Aortic Valve Repair: A Standardized Approach

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Tite

Repair-oriented classification of aortic insufficiency: Impact on surgical techniques and clinical outcomes

Munir Boodhwani, MD, MMSc, Laurent de Kerchove, MD, David Glineur, MD, Alain Poncelet, MD, Jean Rubay, MD, Parla Astarci, MD, Robert Verhelst, MD, Philippe Noirhomme, MD, and Gébrine El Khoury, MD

Objective: Valve repair for aortic insufficiency requires a tailored surgical approach determined by the leaflet and aortic disease. Over the past decade, we have developed a functional classification of AI, which guides repair strategy and can predict outcome. In this study, we analyze our experience with a systematic approach to aortic valve repair.

Methods: From 1996 to 2007, 264 patients underwent elective aortic valve repair for aortic insufficiency (mean age – 54 ± 16 years; 79% male). AV was tricuspid in 171 patients bicuspid in 90 and quadricuspid in 3. One hundred fifty three patients had type I dysfunction (aortic dilatation), 134 had type II (cusp prolapse), and 40 had type III (restrictive). Thirty six percent (96/264) of the patients had more than one identified mechanism.

Results: In-hospital mortality was 1.1% (3/264). Six patients experienced early repair failure; 3 underwent re-repair. Functional classification predicted the necessary repair techniques in 82-100% of patients, with adjunctive techniques being
47 [29–73] mont
95 ± 3%. Ten p
and from AV re
9%; 93 ± 5%) o

Conclusion: Aor
functional classif
niques required a
tion, is an import

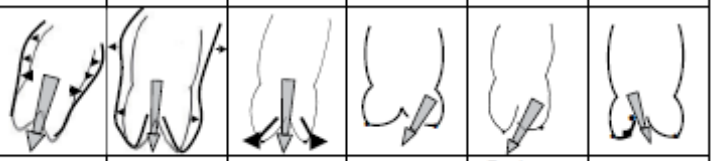
AI Class	Type I: Normal cusp motion with FAA dilatation or cusp perforation				Type II: Cusp Prolapse	Type III: Cusp Restriction
	Ia	Ib	Ic	Id		
Mechanism						
Repair Techniques (Primary)	STJ remodeling *Ascending aortic graft*	Aortic Valve sparing: *Reimplantation or Remodeling with SCA*	SCA	Patch Repair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

FIGURE 1. Repair-oriented functional classification of aortic insufficiency *(AI)* with description of disease mechanisms and repair techniques used. *FAA*, Functional aortic annulus; *STJ*, sinotubular junction; *SCA*, subcommissural annuloplasty.

Aortic Valve Repair Using a Differentiated Surgical Strategy

Frank Langer, MD; Diana Aicher, MD; Anke Kissinger, Olaf Wendler, MD; Henning Lausberg, MD; Roland Fries, MD; Hans-Joachim Schäfers, MD

Background—Reconstruction of the aortic valve for aortic regurgitation (AR) remains challenging, in part because of not only cusp or root pathology but also a combination of both can be responsible for this valve dysfunction. We have systematically tailored the repair to the individual pathology of cusps and root.

Methods—Between October 1995 and August 2003, aortic valve repair was performed in 282 of 493 patients undergoing surgery for AR and concomitant disease. Root dilatation was corrected by subcommissural plication (n=59), supracommissural aortic replacement (n=27), root remodeling (n=175), or valve reimplantation within a graft (n=24). Cusp prolapse was corrected by plication of the free margin (n=157) or triangular resection (n =36), cusp defects were closed with a pericardial patch (n=16). Additional procedures were arch replacement (n=114), coronary artery bypass graft (n=60) or mitral repair (n=24). All patients were followed-up (follow-up 99.6% complete), and cumulative follow-up was 8425 patient-months (mean, 33±27 months).

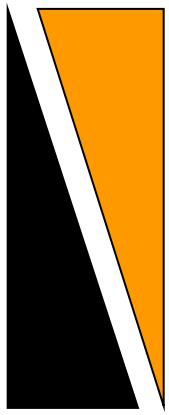
Results—Eleven patients died in hospital (3.9%). Nine patients underwent reoperation for recurrent AR (3.3%). Actuarial freedom from AR grade ≥II at 5 years was 81% for isolated valve repair, 84% for isolated root replacement, and 94% for combination of both; actuarial freedom from reoperation at 5 years was 93%, 95%, and 98%, respectively. No thromboembolic events occurred, and there was 1 episode of endocarditis 4.5 years postoperatively.

Conclusions—Aortic valve repair is feasible even for complex mechanisms of AR with a systematic and individually tailored approach. Operative mortality is low and mid-term durability is encouraging. The incidence of valve-related morbidity is low compared with valve replacement. (*Circulation*. **2004;110[suppl II]:II-67–II-73.**)

Causes of Aortic Regurgitation

Aortic aneurysm
Marfan‘s syndrome
Aortic dissection
Congenital abnormalities
Myxomatous degeneration
Rheumatic disease
Infective endocarditis
Calcific degeneration

Root pathology



Cusp pathology

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Aortic root dilatation may alter the dimensions of the valve leaflets☆

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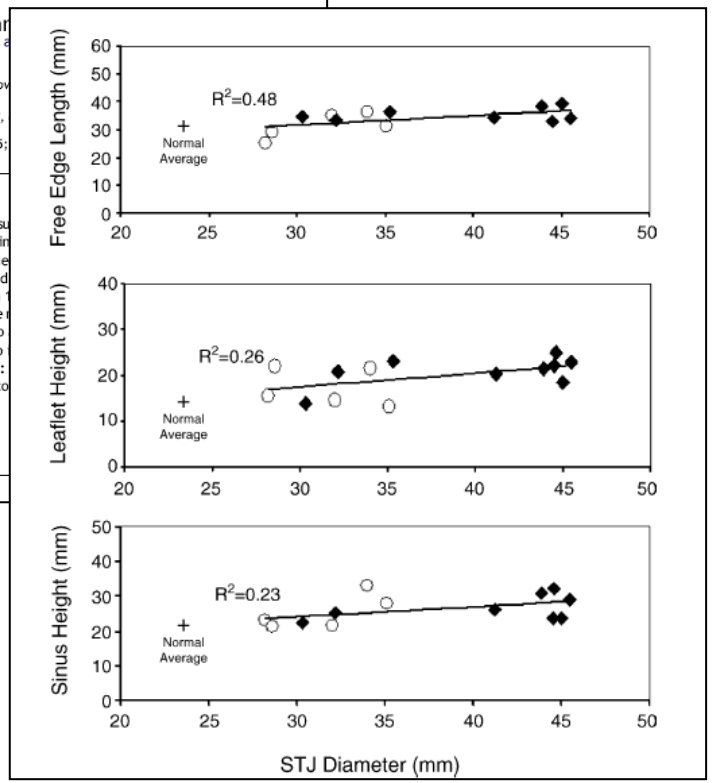
Abstract

Objective: Valve-sparing surgery can be used in patients with dilated aortic roots and aortic insu
practice, in part because the spared valve may be incompetent. Our goal was to study how the din
changed in such patients. **Methods:** Fourteen patients with dilated aortic root and AI were examine
annulus diameter, sinotubular junction (STJ) diameter, sinus height, leaflet free-edge length, and
among these dimensions and with the AI grades were explored. Measurements were also made in t
molds. **Results:** There was no evident change in the average diameter of the annulus between the r
roots. The STJ diameter was obviously increased in the dilated aortic roots; the aortic sinuses also
than normal. The leaflet free-edge length, the leaflet height, and the sinus height were found to
degree of AI was not found to correlate well with any of the dimensions measured. **Conclusions:**
parallel to aortic root dilatation with AI. Therefore, during valve sparing, it may be necessary to co
leaflet free-edge length to achieve a competent valve.

