Selection of Valve Prostheses

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조 민 섭

Types of Prosthetic Valve

- Bioprosthetic
  - Porcine valve
  - Bovine pericardial valve
- Mechanical valve
  - Ball in Cage
  - Disc valves
    - Single tilting valves
    - Bileaflet valves

Types of Substitues Depending on Source

- Autograft
  - Ross operation
- Homograft
  - Cadaveric human aortic and Pul. Valves
- Heterograft
  - Bioprosthetic ; Porcine, Bovine peircardial

History

- 1952 Hunfnagel ball valve
  - place in descending thoracic aorta
- 1956 Murray
  - Aortic homograft in descending thoracic aorta

History

- 1961 Star-Edward Caged ball valve

History

- 1966 Wada, Tiling disc valve
- 1967 Lillehei-Kaster
- 1969 Bjork Shiley
- 1977 Medtronic-Hall tilting disc valve

History

- 1977 St. Jude Medical Valve , bileaflet
  - Most commonly implanted mechanical valves
  - Low bulk and flat profile
  - Superior hemodynamics
  - have a greater effective opening area
  - lower transvalvular pressure gradient at any outer diameter and cardiac output

Flow Pattern of Mechanical prostheses

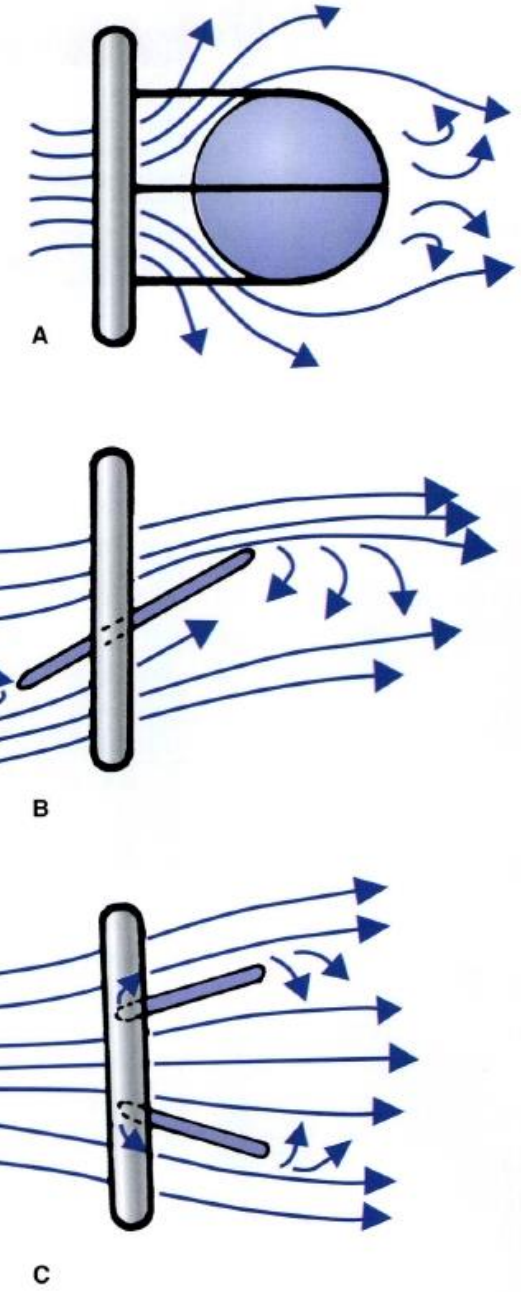

FIGURE 42-4 Flow characteristics of different mechanical valve designs. (A) Ball-and-cage. (B) Tilting-disk. (C) Bileaflet.

