Παραβαλβιδική διαφυγή και αιμόλυση

Διάγνωση και αντιμετώπιση

ΕΦΗ Γ. ΡΟΥΣΚΑ, MD

EAE Accreditation Committee member

Β΄ Καρδιολογική Κλινική ΓΝΑ "Ευαγγελισμός"

Definition

- Paraprosthetic Valvular Leak (PVL) is a well recognized complication of Prosthetic Valve Replacement

- It is a sequel of the incomplete apposition of the sewing ring to the native tissue due to suture dehiscence

PVL – Prevalence

- Depends on the method of detection
  - 2.5 % pre-echocardiographic era (HF, endocarditis, haemolytic anaemia, usu.reoperation)

    Ionescu A et al. Heart 2003;89:1316
- PVL has been reported using systematic ITOE in:
  - 10% in aortic position
  - 33% in mitral position

    Ionescu A et al. Heart 2003;89:1316
  - 17.7% in aortic position
  - 22.6% in mitral position

    O'Rourke et al. JACC 2001;38:163
- Depends on the time of study
  - multiple paravalvular jets are detected by ITOE (more common and larger in the mitral position and with mechanical valves) but they improve overall with **protamine**

Morehead et al. Ann Thorac Surg 2000;69:135

PVL – Natural History

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Valve Surgery

Outcome of Mild Periprosthetic Regurgitation Detected by Intraoperative Transesophageal Echocardiography

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David J. Malenka, MD, FACC,† Charles A. S. Marrin, MB, BS,‡ Brenda E. Arbuckle, BA,†
Jonathan F. Plehn, MD, FACC§

White River Junction, Vermont; Lebanon, New Hampshire; and Roslyn, New York

CONCLUSIONS Trivial or mild PPR is a frequent finding on intraoperative TEE. Smaller body size and the use of a bioprosthetic valve are significantly associated with PPR. The clinical significance and natural history of PPR is benign in most cases. (J Am Coll Cardiol 2001;38:163–6) © 2001 by the American College of Cardiology

PVL – Natural History

Table 1. Outcome of Periprosthetic Regurgitation

Mortality	Group 1 PPR Present (n = 113)	Group 2 No PPR (n = 495)	p Value
Six week (%)	10.6	8.1	0.32
Progression of PPR	**n**		
Intraoperative TEE			
Trivial or mild PPR	113		
Early TTE (within 6 weeks)	100		
No PPR	56		
Trivial or mild PPR	44		
Moderate PPR	0		
Severe PPR	0		
Late TTE (between 6 months and 5 years; mean 2.1 yr)	50		
No PPR	27		
Trivial or mild PPR	19		
Moderate PPR	3		
Severe PPR	1		

18.3%

O'Rourke et al. JACC 2001;38:163

PVL – Natural History

Aortic position

Natural history of early aortic paraprosthetic regurgitation: A five-year follow-up

Loukianos S. Rallidis, MD, Ioannis E. Moyssakis, MD, Ignatios Ikonomidis, MD, and Petros Nihoyannopoulos, MD, FACC, FESC *London, United Kingdom*

Results Paraprosthetic leaks were detected in 40 (47.6%) aortic prostheses during the early study; the majority (90%) were small. All leaks remained unchanged during the follow-up period. Left ventricular dimensions and function did not differ between patients with or without paravalvular leak during the follow-up. Left ventricular fractional shortening, however, increased during the intermediate study in both subgroups, indicating improved left ventricular function overall. Three patients had severe paravalvular regurgitation suddenly develop from late infective endocarditis, and 1 patient had a degenerative tissue valve failure 4 years after implantation.

Conclusions Paraprosthetic aortic leaks detected early after surgery, in the absence of valve infection, are common, are usually small, and have a benign course. However, the development of new, usually severe, regurgitation should raise the suspicion of prosthetic valve endocarditis or bioprosthetic valve failure. (Am Heart J 1999;138:351-7.)

PVL – Prevalence

Mitral position

Incidence of paravalvular leak in subgroups of patients with different underlying diseases

	Mitral valve replacement	Paravalvular leak	Incidence (%)
Mitral valve replacement reoperation	260	32	12.3
Mitral stenosis	84	10	11.9
Mitral valve prolapse	62	11	17.7
Combined mitral valve disease	150	13	8.6
Ischaemic mitral valve regurgitation	24	1	4.7
Endocarditis	29	12	41.4
Paravalvular leak ('re-leak')	20	7	35