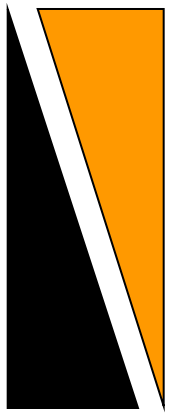
Keywords: Aortic valve; Aortic root; Leaflets; Dimensions; Aneurysm; Insufficiency



Standardized Aortic Valve Repair

Assessment

Root pathology



Correction

Cusp pathology

Standardized Aortic Valve Repair

1. Assessment root
2. Assessment cusps

3. Correction root
4. Correction cusps

Root Assessment

Echo:
Maximum sinus diameter ► >40 / 45-50 mm?
ST diameter
AV diameter (?)

Intraoperative: ► >25 / 28 mm?
AV diameter (!)

AI und TTE/TEE

Root dimensions

AV morphology (bi-/tricuspid)

Prolapse

Calcification?

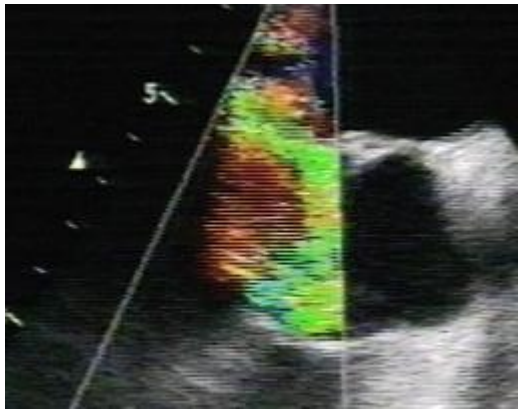
AI und TTE/TEE

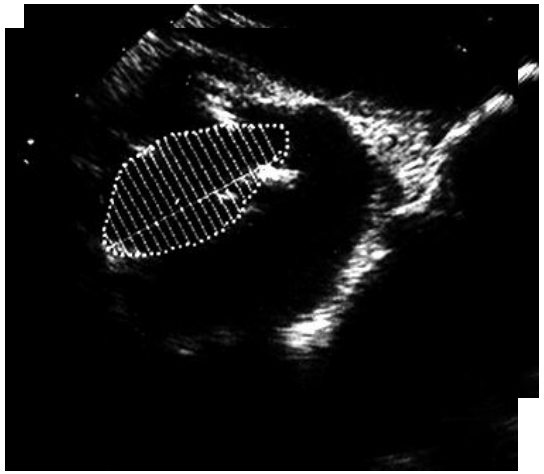
Root dimensions

AV morphology (bi-/tricuspid)

Prolapse

Calcification?





Cusp Assessment

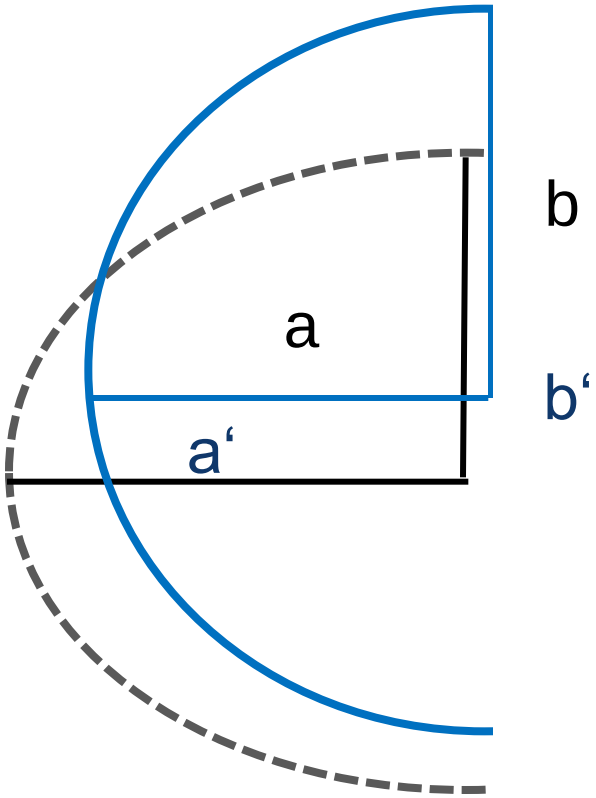
Echo:

- Morphology?
- Eccentricity of the jet?

Intraoperative:

- Morphology?
- Valve configuration?
- Cusp substance?

Reduction of STJ and Cusp Prolapse

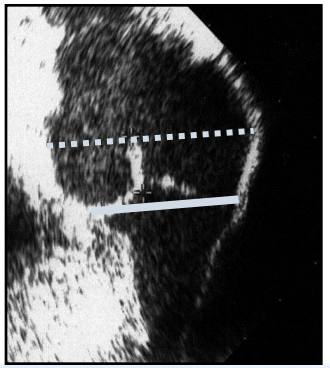


$$C_E = \pi \times [3/2 \times (a+b) - \sqrt{a \times b}]$$

$b \approx r_{aorta}$

$a \approx r_{cusp}$

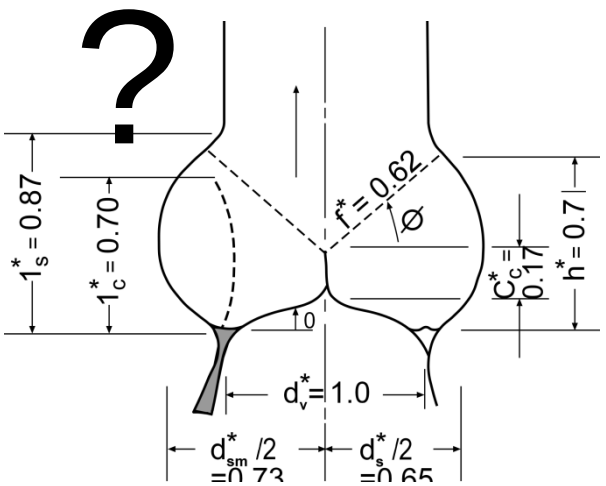
$\Longrightarrow$ $r_{cusp} \approx 1 / r_{aorta}$

