Aortic Valve Repair – a Modular and Geometric Approach

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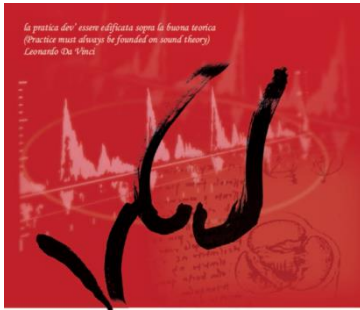

Repair-oriented classification of aortic insufficiency: Impact on surgical techniques and clinical outcomes

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

Objectiv aortic dis strategy a valve repa

Methods age – 54 hundred f had type I

Results: I pair. Func technique 47 [29–7: 95 ± 3% and from 9%; 93 ±

Conclusi functiona niques rec tion, is an

Limitations:

Purely echocardiographic, does not directly relate to morphology/pathology

Does not provide morphologic cut-offs for decision making

Insensitive in defining cusp prolapse in presence of marked aortic dilatation

Type III does not differentiate between restricion due to aortic dilatation and restriction due to cusp degeneration/retraction

Causes of Aortic Regurgitation

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.)

Ac
Aor
Co
My
Rh
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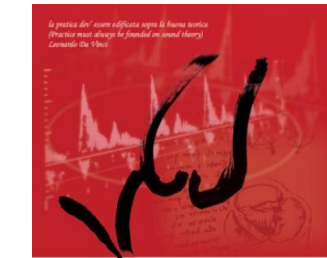
Ca

Cusp pathology



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

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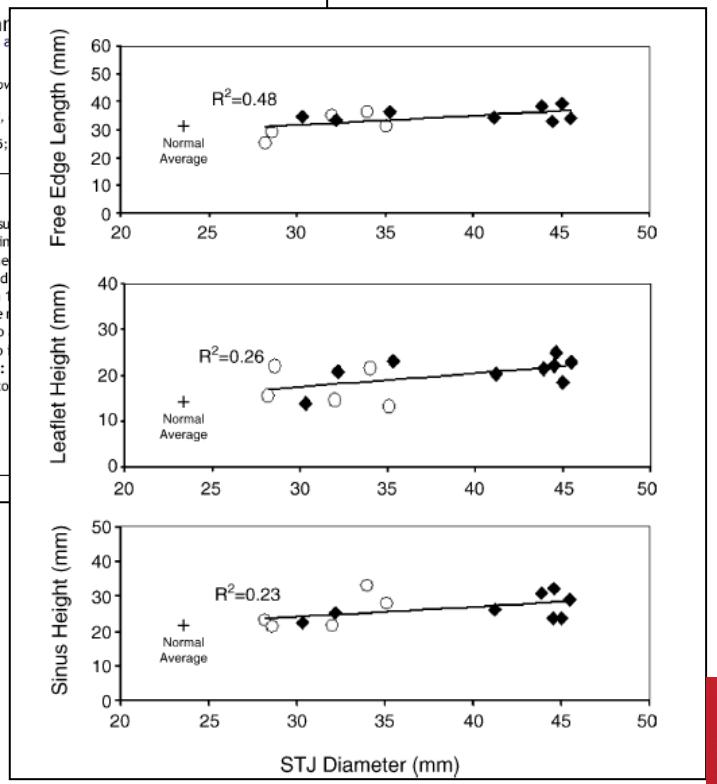
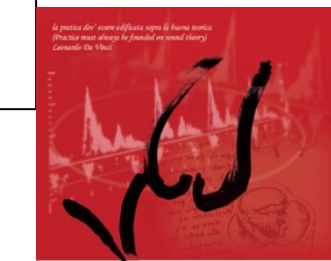
Received 22 June 2005; received in revised form 20 August 2005; accepted 18 September 2005;

Abstract

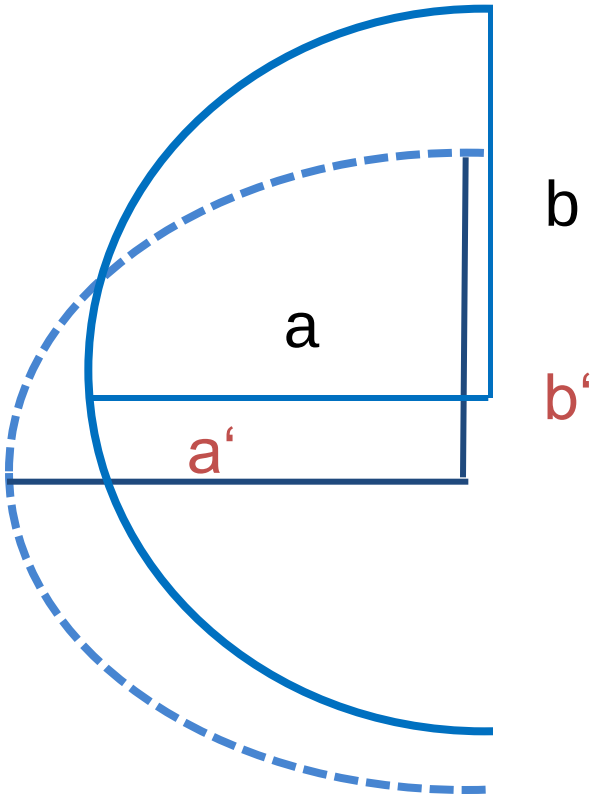
Objective: Valve-sparing surgery can be used in patients with dilated aortic roots and aortic insu
practice, in part because the spared valve may be incompetent. Our goal was to study how the din
changed in such patients. **Methods:** Fourteen patients with dilated aortic root and AI were examine
annulus 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 n
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.

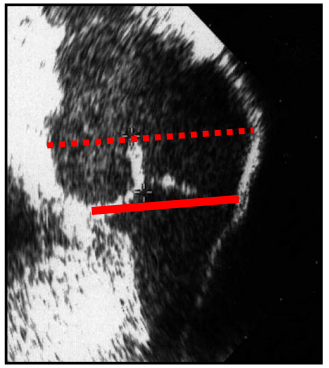
Keywords: Aortic valve; Aortic root; Leaflets; Dimensions; Aneurysm; Insufficiency





Reduction of STJ and Cusp Prolapse



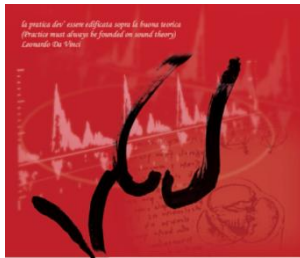


$$C_E = \pi \times \left[3/2 \times (a+b) - \sqrt{a \times b}\right]$$

$b \approx r_{aorta}$

$a \approx r_{cusp}$

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

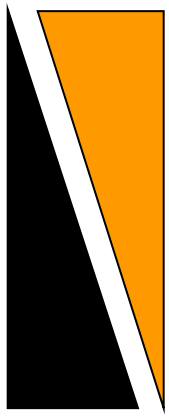


Standardized Aortic Valve Repair

1. Assessment

2. Correction

Root pathology



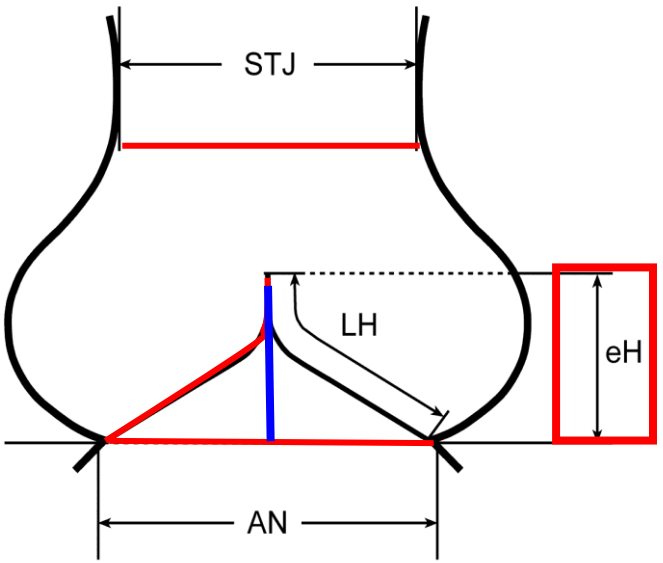
Valve morphology
Cusp pathology

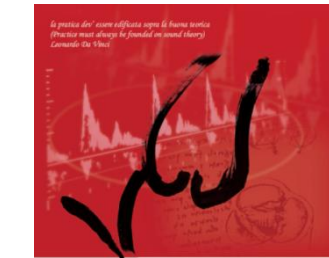
Geometric Determinants of AV Form

ST diameter
Commissural height (?)

