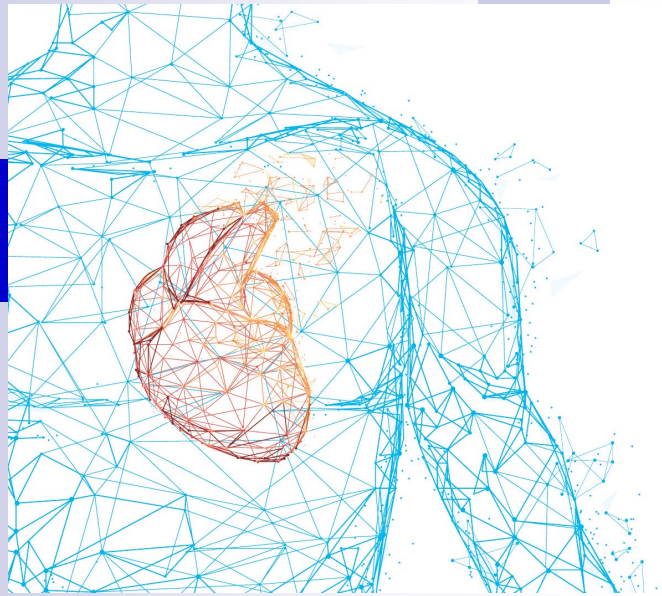
"The future can only be told in hindsight..." (Norman Klein)



Herzchirurgie heute - Moderne Konzepte und Trends

19. KARDIOLOGIE-SYMPOSIUM –
«Relevantes für die Praxis 2026»
des HerzZentrums Hirslanden Zentralschweiz
19.11.2026, LU

Pascal A. Berdat
Heart Care Medical AG
Bellariastrasse 38
8038 Zürich

Agenda

?„Modern“: Zeitgemäss – Fortschrittlich – Neuartig – Trendgerecht

Moderne Herzchirurgie:

- „minimal-invasiv“ - „minimal-access“, off-pump, hybrid (Chirurgie & Intervention), robotics
- Reduktion der Invasivität – Verbesserung der Biokompatibilität
- Heart-team zentral für Entscheidungsfindung: Procedural risks, benefits, anatomy, co-morbidity, expected outcome, lifetime management, patient preference
- Patient in Entscheidung eingebunden

Behandlung der KHK - ESC Guidelines: Wie?

Indikationen für ACB: Unverändert

Wie?

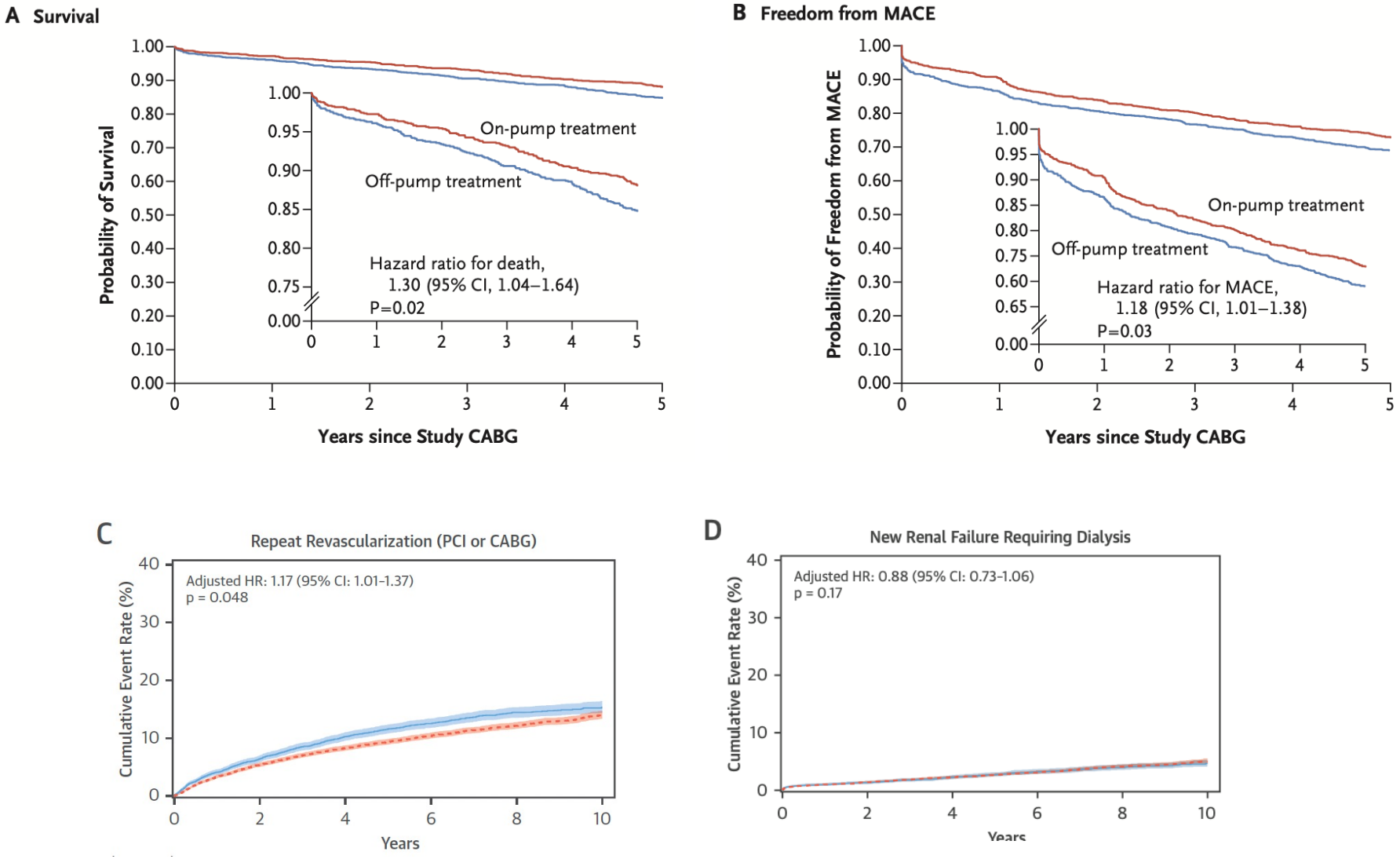
- Zugang?
  - Sternotomie, Thorakotomie?
- ECC? Off-pump = minimal-invasiv
  - Art der Kanülierung? Mit AXC? Aortic no-touch?
  - Art der Kardioplegie? Antegrad, retrograd?
- Graftmaterial?
  - Arteriell? Venös? LIMA? RIMA? RA? SVG?
  - Zielgefässe?

«Arterial grafting with left internal mammary artery (LIMA) to the LAD system and multiple arterial grafting reduces the risk of graft occlusion, thus increasing the longevity of revascularization efficacy after CABG.[1,2] »

1 Sabik JF III, Blackstone EH, Gillinov AM, Banbury MK, Smedira NG, Lytle BW. Influence of patient characteristics and arterial grafts on freedom from coronary reoperation. J Thorac Cardiovasc Surg 2006;131:90–8. https://doi.org/10.1016/j.jtcvs.2005.05.024

2 Locker C, Schaff HV, Dearani JA, Joyce LD, Park SJ, Burkhart HM, et al. Multiple arterial grafts improve late survival of patients undergoing coronary artery bypass graft surgery: analysis of 8622 patients with multivessel disease. Circulation 2012;126: 1023–30. https://doi.org/10.1161/CIRCULATIONAHA.111.084624

ACB: Mit oder ohne HLM?

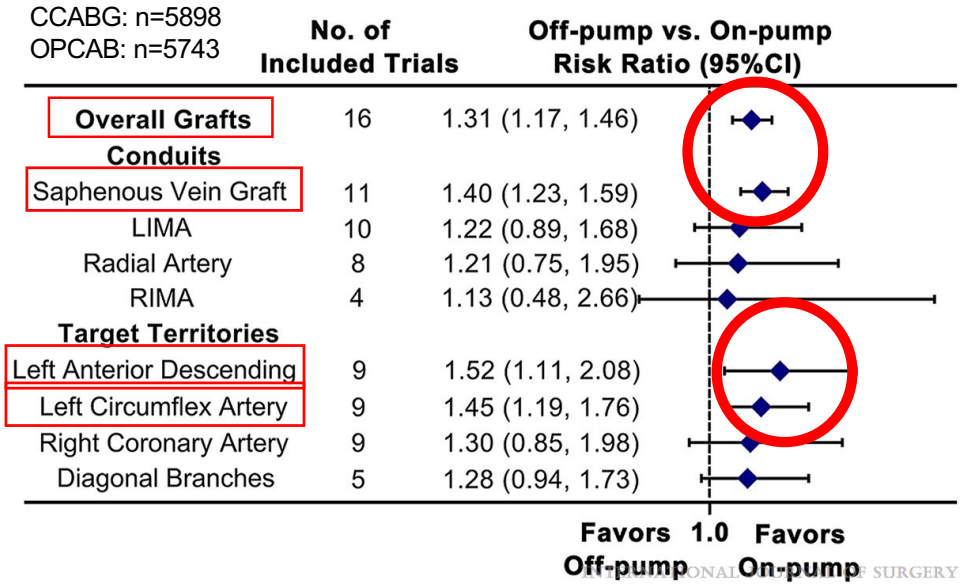


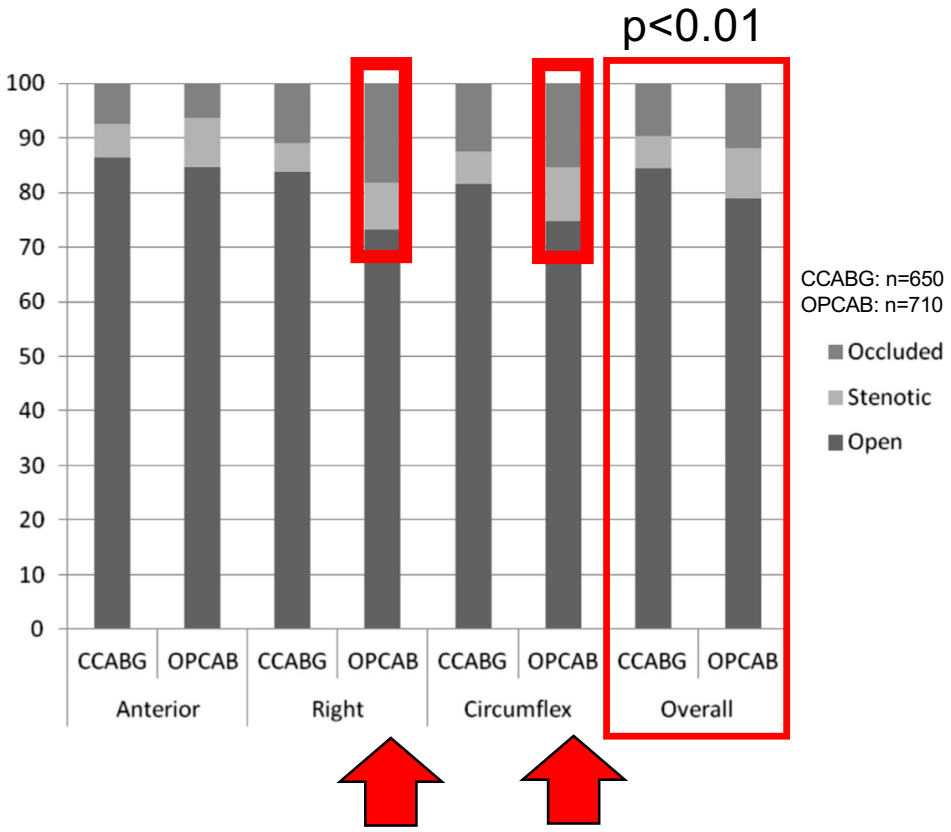
1 Laurie Shroyer et al. Five-Year Outcomes after On-Pump and Off-Pump Coronary-Artery Bypass. N Engl J Med 2017;377:623-32. DOI: 10.1056/NEJMoa1614341

