Heart Valve Prostheses의 특성과 선택

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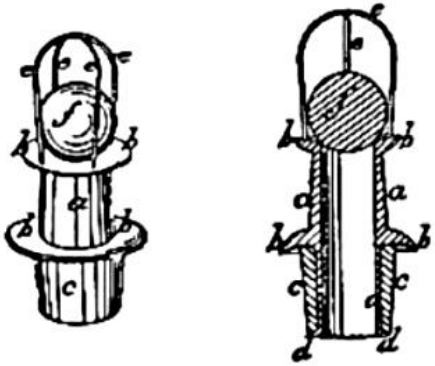
Agenda

- Development of Prosthetic Heart Valves
- Flow Characteristics of prosthesis
- Materials and designs
- Designs and outcomes
- Selection of prosthesis
  - (tissue vs mechanical;)

Evolution of Heart Valve Prosthesis

- The development of original ball-and-cage design can be attributed to the bottle stopper in 1858



- First implanted to the human in a closed procedure in September of 1952 by

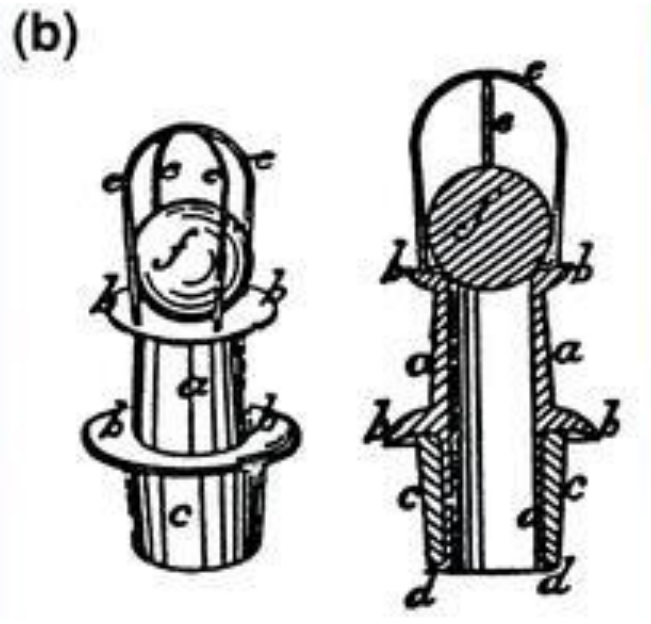
  Charles Hufnagel

Evolution of Mechanical Heart Valves

The first prosthetic heart valve was implanted in 1952 by Charles Hufnagel. The device was an acrylic ball valve inserted into the descending aorta. As the valve only prevented regurgitant flow from the lower body, cardiac work was only partially relieved and coronary flow was not improved. In addition, *embolization* and *thrombosis* of the valve frequently occurred, and the noise generated by the valve was disconcerting — reminiscent, according to some, of a ticking time bomb.

- Hufnagel Artificial Heart Valve in the collection of the National Museum of Health and Medicine

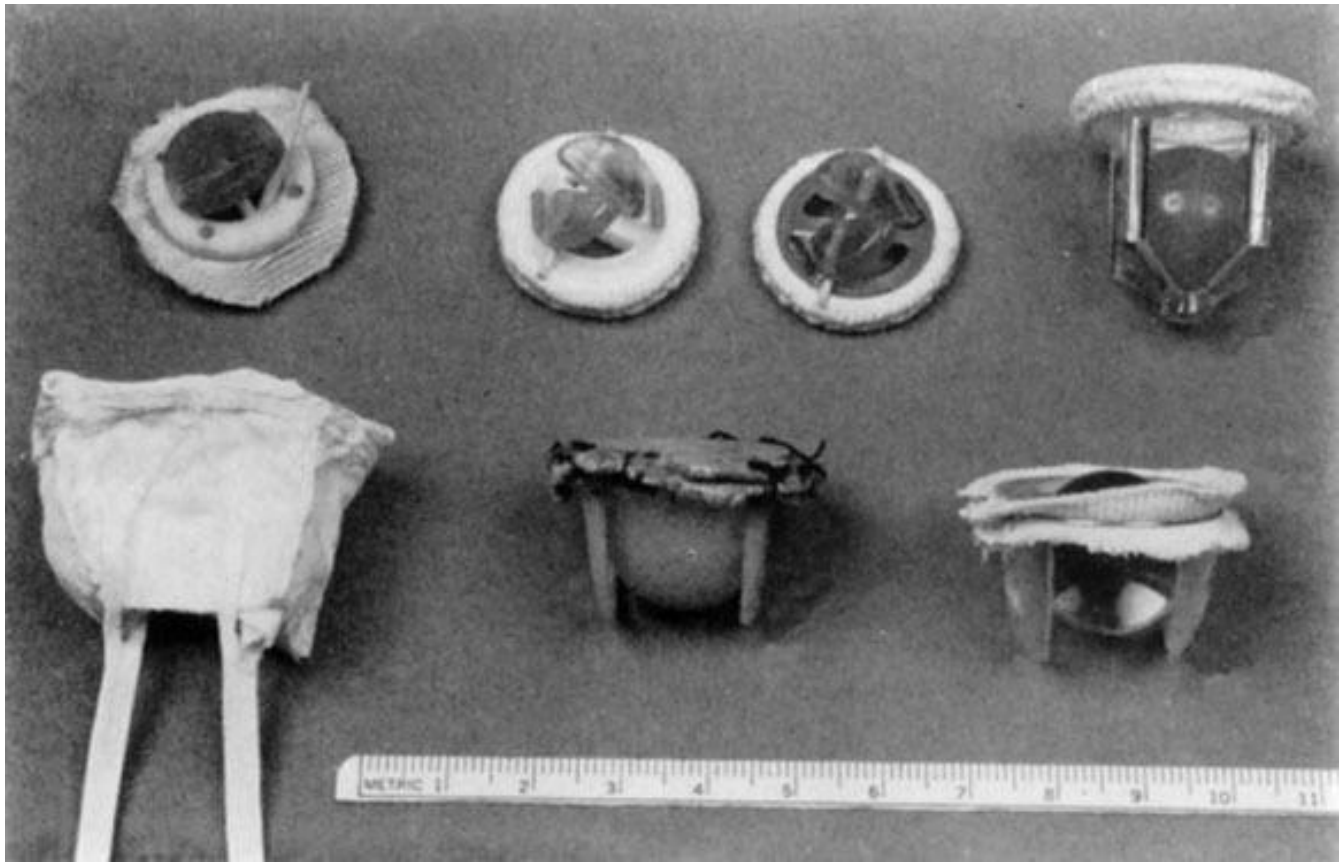
Hufnagel and sutureless valve



Magovern-Cromie valve

Evolution of Heart Valve Prosthesis

1950's



American Heart Journal 2001 141, 849-855DOI: (10.1067/mhj.2001.114978)

Albert Starr and Liles Lowell Edwards

- From the entry for Miles Lowell Edwards (1898-1982) in the Oregon History Center Oregon Encyclopedia:

- On September 21, 1960, **Starr successfully inserted a "ball-in-cage" prosthetic valve into a patient's mitral valve**, which was severely diseased because of rheumatic fever. Within two years, Edwards and Starr had invented a life-saving aortic valve prosthesis, which would save the lives of several hundred thousand patients around the world. In April 1961, Edwards became an early pioneer in the biomedical high-tech field when he founded Edwards Laboratories in Santa Ana, Ca
valve prostheses.

Evolution of Prosthetic Heart Valve

1960's

- Tissue valve investigated to overcome the disadvantage of mechanical valve
  - 1962: Ross and Boyes performed the 1st allograft replacement from cadaver
  - 1964: Duran & Gunning used the 1st heterograft, a porcine aortic valve
  - 1965: Jean-Paul Benet et al used mercurochrome- and formalin-treated heterografts in 5 patients
  - 1967: Ross introduced pulmonary autograft for AVR
  - 1968: Carpentier demonstrated that ***glutaraldehyde*** preservation improved stability of heterograft

Evolution of Prosthetic Heart Valve

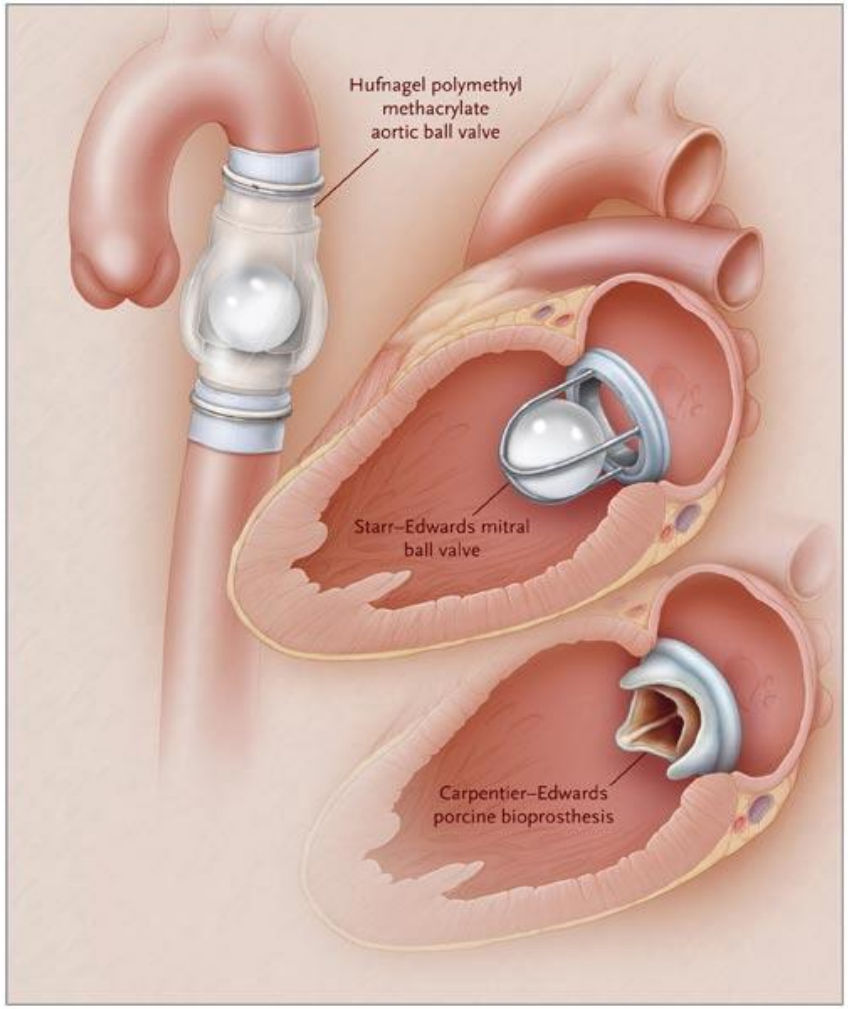
1970's

- Continued development of tissue valves
  - Early 70's: Kaiser & Hancock developed the first successful porcine bioprosthesis-metal stent, t plastic

  - 1976, Carpentier & Edwards developed porcine with an Elgiloy stent

  - 1976: Ionescu & Shiley introduced bovine pericardial valve with polyester covered flexible stent

Three Stages in the Evolution of Prosthetic Heart Valves



The **Hufnagel** aortic ball valve was designed for rapid surgical implantation.

A design breakthrough was achieved by **Starr and Edwards**, who engineered an integrated structure consisting of ***a stainless-steel cage a fixation ring made from knitted Teflon cloth, and a heat-cured silastic ball***.

Carpentier advanced the concept of a “bioprosthesis,” combining biologic and mechanical structures.

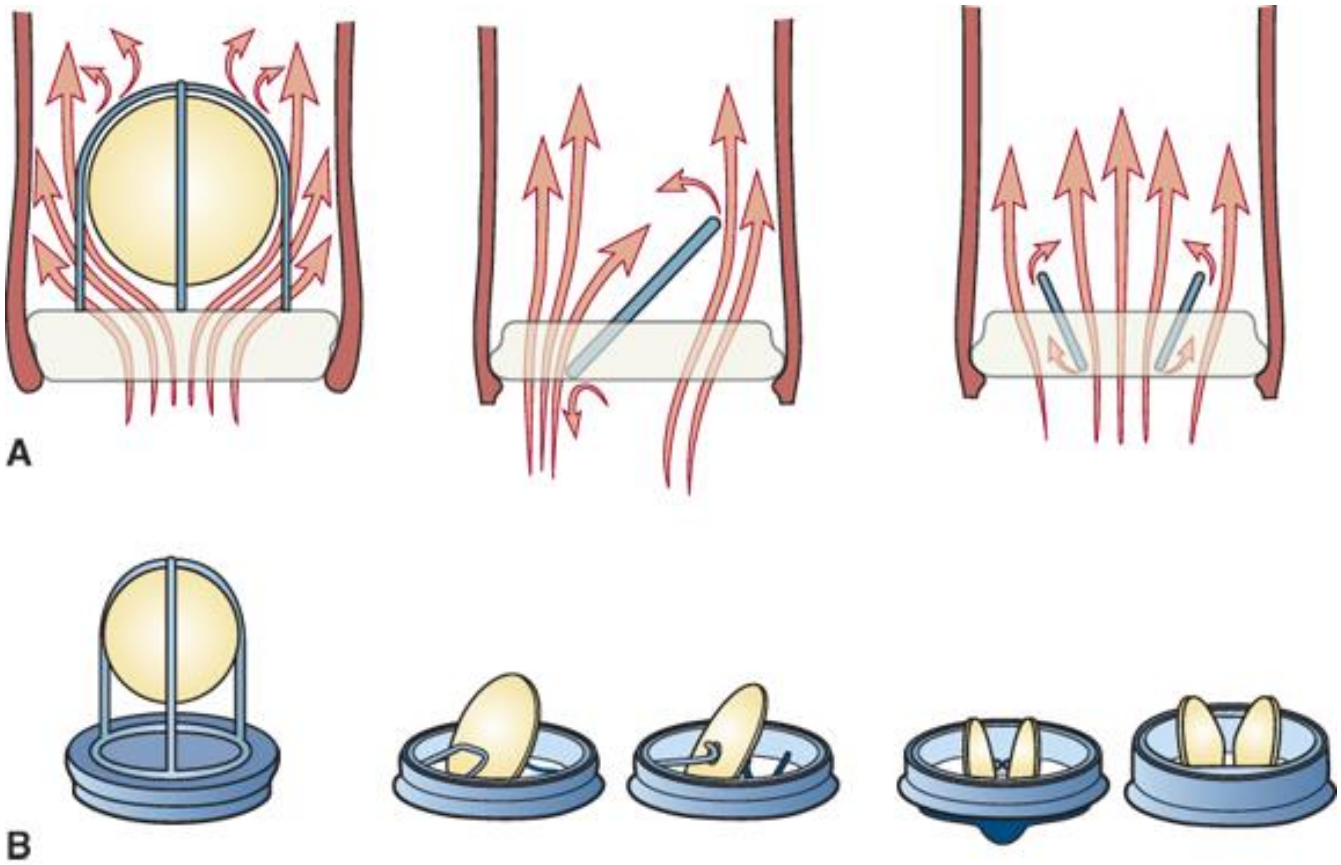
Chaikof EL. N Engl J Med 2007;357:1368-1371.

Different Types of Valve Substitutes

- Homografts (allograft)
  - Cadaveric human aortic and pulmonary valves
- Heterograft (xenograft)
  - Bioprosthetic valves
    - Porcine(pig) aortic valve
    - Bovine pericardial (others)

- Prosthetic Valves
  - Bioprosthetic valves
    - Porcine(pig) aortic valve
    - Bovine pericardial (others)
  - Mechanical
    - Ball in a cage
    - Single or multiple discs

Flow Pattern of Mechanical Prosthesis



1952 : First clinical use of a cardiac valvular prosthesis

1962 : Introduction of the Starr-Edwards ball-and-cage valve

Mid-1960 : Development of low-profile caged-disk valve

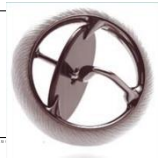
1969-1970 : Introduction of the Bjork-Shiley and Lillehei-Kaster tiling-disc valves

1970 : Introduction of the Hancock porcine xenograft

1976 : Introduction of the Ionescu-Shiley pericardial xenograft

1976 : Introduction of the Carpentier-Edwards porcine xenograft

1977 : Introduction of the Medtronic Hall tilting-disc valve



1977 : First bileaflet St. Jude Medical valve implanted

1980 : Carpentier – Edwards pericardial valve

1992 : First clinical trials of stentless mitral valve

1993 : FDA approval of the CarboMedics billeaflet valve

1997 : First FDA-approved stentless bioprosthetic aortic valve, the Toronto SPV vlave

2000 : FDA approval of the Medtronic Mosaic valve

2000 : FDA approval of the ATS Open Pivot bileaflet mechanical valve

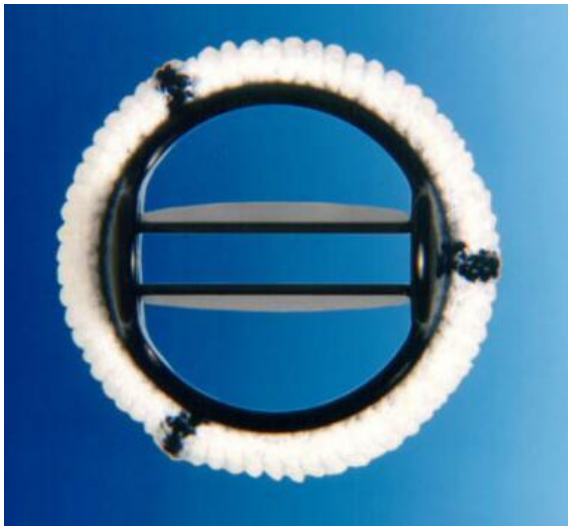
2001-2002 : FDA approval of the On-X bileaflet aortic and mitral valve

2002 : First successful percutaneous transcatheter valve replacement

1950 1960 1970 1980 1990 2000 ...

Bileaflet Prosthetic Heart Valve

- At that time, Mr Villafana's son was recovering from a serious illness. The St Jude valve was proposed as a name by Mr Villafana. Church liturgy teaches that St Jude Thaddeus is the patron saint of difficult cases.
- Implanted in 1977



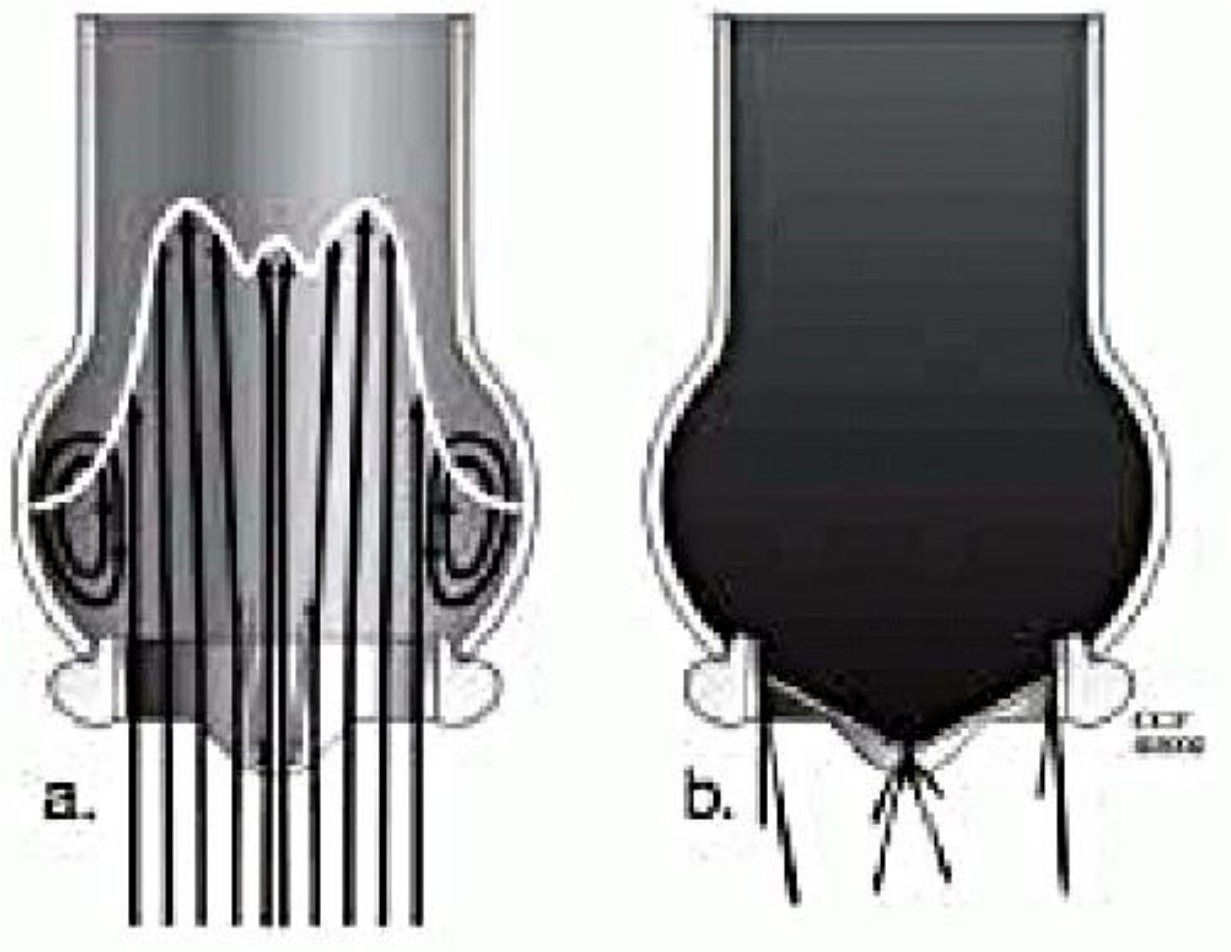
St. Jude Thaddeus

St. Jude,
pray for us.

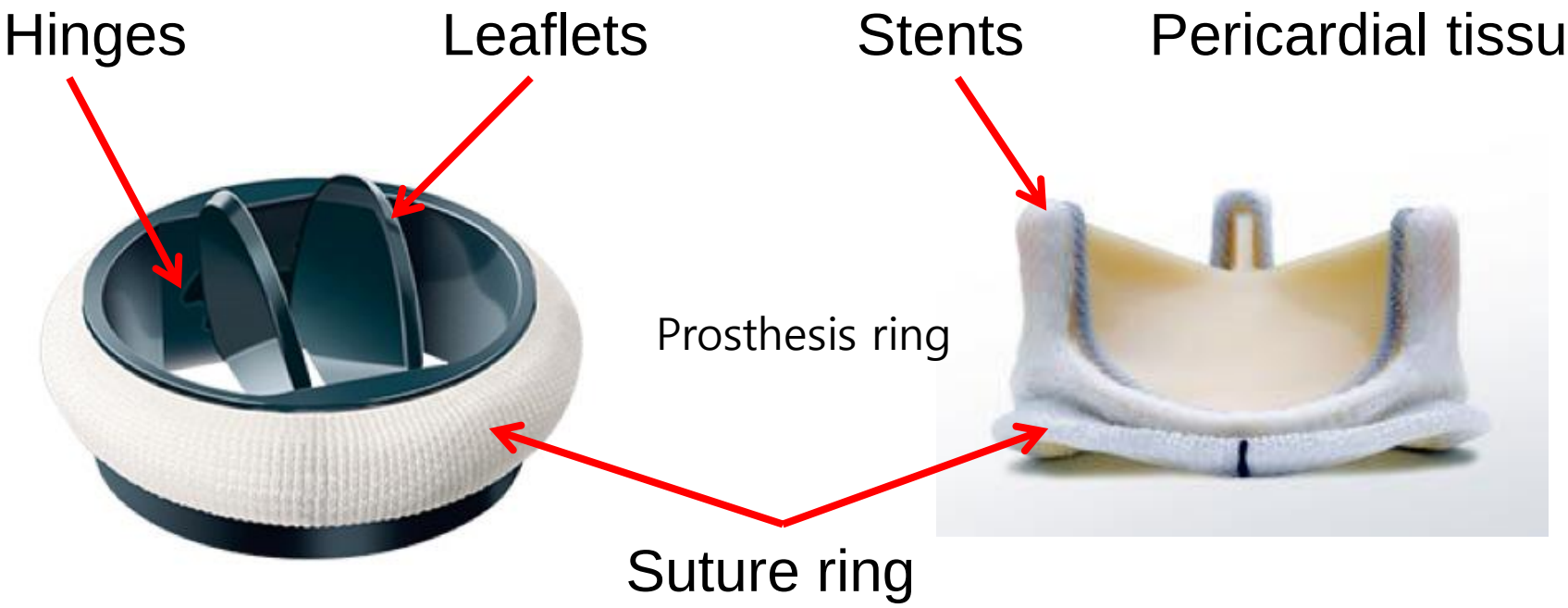
A Healing Prayer to St. Jude

Most holy Apostle, St. Jude, friend of Jesus, I place myself in your care. Pray for me; help me know that with you at my side, I am never alone. Please join me in asking God to send me consolation in my sorrow, courage in my fear, and healing in the midst of my suffering. Ask God to fill me with the grace to accept whatever may lie ahead for me and to strengthen my faith in His healing power. Thank you, St. Jude, for the promise of hope you hold out to all who believe, and inspire me to give this gift of hope to others. Amen.

