

-Aorta- ein eigenständiges Organsystem Therapiemöglichkeiten von Herzchirurgen

Angiologisches Forum 2024



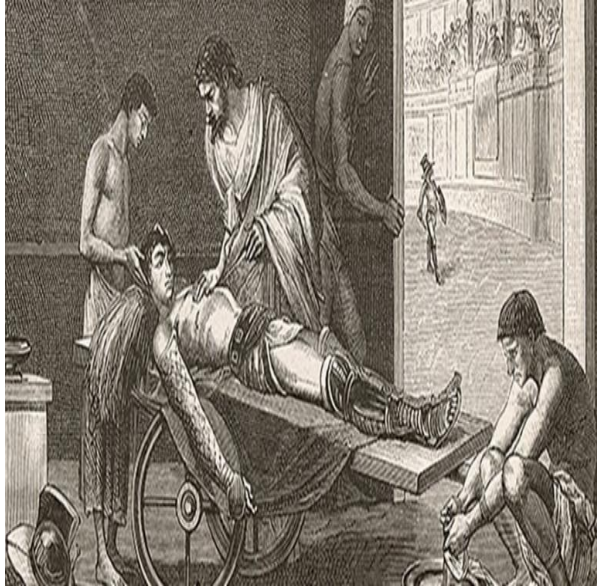
Medizinische Hochschule
Hannover

Disclosures

- ABBOTT
- GETTINGE
- ARTIVION
- MEDTRONIC
- PERICARDCHECK

Lebensader Aorta

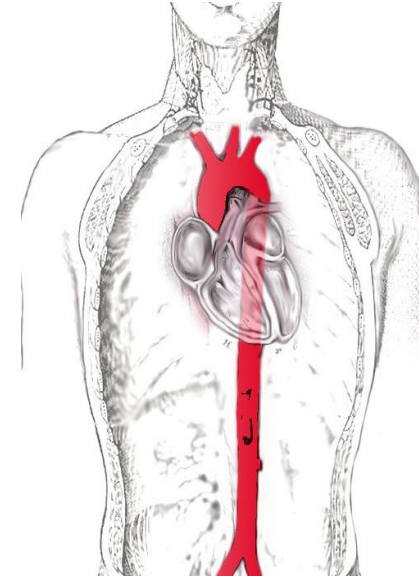
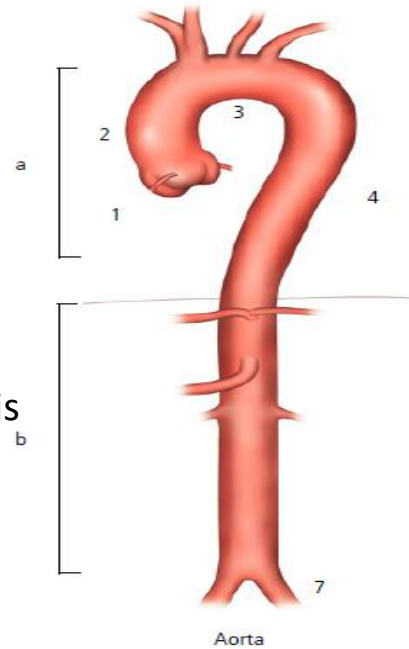
128-199n. Chr.



Galenus von Pergamon
„4 Säfte Lehre“, „Gladiator-Arzt“

Aorta thoracalis

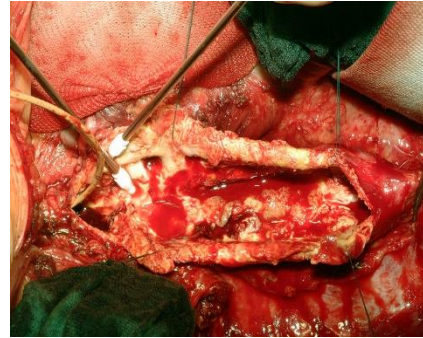
Aorta abdominalis



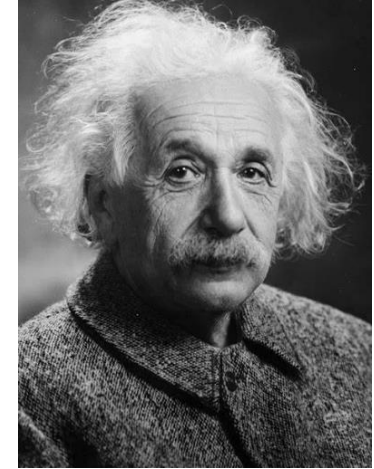
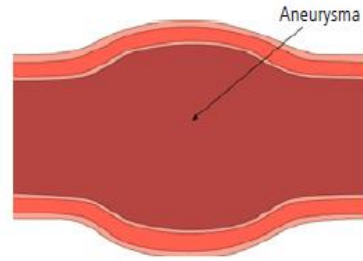
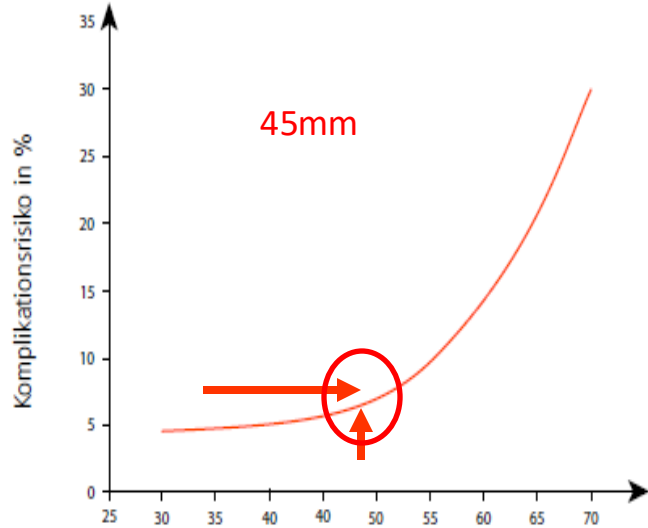
1: Aortenwurzel, 2: Aorta ascendens, 3: Aortenbogen, 4: Aorta descendens

Genese der Aortenerkrankungen

- Atherosklerose
- Degeneration
- Bindegewebserkrankungen
- Trauma
- Aortitis



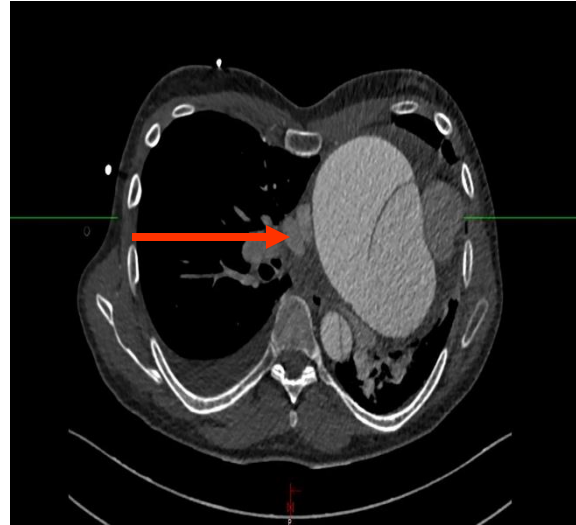
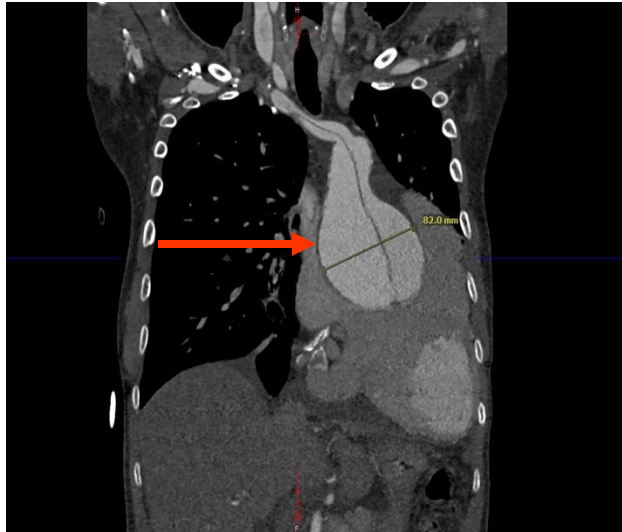
Aortenaneurysmen – „Silent Killer“



