



“Percutaneous MV Repair Techniques”



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<u>Affiliation/Financial Relationship</u>	<u>List of companies</u>
> Grant/Research Support	Abbott, Boeringher, Saint Jude Medical, Medtronic, Edwards
> Consulting Fees/Honoraria	Saint Jude Medical, Novartis
> Major Stock Shareholder/Equity	
> Royalty Income	Landanger
> Ownership/Founder	
> Intellectual Property Rights	Landanger, Delacroix-Chevalier
> Other Financial Benefit	Medtronic, Sorin, Thoratec, Astra Zeneca



The NEW ENGLAND
JOURNAL of MEDICINE

TAVI → Sept. 2010 Partner

Transcatheter Aortic-Valve Implantation for Aortic Stenosis
in Patients Who Cannot Undergo Surgery



Neochord

Annulo
plasty

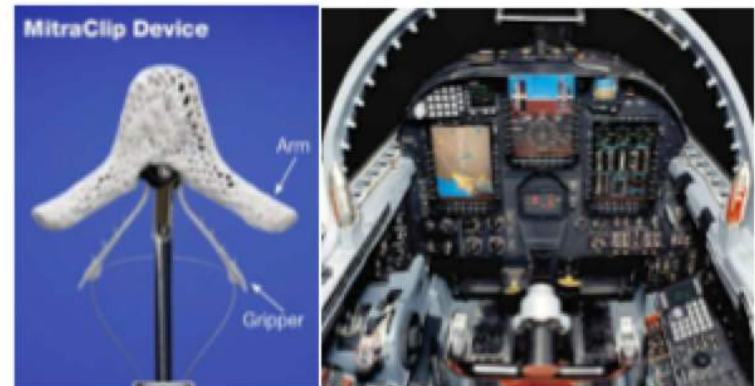
Conclusion

- 1) One disease → Stenosis
- 2) One lesion → Calcification
- 3) One device → Stent + Bioprosth

The NEW ENGLAND
JOURNAL of MEDICINE

MitraClip → Avril 2011 Everest

Percutaneous Repair or Surgery for Mitral Regurgitation



- 1) Multip diseases → Primary/secondary
- 2) Multip lesions → Dystophy/prolaps/restric
- 3) Multip devices → Stent / Bioprosth / Goretex
Clip / rings



Percutaneous Mitral Plasty techniques

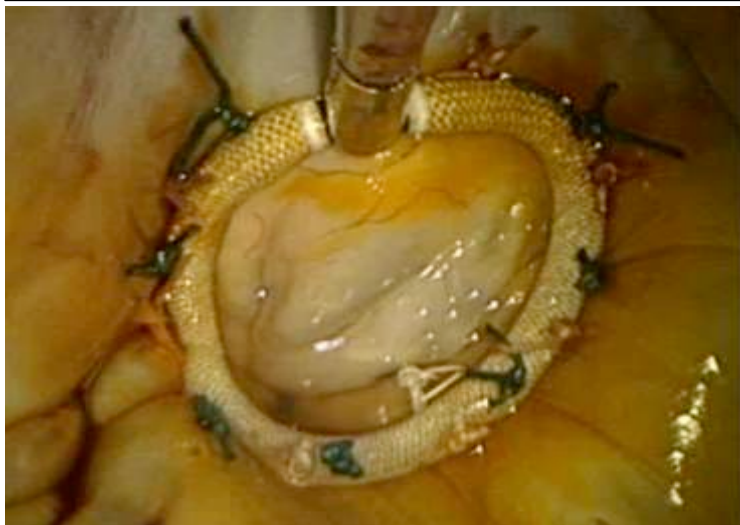
Clip

Neochord

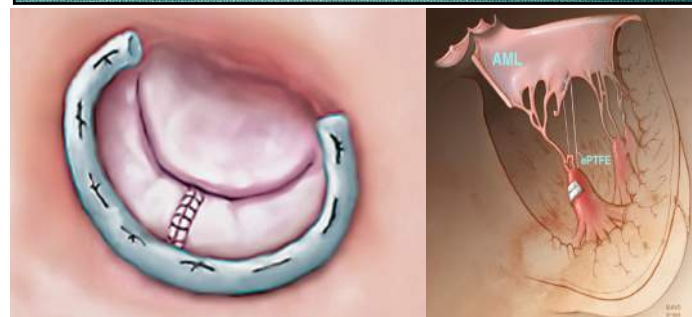
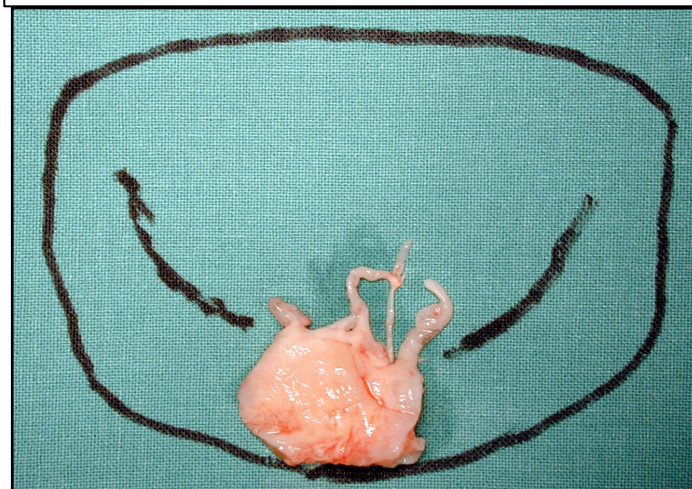
Annulo
plasty

Conclusion

1) Annuloplasty



2) Leaflet repair



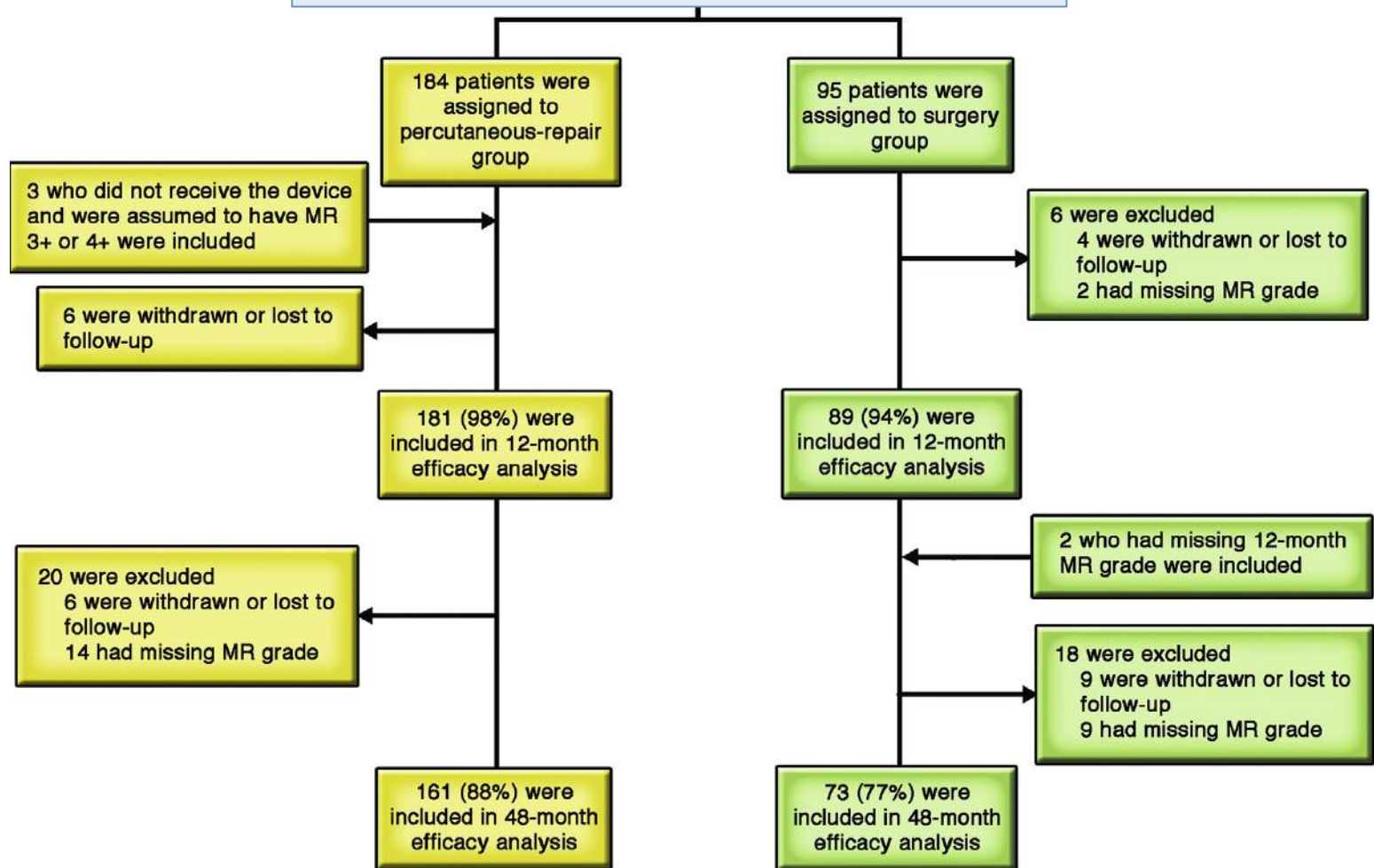


Transcatheter techniques : *From repair to prostheses*

Approach	Commercial	In Development	Abandoned
Edge-to-Edge Repair			
Direct Annuloplasty		      	 
Indirect Annuloplasty			  
Chordal Repair			
Ventricular Remodeling		  	 
Enhanced coaptation		   	
MV Replacement		          	



EVEREST II 279 patients

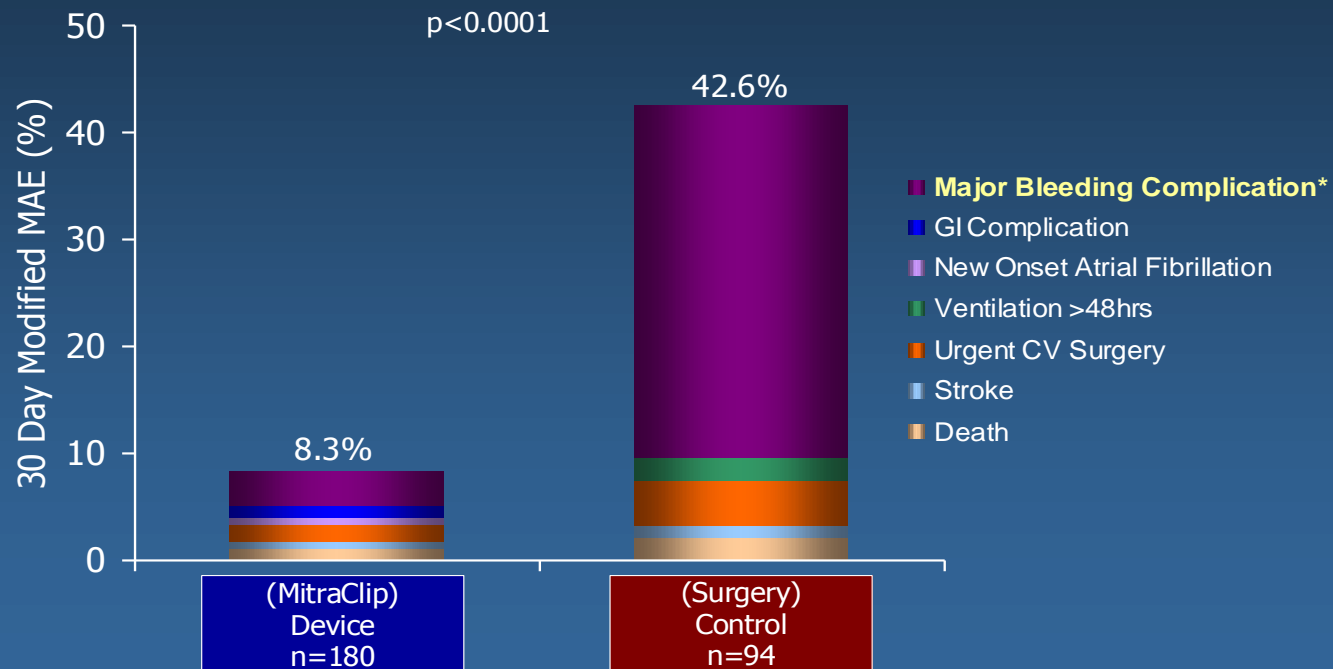




MitraClip > Surgery “Safety”

