Aortic valve replacement

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March 2011

Topics

- Indications of AVR in AS and AR
- Stented and Stentless Valves
- Homograft and autograft
- Outcomes

Aortic Stenosis

- Degree of AS
  - Mild: > 1.5 cm^2
  - Moderate: 1.0-1.5 cm^2
  - Severe: <1.0 cm^2
- Symptoms arise when the average AVA is 0.6 cm^2
- Rate of sudden death is 10% per year in symptomatic patients
- Concentric hypertrophy

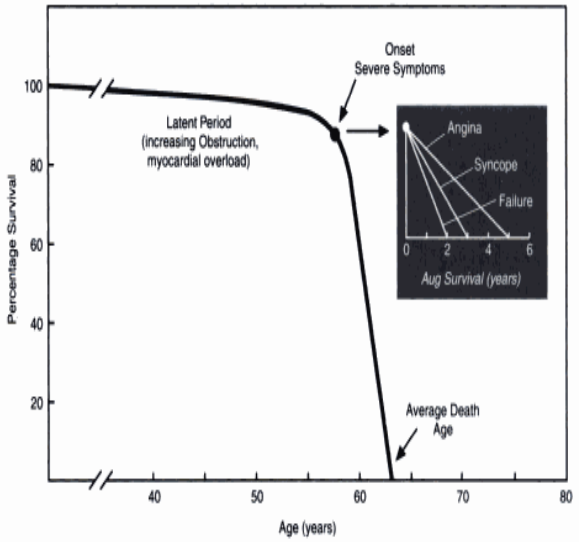


Figure 8–5. The natural history of aortic stenosis. There is little change in survival until the symptoms of angina, syncope, or heart failure develop. Then the decline is precipitous. Adapted, with permission, from Ross J Jr, Braunwald E: Circulation 1968;38(Suppl V):V-61.

- Asymptomatic patients
  - 7% experience death within 1 year of diagnosis
  - 38% experience death after 5 years of diagnosis
  - Average decrease in AVA 0.12 cm^2 per year
  - Average increase in TVG 10-15 mmHg per year
  - Sudden death 0.4% per year

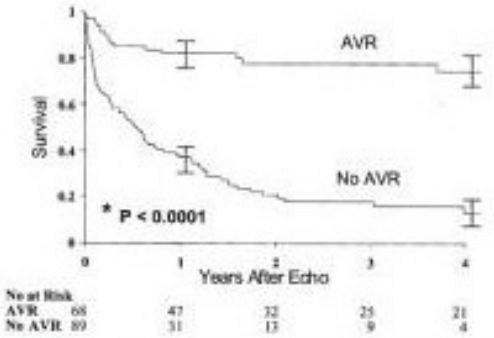
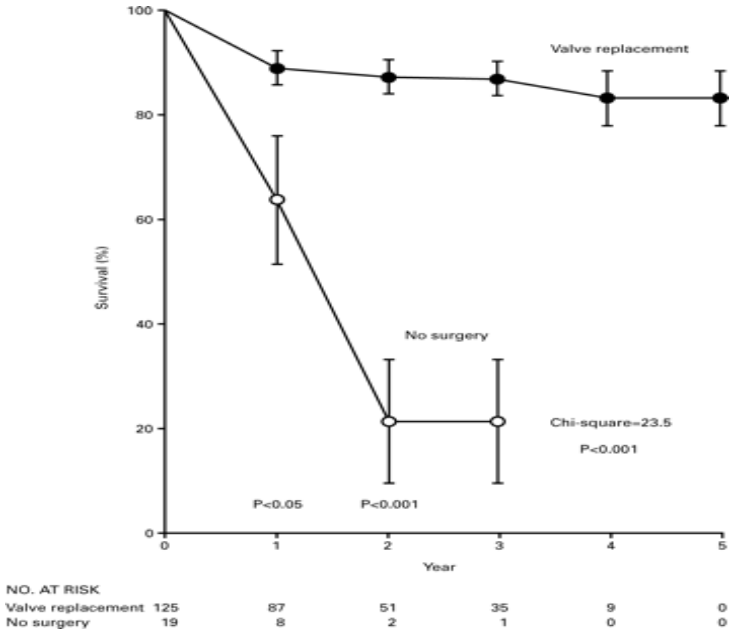


Figure 34-1. Impact of aortic valve replacement on survival in patients with low-gradient aortic stenosis. Survival by Kaplan-Meier analysis among all propensity-matched patients in the aortic valve replacement (AVR) and control (No AVR) groups ($p < 0.0001$). The number of patients at risk during follow-up is shown on the x axis. (*Reproduced with permission from Pereira et al.*[21])

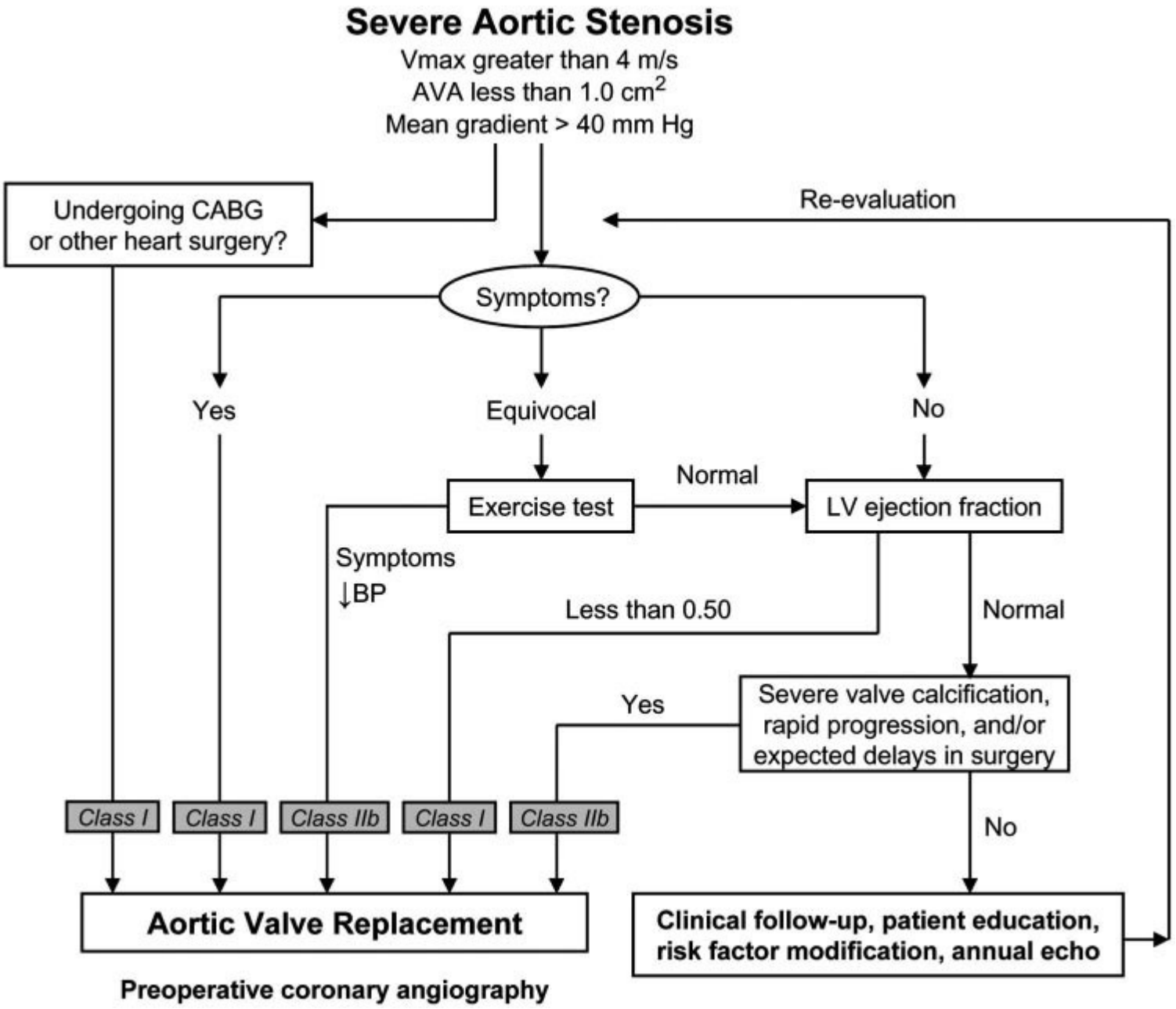
Indications for AVR in AS

- **Class I**
  - **Symptomatic patients with severe AS *(B)***
  - **Severe AS undergoing CABG *(C)***
  - **Severe AS undergoing surgery on Ao or other valve *(C)***
  - **Severe AS and LV dysfunction (EF<50%) *(C)***
- **Class IIa (reasonable)**
  - **Patients with moderate AS undergoing CABG, surgery on Asc Ao, or valve, or combined *(B)***



Survival of patients in symptomatic aortic stenosis compared to those who refused surgery

Schwarz F, Baumann P: Effect of aortic valve replacement on survival : Circulation 1982


Severe Aortic Stenosis
Vmax greater than 4 m/s
AVA less than 1.0 cm2
Mean gradient > 40 mm Hg
Undergoing CABG or other heart surgery?
Re-evaluation
Symptoms?
Yes
Equivocal
No
Exercise test
Normal
LV ejection fraction
Symptoms
↓BP
Less than 0.50
Normal
Severe valve calcification, rapid progression, and/or expected delays in surgery
Yes
No
Class I
Class I
Class IIb
Class I
Class IIb
Aortic Valve Replacement
Clinical follow-up, patient education, risk factor modification, annual echo
Preoperative coronary angiography

Aortic Regurgitation

- **Acute**
  - **Death is the common end-point**
  - **Urgent Surgery**

- **Chronic**
  - **Volume overload -> progressive LV enlargement without ↑ EDP in the asymptomatic phase.**
  - **LV enlargement -> eccentirc hypertrophy with sarcomere replication and elongation of myocytes**
  - **Chamber dilatation + hypertrophy = ↑ LV MASS**
  - **Further increase in hypertrophy -> ↑ EDP, ↑ LV dysfunction, and CHF**

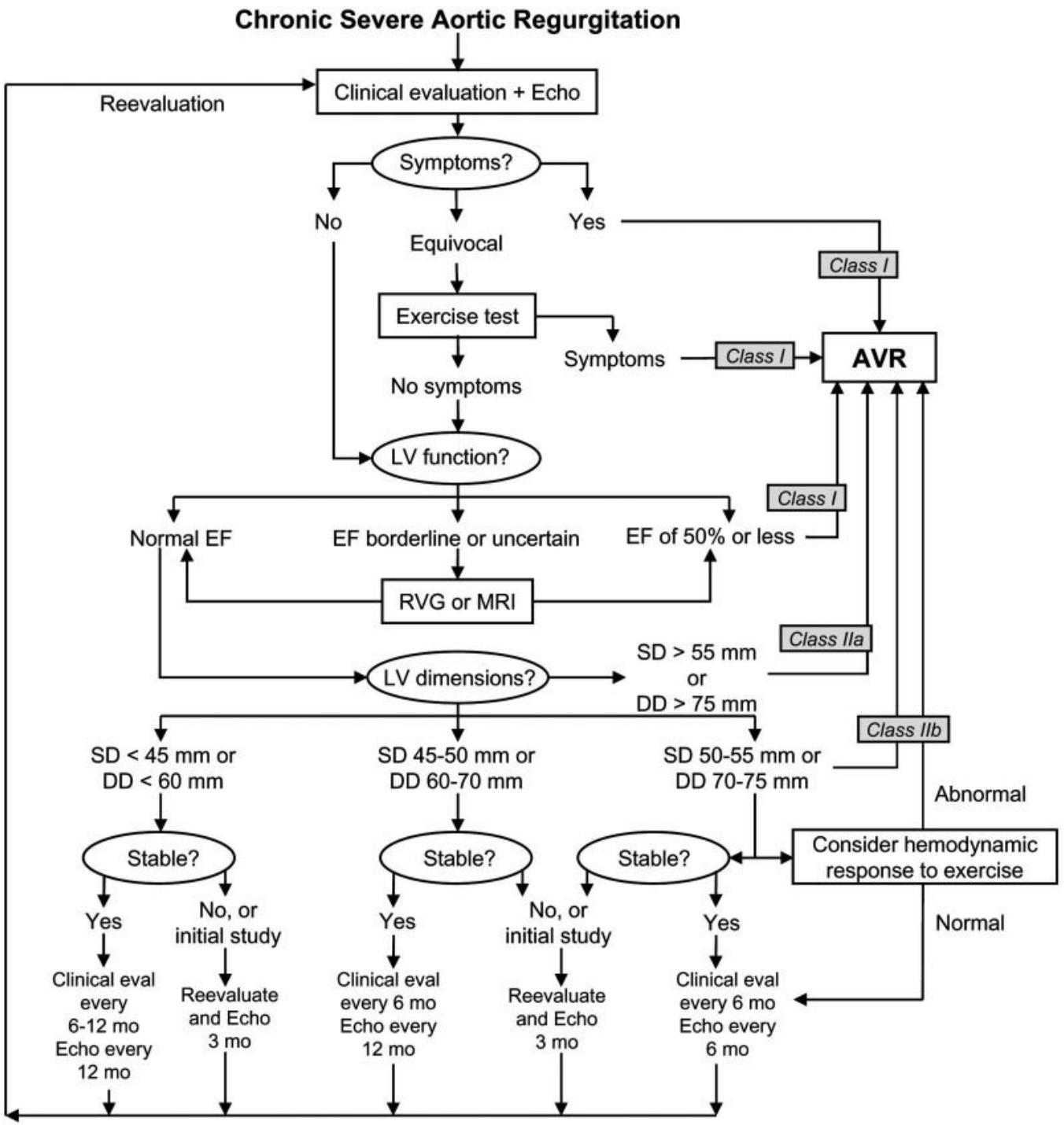
Aortic Regurgitation

- **Symptomatic**
  - **10% mortality per year without surgery**
  - **5-year survival after AVR exceeds 85%**