2 Chikwe, J. et al. Long-Term Outcomes After Off-Pump Versus On-Pump Coronary Artery Bypass Grafting by Experienced Surgeons. J Am Coll Cardiol 2018;72(13):1478–86. https://doi.org/10.1016/j.jacc.2018.07.029

ACB: Mit oder ohne HLM? – Graft Offenheitsraten

CCABG: n=5898
OPCAB: n=5743





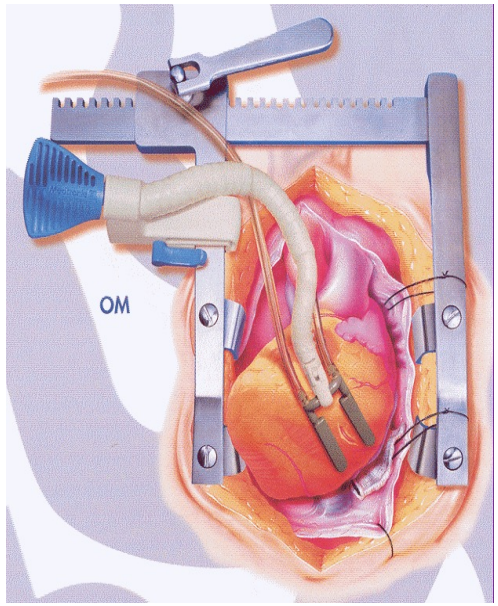
1 Zhou, Zhuoming et al. Randomized evidence on graft patency after off-pump versus on-pump coronary artery bypass grafting: An updated meta-analysis. International Journal of Surgery98:106212, February 2022. doi: 10.1016/j.ijsu.2021.106212

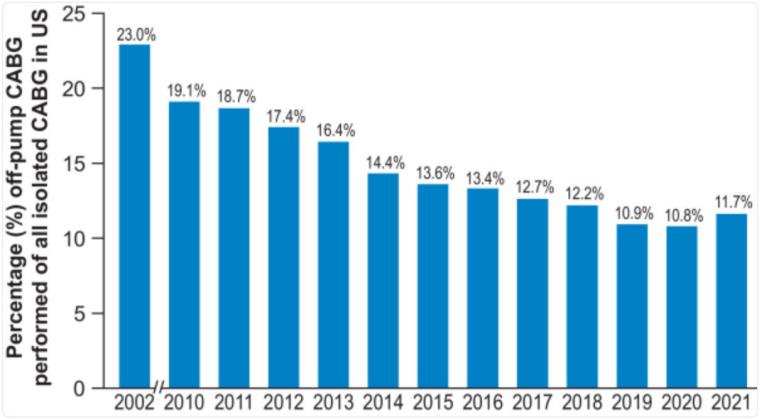
2 Houlind K, Fenger-Gron M, Holme SJ, Kjeldsen BJ, Madsen SN, Rasmussen BS et al. Graft patency after off-pump coronary artery bypass surgery is inferior even with identical heparinization protocols: results from the Danish On-pump Versus Off-pump Randomization Study (DOORS). J Thorac Cardiovasc Surg 2014;148:1812–19.e2.

OPCAB: Erwartungen erfüllt?

- Mortalität: nein
- Myokardinfarkt: nein
- CVI: nein
- Niereninsuffizienz: nein
- Respiratorische Probleme: nein
- Blutverlust: Ja
- Arrhythmien: Ja
- Systemische Inflammation: Ja
- Kürzere Spitaldauer: Ja
- Kürzere Erholung: Ja
- Kosten: nein

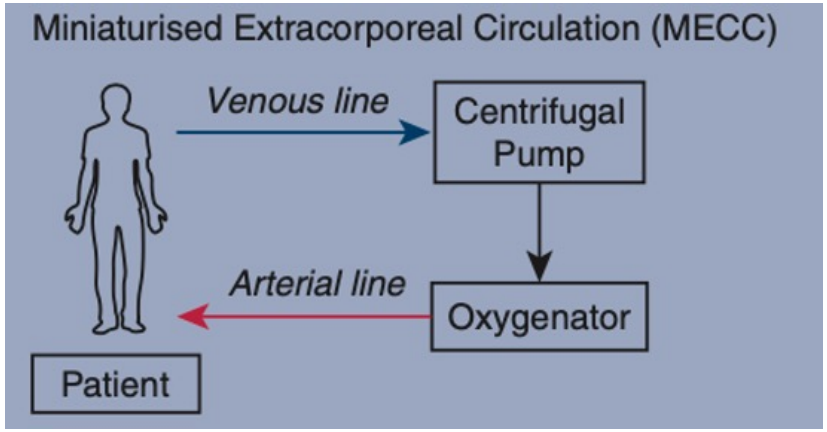
Indikationen: LIMA-RIVA; Ao-no; schwere kombinierte Komorbiditäten





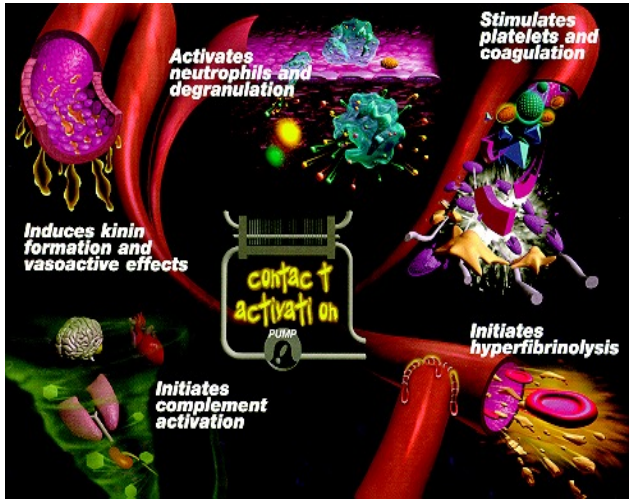
Elizabeth C. Ghandakly et al. Coronary Artery Surgery: Past, Present, and Future. Rambam Maimonides Med J 2024;15 (1):e0001. Review. doi:10.5041/RMMJ.10515

MECC: maximierte Biokompatibilität

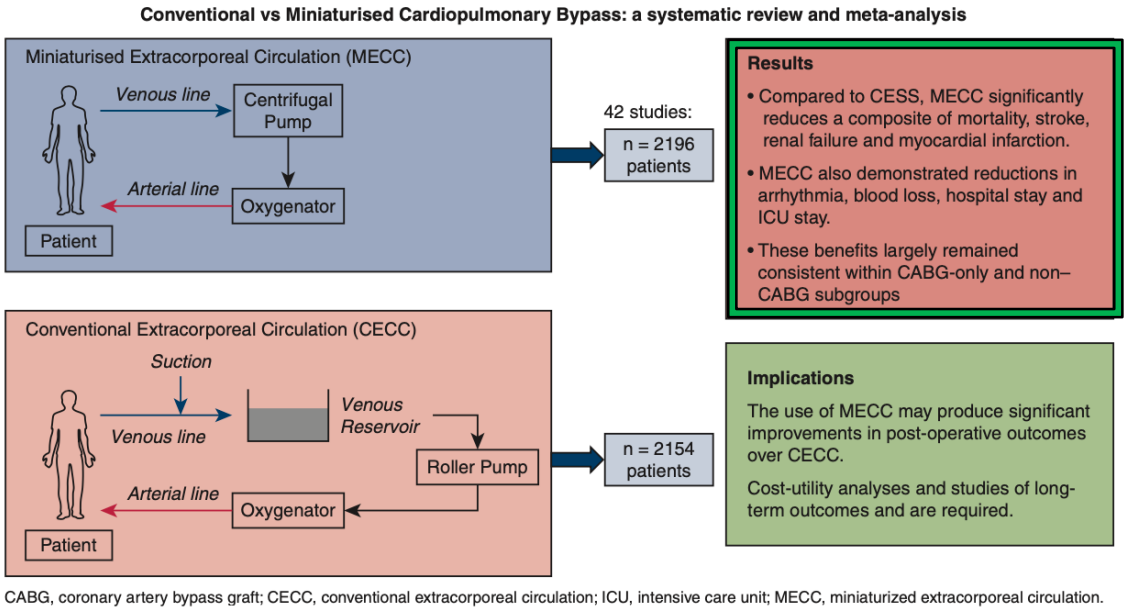




- Blutkontaktoberfläche Komponenten & Luft: Cytokin- & Complement-Aktivierung, Gerinnungstörung
- Hämodilution: Blutung, Transfusion
- Heparinbedarf: Blutung, Transfusion
- Volumendepletion (geschlossenes System): Vasoaktivabedarf
- erhaltene Lungenperfusion: Cytokin- & Complement-Aktivierung
- erhaltene Koronarperfusion: Cardioplexol® Myokardprotektion



MECC: Klinische Vorteile



CABG, coronary artery bypass graft; CECC, conventional extracorporeal circulation; ICU, intensive care unit; MECC, miniaturized extracorporeal circulation.

