



**UKS**  
Universitätsklinikum  
des Saarlandes

Reconstruction of the Aortic Valve and Root: A practical approach

## **Results of Cusp and Root Repair**

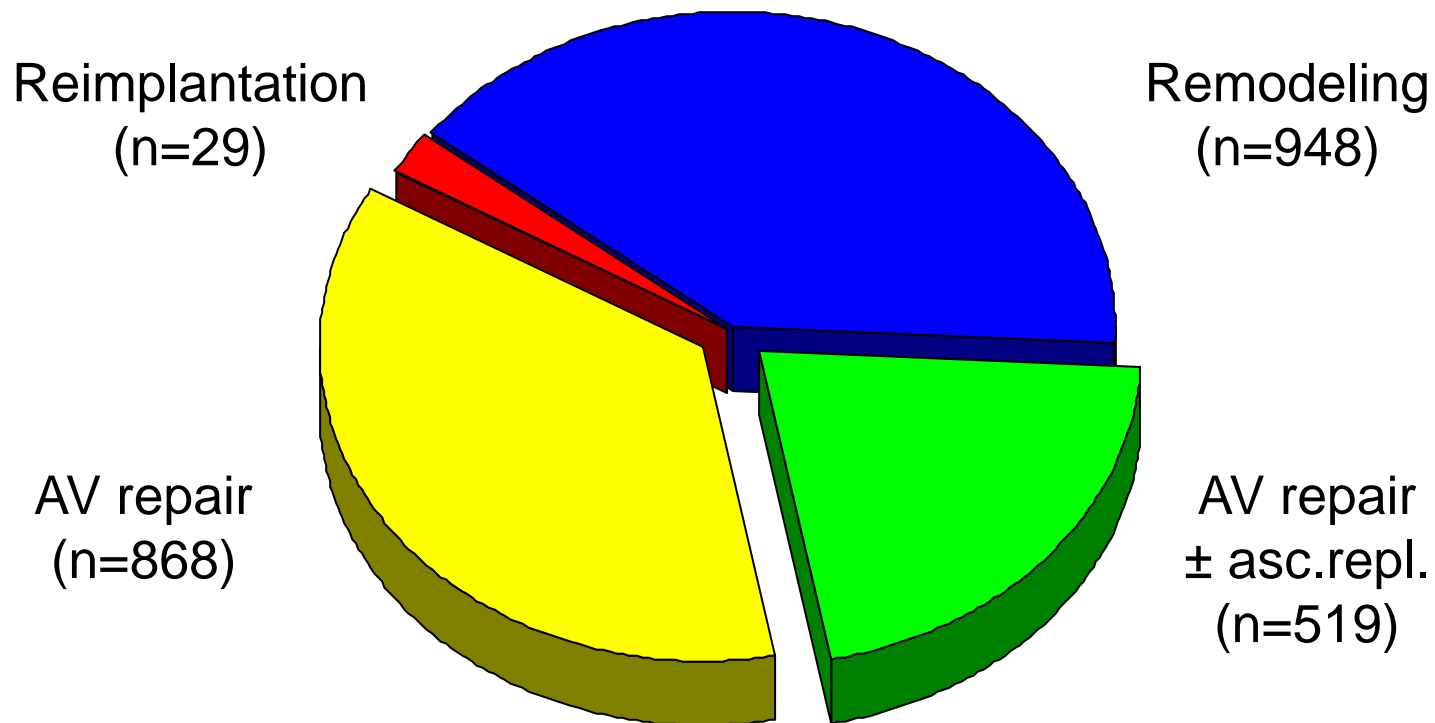
**Christian Giebels**

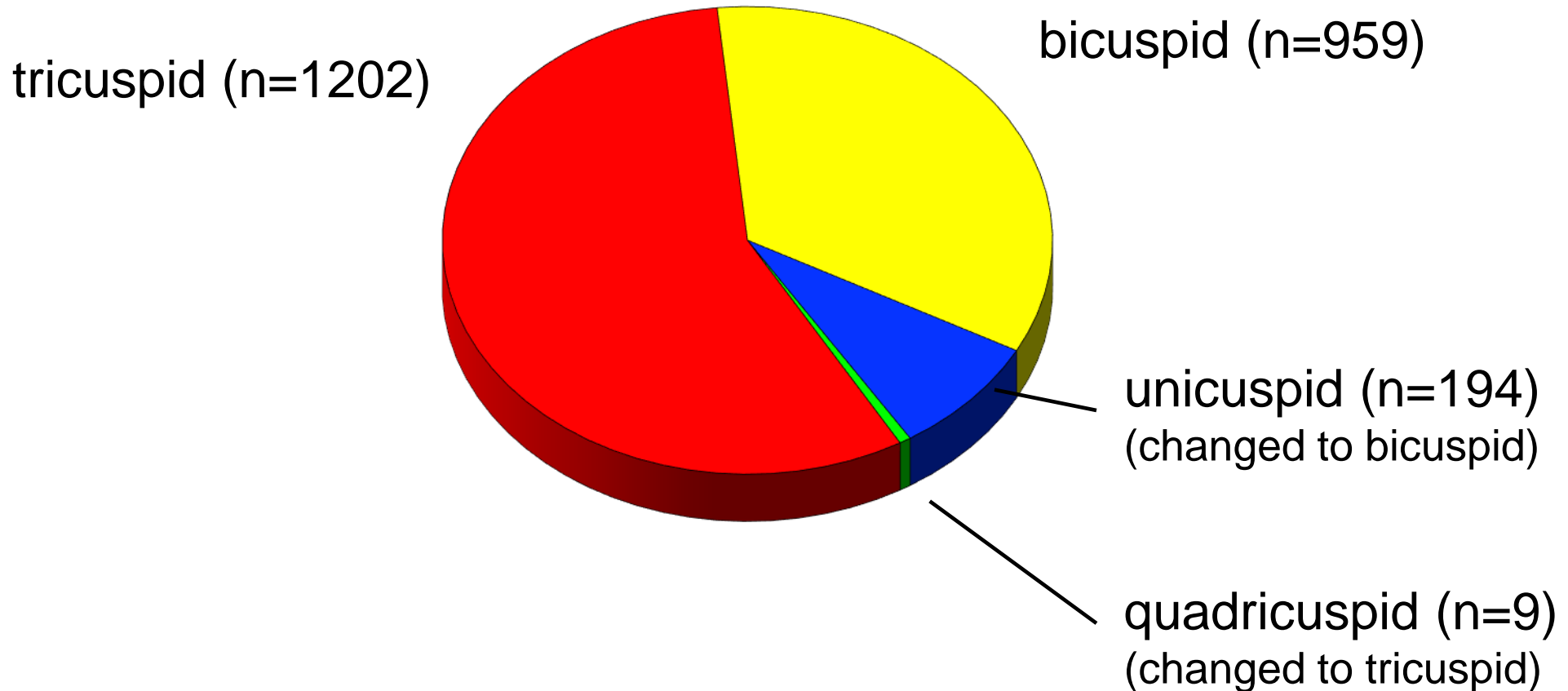
*Dept. of Thoracic and Cardiovascular Surgery  
Saarland University Medical Center  
Homburg/ Saar, Germany*

**Mai 17<sup>th</sup> - 19<sup>th</sup> 2017**

## Aortic Valve Repair (10/95-12/16)

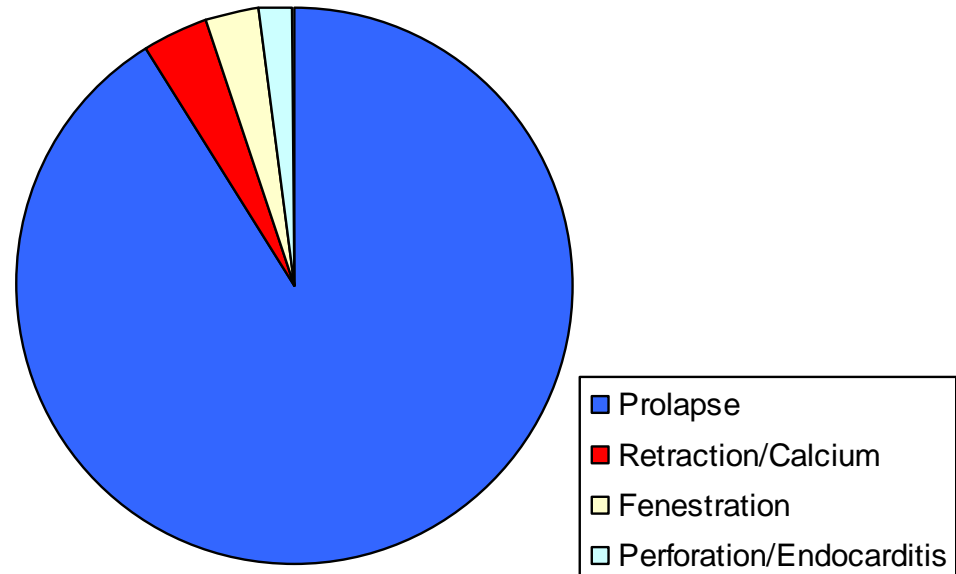
n=2364



AV-Morphology  
(n=2364)

## Causes of Cusp Alterations

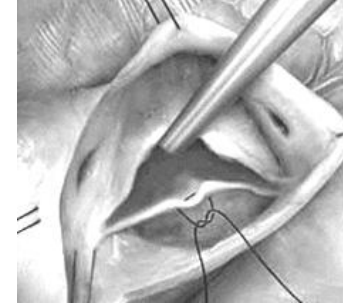
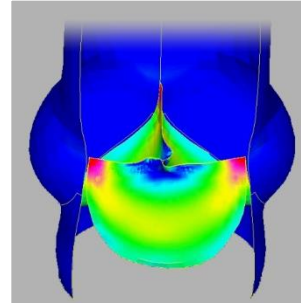
<b>Prolapse</b>	RCC > NCC > LCC	91%
<b>Retraction / Calcium</b>		4%
<b>Fenestration</b>		3%
<b>Perforation / Endocarditis</b>		2%



# Cusp Repair: Prolapse – Homburg Techniques

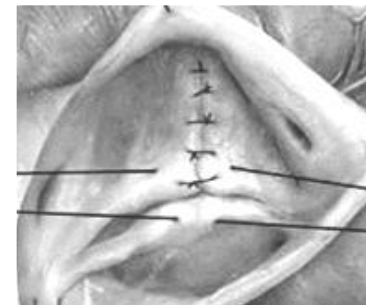
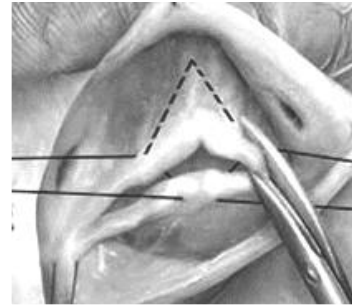
Prolapse

Central Cusp  
Plication



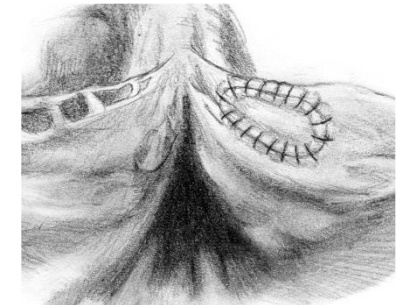
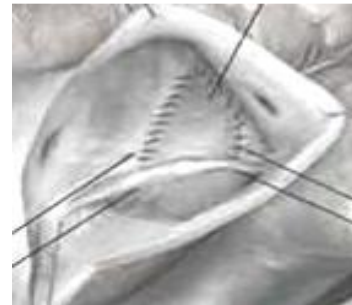
Prolapse +  
Redundancy/  
Fibrosis