Albert Einstein

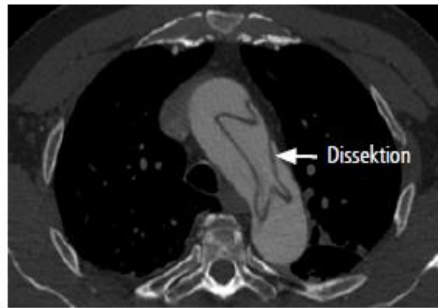
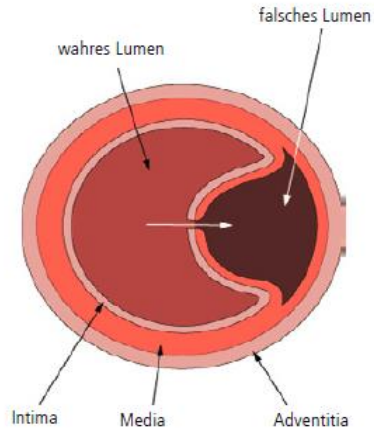
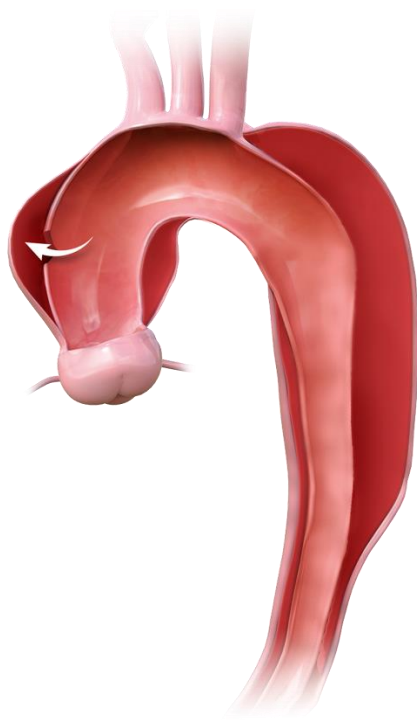
Komplikationswahrscheinlichkeit (Dissektion, Ruptur, Tod) in Abhängigkeit vom Aortendurchmesser
Ab 55 mm Sterblichkeitsrisiko größer als Operationsrisiko (**bisher**)

Aortenaneurysmen – „Silent Killer“



CT – Untersuchung mit Kontrastmittel bei thorakaler Schmerzsymptomatik seit einigen Monaten
Aortenaneurysma 82mm mit akuter Typ A Dissektion

Aortendissektion

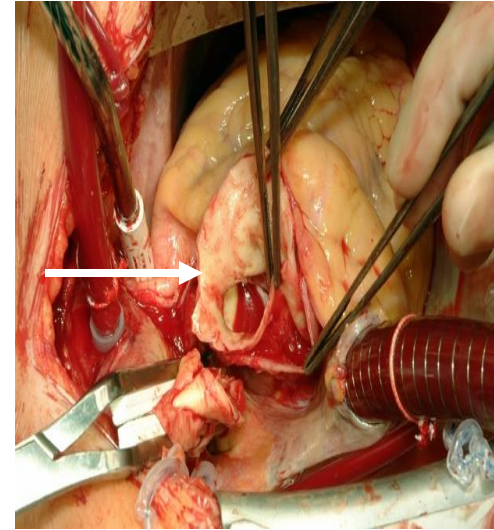
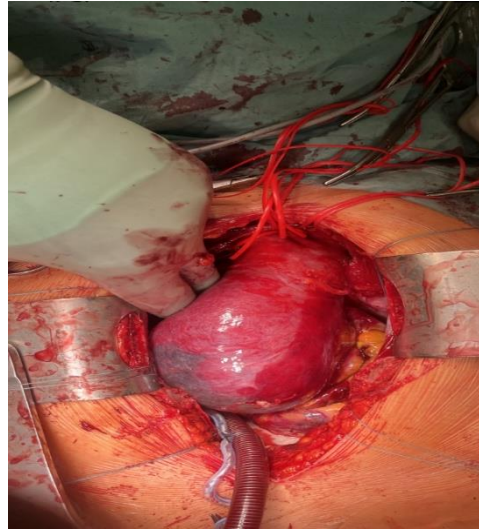


König George II Augustus 1683-1760
(geb. Hannover/Herrenhausen)

Aortendissektion

Etiology of out-of-hospital cardiac arrest diagnosed via detailed examinations including perimortem computed tomography

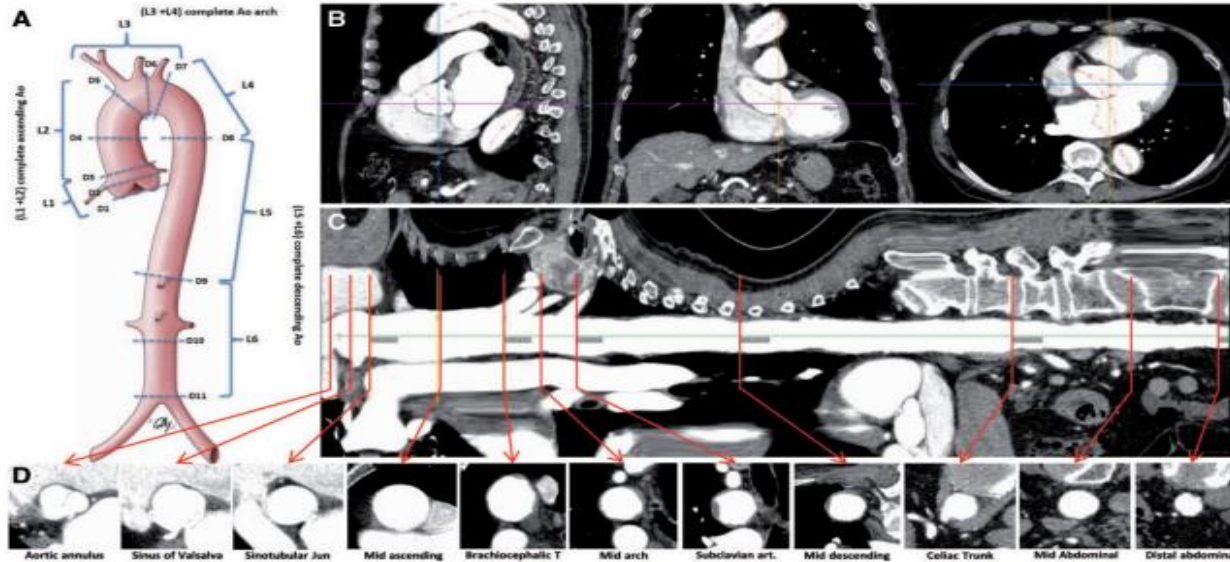
Yoshihiro Moriwaki ¹, Yoshio Tahara, Takayuki Kosuge, Noriyuki Suzuki



Aortendissektion mit 8% Hauptursache für außerklinische Reanimation

Risikofaktor Aortenelongation

Aortic elongation in aortic aneurysm and dissection: the Tübingen
Aortic Pathoanatomy (TAIPAN) project†



Conclusions: Patients with ectatic (45-54 mm diameter) and elongated (≥ 120 mm) ascending aortas represent a high-risk subpopulation for TAD.

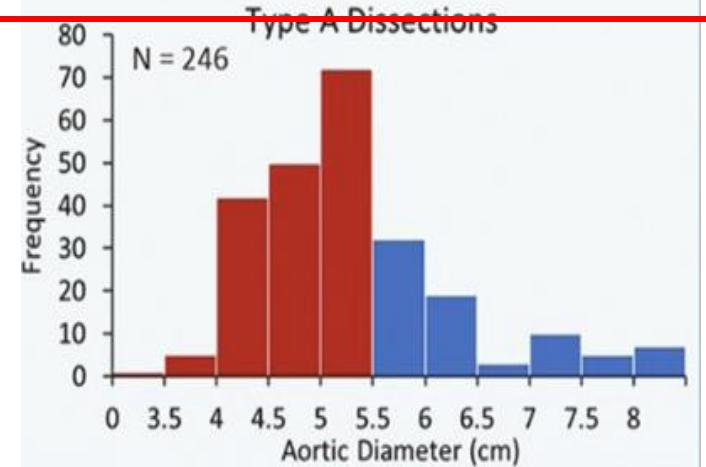
Aneurysmagröße

> [Ann Thorac Surg](#). 2023 Aug;116(2):262-268. doi: 10.1016/j.athoracsur.2023.03.037.
Epub 2023 Apr 14.

Aortic Size at the Time of Type A and Type B Dissections

Zachary G Perez¹, Mohammad A Zafar¹, Juan J Velasco¹, Alexandra Sonsino¹,
Hesham Ellauzi¹, Clerin John¹, Asanish Kalyanasundaram¹, Bulat A Ziganshin¹,
John A Elefteriades²

69% of Type A dissections occur below the 5.5 cm surgical threshold



Conclusions: Aortic diameter at the time of type A dissection is consistent with the new guidelines that recommend surgical intervention at 5.0 cm. Type B dissection occurs at small sizes and cannot be prevented with a size criterion.