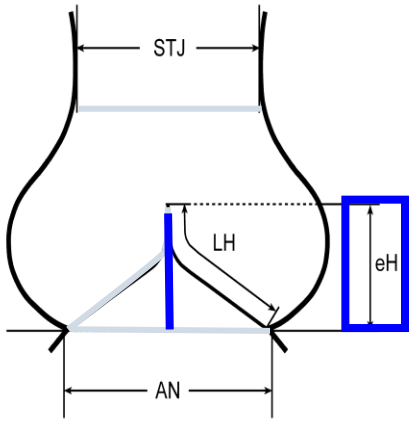


Aortic Valve Repair - Assessment

Solutions

Configuration/coaptation of cusps



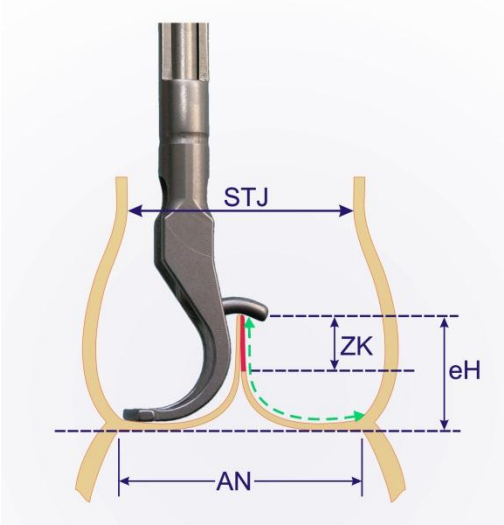


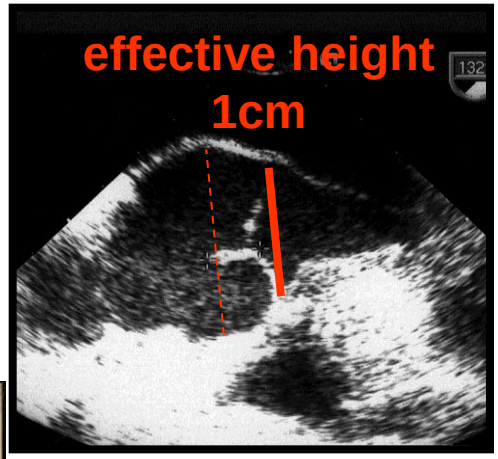
Swanson, Circ Res 1974

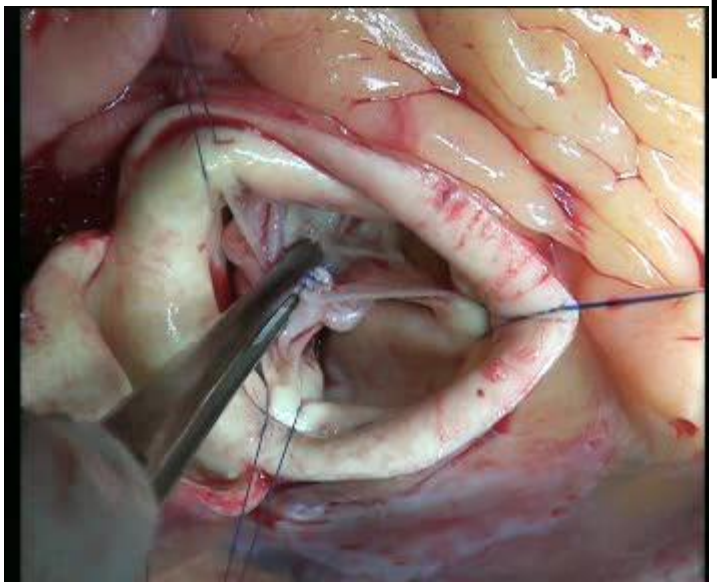
A new approach to the assessment of aortic cusp geometry

Hans-Joachim Schäfers, MD, PhD, Benjamin Bierbach, MD, and Diana Aicher, MD, Homburg/Saar, Germany

Cusp Configuration

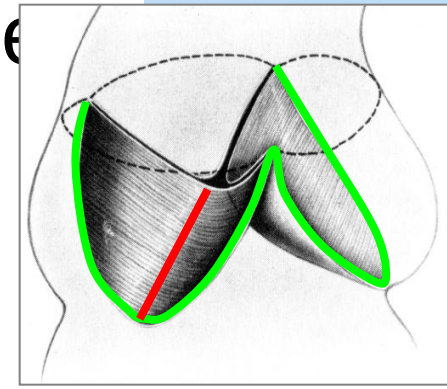






Schäfers HJ et al, JTCVS 2006

Aortic Valve Repair - Assessme



Solutions

Configuration/coaptation of cusps

Cusp height in aortic valve

Hans-Joachim Schäfers, MD,[a] Wolfram S

Objectives: Successful aortic valve rep
available on the normal dimensions of

Methods: The cusp height was measure
A tricuspid anatomy was present in 329
height, weight, preoperative degree of a
analyzed for possible interrelation betw

Results: In the bicuspid valves, the geon
± 2.0). Significant correlations were fo
valves, the height of the noncoronary c
left coronary cusp varied from 12 to 25
to 25 mm (mean, 20.0 ± 2.1). The nonco
cusp ($P = .000$). No difference was fou
between the geometric height and clini
degree of aortic regurgitation.

Conclusions: We found the cusp height
correlates with the clinical variables. T
repair. (J Thorac Cardiovasc Surg 2012;