Triangular  
Resection



Prolapse +  
Calcium/  
Fenestrations

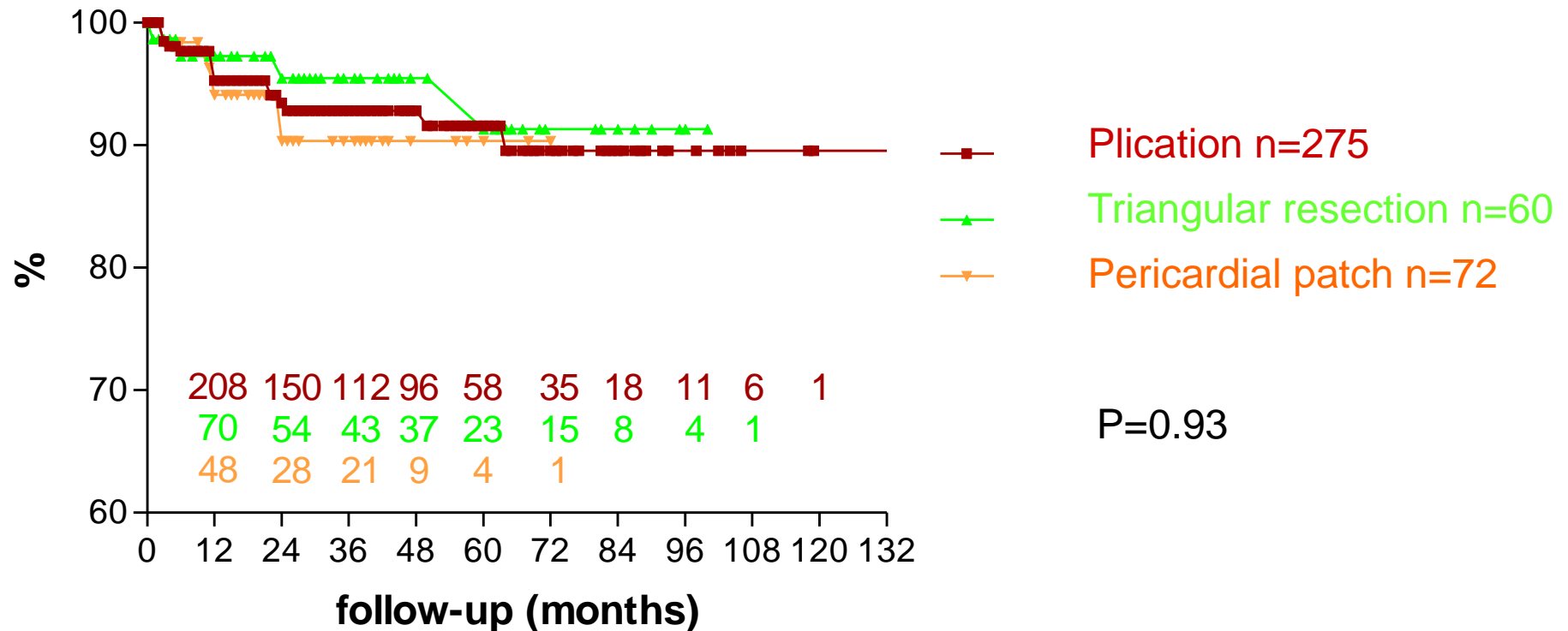
Pericardial  
Patch



# 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 $\geq$ II



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

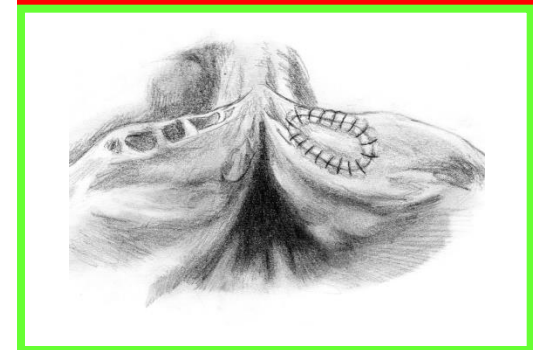
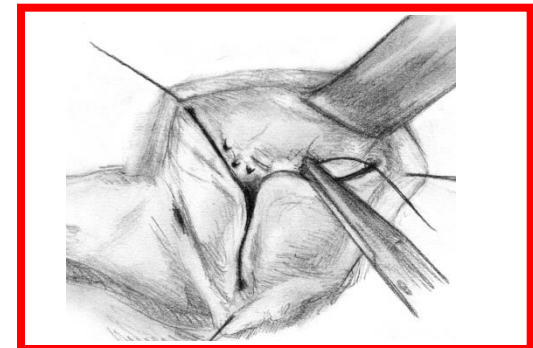
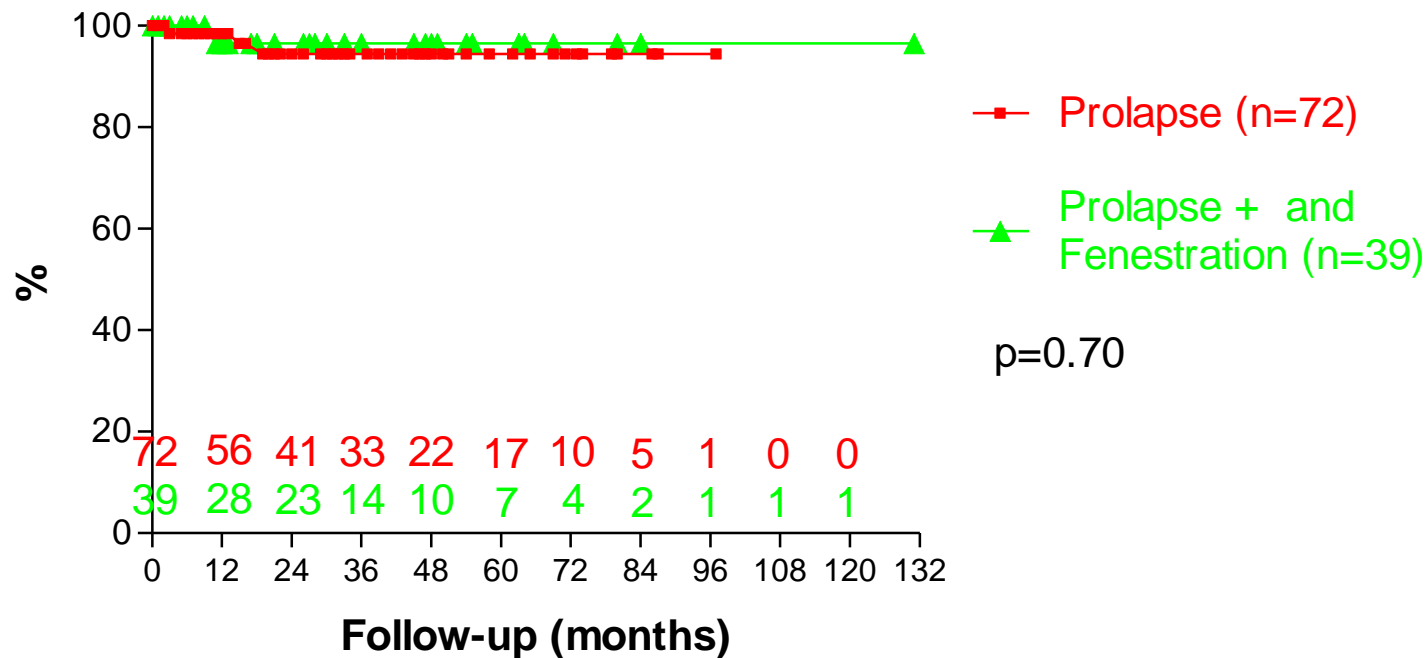
Hans-Joachim Schäfers, MD,<sup>a</sup> Frank Langer, MD,<sup>a</sup> Petra Glombitza, MD,<sup>a</sup> Takashi Kuniyama, MD,<sup>a</sup> Roland Fries, MD,<sup>b</sup> and Diana Aicher, MD<sup>a</sup>

<b>Tricuspid aortic valves</b>	<b>Prolapse (n=72)</b>	<b>Prolapse + Fenestration (n=39)</b>
<b>Plication</b>		
• right-coronary	52	6
• non-coronary	54	12
• left-coronary	14	3
<b>Pericardial patch</b>		
• 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?

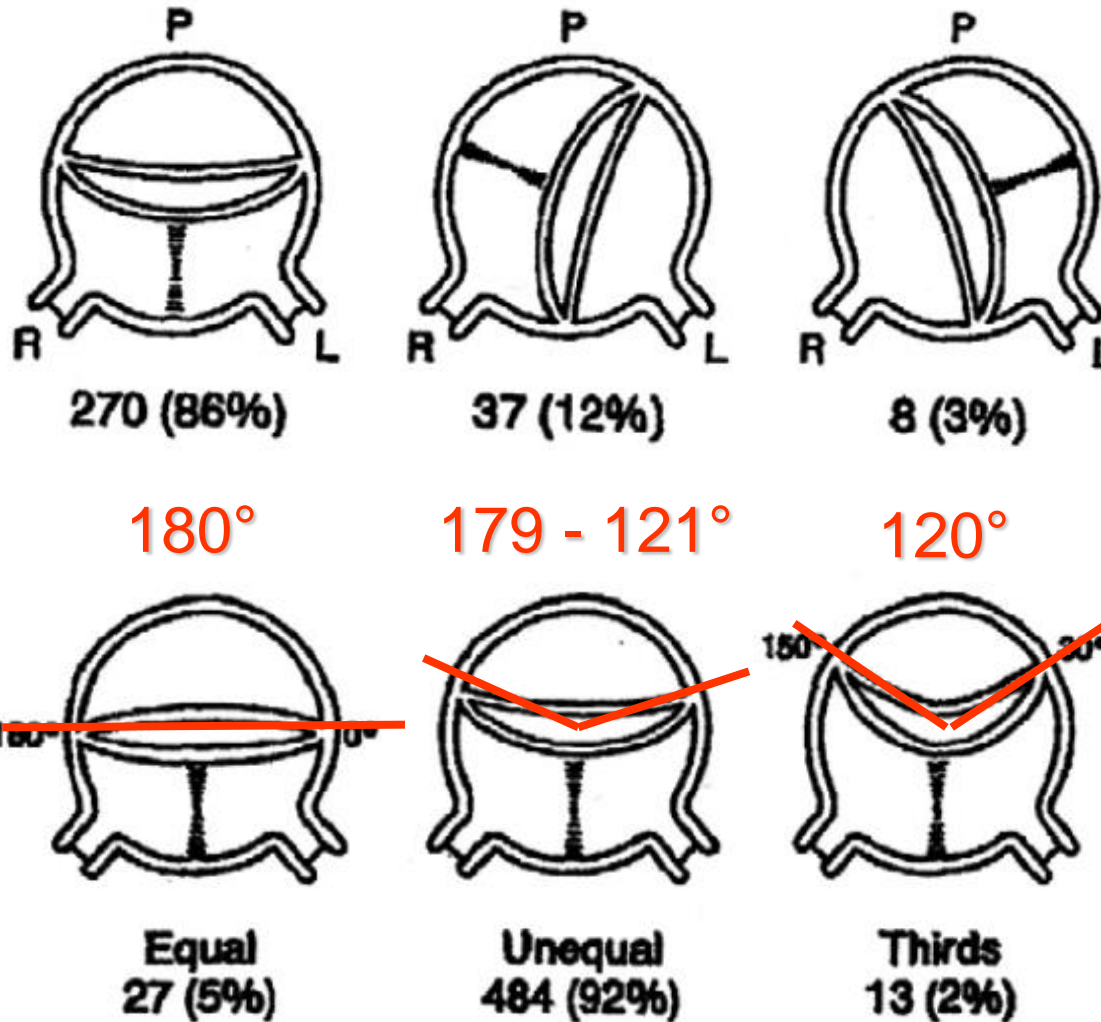
Hans-Joachim Schäfers, MD,<sup>a</sup> Frank Langer, MD,<sup>a</sup> Petra Glombitza, MD,<sup>a</sup> Takashi Kunihara, MD,<sup>a</sup> Roland Fries, MD,<sup>b</sup> and Diana Aicher, MD<sup>a</sup>

