ANGIO UPDATE **2024**

15. und 16. März

Thorakale Aortenerkrankungen

Dittmar Böckler, Heidelberg

Interessenkonflikte

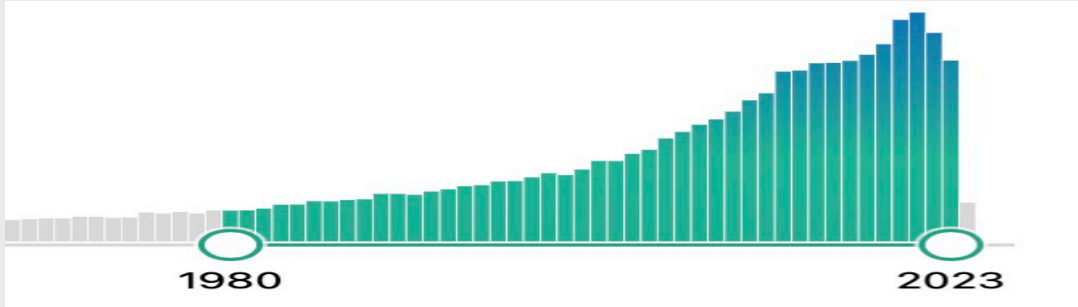
Forschungsunterstützung: Brainlab, DFG, Dietmar Hopp Stiftung, Siemens, Stiftung Chirurgie Heidelberg

Vortragstätigkeit: Abbott, Artivion, Cook, Gore

Beratertätigkeit: Arterica, Artivion, Brainlab, Endologix, Gore, Siemens

Methodik zum Update

- **Pub Med Recherche: “thoracic aortic disease“** https://pubmed.ncbi.nlm.nih.gov/?term=thoracic+aortic+disease+AND+2023&sort=date
- **Publikationen 2023: N=1846**



- **15 Publikationen**
- **Auswahl durch 10 Fachärzte für Gefäßchirurgie**

Thorakale Aortenerkrankungen

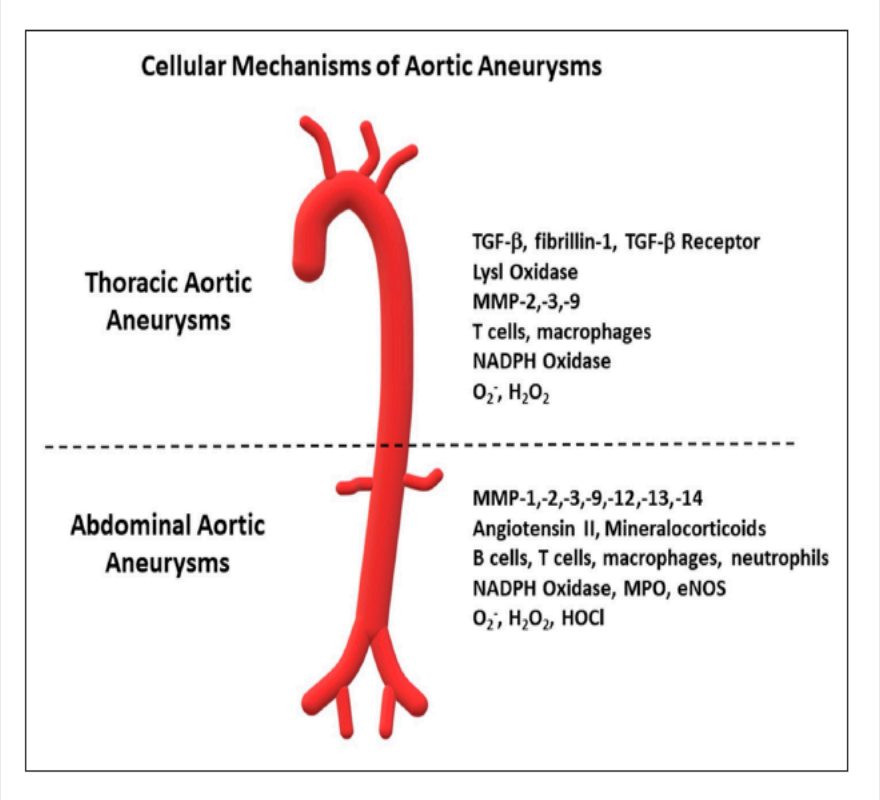
- **Pathogenese thorakaler Aortenpathologien**
  - Aortitis
- **Akutes Aortensyndrom**
  - Aortendissektion Stanford Typ B
  - Intramurales Hämatom
  - Penetrierendes Aortenulcus
- **Aortenbogenerkrankungen**
- **Endovaskuläre Therapie genetischer Aortensyndrome**
  - Marfansyndrom, Ehlers Danlos, Loeys Dietz Syndrom

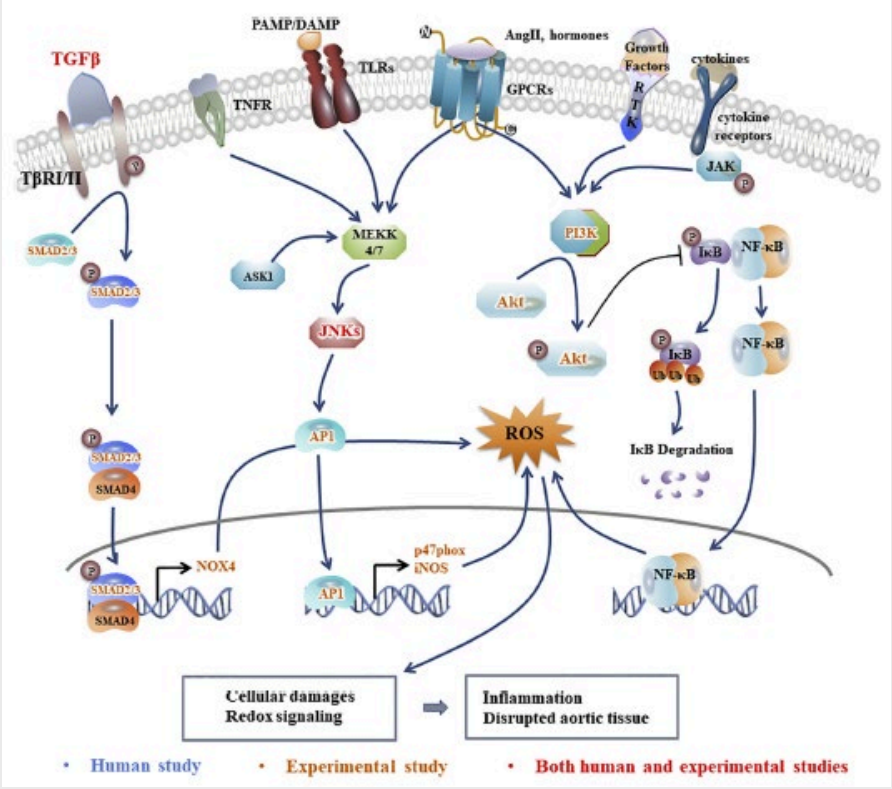
Neues zur Pathogenese thorakaler Aortenpathologien

State of the Art – Pathogenese

Aneurysma-Bildung bei Gefäßen

Quintana RA et al. Circulation Research 2020;124:607-618



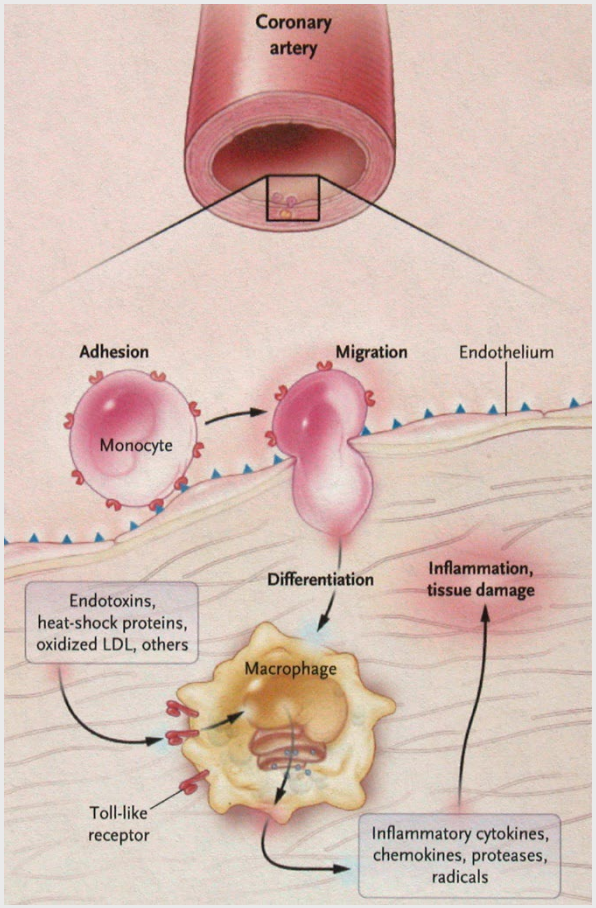


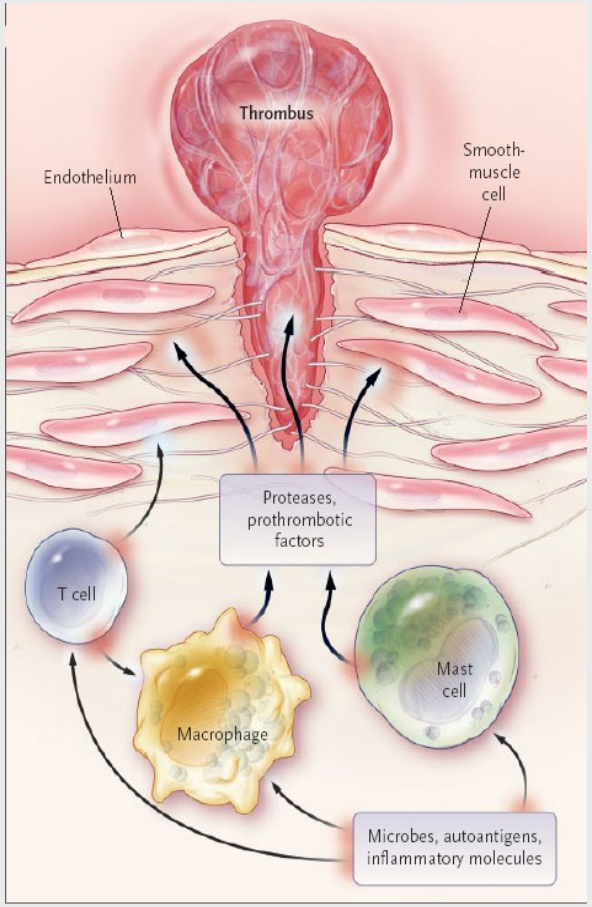
Metalloproteinasen MMP1,9,13- Renin-Angiotensin Mechansimus- oxidativer Stress

State of the Art – Pathogenese

Arteriosklerose und Inflammation

Hansson G, N Eng J Med, 2005;352:685-695





Inflammation- Typen

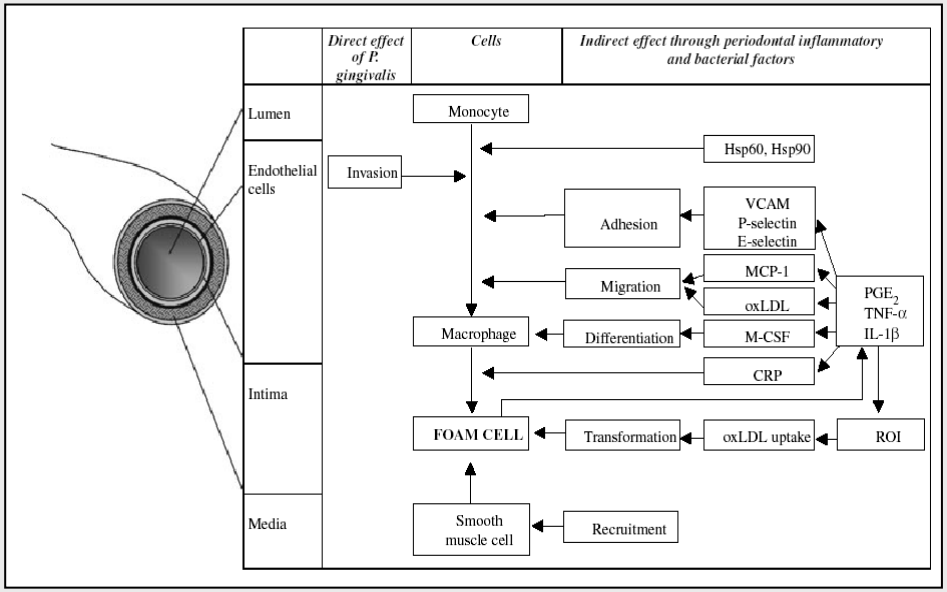
Cox K. et al. **Vascular. 2023 Apr;31(2):257-265.**

- Mykotische Aneurysmen
- Mikrobielle Aortitis
- Infektion eines präexistierendenAneurysmas
- Post-traumatisches falsches Aneurysma
- Aorteninfektion durch Sepsis