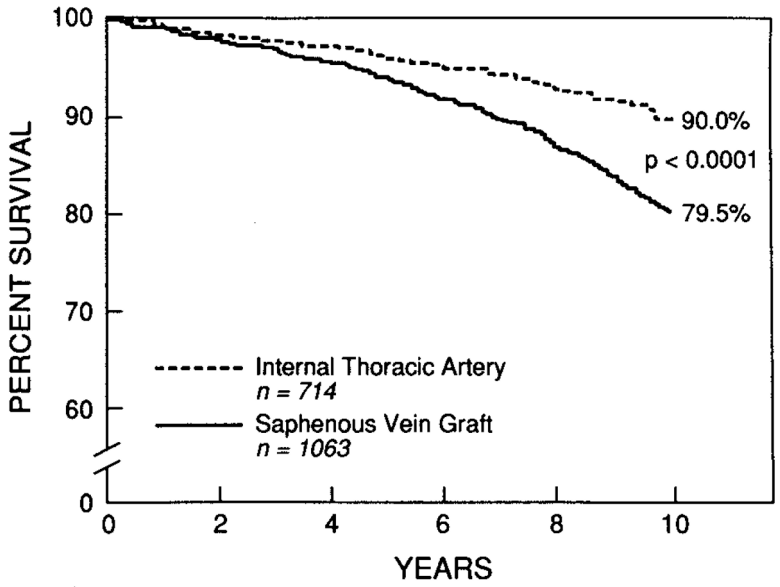
FIGURE 3. Outcomes of patients who underwent conventional extracorporeal circulation (CECC, n = 2154) versus those who underwent miniaturized extracorporeal circulation (MECC, n = 2196). No difference in mortality, stroke, myocardial infarction, and renal failure has been reported. *ICU*, Intensive care unit; *CABG*, coronary artery bypass graft;

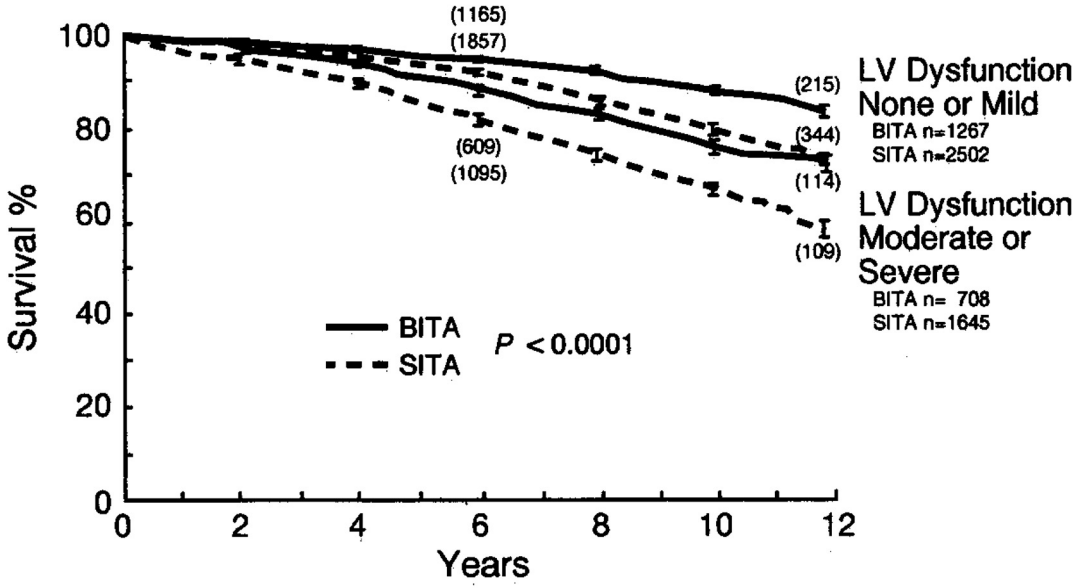
- MACCE
- Nierenversagen

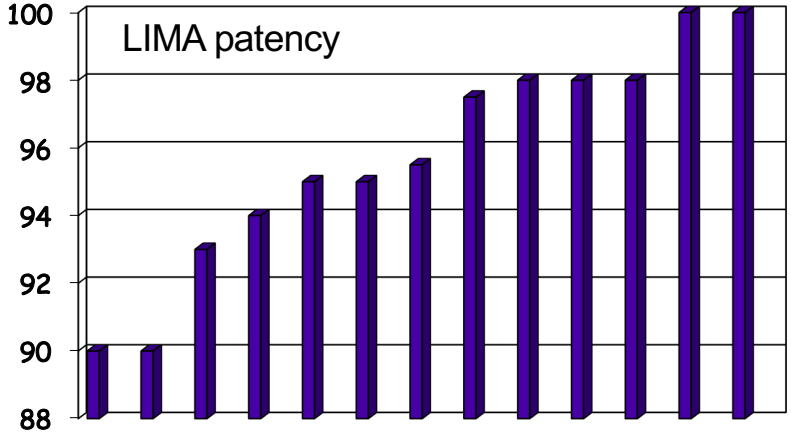
- Arrhythmien
- Blutverlust
- IPS-Dauer
- Spitaldauer

Timothy Cheng et al. Conventional versus miniaturized cardiopulmonary bypass: A systematic review and meta-analysis. JTCVS Open 2021;8:418-41.
https://doi.org/10.1016/j.xjon.2021.09.037

Selektion 1. Graft: IMA-Effekte







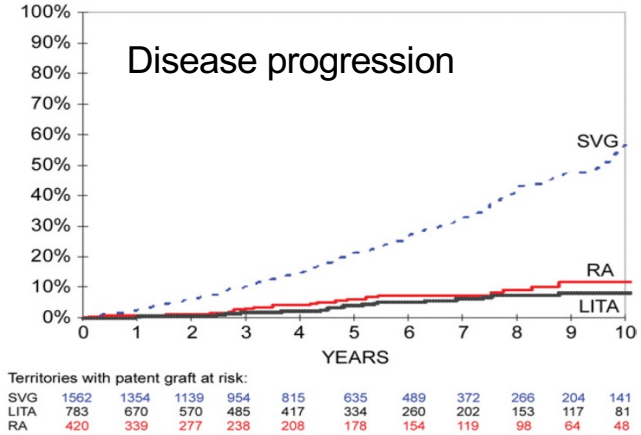
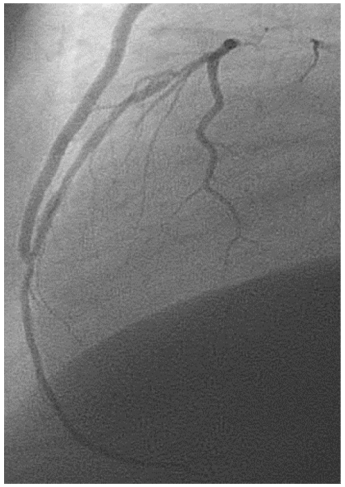


Fig 2. Kaplan-Meier–estimated disease progression rates in all territories with patent conduits. (LITA = left internal thoracic artery; RA = radial artery; SVG = saphenous vein graft.)



1 Loop FD et al. Technique for performance of internal mammary artery-coronary artery anastomosis. JTCVS 1979; 78:460-3.
2 Loop FD et al.Influence of the Internal-Mammary-Artery Graft on 10-Year Survival and Other Cardiac Events. NEJM 1986;314:1-6.
3 Lytle B et al. TWO INTERNAL THORACIC ARTERY GRAFTS ARE BETTER THAN ONE. JTCVS 1999;117:855-72.

Selektion 2. Graft: RA mit Überlebensvorteil

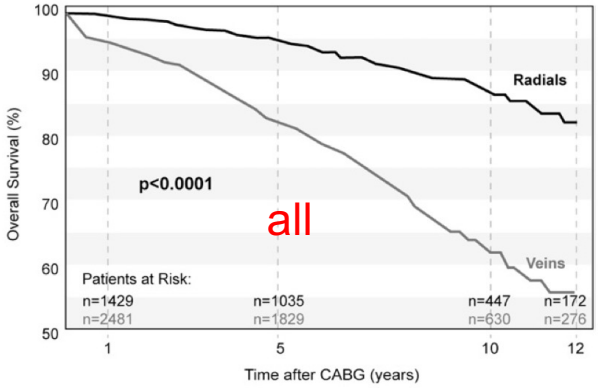


Fig 1. Comparison of unadjusted Kaplan-Meier survival for all patients ($p < 0.0001$, log rank test). CABG = coronary artery bypass graft surgery.

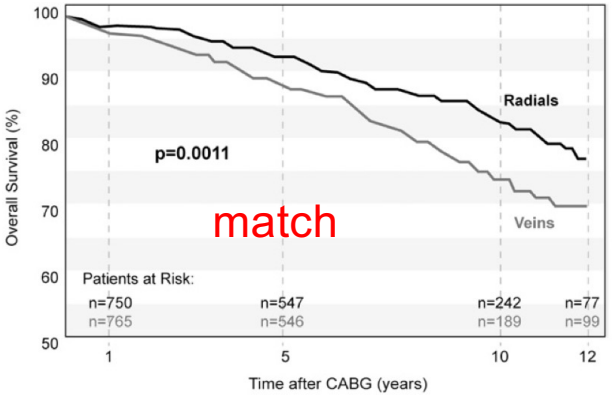
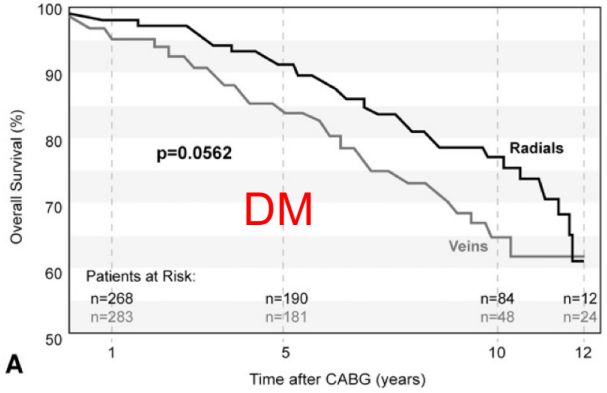


Fig 2. Comparison of Kaplan-Meier survival for propensity-matched patients ($p = 0.0011$, log rank test). CABG = coronary artery bypass graft surgery.



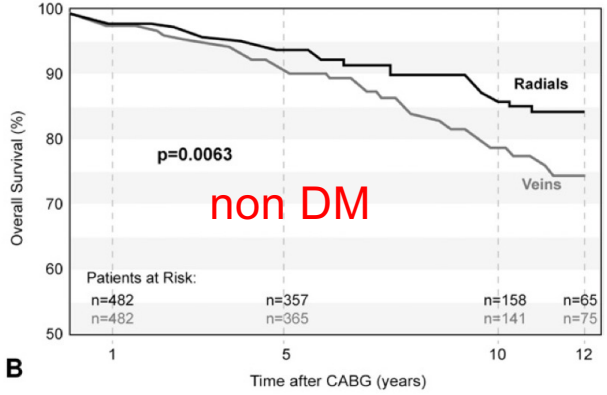
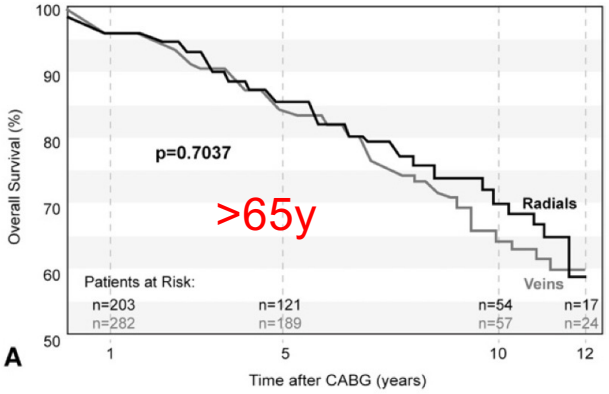


Fig 5. Comparison of Kaplan-Meier survival among propensity-matched (A) diabetic patients ($p = 0.0562$, log rank test) and (B) nondiabetic patients ($p = 0.0063$, log rank test). CABG = coronary artery bypass graft surgery.



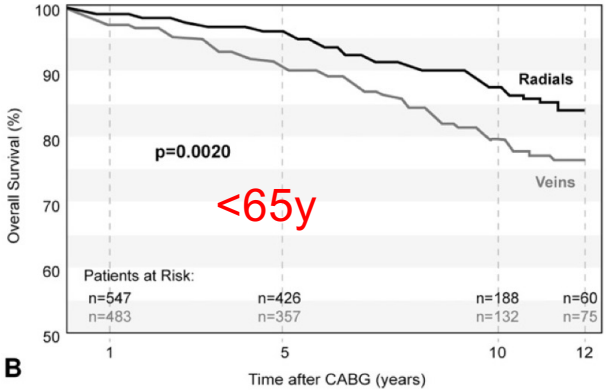


Fig 3. Comparison of Kaplan-Meier survival for propensity-matched patients (A) aged 65 years or more ($p = 0.7037$, log rank test) and (B) aged less than 65 years ($p = 0.0020$, log rank test). CABG = coronary artery bypass graft surgery.