Flow Pattern of St. Jude Medical

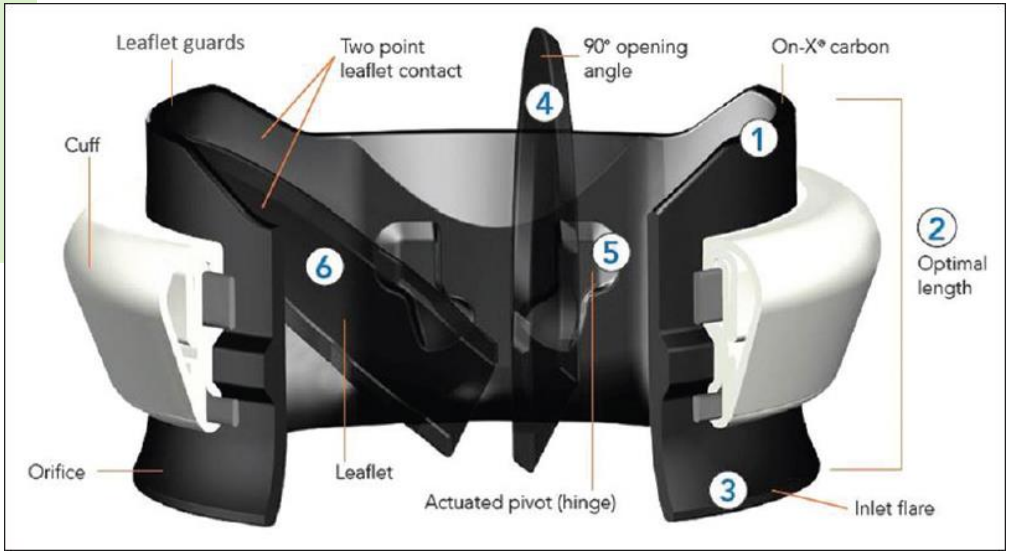


Structure of Prosthetic Valves



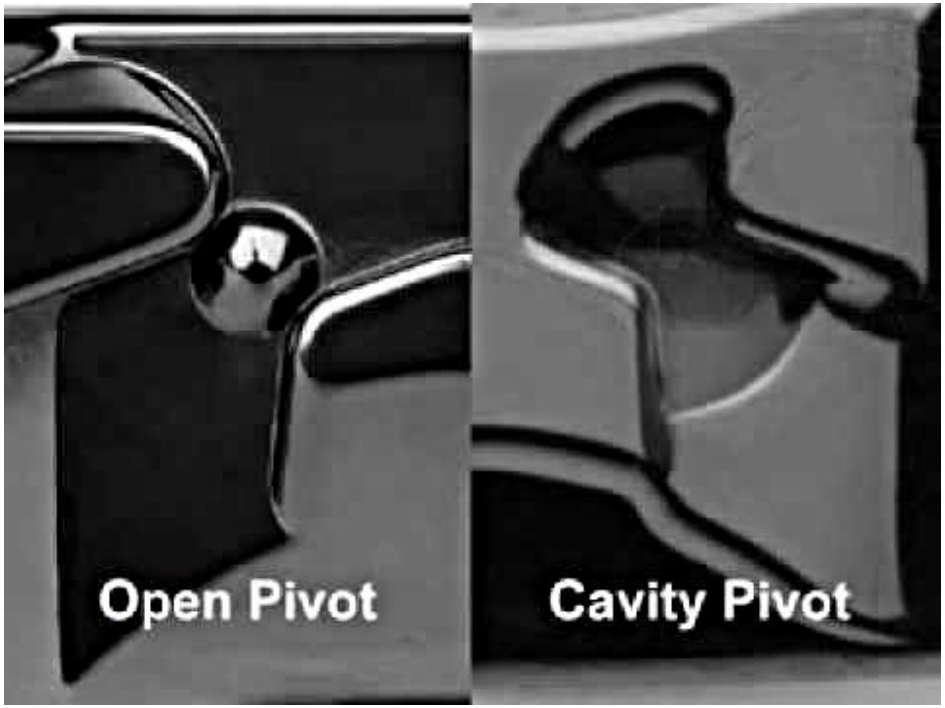
Materials and Design of MHV

Material: pyrolytic carbon



Pivot, Pivot Joint; 선회축(관절)

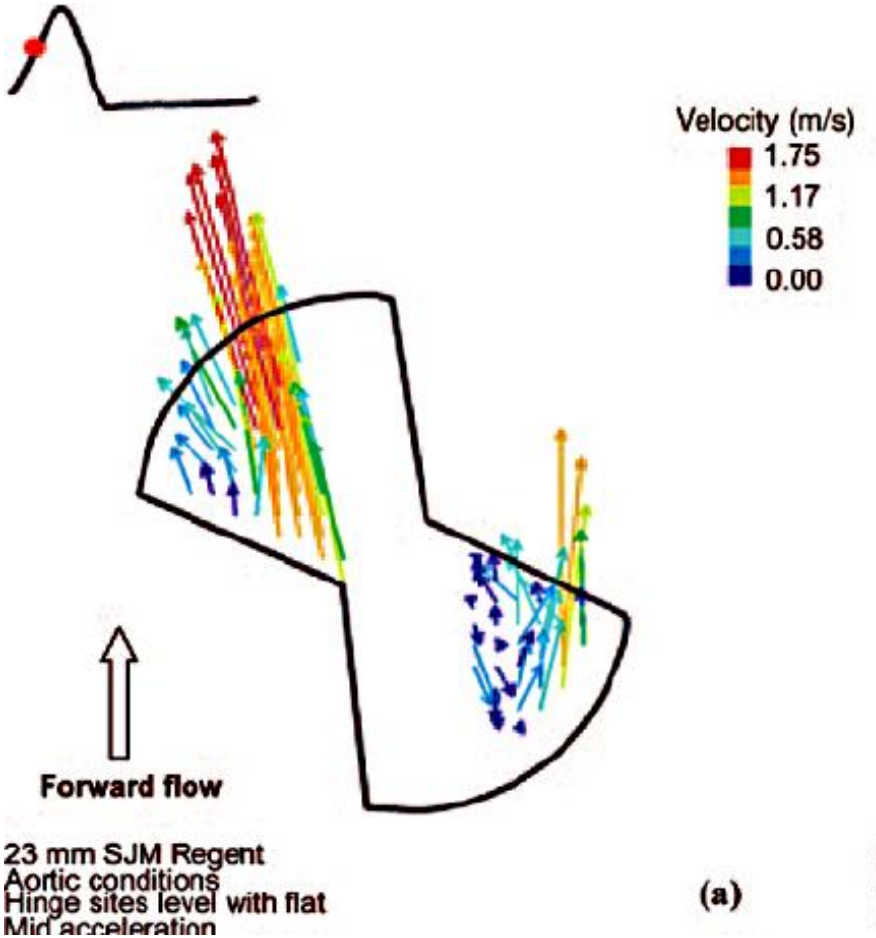
Materials and Design of MHV

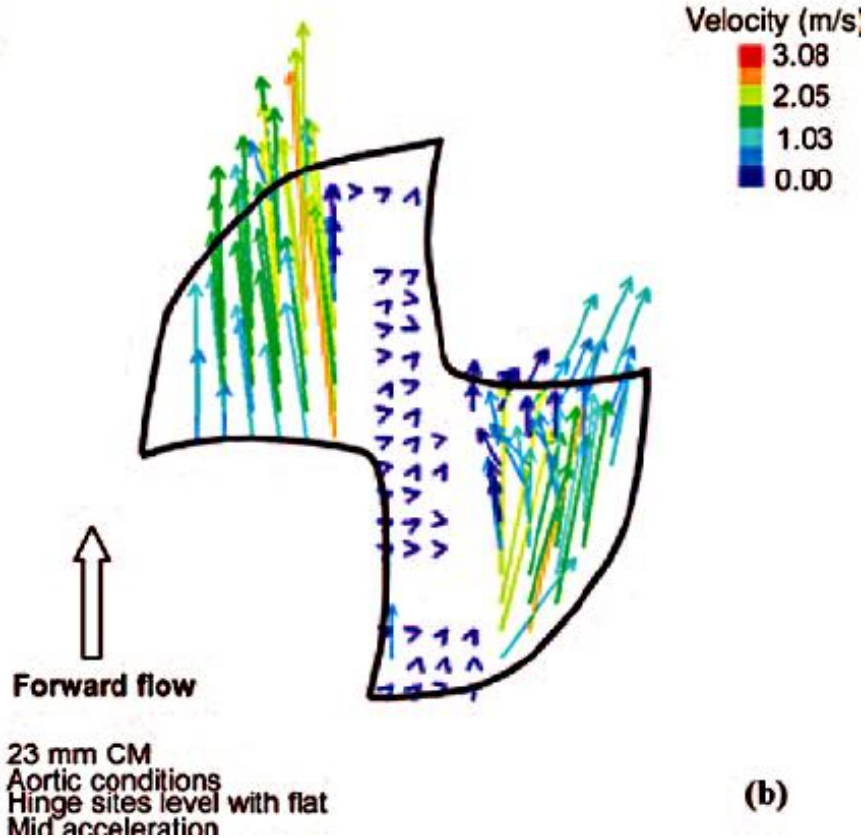


ATS

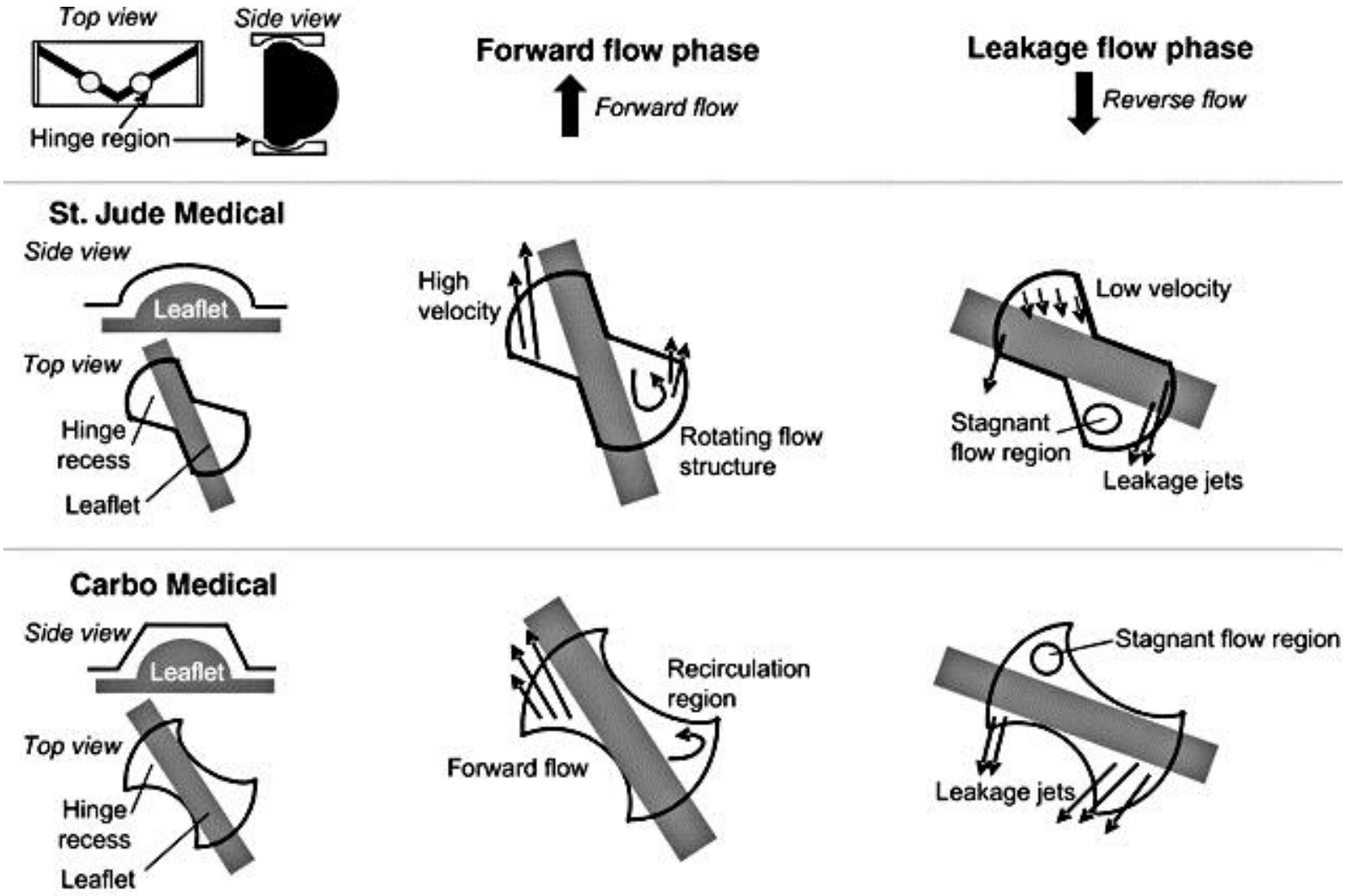
St. Jude
CarboMedics
OnX

Flow Pattern of Prosthesis





Flow Pattern of Prosthesis



The St. Jude Medical Cardiac Valve Prosthesis: A 25-Year Experience With Single Valve Replacement

Robert W. Emery, MD, Christopher C. Krogh, Kit V. Arom, MD, PhD, Ann M. Emery, RN, Kathy Benyo-Albrecht, RN, Lyle D. Joyce, MD, PhD, and Demetre M. Nicoloff, MD, PhD

Cardiac Surgical Associates, PA, St. Paul, Minnesota

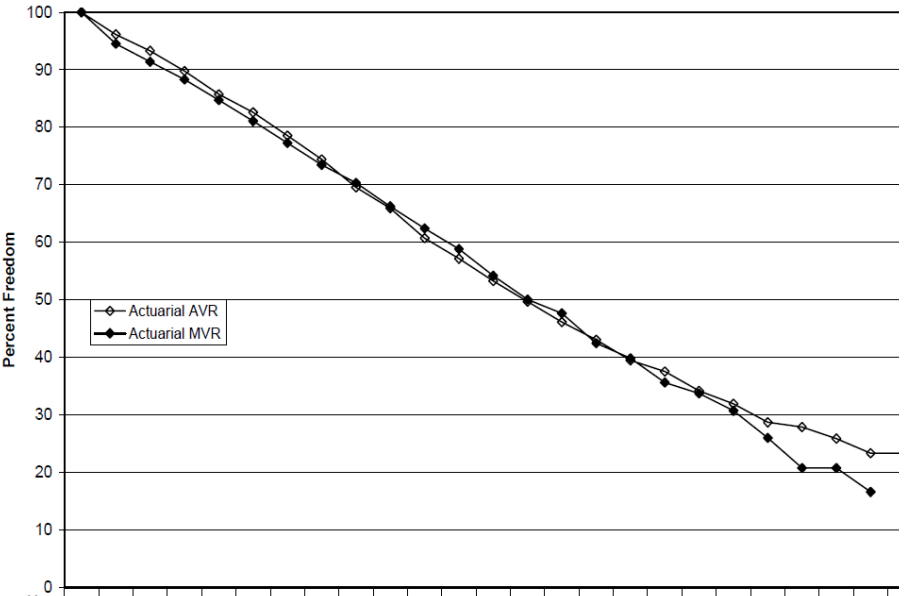
- From October 3, 1977 through October 3, 2002, 6,470 SJM prostheses were implanted.

- The patient population consists of **2,982 single aortic (AVR)** and 1,498 mitral (MVR) valve replacements; of these 28 had repeat single AVR or MVR.

Emery R et al. Ann Thorac Surg. 2005 Mar;79(3):776-82

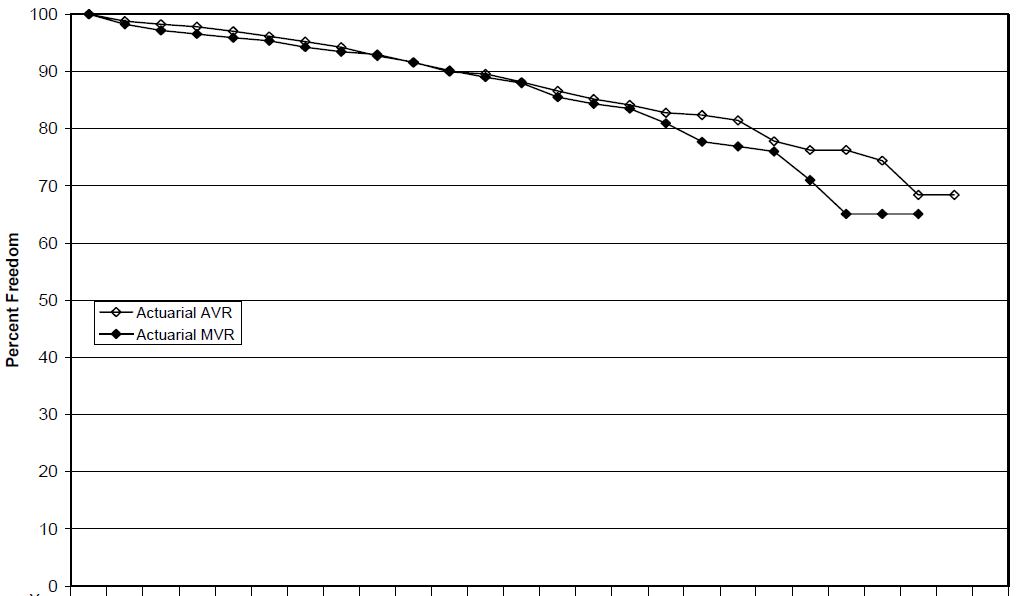
25 year Experiences of SJM

Actuarial Survival



Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
AVR	2856	2664	2484	2254	2018	1827	1631	1418	1207	1021	820	675	547	456	376	313	250	195	144	119	73	54	35	15
MVR	1369	1244	1158	1059	942	833	741	642	552	486	416	355	300	246	210	169	143	101	82	62	44	26	17	3

Free from Valve related Death



Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
AVR	2982	2664	2484	2254	2018	1827	1631	1418	1207	1021	820	675	547	456	376	313	250	195	144	119	73	54	35	15	6	0
MVR	1498	1244	1158	1059	942	833	741	642	552	486	416	355	300	246	210	169	143	101	82	63	44	26	18	3	0	0

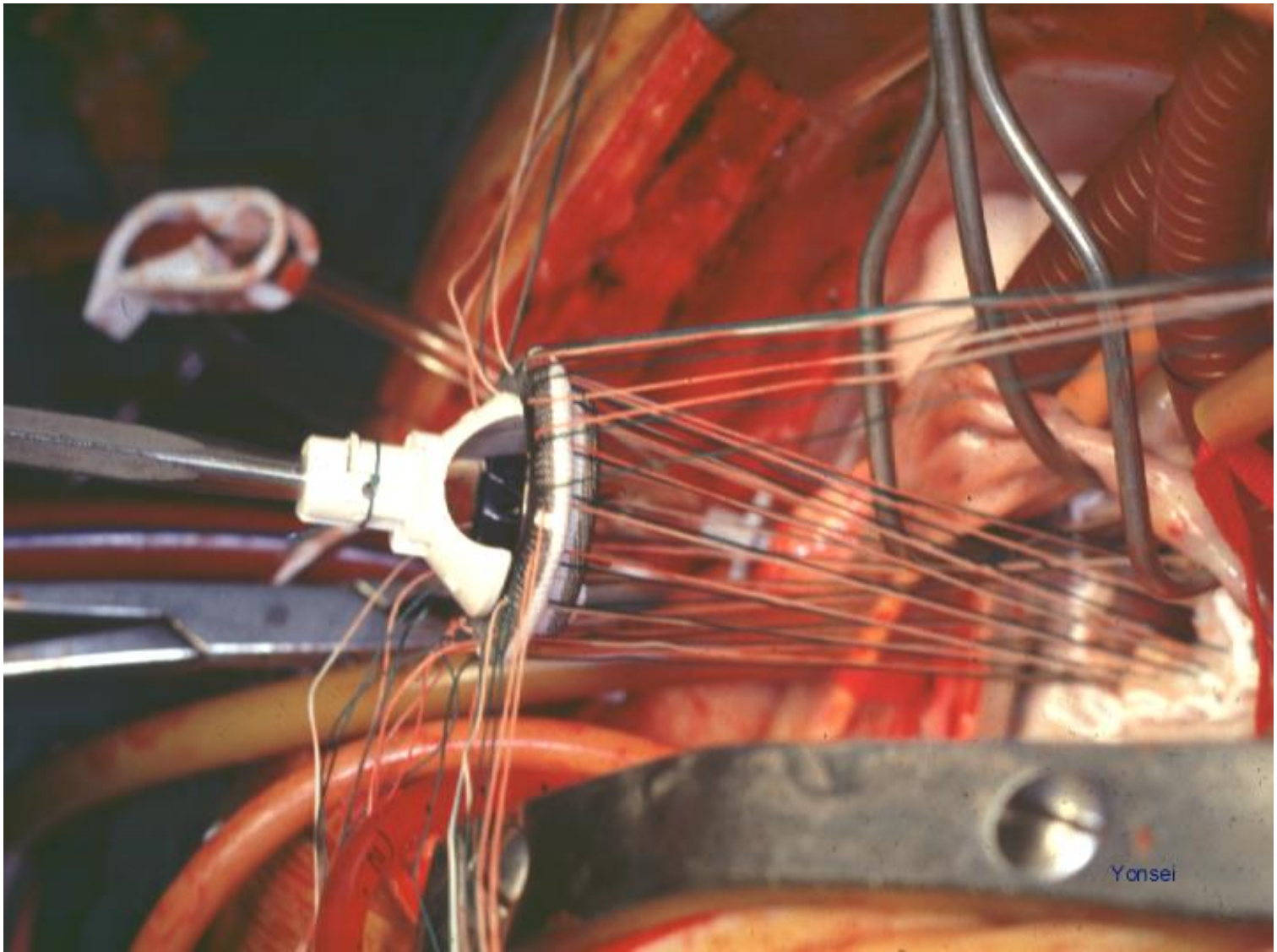
Only one structural valve failure in MVR (1/ 1498; 0.06%)

for range 1 month to 24.8 years, average 7 ± 5 years

Emery R et al. Ann Thorac Surg. 2005 Mar;79(3):776-82

승모판막 대치수술(II)

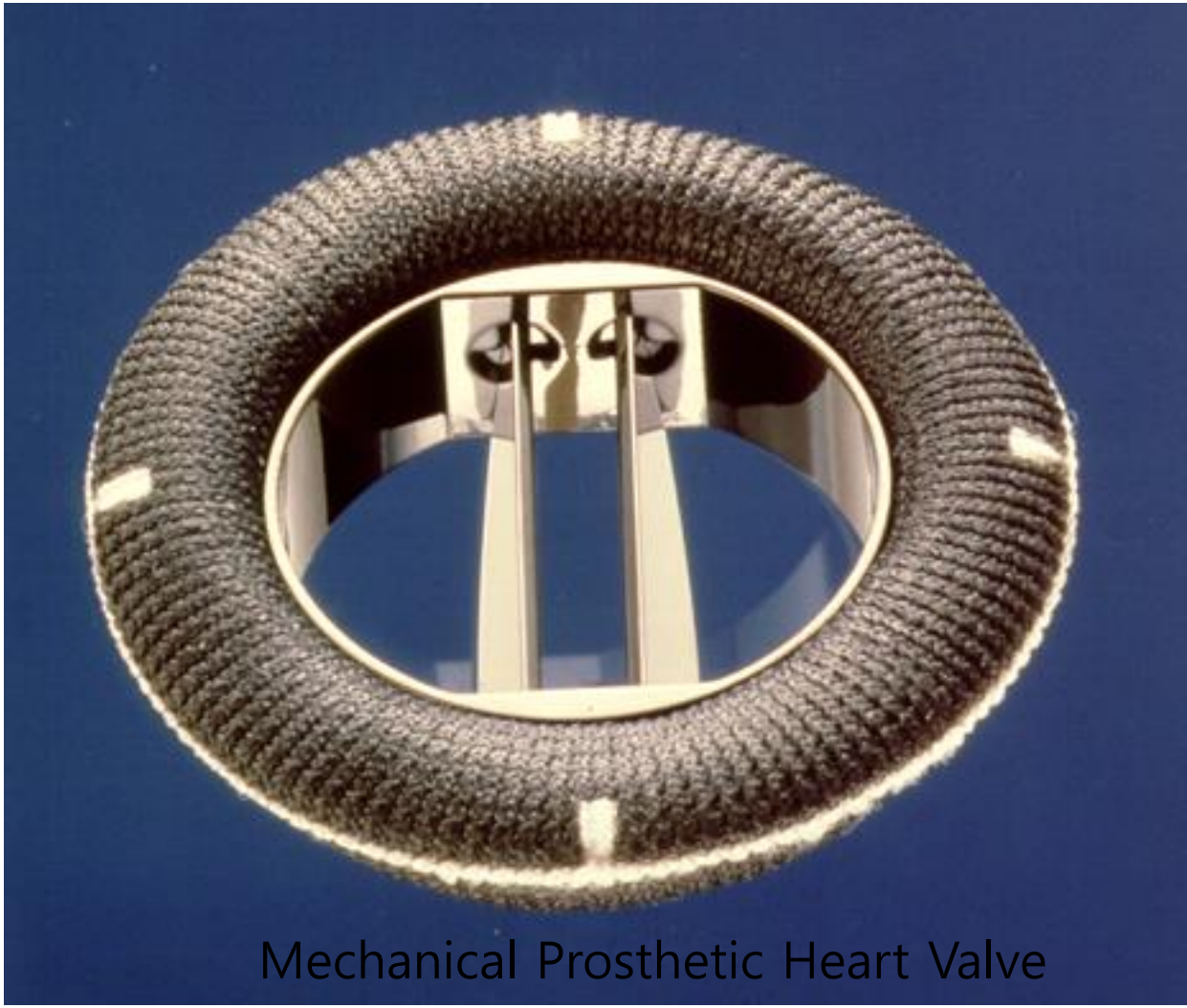
인공판막에 봉합하여 심장에 넣고 이 실들을 결찰한다.