Nicht bakterielle Aortitis

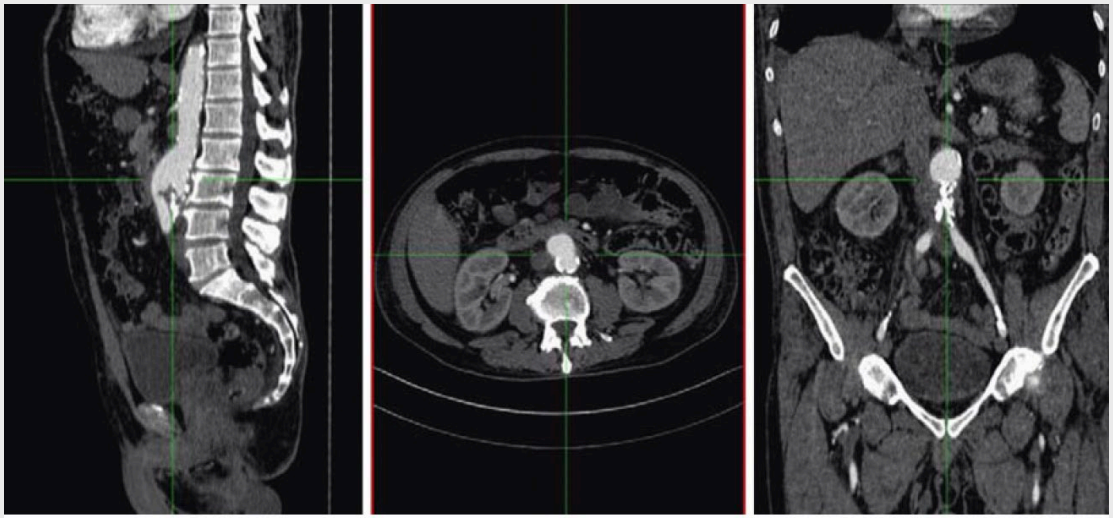
Cox K. et al. **Vascular. 2023 Apr;31(2):257-265.**

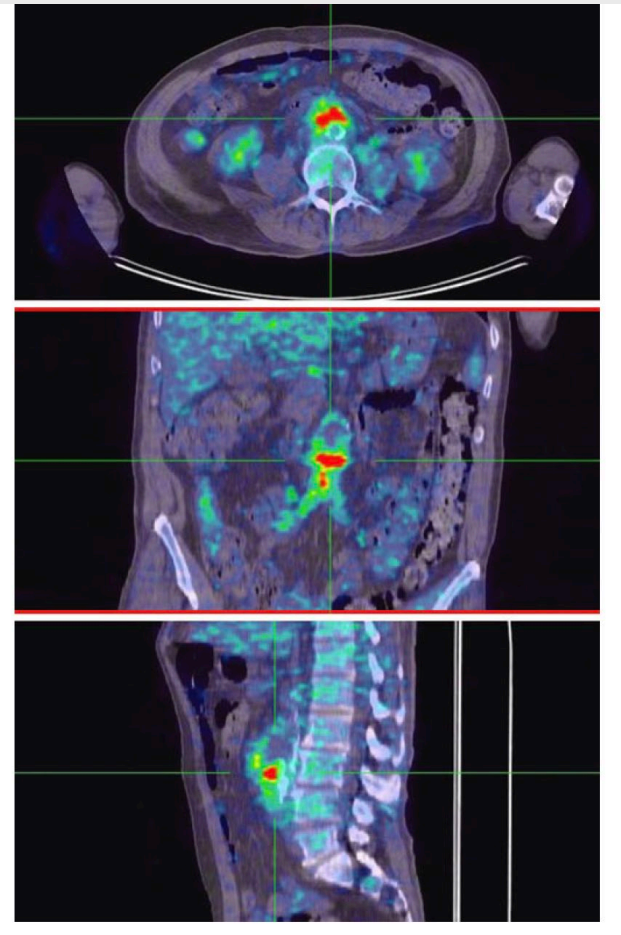
- Th1 Cytokine (IFN-gamma)
- Frühe Arteriosklerose - Induktion



Diagnostik

Kilk K, Böckler D. et al. Chirurg 2010;81:653-656

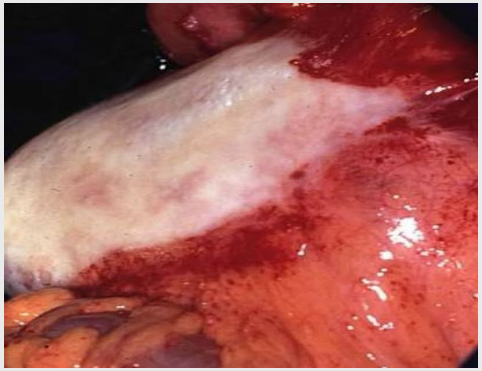


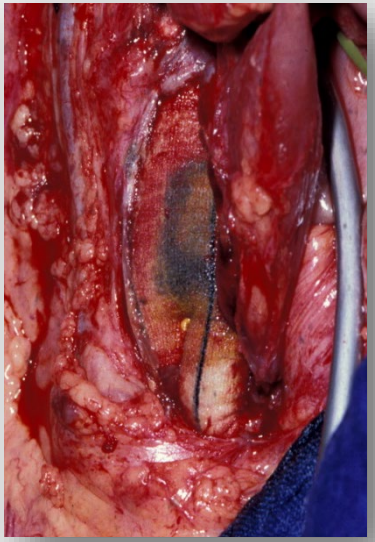


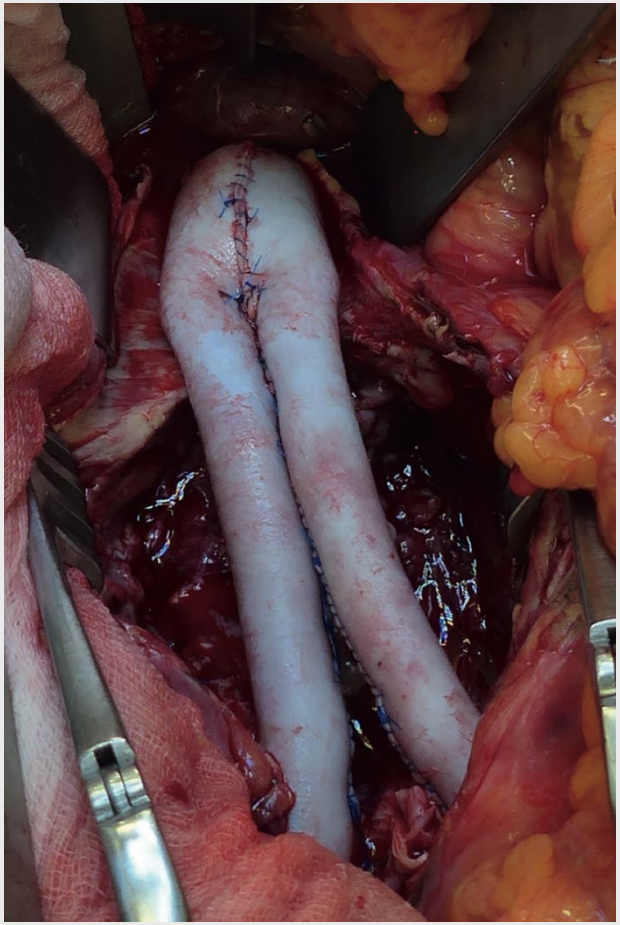
	Sensitivität (%)	Spezifität (%)
Sonographie [12]	„Accuracy“ 38	–
CT [3]	64	86
MRT	Keine genauen Angaben	
Szintigraphie [8]	75	90
PET [3]	91	64
^{18}F-FDG-PET/CT [4]	93	91

