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Future Directions: Structural Heart Disease Interventions

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Structural Heart Interventions

- Shunts
 - ASD and PFO closure
 - VSD closure
 - Fistula closure
- Valvular heart disease
 - Valvuloplasty
 - Paravalvular leak closure
 - Valve repair
 - Valve replacement
- Cardiomyopathies
 - Dilatation and stent implantation of sub- and supra- valvular obstructions
 - Septal ablation
- Left atrial appendage closure
- Heart failure
 - Catheter treatment of LV aneurysms
 - LV remodeling
 - Monitoring
- Some extracardiac diseases
 - Patent ductus closure
 - Angioplasty/stenting of coarctation
 - Stenting of pulmonary artery stenoses
 - Stenting of pulmonary vein stenoses
 - Pulmonary AV Fistula closure
- "Exotic interventions"

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- "Exotic interventions"

Future Directions in PFO Closure

- Indications, reimbursement and use in daily clinical practice will depend on the results of the randomized trials
 - CLOSURE I to be presented at AHA
 - PC Trial 2011
 - If these trials are positive, PFO closure will become one of the most frequent structural heart interventions
 - If these trials are negative, the same will happen
- Technically, there is a trend towards defect anatomy specific closure techniques
 - For example in-tunnel devices
- Bioresorbable devices and closure techniques without a device are under development

Paravalvular Leak Closure

Paravalvular leaks after surgical valve replacement

- Are frequent
 - 12% echo incidence for mitral prostheses
 - 5% aortic prostheses requiring replacement
- May cause severe symptoms
 - Hemolysis, valve insufficiency
- Difficult to treat
 - Mortality for 1st redo around 12%
 - 2nd redo 15%
 - 3rd redo 35%
 - Freedom from recurrence less likely with each repeat redo operation

What about
device closure?

Experience
is very limited

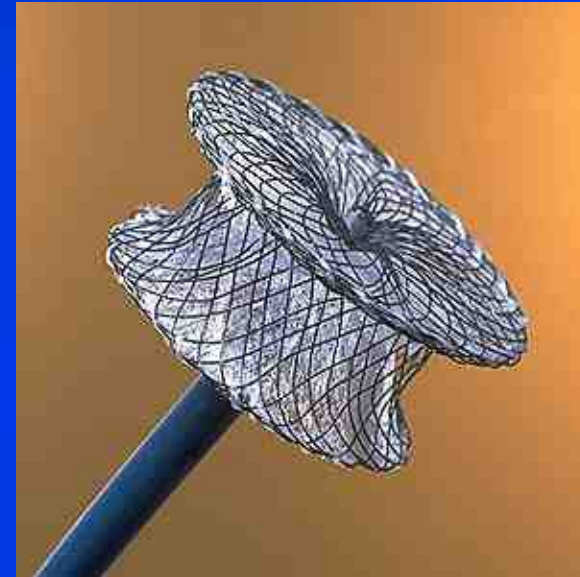
Devices

- Clamshell, Cardioseal-/
Cardioseal-Starflex
- Difficult!
- Not retrievable
- Bad results with Starflex due to the micro-springs



Devices

- Amplatzer
 - VSD Occluder
 - PDA Occluder



What are the Problems?

- Difficulties to cross the defect
- Difficulties to introduce the sheath due to friction
- Device may cause valve leaflet obstruction
- Residual leak due to shape of defect
- Hemolysis
- Delayed tissue covering
- Endocarditis

**What are
the future directions?**

We now have

- Steerable sheaths

Agilis NxT



We now have

- Steerable sheaths
- Improved imaging
 - intra-cardiac echocardiography
 - Trans-venous
 - Trans-arterial
 - the first generation of 3D TEE
- A dedicated device for paravalv leaks
 - and there are more new devices to follow

With 3D TEE shape and size of defects can be visualized directly



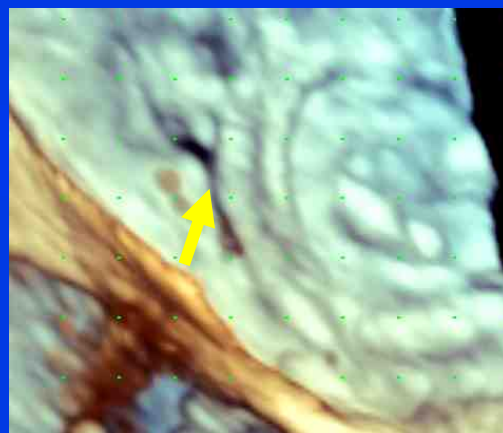
Round



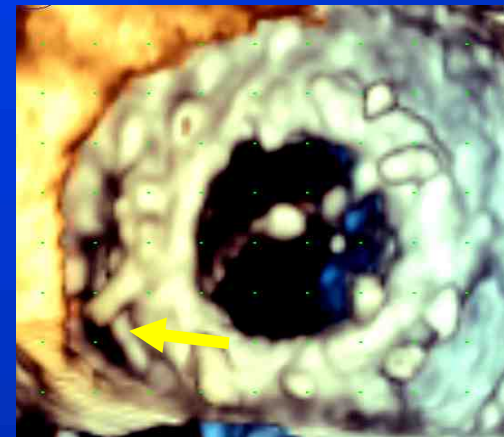
oval



crescentic

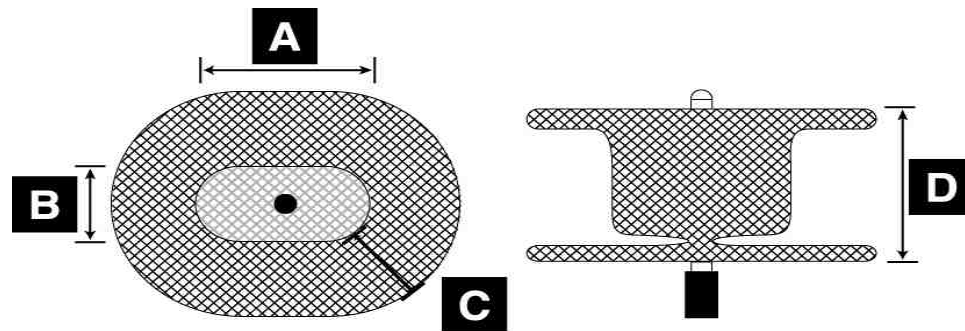


Slit-like



Crescentic cutting edge

Amplatzer Vascular Plug III



- Oval-shaped
- Thinner wires
- More wires
- Multiple layers

➤ smaller pore size

➤ improved surface contact

➤ faster occlusion

Guiding of the Procedure



Opening of LA disc...



After rotation..still suboptimal

This could not be imaged with 2D TEE...

iCi 2010
July 7, 2010
Frankfurt, Germany



IMAGING IN
CARDIOVASCULAR
INTERVENTIONS

INTERVENTIONAL IMAGING:
**A KEY ROLE
FOR SUCCESS**

10

www.ici-congress.org

Even with these new technologies
paravalvular leak closure is still a
difficult and demanding procedure

However, procedural
complications are rare ...

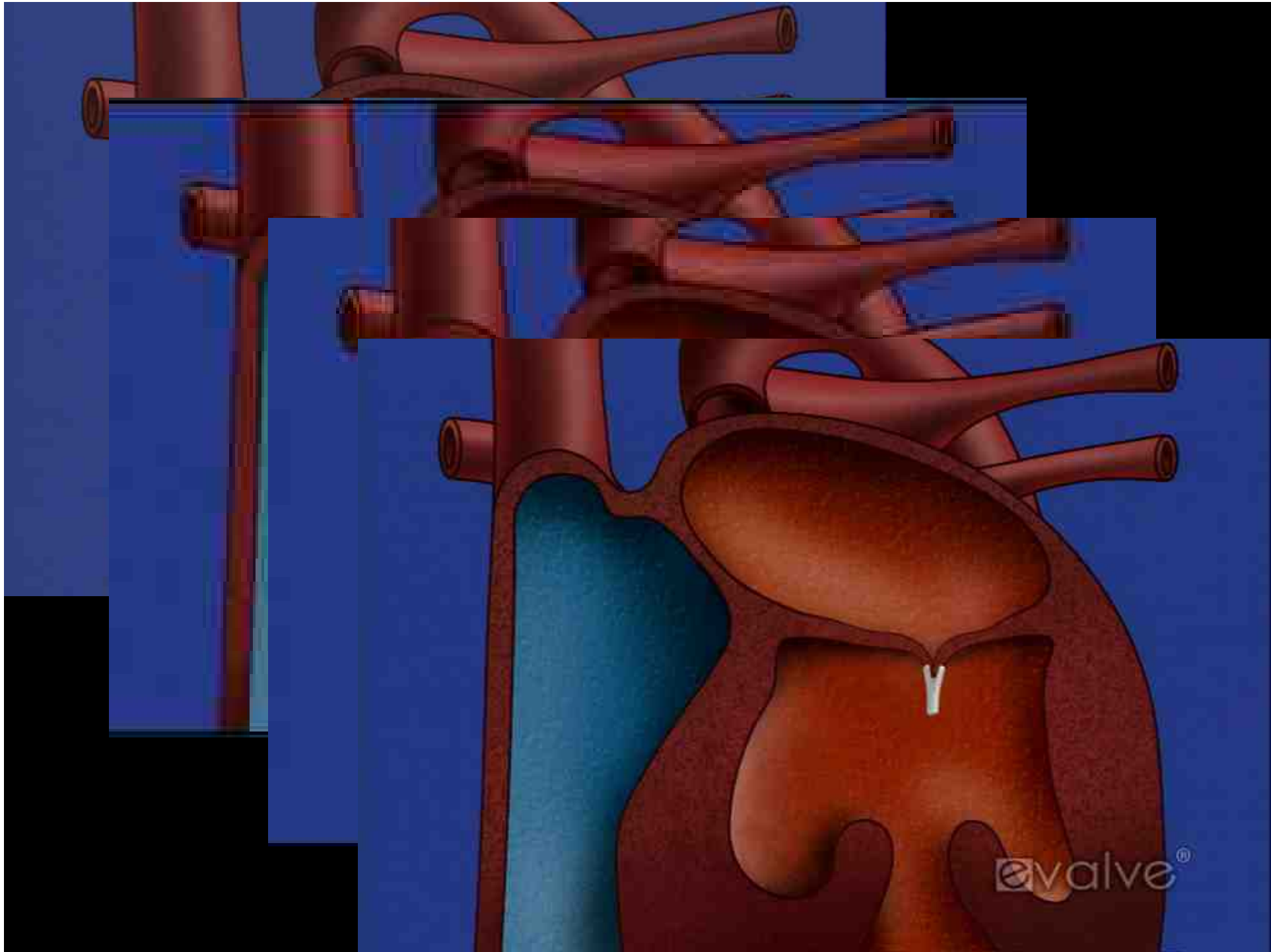
... they usually can be managed by
catheter techniques ...