Robert F. Tranbaugh et al. Radial Artery Conduits Improve Long-Term Survival After Coronary Artery Bypass Grafting. Ann Thorac Surg 2010;90:1165–72

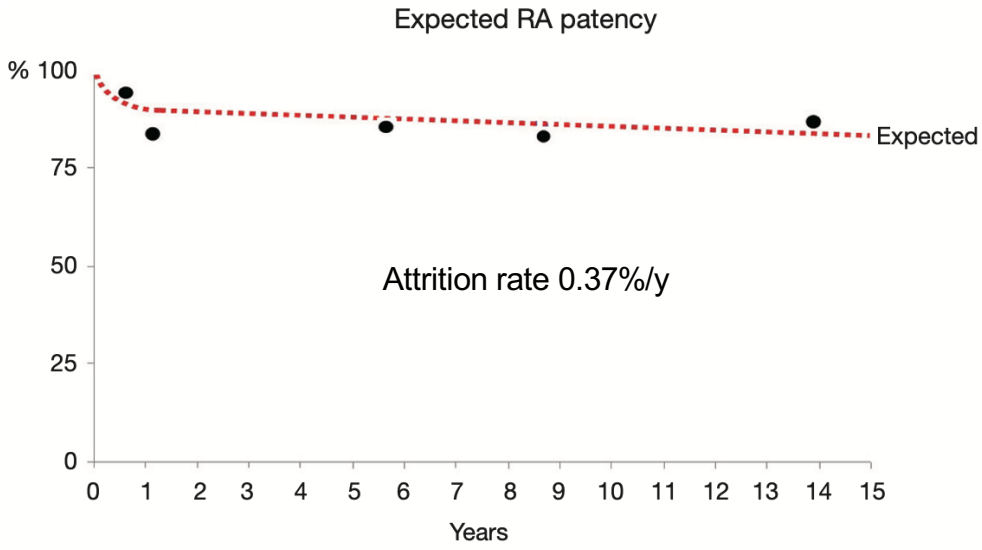
Selektion 2. Graft: Offenheitsraten

Table 1. Angiographic outcomes of currently used coronary artery bypass grafts.

Conduit	Patency Rate
RA	94.1% (95% CI 90.0–97.6)
No touch-SVG	91.4% (95% CI 87.3–94.3)
RITA	89.2% (95% CI 71.2–96.5)
Conventionally harvested SVG	86.3% (95% CI 81.2–90.2)
GEA	61.2% (95% CI 52.2–69.4)

Mean FU time 3.5y

Based on pooled estimates from a meta-analysis of 18 randomized clinical trials (8272 grafts) [102]. CI, confidence interval; LITA, left internal thoracic artery; GEA, gastroepiploic artery; RA, radial artery; RITA, right internal thoracic artery; SVG, saphenous vein graft.



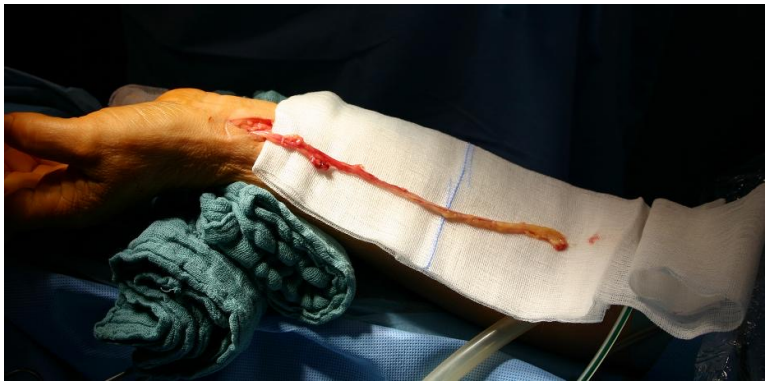
1 Deng, M.X.; Lia, H.; Lee, G.; Rahouma, M.; Franco, A.D.; Demetres, M.; Angelini, G.D.; Gaudino, M.; Fremes, S.E. Angiographic Patency of Coronary Artery Bypass Conduits: An Updated Network Meta-Analysis of Randomized Trials. Braz. J. Cardiovasc. Surg. 2022, 37, 7–31.
2 Achouh P et Acar Christophe: Twenty-year fate of the radial artery graft. Ann Cardiothorac Surg 2013;2(4):481-484. doi: 10.3978/j.issn.2225-319X.2013.07.13

Selektion 2. Graft: Zielgebiet & Stenosegrad

Table 5. Comparison of Radial Artery Graft Patency

Coronary Territory	Anastomoses	Patent	Patency (%)	*p* Value[a]
Left anterior descending	33	30	90.7	0.769[b]
Circumflex	201	186	92.5	0.725[c]
Right coronary artery	135	117	86.7	0.093[d]
Total	369	333	90.2	

[a] Fisher's exact test. [b] Compared with right coronary artery. [c] Compared with left anterior descending. [d] Compared with circumflex.

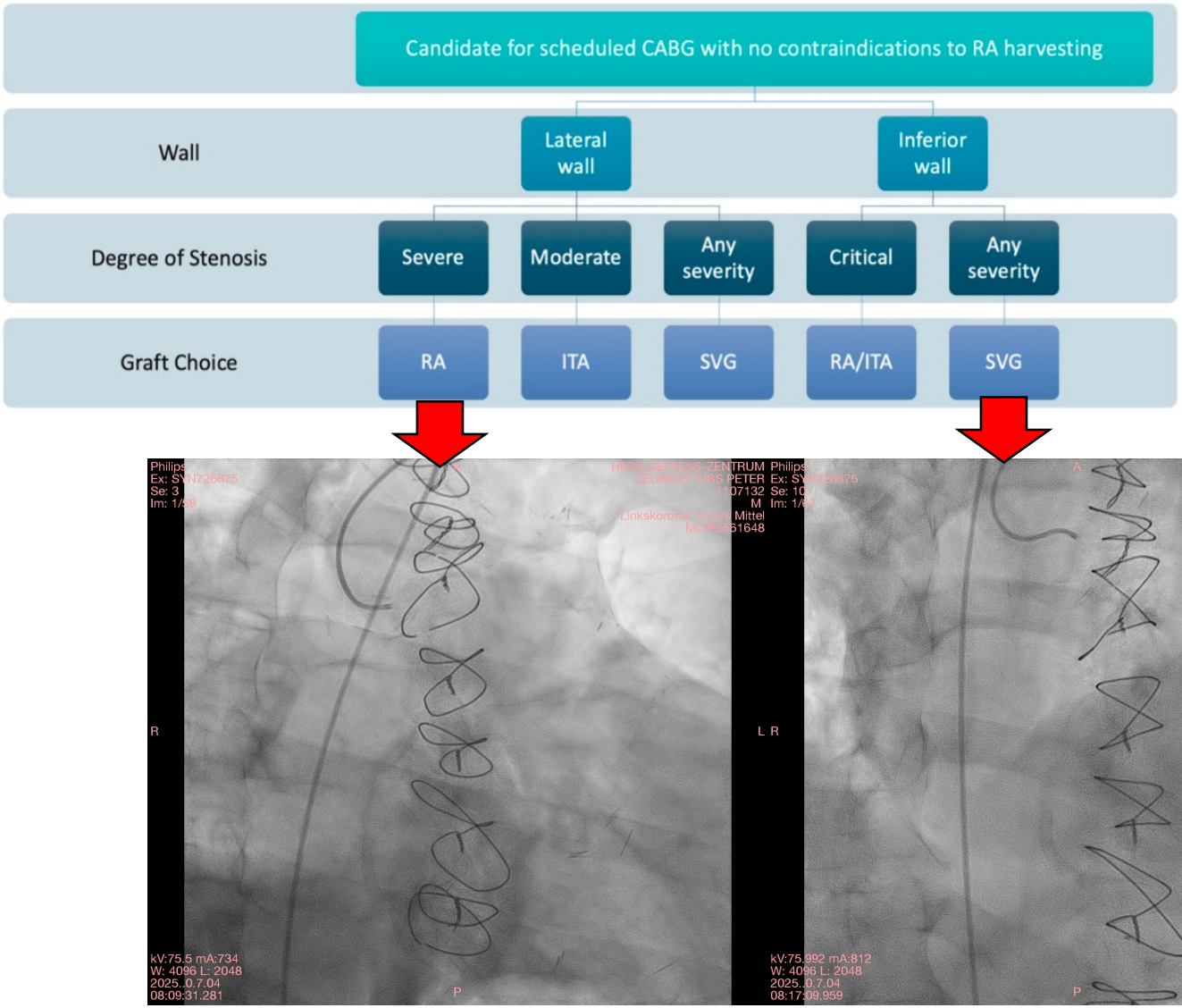


Distal anastomosis				RA
LAD territory	1/24 (4.2)	Reference		
LCX territory	3/44 (6.8)	1.67 (0.13-92.13)	1.00	
RCA territory	5/23 (21.7)	6.16 (0.61-315.0)	.17	
Target vessel stenosis				
≥90%	3/44 (6.8)	Reference		
<90%	6/45 (13.3)	2.05 (0.54-7.79)	.29	
Distal anastomosis				RIMA
LAD territory	6/32 (18.8)	Reference		
LCX territory	14/33 (42.4)	3.14 (0.92-11.90)	.07	
RCA territory	2/17 (11.8)	0.58 (0.05-3.83)	.85	
Target vessel stenosis				
≥90%	6/36 (16.7)	Reference		
<90%	14/43 (32.6)	3.70 (0.63-21.51)	.15	
Distal anastomosis				SVG
LAD territory	51/573 (8.9)	Reference		
LCX territory	87/886 (9.8)	1.04 (0.75-1.44)	.82	
RCA territory	94/779 (12.1)	1.31 (0.94-1.83)	.11	
Target vessel stenosis				
≥90%	116/1045 (11.1)	Reference		
<90%	112/1118 (10.0)	0.95 (0.74-1.22)	.70	

1 Tatoulis M. et al. The Radial Artery in Coronary Surgery: A 5-Year Experience—Clinical and Angiographic Results. Ann Thorac Surg 2002;73:143–8

