Reconstruction of the Aortic Valve and Root: A practical approach

Results of Cusp and Root Repair

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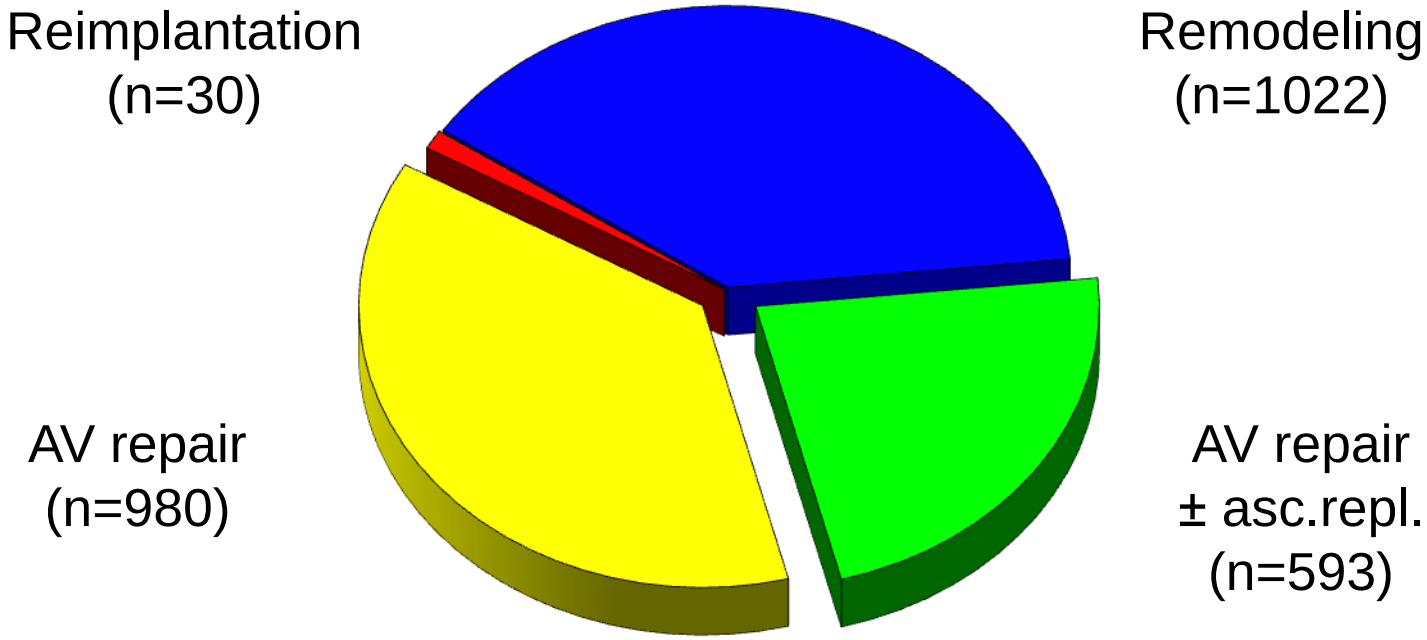
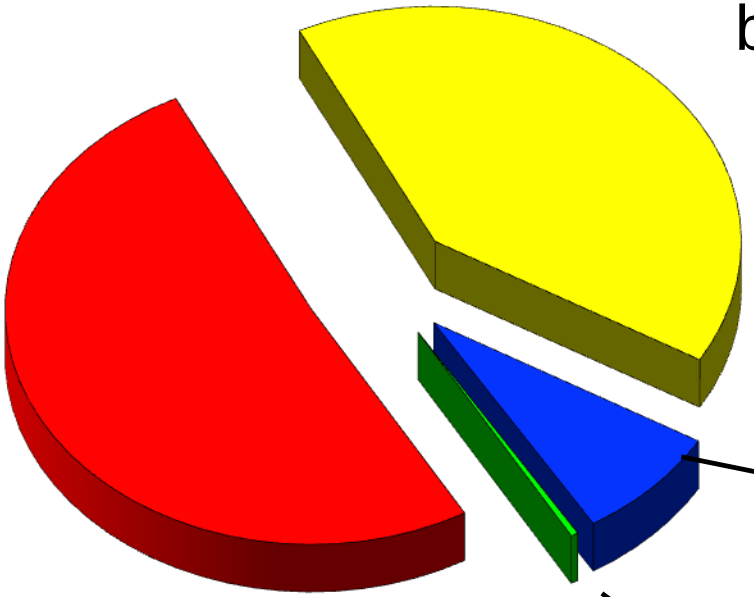
Aortic Valve Repair (10/1995-07/2018)

n=2626



AV-Morphology (n=2626)



tricuspid (n=1339)

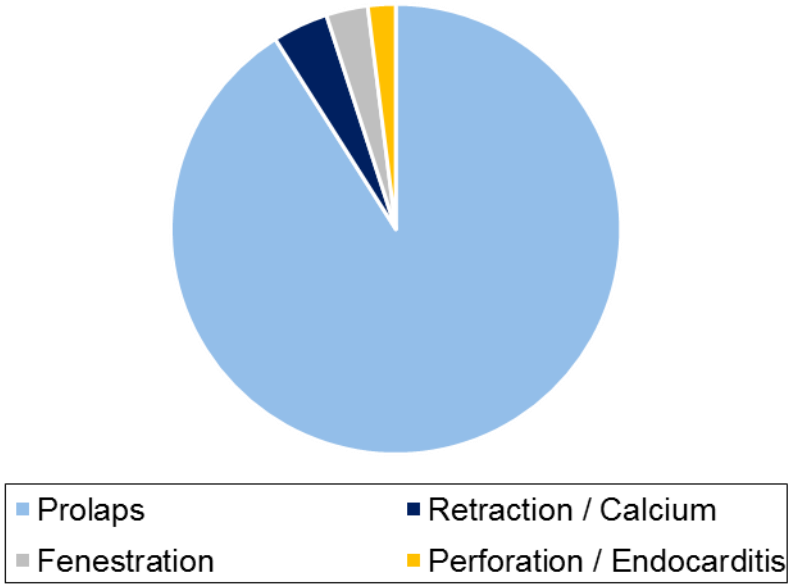
bicuspid (n=1068)

unicuspid (n=207)
(changed to bicuspid)

quadricuspid (n=10)
(changed to tricuspid)

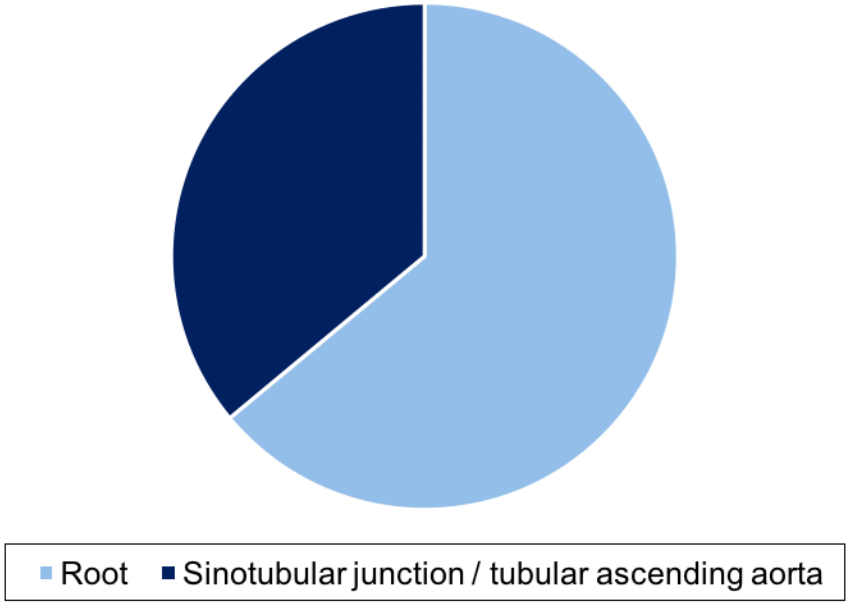
Cusp Causes of AR

Prolapse	RCC > NCC > LCC	91%
Retraction / Calcium		4%
Fenestration		3%
Perforation / Endocarditis		2%



Aortic Causes of AR

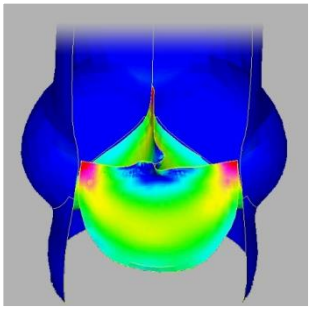
Root	64%
Sinotubular junction/ tubular ascending aorta	36%

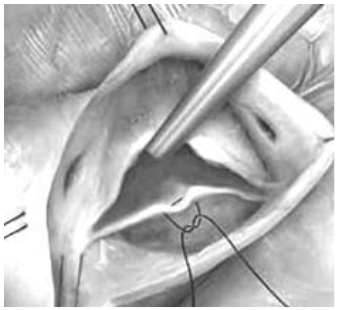


Cusp Repair: Techniques

Prolapse

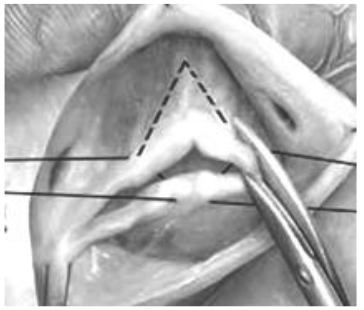
Central Cusp Plication





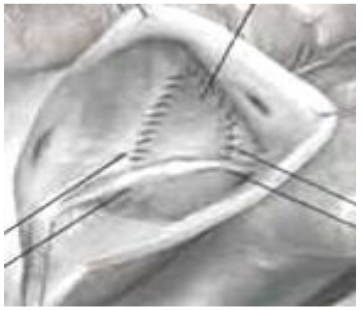
Prolapse + Redundancy/ Fibrosis

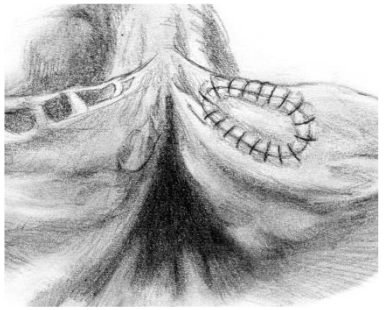
Triangular Resection



Prolapse + Calcium/ Fenestrations

Pericardial Patch

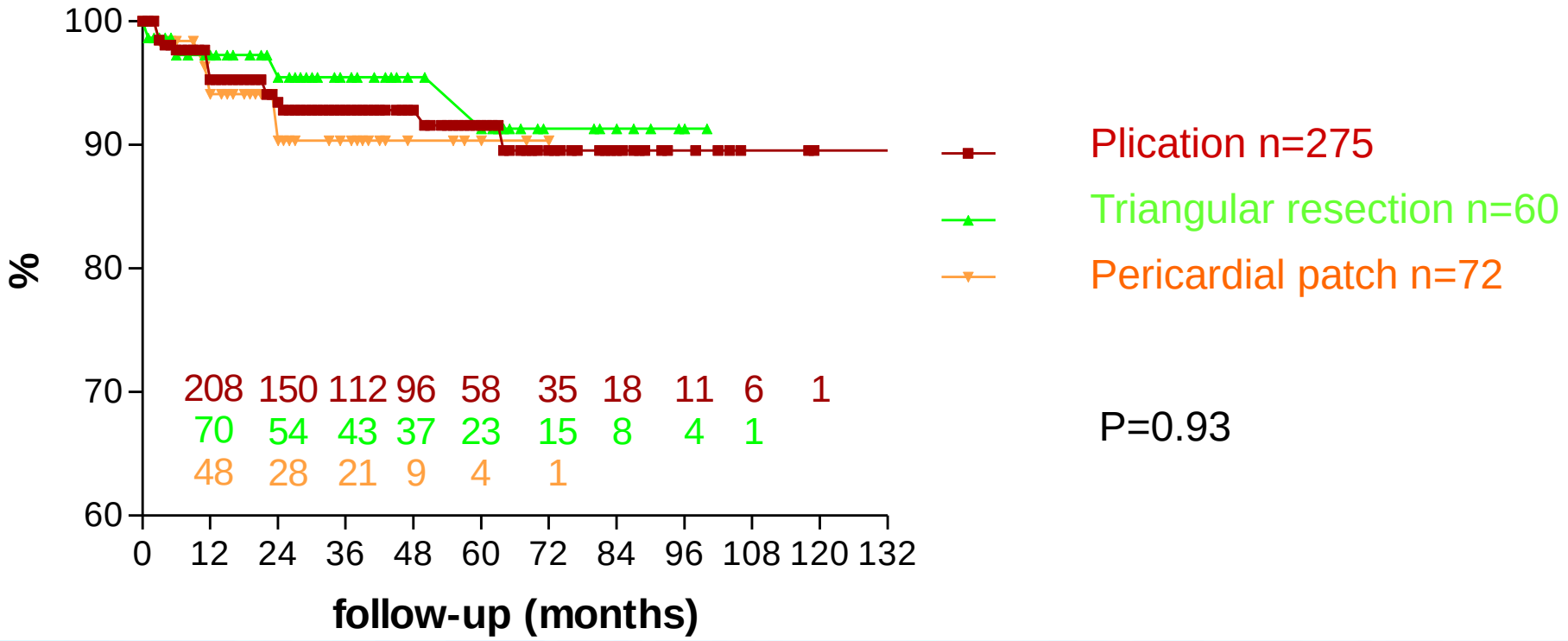




Cusp repair in aortic valve reconstruction: Does the technique affect stability?