... and re-do surgery can still be
performed if necessary ...

For these reasons catheter closure will become the primary treatment option

Transcatheter Valve Repair

- Almost the past in the US
 - the FDA may need years
- Present in Europe
 - Almost routine in selected centers
- Future in Asia





July 8 – 10, 2010 | Frankfurt, Germany

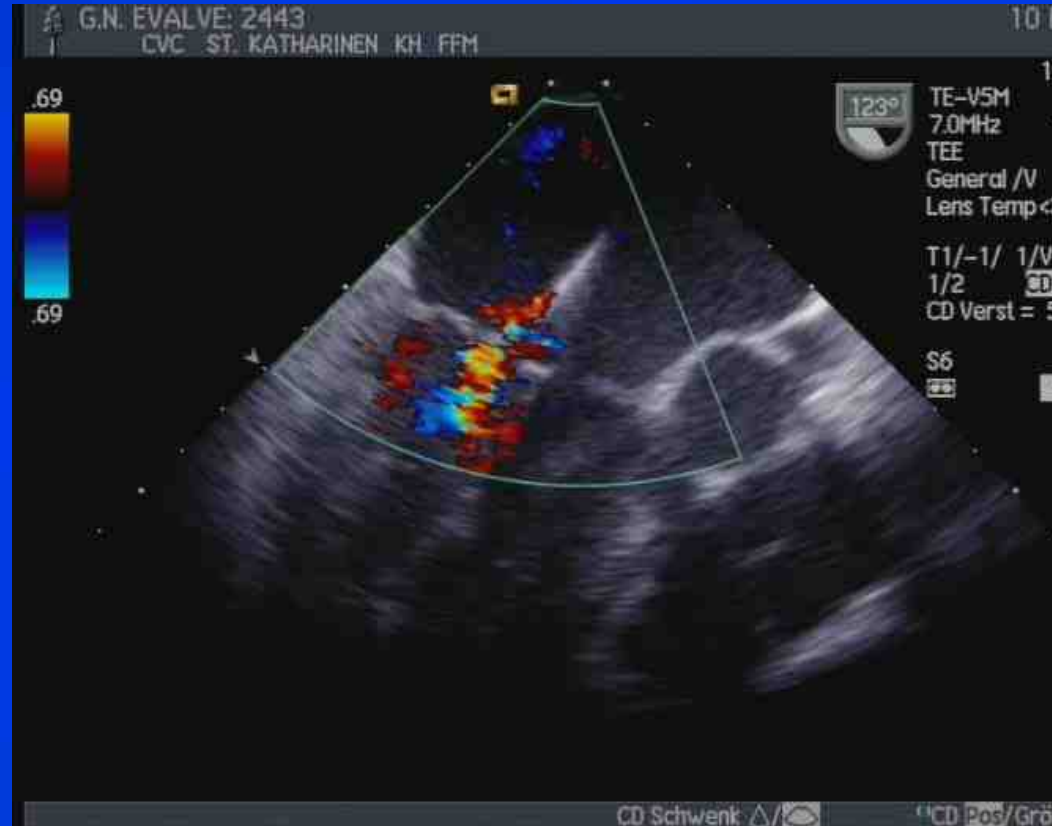
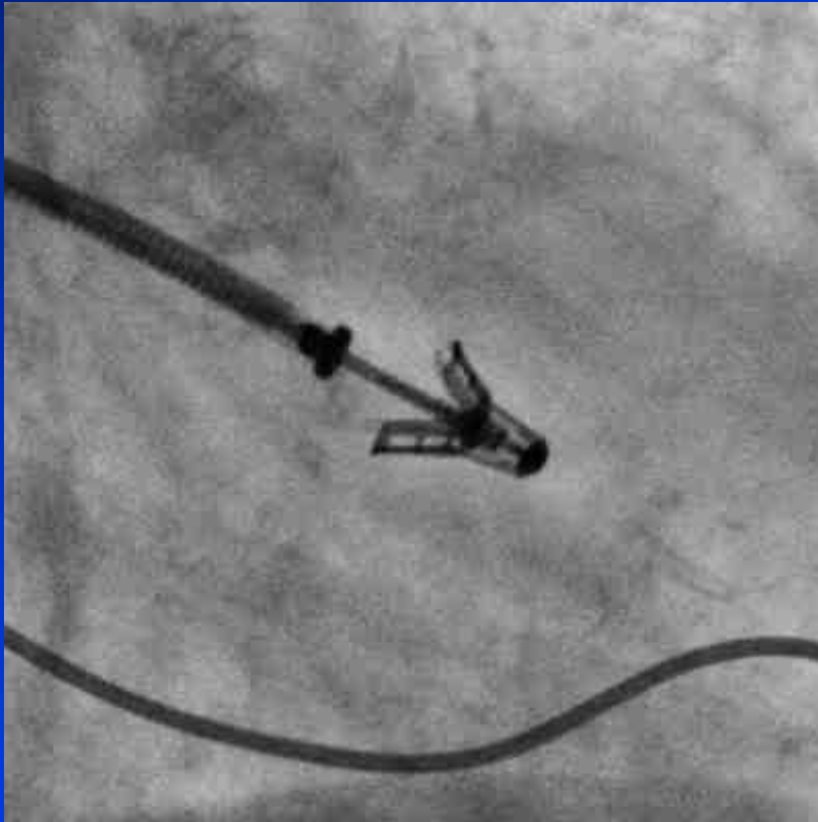
CSI – Catheter Interventions in Congenital & Structural Heart Diseases



www.csi-congress.org

LIVE
CASES

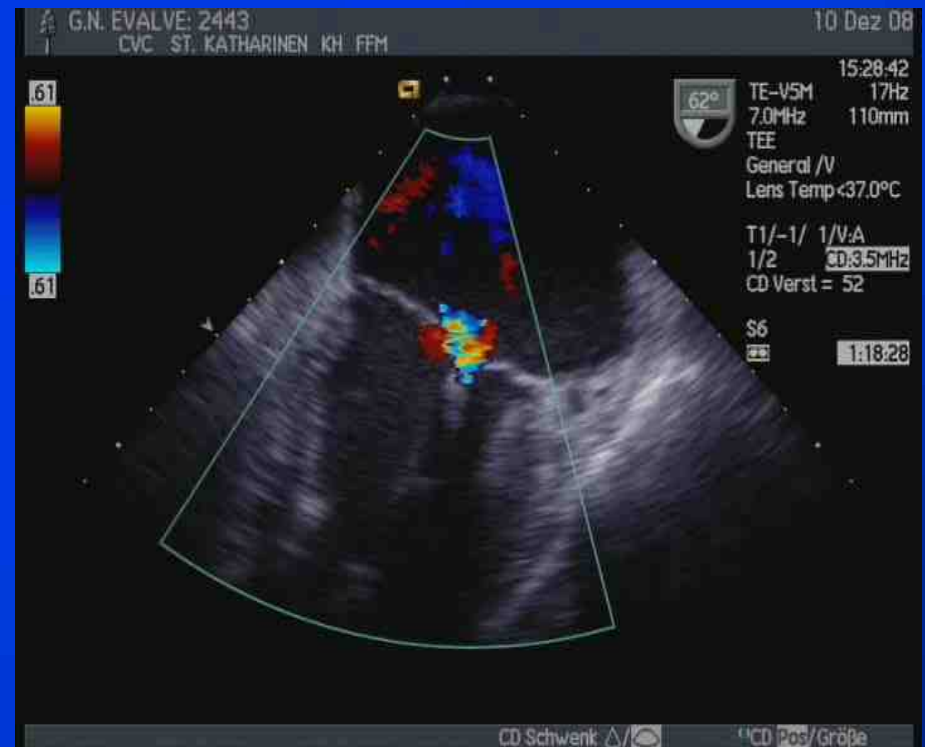
1. Grasping



MR decreases during clip closure

before

after



EVEREST II Randomized Clinical Trial

Study Design

279 Patients enrolled at 37 sites

Significant MR (3+-4+)
Specific Anatomical Criteria

↓
Randomized 2:1

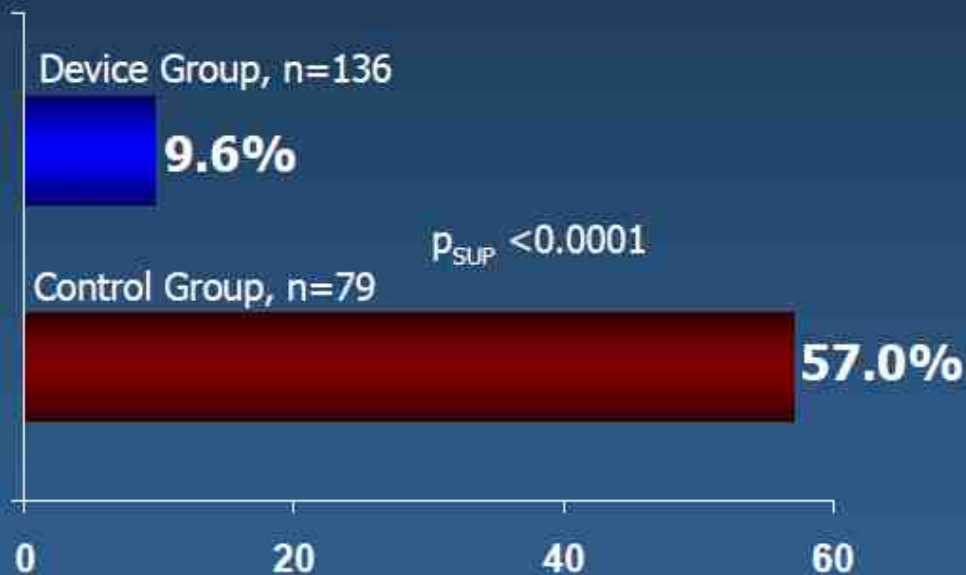
↙ ↘
Device Group
MitraClip System
N=184

↙ ↘
Control Group
Surgical Repair or Replacement
N=95

↓ ↓
Echocardiography Core Lab and Clinical Follow-Up:
Baseline, 30 days, 6 months, 1 year, 18 months, and
annually through 5 years

