Department of Cardiac Surgery
GVM Care and Research
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5 thoughts on surgical mitral valve treatment for secondary regurgitation

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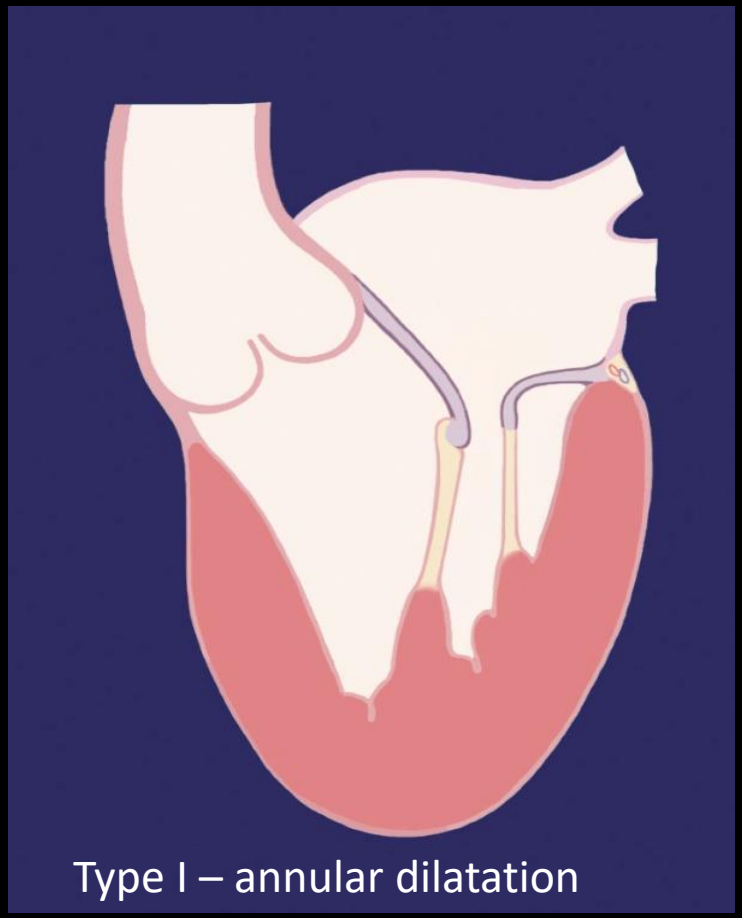
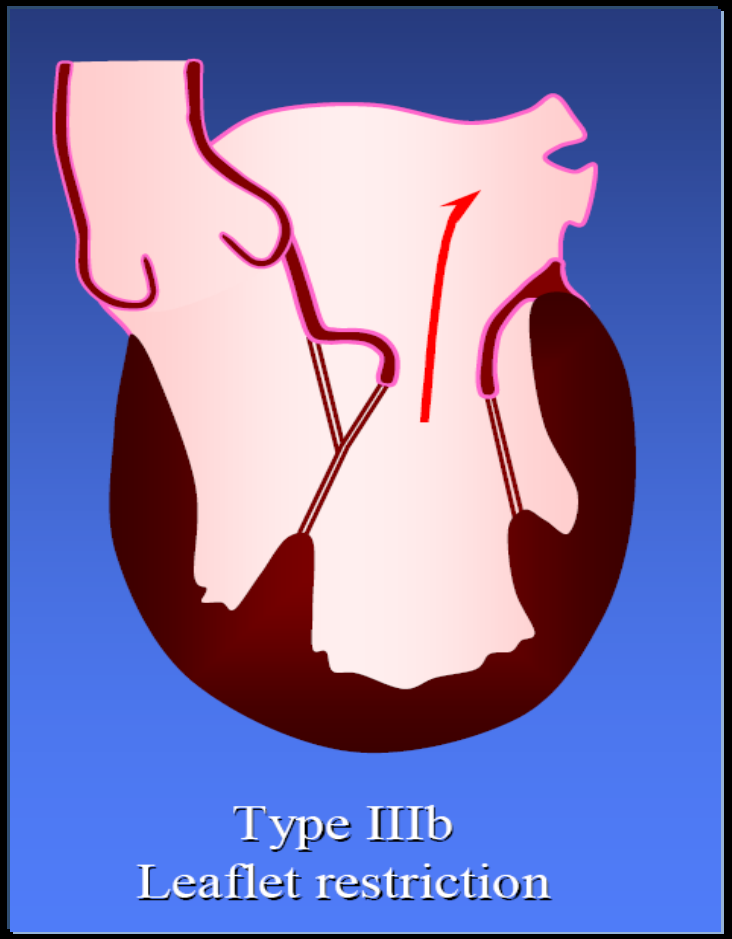
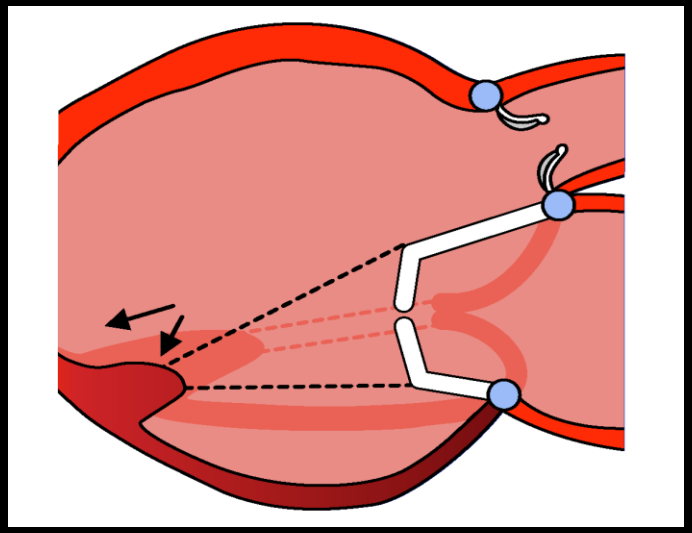
Eurovalve 2024, October 24 – 25, Palermo

Carpentier's Functional classification of sMR





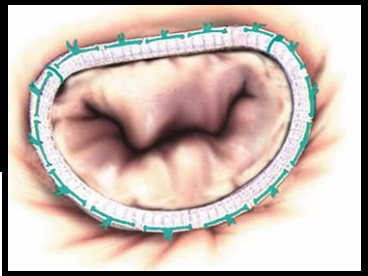
The "RING and RUN" approach
Undersizing annuloplasty for all cases?

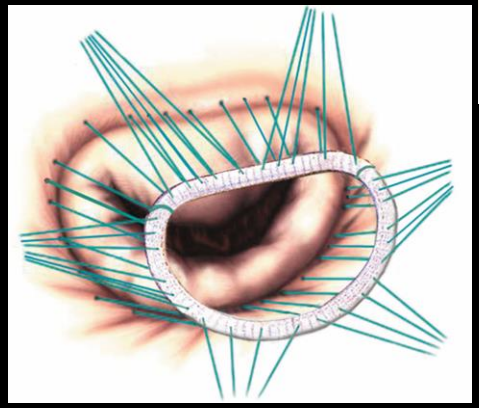


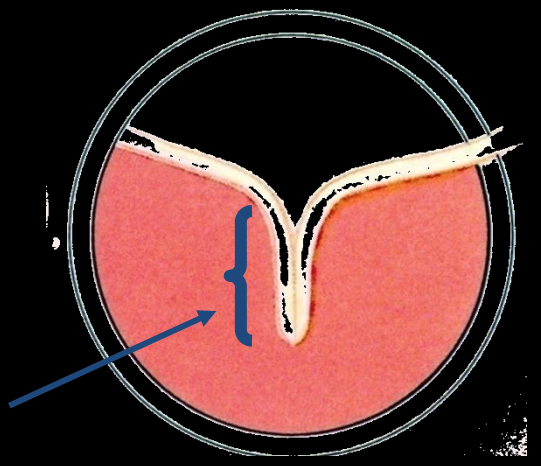
AN ANNULAR SOLUTION TO

A VENTRICULAR PROBLEM

?







Coaptation Reserve
> = 8 mm

Recurrent severe MR up to 30% at 1-year

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Mitral-Valve Repair versus Replacement for Severe Ischemic Mitral Regurgitation

Michael A. Acker, M.D., Michael K. Parides, Ph.D., Louis P. Perrault, M.D., Alan J. Moskowitz, M.D., Annetine C. Gelijns, Ph.D., Pierre Voisine, M.D., Peter K. Smith, M.D., Judy W. Hung, M.D., Eugene H. Blackstone, M.D., John D. Puskas, M.D., Michael Argenziano, M.D., James S. Gammie, M.D., Michael Mack, M.D., Deborah D. Ascheim, M.D., Emilia Bagiella, Ph.D., Ellen G. Moquete, R.N., T. Bruce Ferguson, M.D., Keith A. Horvath, M.D., Nancy L. Geller, Ph.D., Marissa A. Miller, D.V.M., Y. Joseph Woo, M.D., David A. D'Alessandro, M.D., Gorav Ailawadi, M.D., Francois Dagenais, M.D., Timothy J. Gardner, M.D., Patrick T. O'Gara, M.D., Robert E. Michler, M.D., and Irving L. Kron, M.D., for the CTSN*