Diana Aicher, MD, Frank Langer, MD, Oliver Adam, MD, Dietmar Tscholl, MD, Henning Lausberg, MD, and Hans-Joachim Schäfers, MD

Freedom from Aortic Regurgitation ≥ II

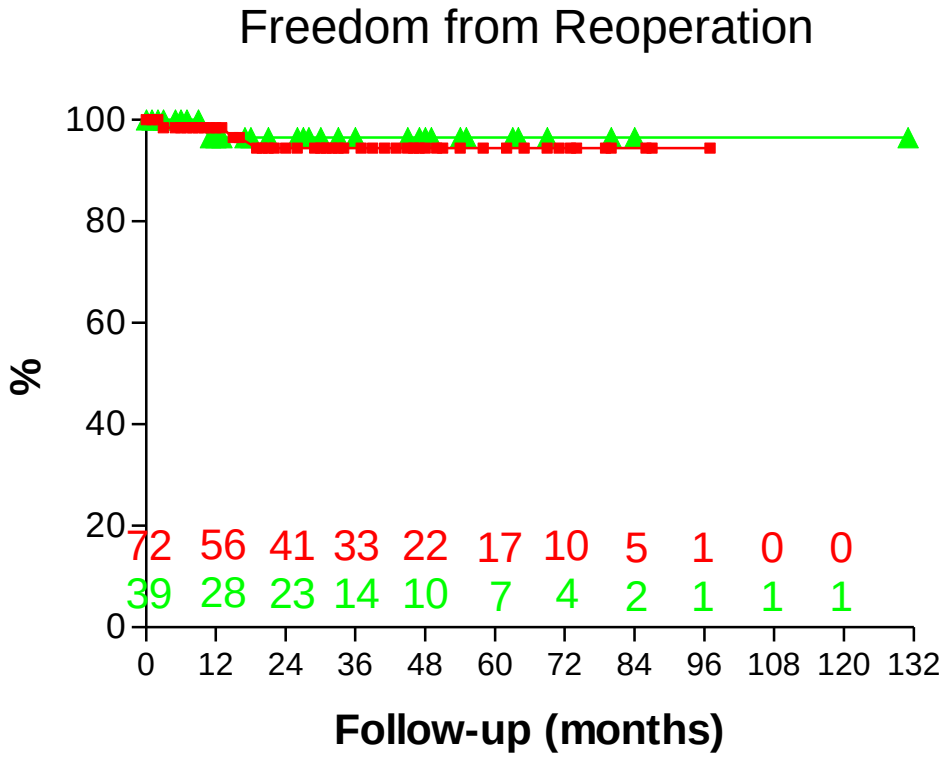


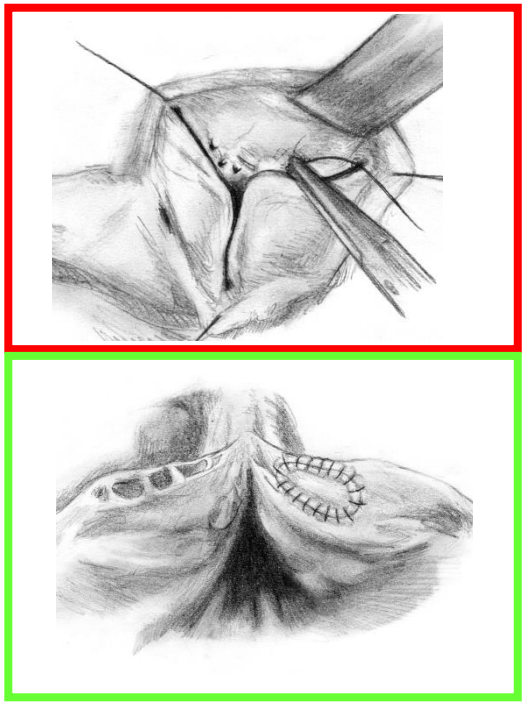
P=0.93

Aicher et al. J Thorac Cardiovasc Surg. 2007 134(6): 1533-38

Aortic valve reconstruction in myxomatous degeneration of aortic valves: Are fenestrations a risk factor for repair failure?

Hans-Joachim Schäfers, MD,[a] Frank Langer, MD,[a] Petra Glombitza, MD,[a] Takashi Kunihara, MD,[a] Roland Fries, MD,[b] and Diana Aicher, MD[a]



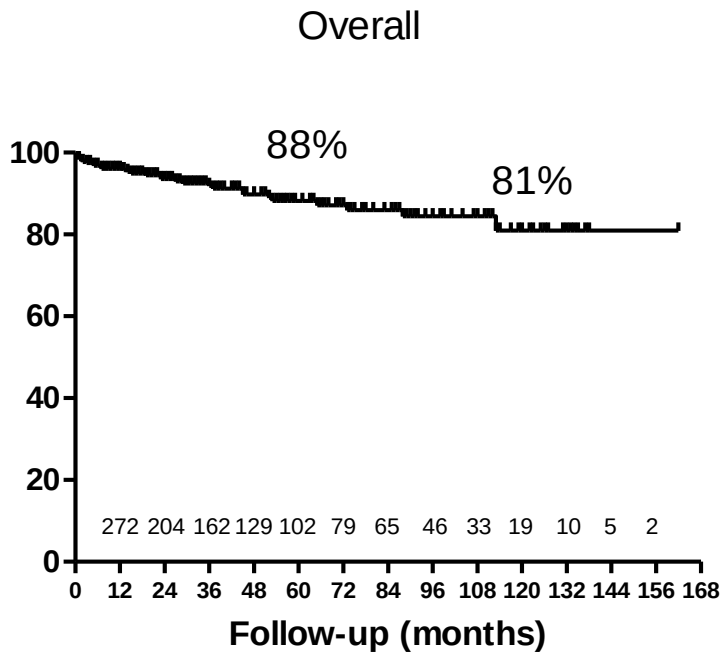


Valve Configuration Determines Long-Term Results After Repair of the Bicuspid Aortic Valve

Diana Aicher, MD; Takashi Kunihara, MD; Omar Abou Issa, MD; Brigitte Brittner, MD; Stefan Gräber, MD; Hans-Joachim Schäfers, MD

Type of fusion		
	right/left	281 (89%)
	right/non	30 (9%)
	left/non	5 (1%)
Commissural orientation		
	>160°	51
	≤160°	265
Fusion		
	partial	122
	complete	194

Actuarial freedom from reoperation



Aicher et al. Circulation 2011 18;123(2):178-85

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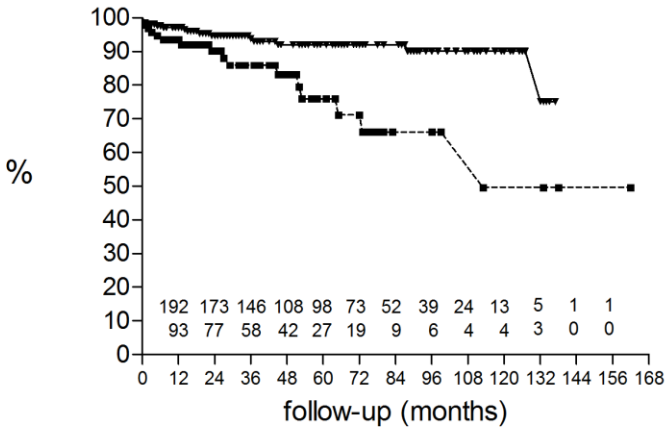
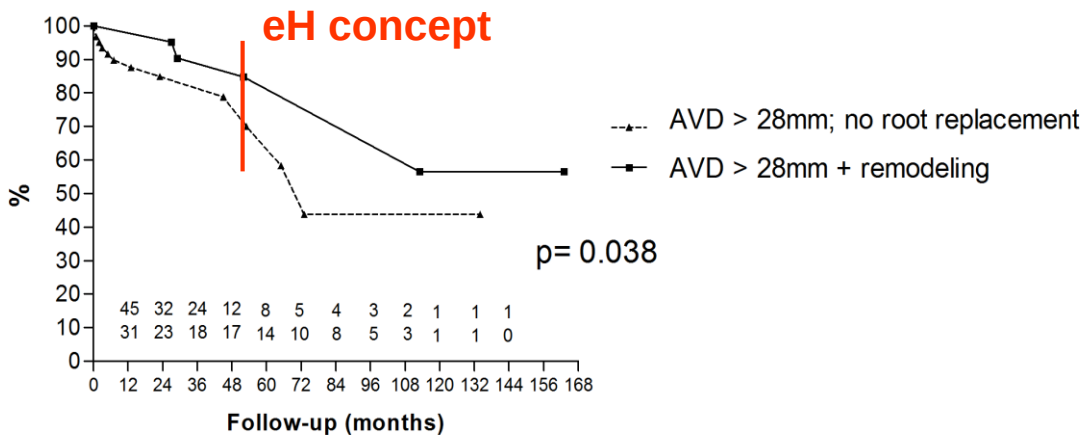


AVD < 29mm n=211

AVD ≥ 29mm n=105

p=0.009



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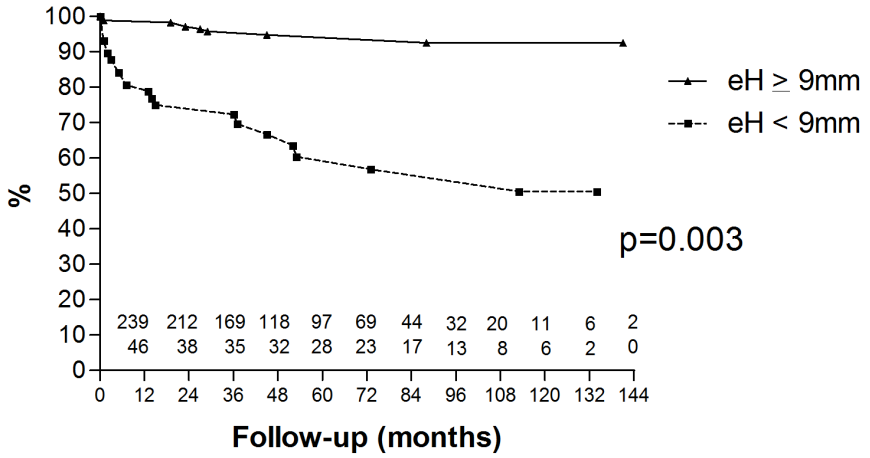
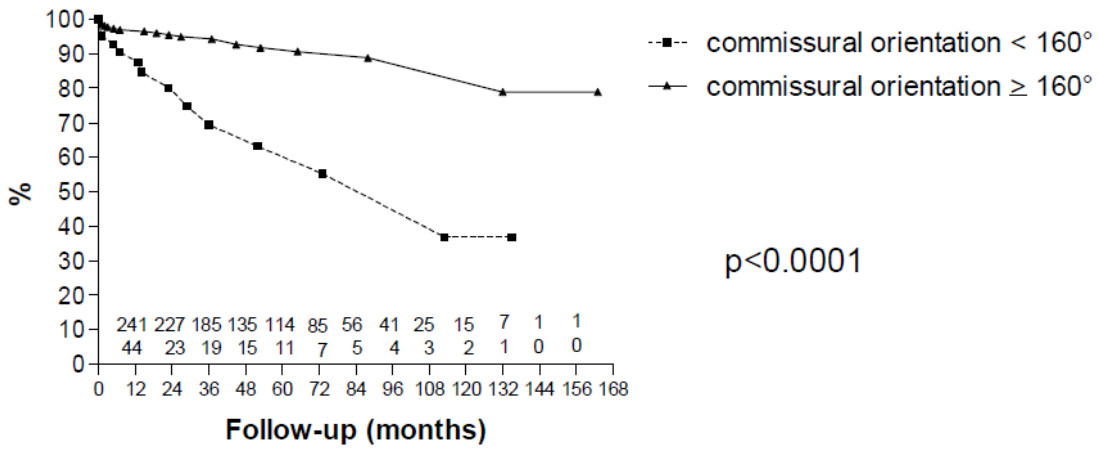


