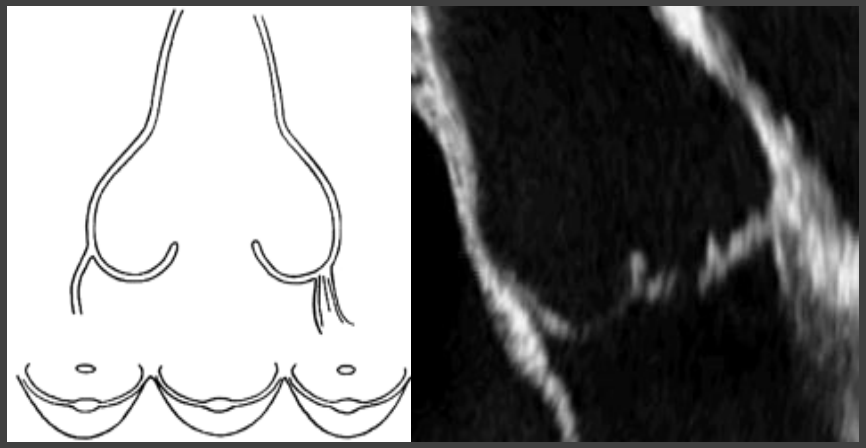
EuroValve, March 10-11 2016, Brussels

Aortic Valve Repair: State of the art

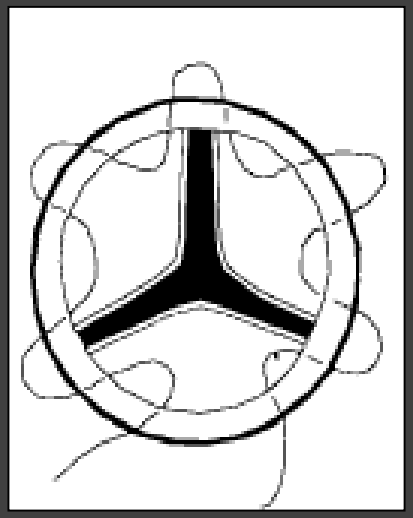
Laurent de Kerchove, MD, PhD

Cliniques Universitaires St-Luc, IREC, UCL, Brussels

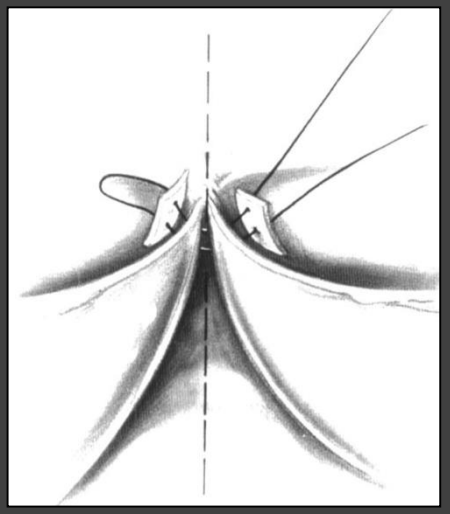
AV repair: the origine of annuloplasty



Circumclusion
Taylor 1958
Carpentier 1990

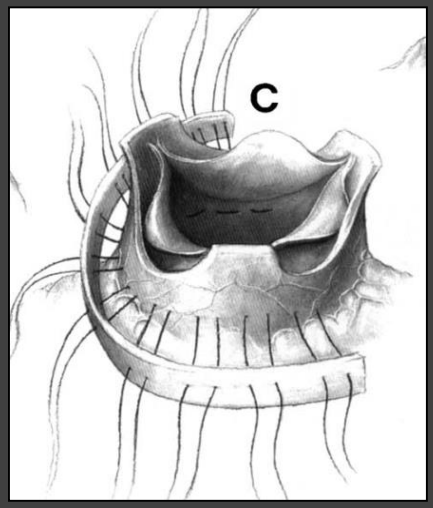


Commissural annoplasty
Cabrol 1966
Cosgrove 1991
Duran 1996



Reimplantation
T. David 1992

Partial external band
T. David 1996

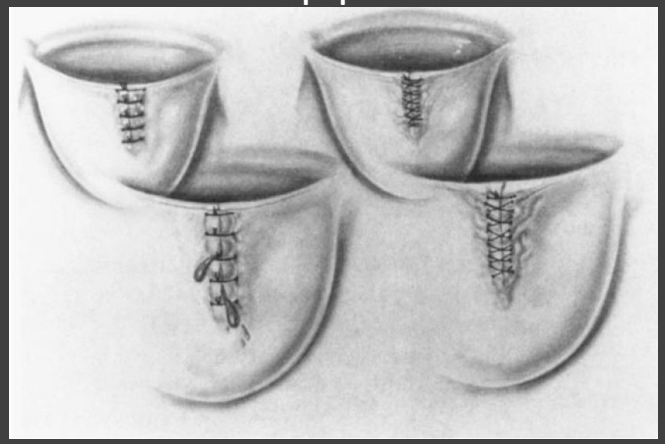


AV repair: the origine of cusp repair

80ties-90ties:

Trusler, Duran, Cosgrove, Fraser, Tolan, Kadri

Central Cusp plication



Commissurotomy

Fig. 1 - Debridement of cusps and aortic valve commissurotomy.

Commissural Cusp plication

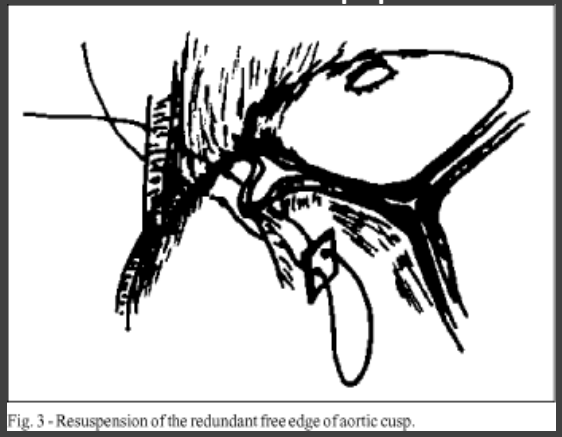
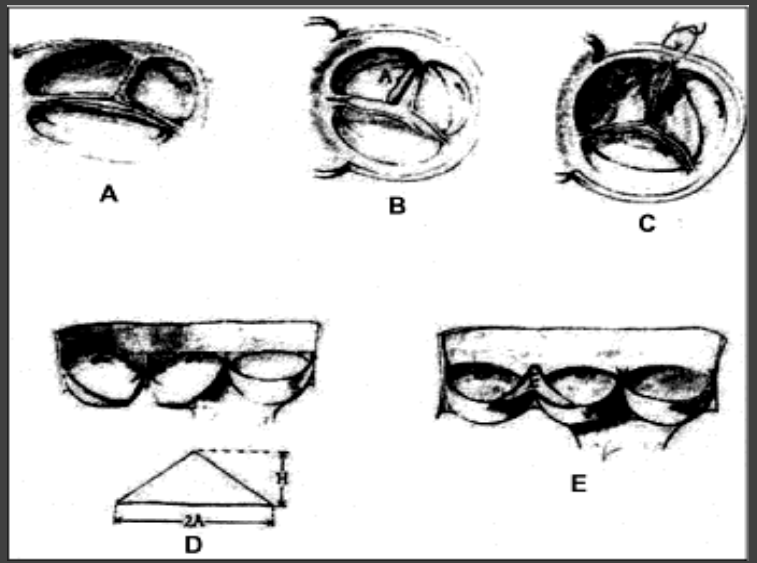
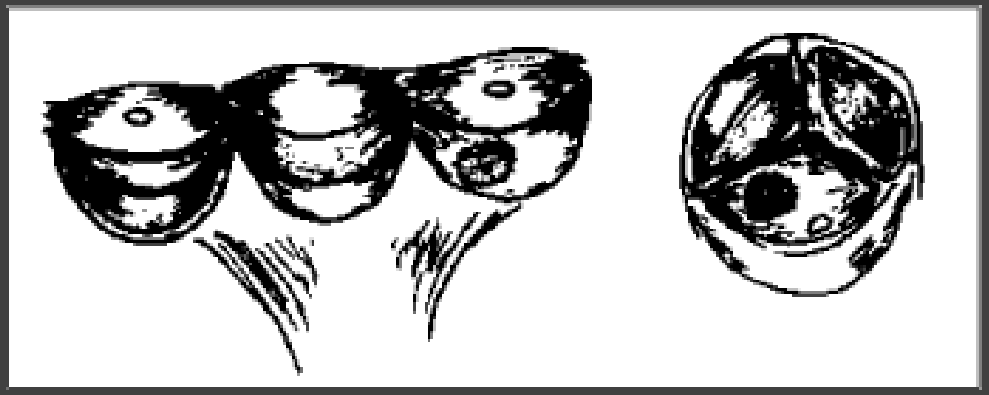


Fig. 3 - Resuspension of the redundant free edge of aortic cusp.

Commissure restoration with patch



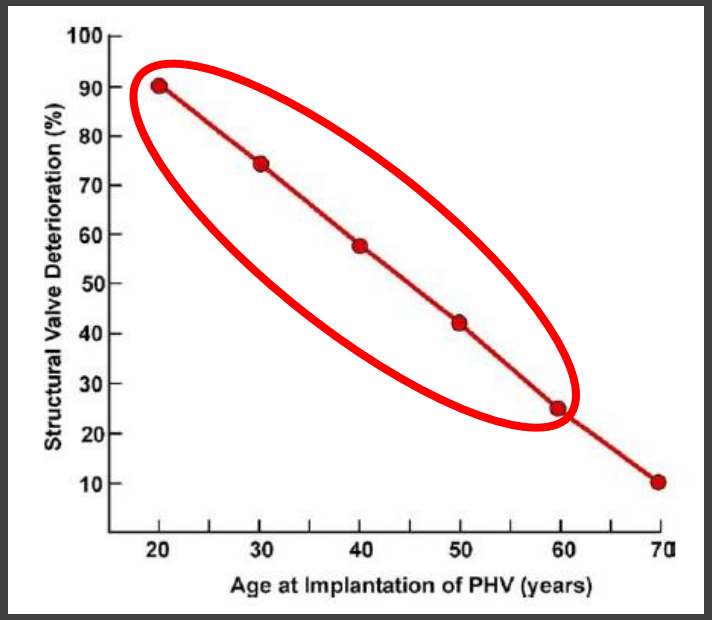
Perforation closure with patch



Patients selection for AV repair

1. Paediatric
2. Young adults

} Main TARGET of AV repair



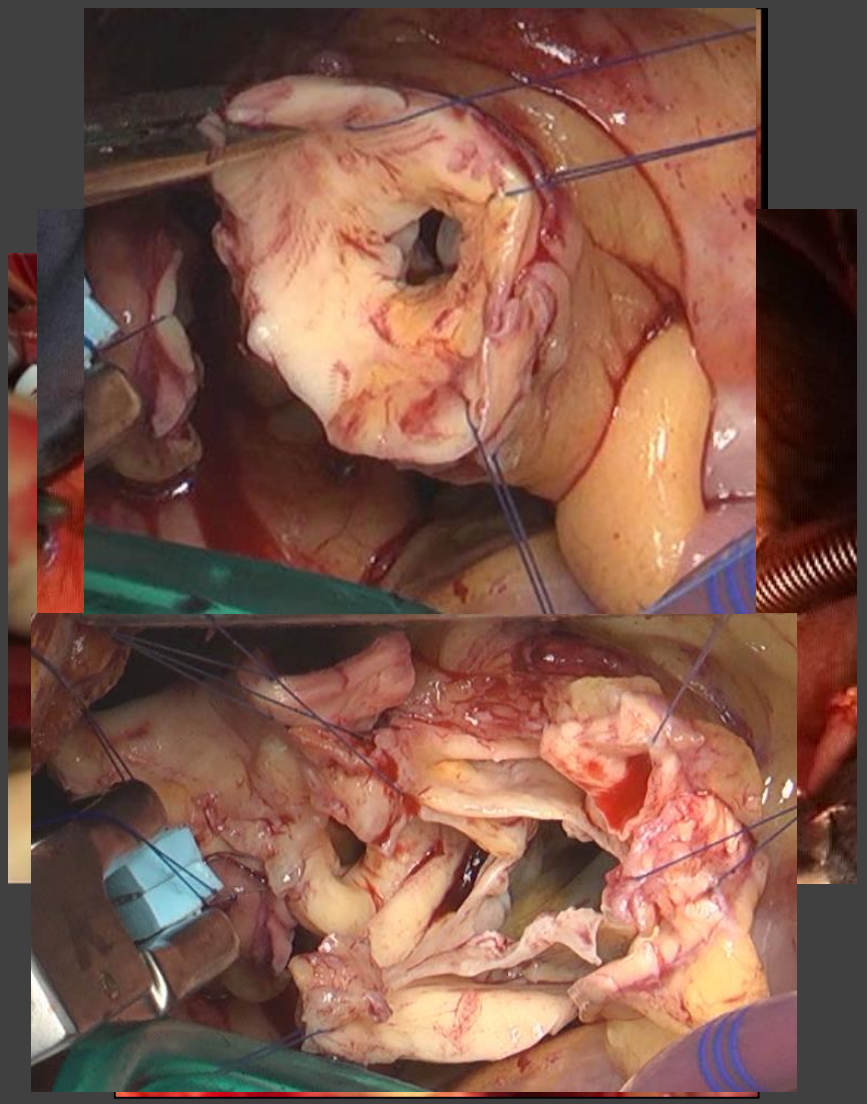
Pathologies treated by AV repair

1. Aortic insufficiency
2. Aortic root and ascending aorta dilatation
3. (Congenital stenosis)

AV repair

Congenital etiologies

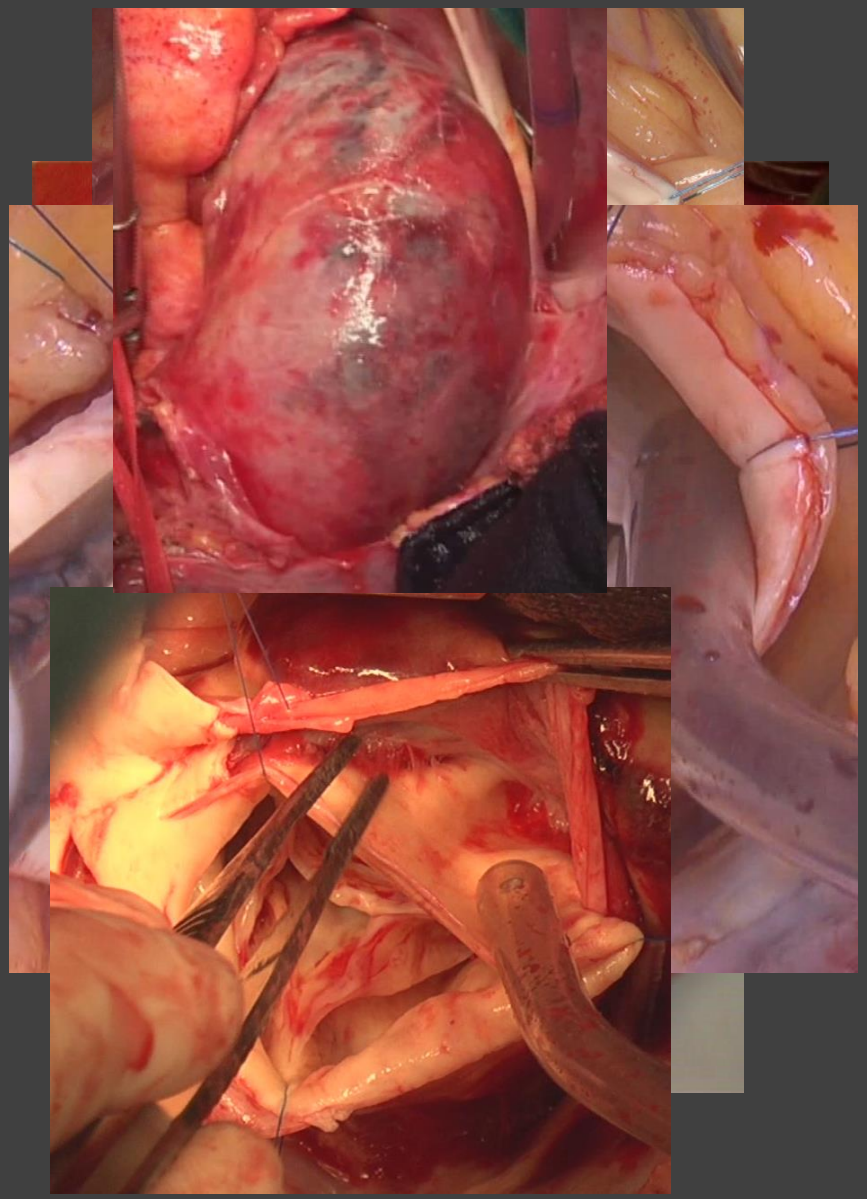
- Moncuspid
- Bicuspid
- Quadricuspid
- Connective tissue disorders (Marfan, Loeys-Dietz, Ehler-Danlos, Familial Aneurysmal disease, …)
- Supra-aortic stenosis



AV repair

Acquired pathologies

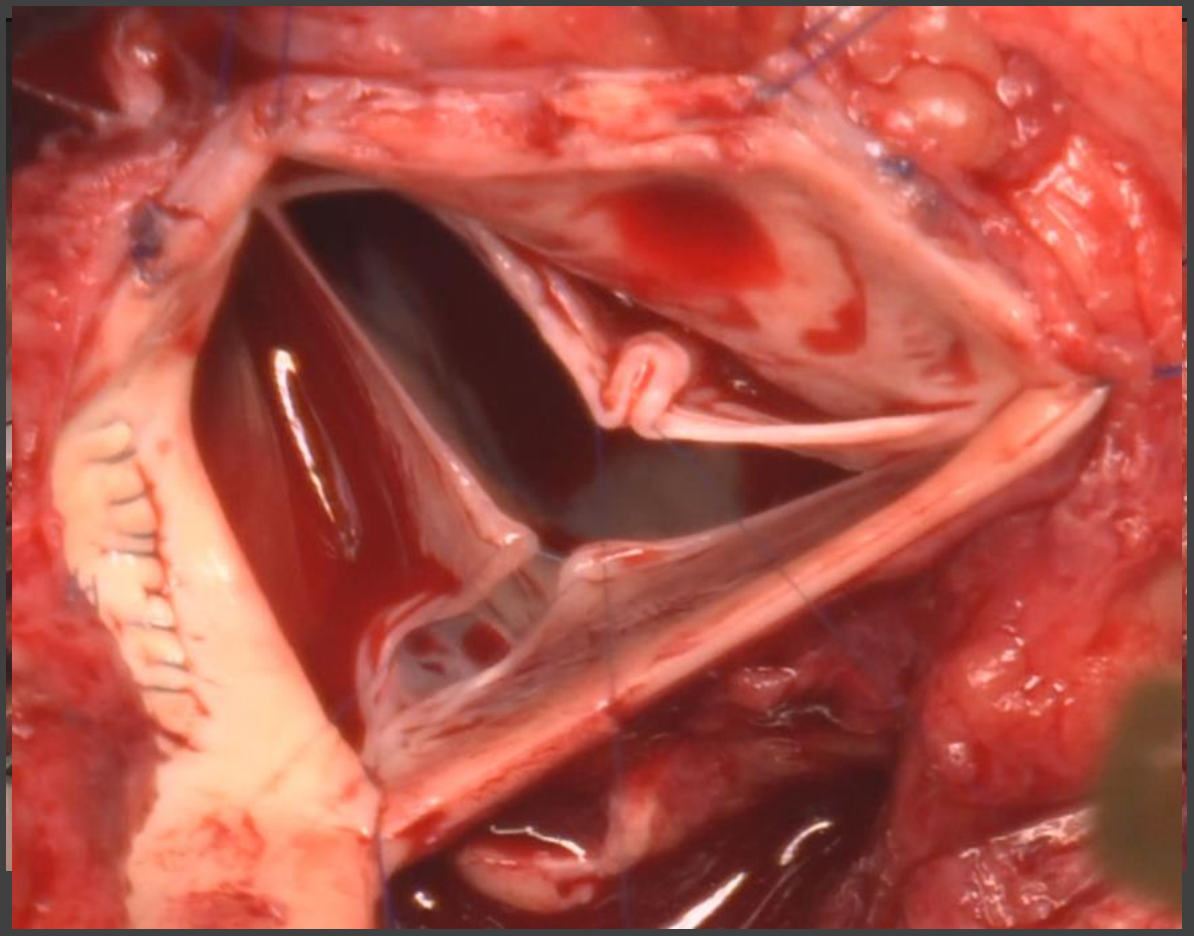
- Degenerative cusp
- Degenerative aortic aneurysm
  (Atherosclerosis)
- Traumatic
- Infectious
- Acute aortic dissection



AV repair

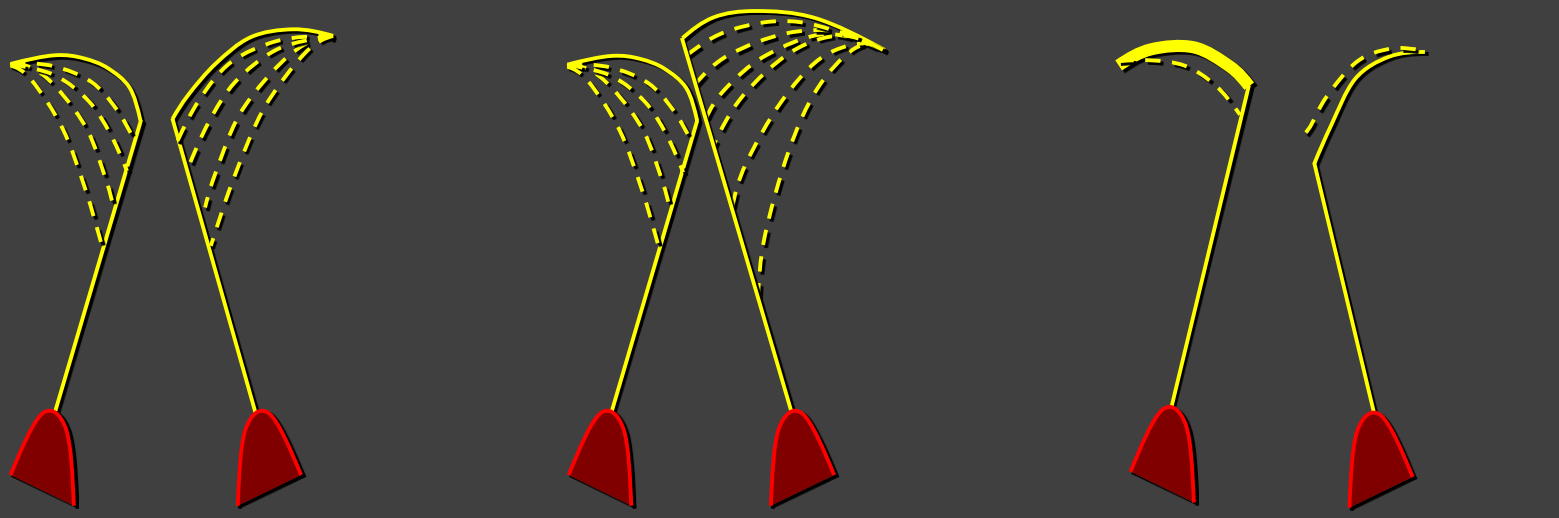
Redo

- Ross repair
- Re-repair



Classification of AV repair

Lesson from the mitral valve



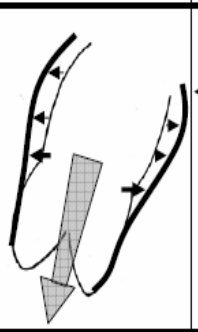
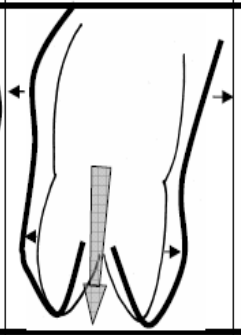
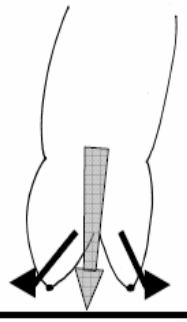
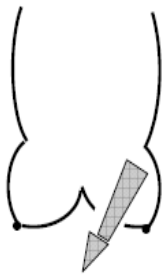
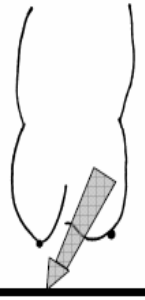
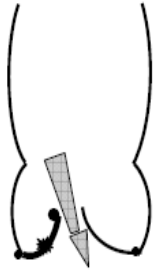
Type I
Annulus dilatation

Type II
Leaflet prolapse

Type III a,b
Leaflet restrictive motion

A. Carpentier, 1983

Repair-oriented Functional Classification of AI

AI Class	Type I Normal cusp motion with FAA dilatation or cusp perforation				Type II Cusp Prolapse	Type III Cusp Restriction
	Ia	Ib	Ic	Id		
Mechanism						
Repair Techniques (Primary)	STJ remodeling *Ascending aortic graft*	Aortic Valve sparing: *Reimplantation or Remodeling with SCA*	SCA	Patch Repair *Autologous or bovine pericardium*	Prolapse Repair *Plication* *Triangular resection* *Free margin Resuspension* *Patch*	Leaflet Repair *Shaving* *Decalcification* *Patch*
(Secondary)	SCA		STJ Annuloplasty	SCA	SCA	SCA

El Khoury G. Cur. Op. Card. 2005

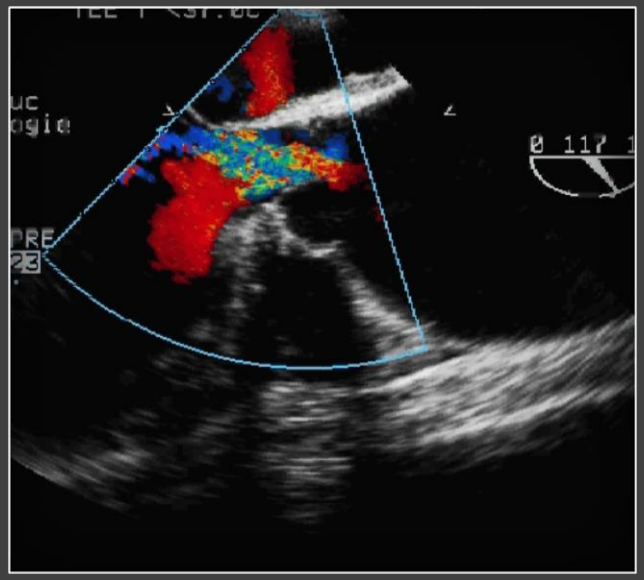
Functional classification of aortic regurgitation

Mechanism of AV dysfunction

Type 1 AR

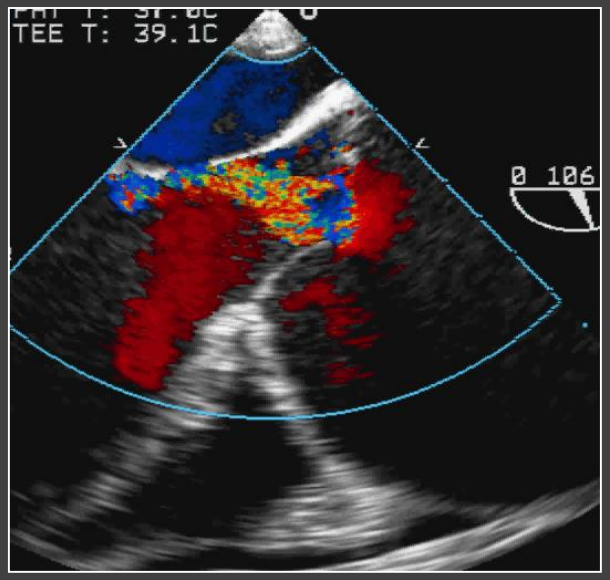
Type 1a

Asc Ao. (STJ)



Type 1b

Root (STJ +VAJ)

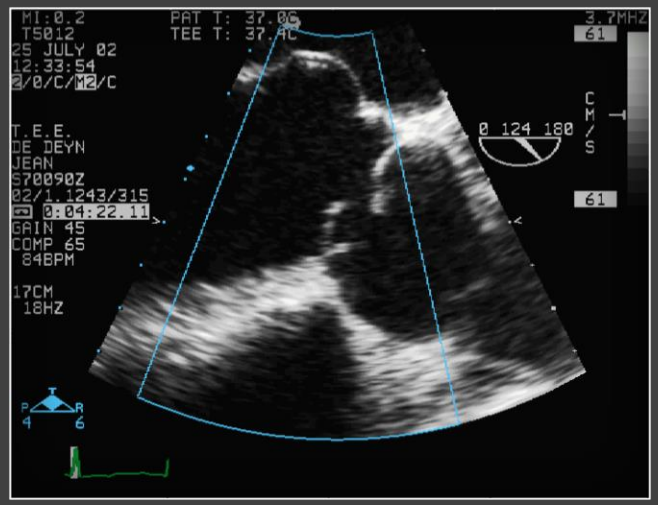


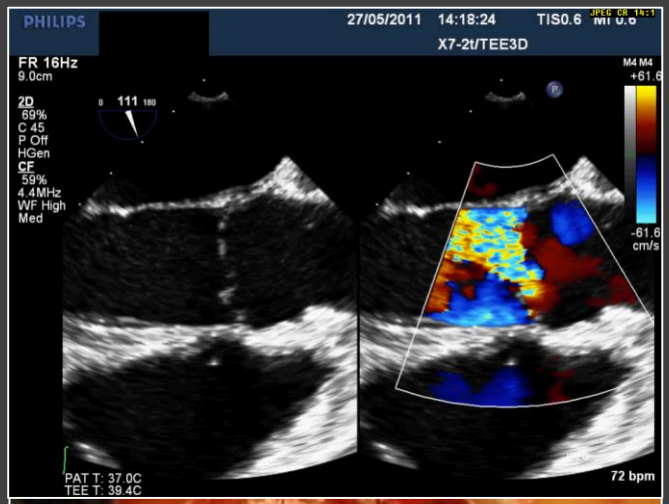
Type 1c

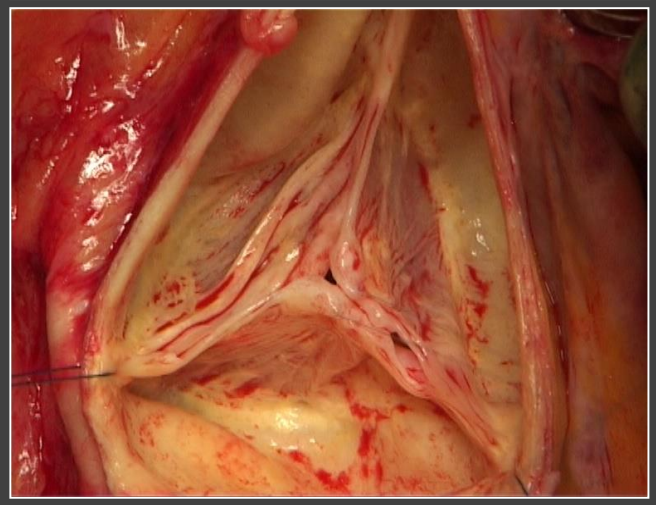
Annulus (VAJ)

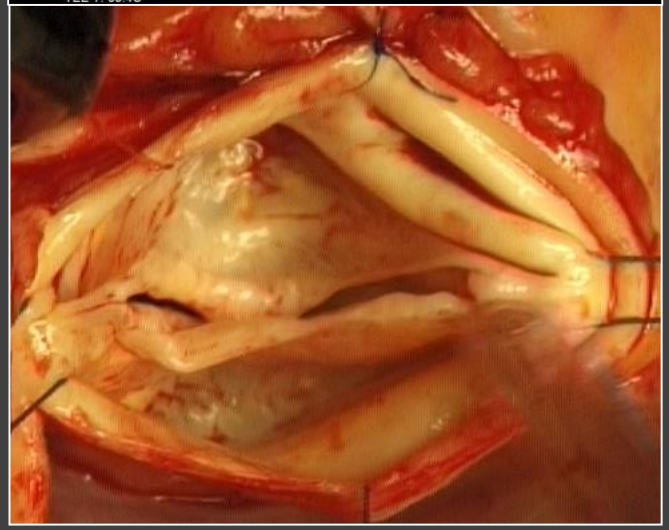
AV Repair: Leaflets lesions

Type 2 AR: Cusp prolapse





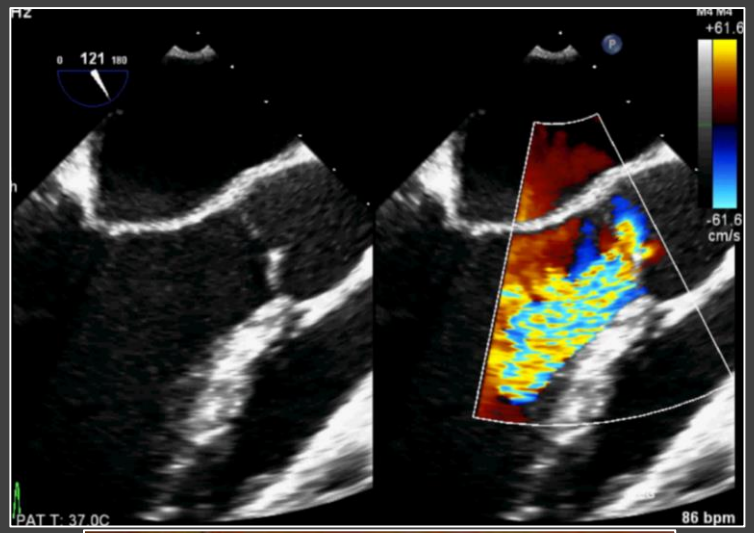


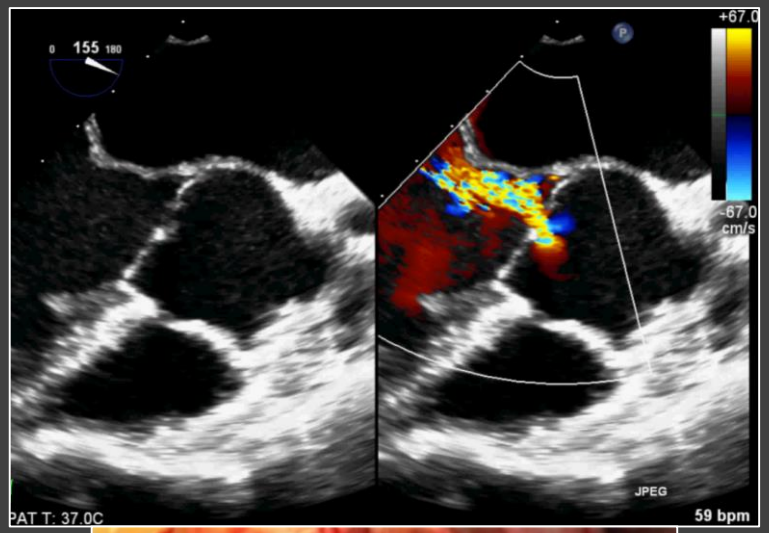


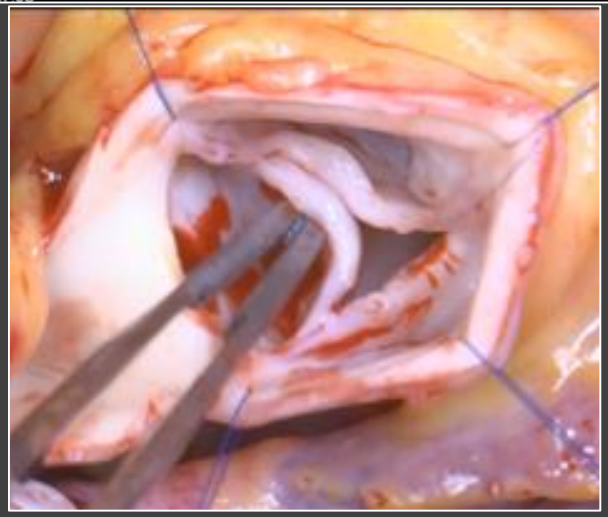
Functional classification of aortic regurgitation