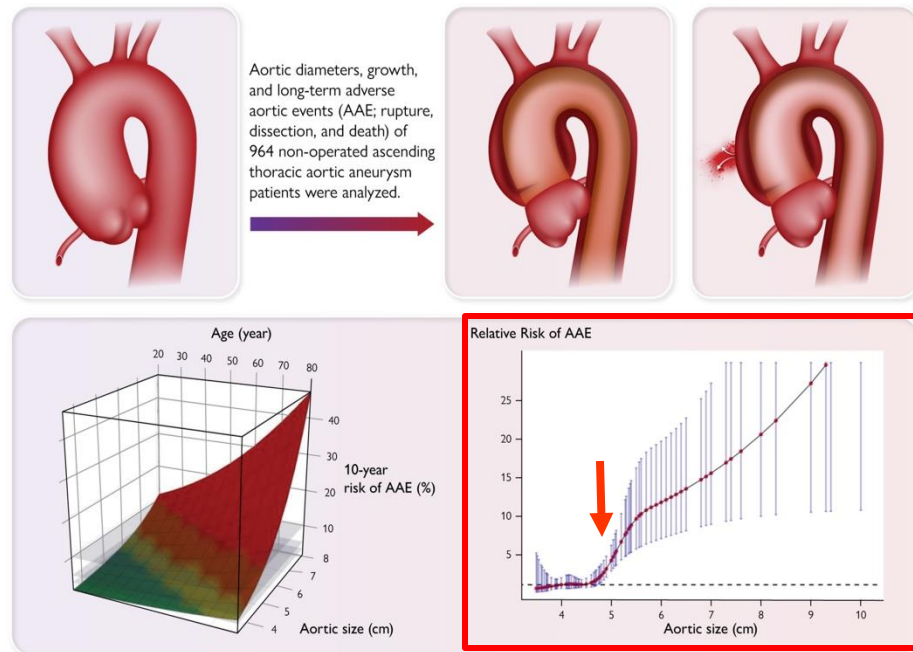
Aneurysmagröße

> *Eur Heart J*. 2023 Mar 30;ehad148. doi: 10.1093/eurheartj/ehad148. Online ahead of print.

Fate of the unoperated ascending thoracic aortic aneurysm: three-decade experience from the Aortic Institute at Yale University

Jinlin Wu^{1,2}, Mohammad A Zafar¹, Yiwei Liu³, Julia Fayanne Chen⁴, Yupeng Li⁵, Bulat A Ziganshin¹, Hesham Ellauzi¹, Sandip K Mukherjee¹, John A Rizzo⁶, John A Elefteriades¹

Conclusion: An aortic size of 5 cm, rather than 5.5 cm, may be a more appropriate intervention criterion for prophylactic ATAA repair. Aortic growth may not be an applicable indicator for intervention.



Operationsstrategie Dissektion

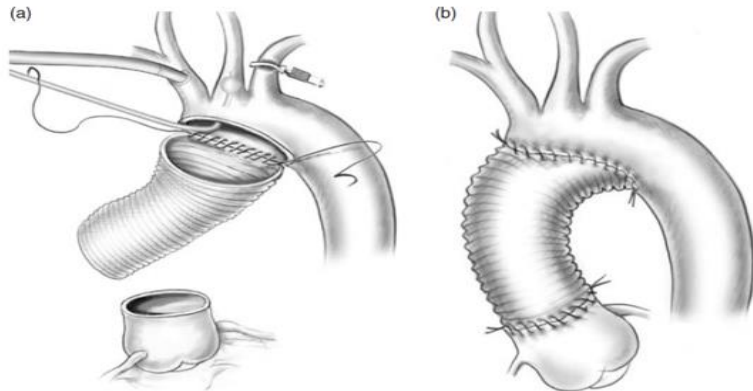
European Journal of Cardio-Thoracic Surgery 49 (2016) 1392–1401
doi:10.1093/ejcts/ezv351 Advance Access publication 13 October 2015

ORIGINAL ARTICLE

Cite this article as: Yan Y, Xu L, Zhang H, Xu Z-Y, Ding X-Y, Wang S-W, et al. Proximal aortic repair versus extensive aortic repair in the treatment of acute type A aortic dissection: a meta-analysis. Eur J Cardiothorac Surg 2016;49:1392–401.

Proximal aortic repair versus extensive aortic repair in the treatment of acute type A aortic dissection: a meta-analysis

Yan Yan^a, Li Xu^a, Hao Zhang^a, Zhi-Yun Xu^{a*}, Xue-Yan Ding^b, Shu-Wei Wang^c, Xiang Xue^a and Meng-Wei Tan^{a*}



- Niedrige Mortalität
- Leicht erhöhte Re-Interventionsrate



ELSEVIER

The Annals of Thoracic Surgery

Available online 28 November 2023

In Press, Journal Pre-proof [?](#) [What's this?](#)



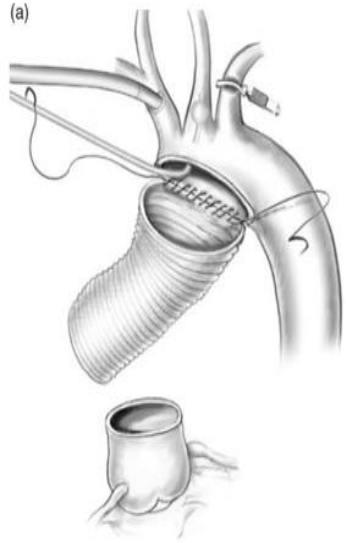
ORIGINAL ARTICLE

Reinterventions After Repair of Acute Type A Aortic Dissection: Incidence, Outcomes, and Risk Factors

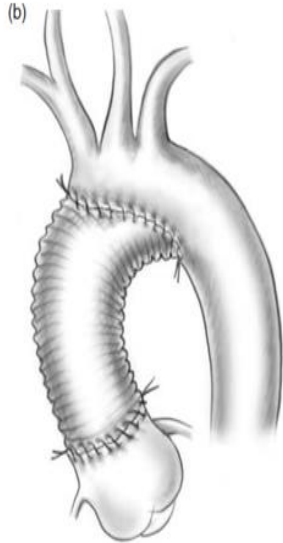
Conclusions: The cumulative incidence of aortic reintervention after ATAAD repair was reasonably low (16% at 10 years), reinterventions were relatively safe (6% operative mortality), and reinterventions did not significantly impact long-term survival.

- 16 % in 10 Jahren
- 6% Mortalität
- Re-Intervention kein Einfluss auf Langzeit-Überleben

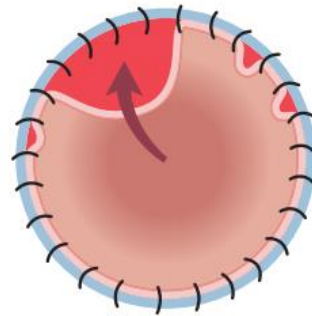
Operationsstrategie Dissektion



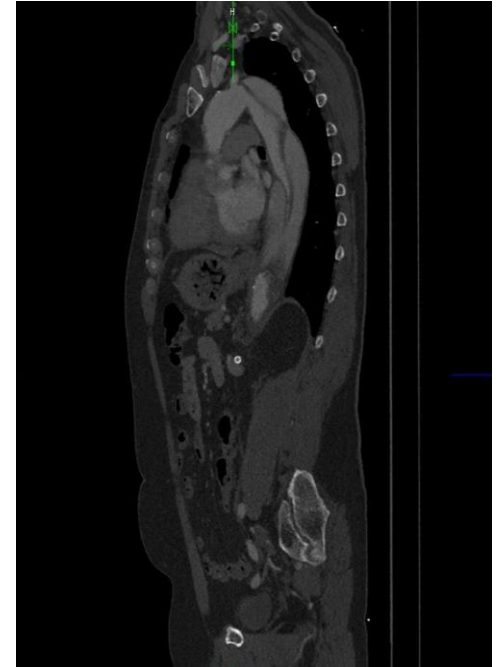
OPEN DISTAL ANASTOMOSIS



RISK of DANE



Distal Anastomotic New Entry



High-Volume Centres

Type A aortic dissection:
optimal annual case volume for surgery

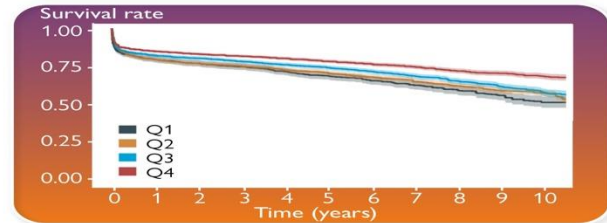
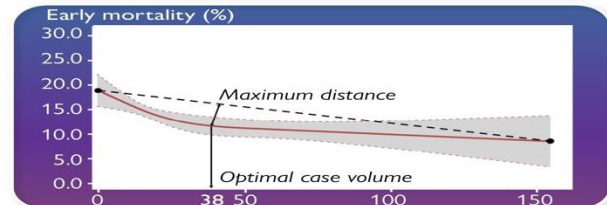
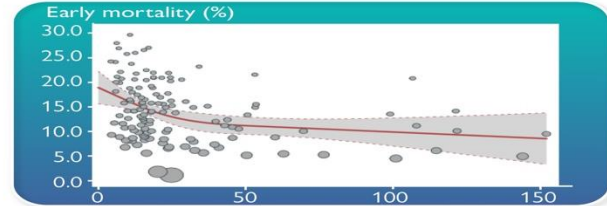


Annual case volume ● 1-19 ● 20-49 ● 50-99 ● 100+

140 studies, 38 276 **real-world** patients, 4 quartiles
Mortality quartile-1 **16.2%** vs quartile-4 **10.3%**

Mathematically derived optimal annual case volume = **38 cases/year**
Number needed to treat to save a life at 30 days in high- vs low-volume centers = **21 patients**

10-year survival quartile-1 **51%** vs quartile-4 **69%**, $p < 0.001$
Adjusted per quartile hazard ratio **0.83**
Number needed to treat to save a life at 10 years in high- vs low-volume centers = **6 patients**



Centralization of ATAAD care to high-volume centres may lead to improved outcomes

Chirurgische Therapie ESC Guidelines 2014



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 Jung (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).