인공 심장판막(기계판막)

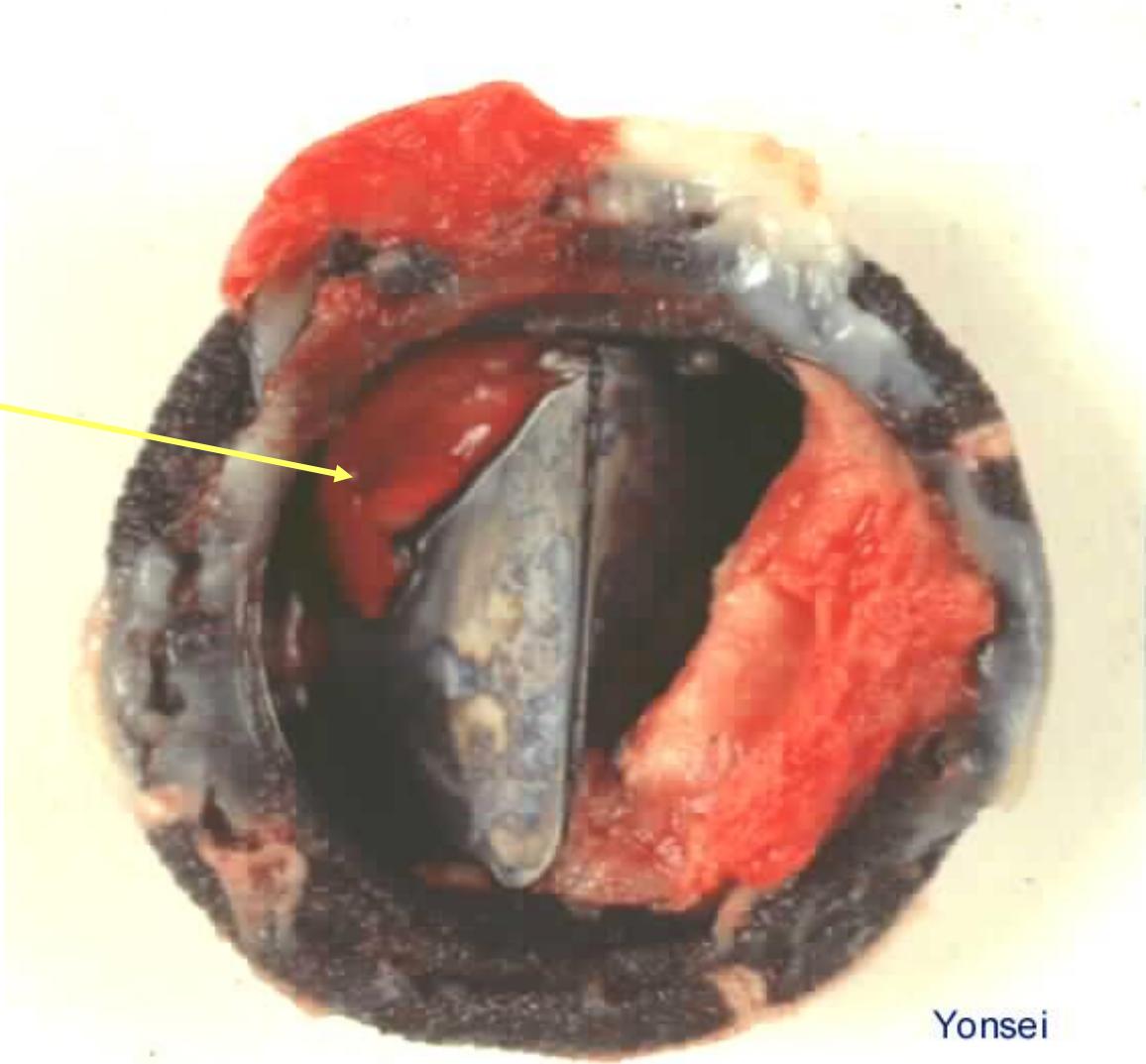
열처리한 탄소재질로
내구성이 좋아
영구적인 것으로
생각하고 있다.

단점으로 혈전증이
발생될 위험이 있기
때문에 항응고제를
평생 복용해야 한다.


Mechanical Prosthetic Heart Valve

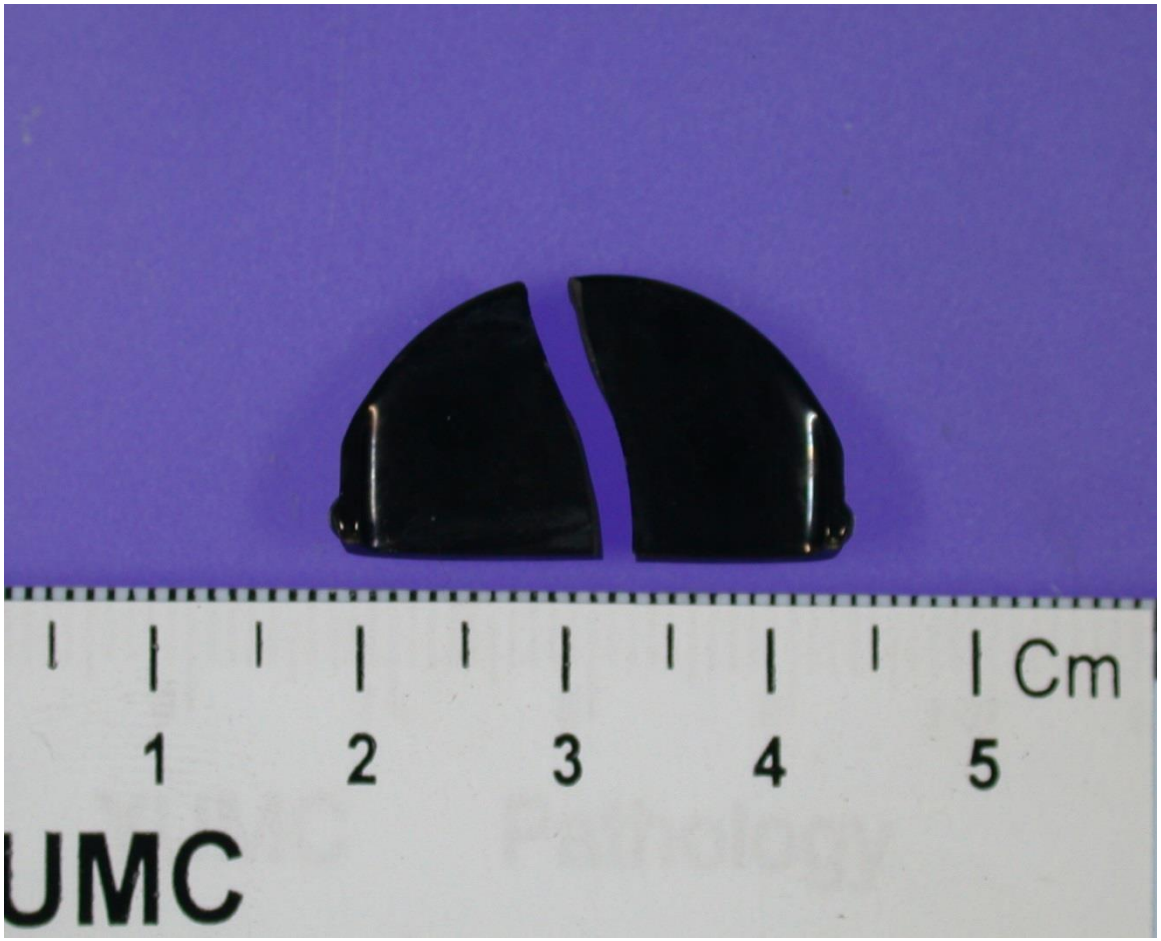
인공 심장판막(기계판막)

항응고제를 제대로
복용하지 않아
인공판막에
혈전이 발생되어
재수술을 하였다.



재수술로 제거한 조직판막

인공 심장판막(기계판막-골절) 부작용



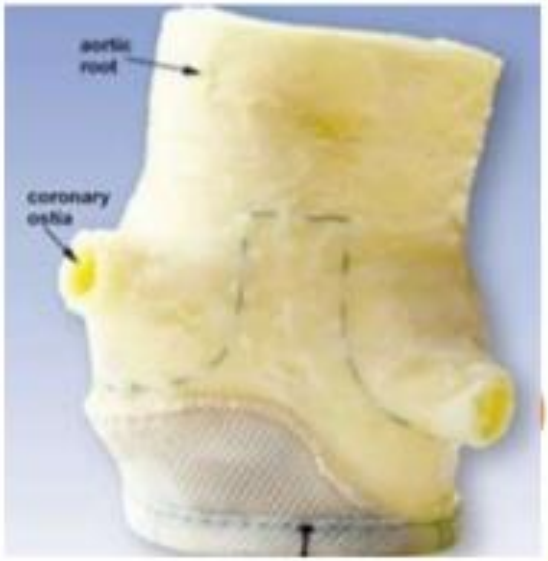
BIOPROSTHETIC VALVE

- TYPES DEPENDING ON SOURCE
  - ✓ XENOGRAFT
  - ✓ HOMO/ALLOGRAFT
  - ✓ AUTOGRAFT

STENTED

- TYPES DEPENDING ON PRESENCE OF STRUTS
  - ✓ STENTED
  - ✓ STENTLESS
    - lower post-operative valvular gradient,
    - greater post-operative effective orifice area index (EOAI),
    - earlier regression of LVH.
    - Stentless heterografts have the disadvantages that their implantation is more complex

STENTLESS



A

Elgiloy wireform stent

Elgiloy/polyester ring
and stent posts

Carpentier-Edwards
Perimount

B

Acetyl homopolymer stent
Stellite ring
Haynes alloy eyelets

Medtronic Hancock II

C

Acetyl stent

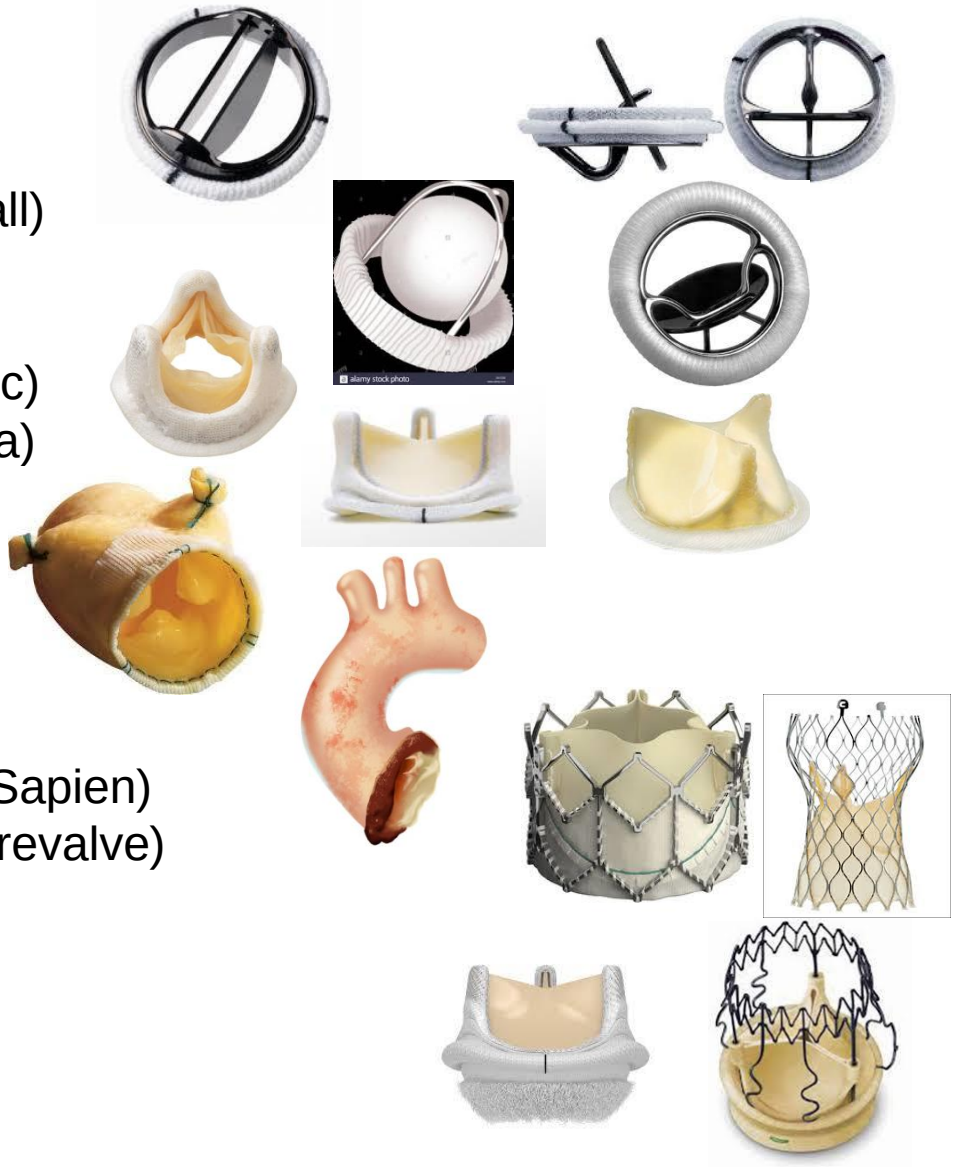
Silicone base ring

Polyester covered stent/base,
and outer layer of pericardium

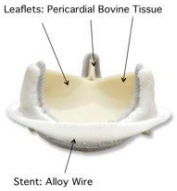
Sorin Mitroflow

Types of Prosthetic Heart Valves

- Mechanical
  - ✓ Bileaflet (St, Jude Medical)
  - ✓ Single tilting disc (Medtronic Hall)
  - ✓ Caged ball (Starr-Edwards)
- Biological stented
  - ✓ Porcine (Medtronic Mosaic, Epic)
  - ✓ Pericardial (C-E Magna, Trifecta)
- Biological stentless
  - ✓ Porcine (Medtronic Freestyle)
  - ✓ Pericardial
  - ✓ Homograft
- Percutaneous
  - ✓ Balloon expandable (Edwards Sapien)
  - ✓ Self expandable (Medtronic Corevalve)
- Rapid deployment
  - ✓ Perceval sutureless (Sorin)
  - ✓ Intuity (Edwards)



Prosthetic Heart Valve



Biological

Stentless porcine

- Edwards Prima Plus
- Medtronic freestyle
- SJM Quattro
- Toronto-SPV

Stented

Medtronic-Hall
Bjork-Shiley

Porcine valve

- CE SAV
- Hancock MO
- Hancock II
- Medtronic Mosaic
- Medtronic Standard
- SJM Bio
- SJM Epic

Pericardial valve

- CE Perimount
- SJM Trifecta
- Mitroflow
- Sorin Pericarbon

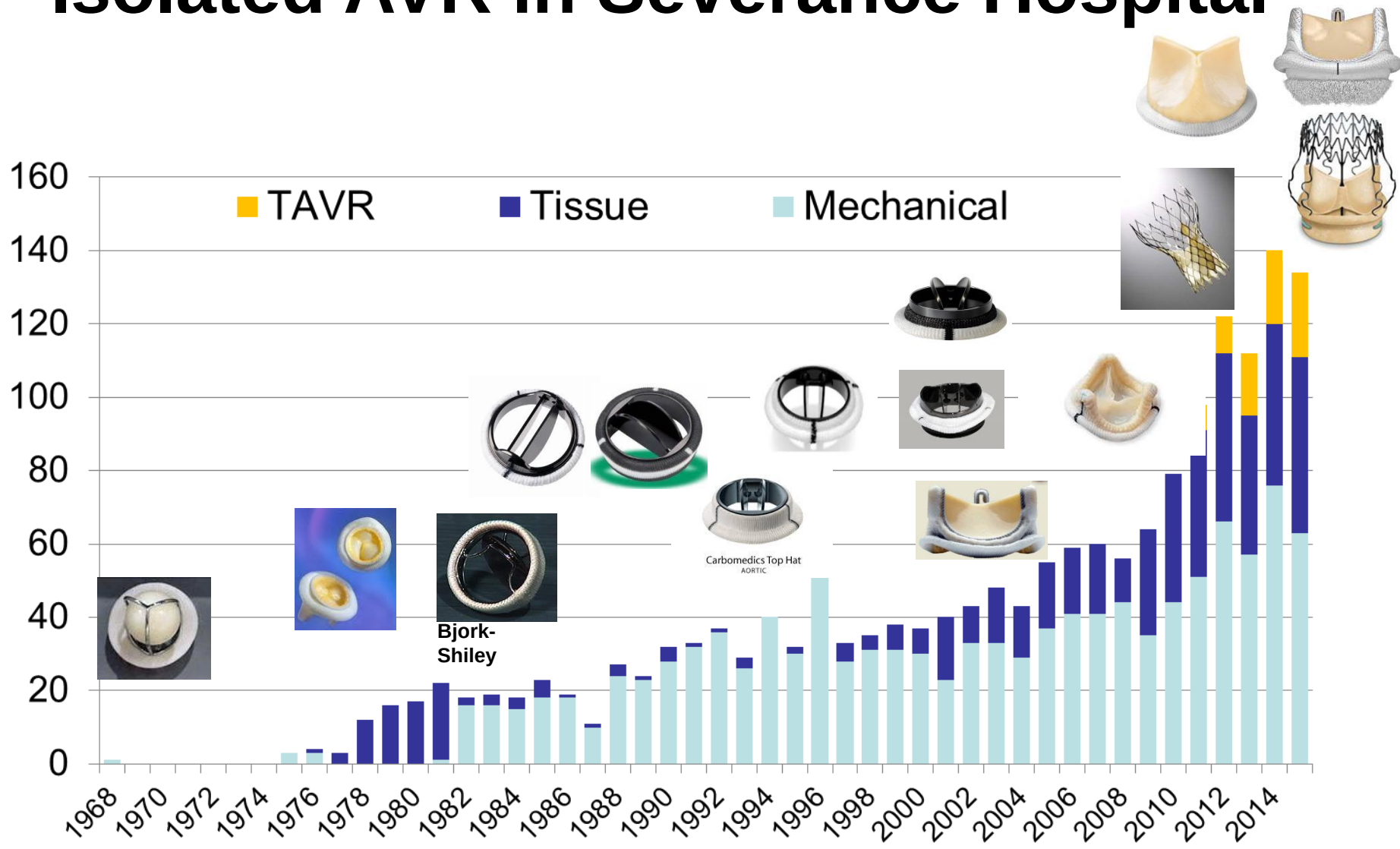
Mechanical

Tilting Disc

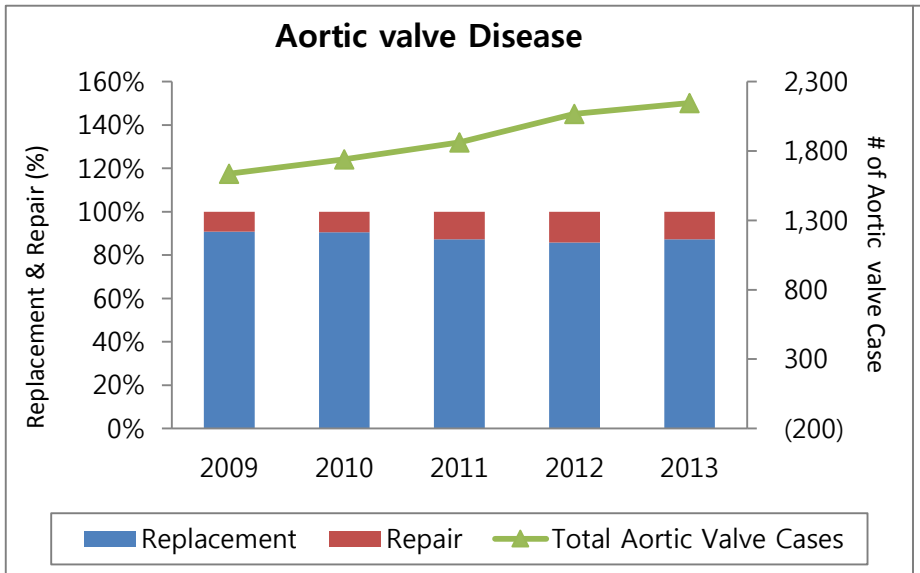
Bileaflet

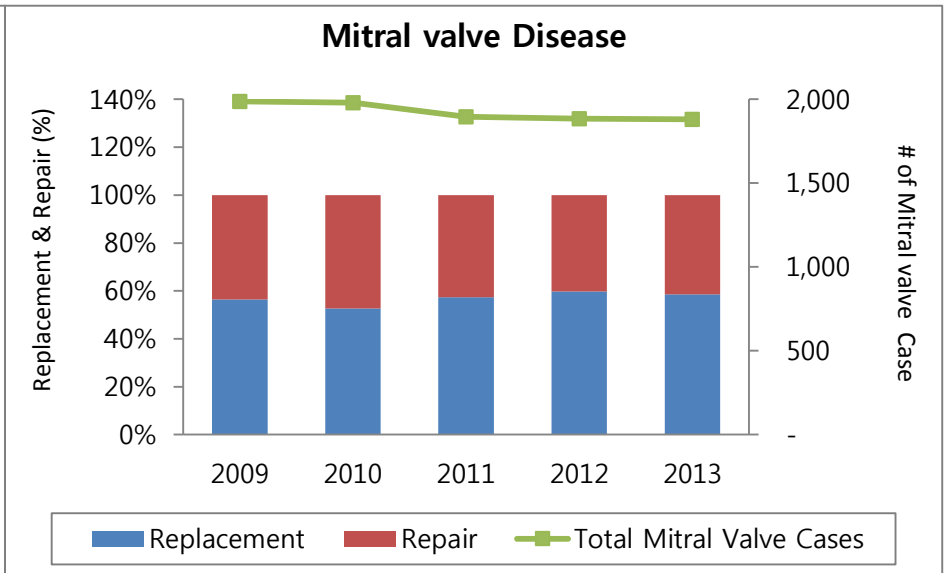
- ATS open pivot
- OnX
- SJM bileaflet
  - *Masters*
  - *Masters silicon coating*
  - *Regent*
  - *Standard*
- Sulzer CarboMedics
- Sorin