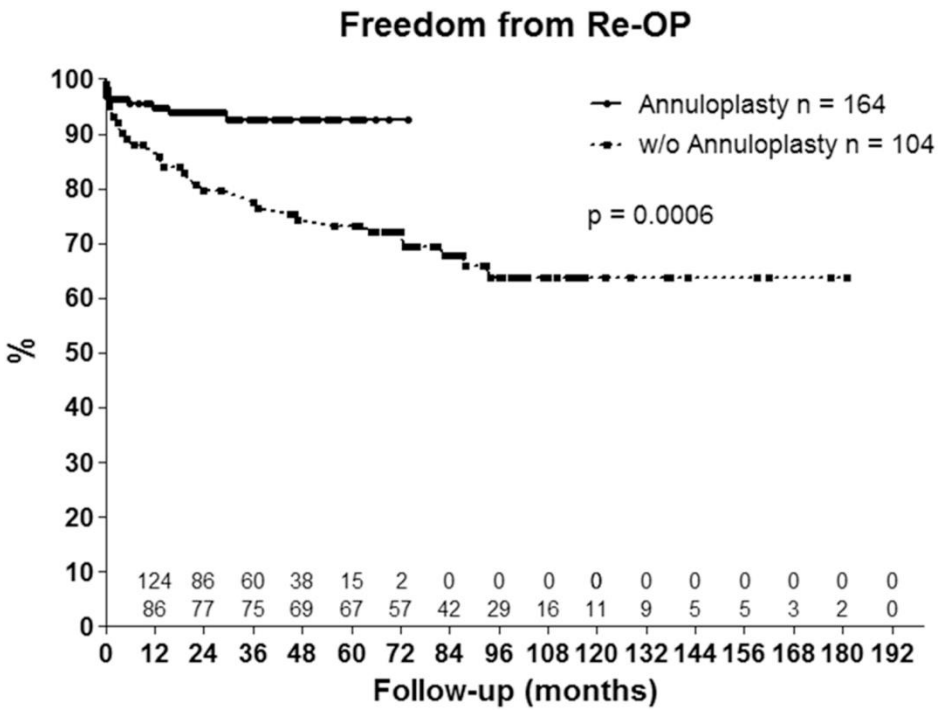


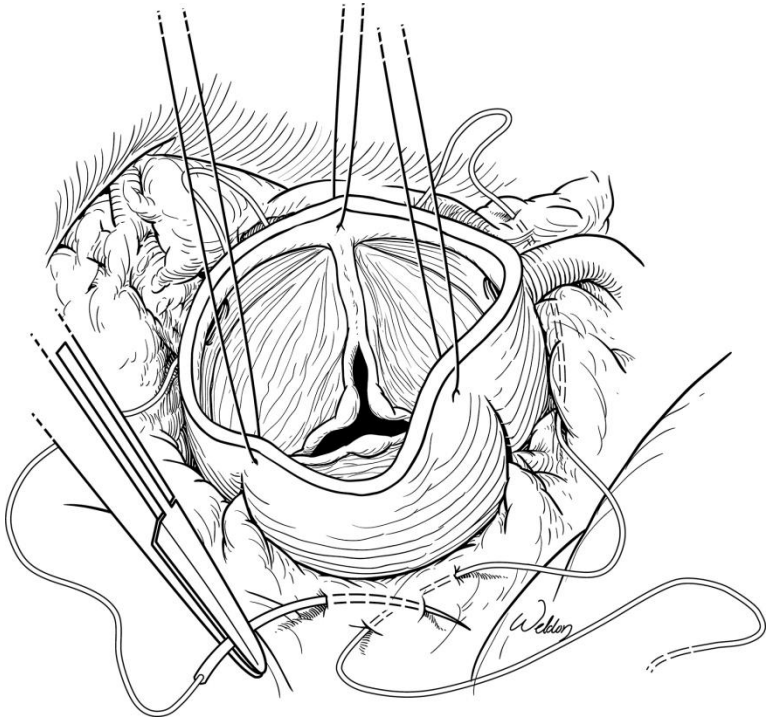
Aicher et al. Circulation 2011 18;123(2):178-85

Suture Annuloplasty Significantly Improves the Durability of Bicuspid Aortic Valve Repair

Ulrich Schneider, MD, Christopher Hofmann, Diana Aicher, MD,
Hiroaki Takahashi, MD, Yujiro Miura, MD, and Hans-Joachim Schäfers, MD

Department of Thoracic and Cardiovascular Surgery, Saarland University Medical Center, Homburg/Saar, Germany



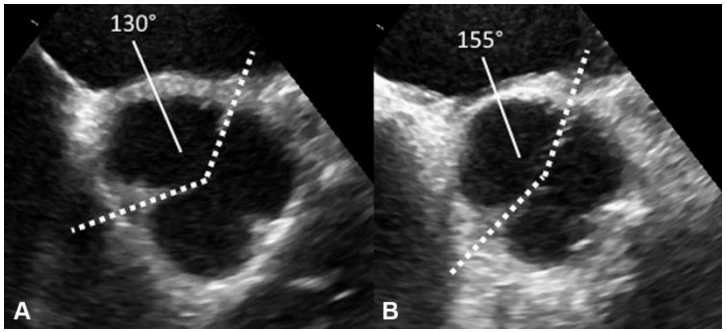


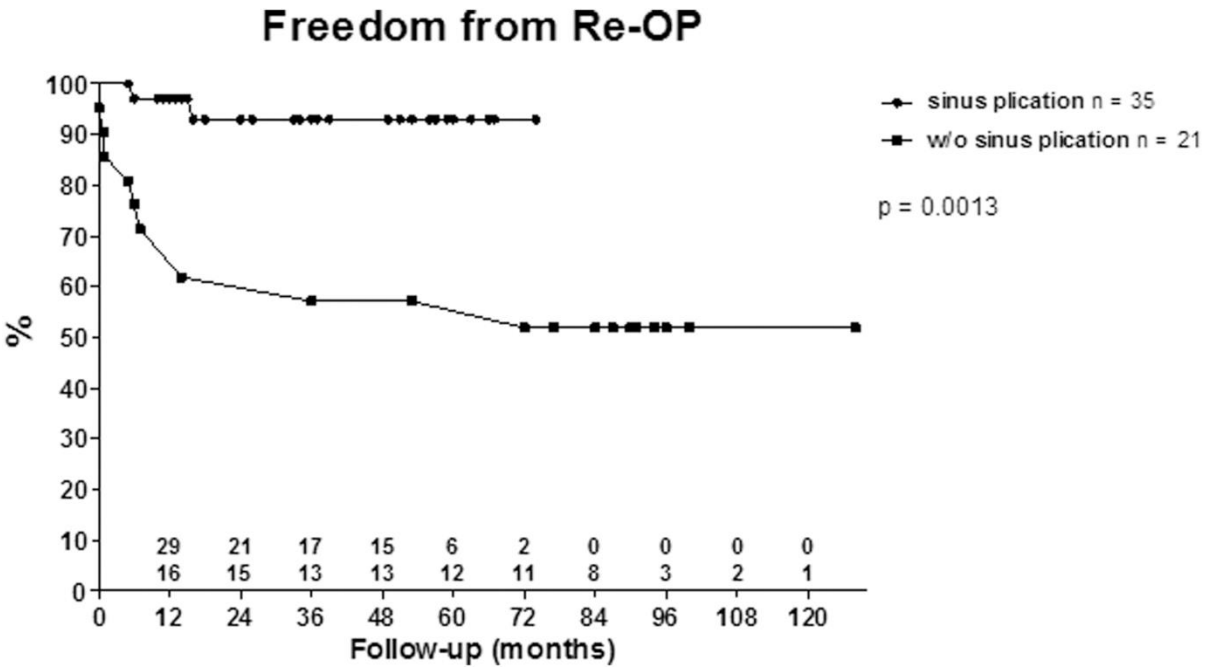
Schneider et al. Ann Thorac Surg. 2017;103(2):504-510

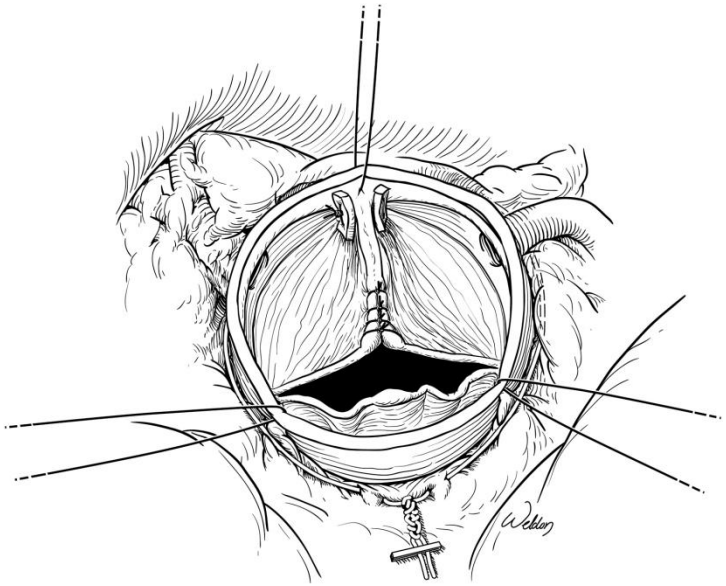
Sinus Plication to Improve Valve Configuration in Bicuspid Aortic Valve Repair—Early Results

Ulrich Schneider, MD, Wolfram Schmied, Dipl-Psych, Diana Aicher, MD, Christian Giebels, MD, Lena Winter, MD, and Hans-Joachim Schäfers, MD

Department of Thoracic and Cardiovascular Surgery, Saarland University Medical Center, Homburg/Saar, Germany





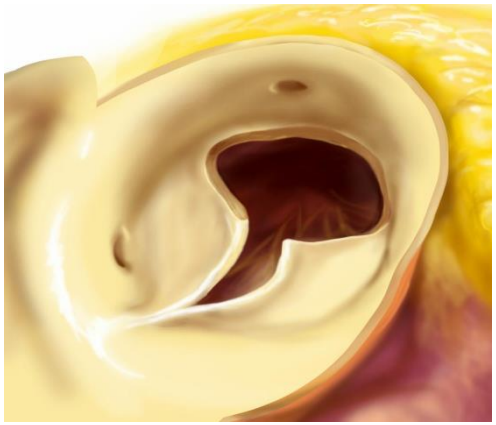


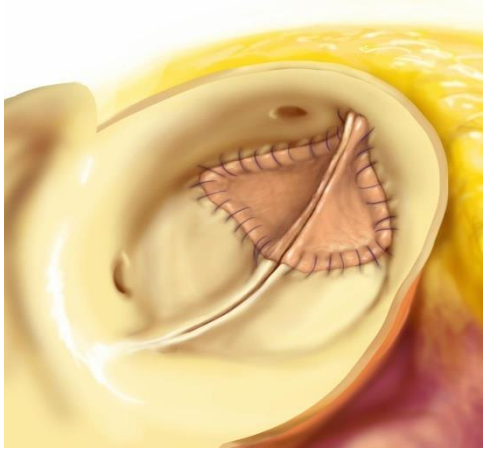
Schneider et al. Ann Thorac Surg. 2017;103:580-6

Bicuspidization of the Unicuspid Aortic Valve: A New Reconstructive Approach

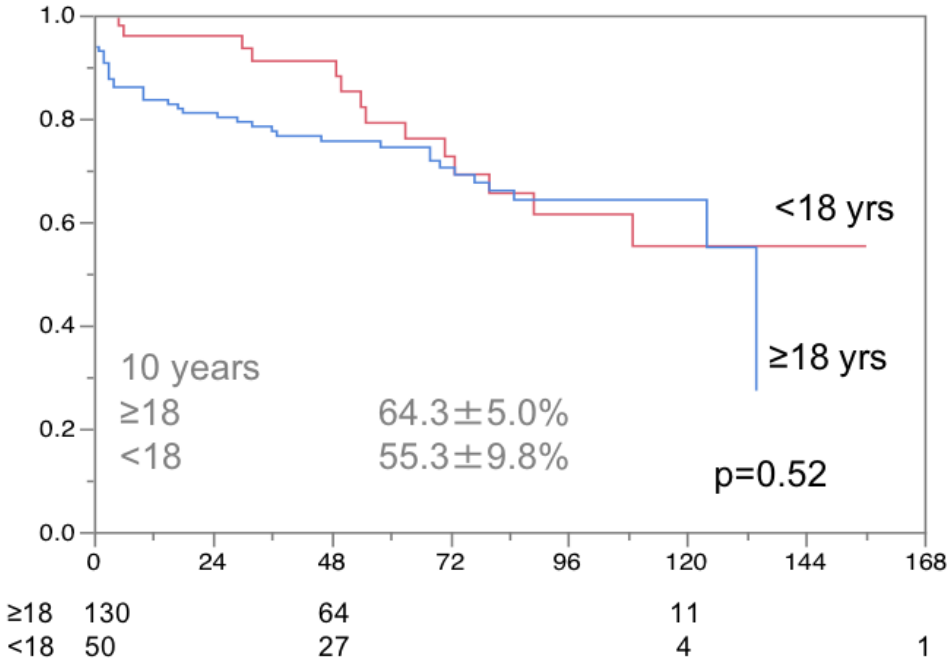
Hans-Joachim Schäfers, MD, Diana Aicher, MD, Svetlana Riodionycheva, MD, Angelika Lindinger, MD, Tanja Rädle-Hurst, MD, Frank Langer, MD, and Hashim Abdul-Khaliq, MD

Departments of Thoracic and Cardiovascular Surgery and Pediatric Cardiology, University Hospitals of Saarland, Homburg/Saar, Germany