Genoni et al. E J Cardiothor Surg 2000; 17:14-19

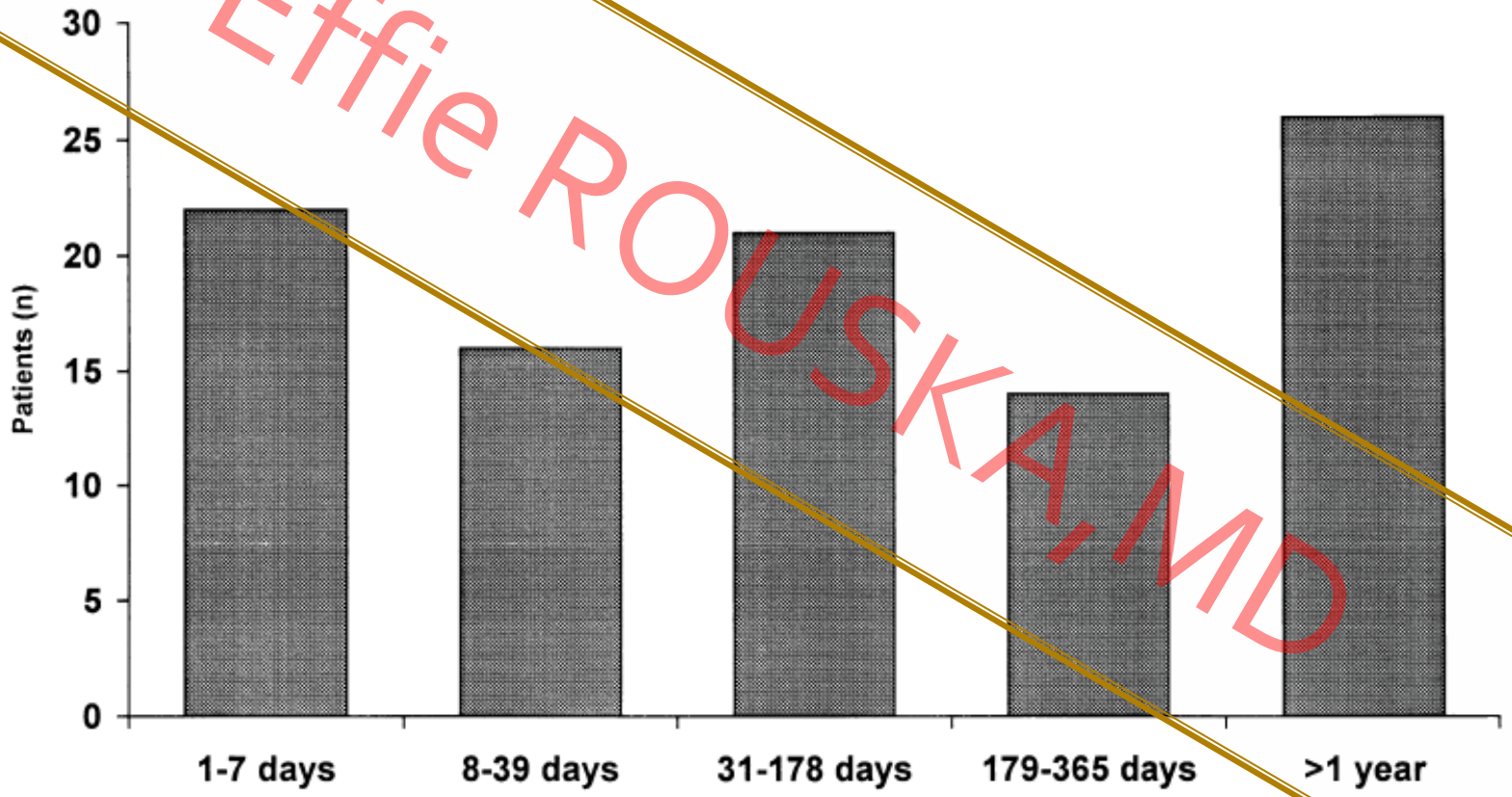


Fig. 2. Interval between mitral valve replacement and diagnosis of paravalvular leak.

Genoni et al. E J Cardiothor Surg 2000; 17:14-19

Predisposing factors

- Favoring conditions:
  - Calcification of the valve annulus
  - Nature of tissue bed (Marfan's syndrome)
  - Infective endocarditis (prior / active)
  - Technical consideration (sizing of prostheses, suturing,etr)

Kirali et al. J Heart Valve Dis 2001 ; 10 : 418-25
Genoni et al. E J Cardiothor Surg 2000; 17:14-19

- Predictive factors:
  - Small BMI
  - Mitral surgery

Ionescu A et al. Heart 2003;89:1316

PVL - Endocarditis

- PVE is a rare (1-6 %) but severe complication
- PVE result in PVL in a rate of 30%
- Only moderate to severe PVR is highly predictive of endocarditis

Habib et al. Heart 2005 ;91:954
Farhat et al. Int Cardiovasc Thor Surg 2007;6: 16
Ronderos et al. J Am Soc Echo 2004;17: 664

Diagnosis of PVL – Clinical view

- Asymptomatic
- Clinical symptoms:
  - New murmur
  - Fatigue / Pallidness (anemia)
  - Jaundice / Dark urine (hemolysis)
  - Heart failure signs