Geometric cusp height (LH)
Effective cusp height (eH)

Sinus diameter (?)
Annular diameter

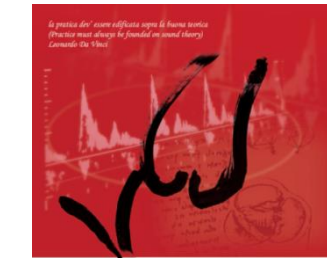




Standardized Aortic Valve Repair

1. Assessment root
2. Assessment cusps

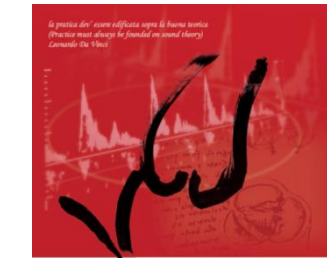
3. Correction root
4. Correction cusps



1. Root Assessment

Echo:
Maximum sinus diameter ► >40 / 45 mm?
ST diameter ► >35 (?)
Annular diameter (?)

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



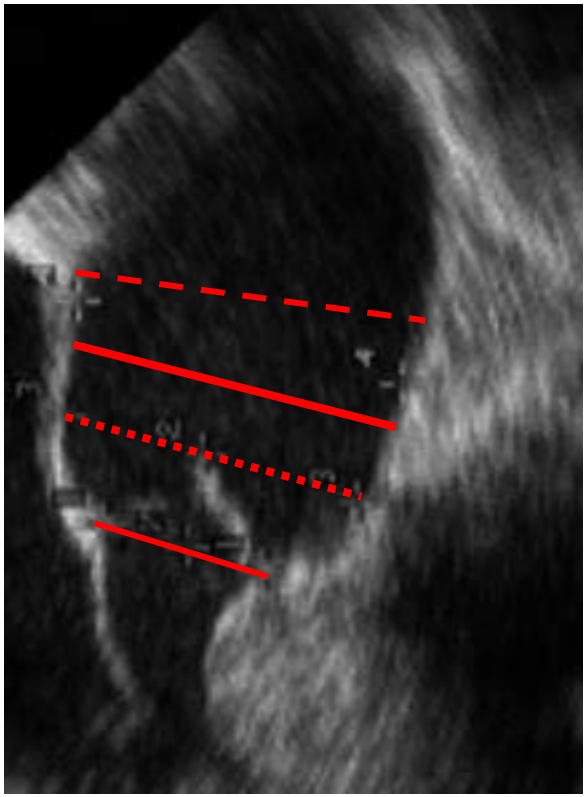
AI und TTE/TEE

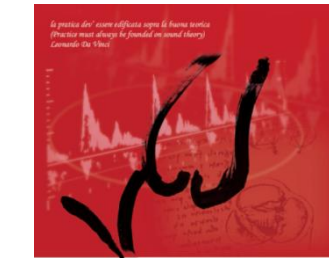
Root dimensions

AV morphology (bi-/tricuspid)

Prolapse

Calcification?





2. Cusp Assessment

Echo:

Valve morphology?

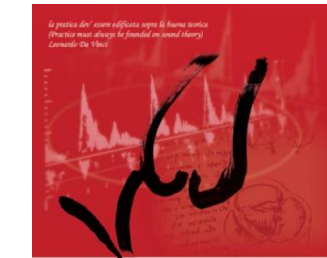
Eccentricity of jet?

Intraoperative:

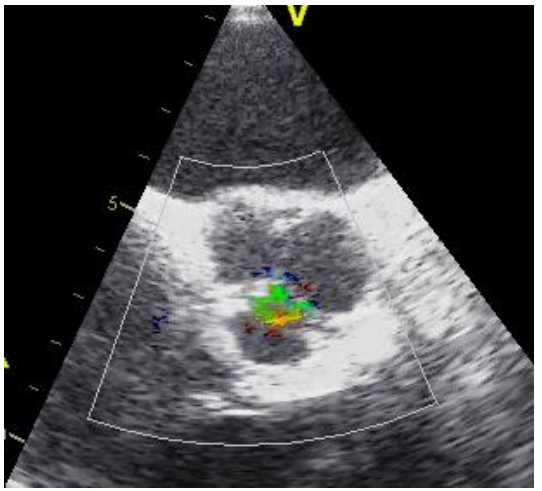
Valve Morphology?

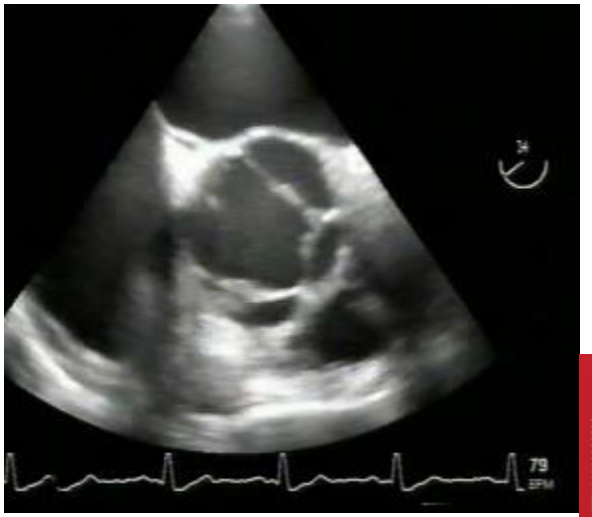
Cusp height/configuration?

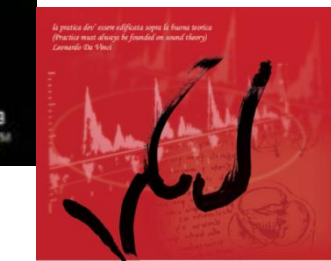
Cusp substance?



Valve Morphology







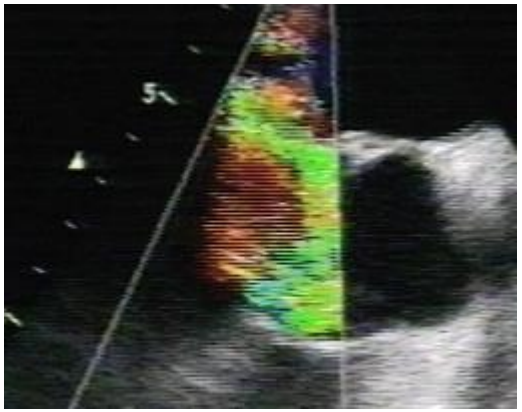
AI und TTE/TEE

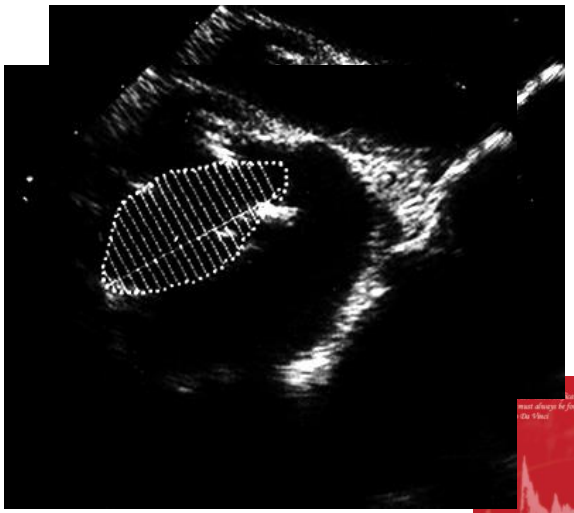
Root dimensions

AV morphology (bi-/tricuspid)

Prolapse

Calcification?