1-year recurrence of mr after undersized annuloplasty in FMR is up to 20%

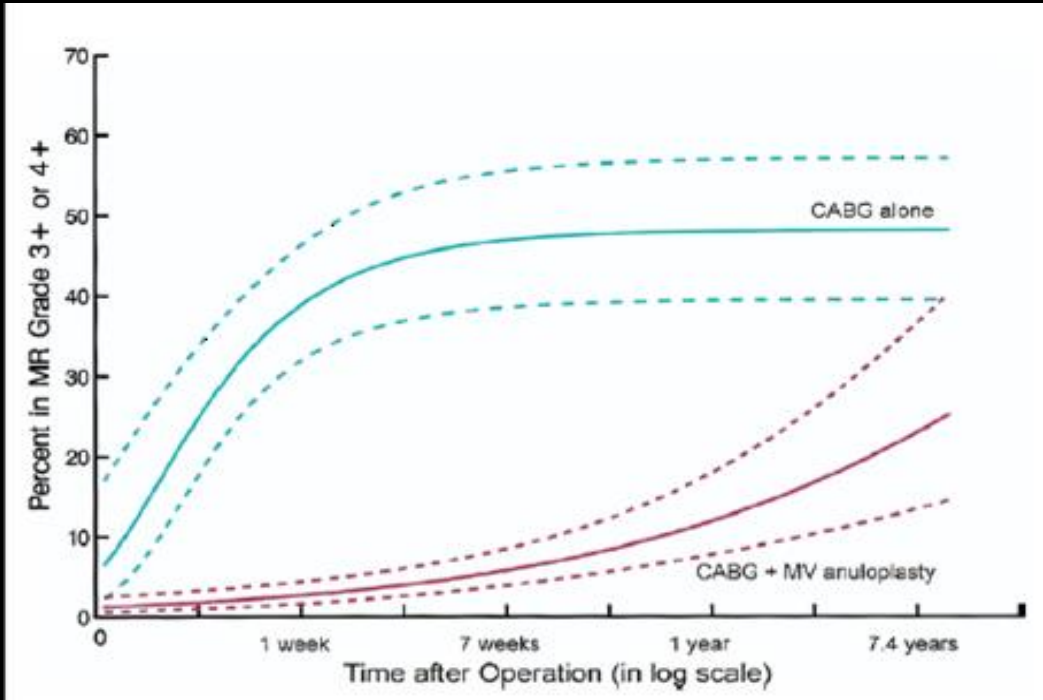


Figure 2 Proportion of Patients in MR Grades 3+ or 4+

- **Early**

  Increased posterior leaflet tethering

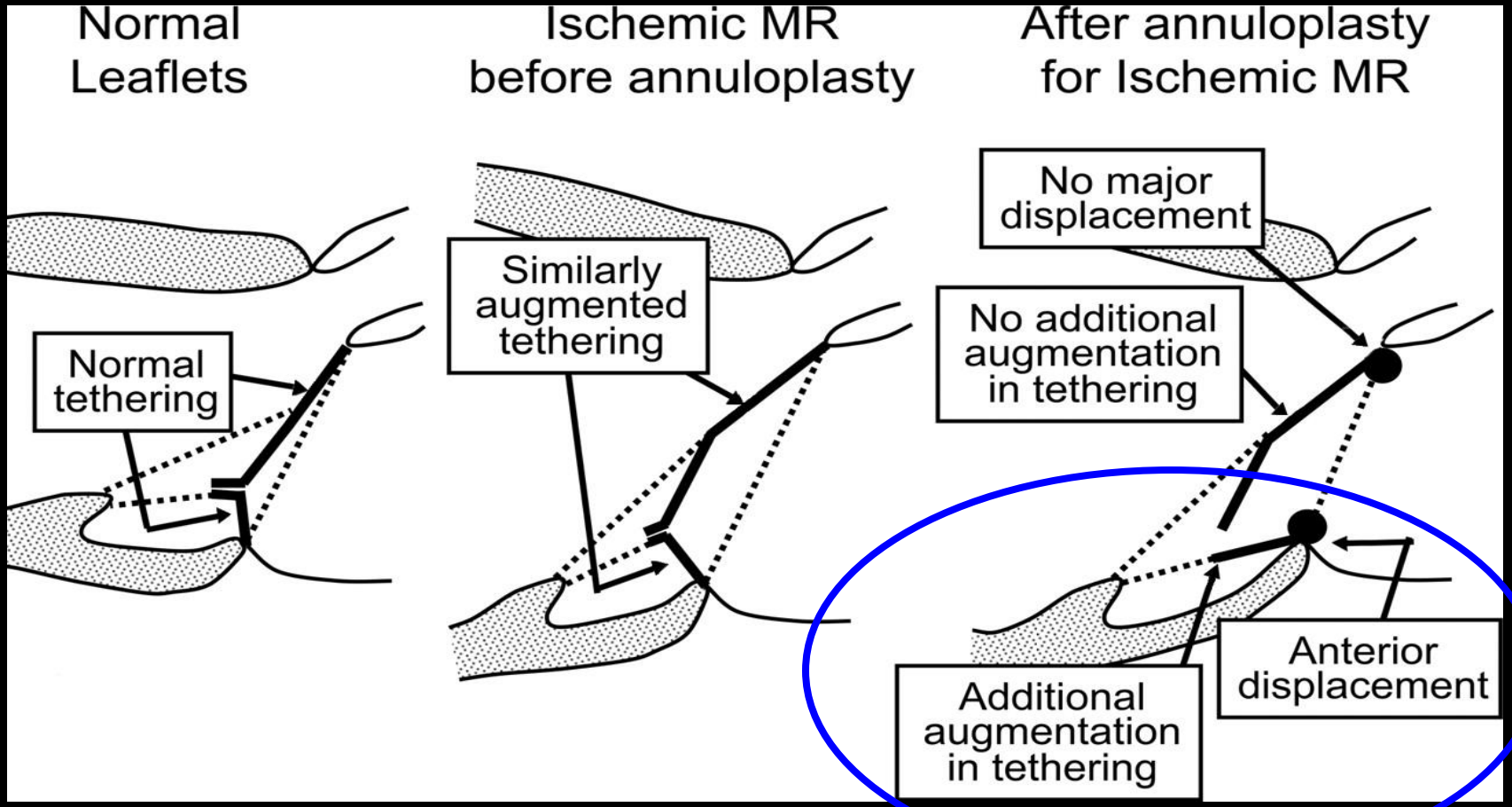
- **Late**

  Ongoing LV remodeling "The moving target"

  Insufficient coaptation reserve

T. Mihalievic et al. JACC 2007;49:2191-201

Mecchanism of recurrent MR after annuloplasty



Kuwahara, E. et al. Circulation 2006;114:I-529-I-534

The high rate of recurrent MR is due to fail in patient's selection and surgical procedures

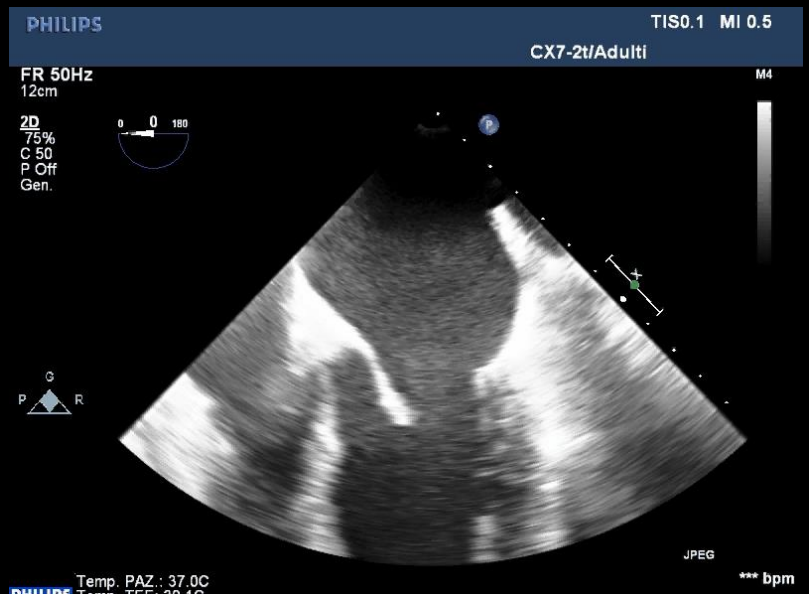
What we did?

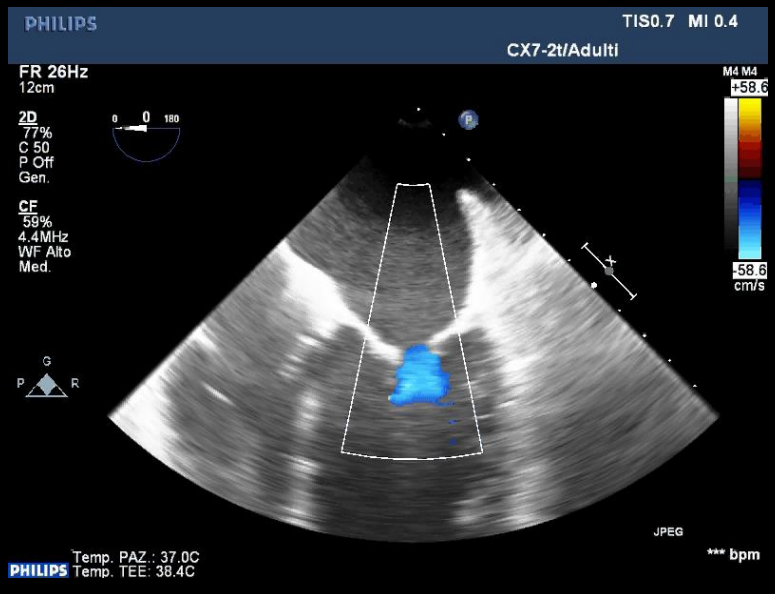
Mitral Valve annuloplasty doesn’t mean mitral valve repair

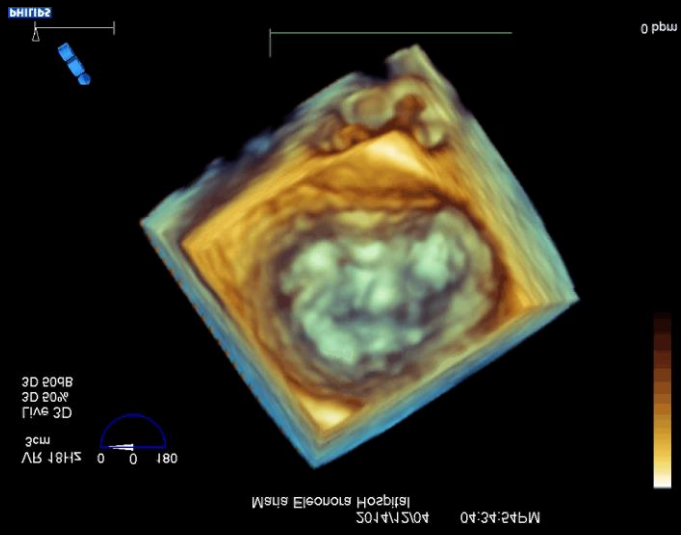
Echocardiographic Predictors for recurrent MR after restrictive annuloplasty	Authors/Reference
Systolic tenting area > 2.5 cm2	Lesniak-Sobelga et al; Kongsaerepong et al.
Coaptation depth/height > 10mm	Gelsomino et al, Calafiore et al, Ciarka et al.
Posterior angle (β) > 45°	Kuwahara et al, Ciarka et al.
Distal anterior angle (α) > 25°	Gelsomino et al, Magne et al, Ciarka et al.
Sphericity index > 0.7	Ciarka et al.
End-systolic inter-papillary muscles distance > 20mm	Roshanali et al.
LV end-dyastolic diameters and volumes	Dion et al, Braun et al, Onorati et al.
Left ventricle dyssynchrony	Van Garsse et al.

Why patients with preoperative echocardiographic predictors for early MR reccurence are still treated with isolated annuloplasty?

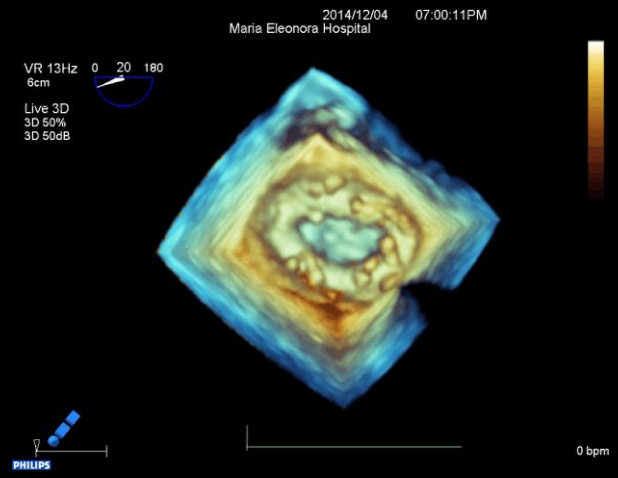
Secondary Type I MR - Isolated restrictive annuloplasty
Preoperative