- **Asymptomatic**
  - **Sudden death < 0.2% per year**
  - **Patients with LV dysfunction experience onset of symptoms at a rate exceeding 25% per year**

Indications for AVR in Chronic AR

- **Class I**
  - **Symptomatic patients with severe AR irrespective of LV systolic function *(B)***
  - **Asymptomatic patients with severe AR and EF at rest < 50% *(B)***
  - **Severe AS undergoing CABG, surgery on Ao or other valve *(C)***
- **Class IIa (reasonable)**
  - **Asymptomatic patients with with severe AR with normal LV function (EF > 50%) but with severe LV dilatation (EDD > 75mm or ESD > 55mm) *(B)***
- **Class IIb (may be considered)**
  - **Moderate AR undergoing surgery on ascending Ao, or CABG *(C)***
  - **Asymptomatic patients with severe AS and normal EF at rest (50%) when LV dilatation exceeds an EDD 70mm or ESD 50mm, when there is evidence of progressive LV dilatation, declining exercise tolerance, or abnormal haemodynamic response to exercise *(C)***
- **Class III**
  - **Not indicated for asymptomatic patients with mild, moderate, or severe AR and normal LV systolic function at rest (EF > 50%) when degree of dilatation is not moderate or severe (EDD <70mm adn ESD <50mm) *(B)***


Chronic Severe Aortic Regurgitation
Reevaluation
Clinical evaluation + Echo
Symptoms?
No
Equivocal
Yes
Class I
Exercise test
Symptoms
Class I
AVR
No symptoms
LV function?
Class I
Normal EF
EF borderline or uncertain
EF of 50% or less
RVG or MRI
Class IIa
LV dimensions?
SD > 55 mm
or
DD > 75 mm
Class IIb
SD < 45 mm or
DD < 60 mm
SD 45-50 mm or
DD 60-70 mm
SD 50-55 mm or
DD 70-75 mm
Abnormal
Stable?
Stable?
Stable?
Consider hemodynamic
response to exercise
Yes
No, or
initial study
Yes
No, or
initial study
Yes
Normal
Clinical eval
every
6-12 mo
Echo every
12 mo
Reevaluate
and Echo
3 mo
Clinical eval
every 6 mo
Echo every
12 mo
Reevaluate
and Echo
3 mo
Clinical eval
every 6 mo
Echo every
6 mo

Operations

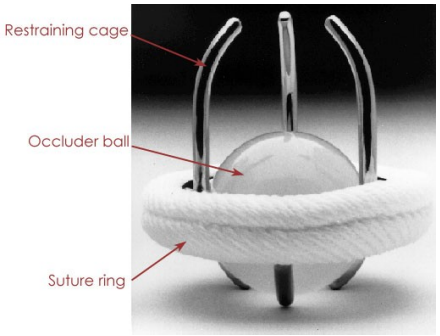
- Aortic Valve Replacement
- Aortic Valve Repair
- Percutaneous

Prostheses Choices

Stented Valves
Stentless Valves
Homograft
Autograft

Stented Valves - Mechanical

- **Cage and Ball**



- **Tilting Monofilament**







Stented Valves - Mechanical

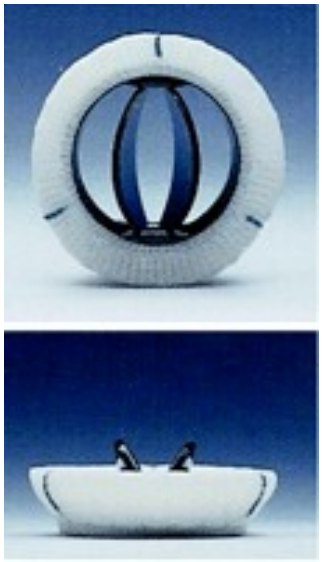
- **Bileaflet Prosthesis**







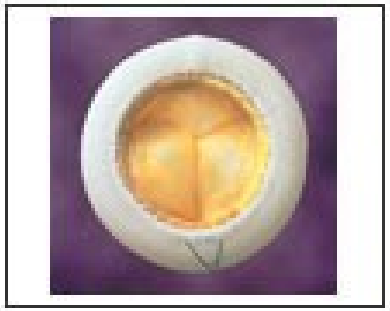






Stented Valves - Bioprothesis

- First Generation



- Second Generation








Stented Valves - Bioprothesis

- **Third Generation**







Recommendations for Valve Choice

Mechanical	Bioprothesis
Indications 1)Expected long life span *(I-B)* 2)Patient with already PMV in a different position *(I-B)* 3)Requiring warfarin *(IIa-C)* 4)≤65 years for AVR and ≤ 70 years for MVR *(IIa-C)* 5)Replacement for thrombosed bioprothesis *(IIb-C)*	Inidcations 1)Cannot take or will not take warfarin *(I-B)* 2)≥ 65 years needing AVR with no risk factors for TE *(I-B)* 3)Compliance with warfarin *(IIa-C)* 4)> 70 years needing MVR with no risk factors for TE *(IIa-C)* 5)Replacement for thrombosed mechanical valve *(IIb-C)* 6)Patients < 65 years *(IIb-C)* 7)Renal failure, on haemodialysis or with hypercalcaemia *(IIb-C)*
Contraindications 1)Renal failure on haemodialysis or with hypercalcaemia *(III-C)* 2)Cannot or will not take warfarin *(III-C)*	Contraindications 1) Adolescent who are still growing *(III-C)*

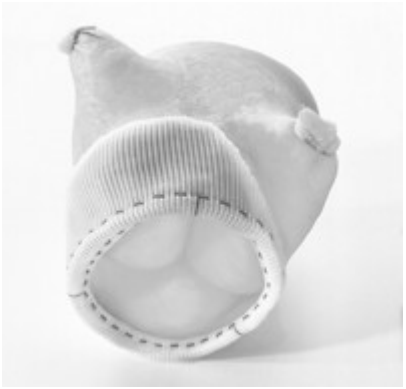
Prostheses Choices

Stented Valves
Stentless Valves
Homograft
Autograft

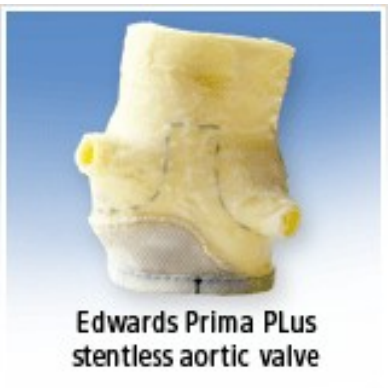
Stentless Valves - Bioprothesis

- Introduced in 1990s









- Three implantation techniques
  - Subcoronary valve replacement
  - Root inclusion
  - Root Replacement

Subcoronary position

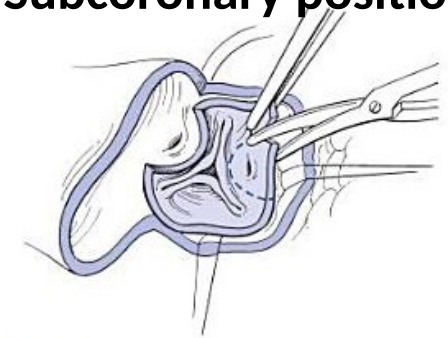




Figure 36-2. Modified subcoronary technique—preparing the sinuses. Either before or after the device is slid down and the proximal sutures tied, the sinuses facing the native left and right coronary ostia are scalloped out below the level of those recipient coronaries. Care is taken to avoid cutting into any cloth covering or getting too close to the leaflets of the new valve. (*Modified and reproduced with permission from Kon ND, Westaby S, Amarasena N, et al: Comparison of implantation techniques using Freestyle stentless porcine aortic valve. Ann Thorac Surg 1995; 59:857.*)

Root inclusion technique

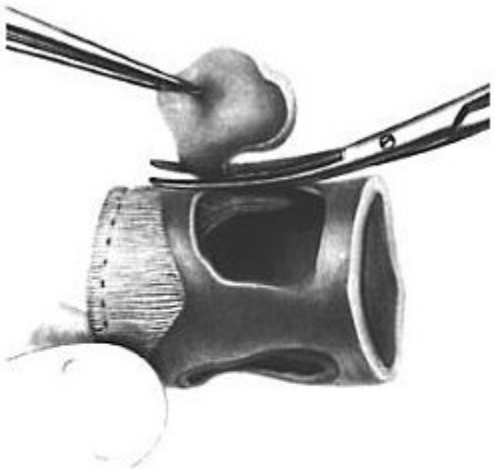


Figure 36-6. Root inclusion technique—trimming out sinuses. Very generous openings are made in the two appropriate sinuses facing the native coronaries without violating the sinotubular junction of the stentless valve. (*Modified and reproduced with permission from Krause AH: Technique for complete subcoronary implantation of the Medtronic Freestyle porcine bioprosthesis. Ann Thorac Surg 1997; 64:1495.*)

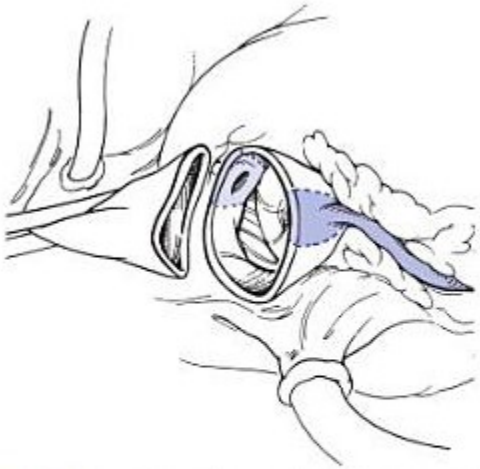
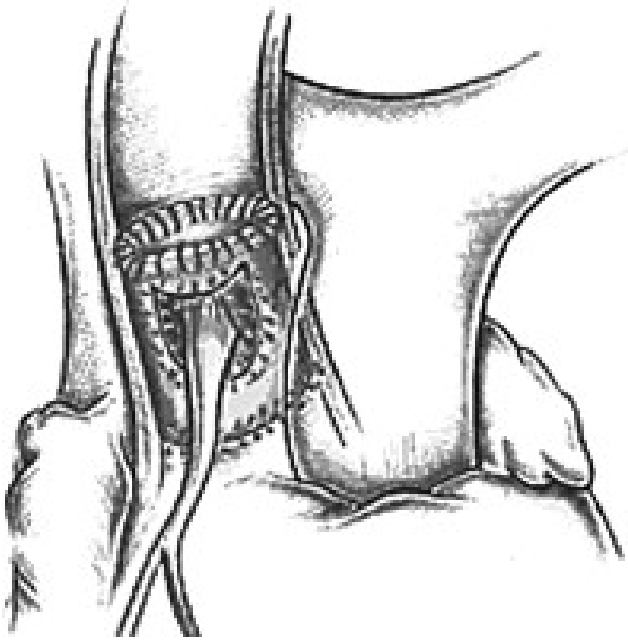


Figure 36-8. Full root technique—initial incisions. The aorta is transsected 1 to 1.5 cm distal to the coronary ostia, which are then mobilized from the root with "buttons" of aortic wall as indicated by the dashed lines. (*Modified and reproduced with permission from Kon ND, Westaby S, Amarasena N, et al: Comparison of implantation techniques using Freestyle stentless porcine aortic valve. Ann Thorac Surg 1995; 59:857.*)



Stentless Valves - Bioprothesis

- **Advantages:**
  - **Small aorta**
  - **Reduce the possibility of patient-prothesis mismatch**
  - **Rapid reduction in LV hypertrophy and improvement in LV function**
  - **10-20% reduction in LV mass occurs within the first 6-12 months**
  - **Low TVG < 10 mmHg**
  - **Low risk of endocaridtis**

Stentless Valves - Bioprothesis

- **Issues:**
  - **AR or Bicuspid pathology: prone to early structural deterioration when used in the subcoronary position**
  - **Progressive root dilatation**
    - **poor leaflet coaptation,**
    - **leaflet tears, and**
    - **recurrent AR**
  - **Technical difficulty**

