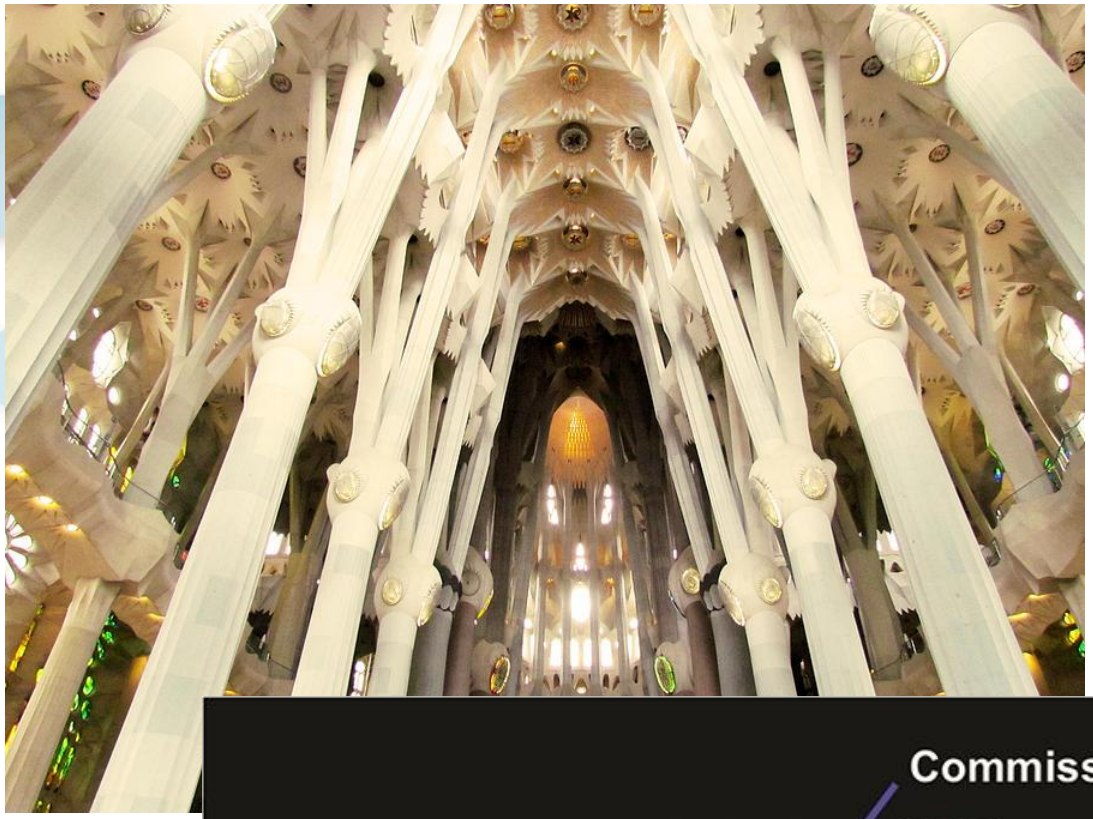
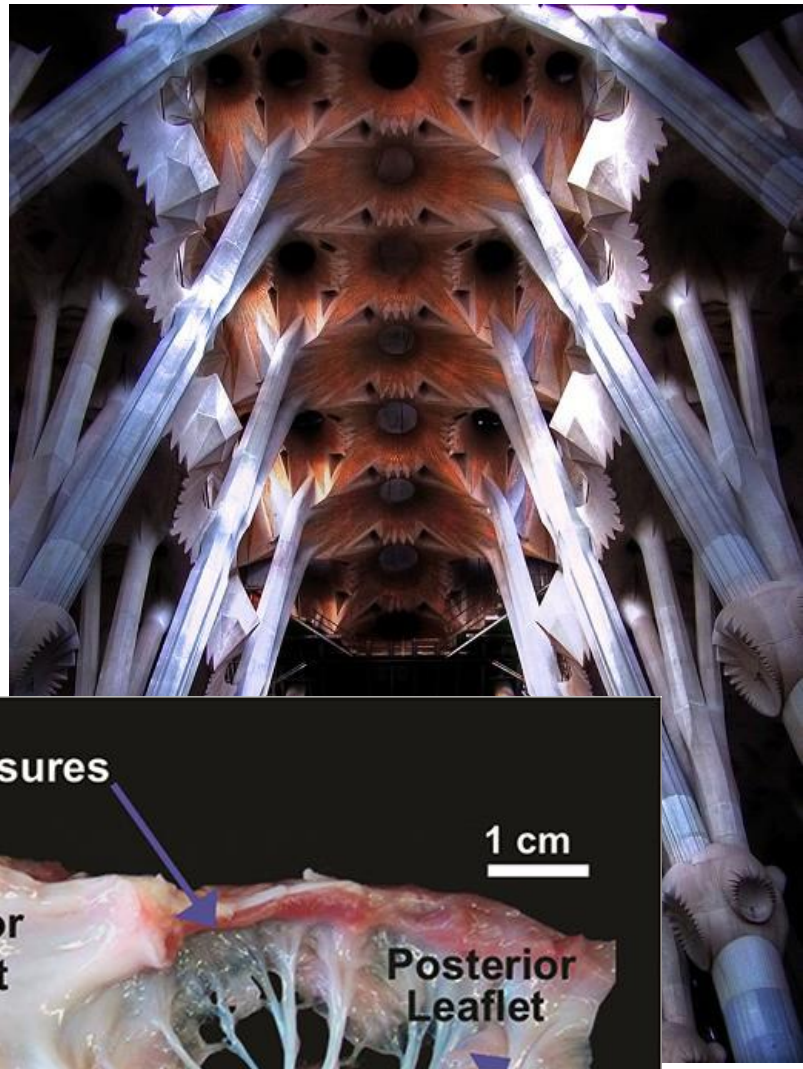
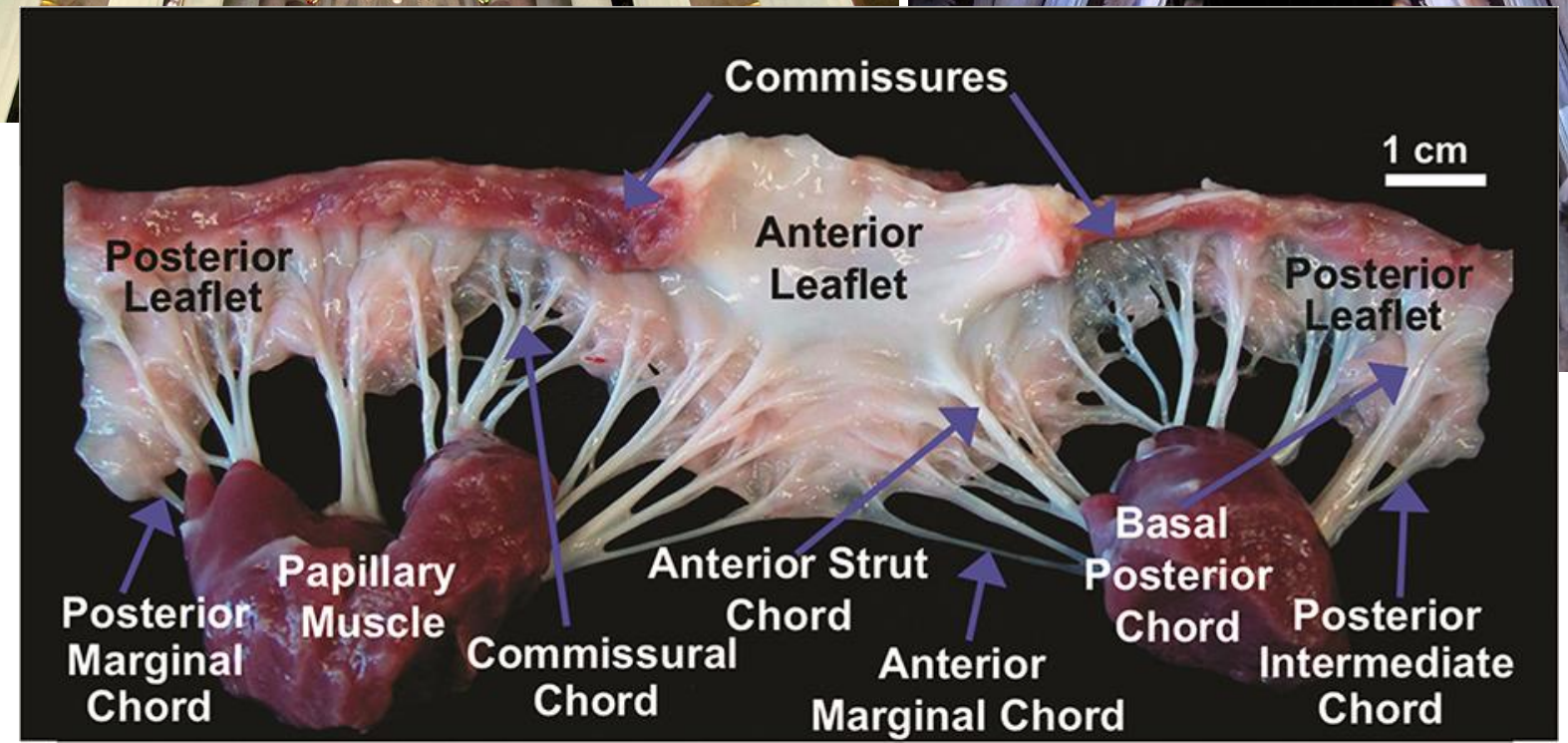
Percutaneous mitral valve repair/replacement

Jan Van der Heyden MD, PhD
St.Antonius Hospital Nieuwegein






Commissures
1 cm
Posterior Leaflet
Anterior Leaflet
Posterior Leaflet
Basal Posterior Chord
Papillary Muscle
Anterior Strut Chord
Posterior Marginal Chord
Commissural Chord
Anterior Marginal Chord
Posterior Intermediate Chord

Difference between AoV and MV

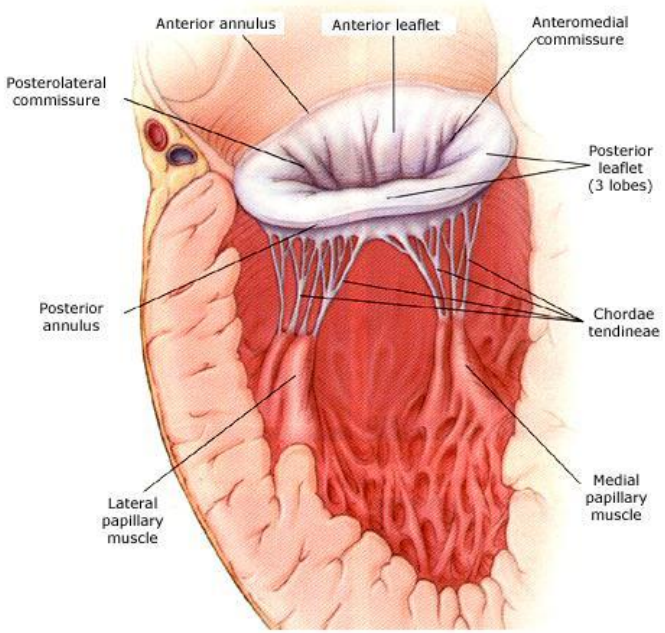
Aortic Valve

Mitral Valve

Transcatheter Mitral Valve Devices
Mechanism of Action

Annulus

- **Indirect annuloplasty**
  - Coronary sinus approach
  - Asymmetrical approach
- **Direct annuloplasty**
  - Mechanical cinching
  - Energy mediated cinching
  - Hybrid



Leaflets

- Edge-to-Edge
- Leaflet ablation
- Space occupier

Left Ventricle

- LV (and MA) remodeling

Chordal implants

- Transapical
- Transapical-Transseptal

MV replacement

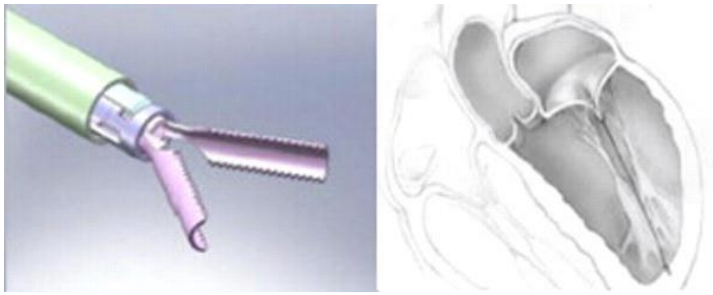
- Right mini-thoracotomy
- Transapical
- Transseptal

Otto *N Engl J Med* 2001:345:740-746

Leaflets

- Edge-to-Edge
- Leaflet ablation
- Space occupier

Edge-to-Edge (leaflet plication)



Device:

Mitraclip / (Mitraflex) / (Mobius)

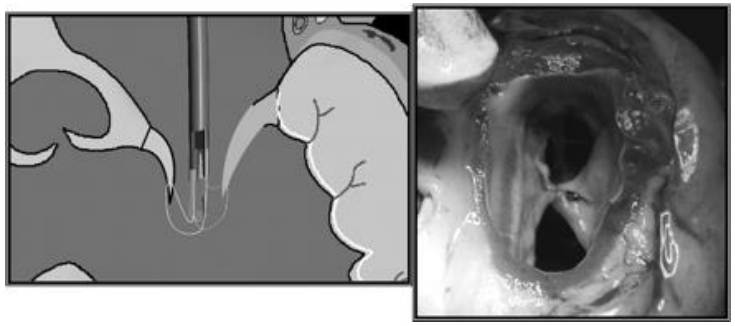
Status:

Randomized trials

Principle:

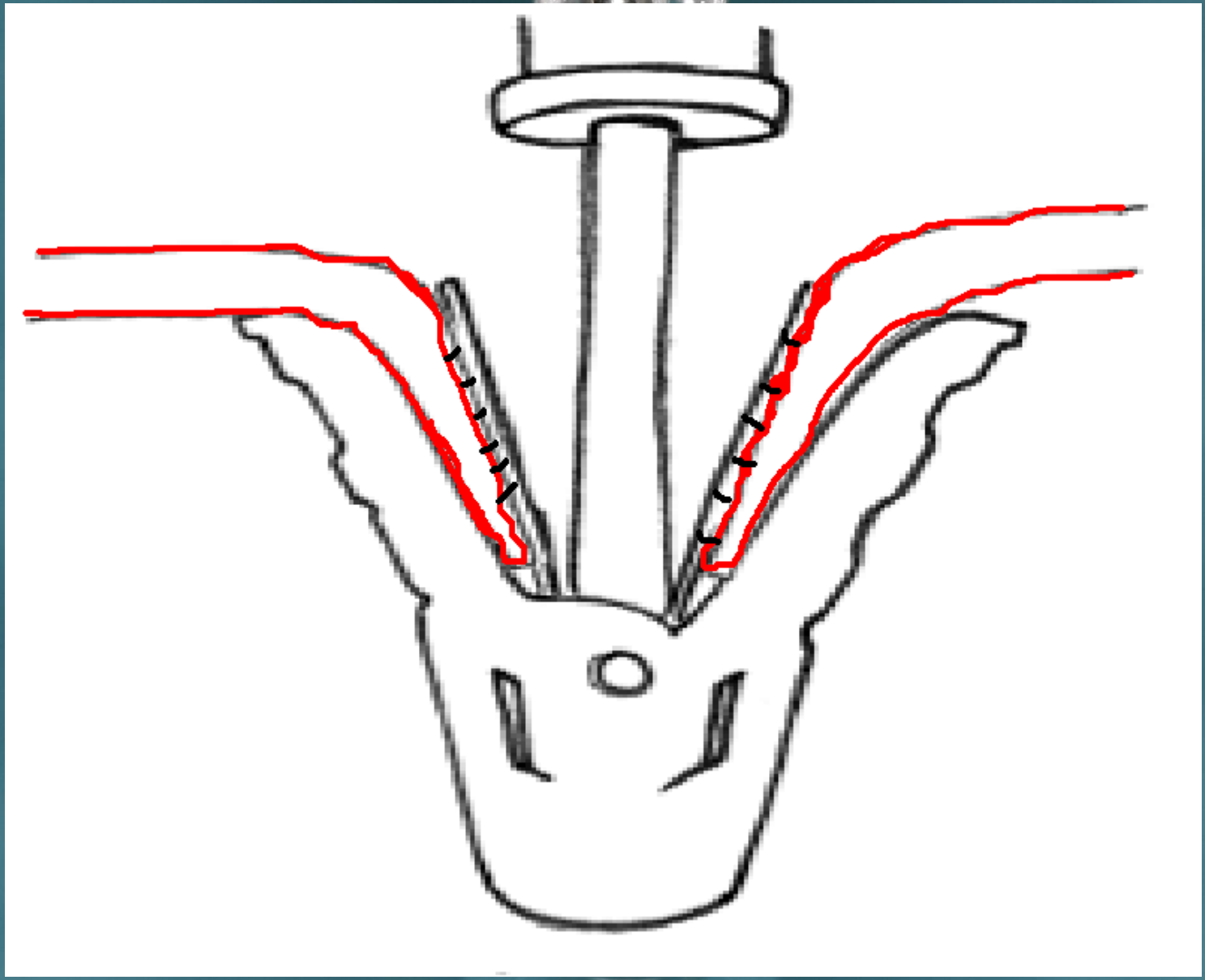
Based on the surgical Alfieri technique which brings the anterior and posterior leaflets together with a suture, creating a "double orifice" MV.

This re-establishes leaflet coaptation, thereby reducing MR.



Limitations:

- Surgical Alfieri typically used with annuloplasty, because suboptimal results without annuloplasty
- Possibility of causing iatrogenic MS



Leaflet ablation

Device:

Thermocool catheter

Status:

Animal models

Principle:

Radiofrequency energy is delivered retrograde from the LV to the leaflet(s) to cause scarring and fibrosis and functional (reduced leaflet motion) alterations

Limitations:

- Only for DMR
- RF ablation not precise
- Leaflet perforation
- Damage to the adjacent cardiac structures

Williams JL et al. J Interv Cardiol. Dec 2008;21(6):547-54.

Space Occupier

Device: Percu-Pro

Status: Phase 1 trial

Principle:

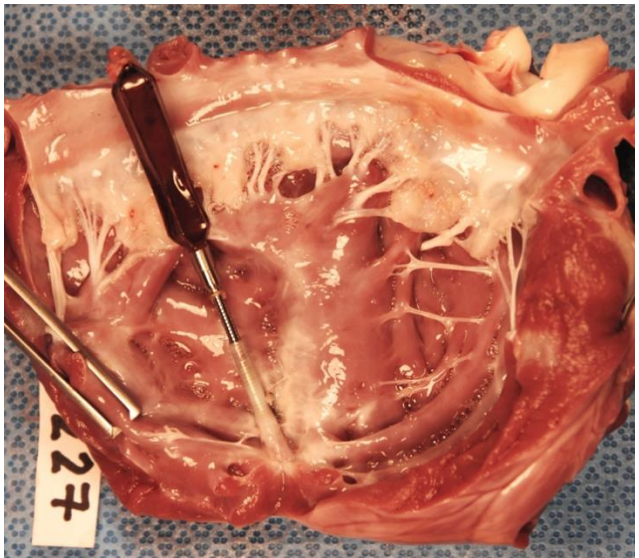
- Device acting like a "buoy" is positioned across the MV orifice to provide a surface against which the leaflets can coapt, reducing MR
- Transseptal implantation, positioned across MV and anchored at the apex

Limitations:

Thrombus formation on the device

Residual MR

Restricted inflow by the spacer



Courtesy to Dr.Svensson
Department of Thoracic and Cardiovascular Surgery
Cleveland Clinic, USA

Annulus

- Indirect annuloplasty
  - Coronary sinus approach
  - Asymmetrical approach
- Direct annuloplasty
  - Mechanical cinching
  - Energy mediated cinching
  - Hybrid

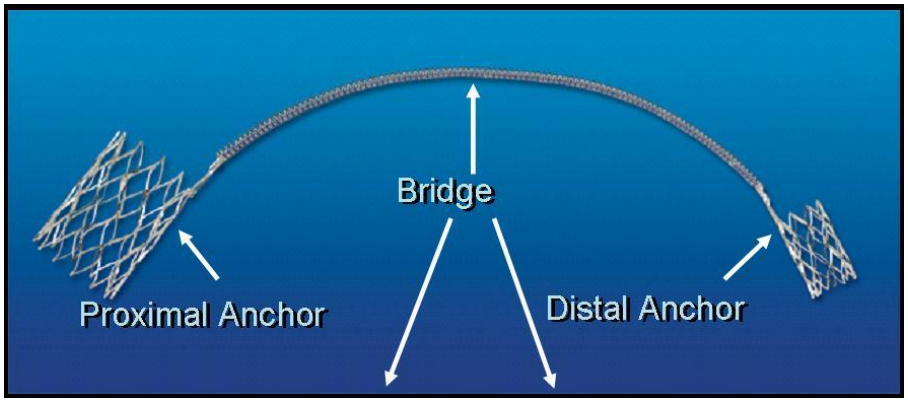
Indirect annuloplasty – Coronary sinus approach

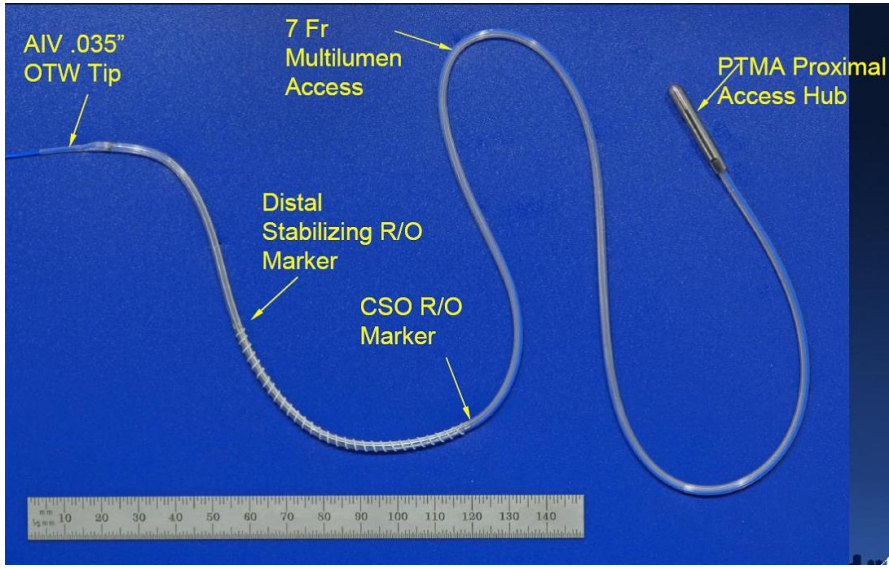
Device:

Carillon / (Monarc/Viking) / (Viacor)

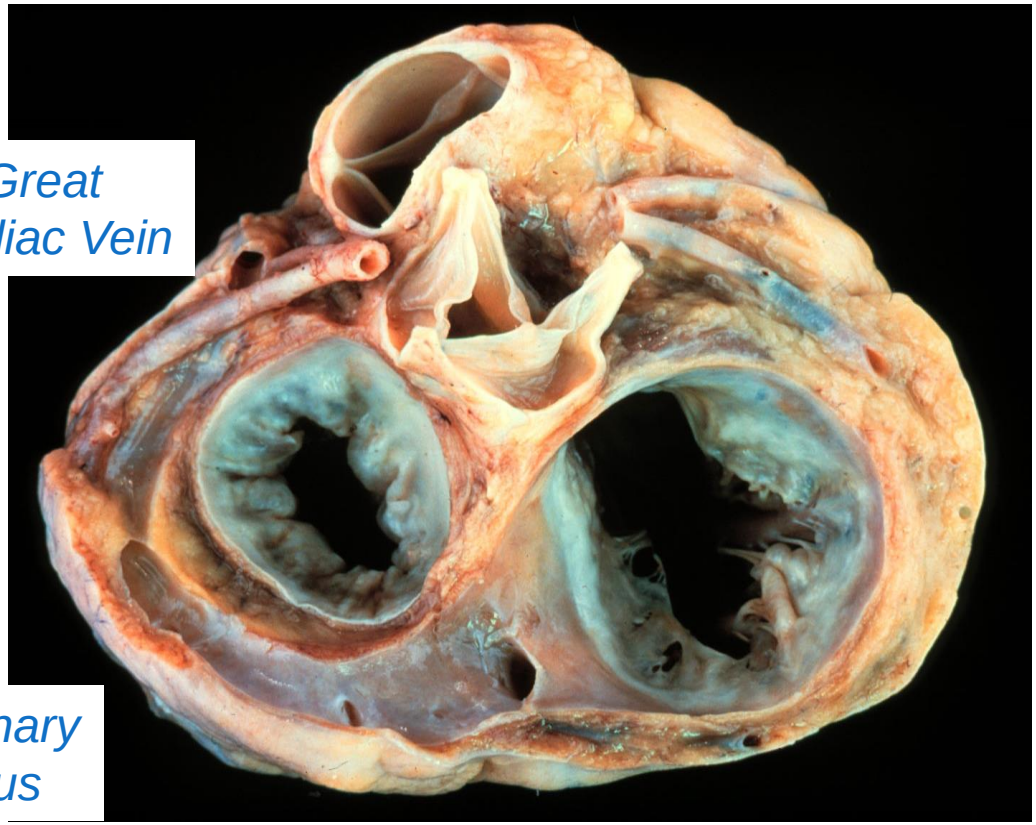
- Status:

Enrollment in multicentre, randomized clinical trial (REDUCE FMR Trial)





Indirect annuloplasty
Coronary sinus approach



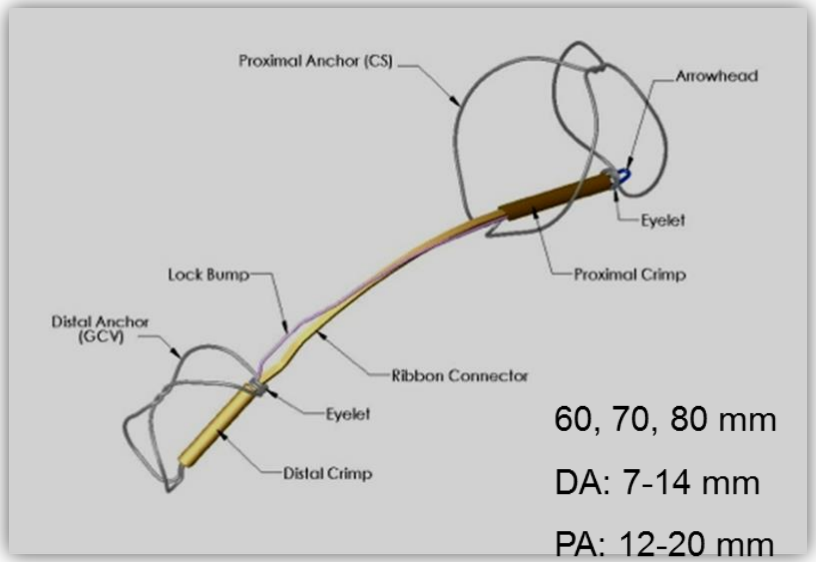
Principle:

- Implantation of devices within the CS with the aim of "pushing" the posterior annulus anteriorly, thereby reducing the septal-lateral (anterior-posterior) dimension of the mitral annulus

- This has been demonstrated in surgical data to improve leaflet coaptation and decrease MR

Timek TA et al. *J Thorac Cardiovasc Surg*. May 2002;123(5):881-8.