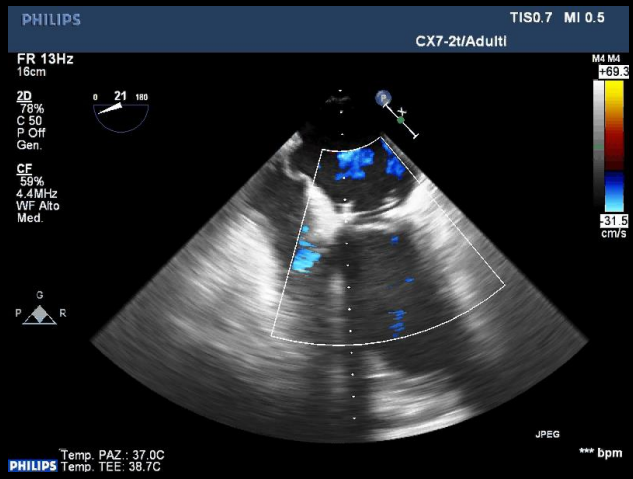


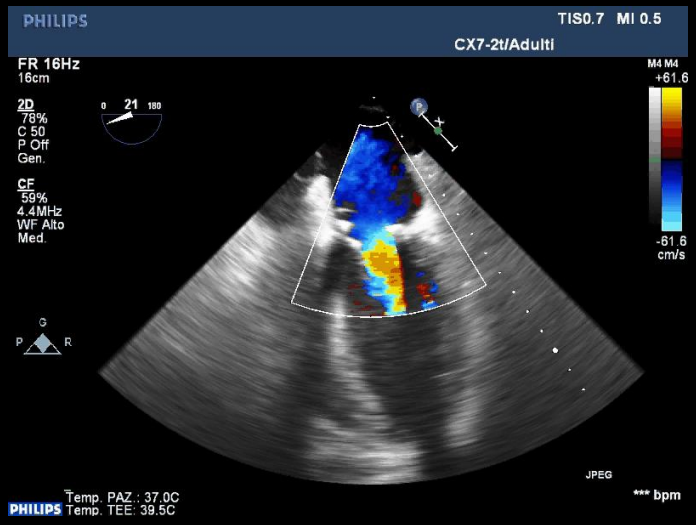




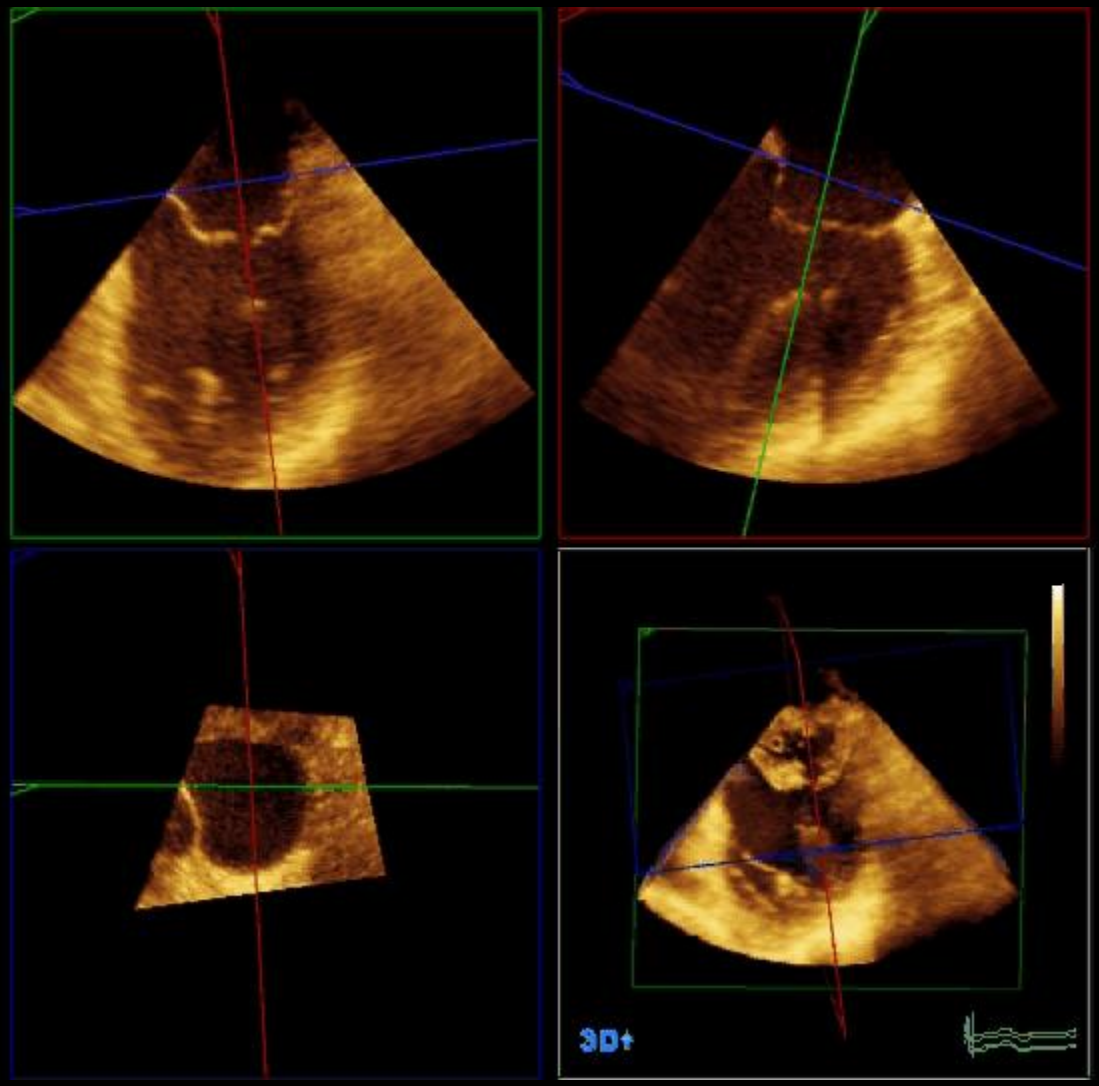
Secondary Type I MR - Isolated restrictive annuloplasty Postoperative







Secondary Type IIIb MR – Annuloplasty + Subannular techniques

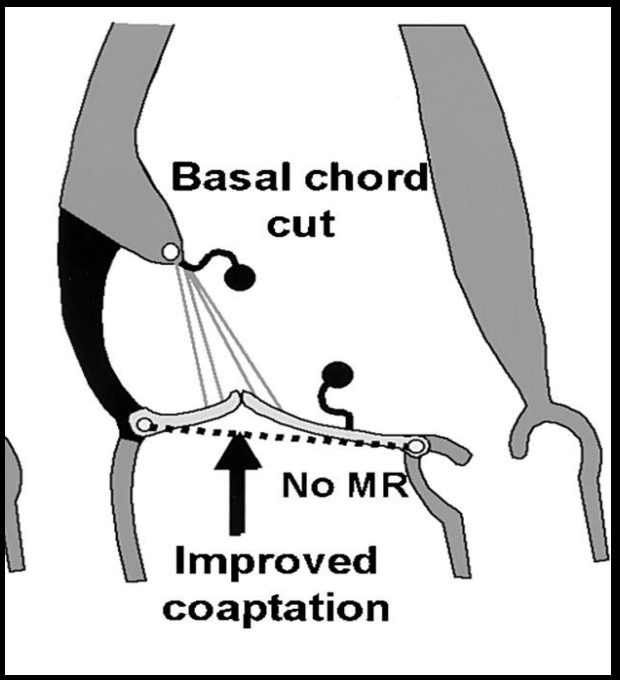


PHILIPS

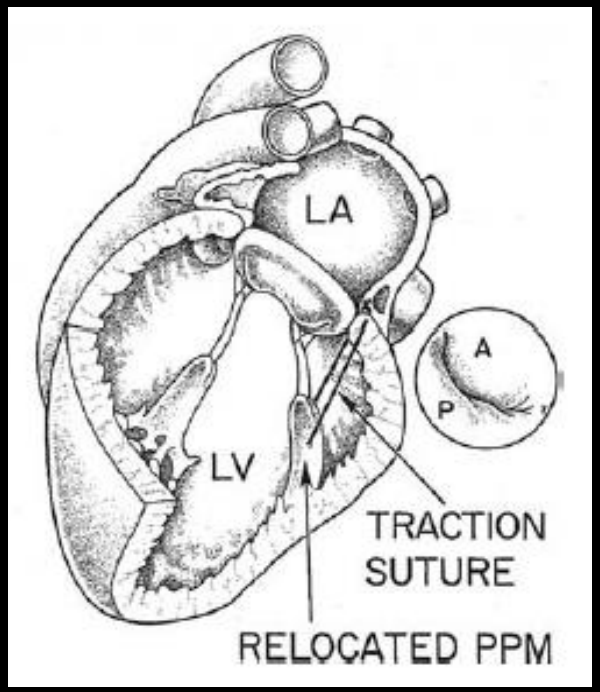
Attemps to improve durability of MVR in FIMR

Sub-anular procedures

(Chordal Cutting, PPM relocation, PPM sling)



Chordal Cutting: A New Therapeutic Approach for Ischemic Mitral Regurgitation
Emmanuel Messas, J. Luis Guerrero, Mark D. Handschumacher, Chris Conrad, Chi-Ming Chow, Suzanne Sullivan, Ajit P. Yoganathan and Robert A. Levine
Circulation 2001;104:1958-1963



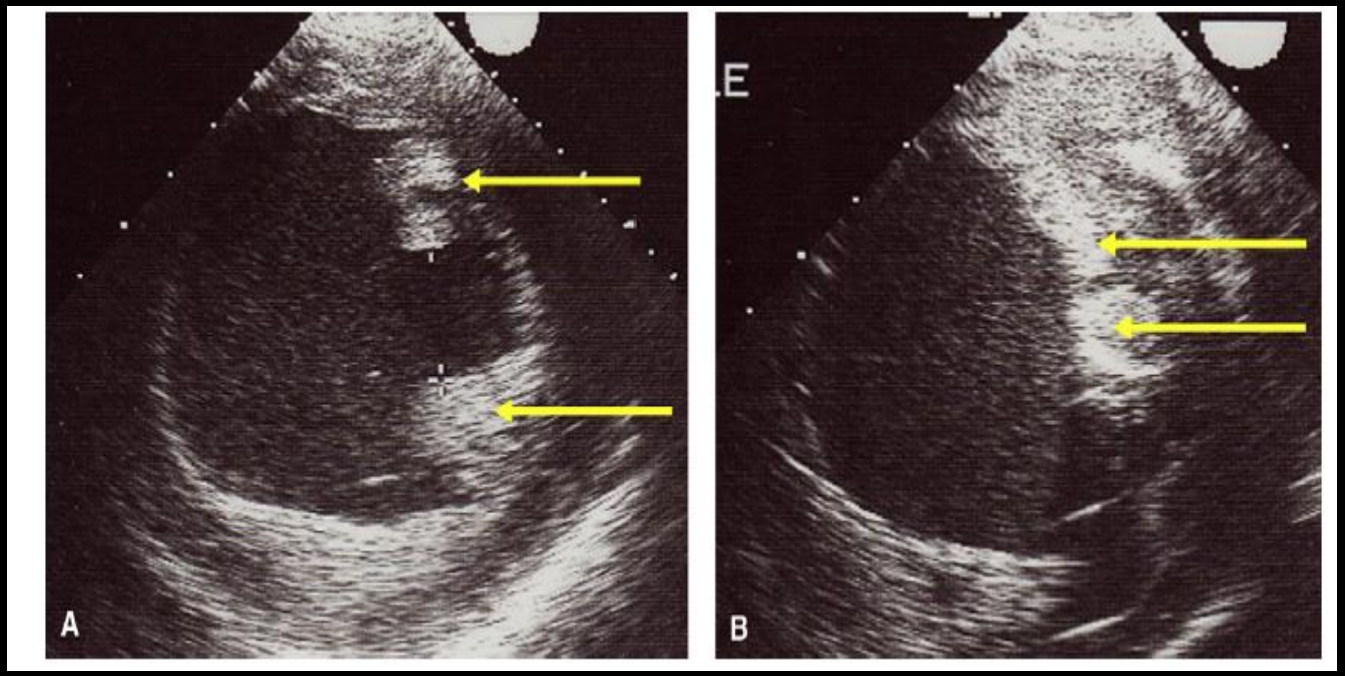
Surgical relocation of the posterior papillary muscle in chronic ischemic mitral regurgitation
Irving L. Kron, G. Randall Green and Jeffrey T. Cope
Ann Thorac Surg 2002;74:600-601