EVEREST II RCT: Primary Endpoints Per Protocol Cohort

Safety
Major Adverse Events
30 days



Met superiority hypothesis

- Pre-specified margin = 6%
- Observed difference = **47.4%**
- 97.5% LCB = 34.4%

LCB = lower confidence bound
UCB = upper confidence bound

Effectiveness
Clinical Success Rate*
12 months



Met non-inferiority hypothesis

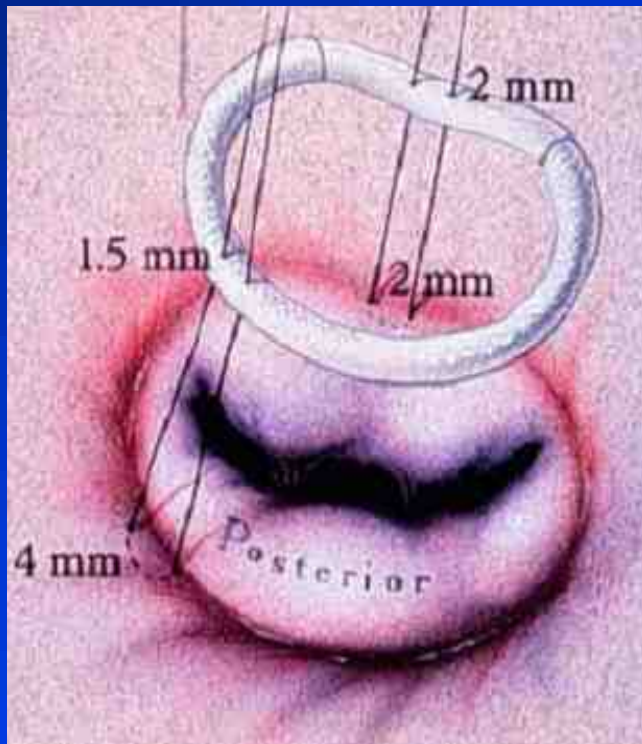
- Pre-specified margin = 31%
- Observed difference = **15.4%**
- 95% UCB = 25.4%

* Freedom from the combined outcome of death, MV surgery or re-operation for MV dysfunction, MR >2+ at 12 months

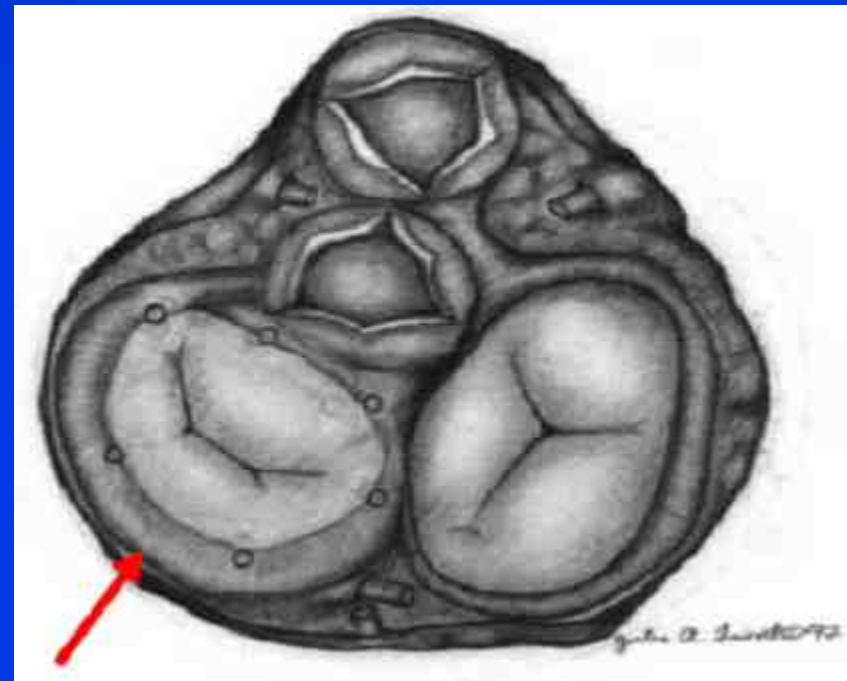
What does that mean?

- The catheter technique is as good as surgery
- Complications are 5 x less frequent as with surgery and less severe
- This is true for surgical candidates, not only for high surgical risk patients
- Without question high surgical risk patients will benefit even more from the catheter approach

Surgeons usually combine mitral valve leaflet repair with anuloplasty



Reduces diameter of annulus



Pushes posterior leaflet forward for better coaptation

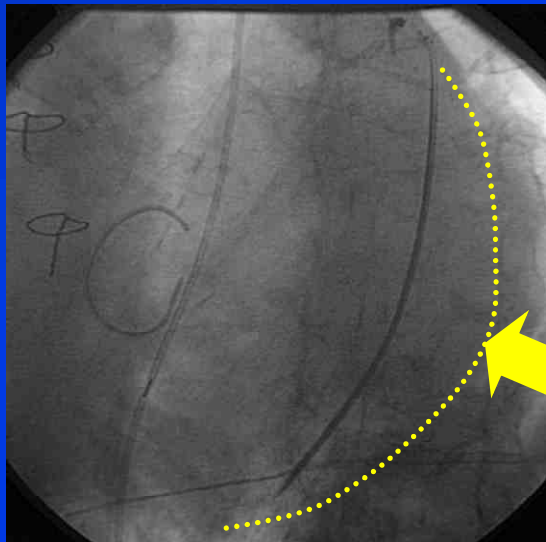
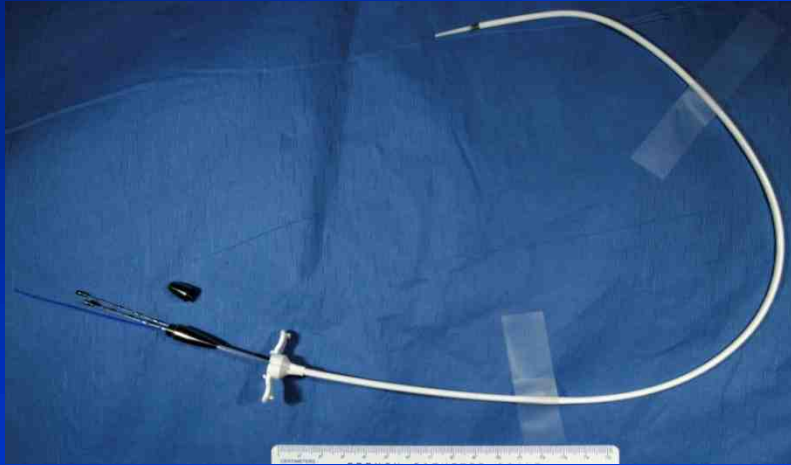
Percutaneous Mitral Repair

- Annuloplasty approaches
 - Coronary sinus annuloplasty
 - Edwards Monarc
 - Cardiac Dimensions Carillon
 - Viacor Shape Changing Rods
 - NIH-Cerclage
 - St. Jude Medical
 - Ample PS3
 - Direct annuloplasty
 - Mitralign Suture-based Plication
 - Guided Delivery AccuCinch
 - Cordis Direct Plication Annuloplasty
 - ReCor Medical
 - QuantumCor RF Annulus Remodeling
 - MiCardia variable size ring (hybrid)
 - Mitral Solutions (hybrid)

Annuloplasty Techniques

- Initially problems
 - Low efficacy
 - Complications due to compression of LCX
- Improved results with
 - better patient selection
 - increased operator experience
 - new devices

The PTMA Implant System

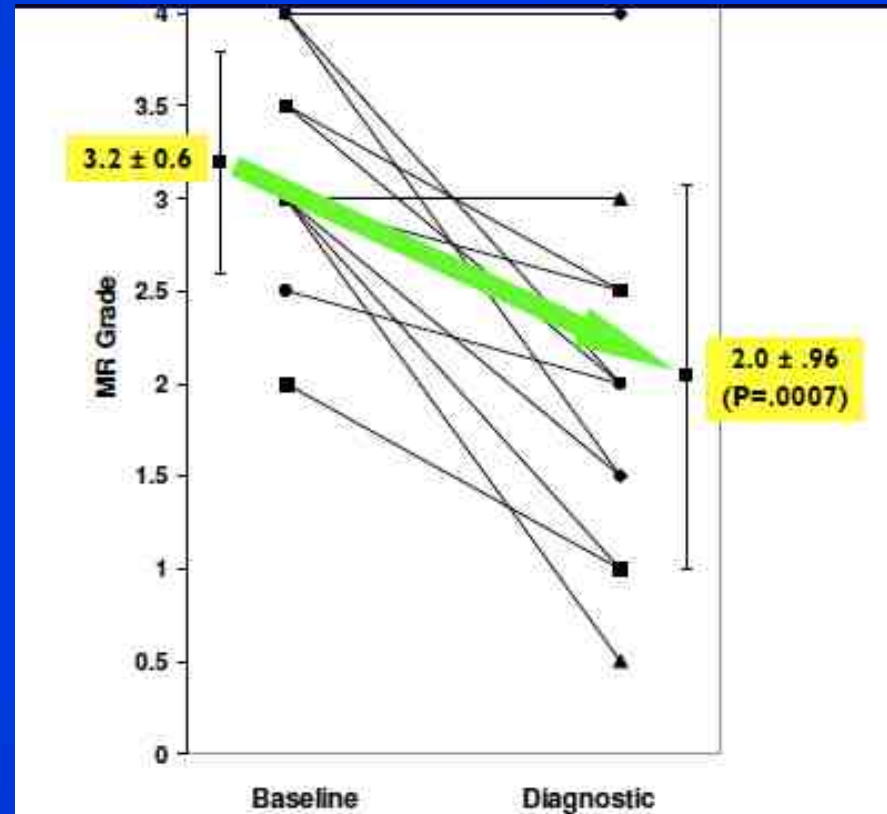


- Percutaneous subclavian access
- Permanent catheter in the coronary sinus
- Nitinol rods are progressively inserted
- Treatment effect is induced by re-shaping the coronary sinus
- Implant can be adjusted or removed
- Device action is one of bending rather than cinching between fixed anchors