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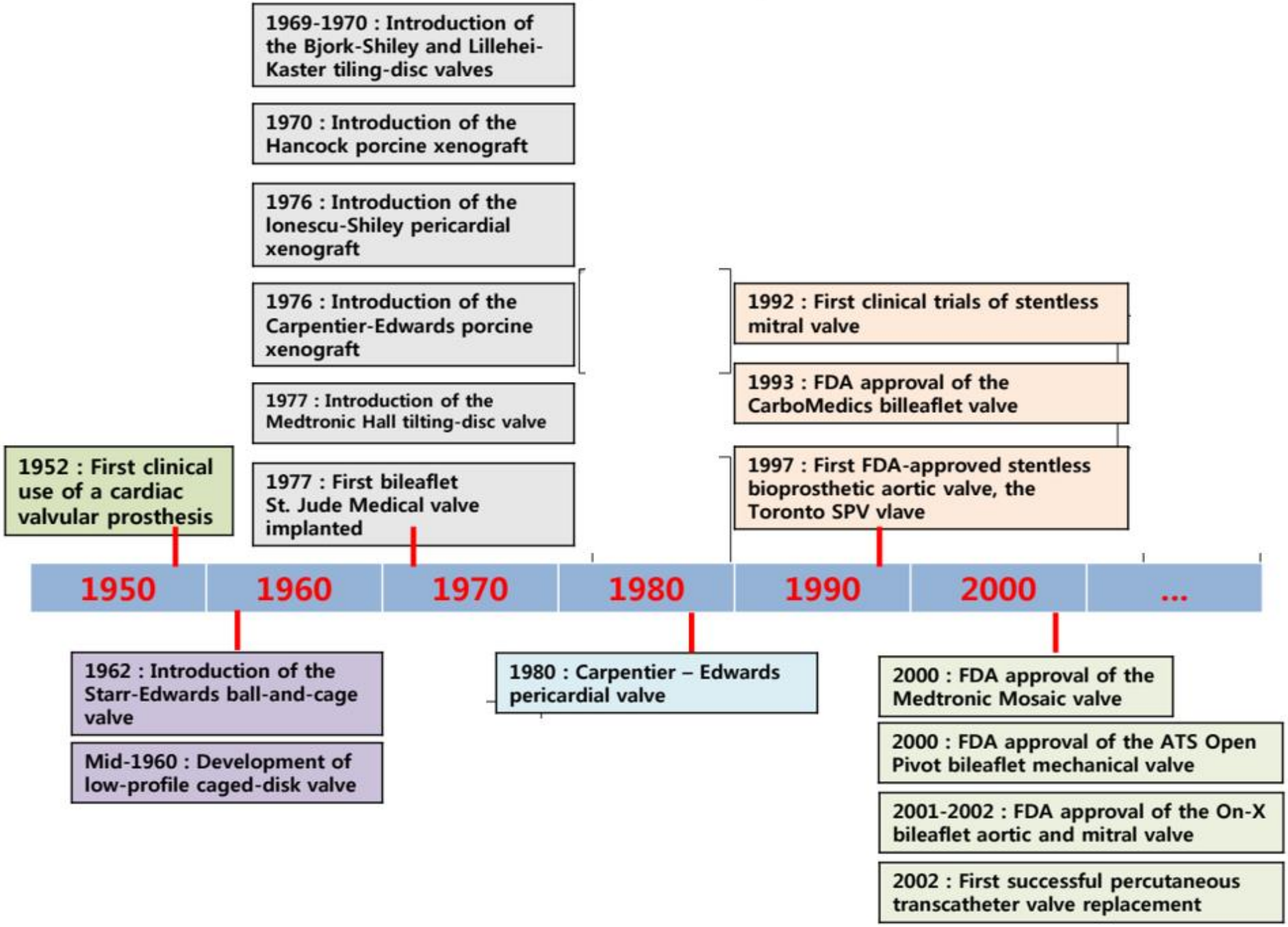
History-Tissue

- 1962 Ross and Boyes, 1st Allograft from cadaver
- 1964 Duran and Gunning, Pocine aortic valve (1st Heterograft)
- 1967 Ross, 1st Pulmonary autograft
- 1970 Hancock porcine graft
- 1976 Carpentier & Edwards Porcine valve
- 1976 Ionescu & Shiley Pericardial valve



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Mechanical Valves

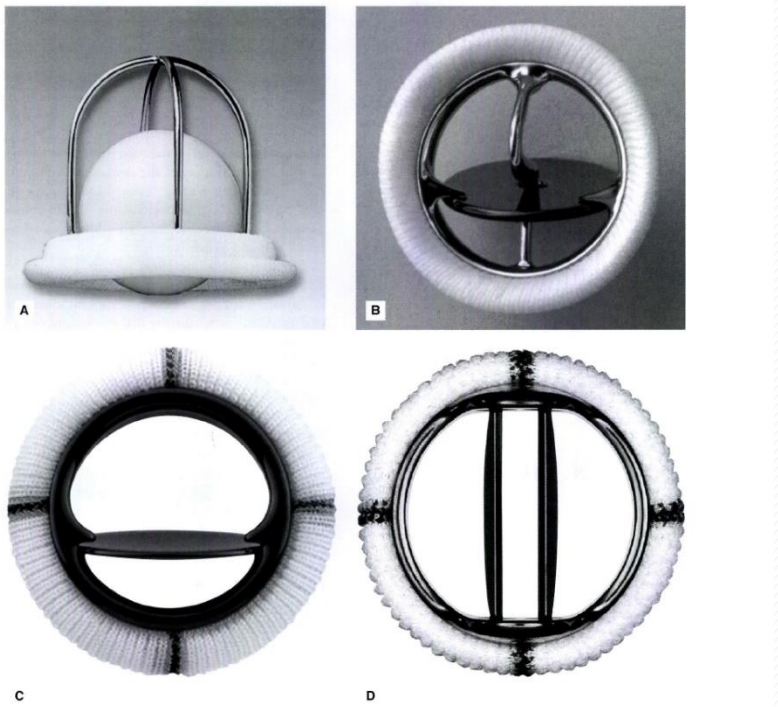
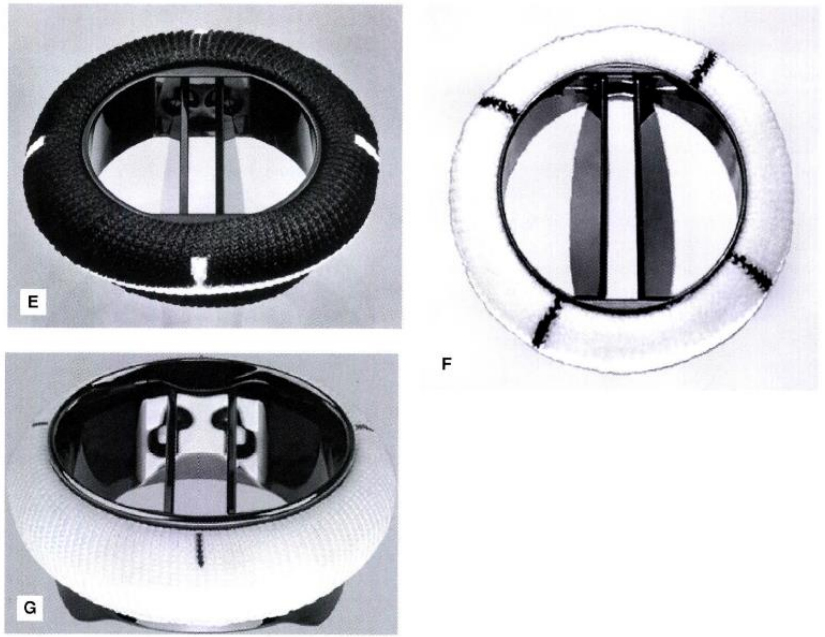


