## The Evidence for Annuloplasty in Aortic Repair

## Ehud Raanani, MD

Cardiothoracic Surgery, Sheba Medical Center "Sackler" School of Medicine, Tel Aviv University

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The Leviev Heart Center

## Outilne

- Anatomical definitions
- Historical perspective
- What are the normal diameters?
- Effect of annular dilatation on the durability of AV repair
- What are the options for annuloplasty?
- Clinical results of annuloplasty
- limitations


## What is the aortic annulus?



## Phenotypes of the ascending aorta



Aortic root aneurysm Valsalva $\geq 45 \mathrm{~mm}$


Supra-coronary aneurysm Valsalva < 40 mm Supracoronary Aorta >45

Isolated AI
Valsalva < 40 mm
Supracoronary Aorta <40

## The surgical correction of aortic insufficiency by circumclusion

Taylor WJ, et al. JTCVS 1958;35:192-231


## First subvalvular aortic annuloplasty Beating Heart Right thoracotomy

11 patients, rheumatic disease $(8 / 11)$

## Subcommissural plication stitches (Cabrol 1966)



Plicating U stitches at the base of the interleaflet triangles

## partial subvalvular annuloplasty

Cabrol C, Treatment of aortic insufficiency
by means of aortic annuloplasty. Arch Mal Coeur Vaiss 1966;59:1305-12.

## Aortic annuloplasty for isolated AI External and Internal



Carpentier 1983


Frater 1986


Haydar 1997


Izumoto
2002


Lansac
2007


Schäfers 2009


Fattouch 2011

## Effect of annulus diameter

$\square$ Six geometries with different annulus diameters
$\square$ Calculated by expanding or shrinking the AA of normal case ( 24 mm )
$\square$ The other dimensions were not changed


## Influence of the geometry on coaptation





## Coaptation vs. effective height

$\square$ Comparison of coaptation during diastole as a function of the effective height
$\square$ The effective height correlates well with valve coaptation
$\square$ The cusps in all the cases with $h_{\mathrm{E}}<9 \mathrm{~mm}$ prolapsed during diastole



## Restore Normal Root Geometry



Kunzelman K, 1994

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

Takashi Kunihara, MD, PhD, ${ }^{\text {a }}$ Diana Aicher, MD, ${ }^{a}$ Svetlana Rodionycheva, MD, ${ }^{\text {a }}$ Heinrich-Volker Groesdonk, MD, ${ }^{\text {a }}$ Frank Langer, MD, ${ }^{\text {a }}$ Fumihiro Sata, MD, PhD, ${ }^{\text {b }}$ and Hans-Joachim Schäfers, MD, PhD ${ }^{\mathrm{a}}$
1995-2009, 401 remodeling, 29 re-implantation (24 marfan pts)

## Stratified by AVJD



The Journal 'B Postoperative years

# Effect of annulus dimension and annuloplasty on bicuspid aortic valve repair ${ }^{+}$ 

Emiliano Navarra ${ }^{a}$, Gebrine El Khoury ${ }^{\text {a }}$, David Glineura ${ }^{\text {a }}$, Munir Boodhwanid, Michel Van Dyck ${ }^{\text {c }}$, Jean-Louis Vanoverschelde ${ }^{\text {b }}$, Philippe Noirhomme ${ }^{\text {a }}$ and Laurent de Kerchove ${ }^{\text {a,* }}$

${ }^{a}$ Division of Cardiothoracic and Vascular Surgery, Cliniques Universitaires Saint-Luc, Université Catholique de Louvain, Brussels, Belgium
${ }^{\text {b }}$ Division of Cardiology, Cliniques Universitaires Saint-Luc, Université Catholique de Louvain, Brussels, Belgium
${ }^{\text {c }}$ Division of Anesthesiology, Cliniques Universitaires Saint-Luc, Université Catholique de Louvain, Brussels, Belgium
${ }^{d}$ Division of Cardiac Surgery, University of Ottawa Heart Institute, Ottawa, ON, Canada

* Corresponding author. Division of Cardiothoracic and Vascular Surgery, CliniquesUniversitaires St-Luc, Avenue Hippocrate 10, 1200 Brussels, Belgium. Tel: +3-22-7646113; fax: +003-22-7648960; e-mail: laurent.dekerchove@uclouvain.be (L de Kerchove).




## Internal



## External


root replacement

## BAV repair (SCA) with dilated annulus (> 27mm): fails in short term



Valve snarino-ront renlacement with the reimnlantation techninne to incre

TABLE 2. Early postoperative outcomes within matched groups

Laurent
Jean-Lo
Postoperative outcomes
Mortality
Reoperation for bleeding
Aortic valve reoperation
Permanent pacemaker insertion
Stroke or transient ischemic attack
Discharge echocardiography*
Aortic insufficiency grade

C

$$
\begin{array}{cc}
26(53 \%) & 32(62 \%) \\
20(41 \%) & 19(36 \%) \\
3(6 \%) & 1(2 \%)
\end{array}
$$

| 0 | $26(53 \%)$ | $32(62 \%)$ |  |
| :---: | :---: | :---: | :---: |
| 1 | $20(41 \%)$ | $19(36 \%)$ | .46 |
| 2 | $3(6 \%)$ | $1(2 \%)$ |  |

Peak gradient

| $\leq 20 \mathrm{~mm} \mathrm{Hg}$ | $25(51 \%)$ | $42(81 \%)$ |  |
| :--- | :---: | :---: | :---: |
| $21-30 \mathrm{~mm} \mathrm{Hg}$ | $14(29 \%)$ | $7(13 \%)$ | .006 |
| $>30 \mathrm{~mm} \mathrm{Hg}$ | $10(20 \%)$ | $3(6 \%)$ |  |

All data represent numbers and percentages of patients. *Early reoperation excluded.