## Freedom from Reoperation





## Anatomic Variants of bicuspid Valve Morphology



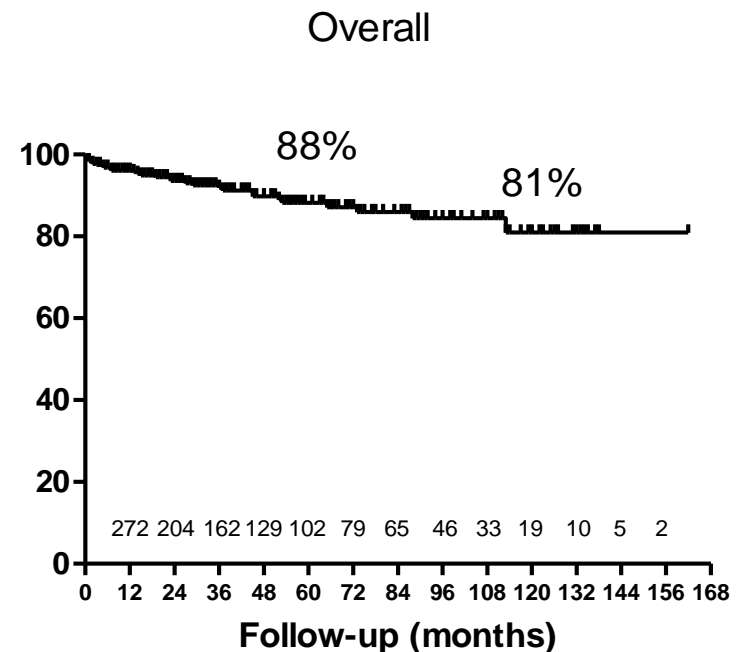


## Valve Configuration Determines Long-Term Results After Repair of the Bicuspid Aortic Valve

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	

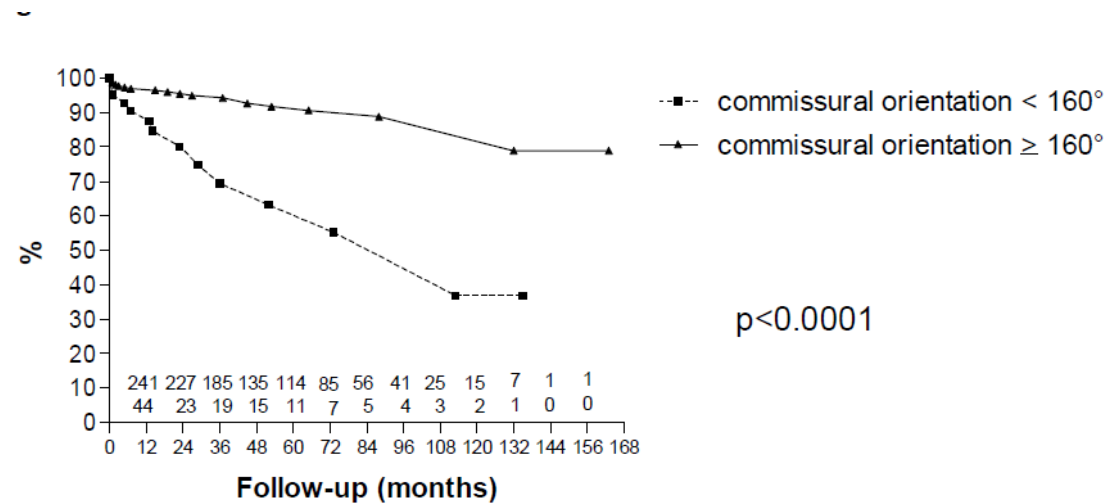
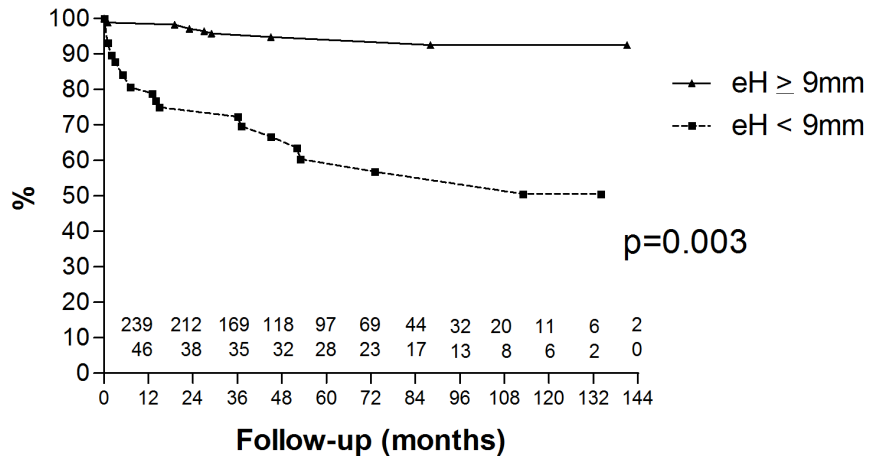
### Actuarial freedom from reoperation



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

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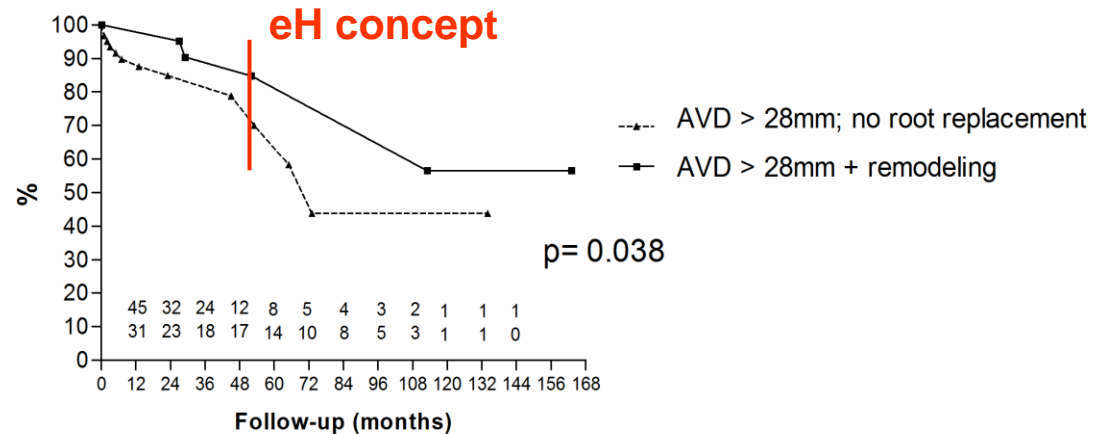
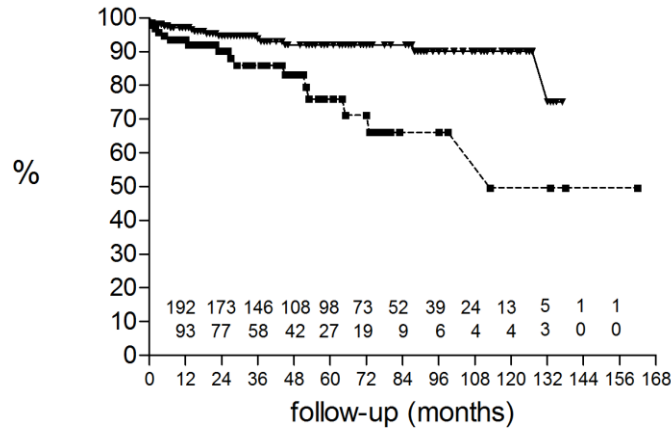
## Actuarial freedom from reoperation



# 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

## Actuarial freedom from reoperation



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

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

**Table 2. Results of Multivariable Analysis of Predictors for Reoperation**

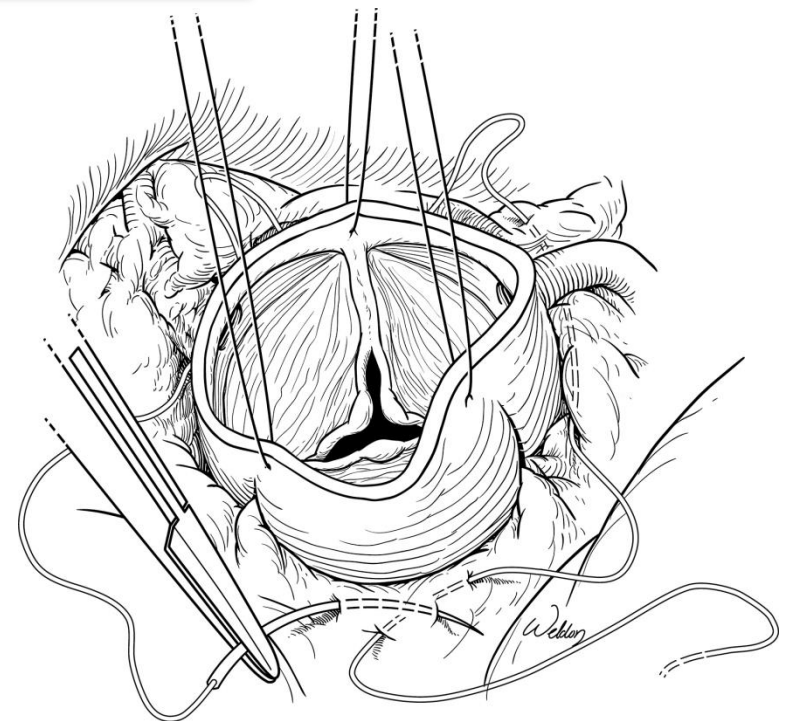
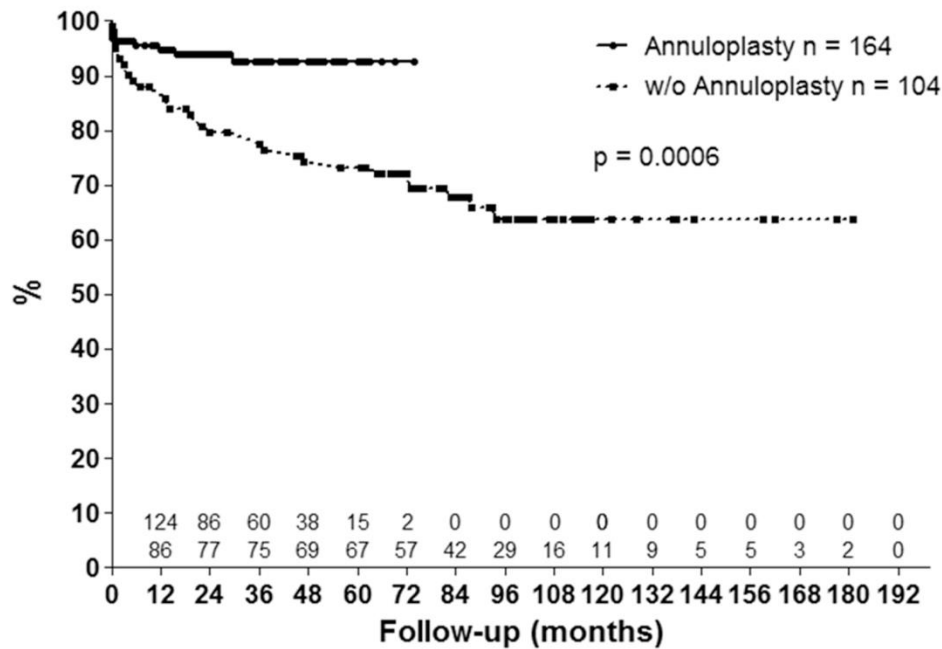
	HR	95% Confidence Interval	<i>P</i>
Age	0.955	0.928–0.982	0.001
eH	0.740	0.612–0.894	0.002
AVD	1.302	1.076–1.575	0.007
Commissural orientation	0.961	0.938–0.985	0.002
Pericardial patch	5.175	2.100–12.753	0.000
Subcommissural plication	0.699	0.299–1.633	0.408
Root repair	2.354	0.770–7.192	0.133

# 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

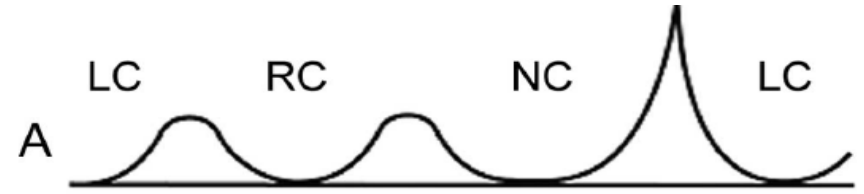
Department of Thoracic and Cardiovascular Surgery, Saarland University Medical Center, Homburg/Saar, Germany

