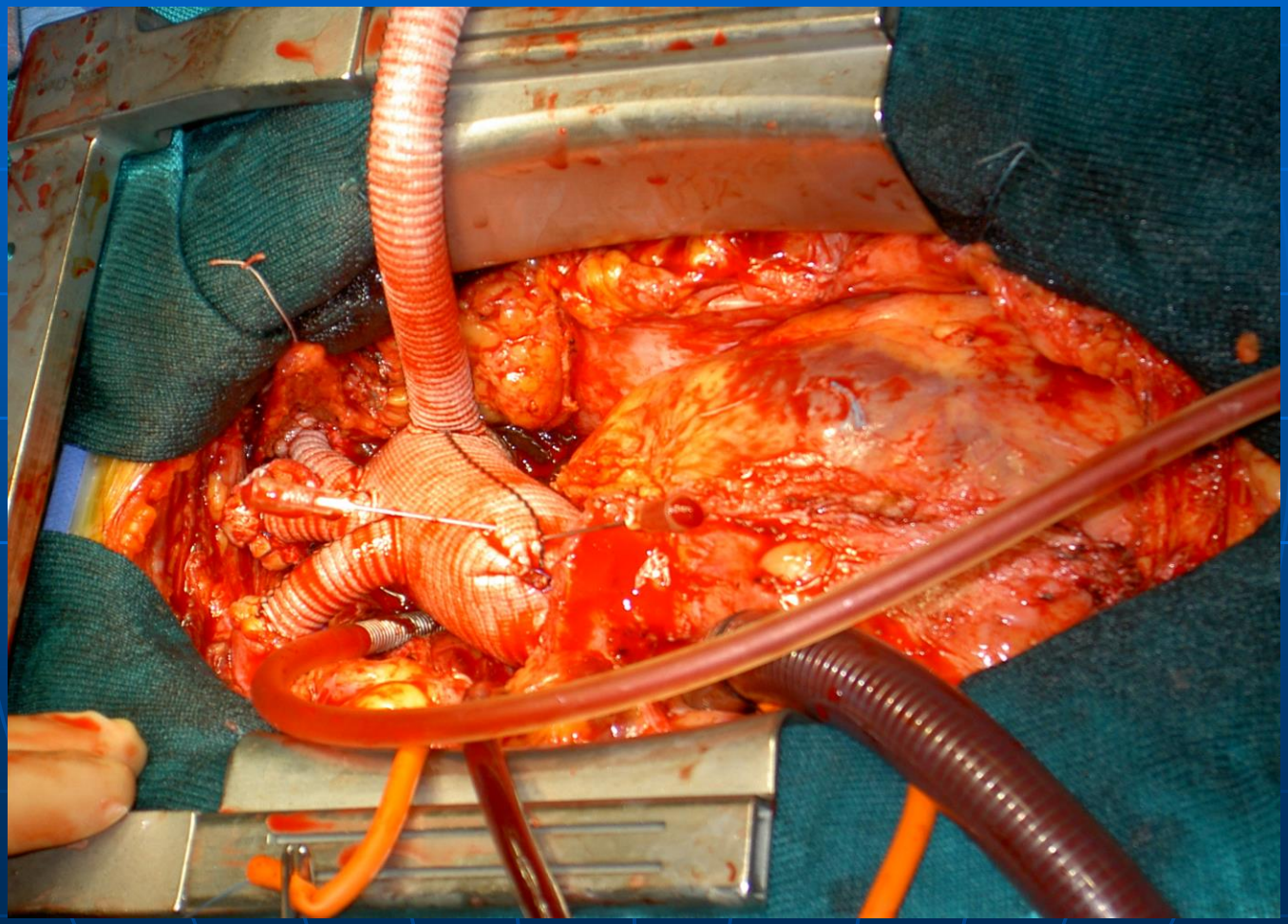
Withdrawal of the graft to anastomose the arch



Trifurcated arch graft



Final picture of type III hybrid arch replacement (frozen elephant trunk)



POSTOPERATIVE CARE

- This is based on two principles :

(I) Haemodynamic stability that allows good blood supply to the organs.

(II) Spinal cord protection (CSF drainage).

- Maintenance of mean blood pressure of 80 – 90 mm Hg and in some cases 90-110 mm Hg (cases with long aortic coverage) .

- Preoperative Lumbar drain especially if the stent-graft is to cover thoracic aorta below T6 or in cases when part of abdominal aorta has been replaced.

Evaggelismos hospital experience

- 125 patients with a acute type A dissection have been treated over the last 5 years. In hospital mortality:12%
- **>300 TEVAR** . Cases include traumatic aortic rupture selective cases of type B aortic dissection, rupture atherosclerotic ulcer of the descending aorta or as supplementary therapy of arch replacement over the last 10 years with excellent results. (Interventional radiology department)
- **15 cases of arch debranching+TEVAR** (Type I hybrid- 1 death)
- **28 cases of arch replacement + TEVAR (type II hybrid** (no death)
- 14 Frozen elephant trank (Type III – 4 deaths)
- A total of 57 hybrid arch replacements (5 deaths = 9%) (5 years)
- Necessary : **TEAM WORK**

PICTURES FROM THE FUTURE:HYBRID ROOMS AND 3D PRINTING

thank you!