## Computer Finite Element Model Stress during peak systole

- TAV has the largest opening area
- Highest stress values are found in BAVs with fused cusps
- Raphe region increases stress magnitudes



BAV no. 1 without raphe


## 180응



## Geometric ring annuloplasty as an adjunct to aortic valve repair: clinical investigation of the HAART 300 device

 Steffen Pfeiffer ${ }^{\text {b }}$, Jan Pirk', Christian Detter ${ }^{\text { }}$, Johannes Kroll ${ }^{\text {h, }}$, Friedhelm Beyersdorf ${ }^{\text {h }}$, Charles D. Griffini, Malakh Shresthá, Christian Nöbauera, Philip S. Crooke ${ }^{k}$, Christian Schreiber ${ }^{\text {a }}$ and Rüdiger Lange ${ }^{\text {a }}$


$\begin{array}{llllllll}\text { At Risk } & 65 & 65 & 65 & 49 & 22 & 12 & 3\end{array}$

## Expensible band (Lansac 2006)



## Surgical Anatomy of the Aortic Annulus: Landmarks for External Annuloplasty in Aortic Valve Repair

Nizar Khelil, MD, Ghassan Sleilaty, MD, Michele Palladino, MD, Mahmoud Fouda, MD, Remi Escande, MD, Mathieu Debauchez, MD, Isabelle Di Centa, MD, and Emmanuel Ld

20
(Ann Thorac Surg 2015;99:1220-7)

## Remodeling root repair with an external aortic ring annuloplasty

Emmanuel Lansac, MD, PhD, ${ }^{\text {a }}$ Isabelle Di Centa, MD, ${ }^{\mathrm{b}}$ Ghassan Sleilaty, MD, ${ }^{\mathrm{a}}$ Stephanie Lejeune, MS, ${ }^{\text {a }}$ Alain Berrebi, MD, ${ }^{\text {a }}$ Pavel Zacek, MD, PhD, ${ }^{\text {c }}$ and Mathieu Debauchez, MD ${ }^{\text {a }}$

(J Thorac Cardiovasc Surg 2017;153:1033-42)

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

Takashi Kun
Heinrich-Vol
Hans-Joachiı

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Freedom from AR \geq II in
cases with AVJD > 28mm
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$P=0.006$


A
Postoperative years
B Postoperative years

## PTFE Annuloplasty Kazui, Svensson, Schäfers 2007



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

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

Isolated Valve Repair

## Immediate



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

## Root Remodeling



FIGURE 4. Postoperative degree of AR at discharge and 12 months after root remodeling (- annular suture: without annuloplasty, + annular suture: with annuloplasty). $A R$, Aortic regurgitation.

## Suture Annuloplasty Significantly Improves the Durability of Bicuspid

 AorFreedom from AR $\geq$ II


Freedom from reoperation after BAV repair in patients with preoperative AVD of >28 mm depending on the use of root replacement.


Significant failure in patients with $\mathrm{a}>28 \mathrm{~mm}$ Annulus whether they have a SCA or "Remodeling" Root.

Aicher D et al. Circulation 2011;123:178-185

## The role of annular dimension and annuloplasty in tricuspid aortic valve repair ${ }^{\dagger}$

Laurent de Kerchove ${ }^{\text {a** }}$, Stefano Mastrobuoni ${ }^{\text {a }}$, Munir Boodhwani ${ }^{\text {b }}$, Parla Astarci ${ }^{a}$, Jean Rubay ${ }^{\text {a }}$, Alain Poncelet ${ }^{\text {a }}$, Jean-Louis Vanoverschelde ${ }^{\text {a,c }, ~ P h i l i p p e ~ N o i r h o m m e ~}{ }^{\mathrm{a}}$ and Gebrine El Khoury ${ }^{\text {a }}$

A


B


Freedom from recurrent AI


## Evidence Limitations

- Series are mixed (root, BAV, TAV)
- Throughout time, several concomitant additional surgical maneuvers were performed in the same pts cohort difficult to isolate the effect of annuloplasty
- The degree of annuloplasty needed for the individual pt is not well defined and should be correlated at least to cusp size


## Thank you



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## A Regulated Trial of Bicuspid Aortic Valve Repair Supported by Geometric Ring Annuloplasty

Domenico Mazzitelli, MD, Steffen Pfeiffer, MD, J. Scott Rankin, MD, Theodor Fischlein, MD, Yeong-Hoon Choi, MD, Thorsten Wahlers, MD, Christian Nöbauer, MD, Christian Schreiber, MD, and Rüdiger Lange, MD
German Heart Center München, München, Germany; Klinikum Nürnberg, Paracelsus Medical University, Nürnberg, Germany; Vanderbilt University, Nashville, Tennessee; and University of Köln, Köln, Germany


16 pts , 2 leaflet tears

## Annulus in Different Phenotypes