FIGURE 42-1 FDA-approved mechanical mitral valves. (A) Starr-Edwards ball-and-cage. (B) Medtronic Hall tilting-disk. (C) Omnicarbon tilting-disk. (D) St. Jude Medical bifleaflet.



(*Continued*) (E) Carbomedics bileaflet. (F) ATS bileaflet. (G) On-X bileaflet.

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Bileaflet Valves

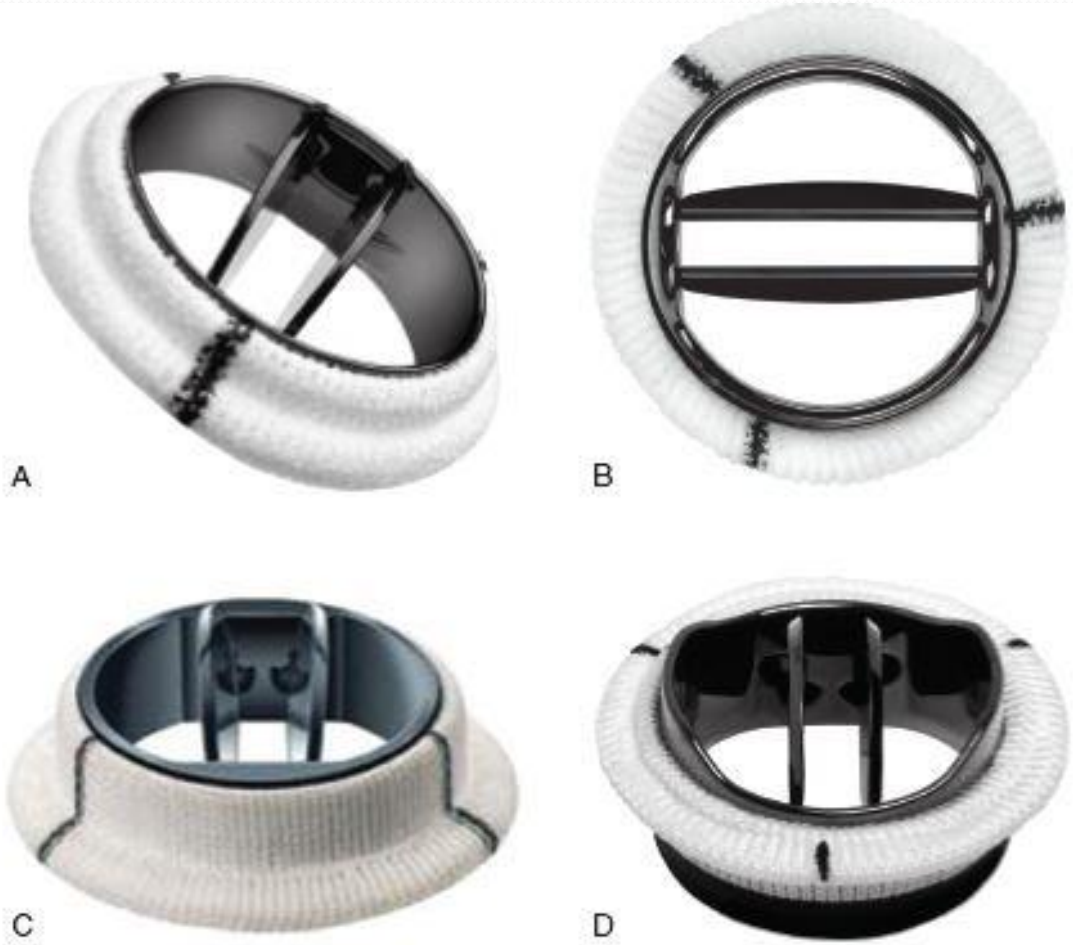
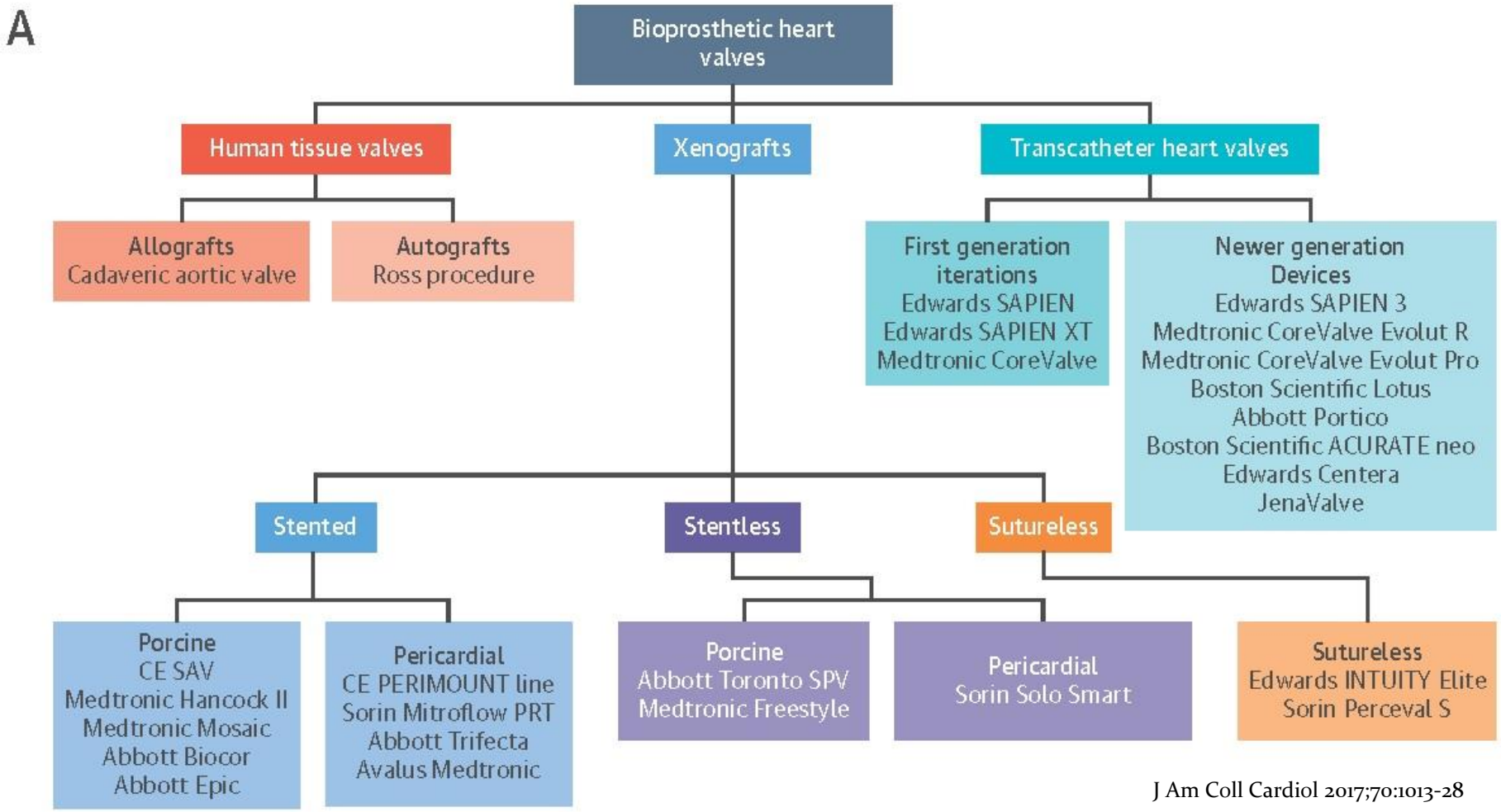
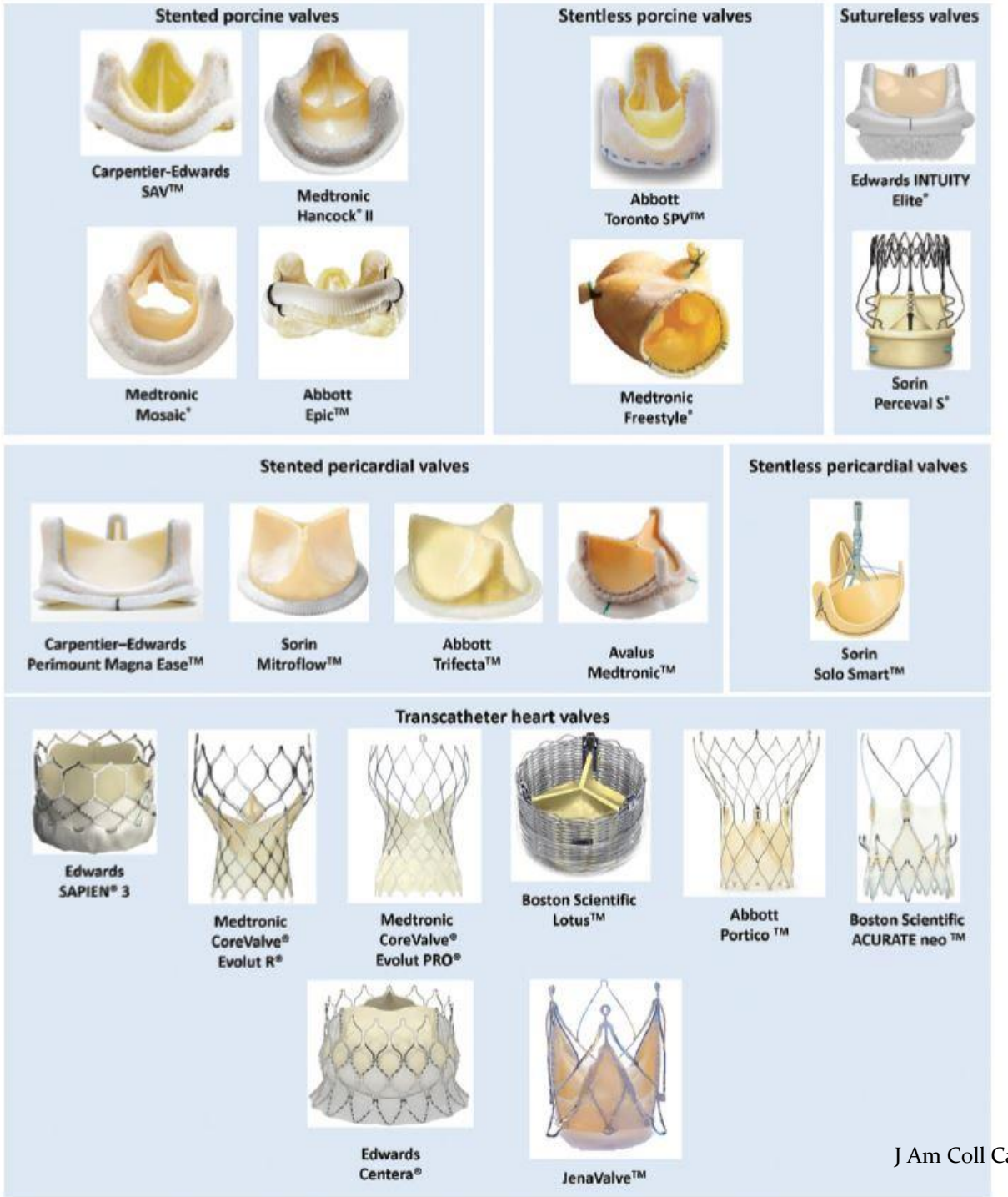