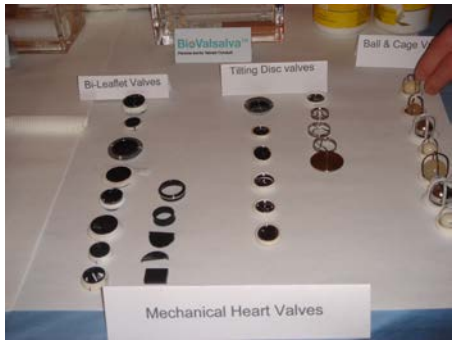
Diagnosis of PVL

- Laboratory Studies
  - **Anemia - Hemolysis**

  (Hb/Ht, LDH, Reticulocyte count, Haptoglobin, Iron, Folic acid, Blood smear exam for schistocytes)

- Imaging Studies
  - Echocardiography
  - (Angiography)

Hemolysis



- Complication of prosthetic heart valves
- Reported rate :
  - 5% to 15% (1960's, 1970's)
  - *Less than* 1% (1990's)
- New generation prostheses associated with lower rates
- However <u>subclinical hemolysis</u> (mild, compensated) still observed in a large proportion of pts (17,8%-51,2%)
- Greater hemolysis in :
  - Double **vs** single valve replacement
  - Mechanical (26%) **vs** biological prostheses (5%)
- The degree of hemolysis not proportional to regurgitation

Shapira Y et al . Cardiology in Review 2009;17:121

Mecozzi G et al . J. Thor Cardiovasc Surg 2002;123:550

Hemolysis: *Pathophysiology*

- Mechanical trauma to RBCs
  - Turbulence of flow through the prostheses (stress forces >3000 dynes/cm^2 on the RBCs)
  - Shear stress
  - Pressure fluctuations
  - Intrinsic abnormalities of the erythrocyte membrane
  - Interaction with foreign surfaces
  - Unfavourable characteristics of the valve
  - Mechanical crushing effect (mechanical valves)

Contributory factors

- Iron-poor red cells
- Folate deficiency
- Chronic infection
- Hemorrhage (anticoagulant therapy) /anemia
- Increased strenuous physical activity

Rajiv M. et al . Clin.Cardiol.21,387-392 (1998)

Hemolysis: *Mechanisms*

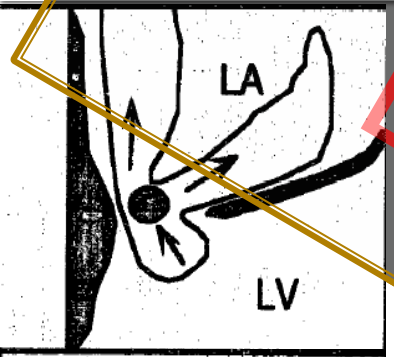
- Structural valve deterioration
  - Extremely rare in new generation mechanical valves
  - Biological valves in the presence of PVL or tissue failure
  - New onset of hemolysis in pt prior free

- Paravalvular leak
  - Irregularity of leaking site / colliding angle play important role
    - Central jets cause less hemolysis than eccentric jets
  - Periprosthetic jet strikes the ridge separating the LPV and LAA
  - Late PVL due to suture dehiscence
    - Annular calcification
    - Localized infection
    - Surgical techniques

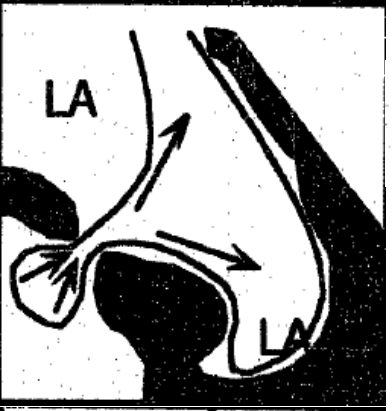
Schwalm SA et al . J Am Soc Echocardiogr 2004;17:913

Shapira Y et al . Cardiology in Review 2009;17:121

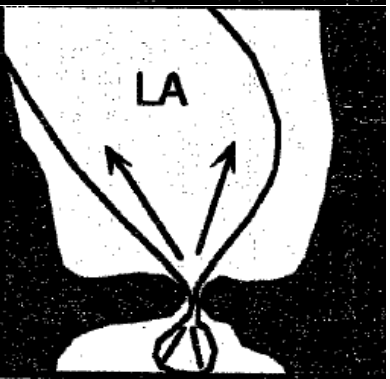
Regurgitant flow with Hemolysis:
Flow simulation



A. Fragmentation
A regurgitant jet is divided by a dehisced annular support ring.



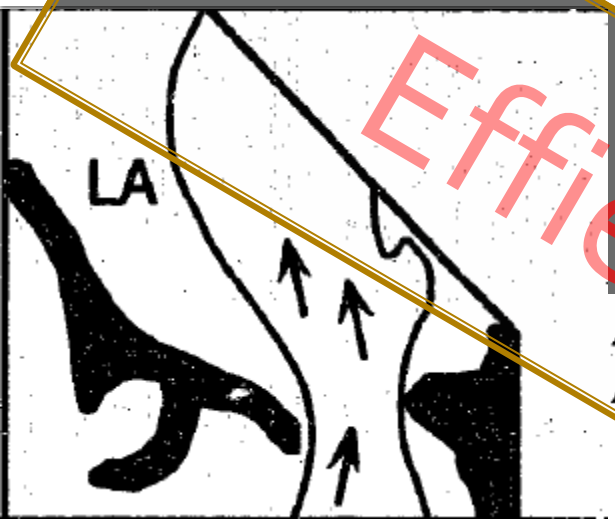
B. Collision
A paravalvular regurgitant jet is suddenly decelerated when colliding with the left atrial appendage wall.