30 Day Modified * MAE

Intent to Treat, Hierarchical Events
Safety endpoint met with a wide margin

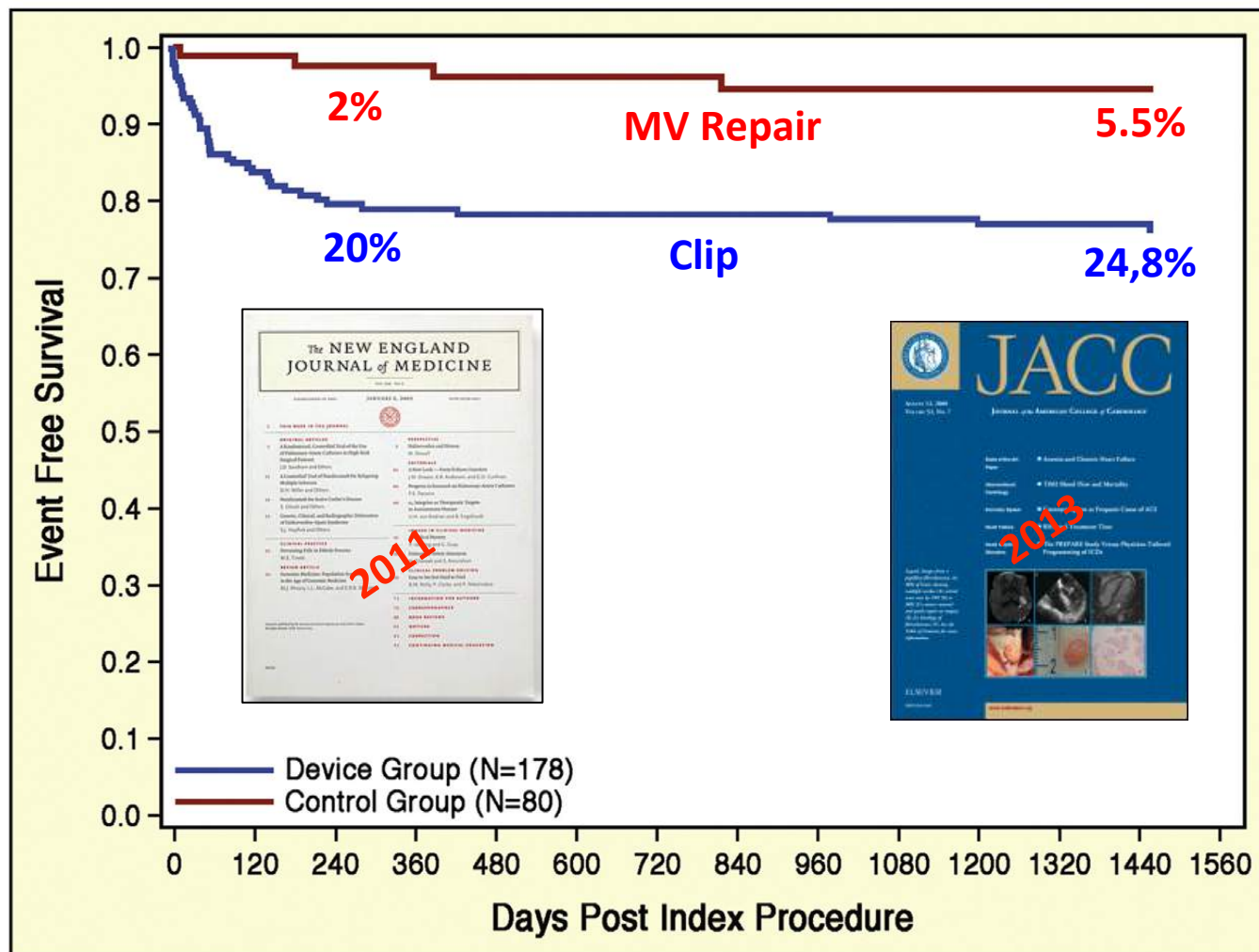


*Major bleeding requiring transfusion = 2U, or surgical intervention.





Reoperation at 1 and 4 years



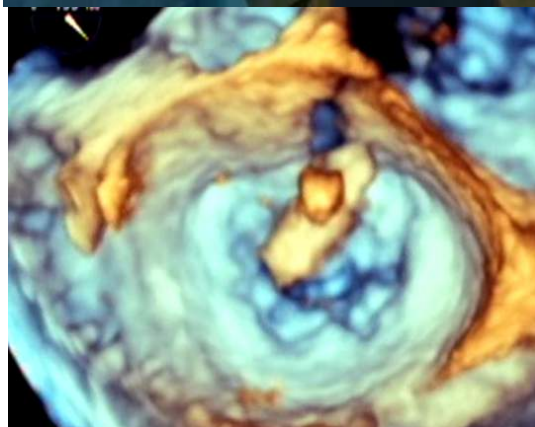
INTRO



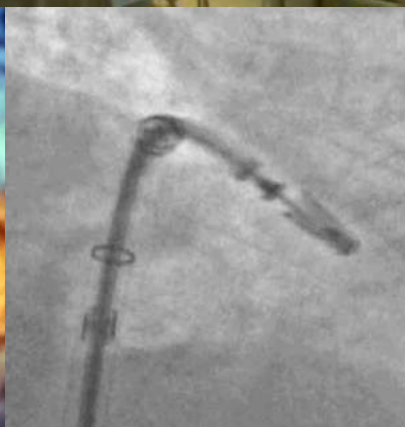
Clip



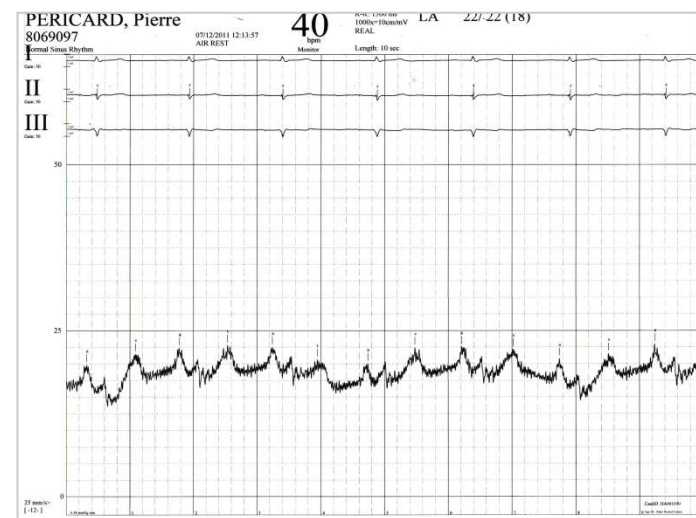
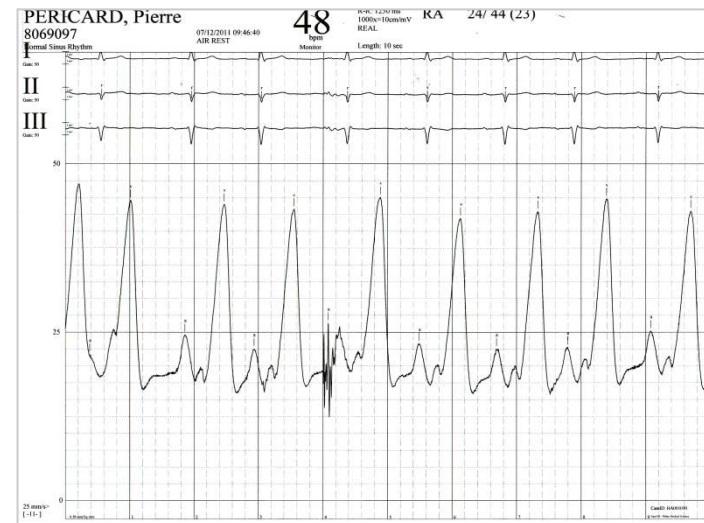
Neochord



Annulo
plasty



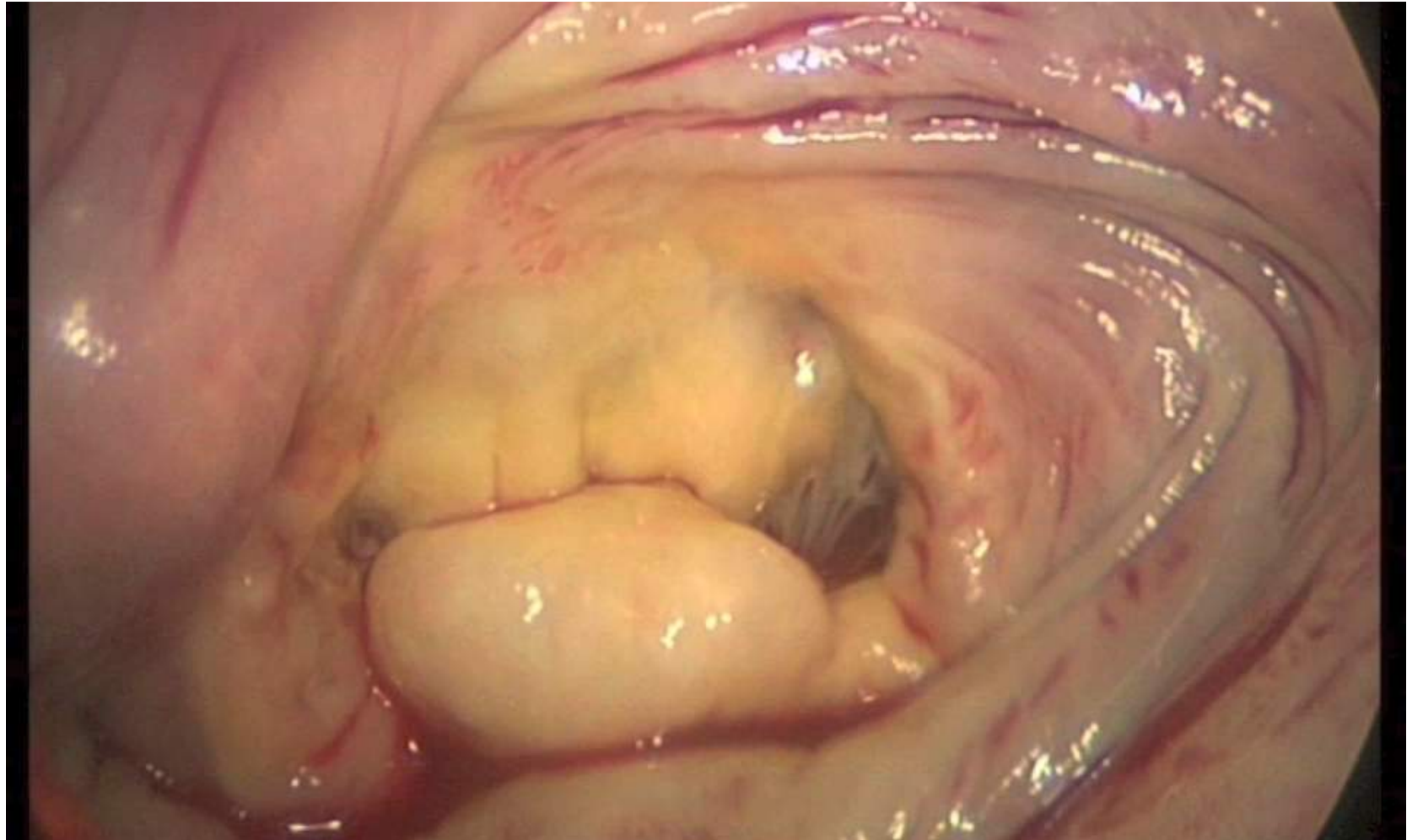
Conclusion



INTRO



Clip



Neochord

Annulo
plasty

Conclusion

Table 13 Indications for mitral valve surgery in chronic secondary mitral regurgitation