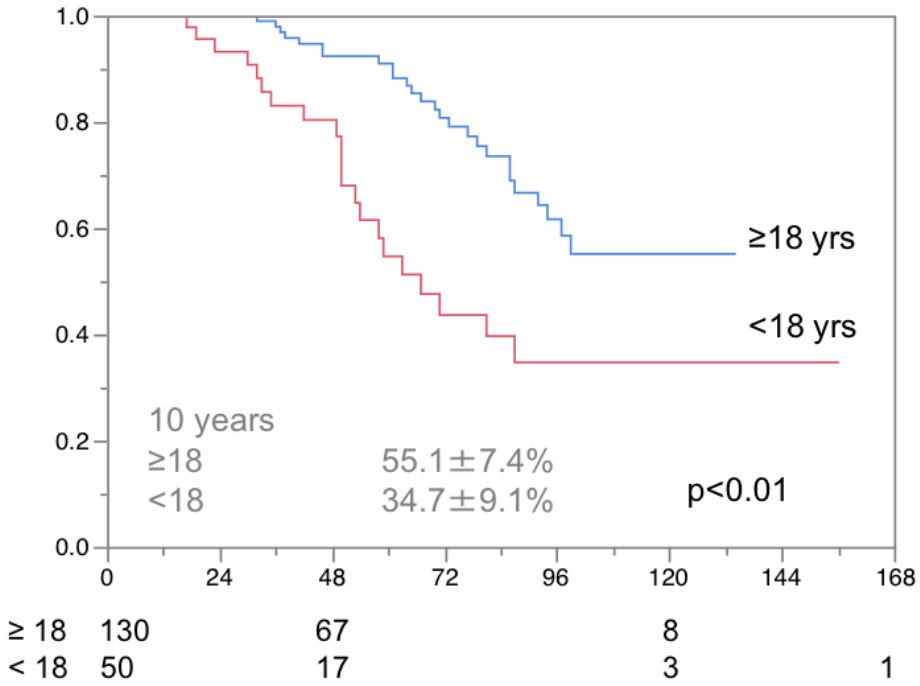




UAV - Freedom from Reoperation



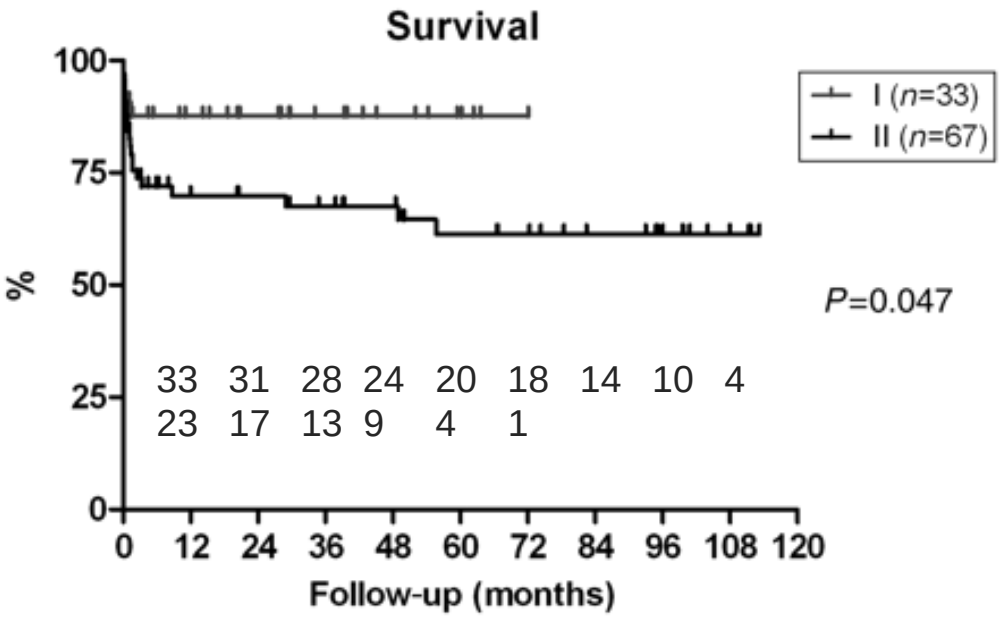
UAV - Freedom from Patch Calcification

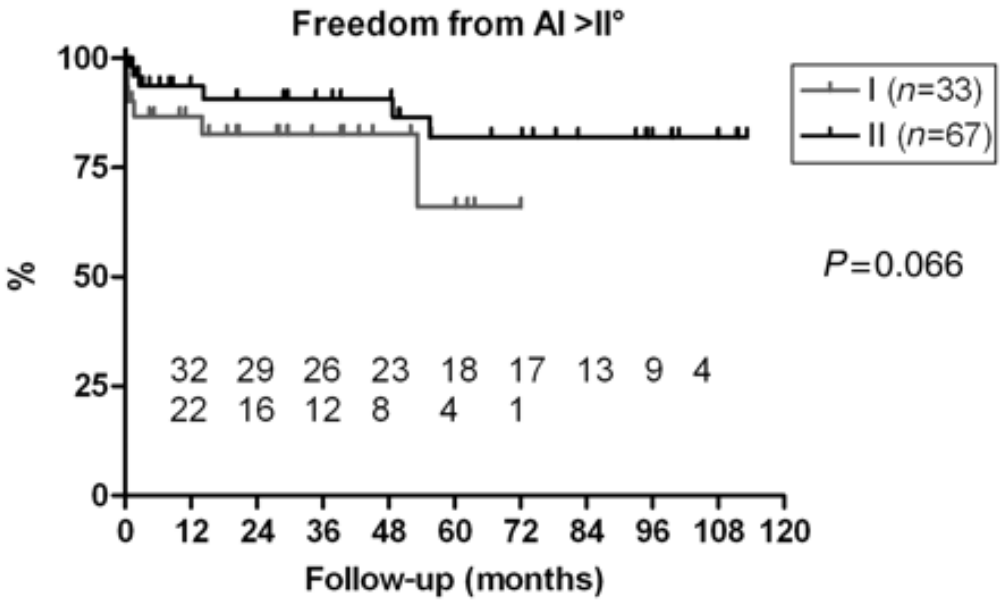


Repair versus replacement of the aortic valve in active infective endocarditis

Katharina Mayer, Diana Aicher, Susanne Feldner, Takashi Kunihara and Hans-Joachim Schäfers*

Department of Thoracic and Cardiovascular Surgery, University Hospital of Saarland, Homburg, Germany





I Aortic valve repair
II Aortic valve replacement

Mayer et al. Eur J Cardiothorac Surg. 2012;42(1):122-7

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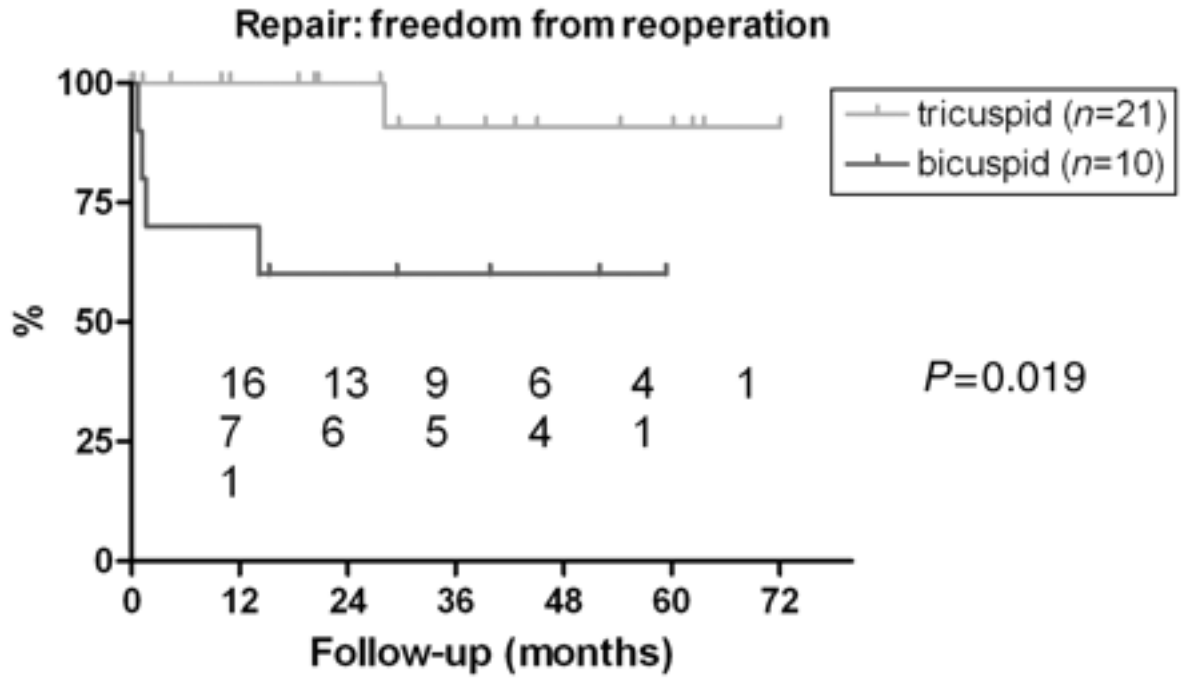
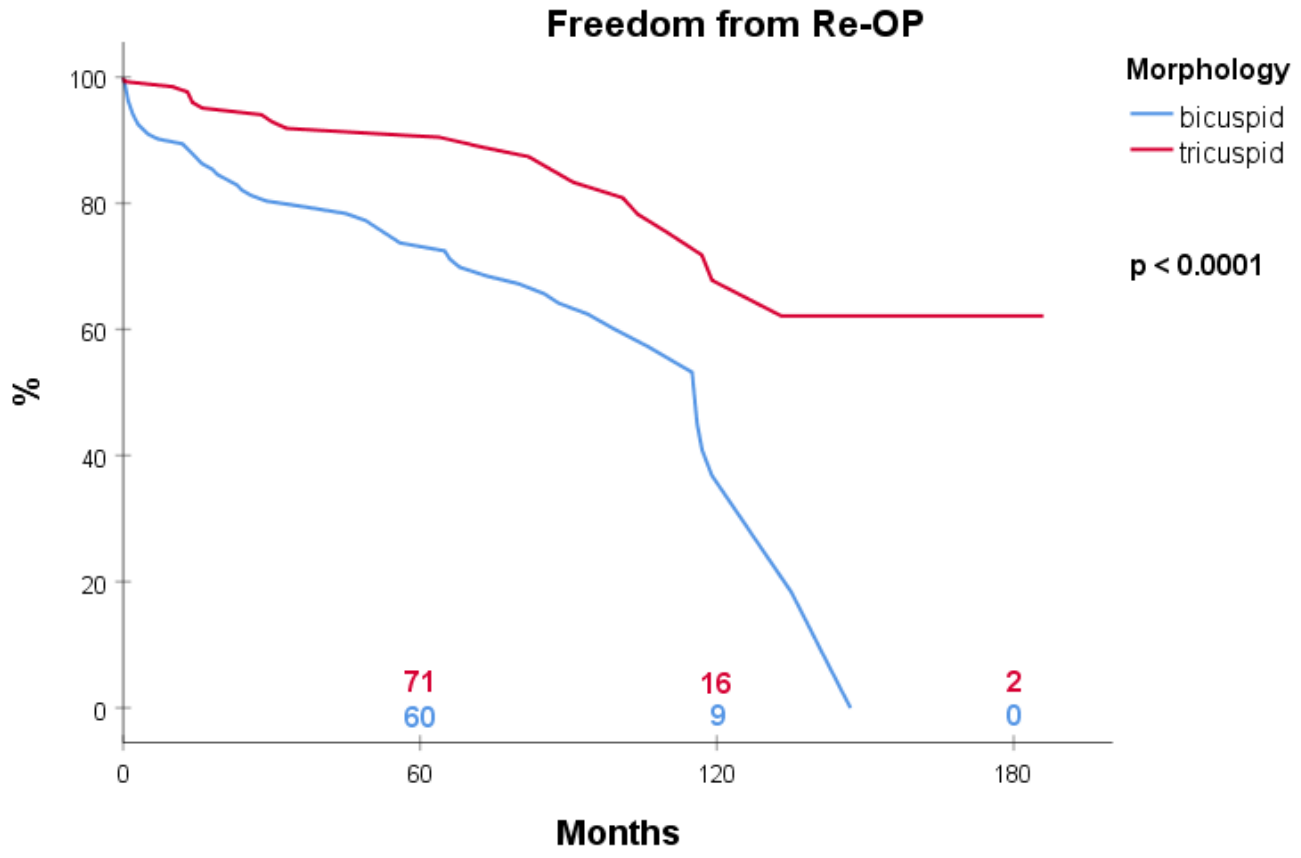
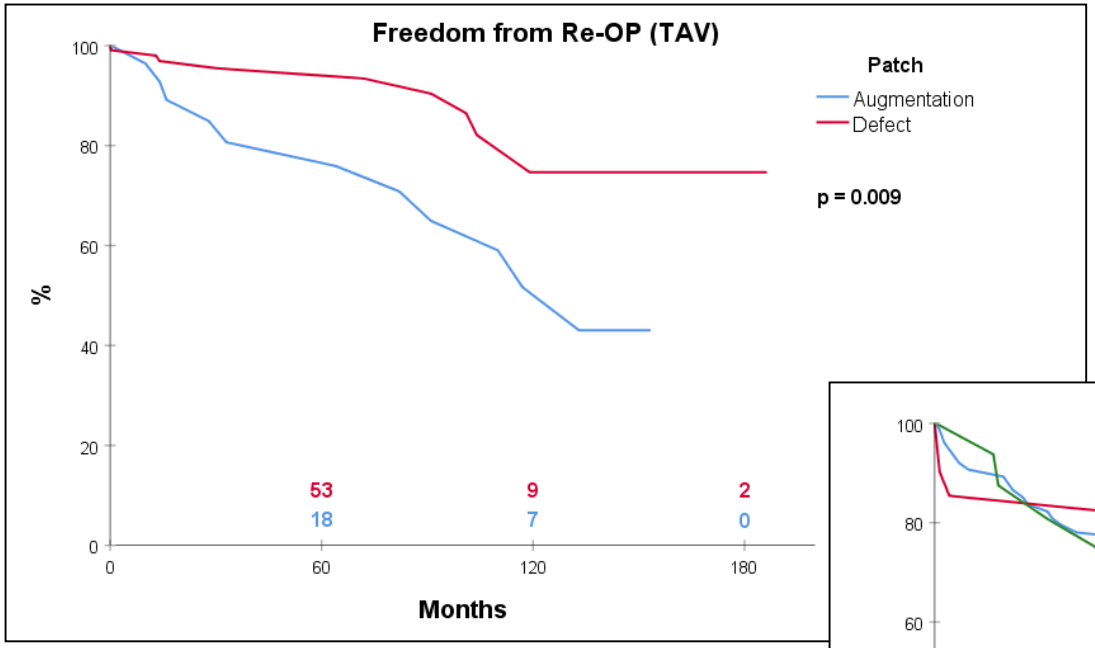


Risk factor for reoperation: size of the pericardial patch (>1cm)

Pericardium in Cusp Repair (n=267)