C. Acceleration
A jet is seen traversing through a small perforation in a thickened degenerated bioprosthesis.

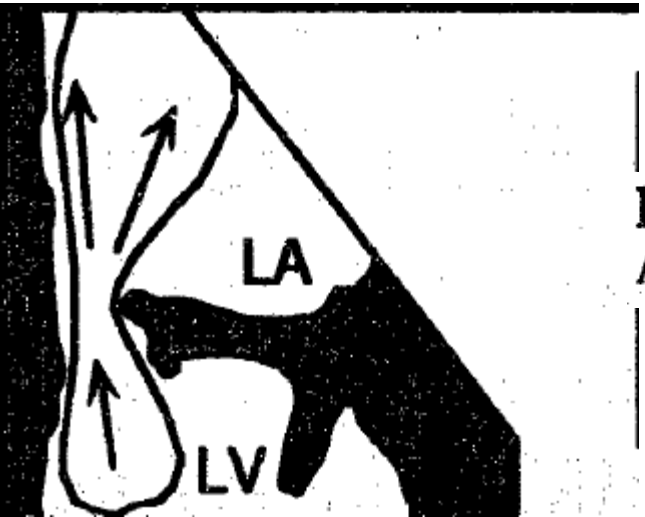
Garcia MJ et al . JACC 1996;27:399

Regurgitant flow without Hemolysis:
Flow simulation



A. Free Jet

A central jet travels through a large orifice in a bioprosthesis with a torn cusp.



B. Deceleration

A large paravalvular mitral regurgitation jet slides gently along the atrial wall.

Garcia MJ et al . JACC 1996;27:399

Hemolysis: *Diagnosis*

- Hb ≤ 10 g / dl
- Presence of schistocytes (fragmented erythrocytes)
- Reticulocytosis
- Serum haptoglobin ≤ 37mg /dl
- Hemoglobinuria
- Indirect hyperbilirubinemia
- Urinary excretion of hemosiderin (free iron)
- LDH ≥ 440 U/L

Maraj R et al . Cl Cardiology 1998;21:387

Shapira Y et al . Cardiology in Review 2009;17:121

Hemolysis: *Diagnosis*

- The anemia is due to the failure of the bone marrow to compensate for the shortened lifespan of the erythrocytes

- Chromium-51 labeling for the measurement of erythrocyte lifespan has been recently replaced by expiratory carbon monoxide concentration

Maraj R et al . Cl Cardiology 1998;21:387

Hemolysis: *Quantification*

No standard method

- Elevated levels of LDH
- High degree of RBC fragments
- High urinary iron concentration
- Need of frequent transfusions

Maraj R et al . Cl Cardiology 1998;21:387

Shapira Y et al . Cardiology in Review 2009;17:121

Hemolysis and MV repair

Hemolysis After Mitral Valve Repair: Mechanisms and Treatment

Buu-Khanh Lam, MD, Delos M. Cosgrove III, MD, Sunil K. Bhudia, MD, and A. Marc Gillinov, MD

Department of Thoracic and Cardiovascular Surgery, Cleveland Clin

(Ann Thorac Surg 2004;77:191–5)

Conclusions. Hemolysis is a mode of failure of mitral valve repair. Patients with hemolysis generally present within 3 months of mitral valve repair. Although echocardiographic features varied, most patients had high-grade MR and regurgitant jets that fragmented or accelerated. Mitral valve replacement yields favorable outcomes for patients with hemolysis after mitral valve repair.

Hemolysis and MV repair
Rate - *Mechanisms*

- Very rare (0.55%)

- "Whiplash motion" of disrupted suture
- Dehisenced annuloplasty ring (para-ring regurgitant jets)
- Protruding paravalvular suture material/ pledgets
- Non-epithilization of ring
- Small but turbulent regurgitant jet against LA