Outcomes of AVR

- Operative Mortality
- Long-Term Survival
- Structural Valve Deterioration
- Freedom from Reoperation
- Prosthesis Thrombosis
- PVE
- Paravalvular Leak and Haemolysis
- Mechanical versus Bioprosthetic Valve
- Stented versus Stentless Valves

Operative Mortality

Table 34–4 Operative Mortality Rates for Aortic Valve Replacement (AVR) Procedures from the Society of Thoracic Surgeons' Database

Operative category	Number	Operative mortality (%)
AVR (isolated)	26,317	4.3
Multiple valve replacement	3840	9.6
AVR + coronary artery bypass	22,713	8.0
Multiple valve replacement + coronary artery bypass	1424	18.8
AVR + any valve repair	938	7.4
Aortic valve repair	597	5.9
AVR + aortic aneurysm repair	1723	9.7
AVR + other*	356	8.4

- **In the absence of major comorbidities and preserved LVF, mortality of isolated AVR < 2%**

- **Risk factors for operative mortality**
  - **Advanced Age**
  - **Poor LV function**
  - **NYHA IV**
  - **CAD**
  - **Pre-op dialysis dependant renal dysfunction**
  - **IE**
  - **Female**
  - **Previous AV surgery**
  - **Emergent or salvage procedure**
  - **Small effective orifice area**

Outcomes of AVR

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- Long-Term Survival
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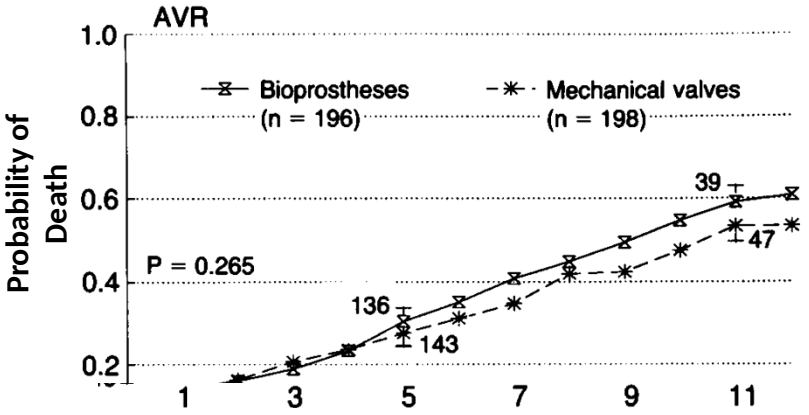
Long-Term Survival

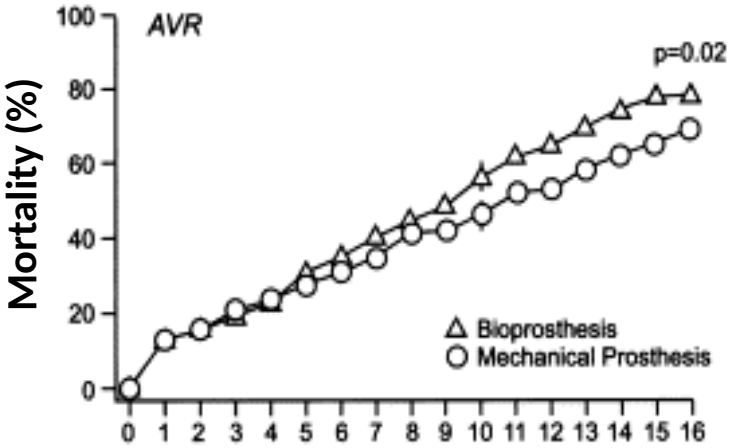
- **Most published series expected survival after AVR is**
  - **80% to 85% at 5 years**
  - **65% to 75% at 10 years**
  - **45% to 55% at 15 years**

- **No differences at 10-year survival between MV and BV**

Long-Term Survival

Veterans Affair Randomised Trial





- 11 years F/U. No probability of death between the two groups (0.57 vs 0.62)
- Overall mortality at 15 years following AVR was 45 to 55%
- Valve-related deaths accounted for 37% of all deaths in patients with mechanical valves and 41% of all deaths in patients with bioprostheses

Hammermeister, K. et al. NEJM 1993;328(18):1289

- All cause mortality was lower in mechanical valve group 66% vs 79%, p=0.02

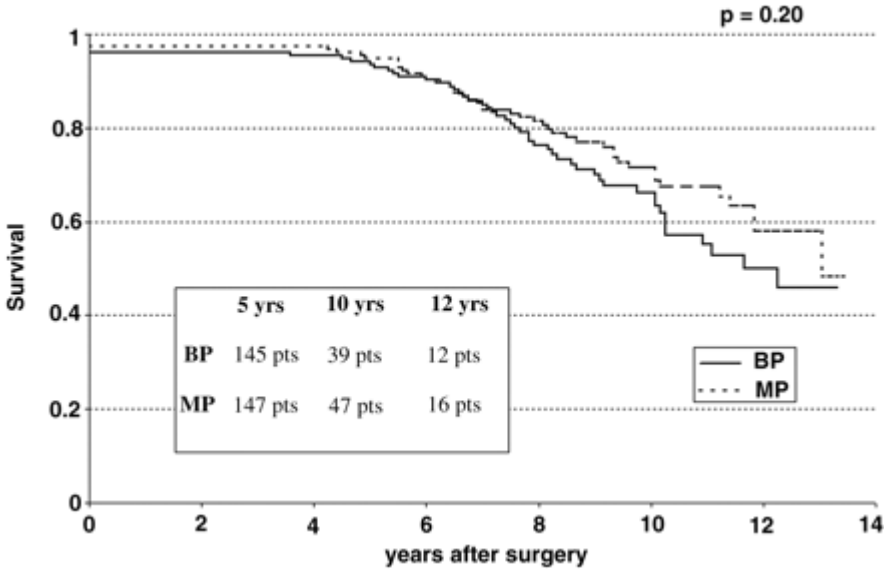
Hammermeister, K. et al. J Am Coll Cardiol 2000;36:1152-1158 Final report of the Veterans Affairs randomized trial

Long-Term Survival

Aortic Valve Replacement: A Prospective Randomized Evaluation of Mechanical Versus Biological Valves in Patients Ages 55 to 70 Years

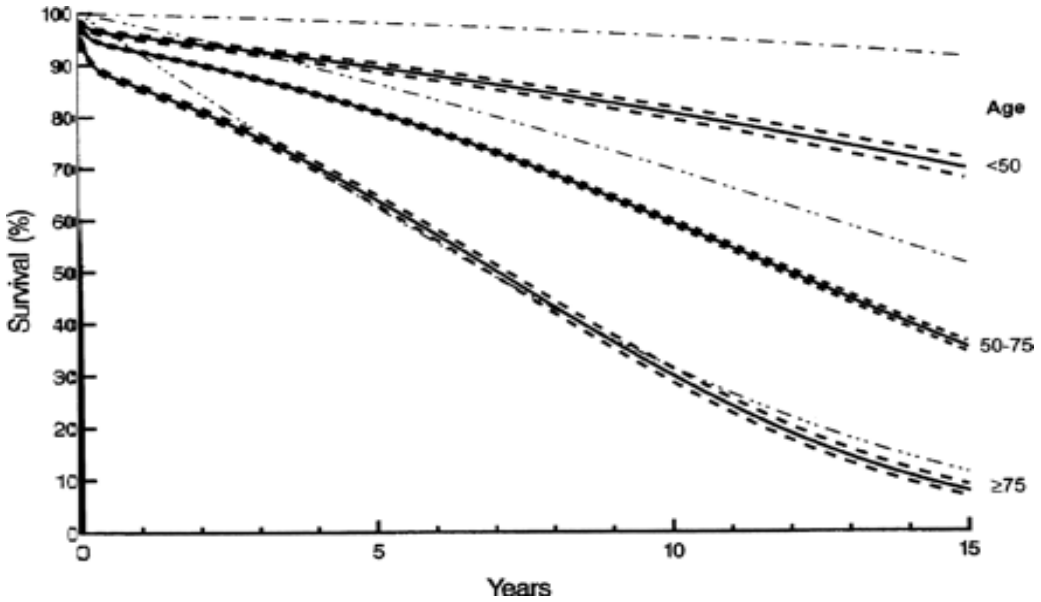
Stassano et al JACC 2009;54:1862

- **January 1995 and June 2003,**
- **310 patients (55-70yrs) were randomized to receive a BP or an MP aortic valve; 155 in each group**
- **At late follow-up (mean 106 ± 28 months) 41 patients died in the MP group and 45 patients died in the BP group (p = 0.6). There was no difference in the survival rate at 13 years between the MP and BP groups.**



Long-Term Survival

- **Projected long-term survival after AVR stratified by age at time of surgery.**



- **Younger patients show more marked departure from normal life expectancy**

Long-Term Survival

Survival Probability Calculated from an Accelerated Time Failure Model for Combinations of Risk Factors*					
CAD	Age >65	NYHA class IV	Left ventricular grade III or IV	Predicted 5-year survival (%)	Predicted 10-year survival (%)
				89.1 (73, 100)	83.9 (73, 95)
X				83.4 (70, 97)	76.2 (67, 85)
	X			84.5 (71, 98)	77.7 (69, 86)
		X		83.6 (70, 97)	76.6 (68, 85)
			X	82.3 (69, 96)	74.8 (66, 84)
X	X			77.1 (66, 88)	68.2 (61, 75)
X		X		75.9 (65, 87)	66.8 (60, 74)
X			X	74.1 (63, 85)	64.6 (58, 72)
	X	X		77.4 (66, 88)	68.6 (62, 76)
	X		X	75.7 (65, 86)	66.5 (59, 74)
		X	X	74.5 (64, 85)	65.1 (58, 72)
X	X	X		67.8 (59, 77)	57.4 (52, 63)
X	X		X	65.7 (57, 75)	55.0 (49, 61)
	X	X	X	66.2 (57, 75)	55.5 (50, 61)
X	X	X	X	54.6 (47, 62)	43.5 (39, 48)

Outcomes of AVR

- Operative Mortality
- Long-Term Survival
- Structural Valve Deterioration
- Freedom from Reoperation
- Prosthesis Thrombosis
- PVE
- Paravalvular Leak and Haemolysis
- Mechanical versus Bioprosthetic Valve
- Stented versus Stentless Valves

Structural Valve Deterioration

- **Mechanical prostheses**

  Other than Bjork-Shiley convexo-concave valve, all mechanical valves are extremely resistant to material fatigue or structural valve deterioration

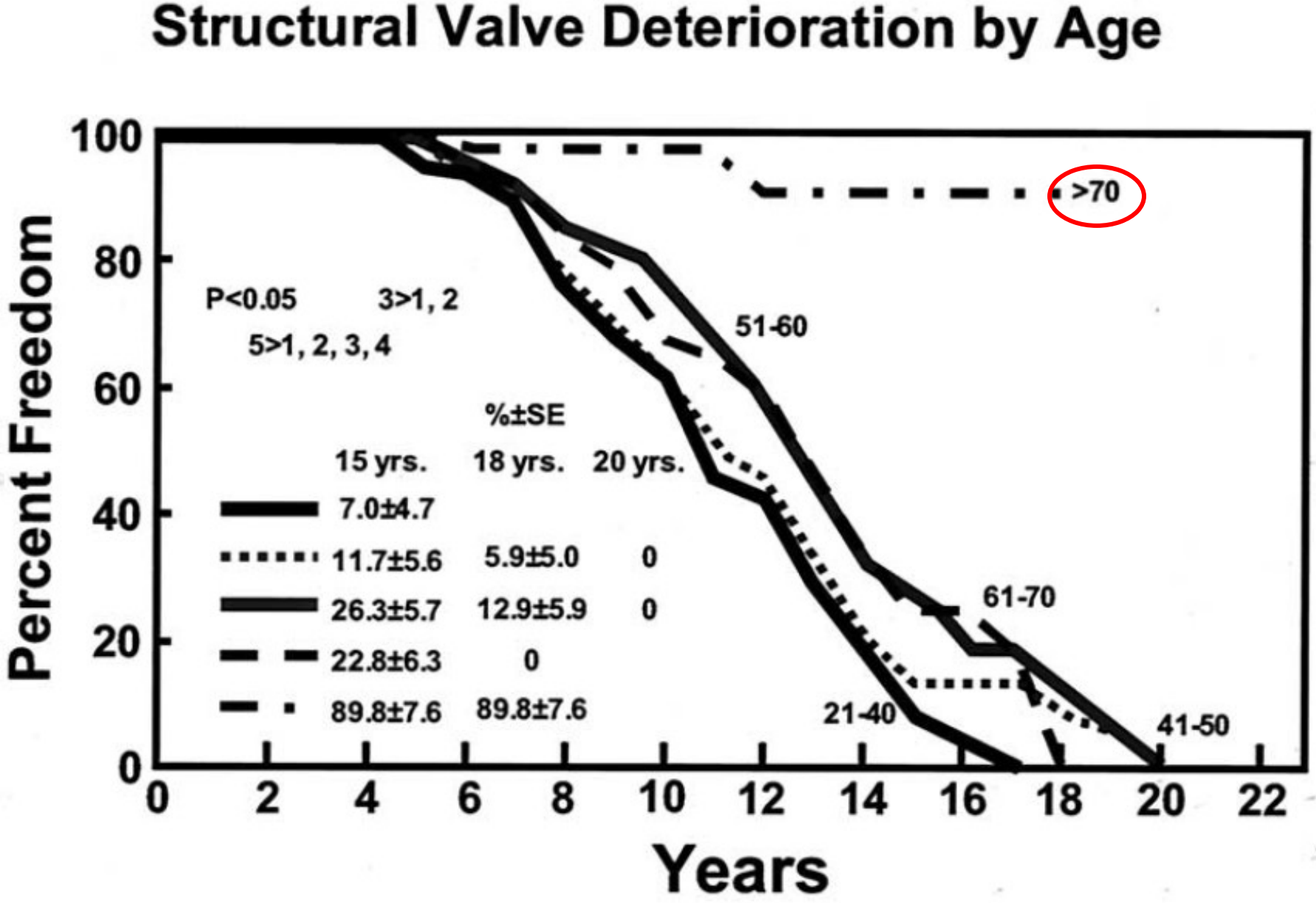
- **Stented bioprostheses**

  Structural deterioration is the most common nonfatal valve-related complication

Table 34–8 Bioprosthetic Valve Failure 10 years After Valve Replacement According to the Patient's Age at the Time of Implantation