Procedural MR Reduction by TEE

(PTOLEMY-1 Trial: n=13)

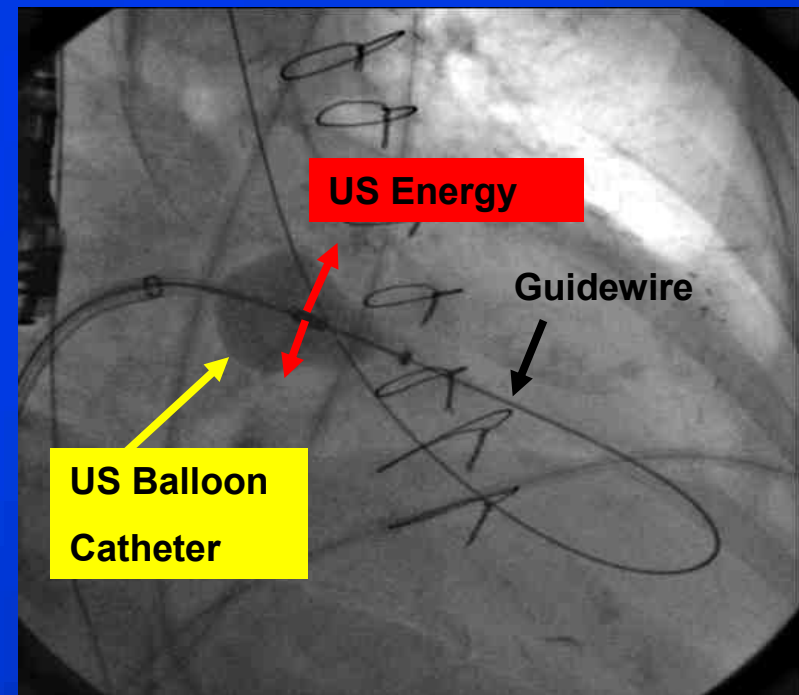
- No adverse events with sequelae
- < 2 hours procedure time
- MR reduction in 11/13 patients



ReCor

High Frequency Ultrasound

- A balloon catheter is advanced via transseptal access into the left atrium
- Balloon is inflated with contrast-water and positioned at the mitral annulus
- High Frequency Ultrasound (HIFU) is delivered circumferentially to produce tissue heating
- 5 applications with 80–130 W for 40-60s
- FIM 25. Feb 2010



ReCor

Balloon position in 3D

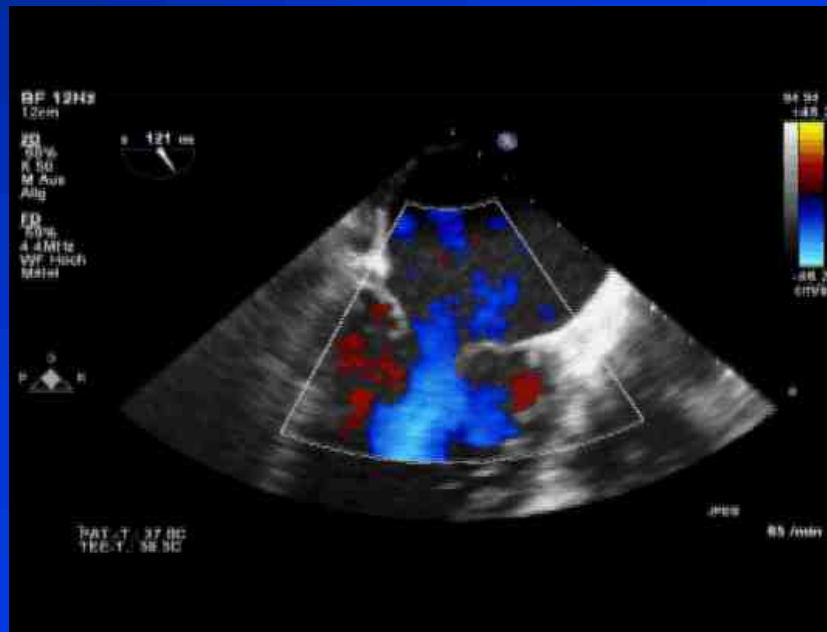


Babic

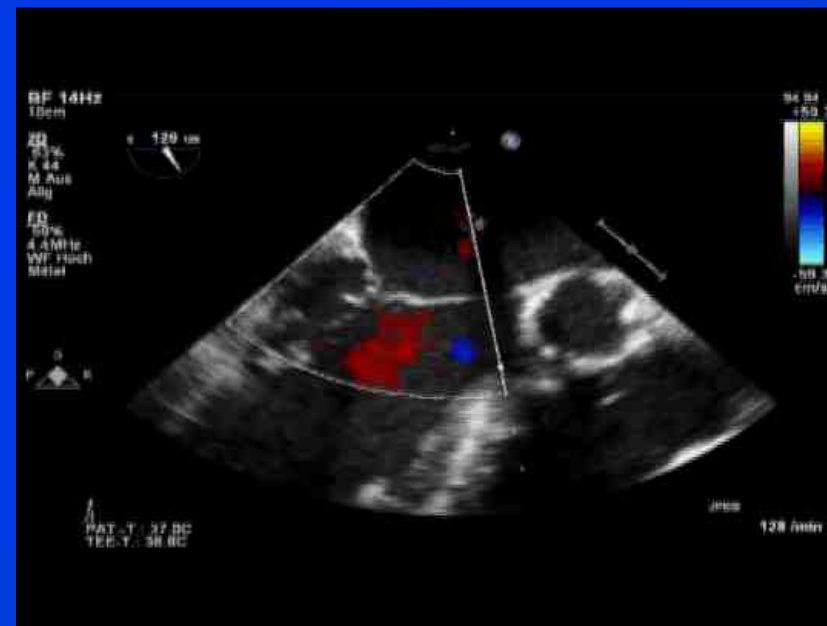
- Percutaneous implantation of artificial chordae tendineae



Babic



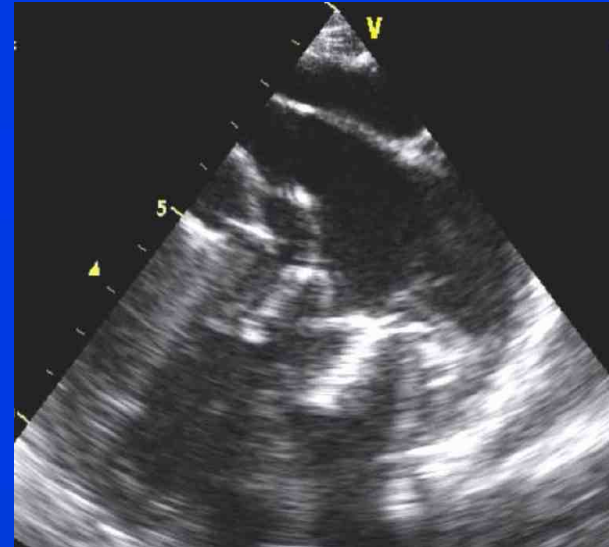
Pre-implant



Post-implant

Lutter Mitral Valve Prosthesis

- Stent mounted valve
- Transapical
- Animal tests are ongoing
- Current trial:
 - Accurate positioning in 4/5 pigs
 - 4 pigs completed 7 days follow-up
 - After 7 days:
 - Correct valve position
 - Only small transvalvular and LVOT gradients
 - No migration or embolism
 - No LVOT obstruction



... and the future of mitral valve interventions?

- We will have to find out which of the many different approaches do work best
- Those will need improvement and refinement
- We will have to combine different techniques like the surgeons do
- At the end, transcatheter techniques will replace surgery as the primary approach not in all but in many patients

Aortic Valve Implantation

CoreValve & Edwards

- Already daily routine in Europe
- > 6000 patients
- Completely percutaneously
- Procedural mortality in many centers < 3%
- Excellent mid-term results

Next generation aortic valves

- Repositionable
- Retrievable
- Low profile (< 18 F sheath)

Heart Leaflet Technologies



**<16 Fr
retrievable**

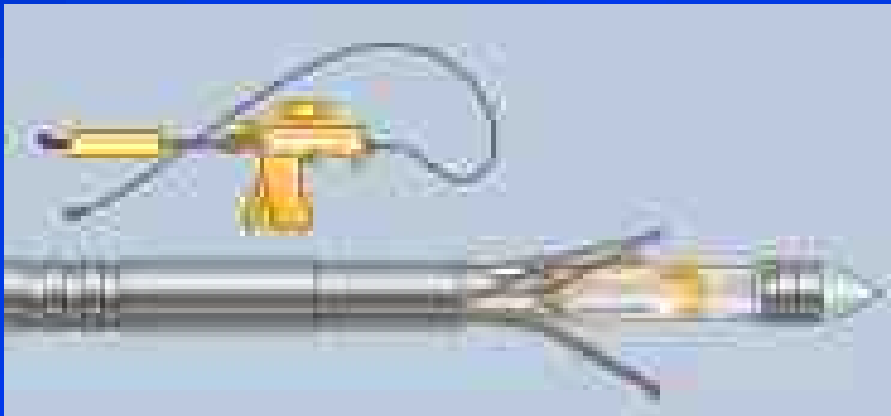


FIM 2009

Jena Valve

Unique design:
Prosthesis is "grabbing"
the native leaflets

Self-expanding
Repositionable
Porcine, equine or
bovine



Transapical human
implantations have been
performed

... and the future of transcatheter
aortic valve implantation?

We will be able to (almost)
completely replace
conventional surgery!