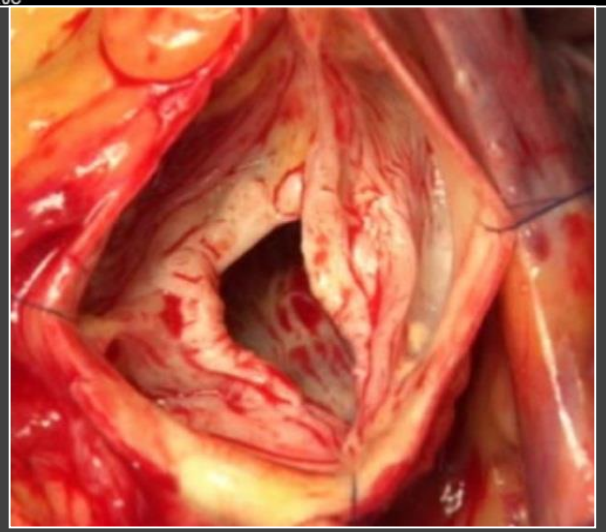
Mechanism of AV dysfunction

Type 3 AR: Restrictive cusp motion







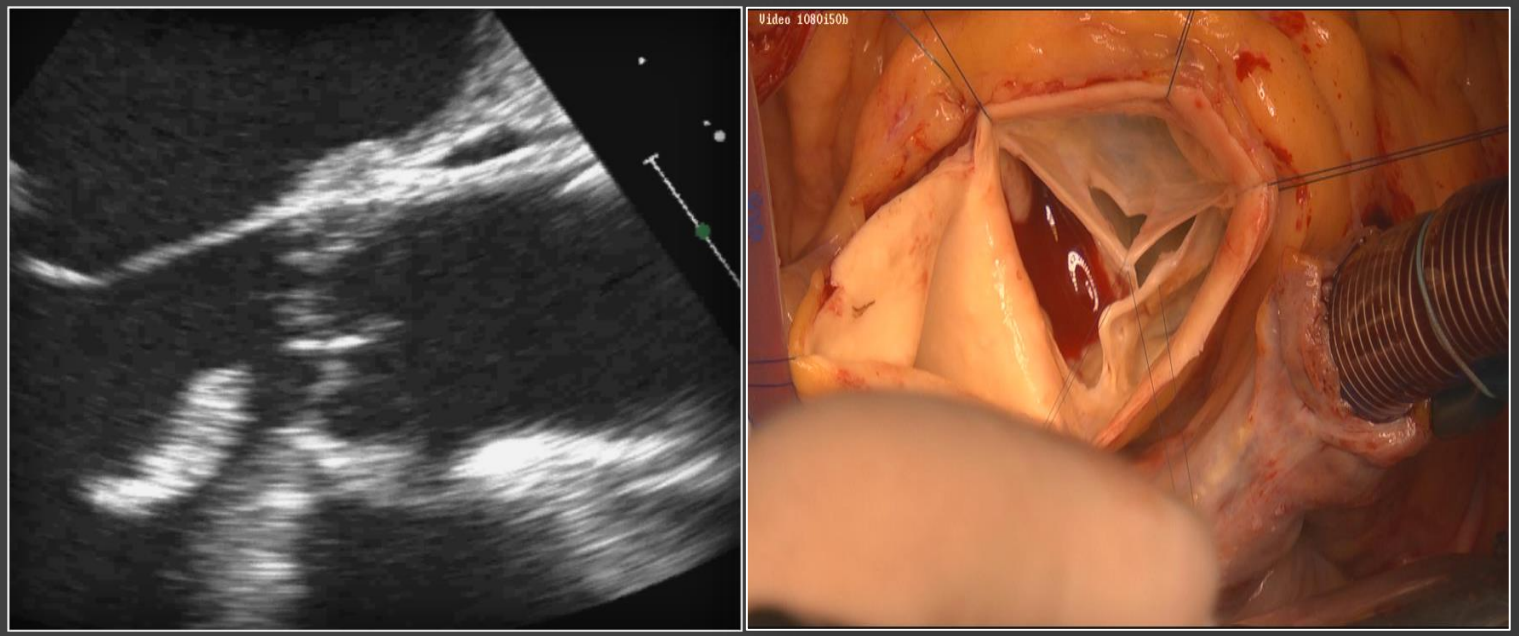


Functional classification of aortic regurgitation

Mechanism of AV dysfunction

Type 1d AR: Cusp perforation/defect

(no prolapse, no restriction)



AV Repair: Techniques

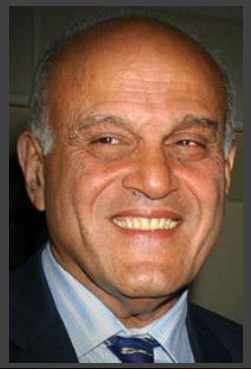
- Type 1a → Asc ao replacement
- Type 1b → Valve Sparing Root Replacement
- Type 1c → Annuloplasty
- Type 2 & 3 → Cusp repair techniques

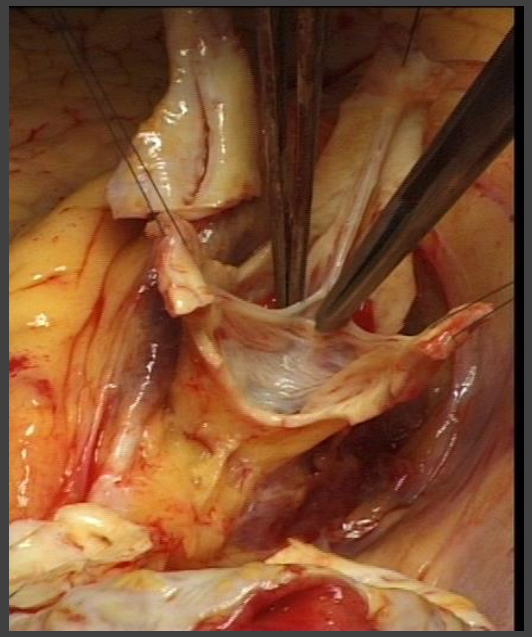
Aim of repair

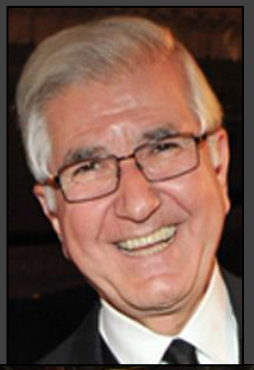
→ *To restore matching between cusp & AV orifice*

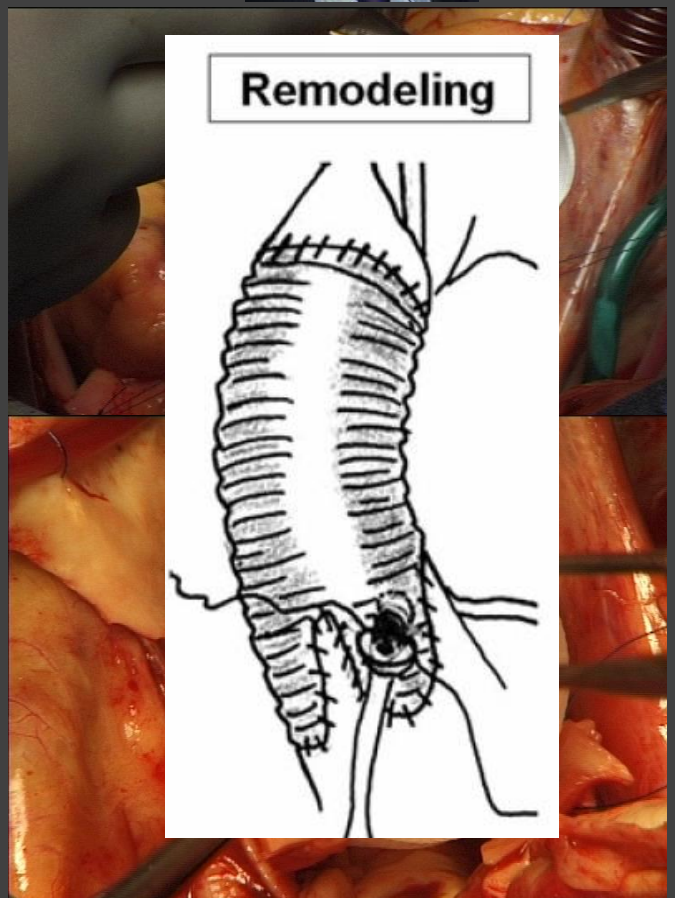
→ *To create an optimal coaptation, stable over time*

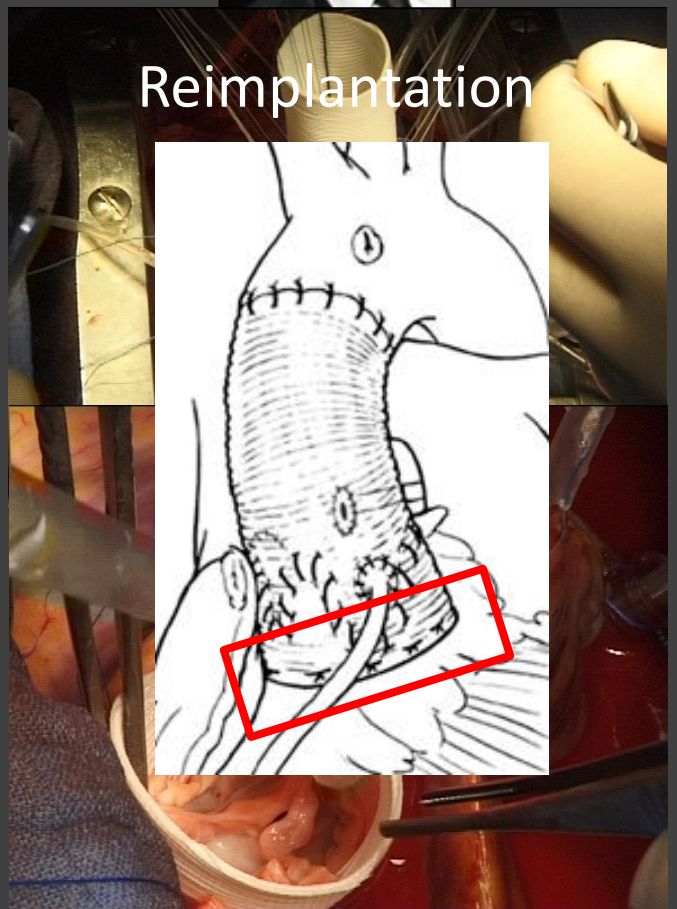
AI Type 1b repair: Valve sparing root replacement



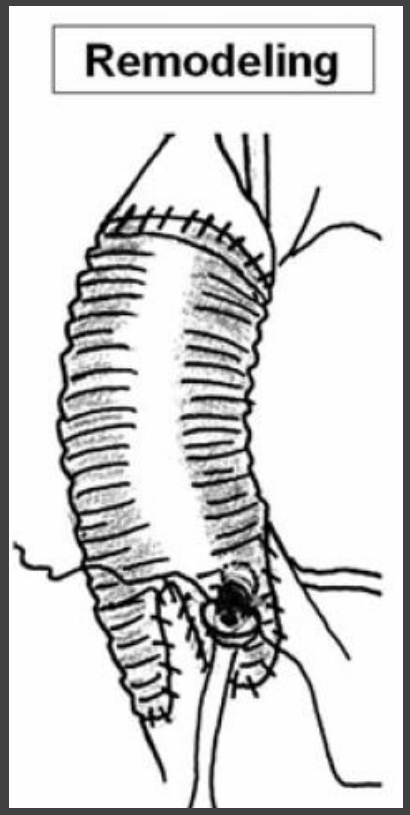




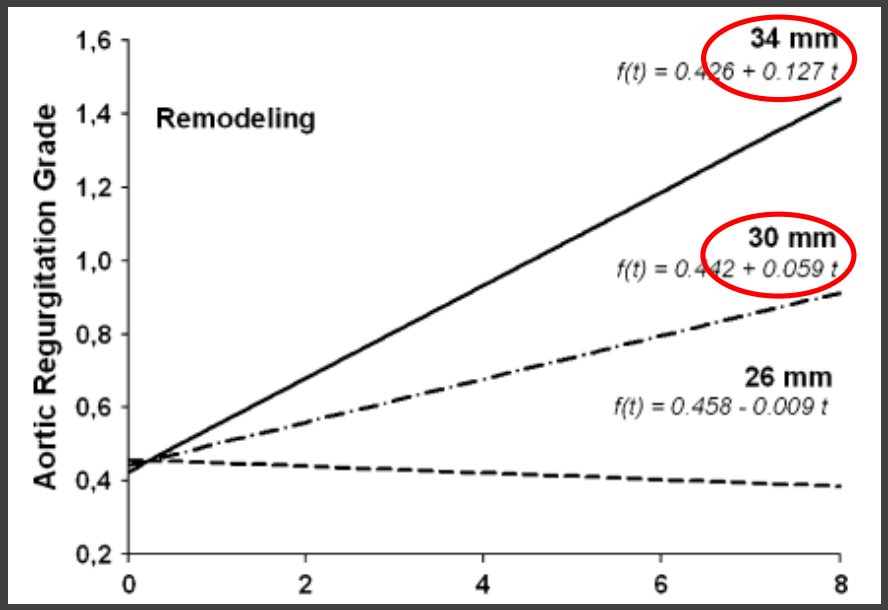


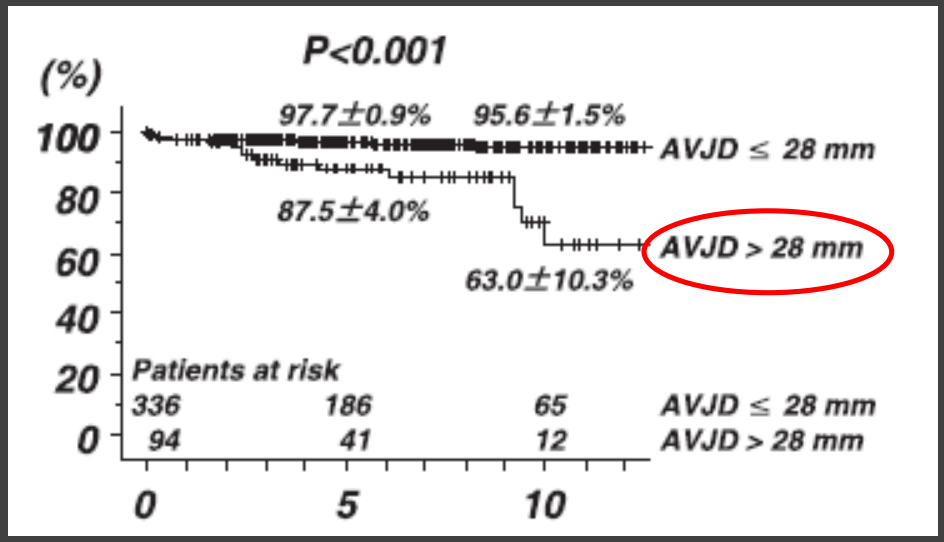


Evolution of the Remodeling technique



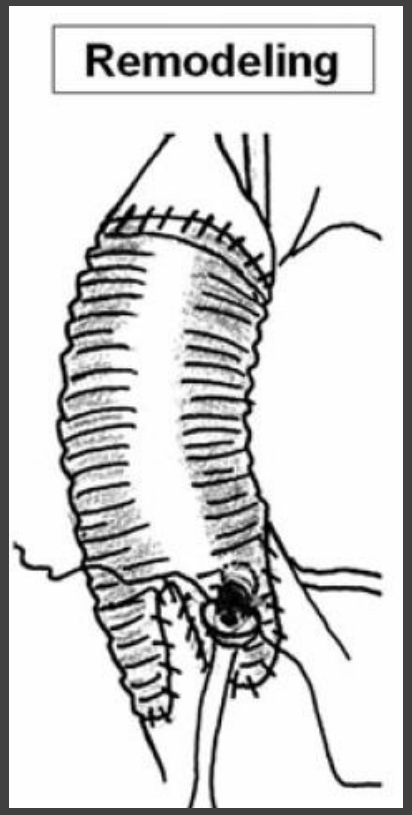
M. Yacoub





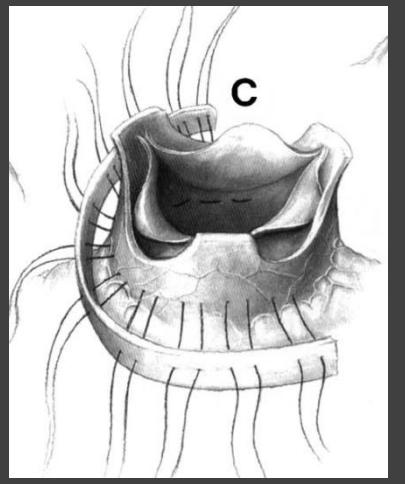
Hanke T. JTCS 2009
Kunihara T. JTCS 2012

Evolution of the Remodeling technique



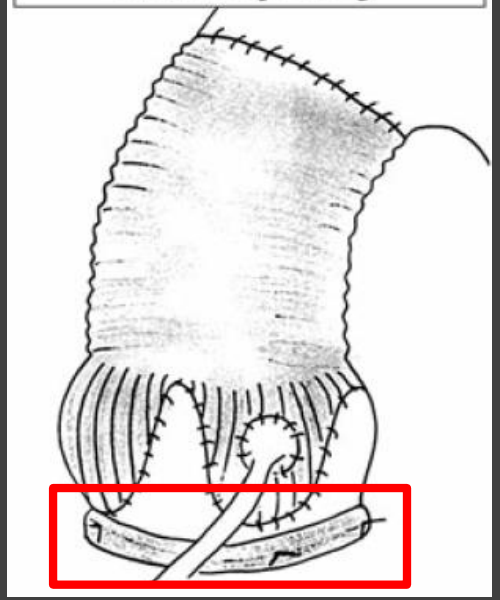
M. Yacoub

Partial external band



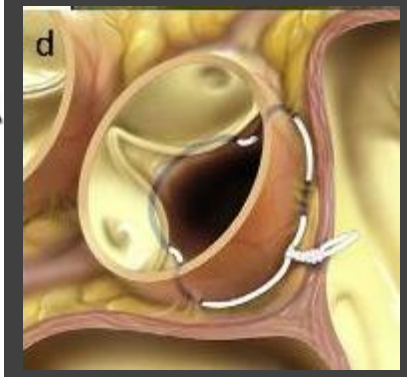
T. David 1996

Remodeling
+
Subvalvular aortic annuloplasty



E. Lansac 2006

Suture Anpl.

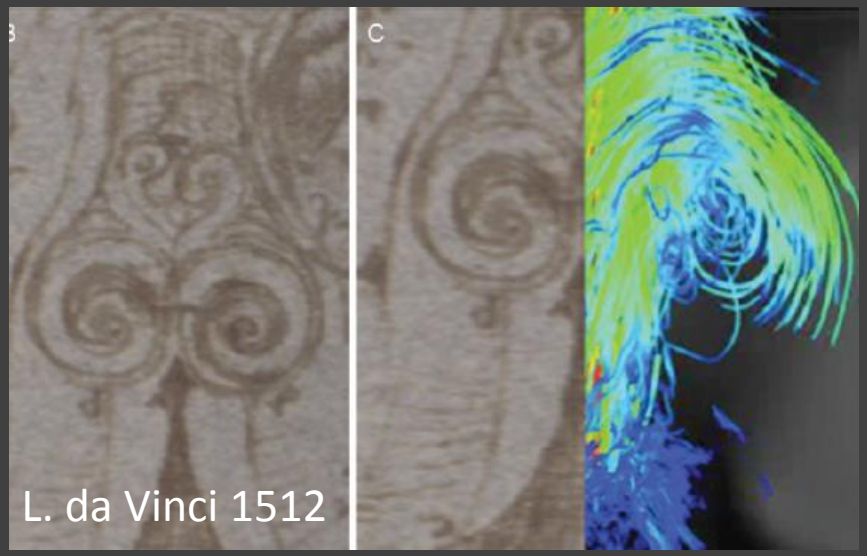


HJ. Schäfers 2013

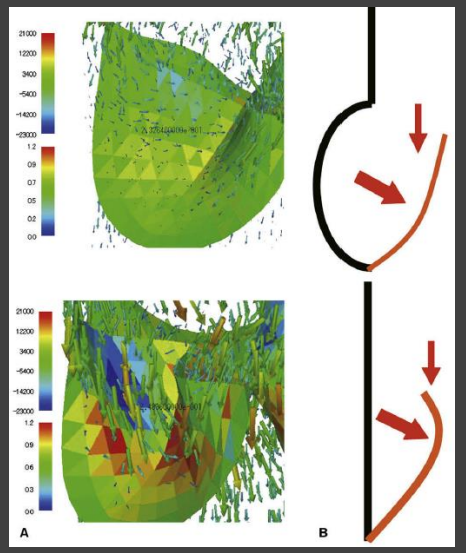
Evolution of the Reimplantation technique

Reimplantation

T. David 1992



Bissell M. Eur Heart J. 2014

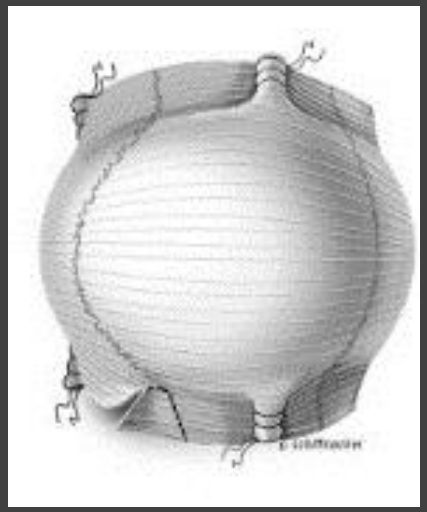


Katayama JTCVS 2008

Evolution of the Reimplantation technique

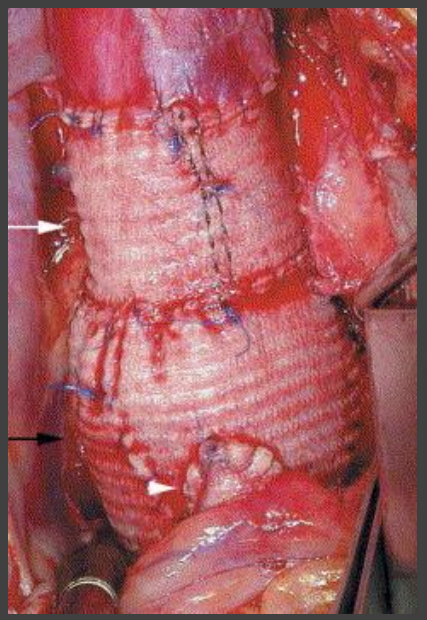
Reimplantation

T. David 1992

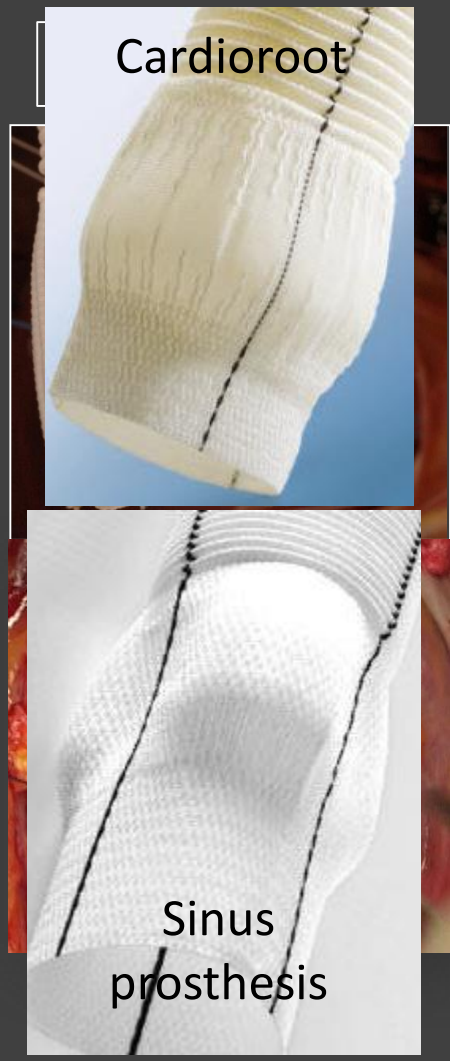


T David “V”