- **Aortenaneurysma: 55mm**
 - **Bicuspide Aortenklappe: 55mm**
 - **Aortenwurzel: 55mm**
 - **Herz OP: AI und 50mm**
-
- **Definitionen - unklar**
 - **Dissektion – unklar**
 - **Aortenelongation - unklar**
 - **Risikofaktoren – unklar**
 - **Wachstumsrate – unklar**
 - **Körpergröße – unklar**
 - **Genetische Ursachen - unklar**

Chirurgische Therapie EASCTS/STS Guidelines 2024

AORTIC DISEASE CLINICAL PRACTICE GUIDELINE

EASCTS/STS Guidelines for Diagnosing and Treating Acute and Chronic Syndromes of the Aortic Organ



Authors/Task Force Members: Martin Czerny^{1,2,*} (Co-Chairperson) (Germany), Martin Grabenwöger^{3,4,*} (Co-Chairperson) (Austria), Tim Berger^{1,2} (Task Force Coordinator), Victor Aboyans^{5,6} (France), Alessandro Della Corte^{7,8} (Italy), Edward P. Chen⁹ (USA), Nimesh D. Desai¹⁰ (USA), Julia Dumfarth¹¹ (Austria), John A. Elefteriades¹² (USA), Christian D. Etz¹³ (Germany), Karen M. Kim¹⁴ (USA), Maximilian Kreibich^{1,2} (Germany), Mario Lescan¹⁵ (Germany), Luca Di Marco¹⁶ (Italy), Andreas Martens^{17,18} (Germany), Carlos A. Mestres¹⁹ (South Africa), Milan Milojevic²⁰ (Serbia), Christoph A. Nienaber^{21,22} (UK), Gabriele Piffaretti²³ (Italy), Ourania Preventza²⁴ (USA), Eduard Quintana²⁵ (Spain), Bartosz Rylski^{1,2} (Germany), Christopher L. Schlett^{2,26} (Germany), Florian Schoenhoff²⁷ (Switzerland), Santi Trimarchi²⁸ (Italy), and Konstantinos Tsagakis²⁹ (Germany), EASCTS/STS Scientific Document Group

European Journal of Cardio-Thoracic Surgery 2024, 65(2), ezad426
<https://doi.org/10.1093/ejcts/ezad426>

GUIDELINES

Cite this article as: Czerny M, Grabenwöger M, Berger T, Aboyans V, Della Corte A, Chen EP et al. EASCTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ. Eur J Cardiothorac Surg 2024; doi:10.1093/ejcts/ezad426.

EASCTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ

Authors/Task Force Members: Martin Czerny¹ ^{a,b,*} (Co-Chairperson) (Germany), Martin Grabenwöger^{c,d,*} (Co-Chairperson) (Austria), Tim Berger^{a,b} (Task Force Coordinator), Victor Aboyans^{e,f} (France), Alessandro Della Corte^{g,h} (Italy), Edward P. Chenⁱ (USA), Nimesh D. Desai^j (USA), Julia Dumfarth^k (Austria), John A. Elefteriades^l (USA), Christian D. Etz^m (Germany), Karen M. Kimⁿ (USA), Maximilian Kreibich^{a,b} (Germany), Mario Lescan^o (Germany), Luca Di Marco^p (Italy), Andreas Martens^{q,r} (Germany), Carlos A. Mestres^s (South Africa), Milan Milojevic^t (Serbia), Christoph A. Nienaber^{u,v} (UK), Gabriele Piffaretti^w (Italy), Ourania Preventza^x (USA), Eduard Quintana^y (Spain), Bartosz Rylski^{a,b} (Germany), Christopher L. Schlett^{b,z} (Germany), Florian Schoenhoff^{aa} (Switzerland), Santi Trimarchi^{ab} (Italy) and Konstantinos Tsagakis^{ac} (Germany), EASCTS/STS Scientific Document Group

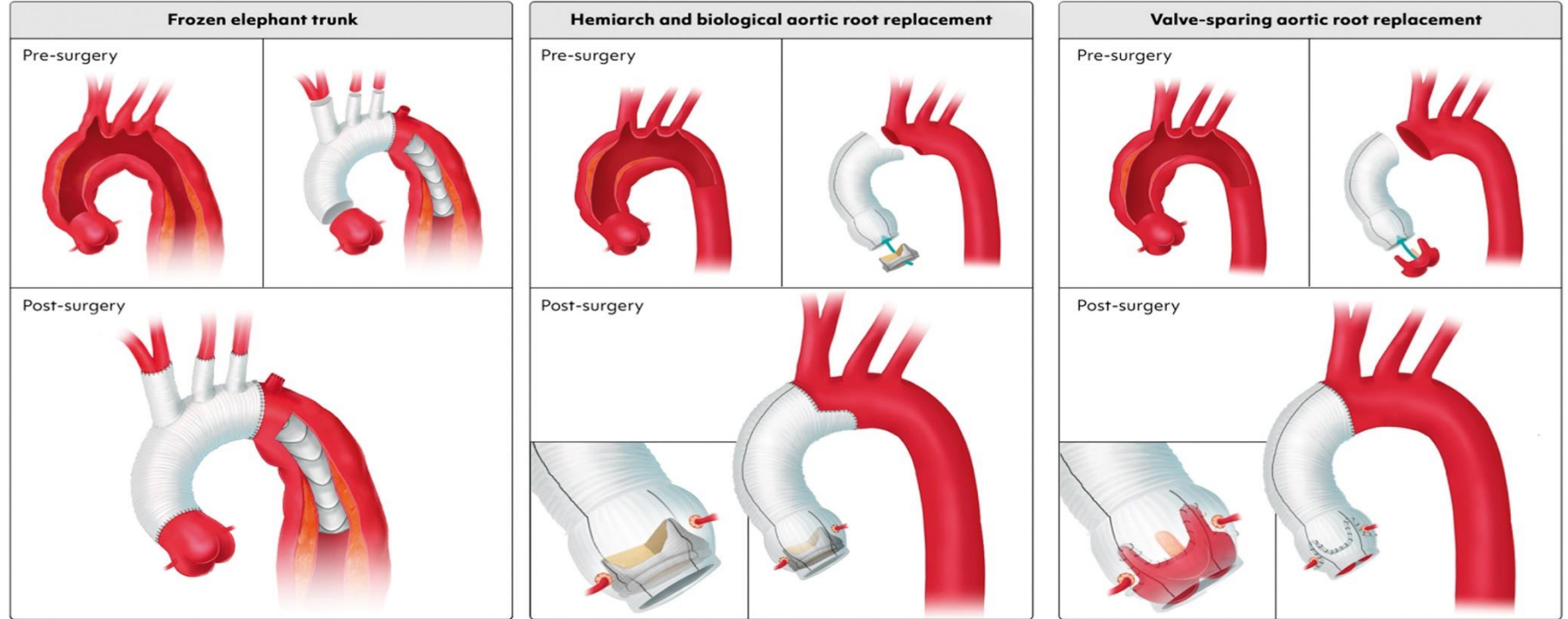
Aortic Guideline EACTS/STS 2024

EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ

- PATHOPHYSIOLOGY AND NATURAL DISEASE COURSE
- **NOMENCLATURE AND RISK STRATIFICATION**
- REPORTING STANDARDS AND QUALITY INDICATORS
- **AORTIC TEAMS AND HEALTHCARE IMPLICATIONS**
- DIAGNOSTIC WORK-UP AND IMAGING
- **ACUTE AORTIC DISEASES**
- CHRONIC DILATATIVE AORTIC DISEASE
- **THERAPEUTIC OPTIONS**
- RARE CONDITIONS
- AORTIC DISEASE IN WOMEN
- INTENSIVE CARE UNIT
- PATIENTS UNDERGOING AORTIC SURGERY
- LIVING WITH AORTIC DISEASE
- FUTURE DIRECTIONS