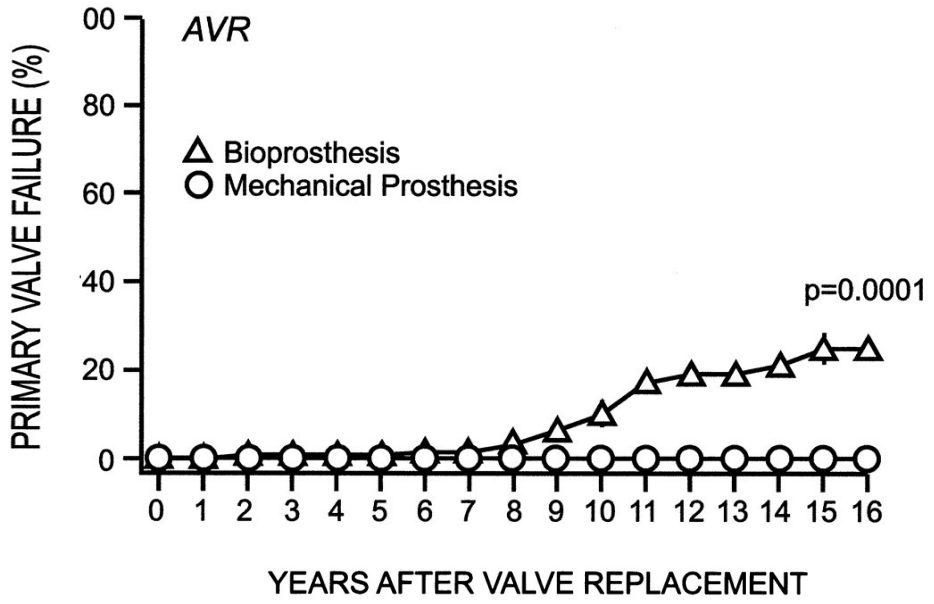
Patient's age (y)	Percentage with valve failure after 10 years
<40	42
40–49	30
50–59	21
60–69	15
>70	10

Source: Adapted from Vongpatanasin et al[166] based on data from Grunkemeier et al.[167]



G 7. Structural valve deterioration by age. (*Adapted from* Jamieson et al; with permission from Ann
orac Surg.)

Structural Valve Deterioration

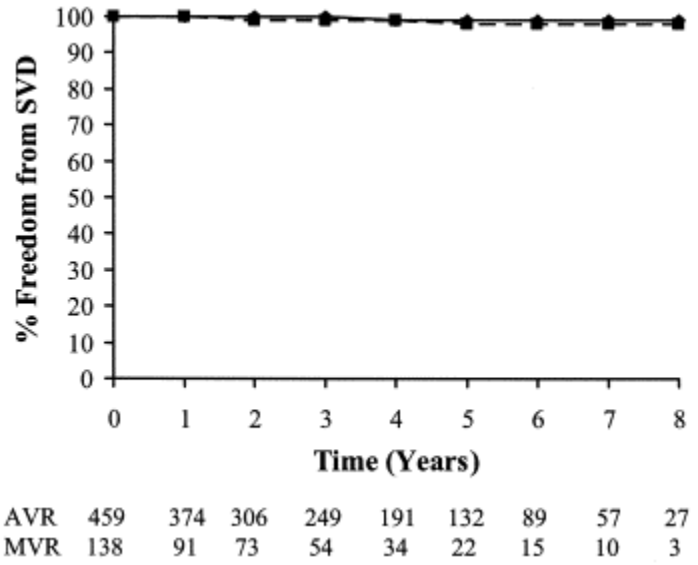


Hammermeister, K. et al. J Am Coll Cardiol 2000;36:1152-1158 Final report of the Veterans Affairs randomized trial

Structural Valve Deterioration

Clinical outcomes with the Hancock II bioprosthetic valve (8-years F/U)
Masters et al. ATS 2004;78:832

- **1991 to 1999**
- **459 patients underwent aortic valve replacement and 138 patients underwent mitral valve replacement with the Hancock II bioprosthesis (Medtronic Inc, Minneapolis, MN).**
- **The mean age was 73.2 ± 0.4 and 72.6 ± 0.8 years in the aortic and mitral groups, respectively. Most patients were in New York Heart Association Class III or IV (50% aortic group and 69% mitral group) and concomitant coronary artery bypass was performed in 49.4% and 52.8% of patients, respectively.**

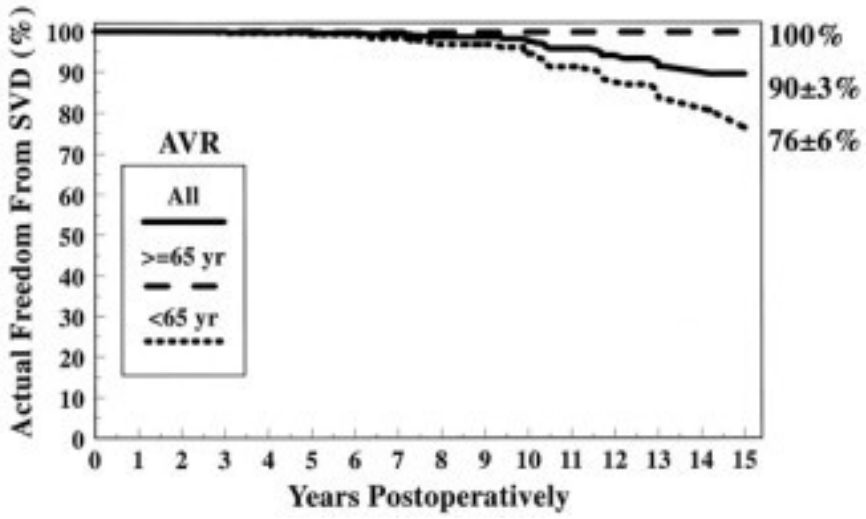


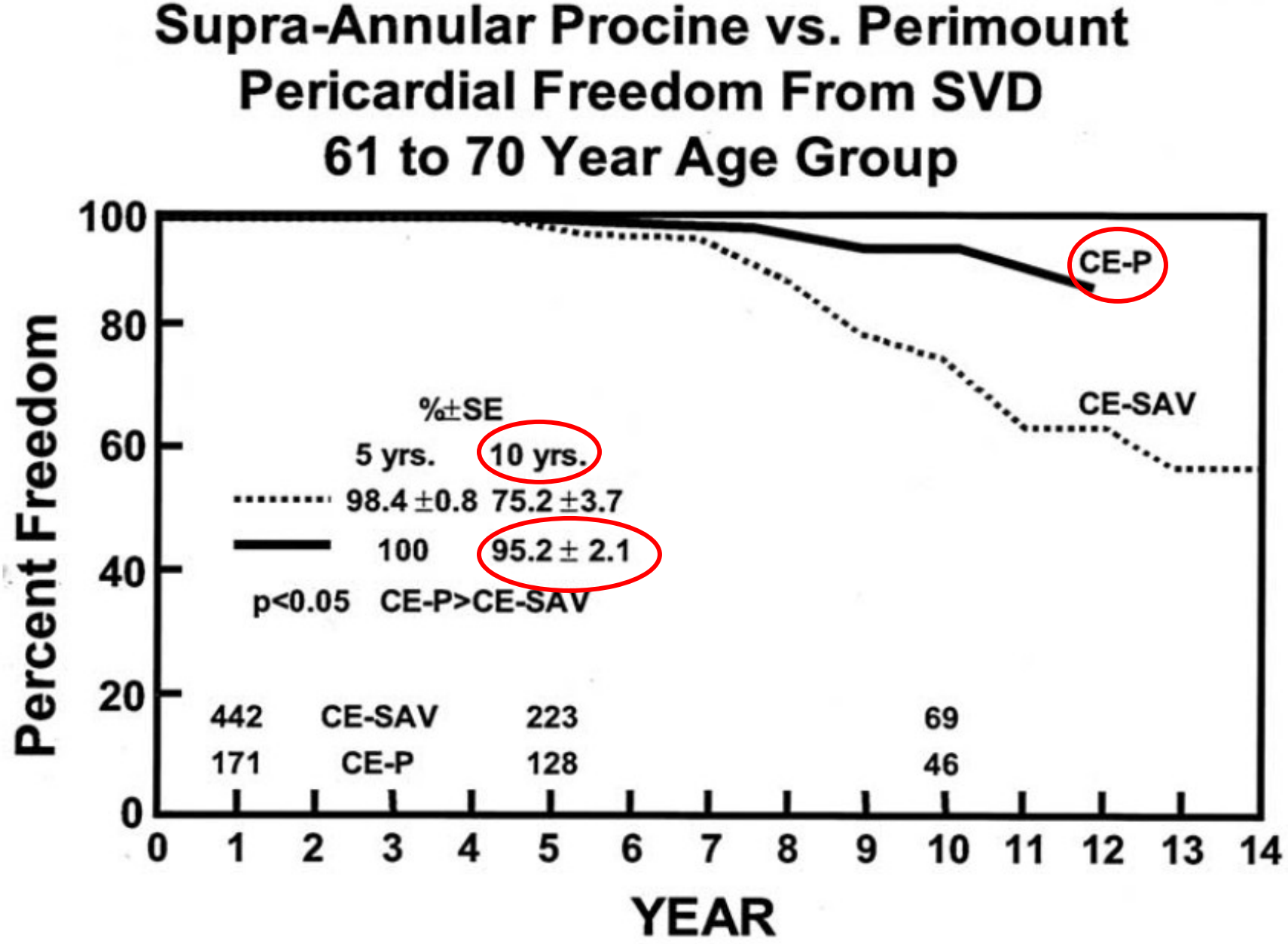
Actuarial freedom from SVD necessitating reoperation: AVR 99% ± 0.5%

Structural Valve Deterioration

Late results of heart valve replacement with the Hancock II bioprosthesis
David et al. JTCVS 2001;121:268-78

- **1982 to 1994**
- **670 patients underwent isolated aortic valve replacement and 310 underwent isolated mitral valve replacement with the Hancock II bioprosthesis (Medtronic Inc, Minneapolis, Minn). Mean age was 65 ± 12 years in both groups.**
- **Most patients were in New York Heart Association functional classes III or IV, and concomitant coronary artery disease was present in 44% of patients in the aortic valve group and 41% of patients in the mitral valve group. Patients were followed up prospectively at periodic intervals.**
- **Mean follow-up was 87 ± 45 months in the aortic valve group and 83 ± 50 months in the mitral valve group, and it was 99% complete.**





IG 4. Durability of porcine native aortic (CE-SAV) and bovine pericardial valves (CE-P). (*Adapted rom* Jamieson et al; with permission from Ann Thorac Surg.)