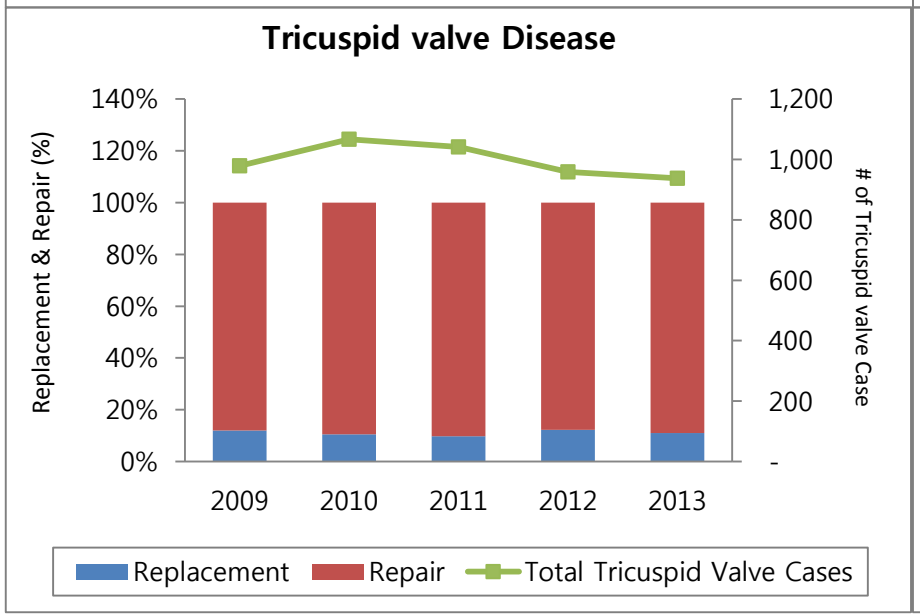
Isolated AVR in Severance Hospital

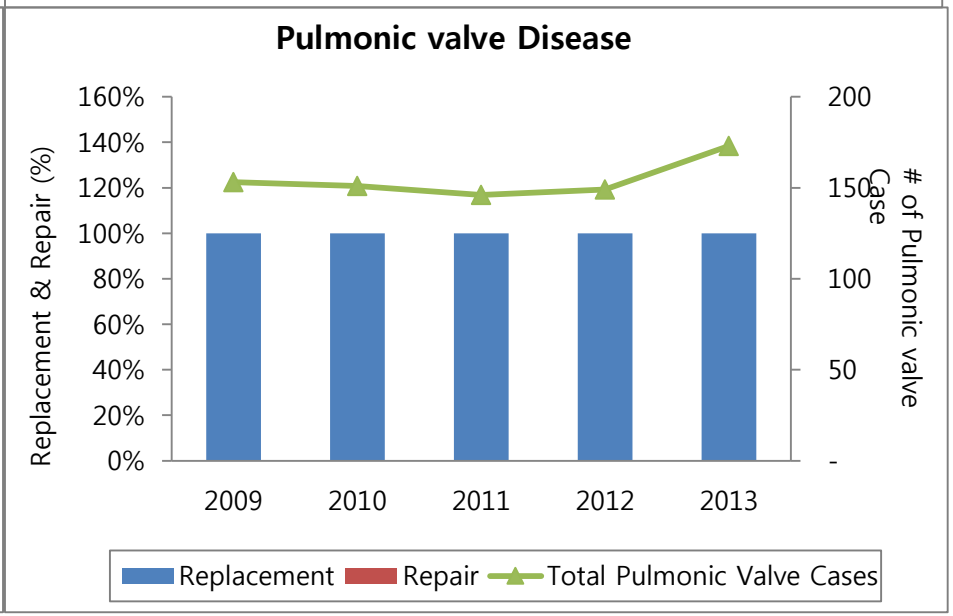


Heart Valve Surgery in Korea





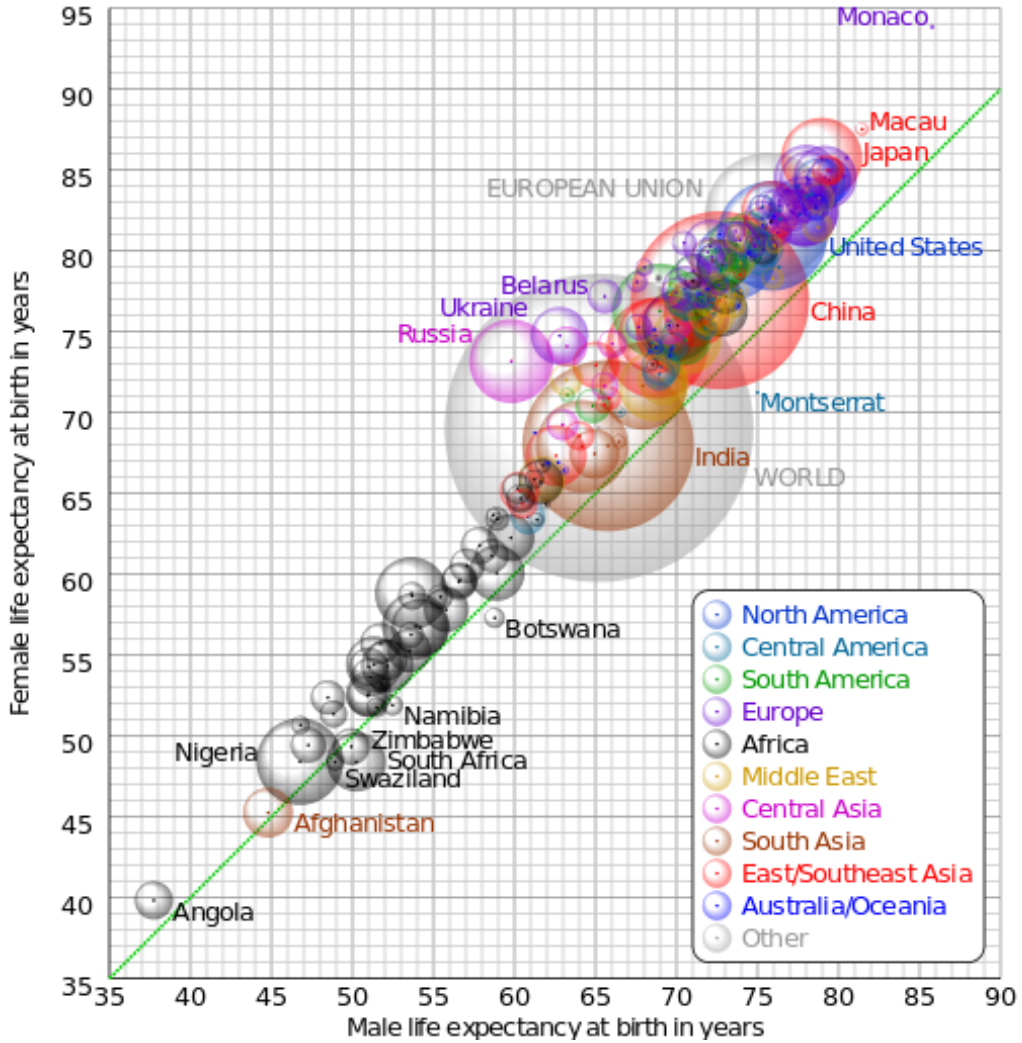




Resource : 건강보험심사평가원(Health Insurance Review & Assessment Service)

SELECTION OF PROSTHESIS

Life Expectancy at Birth, 2011



https://en.wikipedia.org/wiki/Life_expectancy

Life Expectancy in Asia in 2011

		Life Expectancy In 2011		
1	Japan	83		
4	Singapore	82		
4	Austrailia	82		
17	Korea, South	81	27 UK	80
49	China	76	33 USA	79
49	Turkey	76		
61	Vietnam	75		
73	Thailand	74		
73	Malaysia	74		
118	Indonesia	69		
118	Philippine	69		
138	India	65		

*Modified from https://en.wikipedia.org/wiki/**Life_expectancy***

Heart Valves

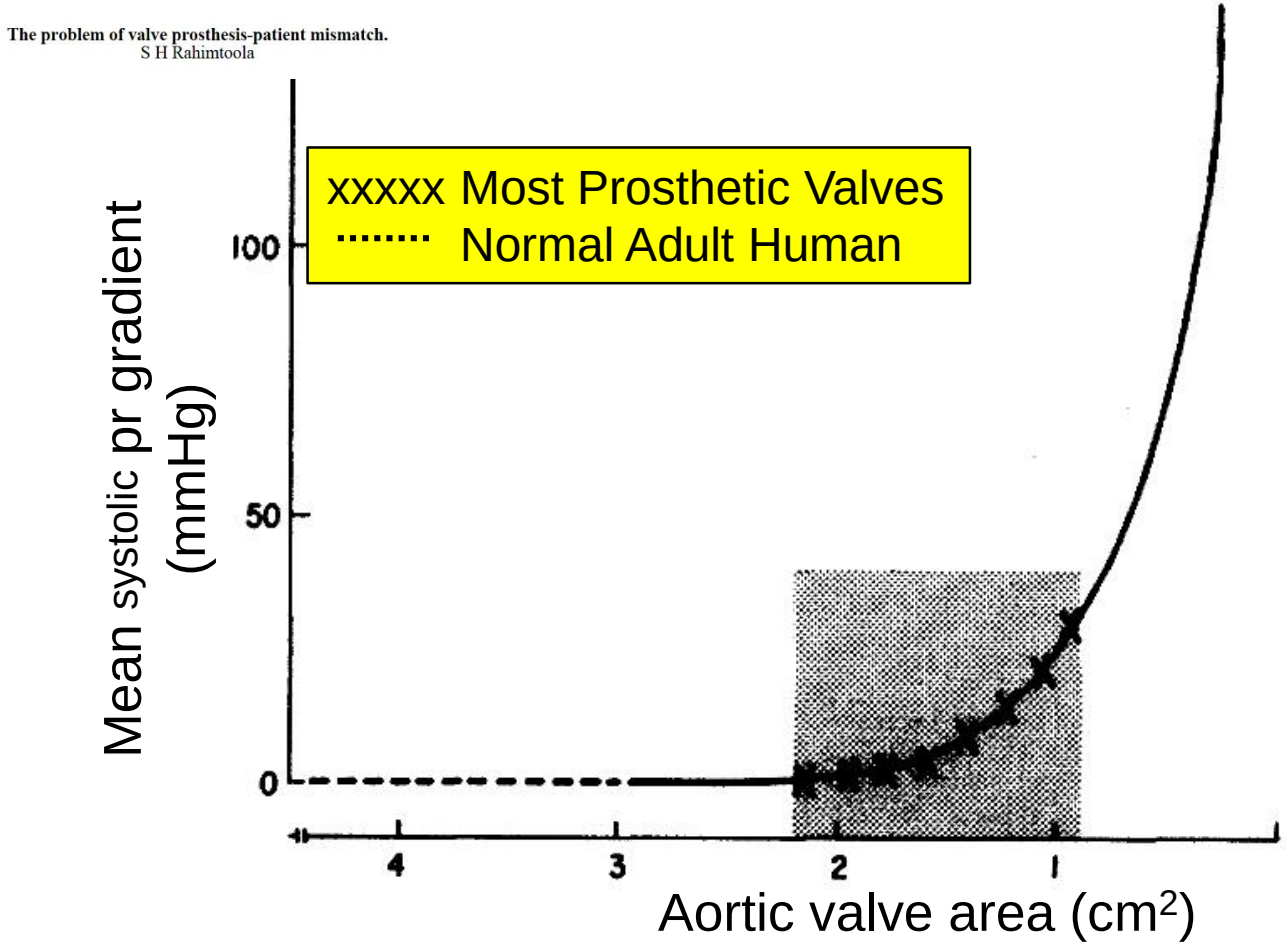
Does Valve Design Affects Clinical Outcomes?

The Problem of Valve Prosthesis-Patient Mismatch

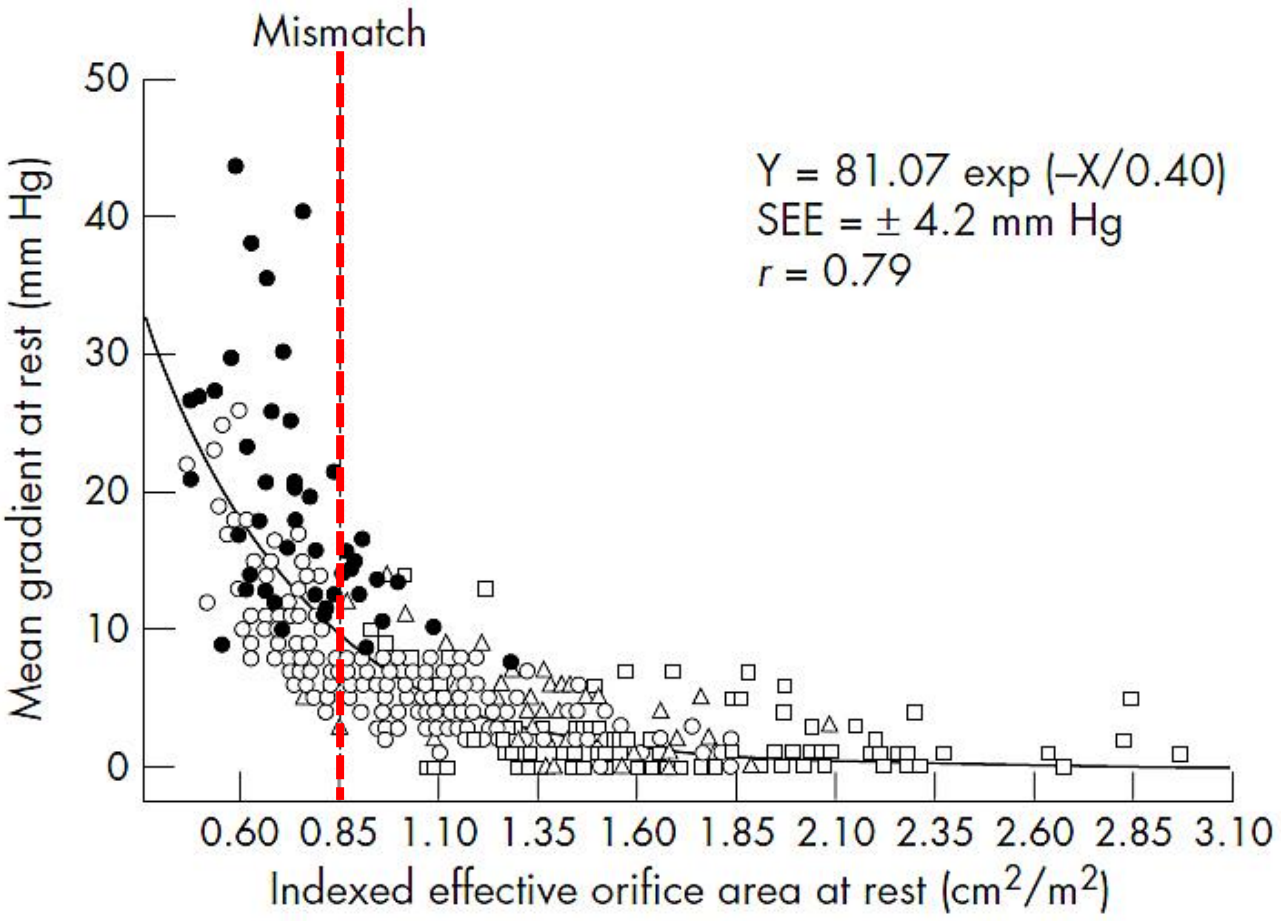
Circulation JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association

Rahimtoola SH, Circulation 1978;58:20-24



Prosthesis-Patient Mismatch



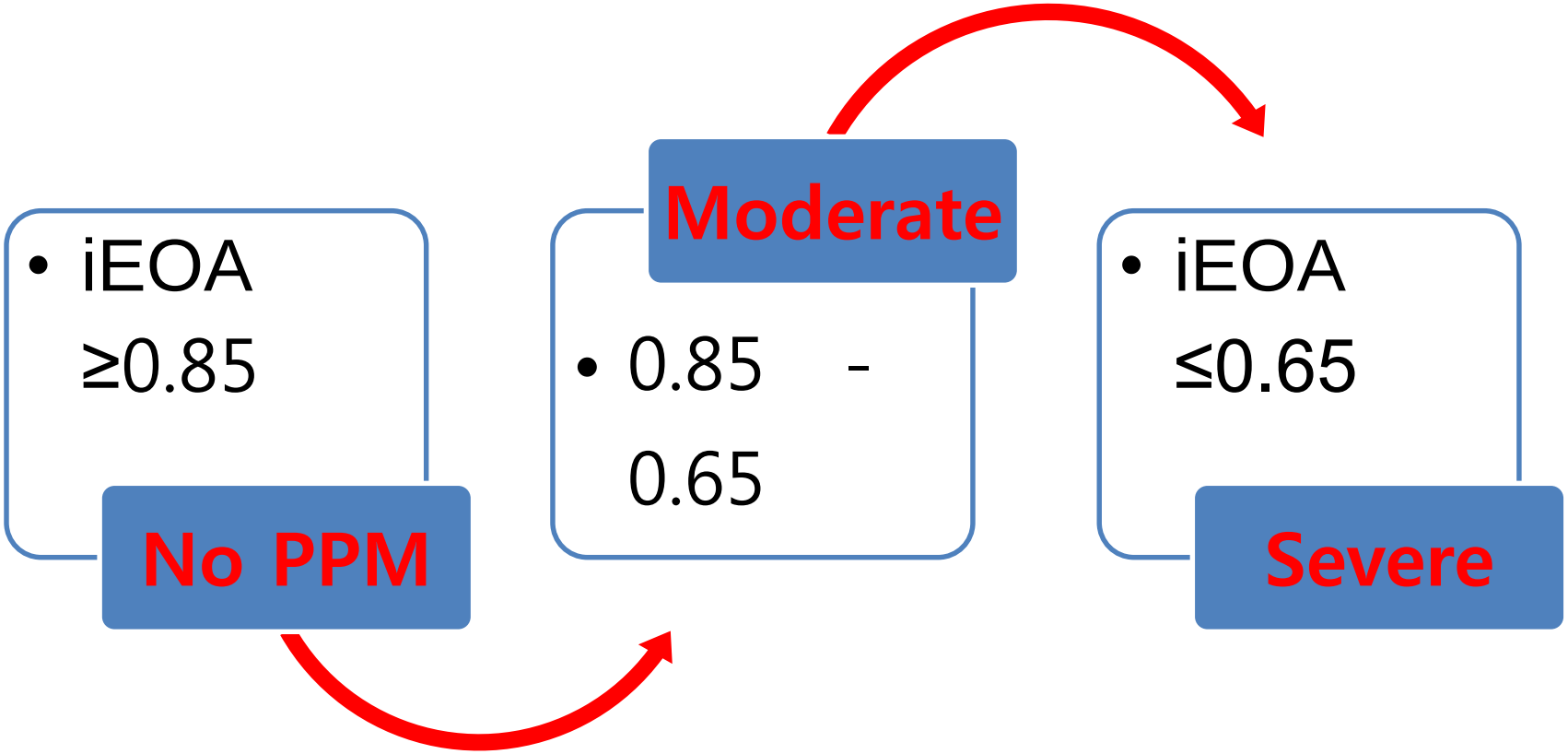
Pibarot P, Dumesnil JG, Heart 2006

The impact of PPM after AVR

RahimtoolaSH, Circulation 1978

- **Higher trans-valvular gradients may**
  - ✓ Increase early and late morbidity
  - ✓ Incomplete left ventricular mass regression
  - ✓ Reduce recovery of LV function
  - ✓ Decrease long-term survival
  - ✓ Others;

Prosthesis-Patient Mismatch



Indexed EOA=EOA/m2

European Heart Journal (2012) **33**, 1518–1529
doi:10.1093/eurheartj/ehs003

CLINICAL RESEARCH
Cardiac surgery

The impact of prosthesis–patient mismatch on long-term survival after aortic valve replacement: a systematic review and meta-analysis of 34 observational studies comprising 27 186 patients with 133 141 patient-years

Stuart J. Head[1]*, Mostafa M. Mokhles[1], Ruben L.J. Osnabrugge[1,2], Philippe Pibarot[3], Michael J. Mack[4], Johanna J.M. Takkenberg[1], Ad J.J.C. Bogers[1], and Arie Pieter Kappetein[1]

Conclusion;
Prosthesis–patient mismatch is associated with an increase in all-cause and cardiac-related mortality over long-term follow-up.

Prosthesis-Patient Mismatch

Questions remained;

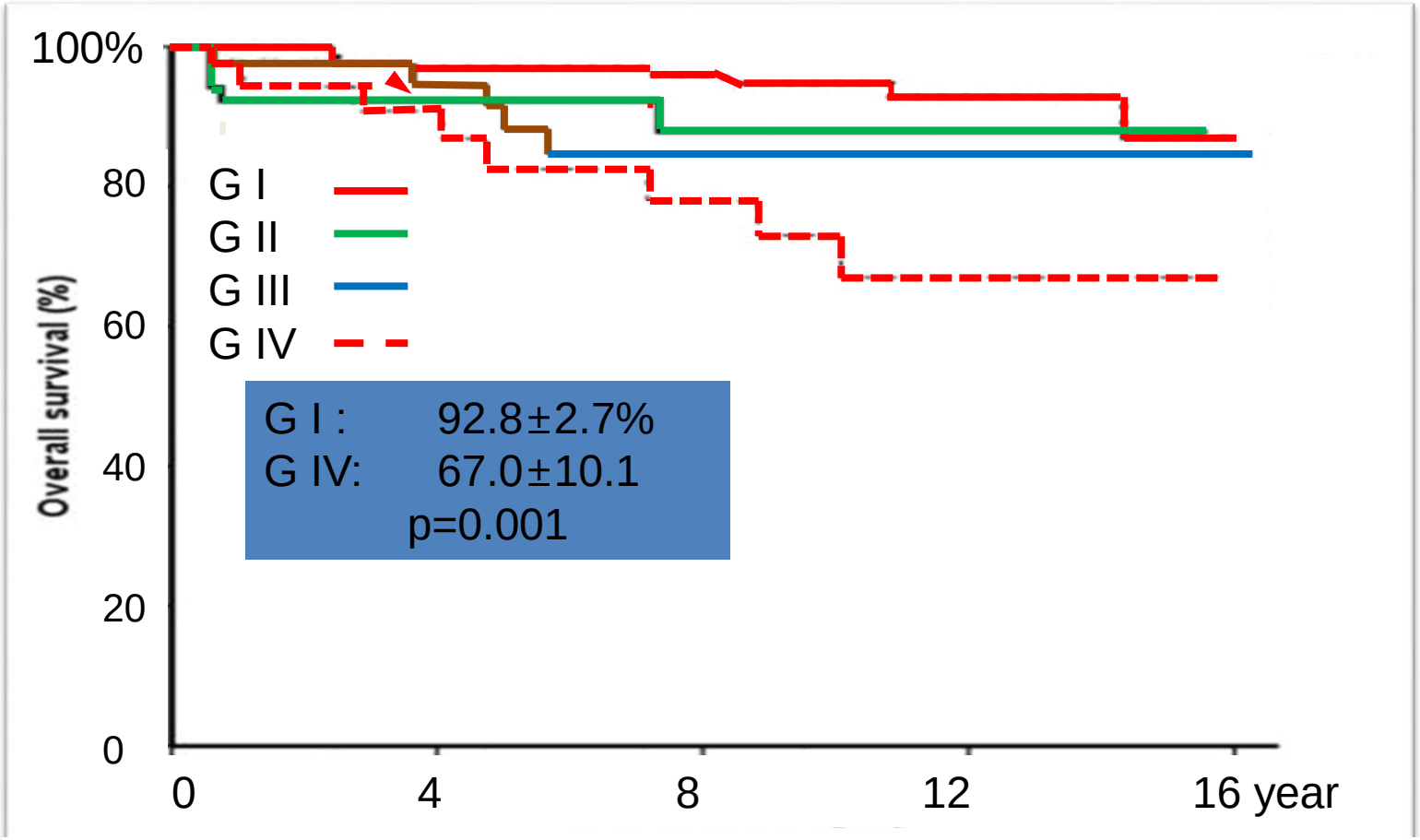
- PPM: Is it a problem for long-term survival?
- What is cut-off value of iEOA?
- Is i-EOA from company reliable?
- What about PG at exercise? How long do we need to follow up?