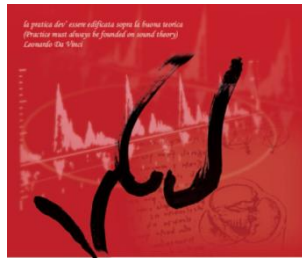


Intraoperative Cusp Assessment

- Morphology (commissural height):
  - Unicuspid
  - Bicuspid
  - Tricuspid
  - Quadricuspid

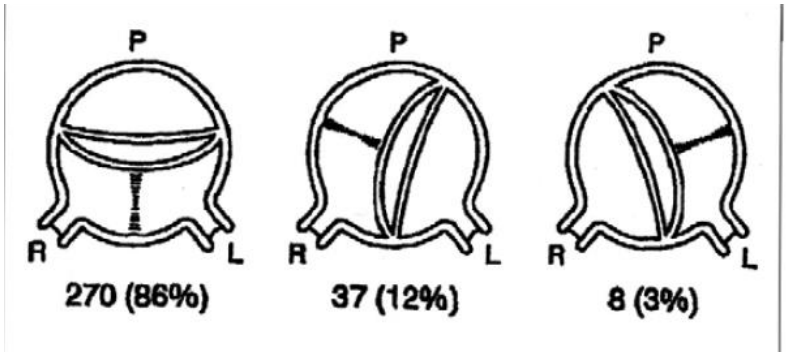
  If non-tricuspid, watch for anatomical variation

- Prolapse?
- Retraction?