And I hope very much that we can do this
together with and not against the surgeons

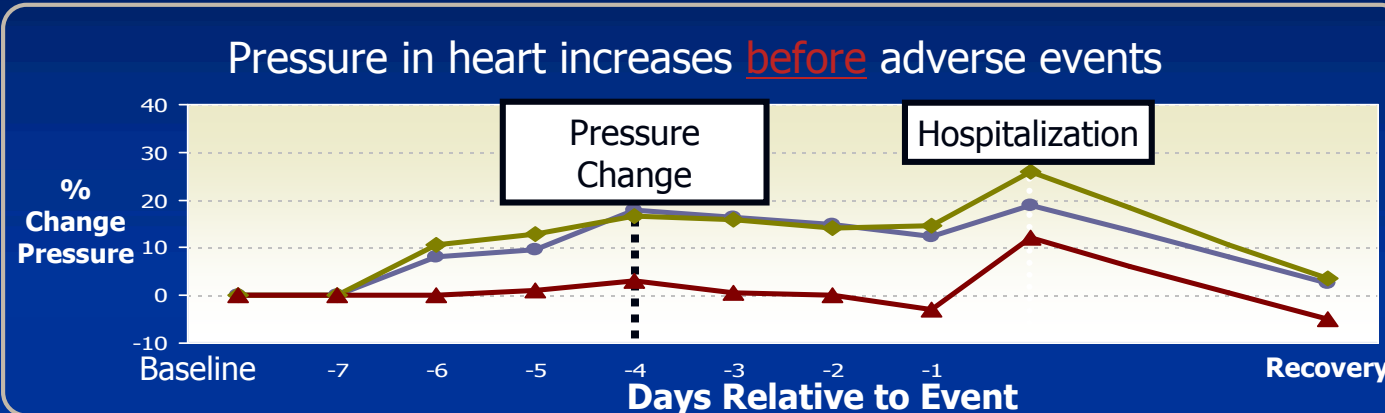
Structural Heart Interventions in Heart Failure Patients

- Acute heart failure
 - Assist devices
- Chronic heart failure
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 - Percutaneous treatment
 - Cardiac assist devices
 - Epicardial techniques
 - Intraventricular approaches

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Heart Failure: Monitoring Can Reduce Hospitalizations



Source: Journal of the American College of Cardiology, Adamson PB et al. J Am Coll Cardiol.2003; 41: 565.

Medtronic COMPASS Trial: 274 pts, Class 3 & 4

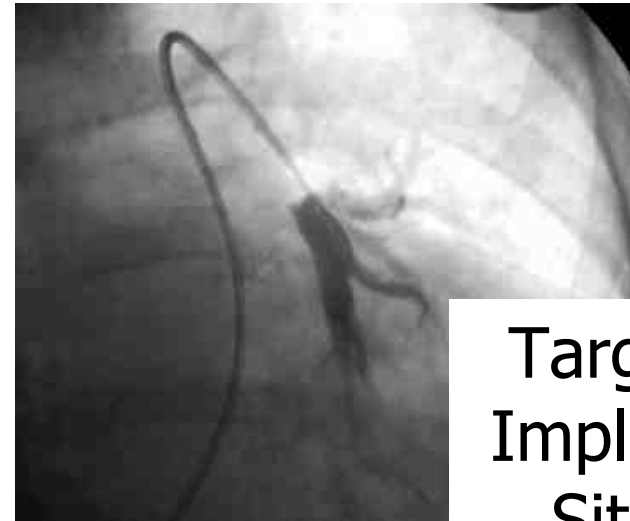
Measure	p ^(a)	% Decline
Reduction in heart failure hospitalizations and ER Visits	p=0.33	↓ 21%
Reduction in heart failure hospitalizations	p=0.03	↓ 36%
Reduction in heart failure hospitalizations: Class 3 patients	p=0.06	↓ 36%

(a) p values less than 0.05 are considered statistically significant.

CardioMEMS

Delivery System and Sensor Design

- Implantable sensor
- Measures the pressure in the pulmonary artery



Target
Implant
Site

HF Sensor Design:

Length: 15mm

Width: 3.5mm

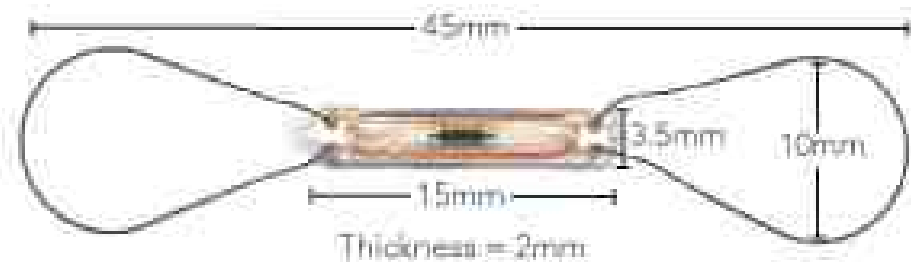
Height: 2.0mm

Wire Loops: 1cm diameter

Total Length with Loops: 4.5cm

Wire Loop Function:

- Maintain alignment with vessel
- Prevent distal embolization



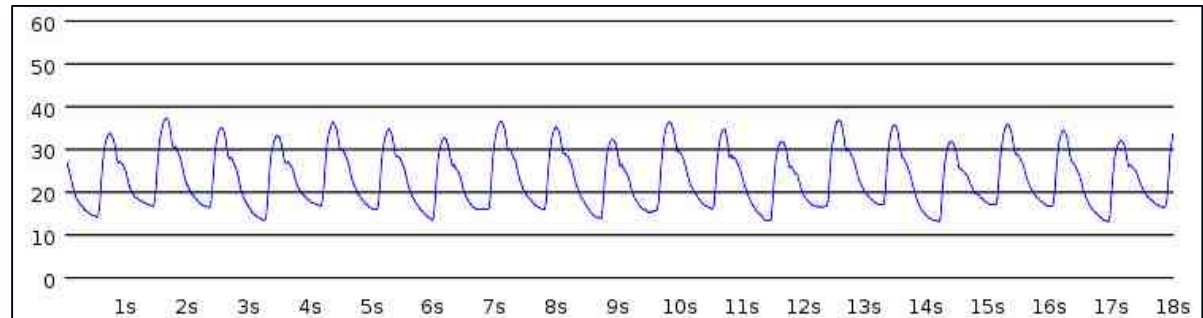
Patient Home Electronics Unit



Patient Data Viewed on Secure Web

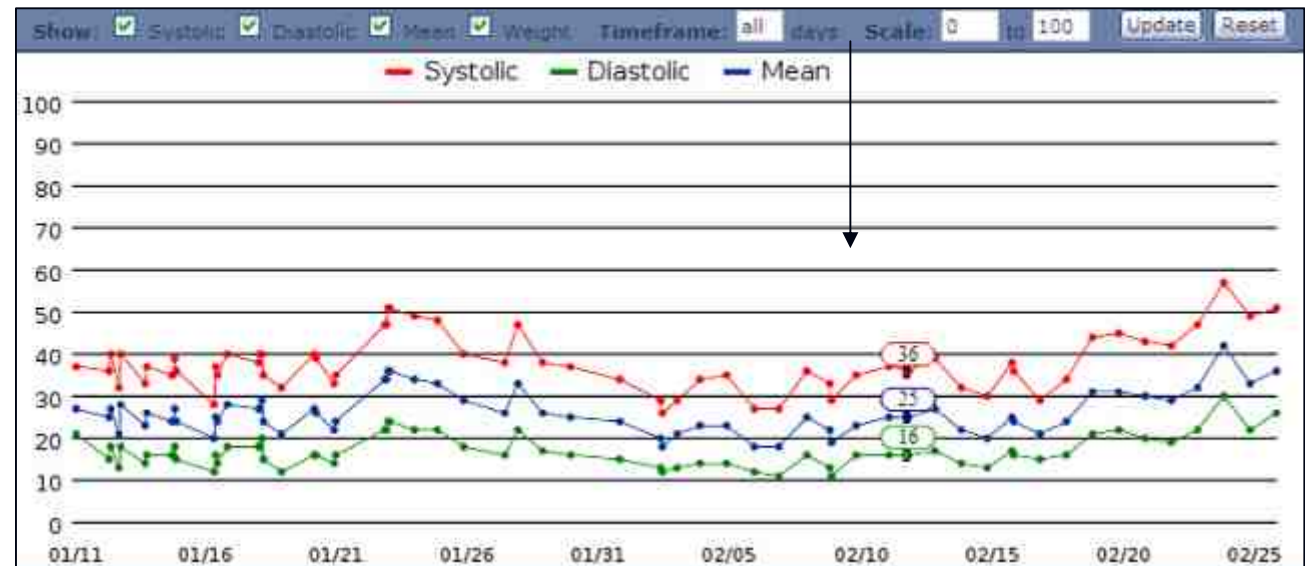
Discrete Data

Systolic	35
Diastolic	16
Mean	23
Cardiac Output	3.5
Heart Rate	65
Frequency Average	36072611
Signal Average	99
Signal Minimum	93



Trend Data

- Real-time
- Daily access
- Physician alerts
- Home transmissions

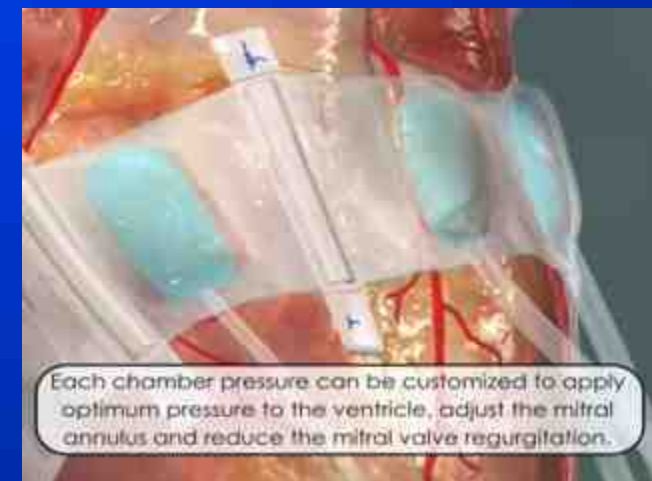
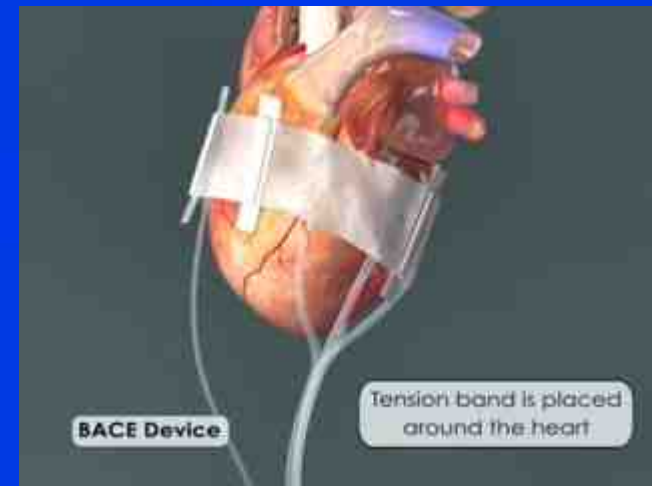