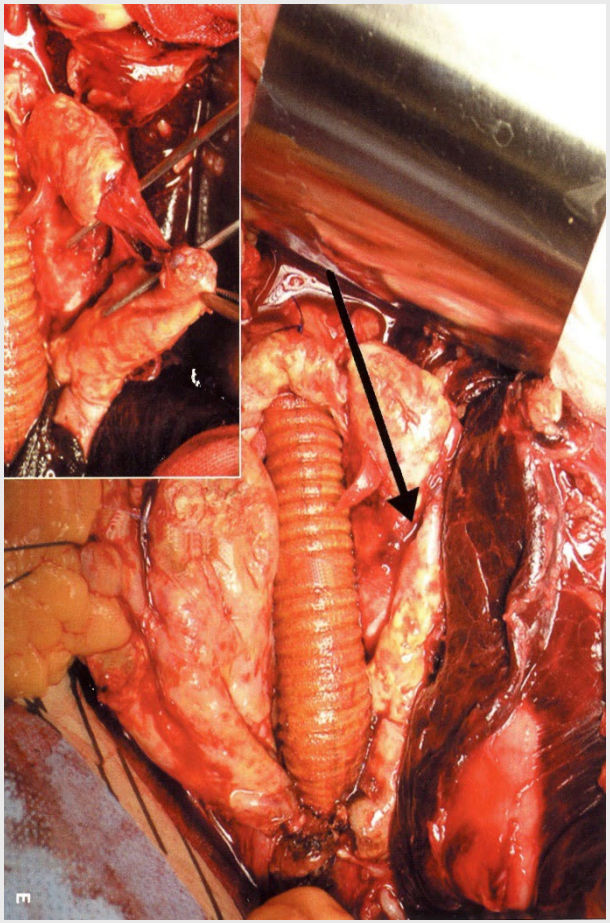
Therapie: Chirurgie

Bildquellen: Böckler D., Heidelberg



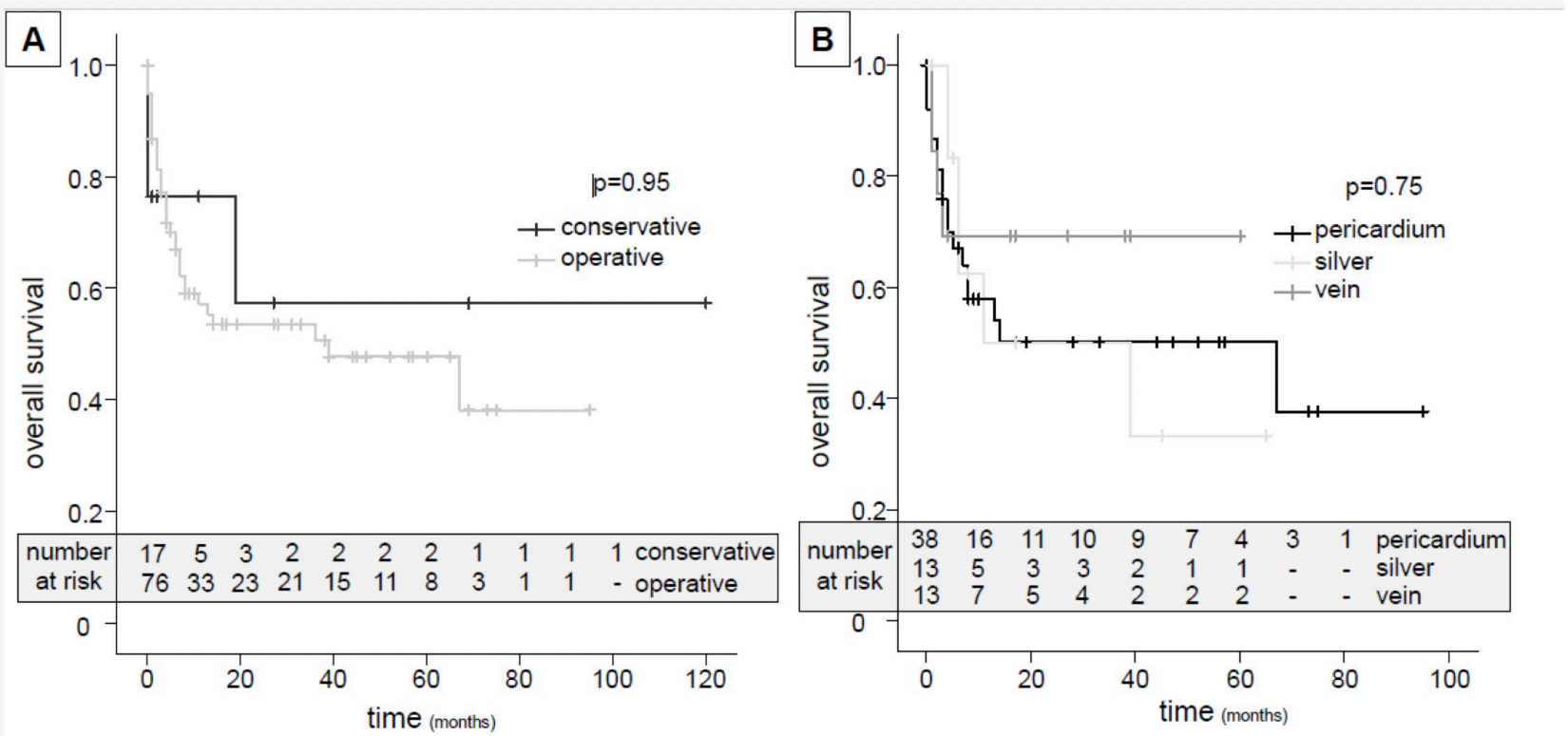






Therapie: Chirurgie

Quelle: Puttini I. et al., J Clin Med 2024;13:269

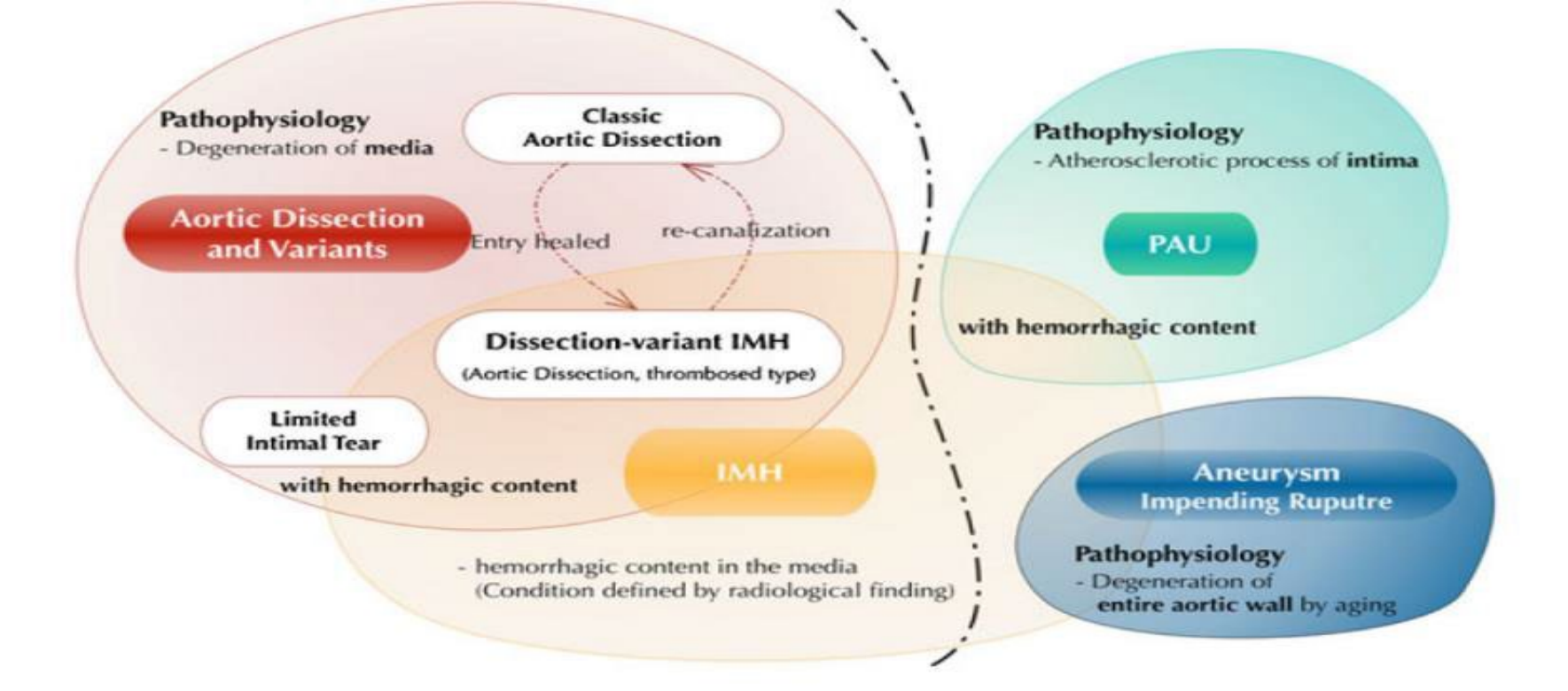


Fazit für Klinik und Praxis

- infektiös > testgerechte Antibiose
- nicht-infektiös > Kortison i.v.
- In 55 der Fälle % zusätzlich Methotrexat
- Diagnostik: PET-CT (höchste Spezifität)
- Chirurgische Therapie: Methode der 1. Wahl
- Vene > Prothese = bovines Perikard
- Keine Leitlinienempfehlung vorhanden
- Prognose bei früher Diagnosestellung besser
- Mortalität: 30-50%

Akutes Aortensyndrom

State of the Art



<u>Akute Aortensydnrom</u>: Aortendissektion, intramurales Hämatom (IMH) und penetrierendes Aortenulcus (PAU)

Aortendissektion Stanford Typ B

State of the Art – Aortendissektion Typ B

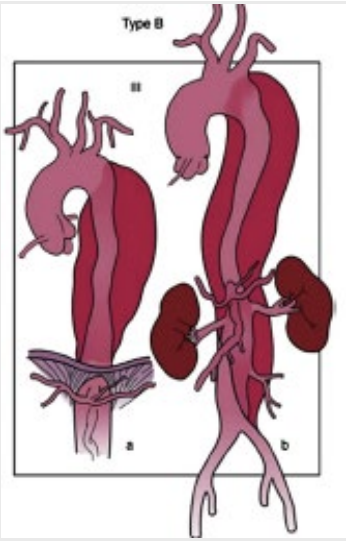
Eur J Vasc Endovasc Surg (2017) 53, 4–52

Editor's Choice — Management of Descending Thoracic Aorta Diseases

Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS)

Writing Committee [a] V. Riambau, D. Böckler, J. Brunkwall, P. Cao, R. Chiesa, G. Coppi, M. Czerny, G. Fraedrich, S. Haulon, M.J. Jacobs, M.L. Lachat, F.L. Moll, C. Setacci, P.R. Taylor, M. Thompson, S. Trimarchi, H.J. Verhagen, E.L. Verhoeven, ESVS Guidelines Committee [b] P. Kolh, G.J. de Borst, N. Chakfé, E.S. Debus, R.J. Hinchliffe, S. Kakkos, I. Koncar, J.S. Lindholt, M. Vega de Ceniga, F. Vermassen, F. Verzini, Document Reviewers [c] P. Kolh, J.H. Black III, R. Busund, M. Björck, M. Dake, F. Dick, H. Eggebrecht, A. Evangelista, M. Grabenwöger, R. Milner, A.R. Naylor, J.-B. Ricco, H. Rousseau, J. Schmidli

Keywords: Clinical practice, Descending thoracic aorta, Descending thoracic aortic management, Guideline, Recommendations, Thoracic aorta abnormalities, Thoracic aorta diseases, Thoracic aorta disorders, Thoraco-abdominal aorta



Recommendation 13	Class	Level of evidence	References
Medical therapy should always be part of the treatment of patients with acute type B dissection	I	C	55,56,60,65,70,77–79
Recommendation 14			
In patients with acute type B aortic dissection, β-blockers should be considered as the first line of medical therapy	IIa	C	79,83,84
Recommendation 15			
In patients with acute type B aortic dissection who do not respond or are intolerant of β-blockers, calcium channel antagonists and/or renin-angiotensin inhibitors may be considered as alternatives or complementaries	IIb	C	79,83

Ref.: ESVS Guidelines (EJVES 2017;46:175-189)

LEITLINIENEMPFEHLUNG: unkomplizierte B-Dissektion > konservative Therapie, sog. best medical treatment (BMT)

Neues zur Epidemiologie der Aortendissektion

Carrel T. et al. Acute aortic dissection. Lancet. 2023 Mar 4;401(10378):773-788

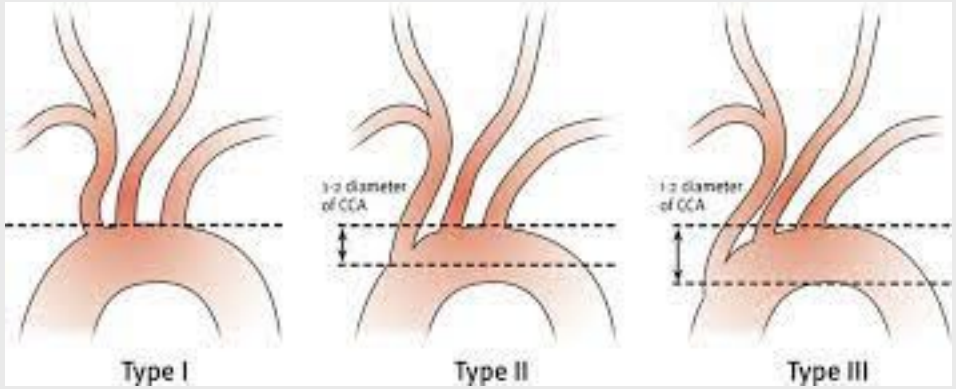
- Inzidenz : 3-16 auf 100.000 (pro Jahr
- Männer 2x häufiger als Frauen (später im Leben)
- Frauen 2-fach erhöhte Prähospital-Sterblichkeit
- Erhöhtes Risiko bei Einnahme: Fluoroquinolone, Kokain, Glukokortikoide, Zytostatika

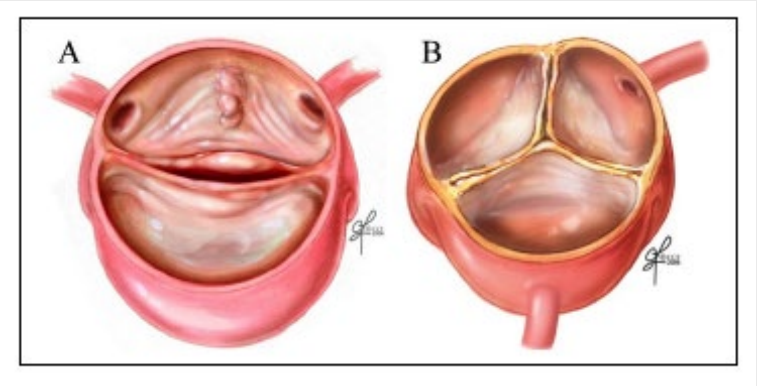
Morphologische Prädiktoren:

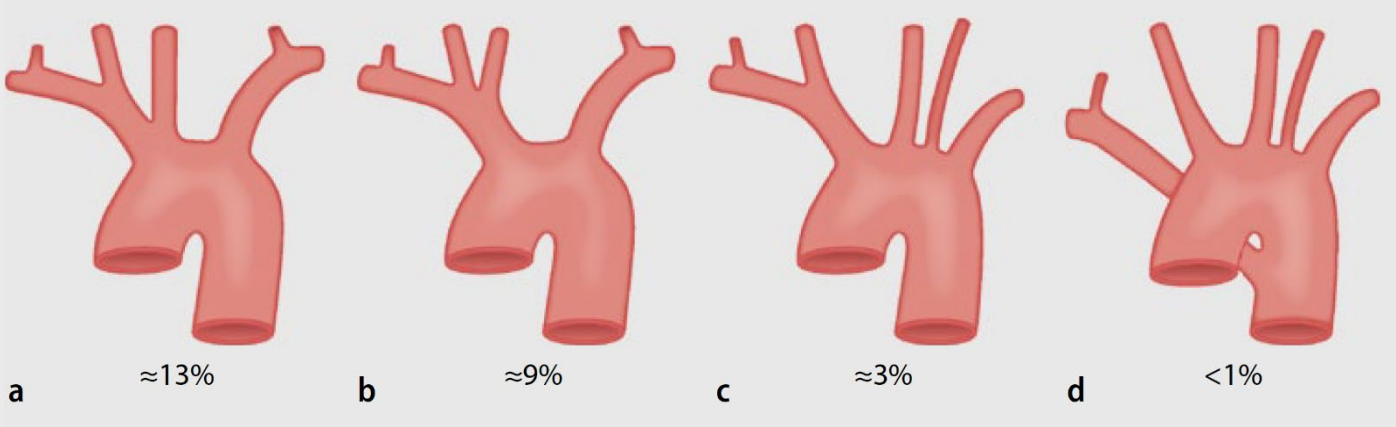
- Aortendurchmesser > 5.5cm bei 18.4% aller Pat.
- Aortenbogen Typ 3
- Truncus bicaroticus
- Bicuspidale Aortenklappe

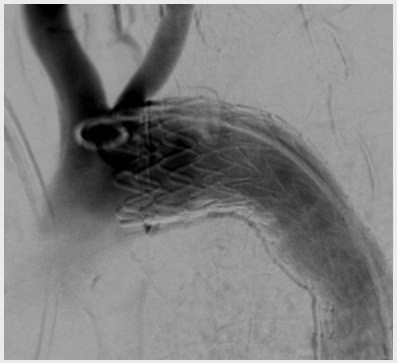
Morphologische Prädiktoren

Carrel T. et al. Acute aortic dissection. Lancet. 2023 Mar 4;401(10378):773-788









Harlan BJ, Starr A, Harwin FM: Manual of cardiac surgery. Volume II. Springer Verlag New York (1980)
Böckler D Kolvenbach R. Gefäßchirurgie 2013;18:415-18

Medikamentöse Therapie

Kreibich M. et al. Intervention rates and outcomes in medically managed uncomplicated descending thoracic aortic dissections. J Thorac Cardiovasc Surg. 2023 Mar;165(3):958-965

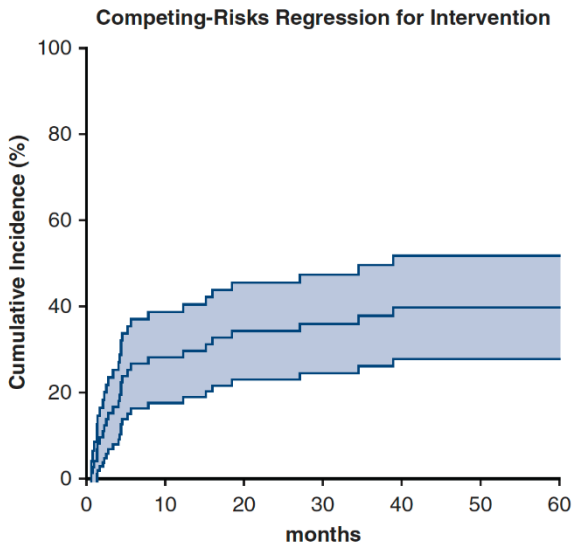


FIGURE E1. Competing risk regression for aortic intervention (competing risk: death) in patients who were discharged with a medically managed uncomplicated type B aortic dissection (without arch involvement). The risk for aortic intervention was 29 ± 11% and 38 ± 12% after 1 and 3 years, respectively. The 95% confidence interval is depicted.