CARILLON Mitral Contour System



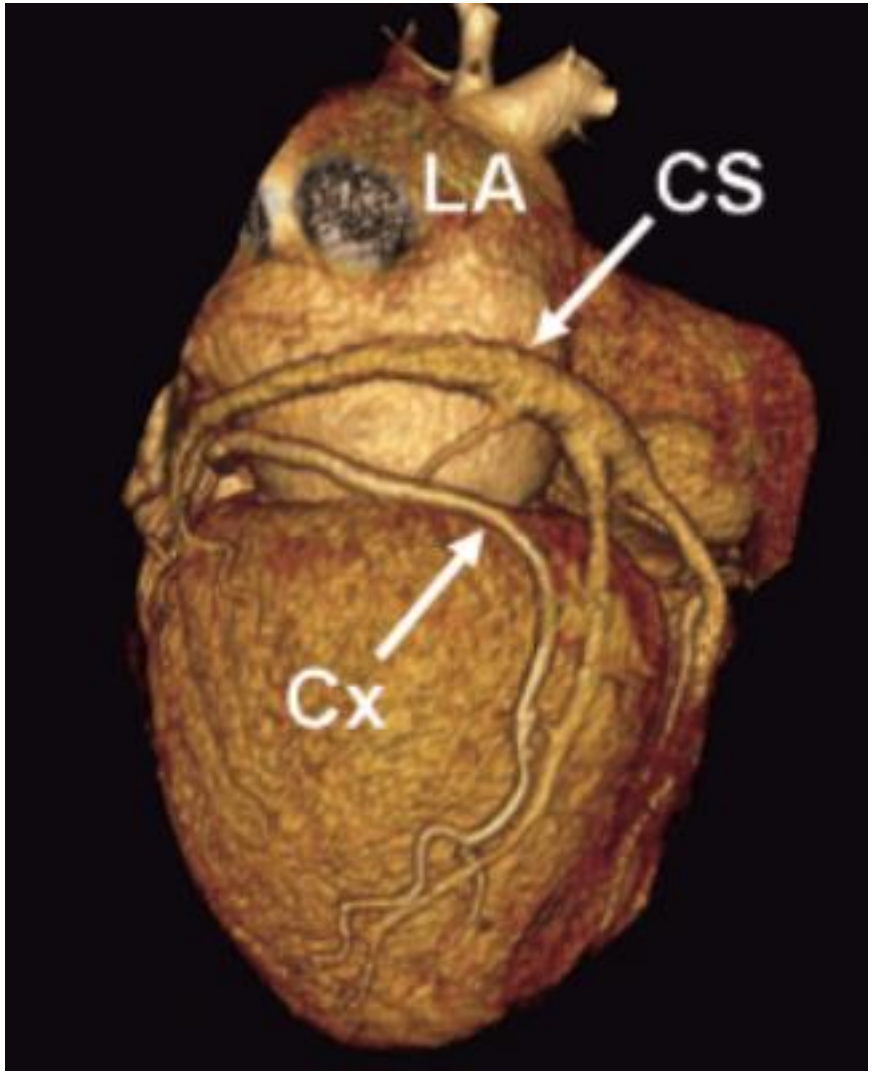
60, 70, 80 mm

DA: 7-14 mm

PA: 12-20 mm

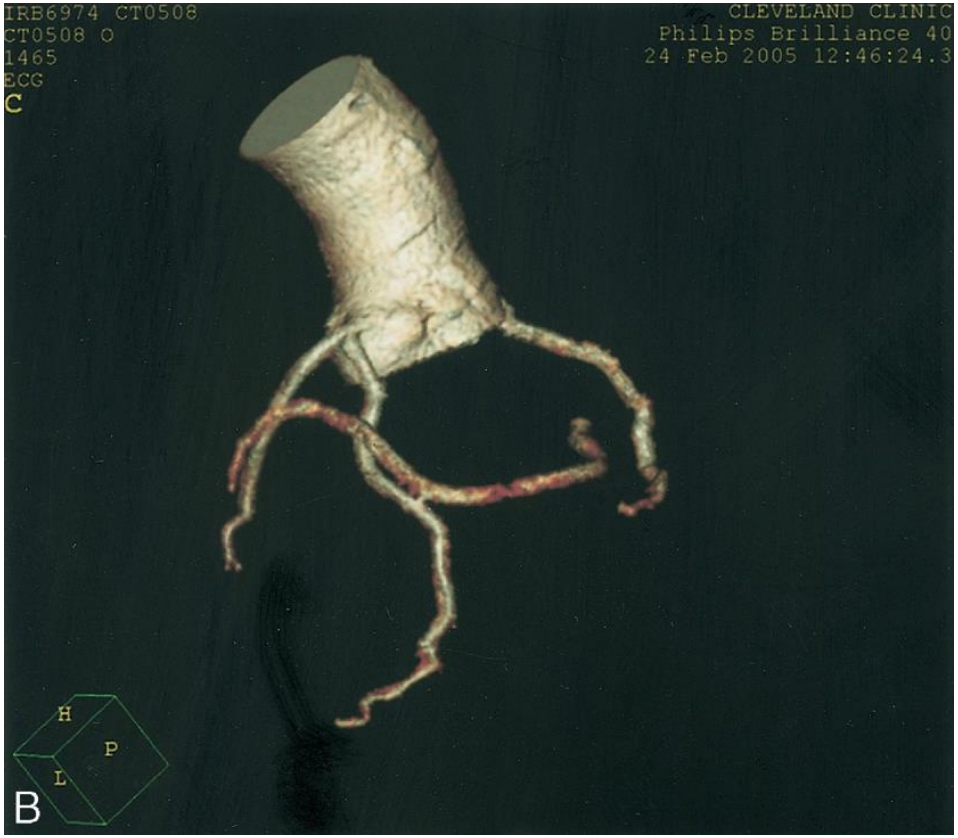
Device Deployment

Relation coronary sinus – MV annulus



Courtesy to Dr.Lederman
National Institutes of Health
Bethesda, MD, USA

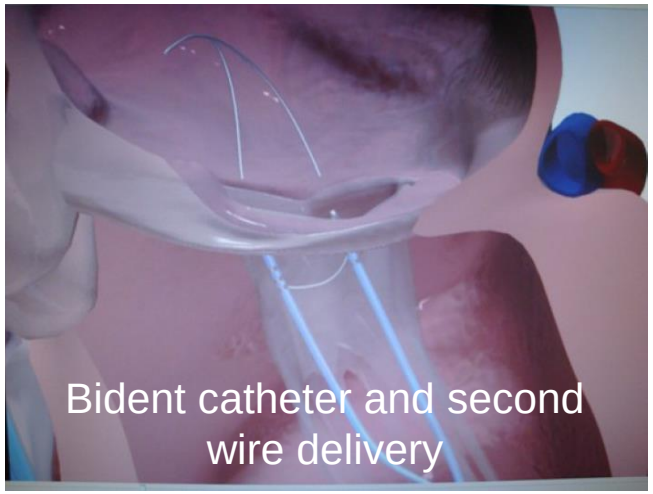
Relation coronary sinus - circumflex artery

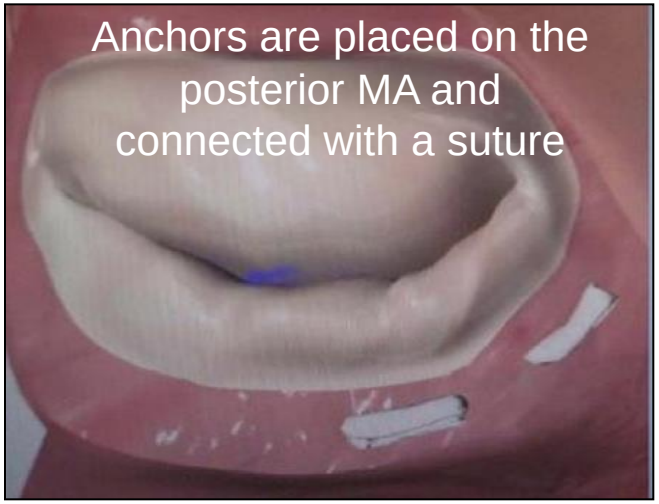


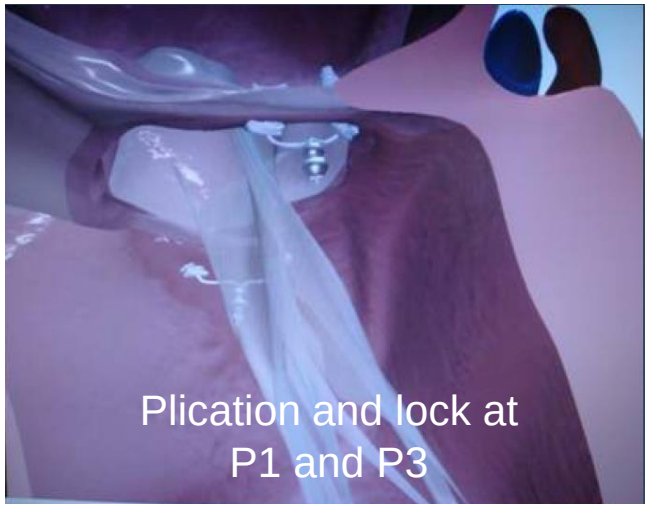
Courtesy to Dr.Kapadia, Cleveland Clinic, USA
Choure AJ et al. JACC 2006

Direct Annuloplasty - Mechanical

Mitralign Device







Mimics surgical suture annuloplasty of Paneth and Burr

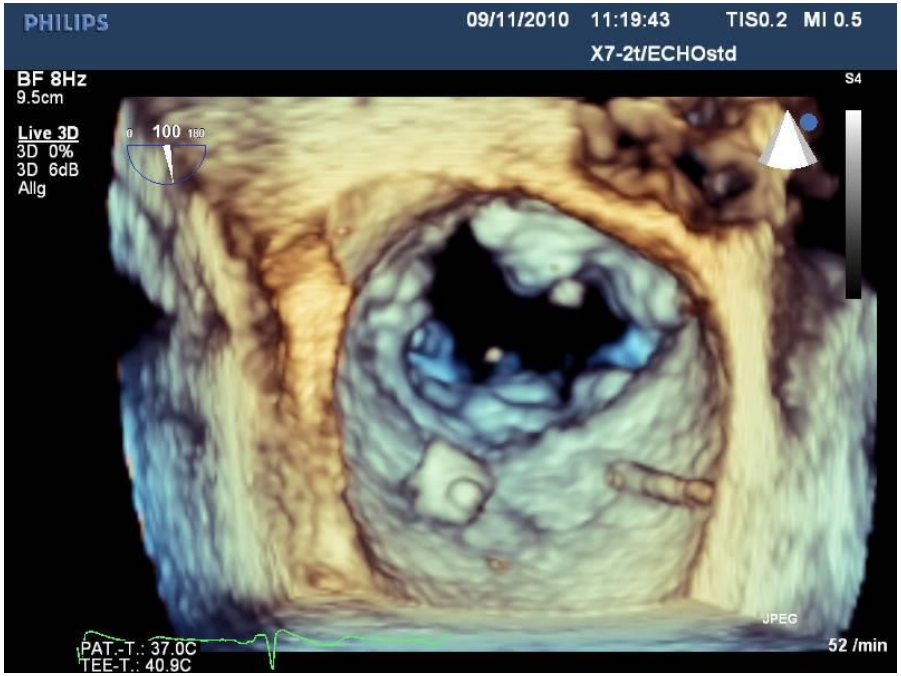
Aybek et al., JTCS. 2006;
Burr LH, Paneth M, et al. JTCVS 1977:73:589

Direct Annuloplasty - Mechanical

Mitralign Device

Wire Placement

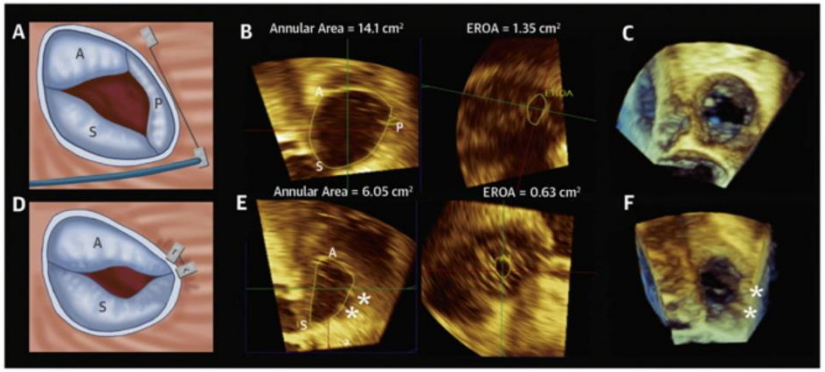
Pledget Delivery



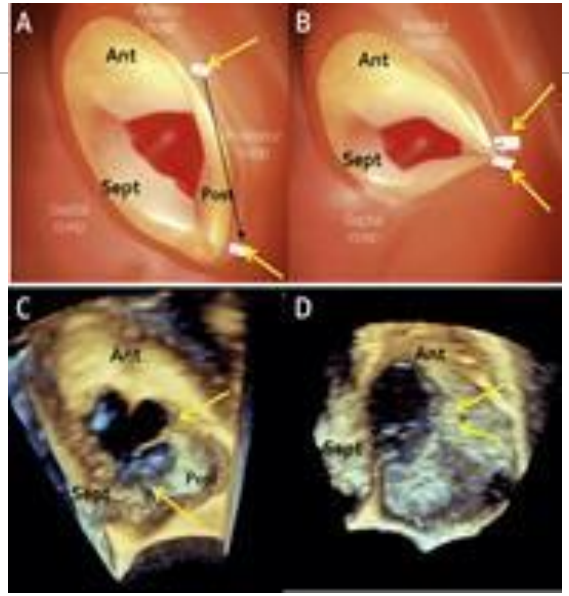
JACC Journals

From: First-in-Human Transcatheter Tricuspid Valve Repair in a Patient With Severely Regurgitant Tricuspid Valve

J Am Coll Cardiol. 2015;65(12):1190-1195. doi:10.1016/j.jacc.2015.01.025



Schofer, J. et al. J Am Coll Cardiol. 2015; 65(12):1190-5.



To perform the transcatheter bicuspidization of the tricuspid valve, the Mitralign system was used to place pledgeted sutures by means of a trans-jugular venous approach. Insulated radiofrequency wires were positioned 2 to 5 mm from the base of the posterior leaflet, 2.6 cm apart. The sutures were drawn together and locked, plicating the posterior annulus.