Outcomes of AVR

- Operative Mortality
- Long-Term Survival
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Freedom from Re-operation

- **Mechanical Valves**
  - **>95% at 10-yr and >90% at 15-yr**
- **Bioprostehtic valves**
  - **>95% at 5-yr, >90% at 10-yr, <70% at 15 yr**

Ref	Prosthesis	Patients	Mean Age	Mean F/U (mo)	Time of SVD estimate (y)	Actuarial Freedom from Re-operation
David, 1998	HCII porcine	723	65 ± 12	658 ± 40	12	89 ± 5
Dellgren, 2002	CE Pericardial	254	71 ± 9	60 ± 31	12	83 ± 9
Poirier, 1998	CE Pericardial	598	65	57.7	12	91 ± 2
Burdon, 1992	HCI and MO	857	59 ± 11	87.6	15	57 ± 3

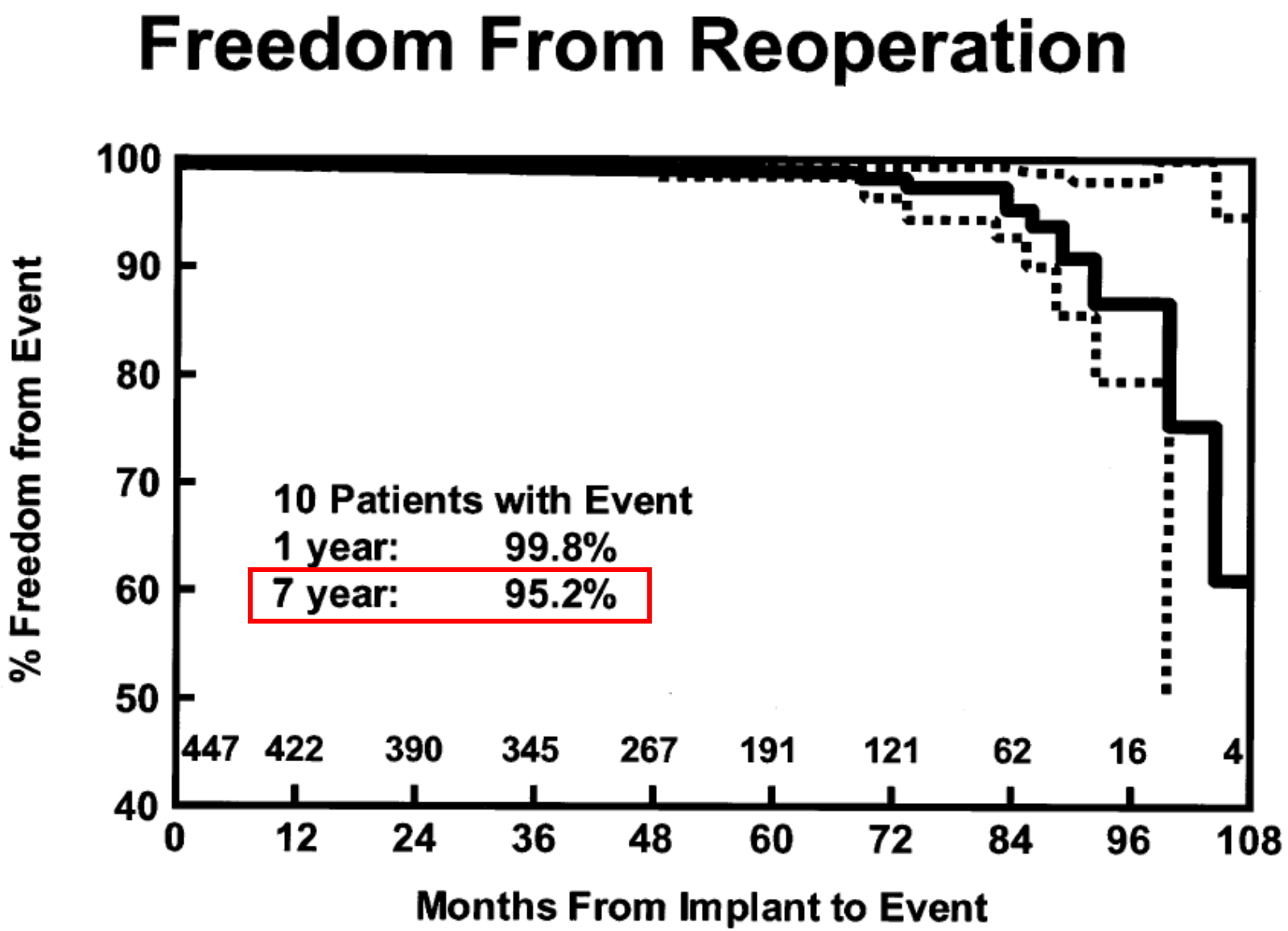


FIG 5. Freedom from reoperation for Toronto stentless valve. (Adapted from Shargall et al; with permission from Semin Thorac Cardiovasc Surg.)

Outcomes of AVR

- Operative Mortality
- Long-Term Survival
- Structural Valve Deterioration
- Freedom from Reoperation
- Prosthesis Thrombosis
- PVE
- Paravalvular Leak and Haemolysis
- Mechanical versus Bioprosthetic Valve
- Stented versus Stentless Valves

Prosthesis Thrombosis

- **It is a rare but potentially devastating outcome after AVR (<0.2% per year)**
- **More often seen in mechanical prostheses**
- **Thrombolysis is recommended in patients with left-sided thrombosis who are experiencing significant heart failure (NYHA class III or higher) and are considered too high risk for surgery.**
- **Cerebral or peripheral thromboembolism occurs in 12% of patients after thrombolytic therapy.**

Prosthesis Thrombosis

- **Surgical treatment includes replacement of the valve or open thrombectomy,**

- **Mortality from either procedure is similar at approximately 10 to 15%.**

- **As recurrent thrombosis after de-clotting occurs in up to 40% of patients valve replacement is recommended in virtually all patients who are managed operatively**

Outcomes of AVR

- Operative Mortality
- Long-Term Survival
- Structural Valve Deterioration
- Freedom from Reoperation
- Prosthesis Thrombosis
- PVE
- Paravalvular Leak and Haemolysis
- Mechanical versus Bioprosthetic Valve
- Stented versus Stentless Valves

PVE

- **Early (<60 days post-implantation)**
  - **usually a sequela of peri-operative bacterial seeding of the valve**
  - ***S. aureus*, *S. epidermidis*, gram-negative bacteria, and fungal infections**
- **Late (>60 days post-implantation)**
  - **septicemia from noncardiac sources**
  - **small proportion of late cases in the first year are attributable to less virulent organisms introduced in the peri-operative period, particularly *S. epidermidis***

PVE

- There is no difference in risk between patients with mechanical and stented bioprosthetic prostheses after the early phase
- Stentless valves and homografts are less likely to develop PVE
  - particularly helpful in valve re-replacement for PVE
- Early PVE is associated with 30 to 80% mortality, while late PVE is associated with 20 to 40% mortality

PVE

- **Indications for re-operations:**
  - **All early cases**
  - **Concomitant HF and valvular dysfunction**
  - **Paravalvular leak or partial dehiscence (if more than 40% of valve circumference involved)**
  - **Presence of:**
    - **Conduction defect, abscess, fistula, aneurysm**
  - **Persistent bacteraemia**
  - **Vegetations larger than 10 mm**
  - **Multiple systemic emboli**

Outcomes of AVR

- Operative Mortality
- Long-Term Survival
- Structural Valve Deterioration
- Freedom from Reoperation
- Prosthesis Thrombosis
- PVE
- Paravalvular Leak and Haemolysis
- Mechanical versus Bioprosthetic Valve
- Stented versus Stentless Valves

Paravalvular Leak and Haemolysis

- **Rare if not PVE**
- **If paravalvular leak is large to cause haemolysis -> lcosure with interrupted pledgetted sutures**
- **Pannus overgrowth and prosthetic structure degeneration interfering with opening -> haemolysis**

Outcomes of AVR

- Operative Mortality
- Long-Term Survival
- Structural Valve Deterioration
- Freedom from Reoperation
- Prosthesis Thrombosis
- PVE
- Paravalvular Leak and Haemolysis
- Mechanical versus Bioprosthetic Valve
- Stented versus Stentless Valves

Stented vs Stentless

Aortic valve replacement with stentless and stented porcine valves: a case-match study

T David, et al. *(JTCVS 1998;116:234)*

Objectives: Toronto SPV and the stented Hancock II bioprosthesis.

Methods: Preoperative clinical variables predictive of death after aortic valve replacement were determined by a stepwise logistic regression analysis in a series of 908 consecutive patients who received porcine aortic bioprostheses during a 14-year interval. Advanced age, New York Heart Association functional class IV, left ventricular ejection fraction of less than 30%, and coronary artery disease were independent predictors of death. On the basis of these four variables, 198 pairs of patients who survived aortic valve replacement with stentless and stented porcine valves were matched. The follow-up, truncated to the shortest interval for each matched pair, was 43 ± 24 months for both groups.

Results: At 8 years the actuarial survival was 91% ± 4% for the Toronto SPV group and 69% ± 8% for the Hancock II group ($p = 0.006$); the freedom from cardiac-related death was 95% ± 4% for the Toronto SPV and 81% ± 8% for the Hancock II ($p = 0.01$); the freedom from any valve-related complication was 81% ± 5% for the Toronto SPV and 50% ± 10% for the Hancock II ($p = 0.008$). A Cox proportional hazard model demonstrated a significant reduction in cardiac mortality rates and valve-related morbidity in patients who received the Toronto SPV bioprosthesis.

Conclusions: Although it is possible that confounding factors may have played a role in the clinical outcomes of this case-control study, the study suggests that aortic valve replacement with a stentless porcine valve enhances survival. This is believed to be due to the hemodynamic superiority of these valves.

Stented vs Stentless

Stentless vs. Stented Aortic Valve Replacement: Left Ventricular Mass Regression

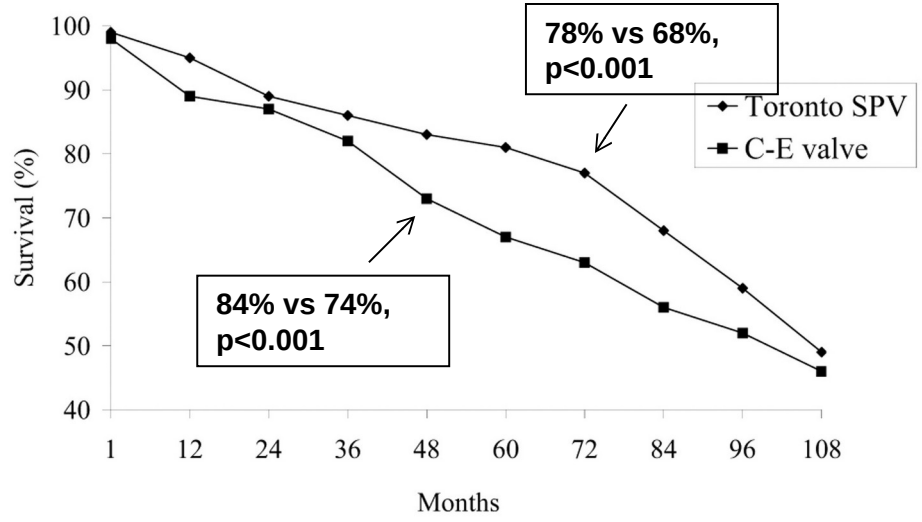
M. Tamim et al *(Asian Cardiovasc Thorac Ann 2005;13:112-118)*

The aim of this retrospective study was to evaluate the time-related regression of left ventricular hypertrophy after stentless vs. stented aortic valve replacement.

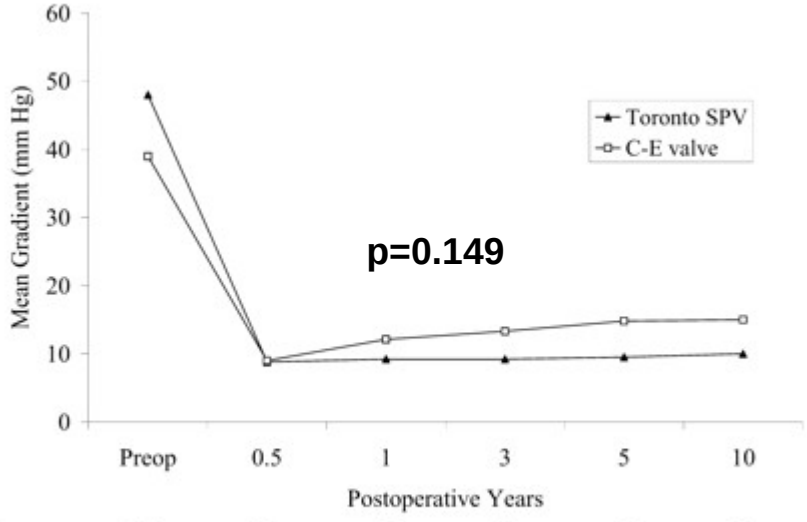
Methods: From January 1992 to December 2002, 145 patients had a Toronto stentless porcine valve and 106 had a stented Carpentier-Edwards aortic valve replacement.

Results: Over a 10-year follow-up, survival was superior in the Toronto group vs. the Carpentier-Edwards group (84% vs. 74% at 4 years; 78% vs. 68% at 6 years; $p < 0.001$). A significant and constant reduction of peak and mean transvalvular gradients after valve replacement resulted in substantial regression of left ventricular mass index in both groups, which did not reach statistical significance. However, this phenomenon stopped at 3 years, and left ventricular mass index increased slowly after 5 years.