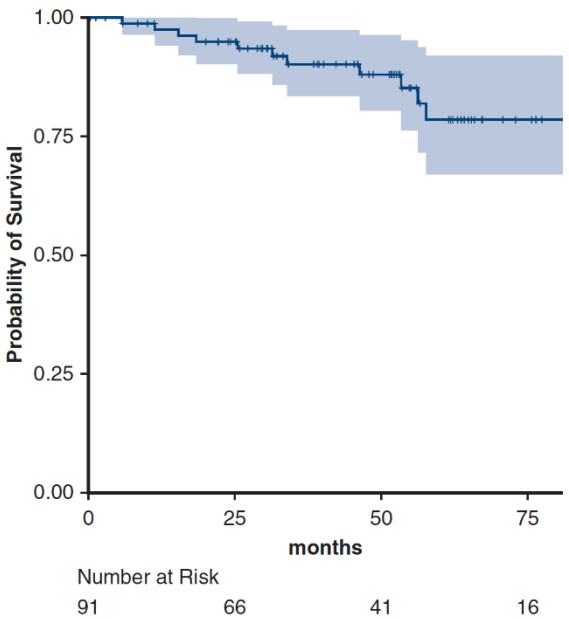


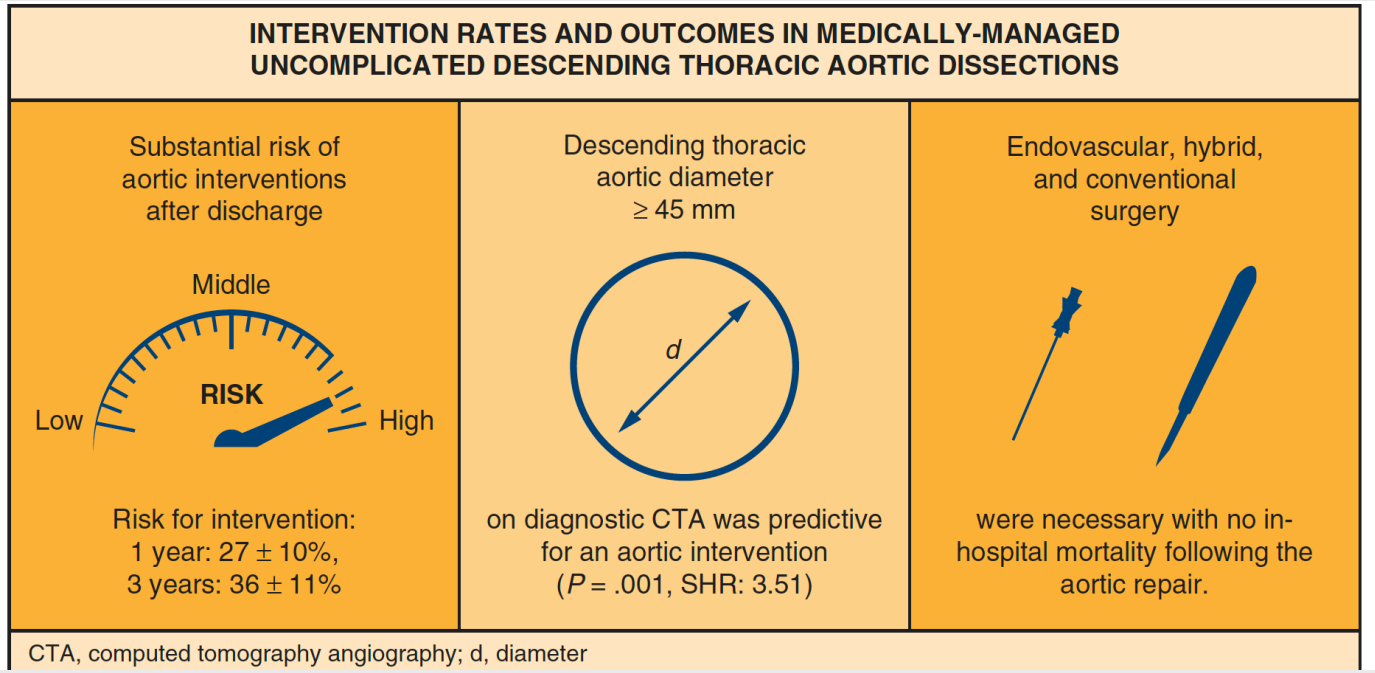
FIGURE E2. Kaplan–Meier analysis of overall survival in patients who were discharged with a medically managed uncomplicated descending thoracic aortic dissection. The 95% confidence intervals are depicted.

Risiko einer Intervention: 27% nach 1 J. und 36% nach 3 J.

Aortendurchmesser > 45 mm = unabhängiger Risikofaktor

Konservative Therapie der B-Dissektion

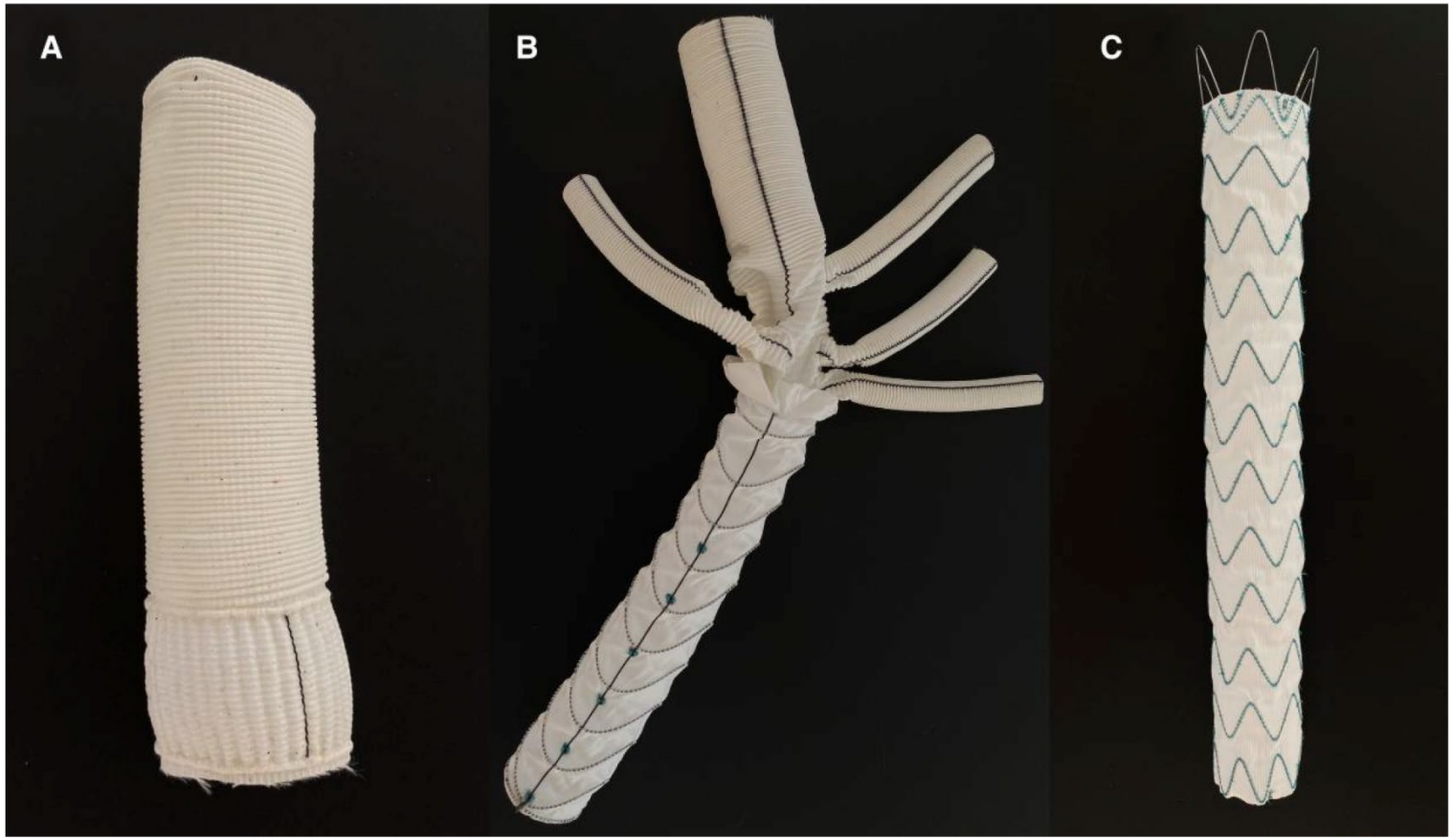
Kreibich M. et al. Intervention rates and outcomes in medically managed uncomplicated descending thoracic aortic dissections. J Thorac Cardiovasc Surg. 2023 Mar;165(3):958-965



- Hohe Wahrscheinlichkeit für aortale Intervention (93% endovaskulär)
- Durchmesser > 45 mm = Risikofaktor
- Operative Rekonstruktionen: endovaskulär, offen, Hybrid

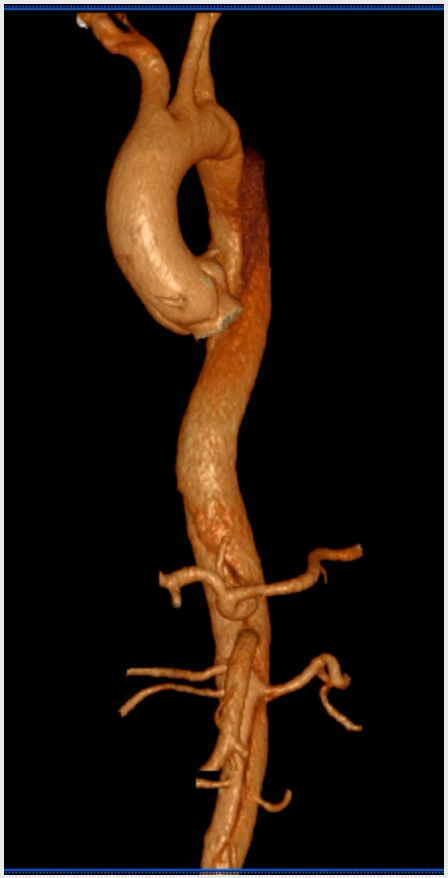
Rekonstruktionstechniken

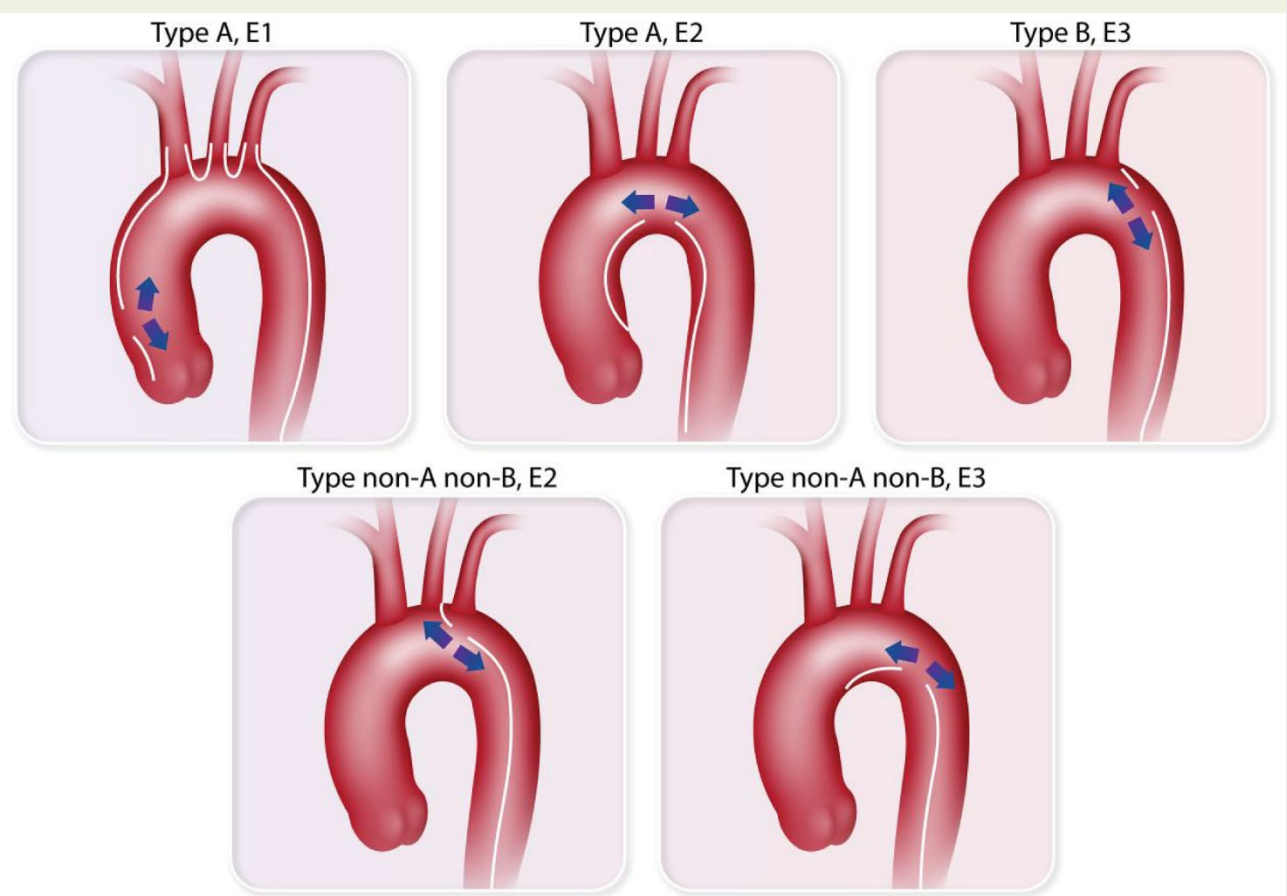
Rylski B. ***et al. Acute Aortic dissection: evidence, uncertainties and future therapies. Eur Heart J 2023;44:813-821***