FIGURE 76-1 ■ Mechanical bileaflet valves. **A**, Open Pivot Mechanical Valve. **B**, The Regent mechanical valve. **C**, The Top Hat mechanical valve. **D**, The On-X Heart Valve. (**A**, Courtesy Medtronic, Inc., Minneapolis, MN. **B**, Courtesy St. Jude Medical, Inc., Minneapolis, MN. **C**, Courtesy Sorin Group, Inc., Milan, Italy. **D**, Courtesy On-X Life Technologies, Inc., Austin, TX.)

Bioprosthetic valves



J Am Coll Cardiol 2017;70:1013-28



J Am Coll Cardiol 2017;70:1013-28

TABLE 76-1 Mechanical Valve Choices

Valve Type	Manufacturer	Name	Position	Available Sizes (mm)
Bileaflet	Medtronic	Open Pivot AP360	Aortic	16-26
		Open Pivot AP	Aortic	16-26
			Mitral	16-26
		Open Pivot Standard	Aortic	19-31
			Mitral	25-33
	St. Jude Medical	Masters	Aortic	19-31
			Mitral	19-33
		Masters HP	Aortic	17-27
			Mitral	17-27
		Regent	Aortic	19-27
	Sorin Group	Bicarbon Fitline*	Aortic	19-31
			Mitral	19-33
		Bicarbon Overline*	Aortic	16-24
		Bicarbon Slimline*	Aortic	17-27
		Carbomedics Top Hat	Aortic	19-27
		Carbomedics OptiForm	Mitral	23-33
		Carbomedics Reduced	Aortic	19-29
		Carbomedics Standard	Aortic	19-31
			Mitral	21-33
		Carbomedics Standard Pediatrics	Aortic	16-18
			Mitral	16, 18, 21
		Carbomedics Orbis*	Aortic	19-31
			Mitral	21-33
	On-X	Standard Sewing Ring	Aortic	19-27/29
			Mitral	23-31/33
		Conform-X Sewing Ring	Aortic	19-27/29
			Mitral	25/33
		Anatomic Sewing Ring	Aortic	19-27/29

*Available only outside the United States.