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Mardil's BACE System

- Silicone band with inflatable chambers placed around LV
- Surgically implanted (minimal invasive or open chest)
- Can be remotely adjusted after implantation
- Can be removed
- FIM:
 - N = 11
 - Mean reduction in MR > 2.5
 - Improvement in heart failure
 - No device related AEs



Dor Procedure

Aneurysm Resection



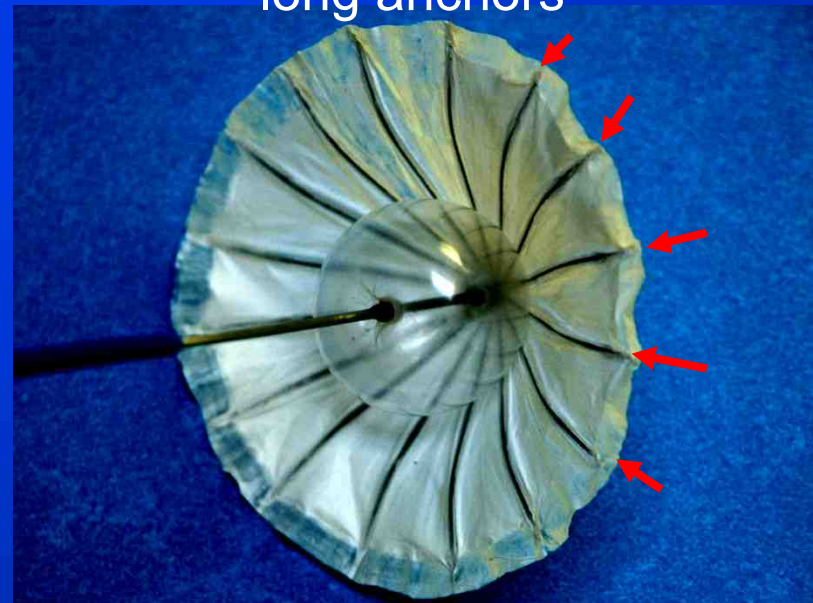
- Reduces the LV size
 - reduces LV wall stress
- Improves contractility of remote myocardium

VPD-Implant

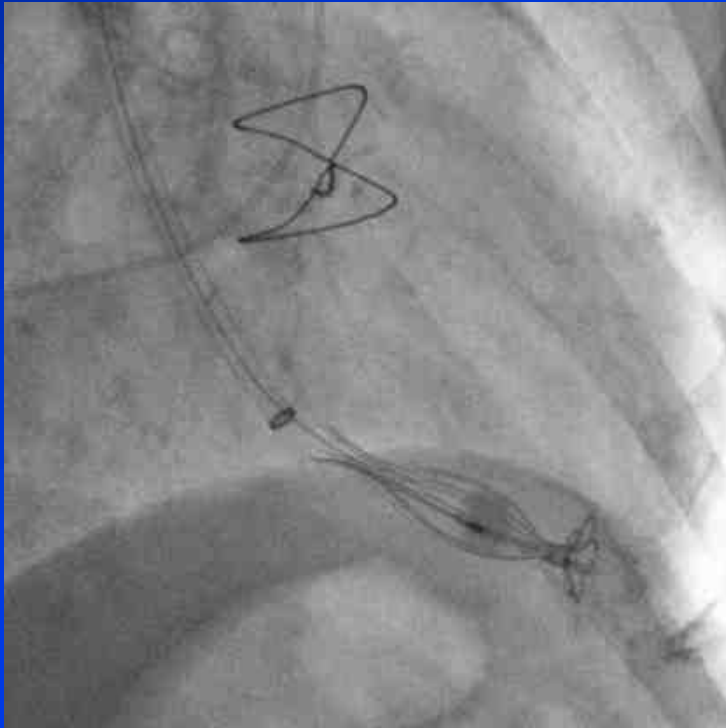
- First device designed to treat LV wall abnormalities by catheter techniques
- Umbrella-like occlusive membrane with a nitinol frame
- 2 mm long anchors
- Two sizes (75/85mm)
- Introduced through a 14 F sheath