**Freedom from Re-OP**

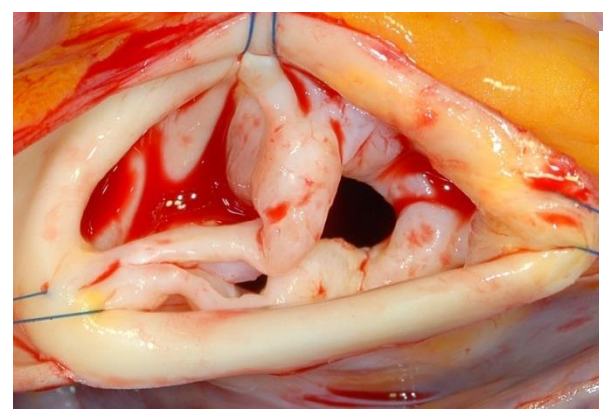


## Unicuspid aortic valve repair

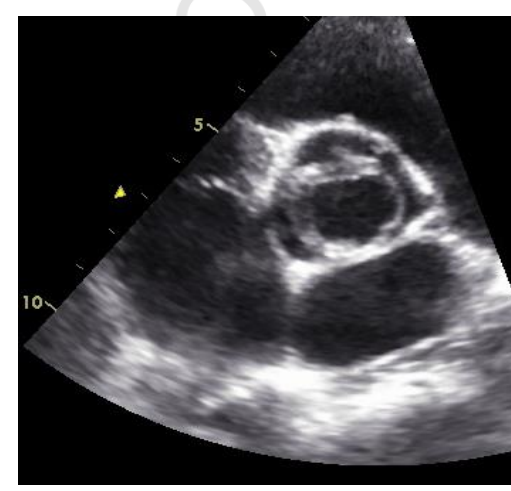
Unicuspid morphology



intraoperative



TEE

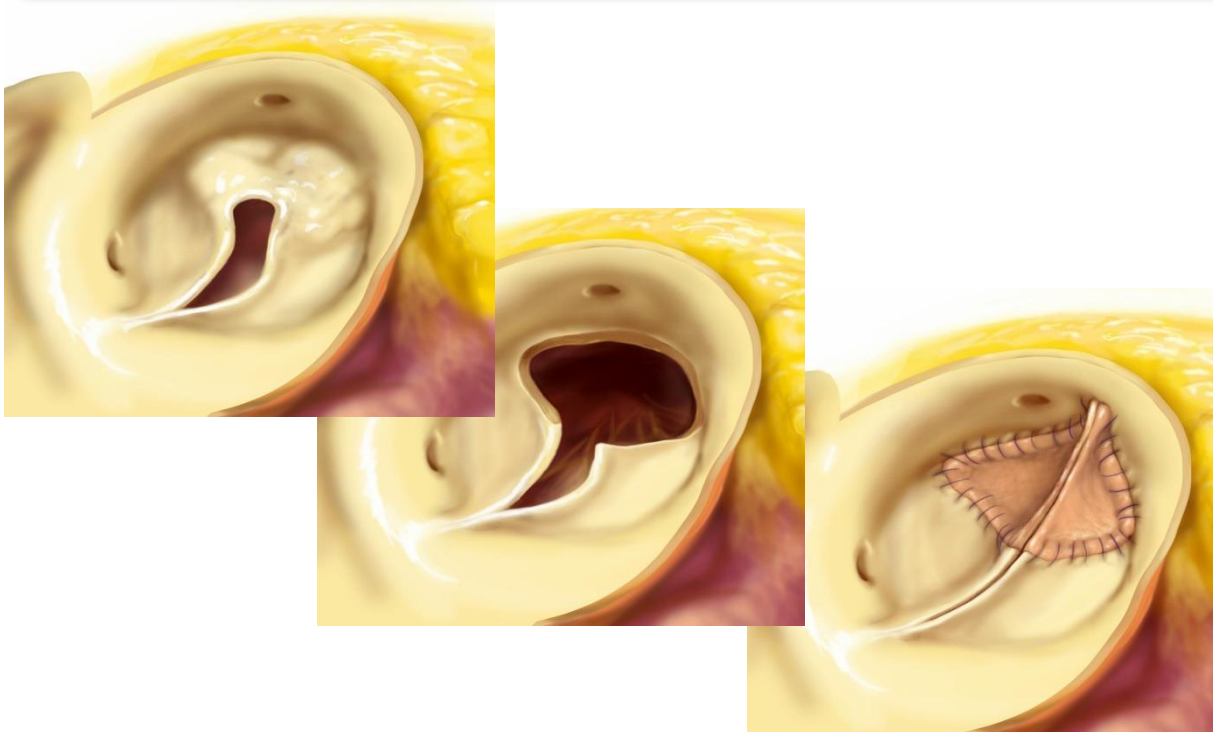


Results of Cusp and Root repair

# Bicuspidization of the Unicuspid Aortic Valve: A New Reconstructive Approach

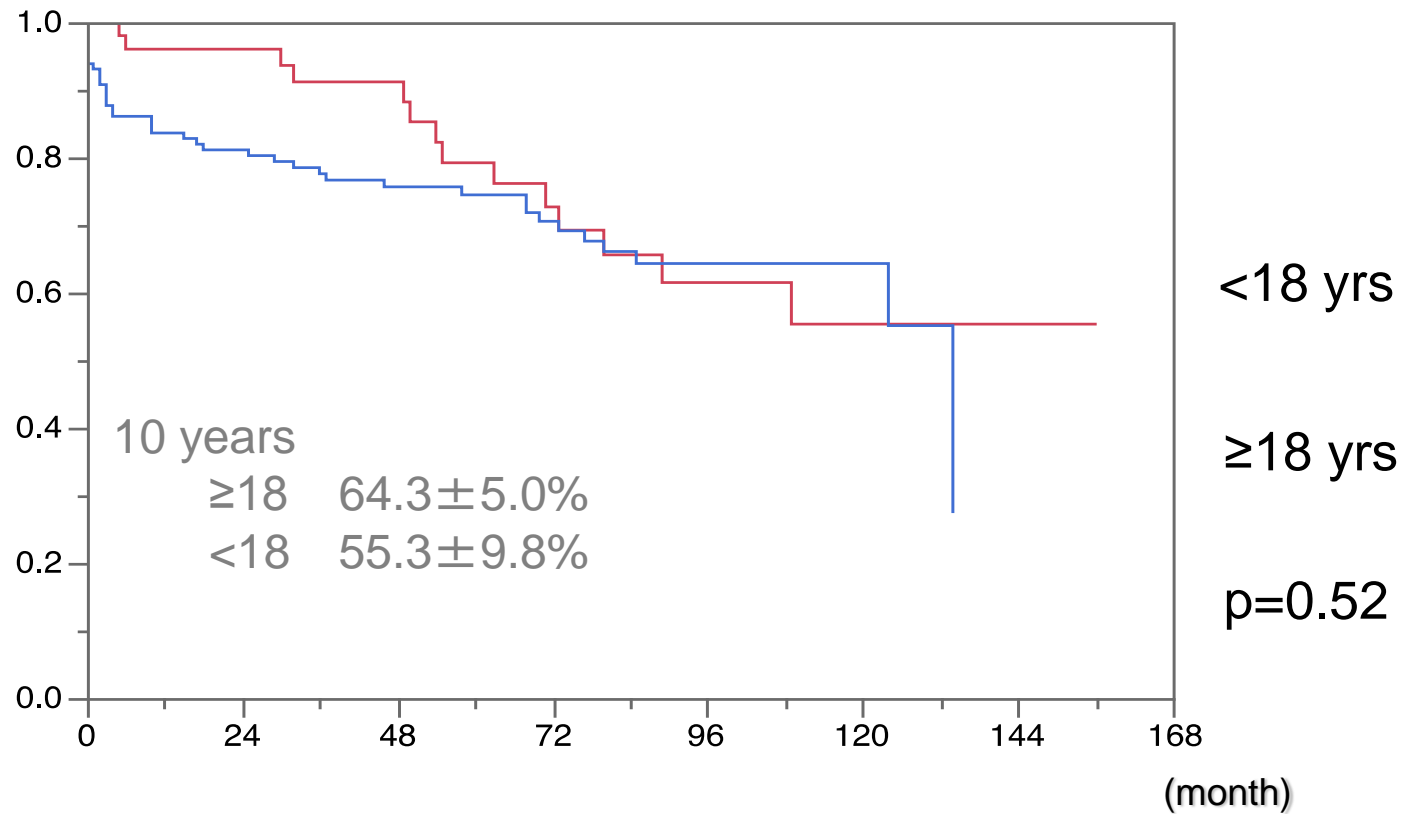
Hans-Joachim Schäfers, MD, Diana Aicher, MD, Svetlana Riodionycheva, MD, Angelika Lindinger, MD, Tanja Rädle-Hurst, MD, Frank Langer, MD, and Hashim Abdul-Khaliq, MD

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





## UAV - Freedom from Reoperation



Number at risk

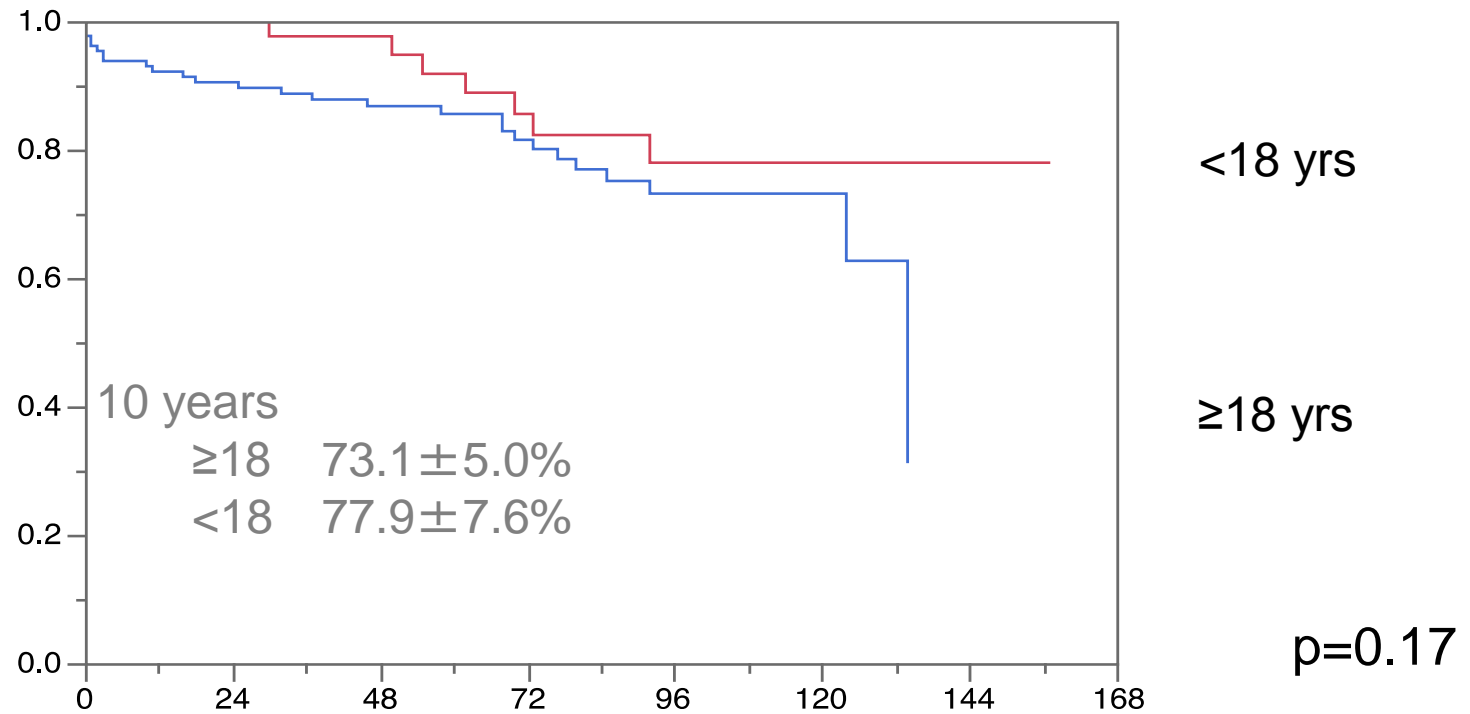
$\geq 18$	130
$< 18$	50

64
27

11
4

1
---

# UAV - Freedom from Valve Replacement



Number at risk

$\geq 18$	130
$< 18$	50

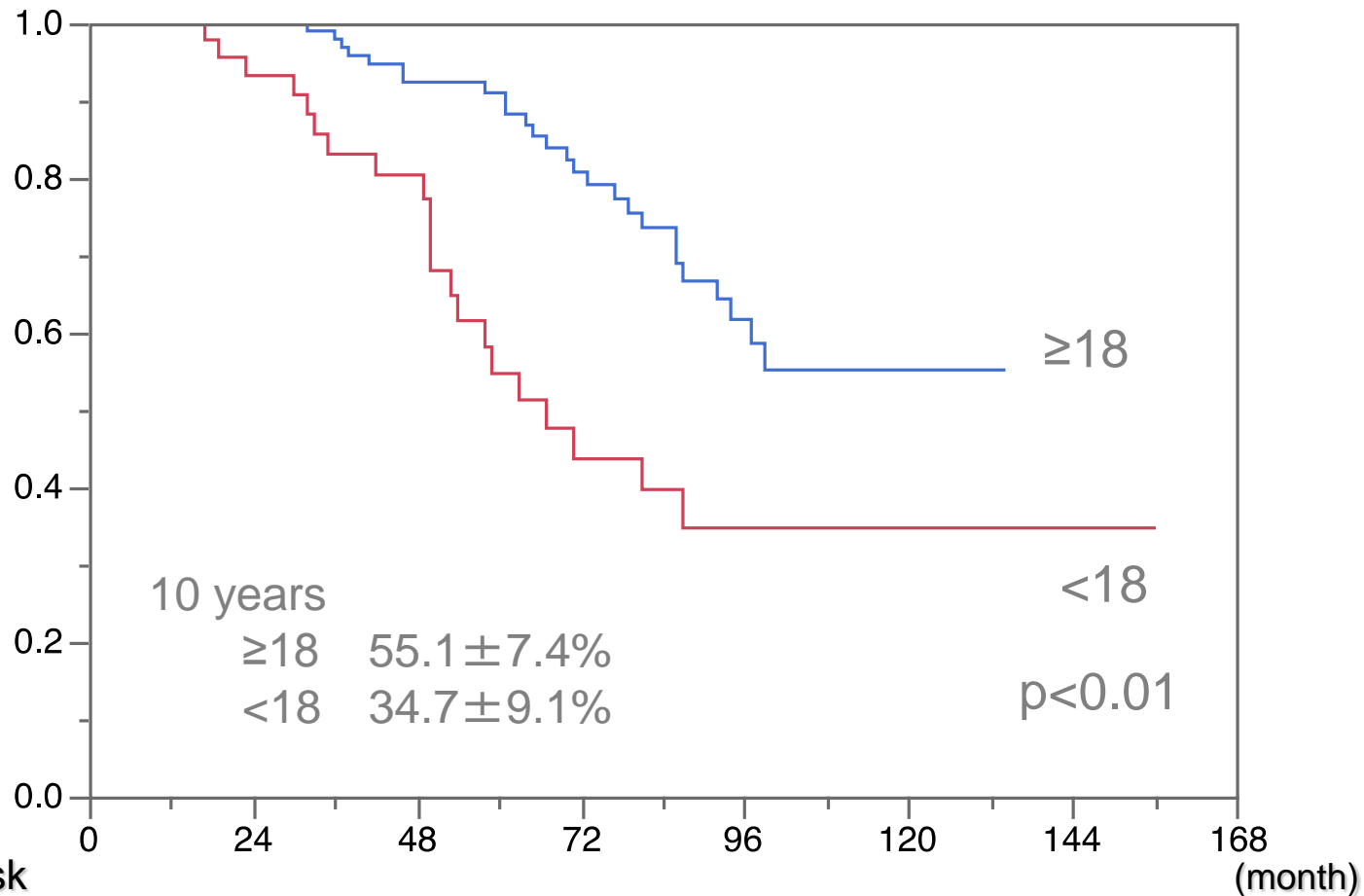
71
32

11
6

(month)