Klassifikationen der Aortendissektion (Stanford)

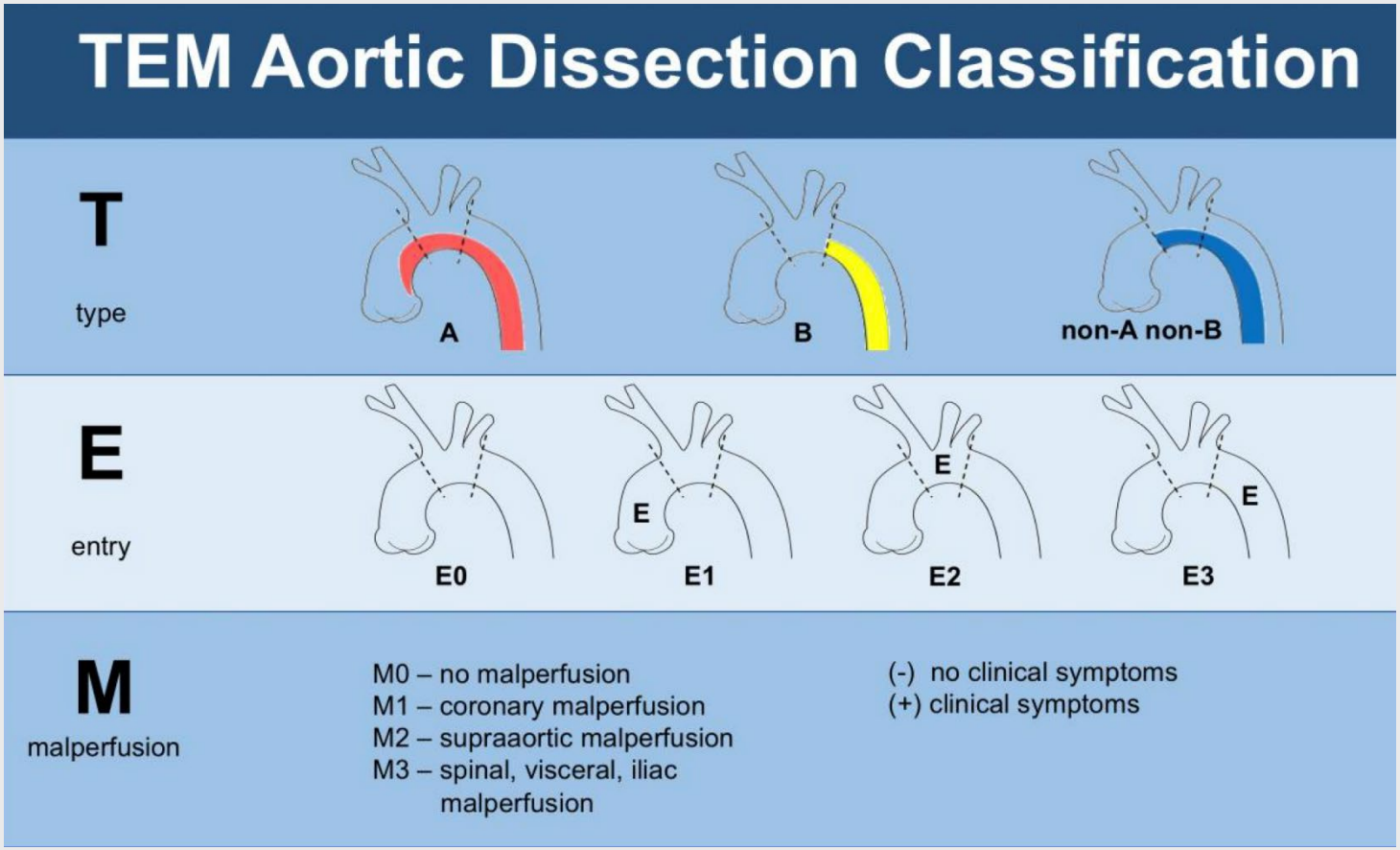
Rylski B. ***et al. Acute Aortic dissection: evidence, uncertainties and future therapies. Eur Heart J 2023;44:813-821***





Klassifikationen der Aortendissektion (TEM)

Rylski B. ***et al. Acute Aortic dissection: evidence, uncertainties and future therapies. Eur Heart J 2023;44:813-821***



Fazit für Klinik und Praxis

- B- Dissektion Inzidenz 16/100.000
- Frauen seltener aber höhere Mortalität
- Morphologische Prädiktoren im CT
- Medikamentöse Therapie bei unkompl. B- Dissektion
- Interventionswahrscheinlichkeit nach kons. Th. Hoch
- Mortalität nach BMT :25 % in 4 J.
- >Enges Follow-up mit CT-Angiographie
- Rolle der endovaskulären Therapie nimmt zu

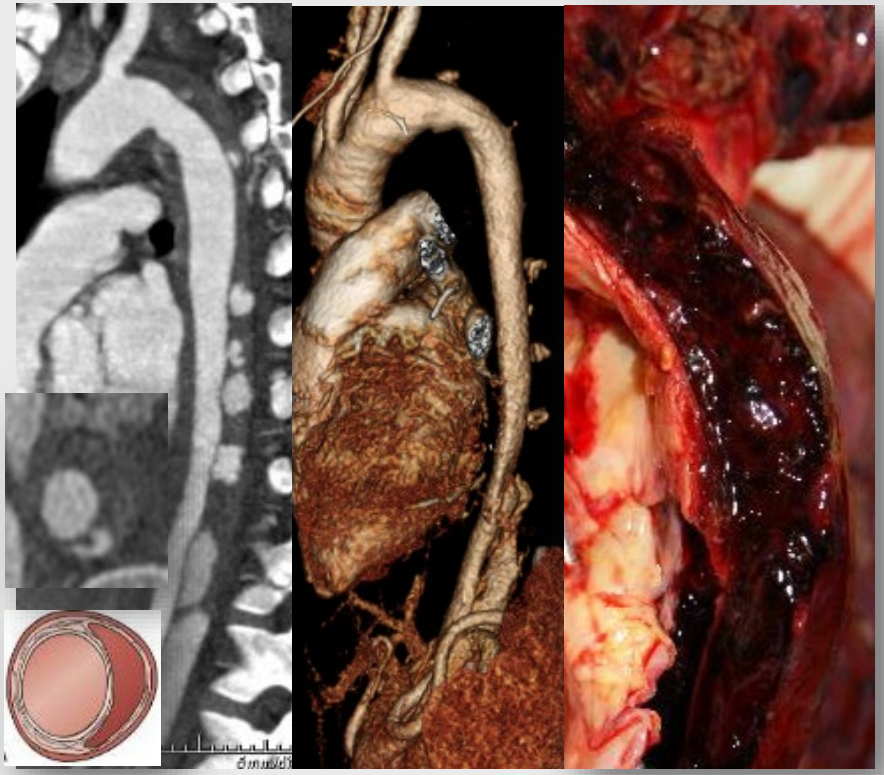
Intramurales Hämatom (IMH)

Hintergrundwissen IMH

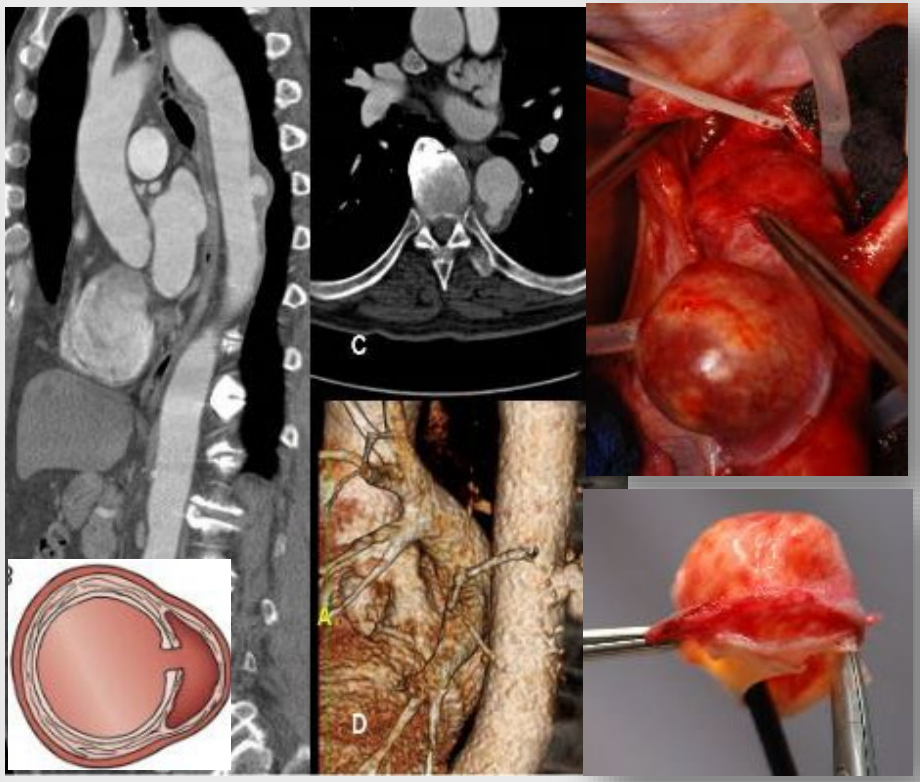
Nienaber CA Circulation 1995 and 2002 , [2] Cronenwett Rutherford's Texbook of Surgery , 7th Edition

- Erstbeschreibung durch Krukenberg 1920
- Ansammlung von Blut/Hämatom in der Mediaschicht Collection
- Spontanruptur der Vasa vasorum
- Mikroeinrisse der Intima
- Keine Dissektionsmembran, Falsches Lumen,
- IMH als Vorstufe des PAU

State of the Art



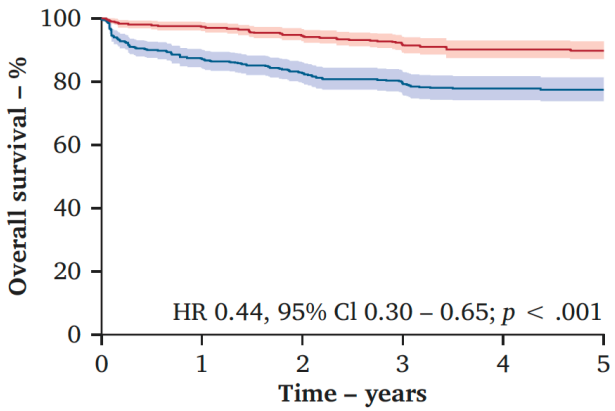
Intramurales Hämatom (IMH)



Penetrierendes Aortenulcus (PAU)

Medikament. Therapie vs. Endovaskulär bei IMH

Pompeu Sa et al. **Five Year Results of Endovascular versus Medical Therapy in Acute Type B Aortic Intramural Haematoma: Meta-Analysis of Reconstructed Time to Event Data. Eur J Vasc Endovasc Surg. 2023 Dec**



No. at risk						
Medical therapy	503	420	377	341	297	247
TEVAR	474	446	425	401	364	325
Standard error						
Medical therapy	0.00%	1.50%	1.71%	1.86%	1.91%	1.93%
TEVAR	0.00%	0.73%	1.05%	1.30%	1.40%	1.43%

Figure 3. Pooled Kaplan–Meier curves showing all-cause mortality following thoracic endovascular aortic repair (TEVAR) compared with medical therapy for type B intramural haematoma (IMH).