Cerfolio et al .Eur J Cardiothorac Surg 1997;11:479

Yeo et al .JACC 1998;32:717

Diagnosis of PVL by Echocardiography

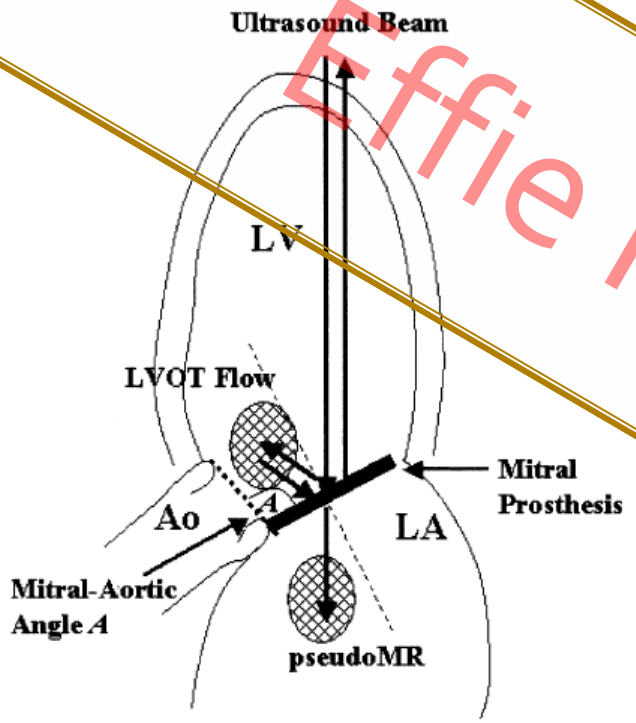


Figure 1 Proposed mechanism of acoustic mirroring and artifact generation by prosthetic valve. Ultrasound beam travels through left ventricular (*LV*) cavity and is reflected off mitral prosthesis canted toward LV outflow tract (*LVOT*) flow. Red blood cells passing through LVOT scatter some sound back toward prosthesis, where it is reflected toward transducer. Because of increased transit time taken for reflections, reflected LVOT flow is projected into left atrium (*LA*) as pseudo-mitral regurgitation signal. *Ao*, Aorta; *Angle A*, angle between aortic annulus and mitral prosthesis.

- TTE: avoiding misdiagnosis in the presence of mitral mechanical prostheses

An apparent systolic jet in the LA by color Doppler that appears similar to MR (pseudo MR)

is caused by acoustic mirroring of the LVOT flow by sound reflected off the prosthesis, projecting flow into the LA because of longer transit time

Rudski et al . Am Soc Echo 2004;17:829

TTE: Pitfalls Leading to Misdiagnosis

Transthoracic echocardiography is the main diagnostic modality for the initial and serial evaluation of prosthetic valve function.

Its main limitation relates to acoustic shadowing and reverberations generated by the sewing rings of both bioprosthetic and mechanical valves and the occluders of mechanical valves.

Barbetseas J, et al. : Echocardiography 2007;24:772

Paraprosthetic Leak Unmasked by Combined Enoxaparin/Warfarin Therapy for Thrombosed Mitral Valve

John Barbetseas, M.D., Dimitris Tsiachris, M.D., Christina Chrysohoou, M.D., Stella Brilli, M.D., Maria Bonou, M.D., and Christodoulos Stefanadis, M.D.

First Department of Cardiology, University of Athens Medical School, Hippokration Hospital, Athens, Greece

(ECHOCARDIOGRAPHY, Volume 26, October 2009)

Barbetseas J, et al. : Echocardiography 2009;26:1105

Diagnosis of PVL by Echocardiography

- The best univariate predictors of **significant MR**:
  - peak velocity of mitral inflow
  - mean gradient
  - tricuspid regurgitation velocity (PHT)
  - isovolumic relaxation time (reflecting LA pressure)
  - ratio of time velocity integral of mitral inflow to time velocity integral in the left ventricular outflow (TVI MV/TVI LVO)

Olmos L et al . Am J Cardiol 1999;83:199

Diagnosis of PVL – Echocardiography

TTE

Peak Early Diastolic Velocity Rather Than Pressure Half-Time Is the Best Index of Mechanical Prosthetic Mitral Valve Function

Valerian Fernandes, MD, Leopoldo Olmos, MD, Sherif F. Nagueh, MD, Miguel A. Quiñones, MD, and William A. Zoghbi, MD

(Am J Cardiol 2002;89:704–710)

TABLE 3 Sensitivity, Specificity, Positive (PPV) and Negative (NPV) Predictive Values of Various Doppler Indexes for Identifying Dysfunctional Prosthetic Mitral Valves*

Index	Sensitivity	Specificity	PPV	NPV
Peak E velocity ≥1.9 m/s	92%	78%	83%	90%
VTI_{pmv}/VTI_{lvo} ≥2.2	91%	74%	80%	87%
PHT ≥130 ms	38%	99%	96%	57%

*Cut-off values were selected from the receiver-operating characteristic.