2
---

## UAV - Freedom from Patch Calcification



Number at risk

$\geq 18$	130	67	8	
$< 18$	50	17	3	1

67

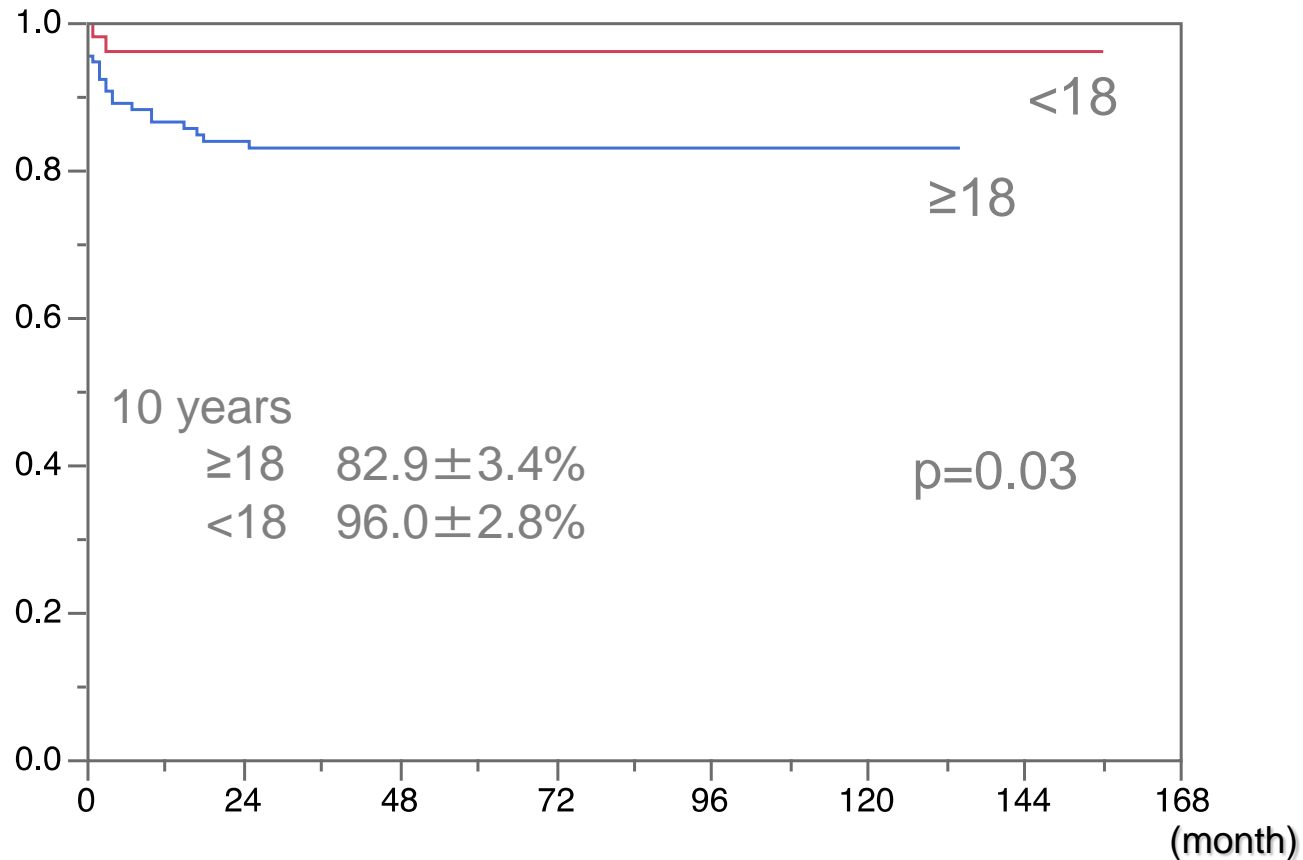
17

8

3

1

## UAV - Freedom from Suture Dehiscence



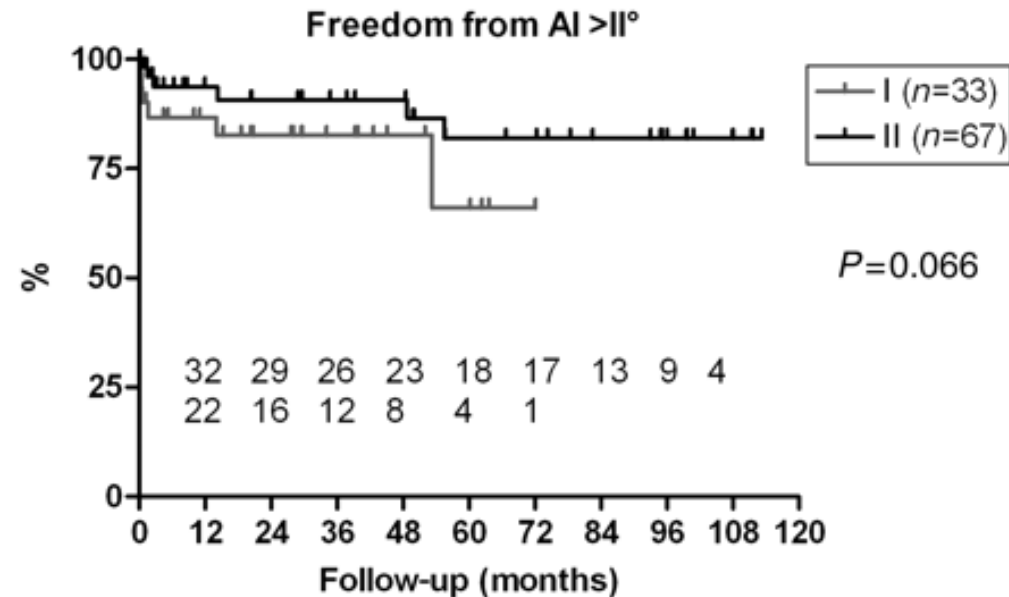
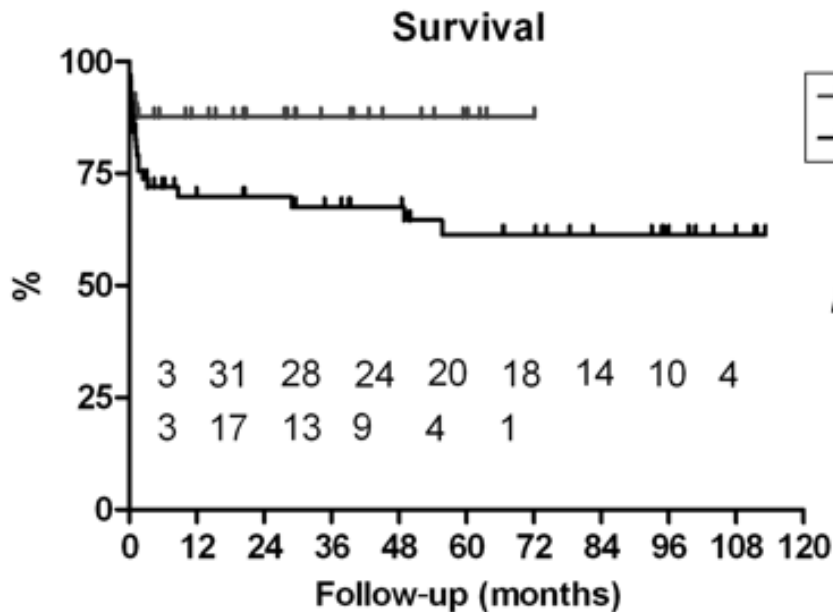
Number at risk	
$\ge 18$	130
$< 18$	50

	65	11	
	27	4	1

# 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

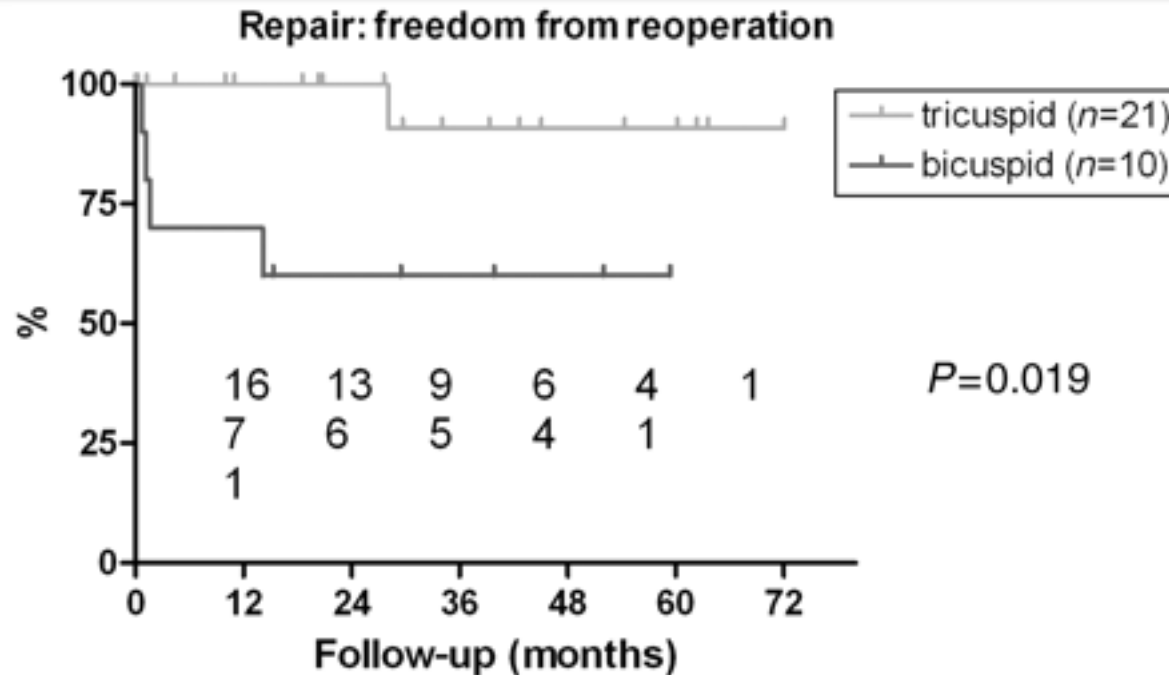


I Aortic valve repair  
 II Aortic valve replacement

# Repair versus replacement of the aortic valve in active infective endocarditis

Katharina Mayer, Diana Aicher, Susanne Feldner, Takashi Kuniyama 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.