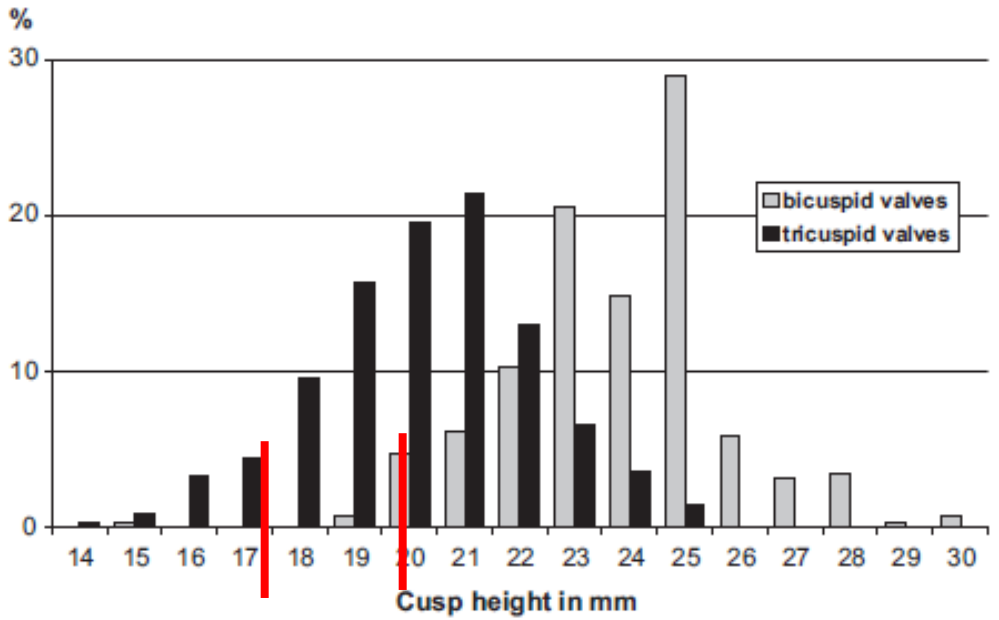
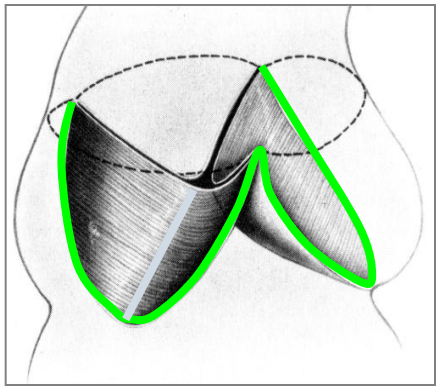
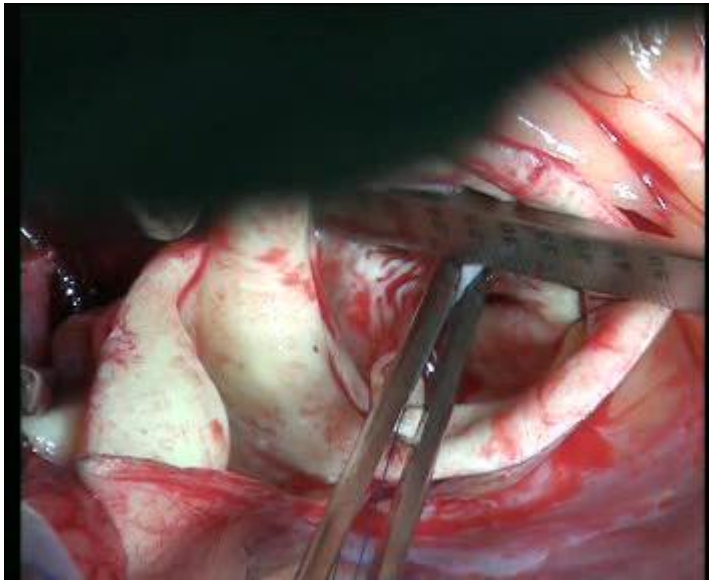


FIGURE 3. Distribution of geometric height in bicuspid (n = 289; nonfused cusps) and tricuspid (n = 332; mean of all 3 cusps) aortic valves.

Aortic Valve Repair - Assessment

Configuration/coaptation of cusps





TAV: 17-22 mm
BAV: 20-25 mm

Cusp Assessment

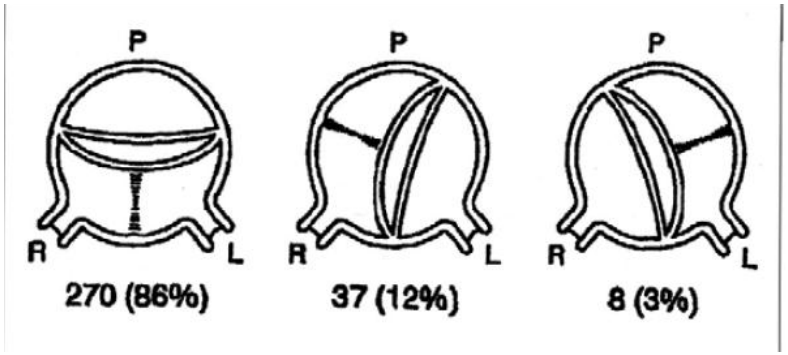
Morphology (commissural height):

- Unicuspid
- Bicuspid
- Tricuspid
- Quadricuspid

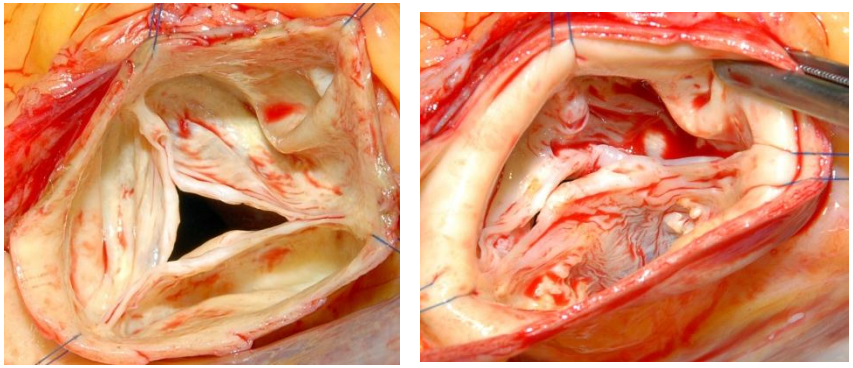
If non-tricuspid, watch for anatomical variation

Bicuspid Aortic Valve (BAV) Morphology

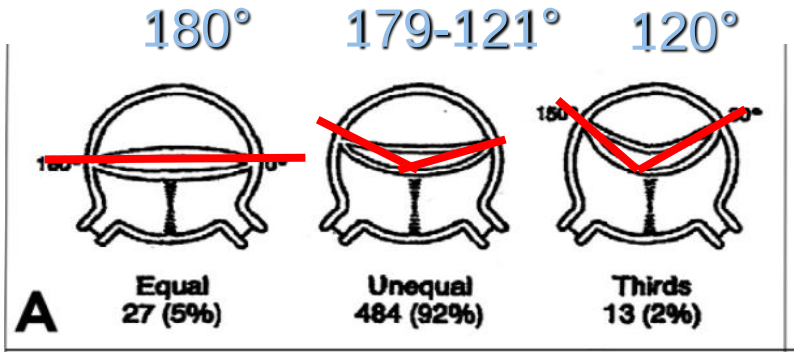
pattern of fusion



degree of fusion



commissural orientation



Sabet et al, *Mayo Clin Proc*, 1999;74:14-26

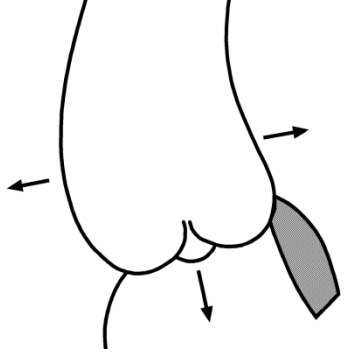
Root Correction

If

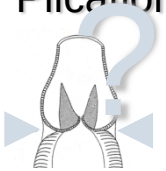
STJ > 30-35 mm (?)
Sinus > 40 (UAV/BAV) -45 (-50) (TAV) mm