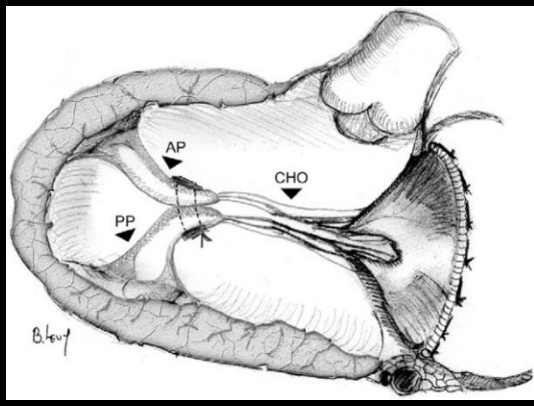
Papillary muscle sling: a new functional approach to mitral repair in patients with ischemic left ventricular dysfunction and functional mitral regurgitation
Ulrik Hvass, Michel Tapia, Frank Baron, Bruno Pouzet and Abdel Shafy
Ann Thorac Surg 2003;75:809-811

The papillary muscle sling for ischemic mitral regurgitation

Ulrik Hvass, MD, and Thomas Joudinaud, MD

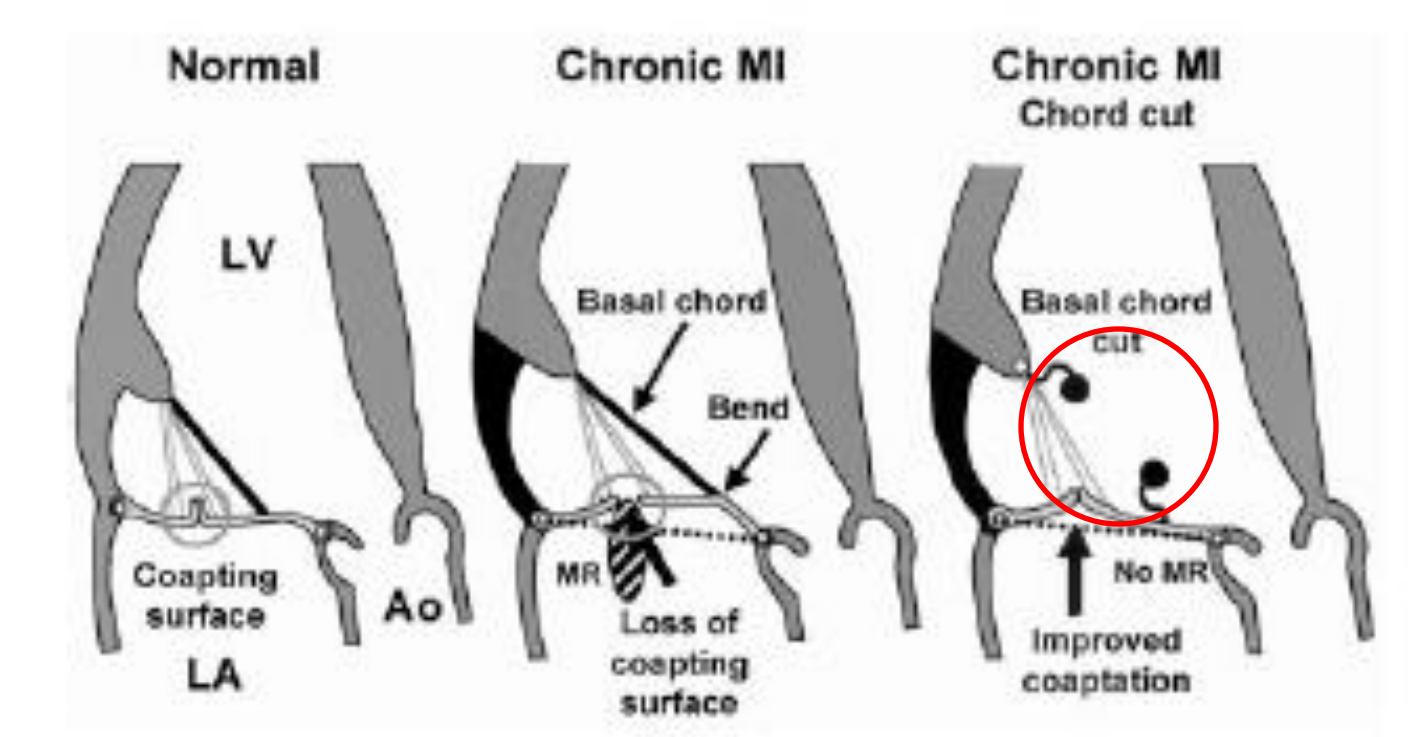
Conclusion: Reapproximating the papillary muscles has an immediate effect on mitral leaflet mobility by suppressing the tethering resulting from displacement of the papillary muscles. It has an effect in preventing recurrent mitral regurgitation by avoiding further papillary muscle displacement. In this cohort of severely disabled patients, reverse remodeling can be expected with the double-level repair. (J Thorac Cardiovasc Surg 2010;139:418-23)





Efficacy of Chordal Cutting to Relieve Chronic Persistent Ischemic Mitral Regurgitation

Emmanuel Messas, MD, MSc; Bruno Pouzet, MD; Bernard Touchot, MD; J. Luis Guerrero, BS; Gus J. Vlahakes, MD; Michel Desnos, MD; Philippe Menasché, MD, PhD; Albert Hagège MD, PhD; Robert A. Levine, MD



(*Circulation*. 2003;108[suppl II]:II-111-II-115.)

Relief of Mitral Leaflet Tethering Following Chronic Myocardial Infarction by Chordal Cutting Diminishes Left Ventricular Remodeling

Emmanuel Messas, MD, PhD[1], Alain Bel, MD[1], Catherine Szymanski, MD[1], Iris Cohen, MD[1], Bernard Touchot, MD[1], Mark D. Handschumacher, BS[2], Michel Desnos, MD[1], Alain Carpentier, MD, PhD[1], Philippe Menasché, MD, PhD[1], Albert A Hagège, MD, PhD[1], and Robert A. Levine, MD[2]

Circ Cardiovasc Imaging. 2010 November 1; 3(6): 679–686.

Conclusions—Reduced leaflet tethering by chordal cutting in the chronic post-MI setting substantially decreases the progression of LV remodeling with sustained reduction of MR over a chronic follow-up. These benefits have the potential to improve clinical outcomes.

Initial results of the chordal-cutting operation for ischemic mitral regurgitation

Michael A. Borger, MD, PhD, Patricia M. Murphy, MD, Asim Alam, MD, Shafie Fazel, MD, PhD, Manjula Maganti, MSc, Susan Armstrong, MSc, Vivek Rao, MD, PhD, and Tirone E. David, MD

J Thorac Cardiovasc Surg 2007;133:1483-92

TABLE 4. Intraoperative transesophageal echocardiographic measurements

Variable	Control (n = 39)	Chordal cutting (n = 36)	*P* value
Mitral annular diameter (mm)	34 ± 1	35 ± 1	.3
Tent area (cm^2)	2.5 ± 0.2	2.9 ± 0.2	.14
AMVL–posterior LV (mm)	24 ± 9	21 ± 6	.2
Prerepair to postrepair reduction			
Mitral annulus	28% ± 3%	33% ± 2%	.2
Tent height	20% ± 3%	24% ± 4%	.4
Tent area	41% ± 3%	53% ± 3%	.01
AMVL–posterior LV	11% ± 4%	24% ± 3%	.01

Conclusion: Chordal cutting improves mitral valve leaflet mobility and reduces mitral regurgitation recurrence in patients with ischemic mitral regurgitation, without any obvious deleterious effects on left ventricular function.

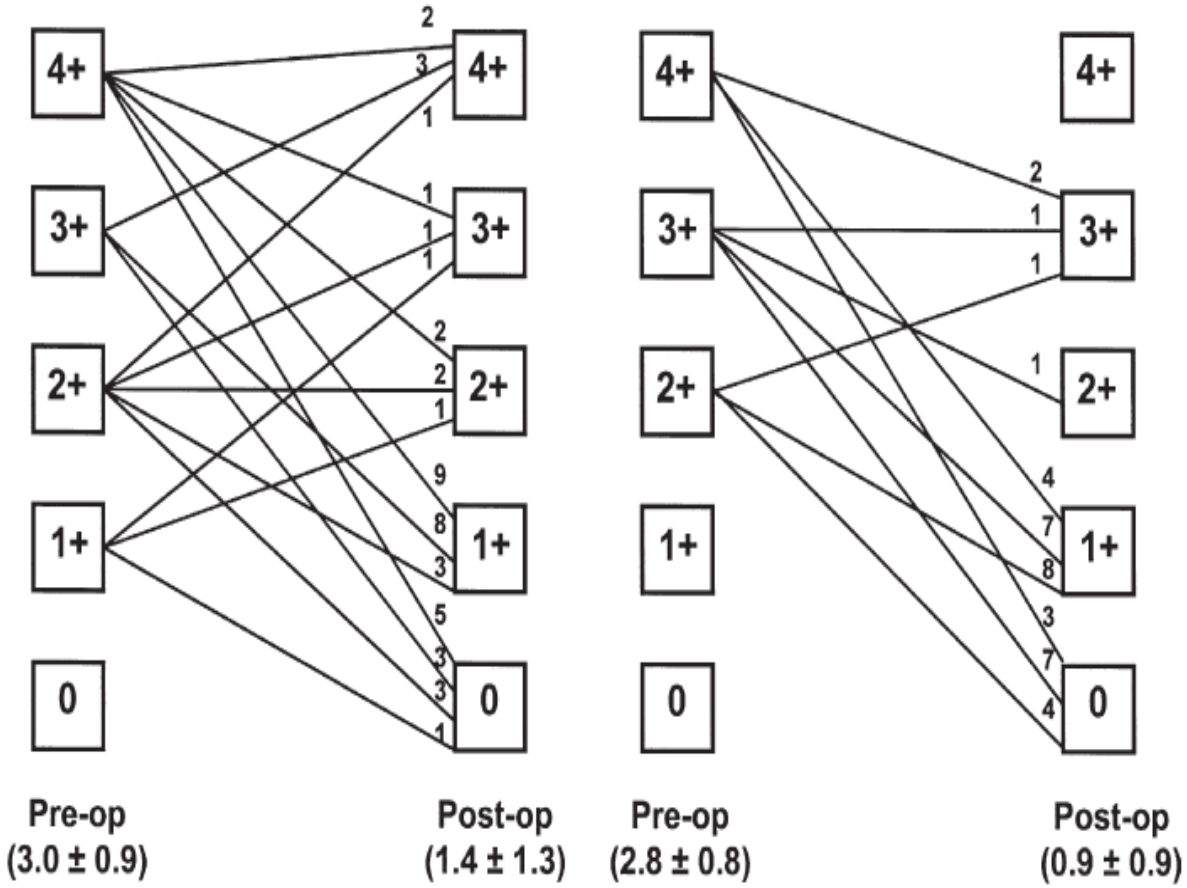


Figure 1. Grade of MR preoperatively and during follow-up in the control group *(left)* and the chordal-cutting group *(right)*. Both groups showed a significant reduction in the grade of MR from before to after surgery ($P < .001$). Preoperative MR grade was similar between groups, but postoperative MR grade was lower in the chordal-cutting group ($P = .04$). *MR*, mitral regurgitation.