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

Takashi Kuniyara, MD, PhD,<sup>a</sup> Diana Aicher, MD,<sup>a</sup> Svetlana Rodionycheva, MD,<sup>a</sup> Heinrich-Volker Groesdonk, MD,<sup>a</sup> Frank Langer, MD,<sup>a</sup> Fumihiko Sata, MD, PhD,<sup>b</sup> and Hans-Joachim Schäfers, MD, PhD<sup>a</sup>

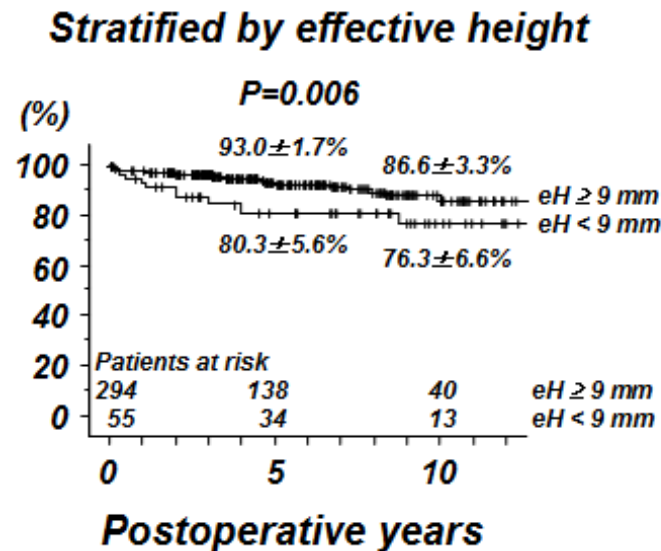
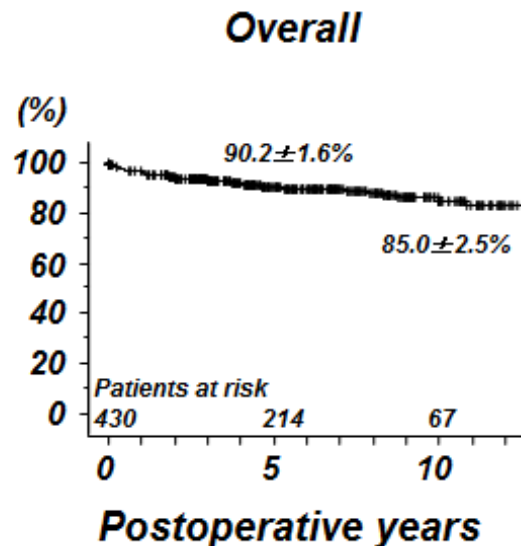
	Remodeling (N=401)	Reimplantation (N=29)	p
Age (years)	58 ± 15	42 ± 16	
Sex (m/f)	300/101	19/8	
Tricuspid AV	271	27	
BAV/UAV	124/6	2/-	
Diagnosis: Aneurysm	336	22	
AADA	59	7	
CADA	6	-	
Marfan	13	12	
Myocardial Ischemia (min)	82 ± 20	112 ± 24	0.01
Hospital mortality			
total	13/401 (3.2 %)	0/29	0.32
elective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



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

Takashi Kuniyara, MD, PhD,<sup>a</sup> Diana Aicher, MD,<sup>a</sup> Svetlana Rodionychewa, MD,<sup>a</sup> Heinrich-Volker Groesdonk, MD,<sup>a</sup> Frank Langer, MD,<sup>a</sup> Fumihiro Sata, MD, PhD,<sup>b</sup> and Hans-Joachim Schäfers, MD, PhD<sup>a</sup>

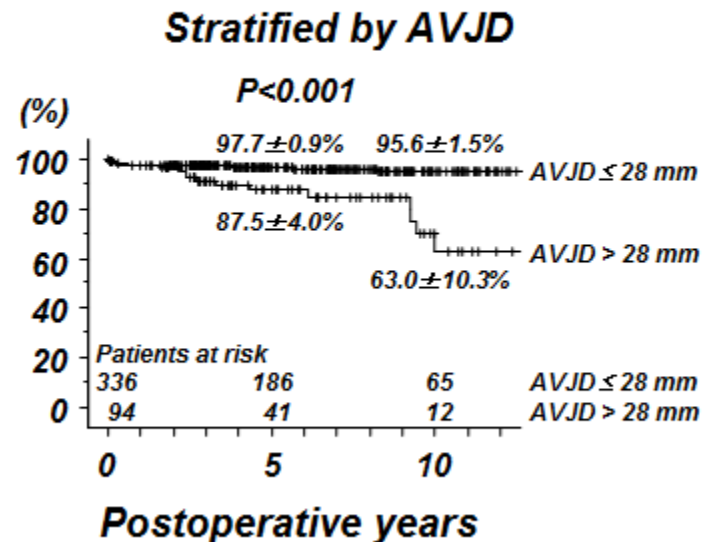
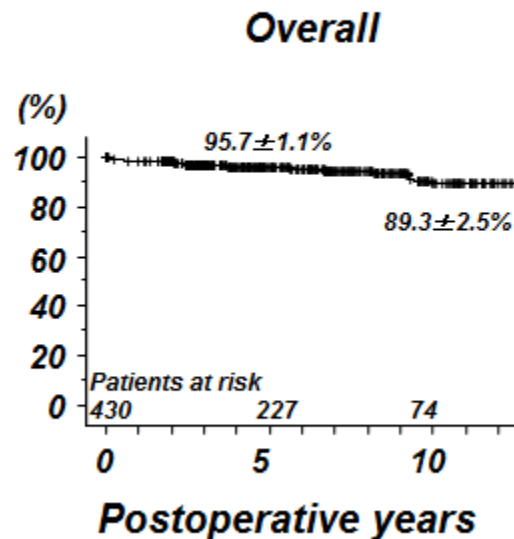
## Freedom from AR $\geq$ II



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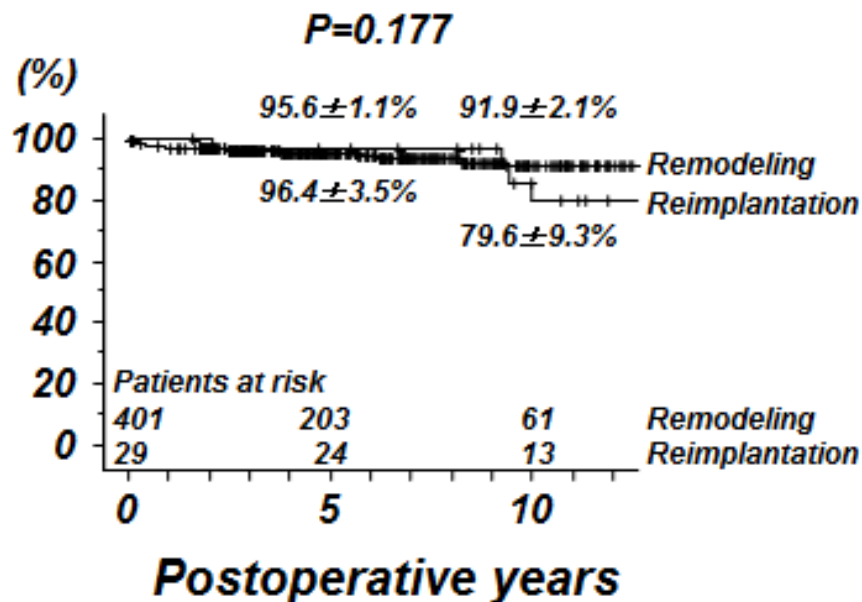
## Freedom from Reoperation



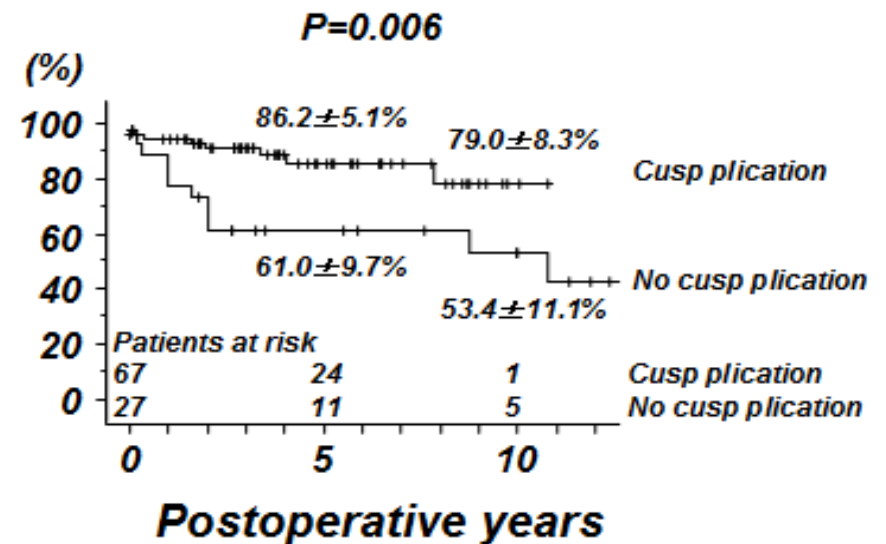
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## Freedom from Reoperation



## Freedom from AR ≥ 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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	Univariate <i>P</i> value	Multivariate <i>P</i> value	HR	95% CI
<b>AR grade <math>\geq</math> II</b>				
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		
<b>Reoperation</b>				
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.

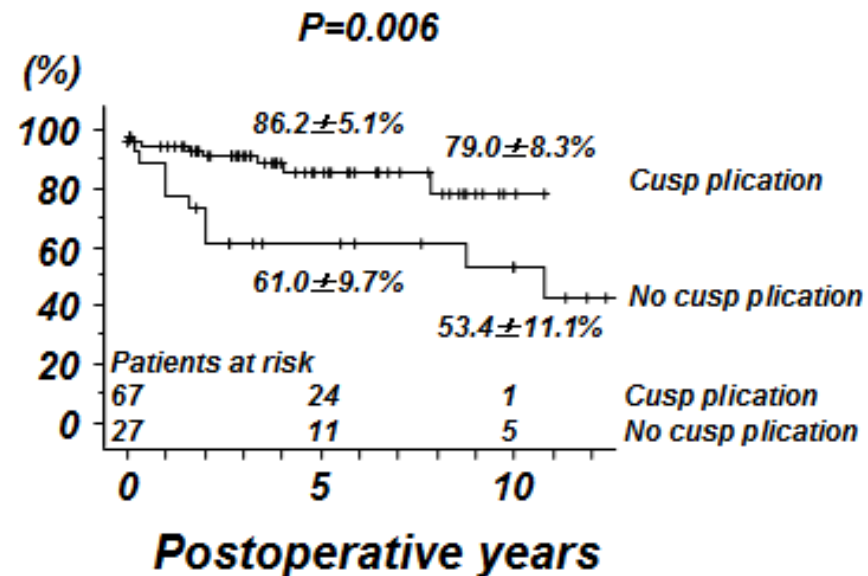
Suboptimal valve stability for AVJ > 28mm:

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

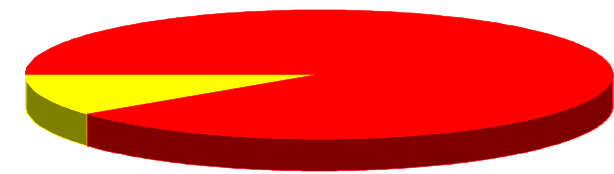
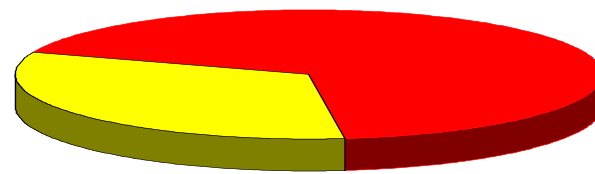
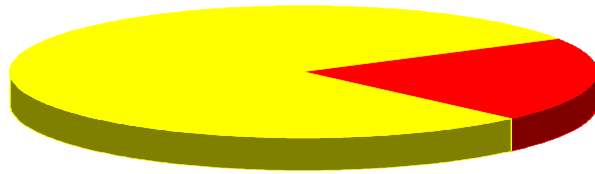
	Remodeling n=401	Reimplantation n=29
Cusp prolapse	10	-
Cusp suture dehiscence	6	-
Cusp retraction	3	-
Endocarditis	2	1
Commissural detachment	-	2
Aortic valve stenosis	1	-
	22 (5.5%)	3 (10.3%)