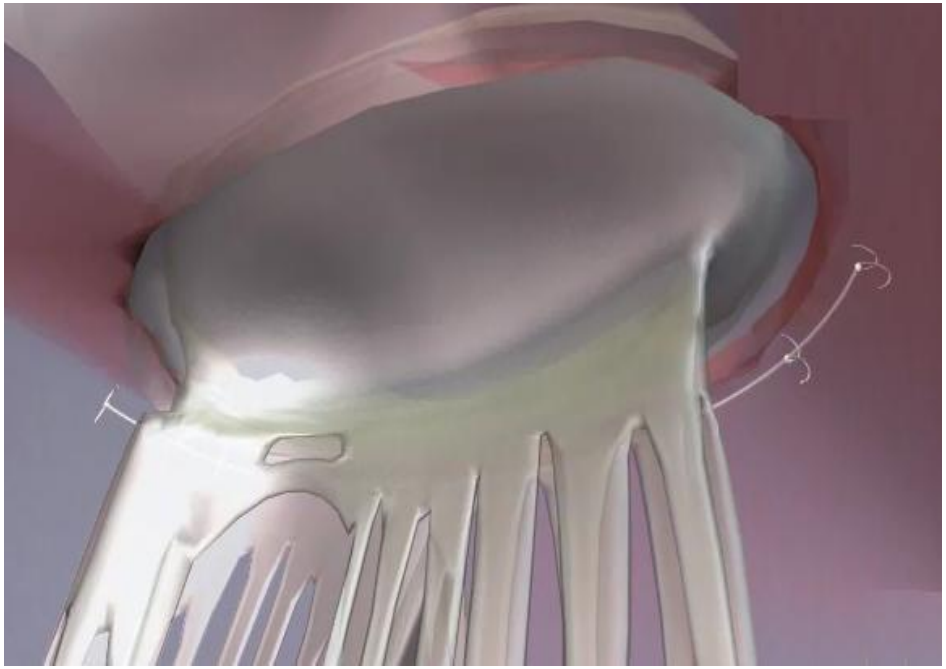
Figure Legend:

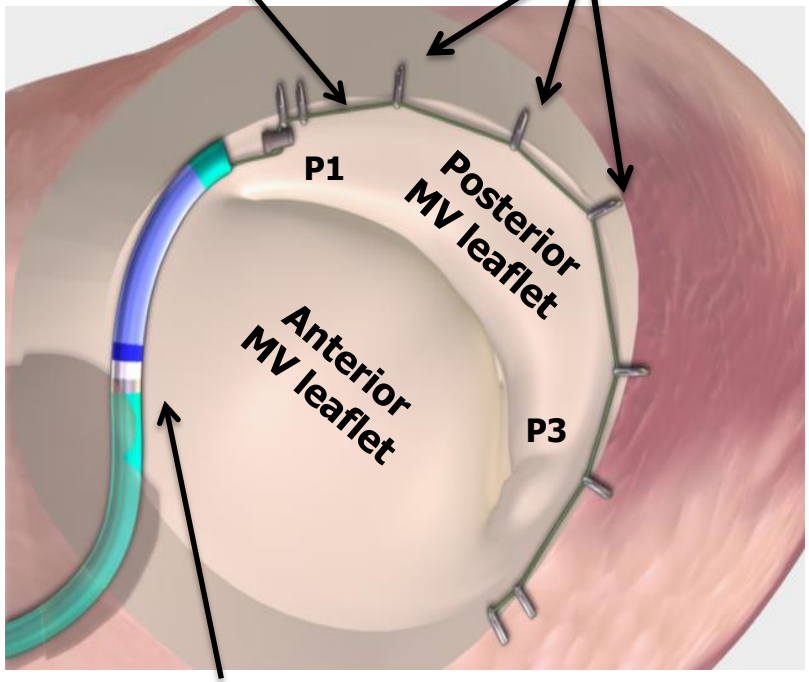
Transcatheter Tricuspid Valve Repair: Multi-Planar 3-Dimensional Transesophageal Echocardiographic Reconstruction

Baseline images of the native tricuspid annulus are shown. (A) Image of the native tricuspid annulus before repair; (B) image of 3-dimensional reconstruction of the annulus and effective regurgitant orifice area (EROA); (C) associated 3-dimensional volume. (D to F) Corresponding post–transcatheter tricuspid valve repair images of the tricuspid annulus. Asterisks in E and F show the position of the pledgeted sutures. A = anterior tricuspid valve leaflet; S = septal leaflet; P = posterior leaflet.

Direct Annuloplasty - Mechanical

GDS Accucinch

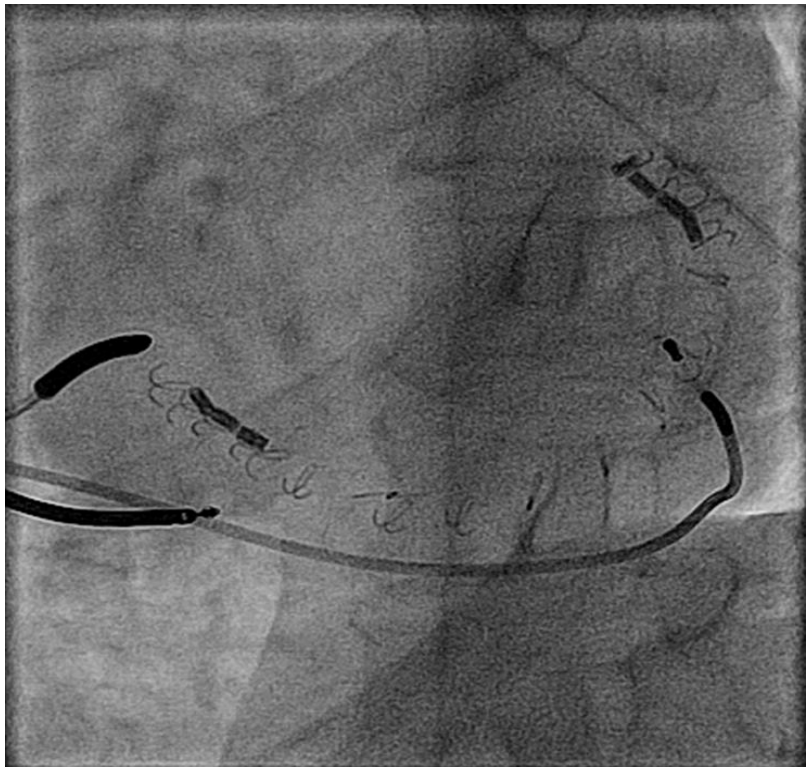


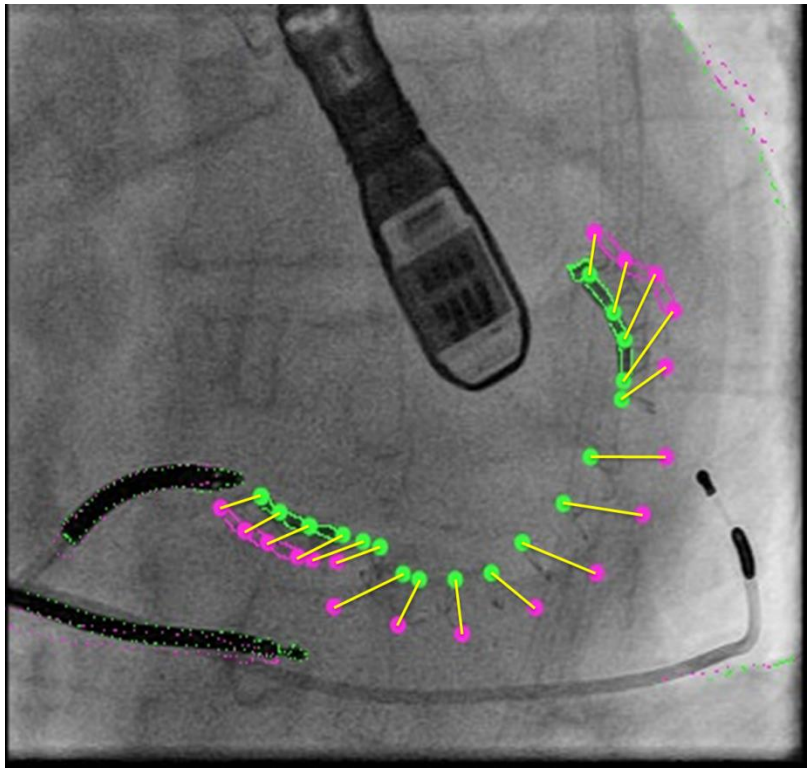


Sub-valvular placement of anchors and a cinching cable along the posterior LV wall via a retrograde trans-femoral approach

