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Reconstruction of the Aortic Valve and Root: A practical Approach

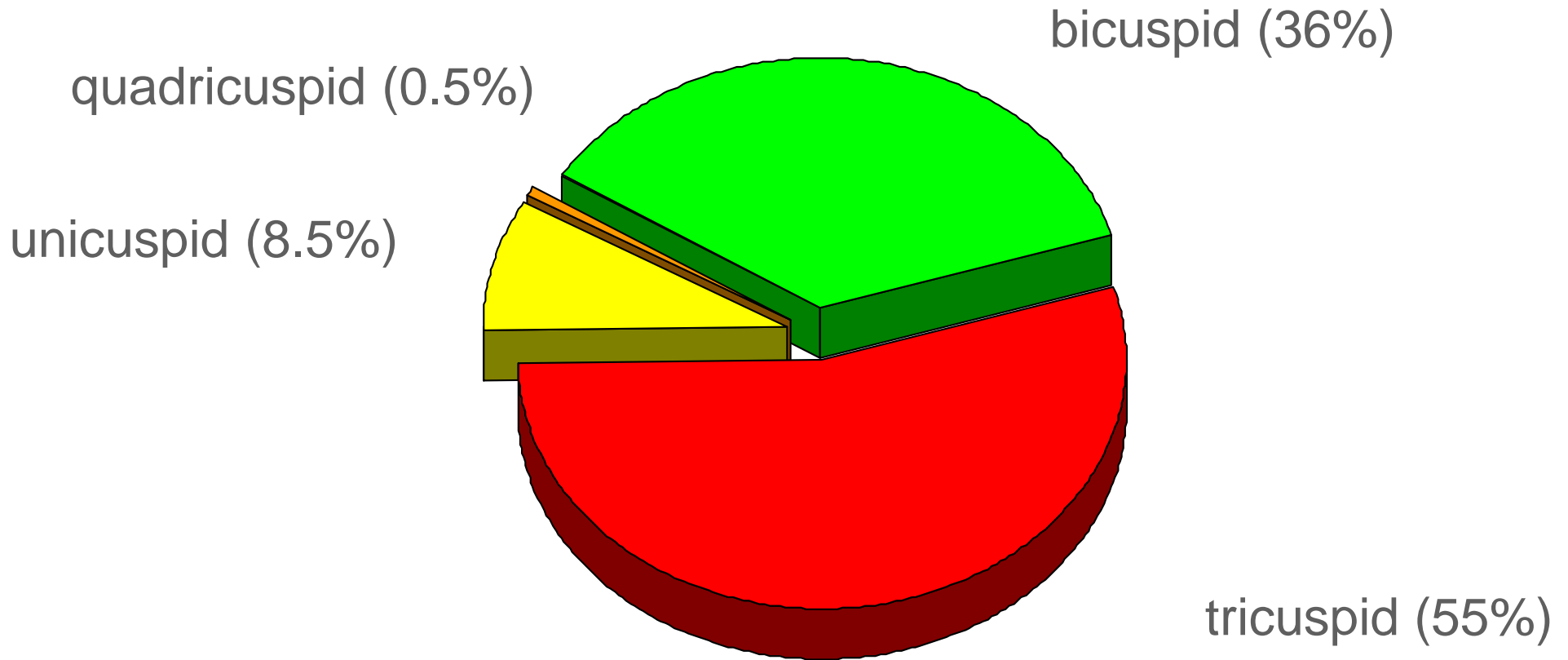
Results of Root and Cusp Repair

Prof Dr Diana Aicher

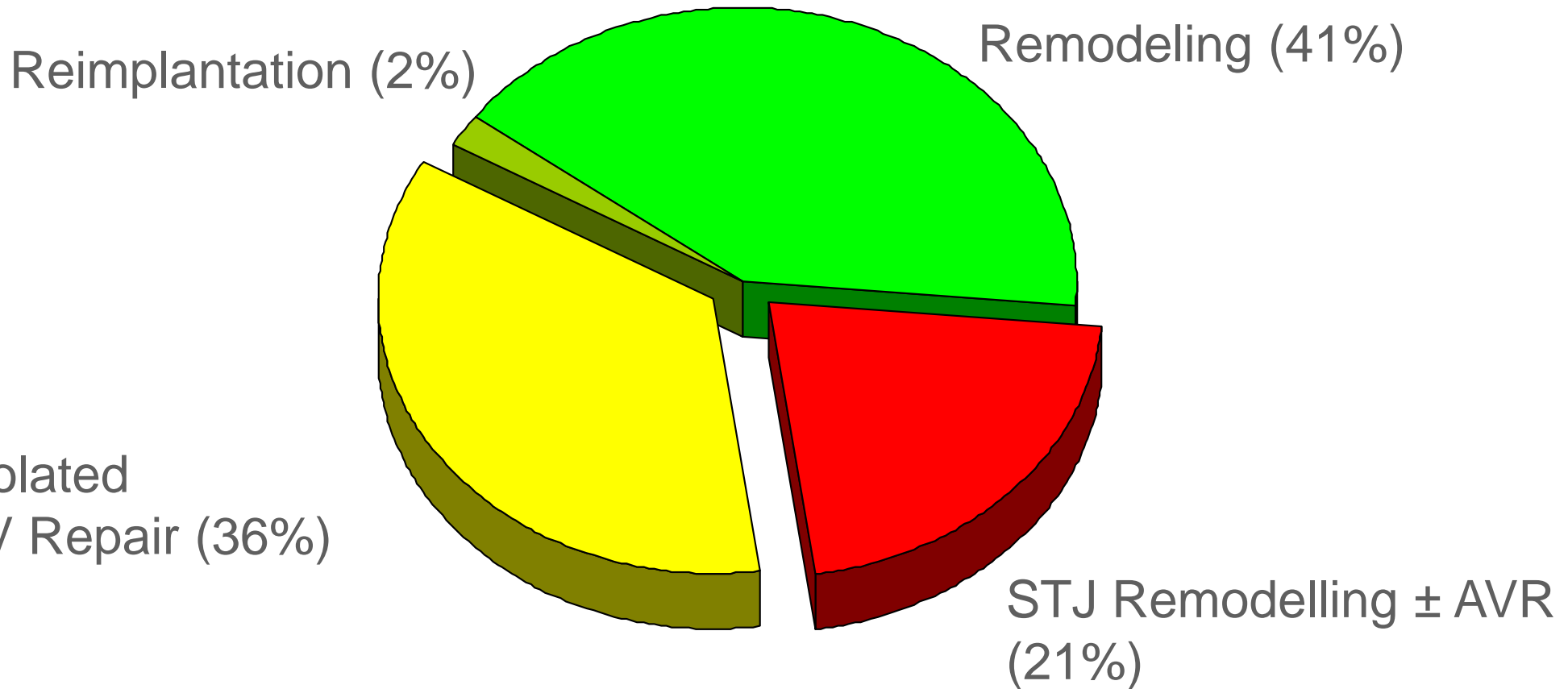
September 14th-16th 2016



Aortic Valve Morphology n=2217



Aortic Valve Repair n=2217

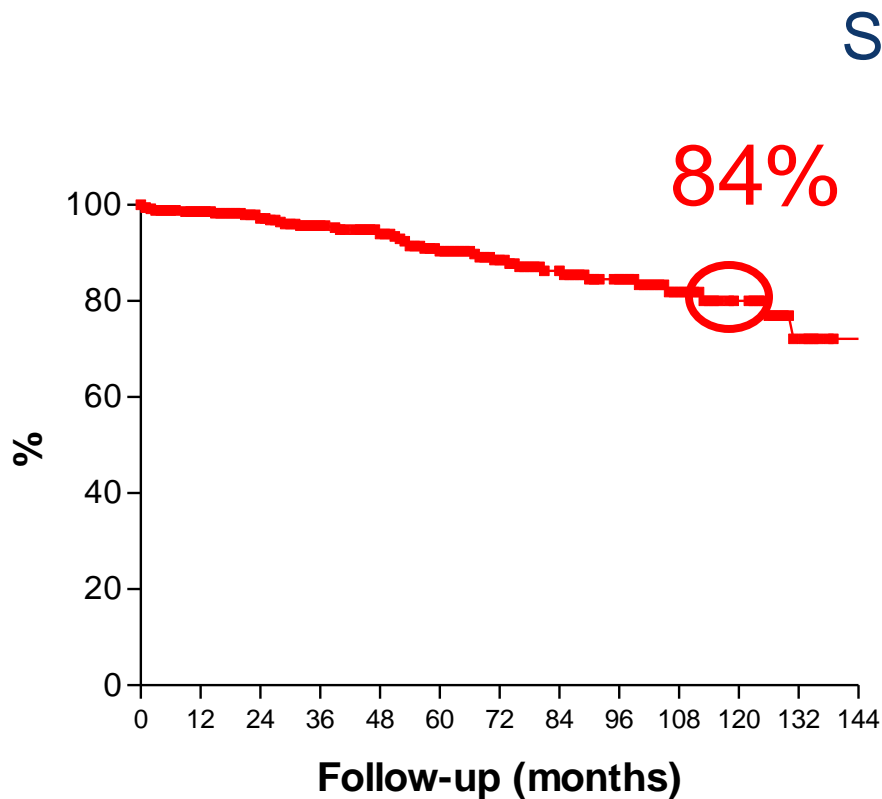


Valve preserving surgery (10/1995- 3/2009)

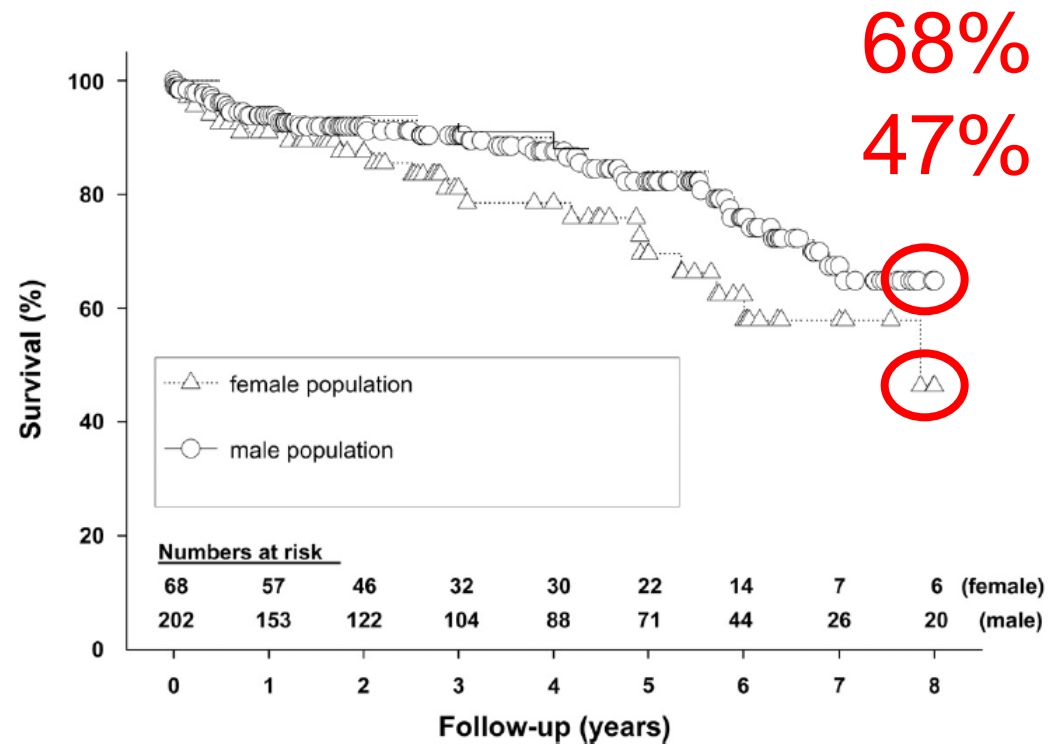
	Remodeling (N=401)	Reimplantation (N=29)	p
Age (years)	58 ± 15	42 ± 16	
Sex (m/f)	300/101	19/8	
Tricuspid AV	271	27	
BAV/UAV	124/6	2/-	
Diagnosis: Aneurysm	336	22	
AADA	59	7	
CADA	6	-	
Marfan	13	12	
Myocardial Ischemia (min)	82 ± 20	112 ± 24	0.01
Hospital mortality			
total	13/401 (3.2 %)	0/29	0.32
elective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

Results of Root and Cusp Repair

Aortic Root Repair (Homburg)