	Class ^a	Level ^b
Surgery is indicated in patients with severe MR ^c undergoing CABG, and LVEF >30%.	I	C
Surgery should be considered in patients with moderate MR undergoing CABG. ^d	IIa	C
Surgery should be considered in symptomatic patients with severe MR, LVEF <30%, option for revascularization, and evidence of viability.	IIa	C
Surgery may be considered in patients with severe MR, LVEF >30%, who remain symptomatic despite optimal medical management (including CRT if indicated) and have low comorbidity, when revascularization is not indicated.	IIb	C

6.2.4 Percutaneous intervention

Experience from a limited number of patients in the EVEREST trials and from observational studies suggests that percutaneous edge-to-edge mitral valve repair is feasible—at low procedural risk—in patients with secondary MR in the absence of severe tethering and may provide short-term improvement in functional condition and LV function.^{136,137}

These findings have to be confirmed in larger series with longer follow-up and with a randomized design. Data on coronary sinus annuloplasty are limited and most initial devices have been withdrawn

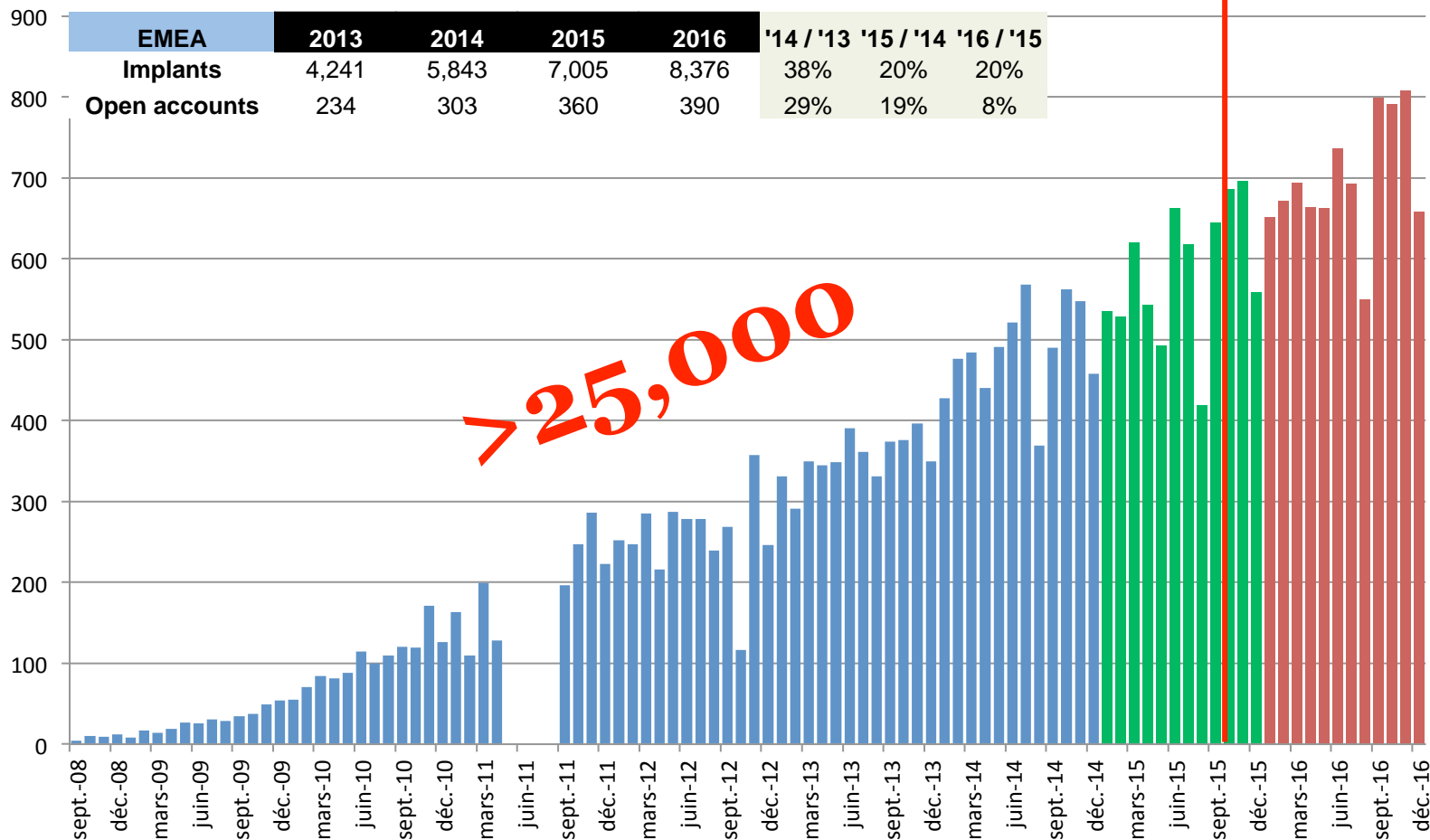
Neocho

Annulo
plasty

Conclusion



Transcatheter techniques : From Mitraclip to prostheses





After Everest : Cohorts & Registries ?

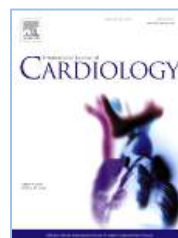
Percutaneous Mitral Valve Edge-to-Edge Repair

In-Hospital Results and 1-Year Follow-Up of 628 Patients of the 2011-2012 Pilot European Sentinel Registry

Long-term survival after MitraClip[®] therapy in patients with severe mitral regurgitation and severe congestive heart failure: A comparison among survivals predicted by heart failure models

Thomas Schau (MD)^{a,1,2}, Akihiro Isotani (MD)^{a,1}, Michael Neuss (MD)^a, Maren Schöpp (MD)^a, Martin Seifert (MD)^a, Christin Höpfner (MD)^a, Daniel Burkhoff (MD, PhD)^b, Christian Butter (MD)^a

^aHeart Center Brandenburg, in Bernau, Bernau, Germany
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^aHeart Center Brandenburg, in Bernau, Bernau, Germany
^bColumbia University, New York, NY, USA

Percutaneous Mitral Valve Repair for Mitral Regurgitation in High-Risk Patients

Results of the EVEREST II Study

Donald D. Glower, MD,^a Saibal Kar, MD,^b Alfredo Trento, MD,^c D. Scott Lim, MD,^d Tanvir Bajwa, MD,^e Ramon Quesada, MD,^f Patrick L. Whitlow, MD,^g Michael J. Rinaldi, MD,^h Paul Grayburn, MD,ⁱ Michael J. Mack, MD,^j Laura Mauri, MD,^k Patrick M. McCarthy, MD,^l Ted Feldman, MD^m



Predictors of clinical outcomes after edge-to-edge percutaneous mitral valve repair

Davide Capodanno, MD, PhD,^{a,c} Marianna Adamo, MD,^{b,c} Marco Barbanti, MD,^a Cristina Giannini, MD,^c Maria Luisa Laudisa, MD,^d Stefano Cannata, MD,^a Salvatore Currello, MD,^b Sebastiano Immè, MD,^a Diego Maffeo, MD,^b Francesco Bedogni, MD,^d Anna Sonia Petronio, MD,^c Federica Etori, MD,^b Corrado Tamburino, MD, PhD,^a and Carmelo Grasso, MD^a, on behalf of the GRASP-IT Investigators Catania, Brescia, Pisa, and Milan, Italy

Association of tricuspid regurgitation with clinical and echocardiographic outcomes after percutaneous mitral valve repair with the MitraClip System: 30-day and 12-month follow-up from the GRASP Registry

Yohei Ohno^{1,2†}, Guilherme F. Attizzani^{1,3,4†}, Davide Capodanno^{1,5}, Stefano Cannata¹, Fabio Dipasqua¹, Sebastiano Immè¹, Marco Barbanti¹, Margherita Ministeri¹, Anna Caggegi¹, Anna M. Pistrutto¹, Marta Chiarandà¹, Giuseppe Ronsivalle¹, Sandra Giaquinta¹, Silvia Farruggio¹, Sarah Mangiafico¹, Salvatore Scandura¹, Corrado Tamburino^{1,5}, Piera Capranzano^{1,5,‡}, and Carmelo Grasso^{1,5}

Meta-Analysis of the Usefulness of Mitraclip in Patients With Functional Mitral Regurgitation

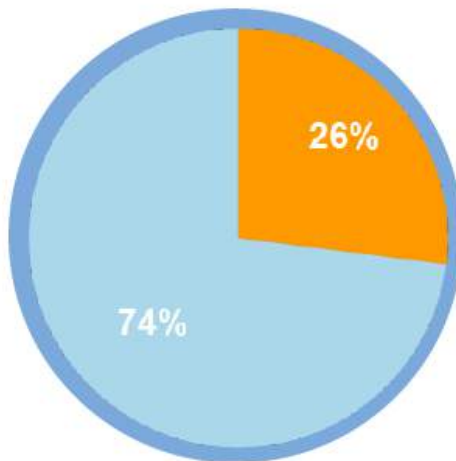
Fabrizio D'ascenzo, MD^a, Claudio Moretti, MD^a, Walter Grosso Marra, MD^a, Antonio Montefusco, MD^a, Pierluigi Omede, MD^a, Salma Taha, MD^{a,b,c}, Davide Castagno, MD^a, Oliver Gaemperli, MD^c, Maurizio Taramasso, MD^a, Simone Frea, MD^a, Stefano Pidello, MD^a, Volker Rudolph, MD^f, Olaf Franzen, MD^g, Daniel Braun, MD^h, Cristina Giannini, MDⁱ, Huseyin Ince, MD^j, Leor Perl, MD^k, Giuseppe Zoccai, MD^l, Sebastiano Marra, MD^a, Maurizio D'Amico, MD^a, Francesco Maisano, MD^m, Mauro Rinaldi, MD^a, and Fiorenzo Gaita, MD^a



1) Indications : ➔ Shift towards Secondary MR

EVEREST II

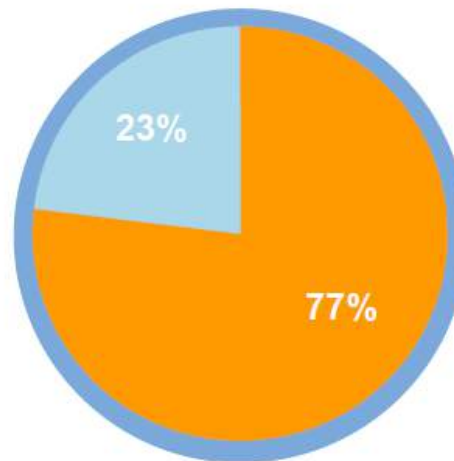
(Randomized Controlled Trial)