Control group
14 pts ≥ moderate MR

Chordal cutting group
5 pts ≥ moderate MR

Chordal cutting in ischemic mitral regurgitation: A propensity-matched study

Antonio M. Calafiore, MD,[a] Reda Refaie, MD,[a] Angela L. Iacò, MD,[a] Mahmood Asif, MD,[a] Heythem S. Al Shurafa, MD,[b] Hussein Al-Amri, MD,[b] Antonella Romeo, MD,[c] and Michele Di Mauro, MD[a,d]

Conclusions: In selected patients with a BA <145° and coaptation depth ≤10 mm, CC is related to less MR return or persistence, improved EF, and lower New York Heart Association class. (J Thorac Cardiovasc Surg 2014;148:41-6)

TABLE 1. Preoperative clinical and echocardiographic data

Variable	CC group (n = 26)	No-CC group (n = 26)	*P* value
Age (y)	61 ± 9	62 ± 10	.706
Female gender (n)	9	8	1.000
NYHA class	2.7 ± 0.6	2.6 ± 0.7	.583
EuroSCORE	8.1 ± 3.9	7.5 ± 4.6	.614
Diabetes mellitus (n)	15	18	.565
Previous AMI (n)			1.000
Anterior	20	19	
Inferior	6	7	
EF (%)	31 ± 5	29 ± 8	.285
LVEDD (mm)	56 ± 7	57 ± 11	.697
LVESD (mm)	43 ± 8	44 ± 11	.709
Coaptation depth (mm)	9.1 ± 0.6	8.9 ± 0.7	.274
Coaptation length (mm)	3.2 ± 0.7	3.5 ± 1.1	.246
MR grade (1-4)	3.6 ± 0.6	3.3 ± 0.8	.132
PAPs (mm Hg)	47 ± 10	52 ± 13	.126
Mitral leaflet tethering (°)			
α	50 ± 6	49 ± 7	.274
β	44 ± 5	45 ± 8	.591
BA	137 ± 4	137 ± 6	1.000
α/β	1.13 ± 0.3	1.09 ± 0.3	.633
α Excursion	13 ± 9	14 ± 8	.612
β Excursion	26 ± 12	27 ± 9	.735
Proximal AL (mm)	14 ± 2	14 ± 2	1.000
Distal AL (mm)	13 ± 2	14 ± 3	.163

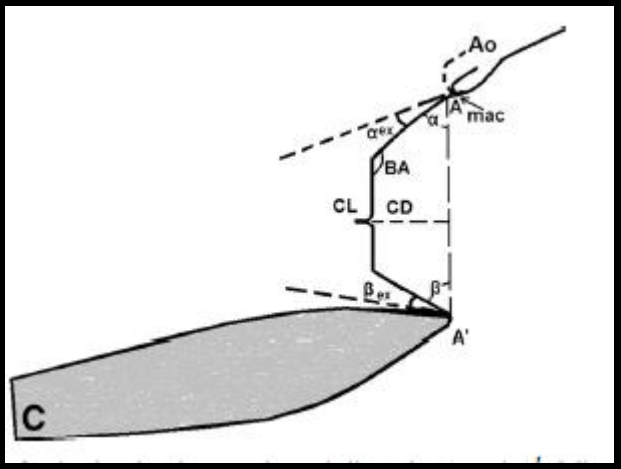


TABLE 2. Surgical details

Variable	CC (n = 26)	No-CC (n = 26)	*P* value
SMB40 (n)	26	—	NA
Physioring (n)	—	26	NA
CABG (n)	26	26	1.000
TV surgery (n)	10	2	.021

CC, Chordal cutting; *No-CC*, no chordal cutting; *NA*, not applicable; *CABG*, coronary artery bypass grafting; *TV*, tricuspid valve.

Cutting second chordae impair ventricular function

Influence of Anterior Mitral Leaflet Second-Order Chordae Tendineae on Left Ventricular Systolic Function

Sten Lyager Nielsen, MD, PhD; Tomasz A. Timek, MD; G. Randall Green, MD;

Anterior Chordal Transection Impairs Not Only Regional Left Ventricular Function But Also Regional Right Ventricular Function in Mitral Regurgitation

Thierry Le Tourneau, MD; Daniel Grandmougin, MD; Claude Foucher, MD;
Eugene P. McFadden, MRCPI; Pascal de Groote, MD; Alain Prat, MD;
Henri Warembourg, MD; Ghislaine Deklunder, MD, PhD

chordae because this may compromise LV systolic function in ventricules that are already impaired

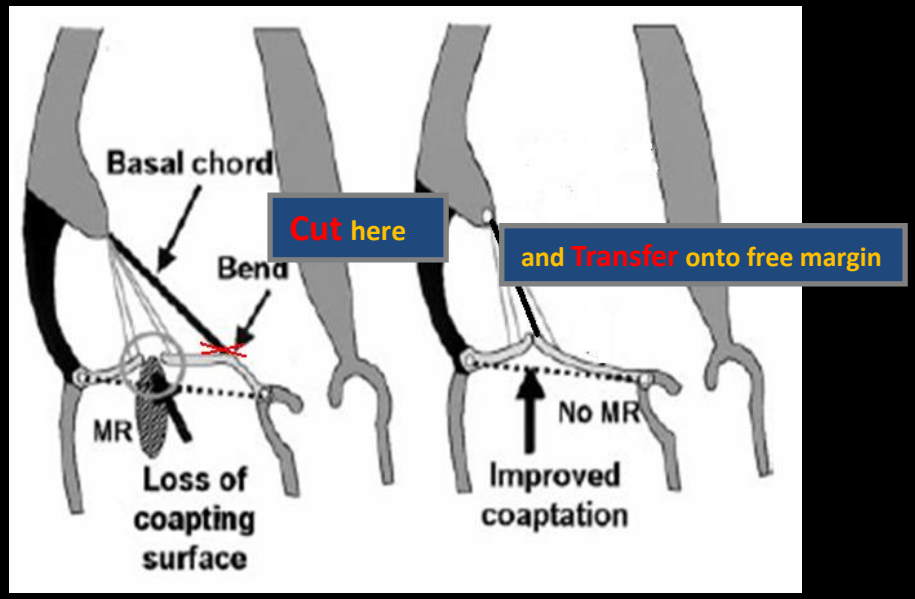
(*Circulation*. 2001;104[suppl I]:I-41-I-46.)

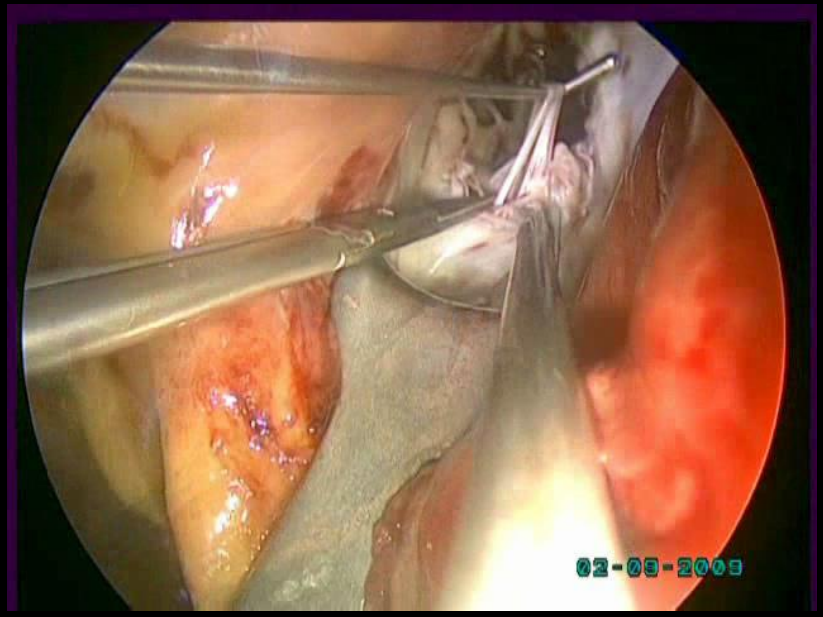
Cut-and-Transfer Technique for Ischemic Mitral Regurgitation and Severe Tethering of Mitral Leaflets

Giangiuseppe Cappabianca, MD, Samuele Bichi, MD, Davide Patrini, MD, Pasquale Pellegrino, MD, Camillo Poloni, MD, Elena Perlasca, MD, Marianna Redaelli, MD, and Giampiero Esposito, MD

Department of Cardiac Surgery, "Humanitas Gavazzeni" Hospital, Bergamo, Italy

(Ann Thorac Surg 2013;96:1607–13)



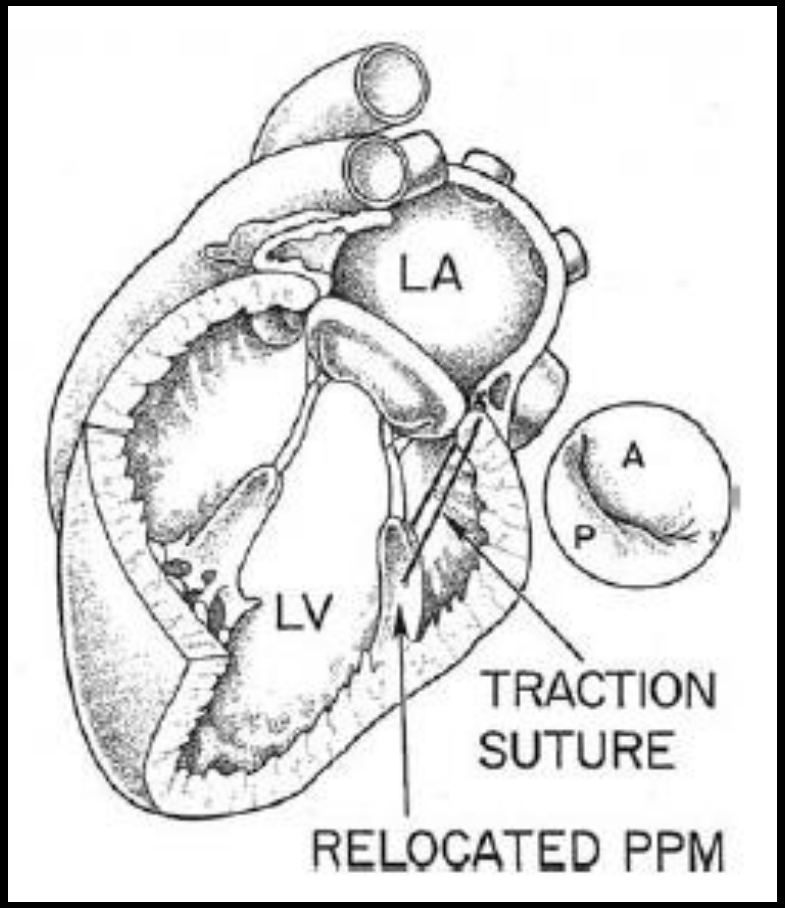


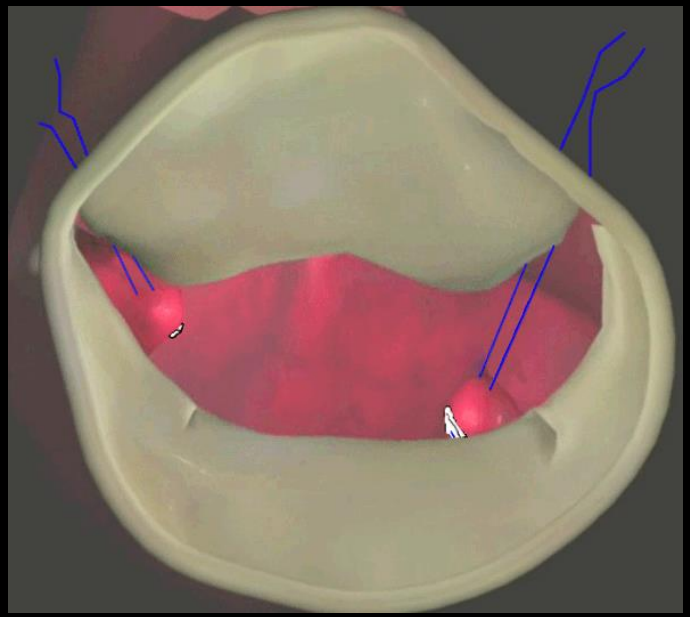
Surgical Relocation of the Posterior Papillary Muscle in Chronic Ischemic Mitral Regurgitation