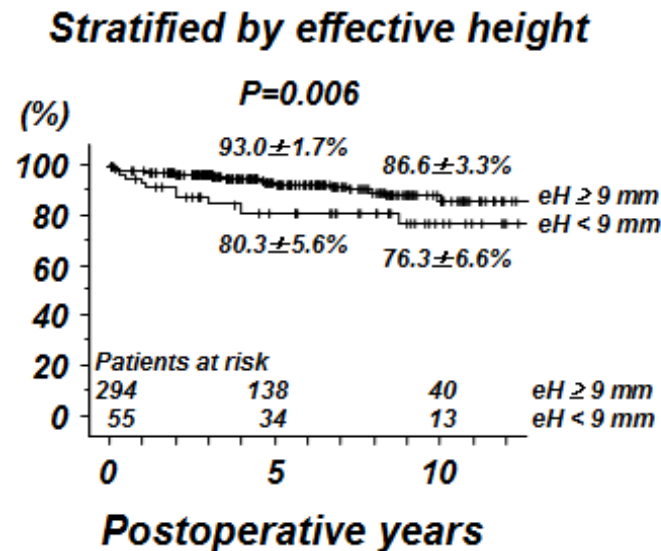
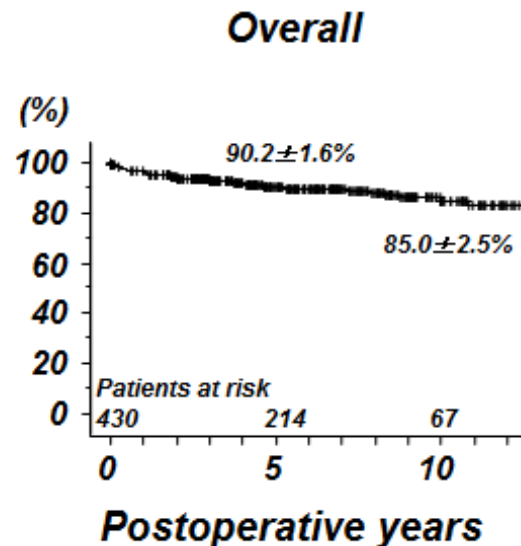
Aortic Root Replacement (Composite)



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,[~] Heinrich-Volker Groesdonk, MD,^a Frank Langer, MD,^a Fumihiko Sata, MD, PhD,^b and Hans-Joachim Schäfers, MD, PhD^a

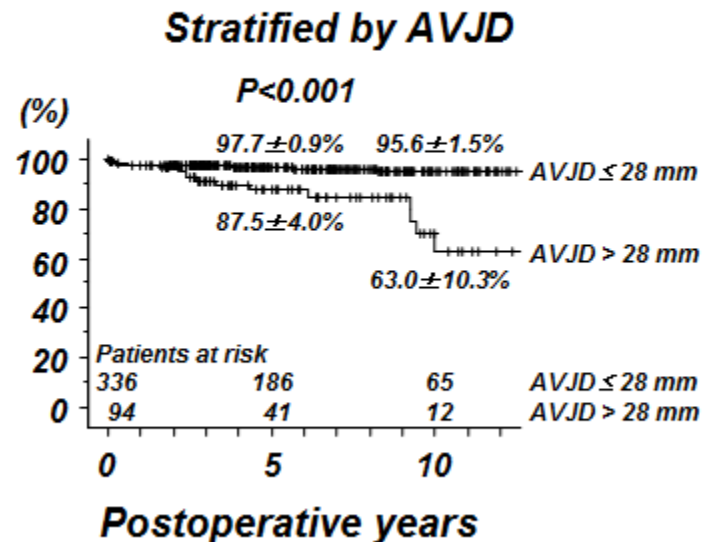
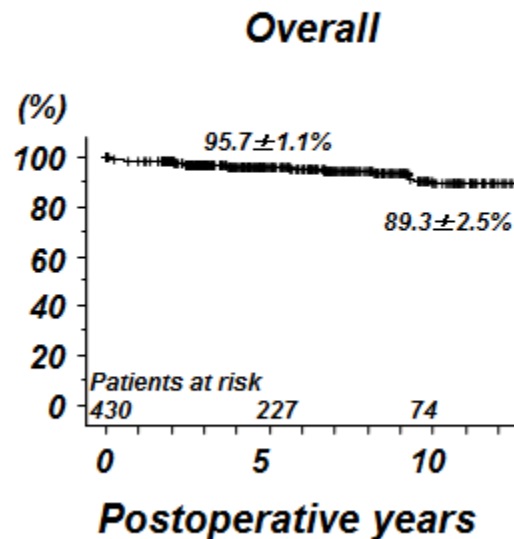
Freedom from AR \geq II



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

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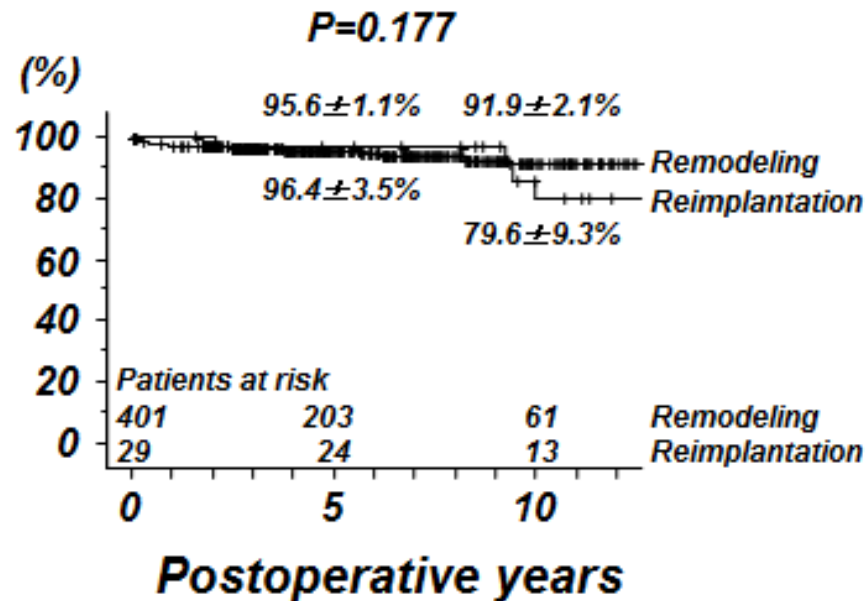
Freedom from Reoperation



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

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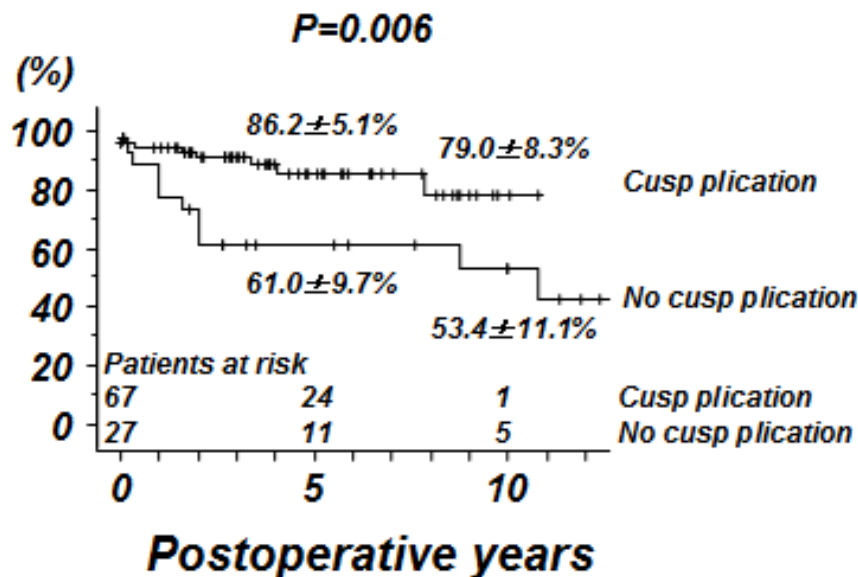
Freedom from Reoperation



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

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Hans-Joachim Schäfers, MD, PhD^a

**Freedom from AR \geq II in
cases with AVJD $>$ 28mm**



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

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Hans-Joachim Schäfers, MD, PhD^a

TABLE 1. Predictors of late aortic valve stability

	Univariate <i>P</i> value	Multivariate <i>P</i> 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	.565		
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	.007	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.

Valve-preserving Surgery

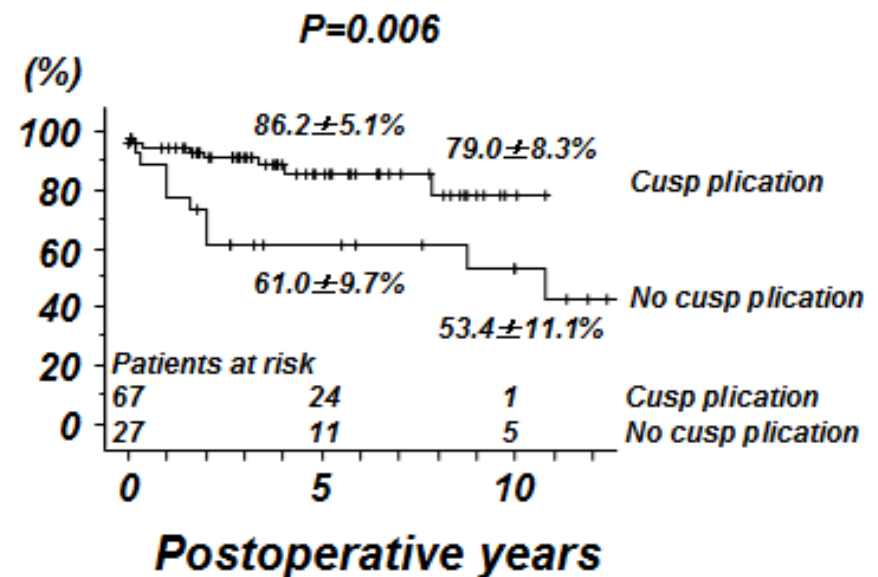
Suboptimal valve stability for AVJ > 28mm:

AVJ > 28mm risk factor or

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



Freedom from AR \geq II in cases with AVJD > 28mm



Valve-preserving Surgery: Reasons for Reoperation

	Remodeling n=401	Reimplantation n=29
Cusp prolapse	10	-
Cusp suture dehiscence	6	-
Cusp retraction	3	-
Endocarditis	2	1
Commissural detachment	-	2
Aortic valve stenosis	1	-
	22 (5.5%)	3 (10.3%)

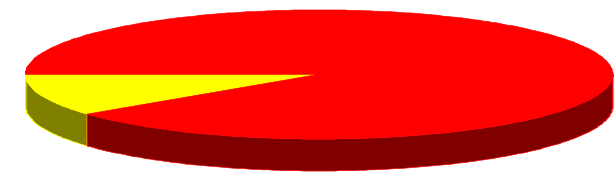
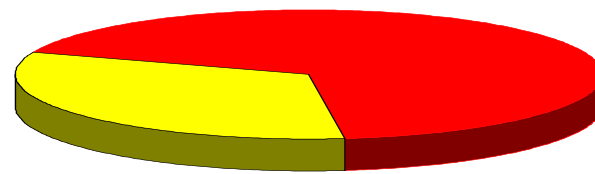
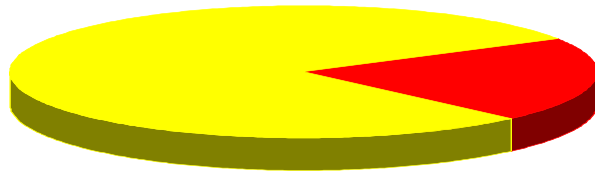
Results of Root and Cusp Repair

Cusp prolapse correction (%)