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TABLE 76-2 Bioprosthetic Valve Choices

Valve Type	Manufacturer	Name	Position	Available Sizes (mm)
Stented porcine	Medtronic	Hancock II	Aortic	21-29
			Mitral	25-33
		Hancock II Ultra	Aortic	21-29
		Mosaic	Aortic	19-29
			Mitral	25-33
		Mosaic Ultra	Aortic	19-29
	Edwards Lifesciences	Carpentier-Edwards Standard Porcine (2625 and 6625)	Aortic	19-31
			Mitral	25-33
		Carpentier-Edwards S.A.V.	Aortic	19-31*
		Porcine (2650)	Mitral†	25-33
		Carpentier-Edwards Duraflex Low Pressure Porcine† (6625LP)	Mitral	27-35
		Carpentier-Edwards Duraflex Low Pressure Porcine with Extended Sewing Ring† (6625-ESR-LP)	Mitral	27-35
	St. Jude Medical	Epic	Aortic	21-29
			Mitral	25-33
		Epic Supra	Aortic	19-27
		Biocor	Aortic	21-29
			Mitral	25-33
		Biocor Supra	Aortic	19-27
Stented bovine pericardial	Edwards Lifesciences	Carpentier-Edwards PERIMOUNT (2700 and 2700TFX)	Aortic	19-29
		Carpentier-Edwards PERIMOUNT RSR (2800 and 2800TFX)	Aortic	19-29
		Carpentier-Edwards PERIMOUNT Plus (6900P and 6900PTFX)	Mitral	25-33
		Carpentier-Edwards PERIMOUNT Magna (3000 and 3000TFX)	Aortic	19-29
		Carpentier-Edwards PERIMOUNT Magna Ease (3300TFX, 7300TFX)	Aortic	19-29
			Mitral	25-33
	Sorin Group	Mitroflow	Aortic	19-29
		Soprano Armonia†	Aortic	19-33
		Pericarbon More†	Mitral	19-33
	St. Jude Medical	Trifecta	Aortic	19-29
Stentless	Medtronic	Freestyle	Aortic	19-29
		3f	Aortic	19-29
	Sorin Group	Pericarbon Freedom†	Aortic	15-29
		Freedom Solo†	Aortic	19-27
	Edwards Lifesciences	Prima Plus	Aortic	21-29
Sutureless bovine pericardial	Medtronic	3f Enable†	Aortic	19-29
	Sorin Group	Perceval S†	Aortic	S, M, L, XL
	Edwards Lifesciences	Edwards Intuity†	Aortic	19-27
Transcatheter	Edwards Lifesciences	Sapien	Aortic	23, 26
		Sapien XT	Aortic	23, 26, 29
	Medtronic	CoreValve	Aortic	23, 26, 29, 31
	St. Jude Medical	Portico†	Aortic	25

*Sizes 19, 29, and 31 available only outside the United States.
†Available only outside the United States.
‡Available only in the United States.
RSR, Reduced sewing ring.

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Ideal Prostheses

- Good Hemodynamic
- Quiet
- Require no anticoagulation
- Last for life time
- Cheap
- Easy to implant

TABLE 29-1: Comparison of Mechanical and Tissue Alternatives for Aortic Valve Replacement

	Mechanical	Stented bioprosthetic	Stentless bioprosthetic	Allograft	Autograft
Advantages	Long durability Easy implantation Good EOAI	Easy implantation No anticoagulation	Larger EOAI compared with stented valve. Root replacement is available option	Excellent EOAI All biologic material good for use in endocarditis	Excellent EOAI Living valve Long durability possible
Disadvantages	Anticoagulation Emboli/bleeding Noise	Durability limited Poor EOAI in small valve sizes	Durability limited More complex operative technique Harder reoperation	Complex technique Availability limited Durability limited	Complex operation Double valve or Root replacement with potential late failure of either

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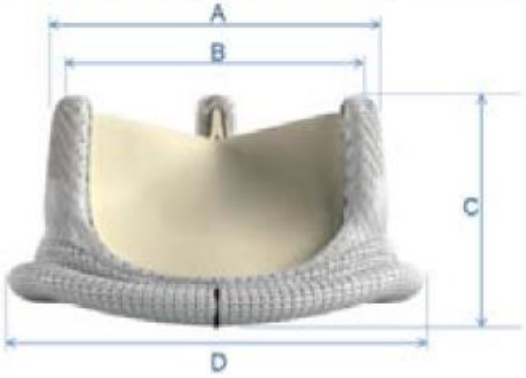
Diameters of Prostheses

Edwards Pericardial Aortic Bioprosthesis, Model 11000A



Size (mm)	19	21	23	25	27	29
A. Tissue Annulus Diameter (Stent Diameter, mm)	19	21	23	25	27	29
B. Internal Diameter (Stent ID, mm)	18	20	22	24	26	28
C. Profile Height (mm)	13	14	15	16	17	18
D. External Sewing Ring Diameter (mm)	24	26	28	30	32	34

Selection of Prostheses

- 45세 남자
- Severe MS
- No other specific comorbidity

- Homeless
- Heavy smoker
- 수술전일 escape
- 수개월후 숙박업소에 쓰러져 있는 환자를 교회에서 모시고 다시 병원내원

Selection of Prostheses

- 40세 여자
- Severe MS
- 평소 패러 글라이딩등 extreme sport 즐기는 환자

Factors for selection of Prostheses

- Patient's Age
- Life expectancy
- Preference
- Ix or CIx to Anticoaglation
- Special Patient Groups
- Optimal Hemodynamic performance