Irving L. Kron, MD, G. Randall Green, MD, and Jeffrey T. Cope, MD

Department of Thoracic and Cardiovascular Surgery, University of Virginia, Charlottesville, Virginia

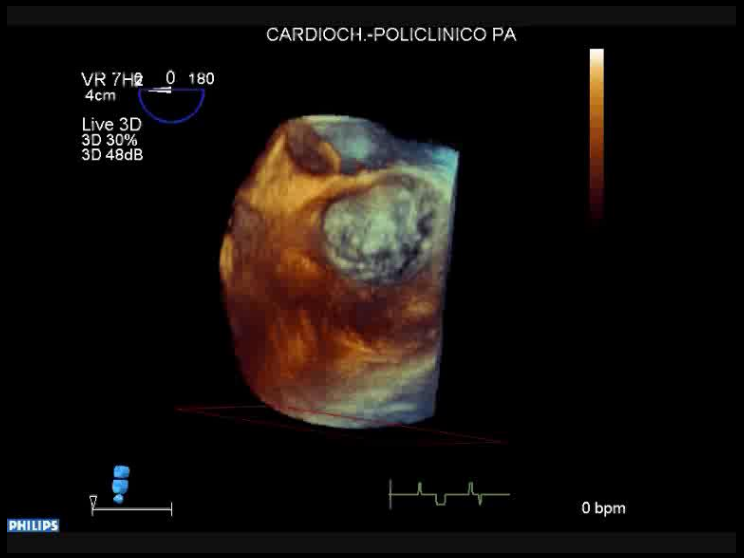
(Ann Thorac Surg 2002;74:600–1)



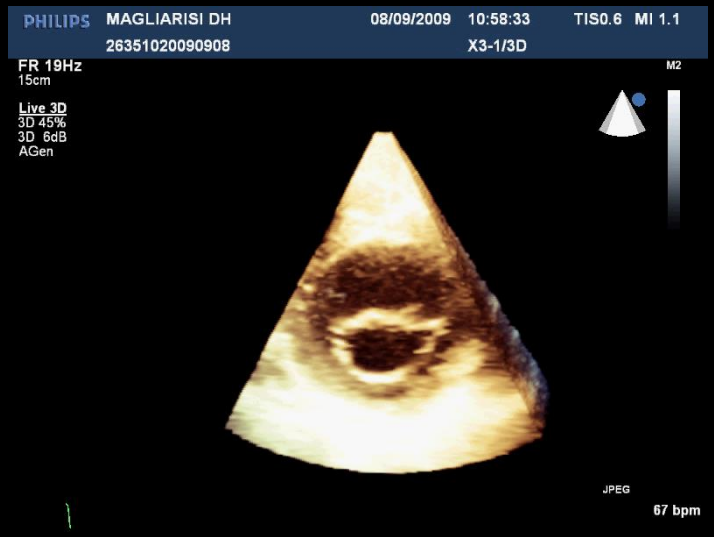


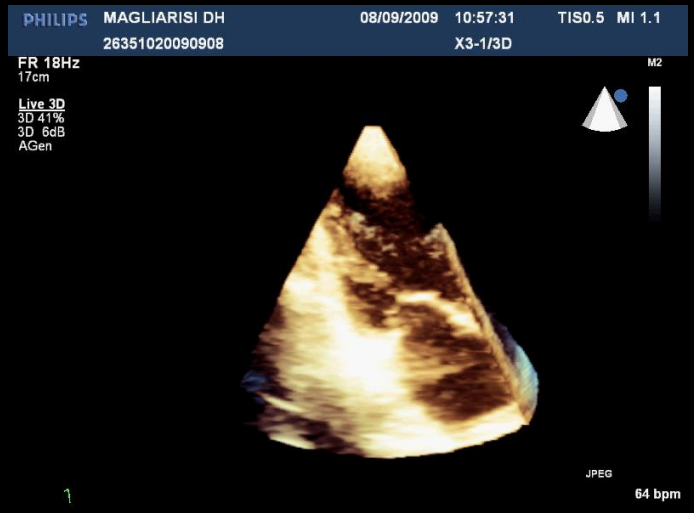
Which PPM?