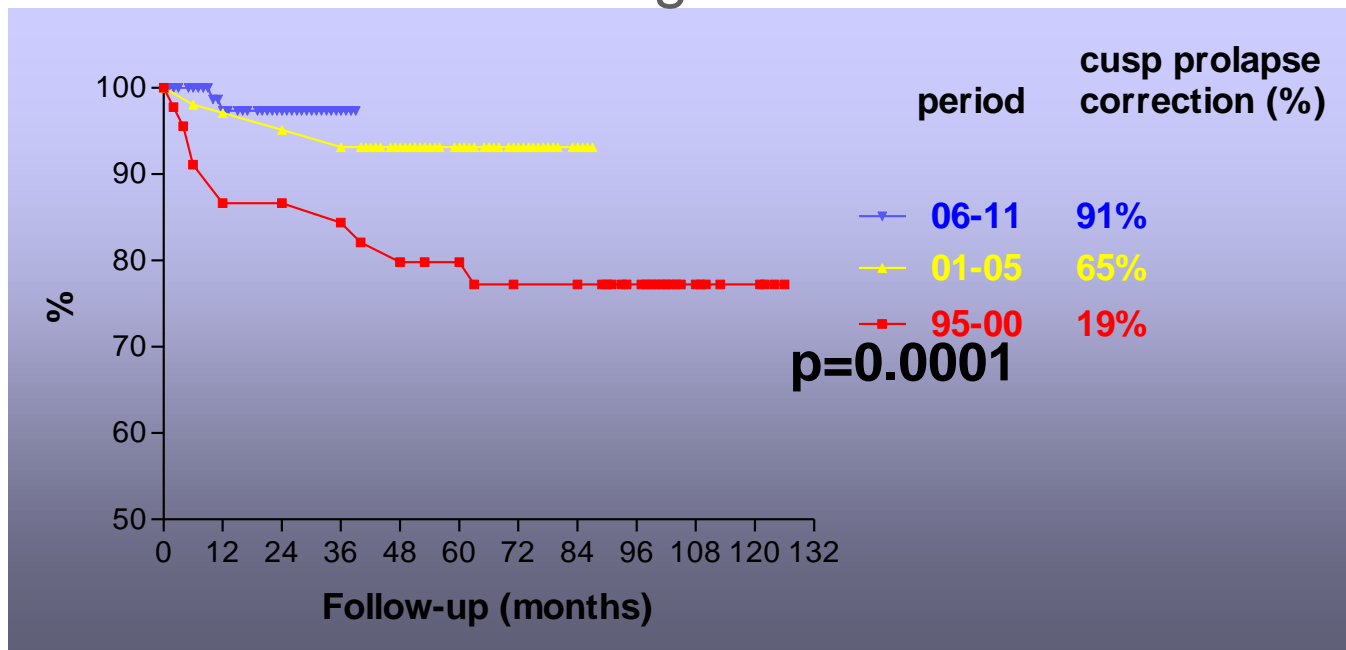
1995-2000: 19%

2001-2005: 65%

2006-2011: 91%



Learning Curve

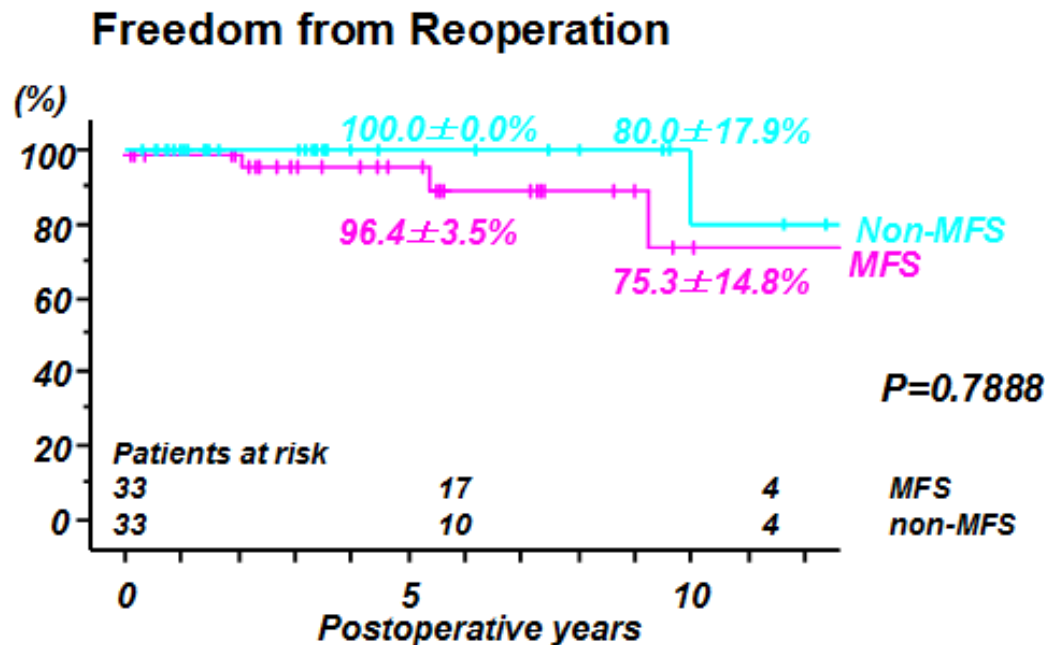


J Heart Valve Dis. 2012 Sep;21(5):615-22.

Outcomes after valve-preserving root surgery for patients with Marfan syndrome.

Kunihara T¹, Aicher D, Rodionychewa S, Asano M, Tochii M, Sata F, Schäfers HJ.

Long-term valve stability between patients with Marfan and propensity score-matched cohort without Marfan.



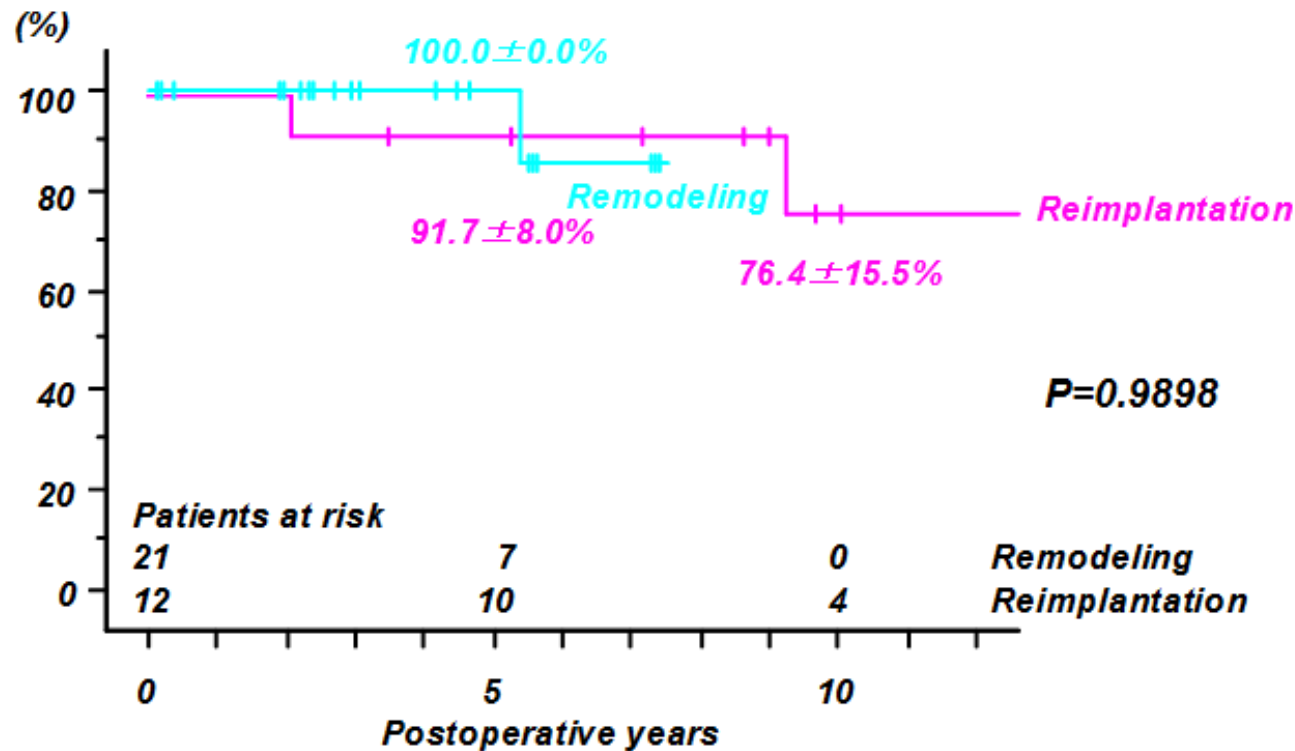
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Freedom from Reoperation of MFS





Root Remodeling and Aortic Valve Repair for Unicuspid Aortic Valve

Marco Franciulli, MD, Diana Aicher, MD, Tanja Rädle-Hurst, MD, Hiroaki Takahashi, MD, PhD, Svetlana Rodionycheva, MD, and Hans-Joachim Schäfers, MD, PhD

preoperative patients characteristics (12/2007 and 11/2013)

	range	mean	median
<i>Gender(M/F)</i>		23/2	
<i>Age (y)</i>	21-65	38±12	34
<i>AR (degree)</i>	2.5-3.5	2.9±0.3	3
<i>Preoperative gradient</i>			
<i>max (mmHg)</i>	6-74	21.4±17	20
<i>mean (mmHg)</i>	3-48	11.5±10	10
<i>diameter ascending aorta (mm)</i>	50-64	51±4	50
<i>Sinus diameter (mm)</i>	45-55	48±5	47



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Early Results:

- No death
- 92% AR 0; 8% AR I at discharge,
- systolic mean gradient of 6 ± 3 mmHg at discharge

Mid-term Results:

- No death
- No bleeding or thromboembolic events
- One endocarditis (healed with conservative treatment)

Valve stability:

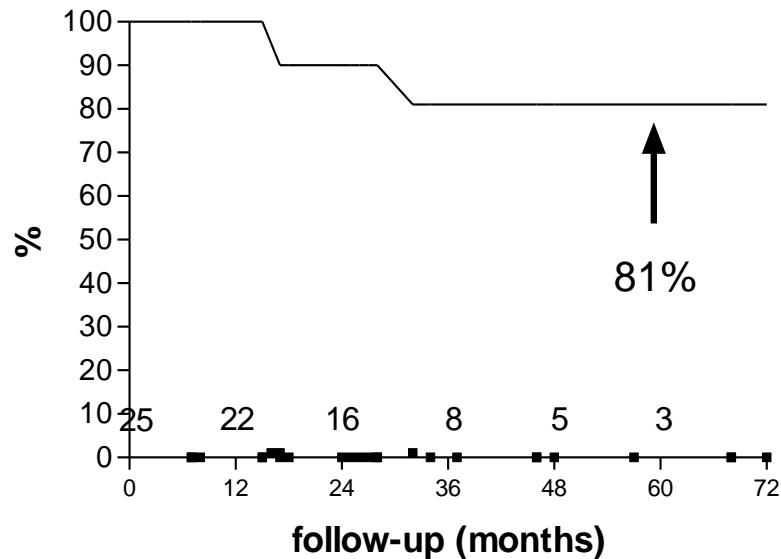
- 3 reoperations (2 suture dehiscence patch/cusp: no annular stabilization; 1 after endocarditis) biologic AV replacement (n=1); re-repair (n=2)
- Of 5 patients without annular support, 2 underwent reoperation (40%) versus 1 of 20 (5%) who were treated by suture annuloplasty.

Root Remodeling and Aortic Valve Repair for Unicuspid Aortic Valve

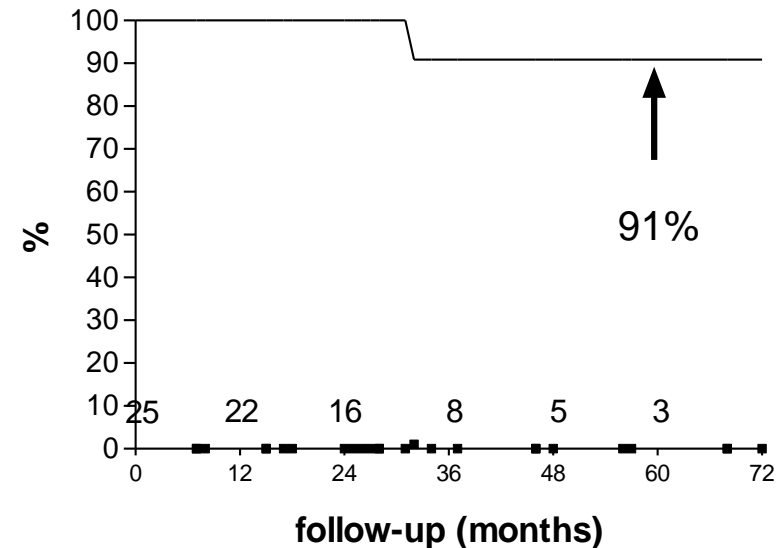
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Results:

freedom from reoperation



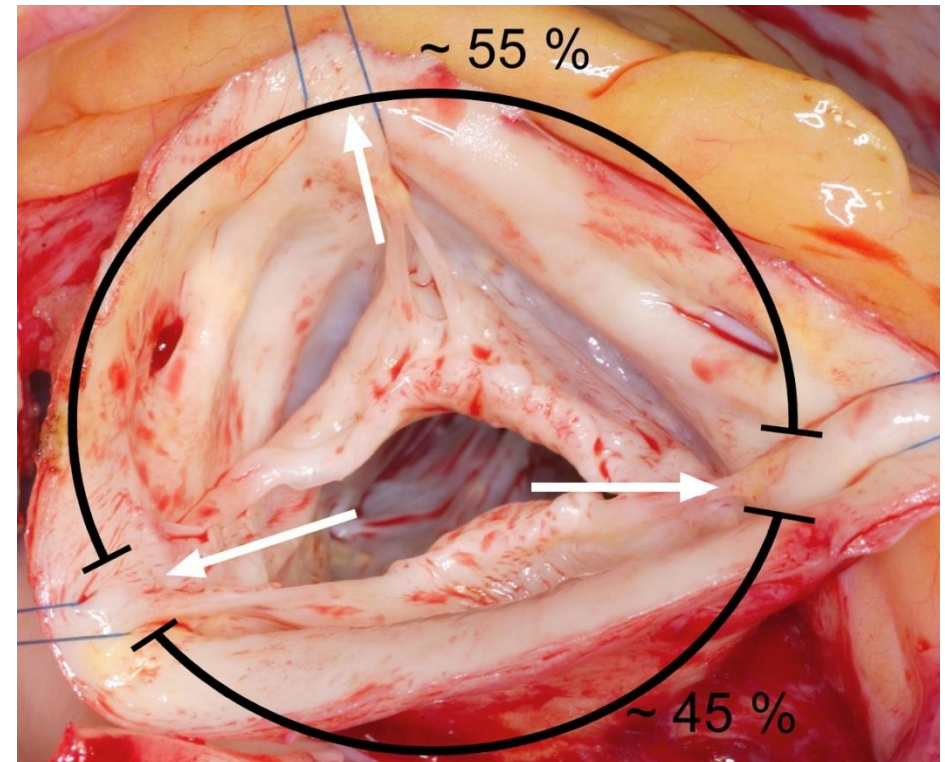
freedom from valve replacement



Cumulative follow-up 677 months (mean 27 ± 18 months)

Advantages of Remodeling

- Identical valve stability compared to reimplantation
- Shorter ischemic time
- Individual anatomy in different morphologies (asymmetry regarding position of the coronary ostias and depth of the sinuses) can be easily adapted by remodeling
- Preserved aortic distensibility



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.