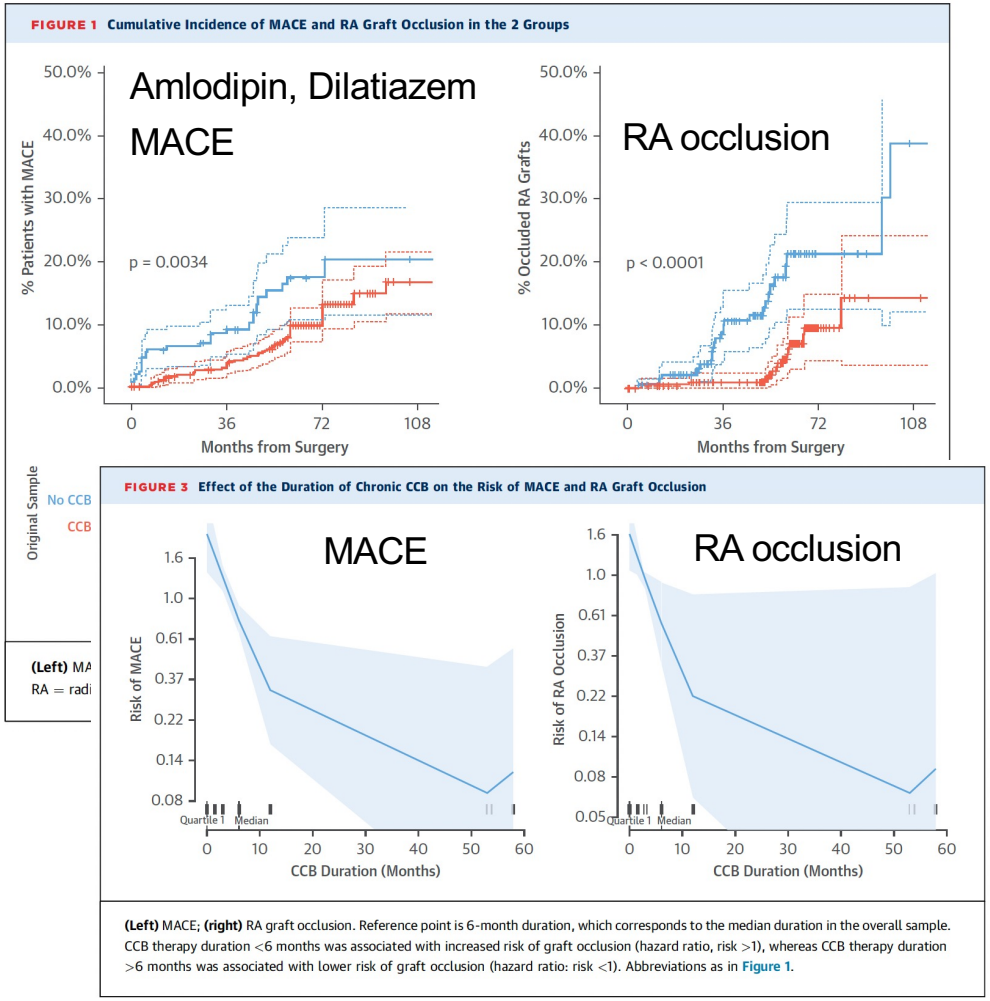
2 Alboom et al. Conduit selection and early graft failure in coronary artery bypass surgery: A post hoc analysis of the Cardiovascular Outcomes for People Using Anticoagulation Strategies (COMPASS) coronary artery bypass grafting study. J Thorac Cardiovasc Surg 2023;165:1080-9. https://doi.org/10.1016/j.jtcvs.2022.05.028

Graft Selektion: 2. Graft - Zielgebiet



Gaudino, M.; Taggart, D.; Suma, H.; Puskas, J.D.; Crea, F.; Massetti, M. The Choice of Conduits in Coronary Artery Bypass Surgery. J. Am. Coll. Cardiol. 2015, 66, 1729–1737.

Offenheitsrate RA: Spasmusprophylaxe



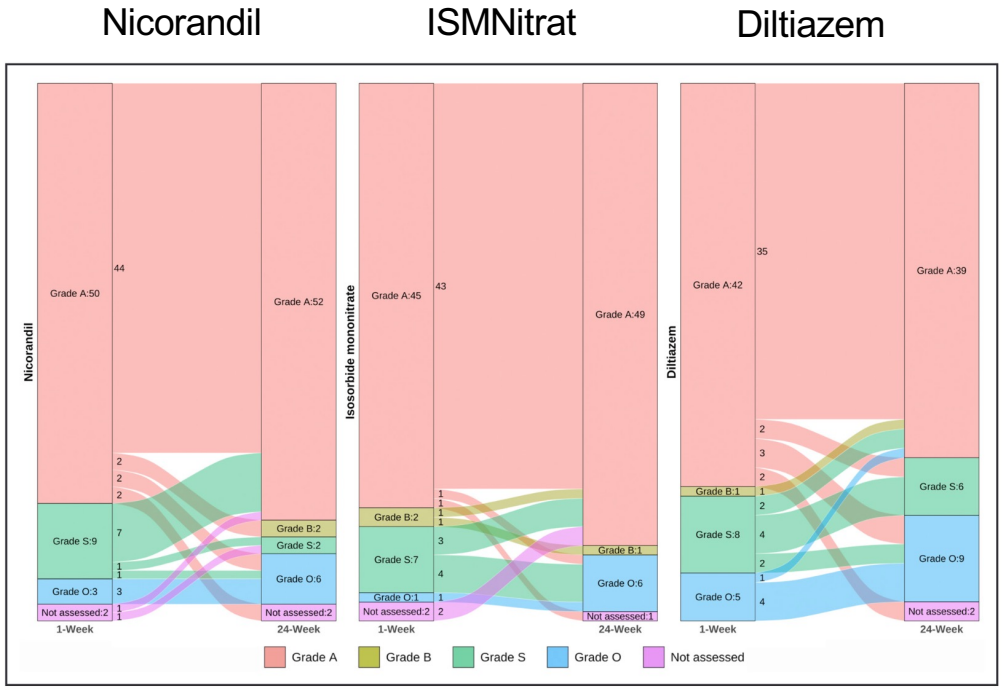


Figure 2. Change in radial artery (RA) graft status at 1 and 24 weeks imaging.
The alluvial plot visually depicts the change of RA graft outcomes from 1 to 24 weeks post-coronary artery bypass grafting. Each color represents a FitzGibbon grade, and the accompanying numbers represent for the corresponding count of RA grafts.

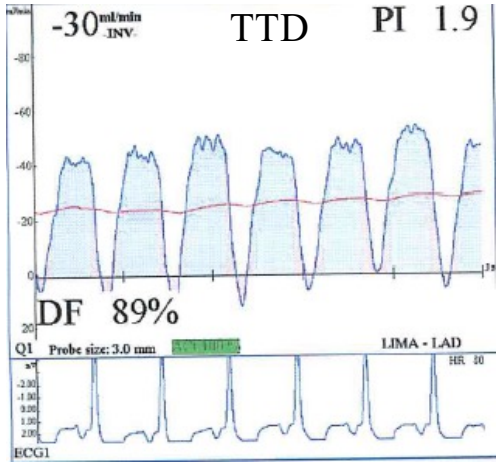
«…use of CCB is associated with higher patency rate and better clinical outcomes at 5 years in patients with RA grafts. Those data support the routine use of CCB, at least for the first 12 months after CABG using the RA.»

Ca-Antagonist für mind 12m oder Nitrat für mind. 6m vorteilhaft!

1 Gaudino et al. Calcium-Channel Blockers for Radial Artery Grafts. J Am Coll Cardiol 2019;73:2299–306.
2 Zhu et al. Circ Cardiovasc Interv. 2025;18:e014542. DOI: 10.1161/CIRCINTERVENTIONS.124.014542

ACB heute – Wie jetzt?

- Reduzierte Invasivität: Kleinere Zugänge, MECC
- Optimale Graft Selektion: RIMA-RCA; RA-RCX; Stenose >70-90%
  RCA: RIMA und SVG gleichwertig
- Multiarteriell komplett: bei < 65j, Diabetes mellitus
- Qualitätskontrolle intraoperativ
- Individuelle Risikoreduktion: Individualisierte Herangehensweise
- OMT postoperativ wichtig: inkl. Spasmusprophylaxe mit Ca-Antagonist
- CAVE: Kontraindikationen RA; Radialer Zugang für Koro: Konflikt

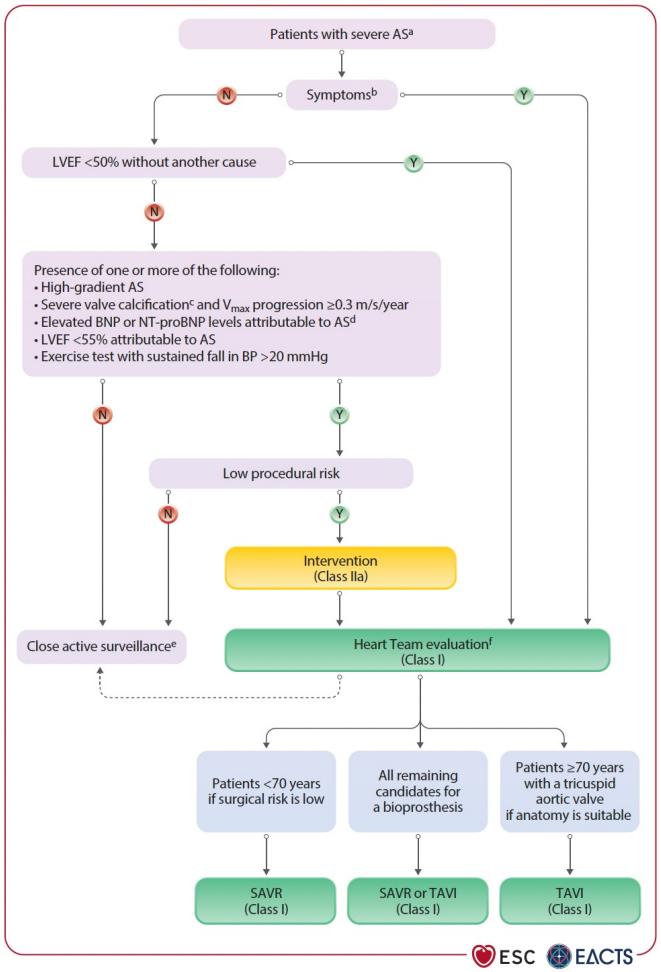


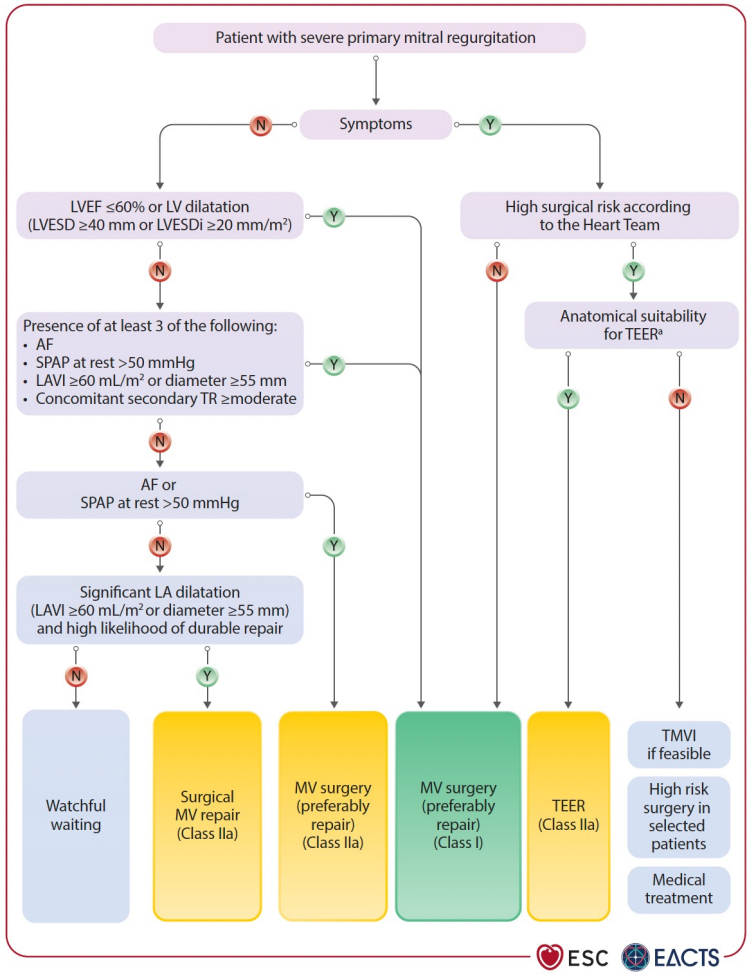






Surgery in Valvular Heart Disease





?