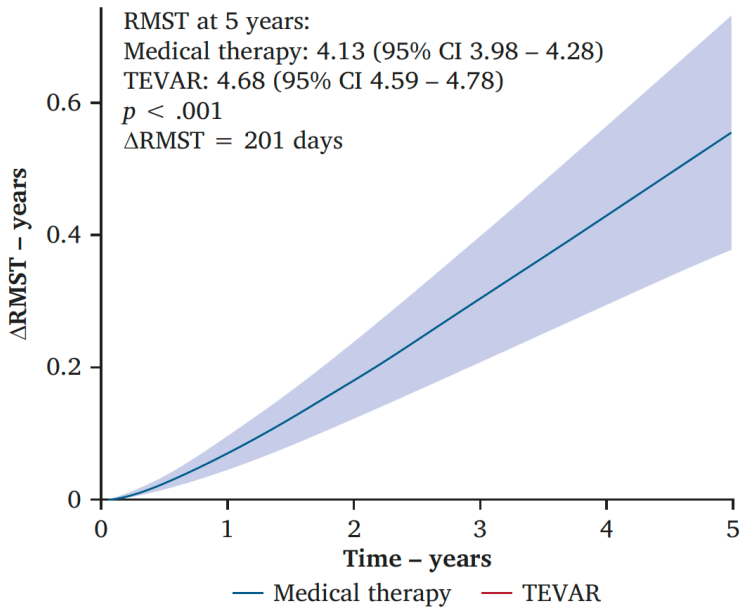


Figure 4. Restricted mean survival time (RMST) following thoracic endovascular aortic repair (TEVAR) compared with medical therapy for type B intramural haematoma (IMH). ΔRMST = difference in restricted mean survival time between TEVAR and medical therapy.

Metaanalyse von 8 Studien: 1015 Patienten

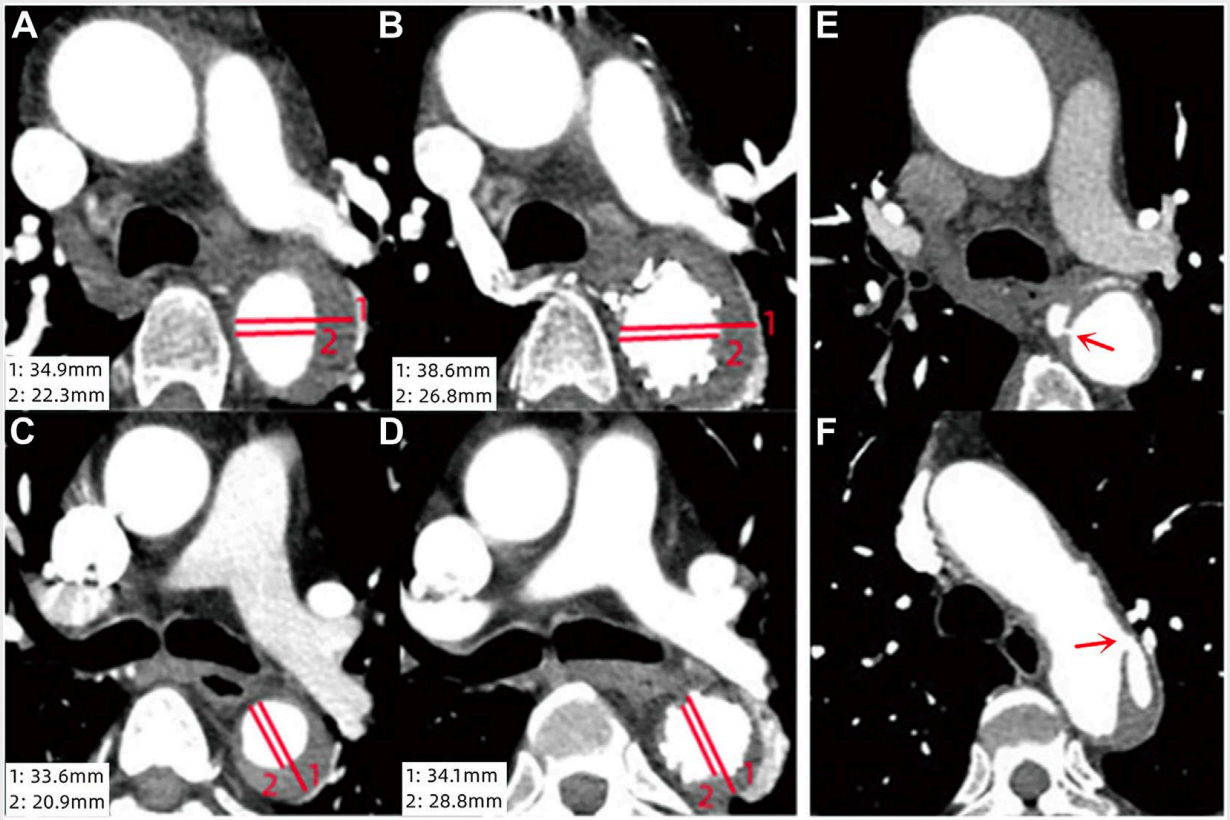
Medikament. Therapie vs. Endovaskulär bei IMH

Pompeu Sa et al. **Five Year Results of Endovascular versus Medical Therapy in Acute Type B Aortic Intramural Haematoma: Meta-Analysis of Reconstructed Time to Event Data. Eur J Vasc Endovasc Surg. 2023 Dec**

- TEVAR hat ein geringere 5 Jahres- Gesamt-Mortalität (HR 0.44)
- TEVAR reduziert signifikant die aorten-assoziierte Mortalität
- TEVAR verlängert signifikant die Lebenserwartung (201 Tage)

Optimaler Zeitpunkt - TEVAR bei IMH

Wang B et al. The Role of Endovascular Repair Timing in Uncomplicated Acute Type B Intramural Hematoma Management. Ann Vasc Surg. 2024 Feb;99:233-241



1

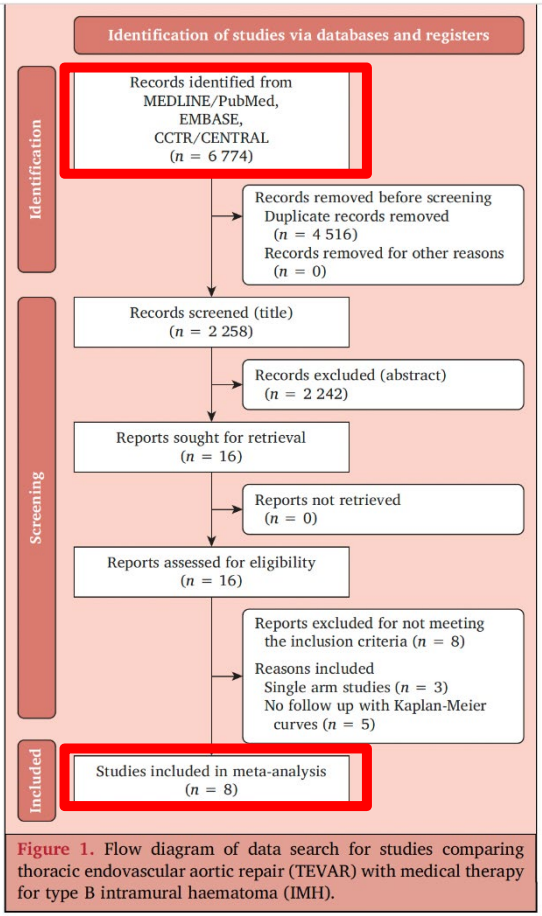
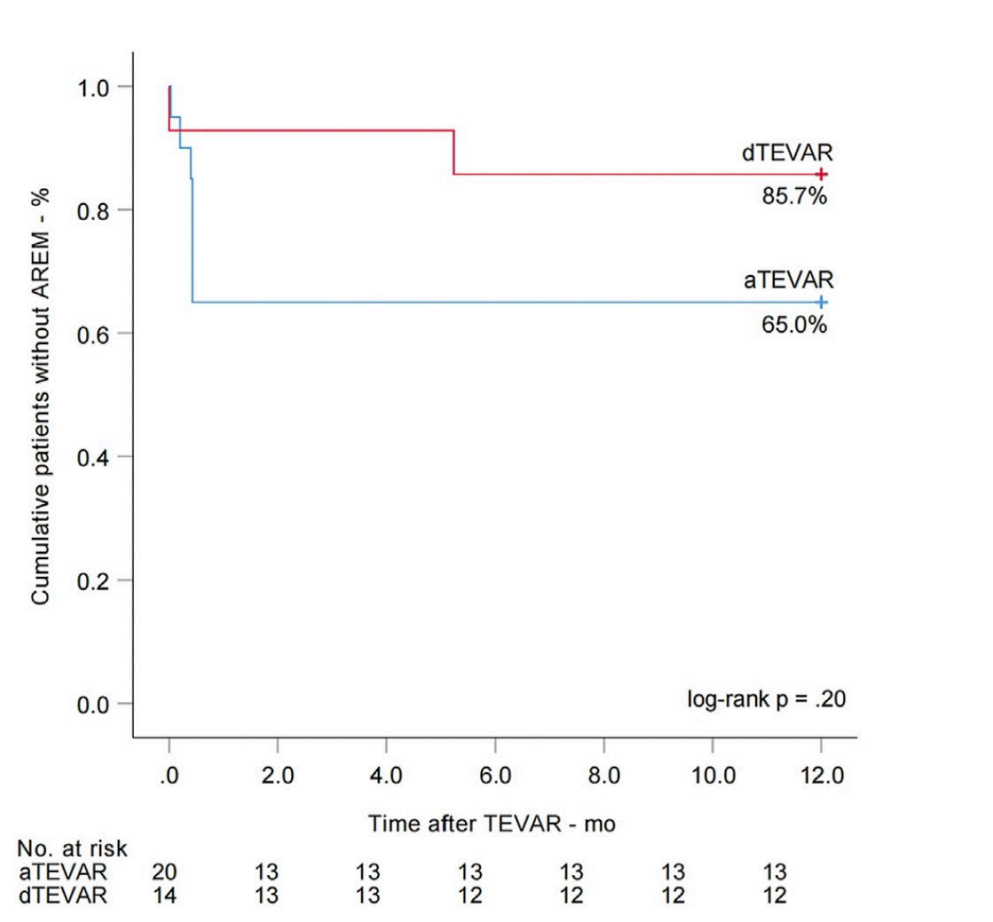


Figure 1. Flow diagram of data search for studies comparing thoracic endovascular aortic repair (TEVAR) with medical therapy for type B intramural haematoma (IMH).

Optimaler Zeitpunkt von TEVAR bei IMH

Wang B et al. The Role of Endovascular Repair Timing in Uncomplicated Acute Type B Intramural Hematoma Management. Ann Vasc Surg. 2024 Feb;99:233-241

- aTEVAR (Op zw. Tag 1-7)
- dTEVAR (Op zw. Tag 8-30)
- 1 Jahres –Follow Up
- Studienendpunkte:
  - Remodellierung der Aorta
  - Gesamtmortalität, aortale Komplikationen



1

Optimaler Zeitpunkt - TEVAR bei B-Dissektion

Saricilar EC et al. Optimal Timing of Thoracic Endovascular Aortic Repair for Uncomplicated Type B Aortic Dissection: A Systematic Review and Meta-Analysis. Eur J Vasc Endovasc Surg. 2023 Jun;65(6):851-860.

Metaanalyse (n= 3 Publikationen)
30 Tage - Ergebnisse

Zeitliche Phasen der B-Dissektion:

- Hyperakute Gruppe: < 2 Tage
- Akute Gruppe: 2-14 Tage
- Subakute Gruppe: 15-90 Tage
- Chronische Gruppe: > 90 Tage

Study or subgroup	Early Events	Early Total	Late Events	Late Total	Odds ratio M-H, random, 95% CI	Odds ratio M-H, random, 95% CI	Weight
Including hyperacute							
Torrent *et al.*[34]	26	446	0	242		30.56 [1.85, 503.78]	19.4%
VIRTUE Registry Investigators[35]	4	49	0	50		9.99 [0.52, 190.67]	18.1%
Xie *et al.*[38]	5	130	1	137		5.44 [0.63, 47.21]	26.3%
Subtotal (95% CI)		**625**		**429**		**10.26 [2.34, 45.08]**	**63.8%**
Total events	35		1				
Heterogeneity: Tau^2 = 0.00; Chi^2 = 1.09, df = 2 (p = .58); I^2 = 0%							
Test for overall effect: Z = 3.08 (p = .002)							
Excluding hyperacute							
Desai *et al.*[14]	3	70	0	18		1.92 [0.09, 38.82]	17.7%
Miyairi *et al.*[15]	0	97	5	283		0.26 [0.01, 4.74]	18.5%
Subtotal (95% CI)		**167**		**301**		**0.68 [0.08, 5.51]**	**36.2%**
Total events	3		5				
Heterogeneity: Tau^2 = 0.00; Chi^2 = 0.89, df = 1 (p = .35); I^2 = 0%							
Test for overall effect: Z = 0.36 (p = .72)							
Total (95% CI)		**792**		**730**		**4.02 [0.87, 18.66]**	**100.0%**
Total events	38		6				
Heterogeneity: Tau^2 = 1.12; Chi^2 =6.31, df = 4 (p = .18); I^2 = 37%							
Test for overall effect: Z = 1.78 (p = .08)							
Test for subgroup differences: Chi^2 = 4.31, df = 1 (p = .04), I^2 = 76.8%							

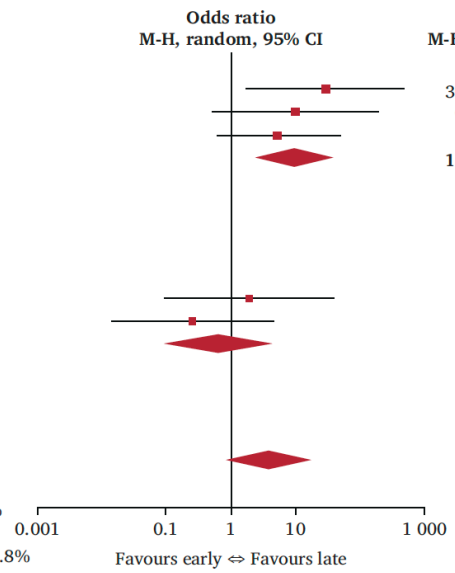


Figure 4. Forest plot of 30 day death of studies within the meta-analysis, including odds ratios and 95% confidence interval (CI) for subgroups where hyperacute was included or excluded. When both hyperacute and acute phase thoracic endovascular aortic repair (TEVAR) were combined, delayed intervention was clearly favoured, but exclusion of the hyperacute phase TEVAR demonstrated no significant difference. There was an I^2 score of 37%, suggesting moderate heterogeneity between studies.