Annular reduction (?)
STJ remodeling
Root remodeling
Valve reimplantation

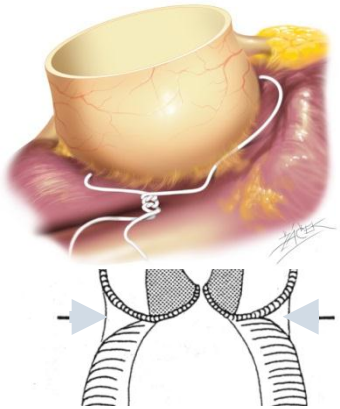
Root Repair – Technical Options



Subcommissural Plication

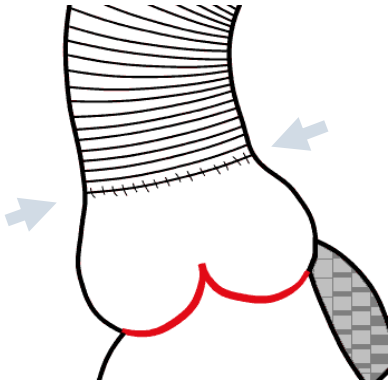


(Cabrol 1966)



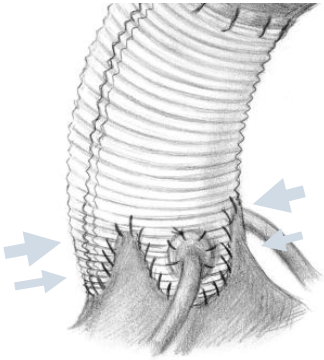
Aortoventricular Plication (AVJ > 27mm)

ST Junction Remodelling



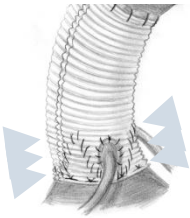
(Frater 1986) (Sinus < 40-45 mm, STJ > 30 mm)

Root Remodeling



(Yacoub 1993) (Sinus > 45 mm),

Reimplantation of Aortic Valve



(David 1992) (AVJ ≥ 30 mm)

THG

Cusp Correction

If

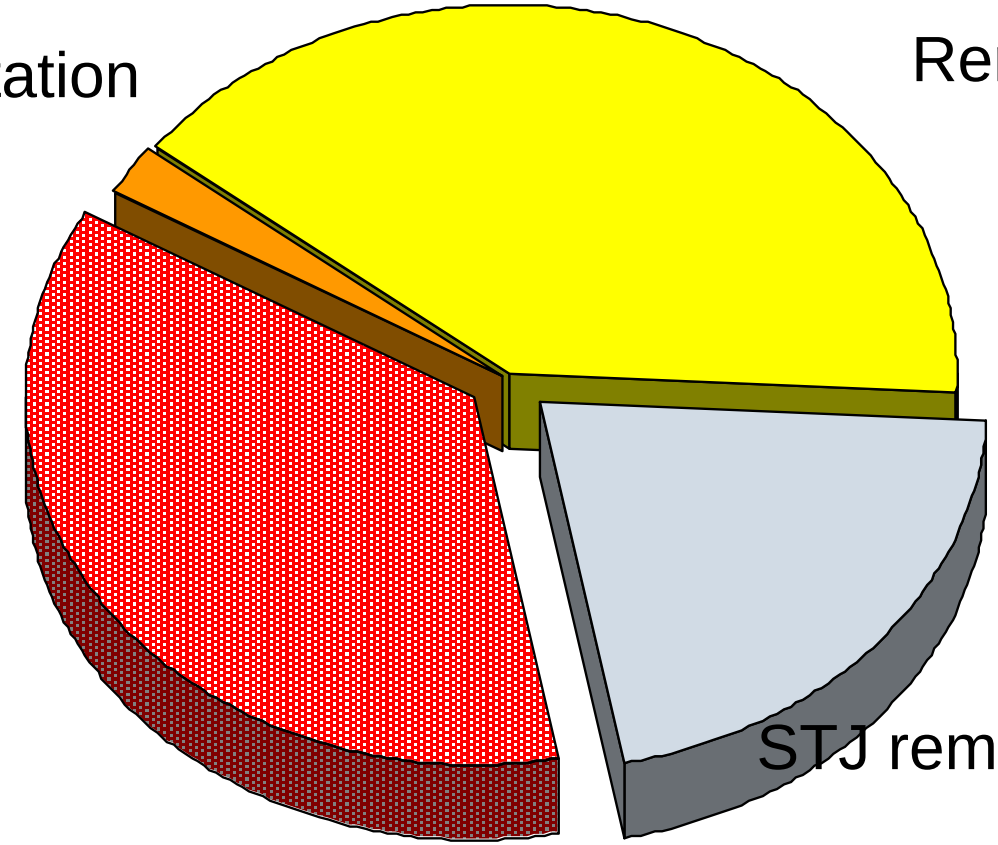
- prolapse (eH ≤ 8 mm)
- structural defect
- anatomical variant

Plication of free margin / triangular resection
Patch correction
Conversion of anatomy (BAV, TAV constant)