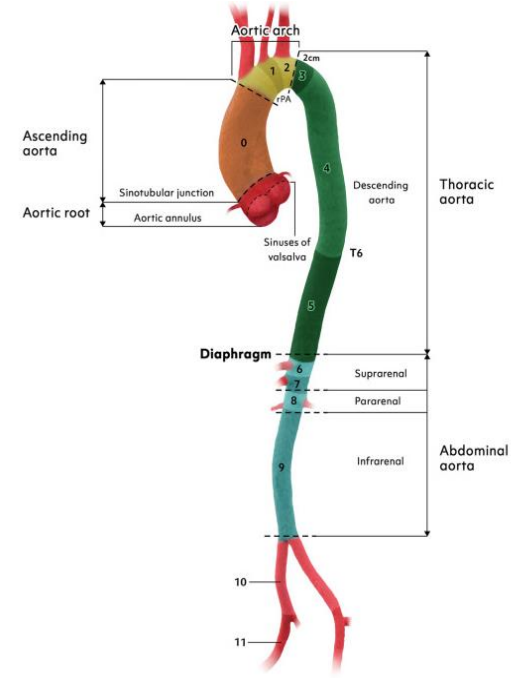
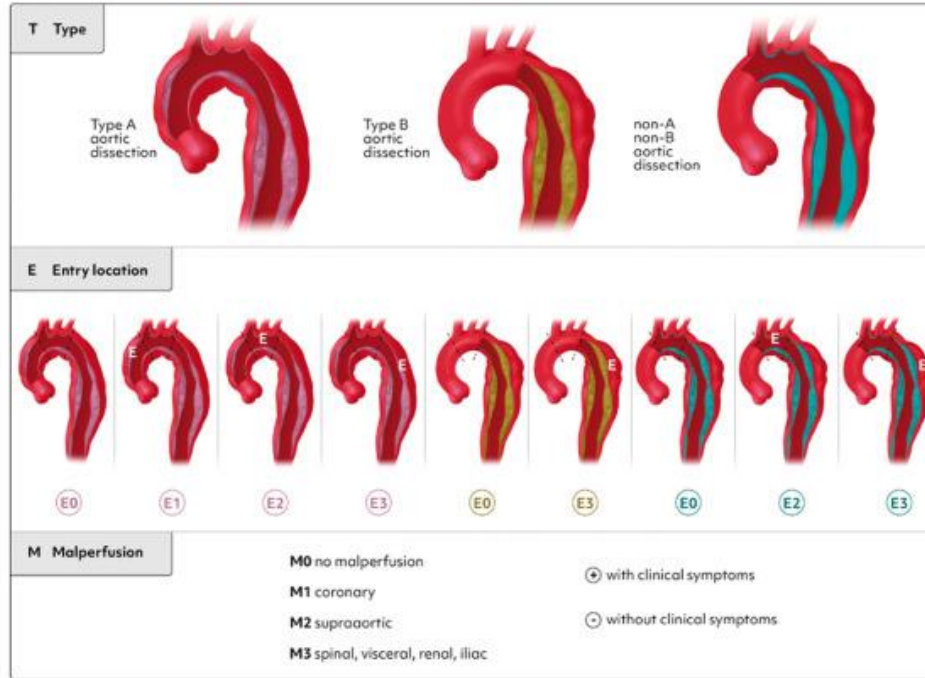
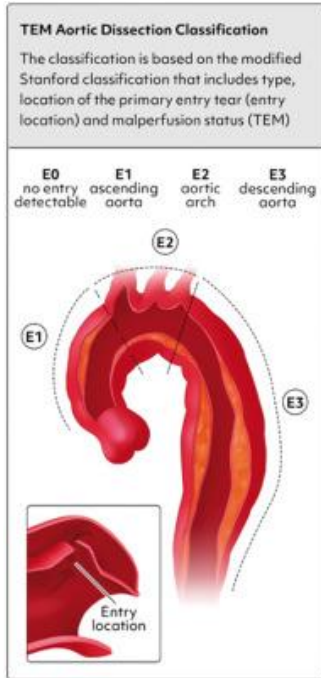
Chirurgische Therapie in Abhängigkeit der Lokalisation

Frozen elephant trunk, Hemiarch replacement, David operation



Aortic Guideline EACTS/STS 2024

EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ



Aortic Guideline EACTS/STS 2024

EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ

Type A aortic dissection.

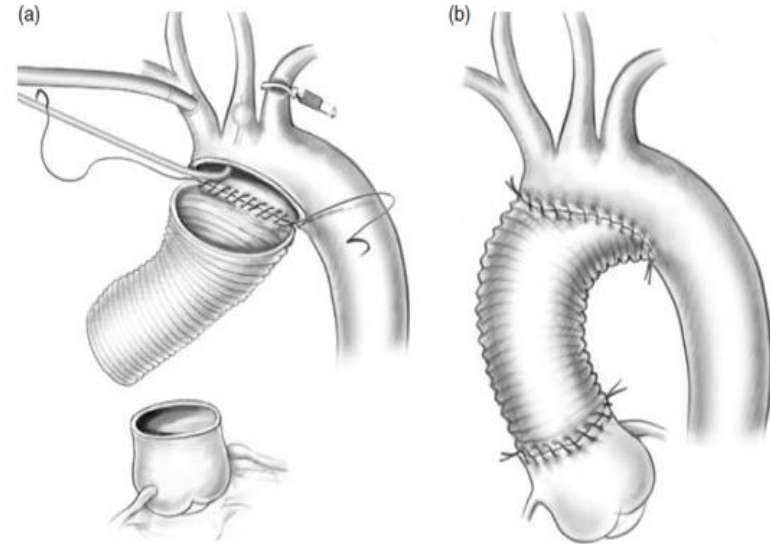
Recommendation Table 5: Acute aortic diseases: Type A aortic dissection

| Recommendations | Class ^a | Level ^b | Ref ^c |
|--|--------------------|--------------------|------------------|
| Initiation of emergency surgery is recommended in patients presenting with acute type A aortic dissection. | I | B | [211, 212] |
| A tear-oriented approach with exclusion or resection of the primary entry tear in the ascending aorta and arch is recommended. | I | B | [213, 214] |
| Inspection and coverage of communications between lumina in the proximal descending aorta may be considered in specialized centres for prognostic reasons. | IIb | C | - |
| Despite preoperative neurologic dysfunction or non-haemorrhagic stroke, open repair should be considered. | IIa | B | [215–217] |
| In case of clinical and imaging evidence of visceral malperfusion, revascularization may be considered prior to aortic repair. | IIb | C | - |
| Antegrade systemic perfusion via axillary or direct aortic cannulation should be considered. | IIa | B | [218, 219] |
| An open distal anastomosis during lower body hypothermic circulatory arrest is recommended. | I | B | [220, 221] |

^aClass of recommendation.

^bLevel of evidence.

^cReferences.