Stanford Modification

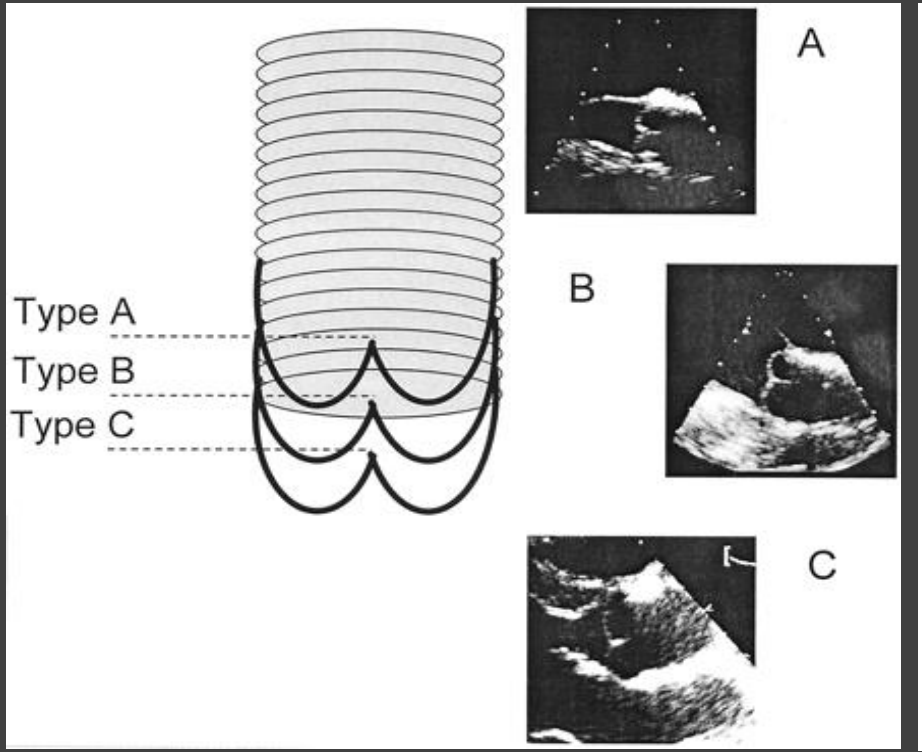


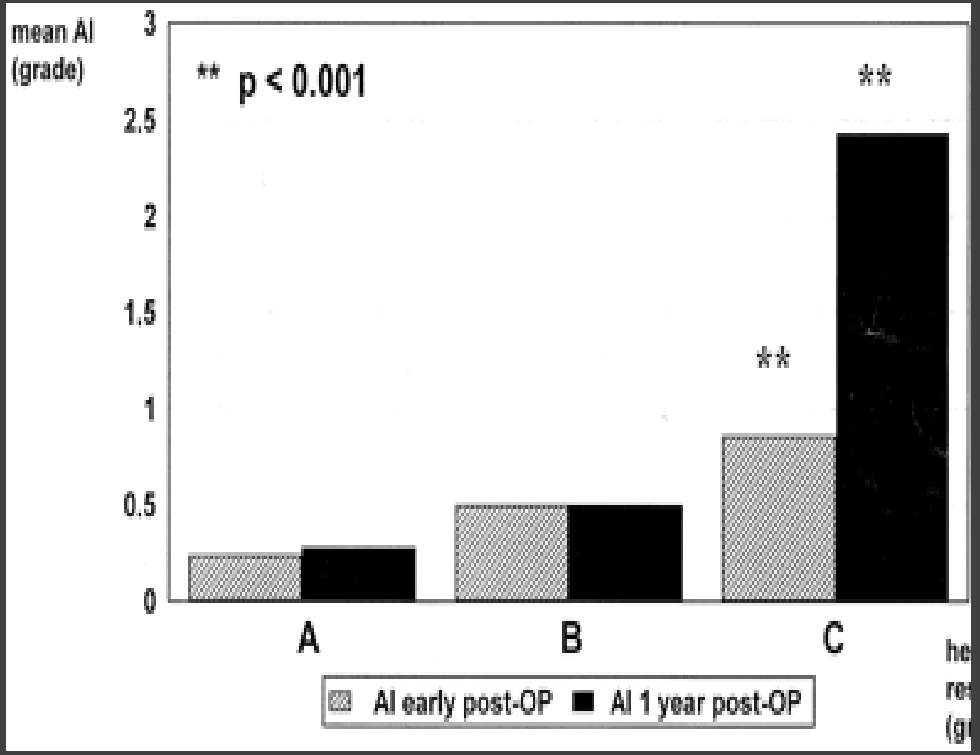
C. Miller



Predictors of recurrent AI

Coaptation height

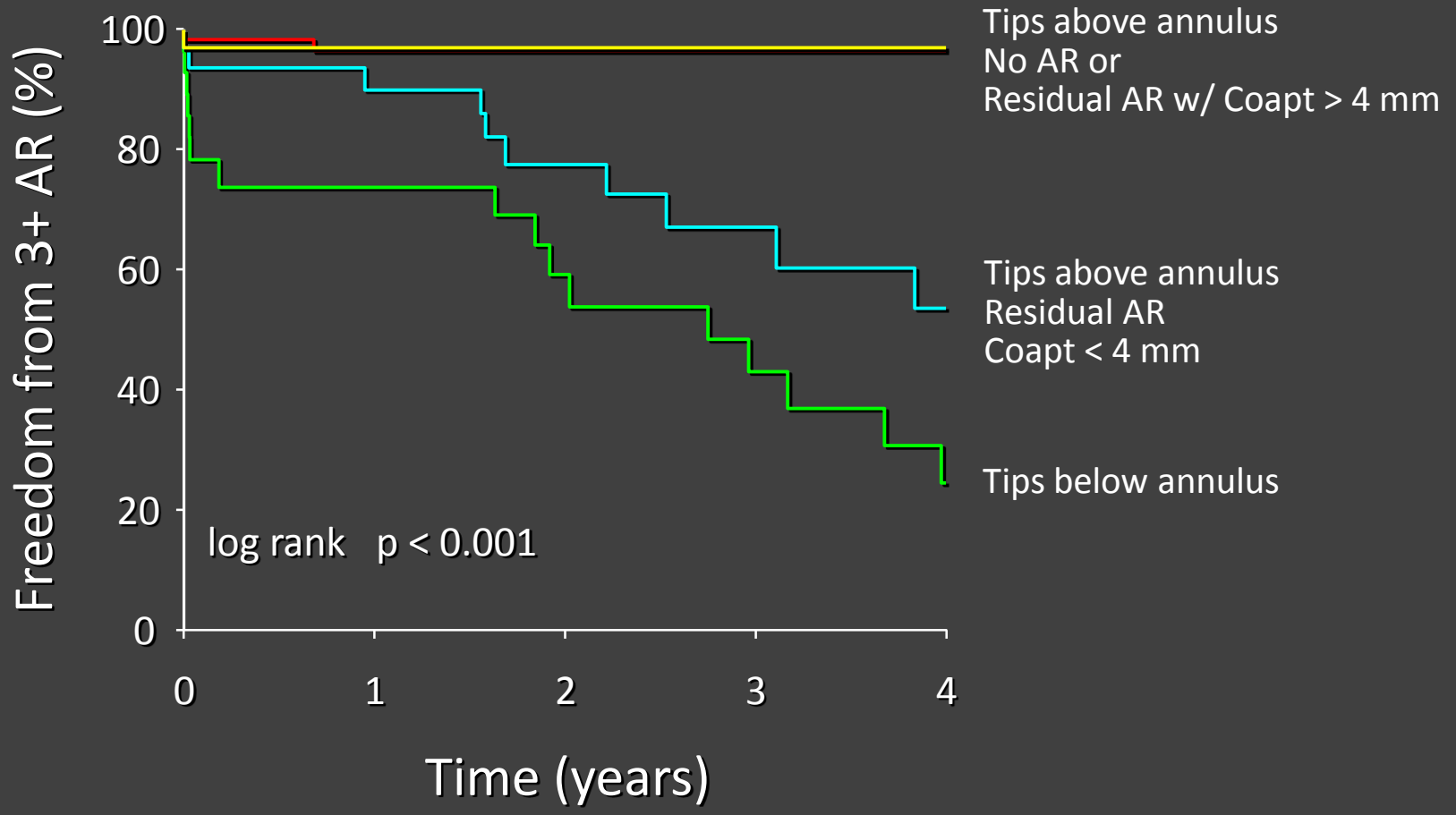




Pethig K. Ann Thorac Surg, 73:29-33, 2002

Predictors of recurrent AI

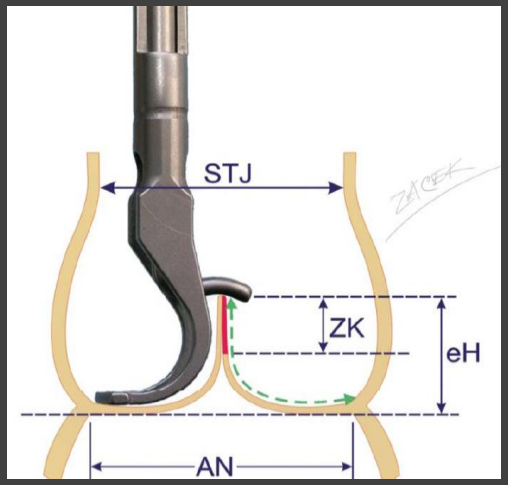
Coaptation height

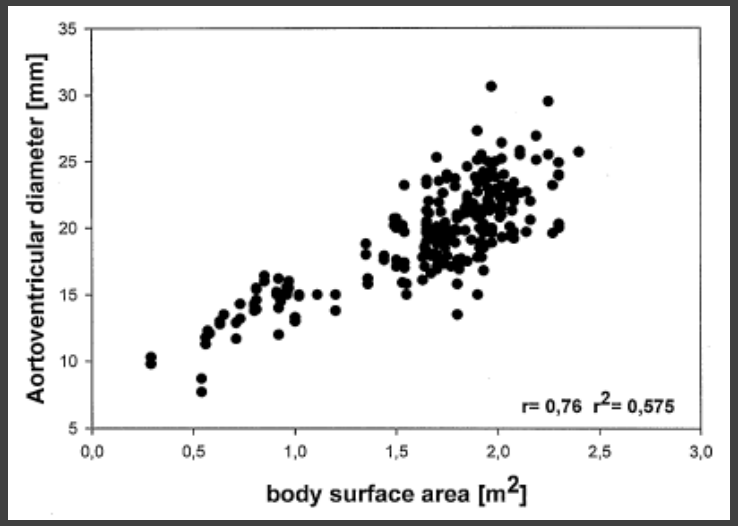


le Polain de Waroux JB, JACC Cardiovasc. Imaging 2009;2(8):931-9

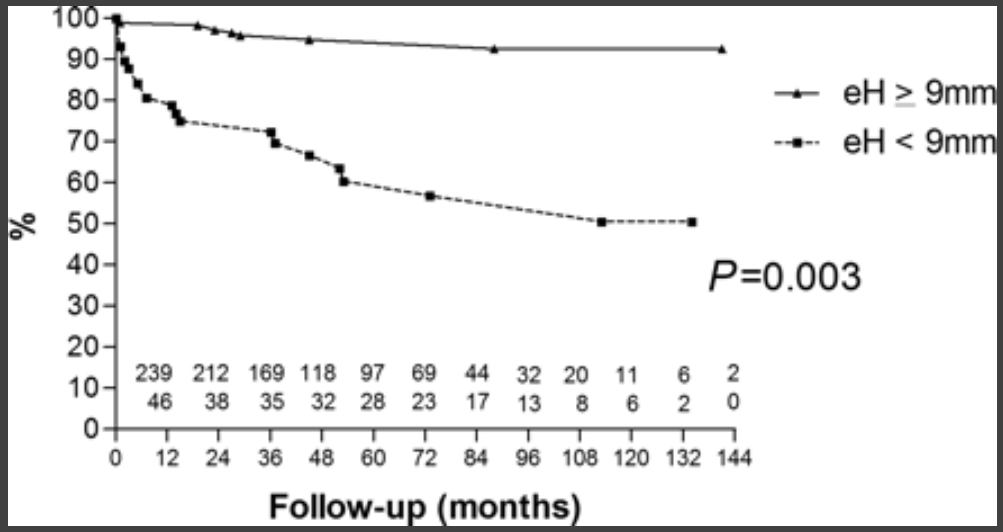
Predictors of recurrent AI

Coaptation height



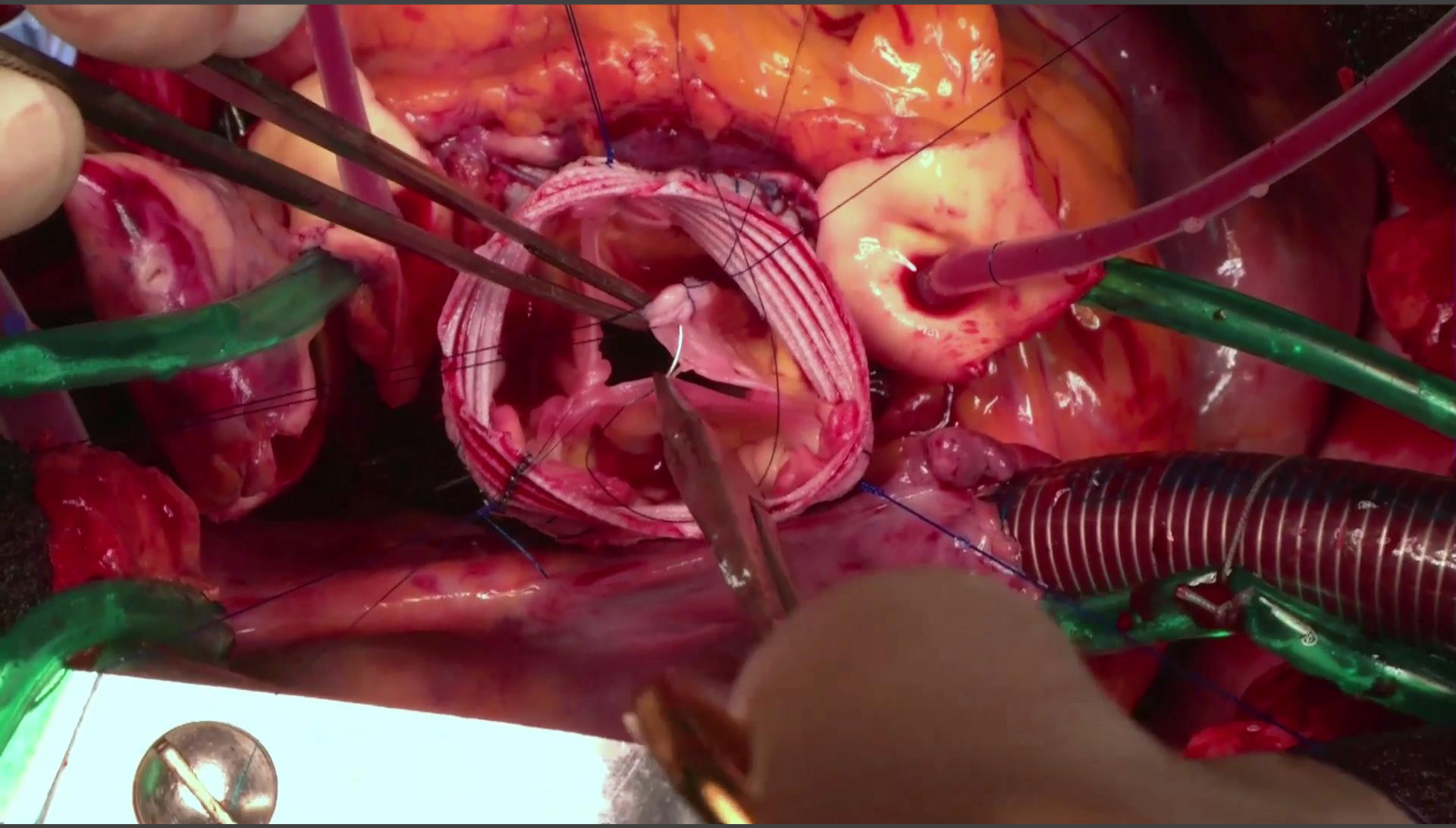


Bierbach B.O. EJTCS 2010



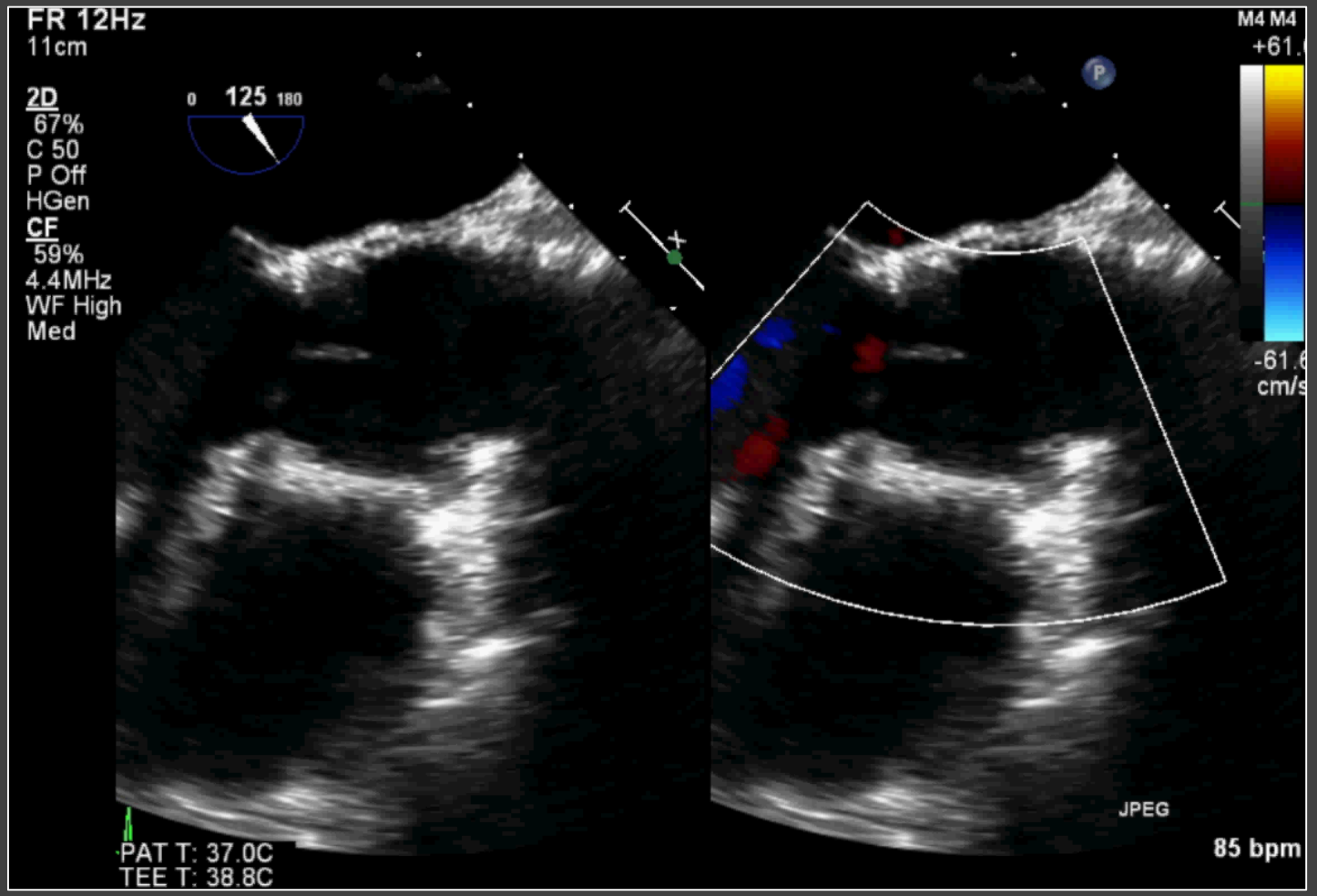
Aicher D. Circulation ;123:178-85, 2011

Reimplantation Technique

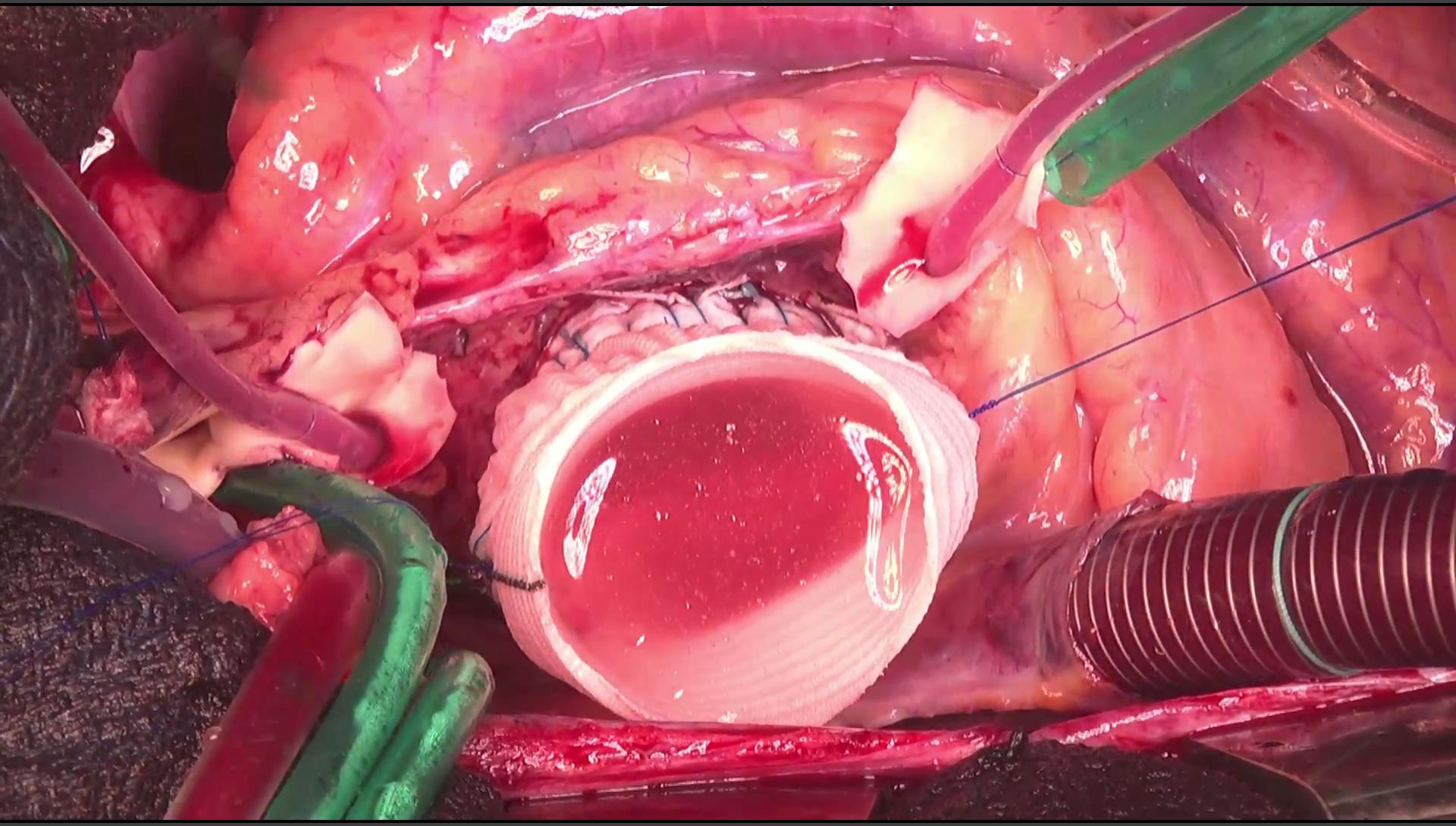


Reimplantation Technique

Post-repair TEE

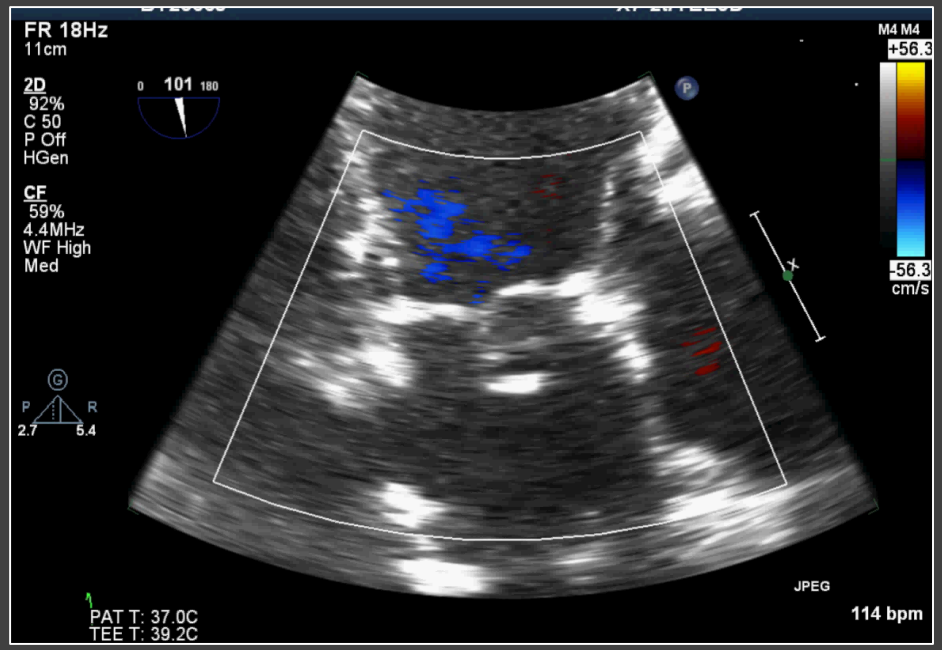


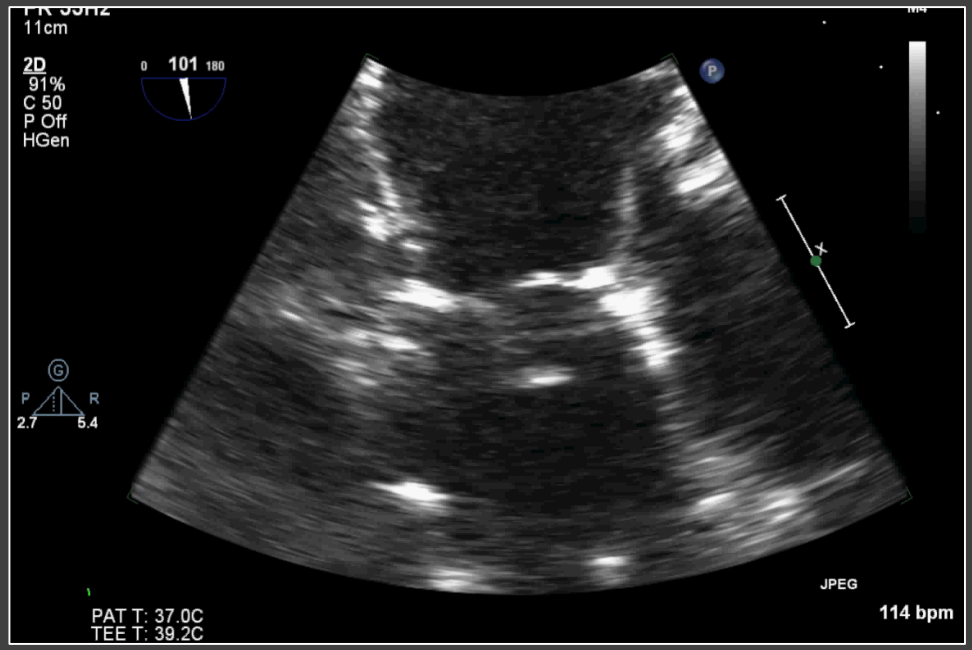
Reimplantation Technique



Reimplantation Technique

Post-repair TEE



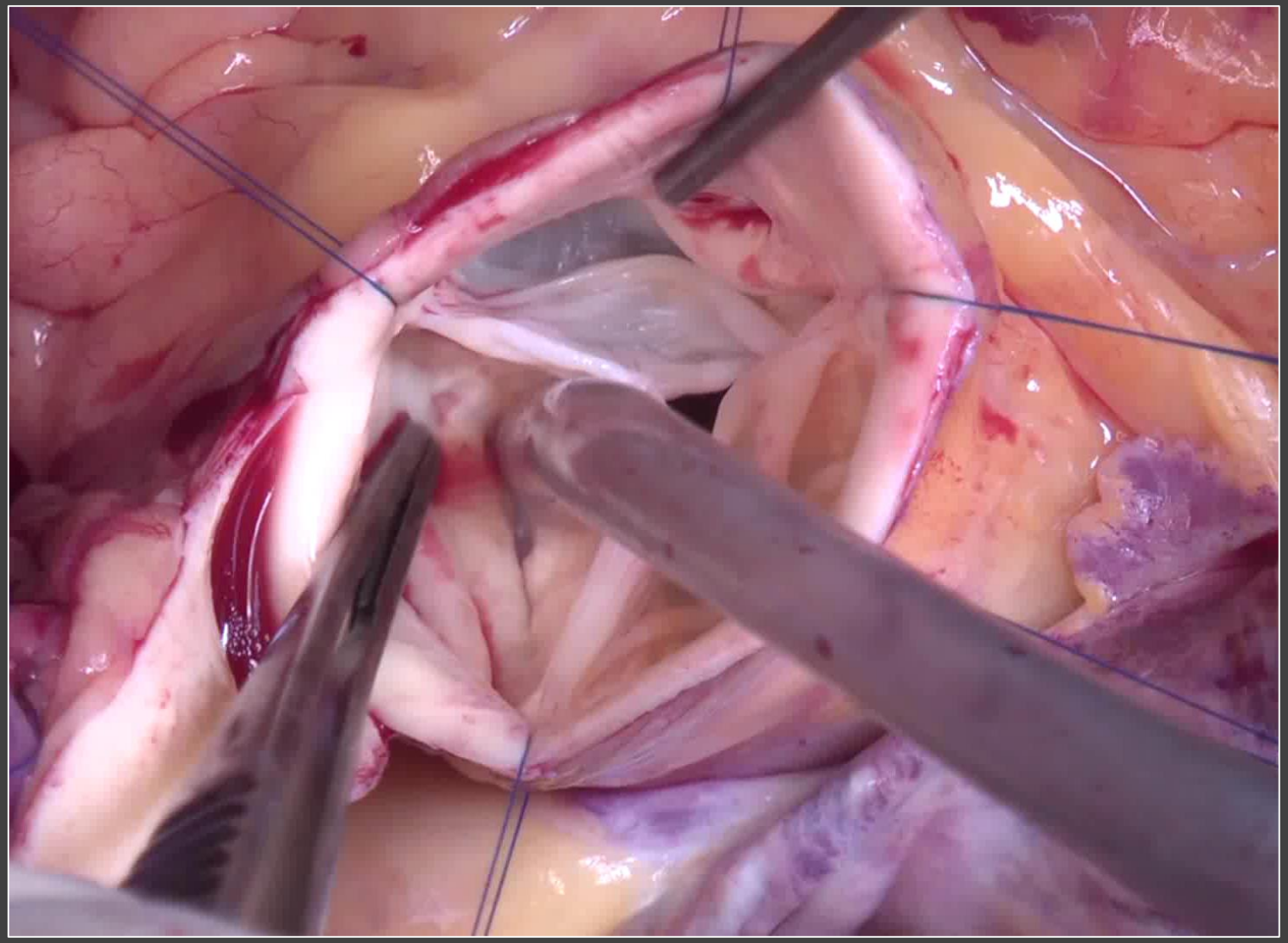


Cusp repair techniques

Cusp lesions	Repair techniques
• Prolapse (Type 2)	
- Free margin elongation	→ Central plication / GTx resusp.
- Fenestration (large/rutpured)	→ GTx resusp. / Patch
- Commissure disruption	→ Trusler stitch
• Restriction (Type 3)	
- Raphe in BAV	→ Resection/direct closure/patch
- Unicuspid valve	→ Patch
- Calcification	→ Leaflet replac. with patch
• Perforation (Type 1d)	→ Patch

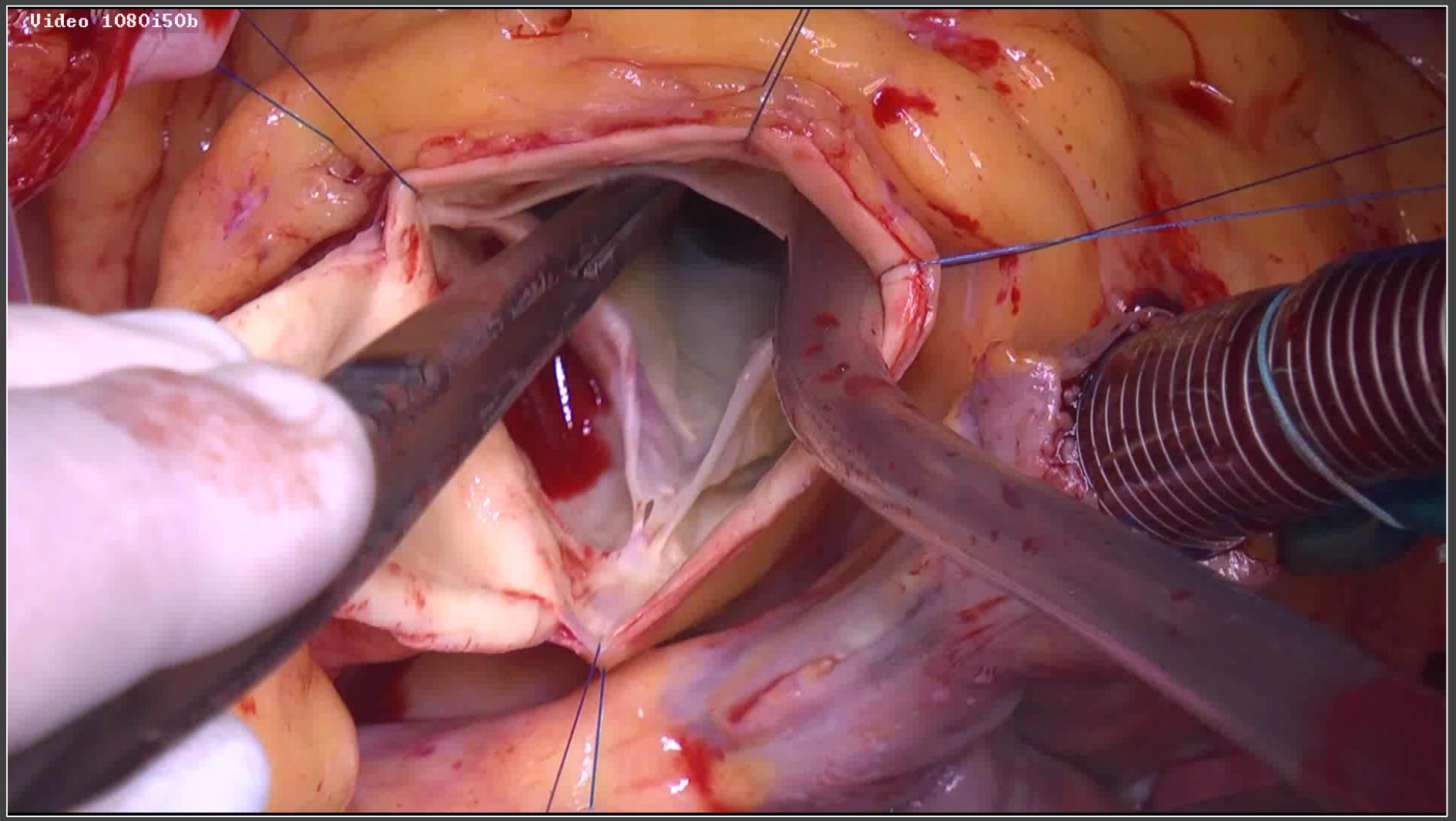
AV Repair

Central Plication



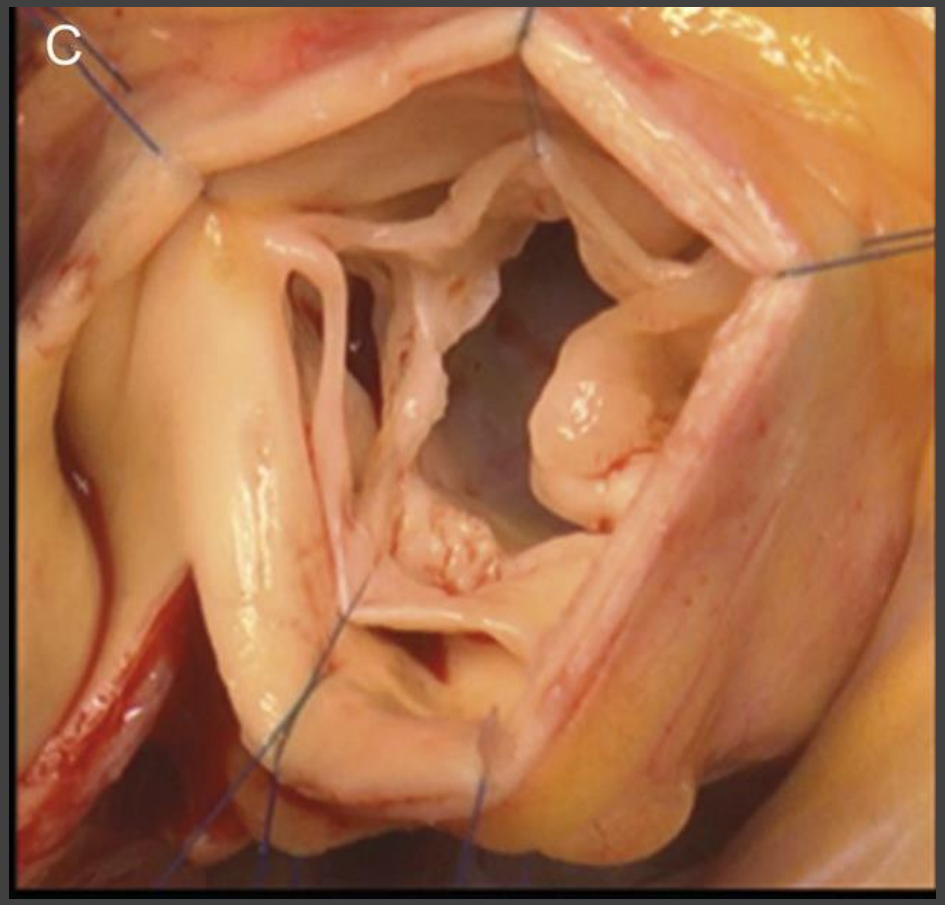
AV Repair

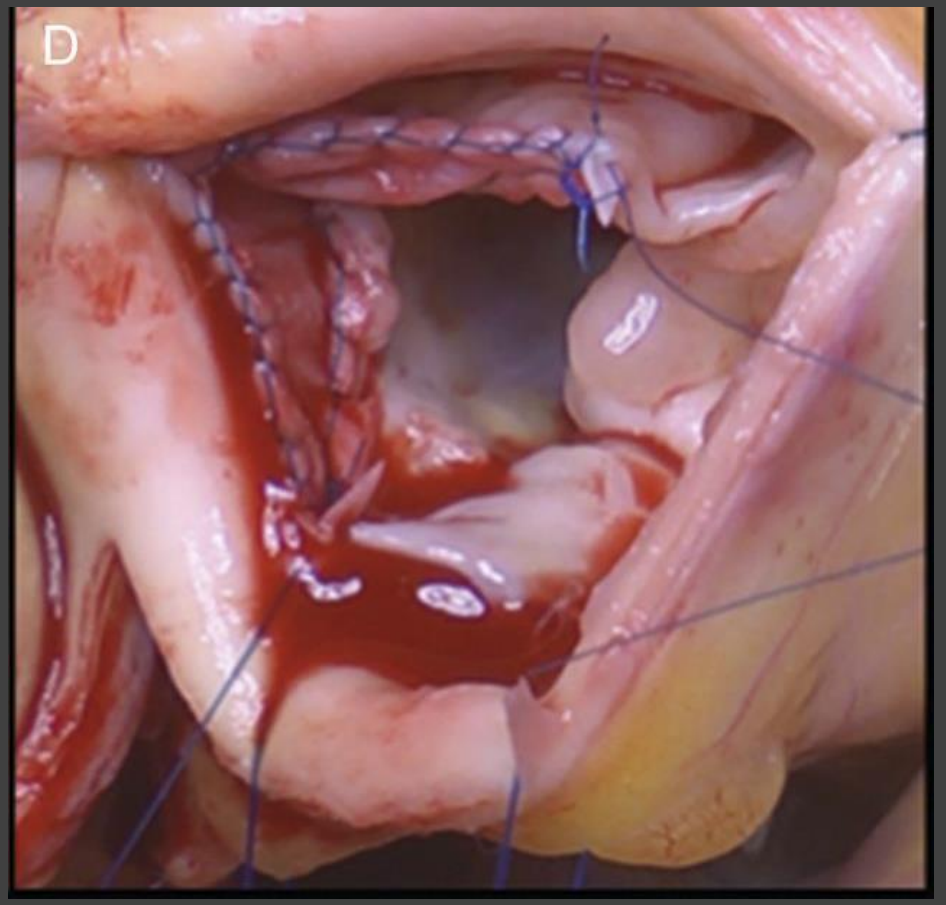
Patch: Perforation Closure



AV Leaflet Repair: Fenestration

Patch





BAV Repair

Cusp Anatomy

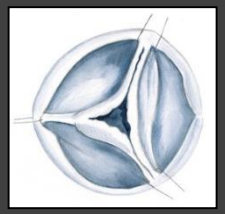
Type 0

Type 1

Raphe Morphology

Prolapsing

Restrictive



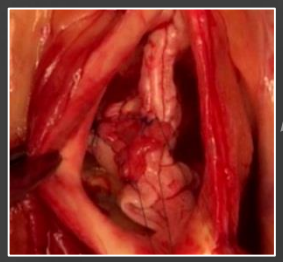
Raphe Resected

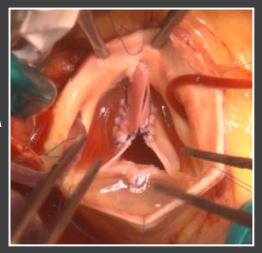
Raphe Thinned

Quantity of Cusp Tissue ?