Effect of the prosthesis–patient mismatch on long-term clinical outcomes after isolated aortic valve replacement for aortic stenosis: A prospective observational study

Soonchang Hong, MD,[a] Gijong Yi, MD,[a] Young-Nam Youn, MD,[b] Sak Lee, MD,[b] Kyung-Jong Yoo, MD,[b] and Byung-Chul Chang, MD[b]

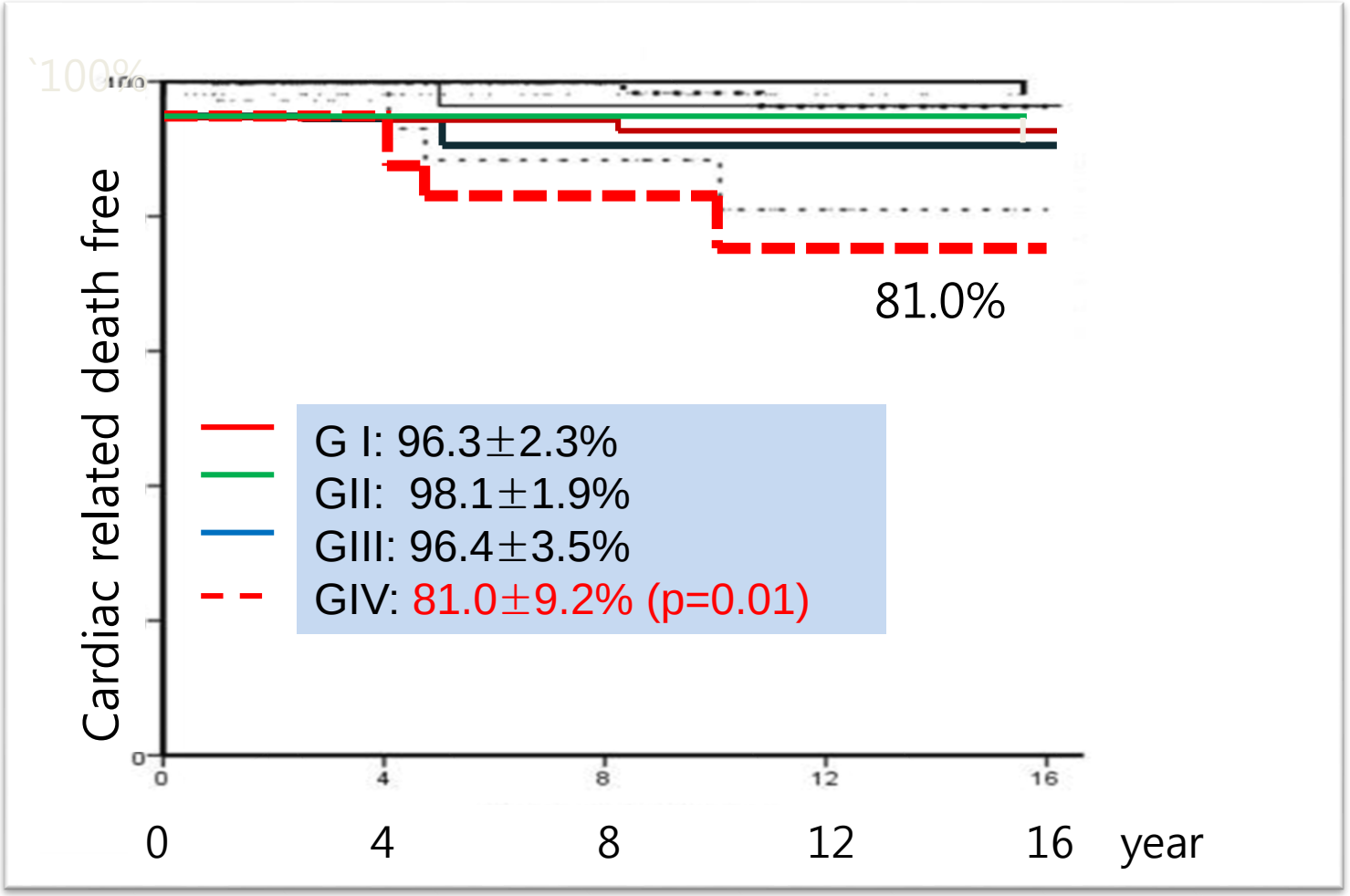
Hong S et al, J Thorac Cardiovasc Surg 2013

Overall Survival at 12 years



Hong S et al, J Thorac Cardiovasc Surg 2013

Cardiac Related Death-Free at 12 years



Hong S et al, J Thorac Cardiovasc Surg 2013

How to overcome PPM?

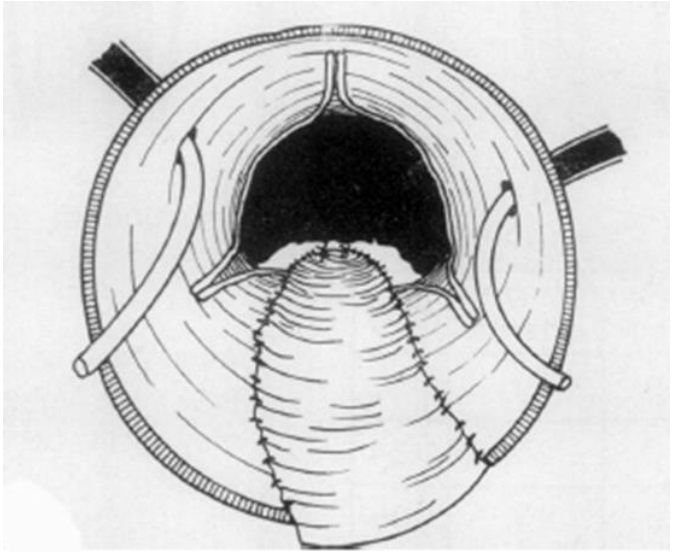
Surgery for Small Aortic Annulus

- **Augmentation annuloplasty**
  - Nicks
  - Manouguian and Seybold-Epting
  - Konno

- **Supra-annular prosthesis**

Aortic Root Enlargement Procedures

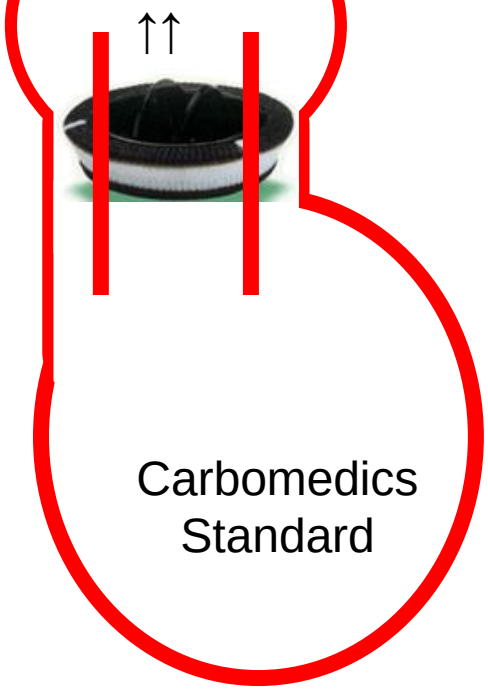
- The Konno procedure is historical, and the **Nicks procedure** with incision of the posterior commissure is the best anatomically of the posterior enlarging procedures.



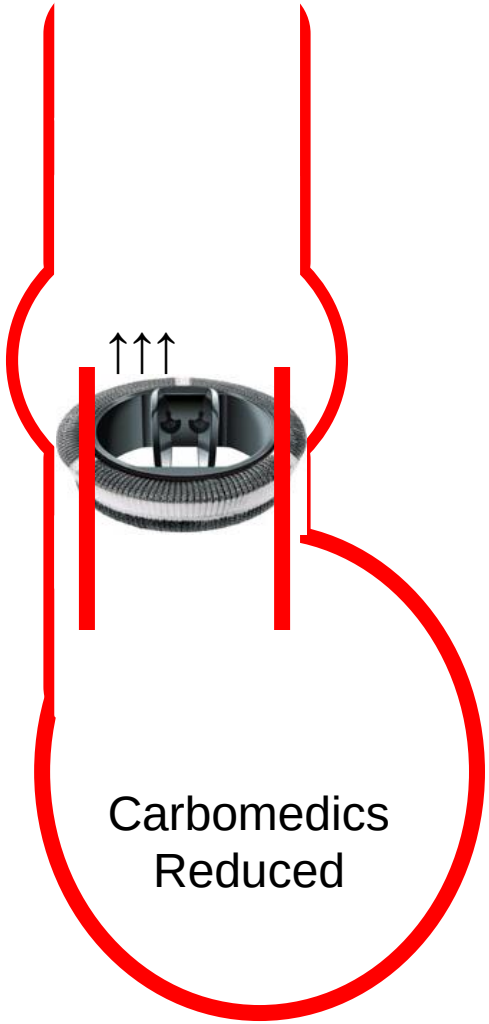
By Donald B. Doty, MD and John R. Doty, MD.
CTS net Jan. 2011

intra, semi-intra, supra

Low flow
High pressure
difference



Carbomedics
Standard



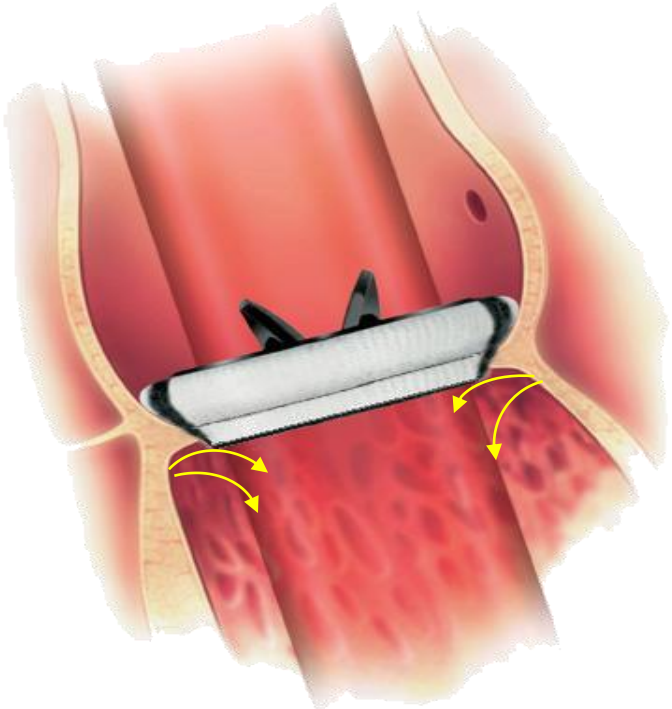
Carbomedics
Reduced

High flow
Low pressure
difference

Sorin
Overline

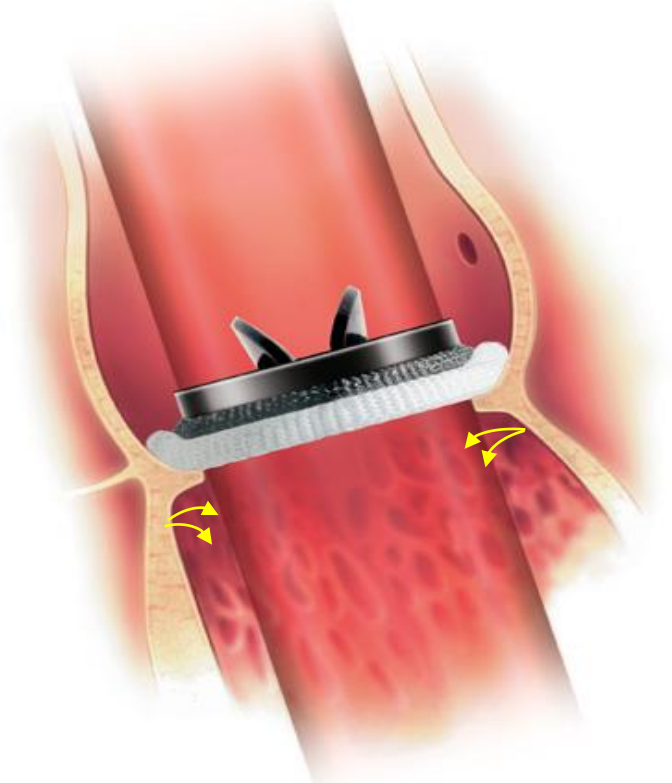
Other than Additional Procedure

Intra-Annular



Large turbulence

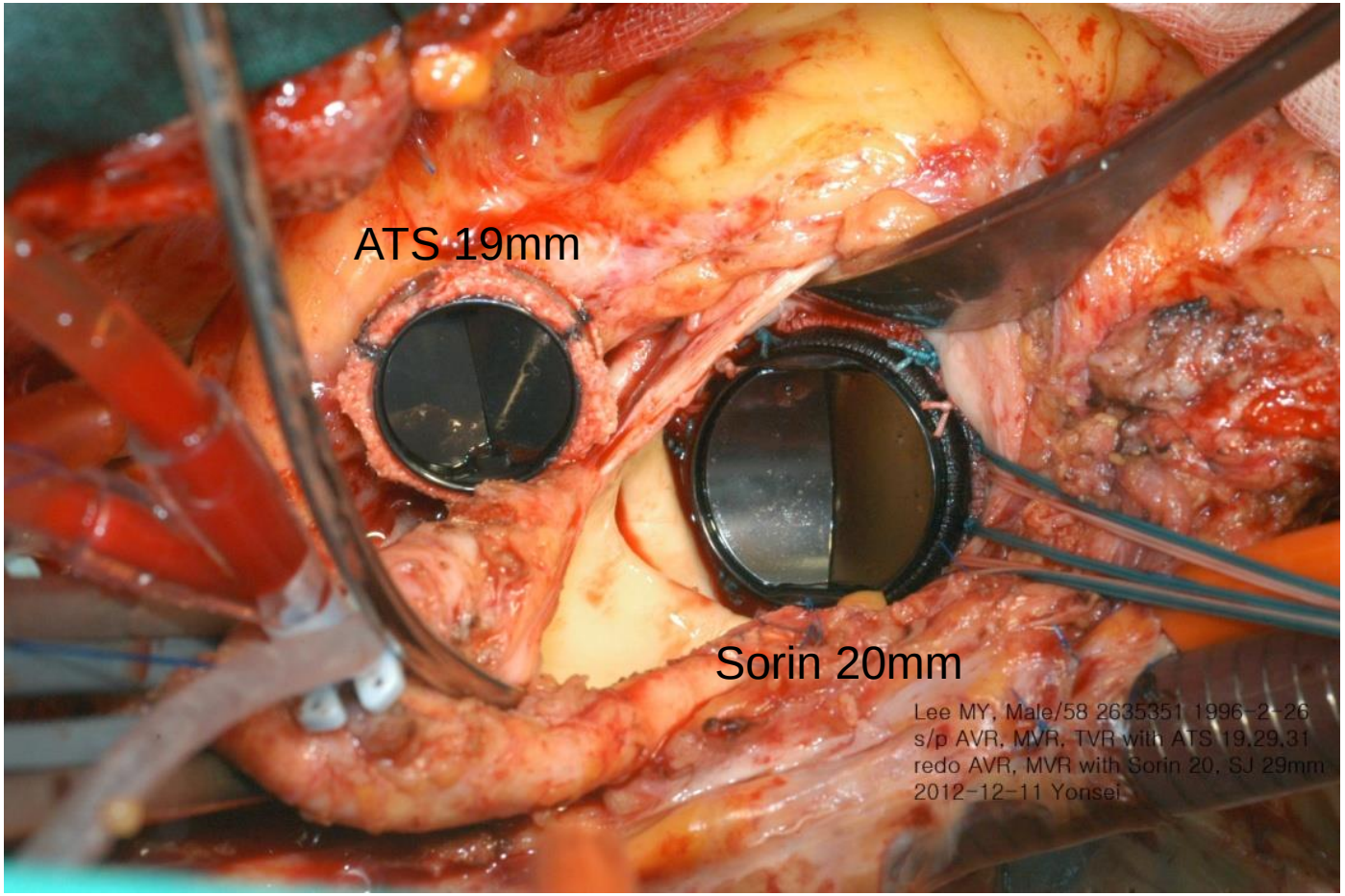
Totally Supra-Annular



Small turbulence

2635351 Lee, MY

s/p AVR, MVR , TVR, with ATS 19, 29, 31mm 1996-2-26



Redo AVR, MVR, with Sorin Overline 20mm and SJ 29mm

Bioprosthesis

Alain Carpentier

- New Heart & New Hope

U.S.News & WORLD REPORT 2013

"Not all innovations represent progress."

—Anonymous

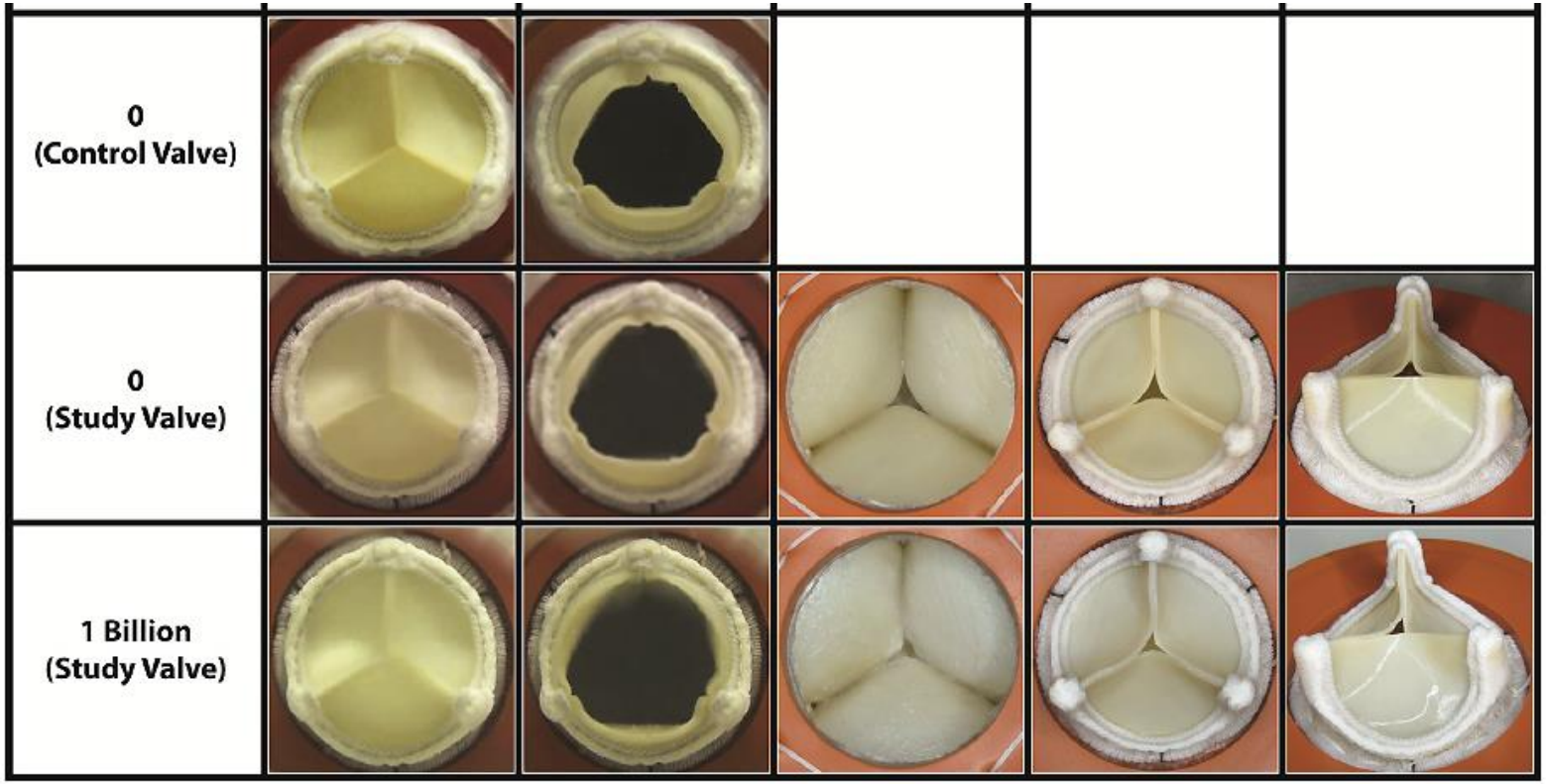
"The feasibility of an operation is not the best indication for its performance."
—Lord Cohen of Birkenhead,
at 1950 Moynihan Lecture,
Royal College of Surgeons, England (1)

Rahimtoola SH. JACC 2010;55:2413

Long-Term Durability of Carpentier-Edwards Magna Ease Valve: A One Billion Cycle In Vitro Study

Vrishank Raghav, PhD, Ikechukwu Okafor, BS, Michael Quach, BS, Lynn Dang, BS, Salvador Marquez, BS, MBA, and Ajit P. Yoganathan, PhD

Wallace H. Coulter Department of Biomedical Engineering, Georgia Institute of Technology & Emory University, Atlanta; School of Chemical and Biomolecular Engineering, Georgia Institute of Technology, Atlanta, Georgia; and Edwards Lifesciences, Irvine, California



Raghav V et al 2016 ATS

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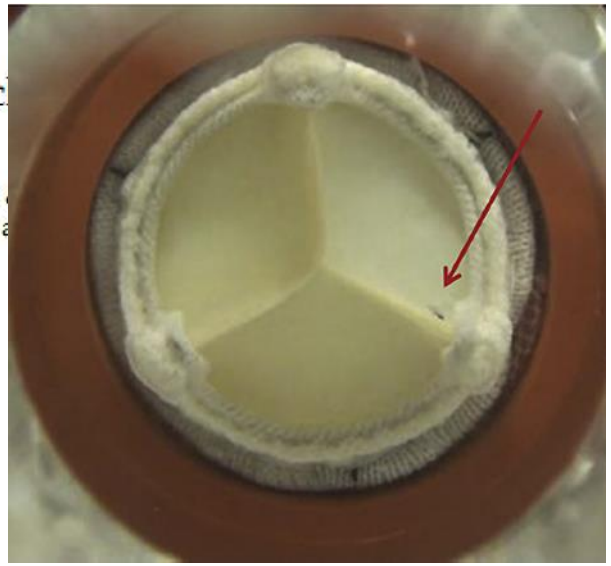
Chemical and Biomolecular Engineering, Georgia Institute of Technology, Atlanta, Georgia; a
California



Conclusions. The Magna Ease valves demonstrated excellent durability and hydrodynamic performance after an equivalent of 25 years of simulated in vitro wear. All study valves successfully endured 1 billion cycles of simulated wear, 5 times longer than the standard requirement for a tissue valve as stipulated in ISO 5840.

(Ann Thorac Surg 2016;■:■–■)

Raghav V et al 2016 ATS

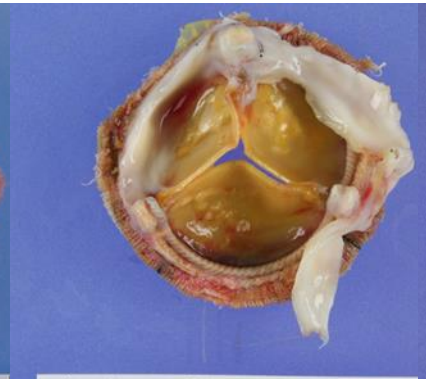
Tissue Valve Prosthesis;

25 YEARS DURABILITY ?

Common Causes of Tissue Valve Failure

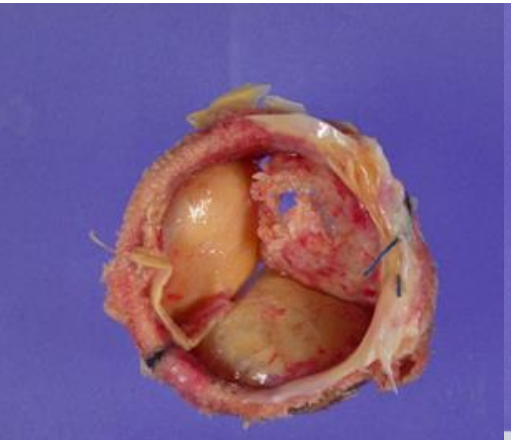
Tissue tearing

Tissue tearing

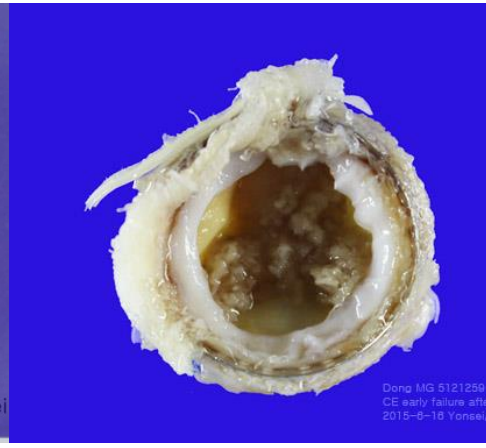


Calcification

Calcification



Calcification & perforation



Infection; H. aphrophilus

Pannus formation

Iresa induced?