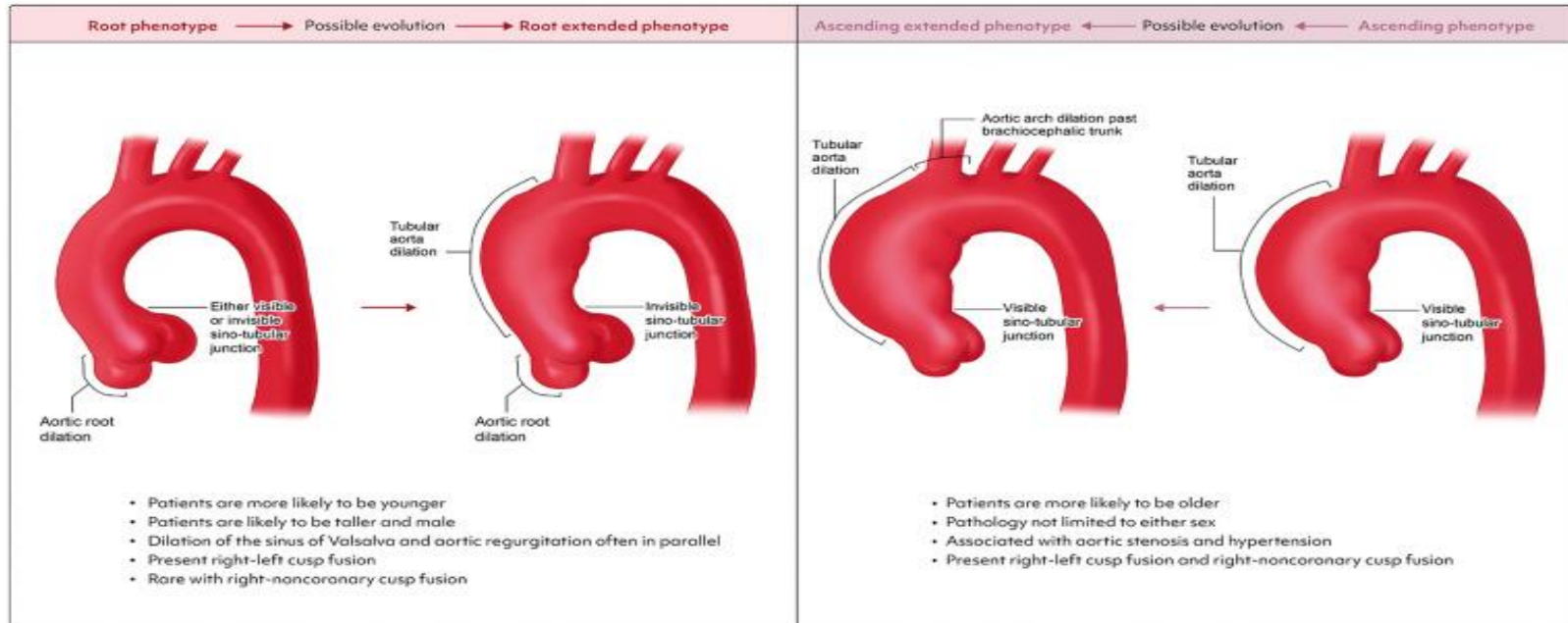


OPEN DISTAL ANASTOMOSIS

Aortic Guideline EACTS/STS 2024

EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ

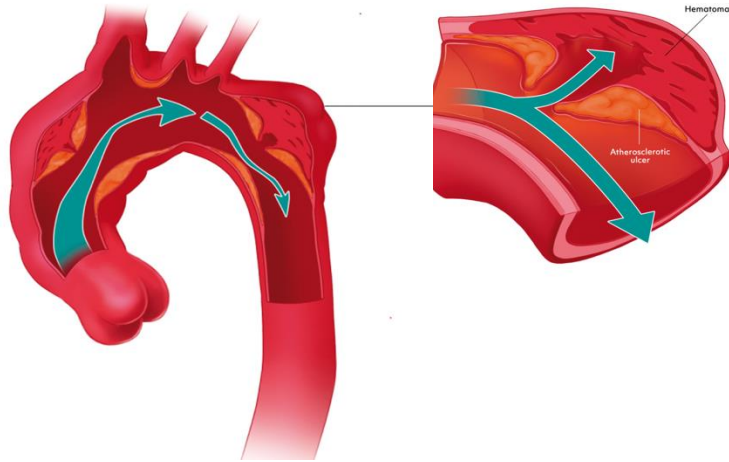
Bicuspid aortic valve aortopathy (BAVA) phenotypes



Aortic Guideline EACTS/STS 2024

EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ

Penetrierendes Aortenulkus (PAU)



Penetrating atherosclerotic ulcer

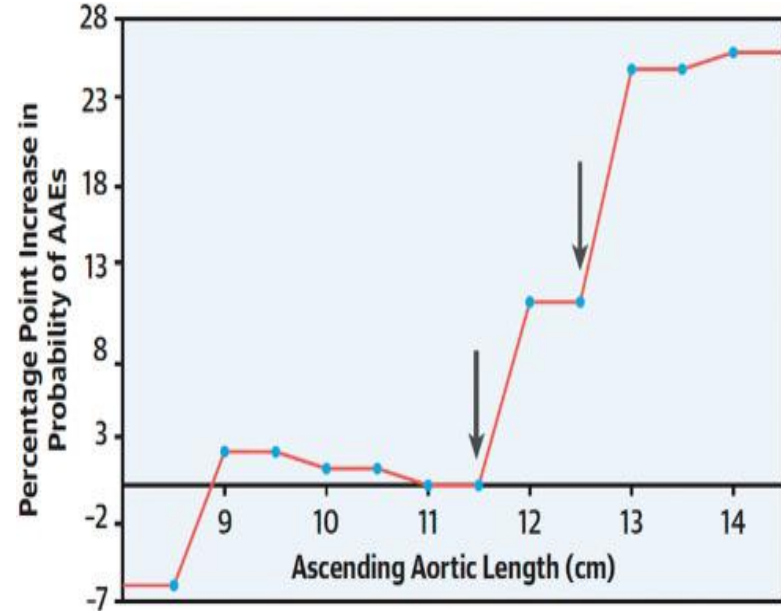
Recommendation Table 10. Acute Aortic Diseases: Penetrating Atherosclerotic Ulcer

| Recommendations | Class ^a | Level ^b | Ref ^c |
|--|--------------------|--------------------|------------------|
| In patients with PAUs in the ascending aorta and the presence of IMH or rupture, urgent aortic repair is recommended. | I | B | 289 |
| In patients with high-risk PAUs located in the distal arch or descending aorta, TEVAR should be considered if anatomically suitable. | IIa | B | 310 |
| In patients with high-risk PAUs located in the distal arch or descending aorta unsuitable for TEVAR, open surgical repair should be considered after careful evaluation of operative risk. | IIa | B | 311 |

Aortic Guideline EACTS/STS 2024

EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ

Aortic Lengths



Aortic Guideline EACTS/STS 2024

EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ

Thresholds for intervention in aortic root and ascending aortic aneurysm

Tricuspid aortic valve (TAV)

Thresholds ascending phenotype:

- ≥ 55 mm (I)
- ≥ 52 mm (IIa)
- ≥ 50 mm in low-risk patients with RF* (IIb)
- ≥ 45 mm when undergoing AV surgery (IIa)



Thresholds root phenotype:

- ≥ 55 mm (I)
- ≥ 50 mm in low-risk patients (IIa)
- ≥ 45 mm when undergoing AV surgery (IIa)



Bicuspid aortic valve (BAV)

Thresholds ascending phenotype:

- ≥ 55 mm (I)
- ≥ 52 mm (IIa)
- ≥ 50 mm in low-risk patients with RF (IIa)
- ≥ 45 mm when undergoing AV surgery (IIa)



Thresholds root phenotype:

- ≥ 50 mm (I)
- ≥ 45 mm when undergoing AV surgery (IIa)



*Risk factors (RF)



Length of ascending aorta ≥ 11 cm



> 3 mm diameter increase per year



Height < 1.69 m



Age < 50 years old



Arterial hypertension

Aortic Guideline EACTS/STS 2024

EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ

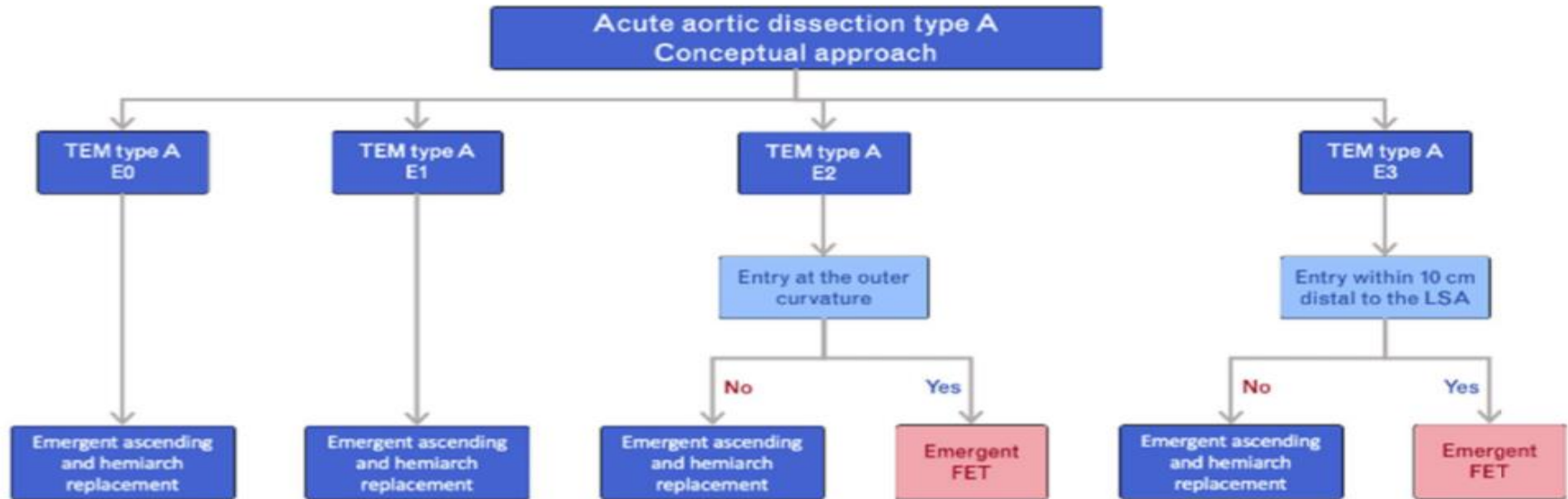


Figure 11: Extent of treatment for acute type A aortic dissection. E0, no entry visible; E1, ascending entry; E2, arch entry; E3 descending entry; FET: frozen elephant trunk; LSA: left subclavian artery; TEM: type, entry, malperfusion.