ABSTRACT Idiopathic dilatation of the aortic root may commonly cause chronic insufficiency of the aortic valve. In these patients the cusp and sinuses are normal or virtually normal in area and pliability and the coronaries are not displaced. The insufficiency in these patients may be totally corrected by an adjustment of the intercommissural distance at the sinus rim level. The dilated ascending aorta is dealt

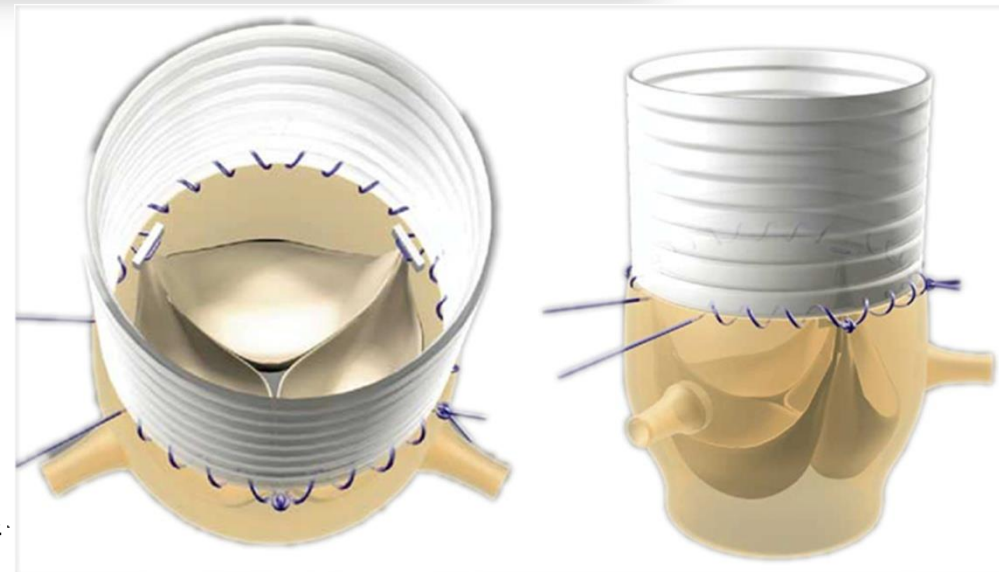
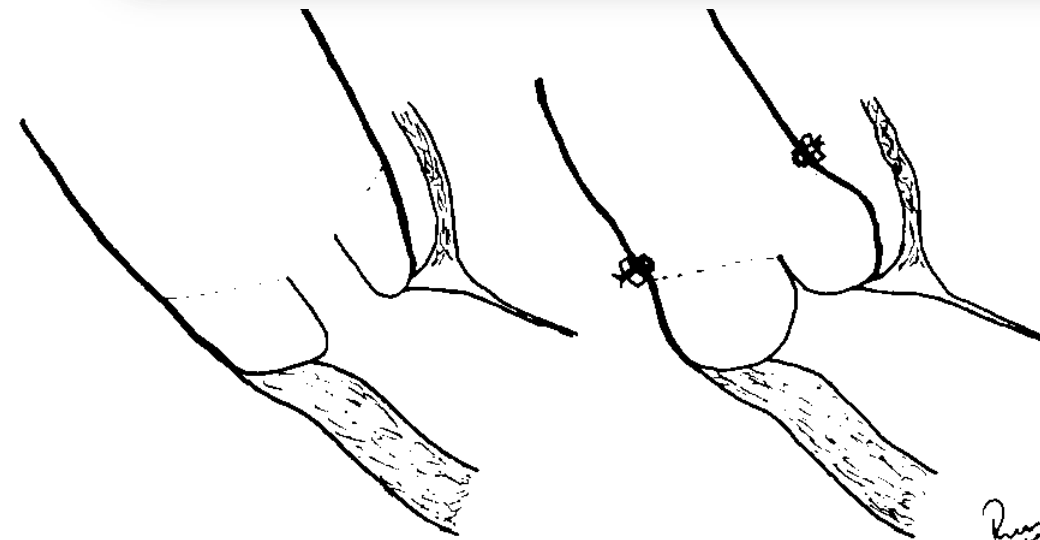


FIGURE 4. *Left.* The sinus rim is fixed in a systolic position. *Right.* The sinus rim reestablished in a diastolic position



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

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

Patients characteristics

n	144
Age (years)	56.0 ± 17
Male, n (%)	103 (71.5)
BSA (m ²)	1.95 ± 0.13
Left ventricular ejection fraction (%)	60.8 ± 13.0
Aortic regurgitation (grade)	3.2 ± 0.4
TAV (tricuspid)	58
Non –TAV (bicuspid /unicuspid)	86(59/27)

Diameter of aortic root (mm)

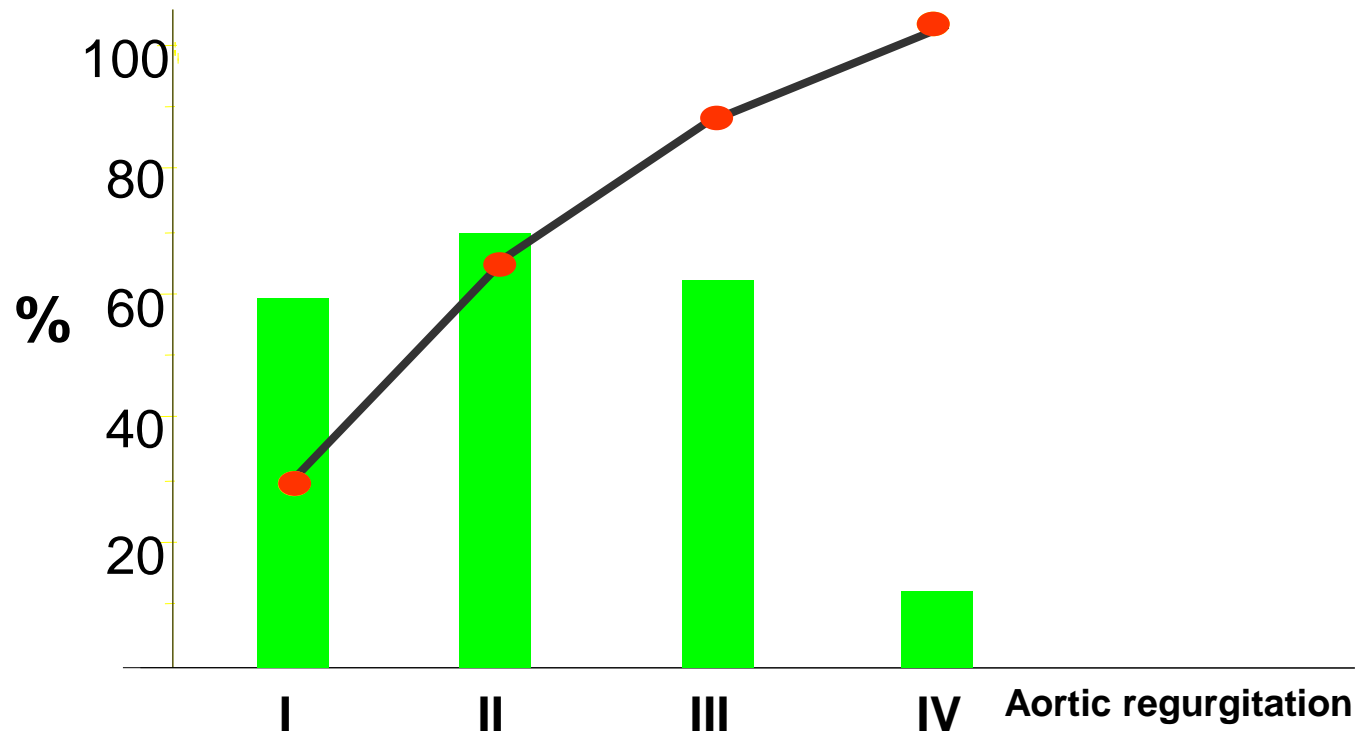
AVJ	27.3 ± 2.4
Sinus valsalva	36.8 ± 2.9
Sinutubular junction	30.7 ± 3.4
Ascending aorta	51.8 ± 6.1

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*

Correlation between cusp prolapse and aortic regurgitation

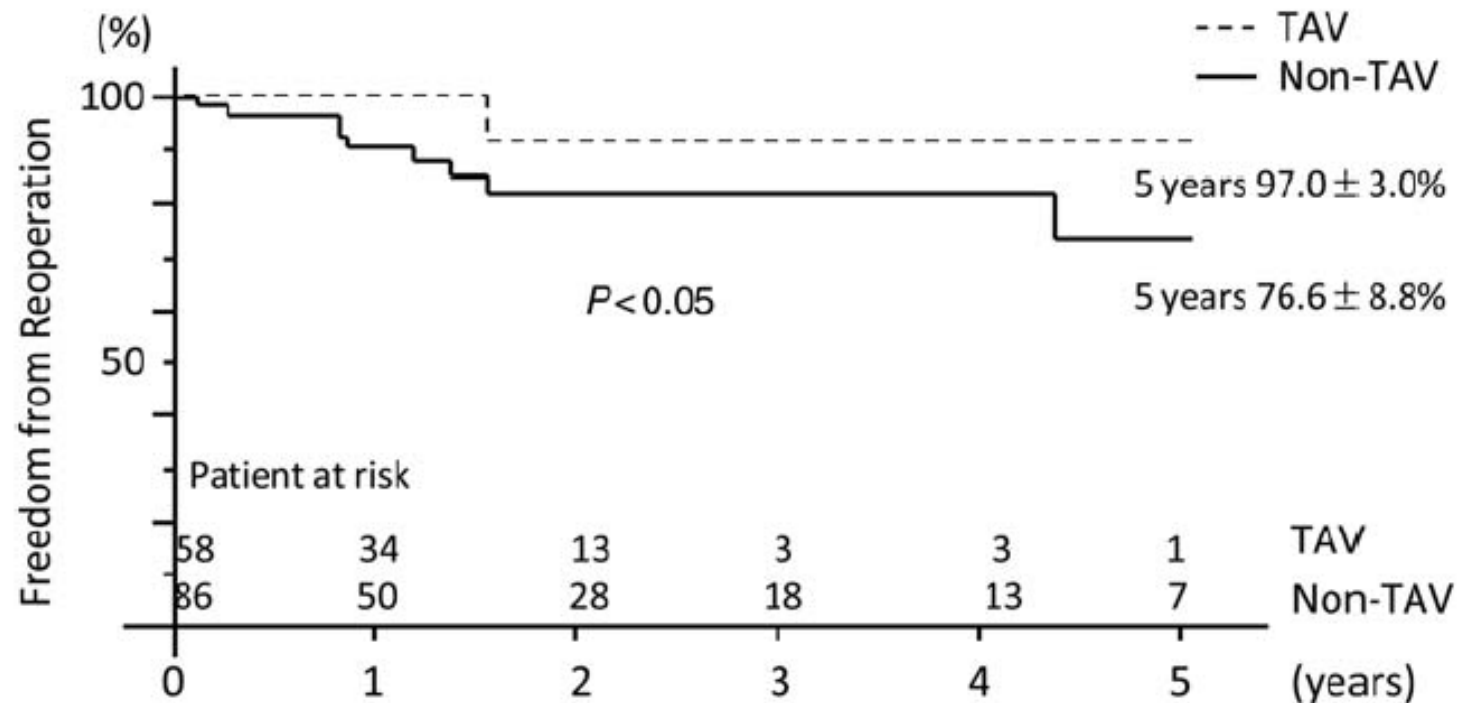
Cusp prolapse





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

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and Hans-Joachim Schäfers*

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 placcation	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.

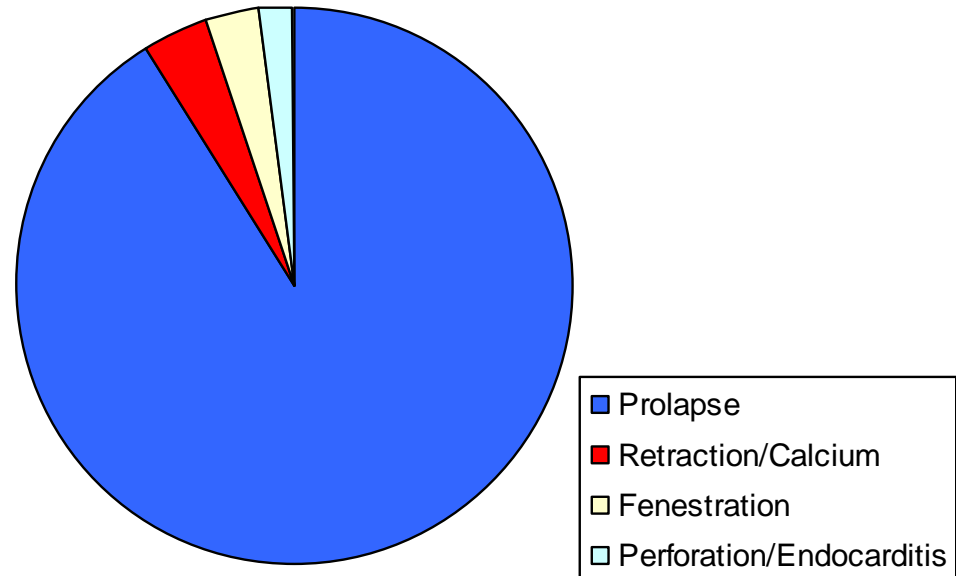


Conclusions: Root Repair

- Valve stability after root remodeling and reimplantation are identical - even in Marfan patients.
- STJ remodelling is a good option in patients with a preserved sinus.
- Additional cusp repair improves long-term results.