• 178 patients

ACCESS EU

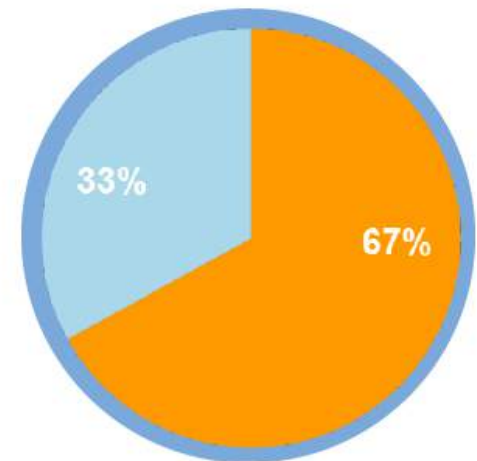
(Europe)



• 567 patients

Commercial

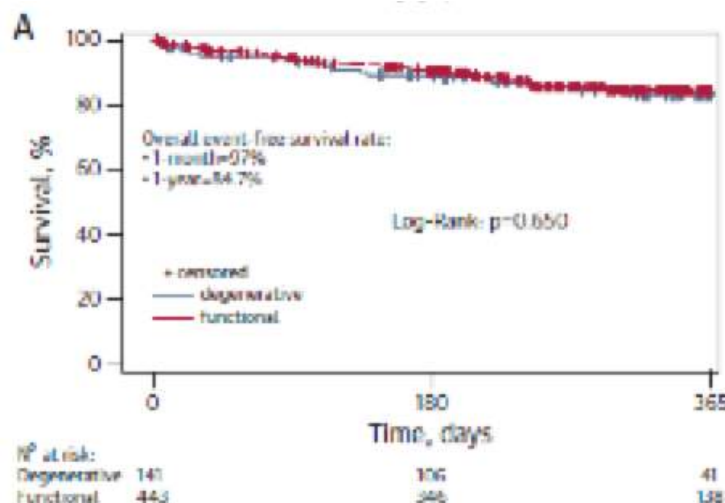
(APJ, CALA, Europe, US)



• 10,614 patients



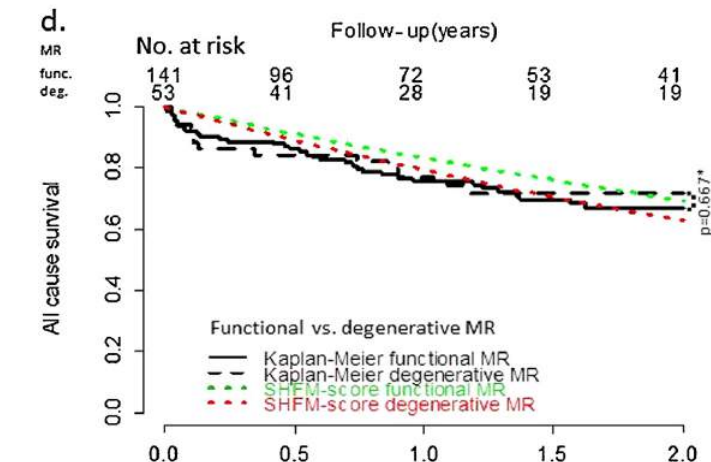
2) Questionable : Impact on mortality ?



Percutaneous Mitral Valve Edge-to-Edge Repair

In-Hospital Results and 1-Year Follow-Up of 628 the 2011-2012 Pilot European Sentinel Registry

Georg Nickenig, MD, PhD,* Rodrigo Estevez-Loureiro, MD, PhD,† Olaf Franzen, MD,‡ Corrado Tamburino, MD, PhD,§



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^b Columbia University, New York, NY, USA

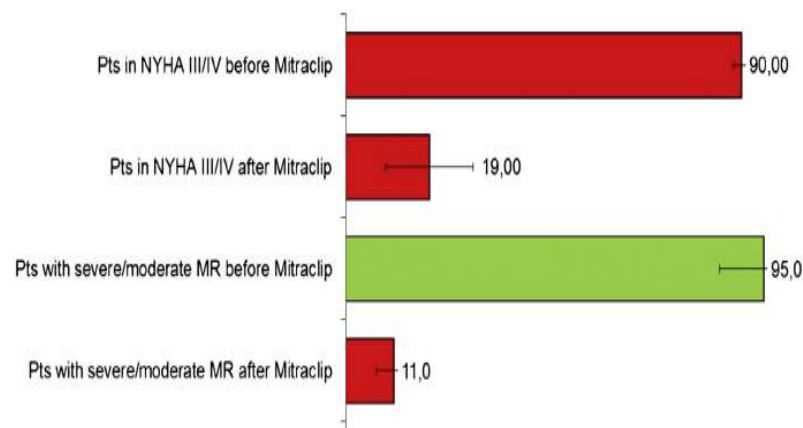
2015

- 628 patients in Europe (25 centers, 8 countries)
- FU for secondary and primary MR
- 1 year echo assesement

- 194 patients (brandeburgh, New york)
- Mortality versus Seattle HF model



3) Likely : Improved Symptoms / decreased MR



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- 628 patients in Europe (25 centers, 8 countries)
- FU for secondary and primary MR
- 1 year echo assessement

- Meta analysis
- 9 studies
- 875 patients



4) Complex : Echographic analysis

Percutaneous Mitral Valve Edge-to-Edge Repair

In-Hospital Results and 1-Year Follow-Up of 628 Patients of
the 2011-2012 Pilot European Sentinel Registry

Georg Nickenig, MD, PhD,* Rodrigo Estevez-Loureiro, MD, PhD,† Olaf Franzen, MD,‡ Corrado Tamburino,



- 628 patients in Europe (25 centers, 8 countries)
- FU for secondary and primary MR
- 1 year echo assesement
- 15 centers with > 90% FU → 368 echo at 1 year

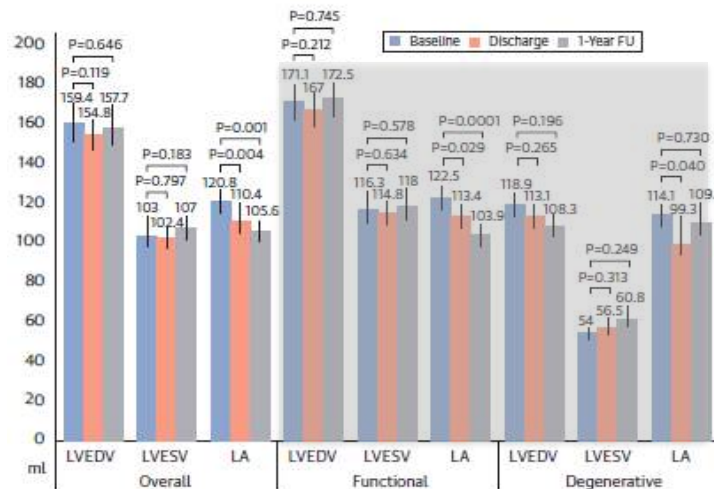


FIGURE 5 Echocardiographic Measurement of Left Ventricular and Left Atrial Volumes at Baseline, Discharge, and 1-Year Follow-Up After TMVR (Paired Data From 368 Patients)

In the overall cohort, a nonsignificant reduction in left ventricular end-diastolic volume (LVEDV) was observed, with a significant reduction in left atrial volume (LA). In functional mitral regurgitation, left ventricular volumes remained stable during follow-up, although a significant reduction in LA was noted. In degenerative mitral regurgitation, the most relevant finding was a reduction in LVEDV over time (nonsignificant). LVESV = left ventricular end-systolic volume; TMVR = transcatheter mitral valve repair.

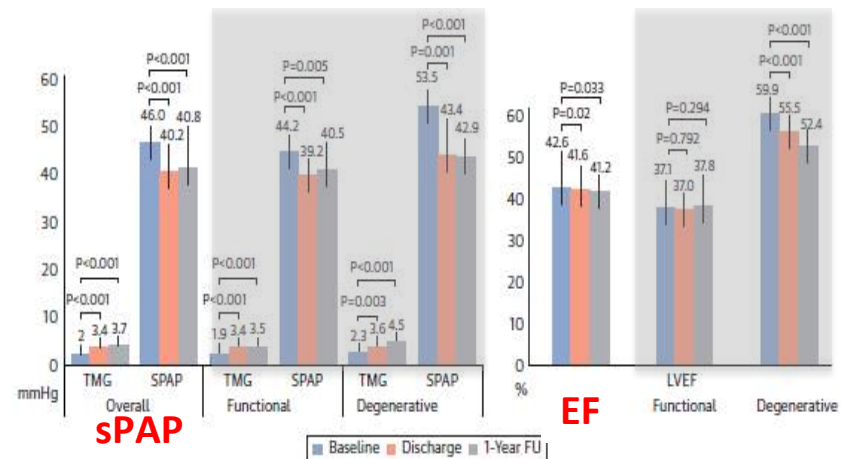


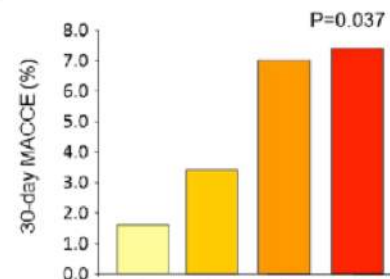
FIGURE 6 Echocardiographic Measurement of Transmitral Pressure Gradient, SPAP, and Ejection Fraction, at Baseline, Discharge, and 1-Year Follow-Up

Significant and persistent reductions in systolic pulmonary artery pressure (SPAP) were observed. After transcatheter mitral valve repair, transmitral pressure gradient (TMG) (mm Hg) increased significantly, although no cases of severe mitral stenosis were reported. LVEF = left ventricular ejection fraction (%).

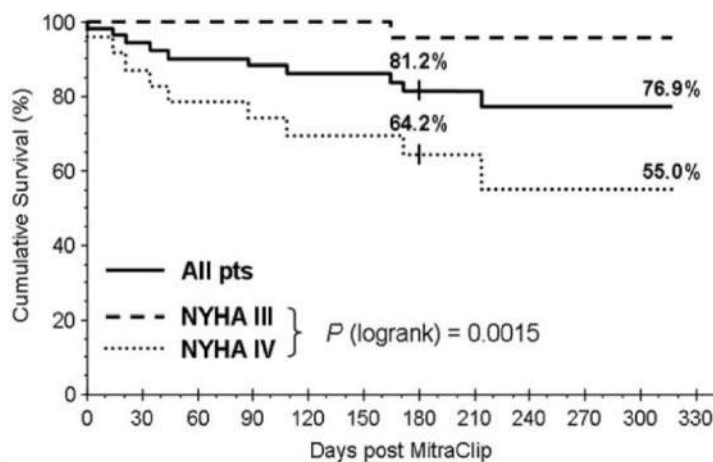


Influence of non-cardiac comorbidities on outcome after percutaneous mitral valve repair: results from the German transcatheter mitral valve interventions (TRAMI) registry