Direct Annuloplasty - Mechanical

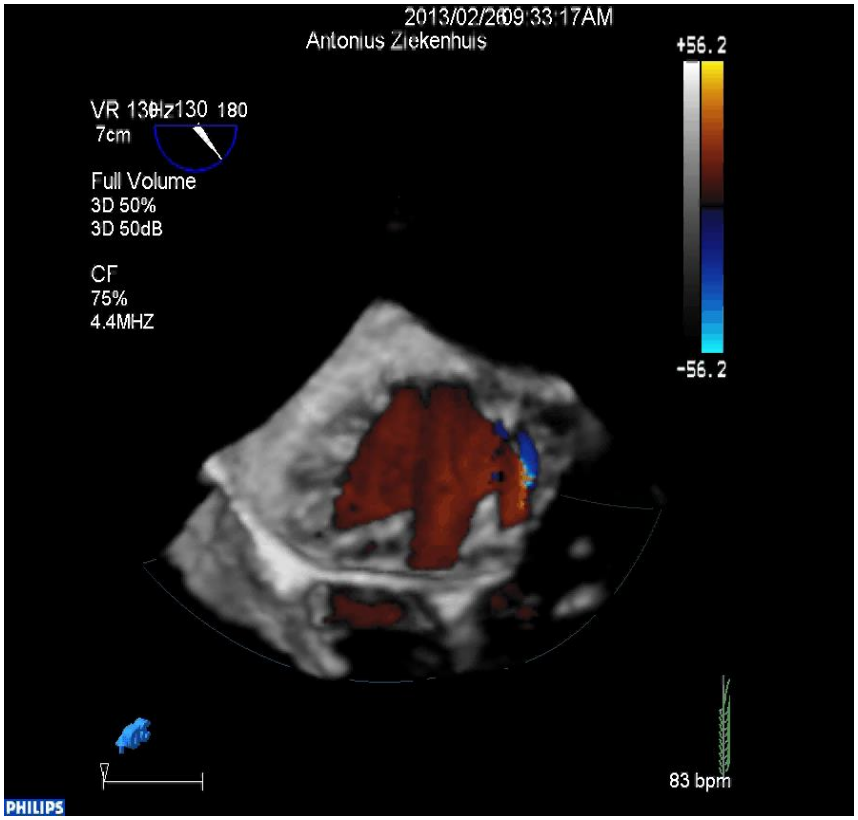
GDS Accucinch



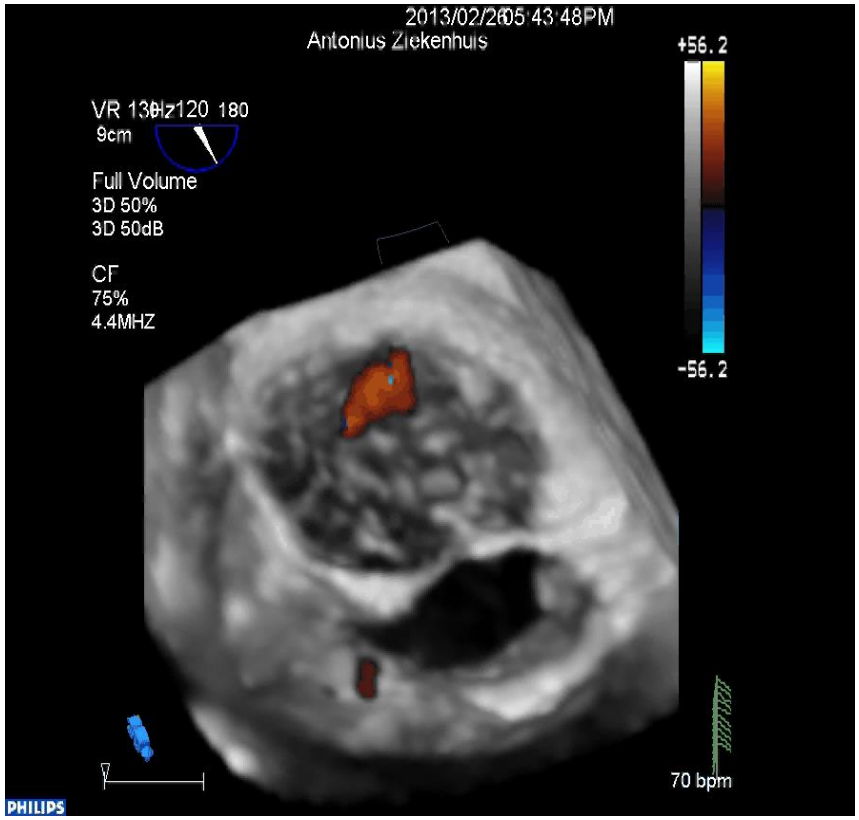


Direct Annuloplasty - Mechanical

GDS Accucinch



Baseline



Final

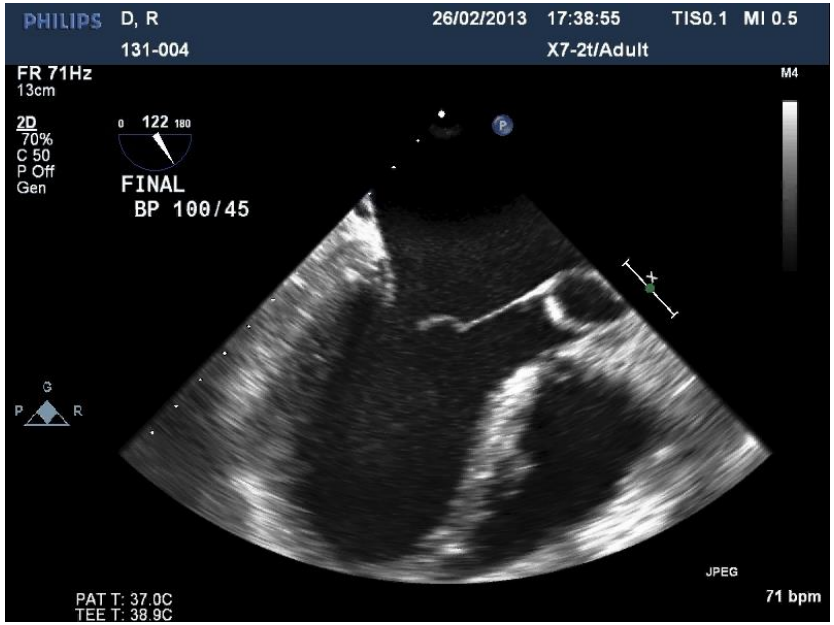
Direct Annuloplasty - Mechanical

GDS Accucinch

Pre-procedure

Annular dimension 51 mm

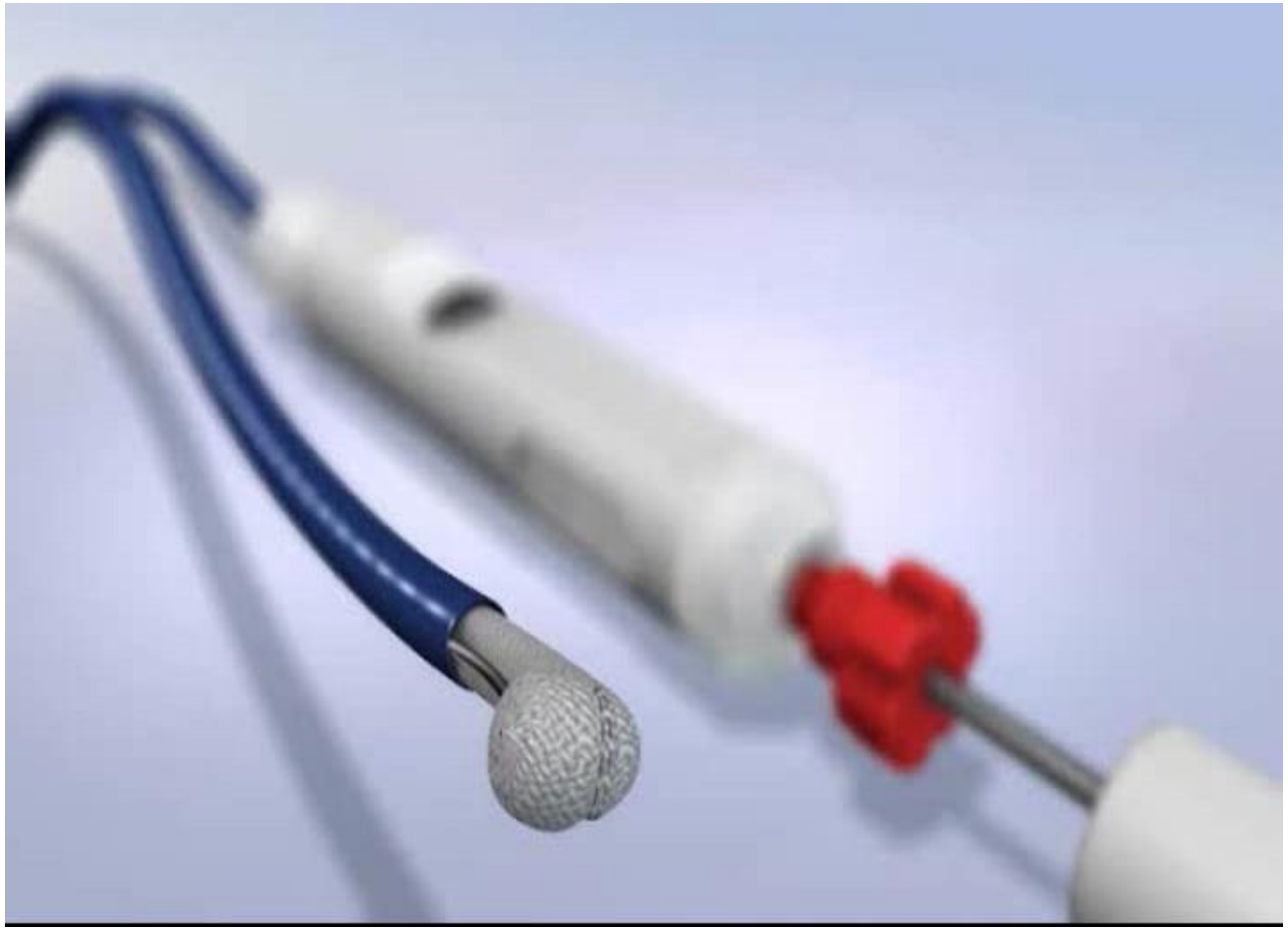
Post-procedure



Annular dimension 41 mm

Direct Annuloplasty – Mechanical

Valtech Cardioband

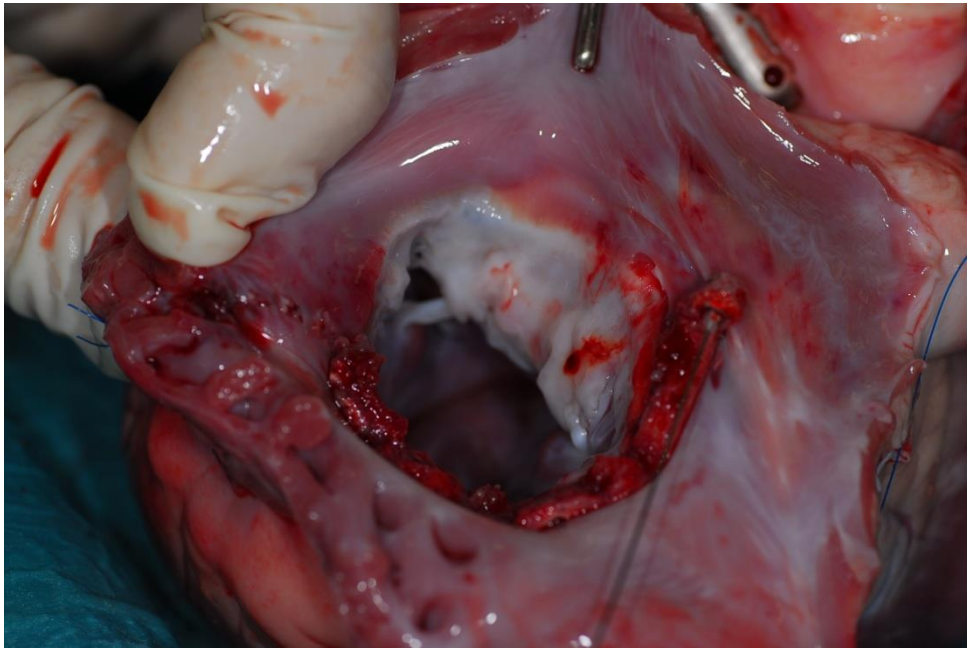


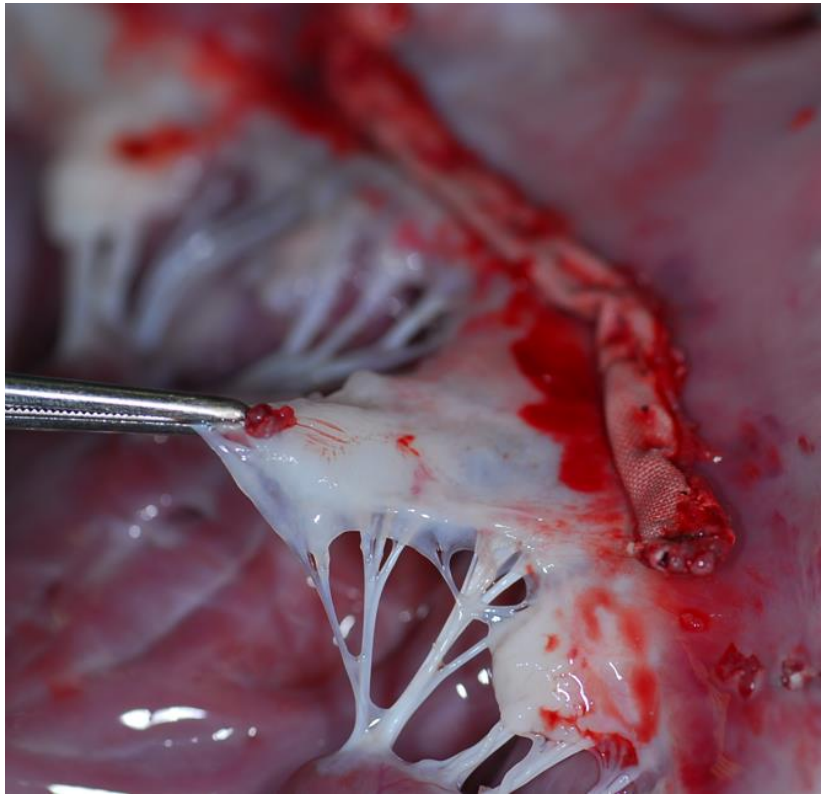
- Fully percutaneous procedure based on surgical principles
- Off-pump adjustment of leaflet coaptation
- Innovative multi-functional catheter system
- Based on technology that is tested surgicaly in current clinical study

Courtesy to Dr.Maisano
San Raffaele Hospital
Milan, Italy

Direct Annuloplasty – Mechanical

Valtech Cardioband





Chordal implantation

- Transapical (Neochord/Valtech Vchordal/Mitralflex)
- Transapical-Transseptal (Babic)

Chordal Implantation

Device: Neochord / Valtech Vchordal / (Babic-device) / (Mitraflex)

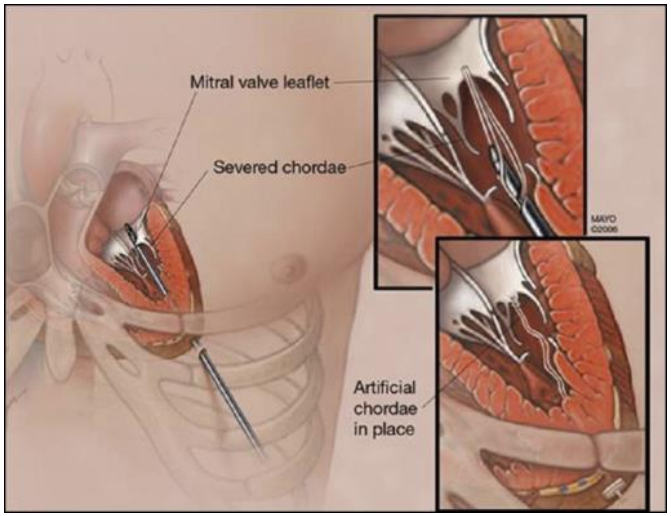
Status: Pre-clinical development /FIM

Principle:

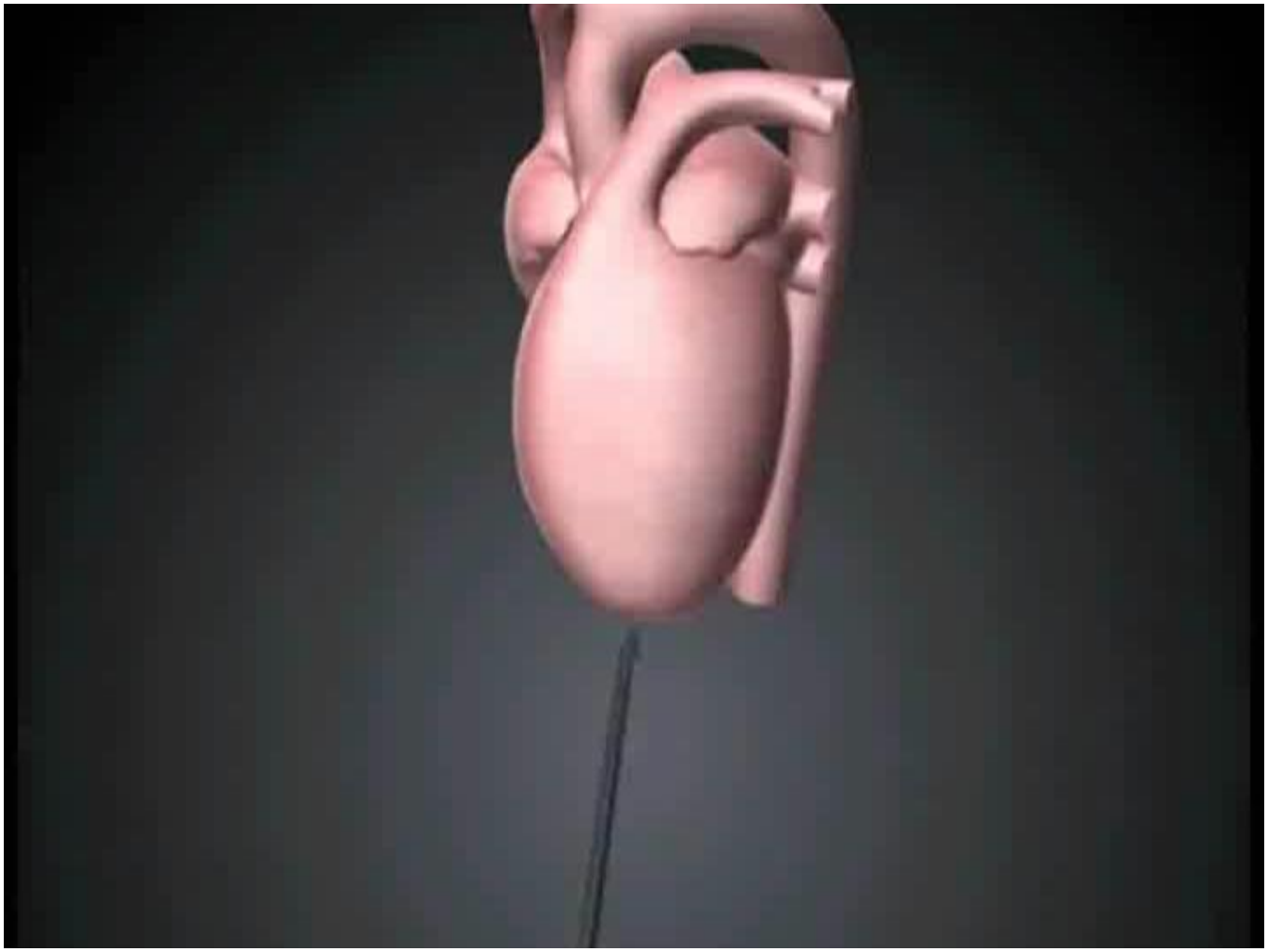
- Synthetic chords or sutures are implanted either from a transapical or transseptal approach and anchored onto the LV myocardium at one end, with the leaflet at the other.
- The length of the chord is then adjusted to achieve optimal leaflet coaptation and reduce MR.