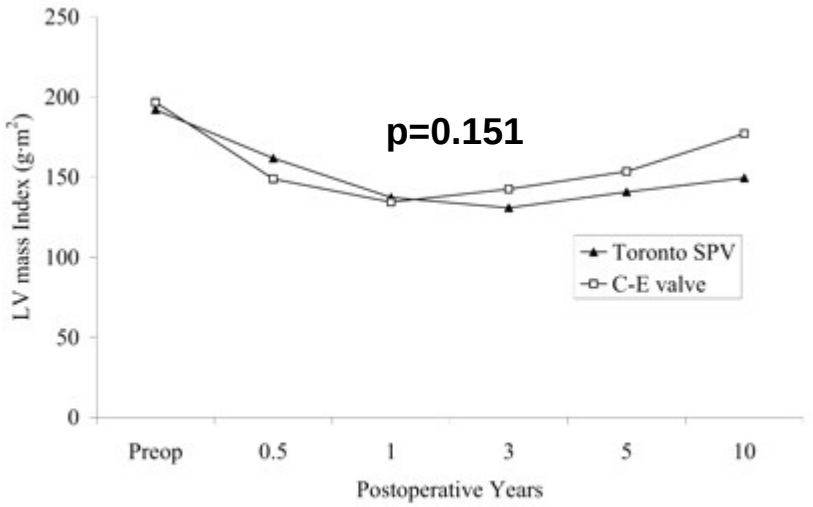
Conclusion: Stentless and stented bioprostheses both showed good early and late clinical and hemodynamic outcomes, with the advantage of better midterm survival for stentless xenografts.



Toronto	135	126	113	95	83	68	52	38	20
C-E	95	81	74	63	53	31	17	14	10



Toronto	145	112	95	65	35	28
C-E	106	75	48	31	25	12



Toronto	143	95	65	35	28	15
C-E	102	75	48	31	25	10

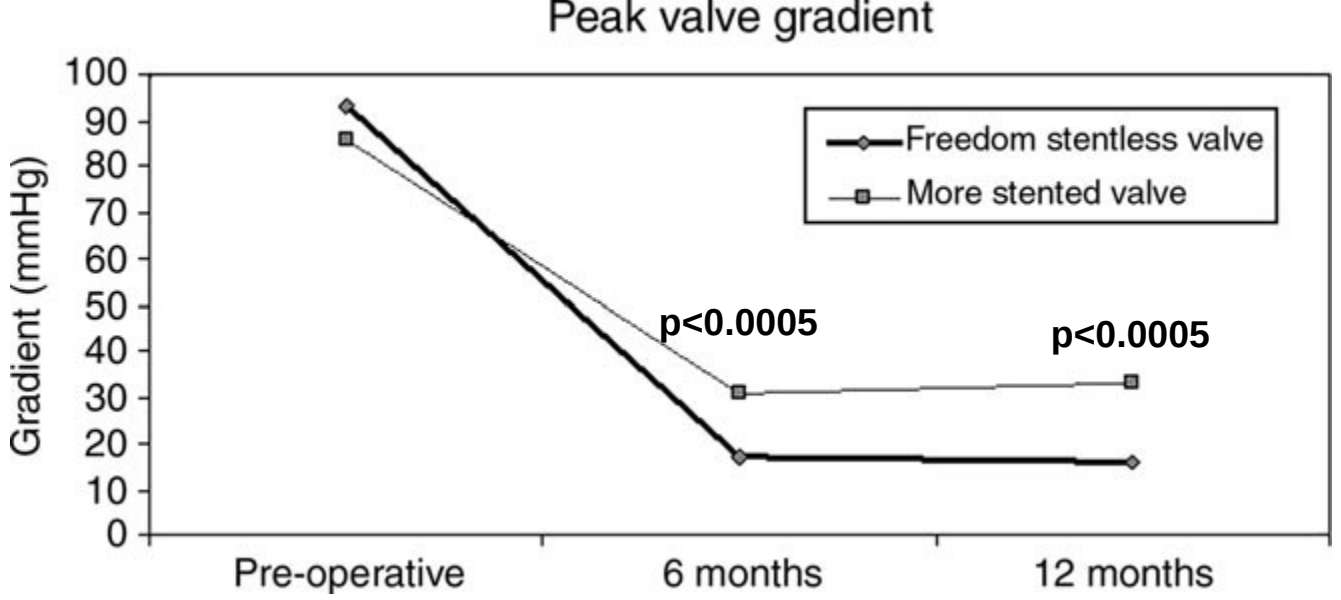
Stented vs Stentless

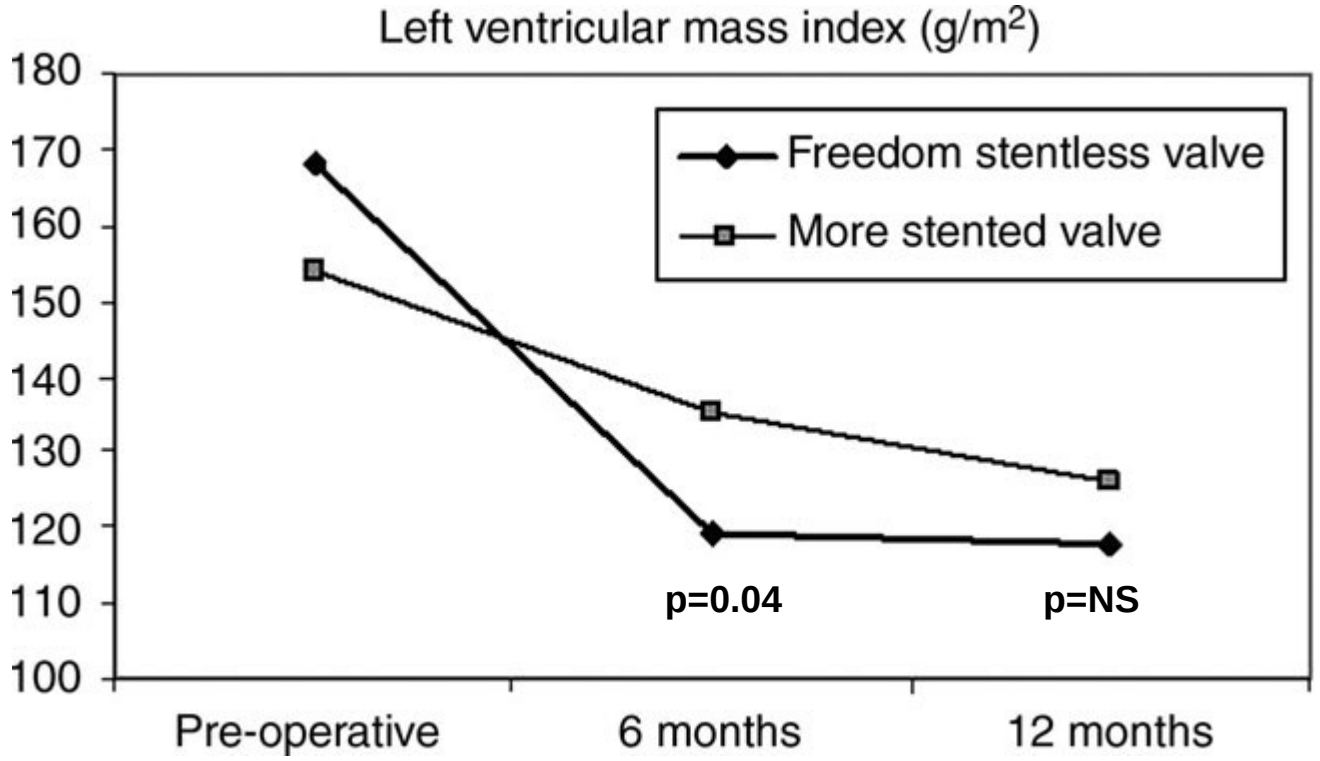
Stentless vs. stented aortic valve bioprostheses: a prospective randomized controlled trial

J. Dunning, et al. ***(Eur Heart Jr 2007;28:2369)***

Methods and results Sixty patients (mean age 73 years) undergoing bioprosthetic aortic valve replacement (AVR) were randomized to either Sorin Freedom stentless (n ¼ 31) or Sorin More stented (n ¼ 29) valves. The primary endpoints were left ventricular mass index (LVMI) reduction at 6 and 12-months. We also assessed post-operative effective orifice area index (EOAI), aortic gradient and operative time. There were no significant differences in baseline characteristics. The stentless valve was associated with a lower post-operative gradient [PG 17 (12) vs. 31 (13) mmHg, P , 0.0001] and greater EOAI [1.1 (0.3) vs. 0.8 (0.2) cm2/m2, P , 0.0001]. A highly significant reduction in LVMI occurred by 6 months in both groups, but LVMI was significantly lower in the stentless group [LVMI 119 (39) vs. 135 (30) g/m2, P ¼ 0.05]. However, there was continued regression of left ventricular hypertrophy (LVH) in the stented but not in the stentless group, resulting in no significant difference in LVMI at 12 months [119 (36) vs. 126 (31) g/m2, P ¼ 0.42].

Conclusion The use of the Sorin Freedom stentless bioprosthesis for AVR results in lower PG and greater EOA when compared with a Sorin More stented valve. This is associated with earlier regression of LVH.


Peak valve gradient
Gradient (mmHg)
100
90
80
70
60
50
40
30
20
10
0
Freedom stentless valve
More stented valve
p<0.0005
p<0.0005
Pre-operative
6 months
12 months


Left ventricular mass index (g/m2)
180
170
160
150
140
130
120
110
100
Freedom stentless valve
More stented valve
p=0.04
p=NS
Pre-operative
6 months
12 months

Stented vs Stentless

Performance of stentless versus stented aortic valve bioprostheses in the elderly patient: a prospective randomized trial

M. Doss, et al. ***(Eur J Cardiothorac Surg 2003;23:299)***

Methods: Forty patients with aortic stenoses, over the age of 75 years, were randomized to receive either the stented Perimount (n=20) or the stentless Prima Plus (n=20) bioprosthesis. Left ventricular mass regression, effective orifice area, ejection fraction and mean gradients were evaluated at discharge, 6 months and 1 year after surgery.

Results: Overall a significant decrease in left ventricular mass was found 1 year postoperatively. However, there was no significant difference in the rate of left ventricular mass regression between the groups. Furthermore, 1 year postoperatively, the hemodynamic performance of the valves and the change in the ejection fraction did not differ between the groups.

Conclusions: Our study shows that in a randomized cohort of elderly patients with aortic stenosis, we were not able to detect significant differences, with regard to hemodynamic performance and regression of left ventricular mass, between the stentless and stented valve groups. To our surprise, previously reported findings of non-randomized trials that showed faster and more complete regression of left ventricular mass and hemodynamic benefits of stentless valves were not reproducible.

Prostheses Choices

Stented Valves
Stentless Valves
Homograft
Autograft

Homograft

- **Aortic homografts have many favourable attributes including**
  - **low operative mortality rate,**
  - **excellent early and midterm hemodynamics with low TVG,**
  - **low thrombogenicity,**
  - **low incidence of prosthetic valve infection,**
  - **Enhancement of LV regresssion**

Homograft

- Structural valve failure increases with time, and is age related (18 to 32% at 20 years)
- Freedom from operation at 20 years (38% to 50%)
- Limited availability
- Technical difficulty
- Reoperations are extremely difficulty

Homograft

- **Considered in:**
  - **Treatment of active endocarditis of either native or prosthetic valve,**
  - **Patients 30-60 yrs old who cannot take warfarin,**
  - **Small aortic annuli,**
  - **Patients requiring composite replacement**

- **Avoided in:**
  - **Patients with heavily calcified non-compliant aortic root,**
  - **Patients < 20 years old**