Influence of extra-cardiac comorbidities →



MitraClip® therapy in patients with end-stage systolic heart failure

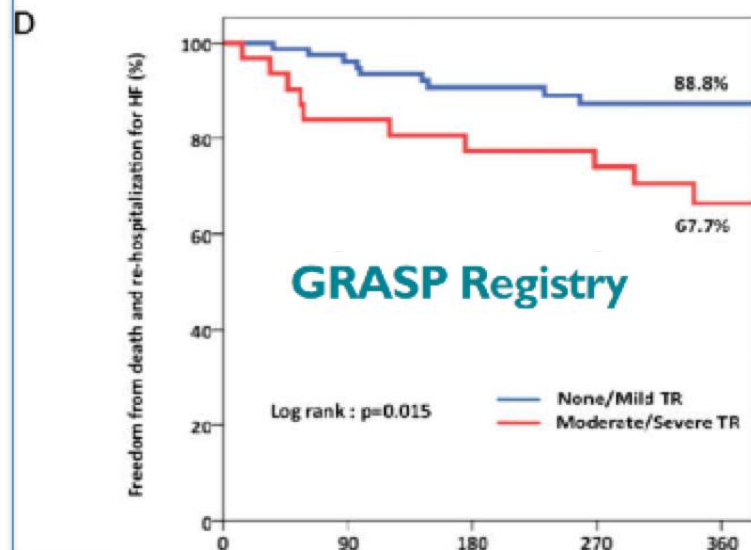


At risk:

	0	30	60	90	120	150	180	210	240	270	300	330
All pts	50	47	45	44	43	38	30	19	11	10	9	
NYHA III	27	27	27	27	27	24	19	12	8	7	6	
NYHA IV	23	20	18	17	16	14	11	7	3	3	3	

Franzen O. Eur J Heart Failure 2011; 13: 569–576

Association of tricuspid regurgitation

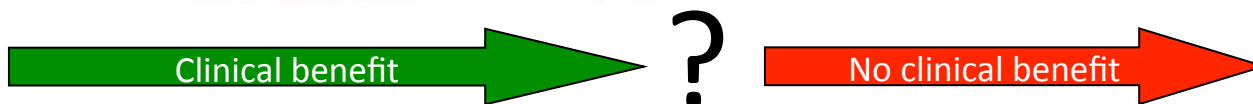


Patients at Risk:

	0	90	180	270	360
None/Mild TR	80	72	61	49	42
Moderate/Severe TR	31	26	24	21	14

Ohno Y. Eur Heart Journal 2014; 15: 51246-55

INTRO



Clip

Neochord

Annulo
plasty

Conclusion

NYHA

I

EARLY

MID

LATE

II

Outpatient clinic

Medical
therapy

CRT
MitraClip

LVAD
HTx

Hospitalization

III

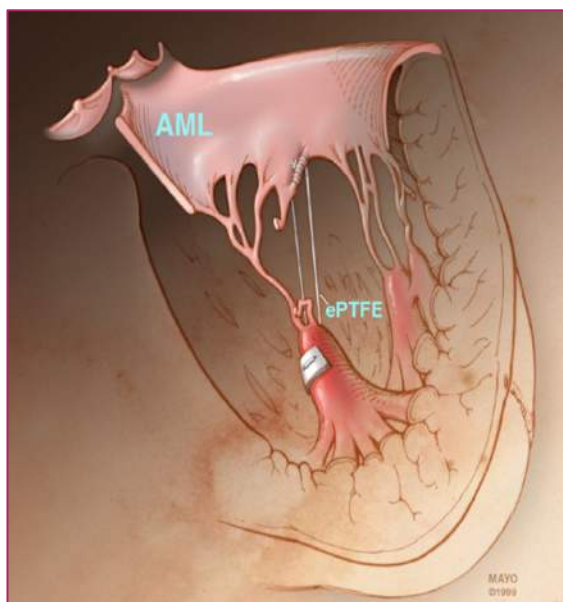
Inotrope use

IV

Ohno et al., Eur Heart J CV Imaging 2014;15:1246-1255



Transapical Off Pump MV Repair

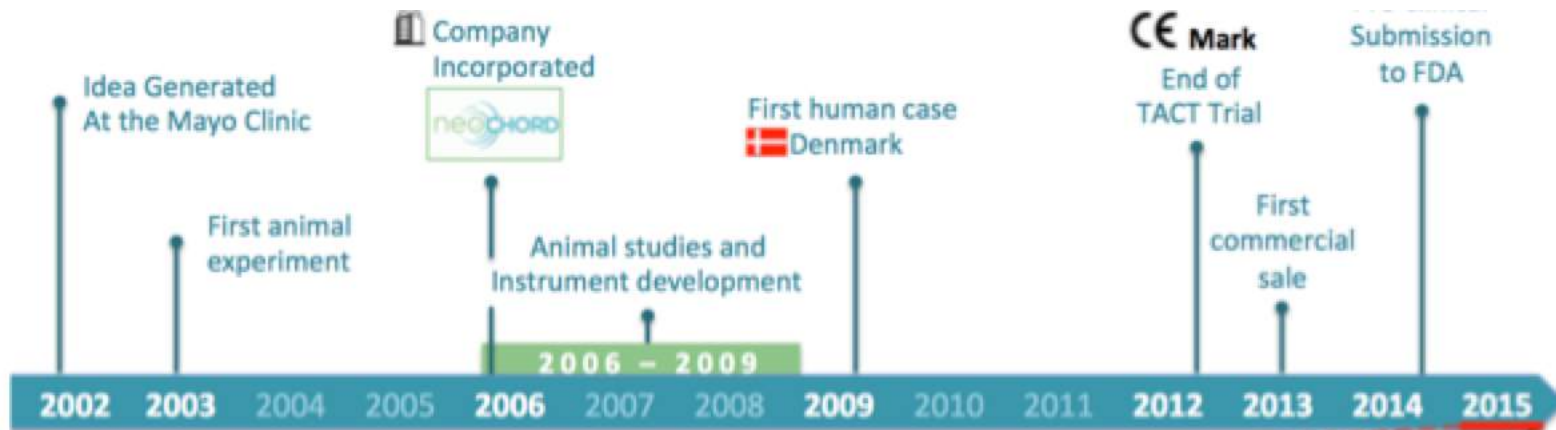
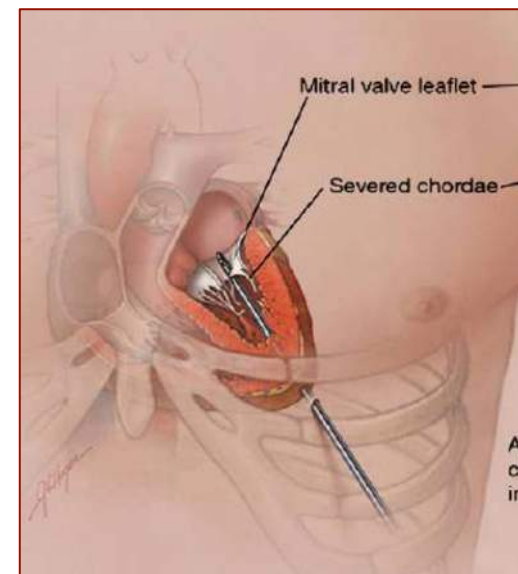


2009 : 1^{er} patient

2013 : CE mark

2014 : 100 Pts

2015 : 300 Pts



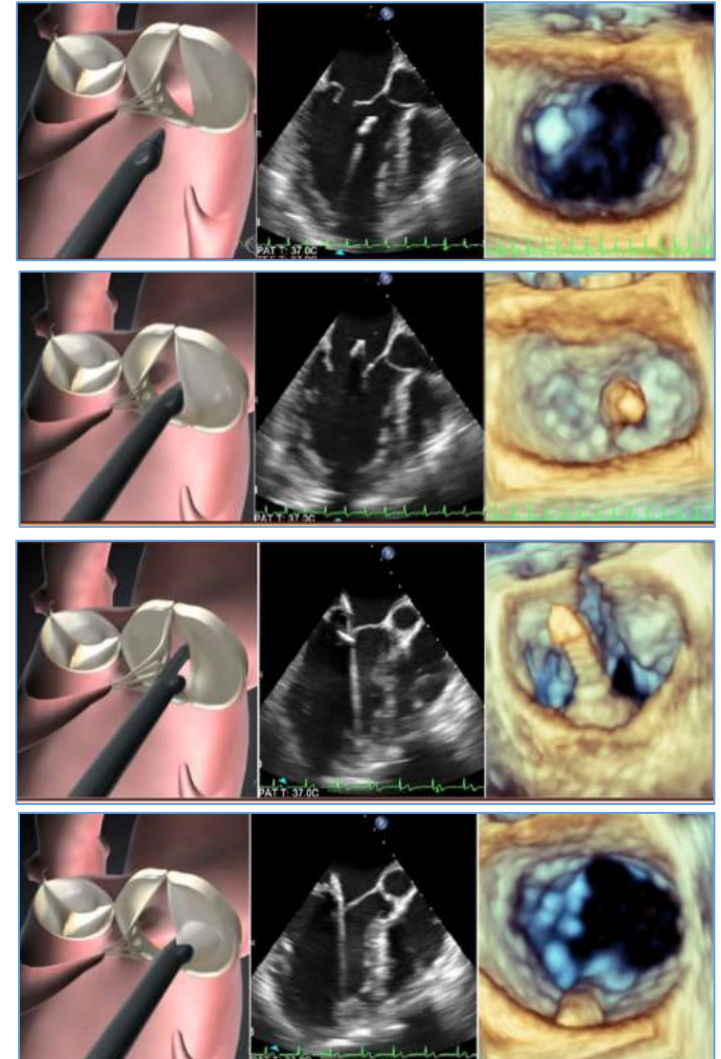
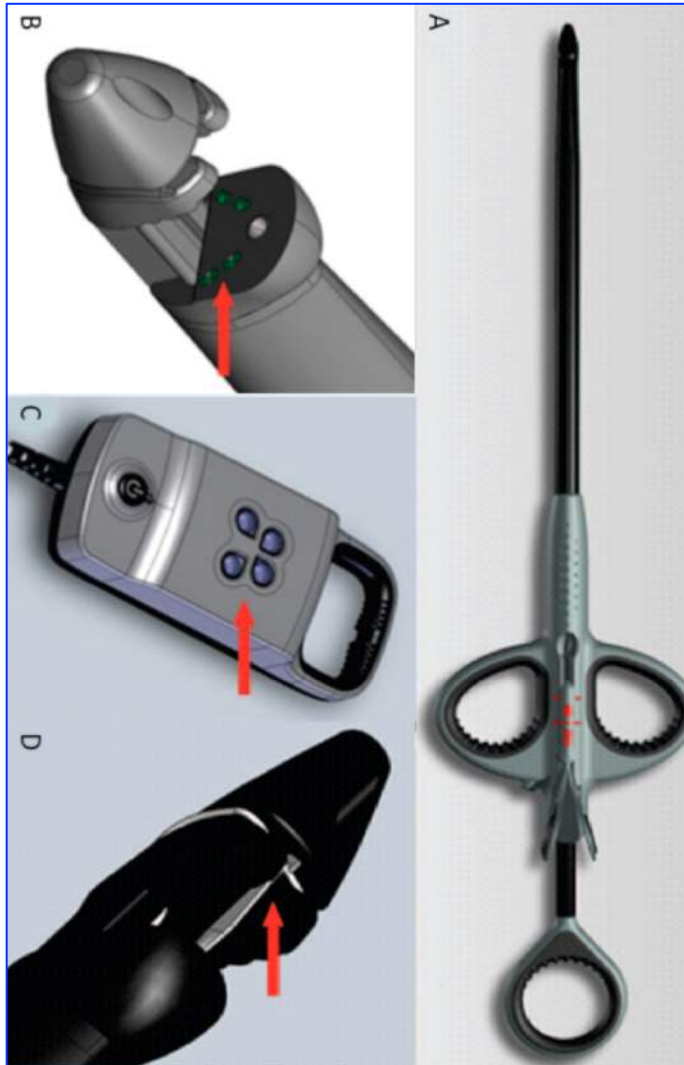
INTRO