Adequate

Inadequate





≈ 180°

≈ 120°

≈ 180°

≈ 120°

Central Plication,
Triangular Resection

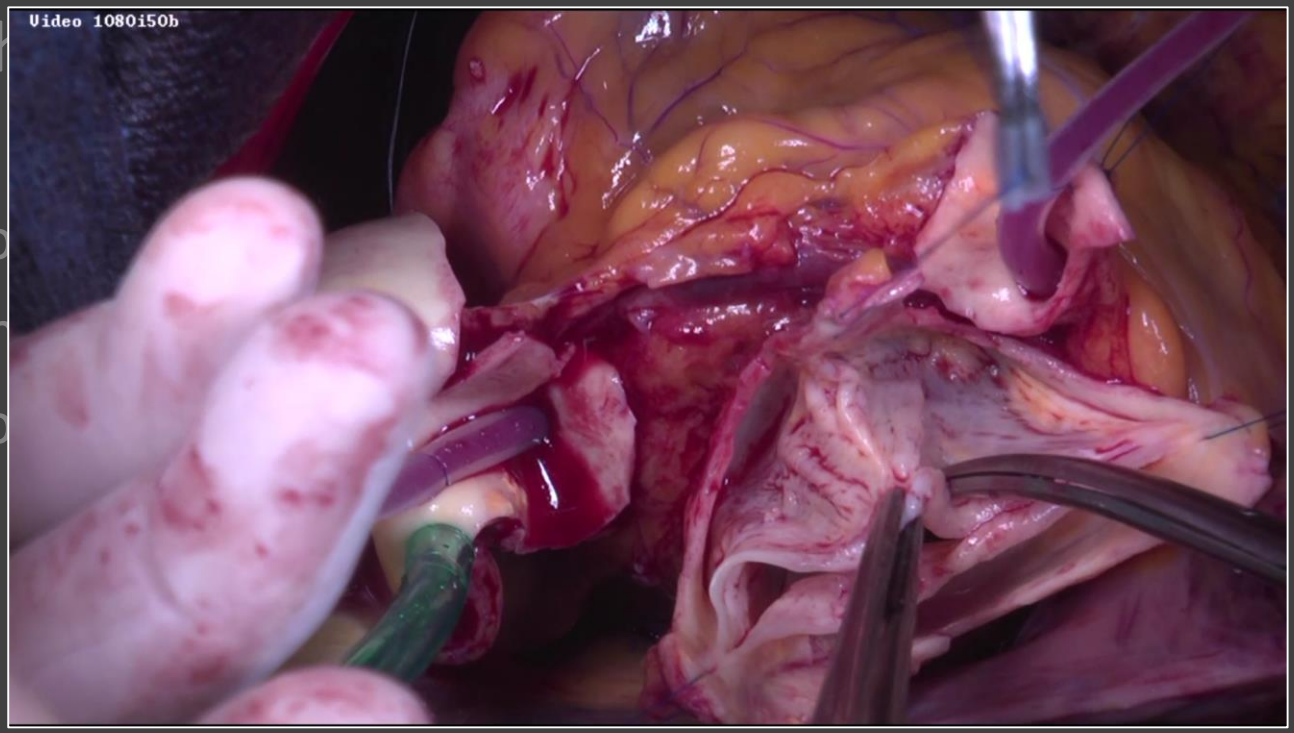
Tricuspidisation

Triangular
Patch

Commissural
Patch

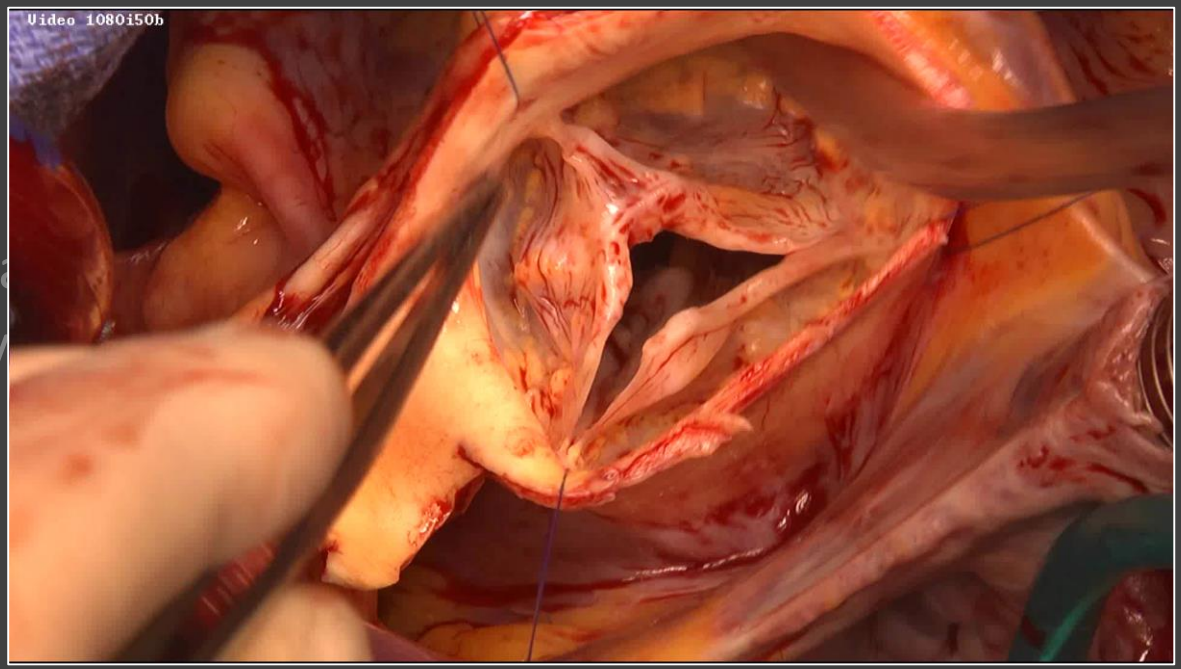
BAV Repair

- Type 0
- Type I:
  - Prolapsing raphe: plication
  - Restrictive raph
    - Direct closure
    - Tricuspidisatio
    - Bicuspid patch
    - Tricuspidisatio



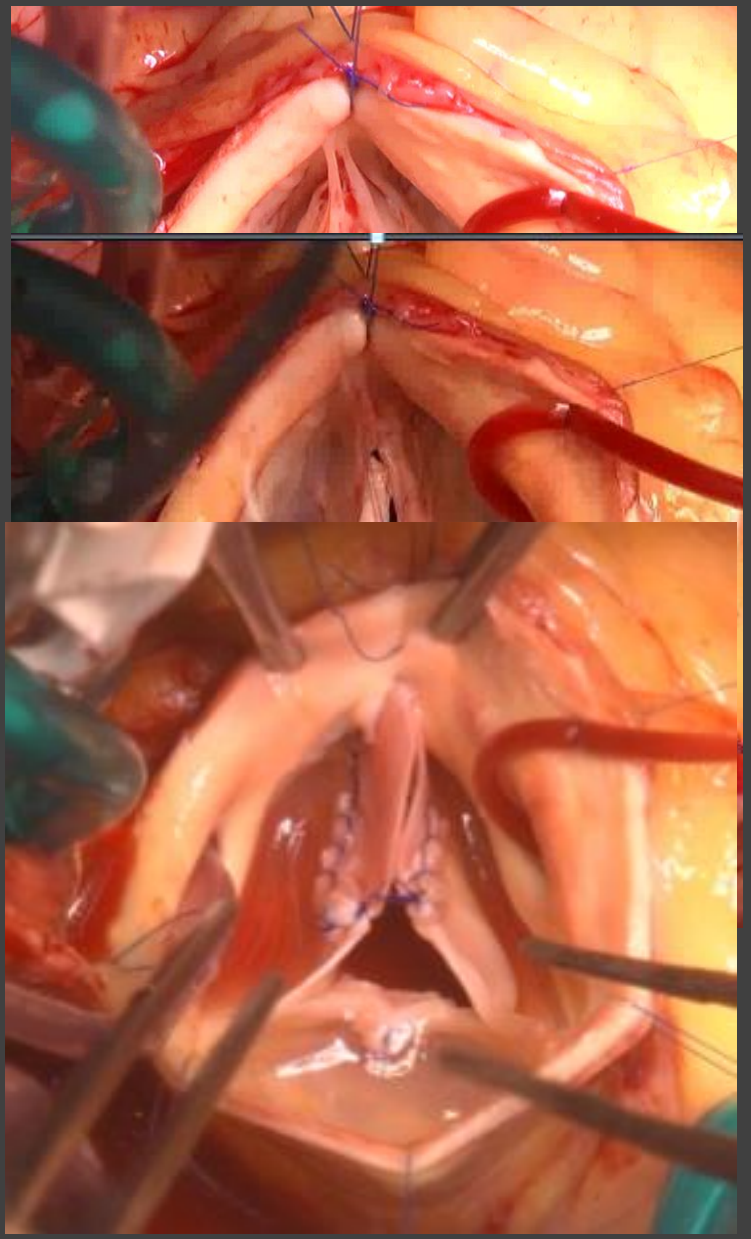
BAV Repair

- Type 0
- Type I:
  - Prolapsing raphe
  - Restrictive raphe
    - Direct closure
    - Tricuspidisation
    - Bicuspid patch rep
    - Tricuspidisation w/



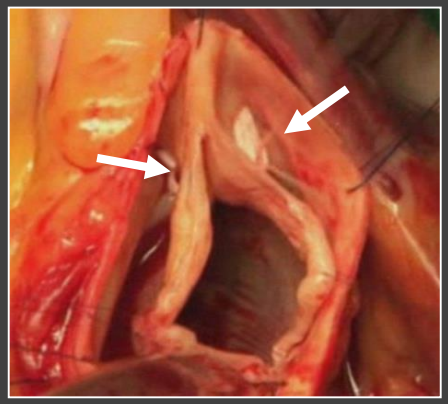
BAV Repair

- Type 0
- Type I:
  - Prolapsing raphe
  - Restrictive raphe
    - Direct closure
    - Tricuspidisation w/o patch
    - Bicuspid patch repair
    - Tricuspidisation w/ patch



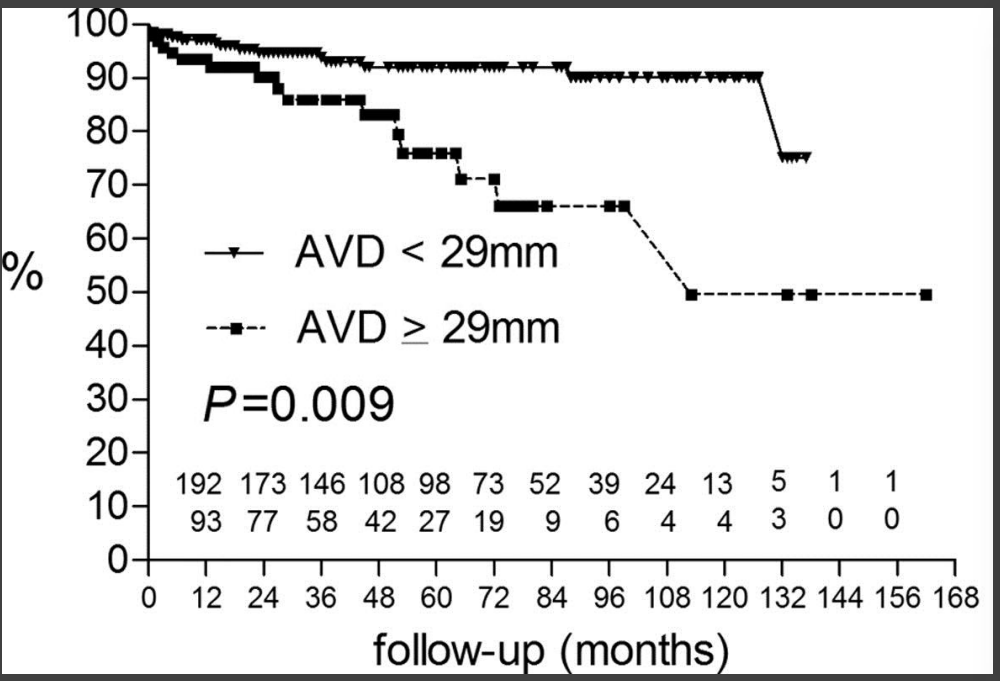
AV repair

VAJ dilatation (AI Type 1c)

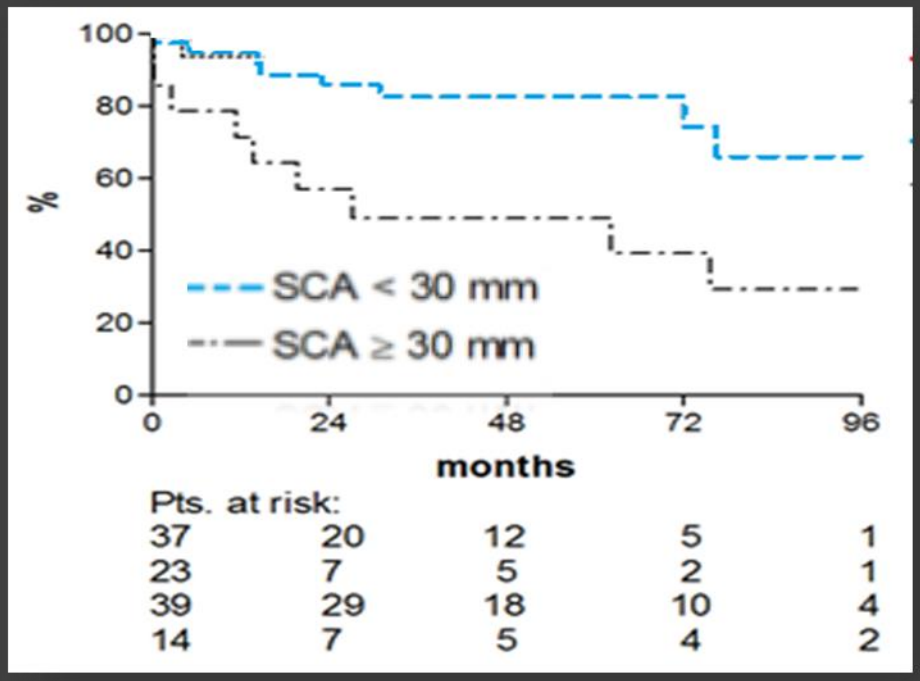


No annuloplasty

SC annuloplasty



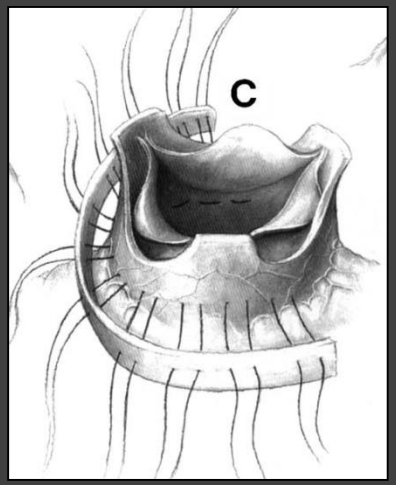
Aicher D. Circ. 2011



Navarra E. EJCTS 2013

Techniques of Circumferential Prosthetic Annuloplasty

Partial external band



T. David 1996

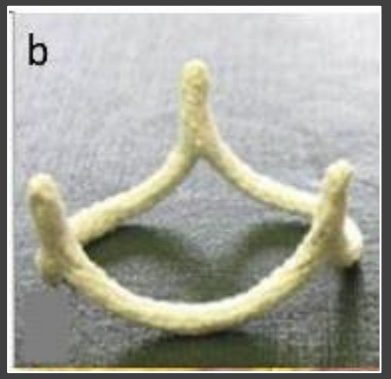
External Ring

E. Lansac 2006

Suture Anpl.

HJ. Schäfers 2013

Internal Ring



J.S. Rankin 2012

AV Repair:

Ring annuloplasty

AV Repair: Hospital Mortality

- 0.6% V. Sharma, H. Schaff JTCVS 2014
- 0.8% J. Price, G. Elkhoury ATS 2013
- 0.8% D. Aicher, H-J Schafers EJCTS 2010
- 1% T. David JTCVS 2014

AV Repair: Valve related event

VSRR

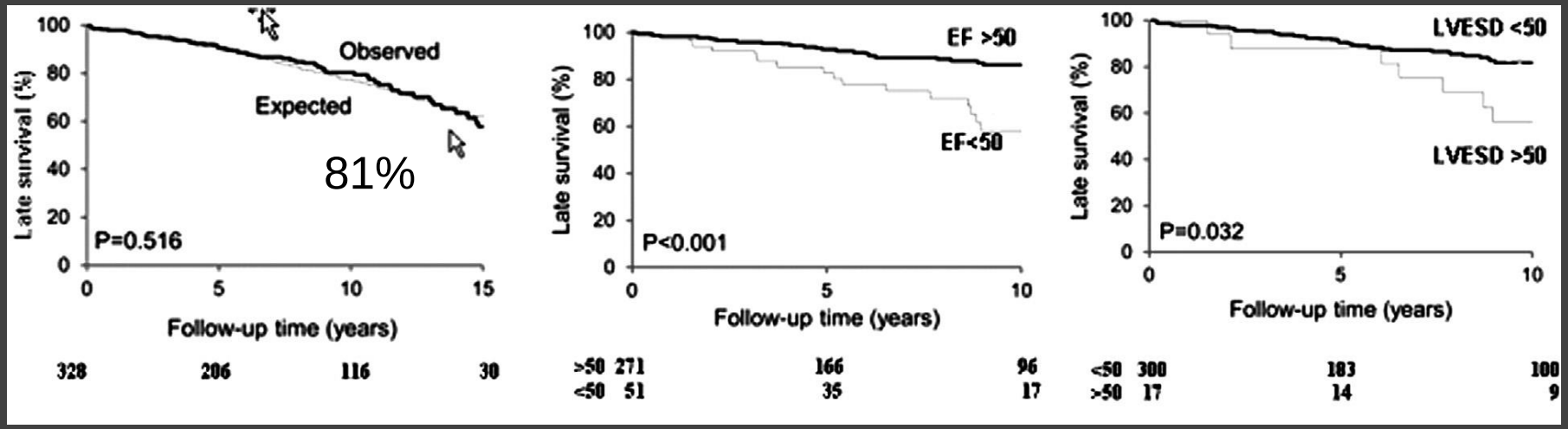
Pooled Late Outcome Events	LOR + 95% CI
Late mortality	1.53 (1.19–1.96)
Reoperation on aortic valve	1.32 (1.0–1.74)
Hemorrhage	0.23 (0.13–0.42)
Thromboembolism	0.41 (0.22–0.77)
Endocarditis	0.23 (0.11–0.51)
MAVRE	1.66 (1.24–2.23)

Bentall

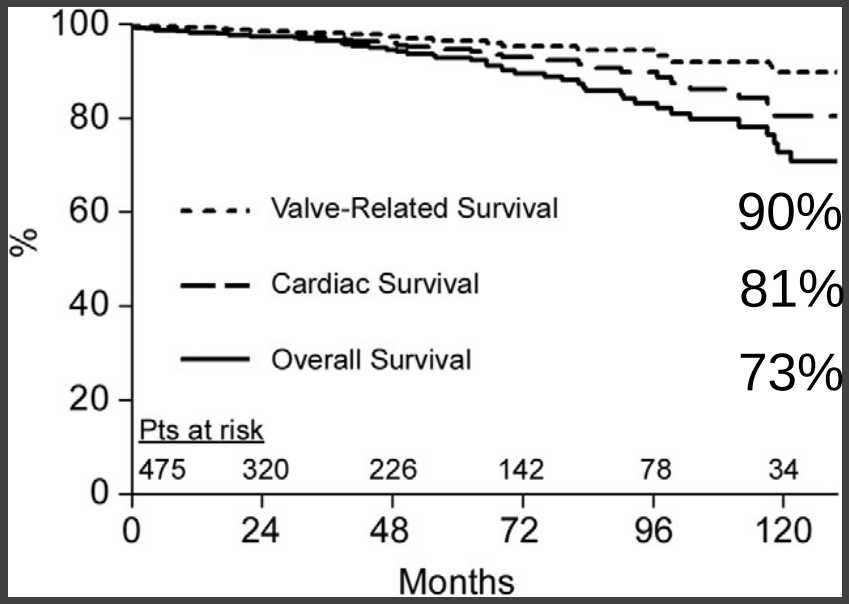
Pooled Late Outcome Events	LOR + 95% CI
Late mortality[a]	2.02 (1.77–2.31)
Valve-related mortality	0.46 (0.36–0.59)
Root reoperation[b]	0.46 (0.36–0.59)
Valve reoperation	0.30 (0.22–0.41)
Hemorrhage	0.64 (0.47–0.87)
Thromboembolism	0.77 (0.60–1.00)
Endocarditis	0.39 (0.33–0.46)
MAVRE	2.66 (2.17–3.24)

B. Arabkhani, JJ. Takkenberg ATS 2015
A. Mookhoek, JJ. Takkenberg ATS 2016

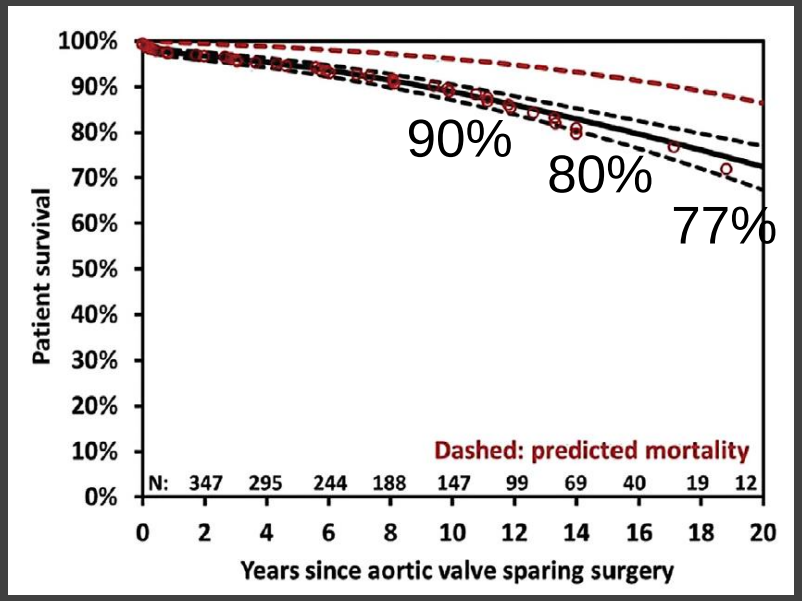
AV Repair: Long term Survival



V. Sharma, H. Schaff JTCVS 2014



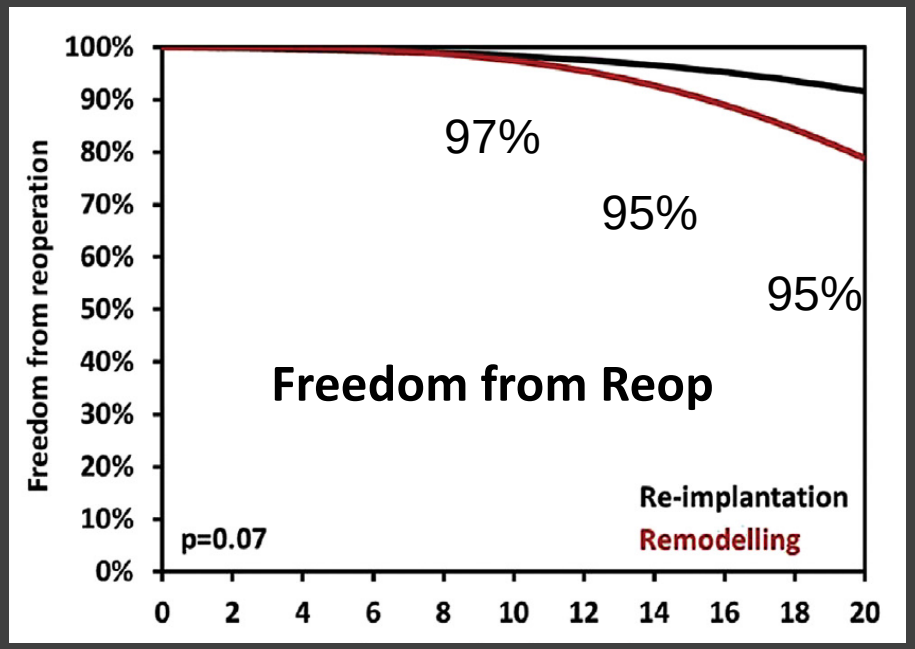
J. Price ATS 2013

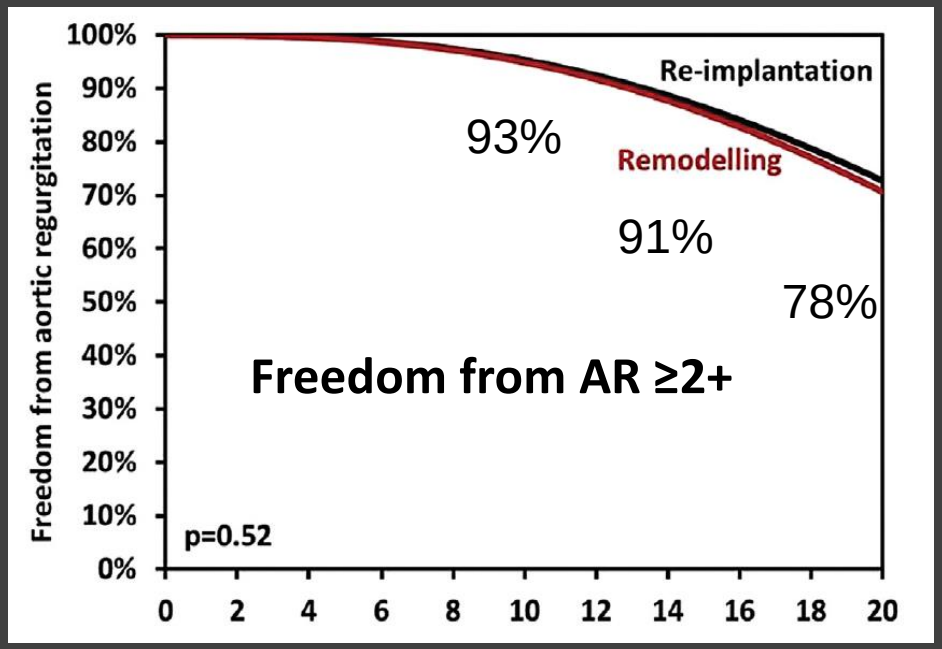


T. David JTCVS 2014

AV repair for AI: Root dilatation (Type 1b)

- Toronto: 1988 – 2010, 371 pts, 9% BAV, 50% cusp repair



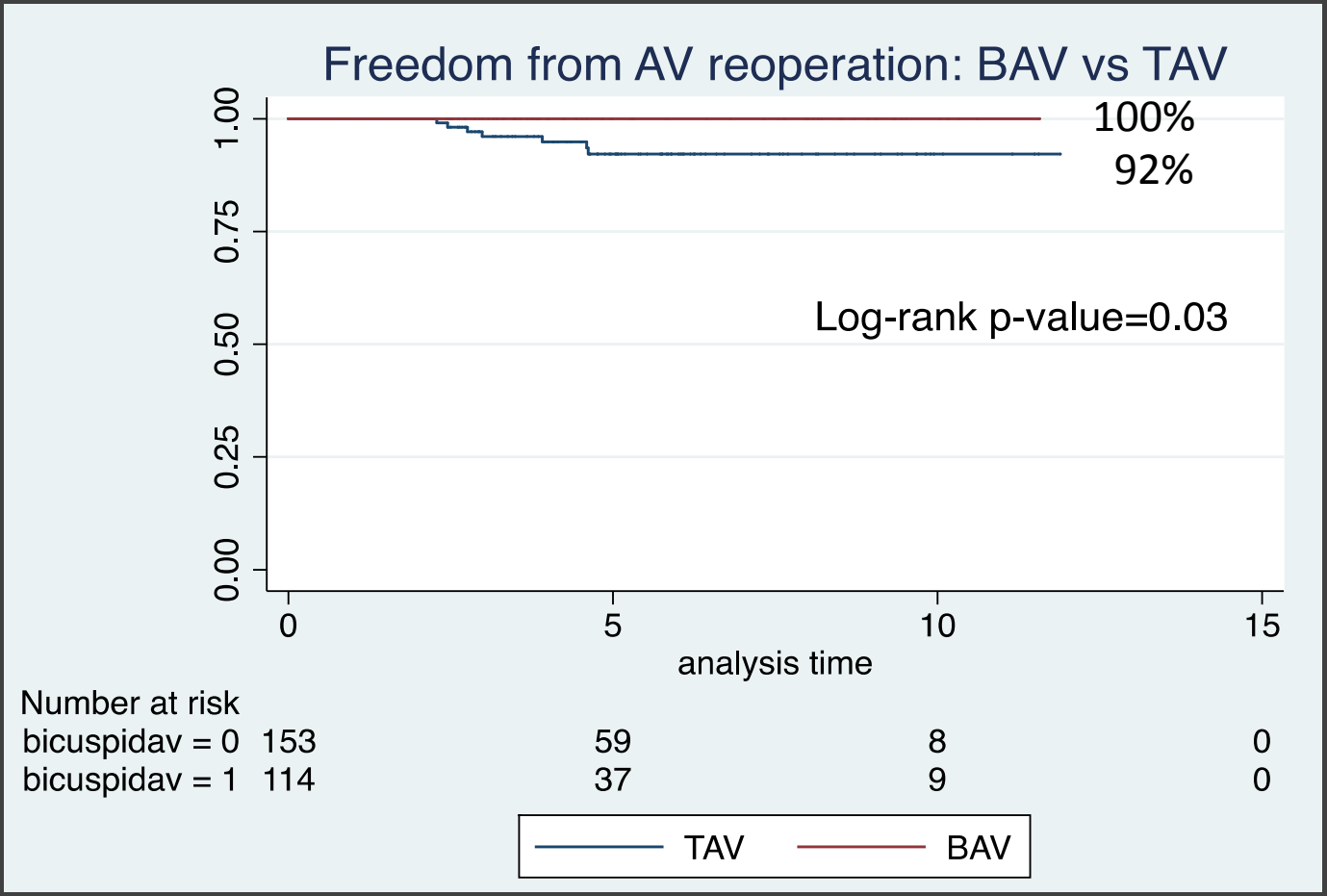


No predictors of recurrent AR

T. David JTCVS 2014

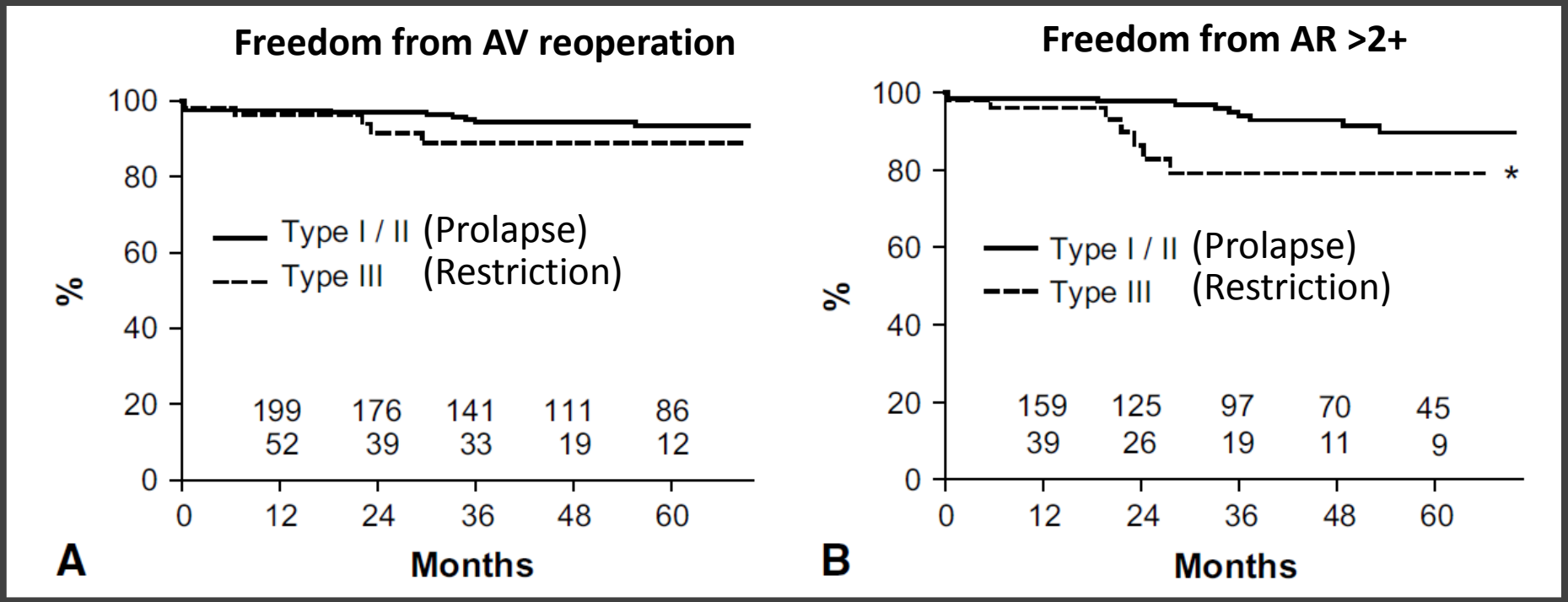
AV repair for AI: Root dilatation (Type 1b)

- Brussels: 1996 – 2014, 275 pts, 43% BAV, 70% cusp repair



S. Mastrobuoni STSA 61st meeting 2014

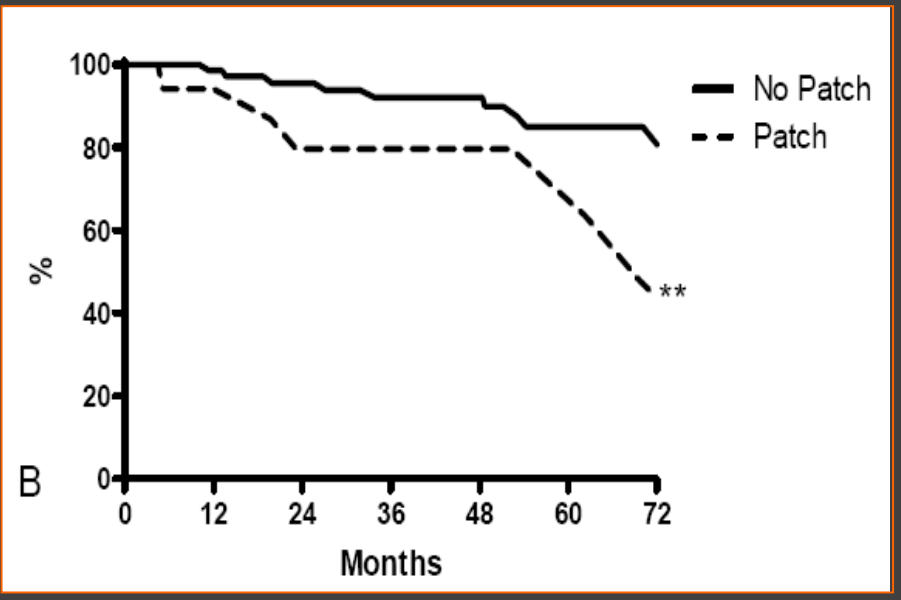
AV Repair:
Type of Aortic Regurgitation



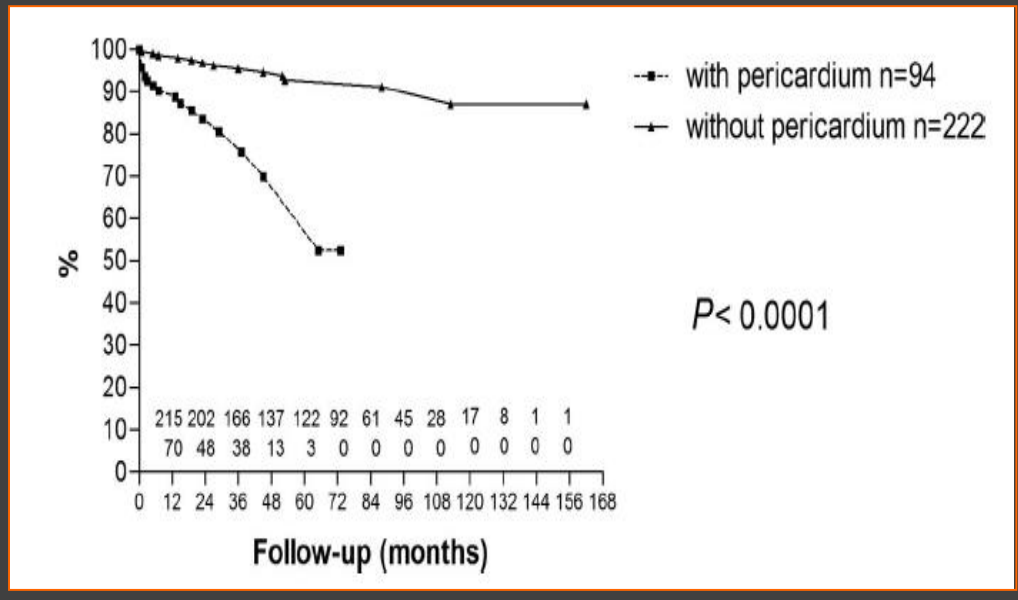
M. Boodhwani, JTCVS 2009

AV repair

Risk factor of repair failure: Patch repair



Boodhwani M. JTCVS 2010

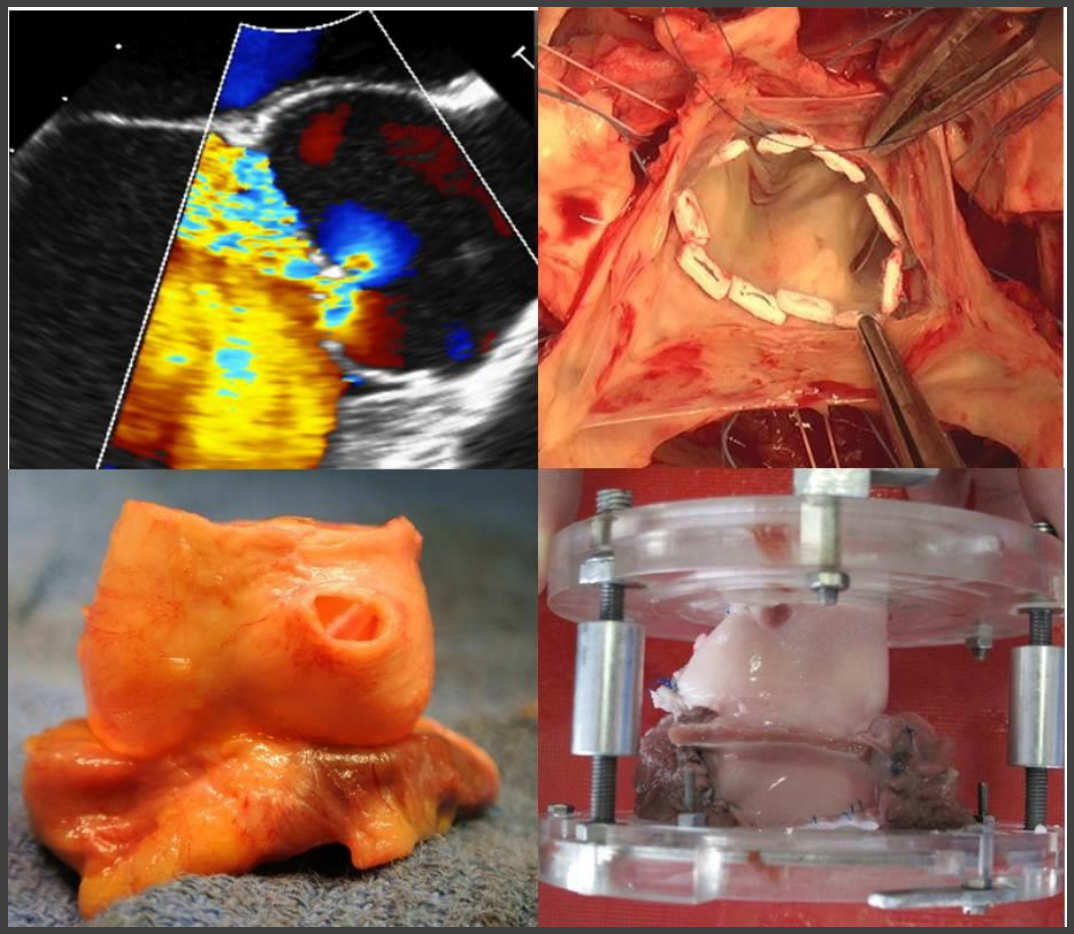


Aicher D. Circ. 2011

AV Leaflet Repair: Conclusions

- The mechanism of AR are actually well understood and the use of a classification of AR help to plan AV repair.
- Surgeon dispose of a wide armamentarium of repair techniques adapted to the variety of valve lesions.
- Durability of cusp repair depend on the quality and quantity of tissues. Long term results of AV repair are excellent for AI Type 1 & 2 repair and acceptable for AI Type 3 (restrictive cusp). New patch material will probably improve results of in this group.
- Next to cusp tissues quality, optimal valve coaptation (eH) and circumf. annuloplasty are other determinants of repair durability.
- Longer follow-up is necessary to investigate 2° and 3° decade after repair.