Homograft

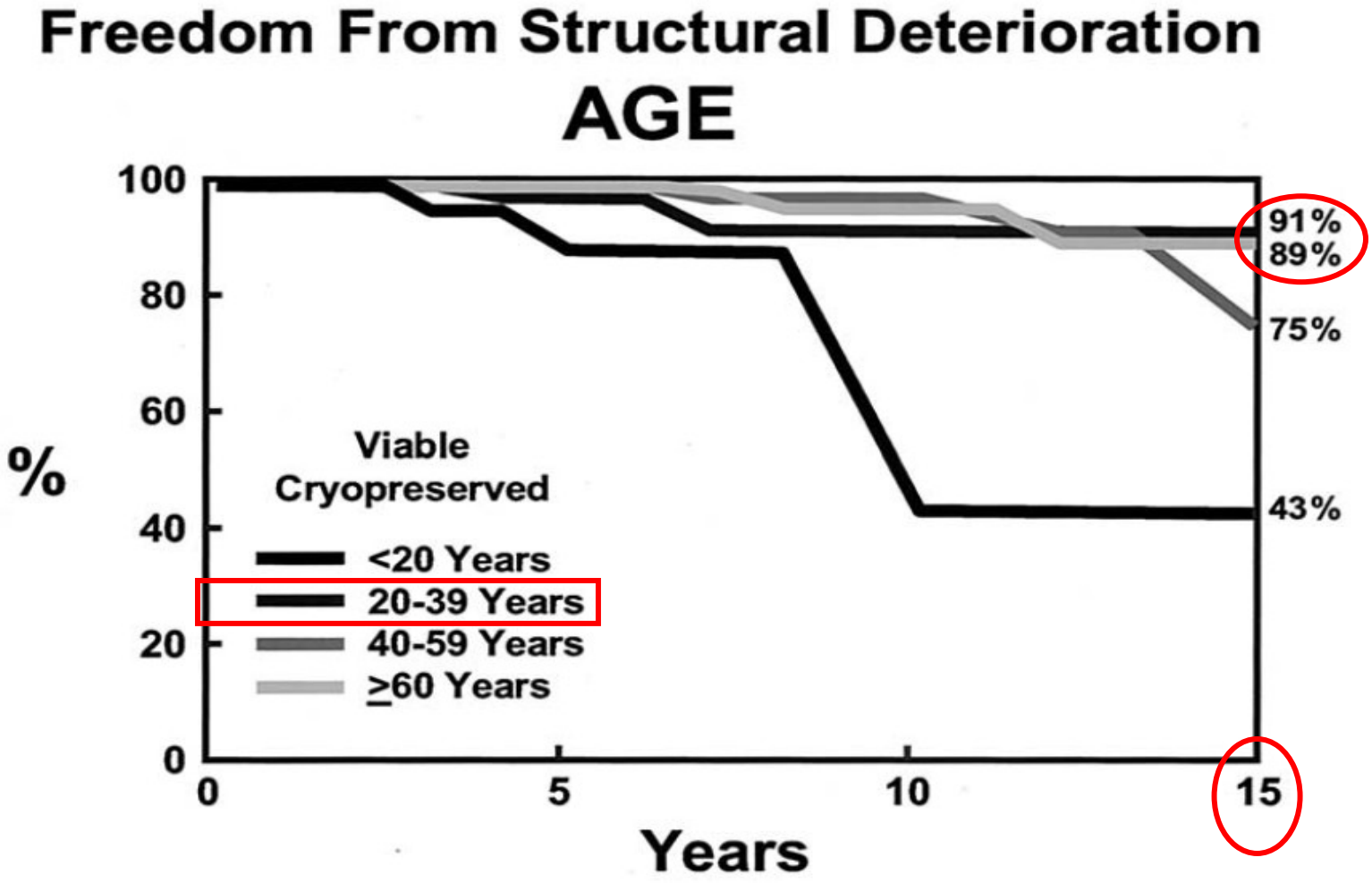
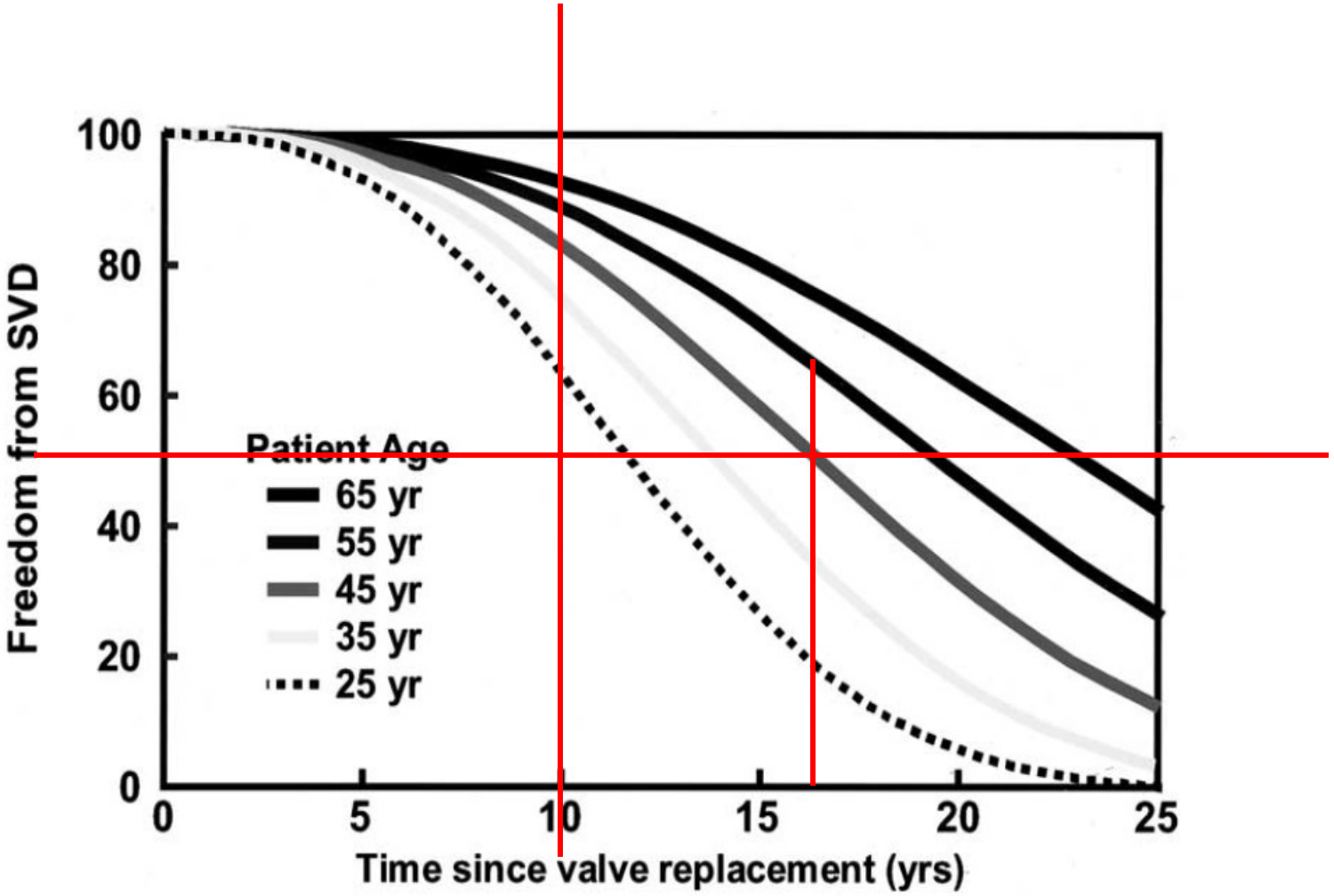


FIG 12. Structural valve deterioration by age group. (*Adapted from* O'Brien et al; with permission from Semin Thorac Cardiovasc Surg.)

Homograft



IG 13. Long-term freedom from structural valve deterioration of aortic allografts by age. (*Adapted om* Takkenberg et al; with permission from Eur J Cardiothorac Surg.)

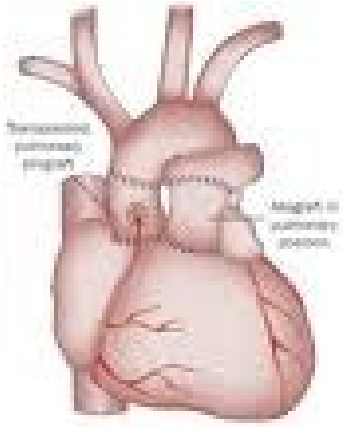
Prostheses Choices

Stented Valves
Stentless Valves
Homograft
Autograft

Autograft (ROSS)

Advantages:

- Freedom from thromboembolism without the need for anticoagulation



- Improved hemodynamics
- Growth of the autograft with time, particularly beneficial for young patients

Autograft (ROSS)

Favourable	Unfavourable
•Young	•Age <1 or > 70 yrs
•Anticoagulation contraindicated	•No contraindication to anticoagulation
•Good LV function	•Severe LV dysfunction
•AS	•AR
•Small normal AO and aortic annulus	•Larger than normal or dilated aorta
•No PV pathology	•PV pathology
•> 20 yrs life expectancy	•Limited life expectancy
•No other valvular disease	•Other valvular disease present (e.g. MV)
•No systemic autoimmune disease	•Autoimmune disease

Autograft (ROSS)

Long-term outcomes after autograft versus homograft aortic root replacement in adults with aortic valve disease: a randomised controlled trial

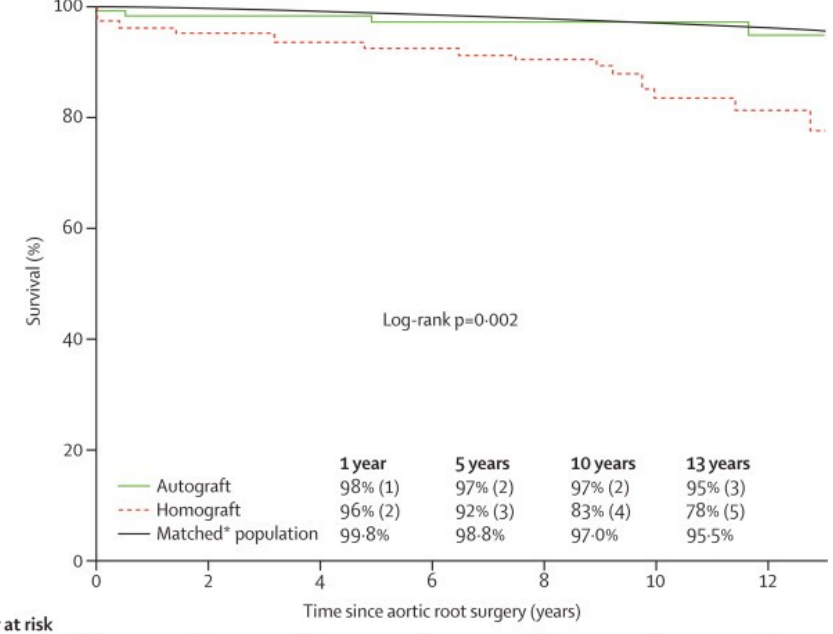
I. El-Hamamsy, Z. Eryigit, L. Stevens, Z. Sarang, R. George, L. Clark, G. Melina, J. Takkenberg, M.H. Yacoub
(The Lancet 2010;376 (9740):524)

Background: The ideal substitute for aortic valve replacement in patients with aortic valve disease is not known. Our hypothesis was that the regulatory and adaptive properties of a living valve substitute could improve the long-term outcomes in patients. We therefore compared these outcomes after autograft aortic root replacement (Ross procedure) versus homograft aortic root replacement in adults.

Methods: Male and female patients (<69 years) requiring aortic valve surgery were randomly assigned in a one-to-one ratio to receive an autograft or a homograft aortic root replacement in one centre in the UK. The random allocation sequence was computer generated. Treatment was not masked. The primary endpoint was survival of patients at 10 years after surgery.

Findings: 228 patients were randomly assigned to receive an autograft or a homograft aortic root replacement. 12 patients were excluded because they were younger than 18 years; 108 in each group received the surgery they were assigned to and were analysed. There was one (<1%) perioperative death in the autograft group versus three (3%) in the homograft group (p=0·621). At 10 years, four patients died in the autograft group versus 15 in the homograft group. Actuarial survival at 10 years was 97% (SD 2) in the autograft group versus 83% (4) in the homograft group. Hazard ratio for death in the homograft group was 4·61 (95% CI 1·71–16·03; p=0·0060). Survival of patients in the autograft group was similar to that in an age-matched and sex-matched British population (96%).

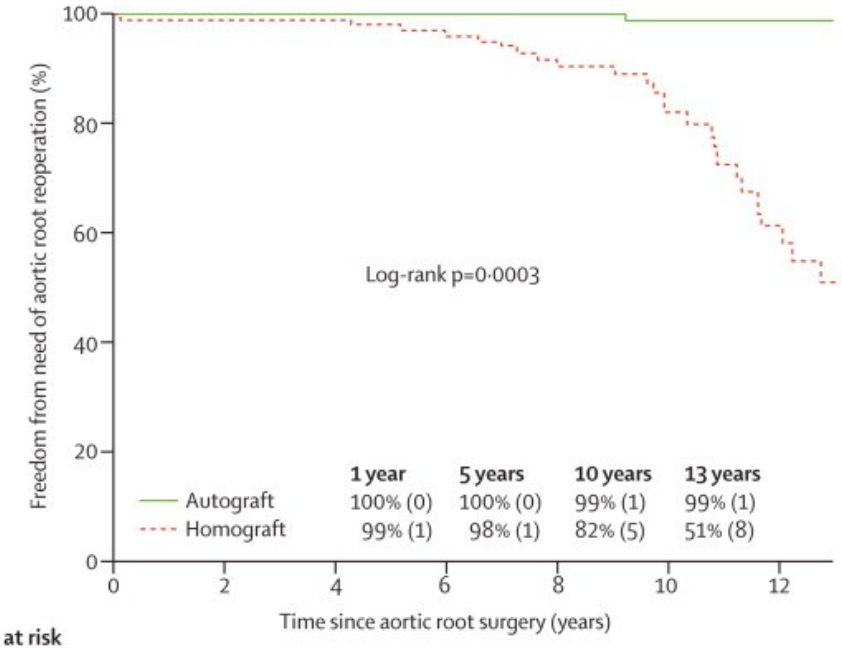
Interpretation: Our findings support the hypothesis that a living valve implanted in the aortic position can significantly improve the long-term outcomes in patients.