Age

- >70 Bioprostheses
- <60 Mechanical

Special Patient Group

- Long term anticoagulation Tx가 필요한 환자
  - A.fib
  - Previous TE events
  - Hypercoagulable state
  - Another mechanical valve in place
  - Intracardiac thrombus
- CIx to Anticoagulation
  - Women of child-bearing age
  - Bleeding disorder
  - Refuse oral anticoagulation Tx
- ESRD
  - Rapid SVD of Bioprosthesis
  - Bleeding d/t Anticoagulation for Mechanical valve

EOA

- EOA ; Effective orifice area
- iEOA = EOA/BSA
- Functional estimate of of the minimal cross sectional area of the transvalvular flow jet
- Dependent on the
  - Geometric area of the prosthesis
  - Shape and size of the LVOT and ascending aorta
  - Blood pressure
  - Cardiac output

Optimal Hemodynamic perfomance

- iEOA > 0.85 ; Acceptable
- 0.65 < iEOA < 0.85 ; Moderate PPM
- iEOA <0.65 ; Severe PPM

Impact of PPM

- Increase early and late morbidity
- Incomplete left ventricular mass regression
- Reduce recovery of LV function
- Decrease long-term survival

Mean EOA in different valve

Valve type	Size (mm)						
	19	21	23	25	27	29	Ref
Mosaic	1.1	1.2	1.4	1.7	1.8	2	Dumesnil et al
Hancock II	1.2	1.3	1.5	1.6	1.6		Dumesnil et al
Perimount	1.1	1.3	1.5	1.8	2.1	2.2	Dumesnil et al
Magna*	1.3	1.7	2.1	2.3	-	-	Dumesnil et al
Biocor (Epic)*	-	1.3	1.6	1.8	-	-	Dumesnil et al
Mitroflow*	1.1	1.3	1.5	1.8	-	-	Dumesnil et al
Trifecta*	1.1	1.7	1.9	2.7	2.9	2.4	Yadlapati et al
Trifecta*	1.8	2	2.2				Levy et al

*These values are based on a limited number of patients and should thus be interpreted with caution.
Adapted with permission from Dumesnil JG, Pibarot P. The problem of severe valve prosthesis-patient mismatch in aortic bioprostheses: near extinction? *J Am Soc Echocardiogr.* 2014 Jun;27(6):598-600.

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SJM Regent® Valve
Effective Orifice Area Index (EOAI) Calculator

	EOAI by Valve Size						
Valve Size (mm)	17	19	21	23	25	27	29
Average EOA* (cm^2)	1.3	1.7	2.0	2.5	2.6	3.5	3.5
BSA (m^2)							
0.6	2.17	2.83	3.33	4.17	4.33	5.83	5.83
0.7	1.86	2.43	2.86	3.57	3.71	5.00	5.00
0.8	1.63	2.13	2.50	3.13	3.25	4.38	4.38
0.9	1.44	1.89	2.22	2.78	2.89	3.89	3.89
1.0	1.30	1.70	2.00	2.50	2.60	3.50	3.50
1.1	1.18	1.55	1.82	2.27	2.36	3.18	3.18
1.2	1.08	1.42	1.67	2.08	2.17	2.92	2.92
1.3	1.00	1.31	1.54	1.92	2.00	2.69	2.69
1.4	0.93	1.21	1.43	1.79	1.86	2.50	2.50
1.5	0.87	1.13	1.33	1.67	1.73	2.33	2.33
1.6	0.81	1.06	1.25	1.56	1.63	2.19	2.19
1.7	0.76	1.00	1.18	1.47	1.53	2.06	2.06
1.8	0.72	0.94	1.11	1.39	1.44	1.94	1.94
1.9	0.68	0.89	1.05	1.32	1.37	1.84	1.84
2.0	0.65	0.85	1.00	1.25	1.30	1.75	1.75
2.1	0.62	0.81	0.95	1.19	1.24	1.67	1.67
2.2	0.59	0.77	0.91	1.14	1.18	1.59	1.59
2.3	0.57	0.74	0.87	1.09	1.13	1.52	1.52
2.4	0.54	0.71	0.83	1.04	1.08	1.46	1.46
2.5	0.52	0.68	0.80	1.00	1.04	1.40	1.40

EOAI = EOA / BSA

EOAI ≥ .85 cm^2/m^2**

.80 cm^2/m^2 ≤ EOAI ≤ .84 cm^2/m^2**

EOAI < .80 cm^2/m^2**

References

*At 12 months post-op. St. Jude Medical, Inc. Pre-Market Approval Application Supplement, SJM Regent heart valve, P810002/S57.

**Pibarot P, Dumesnil, JG. Hemodynamic and clinical impact of prosthesis - patient mismatch in the aortic valve position and its prevention. JACC 2000;36:1131-1141.

FOR INTERNATIONAL USE.