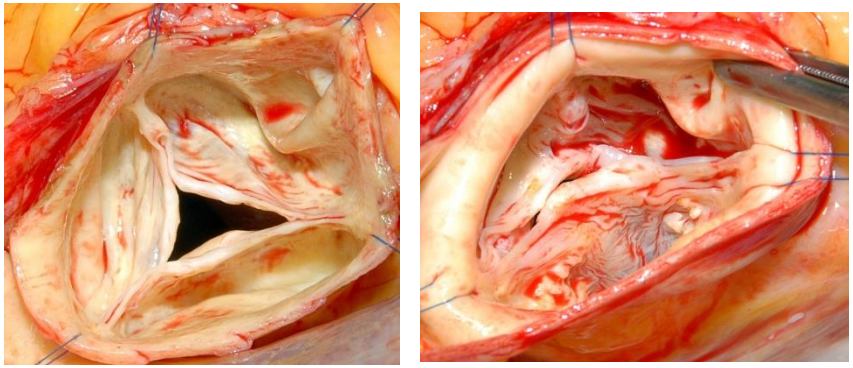


Bicuspid Aortic Valve (BAV) Morphology

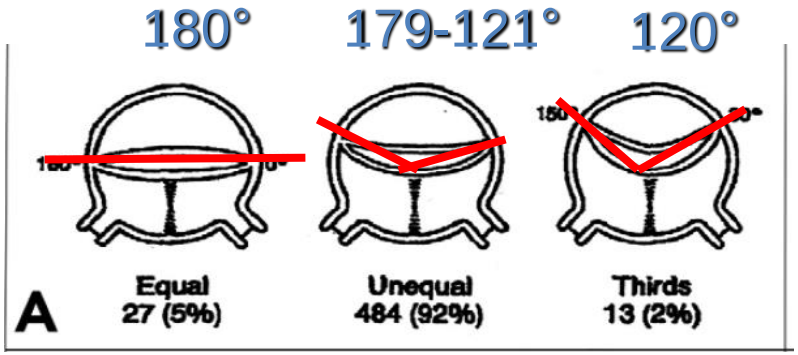
pattern of fusion



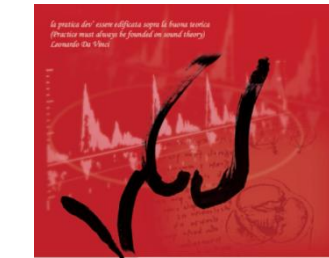
degree of fusion



commissural orientation

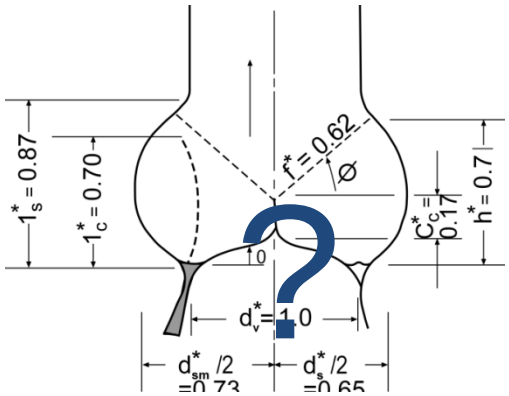


Sabet et al, *Mayo Clin Proc*, 1999;74:14-26

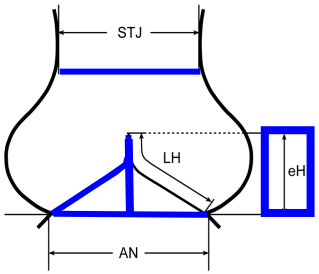


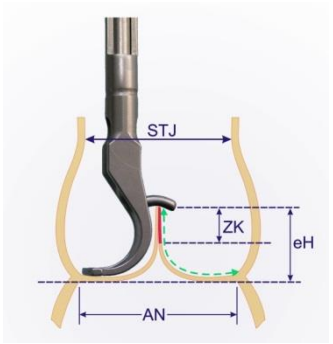
Aortic Valve Repair - Assessment

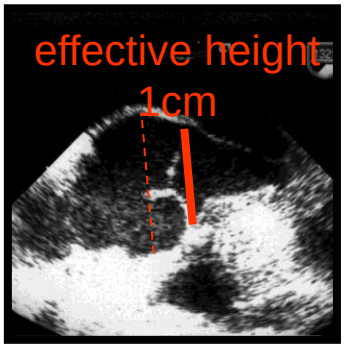
Configuration of cusps



Swanson, Circ Res 1974

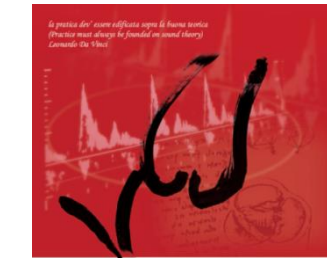




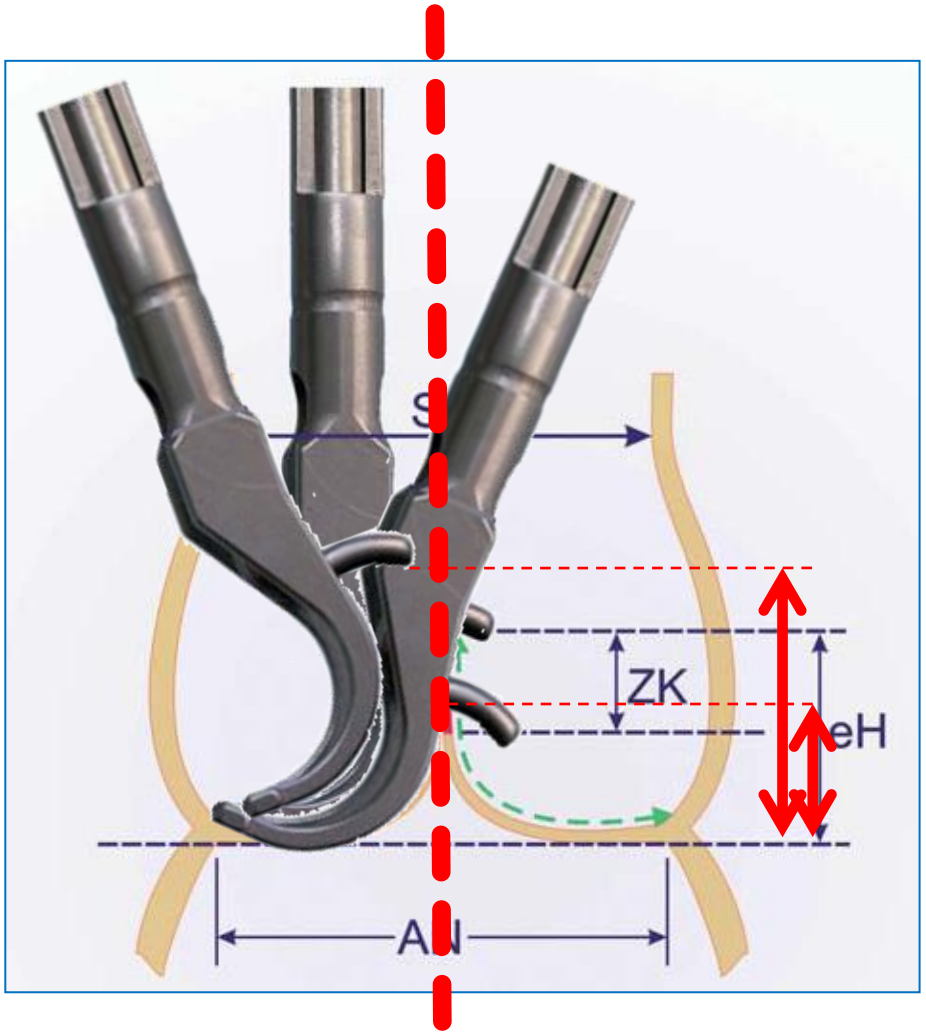


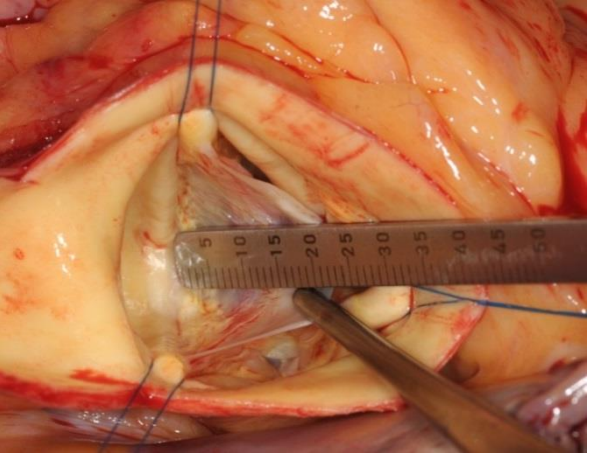
A new approach to the assessment of aortic cusp geometry

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

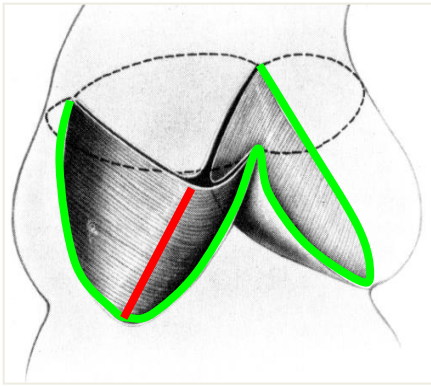


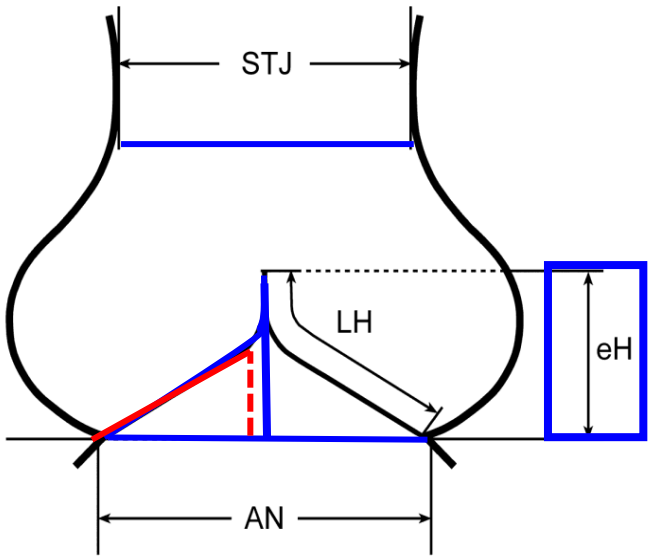
eH Measurement Error

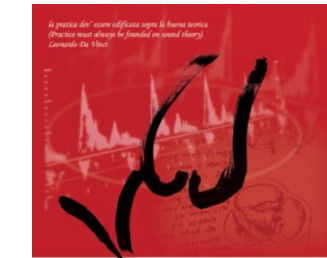




Configurationof cusps

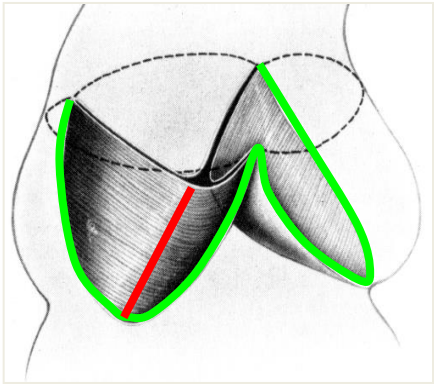


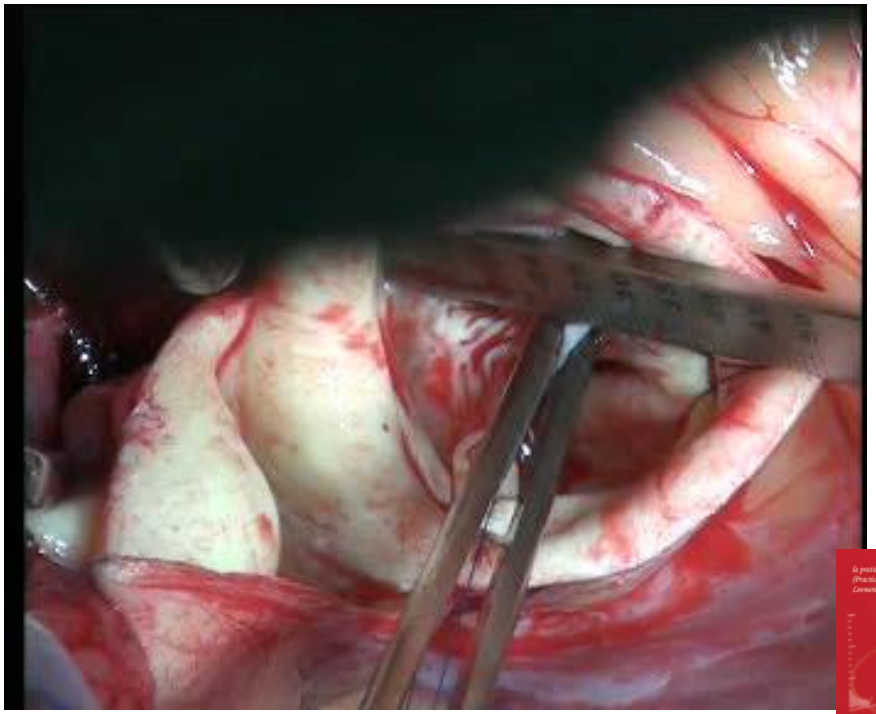




Aortic Valve Repair - Assessment

Configuration/coaptation of cusps





TAV: 18-22 mm
BAV: 20-25 mm

3. Root Correction

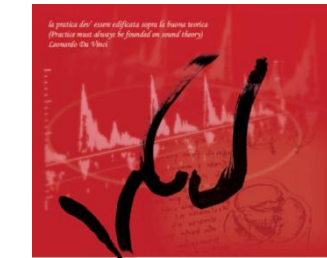
If

Sinus > 40 -45 mm

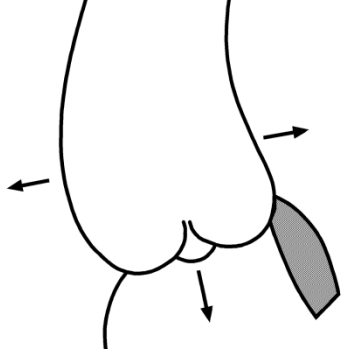
Root remodeling
(Valve reimplantation)