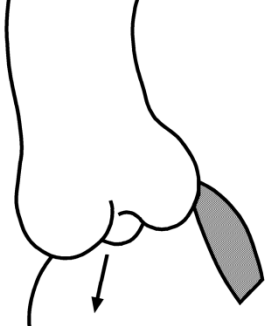
- UAV ► BAV
- QAV ► TAV

AORTIC VALVE REPAIR

n=1832



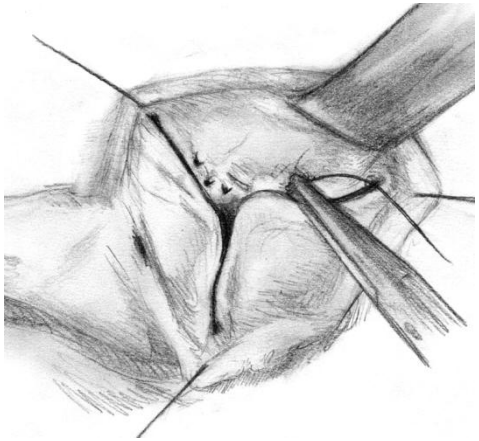
THG



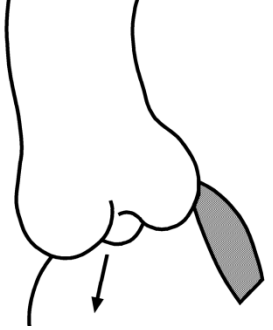
Reconstructive Techniques

Cusp Pathology

Prolapse



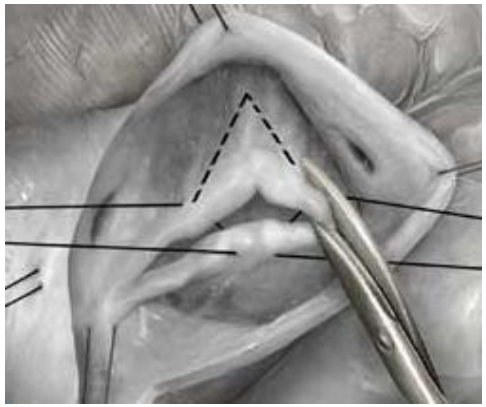
Plication of
Cusp Margin

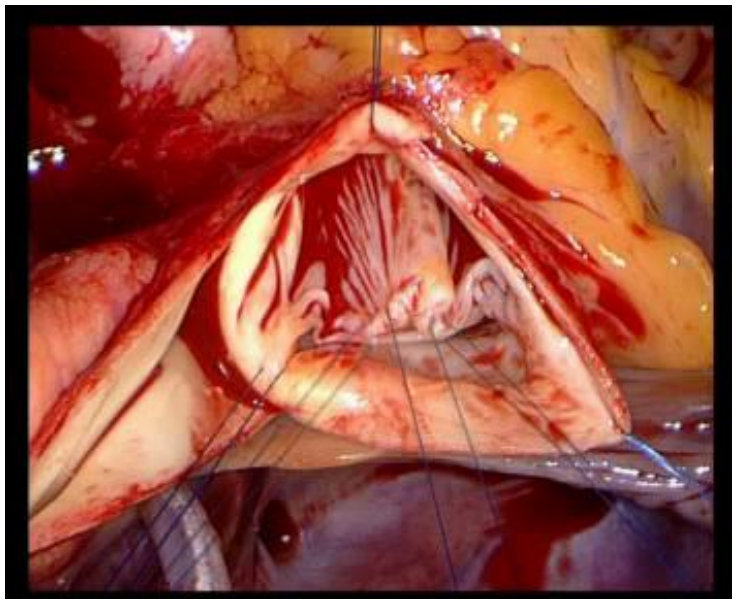


Reconstructive Techniques

Cusp Pathology

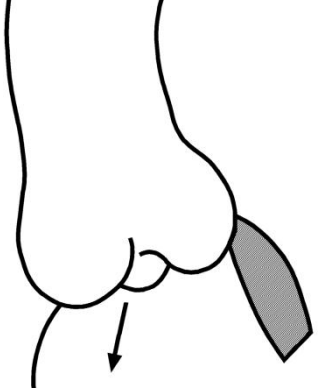
Fibrosis,
Calcium,
Redundancy





Triangular
Resection

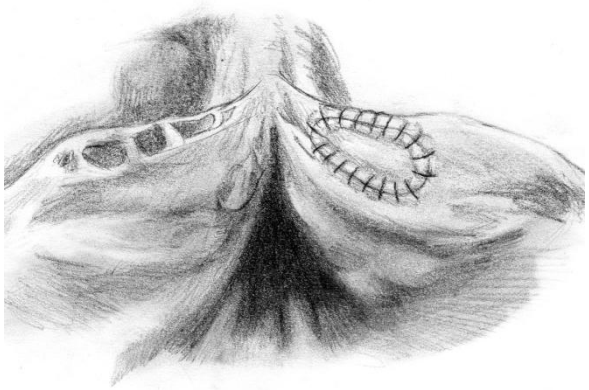
THG



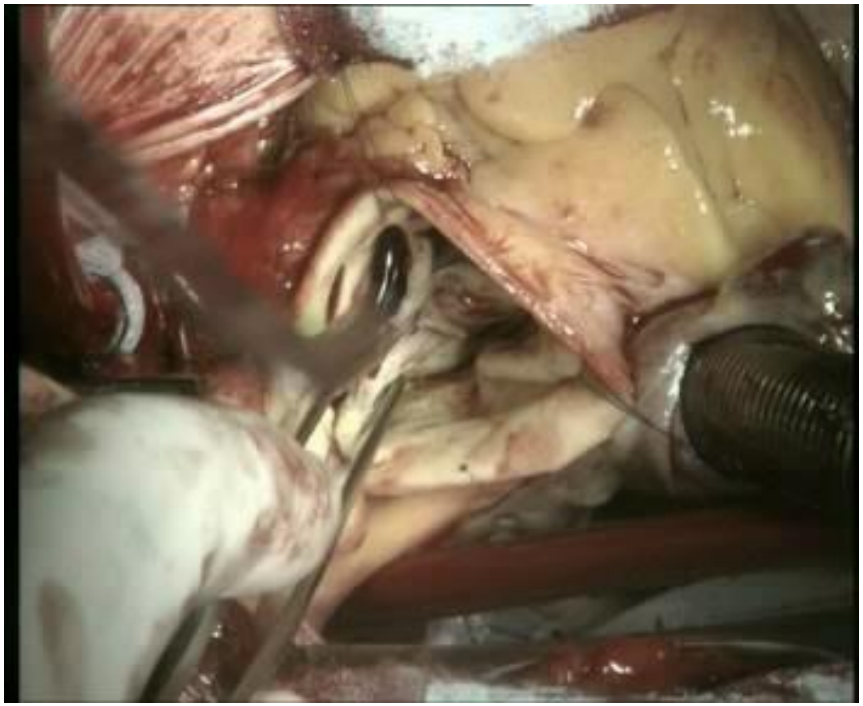
Reconstructive Techniques

Cusp Pathology

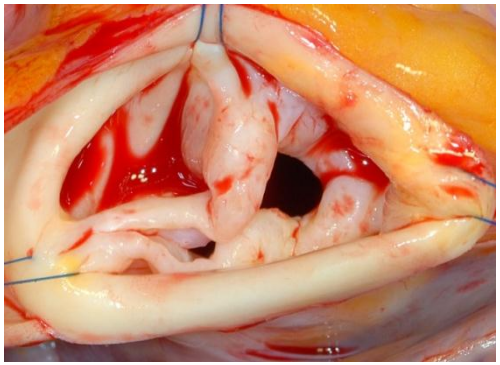
Fenestration

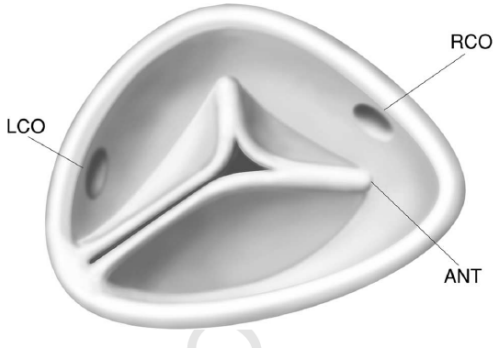


Stabilisation of
cusp (pericardium)