Optimaler Zeitpunkt - TEVAR bei B-Dissektion

Saricilar EC et al. Optimal Timing of Thoracic Endovascular Aortic Repair for Uncomplicated Type B Aortic Dissection: A Systematic Review and Meta-Analysis. Eur J Vasc Endovasc Surg. 2023 Jun;65(6):851-860.

Metaanalyse (n= 3 Publikationen)
1-Jahres Ergebnisse

Zeitliche Phasen der B-Dissektion:

- Hyperakute Gruppe: < 2 Tage
- Akute Gruppe: 2-14 Tage
- Subakute Gruppe: 15-90 Tage
- Chronische Gruppe: > 90 Tage

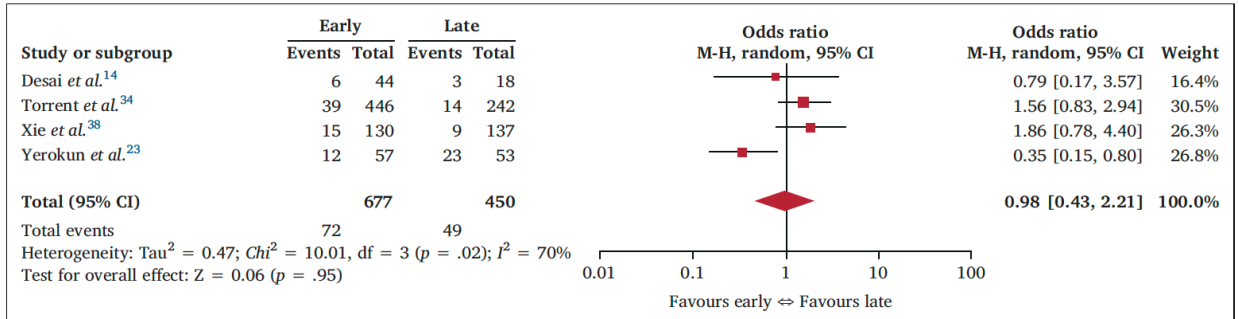


Figure 8. Forest plot of one year all cause death of studies within the meta-analysis, including odds ratios and 95% confidence interval (CI). There was no significant difference between early and delayed thoracic endovascular aortic repair (TEVAR) for this outcome, albeit with high heterogeneity between studies with an I^2 score of 70%. Hyperacute phase TEVAR was unable to be excluded in this arm of the meta-analysis.

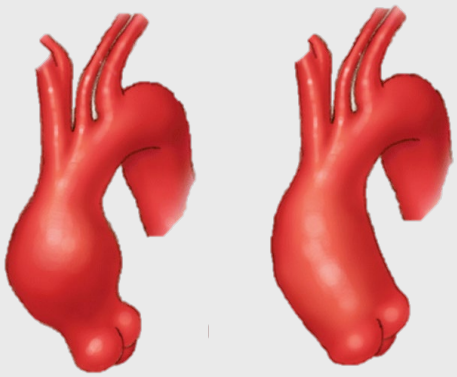
Fazit für Klinik und Praxis

- Endovaskuläre Therapie zeigt Überlebensvorteil für IMH/AoD
- Besseres Outcome bei IMH wenn TEVAR nach Tag 8
- Kein Unterschied ob TEVAR in der akuten / subakuten Phase
- Randomisierte Studien fehlen für TEVAR vs. BMT!
- 3 Studien geplant (UK, Schweden/Dänemark &USA)

Aortenbogen-Pathologien

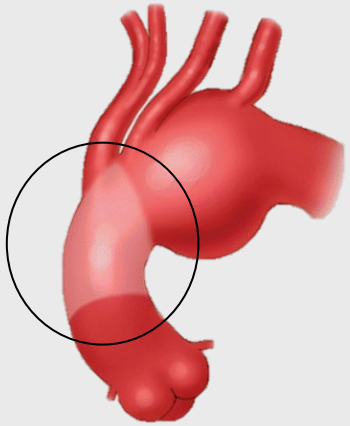
State of the Art

Aorta ascendens



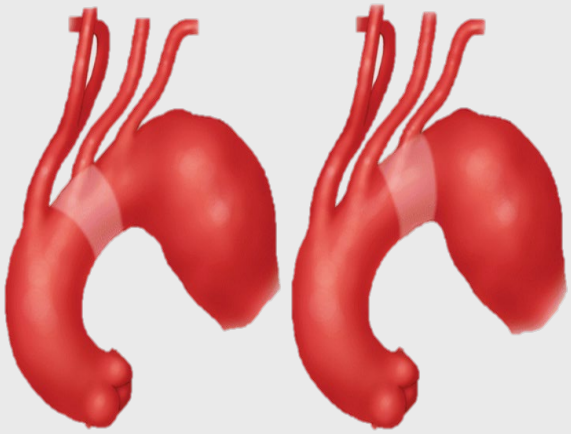
Offene Chirurgie

Pathologien mittlerer Aortenbogen



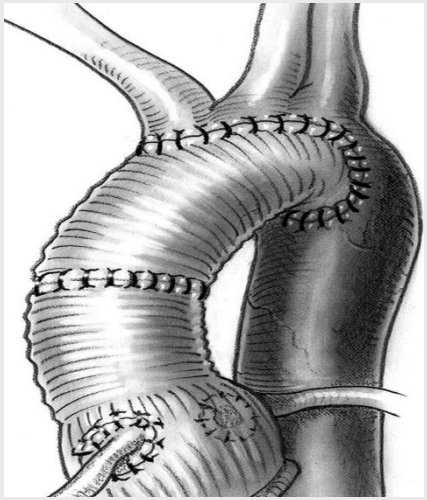
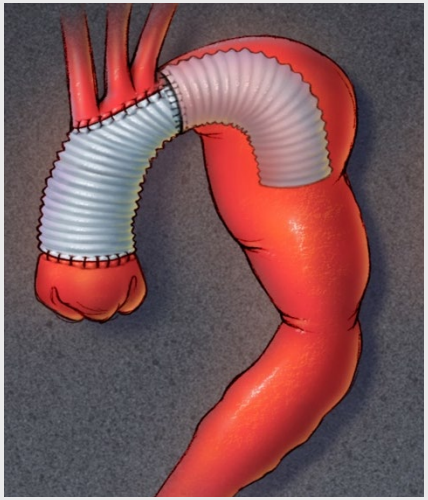
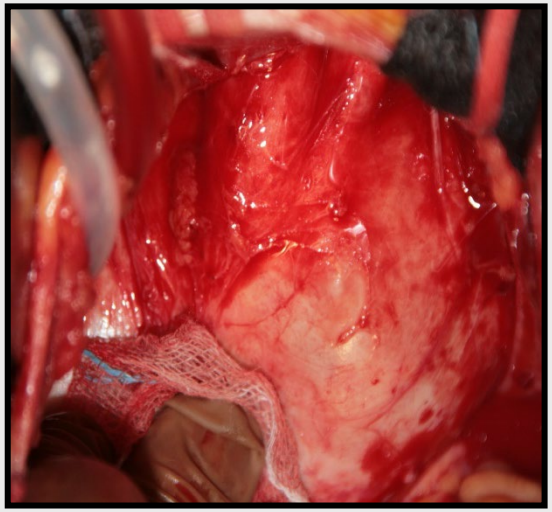
Offene Chirurgie oder endovaskulär

Distaler Bogen / Bogen assoziiert



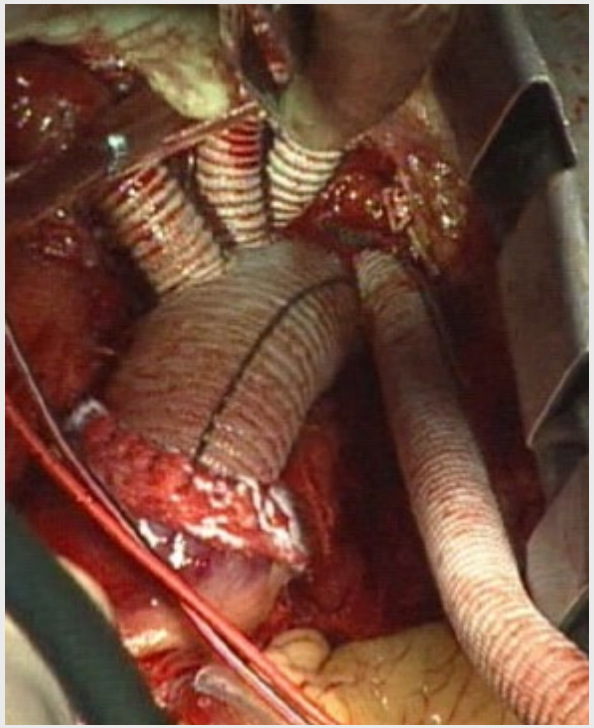
Domäne der endovaskuläre Therapie

State of the Art

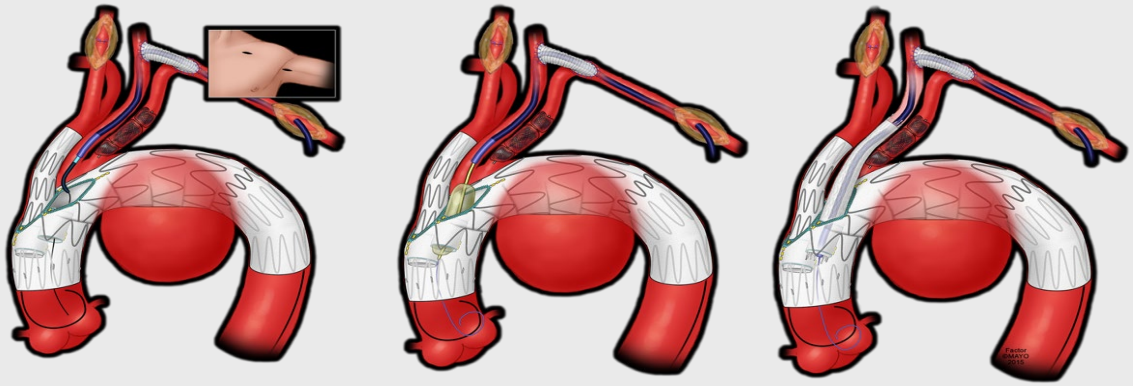
State of the Art

- Tiefe Hypothermie
- Herzstillstand
- Antegrade zerebrale Perfusion
- Operationszeiten time (360 min)
- Krankenhausaufenthalt (20 Tage)



Future State of the Art ?