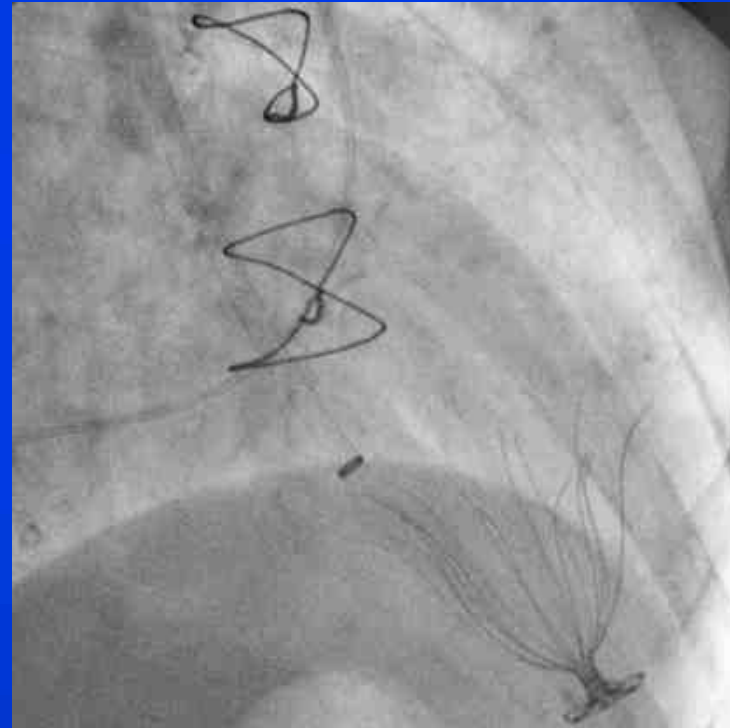
16 struts with 2mm long anchors



Case Example

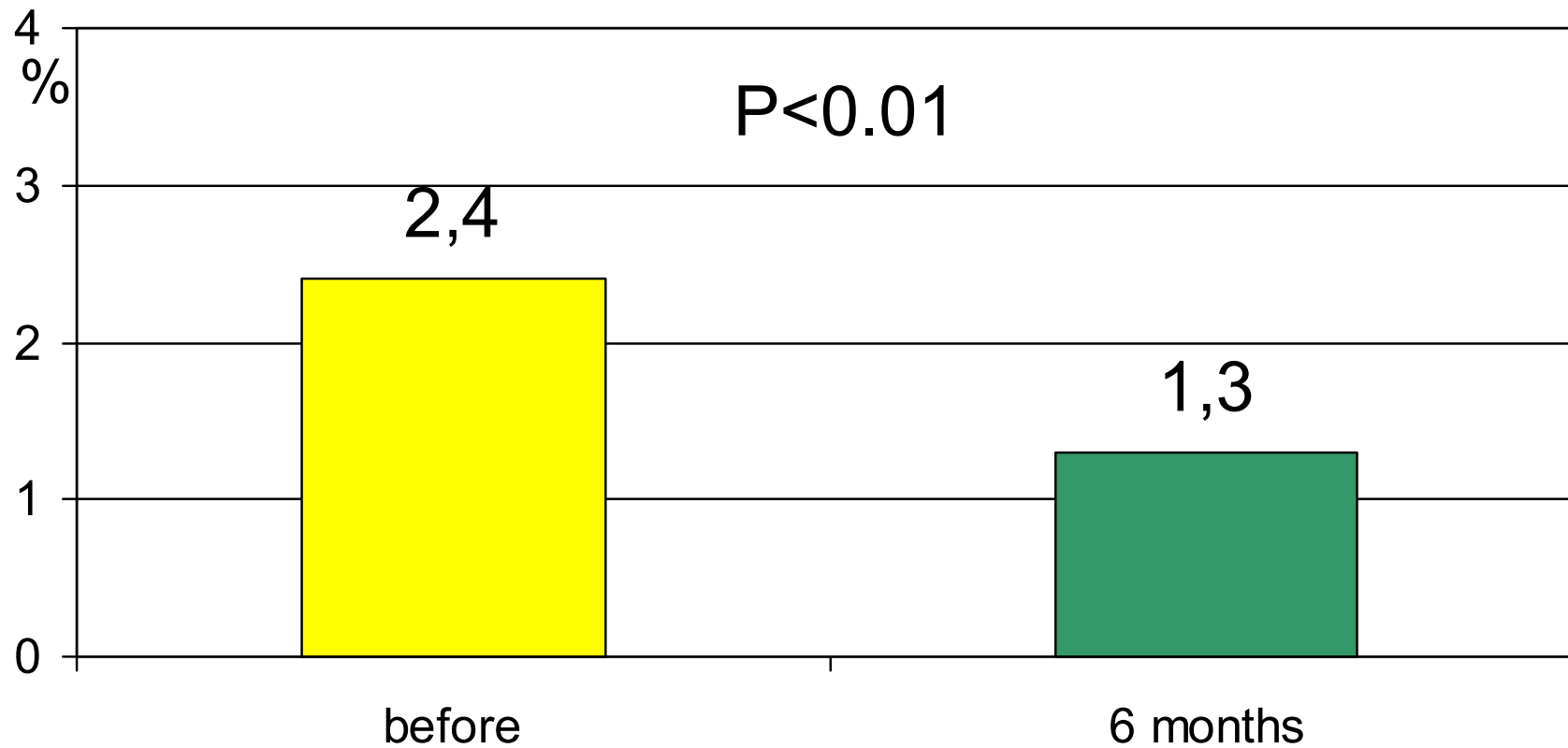


**BALLOON INFLATION TO
EXPAND DEVICE**

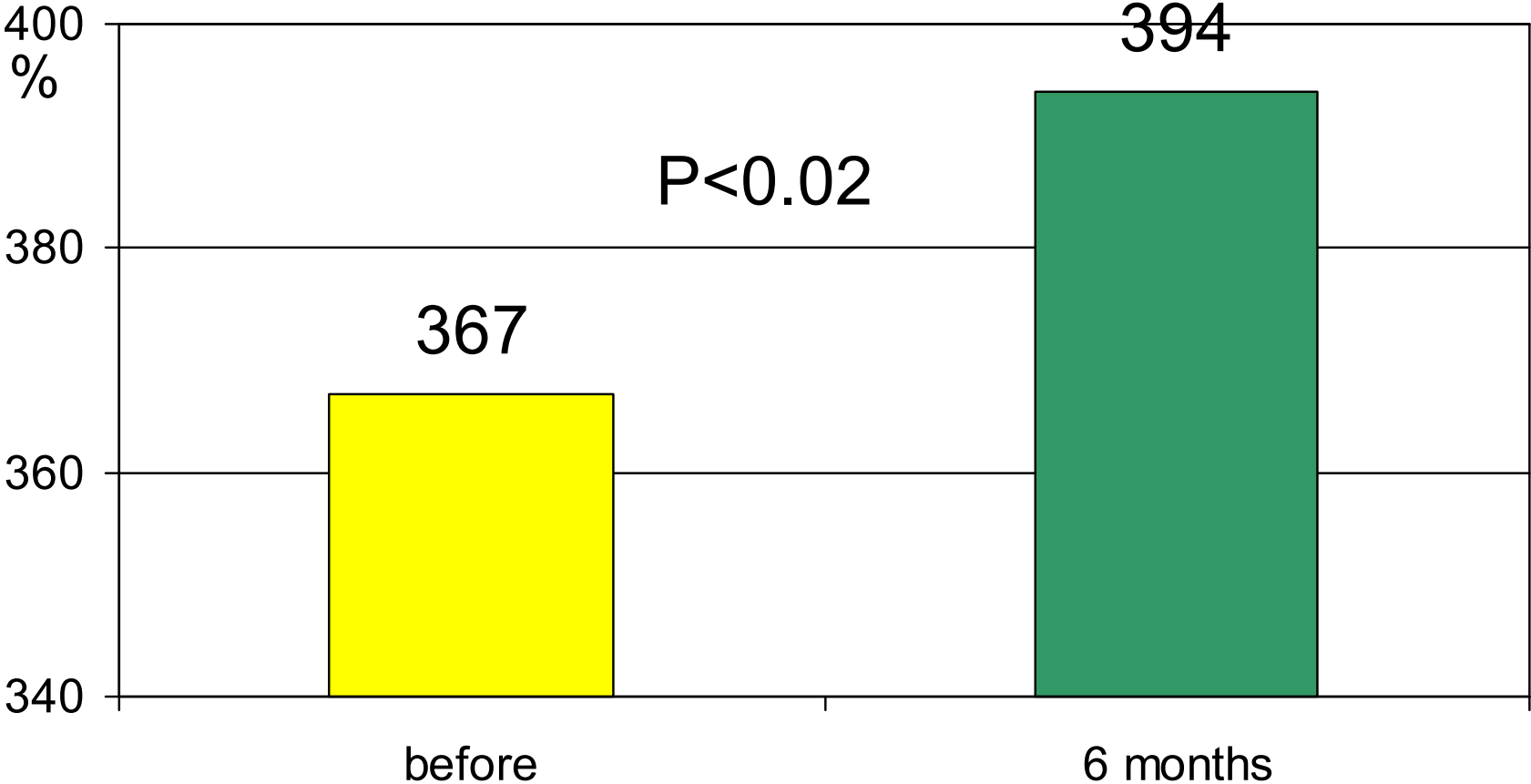


FULL DEPLOYMENT

Efficacy: NYHA Class



Efficacy: Six-Minute Walk



CAUTION: Investigational device. Limited by US law to Investigational Use.
This Material Copyrighted and Confidential.

Left Atrial Appendage Closure

Watchman Device



- Nitinol frame
- PET membrane
- row of fixation bars around the mid perimeter
- 21, 24, 27, 30, 33 mm

CE mark

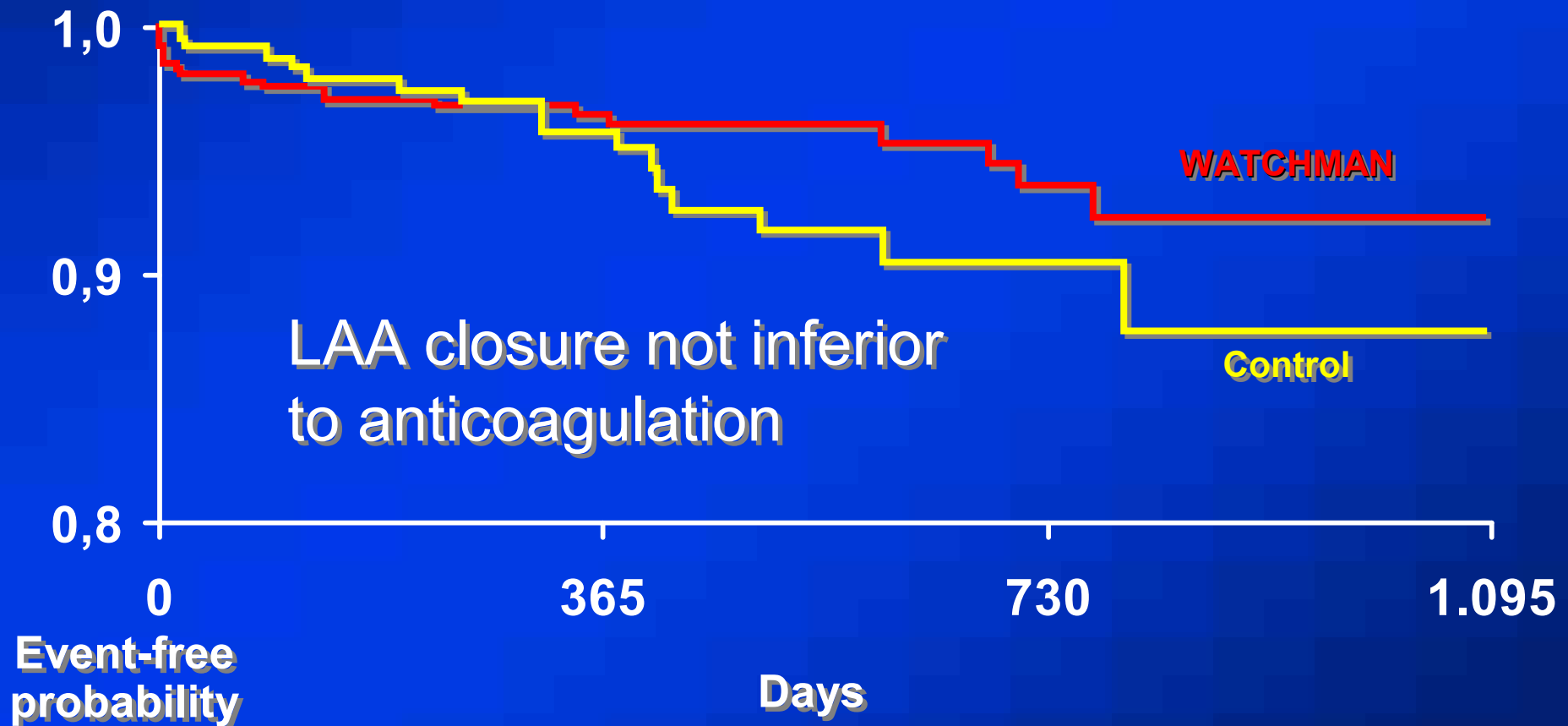
Protect AF

(System for Embolic PROTECTION
in Patients with Atrial Fibrillation)