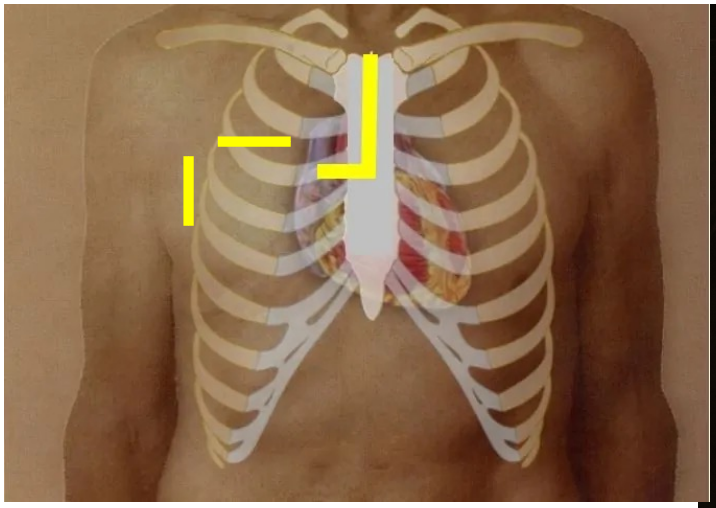
Minimally invasive MV surgery may be considered at experienced centres to reduce the length of stay and accelerate recovery.[557,567]	IIb	B

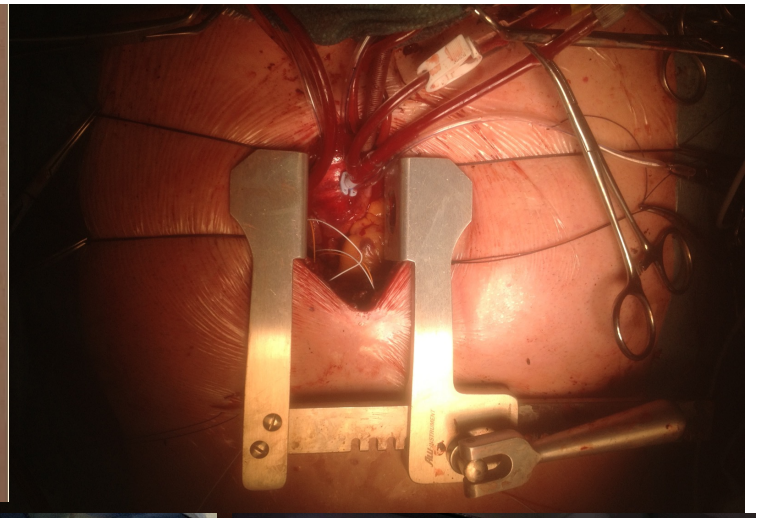
2025 ESC/EACTS Guidelines for management of valvular heart disease. European Heart Journal (2025) 46, 4635–4736. https://doi.org/10.1093/eurheartj/ehaf194