Thank you



AV Repair for AI: VSRR +/- Cusp repair

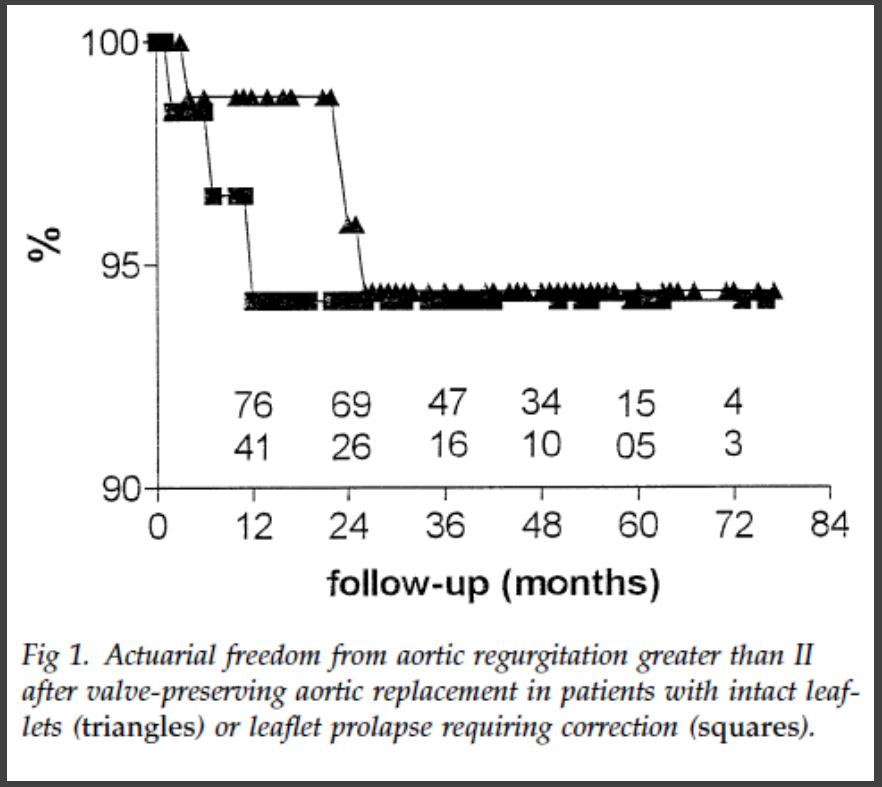
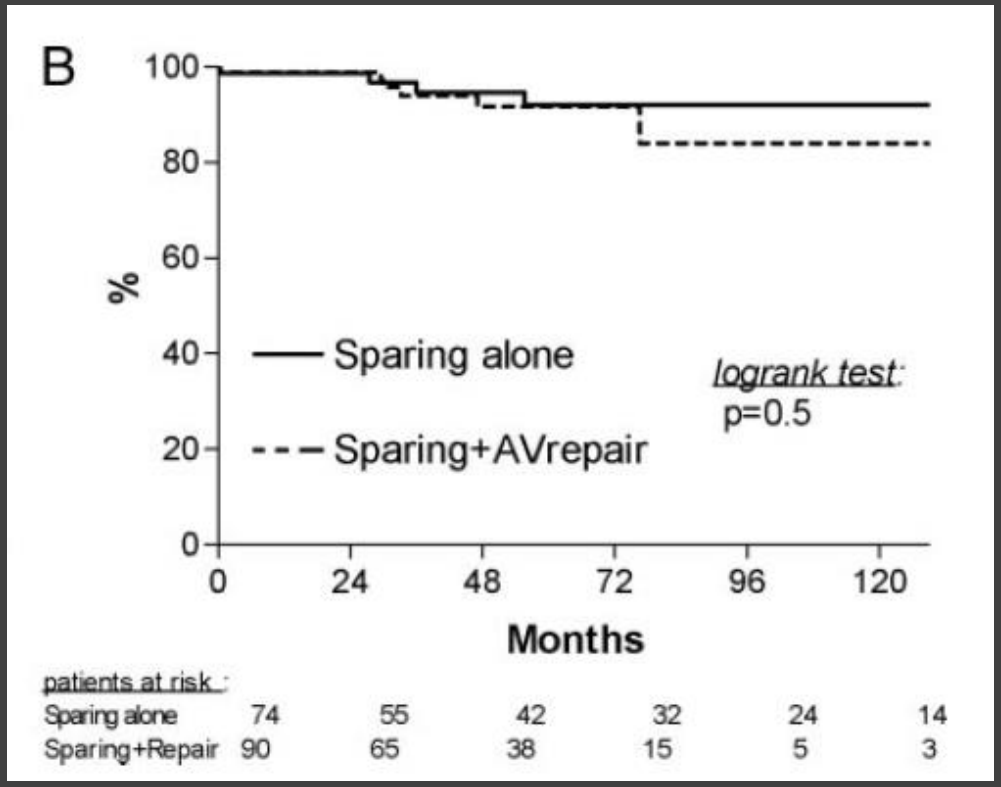


Fig 1. Actuarial freedom from aortic regurgitation greater than II after valve-preserving aortic replacement in patients with intact leaflets (triangles) or leaflet prolapse requiring correction (squares).

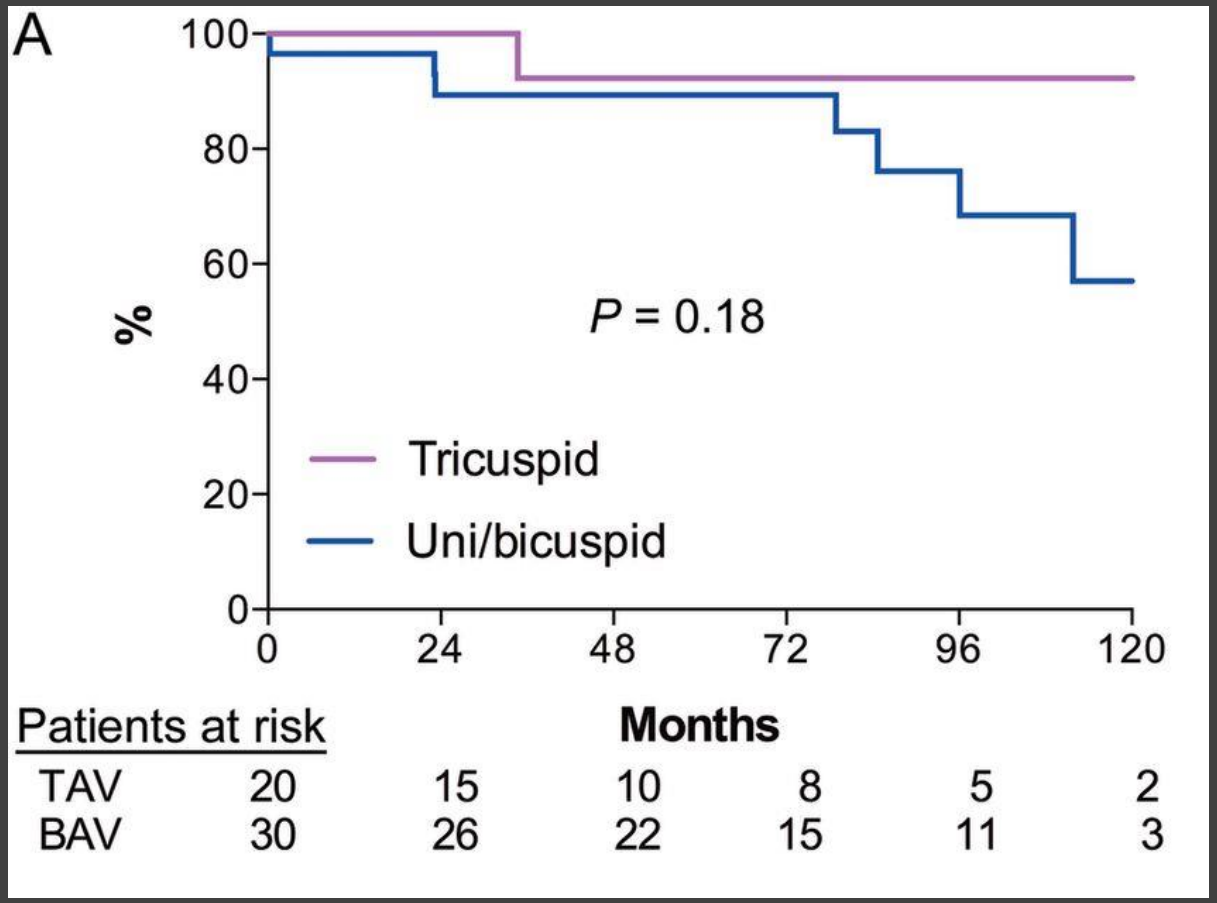
H.J. Schäfers Ann Thor Surg 2002



L. de Kerchove Circulation 2009

AV Repair:

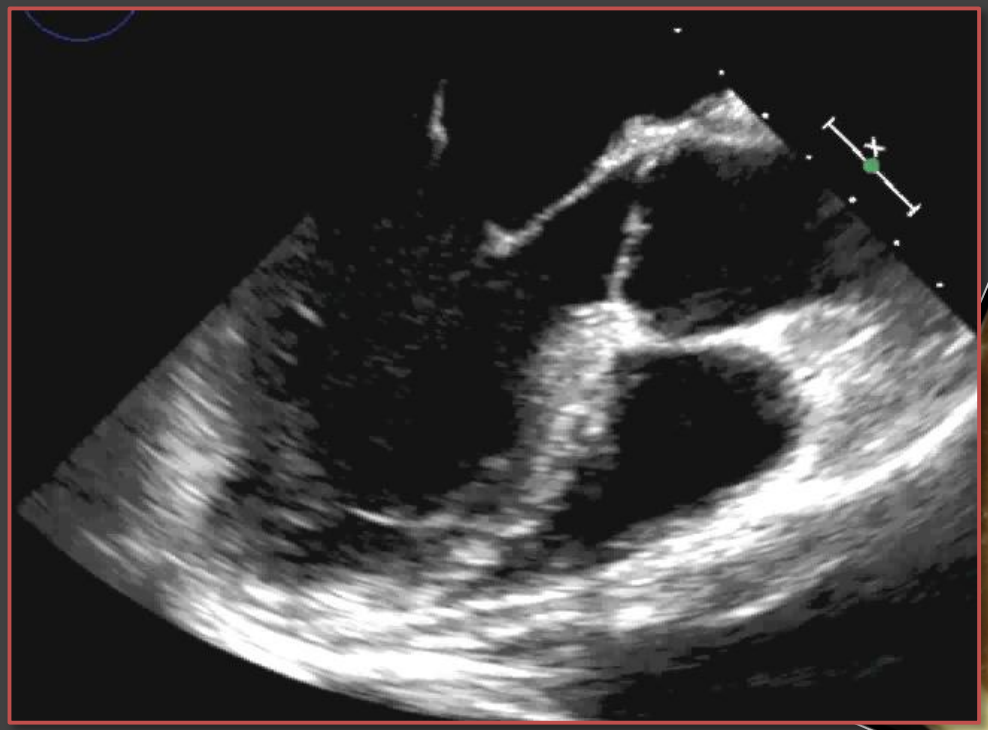
Leaflet repair with patch

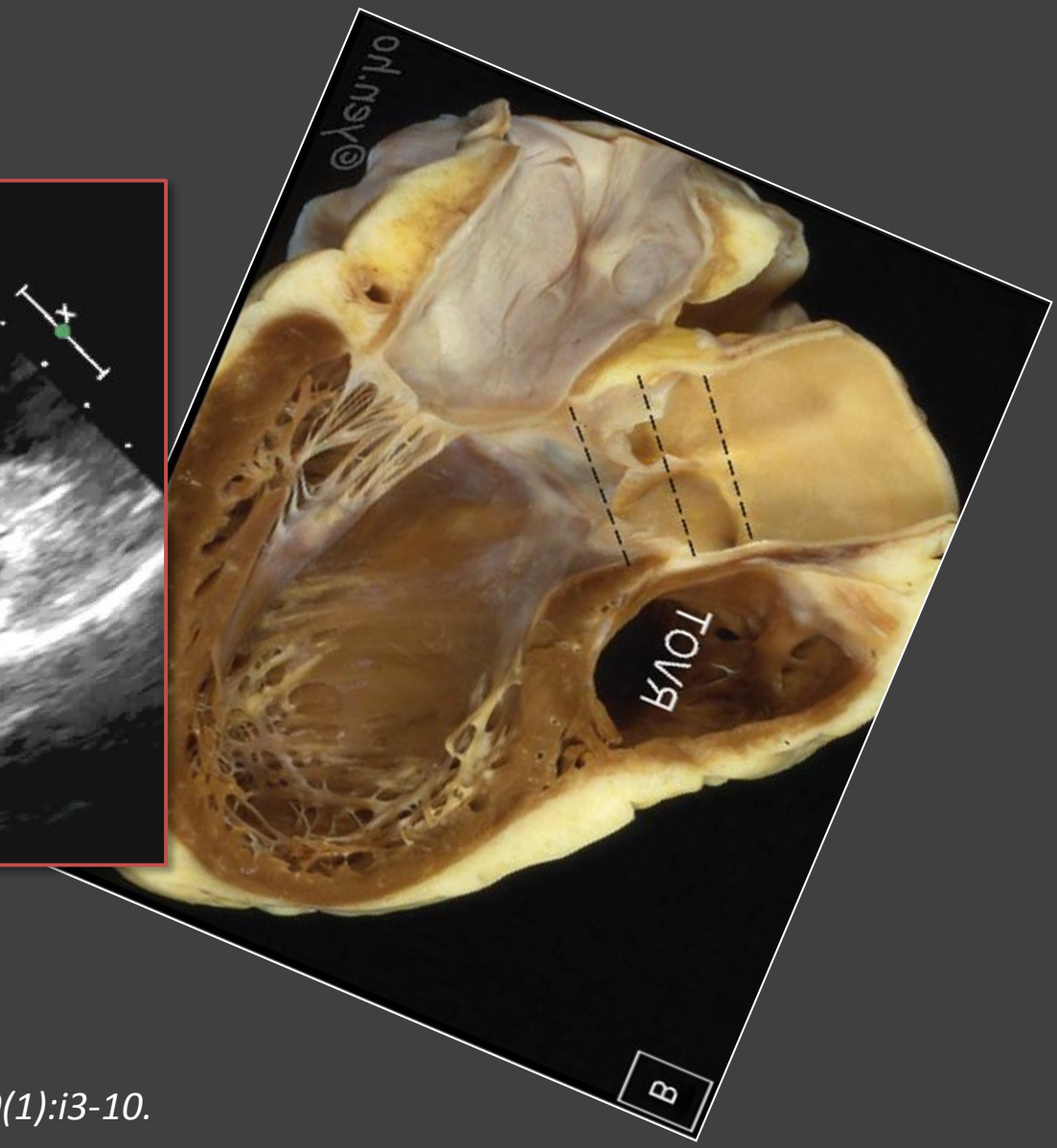


Mozala Nezhad Z. EJCTS 2014

Surgical anatomy of the AV

Adjacent structures to the aortic root

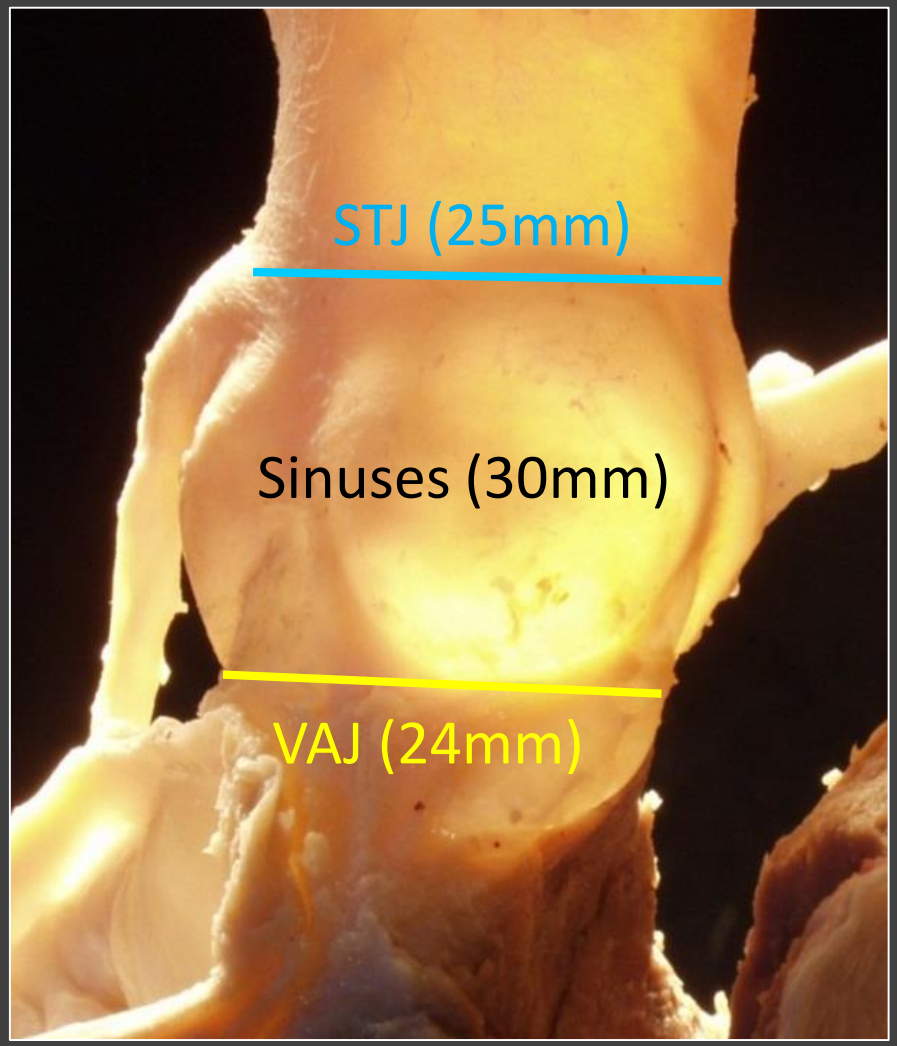


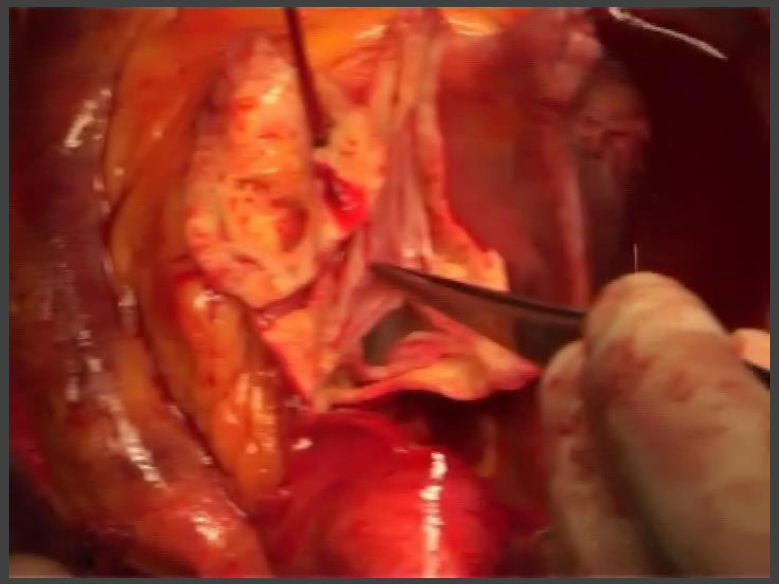


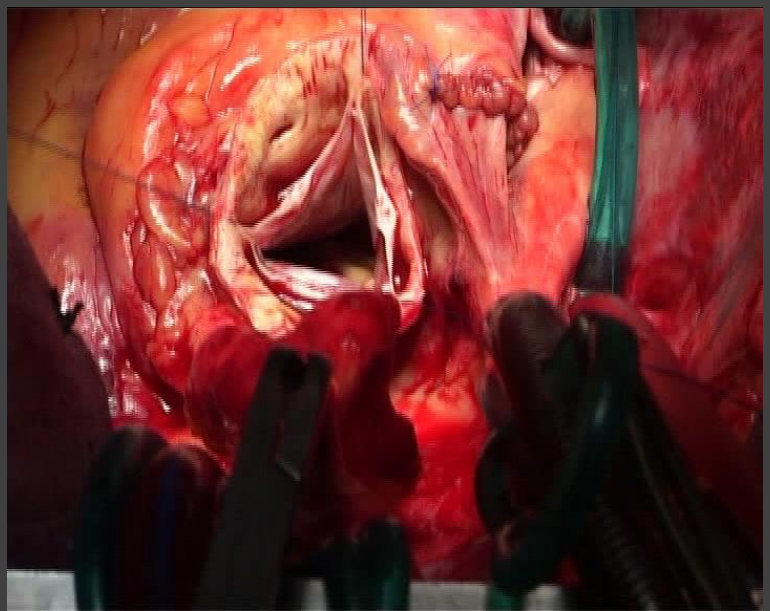
Ho Y., Anderson R. Eur J Echocardiogr. 2009;10(1):i3-10.

Surgical anatomy of the AV

Functional unit

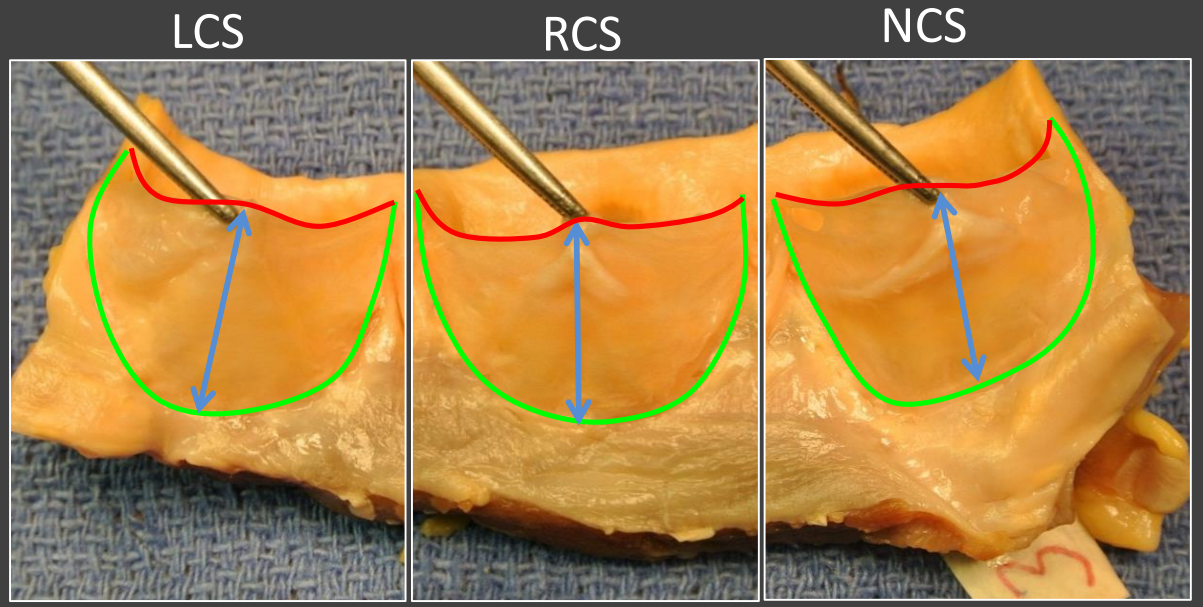






Surgical anatomy of the AV

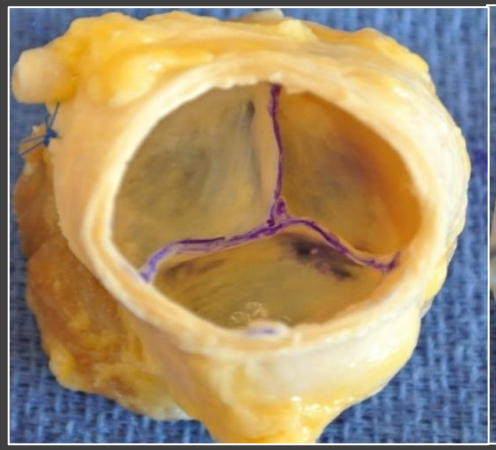
Cusp size

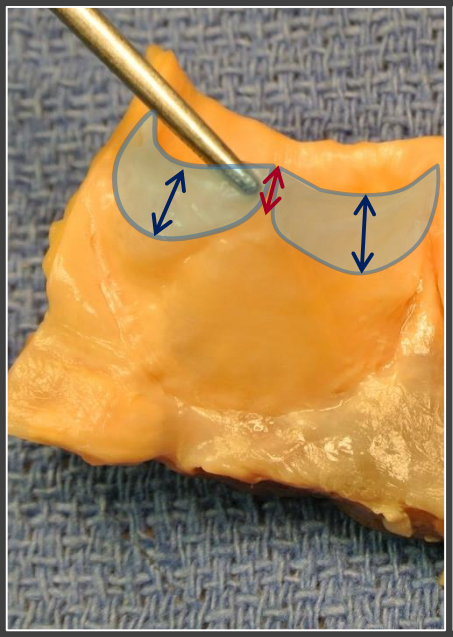


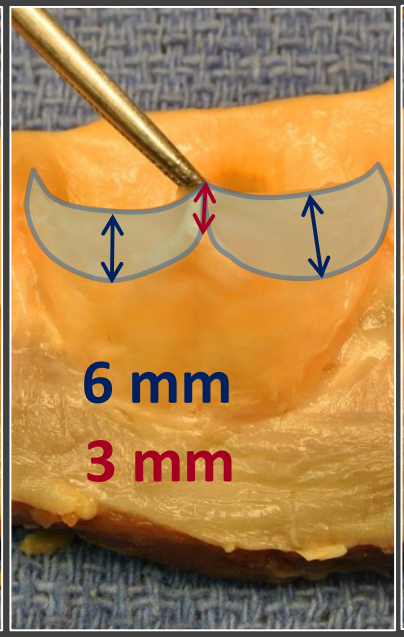
- Cusp height (geometric height): 19 – 20 mm (24 in BAV)
- Free margin length: 32 – 35 mm
- Cusp insertion length:
- Cusp area: 3 cm^2

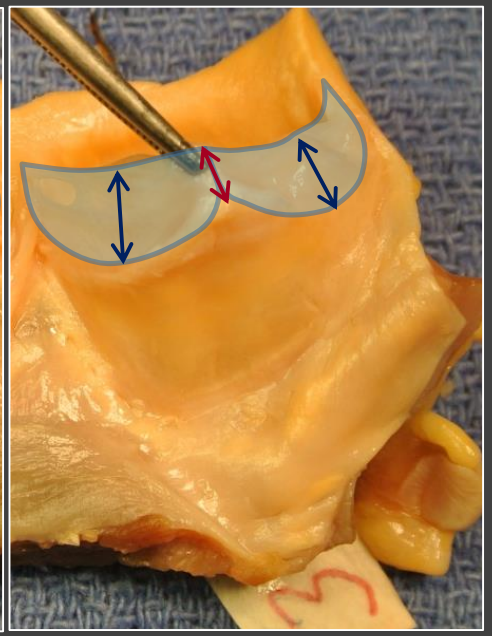
Surgical anatomy of the AV

Cusp coaptation









- Coapt area:
  1 – 1.5 cm^2

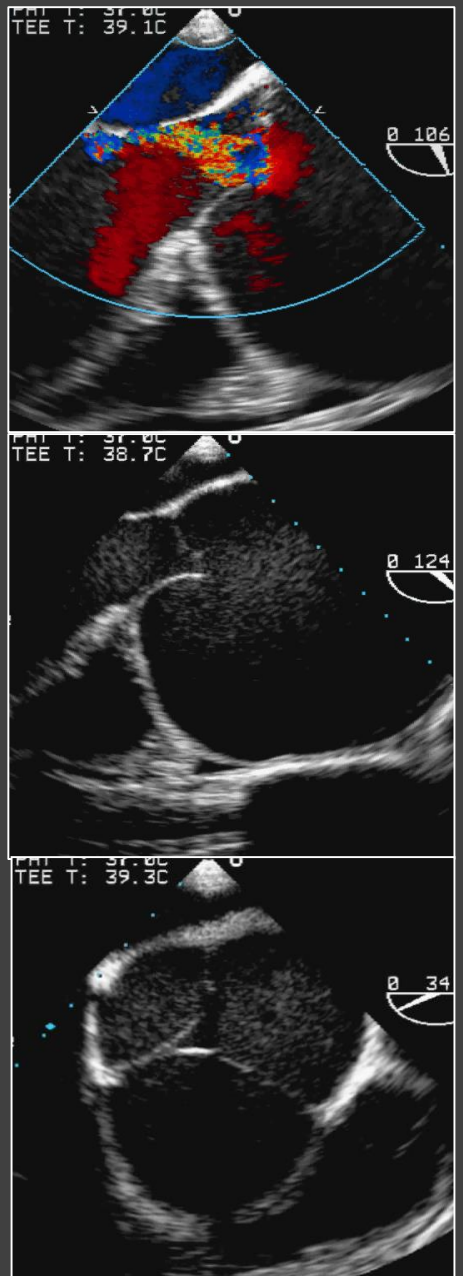
- Coapt area 40% of cusp area

Functional classification of aortic regurgitation

Mechanism of AV dysfunction

Type 1 characteristics

- ✓ Central jet ∟ to subvalvular plane
- ✓ all cusps have same coaptatin hight
- ✓ lack of central coaptation



Functional classification of aortic regurgitation

Mechanism of AV dysfunction

Type 2 AI characteristics:

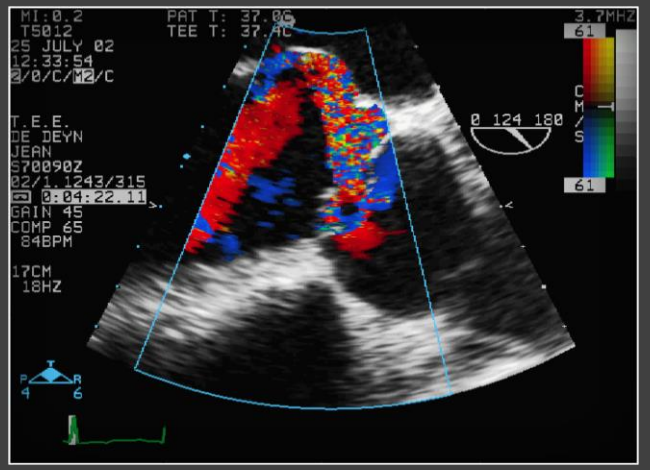
- ✓ Eccentric jet

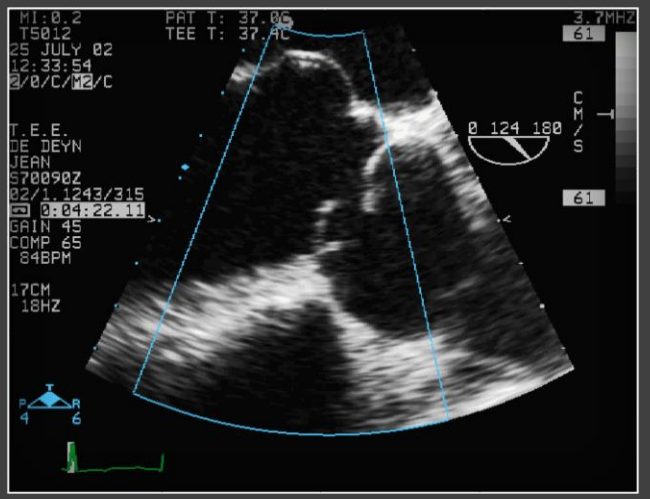
  Sens. 92%, spec. 96%

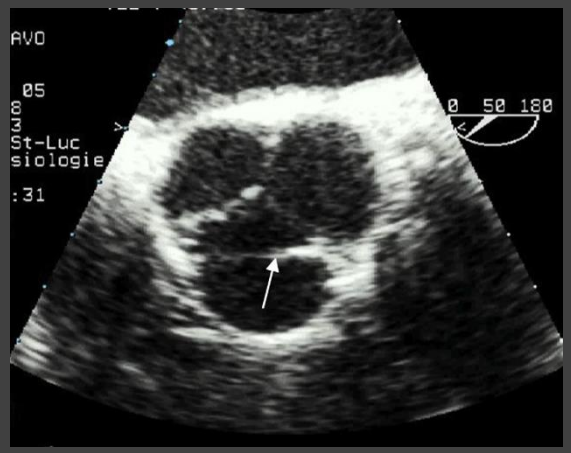
- ✓ Cusp ≠ coaptation height

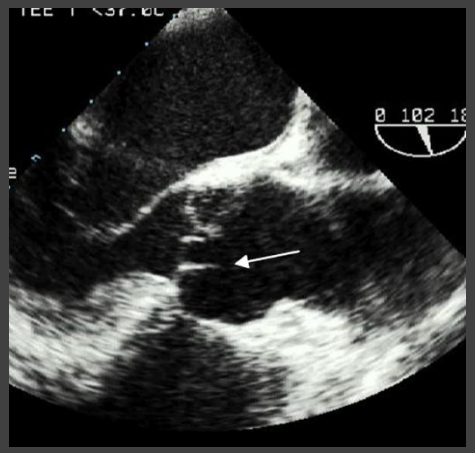
- ✓ Transverse fold in cusp curvature

  Sens. 57%, spec. 92%





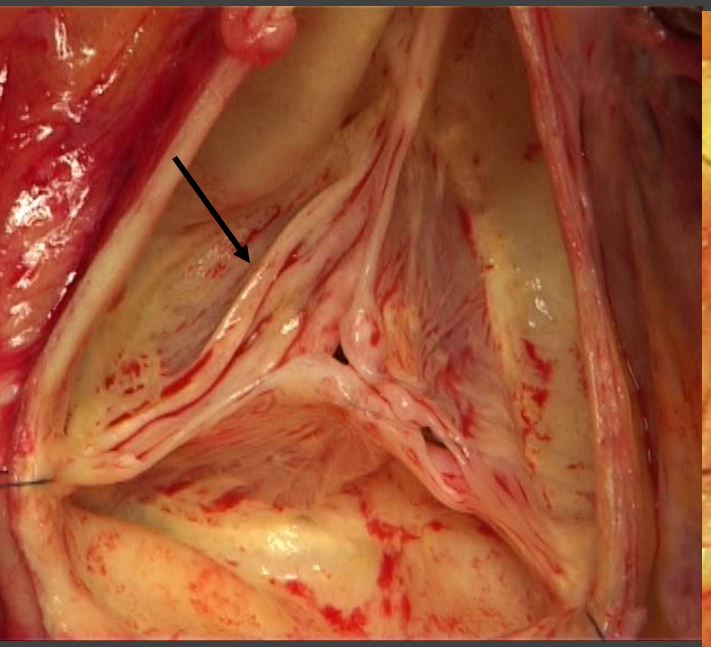




M. Boodhwani, JTCVS 2013

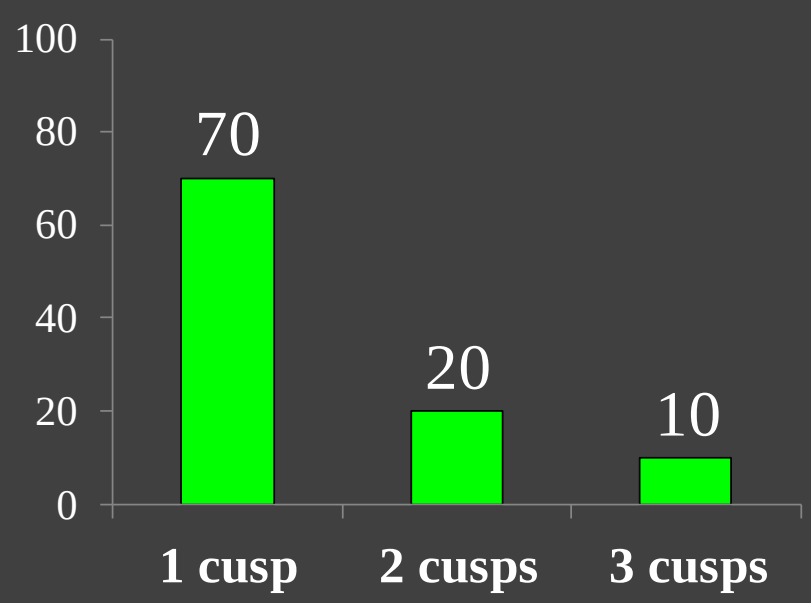
AV Repair: Cusp prolapse

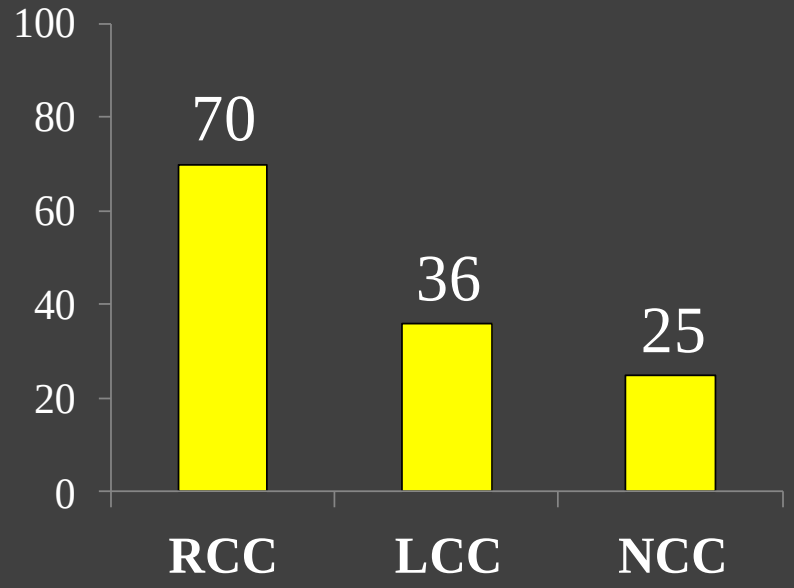
Transverse fold in cusp curvature



Valve Sparing root replacement

Probability of Cusp Repair

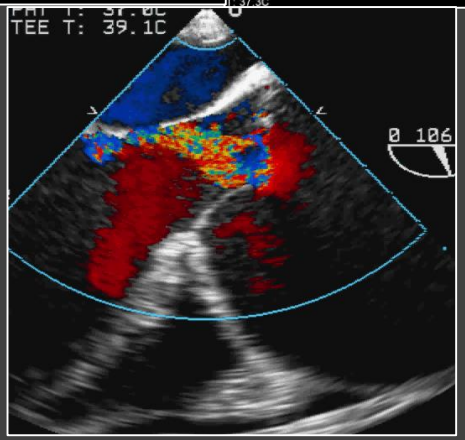




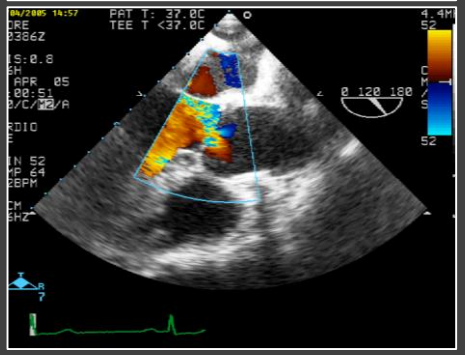
Valve Sparing root replacement

Probability of Cusp Repair

- No AR → low 10 %

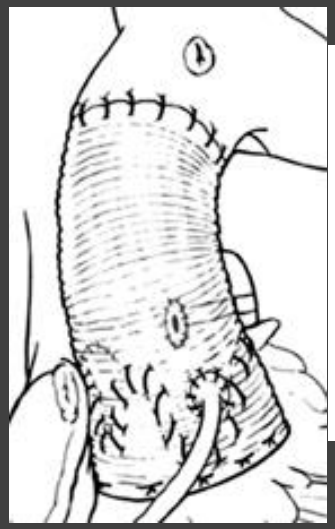


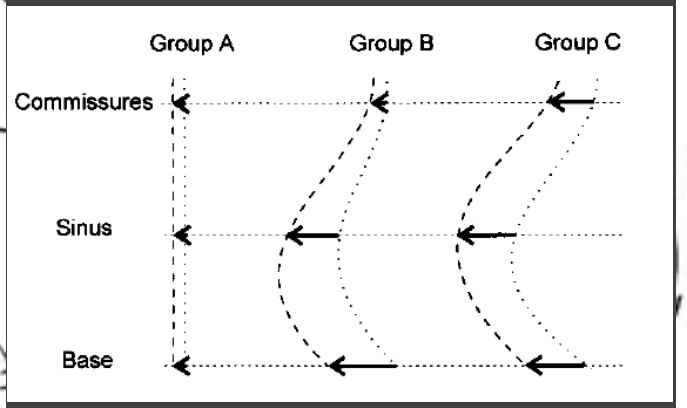
- AR, central jet → Moderate 50 %



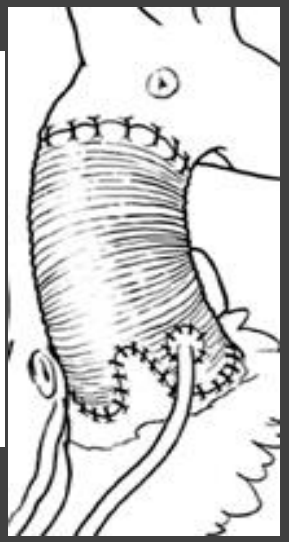
- AR, eccentric jet → High ≈ 100 %

Role of the Sinus of Valsalva

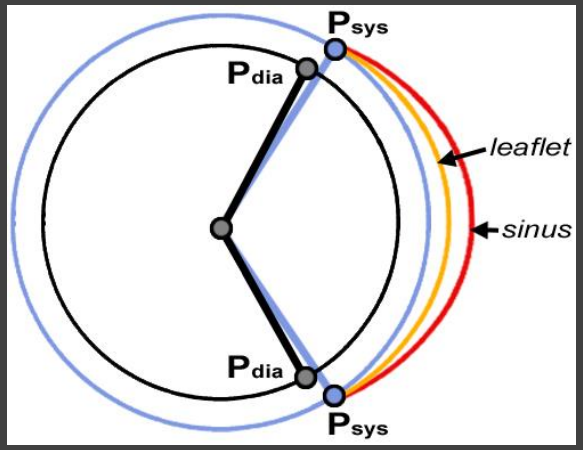




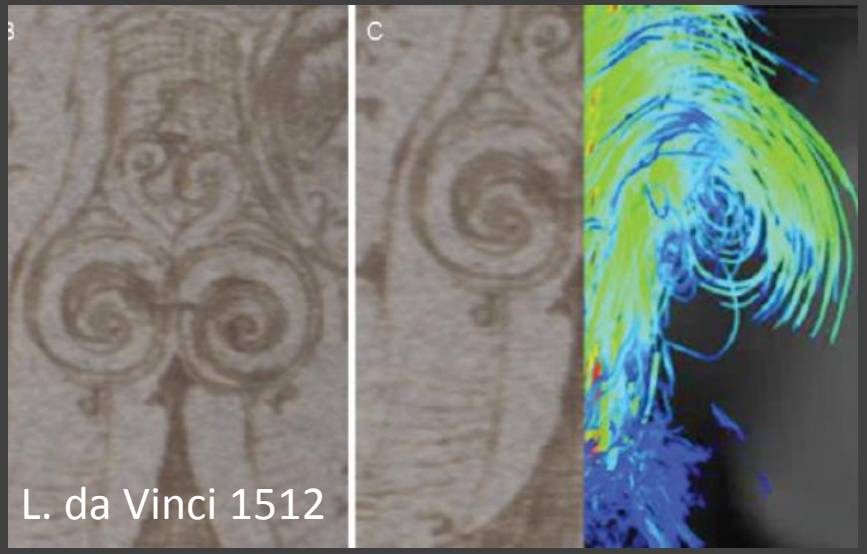
R. Leyh Circ. 1999



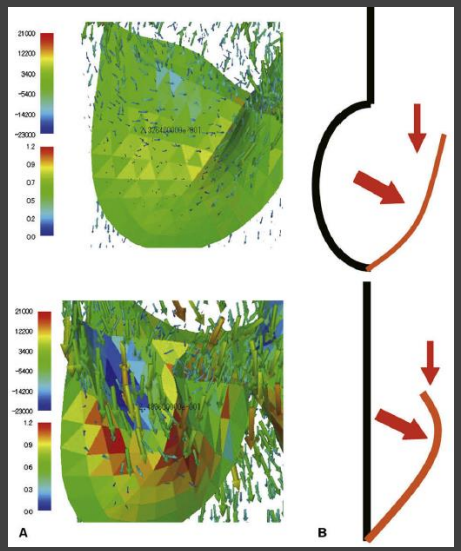
- Maximal opening
- Smooth &"Stress less" closure



H. Sievers



Bissell M. Eur Heart J. 2014



Katayama JTCVS 2008

AV Repair: Valve related event

- Thromboembolic event 0.2 % - 0.7% /y

  92-95% @ 10 y; 87- 90% @ 15 y
- Endocarditis 0.2% /y
- All VRE (reop, thromb, bleed, endoc)

  74 - 90% @ 10 y; 80% @ 18 y

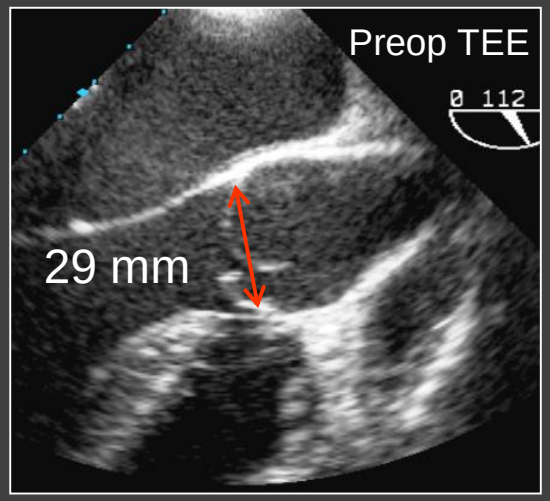
V. Sharma, H. Schaff JTCVS 2014
J. Price, G. Elkhoury ATS 2013
D. Aicher, H-J Schafers EJCTS 2010
T. David JTCVS 2014

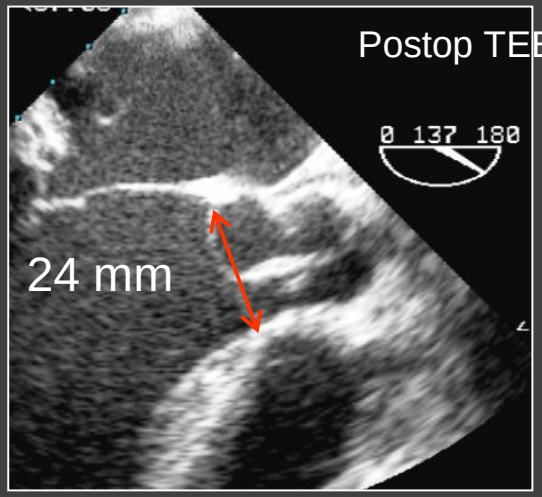
VAJ size after SCA

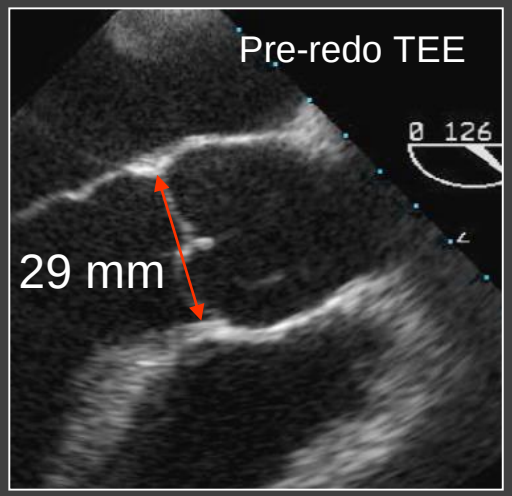
VAJ dilatation

30 y♂: **BAV**, rapher res+direct closure, cusps resusp (Gtx), SCA

→ 6.5 y later: AI 3+

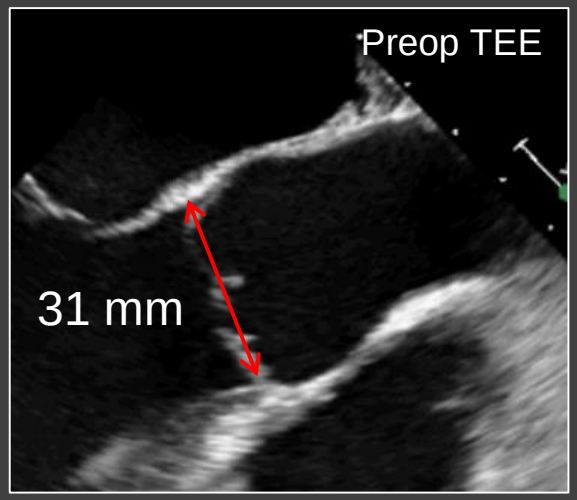


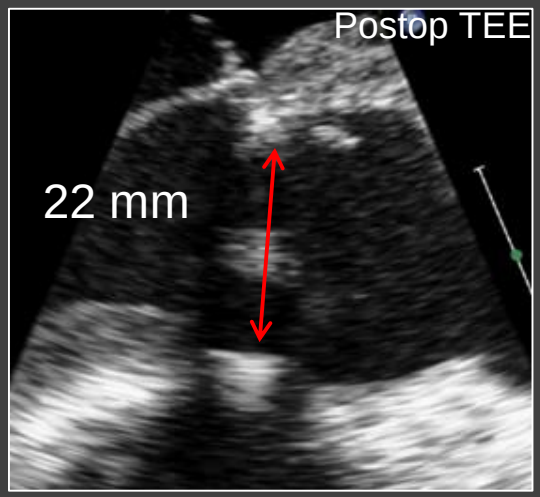


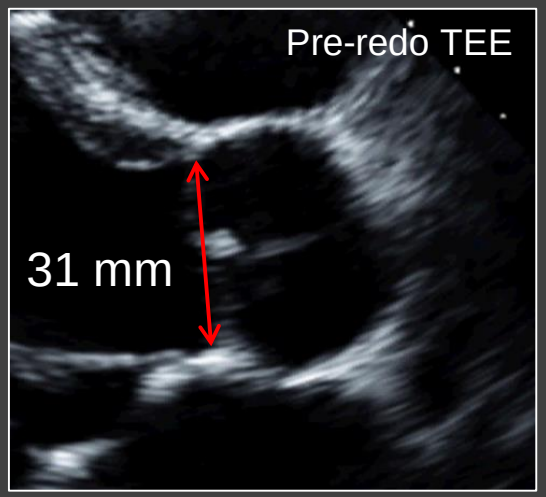


41 y ♂: **TAV**, RC plication and resuspension (Gtx), SCA

→ 2 y later : AI 3+



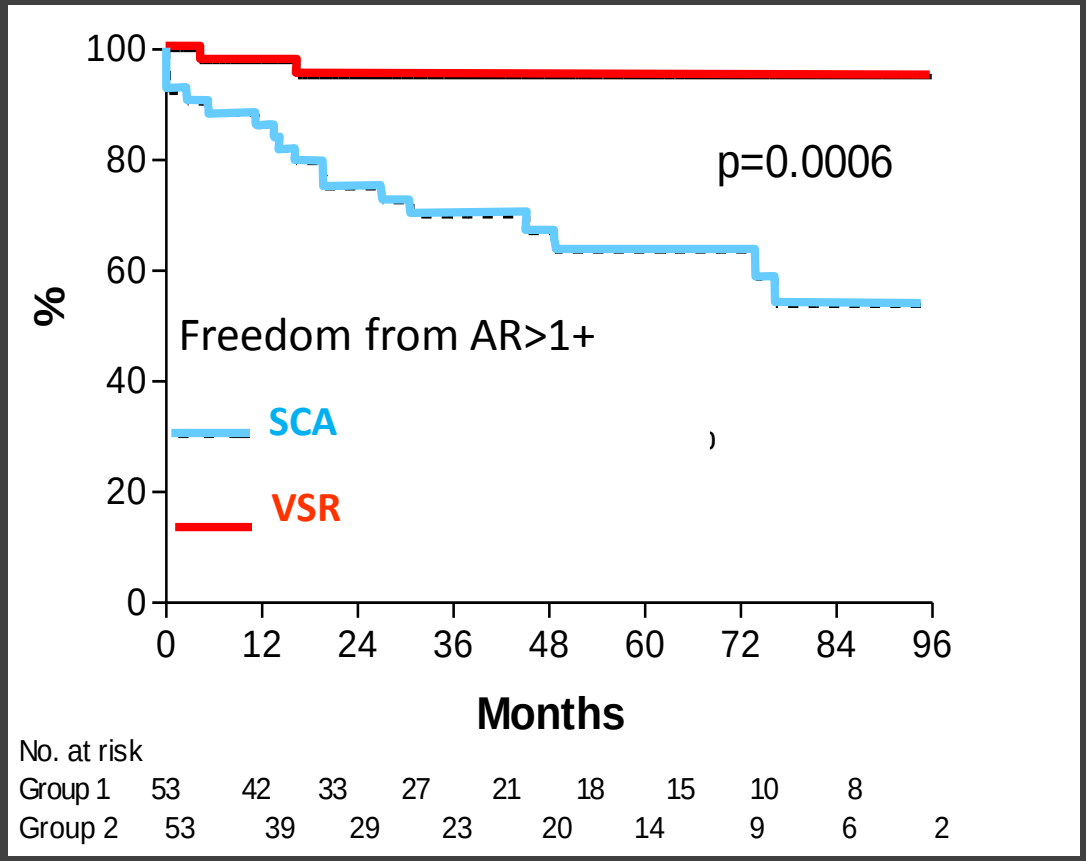




AV repair

VAJ dilatation (AI Type 1c)

Matched comparison VSR vs SCA in BAV repair



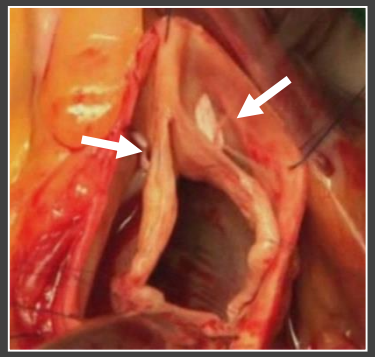
De Kerchove L. JTCVS 2011

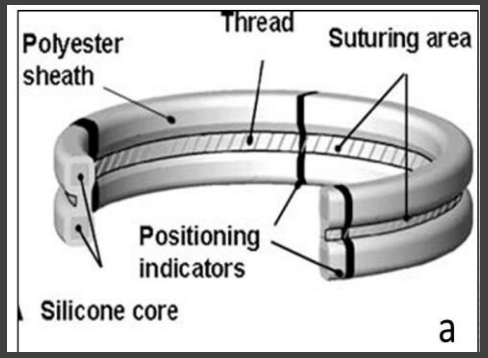
AV repair

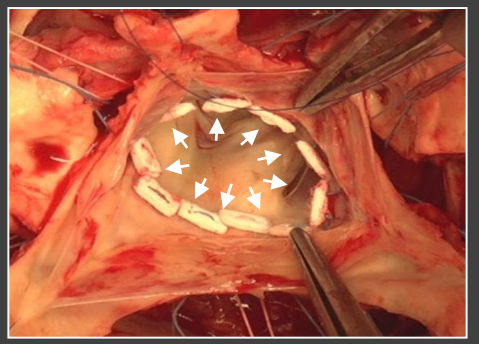
Annuloplasty repair strategy

AV repair for AR

- Normal Root (<45 mm)
  - Normal VAJ (<26 mm) → Subcom. Anpl.
  - Large VAJ (>26 mm) → Ring Annuloplasty
  - Large VAJ (>26 mm) + Modify valve geometry → VS Reimplantation
- Dilated Root (≥45 mm) → VS Reimplantation

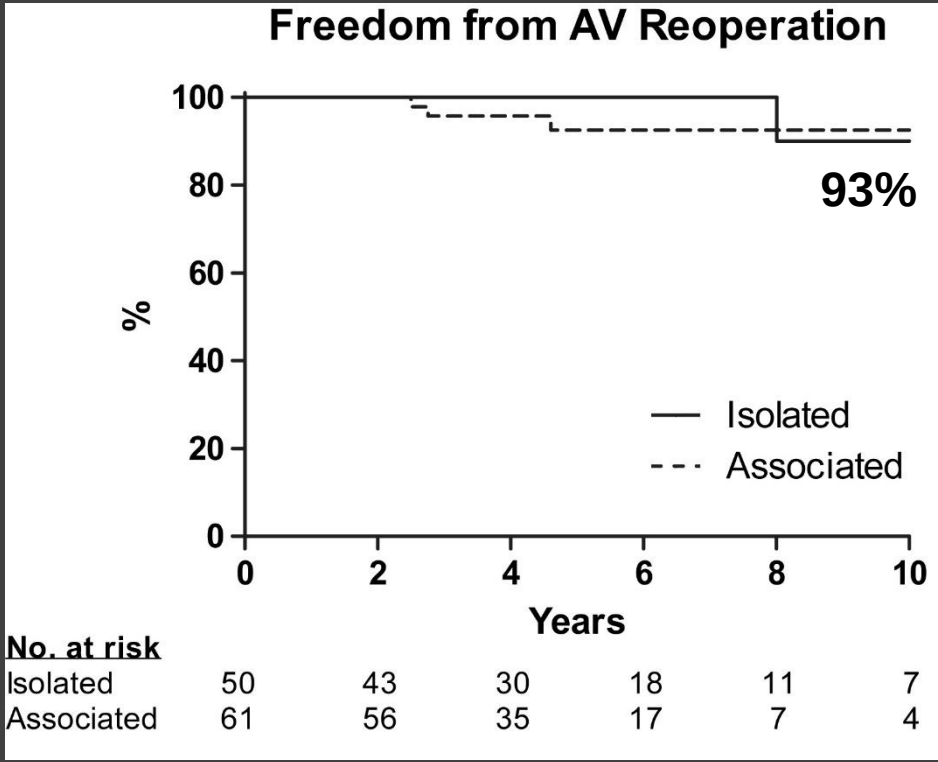


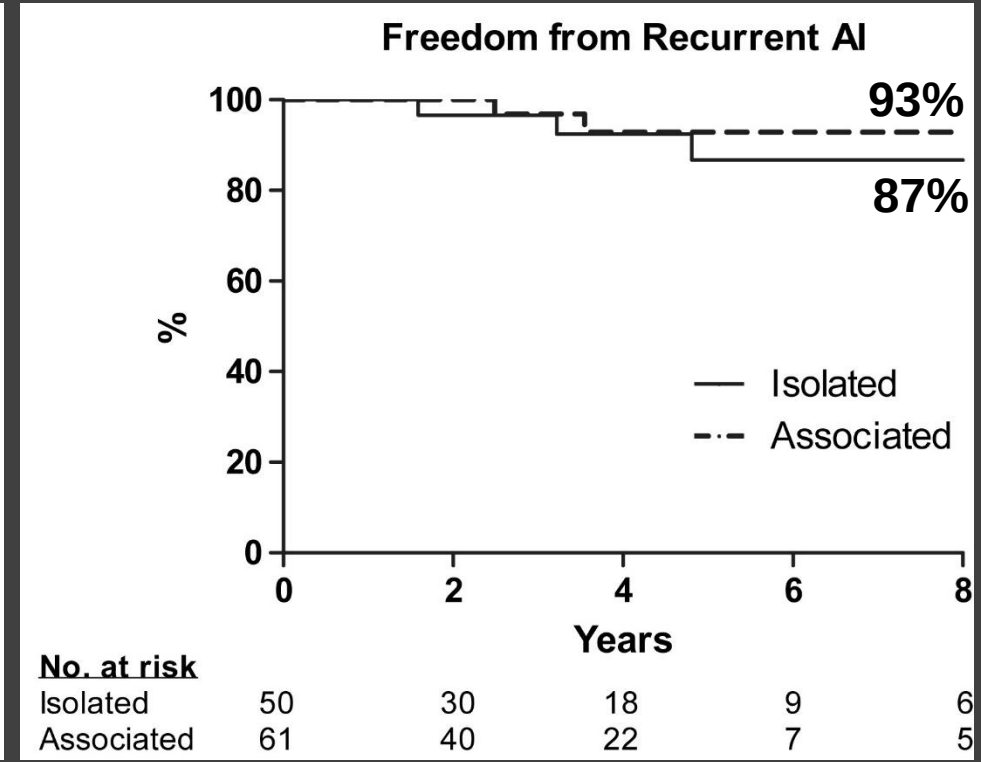




AV Repair:

Prolapse repair (Type 2)





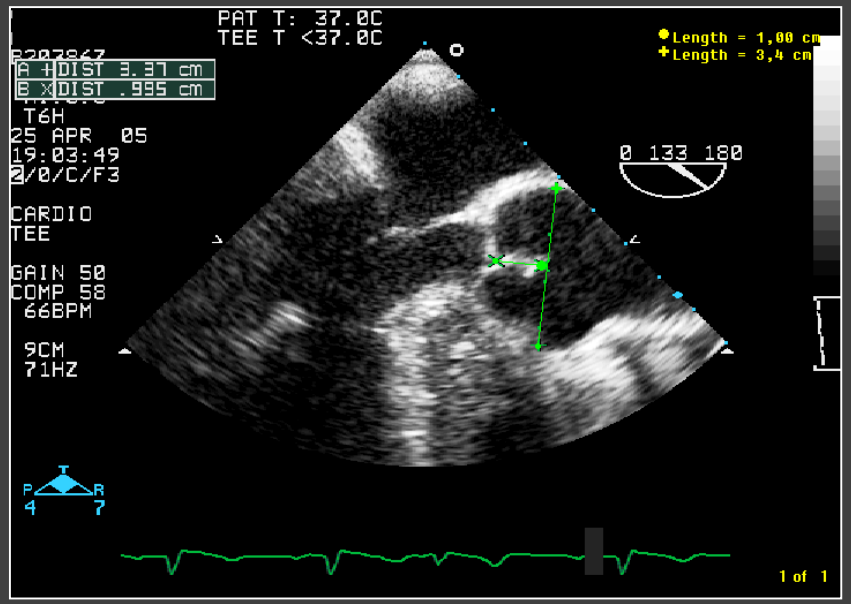
M. Boodhwani, JTCVS 2011

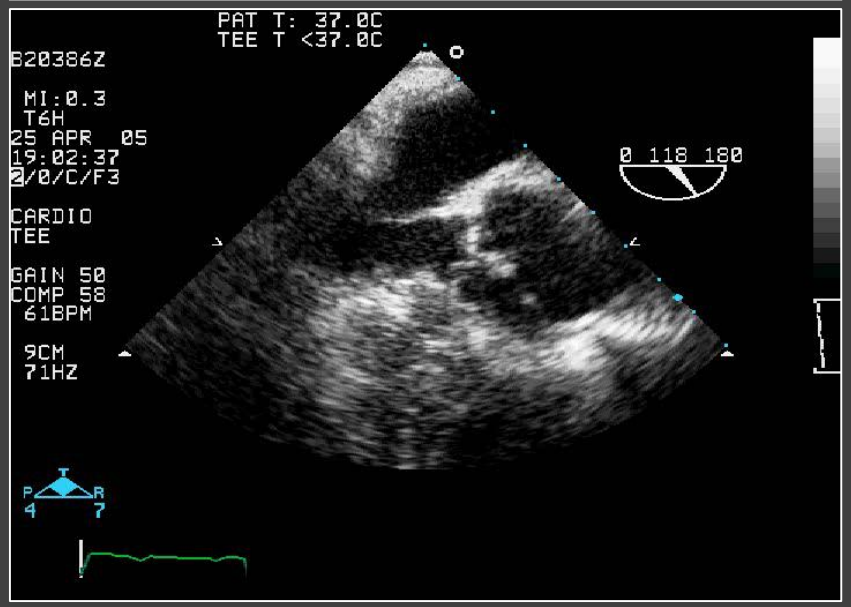
Conclusions

Objective: Optimal coaptation + Stabilisation

- Effective height (eH) ≥ 9 mm
- Coaptation length ≥ 4 mm
- Circumferential annuloplasty

  VAJ >26
- No residual AR

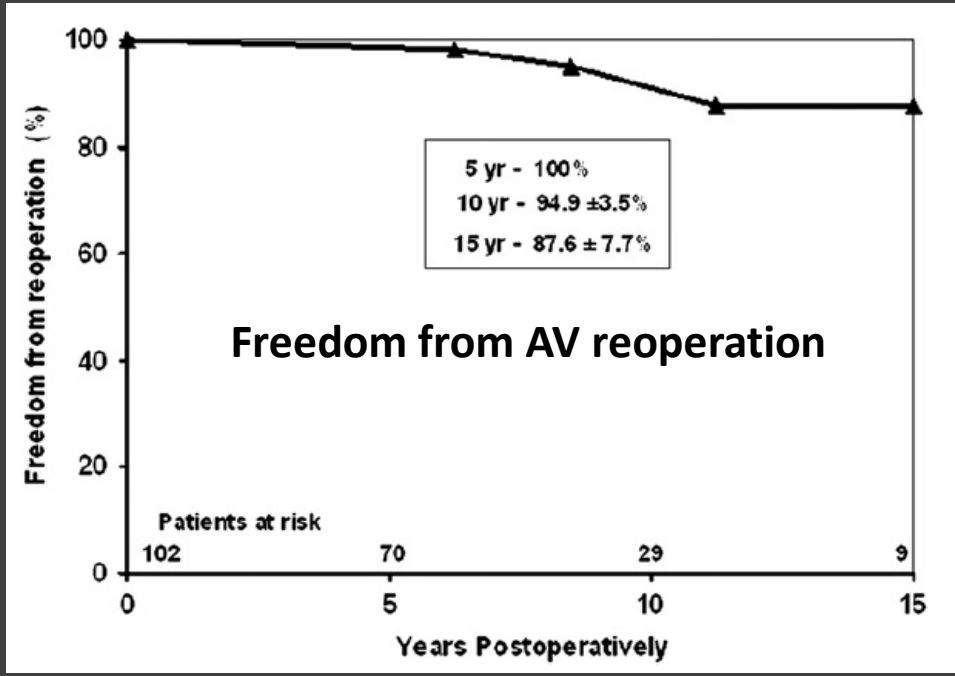


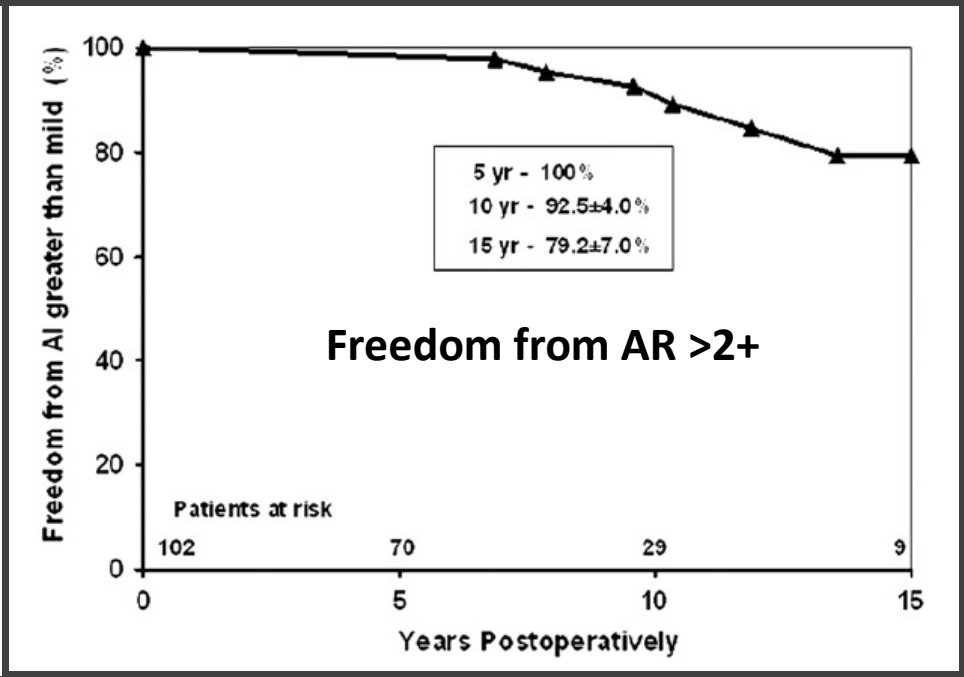


Pethig K. ATS 2002
le Polain de Waroux JB. JACC Card. Im. 2009
Bierbach BO. EJCTS 2010
Aicher D. Circ. 2011
De Kerchove L. JTCVS 2011