Causes of Cusp Alterations

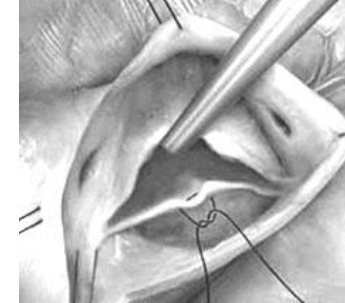
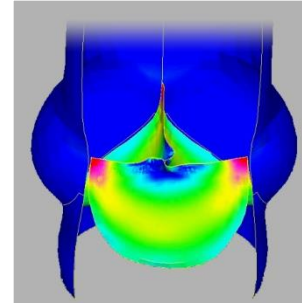
Prolapse	91%
Retraction / Calcium	4%
Fenestration	3%
Perforation/Endocarditis	2%



Cusp Repair: Prolapse – Homburg Techniques

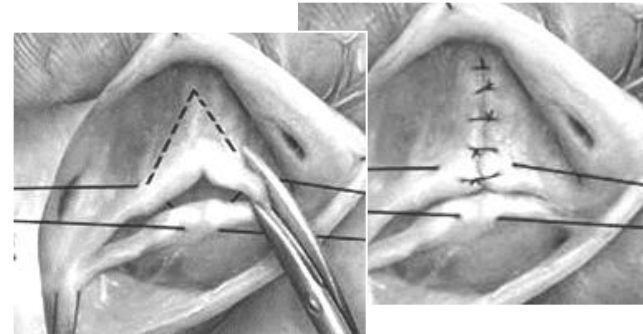
Prolapse

Central Cusp
Plication



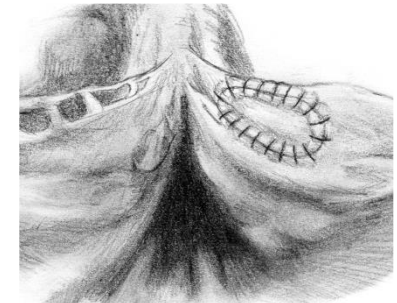
Prolapse +
Redundancy/
Fibrosis

Triangular
Resection



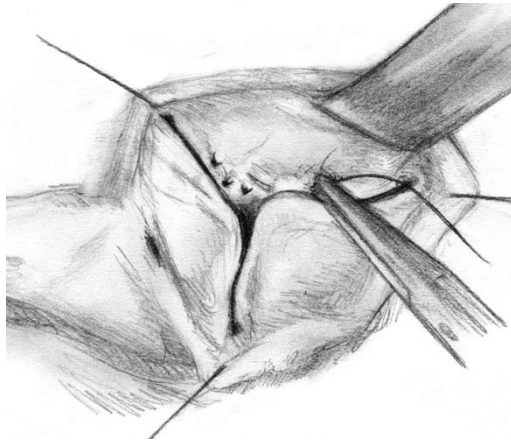
Prolapse +
Calcium/
Fenestrations

Pericardial
Patch

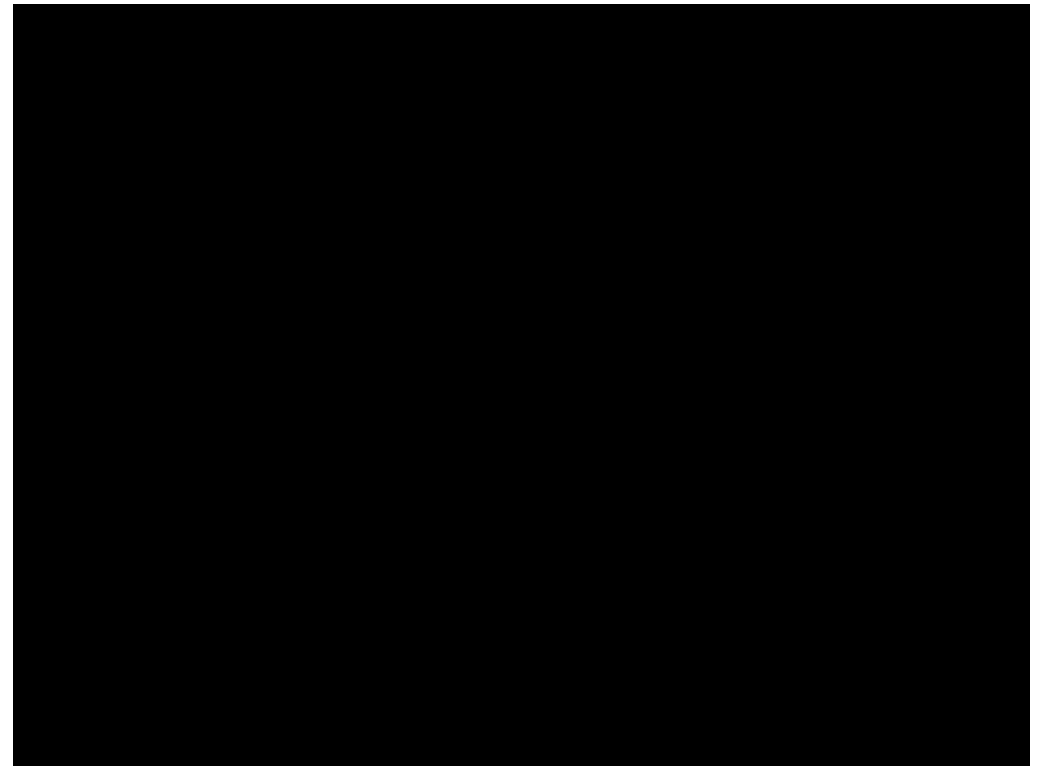


Reconstructive Techniques

Prolaps

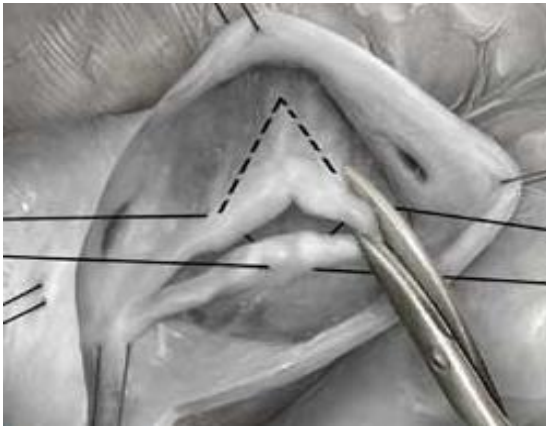


Central Plication

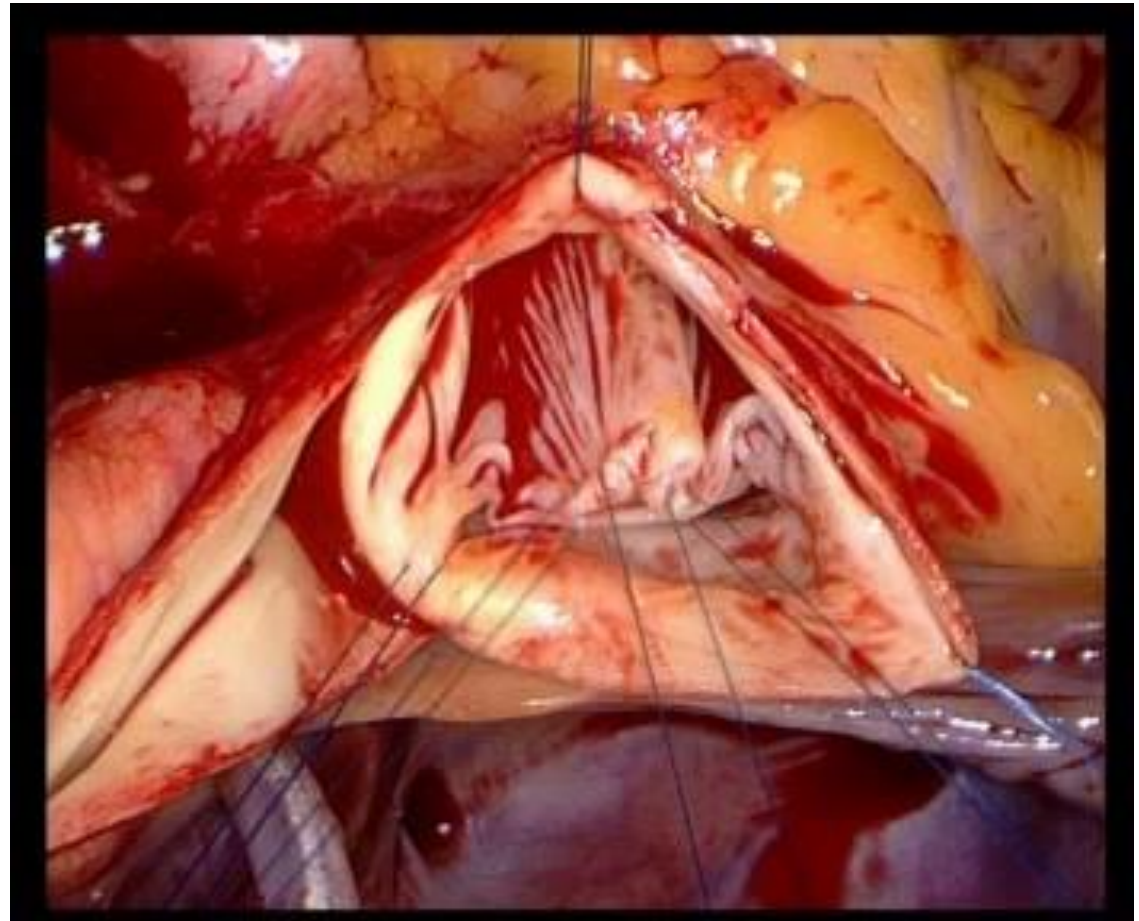


Reconstructive Techniques

Prolapse +Fibrosis/
Calcium, Redundancy

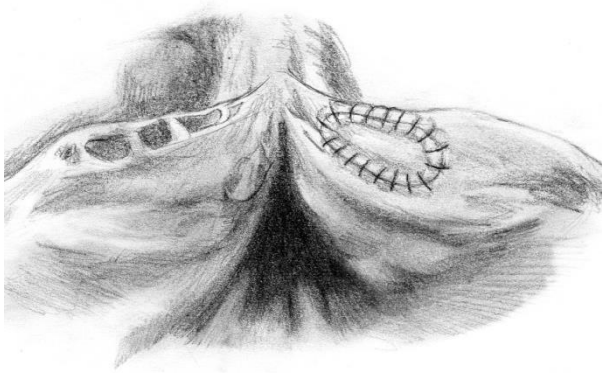


Triangular Resection



Reconstructive Techniques

Prolapse + Fenestration
Perforation



Cusp Stabilisation
(Pericardium)

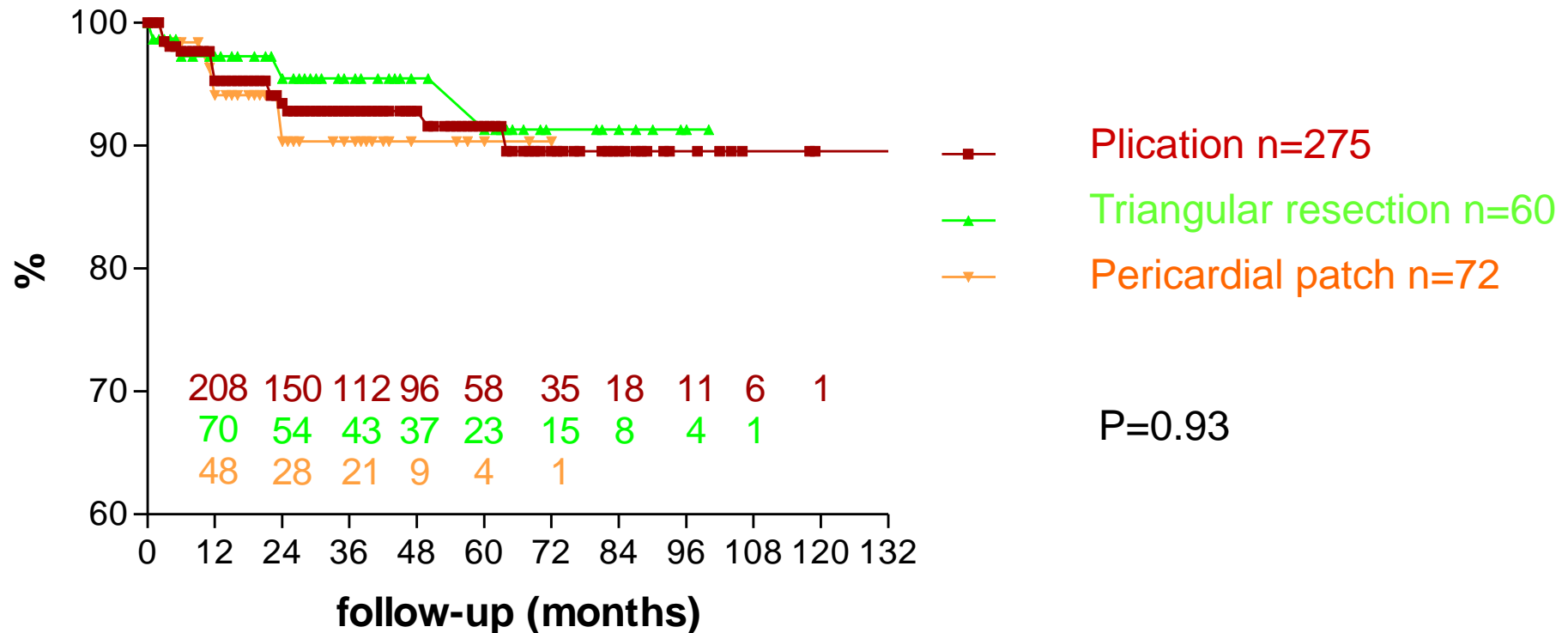




Cusp repair in aortic valve reconstruction: Does the technique affect stability?