- Labled size와 actual size는 다르다
- In general, Newer-generation valves have superior performance over older devices

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2014 AHA/ACC Guideline

Recommendations	COR	LOE
Choice of valve intervention and prosthetic valve type should be a shared decision process.	I	C
A bioprosthesis is recommended in patients of any age for whom anticoagulant therapy is contraindicated, cannot be managed appropriately, or is not desired.	I	C
A mechanical prosthesis is reasonable for AVR or MVR in patients younger than 60 years who do not have a contraindication to anticoagulation.	IIa	B
A bioprosthesis is reasonable in patients older than 70 years.	IIa	B
Either a bioprosthetic or mechanical valve is reasonable in patients between 60 and 70 years old.	IIa	B
Replacement of the aortic valve by a pulmonary autograft (the Ross procedure), when performed by an experienced surgeon, may be considered in young patients when VKA anticoagulation is contraindicated or undesirable.	IIb	C

Circulation 129:e521–643, 2014.

2017 AHA/ACC Guideline

Table 3. Factors Used for Shared Decision Making About Type of Valve Prosthesis

Favor Mechanical Prosthesis	Favor Bioprosthesis
Age <50 y	Age >70 y
Increased incidence of structural deterioration with bioprosthesis (15-y risk: 30% for age 40 y, 50% for age 20 y)	Low incidence of structural deterioration (15-y risk: <10% for age >70 y)
Lower risk of anticoagulation complications	Higher risk of anticoagulation complications
Patient preference (avoid risk of reintervention) of valve sounds)	Patient preference (avoid risk and inconvenience of anticoagulation and absence
Low risk of long-term anticoagulation	High risk of long-term anticoagulation
Compliant patient with either home monitoring or close access to INR monitoring	Limited access to medical care or inability to regulate VKA
Other indication for long-term anticoagulation (eg, AF)	Access to surgical centers with low reoperation mortality rate
High-risk reintervention (eg, porcelain aorta, prior radiation therapy)	
Small aortic root size for AVR (may preclude valve-in-valve procedure in future).	

AF indicates atrial fibrillation; AVR, aortic valve replacement; INR, International Normalized Ratio; and VKA, vitamin K antagonist.

Circulation. 2017;135:e1159–e1195.

2017 ESC/EACTS Guidelines

Choice of the aortic/mitral prosthesis in favour of a mechanical prosthesis; the decision is based on the integration of several of the following factors

Recommendations	Class[a]	Level[b]
A mechanical prosthesis is recommended according to the desire of the informed patient and if there are no contraindications to long-term anticoagulation.[c]	I	C
A mechanical prosthesis is recommended in patients at risk of accelerated structural valve deterioration.[d]	I	C
A mechanical prosthesis should be considered in patients already on anticoagulation because of a mechanical prosthesis in another valve position.	IIa	C
A mechanical prosthesis should be considered in patients <60 years of age for prostheses in the aortic position and <65 years of age for prostheses in the mitral position.[e]	IIa	C
A mechanical prosthesis should be considered in patients with a reasonable life expectancy[f] for whom future redo valve surgery would be at high risk.	IIa	C
A mechanical prosthesis may be considered in patients already on long-term anticoagulation due to the high risk for thromboembolism.[g]	IIb	C

LV = left ventricular.
[a]Class of recommendation.
[b]Level of evidence.
[c]Increased bleeding risk because of comorbidities, compliance concerns or geographic, lifestyle or occupational conditions.
[d]Young age (<40 years), hyperparathyroidism.
[e]In patients 60–65 years of age who should receive an aortic prosthesis and those between 65 and 70 years of age in the case of mitral prosthesis, both valves are acceptable and the choice requires careful analysis of factors other than age.
[f]Life expectancy should be estimated at > 10 years according to age, sex, comorbidities and country-specific life expectancy.
[g]Risk factors for thromboembolism are atrial fibrillation, previous thromboembolism, hypercoagulable state and severe LV systolic dysfunction.

European Heart Journal (2017) 38, 2739–2791

2017 ESC/EACTS Guidelines

Choice of the aortic/mitral prosthesis in favour of a bioprosthesis; the decision is based on the integration of several of the following factors

Recommendations	Class[a]	Level[b]
A bioprosthesis is recommended according to the desire of the informed patient.	I	C
A bioprosthesis is recommended when good-quality anticoagulation is unlikely (compliance problems, not readily available) or contraindicated because of high bleeding risk (previous major bleed, comorbidities, unwillingness, compliance problems, lifestyle, occupation).	I	C
A bioprosthesis 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 there is a low likelihood and/or a low operative risk of future redo valve surgery.	IIa	C
A bioprosthesis should be considered in young women contemplating pregnancy.	IIa	C
A bioprosthesis should be considered in patients >65 years of age for a prosthesis in the aortic position or > 70 years of age in a mitral position or those with a life expectancy[c] lower than the presumed durability of the bioprosthesis.[d]	IIa	C

[a]Class of recommendation.
[b]Level of evidence.
[c]Life expectancy should be estimated according to age, sex, comorbidities and country-specific life expectancy.
[d]In patients 60–65 years of age who should receive an aortic prosthesis and those between 65 and 70 years of age in the case of mitral prosthesis, both valves are acceptable and the choice requires careful analysis of factors other than age.

European Heart Journal (2017) 38, 2739–2791


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