AV repair for AI: Root dilatation (Type 1b) in Marfan syndrome

- Toronto: 1988 – 2006, 103 pts, mean age 37 y

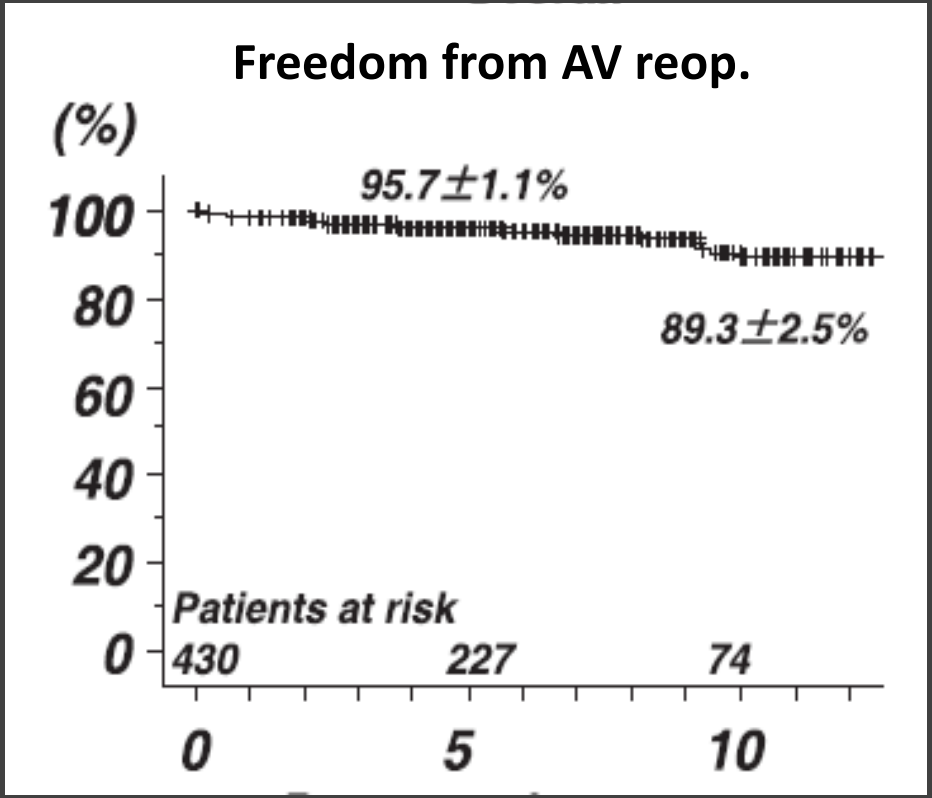


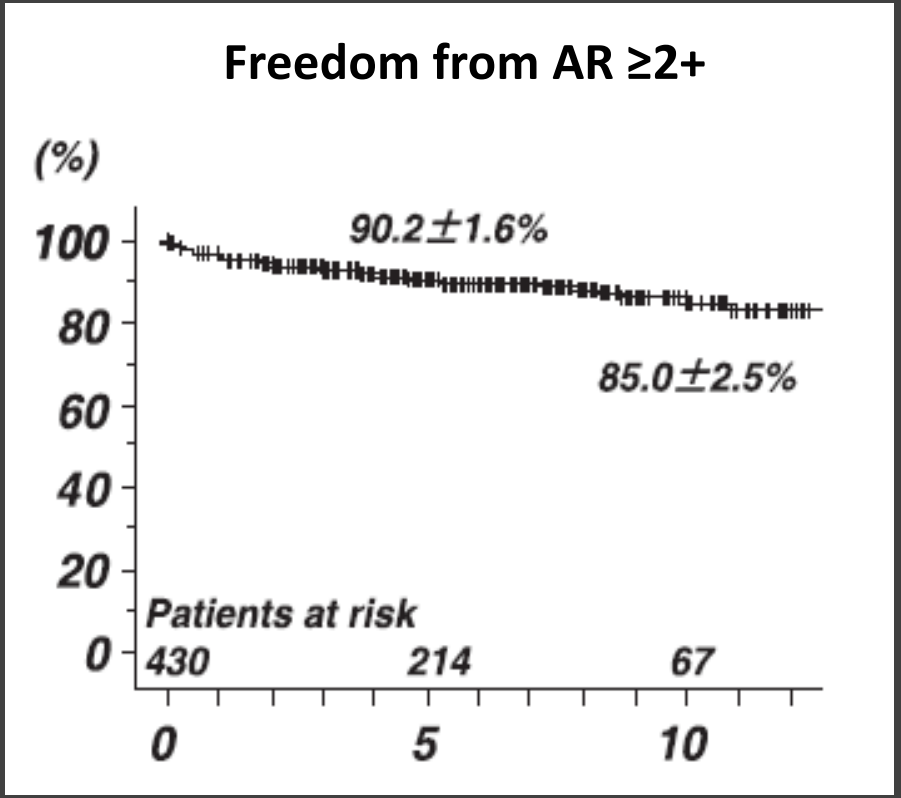


T. David, JTCVS 2009

AV repair for AI: Root dilatation (Type 1b)

- Homburg: 1995 – 2009, 430 pts, 30% BAV, 73% cusp repair





T. Kunihara JTCVS 2012

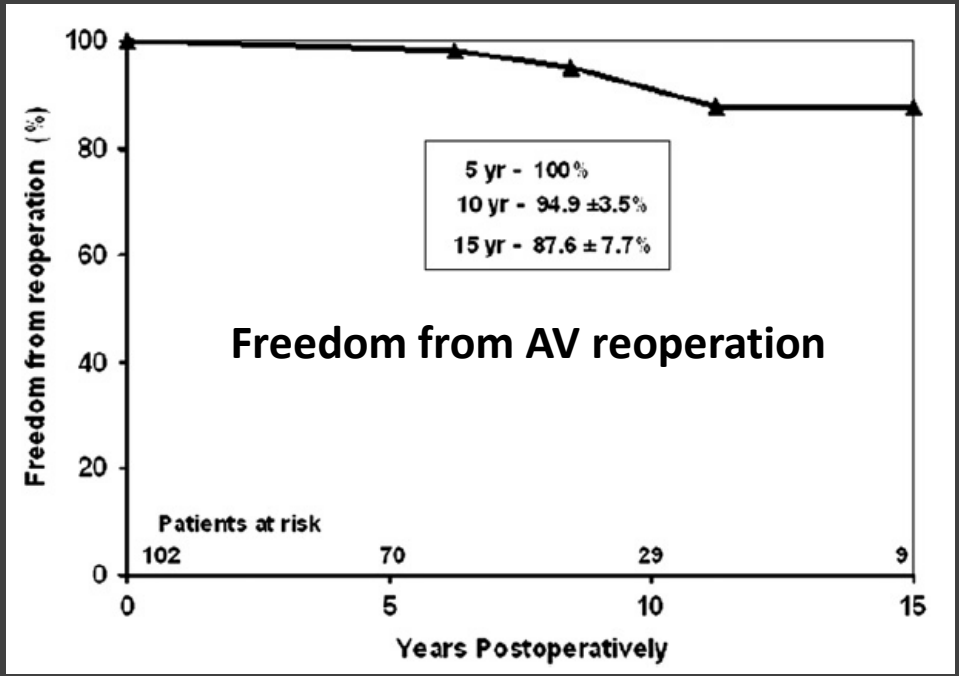
AV Repair: Freedom from Reoperation & AI

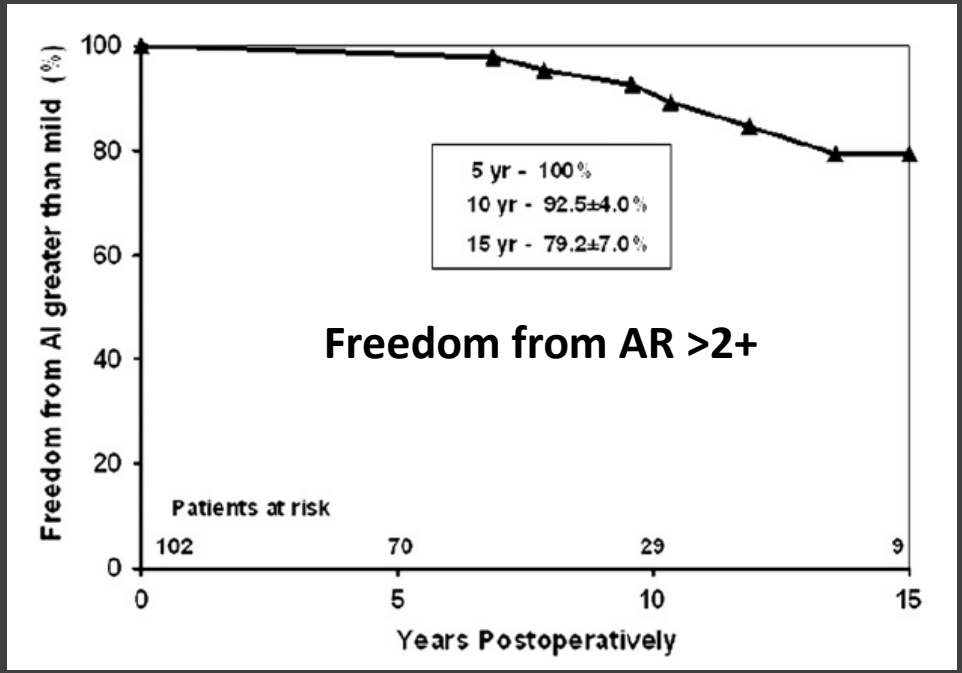
Authors	Period	Cohort	Technique	FF AV Reop	FF recurrent AR >2+
H. Schaff JTCVS 2014	1986- 2011	331	Cusp 100% Sparing 0%	10 y 80%	10 y 75%
T. Kunihara JTCVS 2012	1995-2007	640	Cusp 80% Sparing 50%	10 y 88%	10 y 80%
J. Price ATS 2013	1995-2010	475	Cusp 68% Sparing 50%	10 y 86%	10 y 85%
T. David JTCVS 2014	1988- 2010	371	Cusp 50% Sparing 100%	10 y 97% 18 y 95%	10 y 93% 18 y 78%

Root pathology > Cusp pathology

AV Repair:

Valve sparing in Marfan Syndrome





T. David, JTCVS 2009

AV Repair:

Leaflet repair in valve sparing surgery

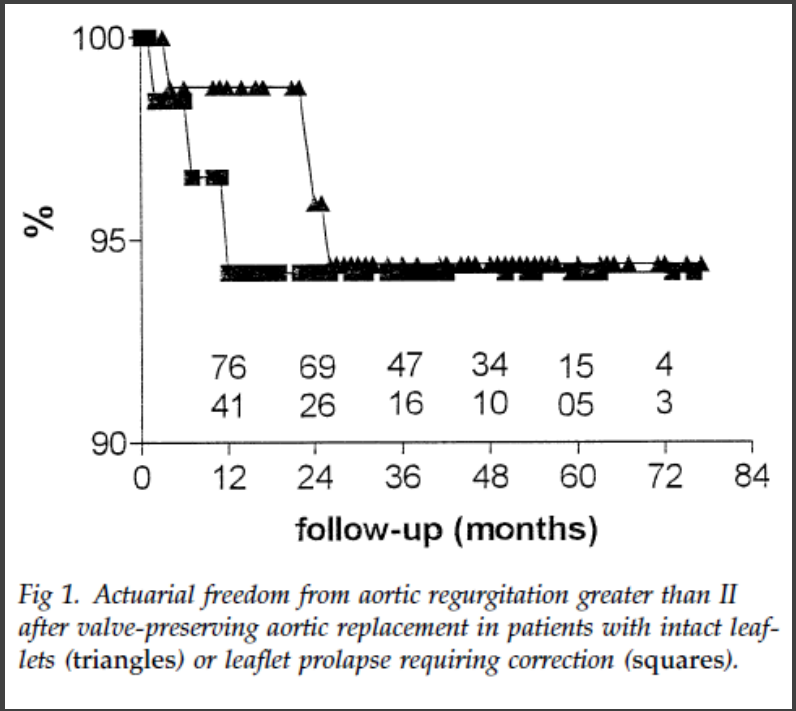
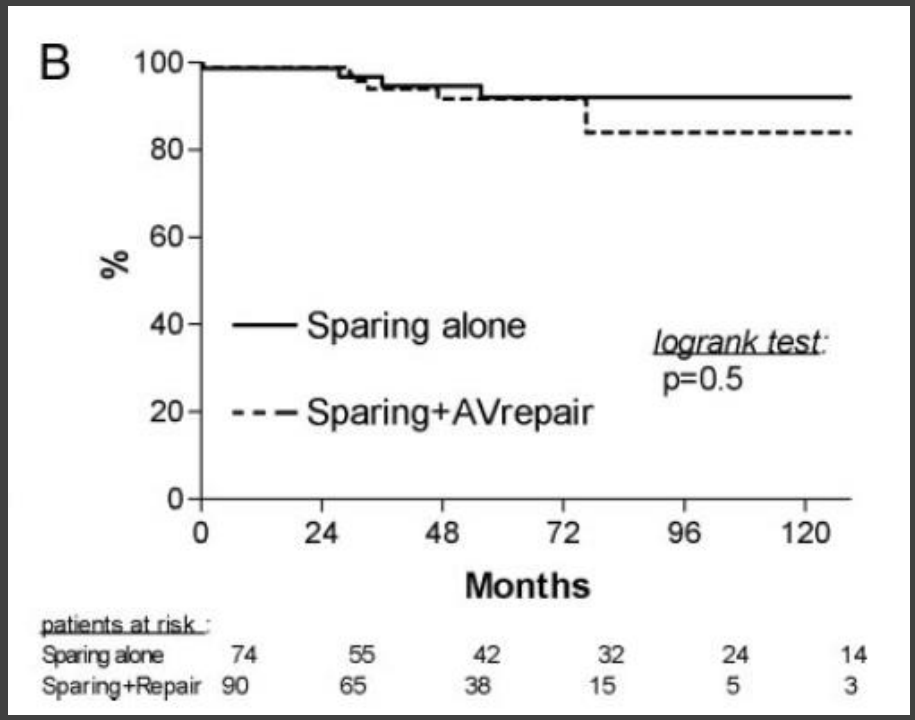


Fig 1. Actuarial freedom from aortic regurgitation greater than II after valve-preserving aortic replacement in patients with intact leaflets (triangles) *or leaflet prolapse requiring correction* (squares).

H.J. Schäfers ATS 2002



L. de Kerchove Circ. 2009

Cusp repair = risk factor of reoperation or recurrent AR

- *E. Lansac EJCTS 2010 (negative impact of cusp repair decrease with experience)*
- *P.P. Urbanski EJCTS 2012*

AV repair

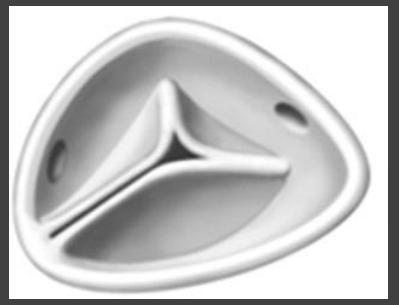
TAV versus BAV

Freedom from reoperation

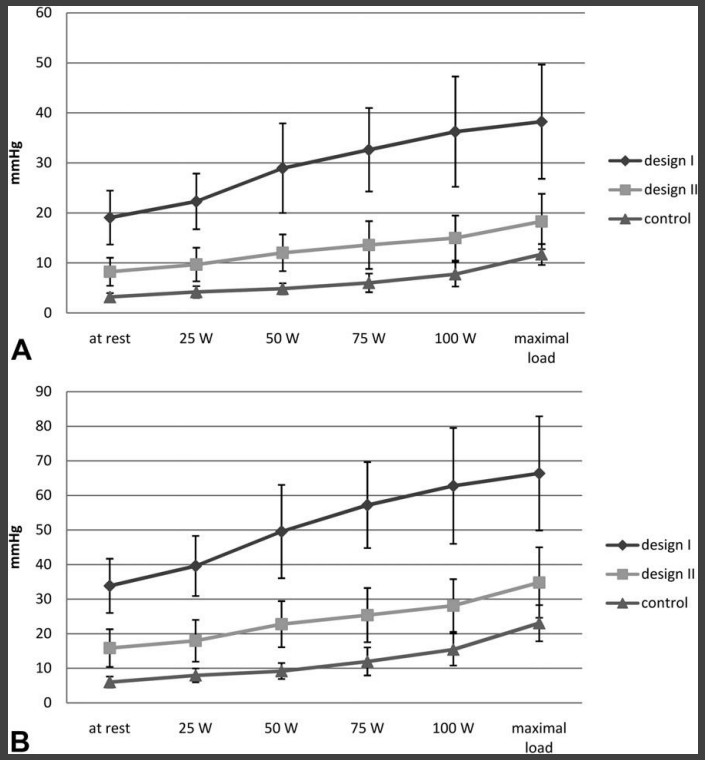
BAV		TAV
• 84% (7 y) *Casselman JTCVS 1999*	<	• 94% (12 y) *David JTCVS 2010*
• 81% (10 y) *Aicher EJCTS 2010*		• 93% (10 y) *Aicher EJCTS 2010*
• 81% (10 y) Price ATS *2013*		• 89% (10 y) *Price ATS 2013*

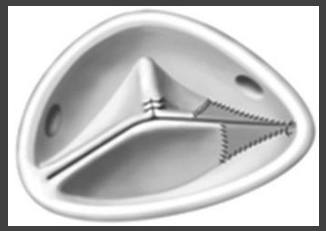
AV Leaflet Repair: Results

Unicuspid valve repair



- 2001 – 2011: 118 pts
- mean age: 27 years
- FF reoperation @ 3 years: 80% 86 %





Design I

Design II

D. Aicher JTCVS 2013

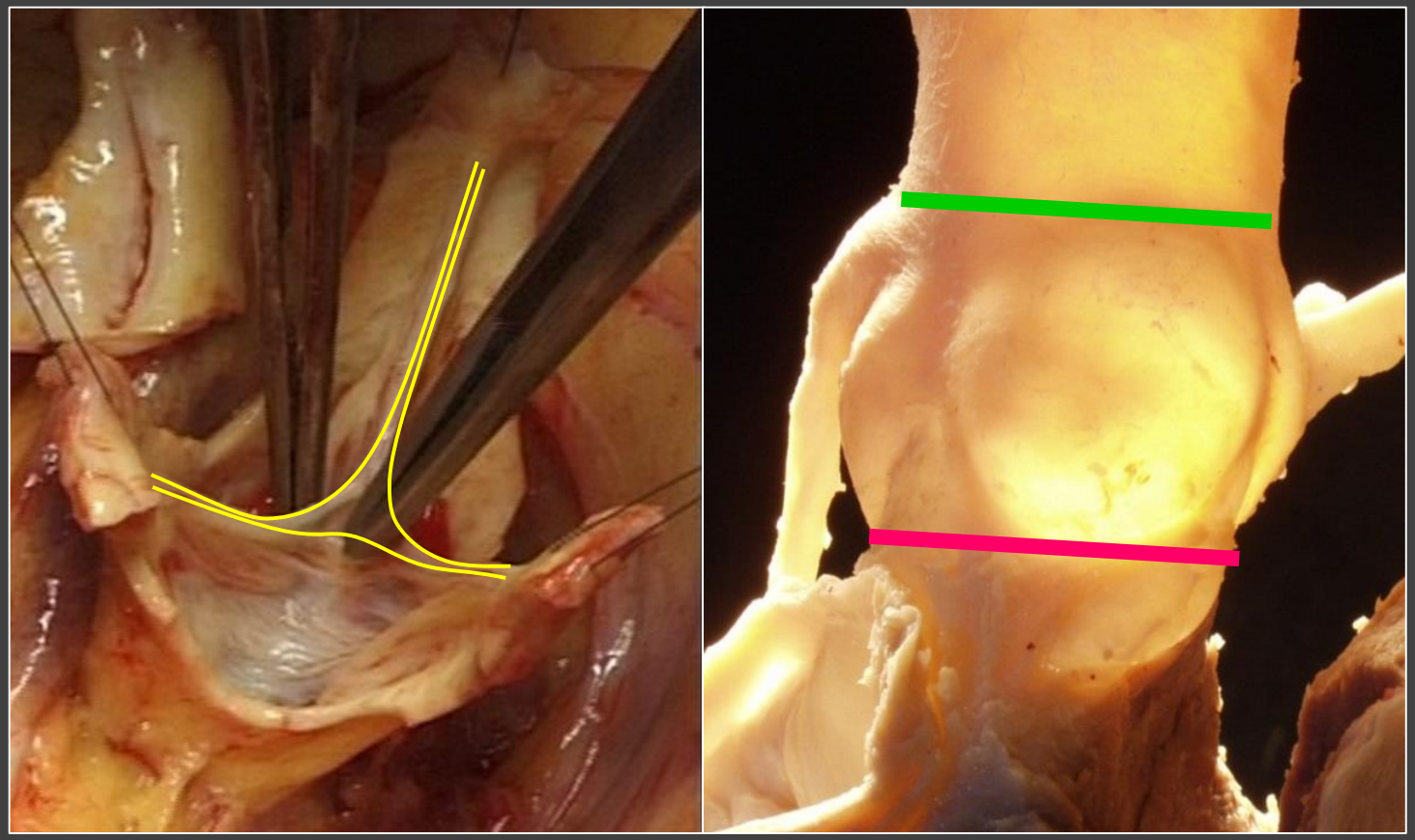
Functional classification of aortic regurgitation

The functional aortic valve unit

1. Cusp

2. STJ

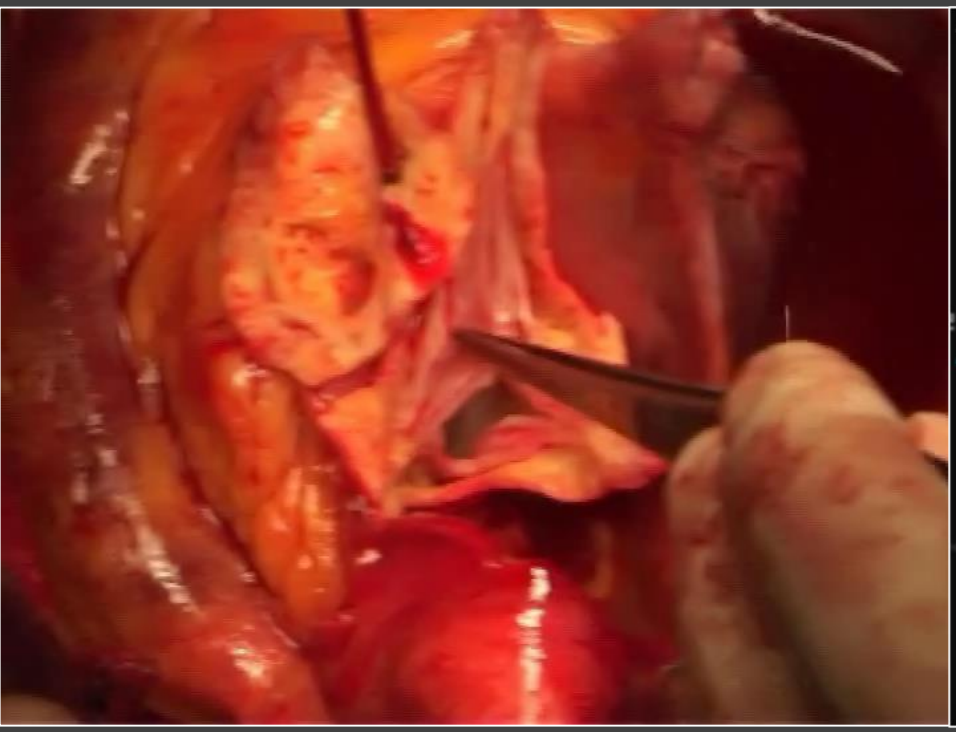
3. VAJ

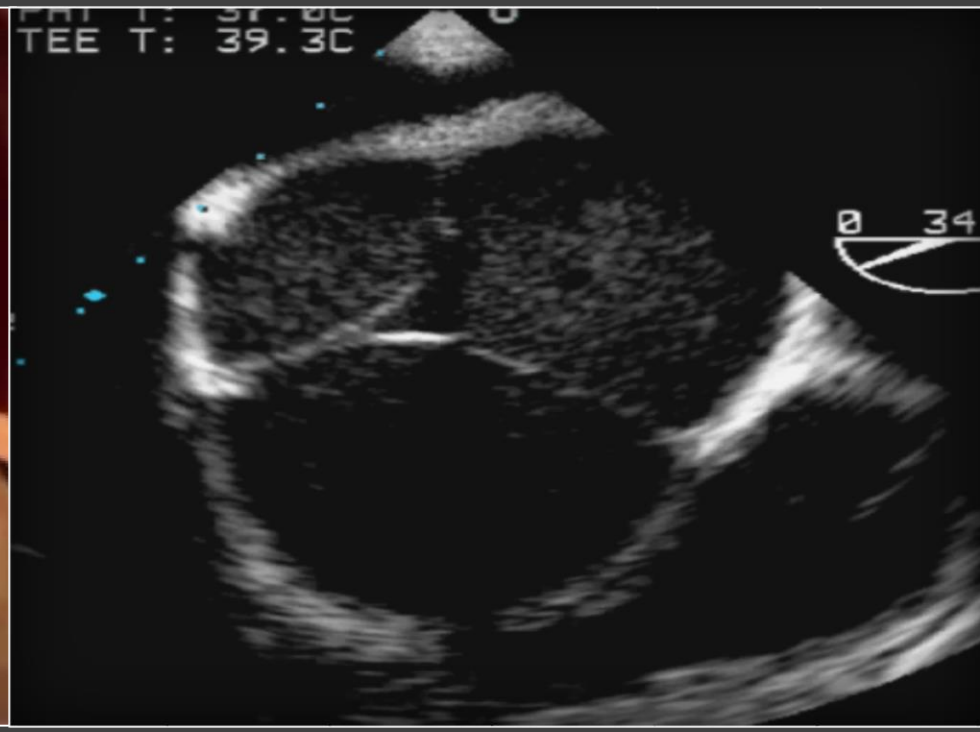


Functional classification of aortic regurgitation

Mechanism of AV dysfunction

STJ dilatation



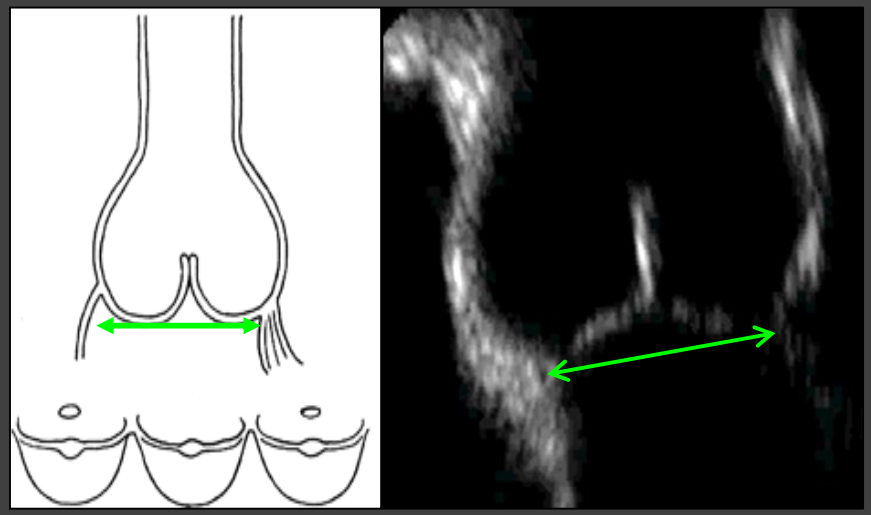


Functional classification of aortic regurgitation

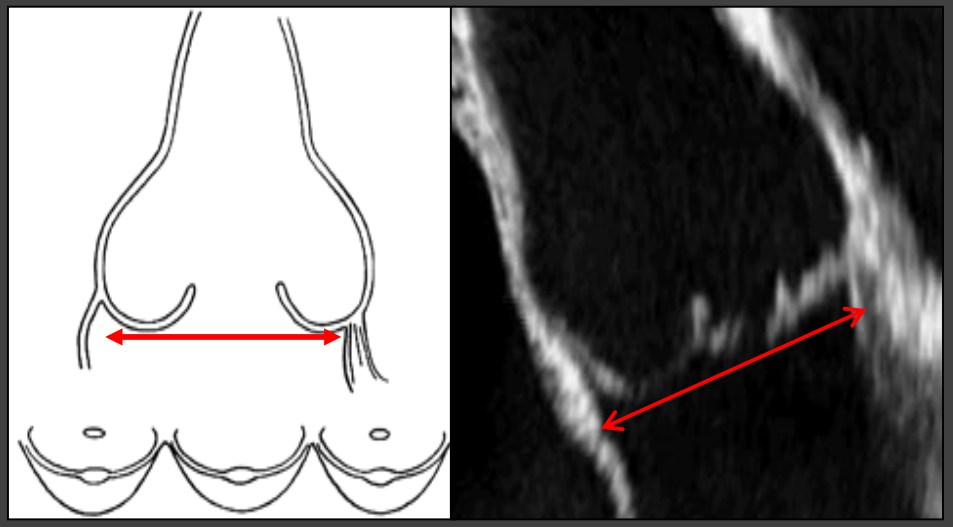
Mechanism of AV dysfunction

VAJ dilatation, "Annuloectasia"

Normal



Dilated



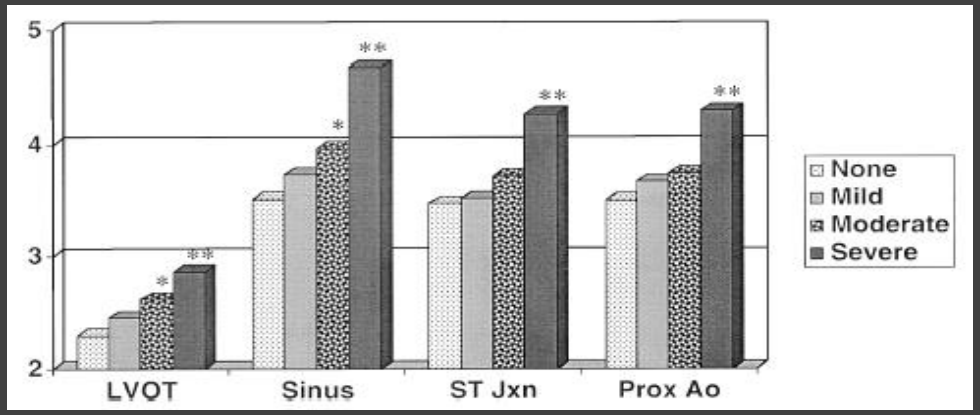
Functional classification of aortic regurgitation

Mechanism of AV dysfunction

Table II. Degree of AR and aortic root size indexed by body surface area at follow-up study

	Mild AR (cm/m^2) ($n = 67$)	Moderate AR (cm/m^2) ($n = 45$)	Severe AR (cm/m^2) ($n = 15$)	p Value*
Aortic anulus	1.29 ± 0.23	1.38 ± 0.23	1.39 ± 0.11	0.055
Valsalva sinuses	1.89 ± 0.34	2.04 ± 0.31	2.09 ± 0.32	0.025
Supraaortic ridge	1.49 ± 0.30	1.71 ± 0.35	1.76 ± 0.43	0.001
Ascending aorta	1.97 ± 0.42	2.16 ± 0.49	2.19 ± 0.47	0.049

Padial LR, Am Heart J. 1997



Keane MG, Circulation. 2000

In patients with chronic AR, the severity of AR is correlated with the degree of STJ and VAJ dilatation

AV Repair

*Surgery for A*I

- Symptomatic severe AI
- Assympt severe AI + EF <50%

  or + LVED >65 (70) mm, LVES >50 mm

Surgery for Ao. Aneurism

- > 55 mm in TAV
- > 50 mm in Marfan, BAV at risk
- > 45 mm in Marfan at risk, if surgery for severe AI

AV Repair

Aorta lesions	Repair techniques
• Type 1a: STJ (Asc Ao)	→ Supra cor. Asc Ao replac.
• Type 1b: STJ + VAJ (Root)	→ AV sparing Reimpl./ Remodel.
• Type 1c: VAJ	→ SCA / Ring annuloplasty

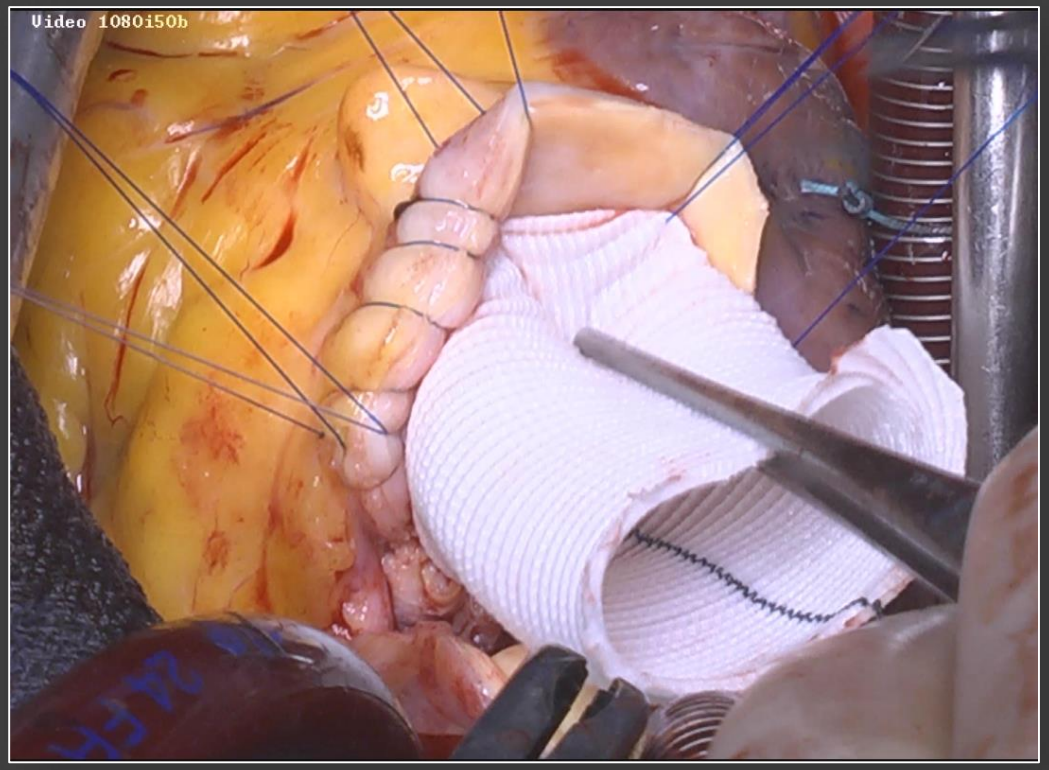
AV Repair

Aorta lesions

- Type 1a: STJ (Asc Ao)

Repair techniques

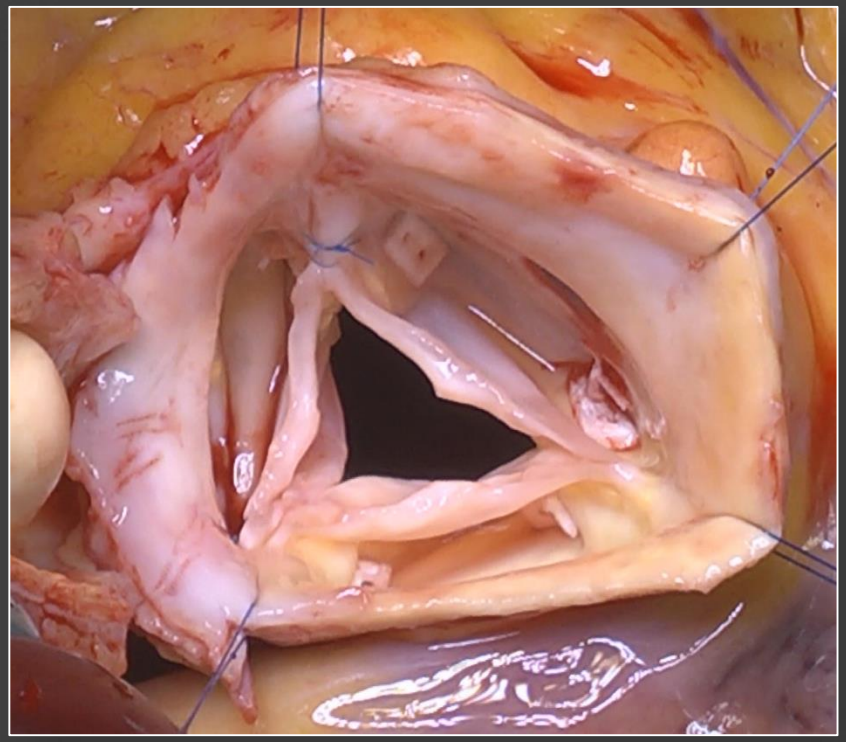
→ Supra cor. Asc Ao replac.