Limitations:

- Mainly for DMR
- Residual leaflet prolapse / Leaflet restriction
- Residual MR
- Device thrombus formation



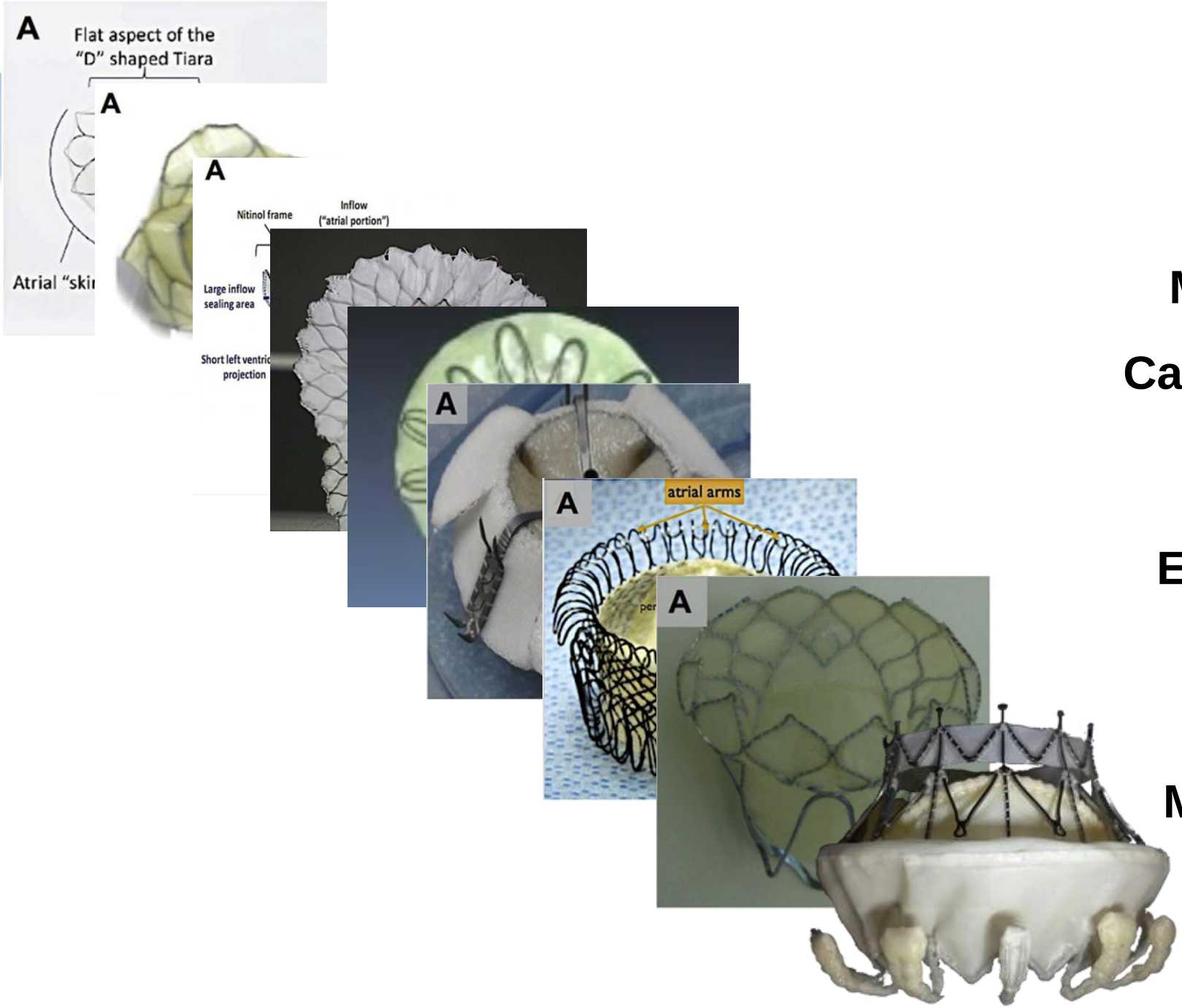
Chordal Implantation



Transcatheter Mitral Valve Implantation (TMVI)

Challenges TMVI

- MA has asymmetrical saddle shape
- Different anchoring designs might be required for different MR etiologies
- Paravalvular leaks
- LVOT obstruction might occur due to retained native valve tissue



Tiara

Tendyne

Medtronic

Cardiovalve

HighLife

Endovalve

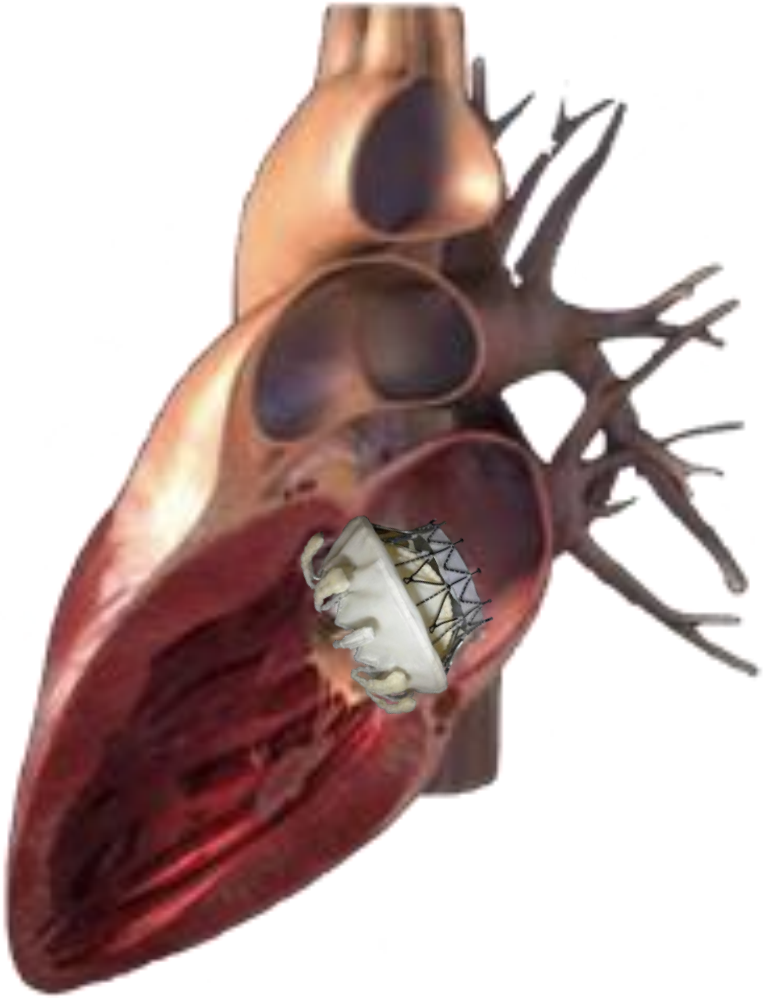
Gorman

MitrAssist

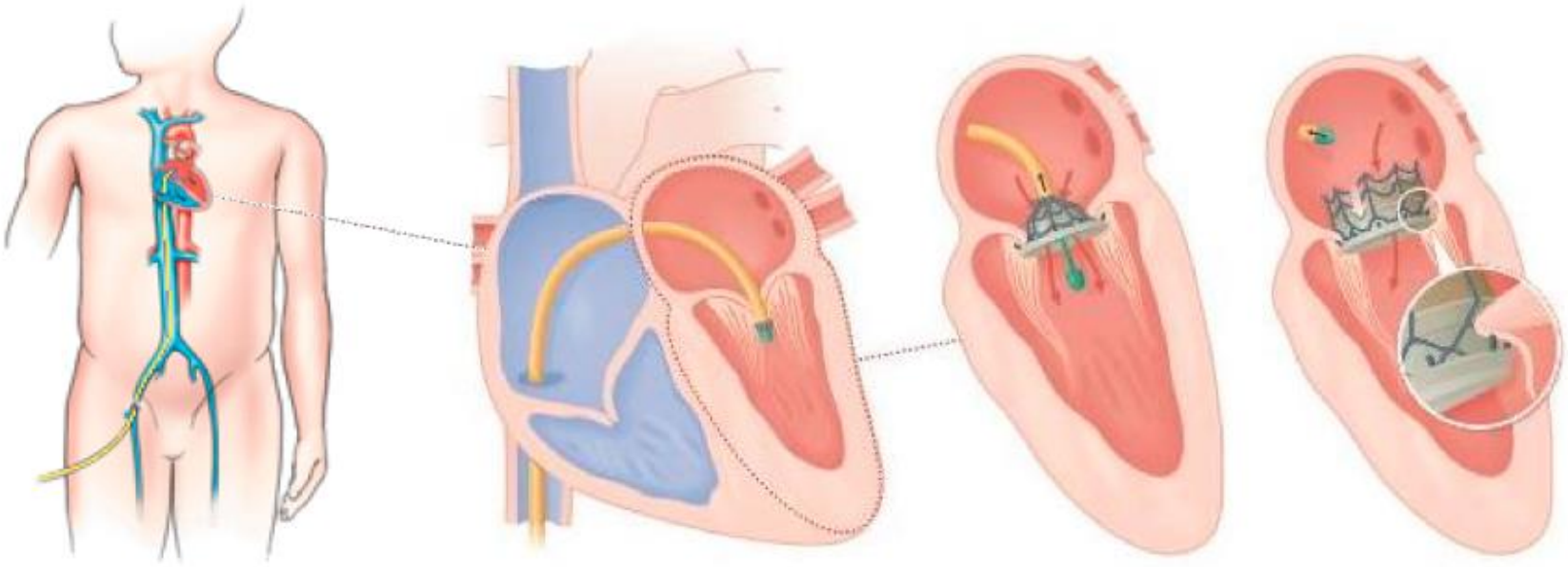
CardiaQ

CardiAQ™ TMVI System

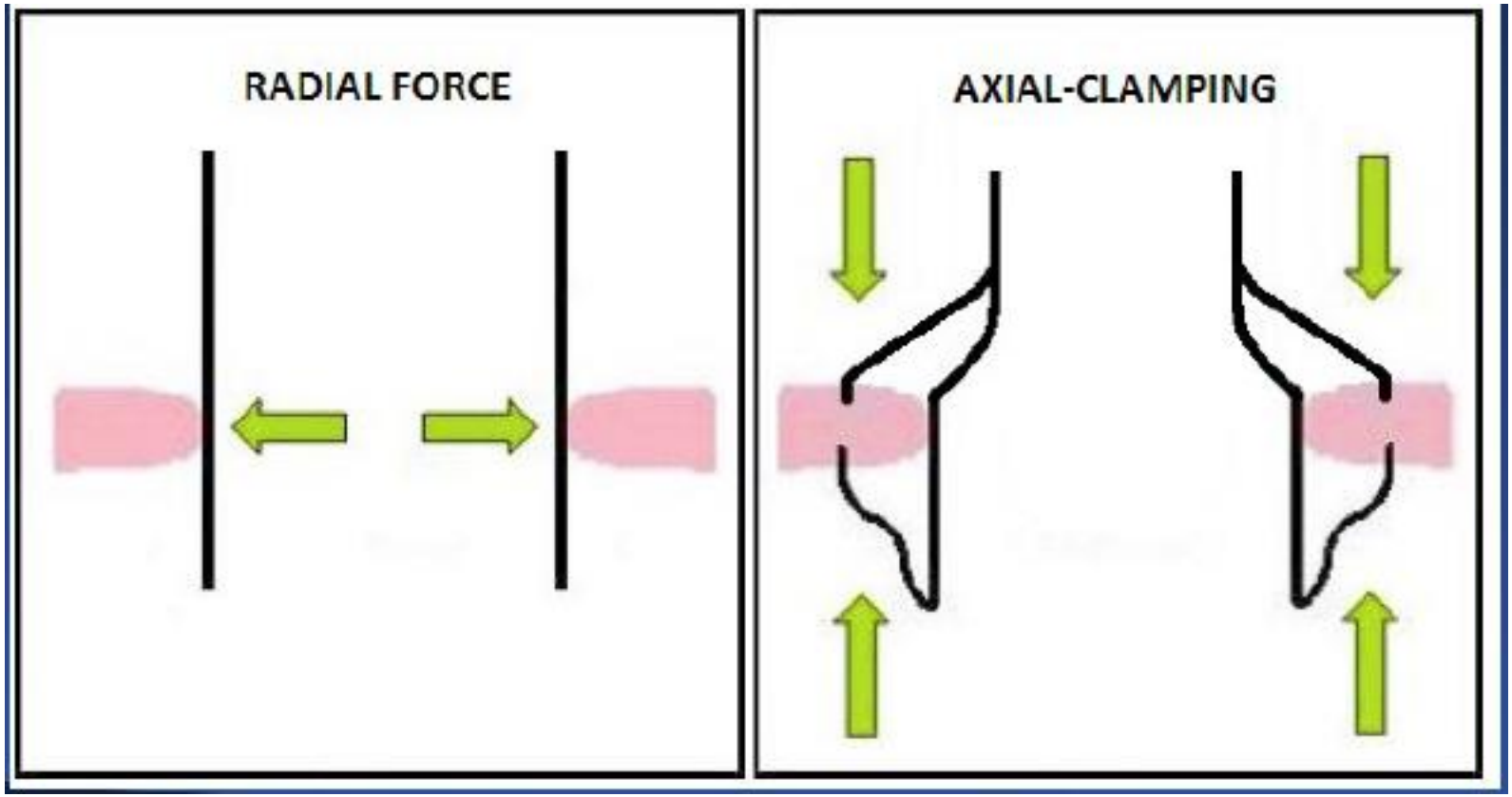
- **MULTIPLE ACCESS ROUTES**
  - **TF** – Trans-Femoral vein, trans-septal, antegrade approach
  - **TA** – Trans-Apical, retrograde approach
- **POSITIONING & CONTROL**
  - Multi-stage controlled deployment
  - Intra/Supra annular placement
  - Self-positioning within native valve annulus
- **ANCHORING**
  - Unique frame designed for annular attachment **without radial force**
  - Preserves chords and uses native leaflets
  - Load distribution between chords and annulus



CardiAQ TMVI Procedure Overview

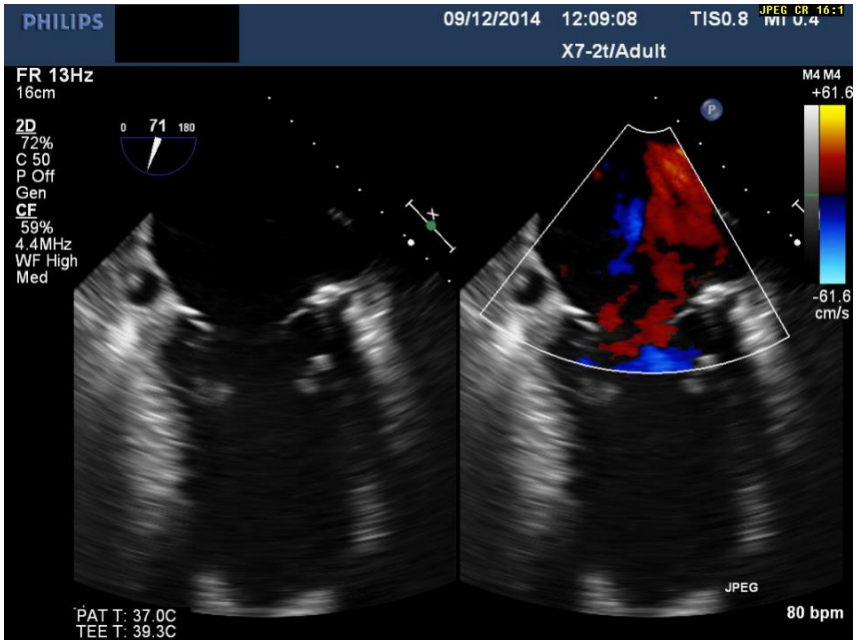


For illustration only - the devices depicted are not an accurate reflection of the CardiAQ TMVI technology