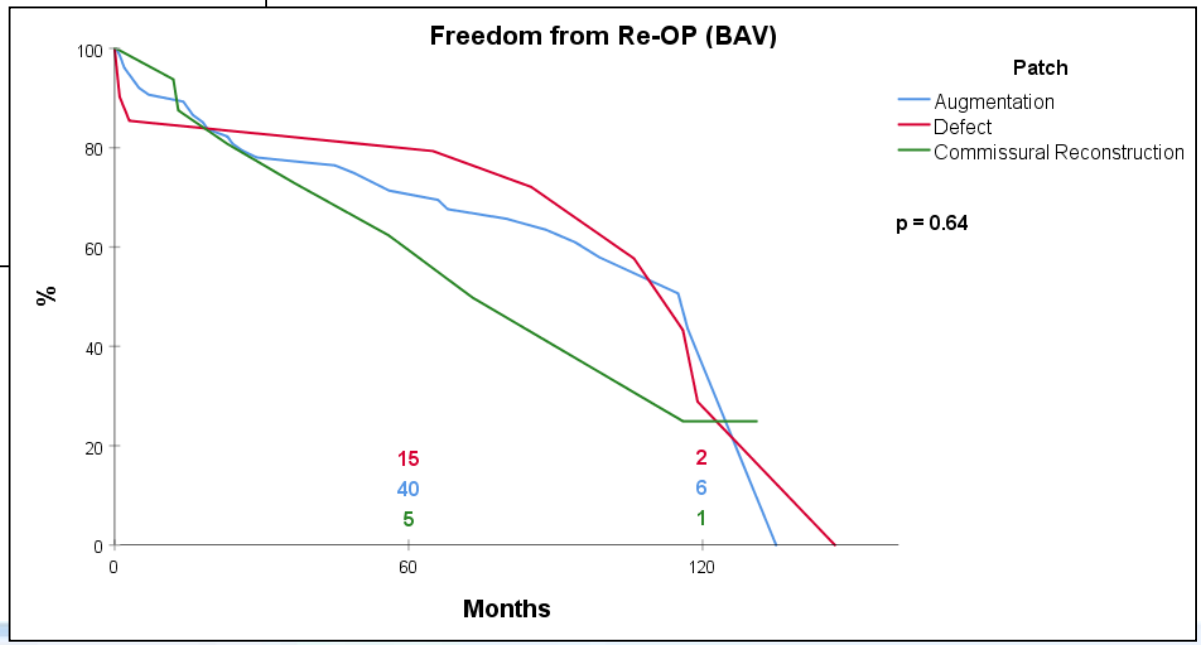
Pericardium in Cusp Repair



Augmentation: retraction

Defect: fenestration, s/p local resection

Commissural reconstruction



Conclusions

- Aortic cusp repair is possible with different techniques.
- Aortic cusp repair is possible in all valve morphologies – with good long-term results in bicuspid and tricuspid valve morphology.
- Suture annuloplasty improves long-term results and Sinus plication improves mid-term results in bicuspid AVR.
- In active infective endocarditis results of aortic cusp repair strongly depend on valve morphology and size of the implanted patch.
- Pericardial cusp repair is only possible with good long-term results for defect closure in tricuspid AVR.

Preoperative aortic root geometry and postoperative cusp configuration primarily determine long-term outcome after valve-preserving aortic root repair

Takashi Kunihara, MD, PhD,[a] Diana Aicher, MD,[a] Svetlana Rodionycheva, MD,[a] Heinrich-Volker Groesdonk, MD,[a] Frank Langer, MD,[a] Fumihiro Sata, MD, PhD,[b] and Hans-Joachim Schäfers, MD, PhD[a]

	Remodeling (N=401)	Reimplantation (N=29)	p
Age (years)	58 ± 15	42 ± 16	
Sex (m/f)	300/101	19/8	
Tricuspid AV	271	27	
BAV/UAV	124/6	2/-	
Diagnosis: Aneurysm	336	22	
AADA	59	7	
CADA	6	-	
Marfan	13	12	
Myocardial Ischemia (min)	82 ± 20	112 ± 24	0.01
Hospital mortality			
total	13/401 (3.2 %)	0/29	0.32
elective	9/342 (2.6%)	0/22	0.33
emergency	4/59 (6.8%)	0/7	0.08

Kunihara et al. J Thorac Cardiovasc Surg. 2012;143(6):1389-1395

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Preoperative aortic root geometry and postoperative cusp configuration primarily determine long-term outcome after valve-preserving aortic root repair

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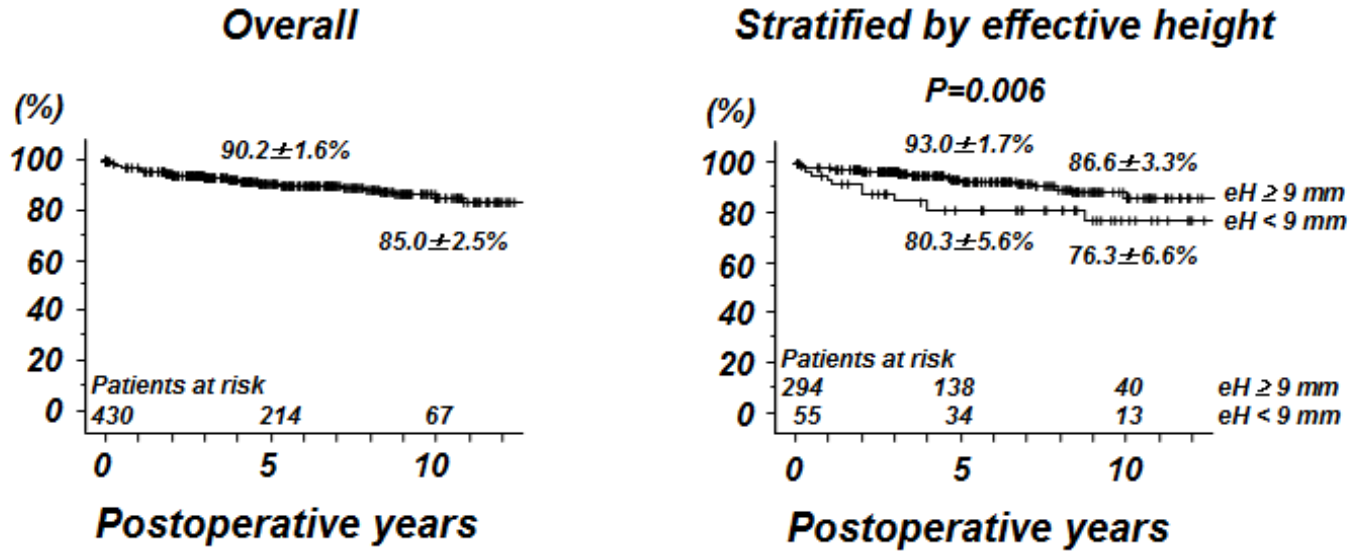
Freedom from AR ≥ II



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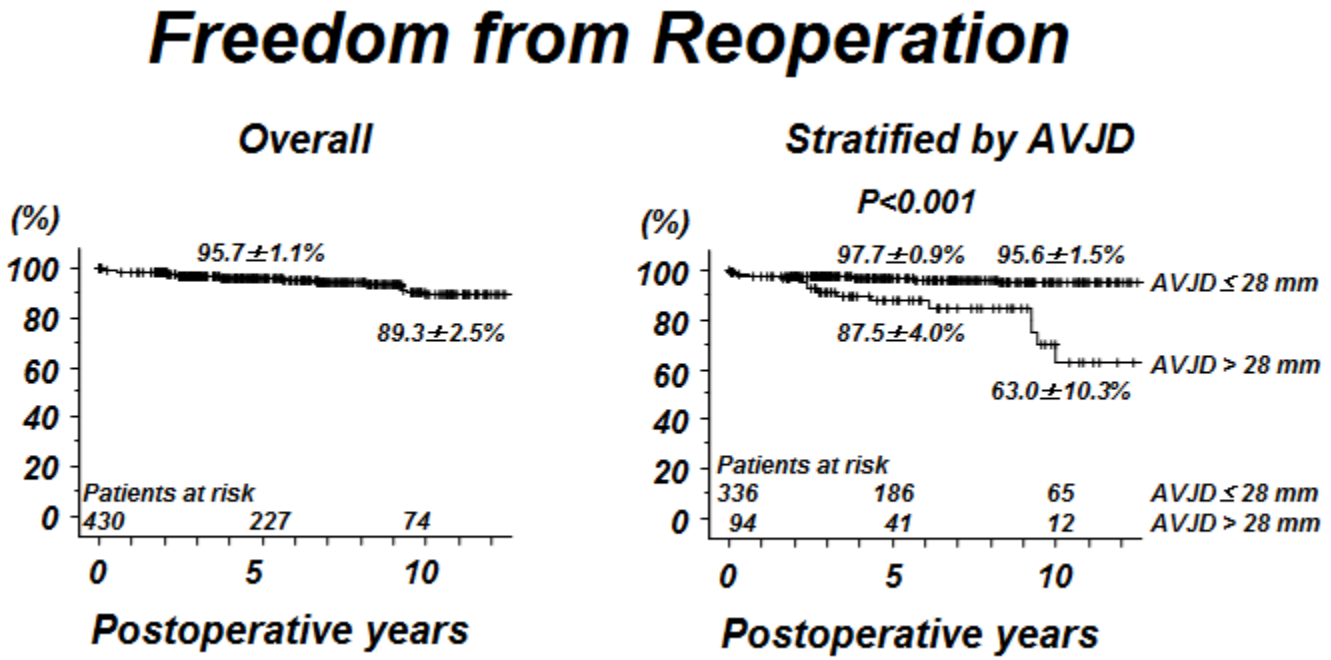

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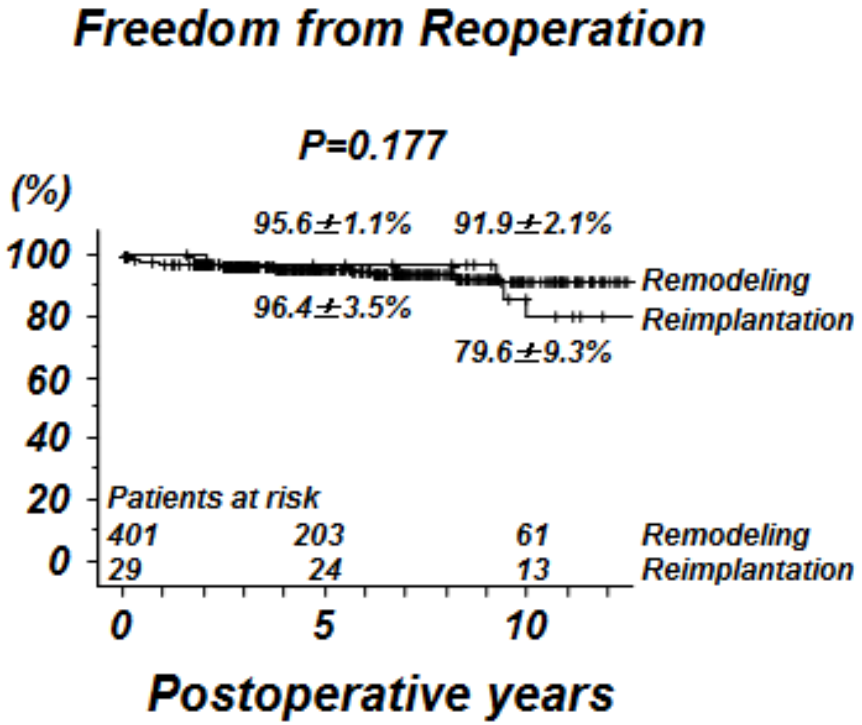

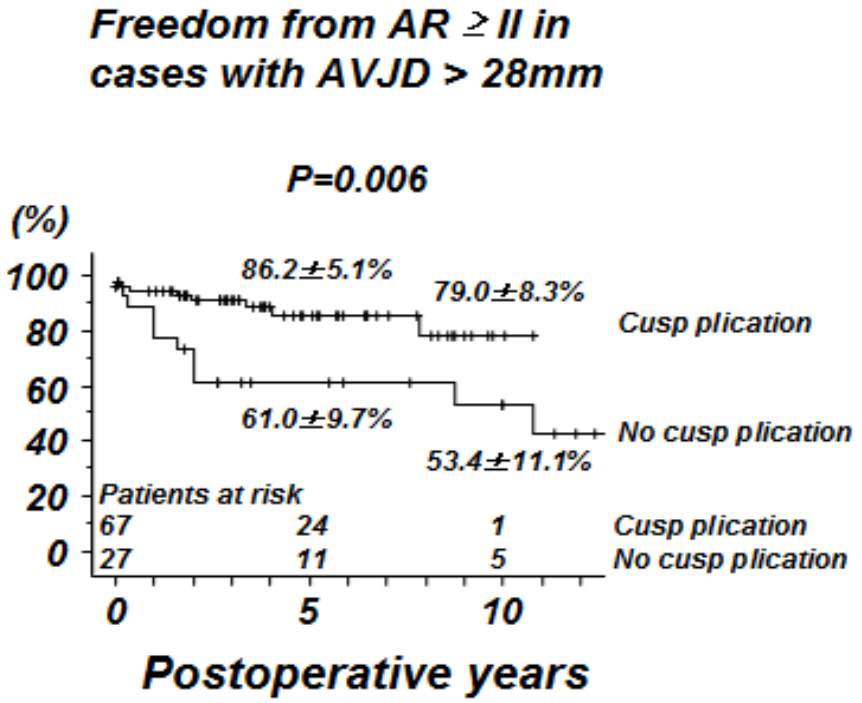

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TABLE 1. Predictors of late aortic valve stability

	Univariate	Multivariate		
	P value	*P* value	HR	95% CI
AR grade ≥ II				
AVJ diameter > 28 mm	<.001	<.001	3.326	1.833–6.036
eH < 9 mm	<.001	<.001	3.354	1.857–6.060
STJ diameter	.025	.563		
Use of pericardial patch	.068	.071		
Concomitant CABG	.142	.177		
Reoperation				
AVJ diameter > 28 mm	<.001	<.001	5.076	2.281–11.300
Use of pericardial patch	.005	.022	3.815	1.208–12.048
eH < 9 mm	.042	.049	2.272	1.002–5.152
Body height	.115	.505		
Operative procedure	.177	.986		
Use of cusp plication	.188	.303		

Predictors of recurrent AR grade II or greater or reoperation on the aortic valve. *HR*, Hazard ratio; *CI*, confidential interval; *eH*, effective height; *CABG*, coronary artery bypass grafting.