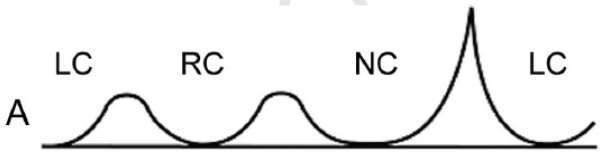


Bicuspidization of the Unicuspid Aortic Valve

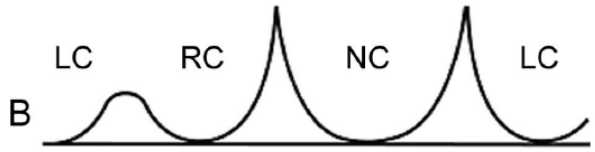




unicuspid



bicuspid



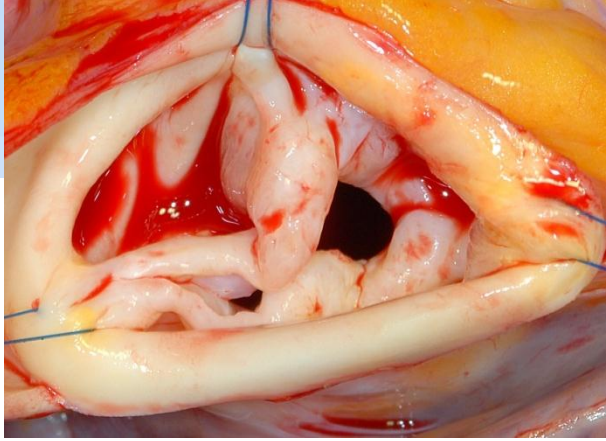
Anderson RA, JHVD 2001

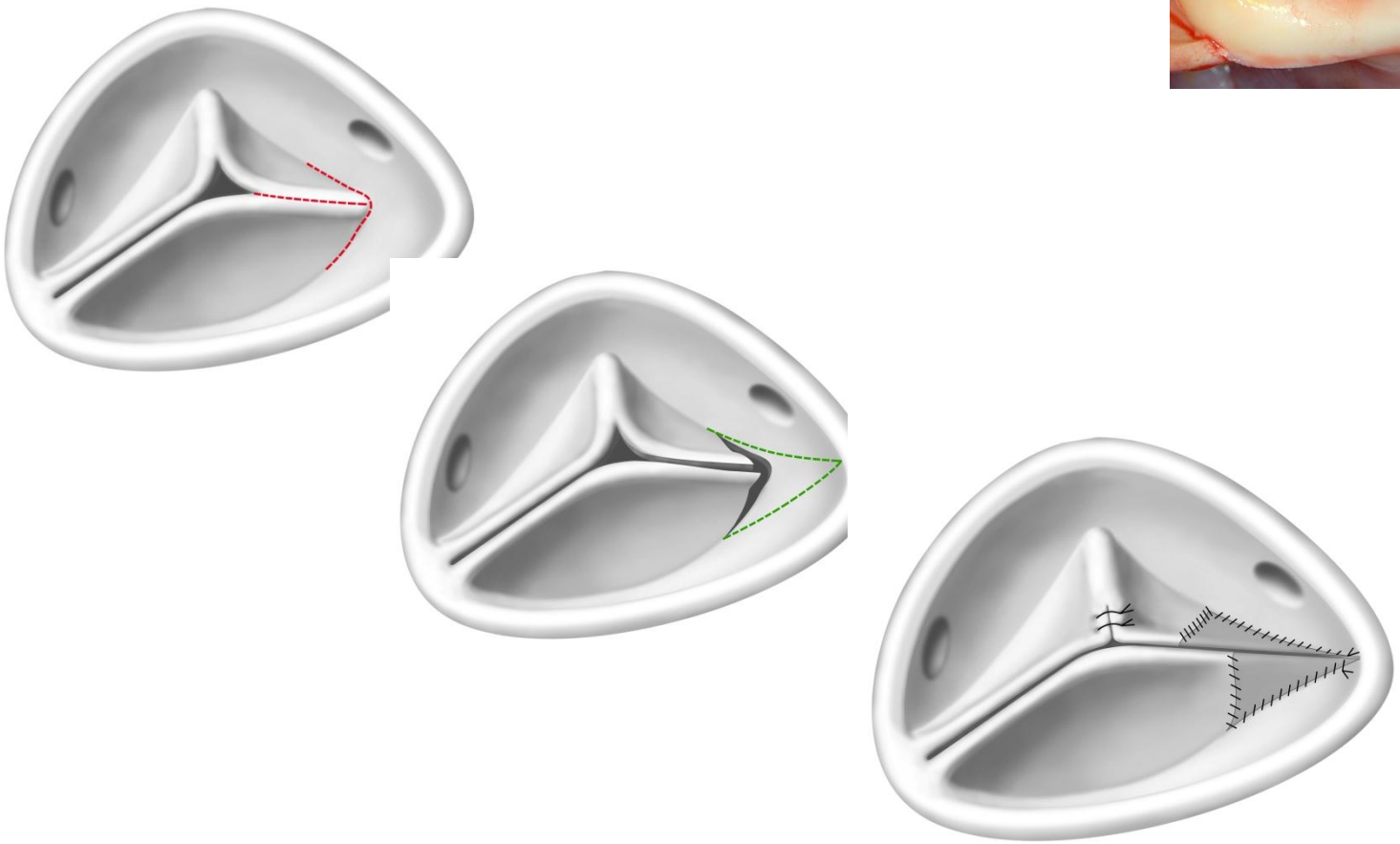
Aortic Valve Anatomy

Morphology	Incidence	Mean Age of Failure
Unicuspid	< 1%	20s
Bicuspid	2%	60s
Tricuspid	97 %(?)	?
Quadricuspid	< 1 %	40s

Roberts WC, Circulation

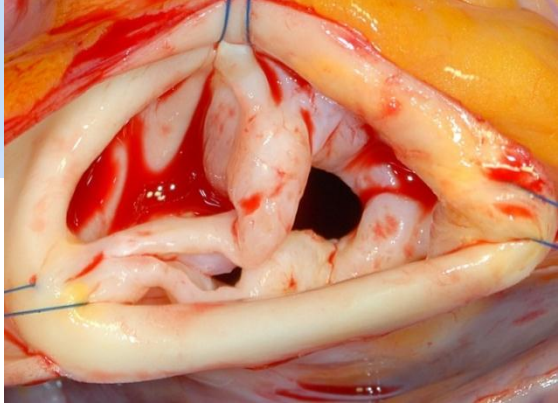
Bicuspidization of the Unicuspid Aortic Valve