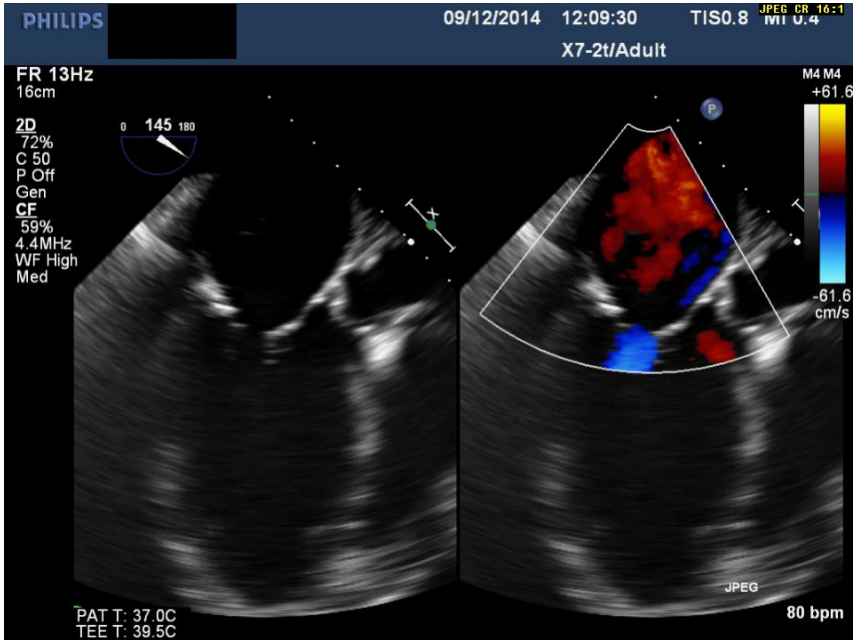

RADIAL FORCE
AXIAL-CLAMPING

Preprocedural images

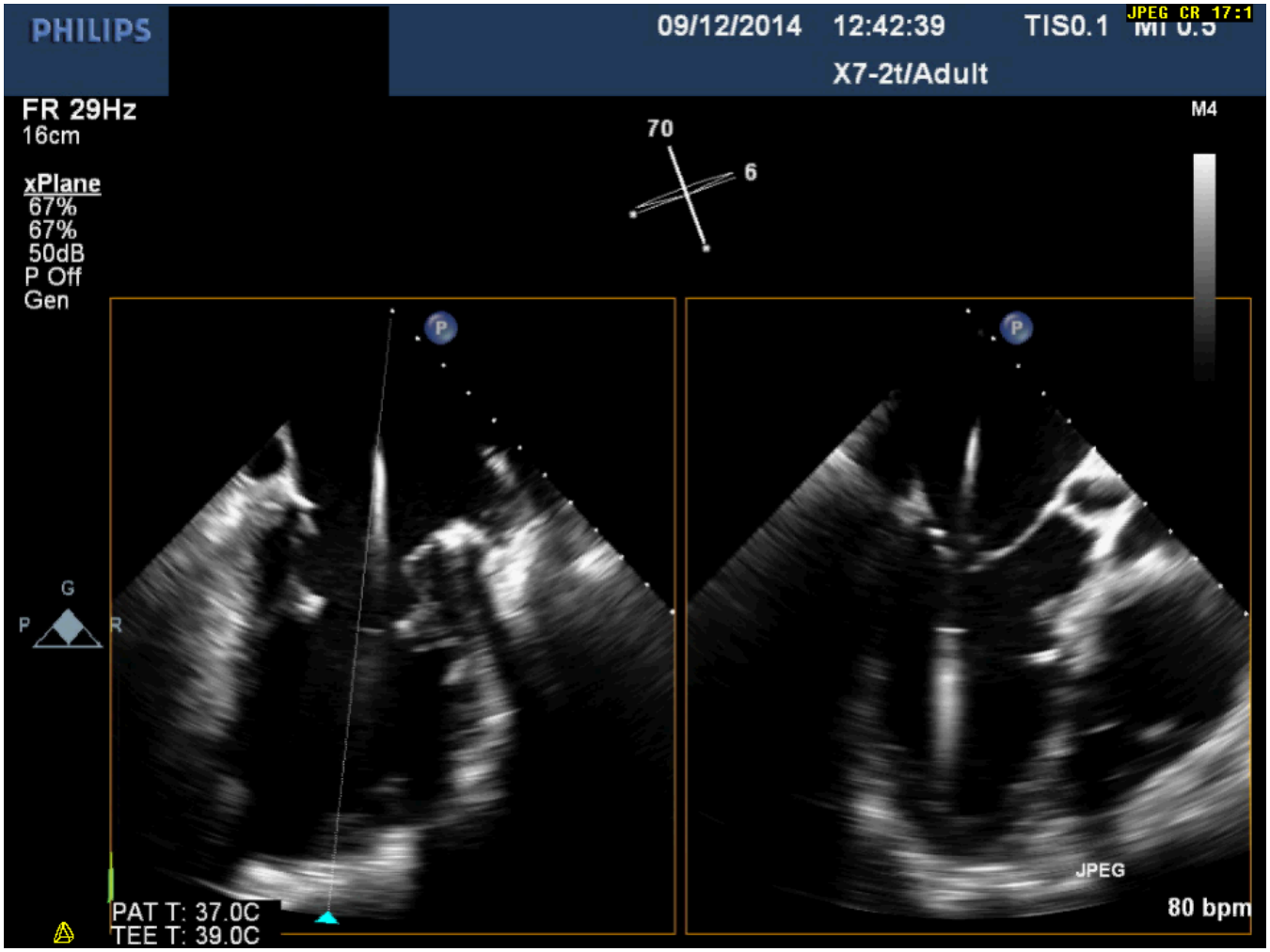
Intercommisural view



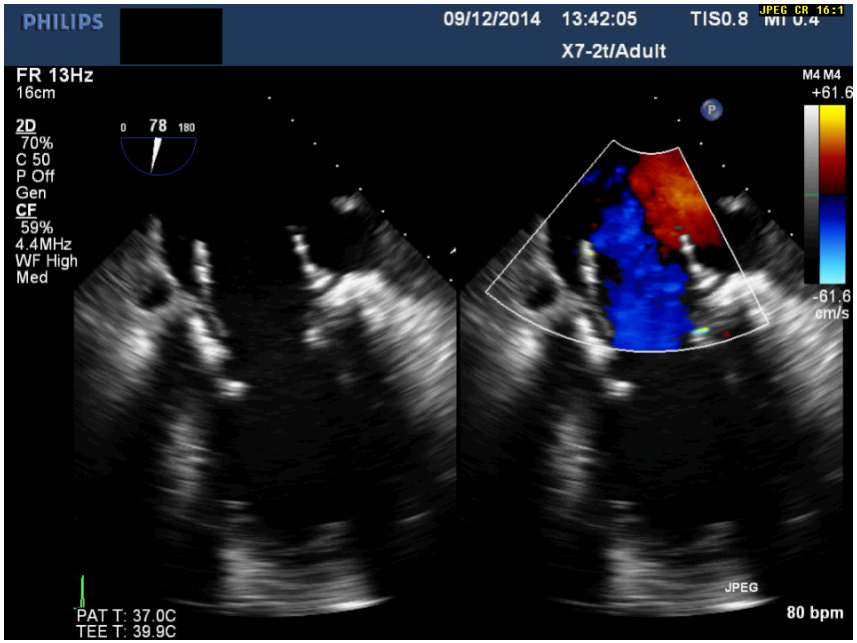
LVOT view



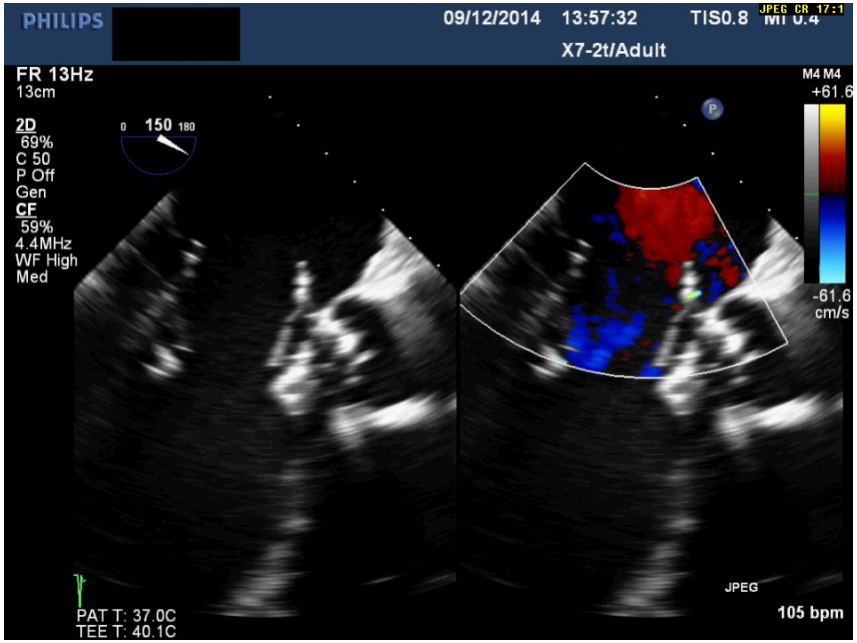
Passage wire

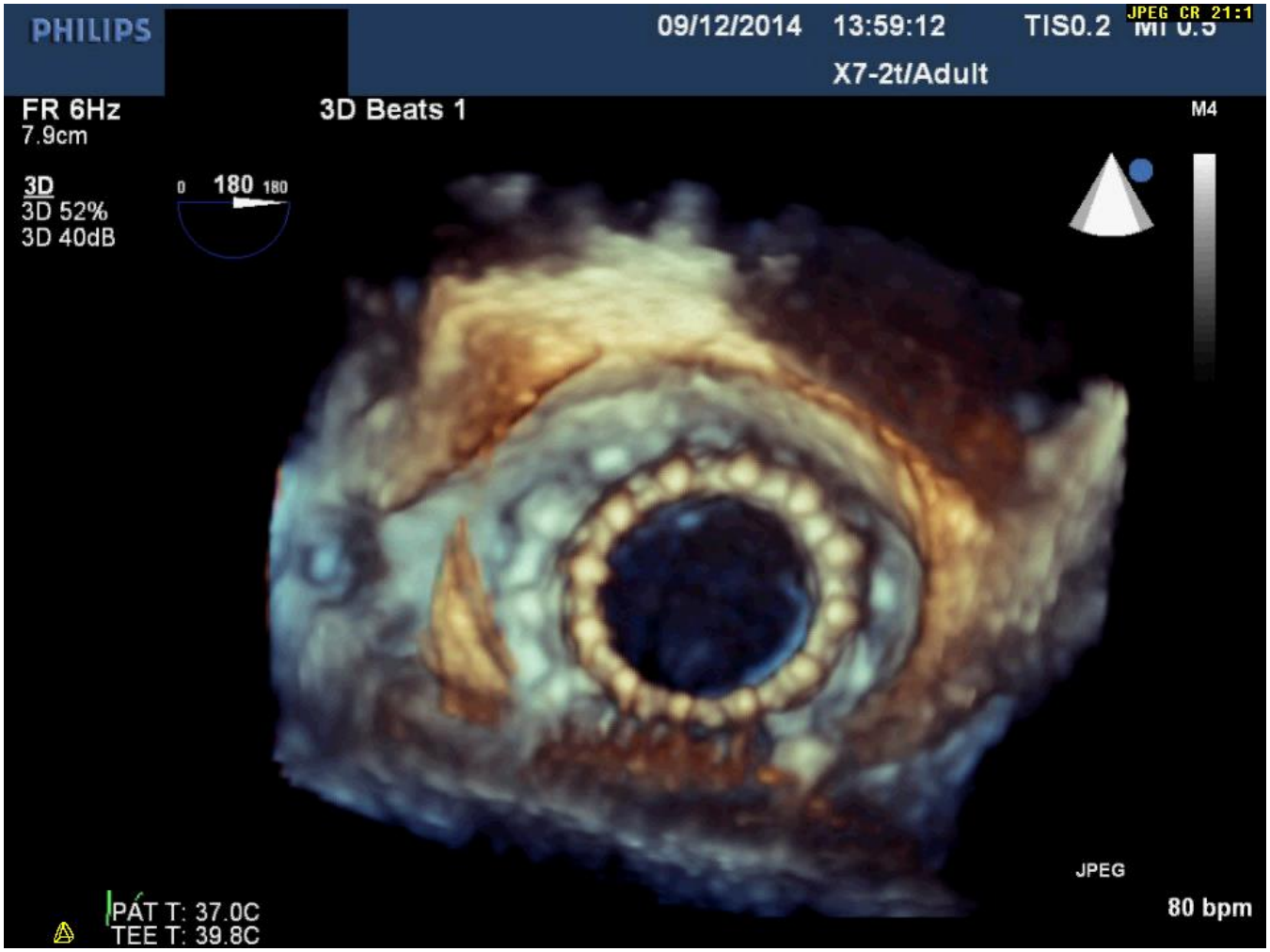


Intercommisural view



LVOT view

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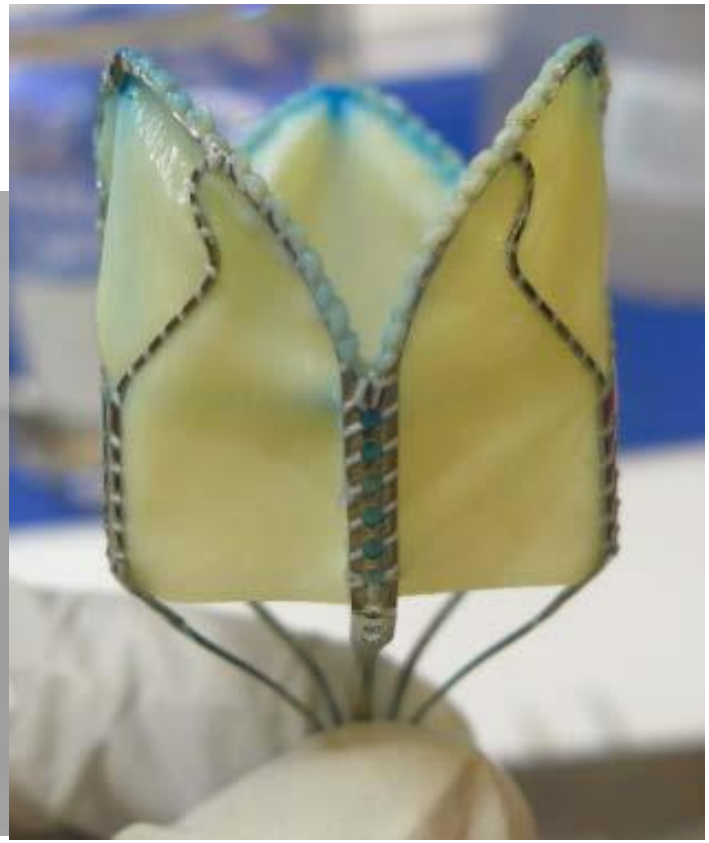
09/12/2014 13:59:12
TIS0.2
JPEG CR 21:1
X7-2t/Adult
FR 6Hz
7.9cm
3D Beats 1
M4
3D
3D 52%
3D 40dB
0 180 180
JPEG
PAT T: 37.0C
TEE T: 39.8C
80 bpm