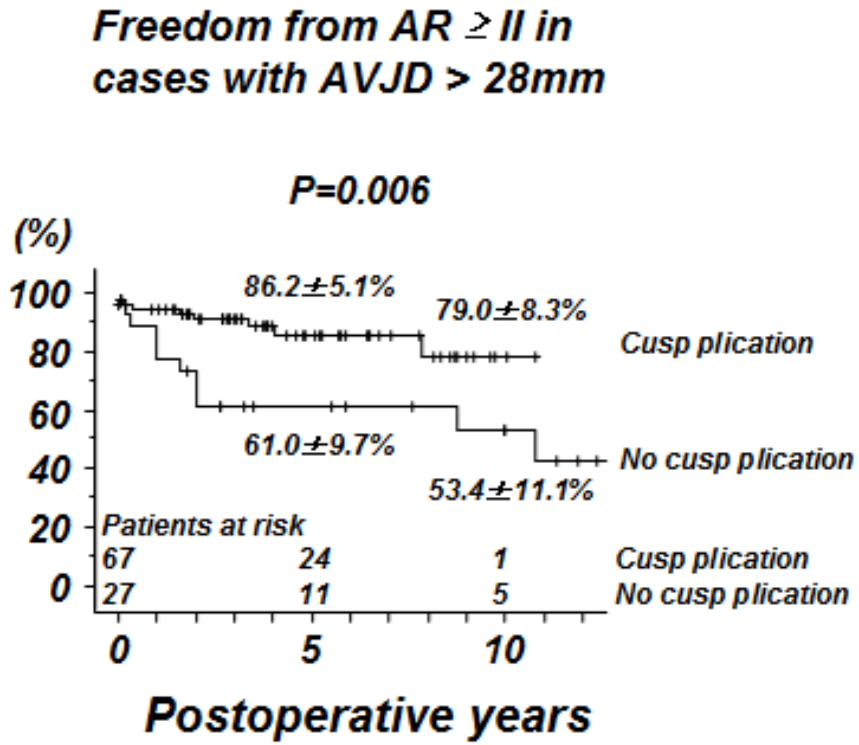
Kunihara et al. J Thorac Cardiovasc Surg. 2012;143(6):1389-1395

Suboptimal valve stability for AVJ > 28mm:

AVJ > 28mm risk factor or

AVJ indicator for large root (+ large cusps) which will prolapse after more reduction of root dimensions

?



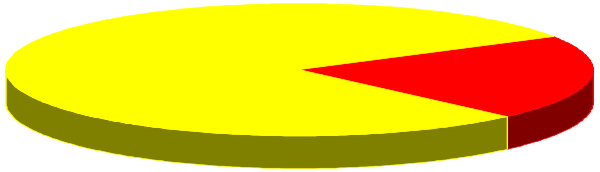
Valve-preserving Surgery: Reasons for Reoperation

04/1997 – 03/2017

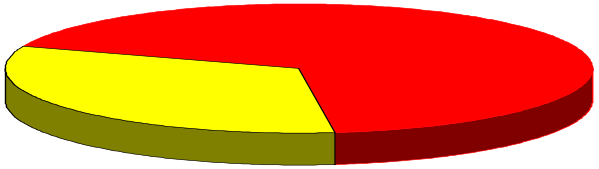
	1997 – 2004	2004 – 2017
Cusp prolapse	10	-
Patch dehiscence	-	10
Cusp retraction	2	6
Cusp suture dehiscence	1	5
Endocarditis	-	6
Aortic valve stenosis	5	1
Abnormal root configuration	-	2
Erosion (use of braided polyester suture)	-	2
Unrecognized UAV	1	-

Cusp prolapse correction (%)

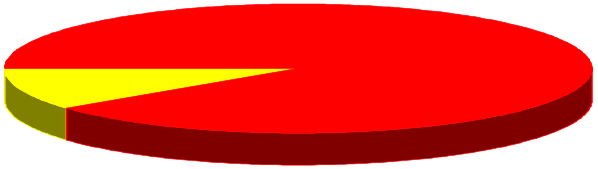
1995-2000: 19%



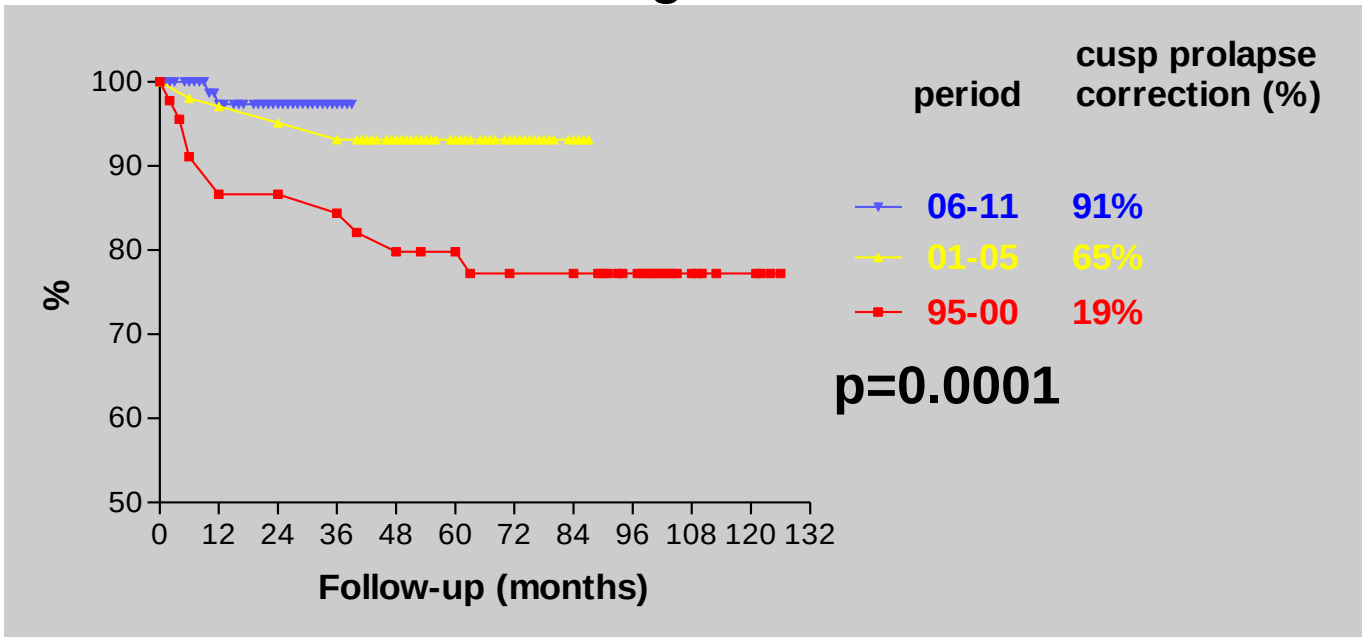
2001-2005: 65%



2006-2011: 91%



Learning Curve



Reexamining remodeling

Hans-Joachim Schäfers, MD,[a,c] Alexander Raddatz, MD,[b] Wolfgang Schmied, Dipl Psych,[a] Hiroaki Takahashi, MD,[a] Yujiro Miura, MD,[a] Takashi Kunihara, MD,[a] and Diana Aicher, MD[a]

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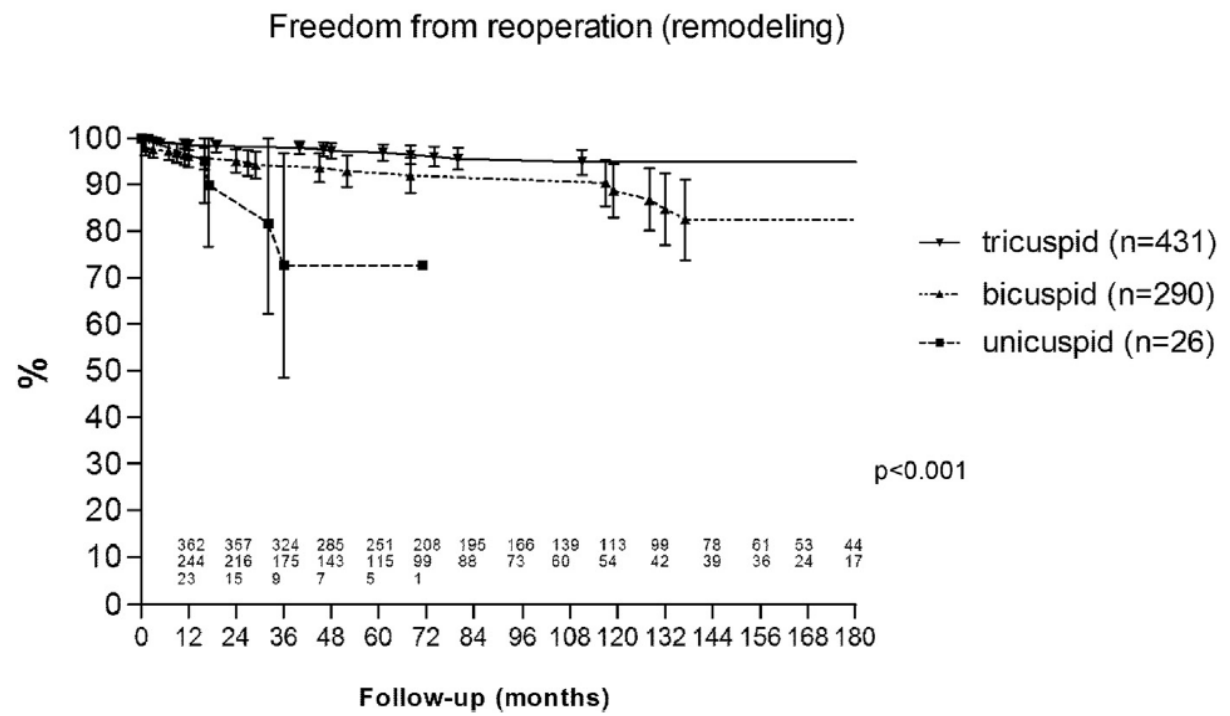

FIGURE 1. Kaplan–Meier analysis of freedom from reoperation after root remodeling for different aortic valve morphologies. Stability is significantly superior for tricuspid aortic valve anatomy compared with bicuspid or unicuspid anatomy.

Reexamining remodeling

Hans-Joachim Schäfers, MD,[a,c] Alexander Raddatz, MD,[b] Wolfgang Schmied, Dipl Psych,[a] Hiroaki Takahashi, MD,[a] Yujiro Miura, MD,[a] Takashi Kunihara, MD,[a] and Diana Aicher, MD[a]

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TABLE 2. Risk factors by multivariate Cox regression analysis (−2 log-likelihood function = 161.87, chi-square = 72.79, $P < .001$)

Variable	*P* value	HR	95% CI
Diameter of AV junction (mm)	<.001	1.43	1.21-1.69
Use of annuloplasty	.01	1.28	1.89-66.26
Myocardial ischemia (min)	.04	0.96	0.93-1.00
Effective height	<.001	0.58	0.43-0.79
Use of pericardial patch	<.001	6.24	2.30-16.90

AV, Aortoventricular; *CI*, confidence interval; *HR*, hazard ratio.

Follow-up (months)

FIGURE 3. Kaplan–Meier analysis of freedom from AR II or greater after root remodeling in tricuspid aortic valves analyzed by time periods related to operative modifications. The use of the effective height concept was started in late 2004, and a suture annuloplasty was added in 2009. There was a significant and stepwise increase in the proportion of valves with good function. *AR*, Aortic regurgitation.