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

Freedom from Aortic Regurgitation \geq II





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

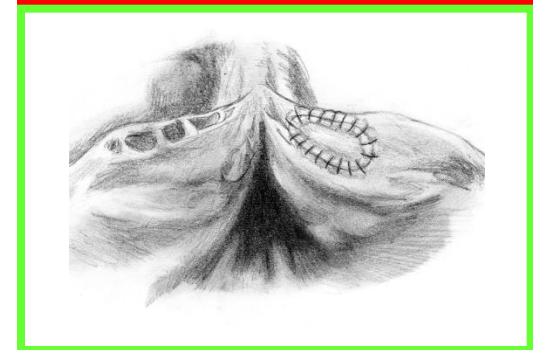
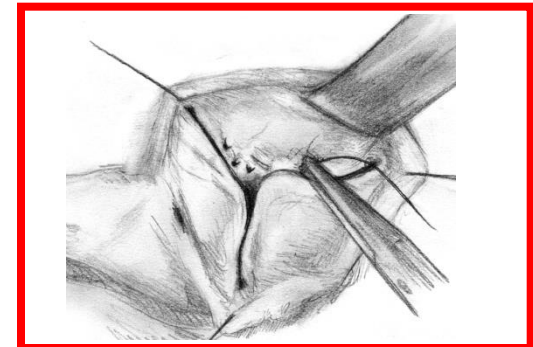
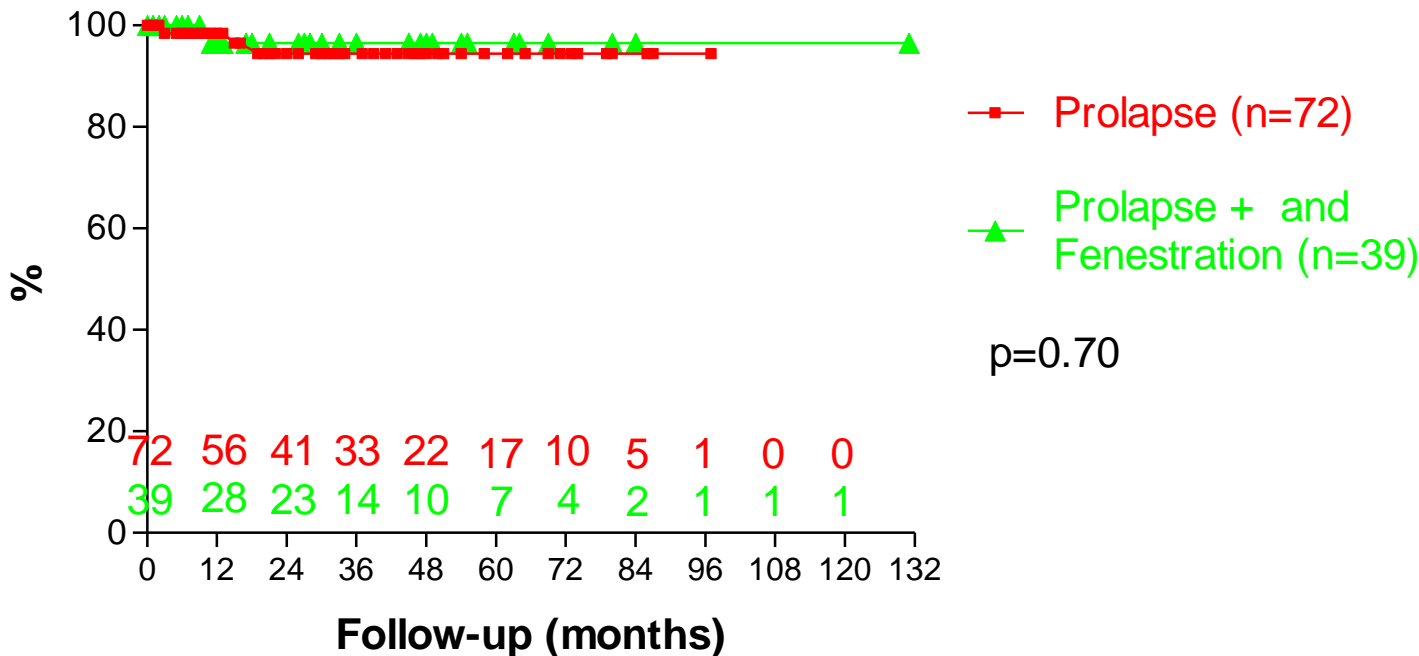
Hans-Joachim Schäfers, MD,^a Frank Langer, MD,^a Petra Glombitza, MD,^a Takashi Kunihara, MD,^a Roland Fries, MD,^b and Diana Aicher, MD^a

Tricuspid aortic valves	Prolapse (n=72)	Prolapse + Fenestration (n=39)
Plication		
• right-coronary	52	6
• non-coronary	54	12
• left-coronary	14	3
Pericardial patch		
• right-coronary		28
• non-coronary		9
• left-coronary		4
• 1 cusp	39	17
• 2 cusps	29	15
• 3 cusp	4	7

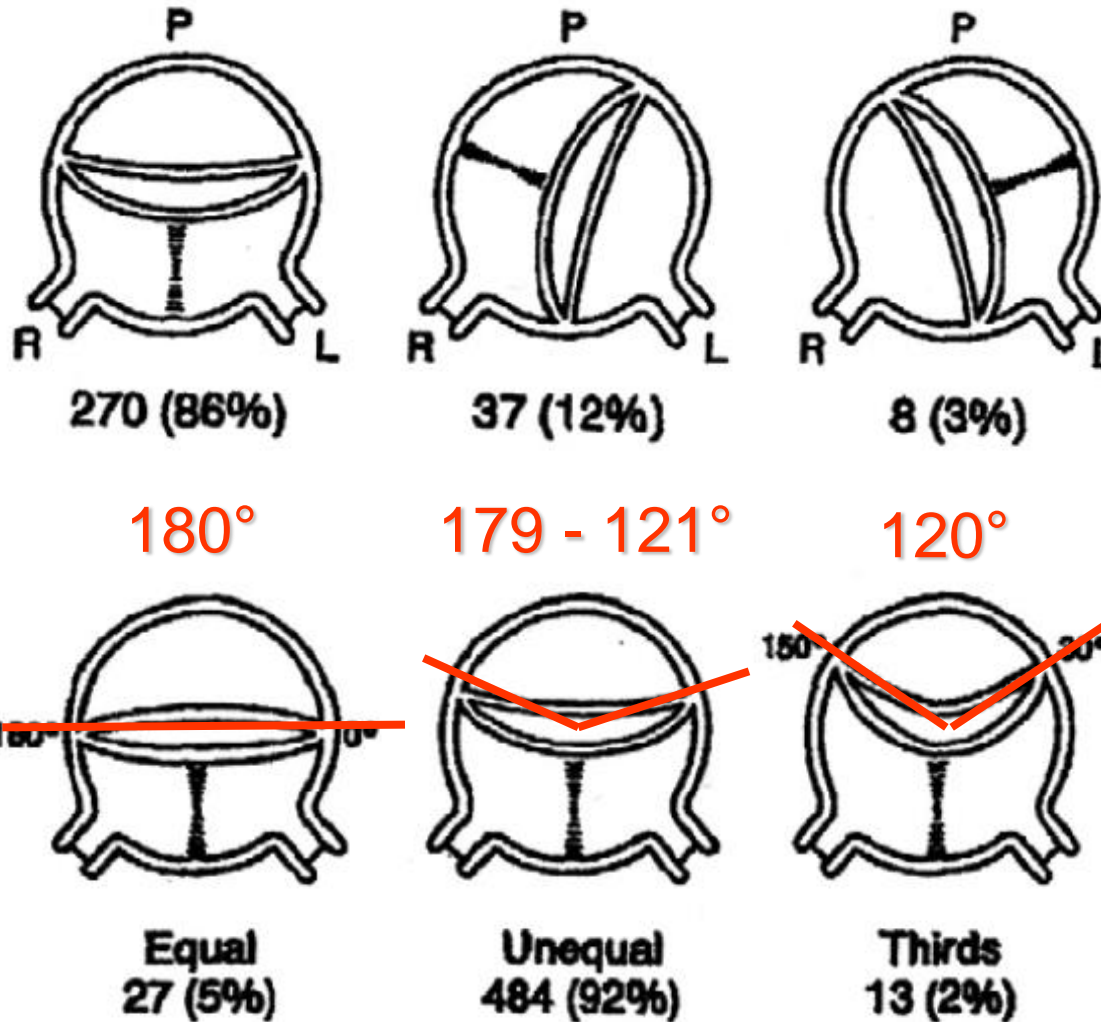
Aortic valve reconstruction in myxomatous degeneration of aortic valves: Are fenestrations a risk factor for repair failure?

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Freedom from Reoperation



Anatomic Variants of bicuspid Valve Morphology



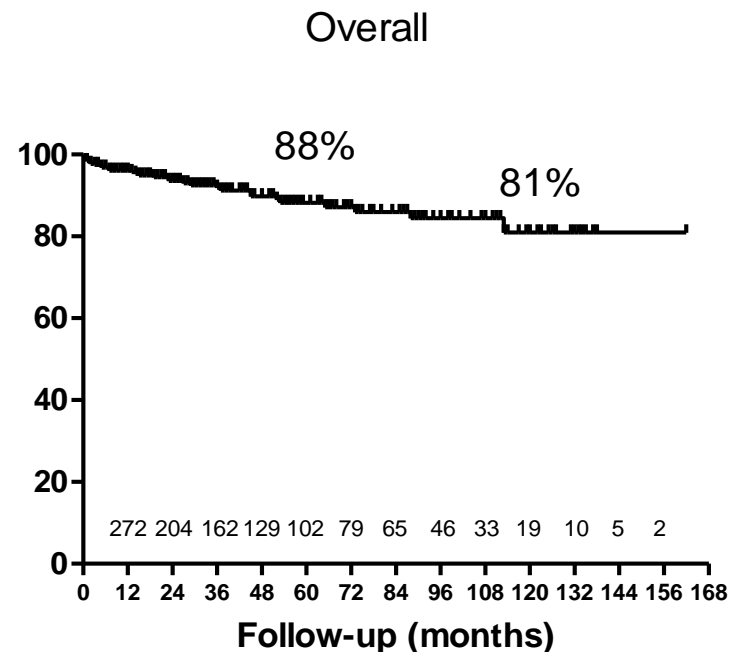


Valve Configuration Determines Long-Term Results After Repair of the Bicuspid Aortic Valve

Diana Aicher, MD; Takashi Kuniyama, 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	

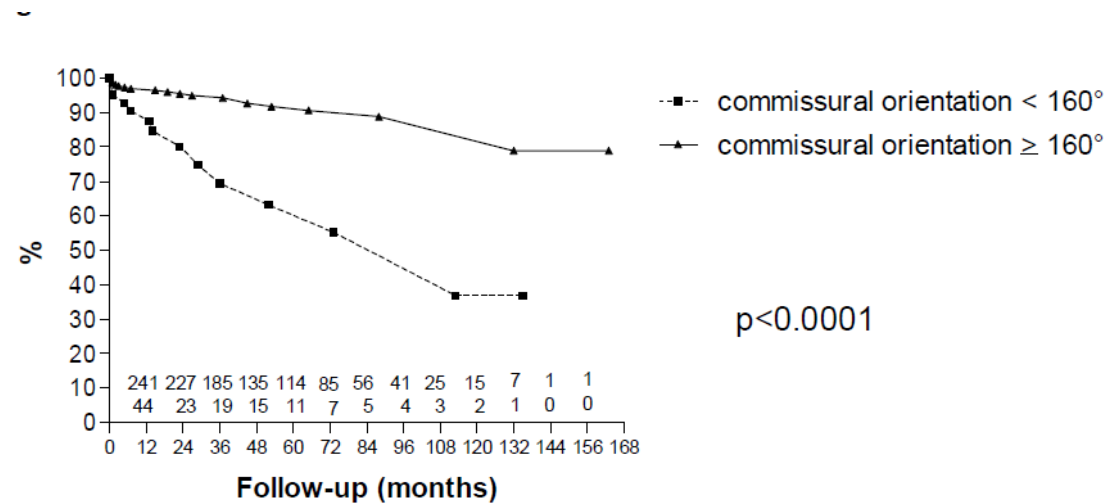
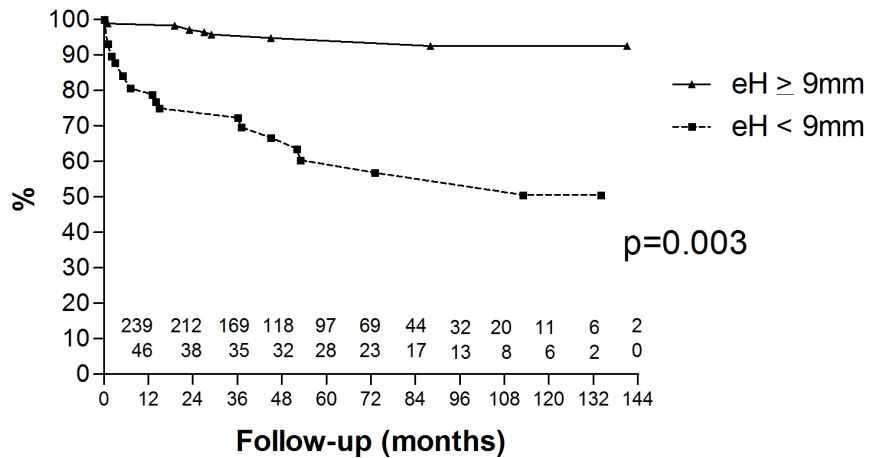
Actuarial freedom from reoperation