Clip

Neochord

Annulo
plasty

Conclusion



INTRO

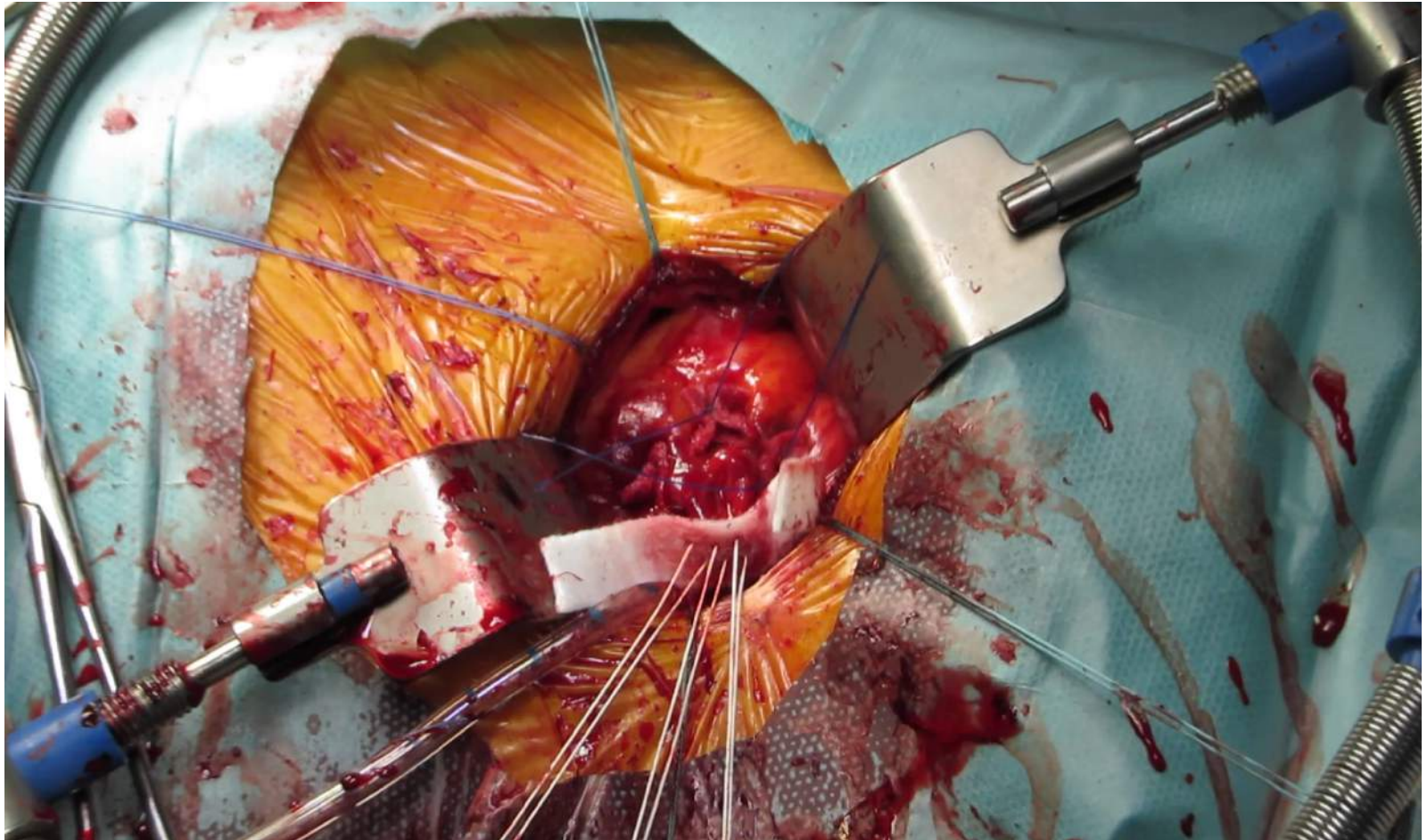


Clip

Neochord

Annulo
plasty

Conclusion





Off-Pump Transapical Implantation of Artificial Neo-Chordae to Correct Mitral Regurgitation

The TACT Trial (Transapical Artificial Chordae Tendinae) Proof of Concept

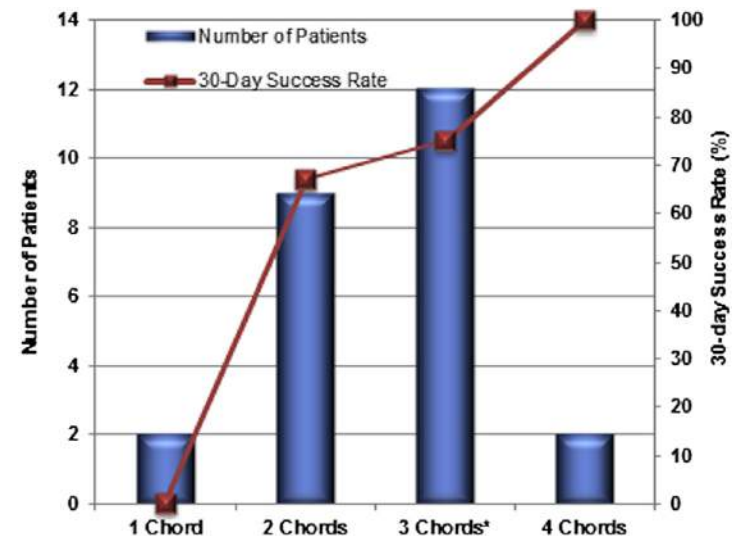
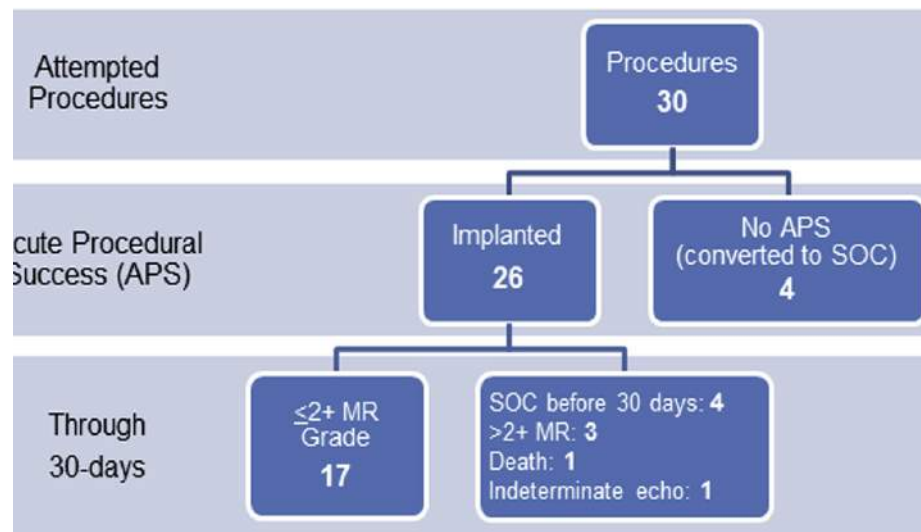
Joerg Seeburger, MD, PhD,* Mauro Rinaldi, MD,† Stefano Salizzoni, MD,† Ruediger Lange, MD,† Ottavio Alfieri, MD, PhD,‡ Michael Andrew Borger, MD, PhD,§ Friedrich Wilhelm Mohr, MD, PhD,* Audrius A. Stankunas, MD, PhD,*

Leipzig, Munich, and Bad Nauheim, Germany; Turin and Milan, Italy; Aarhus, Denmark; and Vilnius, Lithuania

- 7 centres, 30 patients
- 1 décès, 1 petit AVC
- Succès primaire 86,7% (=4 échecs = 4 MVR)
- À 30 jours : 17 patients IM ≤ 2 (=4 MVR)
 - 2 patients chez les 15 premiers inclus
 - 17 patients chez les 15 derniers inclus



2014





Acute safety and efficacy of the NeoChord procedure[†]

Padova and Vilnius → Interactive CardioVascular and Thoracic Surgery 2015

Andrea Colli^{a,*}, Erica Manzan^a, Kestutis Rucinskas^b, Vilius Janusauskas^b, Fabio Zucchetta^a, Diana Zakarkaitė^b,

Audrius Aidietis^b and Gino Gerosa^a

Table 2: Procedural results

Variable	N = 63 Median (IQR I, III)
NeoChords attempted (n)	4 (4–5)
NeoChords left (n)	4 (3–4)
Two neoChords	2 (3.2%)
Three neoChords	20 (32%)
Four neoChords	28 (44%)
Five neoChords	10 (16%)
Six neoChords	2 (3%)
Seven neoChords	1 (2%)
Operative time (min)	130 (117.5–150)
Intensive care unit stay (h)	24 (24–24)
≤24	50 (80%)
25–48	7 (11%)
>48	6 (9%)
Mechanical ventilation time (h)	3 (2–5)
0 (extubation in the operation theatre)	7 (11%)
≤3	33 (52%)
4–6	17 (27%)
>6	6 (9%)
Hospital stay (days)	8 (6–11)
Discharge at home	9 (14%)
Discharge at a cardiac rehabilitation centre	54 (86%)

Safety

Perioperative complications (n)	
Ventricular fibrillation	3 (5%)
CPB/ECMO	1 (2%)
Bleeding requiring >2 blood units	3 (5%)
Surgical revision for bleeding	0
Apex bleeding or rupture	0
Conversion to conventional surgery	0
Major adverse events (n)	
Death	0
Stroke	0
Acute myocardial infarction	1 (2%)
Septicaemia	2 (3%)

Efficacy

Residual MR at 30 days (n)	
0+	29 (46%)
1+	16 (25%)
2+	10 (16%)
3+	7 (11%)
4+	1 (2%)
NYHA Class at 30 days (n)	
I	55 (87%)
II	4 (6%)
III	4 (6%)



Type A

- Eccentric regurgitant jet
- Central P2 prolapse, extension up to 50% of entire PML. No pericommissural involvement.
- No anterior leaflet prolapse or tethering
- No severe LV dilatation

Type B

- Eccentric regurgitant jet
- Extension of prolapse to include the portions of P1 or P3 adjacent to P2
- Or may have more than one prolapsing segment (P1+P2, P2+P3)

Type C

- Prolapse extending towards the commissures, involvement of anterior leaflet
- LV dilatation with initial tethering of AL (gullwing sign)
- Central component to regurgitant jet (lack of central coaptation)
- Calcified leaflet segments

04

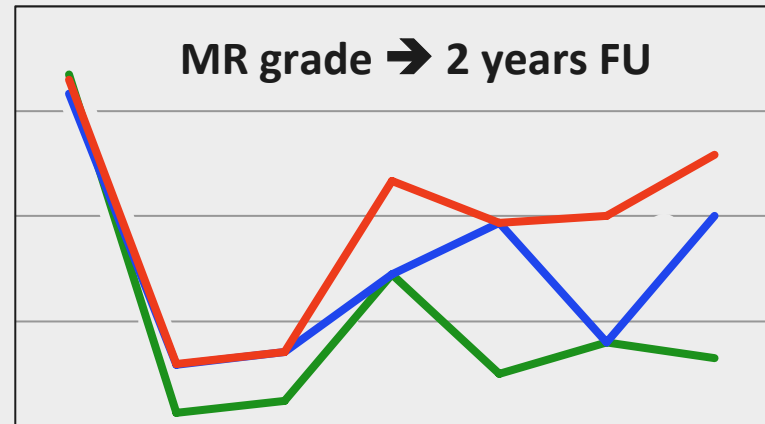
03

02

01

00

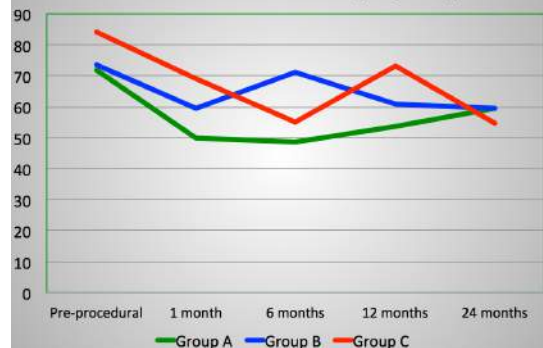
MR grade → 2 years FU



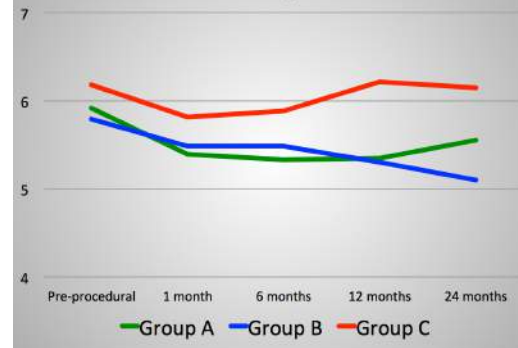
Preop Intraop Discharge 1month 6months 12months 24months