Number at risk

Autograft	108	103	102	101	91	66	34
Homograft	108	101	99	98	86	52	33

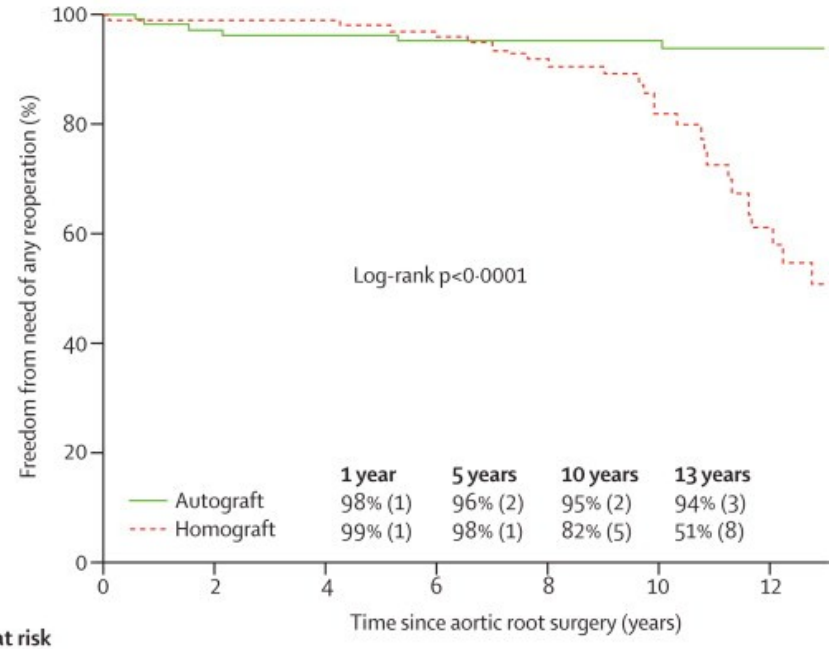
A



Number at risk

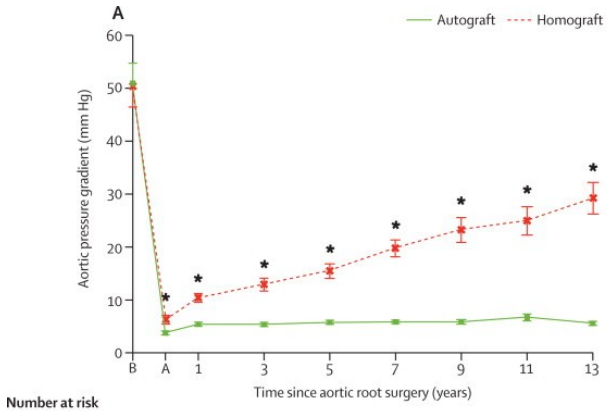
Autograft	108	103	102	101	91	66	34
Homograft	108	100	98	94	78	42	19

B



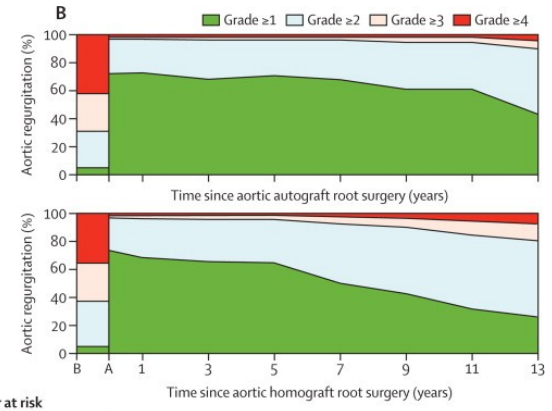
Number at risk

Autograft	108	100	98	96	86	64	34
Homograft	108	100	98	94	78	42	19



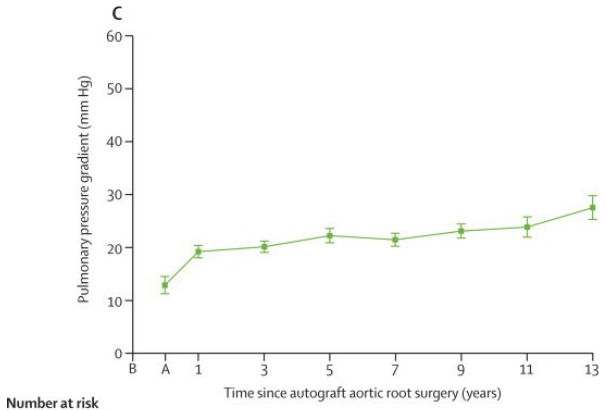
Number at risk

Autograft	102	83	101	106	93	73	78	50	25
Homograft	106	81	103	108	92	92	78	45	20



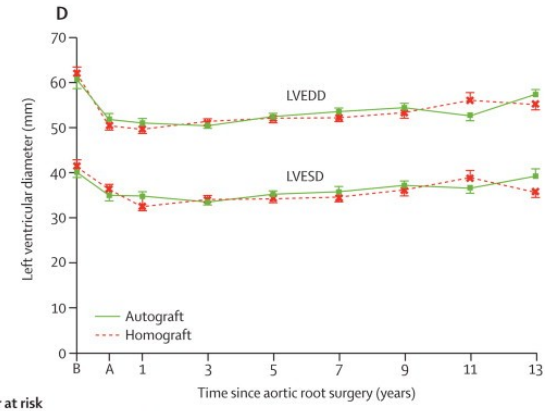
Number at risk

Autograft	108	87	111	111	91	73	78	54	27
Homograft	108	81	103	112	92	94	75	44	22



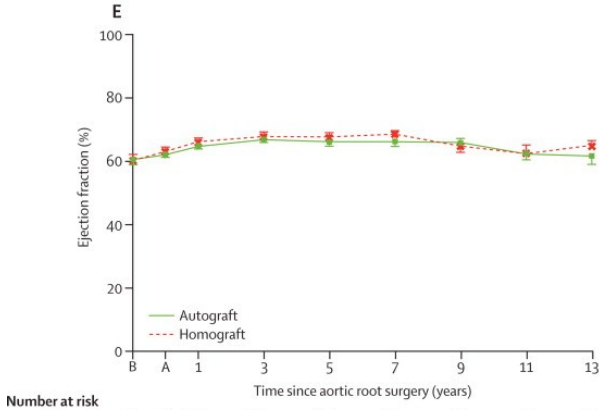
Number at risk

Autograft	63	91	103	93	75	76	49	26	



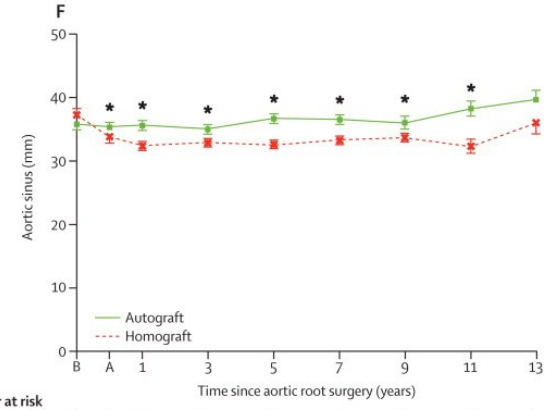
Number at risk

Autograft	102	83	106	113	94	72	77	52	29
Homograft	99	80	101	107	93	92	78	43	20



Number at risk

Autograft	72	76	99	101	88	65	67	42	23
Homograft	83	81	96	109	91	92	74	40	15



Number at risk

Autograft	41	45	59	70	62	53	64	40	23
Homograft	32	35	55	70	72	76	53	24	11

Thromboembolism

Mechanical Valve

- **The overall linearized risk in patients on warfarin therapy is 1 to 2% per year in most published series**

- **A meta-analysis of over 13,000 patients showed that the incidence of major embolism in mechanical valves:**

  - **without antithrombotic therapy was 4 per 100 patient-years**
  - **with antiplatelet therapy this risk was 2.2 per 100 patient-years**
  - **with warfarin therapy it was reduced to 1 per 100 patient-years**

Thromboembolism

Bioprosthetic Valve

- **Linearized risk for thromboembolism is between 0.5 and 1% per year**

- **This risk appears to be lower in patients with stentless heterograft, allograft, or autograft valves**

AVR in infective Endocarditis

- Heart failure due to stenosis or regurgitation
- Heart block or root abscess
- Fungal or other highly resistant organisms
- Large vegetations

Prosthesis-Patient Mismatch

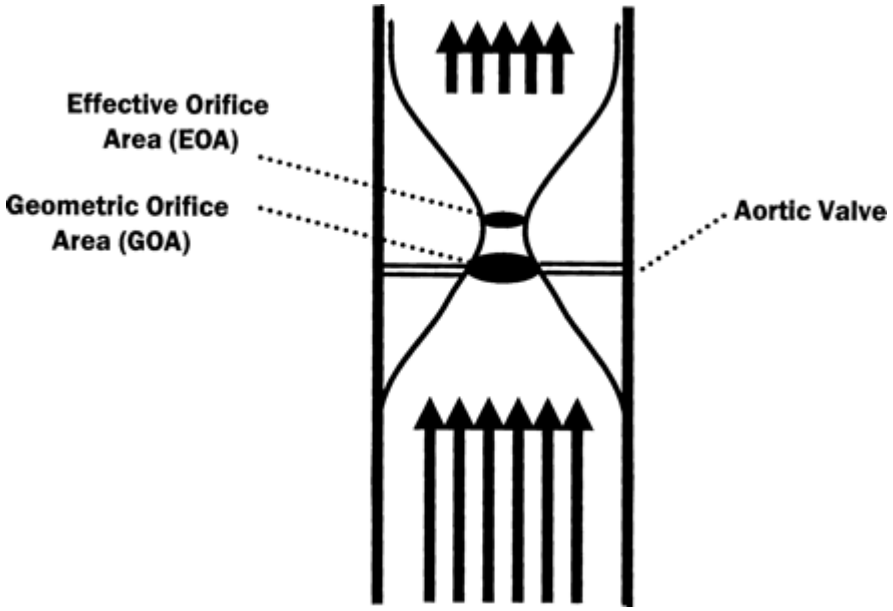
- **Rahimtoola defined prosthesis-patient mismatch as "a condition that occurs when the valve area of a prosthetic valve is less than the area of that patient's normal valve"**

  (Rahimtoola SH: The problem of valve prosthesis-patient mismatch. *Circulation* 2002; 58:20)

- **Dumesnil and Pibarot redefined prosthesis-patient mismatch as "prosthesis-patient mismatch occurs when the EOA of the prosthesis is too small in relation to the patient's body size, resulting in abnormally high postoperative gradients"**

  Dumesnil JG, Pibarot P: Prosthesis-patient mismatch and clinical outcomes: the evidence continues to accumulate. *J Thorac Cardiovasc Surg* 2006; 131:952

EOA



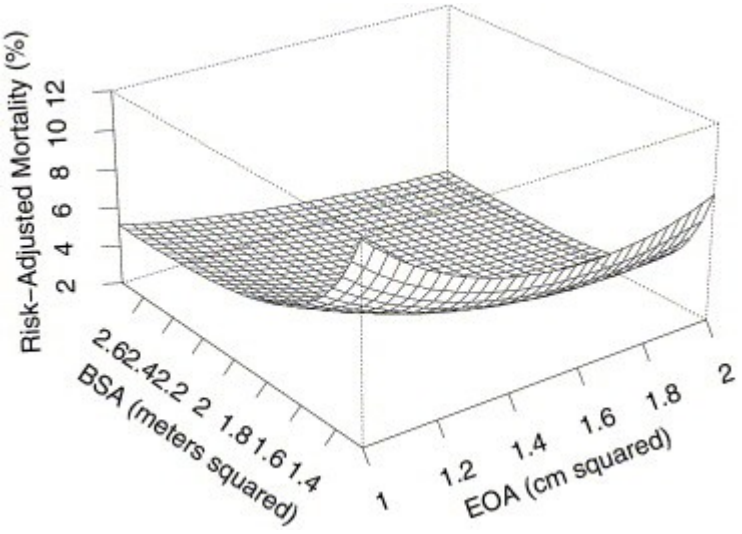
$$EOA = (CSA_{LVOT} \times TVI_{LVOT})/TVI_{AO}$$

IEOA = EOA / BSA

Mismatch occurs if IEOA < 0.85 cm^2/m^2

Prosthesis-Patient Mismatch

- The significance of prosthesis-patient mismatch is controversial



The least risk-adjusted mortality is achieved with IEOA 0.76
Bridges et al. JTCVS 2007;133(4):1012

Conclusion

- **Aortic valve surgery in the current era carries a low mortality and low valve-related complications**
- **Stentless valves have better outcome than stented valves**
- **Problems of structural valve deterioration in bioprosthetic valves remains. This is, however, reduced in older patients**
- **Ross procedure has better outcomes than homograft**