Valve-sparing aortic root replacement in patients with Marfan syndrome—the Homburg experience

Ulrich Schneider, Tristan Ehrlich, Irem Karliova, Christian Giebels, Hans-Joachim Schäfers

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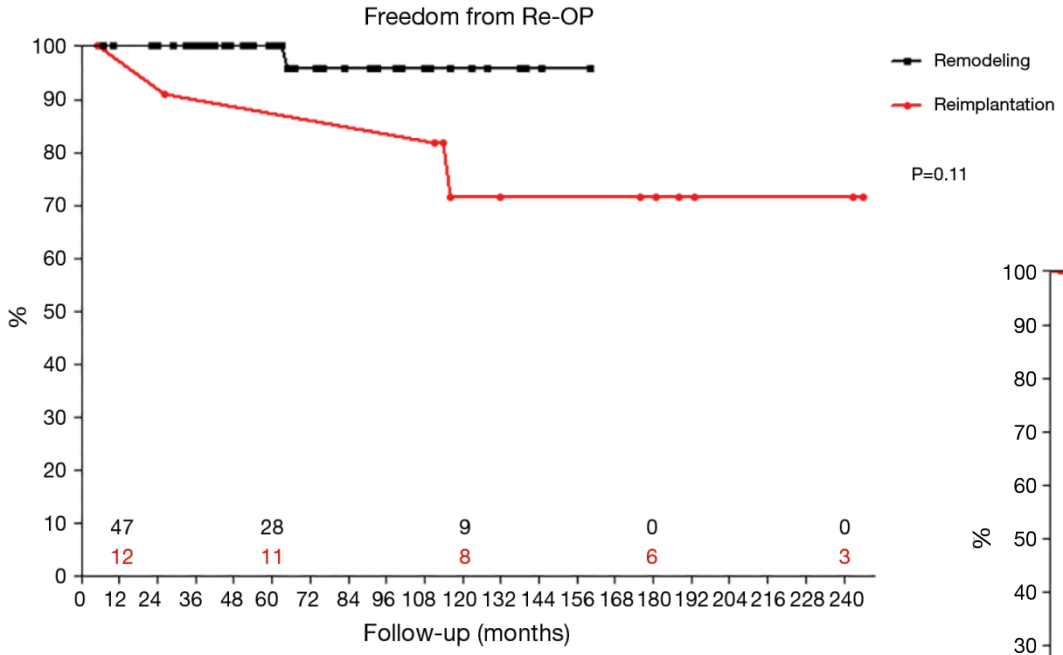
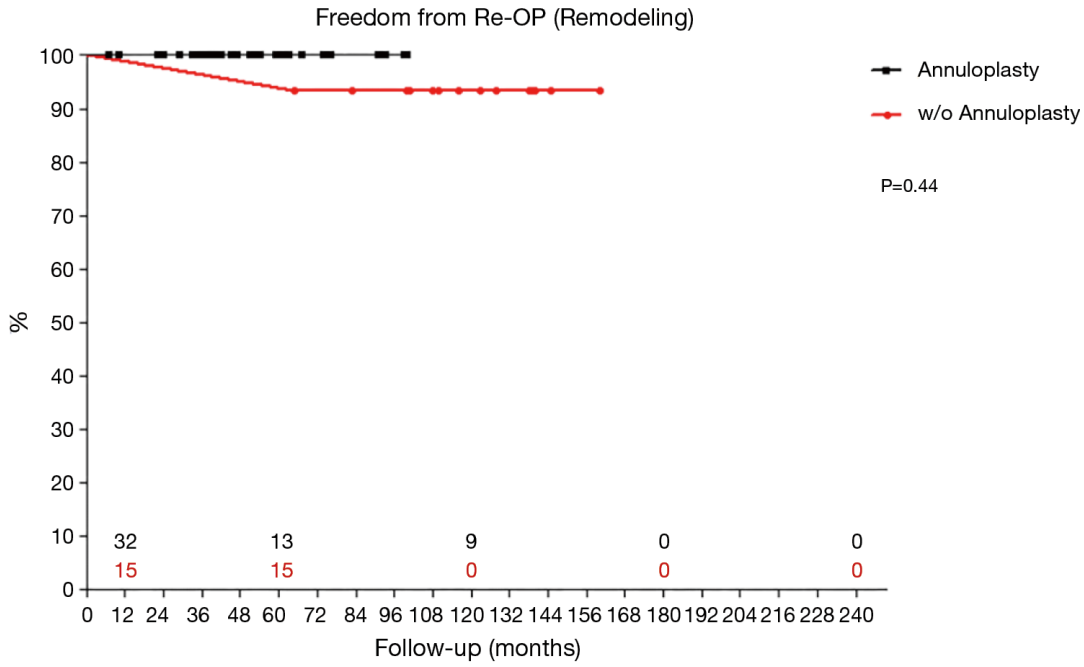


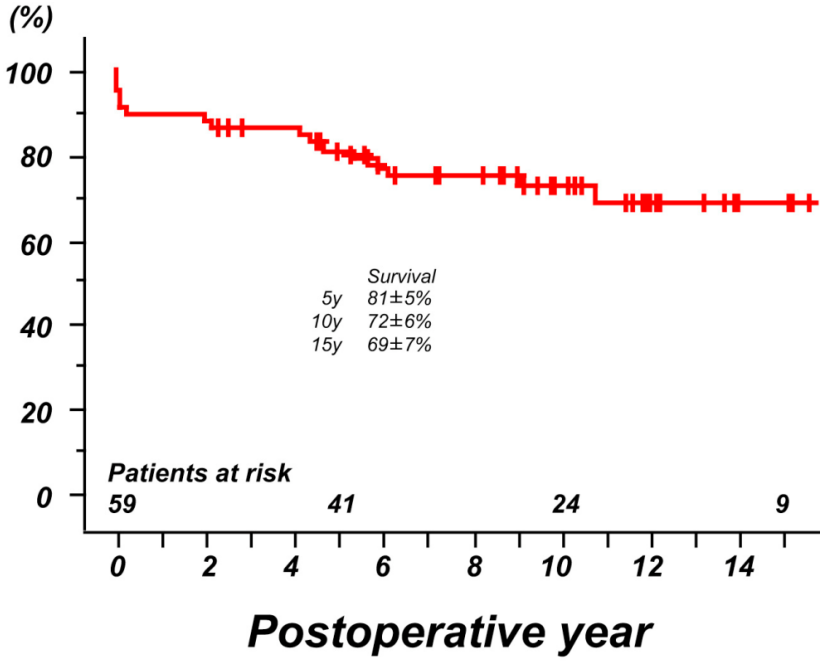


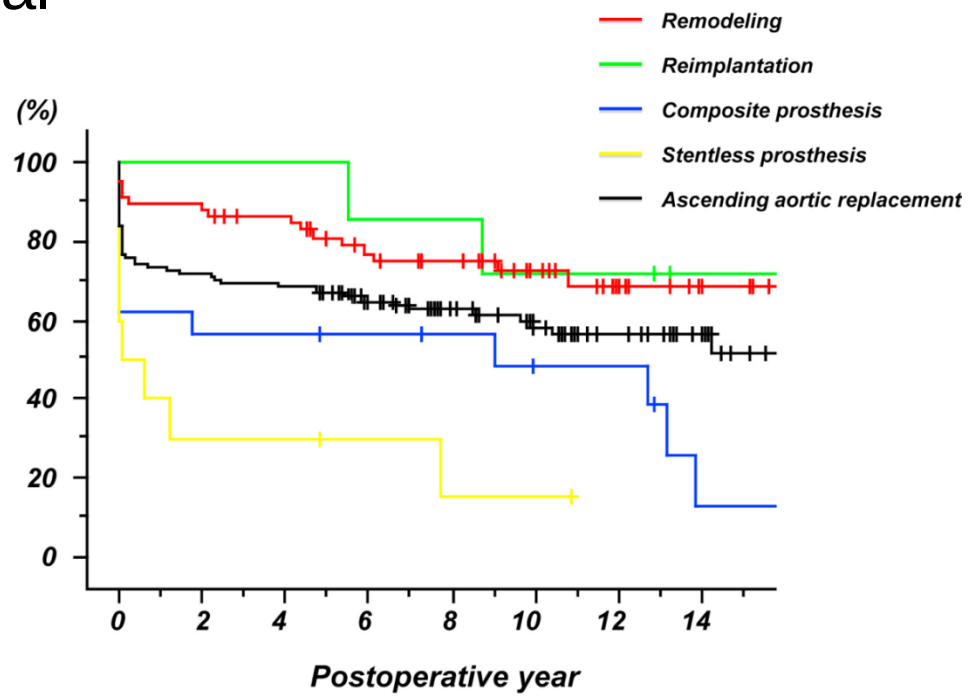
Schneider et al. Ann Cardiothorac Surg. 2017 Nov;6(6):697-703

Aortic root remodeling leads to good valve stability in acute aortic dissection and preexistent root dilatation

Takashi Kunihara, MD, PhD, Niklas Neumann, MD, Steffen Daniel Kriechbaum, MD, Diana Aicher, MD, and Hans-Joachim Schäfers, MD, PhD

Survival



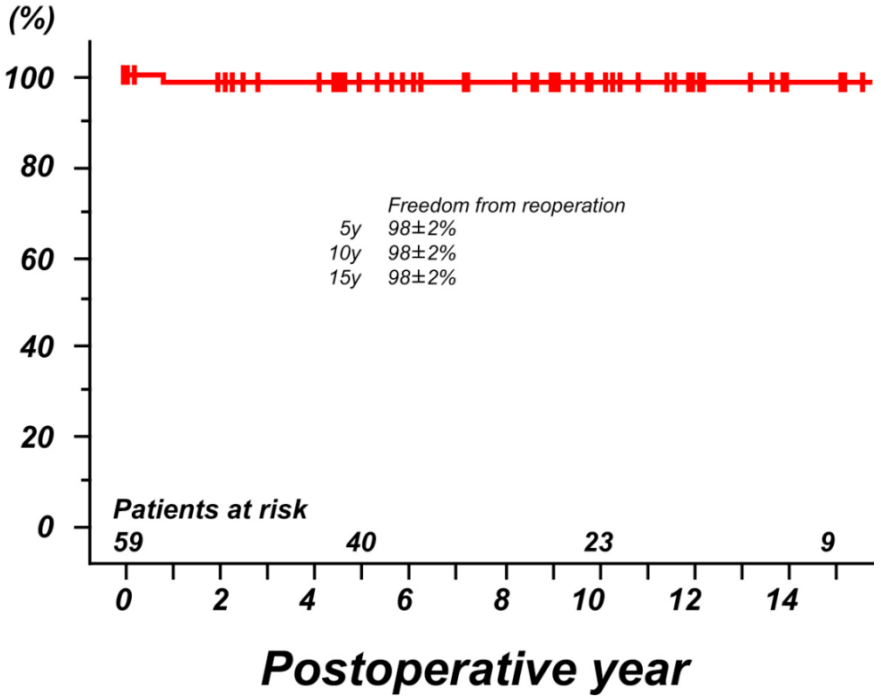


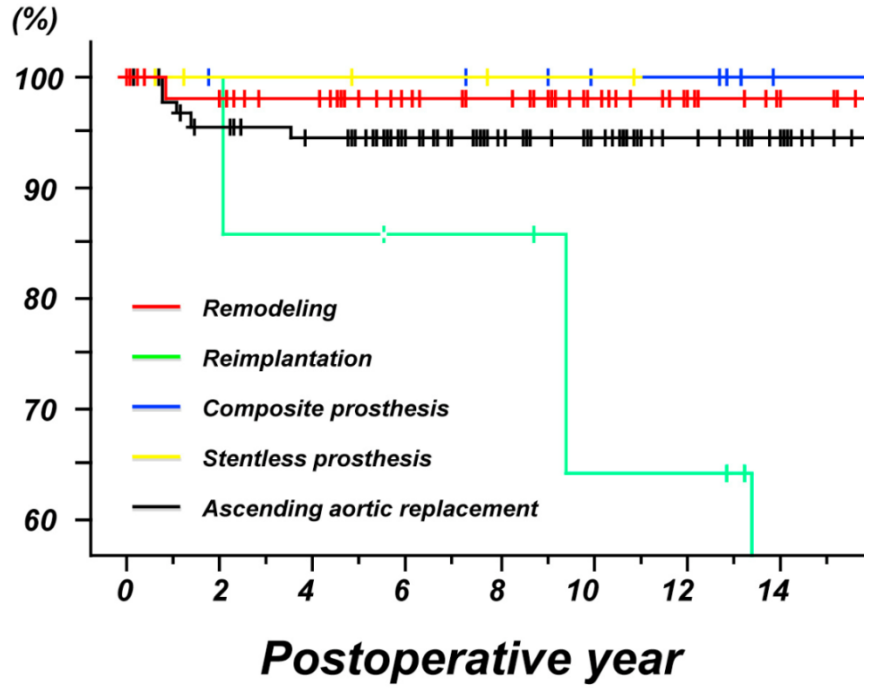
Kunihara et al. J Thorac Cardiovasc Surg. 2016;152(2):430-436

Aortic root remodeling leads to good valve stability in acute aortic dissection and preexistent root dilatation

Takashi Kunihara, MD, PhD, Niklas Neumann, MD, Steffen Daniel Kriechbaum, MD, Diana Aicher, MD, and Hans-Joachim Schäfers, MD, PhD

Freedom from Reoperation





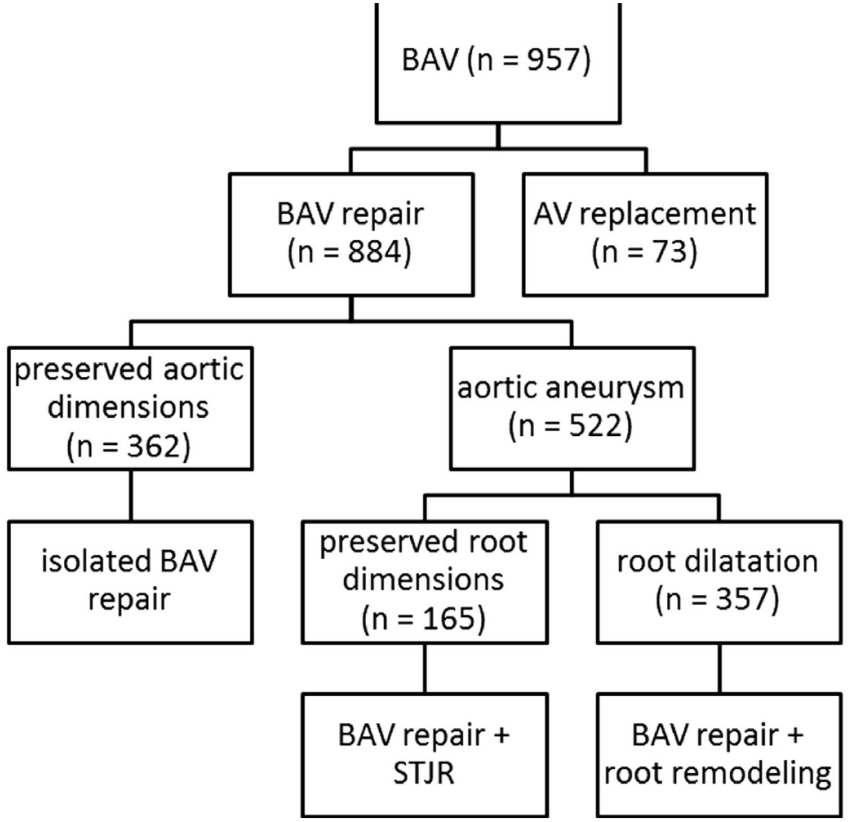
Kunihara et al. J Thorac Cardiovasc Surg. 2016;152(2):430-436

Two decades of experience with root remodeling and valve repair for bicuspid aortic valves

Ulrich Schneider, MD,[a] Susanne K. Feldner, MD,[a] Christopher Hofmann,[a] Jakob Schöpe, MSc,[b] Stefan Wagenpfeil, PhD,[b] Christian Giebels, MD,[a] and Hans-Joachim Schäfers, MD[a]

Methods: Between November 1995 and December 2015, 357 patients (324 age 10-80 years; mean, 49 ± 13 years) underwent combined bicuspid aortic repair and root remodeling. Aortic regurgitation was relevant in 265 case main indications for surgery were aortic regurgitation (n = 241), aortic ane (n = 102), and acute dissection (n = 9). In 225 instances, a suture annulo was added. Cusp calcification was present beyond the raphe in 52 cases, a autologous pericardial patch was implanted for partial cusp replacement cases. All patients were followed. Follow-up was 97.8% complete with a of 57 ± 51 months (median, 39 months).