Both PPMs relocation

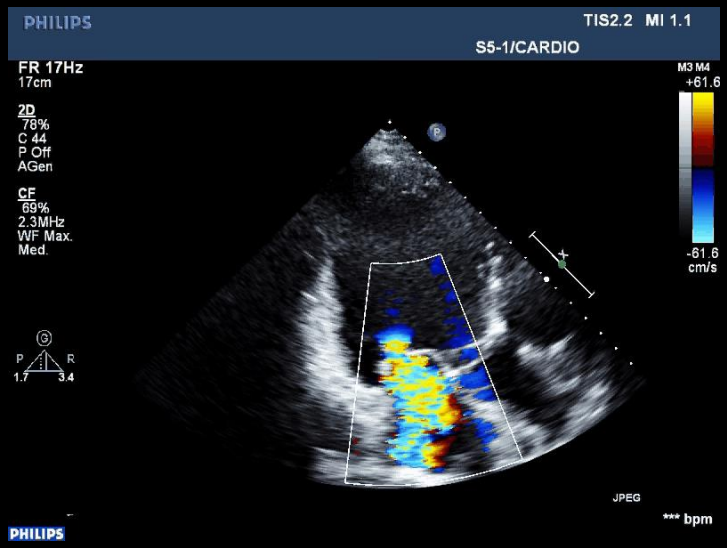


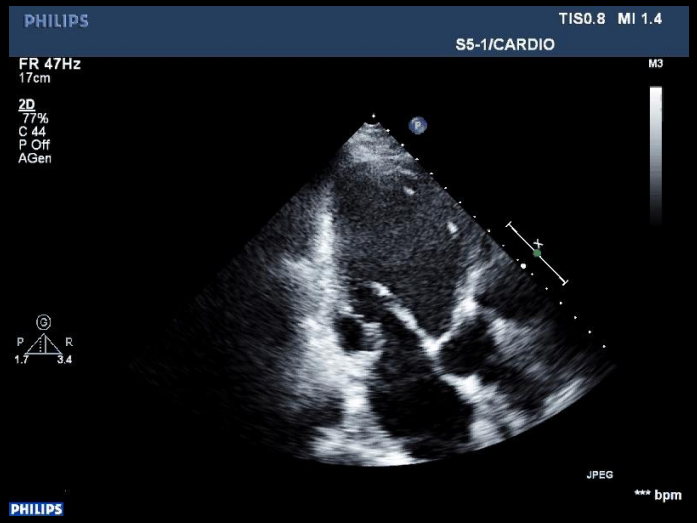
Posterior PPM relocation

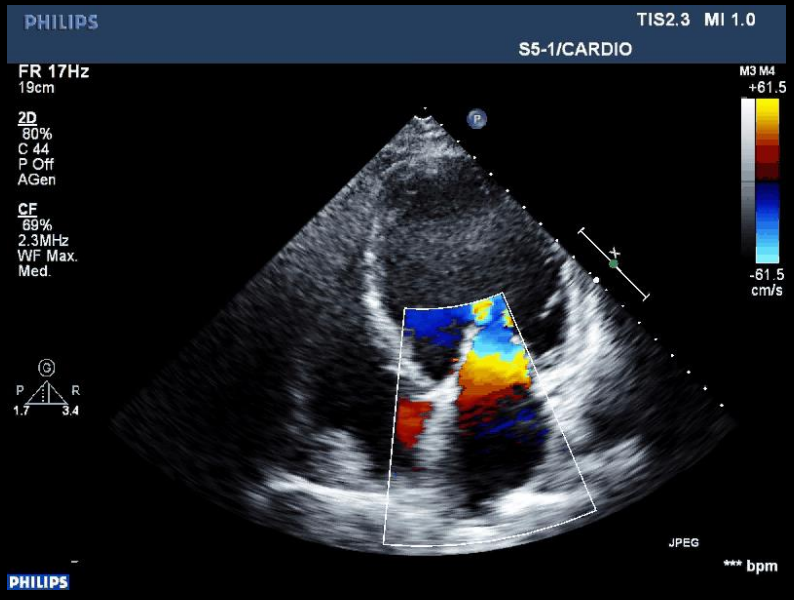




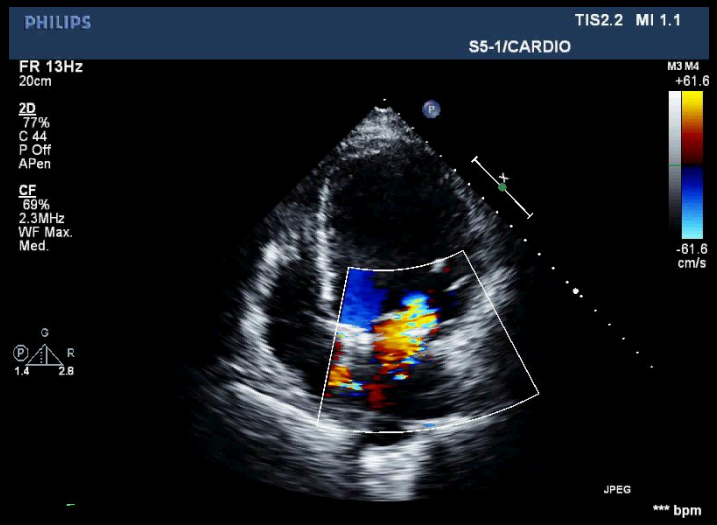
Secondary Type IIIb MR - preoperative

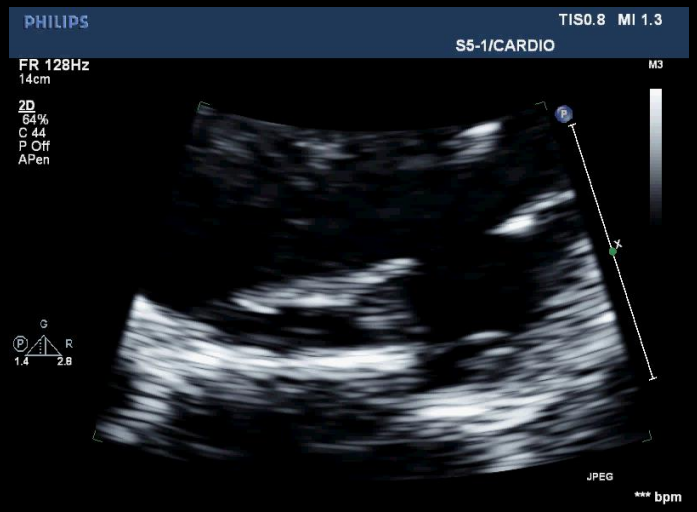


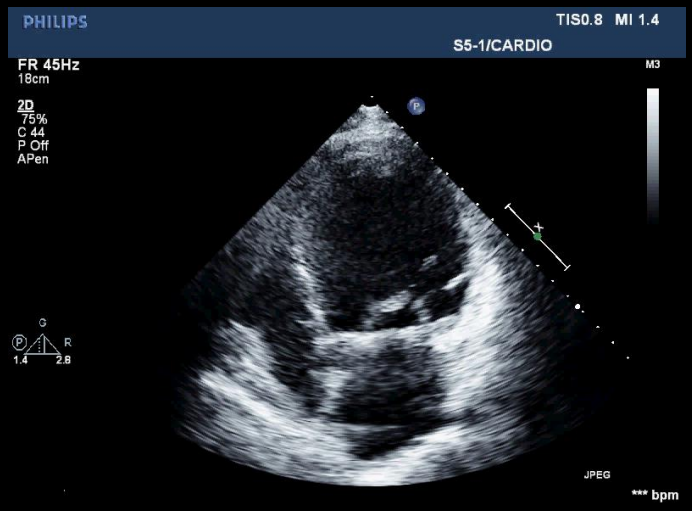


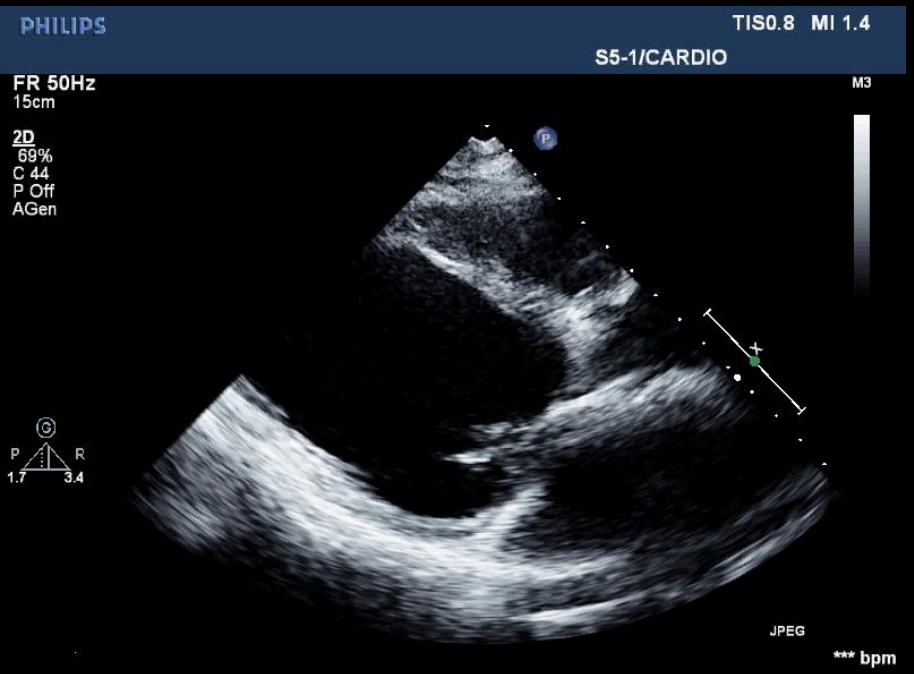


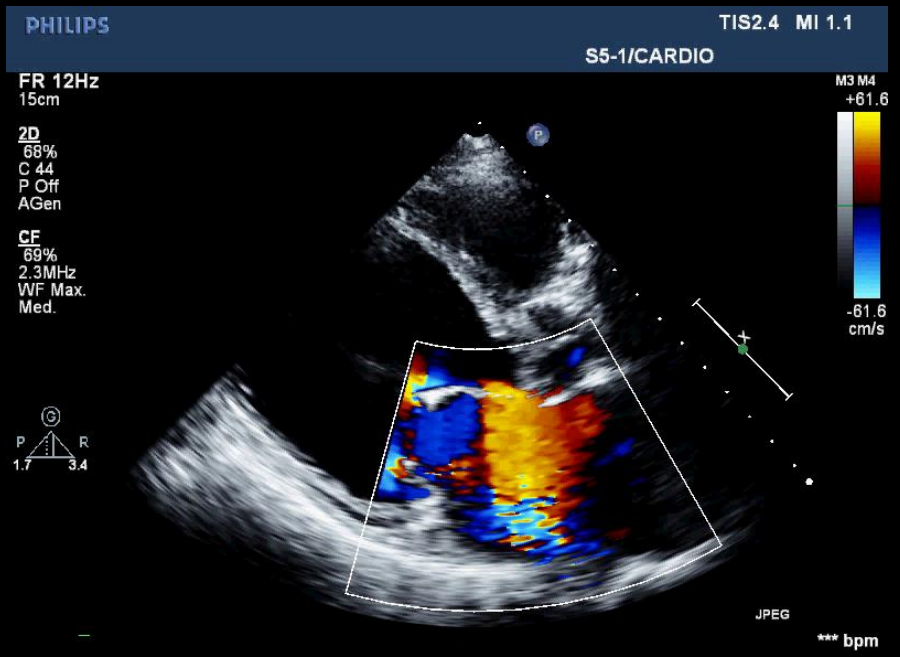
Secondary Type IIIb MR – post undersizing annuloplasty

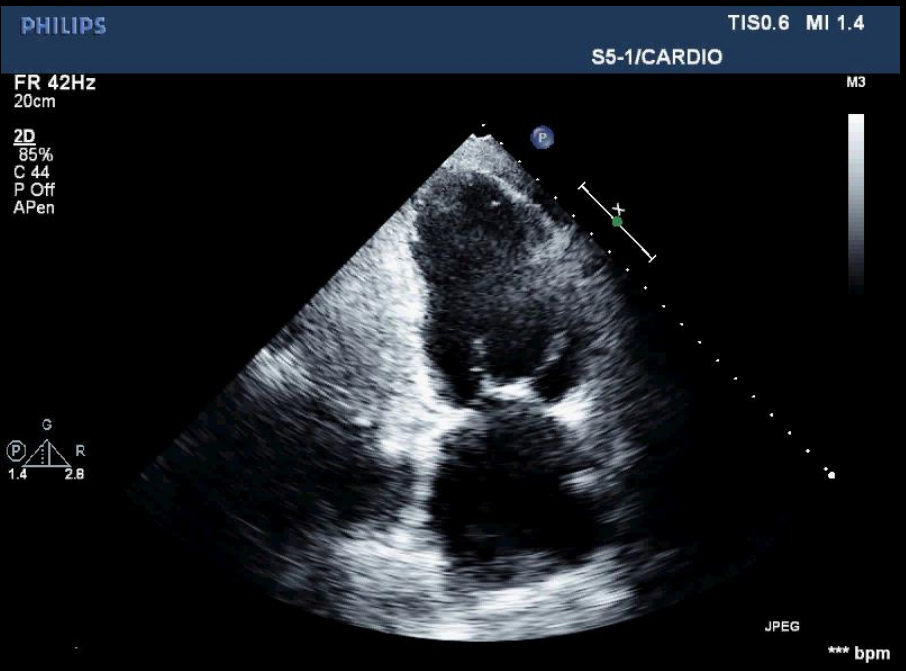


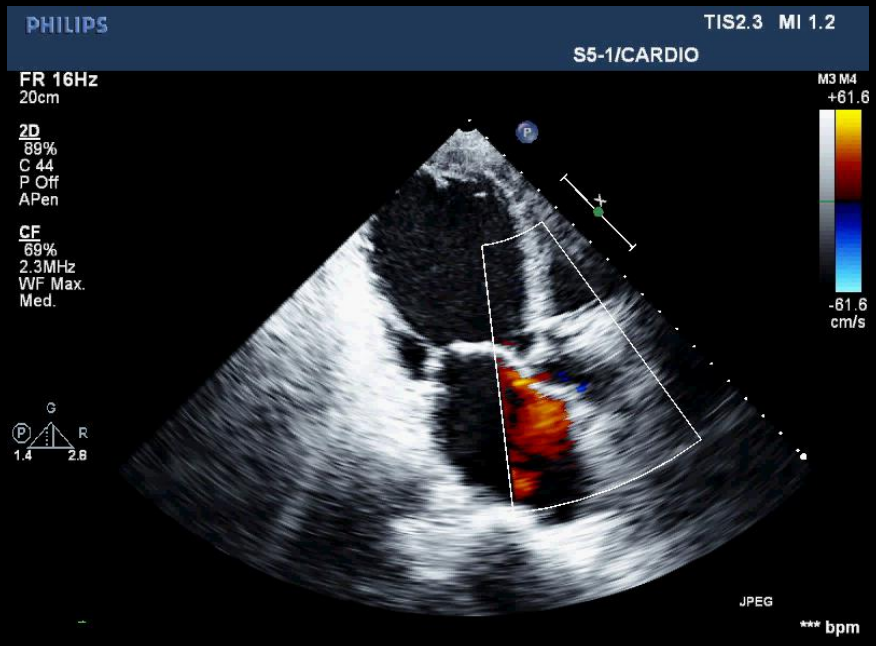




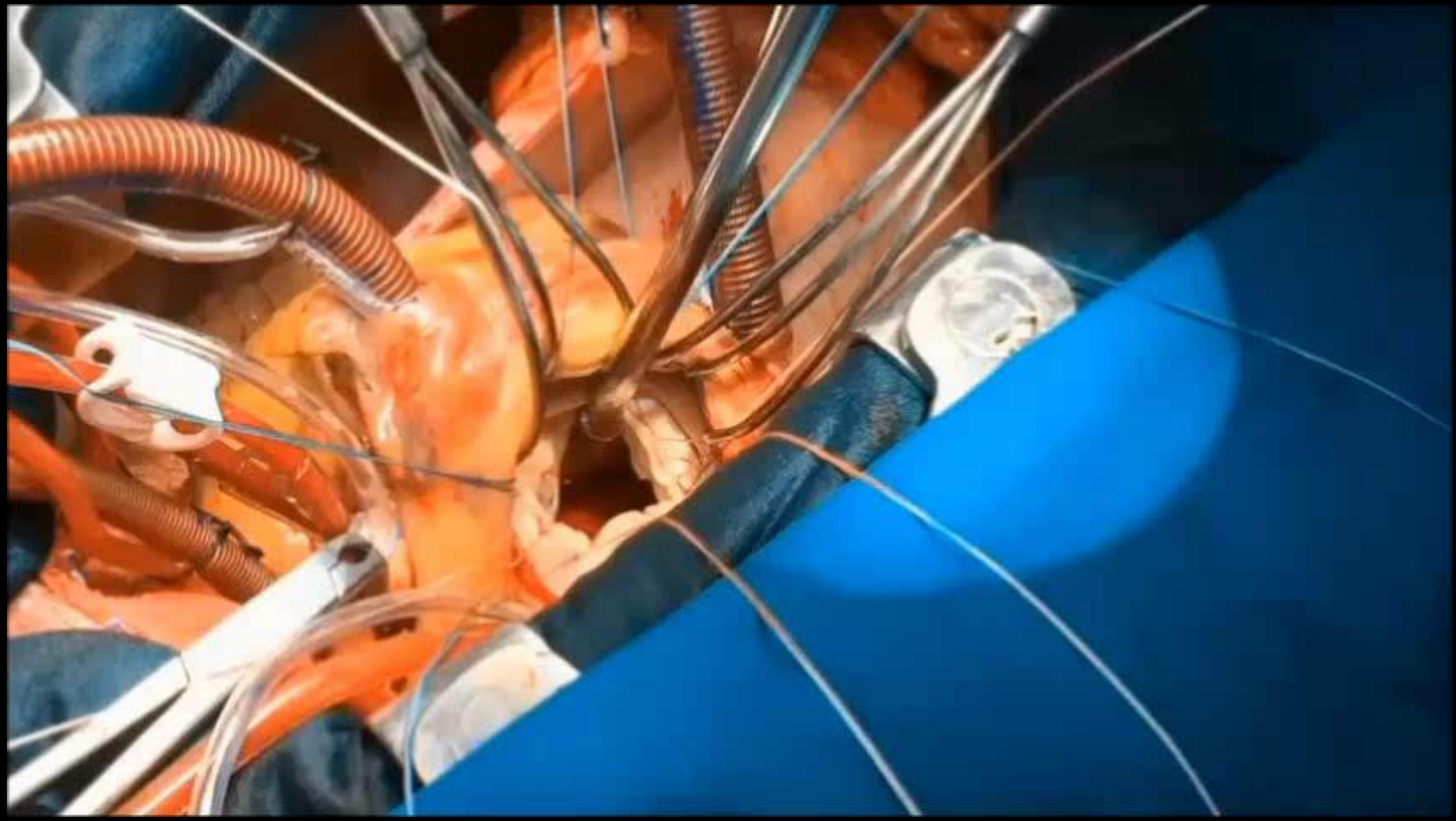

PHILIPS
TIS0.8 MI 1.4
S5-1/CARDIO
FR 50Hz
15cm
2D
69%
C 44
P Off
AGen
M3
JPEG
*** bpm