AV Repair

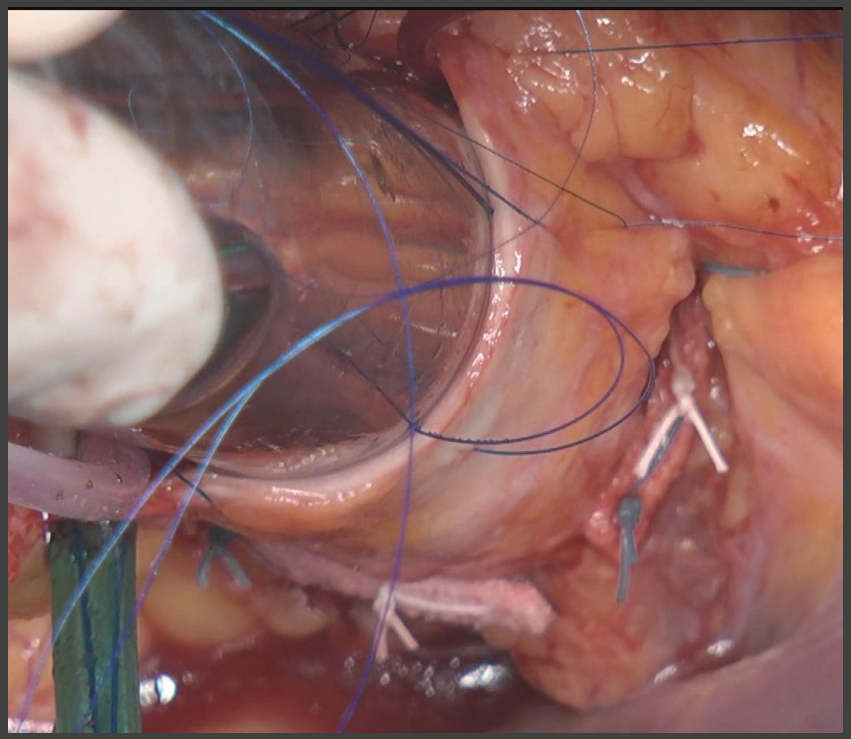
Aorta lesions

- Type 1c: VAJ



Repair techniques

→ SCA / Ring annuloplasty

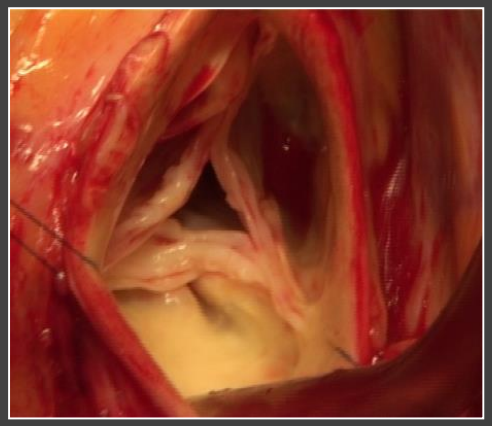


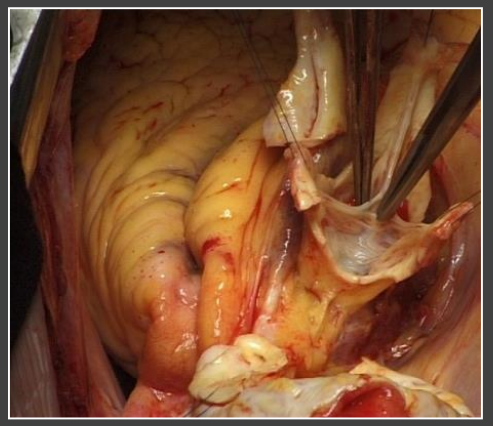
Principles of AV repair/sparing surgery

1. Repair and preserve cusp geometry and motion

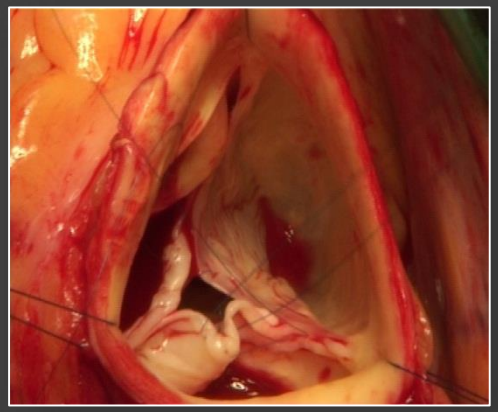
+

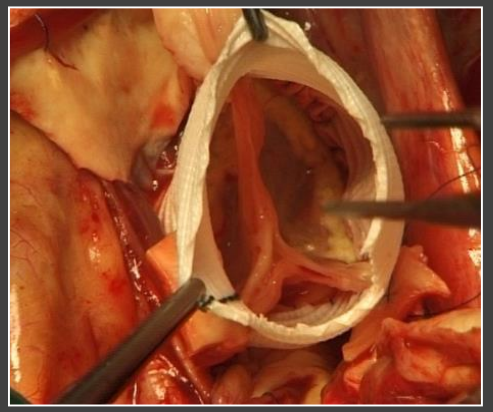
2. Remodel and stabilize the FAA





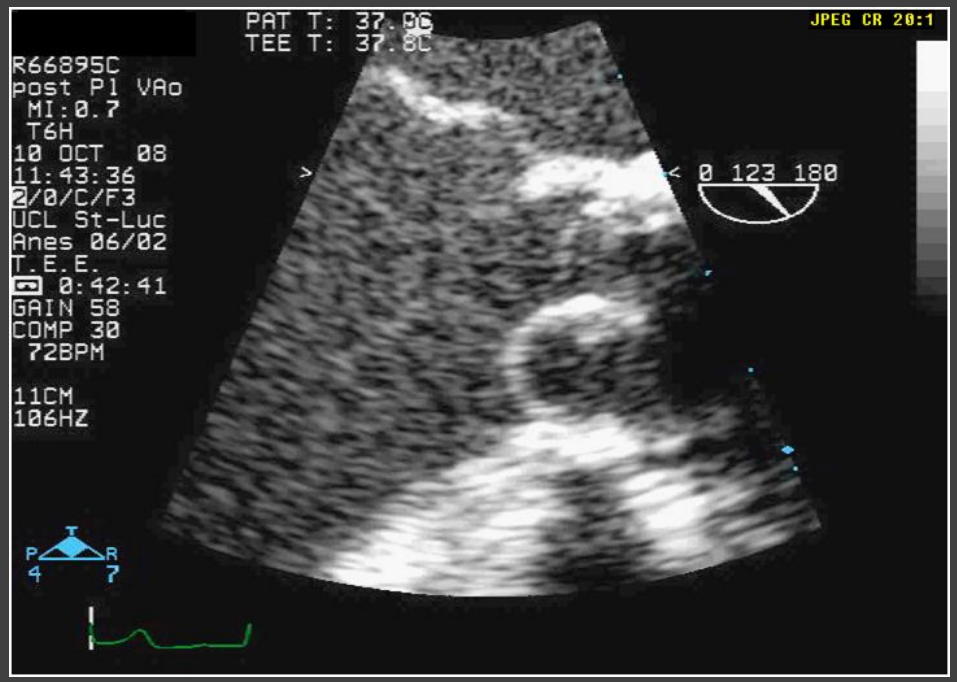
To create an optimal area of coaptation, stable over time

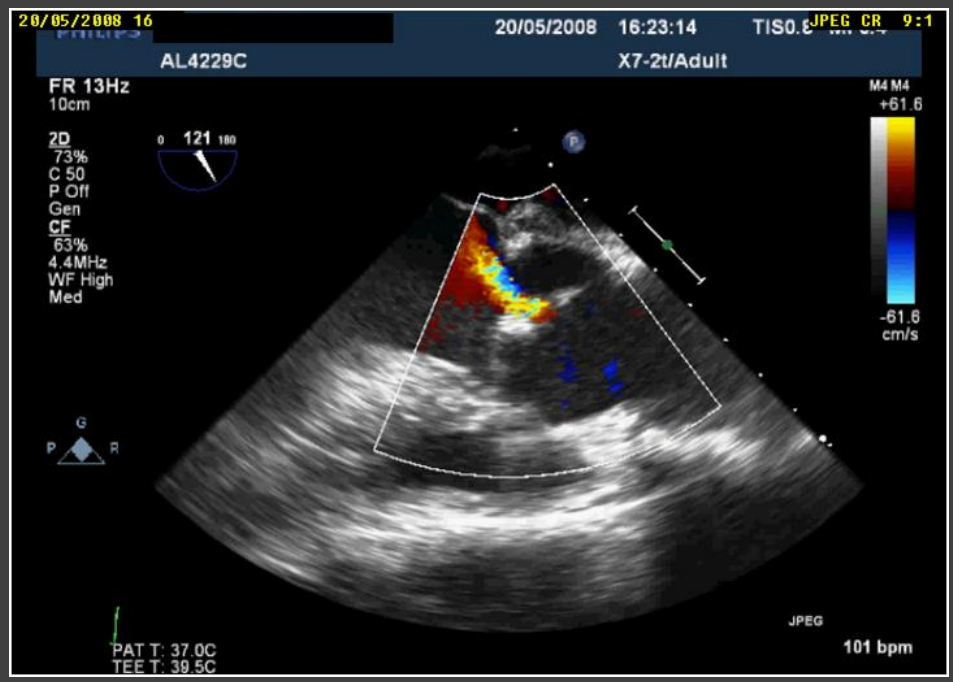




Principles of AV repair/sparing surgery

Optimal coaptation ?



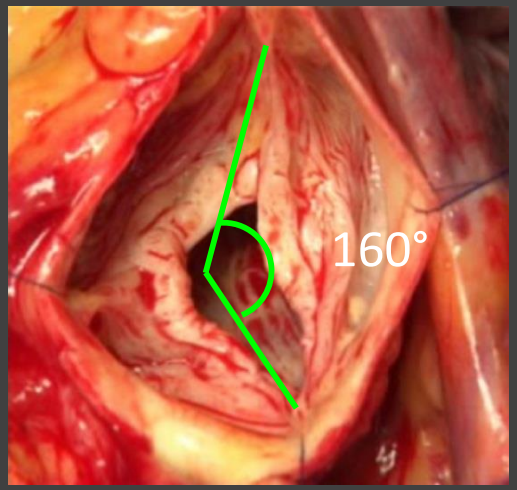


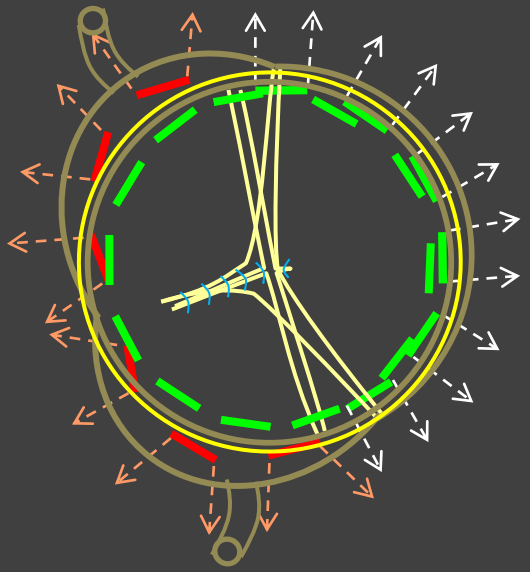
BAV repair

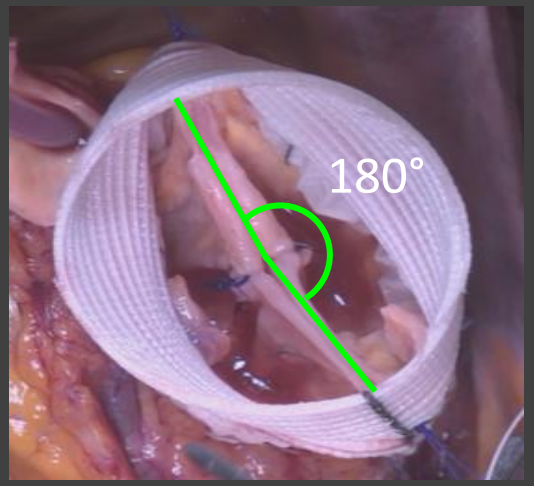
Valve sparing Reimplantion

1. Circumferential prosthetic based annuloplasty
2. Modify commissure orientation (≈180°)
    - Improve durability
    - Reduce the need of patch repair

Type 1 BAV





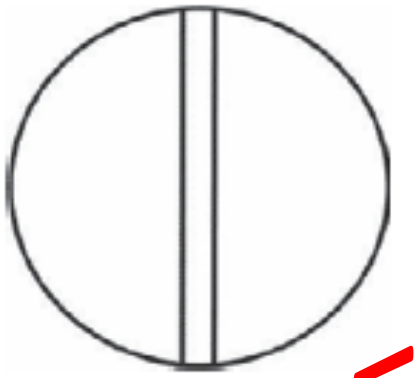
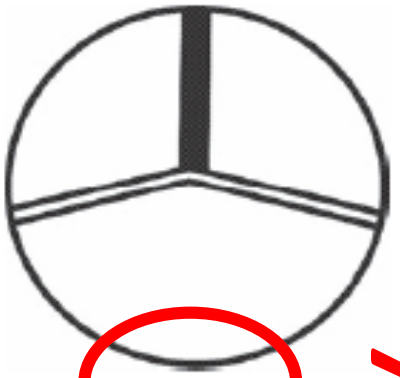
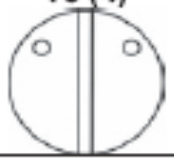
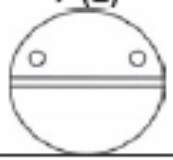


AV Repair

- Classification
- Techniques of repair
  - Cusp repair
  - Aortic repair/ annuloplasty
- Results of repair

BAV Repair

Classification of cusp phenotypes

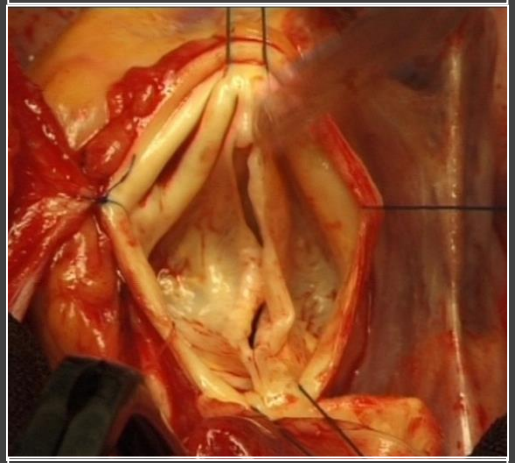
main category: number of raphes	0 raphe - Type 0		1 raphe - Type 1			2 raphes - Type 2
						
	21 (7)	<<	269 (88)	>>>		14 (5)
1. subcategory: spatial position of cusps in Type 0 and raphes in Types 1 and 2	lat 13 (4)	ap 7 (2)	L – R 216 (71)	R – N 45 (15)	N – L 8 (3)	L – R / R – N 14 (5)
						
2. subcategory:						
VALVULAR FUNCTION I	6 (2)	1 (0.3)	79 (26)	22 (7)	3 (1)	6 (2)
VALVULAR FUNCTION S	7 (2)	5 (2)	119 (39)	15 (5)	3 (1)	6 (2)
VALVULAR FUNCTION B (I + S)		1 (0.3)	15 (5)	7 (2)	2 (1)	2 (1)
VALVULAR FUNCTION No			3 (1)	1 (0.3)		

H. Sievers, J.Thor. Cardiovasc.Surg. 2007

BAV repair

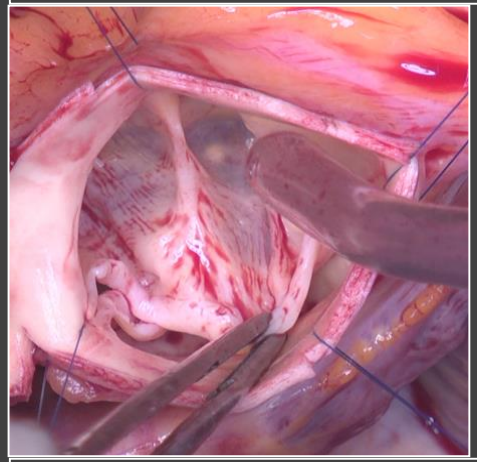
Classification of cusp phenotypes

Type 0 *(Sievers Classif.)*

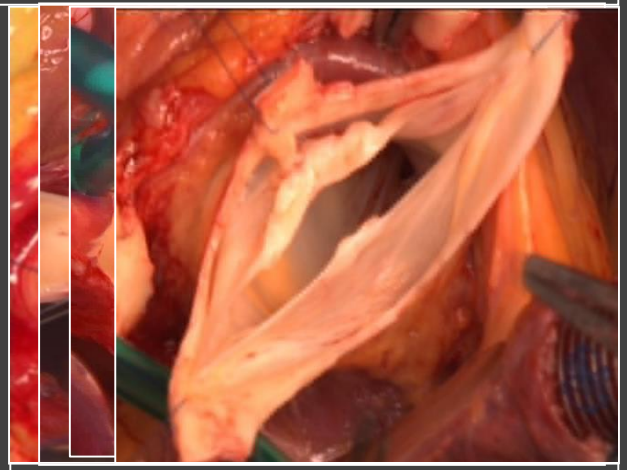


- ≈ 180°
- No raphe
- Prolapse

Type 1 *(Sievers classif.)*



- Raphe
- Complete fusion
- 160° – 180°
- Prolapse

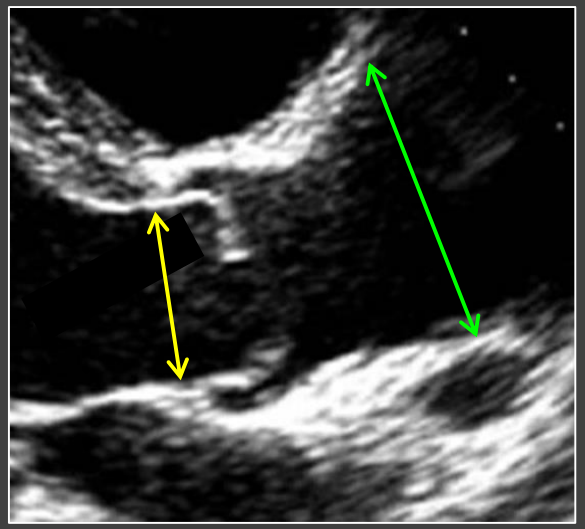


- Thick, calc. raphe
- Incomplete fusion
- 120° – 160 °
- Restrictive

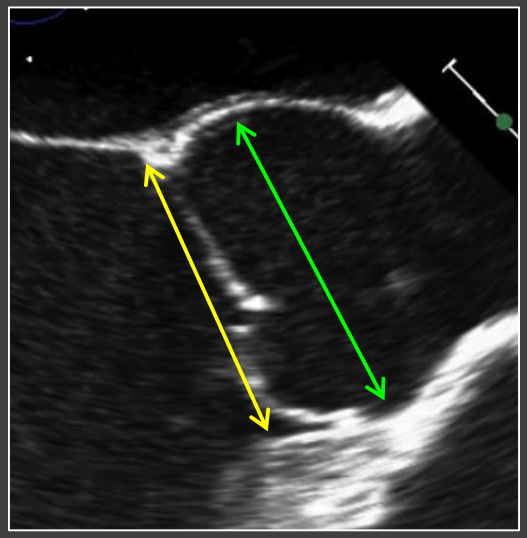
BAV Repair

Aortopathy

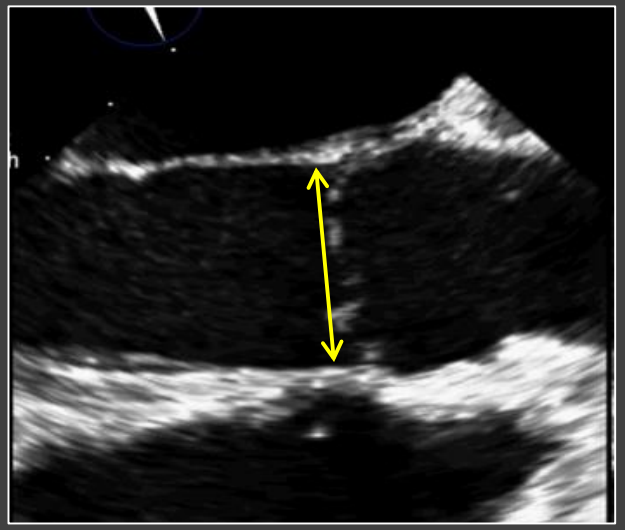
Dilated Asc. Aorta



Dilated Root



Normal Aorta

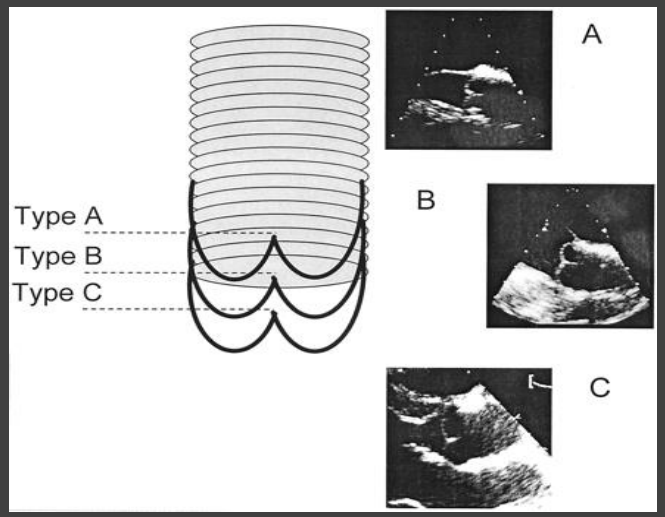


- Dilated ventriculo-aortic junction 28 – 30 mm

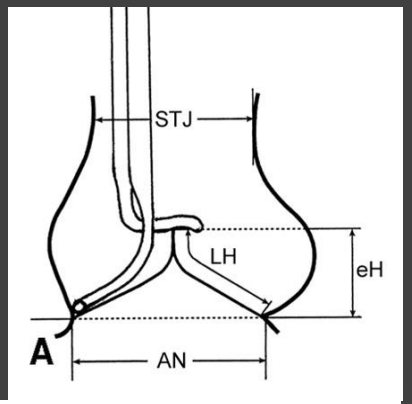
de Kerchove JTCVS 2010
Schäfers JTCVS 2013

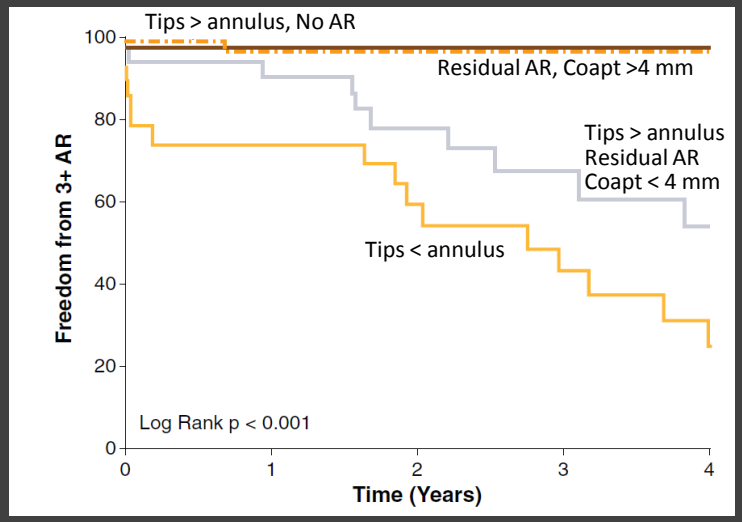
AV repair

Risk factor of repair failure: Cusp coaptation

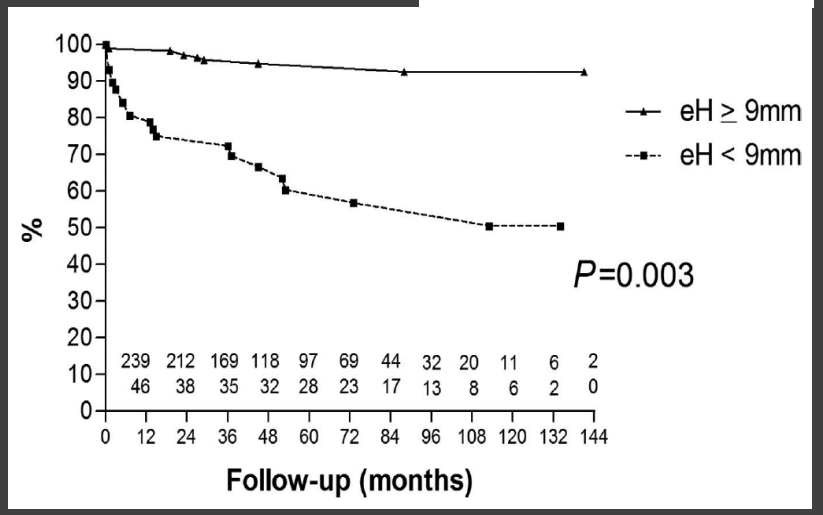


Pethig K. ATS 2002





le Polain JB. JACC Card. Im. 2009



Aicher D. Circ. 2011

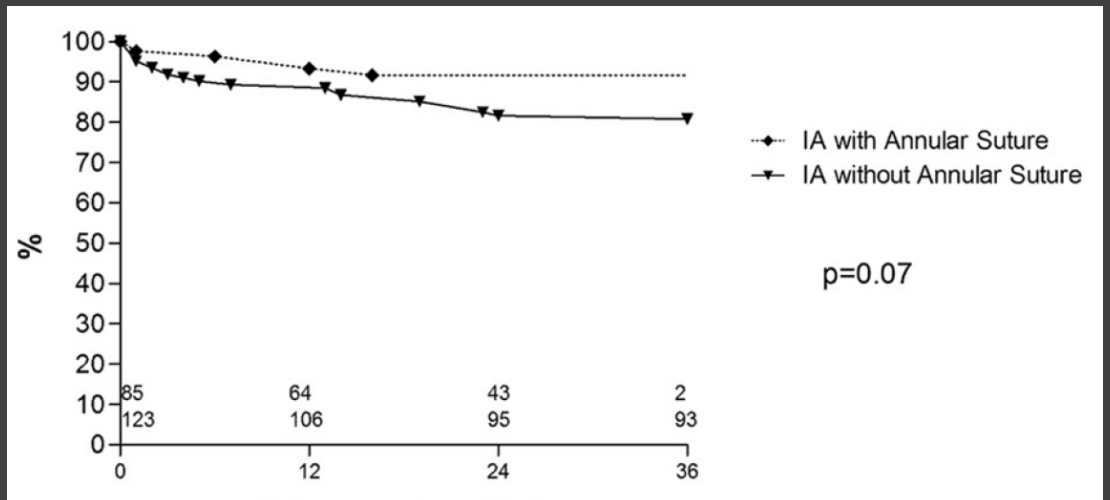
Effect of VAJ annuloplasty on repair durability

✓ *Lansac E., EJCTS 2006:*

- 87 pts, 95% TAV
- 100% Remodeling, 60% with ring annuloplasty
- Less early residual or recurrent AI in Remodeling + ring group

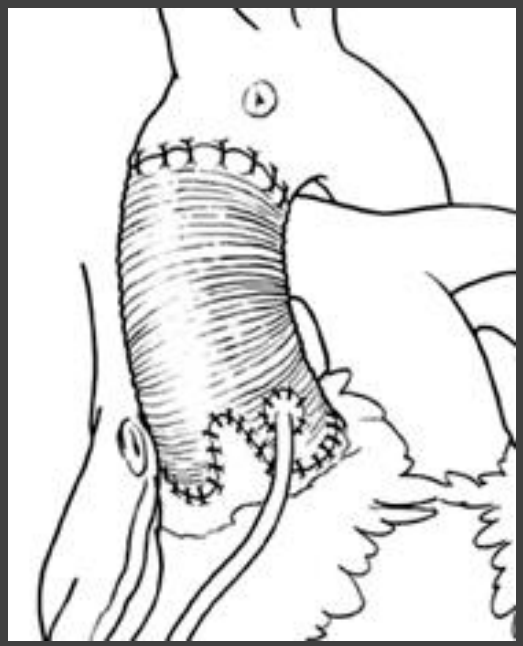
✓ *Aicher D., JTCS 20013:*

- 559 BAV repair
- 193 (34%) VAJ suture annuloplasty in patient VAJ >27 mm
- Less early residual or recurrent AI in annuloplasty group

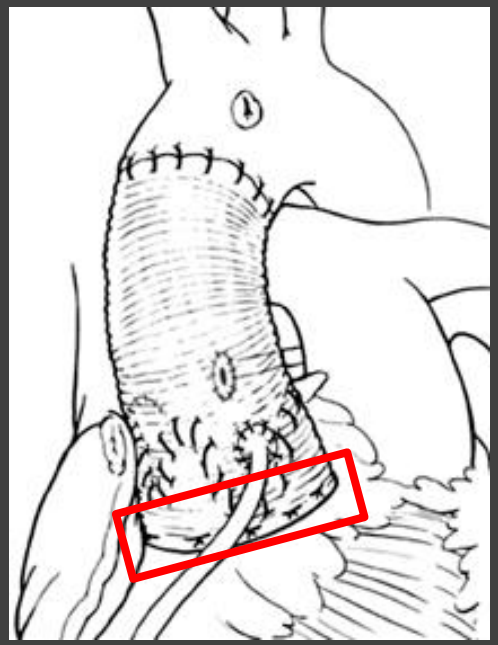


VAJ and valve sparing root replacement

Remodeling



Reimplantation



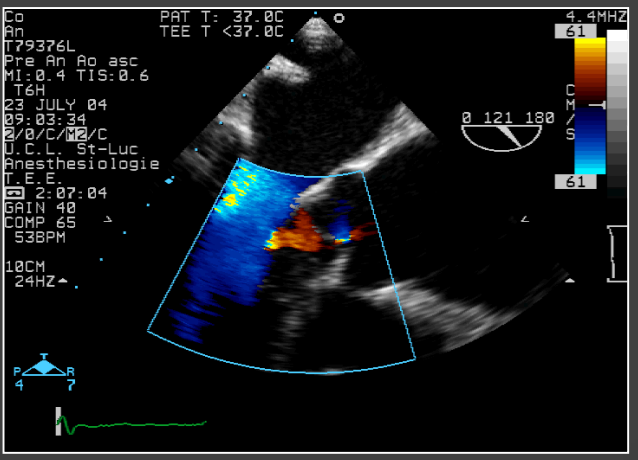
- *Birks EJ., Yacoub MH. Circulation. 1999*
- *De Olievera NC., David TE. JTCVS 2003*
- *Miller DG. JTCVS 2003*
- *Bethea BT., Cameron D. ATS 2004*
- *David T. JTCVS 2006*
- *Erasmi A., Sievers HH. ATS 2007*

Suggest better repair durability with the Reimplantation technique

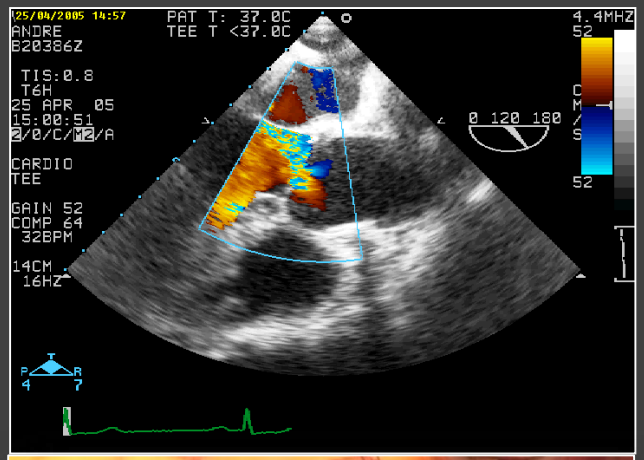
Functional classification of aortic regurgitation

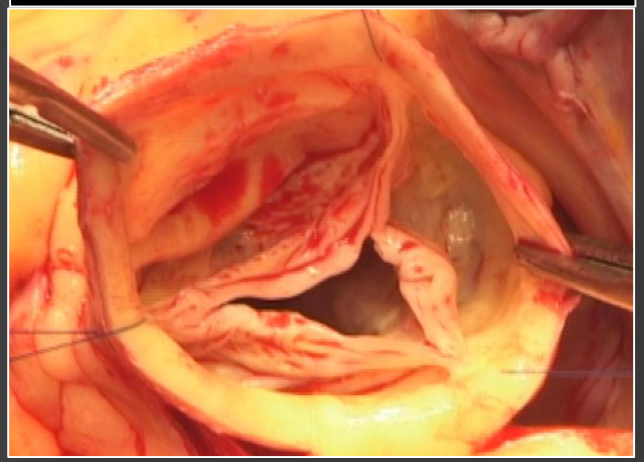
Mechanism of dysfunction may coexist

Type 1a+2

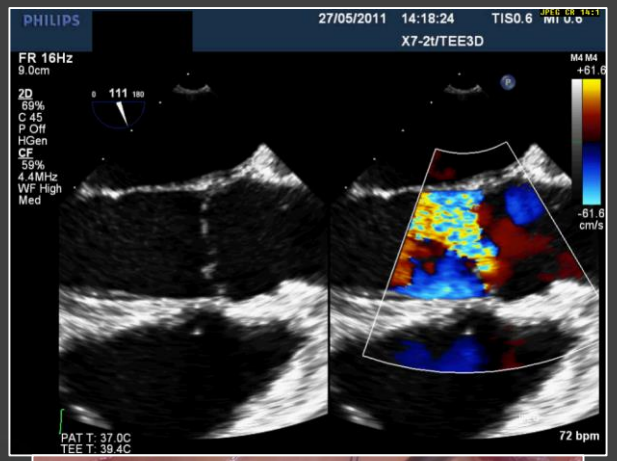


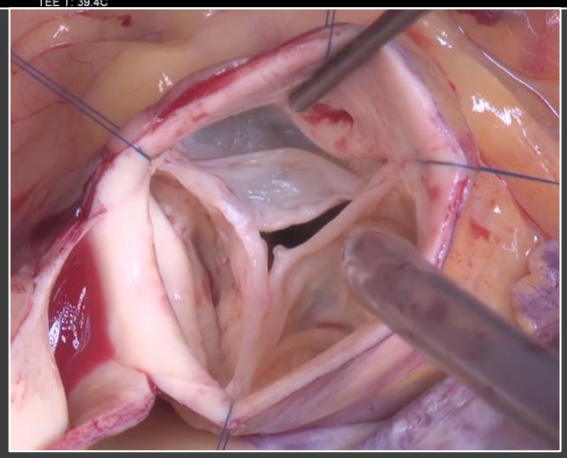
Type 1b+2





Type 1c+2





Valve Sparing root replacement

Probability of Cusp Repair

- AV morphology
  - In tricuspid **52%**
    - T. David JTCS. 2006: ±58%
    - D. Aicher. JTCS 2007: ±53%
  - In bicuspid **93%**
    - D. Aicher. JTCS 2007: ±86%