Selection of prosthesis

PORCINE VERSUS PERICARDIUM

Durability of Bioprosthesis

Durability of pericardial versus porcine bioprosthetic heart valves

Gary L. Grunkemeier, PhD,[a] Anthony P. Furnary, MD,[b] YingXing Wu, MD, MS,[a] Lian Wang, MS,[a] and Albert Starr, MD[c]

Objectives: To compare the probability, and modes, of explantation for Carpentier-Edwards pericardial versus porcine valves.

Methods: Our porcine series began in 1974 and our pericardial series in 1991, with annual prospective follow-up. We used the Kaplan-Meier method and Cox regression for estimation and analysis of patient mortality, and the cumulative incidence function and competing risks regression for estimation and analysis of valve durability.

Results: Through the end of 2010, we had implanted 506 porcine and 2449 pericardial aortic valves and 181 porcine and 163 pericardial mitral valves. The corresponding total and maximum follow-up years were 3471 and 24, 11,517 and 18, 864 and 22, and 645 and 9. The corresponding probabilities (cumulative incidence function) of any valve explant were 7%, 8%, 22%, and 8%, and of explant for structural valve deterioration were 4%, 5%, 16%, and 5% at 15 years for the first 3 series and at 8 years for the fourth (pericardial mitral valve) series. Using competing risks regression for structural valve deterioration explant, with age, gender, valve size, and concomitant coronary bypass surgery as covariates, a slight (subhazard ratio, 0.79), but nonsignificant, protective effect was found for the pericardial valve in the aortic position and a greater (subhazard ratio, 0.31) and almost significant ($P = .08$) protective effect of the pericardial valve in the mitral position. Leaflet tear was responsible for 61% of the structural valve deterioration explants in the porcine series and 46% in the pericardial series.

Durability of Porcine versus Pericardial Bioprosthetic Valve

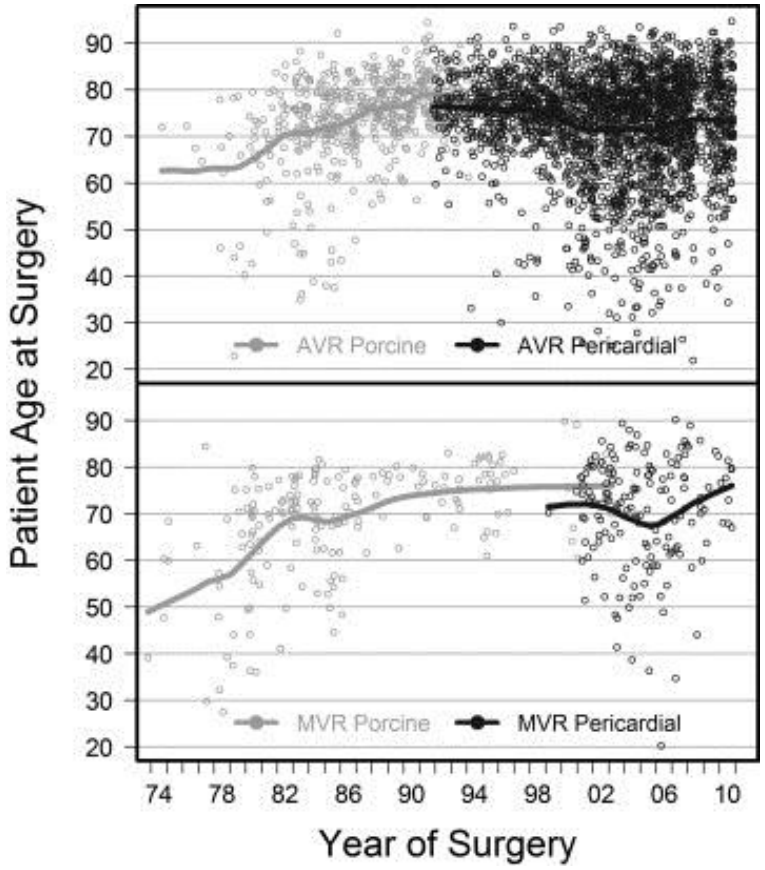


Figure 1. Scatter plot of patient age during implant year, with local regression (LOESS; locally weighted scatterplot smoothing) nonparametric regression curves fit to the individual points. AVR, Aortic valve replacement; MVR, mitral valve replacement.

Grunkemeier GL et al 2012;JTCVS:1381–1386

Durability of Bioprosthesis

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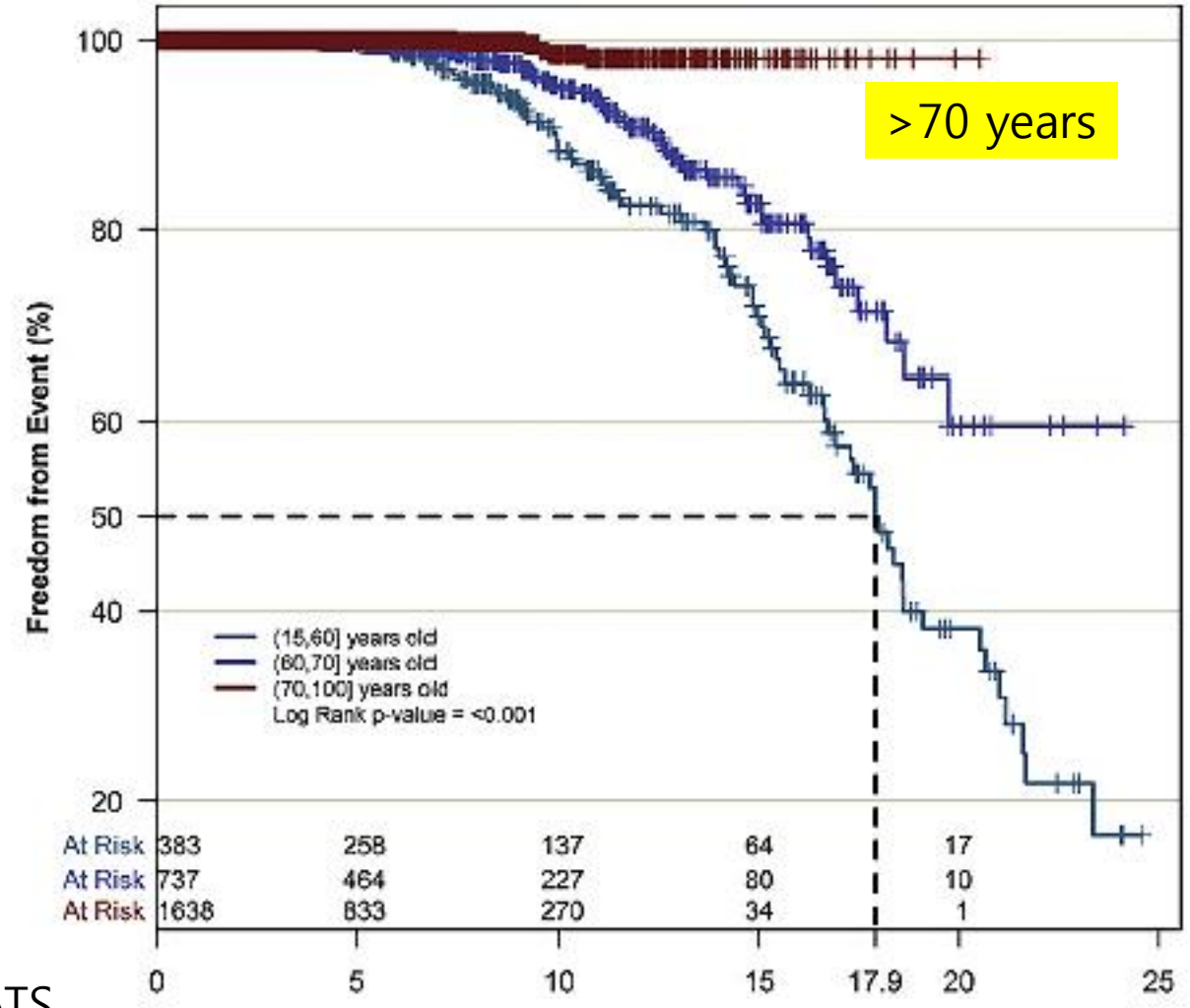
Very Long-Term Outcomes of the Carpentier-Edwards Perimount Valve in Aortic Position

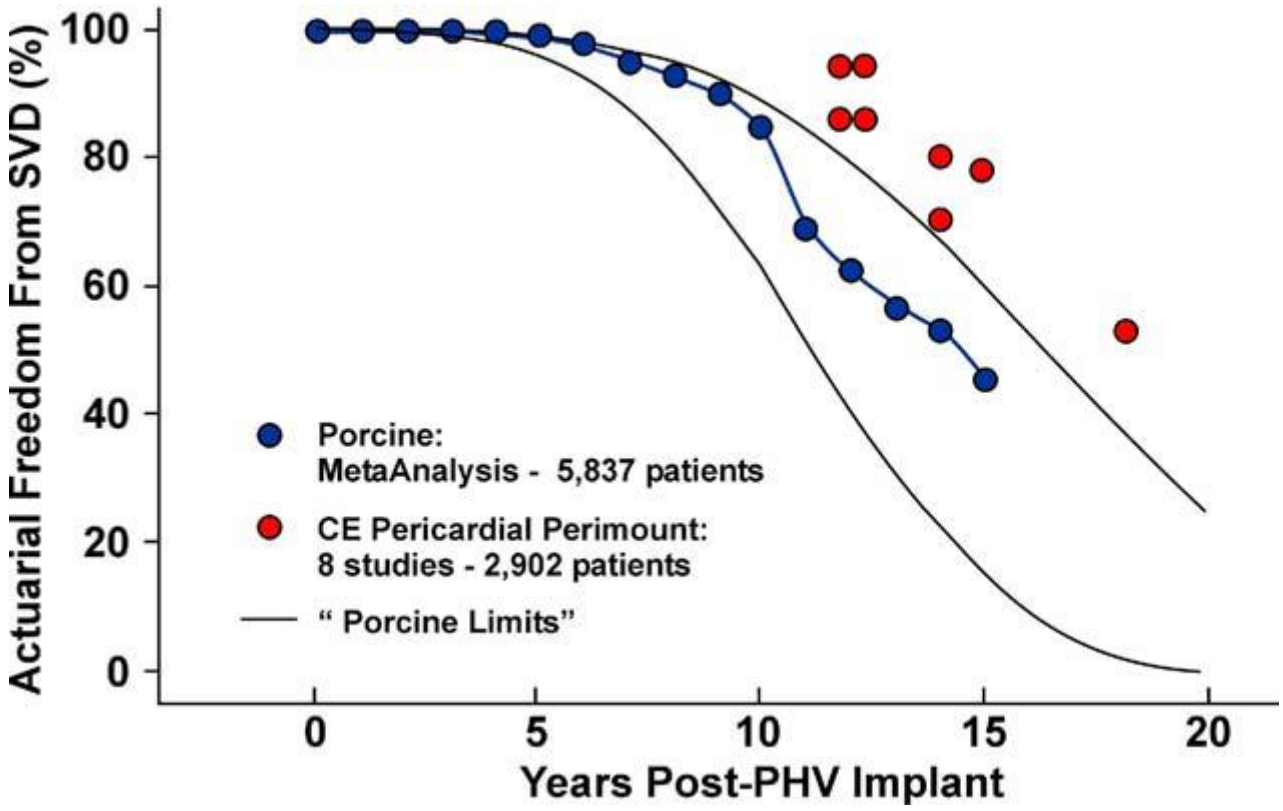
Thierry Bourguignon, MD, A
Alain Mirza, MD, Claudia L
Michel Marchand, MD, and

Department of Cardiac Surgery, Tours Uni
Switzerland



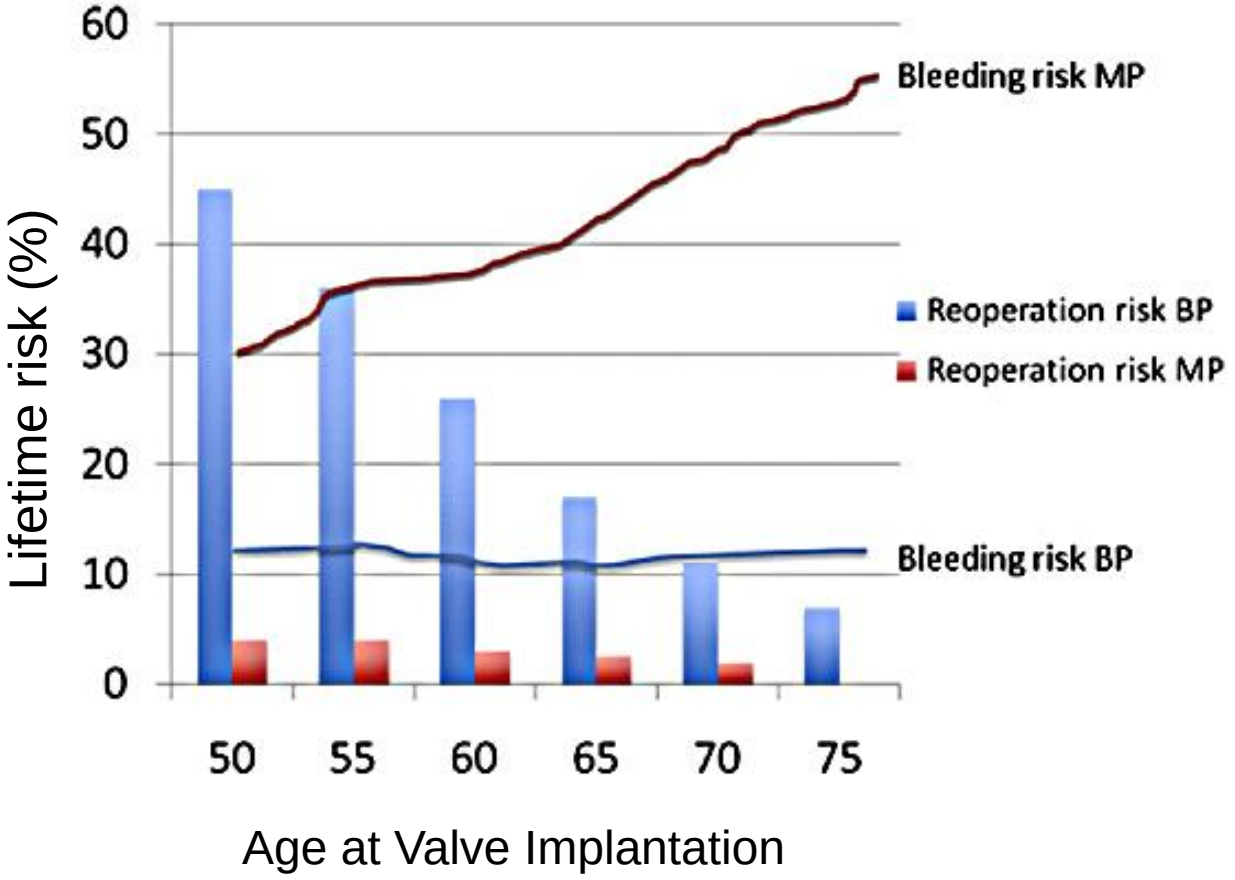
Bourguidnon T et al 2015 ATS

Actuarial free from SVD after AVR



Rahimtoola SH. JACC 2010;55:2413

Durability of Tissue Valves



Chikwe J, Filsoufi F. Seminars Thorac Cardiovasc Surg 2011

Long-Term Durability of Carpentier-Edwards Magna Ease Valve: A One Billion Cycle In Vitro Study

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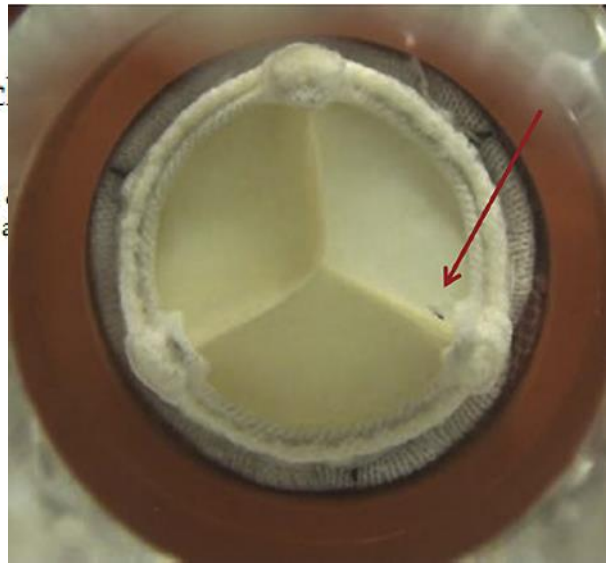
California



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(Ann Thorac Surg 2016;■:■–■)

Raghav V et al 2016 ATS

"Not all innovations represent progress."

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"The feasibility of an operation is not the best indication for its performance."
—Lord Cohen of Birkenhead,
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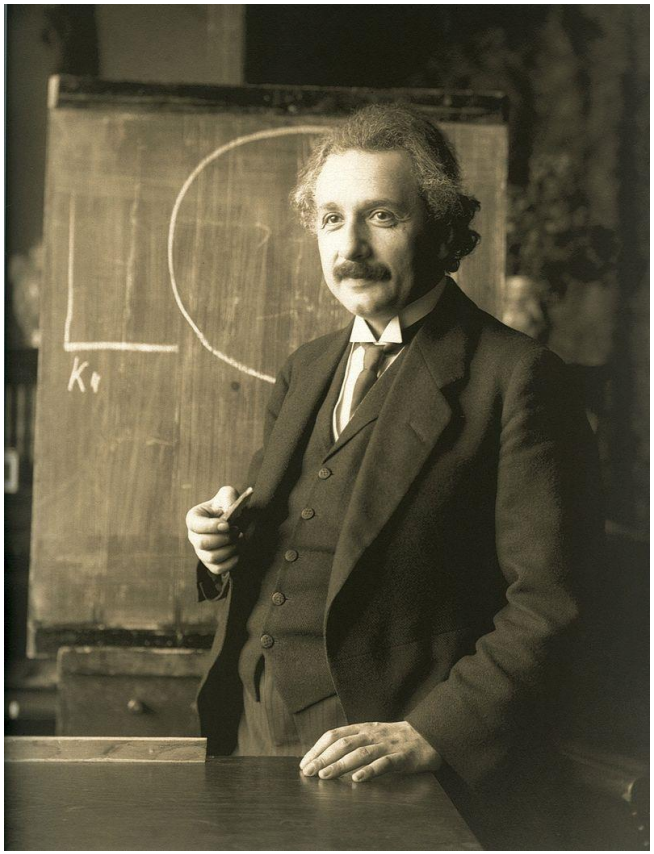
Royal College of Surgeons, England (1)

Rahimtoola SH. JACC 2010;55:2413

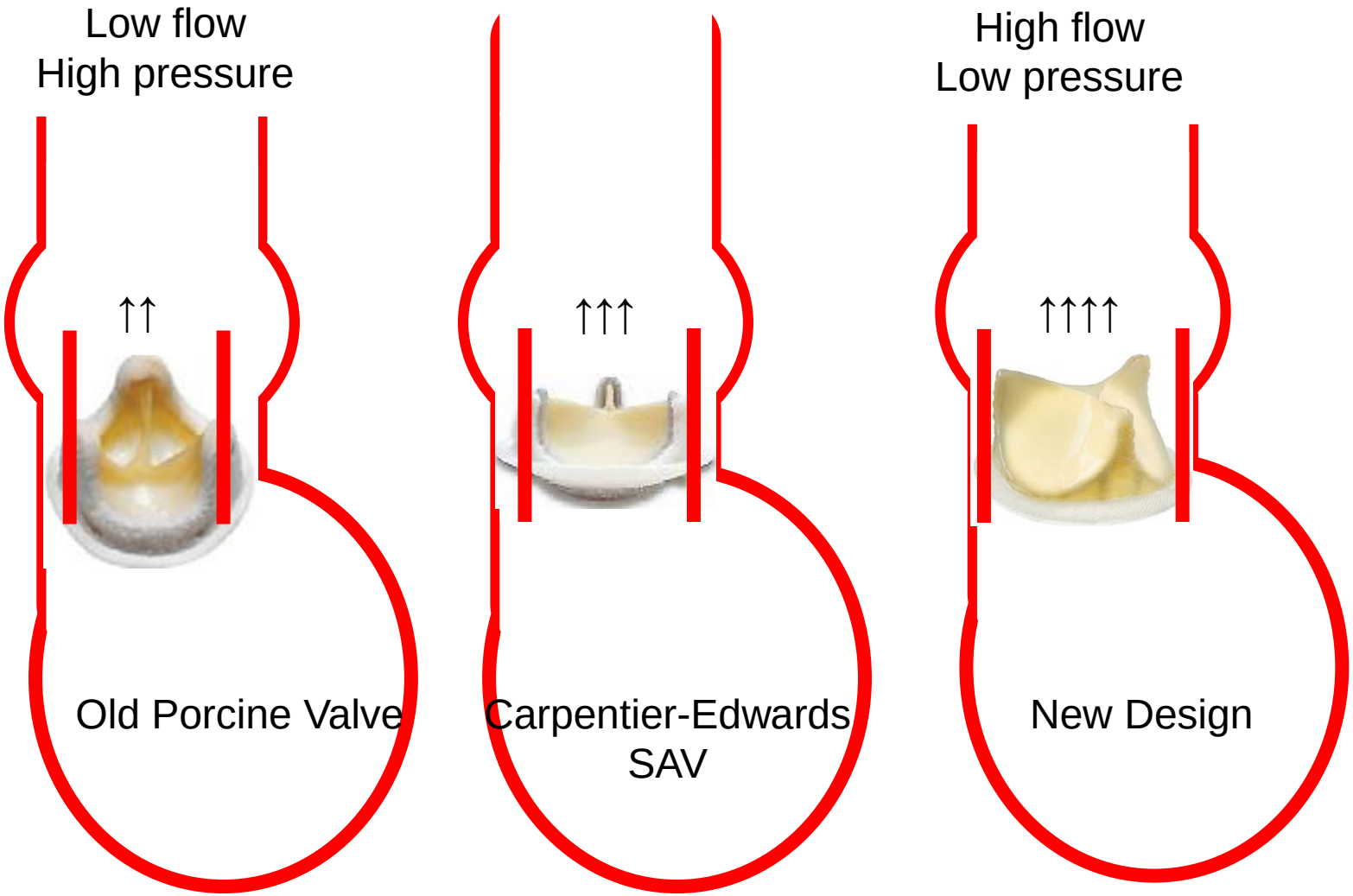
Everything should be made as simple as possible,

but not simpler

–Albert Einstein



intra, semi-intra, supra



Bioprosthesis; recently developed

1. Anti-calcification
2. Design: supra-annular

Edwards Lifesciences
PERIMOUNT
Magna Ease

Medtronic
Hancock II

St Jude
Trifecta

Sorin Group
Mitroflow

Does design affect clinical outcome?

How to Improve long-term outcome?

- Choice of prosthesis; supra-annular type
- Large size;
- Anti-calcification treatment
- Surgical techniques
  - Removal of all aortic valve tissue and calcium
  - Suture technique?
  - Pledgets?