Sinus < 40-45 and STJ > 30-35 mm

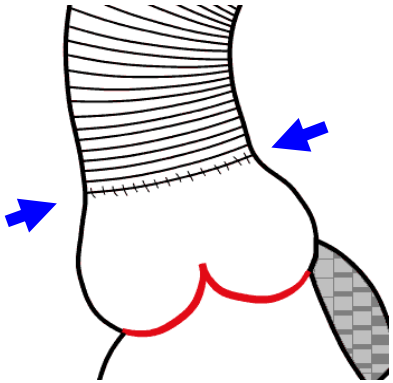
STJ remodeling



Root Repair – Technical Options

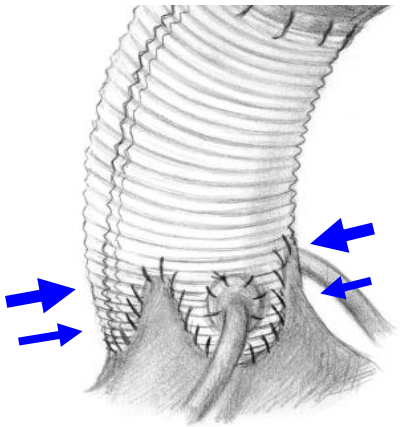


ST Junction Remodelling



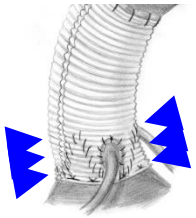
(Frater 1986)
(Sinus < 40-45 mm)

Root Remodeling

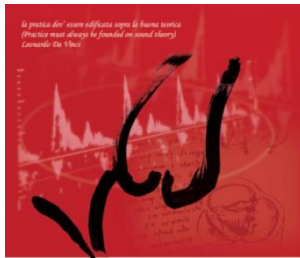


(Yacoub 1993)
(Sinus > 45 mm),

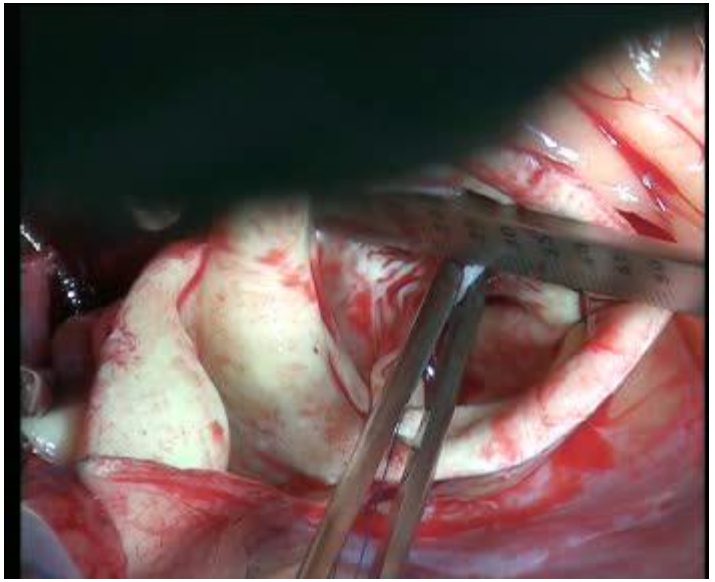
Reimplantation of Aortic Valve



(David 1992)
(AVJ ≥ 30 mm)



Valve Sparing: Our Routine



1. Measure gH and proceed with VPS if gH ≥ 18 mm

2. (Root remodeling)
Take graft according to patient size

BSA	< 1.8 m²	24 mm
	1.8 to 2.2 m²	26 mm
	>2.2 m²	28 mm (?)

if gH ≤ 20 mm consider graft size 2 mm less

4. Cusp Correction

If

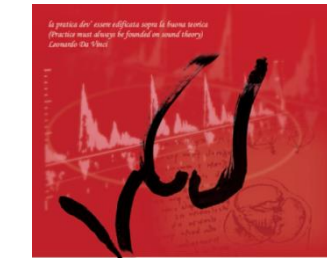
- prolapse (eH ≤ 8 mm)
- structural defect
- anatomical variant

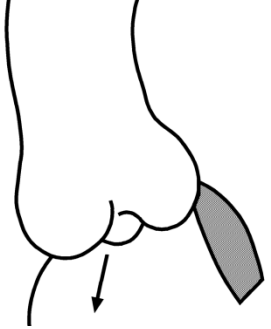
Plication of free margin / triangular resection

Patch correction

Conversion of anatomy (accept BAV, TAV)