Diagnosis of PVL – Echocardiography

TOE

- TOE is exquisitely sensitive for the detection of valvar insufficiency
- All manufactured low profile prosthetic valves have a built-in amount of "normal" regurgitant flow to help reduce the likelihood of valve thrombosis.
- The vena contracta measurement showed the highest correlation and also had the best receiver operating curve for detecting severe valvar insufficiency.
- To recognize a paravalvular leak, TEE must be performed with a high color frame rate and middle range Nyquist limits (up to 50 cm/sec) in several views from several angles outside the sewing ring

Rahko et al . Heart 2004;90:476
Jayawardena et al. Cases Journal 2008; 1: 216

Diagnosis of PVL – Echocardiography

TOE

Assessment of severity of mechanical prosthetic mitral regurgitation by transoesophageal echocardiography

A Vitarelli, Y Conde, E Cimino, T Leone, I D'Angeli, S D'Orazio, S Stellato

Heart 2004;**90**:539–544. doi: 10.1136/hrt.2003.026823

Table 2 Sensitivity and specificity of transoesophageal echocardiographic (TOE) indices to identify angiographically severe prosthetic mitral valve regurgitation

TOE indices	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
MRA >7 cm^2	81	75	84	80
MRA:LAA >0.3	85	80	87	83
PVF-S:D >=0.2	77	85	90	77
Qmax >200 ml/s	96	90	93	95
ROA >0.45 cm^2	96	90	93	95
PJD >0.6 cm	96	95	96	95

NPV, negative predictive value; PPV, positive predictive value.

Diagnosis of PVL – Echocardiography

Real Time 3-D TTE

The newly developed RT 3-D TEE may represent a potential breakthrough in the imaging of leak characteristics, a precise picture of the

- location,
- extent,
- morphology of the defect

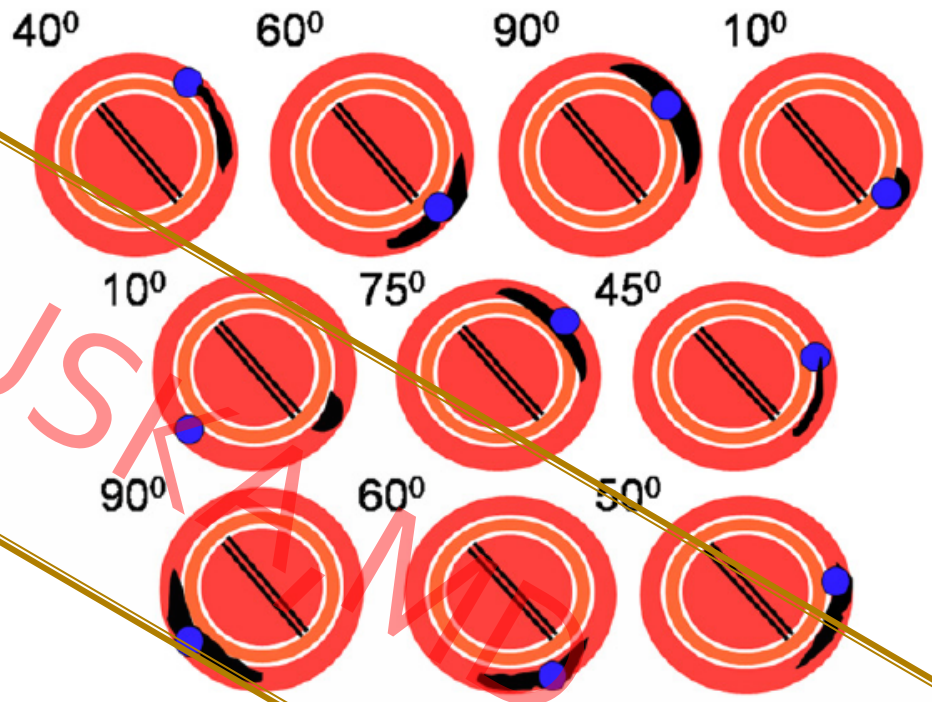
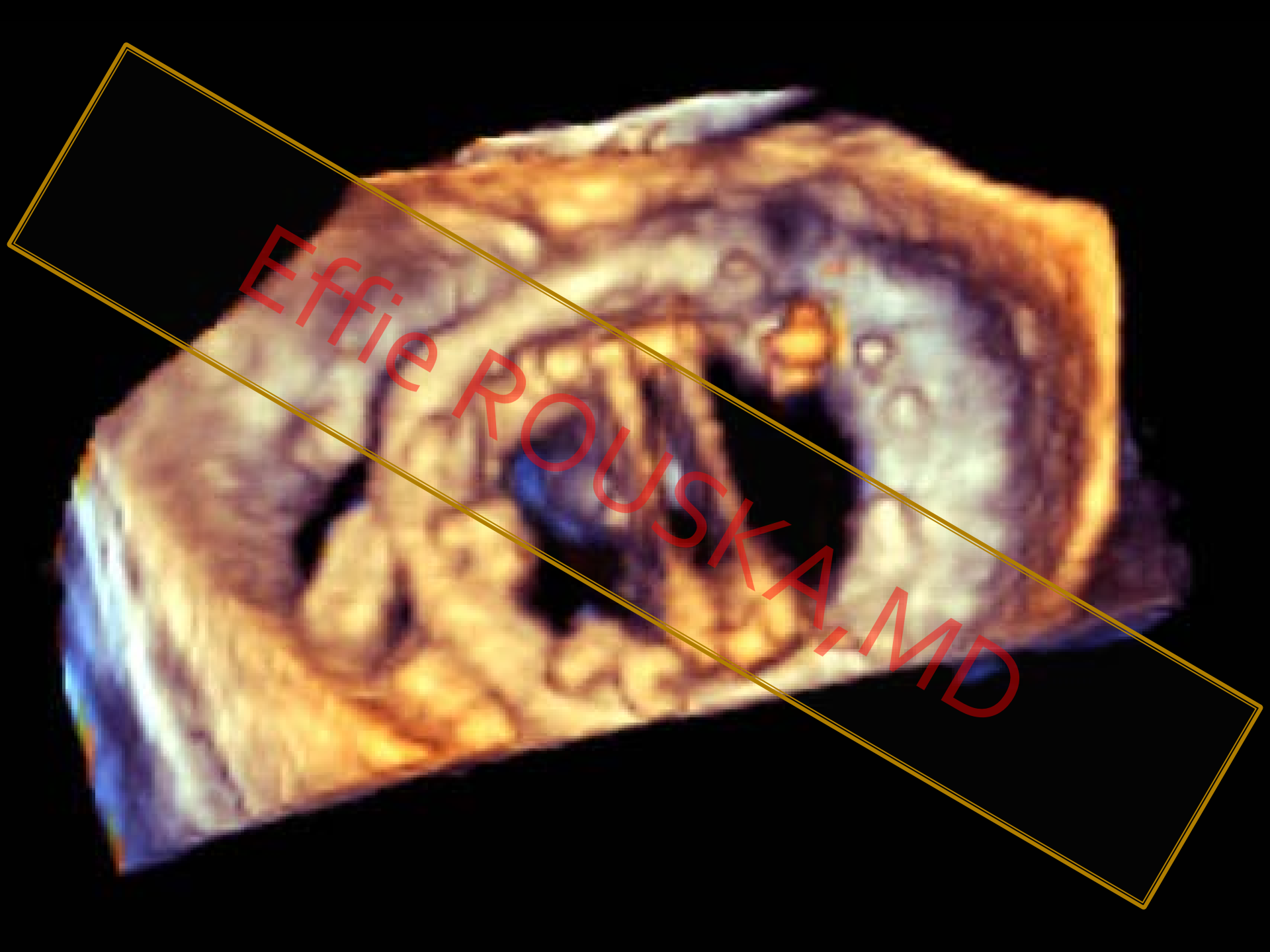