Average — Type A — Type B — Type C

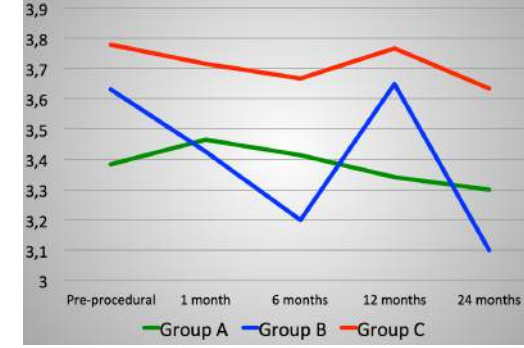
LA volume indexed (ml/m2)



LVEDD, cm



LVEDS, cm



Vilniaus universiteto ligoninės
SANTARIŠKIŲ KLINIKOS

2 years Vilnius Experience, K. Rucinskas Vilnius, Lithuania

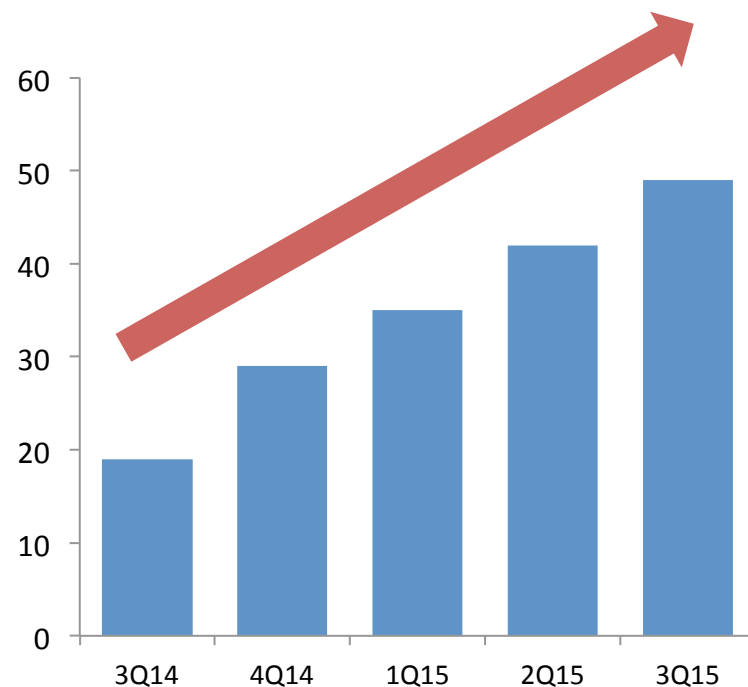


265 patients Worldwide

Currently selling in 10 markets



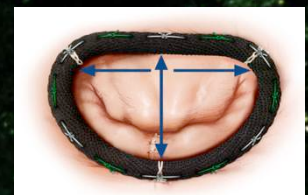
Consistent QOQ Growth in cases



INTRO



Clip



Neochord



Annulo
plasty



Conclusion



INDIRECTE Annuloplasty

Clip



MONARC
(Edwards
Lifesciences
LLC)

**Two-anchor design
with chronic
reshaping (6weeks)
by a foreshortening
bridge**

**EVOLUTION
trial
(72 pts
82% success)**

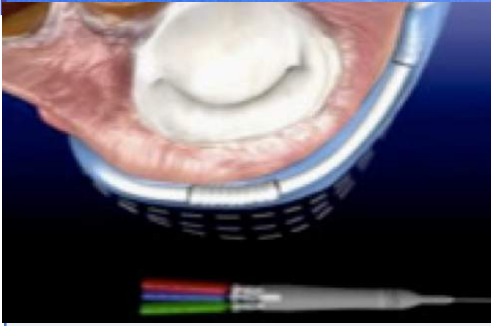
Neochord



CARILLON
(Cardiac
Dimensions
Inc)

**Acute reshaping
device acting in
P2P3, repositionable,
retrievable**

**AMADEUS trial
(113 pts
58 % success)**

Annulo
plasty

PTMA
(Viacor Inc)

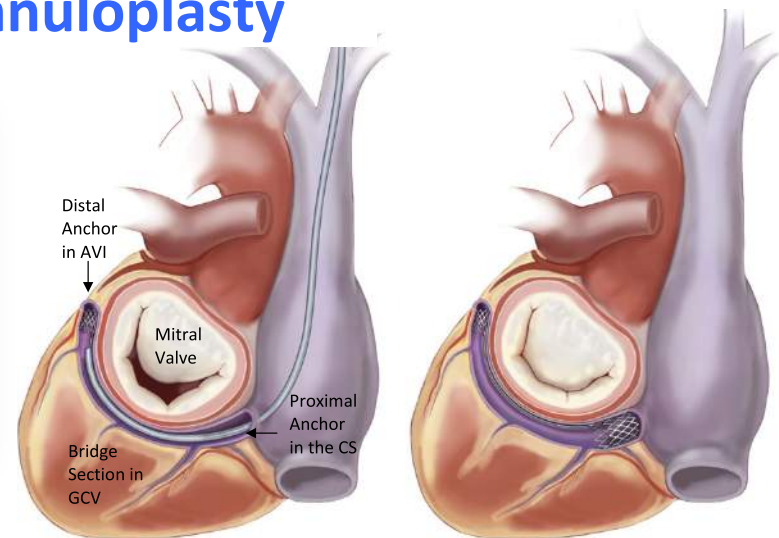
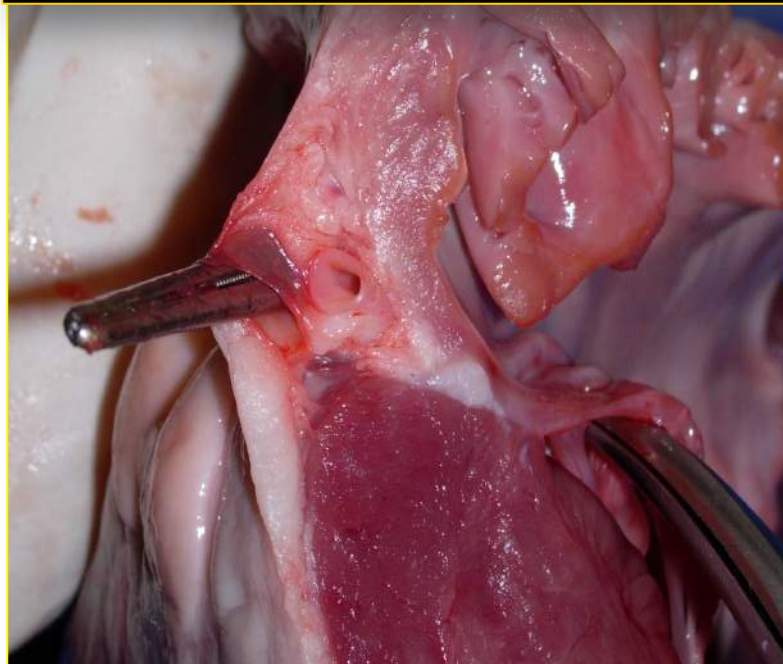
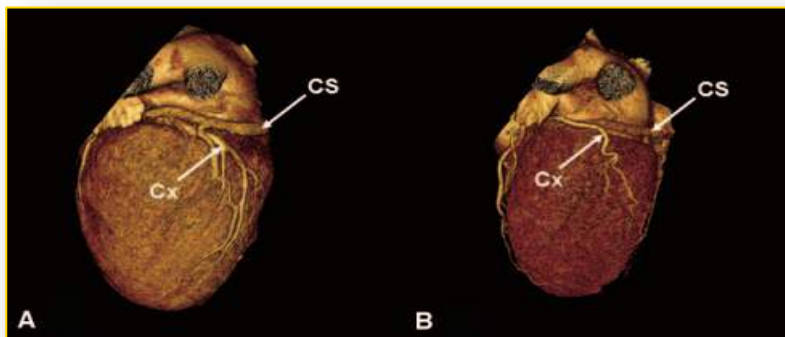
**Tri-lumen catheter,
reshapable,
possibility of
multiple long term
adjustment**

**PTOLEMY
(31 pts
29 % success)**

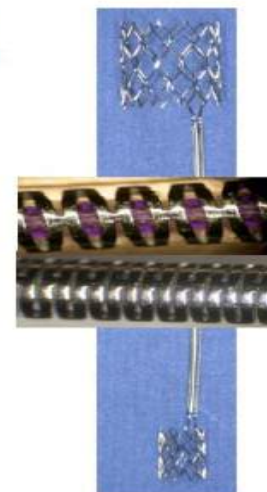
Conclusion



INDIRECTE Annuloplasty



The MONARC system Delayed Release-in situ

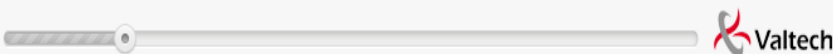
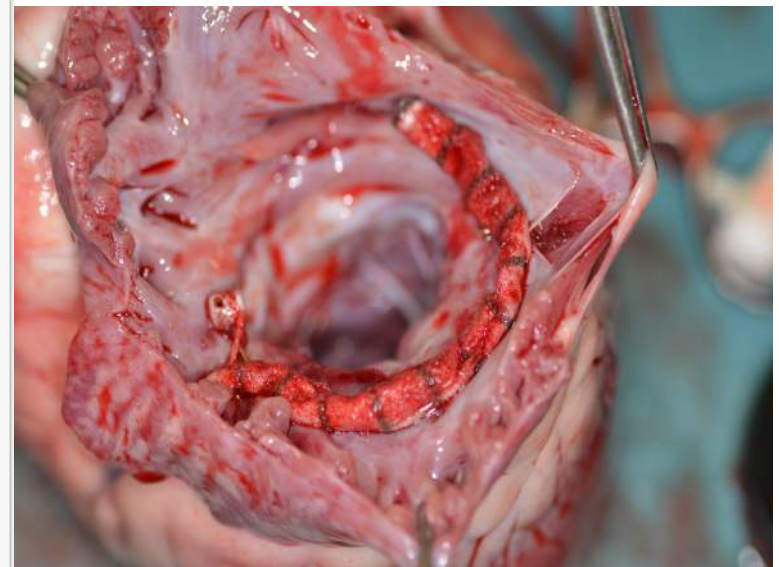
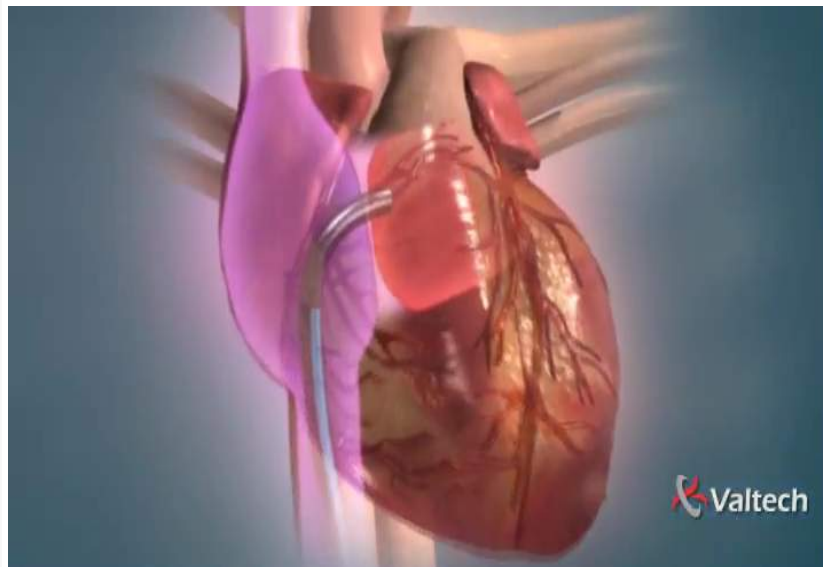