- UAV ► BAV
- QAV ► TAV

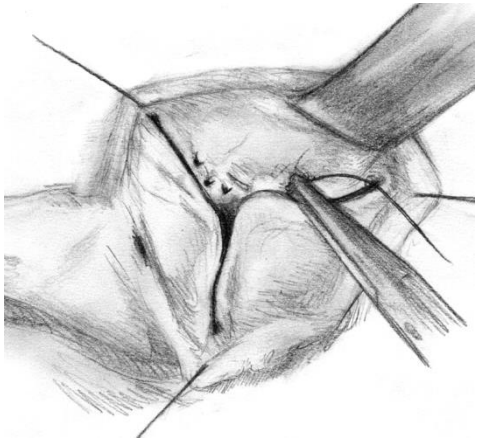




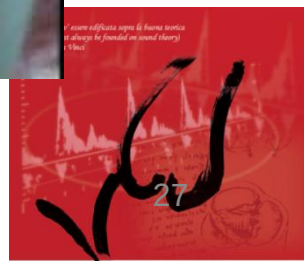
Reconstructive Techniques

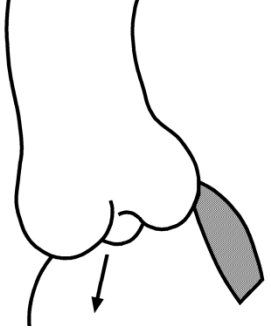
Cusp Pathology

Prolapse



Plication of
Cusp Margin

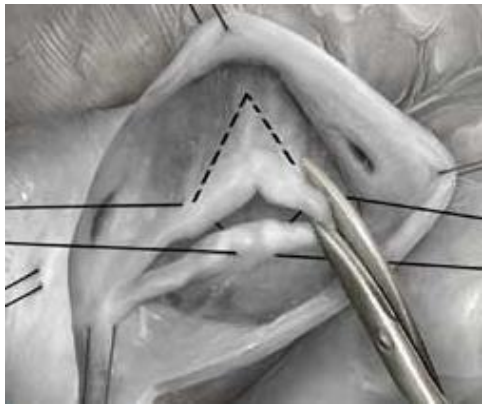




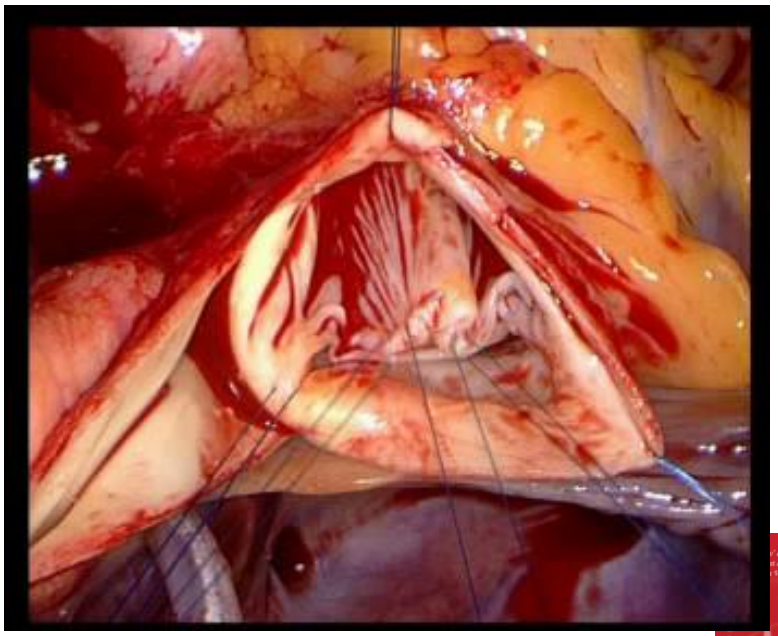
Reconstructive Techniques

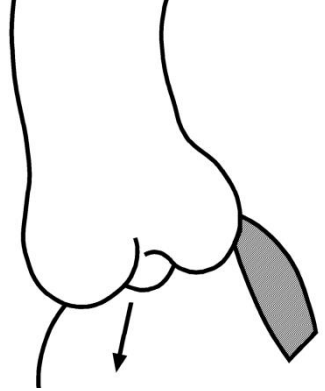
Cusp Pathology

Fibrosis,
Calcium,
Redundancy



Triangular
Resection

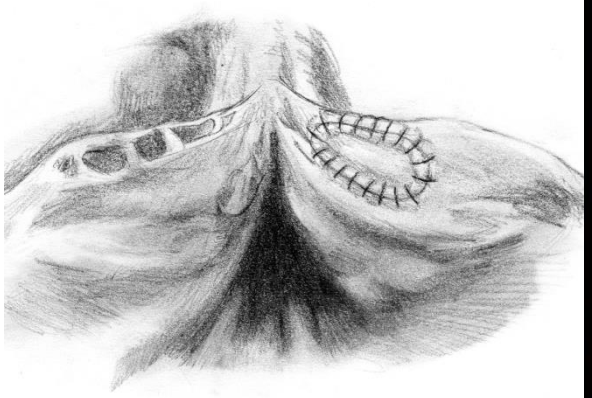




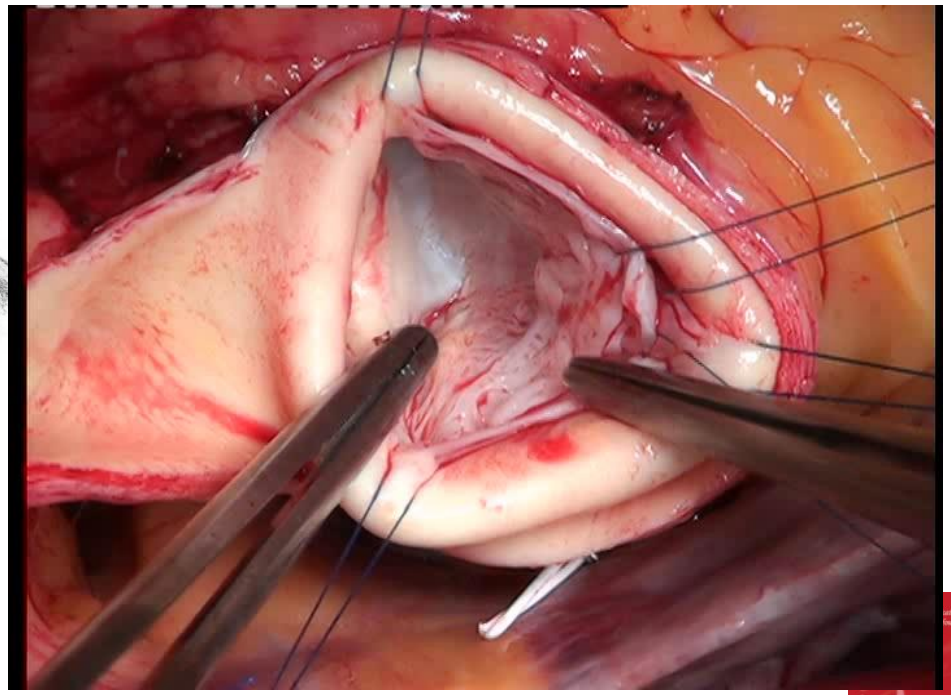
Reconstructive Techniques

Cusp Pathology

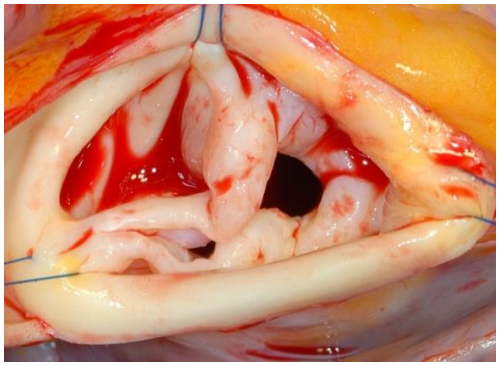
Fenestration

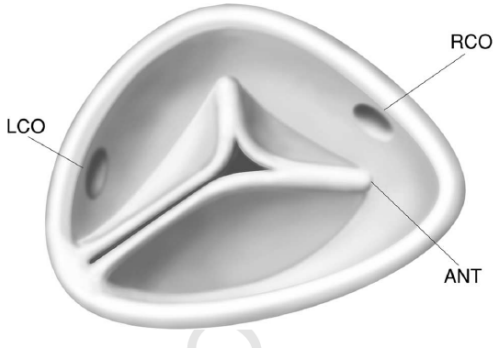


Stabilisation of cusp (pericardium)