Figure 4 Echocardiographic characteristics of the dehiscences in the 10 patients with significant persisting regurgitation. Schematic representation of the mitral prostheses of the 10 patients with significantly persistent regurgitation, showing the morphology of the residual dehiscences *(black area)*, as well as how far they extend along the prosthetic annulus (in degrees) and also the location and situation of the implant devices *(circles)* inside the dehiscences.

Kronzon et al . JACC 2009;53:1543
Singh et al. Echocardiography 2009; 26: 980
Garcia-Fernandez et al . J Am Soc Echo 2010; 23:


Effie ROUSKA,MD

PVL - Management

- Medical
- Surgical
- Percutaneous closure

Παρουσίαση περιστατικού

Ιστορικό- Παρούσα νόσος

- Γυναίκα (49 ετών)
- 1979: Συμπτωματική στένωση μιτροειδούς ρευματικής αιτιολογίας :

  MVR με πρόσθεση Bjork-Shiley

  (1ο χειρουργείο)

- 1990: ΟΠΟ – Καρδιογενές **shock**

  Θρόμβωση πρόσθεσης

  Χειρουργική εξαίρεση/καθαρισμός θρόμβου

  (2ο χειρουργείο)

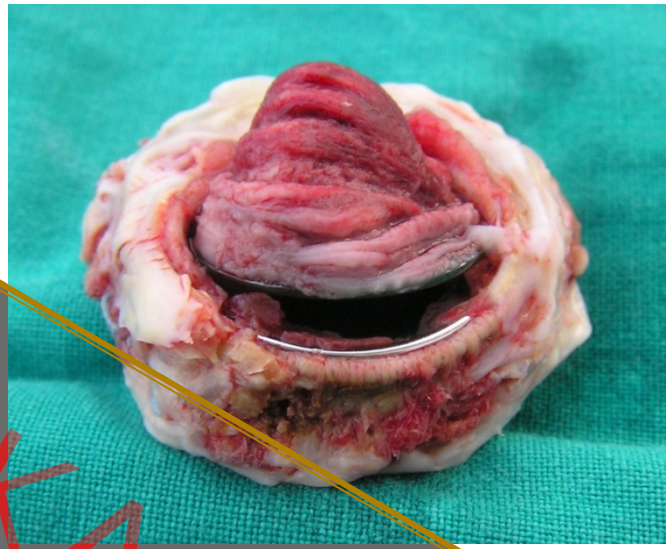
- 2007: : NYHA III, επιδείνωση το τελευταίο 2μηνο, ΟΠΟ