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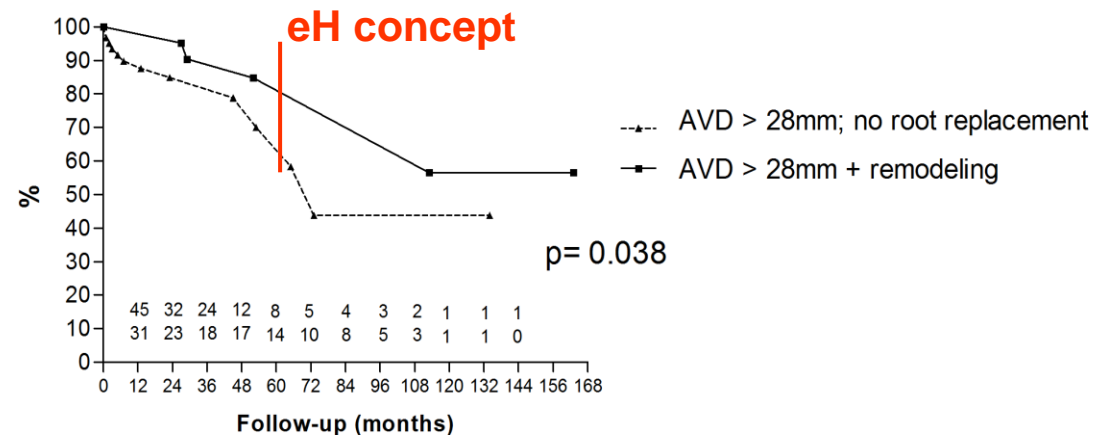
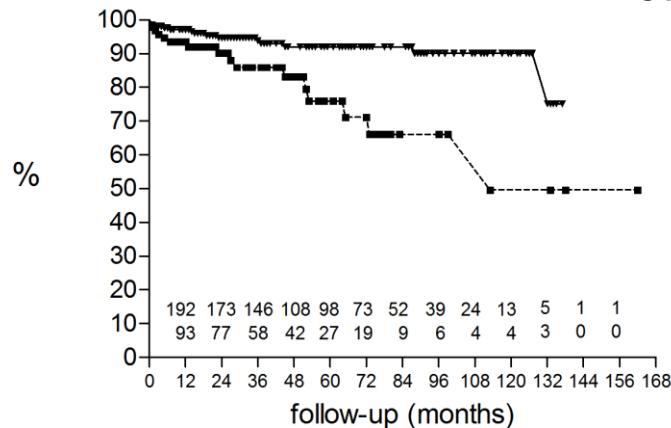
Actuarial freedom from reoperation



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Table 2. Results of Multivariable Analysis of Predictors for Reoperation

	HR	95% Confidence Interval	<i>P</i>
Age	0.955	0.928–0.982	0.001
eH	0.740	0.612–0.894	0.002
AVD	1.302	1.076–1.575	0.007
Commissural orientation	0.961	0.938–0.985	0.002
Pericardial patch	5.175	2.100–12.753	0.000
Subcommissural plication	0.699	0.299–1.633	0.408
Root repair	2.354	0.770–7.192	0.133

Early results with annular support in reconstruction of the bicuspid aortic valve

Diana Aicher, MD, Ulrich Schneider, Wolfram Schmied, Dipl Psych, Takashi Kuniyara, MD, Masato Tochii, MD, and Hans-Joachim Schäfers, MD, PhD

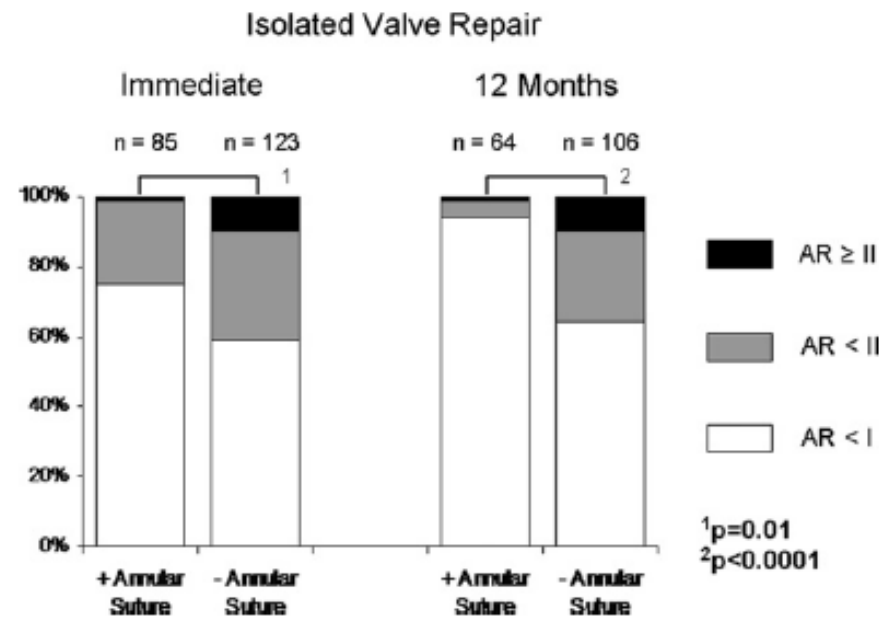
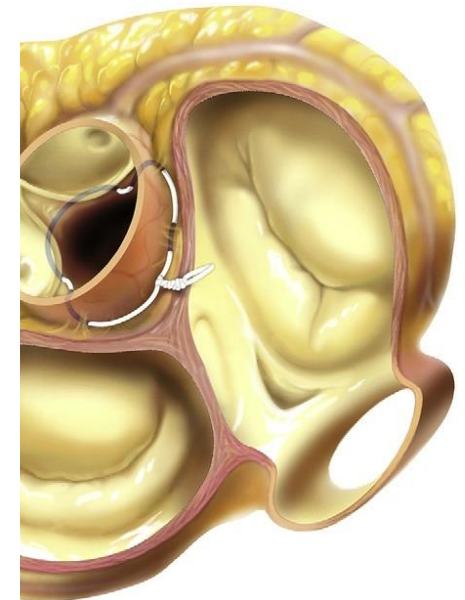
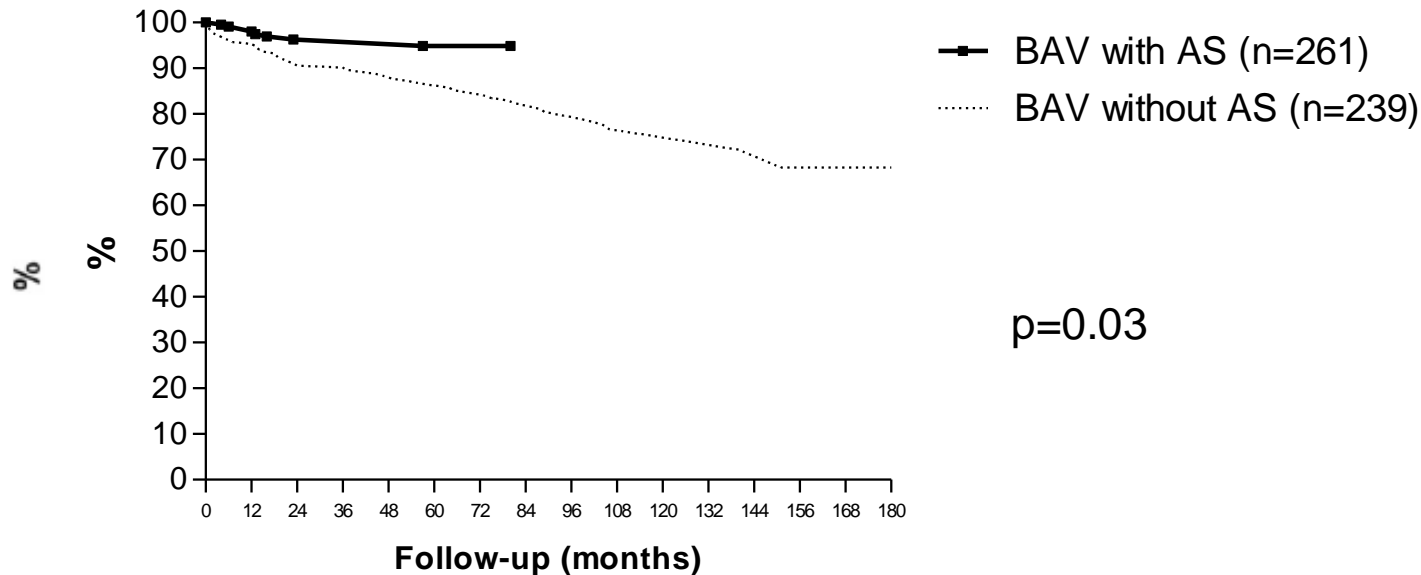


FIGURE 2. Postoperative degree of AR at discharge and 12 months after isolated aortic valve repair (- annular suture: without annuloplasty, + annular suture: with annuloplasty). AR, Aortic regurgitation.

Early results with annular support in reconstruction of the bicuspid aortic valve

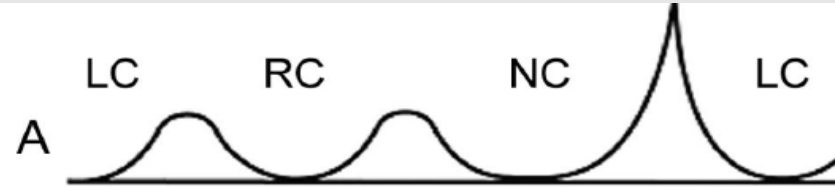
Diana Aicher, MD, Ulrich Schneider, Wolfram Schmied, Dipl Psych, Takashi Kuniyama, MD, Masato Tochii, MD, and Hans-Joachim Schäfers, MD, PhD

Freedom from reoperation

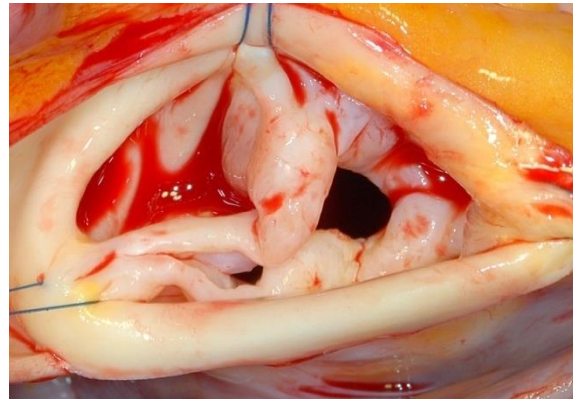


Unicuspid aortic valve repair

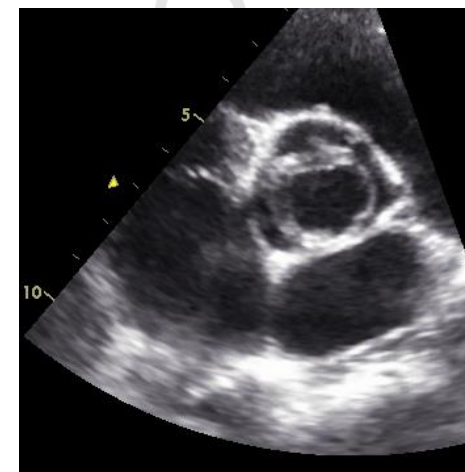
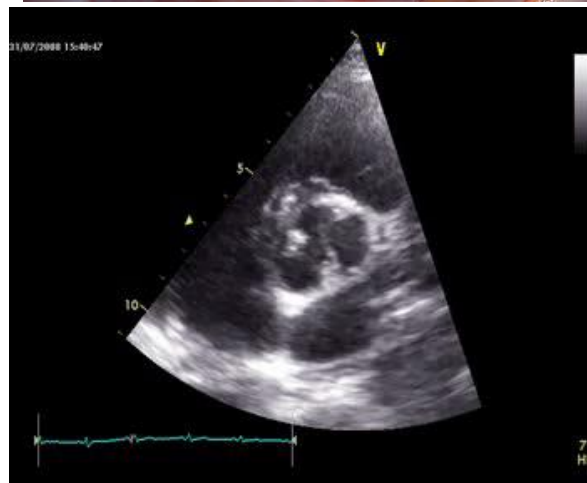
Unicuspid morphology



intraoperative



TEE



Results of Root and Cusp Repair

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

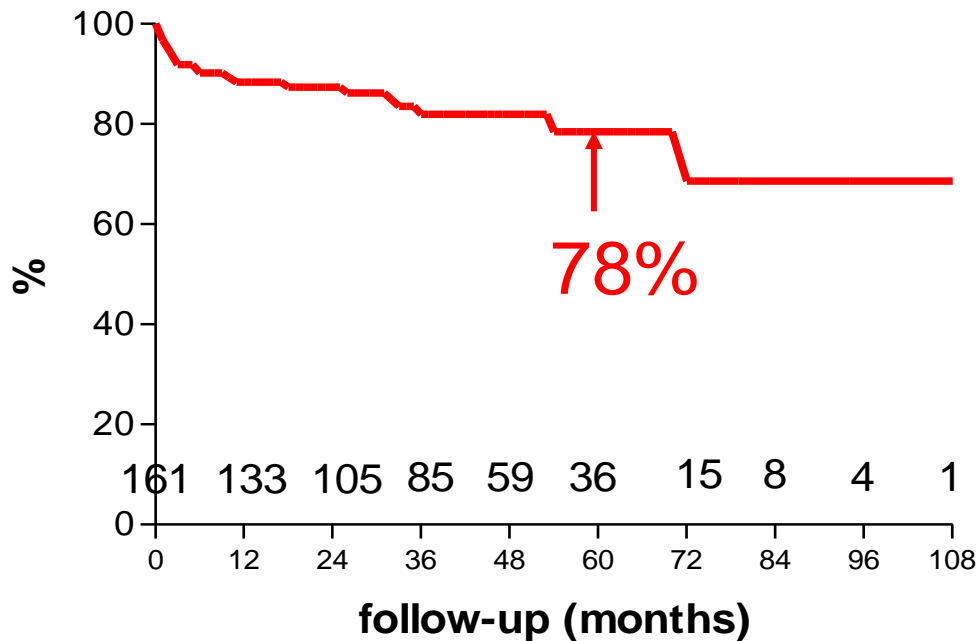
Departments of Thoracic and Cardiovascular Surgery and Pediatric Cardiology, University Hospitals of Saarland, Homburg/Saar, Germany