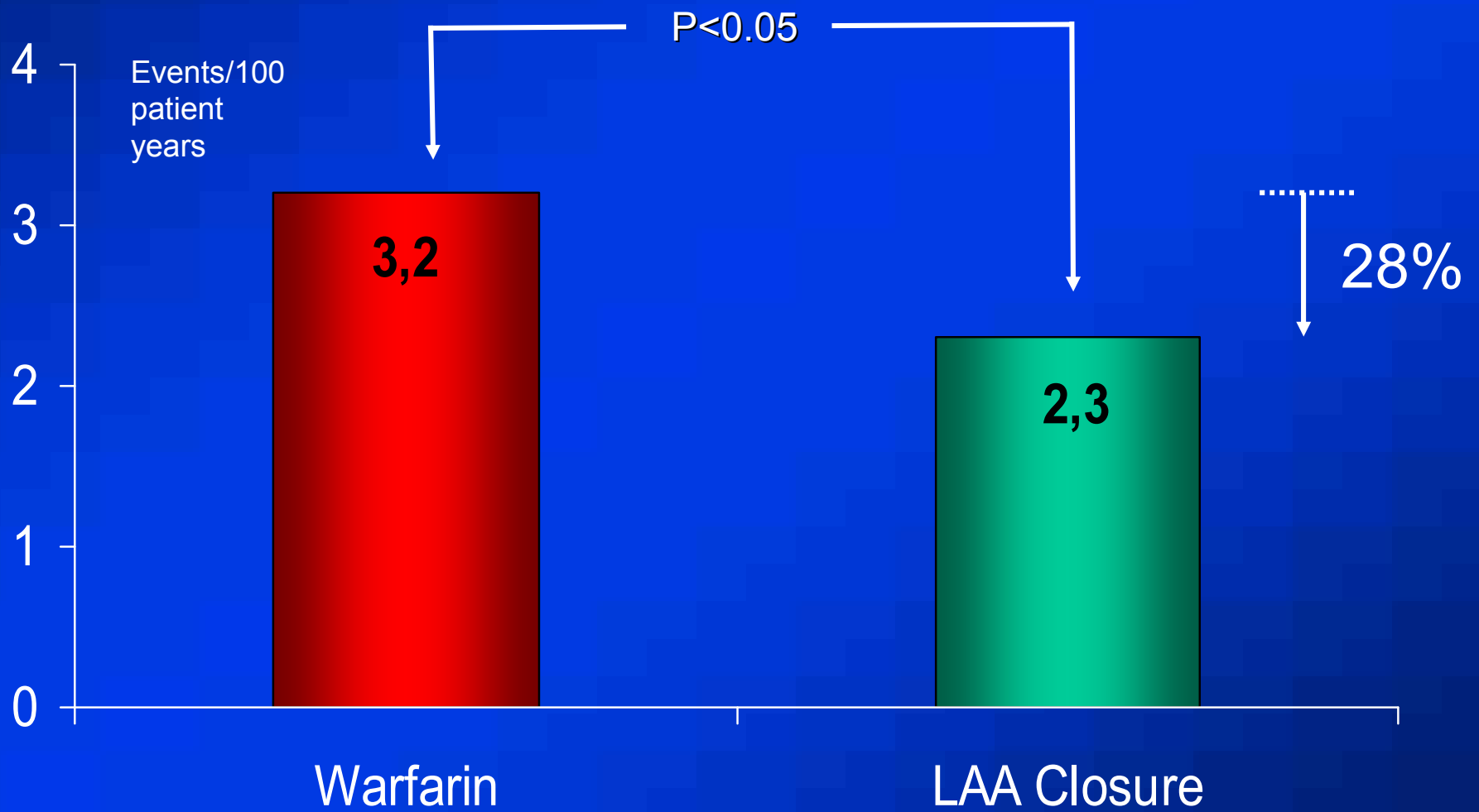
- Multicenter
- Prospective randomized
- WATCHMAN vs coumadin 2:1
- Non-inferiority trial
- 800 pts (enrollment closed June 2008)
- > 900 patient-years

Primary Efficacy Endpoint

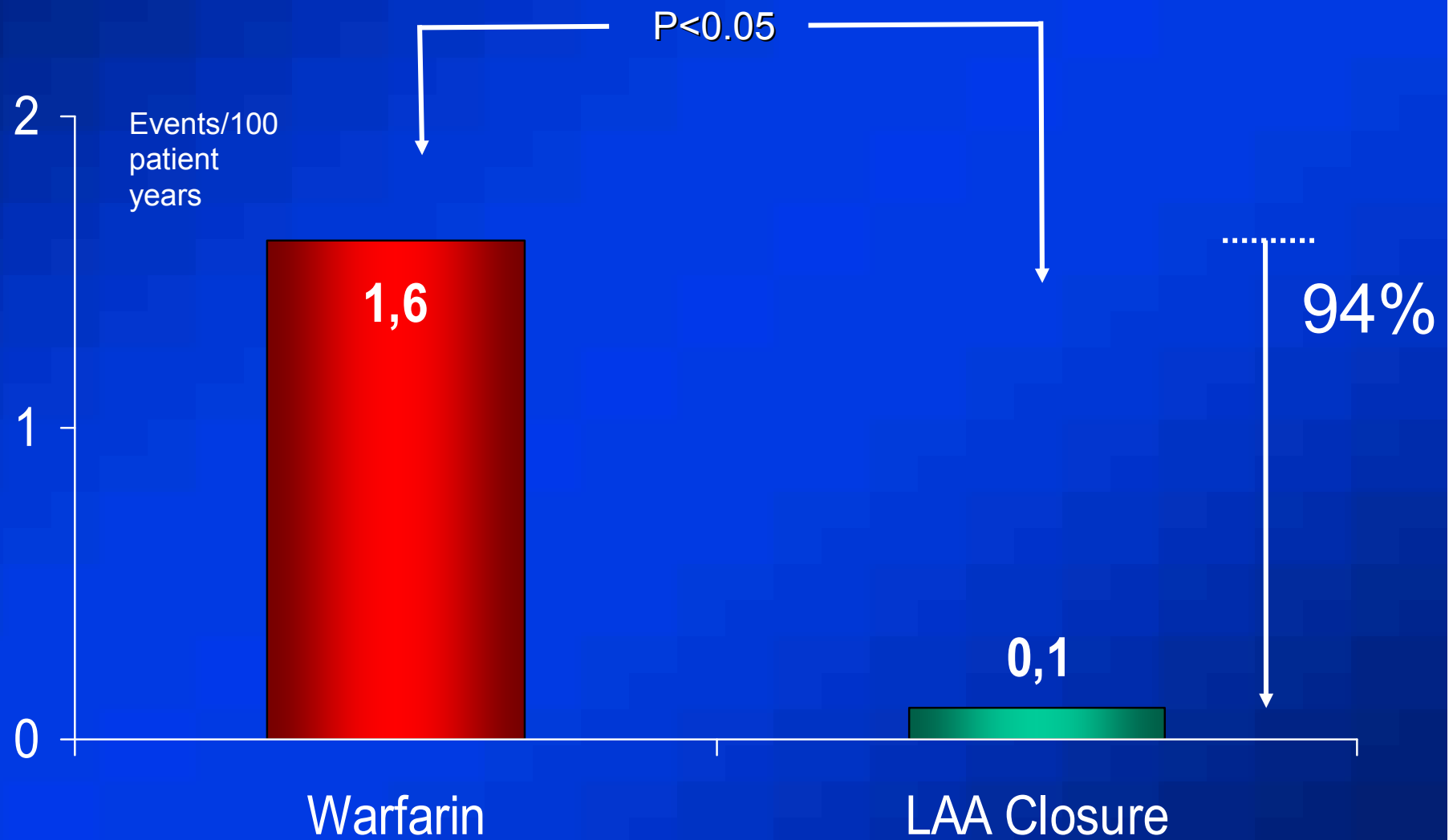
Freedom from Stroke, Death, Systemic Embolization



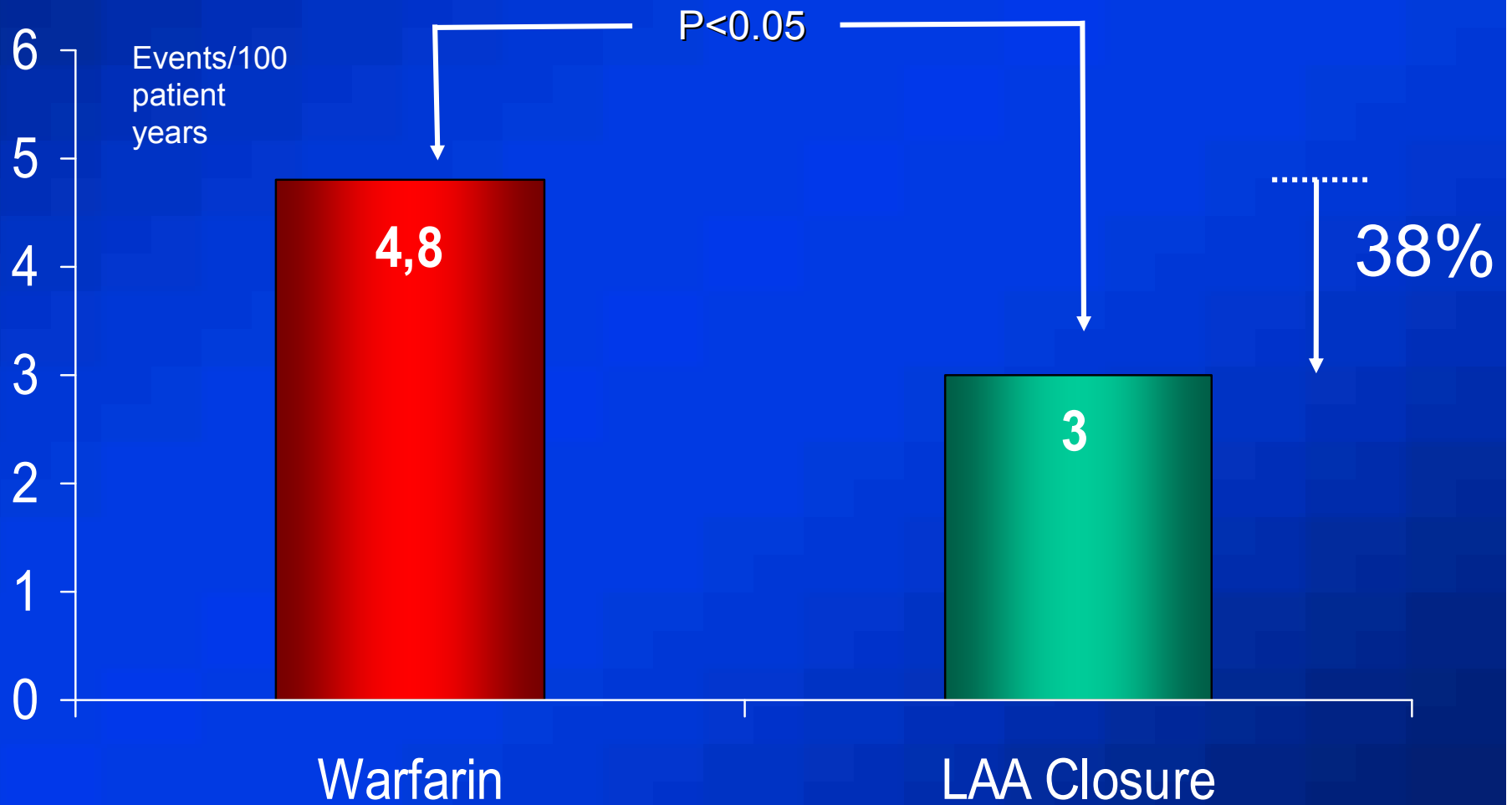
All Stroke



Hemorrhagic Stroke



Mortality



Future Directions?

PROTECT AF

Most of us did not realize yet that this was a trial with patients who can take anticoagulation

Left atrial appendage closure will become the primary treatment in patients with atrial fibrillation

70 Million worldwide