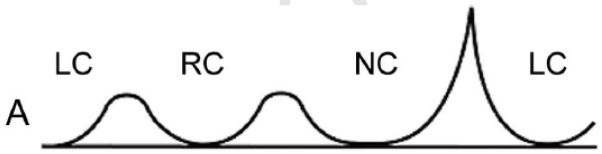


Bicuspidization of the Unicuspid Aortic Valve

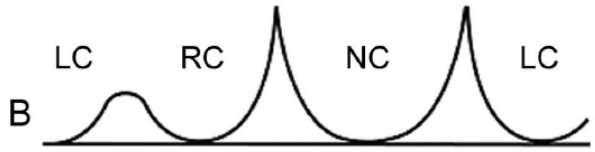




unicuspid



bicuspid

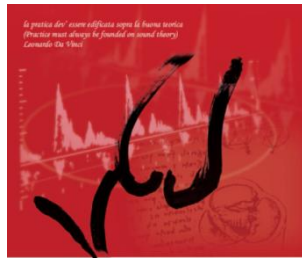


Anderson RA, JHVD 2001

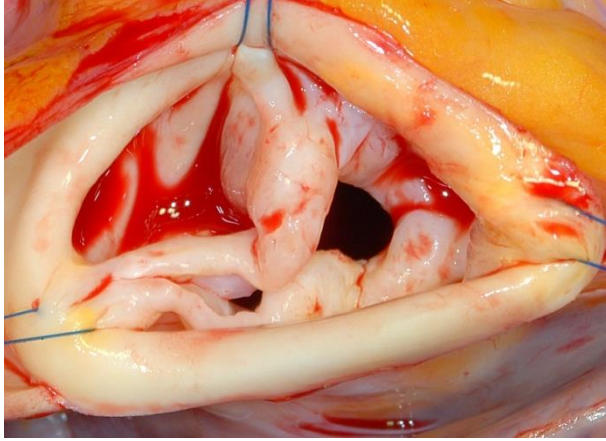
Aortic Valve Anatomy

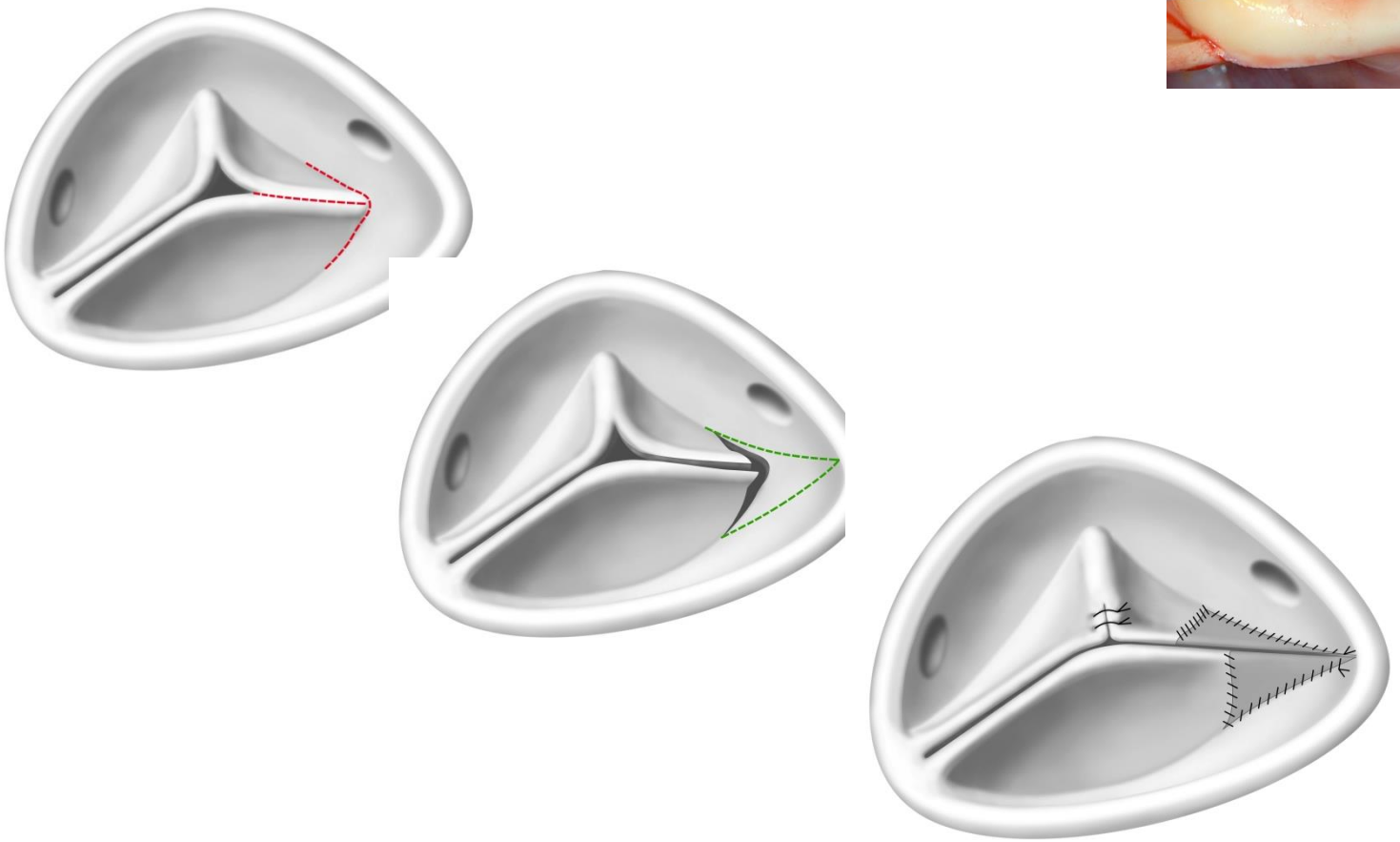
Morphology	Incidence	Mean Age of Failure
Unicuspid	< 1%	20s
Bicuspid	2%	60s
Tricuspid	97 %(?)	?
Quadricuspid	< 1 %	40s

Roberts WC, Circulation 2005

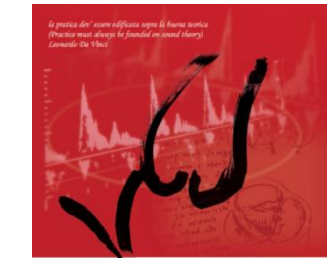


Bicuspidization of the Unicuspid Aortic Valve

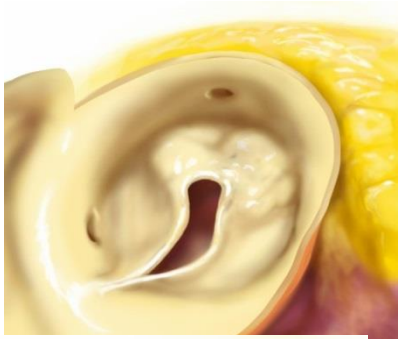


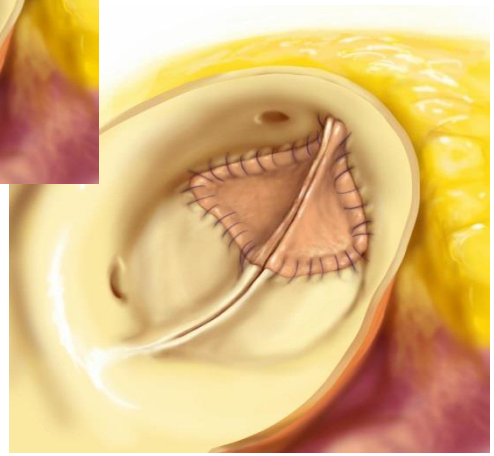


Schäfers HJ, ATS 2008

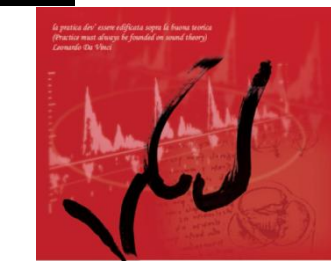


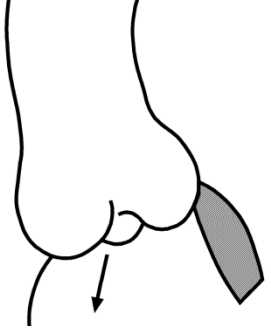
Bicuspidization of the Unicuspid Aortic Valve II





UAV - Design II

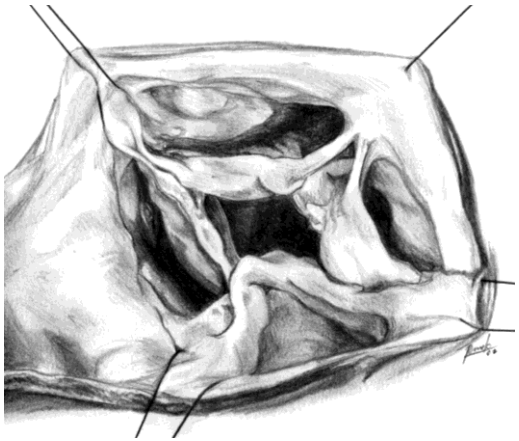




Reconstructive Techniques

Cusp Pathology

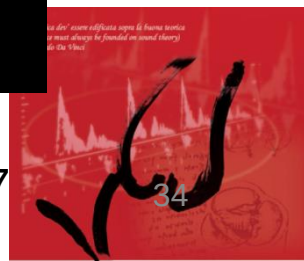
Anomaly



Conversion of configuration

Quadricuspid AV

Schmidt et al., Ann Thorac Surg 2007

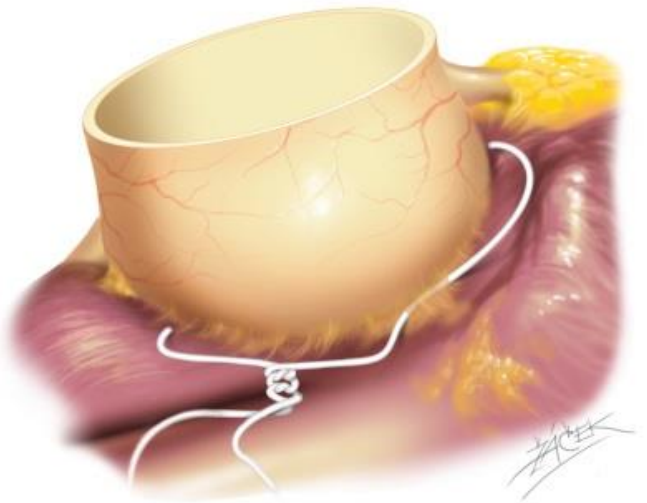


Annuloplasty

If

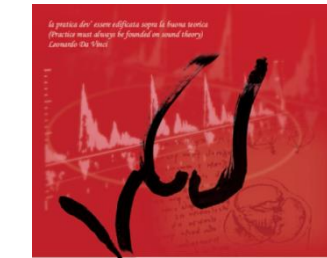
basal diameter > 26-27 mm

Annular reduction

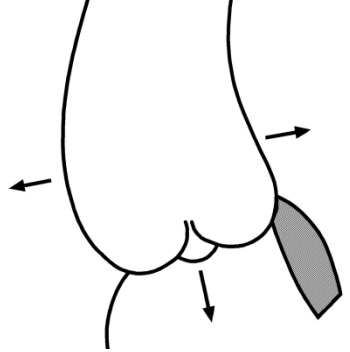


- ► 25 mm for BSA > 2 m²
- ► 23 mm for BSA < 2 m²

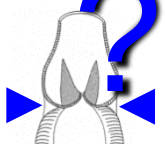
Reduce by 2 mm for
gH < 19 (TAV) / 22 (BAV) mm