Advantage and Disadvantage

Biological Valve

- Durability 10-20 years
  - *Worse in younger patients*
- TE; reduced incidence
- Bleeding; low
- More flow stenosis in small stented valve
- Paravalvular leak: low
- Profile: high

Mechanical Valve

- Durability: > 30 years
  - *Low structural failure*
- TE; higher incidence
- Bleeding: high
- EOAI: better? in supra-annular type
- Paravalvular leak: high?
- Low profile

Choice of the aortic/mitral prosthesis

in favor of a bioprosthesis

ESC/EACTS Guidelines 2012

	Class	Level
A bioprosthesis is recommended according to the desire of the informed patient.	I	C
A bioprosthesis is recommended when good quality anticoagulation is unlikely or contraindicated because of high bleeding risk(prior major bleed; comorbidities; unwillingness ; compliance problems; lifestyle; occupation).	I	C
A bioprothesis is recommended for reoperation for mechanical valve thrombosis despite good long-term anticoagulant control.	I	C
A bioprosthesis should be considered in patients for whom future redo valve surgery would be at low risk.	IIa	C
A bioprosthesis should be considered in young women contemplating pregnancy.	IIa	C
A bioprosthesis should be considered in patients aged **> 65 years** for prosthesis in aortic position or > 70 year in mitral position, or those with life expectancy lower than the presumed durability of the bioprosthesis.	IIa	C

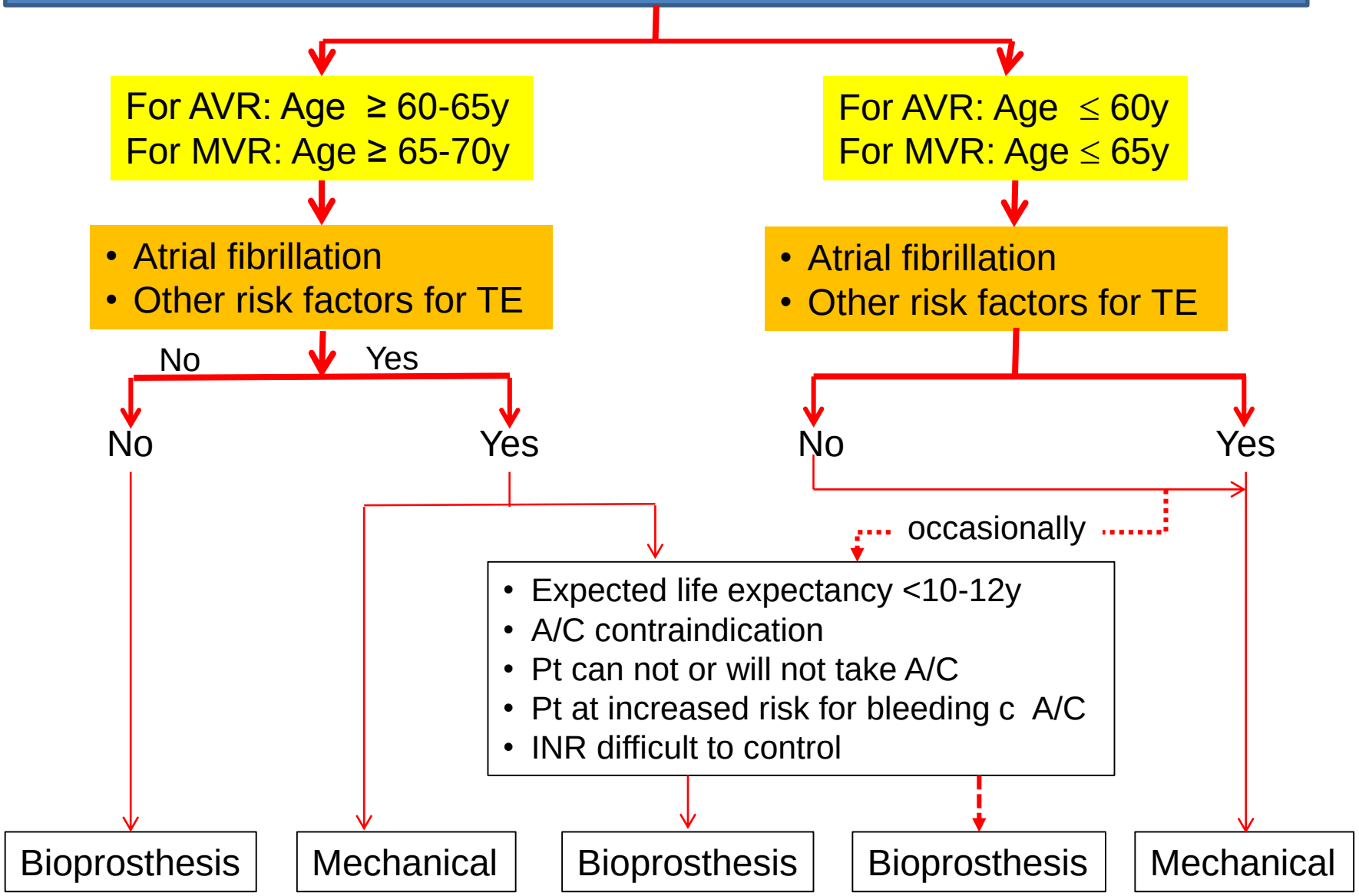
Choice of the aortic/mitral prosthesis

in favor of a mechanical prosthesis

ESC/EACTS Guidelines 2012

	Class	Level
A mechanical prosthesis is recommended according to the desire of the informed patient and if there are no contraindications for long-term anticoagulation.	I	C
A mechanical prosthesis is recommended in patients at risk of accelerated structural valve deterioration.	I	C
A mechanical prosthesis is recommended in patients already anticoagulation as a result of having a mechanical prosthesis in another valve position.	I	C
A mechanical prosthesis should be considered in patients **aged <60 years for prostheses in the aortic position** and<65 years for prostheses in the mitral position.	IIa	C
A mechanical prosthesis should be considered in patients with a reasonable surgery would be at high risk.	IIa	C
A mechanical prosthesis may be considered in patients already on long-term anticoagulation due to high risk of thromboembolism.	IIb	C

Selection of Prosthetic Heart Valve



Fuster V et al in Hurst's The Heart, 13th ed

CV surgeon; perfect Doctor

Development of Bioprosthesis

- **The First Generation**
- **Fixed with G-A at 10mmHg**

- The Second
- Fixed with G-A at 2mmHg
- Anti-calcification
  - Initially treated with polysorbate 80
  - And polysorbate and ethanol

Editorial Comment

The Problem of Severe Valve Prosthesis-Patient Mismatch in Aortic Bioprostheses: Near Extinction?

Jean G. Dumesnil, MD, FRCP (C), FACC, FASE (Hon), and Philippe Pibarot, DVM, PhD, FACC, FAHA, FASE, *Quebec, Quebec, Canada*

Table 1 Illustrative mean values for effective orifice areas in different types of aortic bioprostheses

Prosthetic	Valve size (mm)					
	19	21	23	25	27	29
Aortic stented bioprostheses						
Mosaic	1.1	1.2	1.4	1.7	1.8	2.0
Hancock II	—	1.2	1.3	1.5	1.6	1.6
Carpentier-Edwards Perimount	1.1	1.3	1.5	1.8	2.1	2.2
Carpentier-Edwards Magna*	1.3	1.7	2.1	2.3	—	—
Biocor (Epic)*	—	1.3	1.6	1.8	—	—
Mitroflow*	1.1	1.3	1.5	1.8	—	—
Trifecta (Yadlapati *et al.*)*	1.1	1.7	1.9	2.7	2.9	2.4
				2.2		
				2.0	2.3	—
				1.7	2.1	2.7

with caution.

prostheses may have a beneficial "reserve of opening," resulting in a lesser increase in gradients during exercise. Finally, these results provide further support for the efficient use of a prospective strategy to avoid PPM. With these developments, we are indeed hopeful that the problem of PPM, particularly severe PPM, can soon be considered as near extinction.

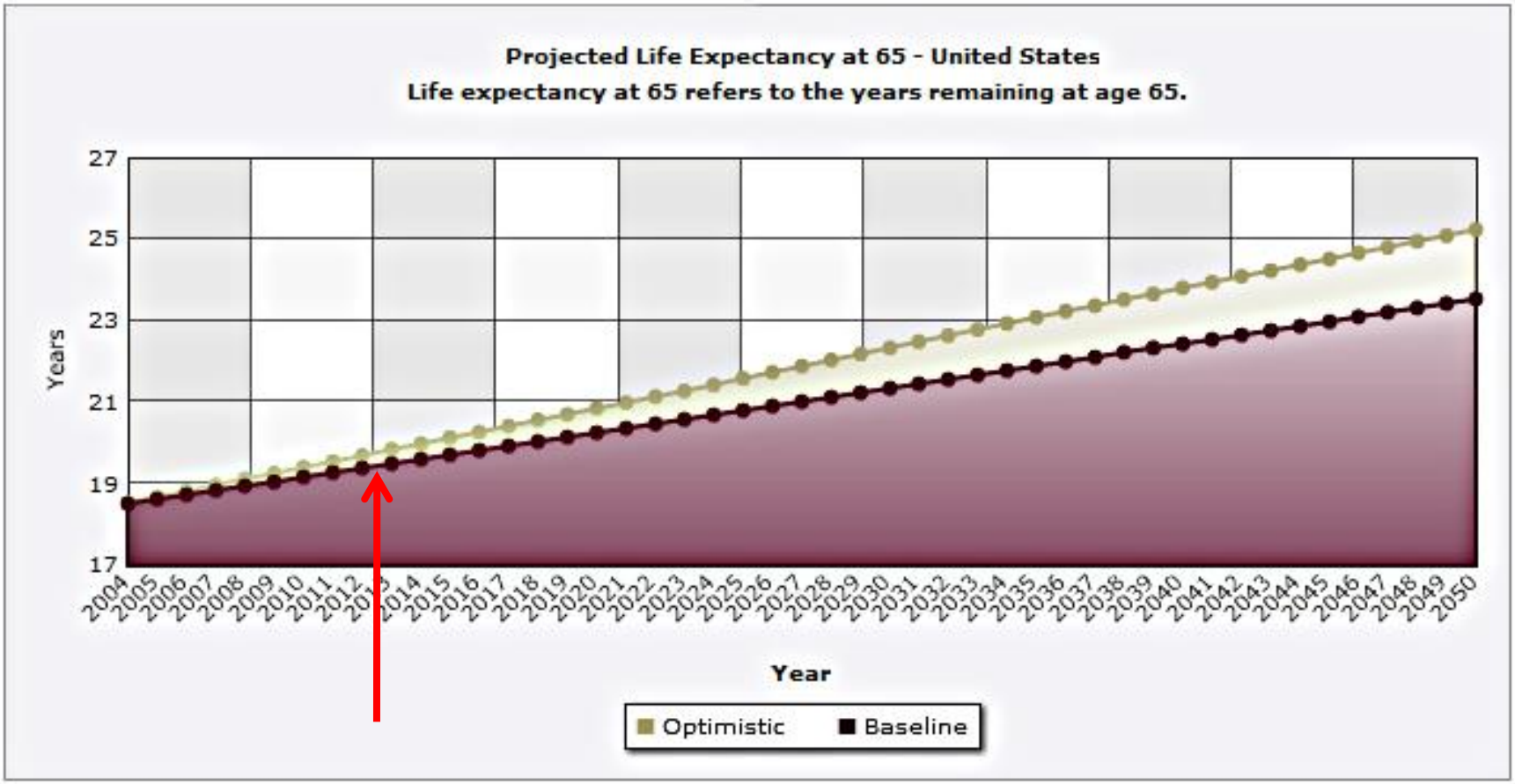
Dumesnil JG 2014 J Am S Echo

Does Valve Design Affect Clinical Outcomes?

Summary

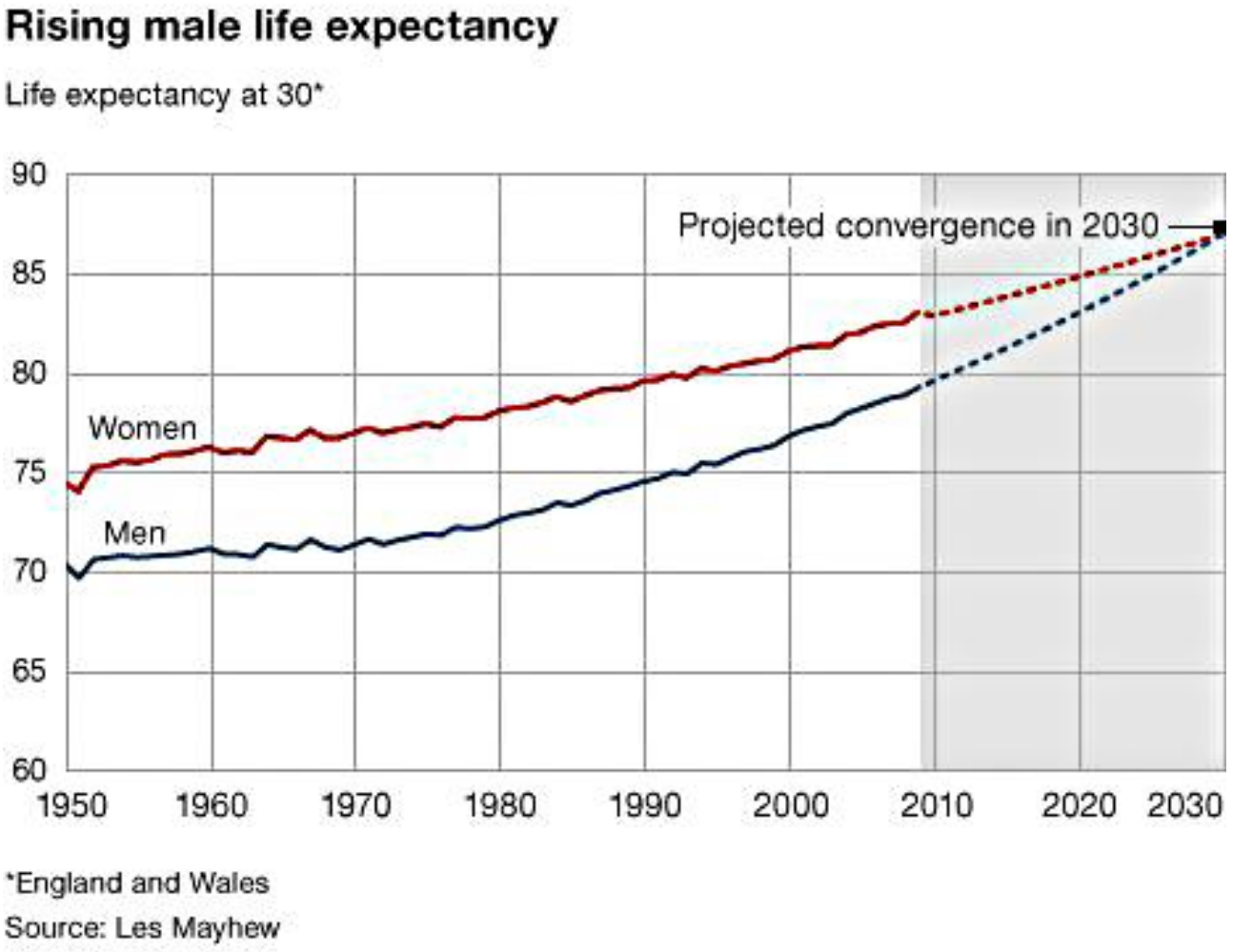
- In patients of small aortic annulus, 1 or 2 size larger prosthesis could be selected with development of new design of large GOA.
- Selection of supra-annular aortic prosthesis thought to prevent severe PPM and to prevent pannus formation with reduction of turbulent flow, especially for patients requiring aortic and mitral valve replacement.

Projected Life Expectancy at 65 (2004-2050)

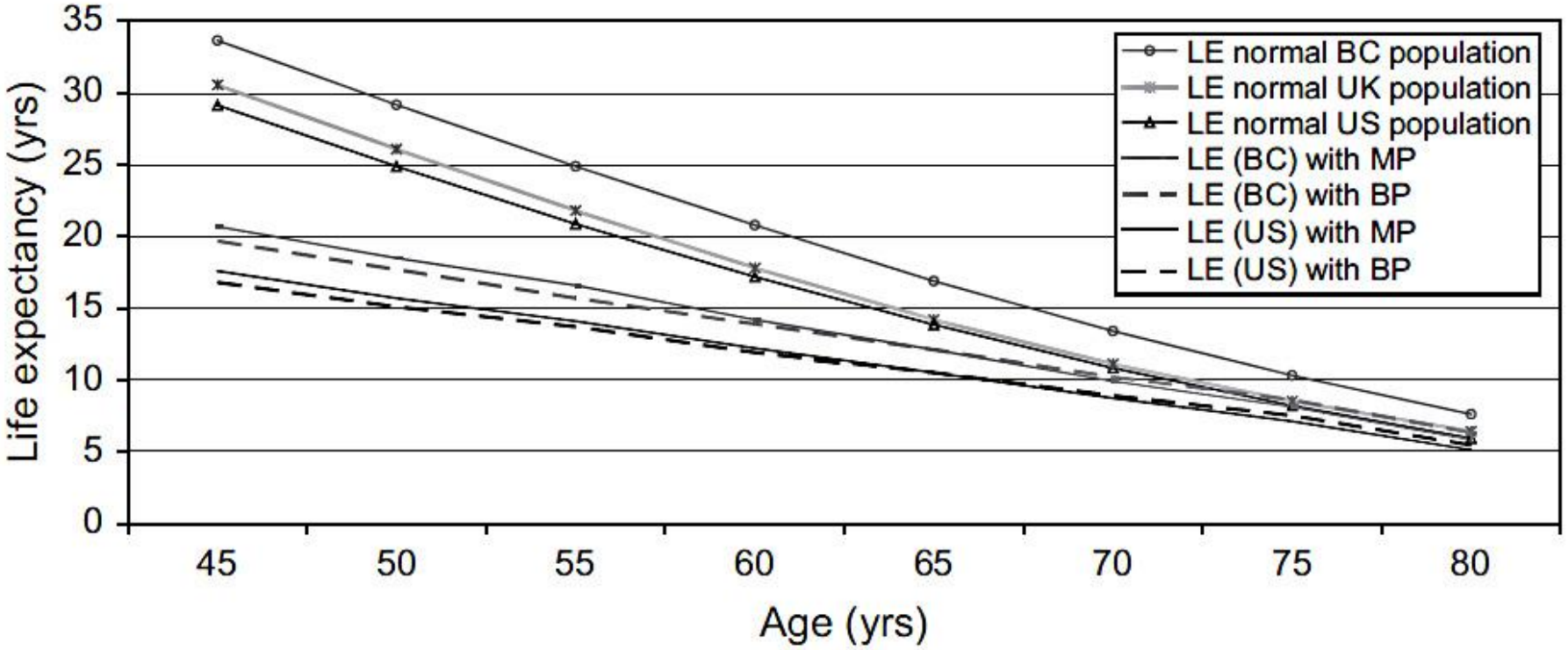


http://www.chronicdiseaseimpact.com/ebcd.taf?cat=intergen&type=life

Life Expectancy In England, 2030

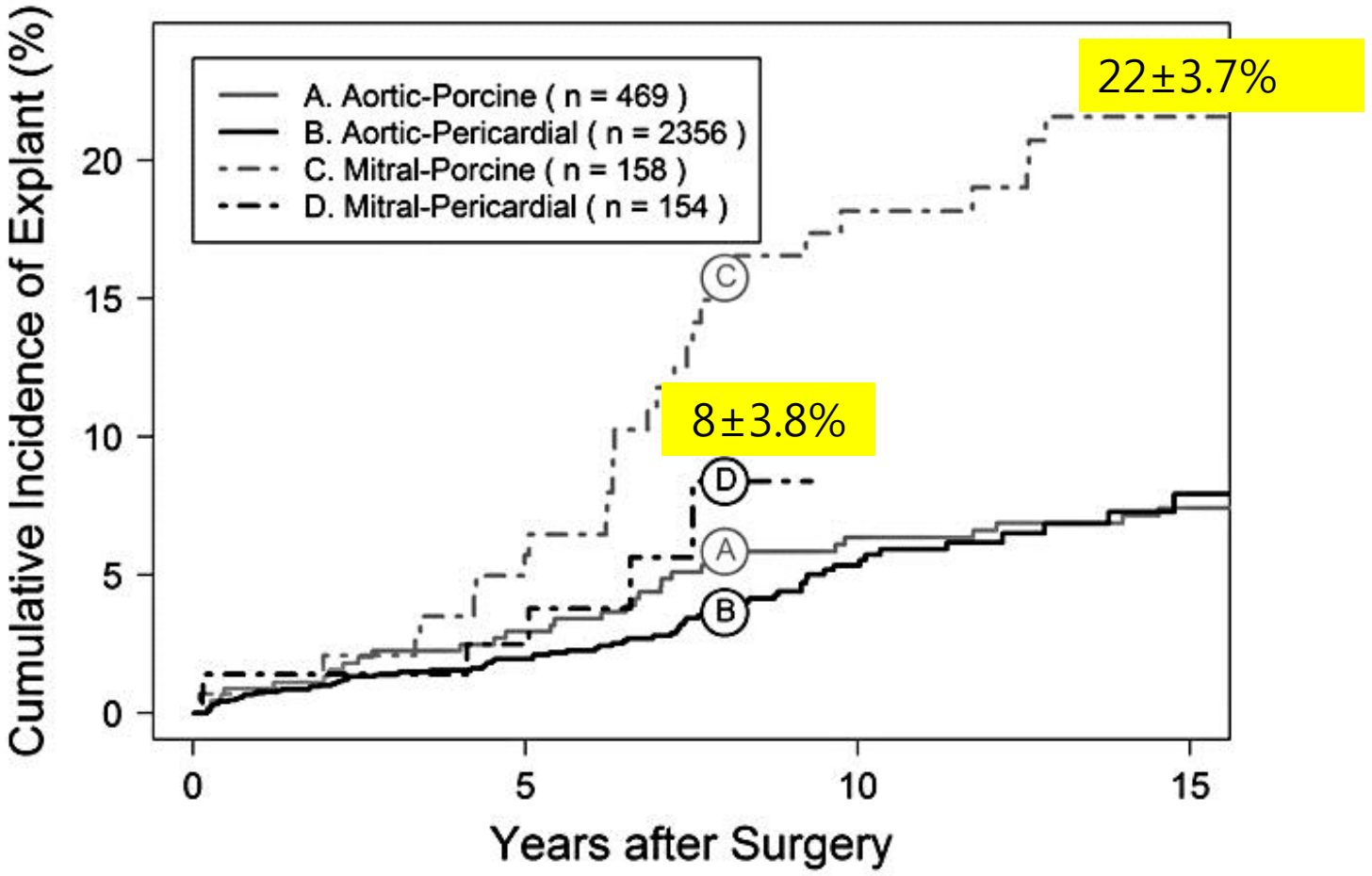


Life Expectancy in Men of Different Ages in BC, Canada



Van Geldorp et al JTCVS 2009;137:881

Durability of Porcine versus Pericardial Bioprosthetic Valve



Grunkemeier GL et al 2012;JTCVS:1381–1386

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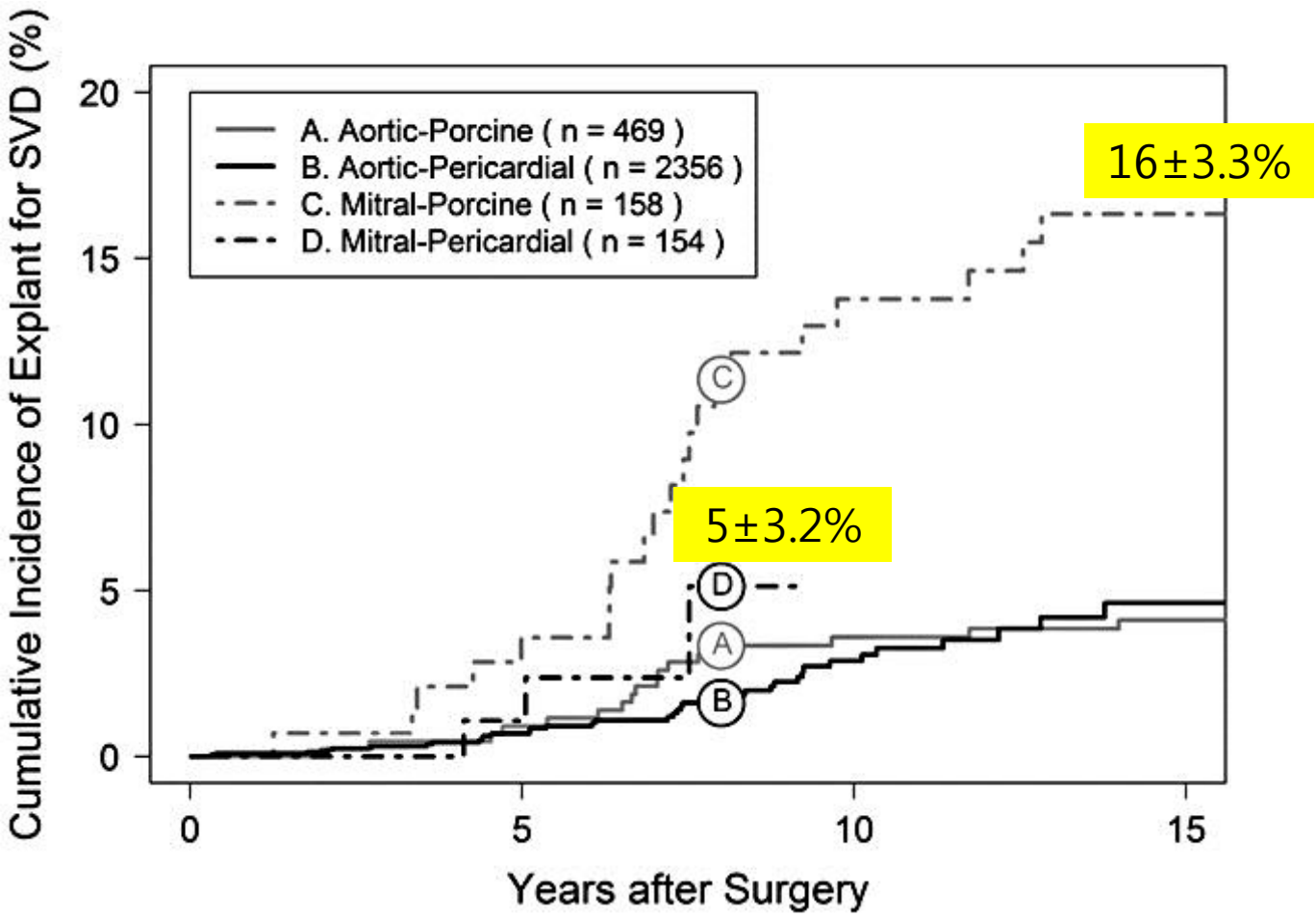


Grunkemeier GL et al 2012;JTCVS:1381–1386

Durability of Porcine versus Pericardial Bioprosthetic Valve

TABLE 3. Multivariate competing risks regression of explantation for SVD with CE tissue valves

	AVR		MVR	
Risk factor	SHR (95% CI)	*P* value	SHR (95% CI)	*P* value
Pericardial valve	0.79 (0.43-1.45)	.448	0.31 (0.08-1.13)	.075
Patient age	0.94 (0.92-0.95)	<.001	0.93 (0.90-0.95)	<.001
Male gender	1.39 (0.62-3.14)	.422	0.40 (0.14-1.16)	.092
CABG	0.50 (0.24-1.05)	.069	1.29 (0.50-3.34)	.656
Valve size	0.96 (0.82-1.12)	.608	1.04 (0.84-1.29)	.762

AVR, Aortic valve replacement; *CABG*, coronary artery bypass grafting; *CE*, Carpentier-Edwards; *CI*, confidence interval; *MVR*, mitral valve replacement; *SHR*, subhazard ratio; *SVD*, structural valve deterioration.