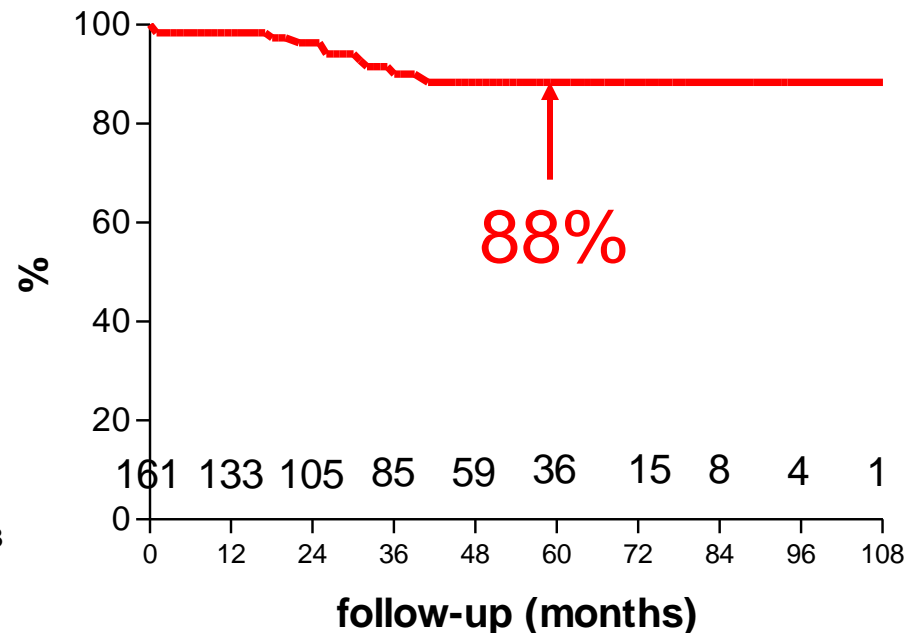
Unicuspid aortic valve repair (n=161)

n= 27 remodeling
 n= 35 STJ remodelling
 n= 99 isolated aortic valve repair

Freedom from Reoperation:



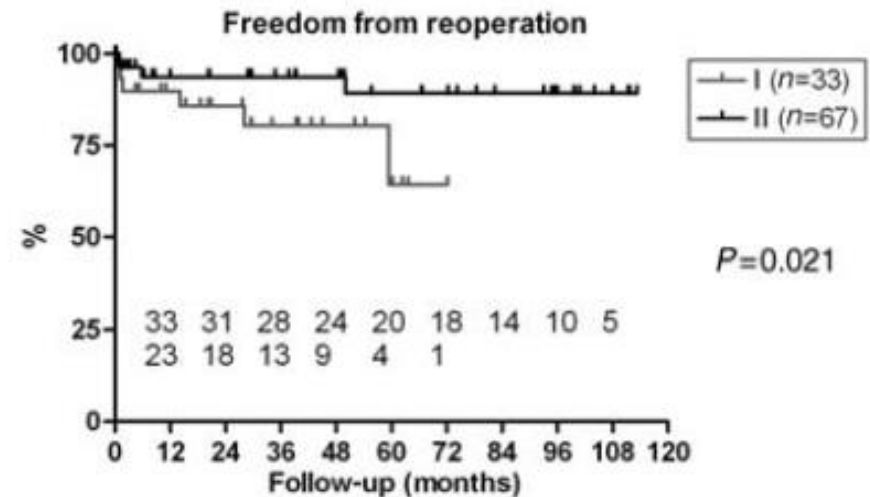
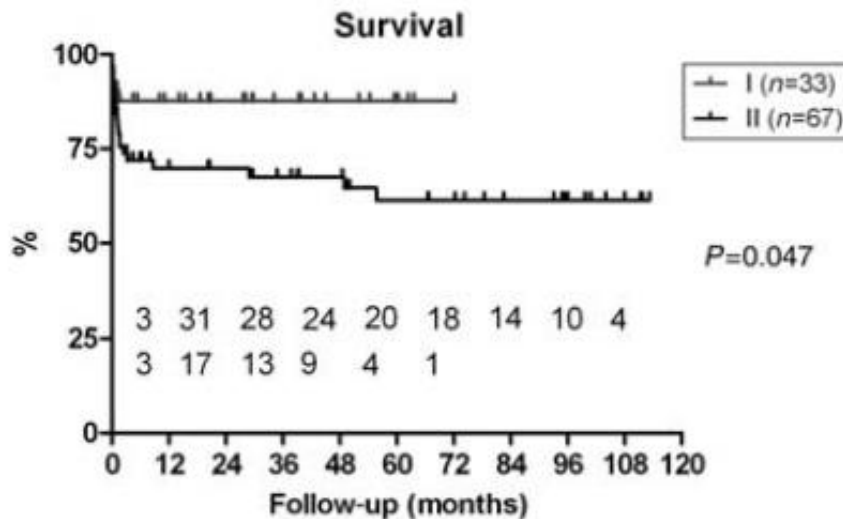
Freedom from Valve Replacement:



Repair versus replacement of the aortic valve in active infective endocarditis

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

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

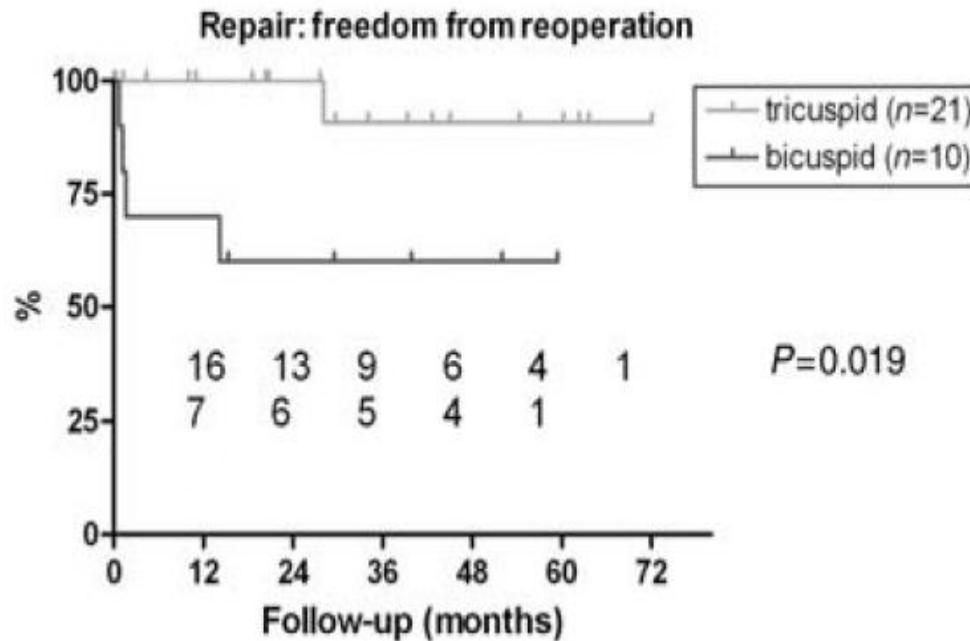


I Aortic valve repair
II Aortic valve replacement

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



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

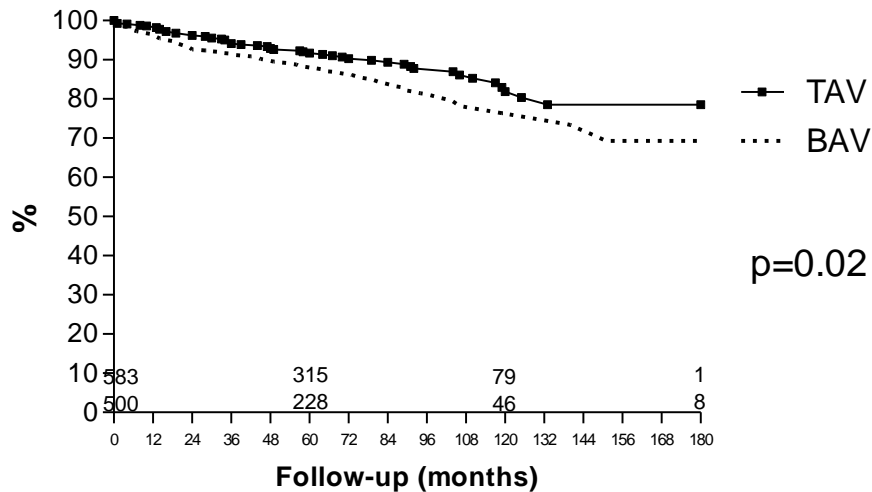


Conclusions

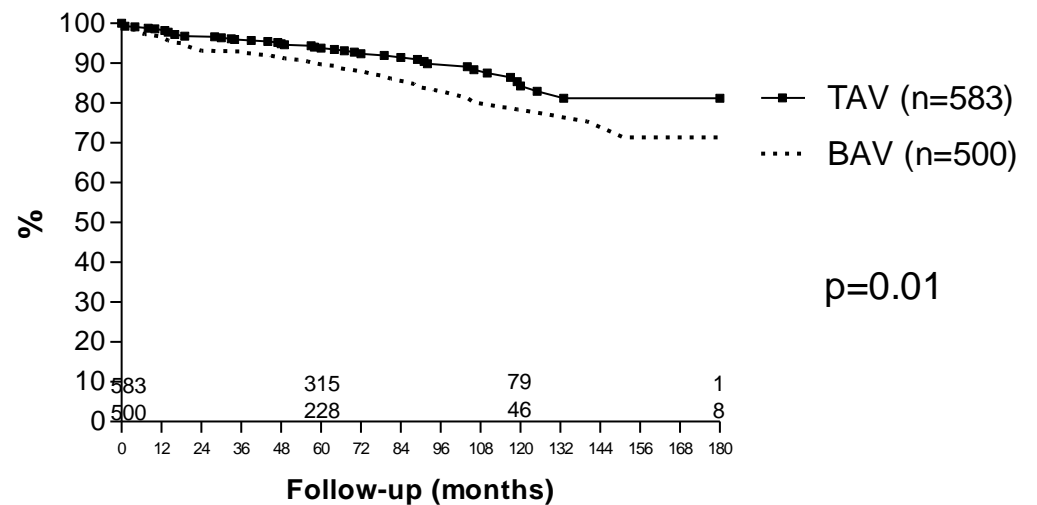
- Aortic cusp repair is possible with different techniques.
- Aortic cusp repair is possible in all valve morphologies – with good long-term results in bicuspid and tricuspid valve morphology.
- A suture annuloplasty improves long-term results in bicuspid AVR.
- In active infective endocarditis results of aortic cusp repair strongly depend on valve morphology and size of the implanted patch.

Isolated AVR in bicuspid and tricuspid AV n=1083

Freedom from aortic regurgitation \geq II



Freedom from reoperation



Results

Tab 1: Predictors of valve stability

	<u>univariate</u> <u>p-value</u>	<u>HR</u>	<u>95% CI</u>	<u>multivariate</u> <u>p-value</u>	<u>HR</u>	<u>95% CI</u>
<u>age</u>	<0.001	0.971	0.958-0.984	0.018	0.986	0.974-0.998
<u>bicuspid</u>	0.021	0.585	0.371-0.923			
<u>grade AR</u>	<0.001	1.957	1.419-2.698	0.065	1.345	0.982-1.841
<u>Prolapse</u>	<0.001	3.349	1.963-5.715			
<u>Retraction</u>	<0.001	0.236	0.13-0.43			
<u>Perforation</u>	0.121	0.328	0.08-1.341			
<u>Fenestration</u>	0.645	0.762	0.239-2.423			
<u>STJ remodeling</u>	<0.001	3.017	1.715-5.308	<0.001	4.488	2.632-7.653
<u>Plication</u>	0.001	2.498	1.426-4.376			
<u>Patch</u>	<0.001	0.286	0.182-0.45			
<u>Triangular Resection</u>	0.027	0.548	0.322-0.932			
<u>Subcommisural Plication</u>	0.154	0.709	0.441-1.138			
<u>Number of cusps</u>	0.623	1.091	0.772-1.541			
<u>AS</u>	0.209	1.421	0.821-2.459	0.06	0.578	0.326-1.023
<u>eH<9mm</u>	<0.001	0.507	0.469-0.547	<0.001	0.454	0.451-0.497

quality Cox-Modell:
 -2 Log-Likelihood = 997.870,
 Chi2 = 784.825, p < .001