Minimal-invasive - Aortic Valve Replacement

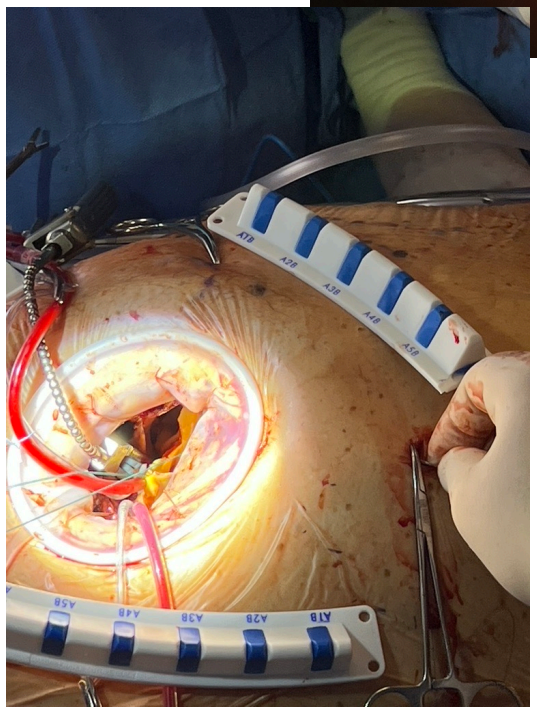










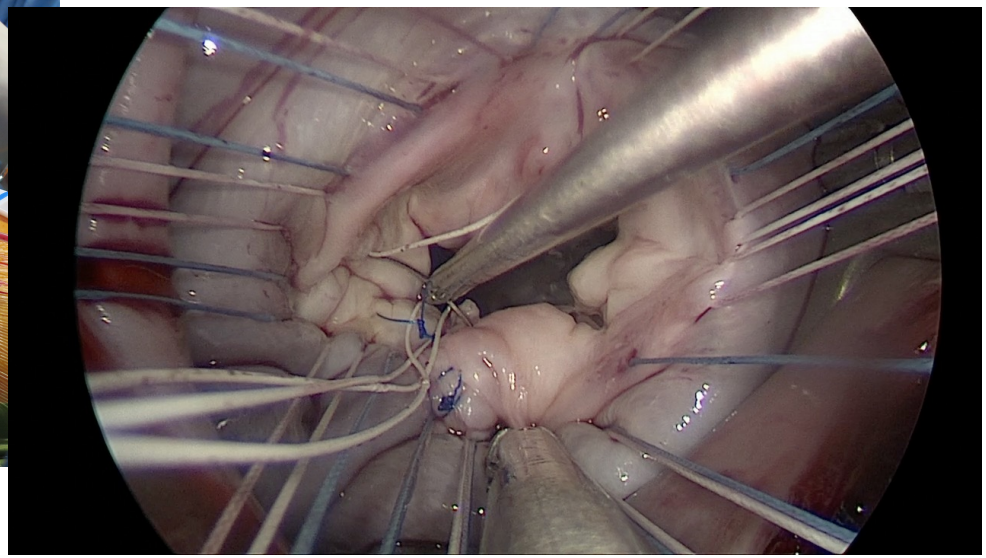


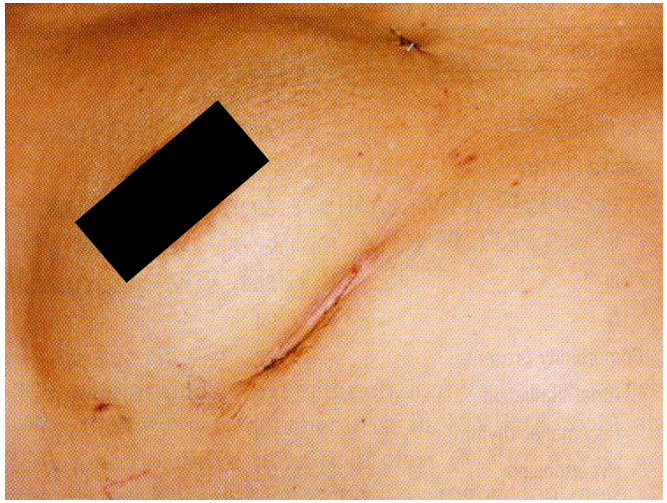


Minimal-invasive endoscopic Mitral Surgery



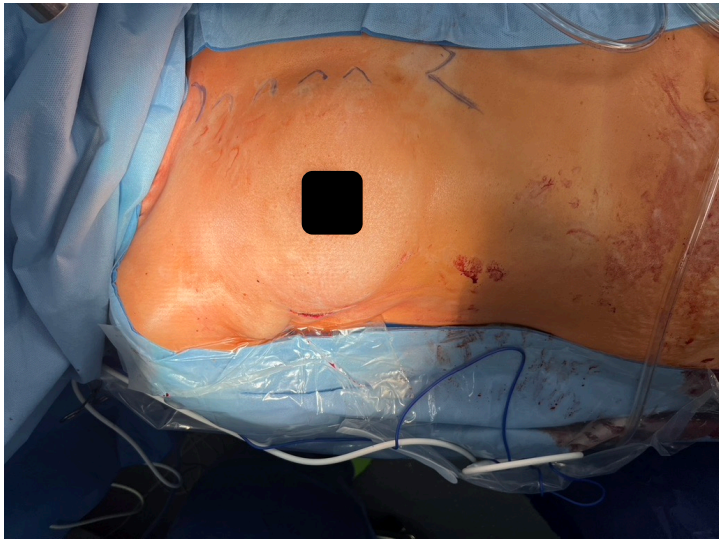


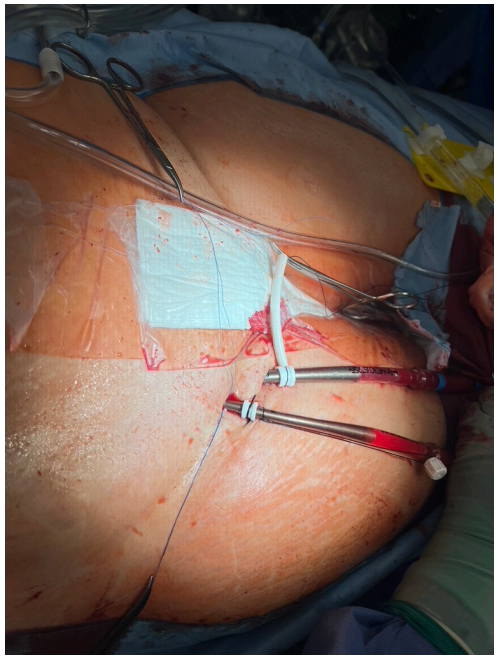


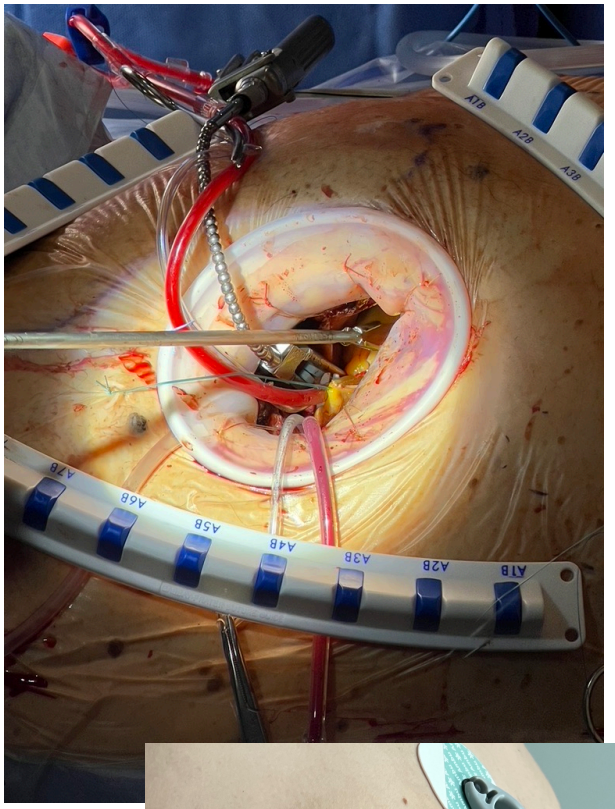


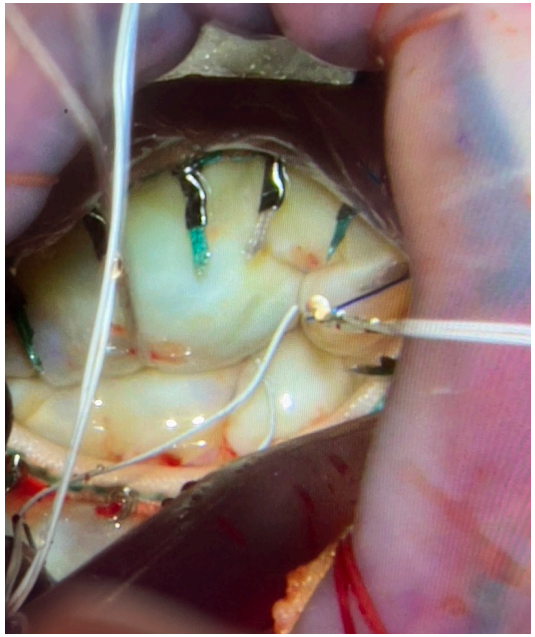


Axillary approach



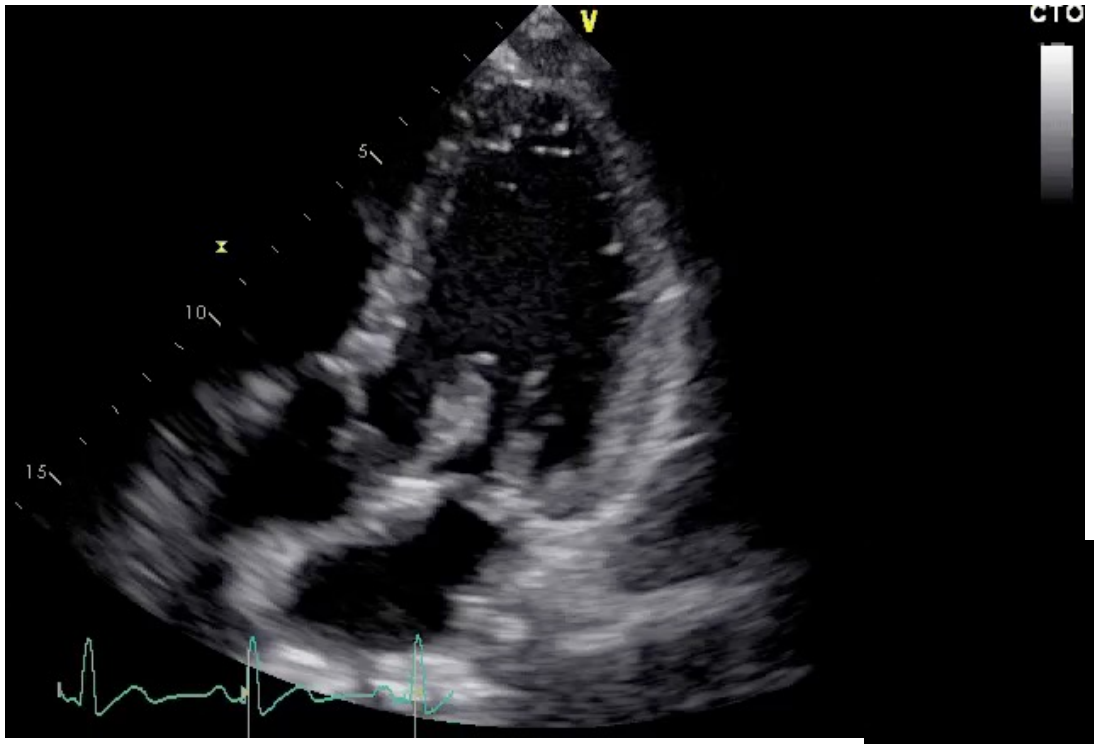






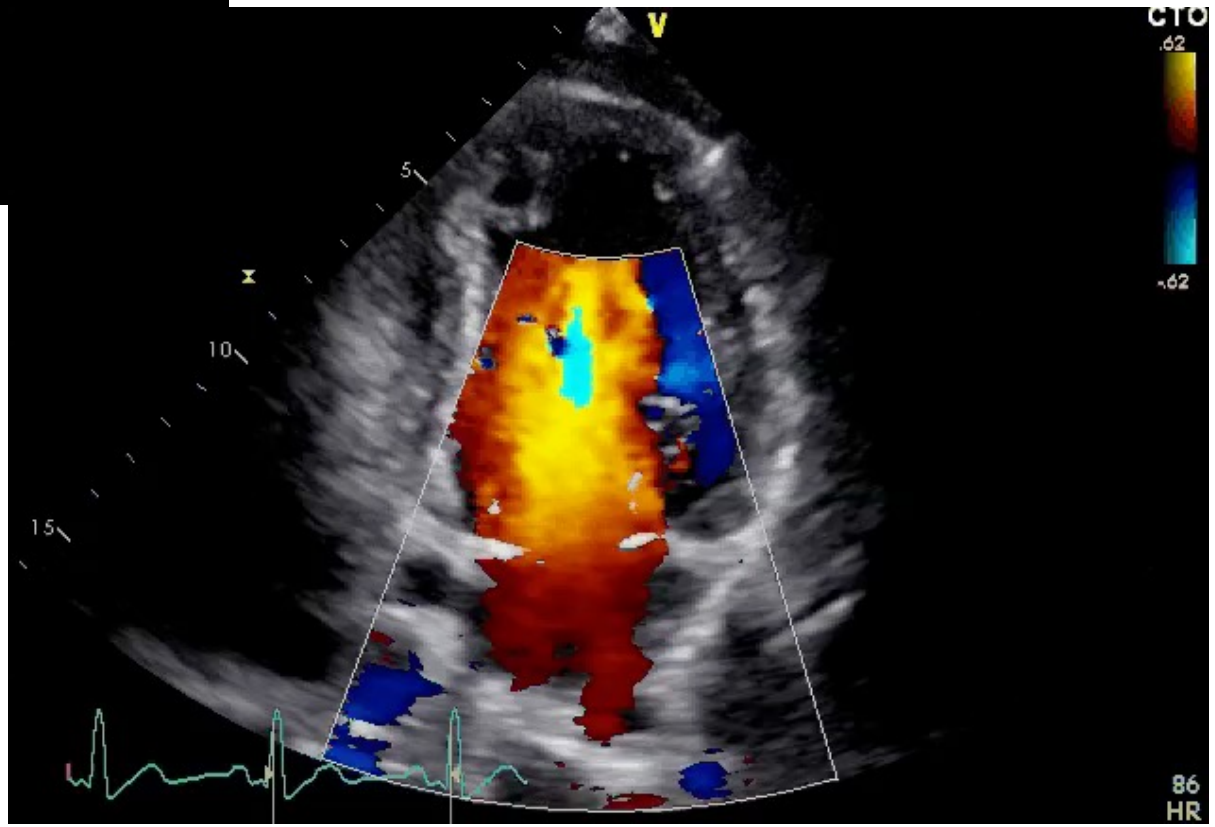






After mitral valve repair:

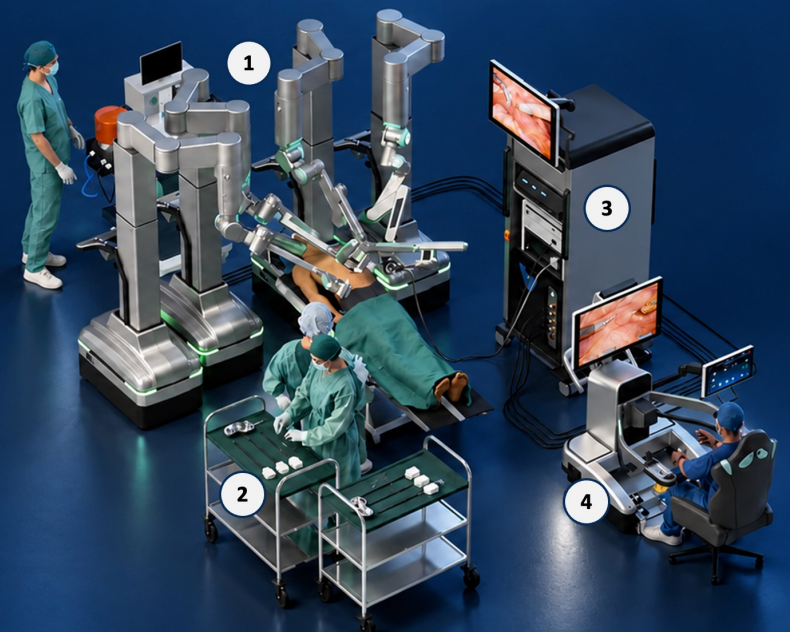
- No residual regurgitation
- High coaptation zone
- Low gradient
- No SAM



Robotics – beyond Intuitive's DaVinci

SSi Mantra Surgical Robotic System

SS Innovations, India



1. **Patient Side Arm Carts**
   Modular, independent carts with up to five robotic arms placed around the operating table
2. **SSi Mudra instruments**
   40+ wristed instruments in 9 mm and 5 mm, including 20+ cardiac instruments such as a cardiac stabiliser and valve retractors
3. **Vision Cart**
   3D 4K endoscopic vision and a shared 3D view for the bedside team
4. **Surgeon Command Center**
   Open console with a 3D 4K monitor viewed through passive 3D glasses, magnetic hand controls and head tracking

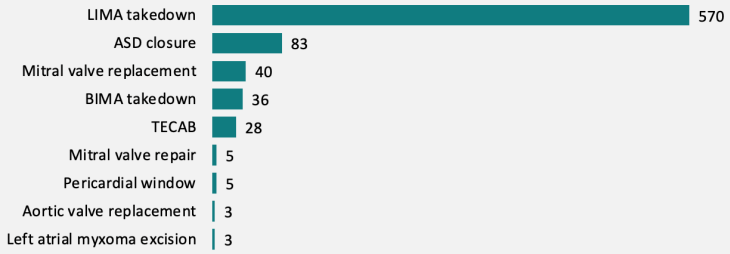
773
robotic cardiac procedures

45
mitral valve procedures (40 replacements, 5 repairs)

83
ASD closures

28
totally endoscopic coronary artery bypass (TECAB)

Cardiac procedures by type



Milestones

June 2023
Robotic coronary bypass with the SSi Mantra, Narayana Hrudayalaya, Bengaluru

November 2024
First robotic TECAB in Southeast Asia, Harapan Kita National Heart Centre, Jakarta [1]