Results: Two patients died (hospital mortality 0.6%), and survival at 15 yea



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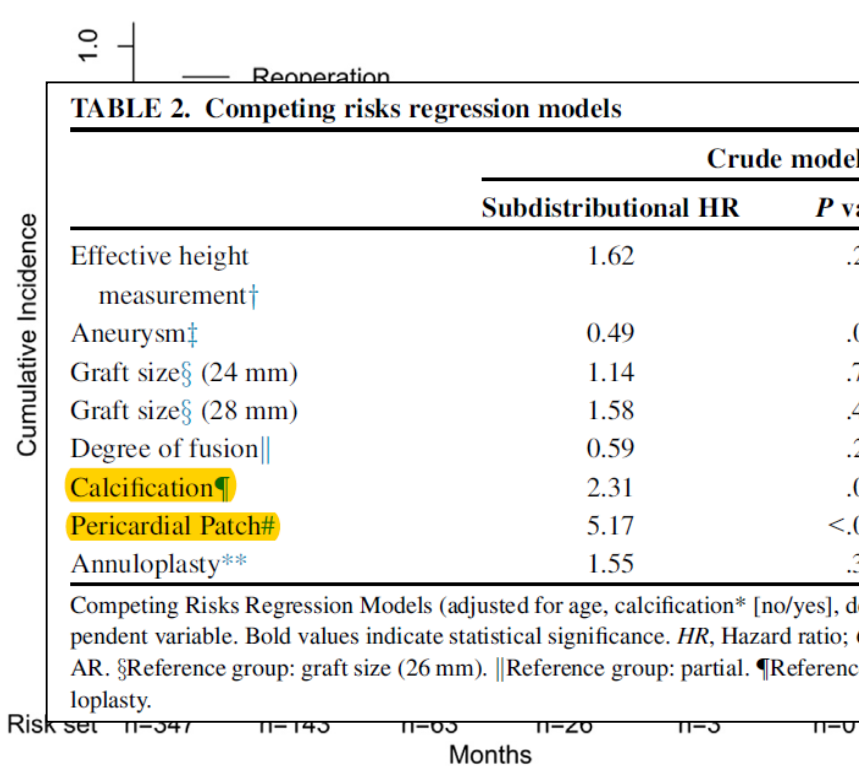


TABLE 2. Competing risks regression models

	Crude model			Adjusted model		
	Subdistributional HR	*P* value	95% CI	Subdistributional HR	*P* value	95% CI
Effective height measurement†	1.62	.240	0.73-3.63	1.23	.680	0.46-3.27
Aneurysm‡	0.49	.083	0.22-1.10	0.53	.130	0.24-1.20
Graft size§ (24 mm)	1.14	.760	0.49-2.65	1.22	.670	0.49-3.03
Graft size§ (28 mm)	1.58	.480	0.44-5.72	1.34	.690	0.32-5.65
Degree of fusion‖	0.59	.220	0.25-1.39	0.38	.034	0.15-0.93
Calcification¶	2.31	.030	1.08-4.94	**4.34**	**.002**	1.69-11.16
Pericardial Patch#	5.17	<.001	2.28-11.7	**4.00**	**.002**	1.65-9.66
Annuloplasty**	1.55	.300	0.68-3.52	1.21	.680	0.49-2.97

Competing Risks Regression Models (adjusted for age, calcification* [no/yes], degree of fusion* [no/yes], sex [male/female]). *Only when not considered as investigated independent variable. Bold values indicate statistical significance. *HR*, Hazard ratio; *CI*, confidence interval. †Reference group: no effective height measurement. ‡Reference group: AR. §Reference group: graft size (26 mm). ‖Reference group: partial. ¶Reference group: no calcification. #Reference group: no pericardial patch. **Reference group: no annuloplasty.

FIGURE 2. Cumulative incidence for reoperation. *Red lines* highlight the 95% confidence interval.

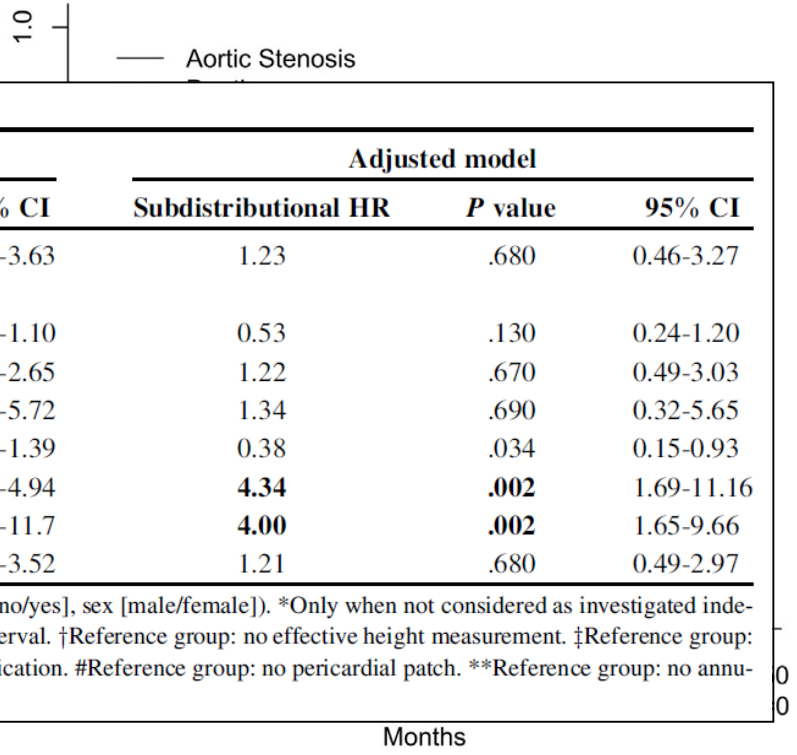


FIGURE 4. Subdistribution cumulative incidence for relevant aortic stenosis (accounted for mortality). *Red lines* highlight 95% confidence interval.

Aortic valve insufficiency due to aortic dilatation: correction by sinus rim adjustment

ROBERT W. M. FRATER, MB.CH.B., M.S., F.R.C.S., F.A.C.S., F.A.C.C.

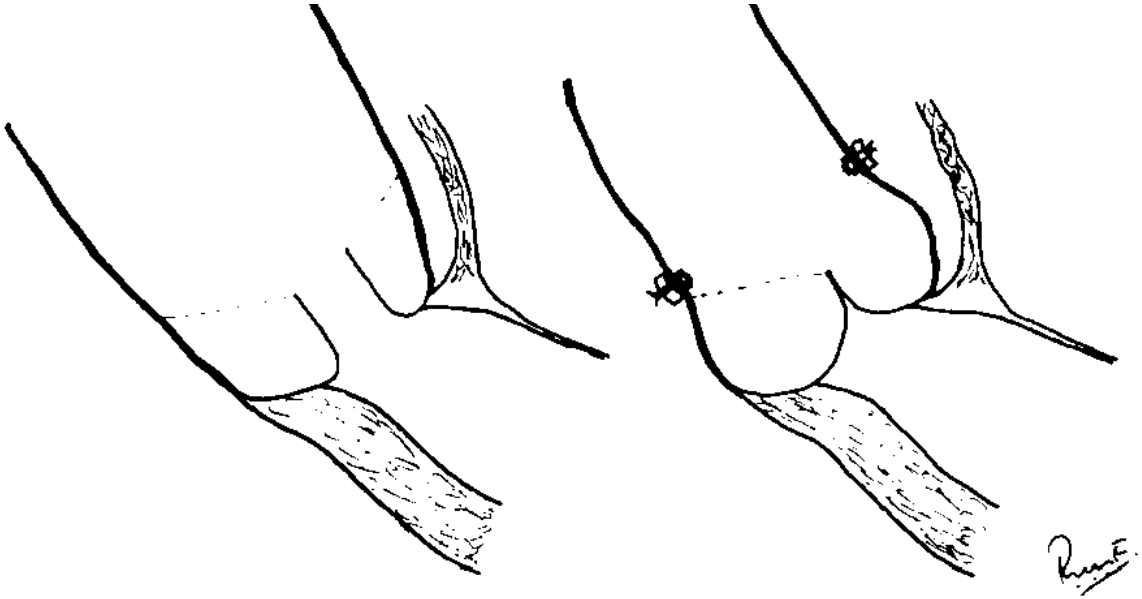
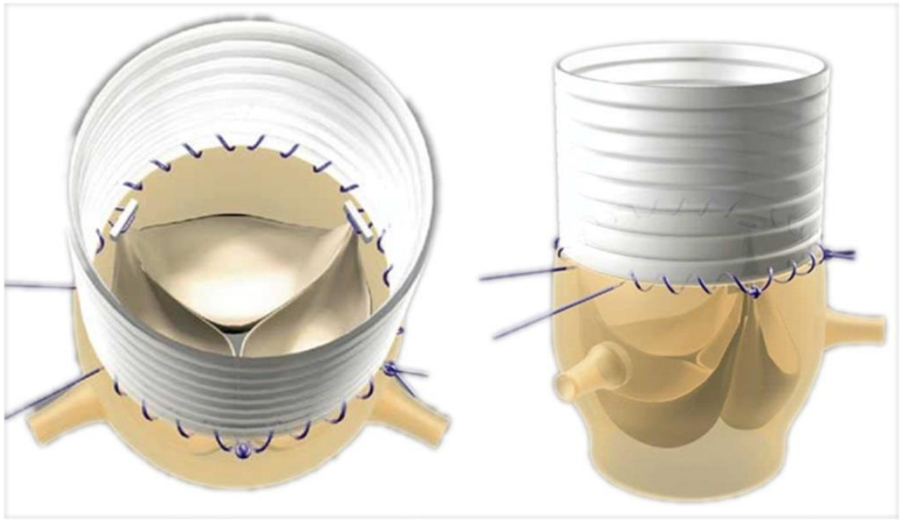


FIGURE 4. *Left*, The sinus rim is fixed in a systolic position. *Right*, The sinus rim reestablished in a diastolic position



Frater RW, Circulation 1986;74:I136-42

Mid-term results after sinutubular junction remodelling with aortic cusp repair†

Mitsuru Asano, Takashi Kunihara, Diana Aicher, Hazem El Beyrouti, Svetlana Rodionycheva, and Hans-Joachim Schäfers*

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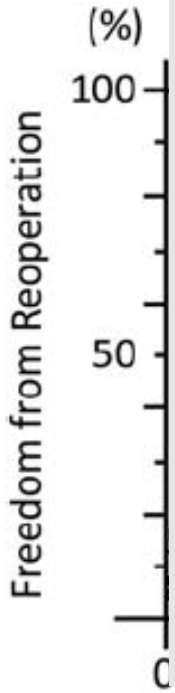

Table 4: Analysis of risk factors for reoperation

	Univariate	Multivariate	HR	95% CI
AVJ > 28 mm	<0.01	<0.01	11.647	2.506–54.134
Pericardial patch	<0.05	0.42		
Non-TAV	0.09	0.21		
Cusp placation	0.10	0.14		
STJ > 30 mm	0.20	0.28		
Sinus valsalva	>40 mm	0.53		

AVJ: aortoventricular junction; STJ: sinutubular junction; HR: hazard ratio; CI: confidence interval.

Asano et al. Eur J Cardiothorac Surg. 2012;42(6):1010-5

Conclusions

- Valve stability after root remodeling and reimplantation are identical
  - even in Marfan patients.
- Additional cusp repair improves long-term results.
- Root remodeling can preserve the aortic valve with excellent long-term stability also in aortic dissection and root dilatation.
- STJ remodeling is a good option in patients with preserved sinus dimensions.

Results of Cusp and Root repair