TENDYNE (Abbott)



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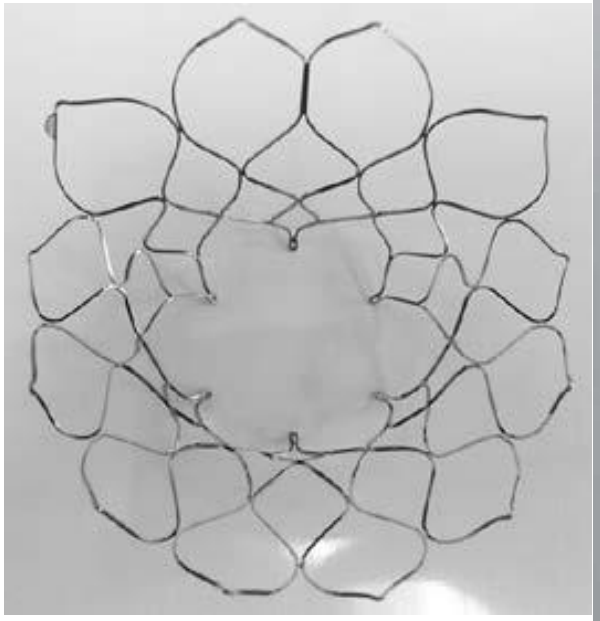

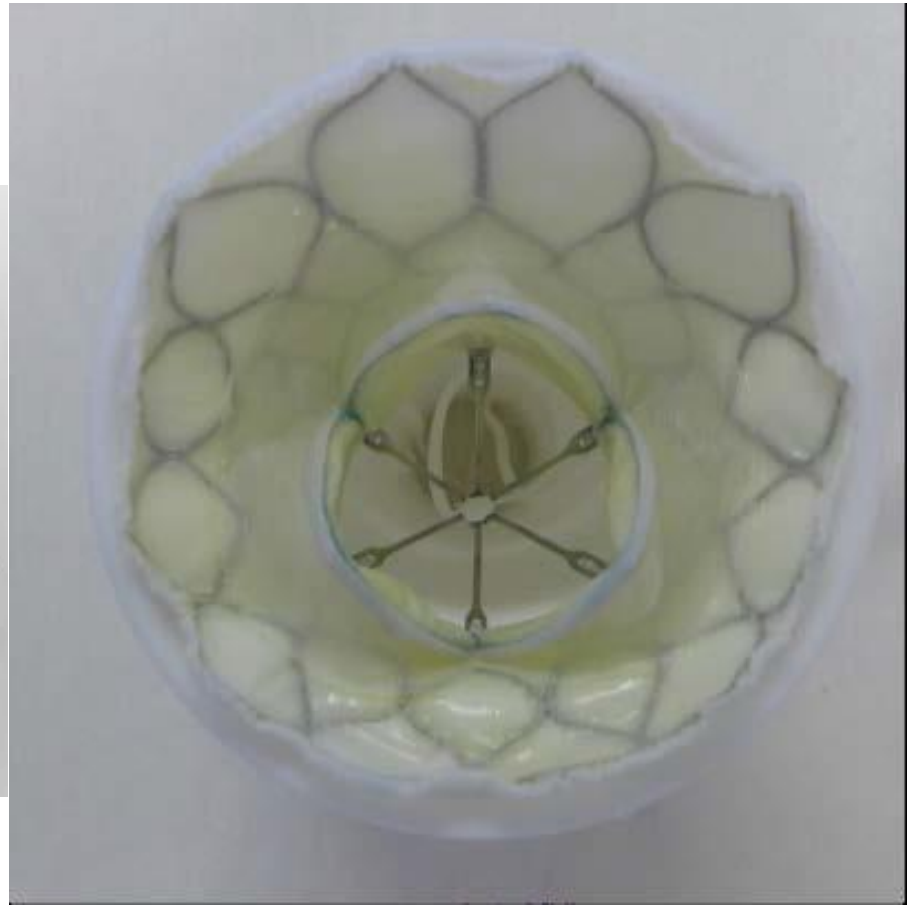

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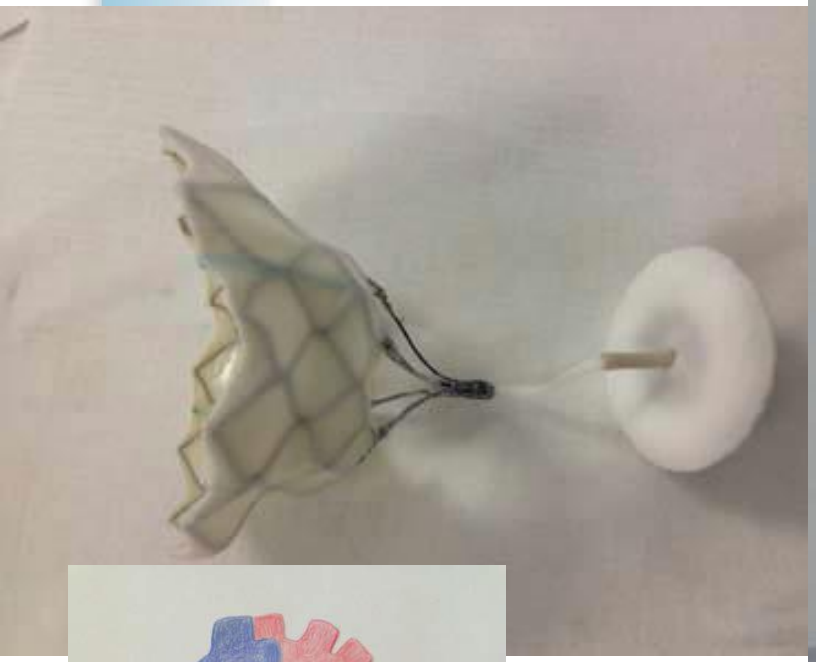

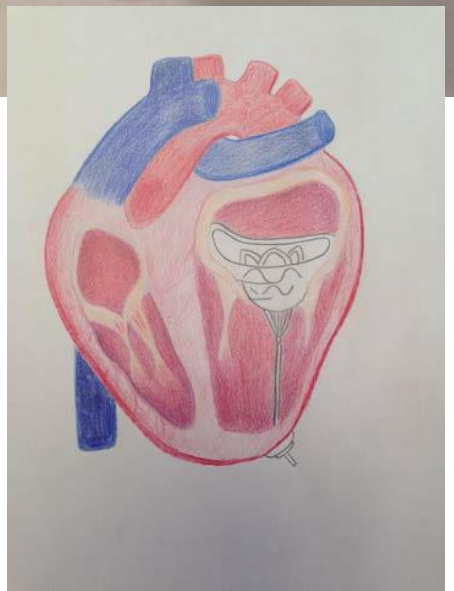

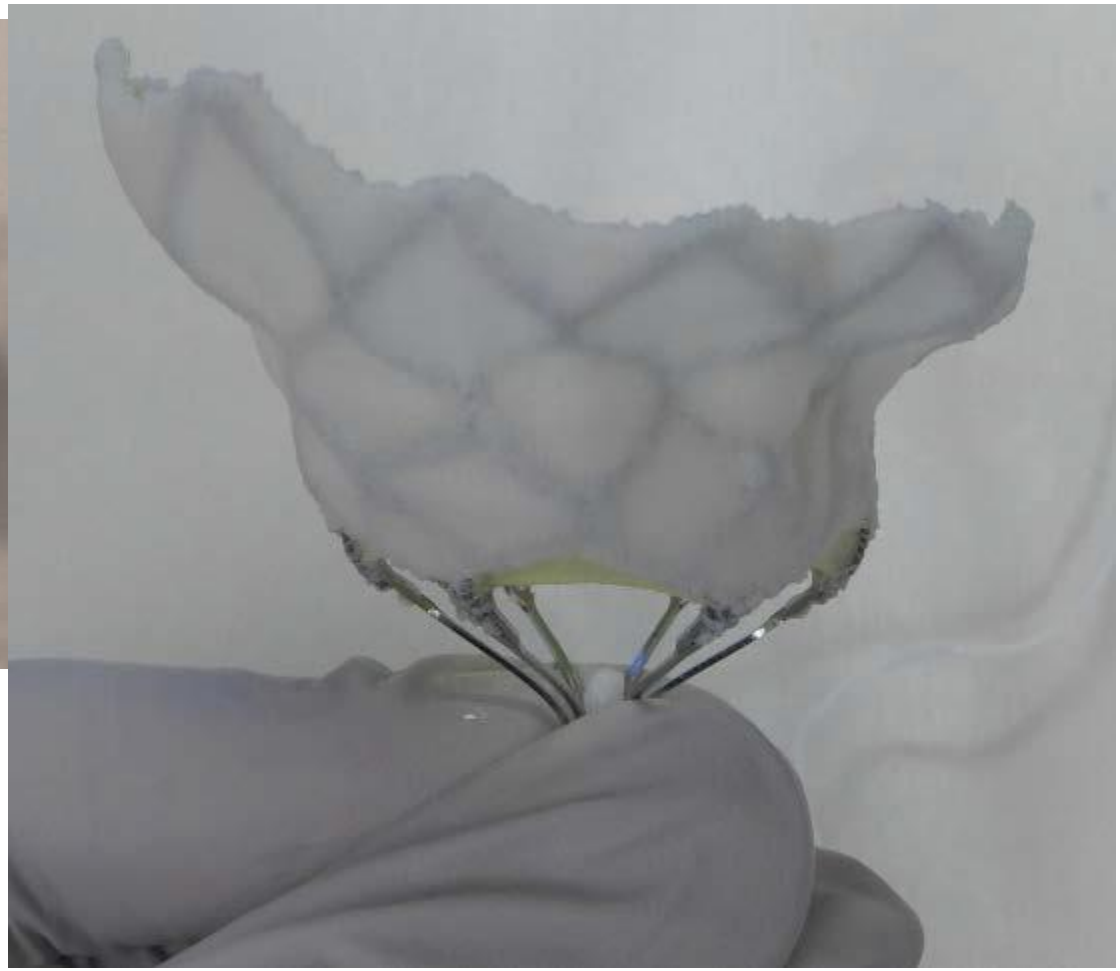

STATE-OF-THE-ART PAPER

Percutaneous Transcatheter Mitral Valve Repair

A Classification of the Technology

Paul T. L. Chiam, MBBS,* Carlos E. Ruiz, MD, PhD†

Singapore; and New York, New York

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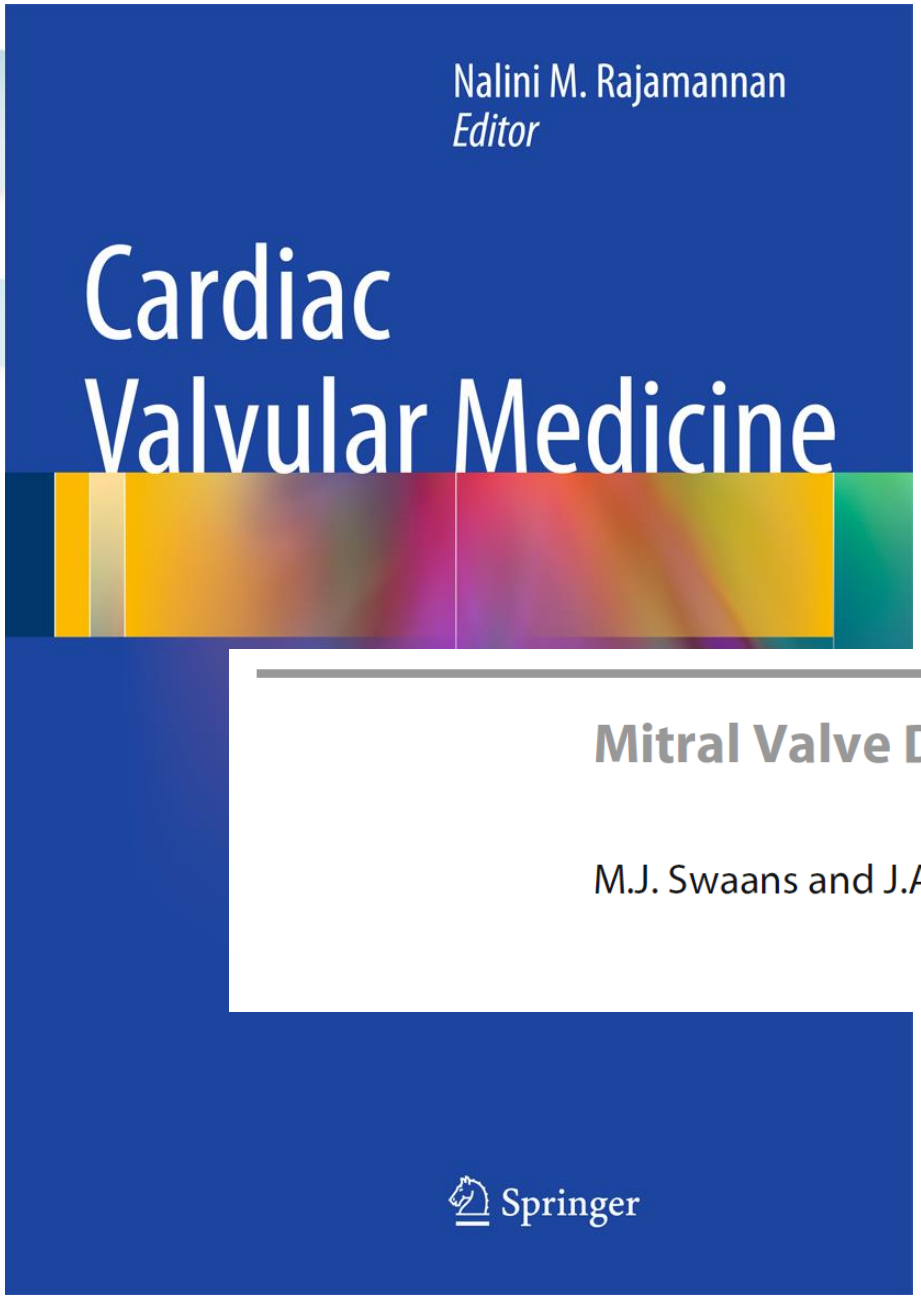

Mitral Valve Devices

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M.J. Swaans and J.A.S. van der Heyden

"This really is an innovative approach, but I'm afraid we can't consider it. It's never been done before."

Thank you for your attention!