# Cusp prolapse correction (%)

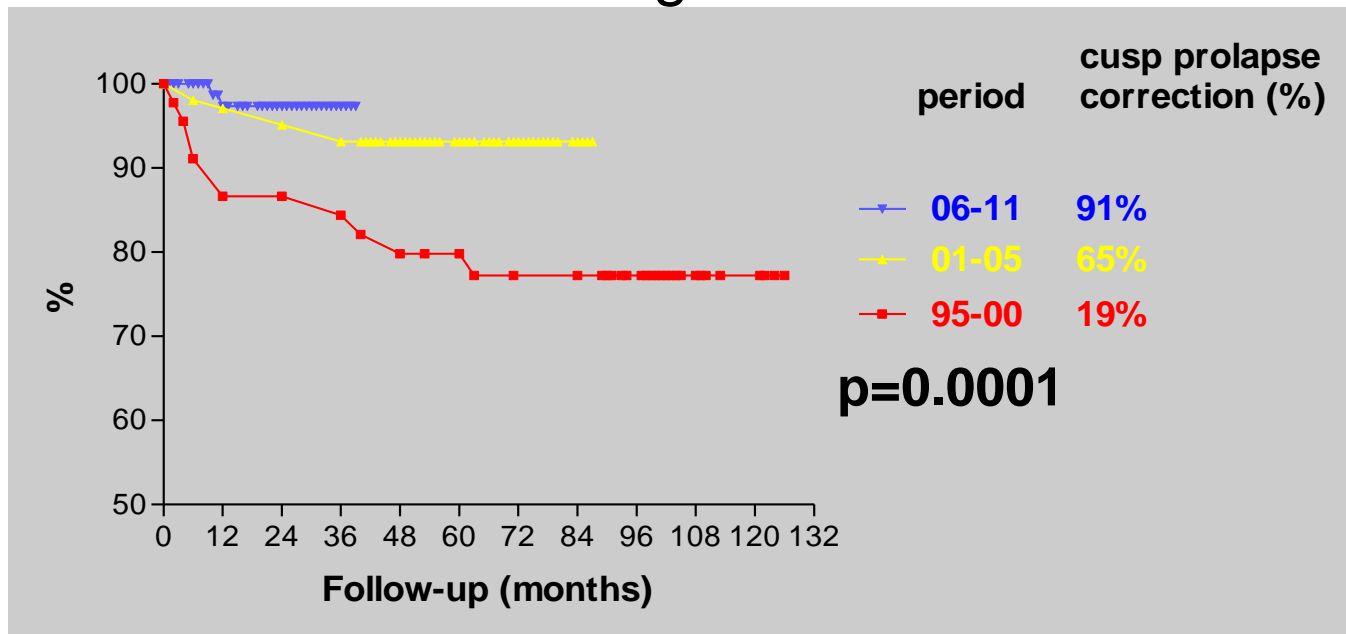
1995-2000: 19%

2001-2005: 65%

2006-2011: 91%



## Learning Curve



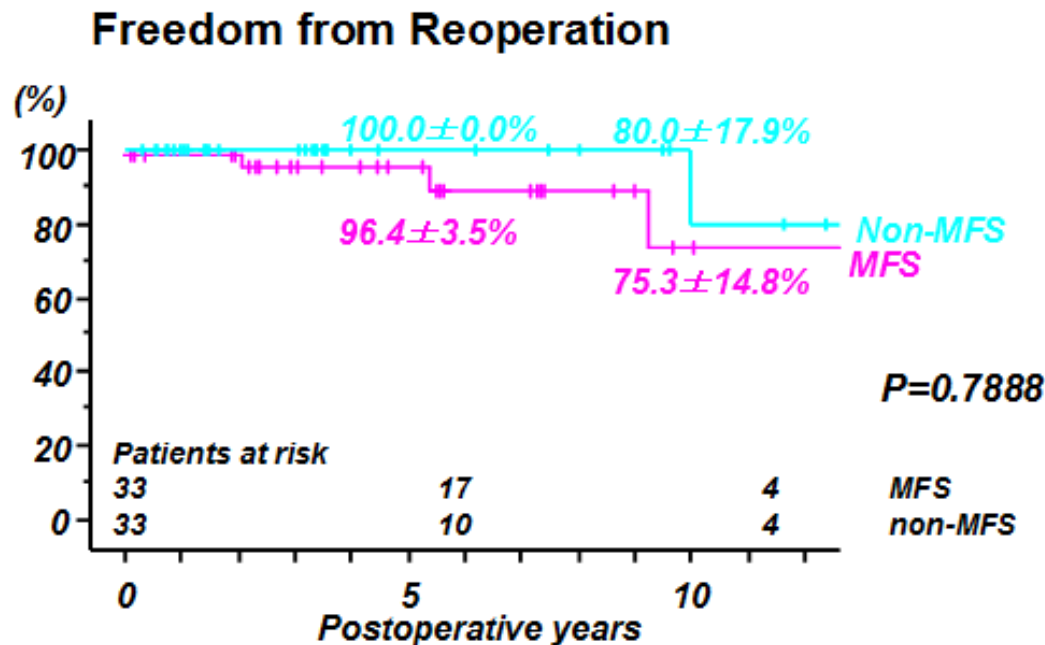
Results of Cusp and Root repair

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

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

Kunihara T<sup>1</sup>, 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.







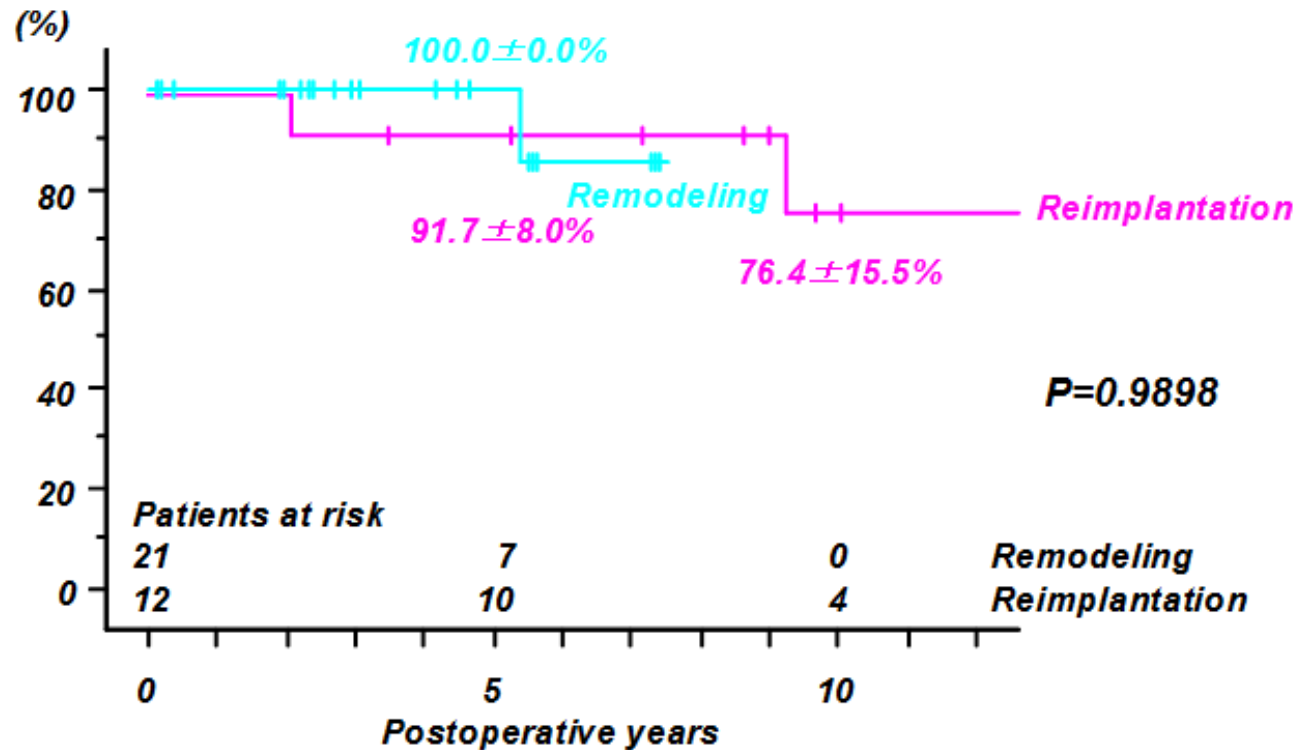
Results of Cusp and Root repair

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

Kunihara T<sup>1</sup>, Aicher D, Rodionychewa S, Asano M, Tochii M, Sata F, Schäfers HJ.

#### 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 Rodionychева, MD, and Hans-Joachim Schäfers, MD, PhD

Departments of Thoracic and Cardiovascular Surgery and Pediatric Cardiology, Saarland University Medical Center, Homburg Saar, Germany

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



## 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 Rodionychева, MD, and Hans-Joachim Schäfers, MD, PhD

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### Early Results:

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

### Mid-term Results:

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

### Valve stability:

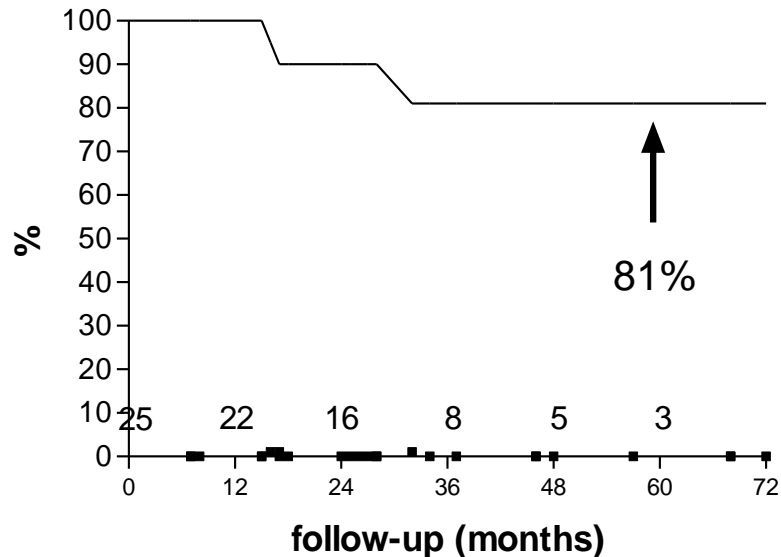
- 3 reoperations (2 suture dehiscence patch/cusp: no annular stabilization; 1 after endocarditis)  
→ biologic AV replacement (n=1); re-repair (n=2)
- Of 5 patients without annular support, 2 underwent reoperation (40%) versus 1 of 20 (5%) who were treated by suture annuloplasty.

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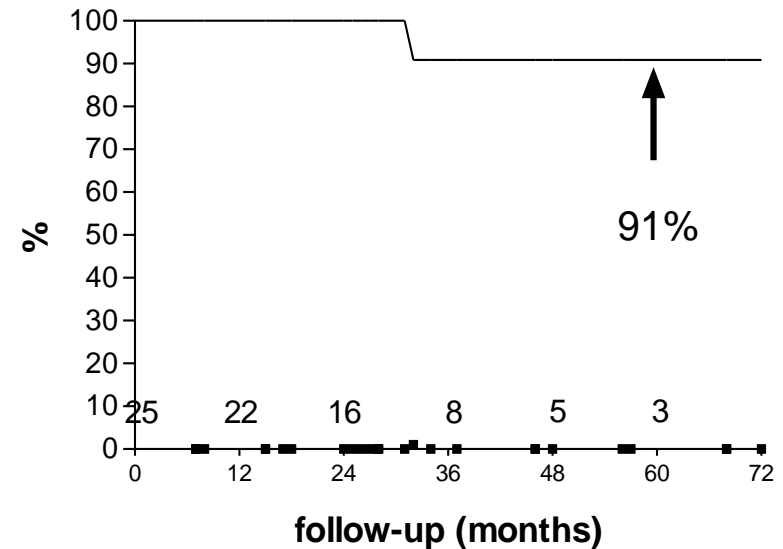
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freedom from reoperation



freedom from valve replacement



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

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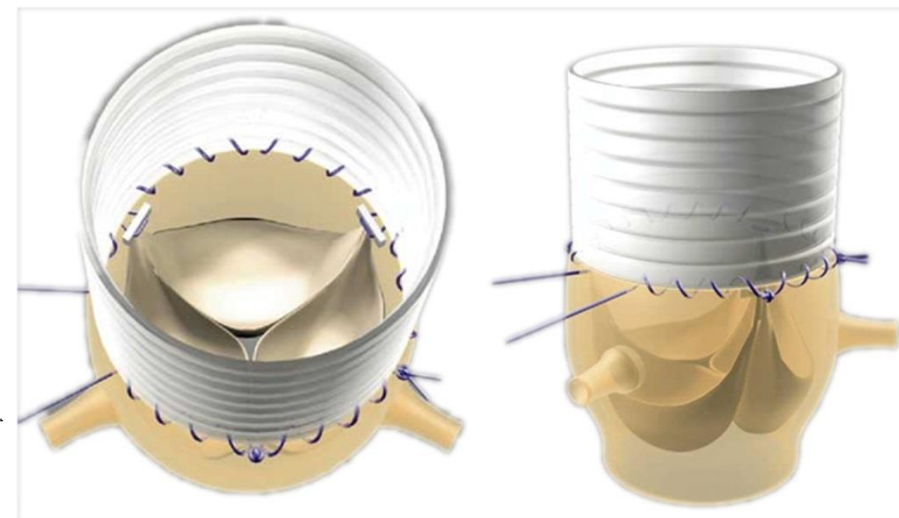
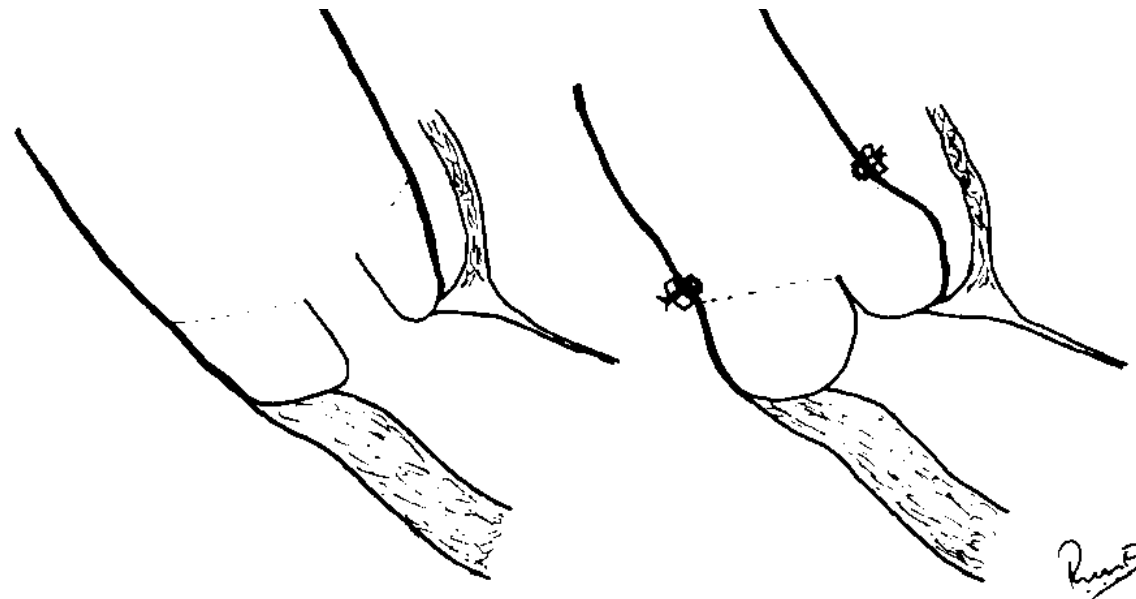