Aortic Guideline EACTS/STS 2024

EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ

Key Message:

- Aorta wurde als eigenständiges Organ deklariert
- Einheitliche Klassifikationen (TEM, GERAADA...)
- Konsensus über Operationsstrategien (Temperatur, Bogenanastomose..)
- Behandlung von komplexe Pathologien in spezialisierten Zentren
- Indikationsstellung hinsichtlich der Pathologie und Morphologie





Op-Indikation:


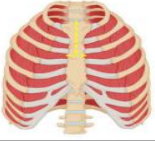
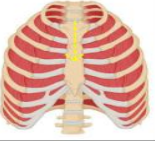

- **Aortenwurzel: BAV und TAV ab 45mm bzw. 50mm**
- **Aorta Aszendenz: ab 50mm**
- **Bei Risikofaktoren: ab 50mm**
- **Anatomische Besonderheiten: ab 50mm**
- **Prophylaktische Indikation: ab 50 mm (Patientenwunsch)**
- **Im Rahmen einer Herzoperation: ab 45mm**
 - MINIMAL INVASIVE AORTENCHIRURGIE?
 - AORTENBOGENSTENT?

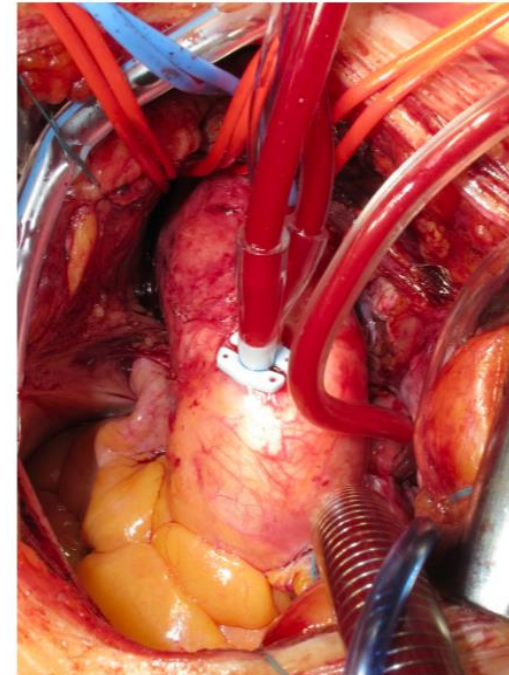
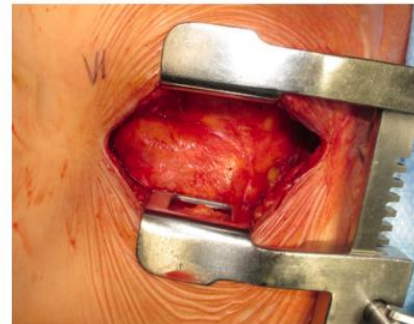
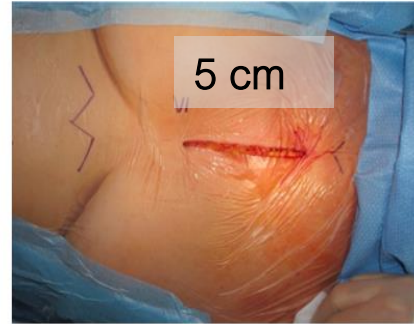
Minimalinvasive Aorten Chirurgie

Review

Expanding the Minimally Invasive Approach towards the Ascending Aorta—A Practical Overview of the Currently Available Techniques

Florian Helms , Bastian Schmack, Alexander Weymann, Jasmin Sarah Hanke, Ruslan Natanov ,
Andreas Martens , Arjang Ruhparwar and **Aron-Frederik Popov** 

| | J-shaped upper hemisternotomy | T-shaped upper hemisternotomy | V-/ Arrow-shaped hemisternotomy | Right anterior/ lateral thoracotomy |
|---------------|--|--|---|---|
| schematic |  |  |  |  |
| advantages | <ul style="list-style-type: none"> • Frequently used, largest experience • lowest sternal trauma among hemisternotomies • Good horizontal stability | <ul style="list-style-type: none"> • Excellent exposure for complex aortic morphologies • Facilitates direct arterial and venous cannulation and venting | <ul style="list-style-type: none"> • Excellent exposure for complex aortic morphologies • Facilitates direct arterial and venous cannulation and venting • Better horizontal stability compared to T-shaped hemisternotomy | <ul style="list-style-type: none"> • Avoids sternal trauma • Immediate postoperative load stability of the thorax |
| disadvantages | <ul style="list-style-type: none"> • Limited exposure for abnormal ascending aorta and aortic arch positions | <ul style="list-style-type: none"> • relatively extensive sternal trauma • Low horizontal / translational stability | <ul style="list-style-type: none"> • relatively extensive sternal trauma | <ul style="list-style-type: none"> • Selective antegrade cerebral perfusion is not possible |
| references | Haunschild 2022 Kaneko 2012 Tabata 2007 Svensson 2001 Byrne 2000 | Haunschild 2022 | Stramolynski 2020 | LaPierta 2017 Lamelas 2018 |

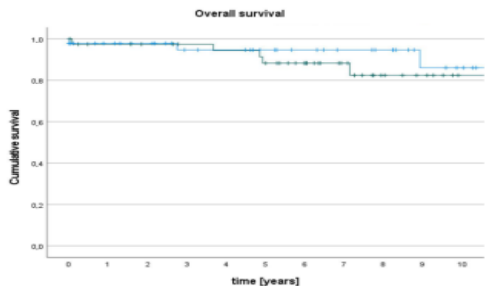


Minimal invasiver Aortenbogenersatz (FET)

Article

Minimally Invasive Approach for Replacement of the Ascending Aorta towards the Proximal Aortic Arch

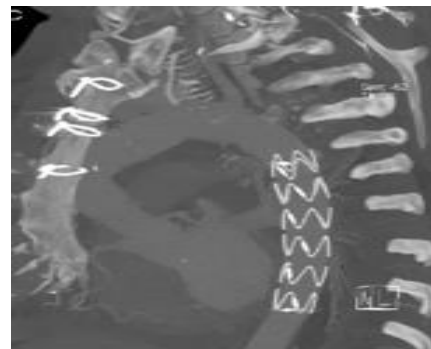
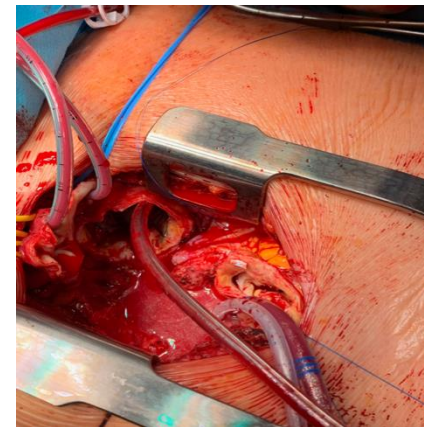
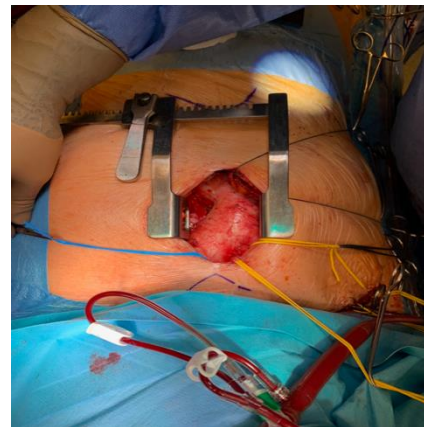
Florian Helms ^{1,*}, Ezin Deniz ^{1,†}, Heike Krüger ¹, Alina Zubarevich ¹, Jan Dieter Schmitto ¹, Reza Poyanmehr ¹, Martin Hinteregger ¹, Andreas Martens ², Alexander Weymann ¹, Arjang Ruhparwar ¹ and Bastian Schmack ^{1,†} and Aron-Frederik Popov ^{1,†}



| Patients at risk | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|----------------------------------|----|----|----|----|----|---|---|---|---|---|----|
| Ascending aorta replacement | 46 | 36 | 31 | 24 | 19 | 7 | | | | | |
| Proximal aortic arch replacement | 40 | 35 | 32 | 23 | 12 | 3 | | | | | |

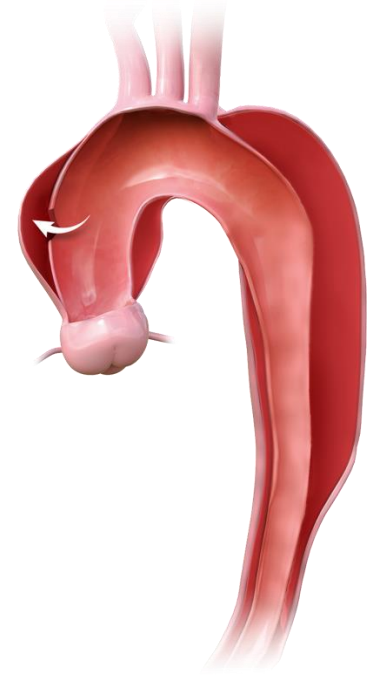
— Ascending aorta replacement — Proximal aortic arch replacement
 + Ascending aorta replacement - censored + Proximal aortic arch replacement - censored

Figure 1. Kaplan–Meier analysis of long-term overall postoperative survival after isolated ascending aorta replacement (blue) or concomitant hemiarch replacement (green). Censored data are marked by horizontal lines.