November 2024 to April 2025
Robotic off-pump CABG series, Indonesia [2]: 13 patients, median operative time 445 min, mean hospital stay 6.2 days, mean hospital cost USD 12,607

EACTS 2026: 6 sessions (20 oral presentations); 2 industry satellite symposia

U.S.
Intuitive DaVinci
n>140,000
FDA/ EU/ CH approved

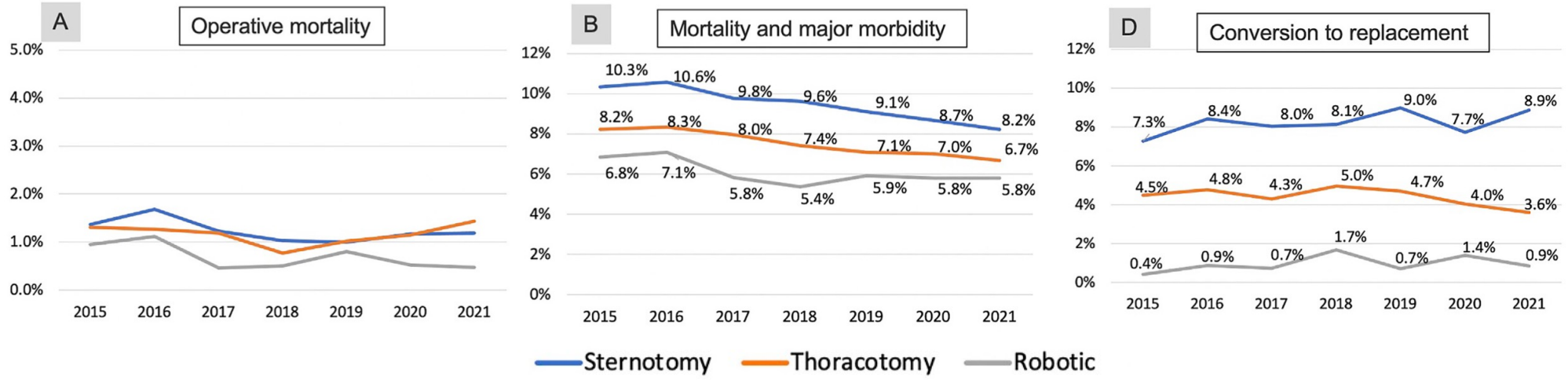
India
SSi Mantra
n=773
FDA/EU/CH approved by end 2026

China
MicroPort MedBot Toumai
n=?
FDA/EU/CH: no approval

Robotic Mitral Repair in the U.S.

TABLE 2 Postoperative Outcomes By Surgical Approach—All Patients

Variable	Robotic (n = 7692)	Thoracotomy (n = 15,725)	Sternotomy (n = 39,705)
Any complication	2349 (30.5)	5672 (36.1)	17,069 (43.0)
Prolonged ventilatory support	205 (2.7)	654 (4.2)	2319 (5.8)
Pneumonia	49 (0.6)	191 (1.2)	595 (1.5)
Permanent stroke	81 (1.1)	199 (1.3)	500 (1.3)
Postoperative atrial fibrillation	1638 (21)	3998 (25)	11,115 (28)
Return to the operating room for reoperation	225 (2.9)	452 (2.9)	1286 (3.2)
Postoperative transfusion	1091 (14.2)	2453 (15.6)	9776 (24.6)
Postoperative length of stay, mean (SD), d	4.9 (3.4)	5.9 (5.0)	7.1 (5.5)
30-day readmission	458 (6.0)	1275 (8.1)	3487 (8.8)
Operative mortality	51 (0.7)	179 (1.1)	489 (1.2)
Major morbidity and mortality	463 (6.0)	1174 (7.5)	3779 (9.5)

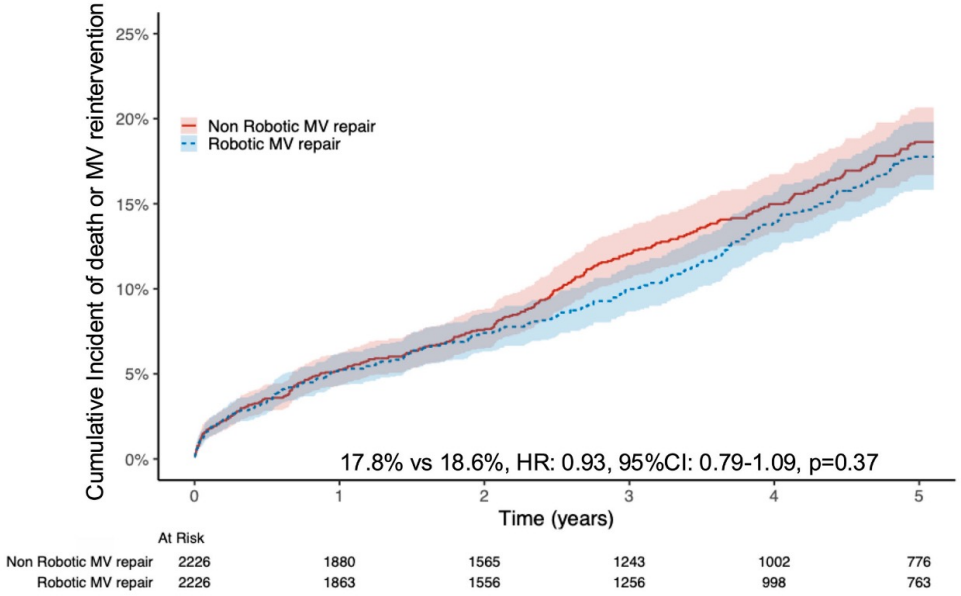


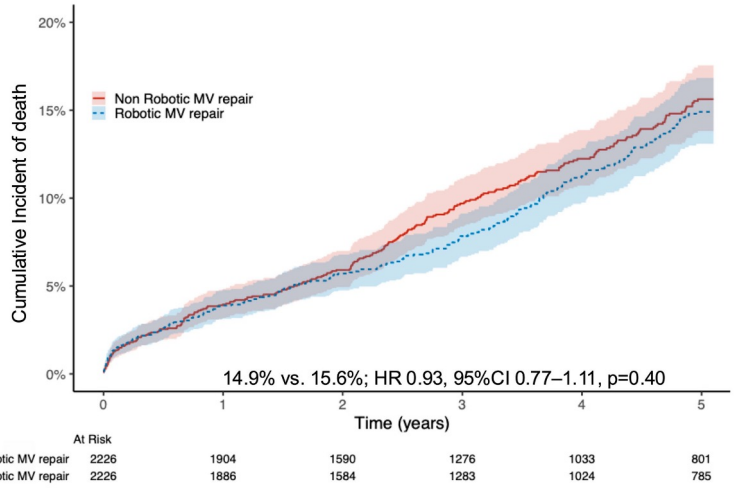
Mori M et al. Robotic Mitral Valve Repair for Degenerative Mitral Regurgitation. Ann Thorac Surg 2024;117:96-105

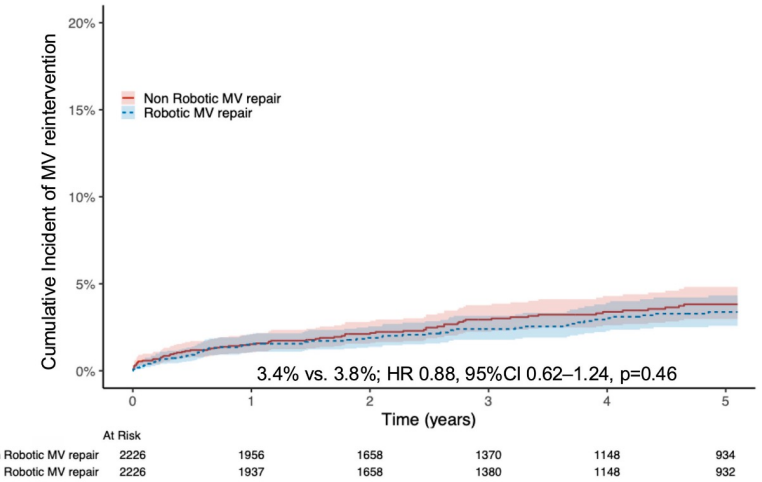
Mortality and Reinterventions after Robotic Mitral Repair in the U.S.

Centers for Medicare and Medicaid database
n=26524; primary repair 2010-2019: robotic 2227 (8.3%), non-robotic 24297

In-hospital outcome:
NOAF and hospital stay: favours r ($p<0.001$)
Death, stroke, bleeding, reintervention: idem







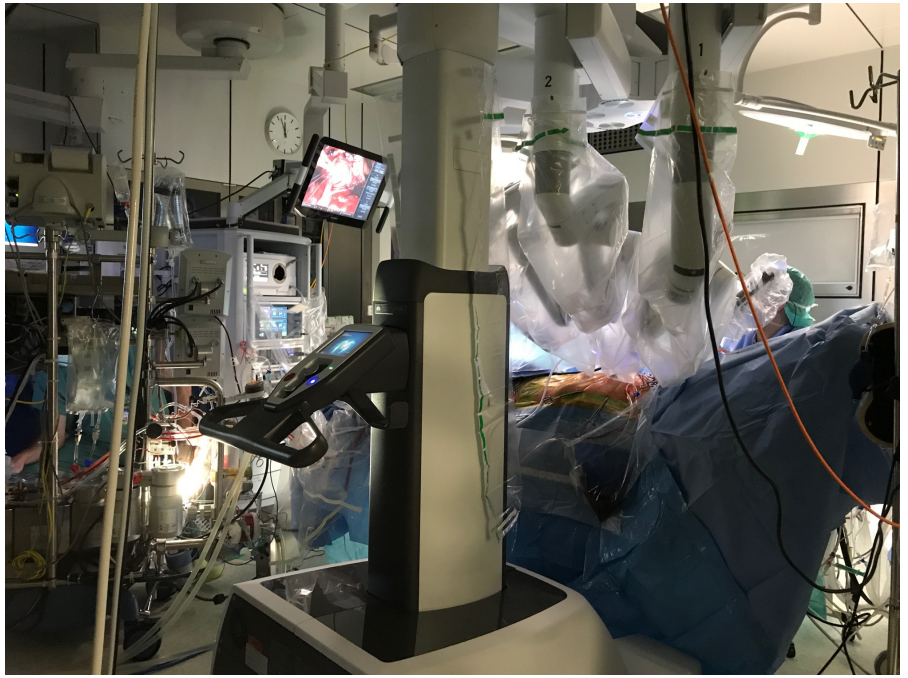
Robotic MVR offers safe, durable, minimally invasive approach to mitral surgery

Tam DY et al. Mortality and Reintervention After Robotic Mitral Repair in the United States. Ann Thorac Surg. 2026 July ; 122(1): 91–99. doi:10.1016/j.athoracsur.2026.01.049.

Robotics

- Pros & cons
  - Maximale Freiheitsgrade Instrumente
  - Softwareunterstützung
  - Visibility (3D)
  - Aufwand und Kosten (Da Vinci >>>Dexter)
  - Adoptibility
  - Remote Surgery
  - Proctoring
  - Klinisch „non-inferior“





Vielen Dank!


EVOLUTION CONTINUES
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ROBERTO MANGOSI