FIGURE 4. *Left*, The sinus rim is fixed in a systolic position. *Right*, The sinus rim reestablished in a diastolic position



## Mid-term results after sinutubular junction remodelling with aortic cusp repair<sup>†</sup>

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### Patients characteristics

<b>n</b>	<b>144</b>
Age (years)	56.0 ± 17
Male, n (%)	103 (71.5)
BSA (m <sup>2</sup> )	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)

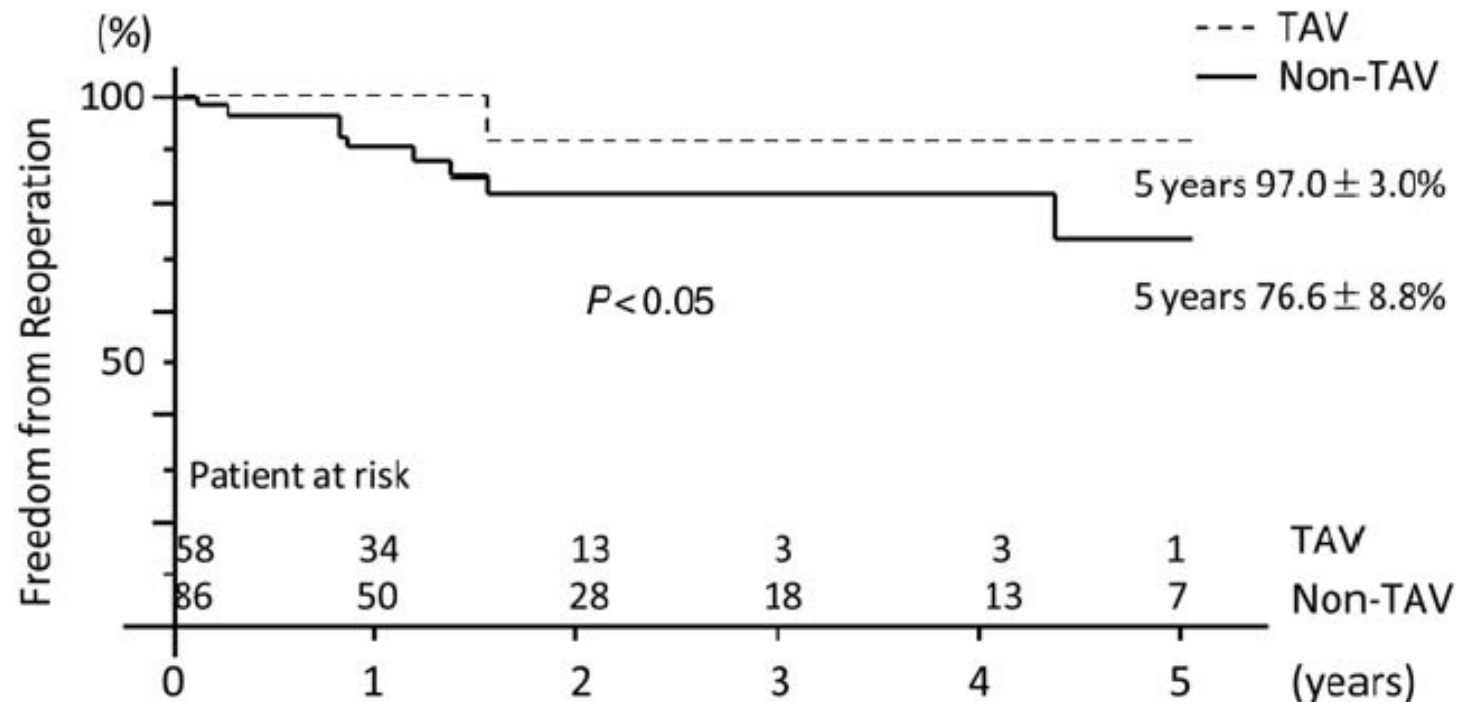
### Diameter of aortic root (mm)

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

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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 placcation	0.10	0.14		
STJ > 30 mm	0.20	0.28		
Sinus valsalva	>40 mm	0.53		

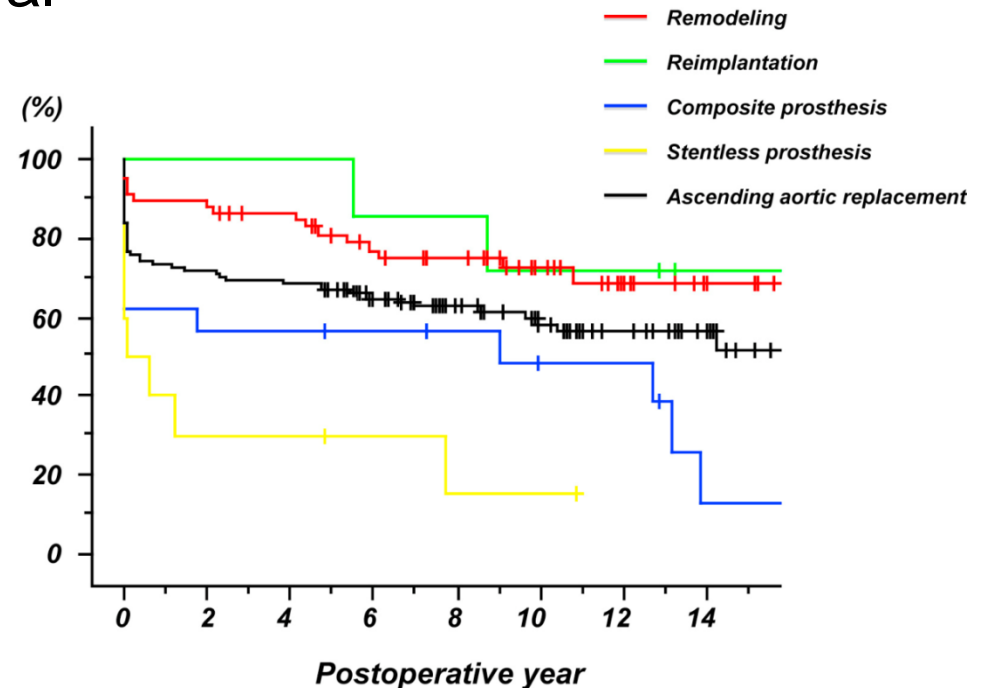
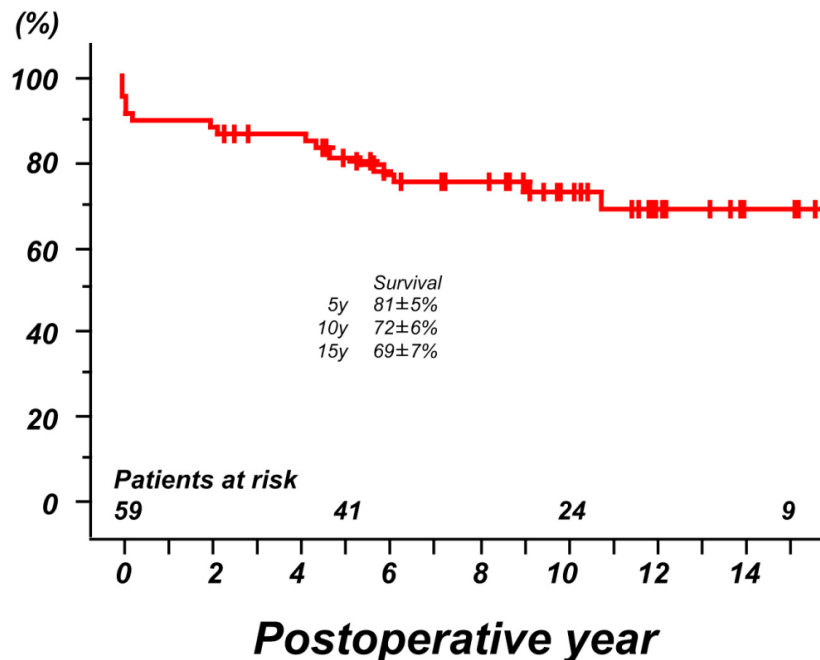
AVJ: aortoventricular junction; STJ: sinutubular junction; HR: hazard ratio; CI: confidence interval.



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

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

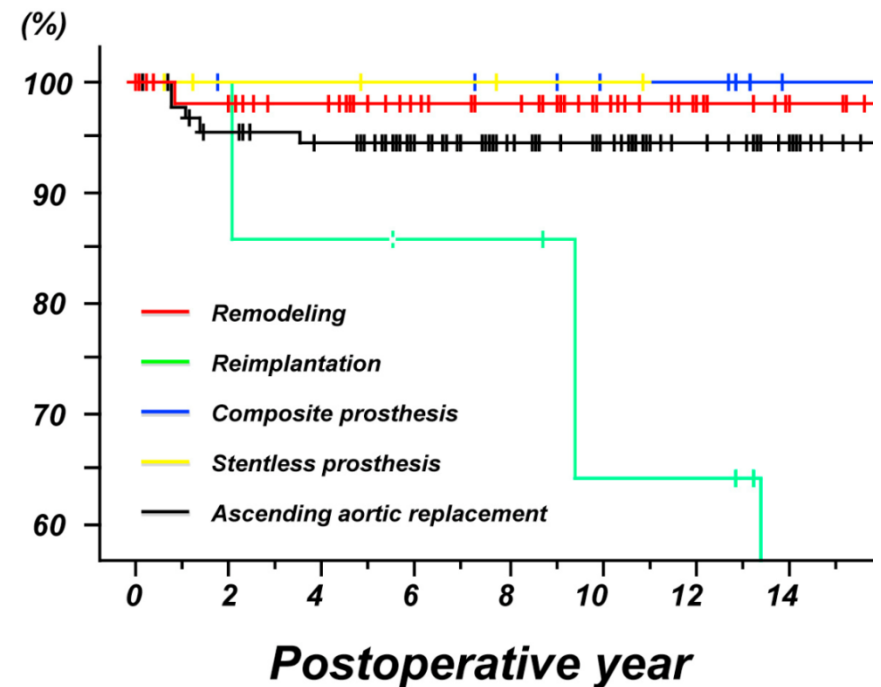
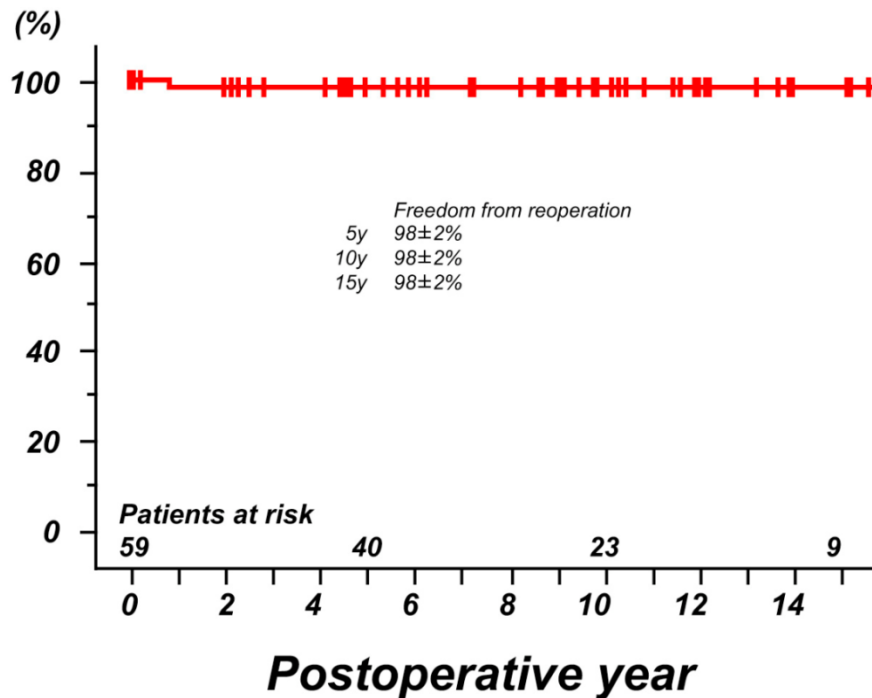
## Survival



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## Freedom from Reoperation





## Conclusions

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