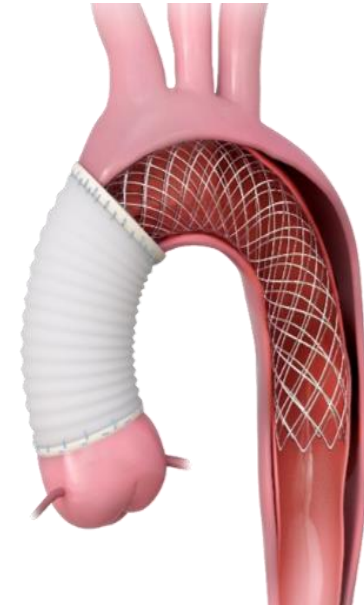
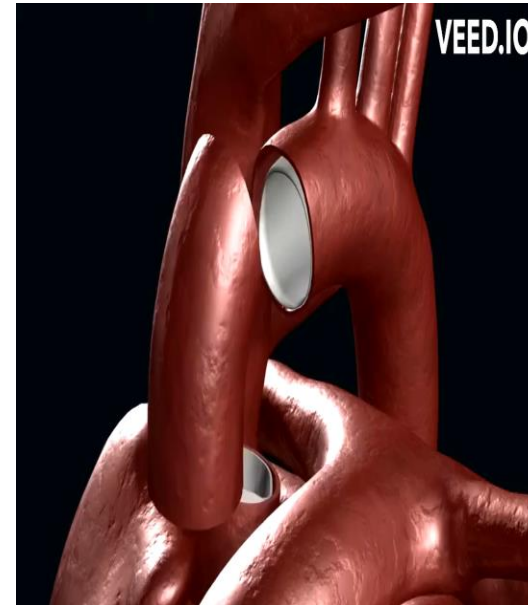
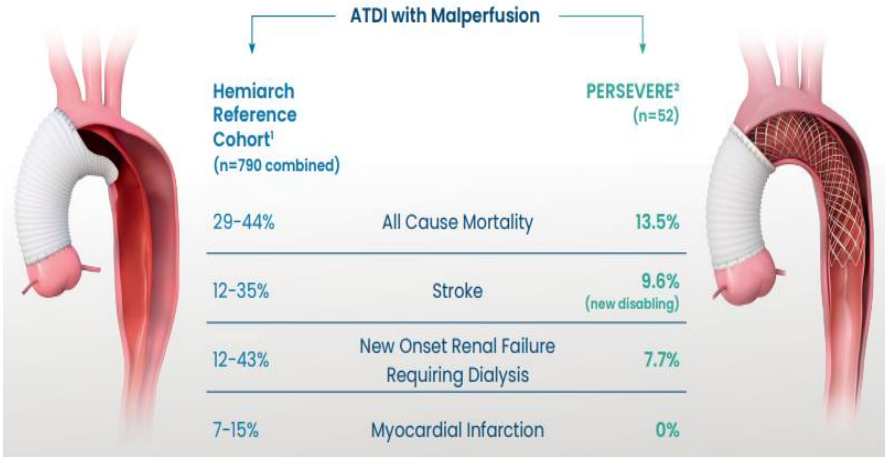
Aortendissektion mit Malperfusion

- Hemiarch repair remains the standard of care for acute DeBakey type I (ADTI) dissection with a primary entry tear in the ascending aorta
- Rates of early major adverse events (MAEs) are especially high in patients who present with malperfusion:
 - Mortality: 29-44%
 - Stroke: 12-35%
 - Renal Failure: 12-43%
 - Myocardial Infarction: 7-15%



AMDS Hybridprothese

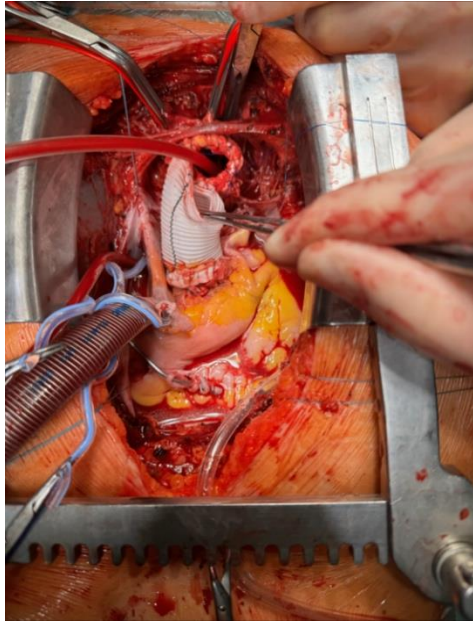
Results: Primary 30-day MAE Endpoint



ARTIVION | AMDS™
Hybrid Prosthesis*

Figure: Implanted AMDS device

AMDS Hybridprothese



ARTIVION | **AMDS™**
Hybrid Prosthesis*

Aortic Guideline EACTS/STS 2024

EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ

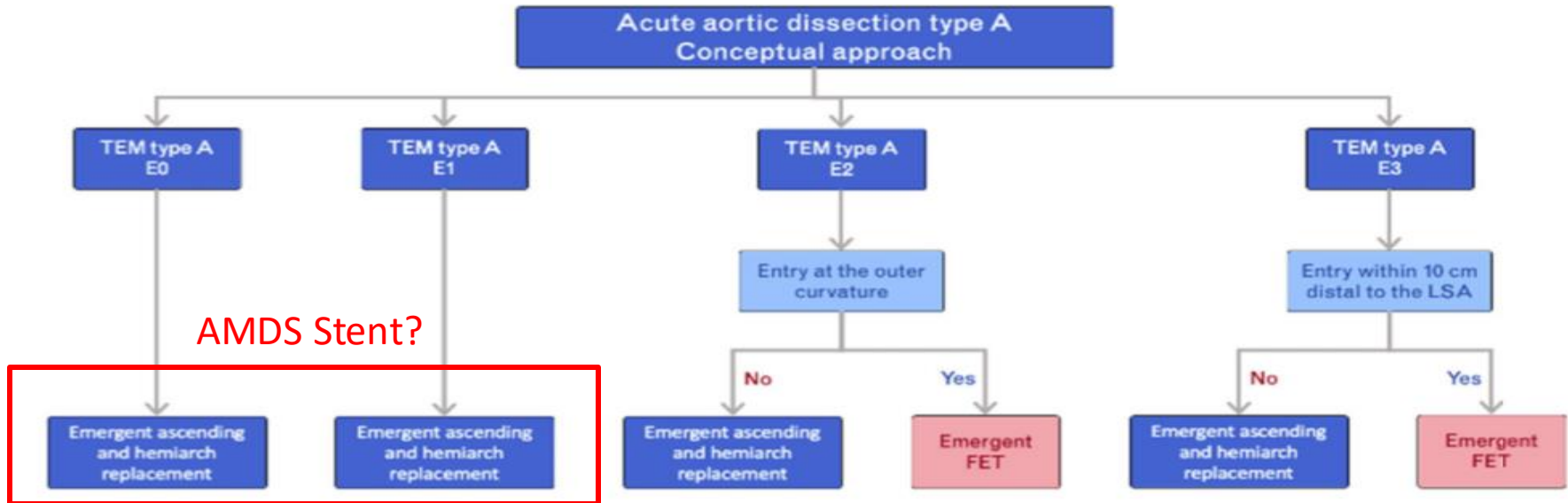


Figure 11: Extent of treatment for acute type A aortic dissection. E0, no entry visible; E1, ascending entry; E2, arch entry; E3 descending entry; FET: frozen elephant trunk; LSA: left subclavian artery; TEM: type, entry, malperfusion.

Herzlichen Dank für Ihre Aufmerksamkeit

Prof. Dr. med. Aron-Frederik Popov

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