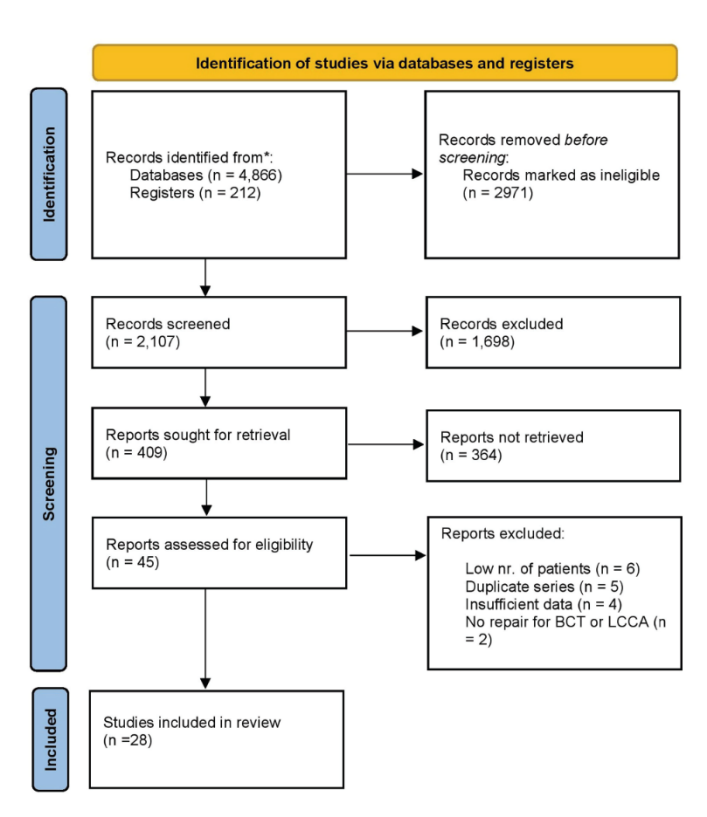
Komplett endovaskuläre Ausschaltung des Aortenbogens



Komplett endovaskuläre Therapie

Ahmad W et al Meta-analysis, and meta-regression of the total endovascular aortic repair in aortic arch. Vasa. 2023 May;52(3):175-185

- 5000 Publikation > 26 Studien
- 2327 Patienten > 3497 Zielgefäße
- Technischer Erfolg: 95.8%
- Primäre Offenheitsrate 97%
- Reinterventionsrate 11.4%



Komplett endovaskuläre Therapie

Ahmad W et al Meta-analysis, and meta-regression of the total endovascular aortic repair in aortic arch. Vasa. 2023 May;52(3):175-185

Table III. The results of the meta-analysis and the assessment of heterogeneity (Cochrane-Q and I^2 tests) and the bias (Egger's test) in the studies according to different outcomes

Outcome*	ChTEVAR	Egger (P)	Q-test (P)	I^2	CMD	Egger (P)	Q-test (P)	I^2	SM-TEVAR	Egger (P)	Q-test (P)	I^2
Technical success	93.9% (81–98%)	.184	<.001	90.7%	94.5% (91.4–96.5%)	<.001	.259	17%	96.9% (93.5–98.6%)	.381	.066	47%
PostOP endoleak I/III	17.5% (9.5–29.8%)	.27	<.001	90%	8.5% (4.8–14.5%)	<.001	<.001	66%	2.8% (1.9–4.3%)	.068	.837	0%
30-day mortality	5.4% (2.2–12.7%)	.108	<.001	84.9%	6% (4.2–8.7%)	<.001	.595	0%	2.7% (1.8–4.1%)	.361	.741	0%
Stroke	3.4% (1.7–6.4%)	.493	.024	58.6%	8.4% (6–11.5%)	<.001	.351	9%	2.7% (1.8–4.1%)	.212	.805	0%
Spinal cord ischemia	1.6% (0.07–3.3%)	.304	.251	23%	3.1% (1.8–5.1%)	<.001	.971	0%	0.9% (0.4–2%)	<.001	.682	0%
Retro. A dissection	1.5% (0.6–3.8%)	.067	.111	42%	2.5% (1.4–4.5%)	.001	.95	0	1.5% (0.8–2.6%)	.263	.6	0
Re-intervention	11.5% (5.5–22.5%)	.161	.001	88%	13.4% (81–21.4%)	<.001	<.001	78%	8.4% (3.5–18.7%)	.23	<.001	82%
Primary patency	97.9% (92.8–99.4%)	.002	.001	73%	97.6% (95.5–98.7%)	<.001	.95	0%	97.2% (89.5–99.3%)	.066	.001	85%

Notes. *The outcomes reported as an estimated pooled proportion with 95% CI (confidence interval).

- 30 Tage Mortalität 6%
- Gesamtsterblichkeit 4.8%
- Schlaganfallrate 8.4%
- Spinale Ischämie 3.1%
- Endoleckagerate 8.5%
- Retrograde A- Dissektion 0.8%

Fazit für Klinik und Praxis

- Die komplett endovaskuläre Ausschaltung von Aortenbogen Pathologien ist zur komplementären Therapie der offenen Chirurgie avanciert.

> Hochrisiko-Patienten

> Interdisziplinäre Fallbesprechung

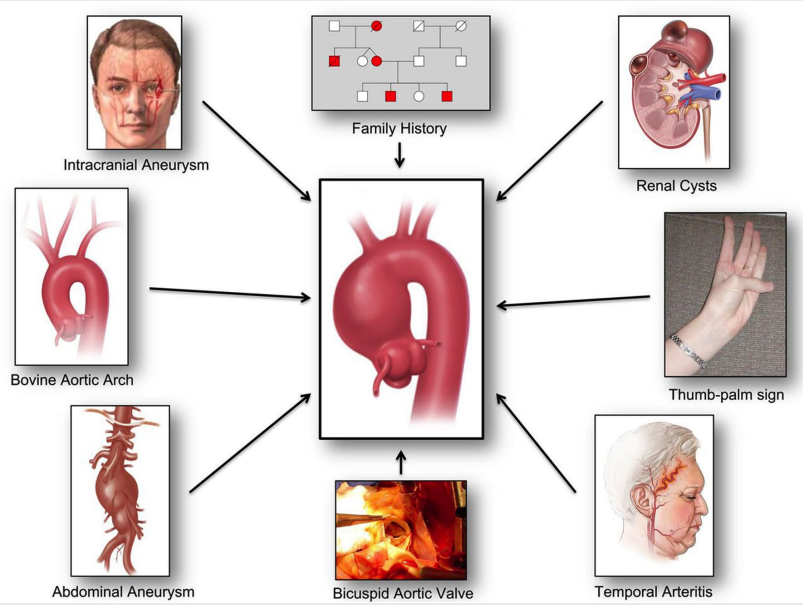
> Behandlung in Aortenzentren (Herzchirurgie & Gefäßchirurgie)

Genetik von thorakalen Aortenerkrankungen

State of the Art

Genetische Aortensyndrome:

- Marfan - Syndrom (MS)
- Ehlers Danlos - Syndrom (EDS)
- Loes - Dietz - Syndrom (LDS)
- Non syndromic familiäre TAA‘s



State of the Art

Tab. 1 Hochrisikogene für pathogene Varianten bei erblichen thorakalen Aortenaneurysmen und Aortendissektionen, TAAD („Aorten-Panelgene"). (Tabelle modifiziert [5, 6])

Gen	Protein	Erkrankung	Pathway	Häufigkeit pathogener Varianten beim erblichen TAAD
ACTA2	Smooth muscle actin α2	Smooth-muscle-dysfunction-Syndrom	SMC	12–21 %
COL3A1	Procollagen type III α1	Vaskuläres Ehlers-Danlos-Syndrom	ECM	Sehr selten
FBN1	Fibrillin-1	Marfan-Syndrom	ECM	3 %
MYH11	Smooth muscle myosin heavy chain 11		SMC	1 %
SMAD3	Mothers against decapentaplegic drosophila homolog 3	Loeys-Dietz-Syndrom Typ 3	TGF-β	2 %
TGFB2	TGF-β2	Loeys-Dietz-Syndrom Typ 4	TGF-β	1 %
TGFBR1	TGF-β receptor type I	Loeys-Dietz-Syndrom Typ 1	TGF-β	3 %
TGFBR2	TGF-β receptor type II	Loeys-Dietz-Syndrom Typ 2	TGF-β	5 %
MYLK	Myosin light chain kinase		SMC	1 %
LOX	Lysyl oxidase	Muskuloskelettale Manifestation bei Marfan-Syndrom	ECM	1,5 %
PRKG1	Protein kinase cGMP-dependent type 1		SMC	1 %

Die Vererbungen sind überwiegend autosomal-dominant
Die Mutationen beim erblichen TAAD führen überwiegend zu 1) strukturellen Defekten der extrazellulären Matrix (ECM), 2) Beeinträchtigung des „transforming growth factor beta (TGF-β) signalling pathways" oder 3) Funktionsverlust der glatten Muskelzellen (SMC) in der Gefäßwand (Verlust der Kontraktilität bzw. „phenotypic switching")

Ph. Erhart . D. Böckler et al , Gefäßchirurgie 2019

EVICTUS - Studie

Olsson KW et al. Outcomes After Endovascular Aortic Intervention in Patients With Connective Tissue Disease. JAMA Surg. 2023 Aug 1;158(8):832-839

Retrospektive Multicenterstudie von 18 Zentren

171 Patienten > TEVAR

Zeitraum 2005-2020

- 142 Marfan Syndrom
- 17 Loeys Dietz Syndrom
- 12 vaskulärer Ehlers Danlos Syndrom

EVICTUS - Studie

Olsson KW et al. Outcomes After Endovascular Aortic Intervention in Patients With Connective Tissue Disease. JAMA Surg. 2023 Aug 1;158(8):832-839

Table 2. Index Procedure Indications

Indication	No. (%)		
	Marfan syndrome (n = 142)	Loeys-Dietz syndrome (n = 17)	Vascular Ehlers-Danlos syndrome (n = 12)
Dissection[a]	128 (90.1)	15 (88.2)	9 (75.0)
Aneurysm[b]	14 (9.9)	2 (11.8)	3 (25.0)
Emergent[c]	57 (40.1)	4 (23.5)	9 (75.0)
Malperfusion	12 (8.5)	2 (11.8)	1 (8.3)
Rupture	8 (5.6)	0	3 (25.0)

EVICTUS - Studie

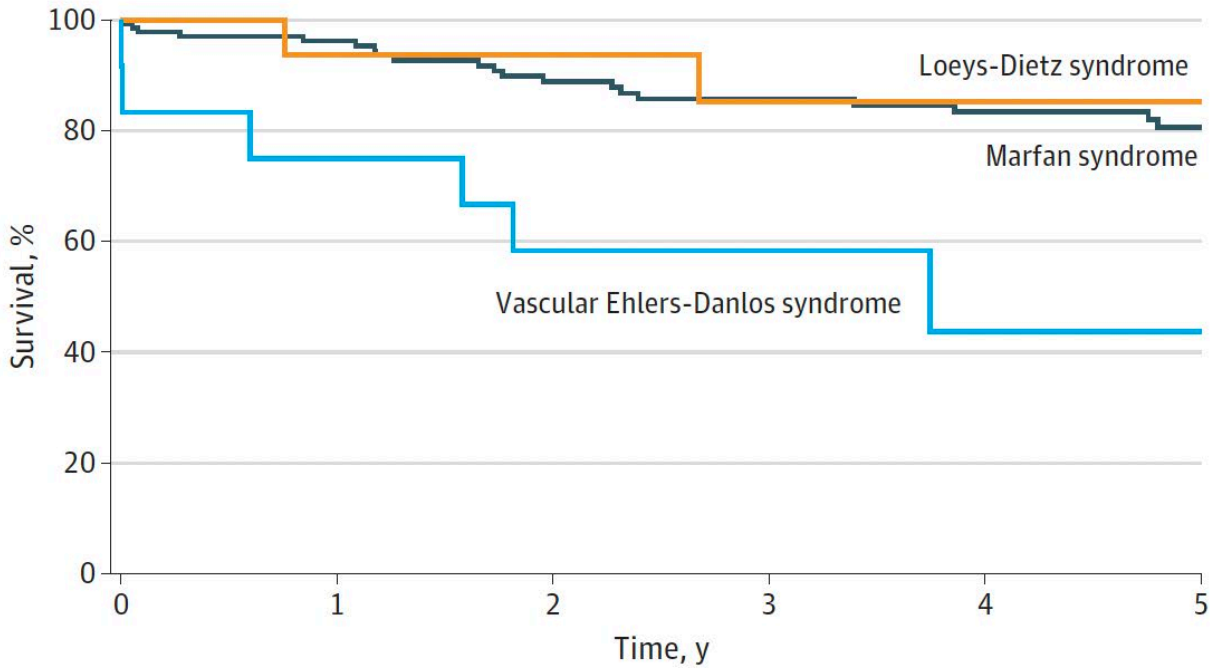
Olsson KW et al. Outcomes After Endovascular Aortic Intervention in Patients With Connective Tissue Disease. JAMA Surg. 2023 Aug 1;158(8):832-839

Table 4. 30-Day Outcomes

Outcome	No. (%)		
	Marfan syndrome (n = 142)	Loeys-Dietz syndrome (n = 17)	Vascular Ehlers-Danlos syndrome (n = 12)
Primary technical success	140 (98.6)	17 (100)	11 (91.7)
Mortality	3 (2.1)	0	2 (16.7)
Conversion	3 (2.1)	0	0
Acute coronary syndrome	0	0	0
Stroke	8 (5.6)[a]	0	2 (16.7)
Spinal cord ischemia	1 (0.7)[b]	0	0
Kidney impairment	3 (2.1)[c]	0	0

EVICTUS - Studie

Olsson KW et al. Outcomes After Endovascular Aortic Intervention in Patients With Connective Tissue Disease. JAMA Surg. 2023 Aug 1;158(8):832-839



No. at risk						
Marfan syndrome	142	110	92	81	69	57
Loeys-Dietz syndrome	17	15	12	11	7	4
Vascular Ehlers-Danlos syndrome	12	10	8	7	4	3

Fazit für Klinik und Praxis

- Genetische Aortenerkankungen sind extrem selten
- Hohe technische Erfolgsrate, mit offenen Verfahren vergleichbares Überleben
- Endovaskuläre Therapie – bisher nicht empfohlen- wird zunehmend auch bei genetischen Syndromen angewendet.