Webb et al Circulation 113:851-855, 2006



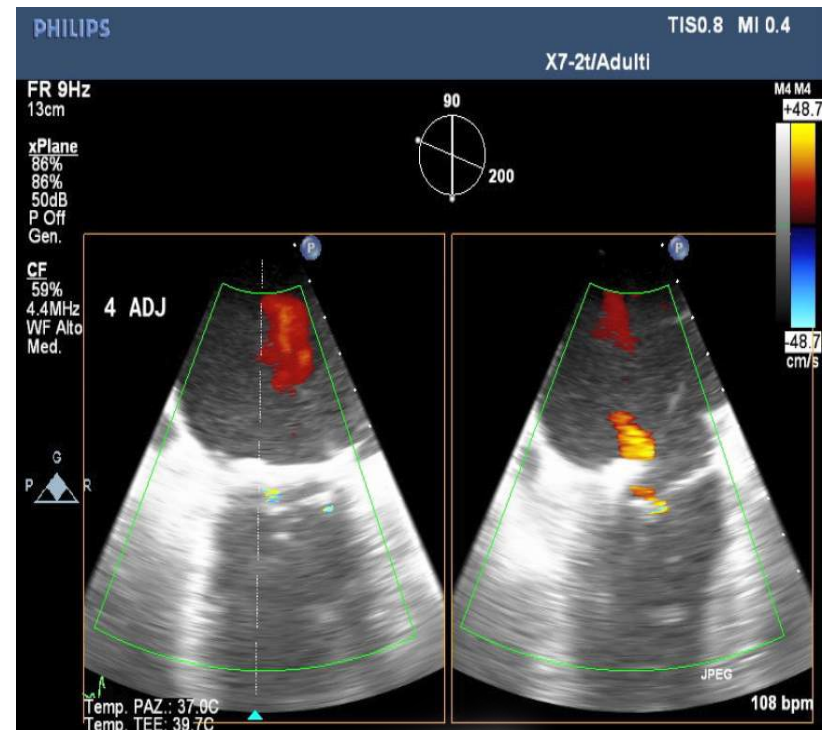
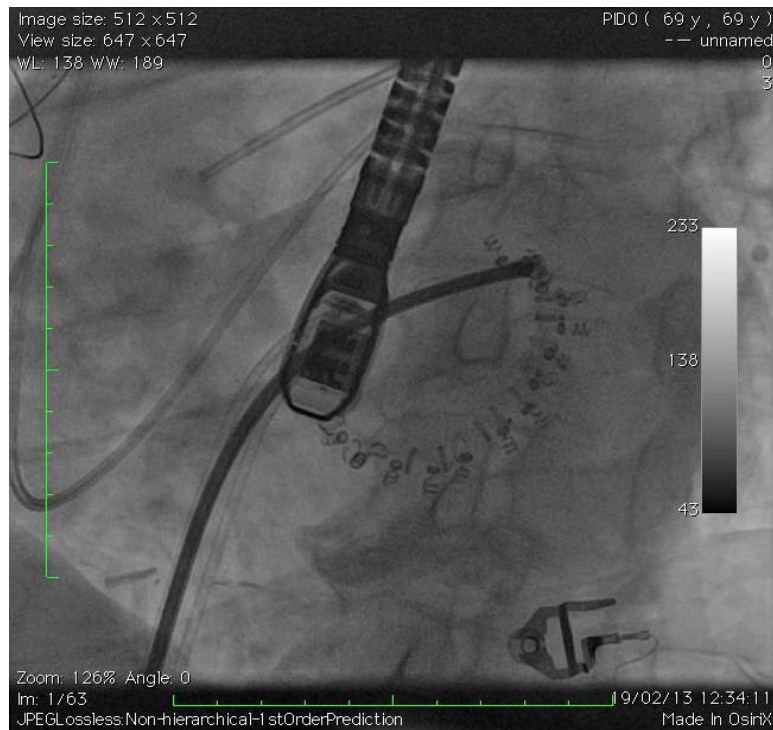
Valtech Cardio – CARDIOBAND

First in man in 2013



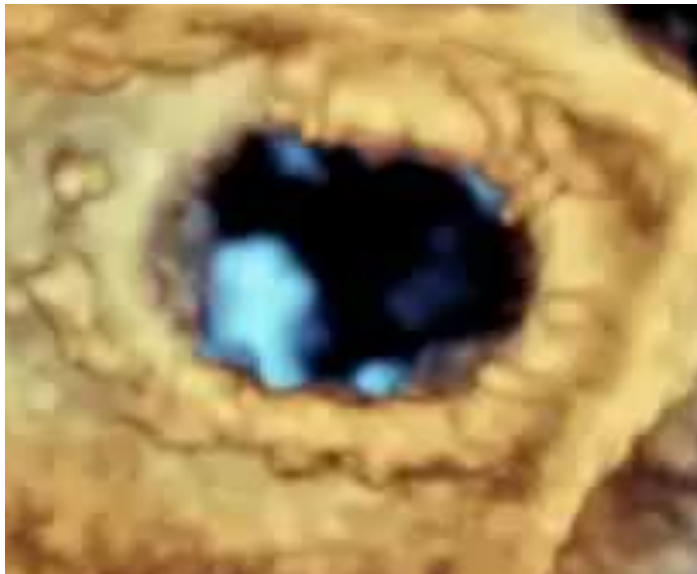


Valtech Cardio – CARDIOBAND

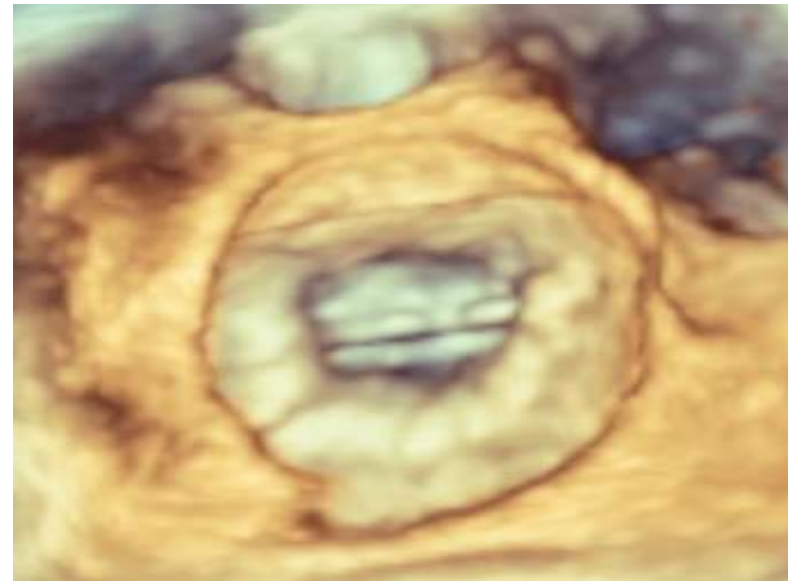




Which is surgical ? Percutaneous ?



Surgical Ring



Cardioband



Cardioband European Study Early Outcomes (N=30)

Courtesy of Francesco MAISANO

Procedure

- Implants successfully deployed on annulus (30/30)
- Average reduction of septolateral diameter 20%

Effectiveness

- MR \leq 2+ in 1 month follow up (N=27) 89%
- MR \leq 2+ in 6 month follow up (N=16) **88%**

Safety

- Procedural mortality 0/30
- 30 days Mortality (according to VARC) 2/30

No Device Related Major Adverse Events as adjudicated by independent committee



Cardioband European Study Early Outcomes (N=30)

Effectiveness

- MR \leq 2+ in 1 month follow up (N=27) 89%
- MR \leq 2+ in 6 month follow up (N=16) 88%
- Accumulative implantation time >270months

Procedure

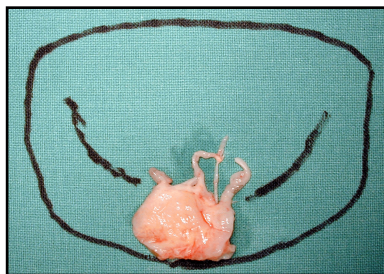
- Implants successfully deployed on annulus (30/30)
- Intra-procedure MR reduction \geq 1 degree (28/30)
- Average reduction of septolateral diameter 20%

Safety

- Procedural mortality 0/30
- 30 days Mortality (according to VARC) 2/30
- **No Device Related Major Adverse Events as adjudicated by independent committee**



Surgical MV Repair



+



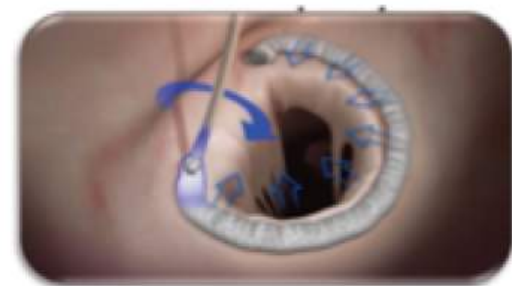
=

Carpentier French Correction

Percutaneous Mitral Plasty techniques



+



=

Fully percutaneous Mitra valve repair



Innovation → Evaluation ?






Percutaneous Mit. V Repair

1) Mitraclip : → PHRC 2012

2) Neochord : → PHRC 2015

3) Annuloplasty : Isolated → in addition to !!!



	COAPT 	RESHAPE-HF 	MITRA.fr 
Sponsor	Abbott Vascular	Abbott Vascular	PHRC / Abbott
Méthodology	Prospective, randomized	Prospective, randomized	Prospective, randomized
Comparison	Optimal Medical Medicatio	Optimal Medical Medication	Optimal Medical Medication
MR etiology	Secondary MR	Secondary MR	Secondary MR
Ejection Fraction	> 30%	15 to 40%	15 to 40%
Hospitalisation HF < 12 months ?		100%	100%
High Risk Patients	Surgical CI (heart team)		Surgical CI (heart team)
NHYA	II, III, IV	III, IV	II, III, IV
Principal Criteria	Safety et efficacy (hospit pour CHF)	% all deaths or rehospitalisation rate HF	% all deaths + % rehospitalisation HF
<u>Hypothesis</u>		18 vs 14 % death and 0,6 vs 0,45 hospit	20 vs 35%
Lost pats		15%	10%
Number of inclusions	430 patients 85 centers	400 x 2	280 patients 26 centers
Number of centres	9	75	18

INTRO

Clip

Neochord

Annulo
plasty

Post
Conclusion