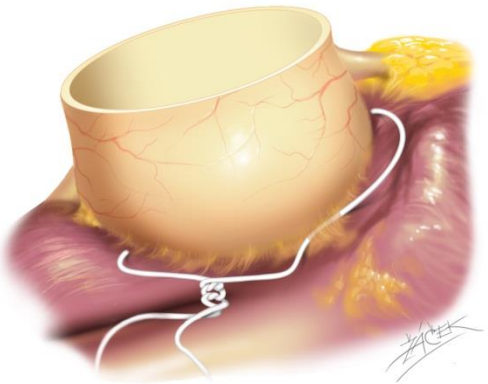
Annuloplasty

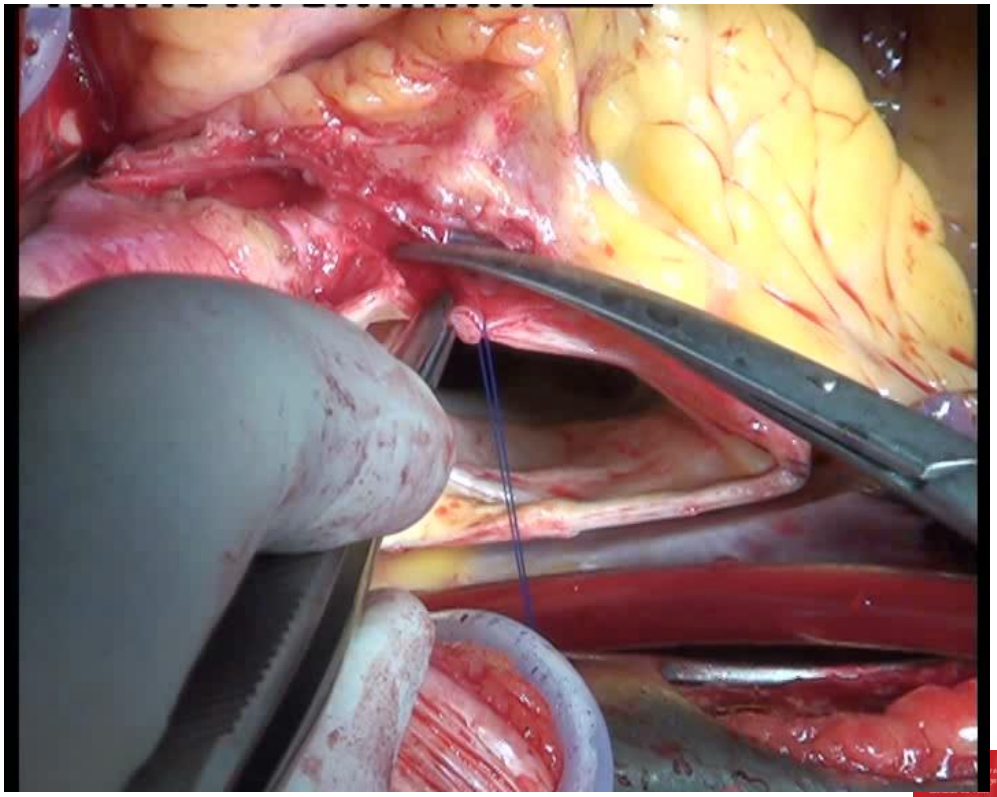


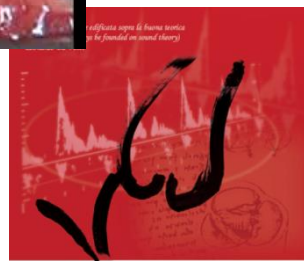
Subcommissural Plication



(Cabrol 1966)







In a Nutshell:

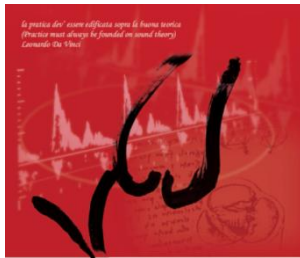
Standardized Aortic Valve Repair

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

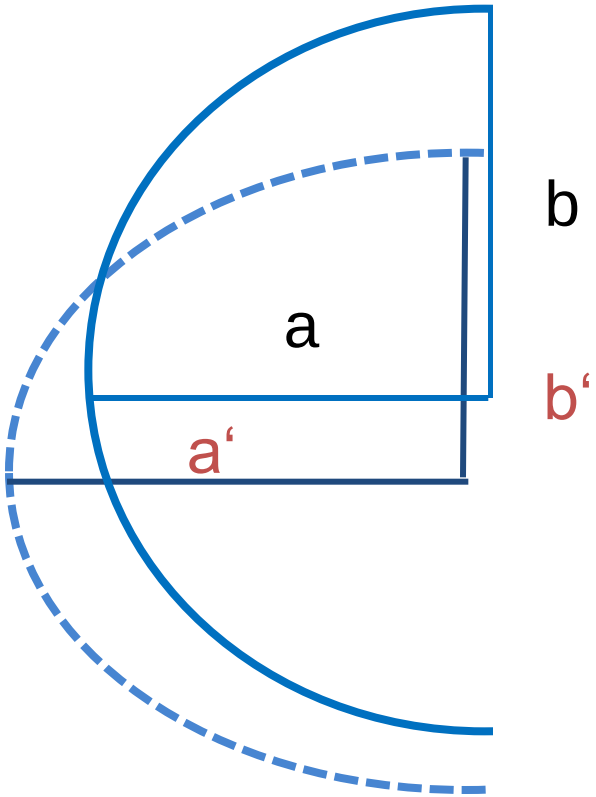
→ Decision for valve preservation

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

→ Root replacement



Reduction of STJ and Cusp Prolapse

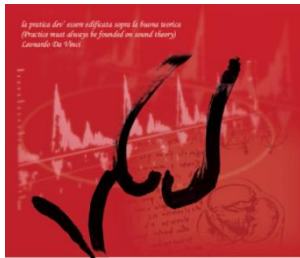


$$C_E = \pi \times \left[3/2 \times (a+b) - \sqrt{a \times b}\right]$$

$b \approx r_{aorta}$

$a \approx r_{cusp}$

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



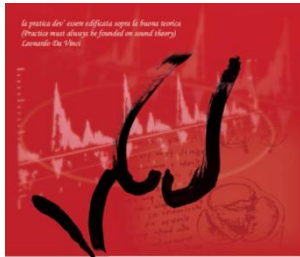
In a Nutshell:
Standardized Aortic Valve Repair

3. No root enlargement

→ Isolated cusp repair

4. Annular diameter > 26-27 mm
   (or gH < 20 in TAV, < 22 in BAV)

→ Annuloplasty



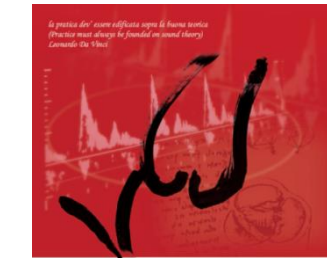
Standardized Aortic Valve Repair

5. If root + cusp necessary,

→ Root repair first (interaction between intercommissural distance and cusp configuration)

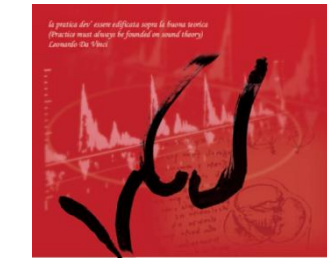
Annular stabilization as needed (AI, durability)

6. Correction of cusp prolapse (eH)



Conclusions

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



econstruction

Dear Prof. Schäfers
Thanks for your help. … In the last two weeks, we had performed 8 cases of aortic valve repair following with your technique.

All the patients had a good results after operation by TEE, including with 4 cases of David Procedure with cusp repair.
…
W.D., MD, PhD