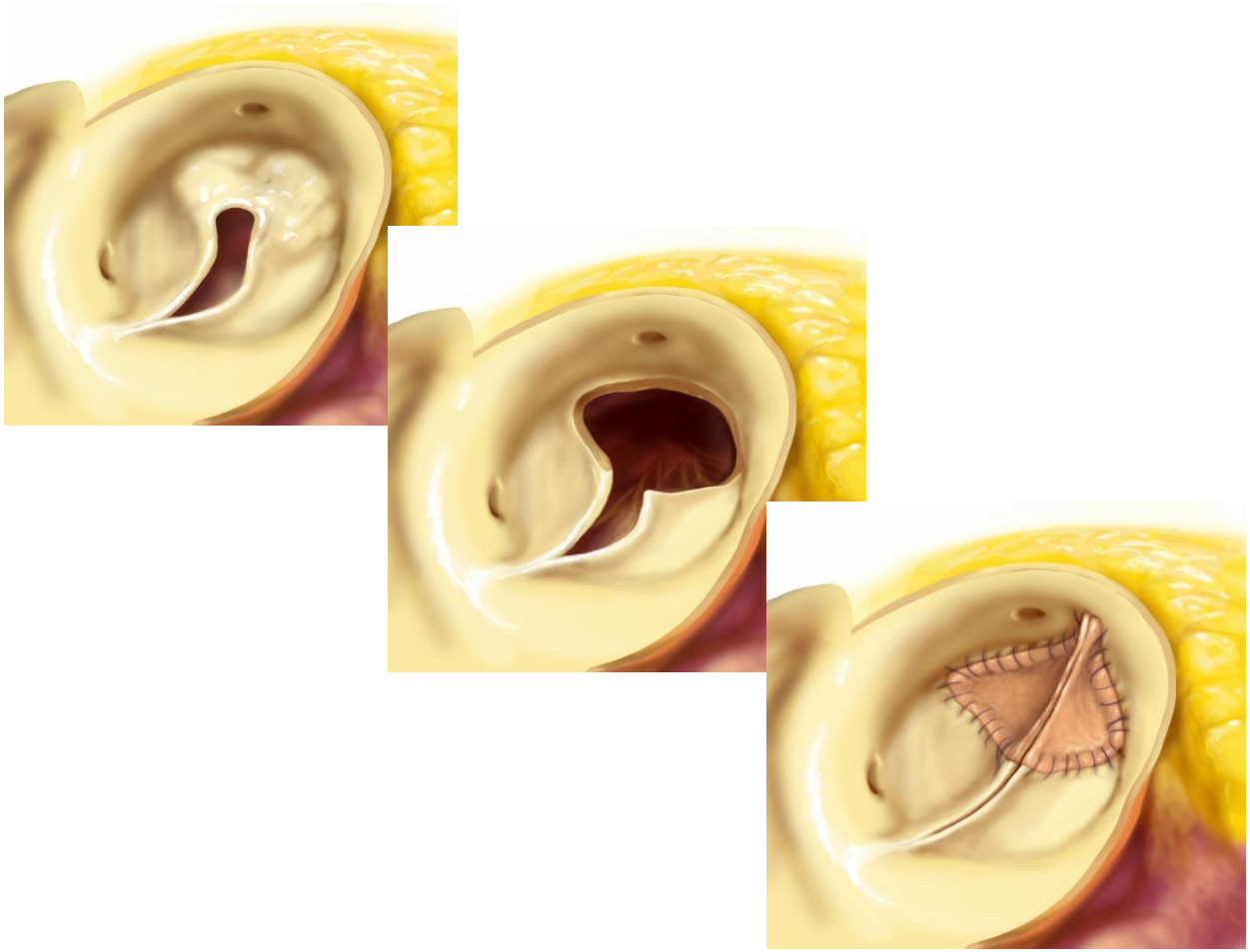


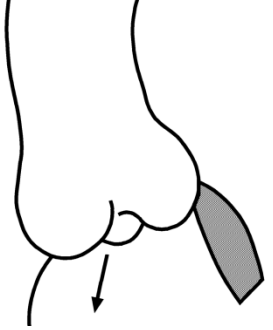


Schäfers HJ, ATS 2008

Bicuspidization of the Unicuspid Aortic Valve II



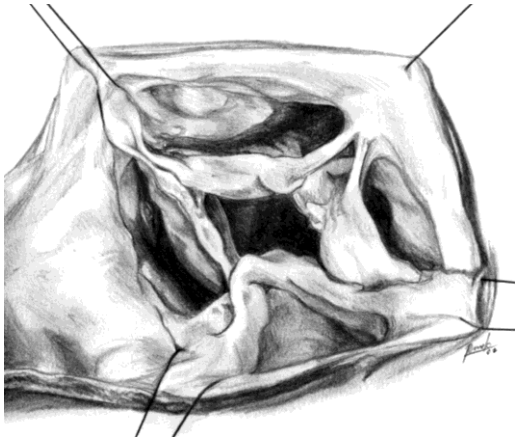




Reconstructive Techniques

Cusp Pathology

Anomaly



Conversion of configuration

Schmidt et al., Ann Thorac Surg 2007

Standardized Aortic Valve Repair

1. No relevant calcification,
   geometric cusp height > 17-20 mm

<u>Decision for valve preservation</u>

2. Sinus diameter > 40 -45 mm
   (and /or BAV < 150° ?)

<u>Root replacement</u>

Standardized Aortic Valve Repair

3. If root + cusp necessary,

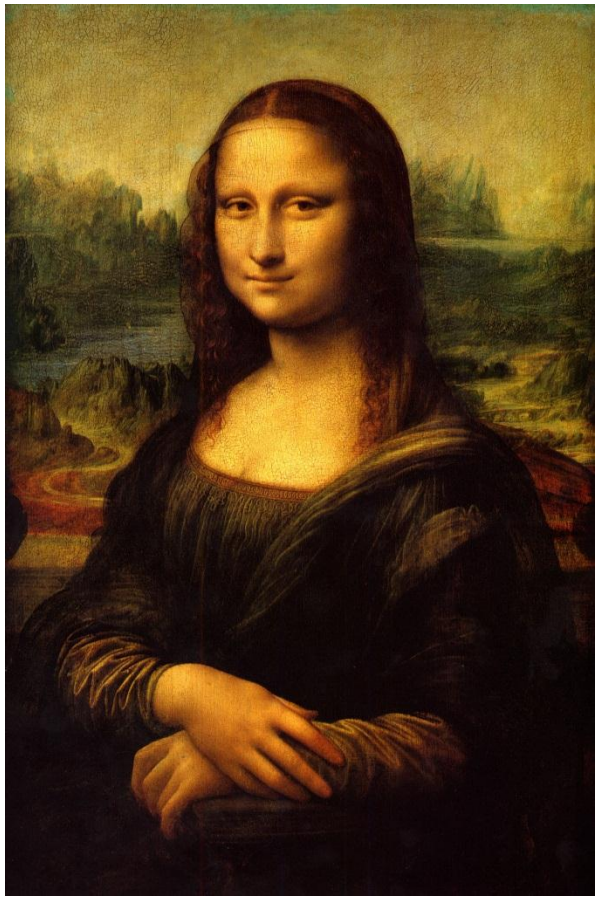
<u>Root repair first (</u>interaction between intercommissural distance and cusp configuration), then

<u>4. Correction of cusp prolapse (eH)</u>

Conclusions

- Systematic analysis + correction of pathologic components
- Many strategies defined
- Normalize cusp configuration (effective height)!
- Specific valve configurations require tailored approach

Aortic Valve Reconstruction




Thank you for your attention