Grunkemeier GL et al 2012;JTCVS:1381–1386

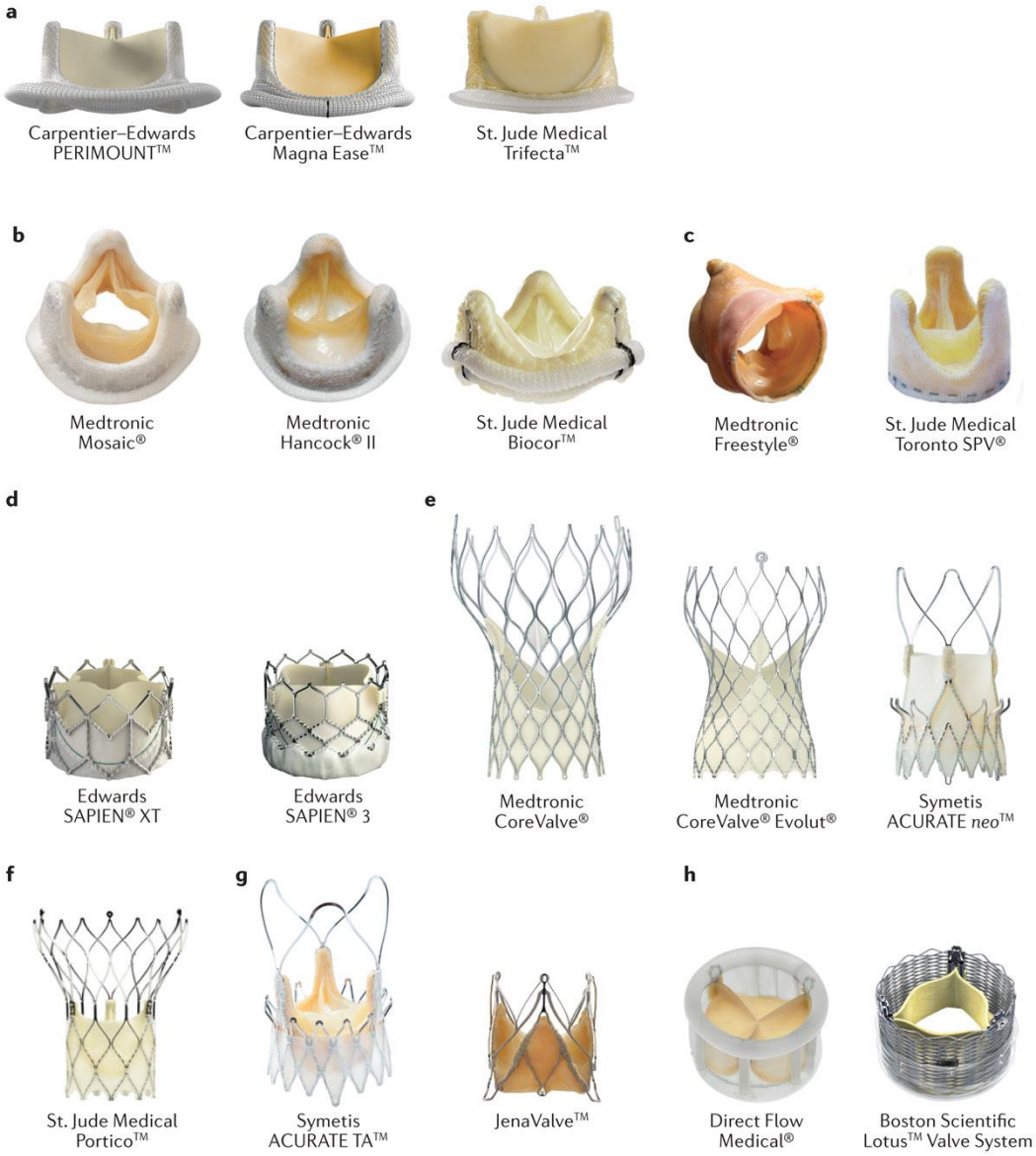
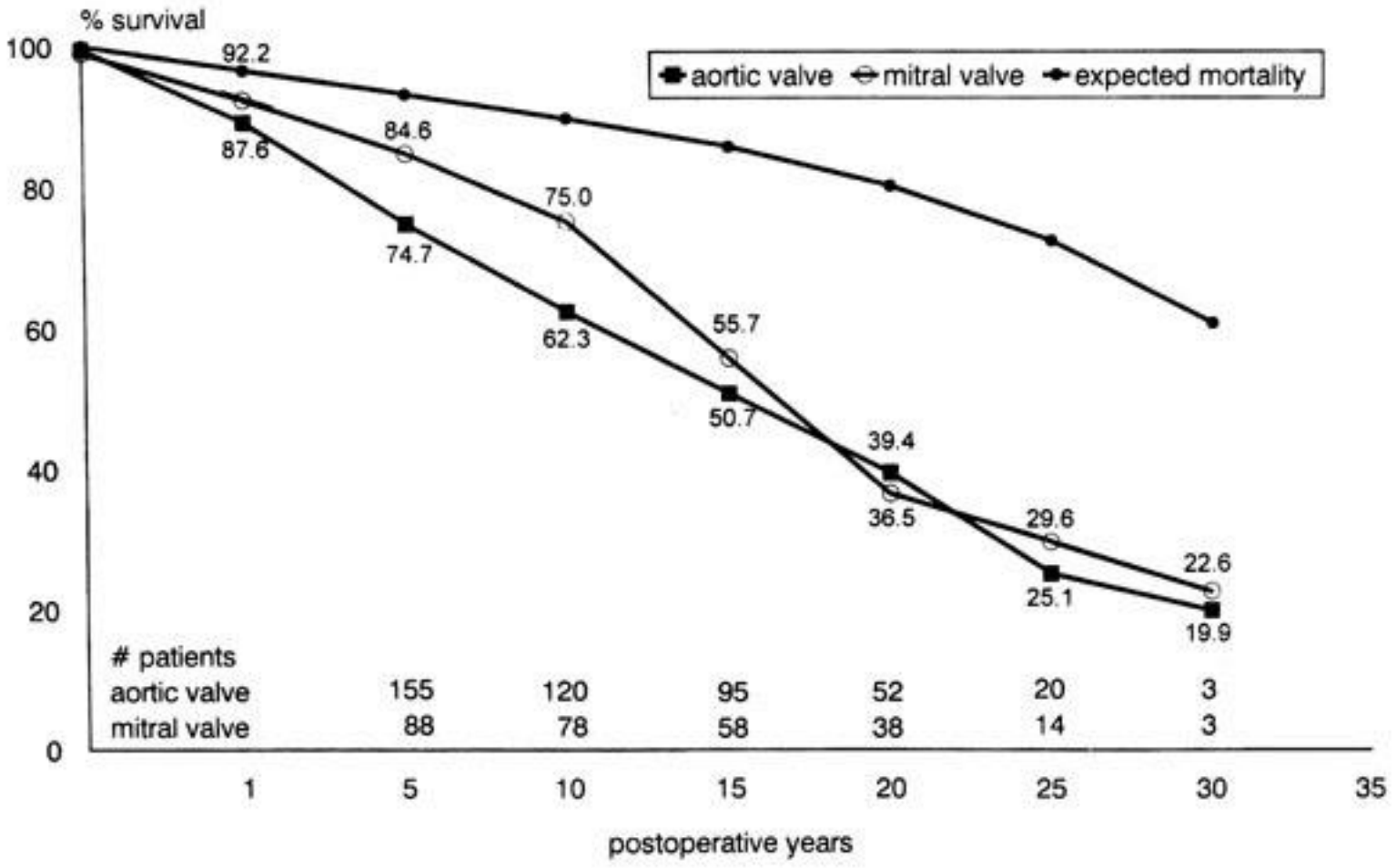


Figure 1 Types of surgical and transcatheter aortic valves

Arsalan, M. & Walther, T. (2016) Durability of prostheses for transcatheter aortic valve implantation
Nat. Rev. Cardiol. doi:10.1038/nrcardio.2016.43

Evolution of Heart Valve Prosthesis



American Heart Journal 2001 141, 849-855DOI: (10.1067/mhj.2001.114978)

Beyond PPM of AV Prosthesis

- **Paravalvular leakage of mitral prosthesis; higher incidence?**
- Pannus formation
- **TR related with LV diastolic failure?**

Beyond PPM of AV Prosthesis

- Paravalvular leakage of mitral prosthesis
- **Pannus formation?**
- TR related with LV diastolic failure?

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ORIGINAL PAPER

Utility of cardiac computed tomography for evaluation of pannus in mechanical aortic valve

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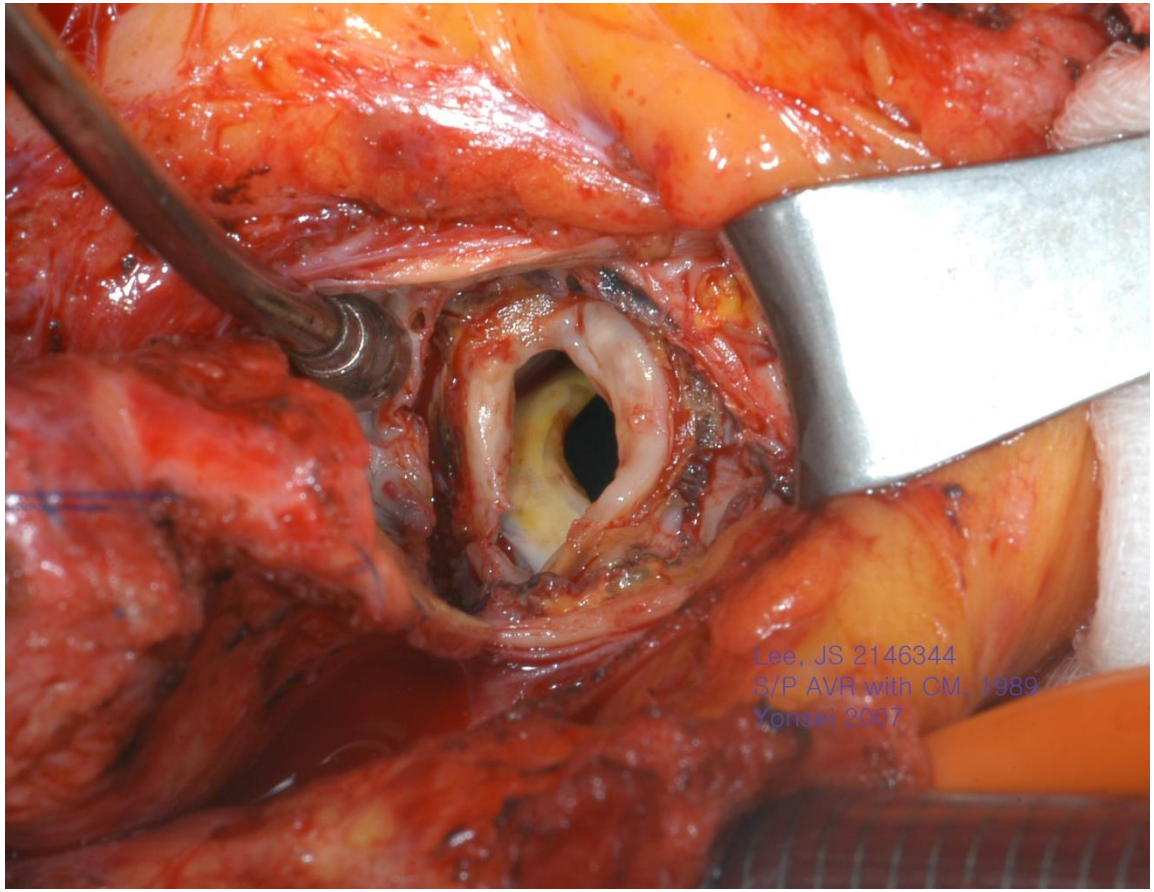
Materials:

Cardiac CT and TTE after AVR in 92 patients between 2010 and 2013
(total number of CT: 20,187)

Redo AVR for pannus or PPM in 12

Subaortic Pannus

Lee, JS, 62/Female, s/p AVR (CM #19), MVR (CM #29) on 1989-11-3
Redo AVR with CM Tophat 23mm, TAP on 2007-10-30



	Preop	Postop
AVA(cm^2):	1.1	2.03
PG(mmHg):	72/40	17/8

Beyond PPM of AV Prosthesis

- Paravalvular leakage of mitral prosthesis
- Pannus formation?
- **TR related with LV diastolic failure?**

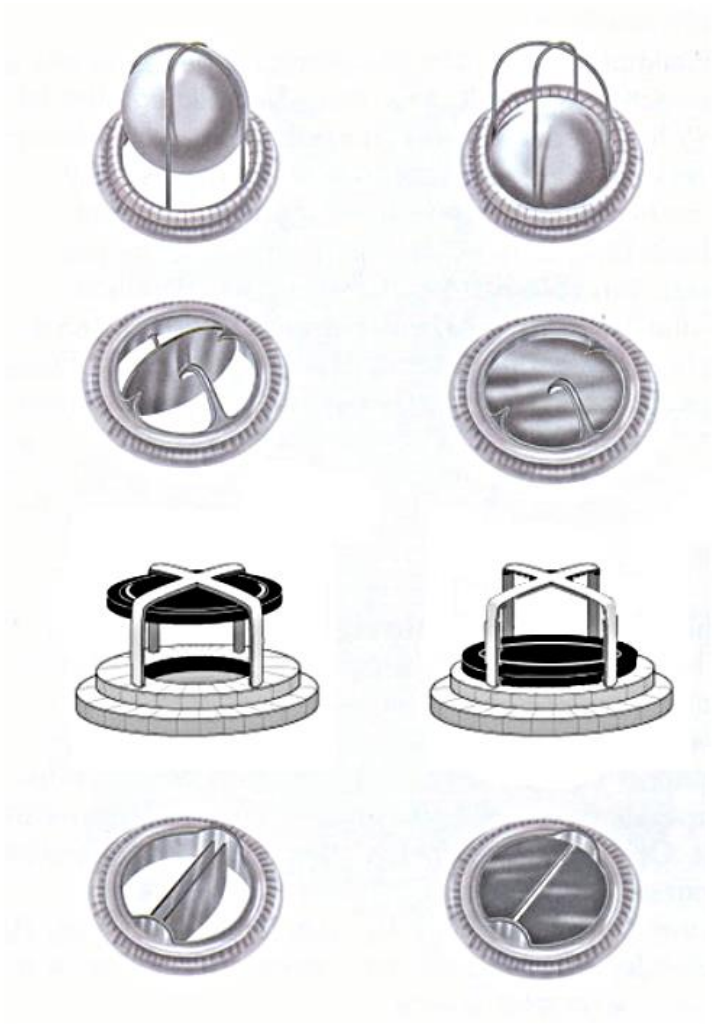
Mechanical Heart Valve Prosthesis

Caged ball valve

Tilting disc valve

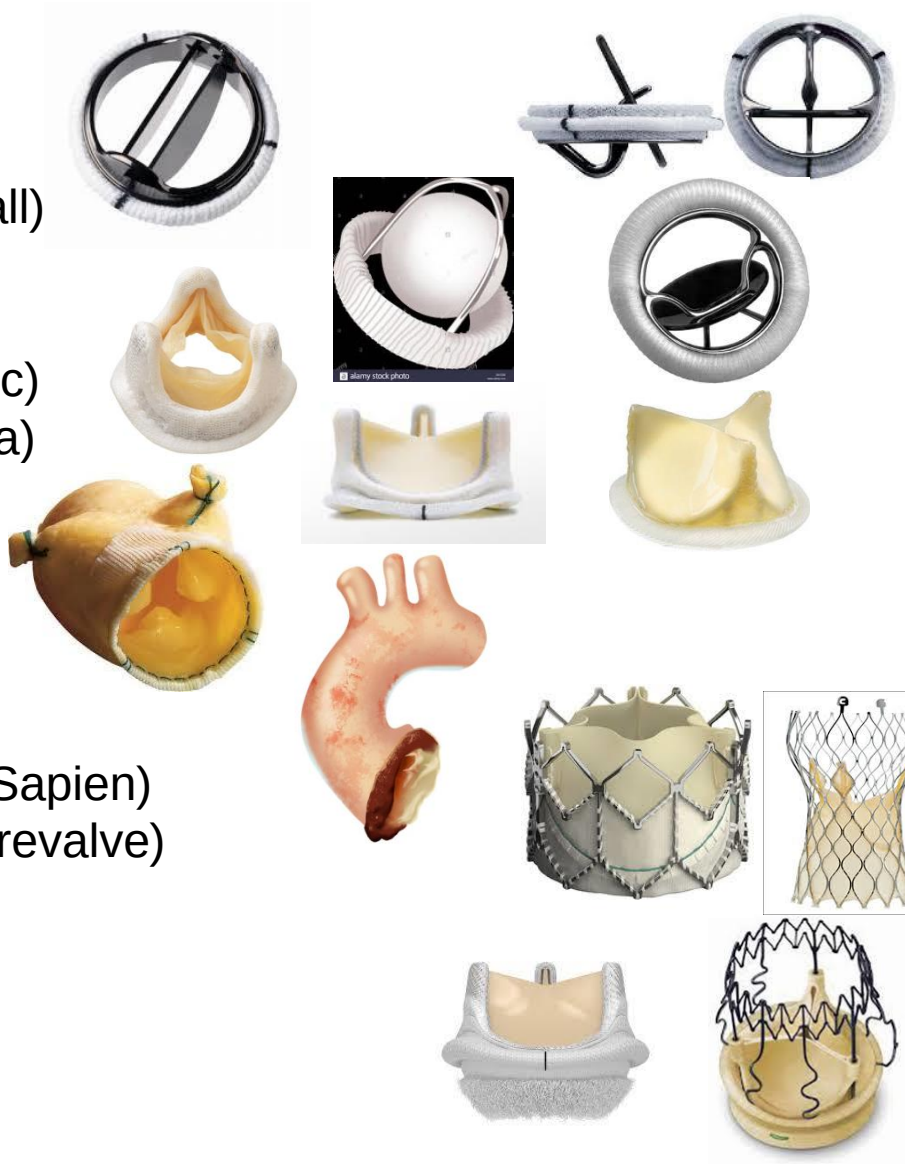
Single leaflet Valve

Bileaflet valve

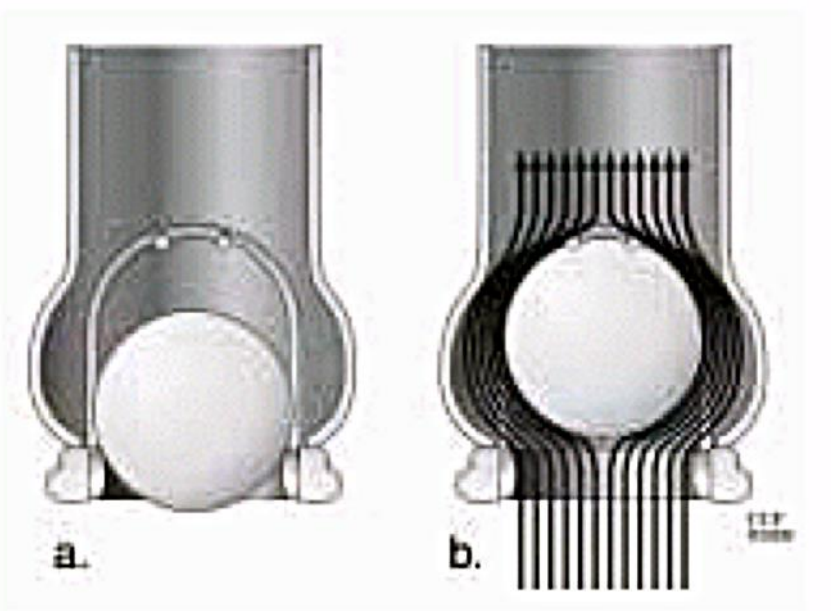


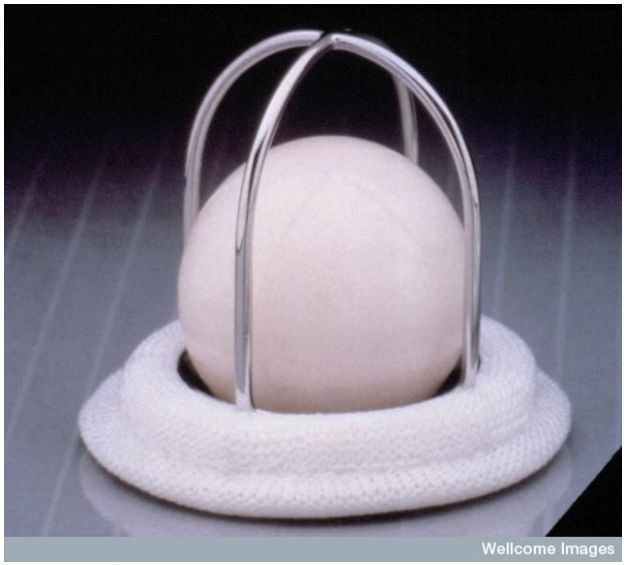
Types of Prosthetic Heart Valves

- Mechanical
  - ✓ Bileaflet (St, Jude Medical)
  - ✓ Single tilting disc (Medtronic Hall)
  - ✓ Caged ball (Starr-Edwards)
- Biological stented
  - ✓ Porcine (Medtronic Mosaic, Epic)
  - ✓ Pericardial (C-E Magna, Trifecta)
- Biological stentless
  - ✓ Porcine (Medtronic Freestyle)
  - ✓ Pericardial
  - ✓ Homograft
- Percutaneous
  - ✓ Balloon expandable (Edwards Sapien)
  - ✓ Self expandable (Medtronic Corevalve)
- Rapid deployment
  - ✓ Perceval sutureless (Sorin)
  - ✓ Intuity (Edwards)



Flow Pattern of Prosthesis





Flow Pattern of Prosthesis