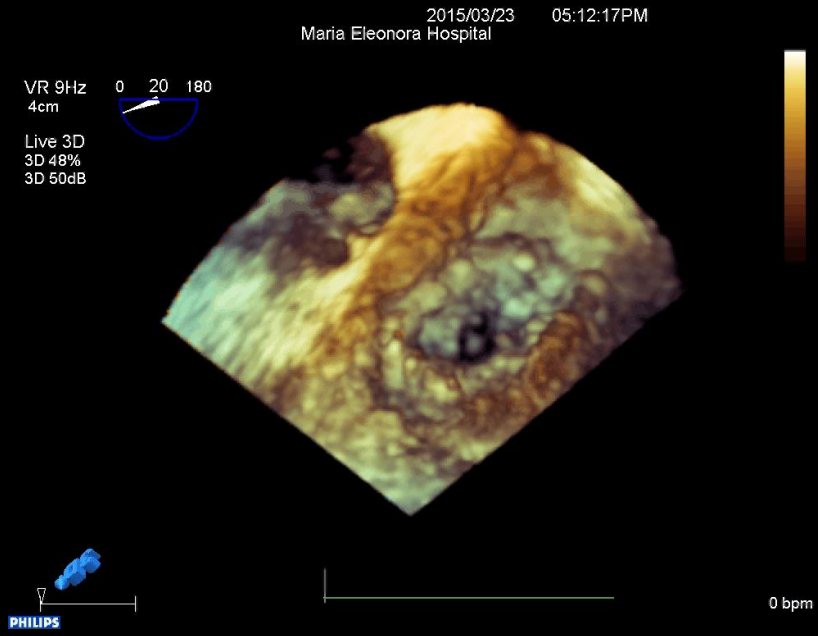

PHILIPS
TIS2.4 MI 1.1
S5-1/CARDIO
FR 12Hz
15cm
2D
68%
C 44
P Off
AGen
CF
69%
2.3MHz
WF Max.
Med.
M3 M4
+61.6
-61.6
cm/s
JPEG
*** bpm

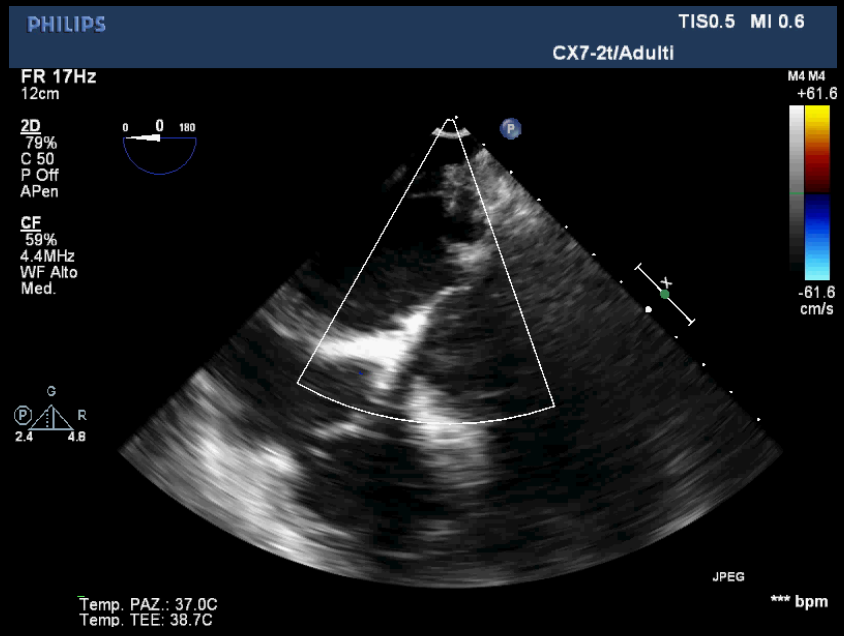

PHILIPS
TIS0.6 MI 1.4
S5-1/CARDIO
FR 42Hz
20cm
2D
85%
C 44
P Off
APen
M3
JPEG
*** bpm

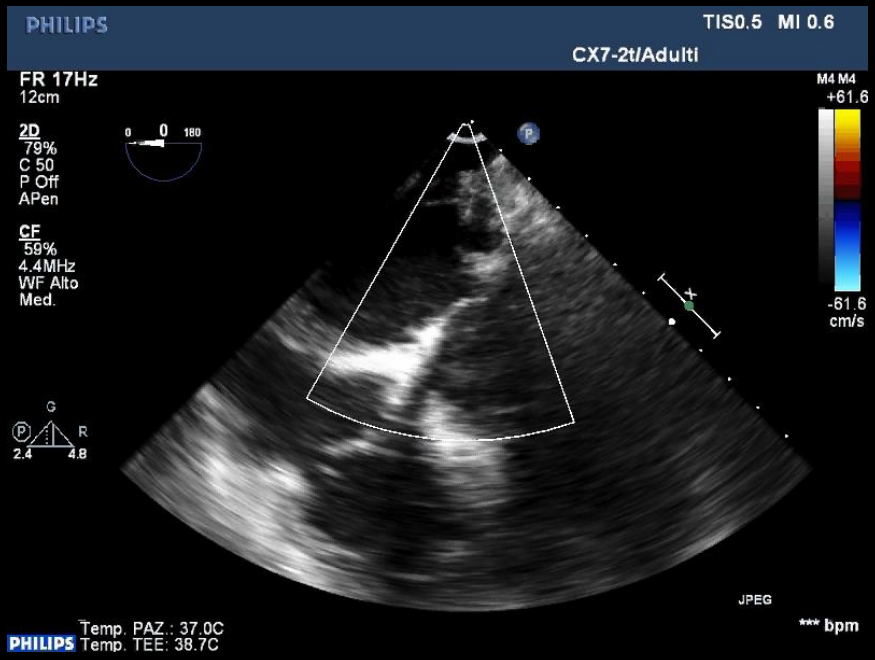

PHILIPS
TIS2.3 MI 1.2
S5-1/CARDIO
FR 16Hz
20cm
2D
89%
C 44
P Off
APen
CF
69%
2.3MHz
WF Max.
Med.
M3 M4
+61.6
-61.6
cm/s
JPEG
*** bpm

Surgical techniques




2015/03/23 05:12:17PM
Maria Eleonora Hospital
VR 9Hz
4cm
0 20 180
Live 3D
3D 48%
3D 50dB
PHILIPS
0 bpm

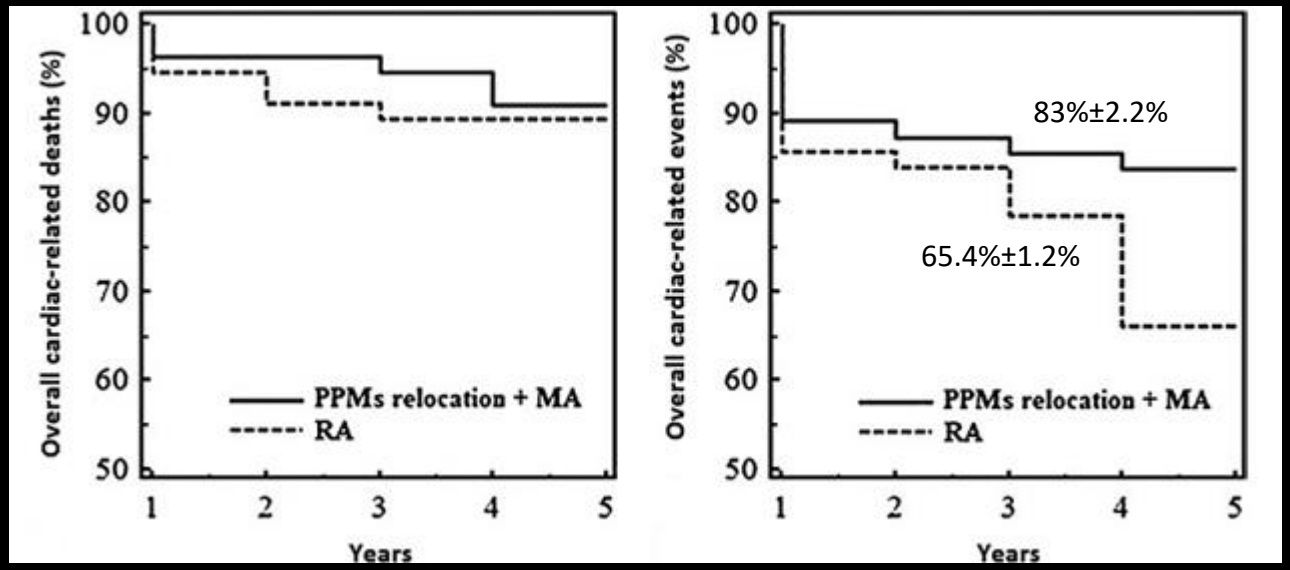

PHILIPS
TIS0.5 MI 0.6
CX7-2t/Adulti
FR 17Hz
12cm
2D
79%
C 50
P Off
APen
CF
59%
4.4MHz
WF Alto
Med.
M4 M4
+61.6
-61.6
cm/s
2.4 4.8
JPEG
*** bpm
Temp. PAZ.: 37.0C
Temp. TEE: 38.7C


PHILIPS
TIS0.5 MI 0.6
CX7-2t/Adulti
FR 17Hz
12cm
2D
79%
C 50
P Off
APen
CF
59%
4.4MHz
WF Alto
Med.
M4 M4
+61.6
-61.6
cm/s
2.4 4.8
JPEG
*** bpm
PHILIPS
Temp. PAZ.: 37.0C
Temp. TEE: 38.7C

Papillary muscle relocation in conjunction with valve annuloplasty improve repair results in severe ischemic mitral regurgitation

Khalil Fattouch, MD, PhD,[a] Patrizio Lancellotti, MD, PhD,[b] Sebastiano Castrovinci, MD,[a] Giacomo Murana, MD,[a] Roberta Sampognaro, MD,[c] Egle Corrado, MD,[d] Marco Caruso, MD, PhD,[d] Giuseppe Speziale, MD,[c] Salvatore Novo, MD,[d] and Giovanni Ruvolo, MD[a]

(J Thorac Cardiovasc Surg 2012;143:1352-5)



Recurrent MR more than moderate occurred in 2.8% vs 11.5% in relocation vs isolated restrictive annuloplasty group, respectively.

5 thoughts on surgical treatment for Secondary MR

Type I

↓

Undersizing Annuloplasty

Type III B → **LVEDD > 65mm**
- Mitral valve replacement
- LV restore + annuloplasty
- Mitral clip

Anular Dilatation

↓

Undersizing

Without Anular Dilatation

↓

Annuloplasty

Subanular Technique

Posterior leaflet thetering
- Posterior Angle > 45°
- Akinetic Posterior Wall

↓

PPM relocation or patch augmentation

Anterior leaflet thetering
- Anterior Angle < 145°
- Seagul Sign

↓

Chordal Cut and Transfer

Both leaflets thetering

↓

Both PPms relocation