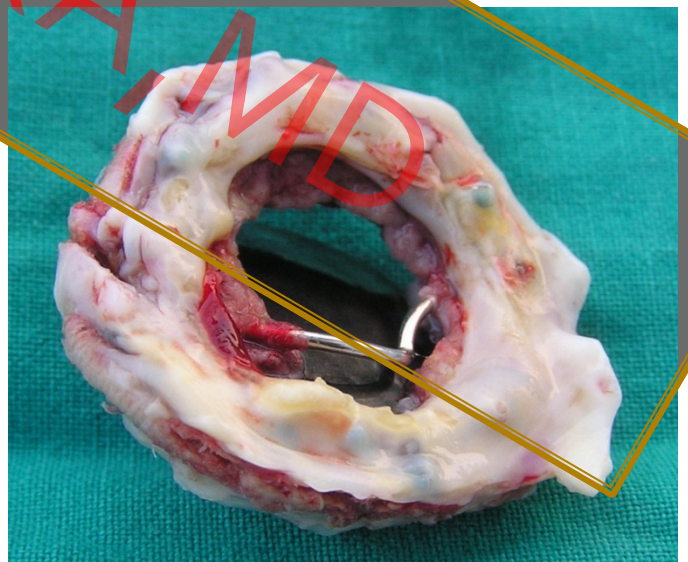
  Δυσλειτουργία πρόσθεσης

  (3ο χειρουργείο)

3ο Χειρουργείο 30/7/2007

- στένωση μηχανικής πρόθεσης λόγω δημιουργίας **pannus**/θρόμβου
- αντικατάσταση παλαιάς μηχανικής πρόθεσης με νέα δίφυλλη μεταλλική *(Optiform No 31/ Carbomedics)*
- Τοποθέτηση δακτυλίου στην τριγλώχινα βαλβίδα **(MC3 30mm, / Edwards)**





Follow - up

- **ΤΤΕ εξόδου** : αναφερόμενο κφ
- **Επανεξέταση** μετά ένα μήνα στα ΕΙ –Κ/Χ κφ
- **Δυο μήνες μετά**: εμπύρετο
  - αποδόθηκε σε λοίμωξη αναπνευστικού – Αντιβίωση
- **15 μέρες μετά**: **ΟΠΟ**
  - επιδείνωση γενικής κατάστασης (αδυναμία, καταβολή)
  - σημεία **NYHA III**
  - **CXR** παθολογική
  - αυξημένη χορήγηση διουρητικών χωρίς βελτίωση
  - παρουσία νέου φυσήματος

Τι μπορεί να συμβαίνει ;

Απόφαση για νέα επέμβαση??

4ο Χειρουργείο 12/12/2007

- Χειρουργική σύγκλειση παραβαλβιδικής διαφυγής

- Άμεσο Post op echo
  απουσία παραβαλβιδικής διαφυγής
  Κλινική εικόνα πολύ καλή

Παρουσίαση περιστατικού

Ιστορικό- Παρούσα νόσος

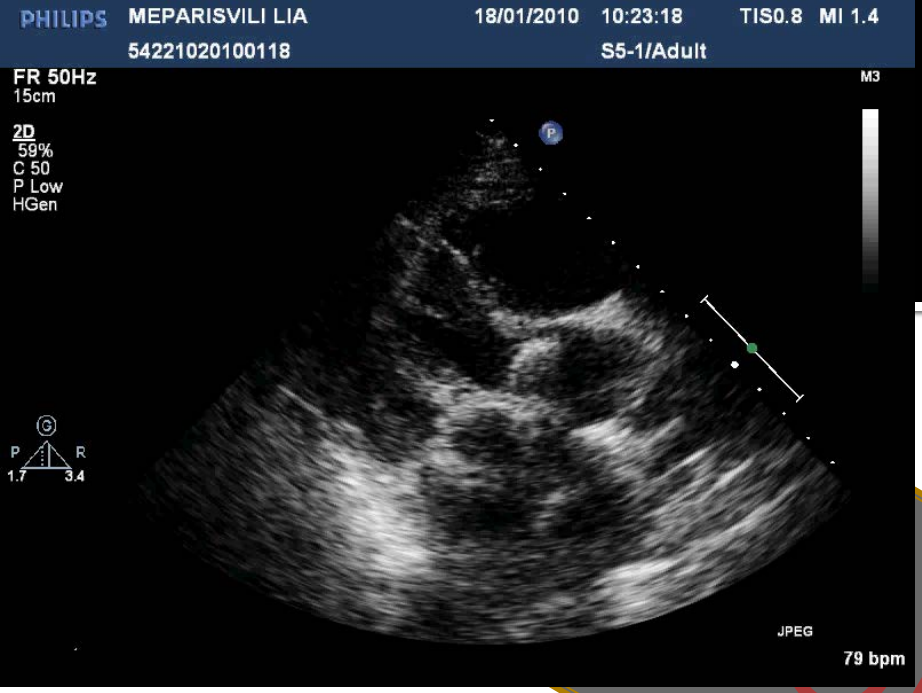
- Γυναίκα 49 ετών
- 12ος /2009: Συμπτωματική στένωση μιτροειδούς και αορτικής βαλβίδας ρευματικής αιτιολογίας

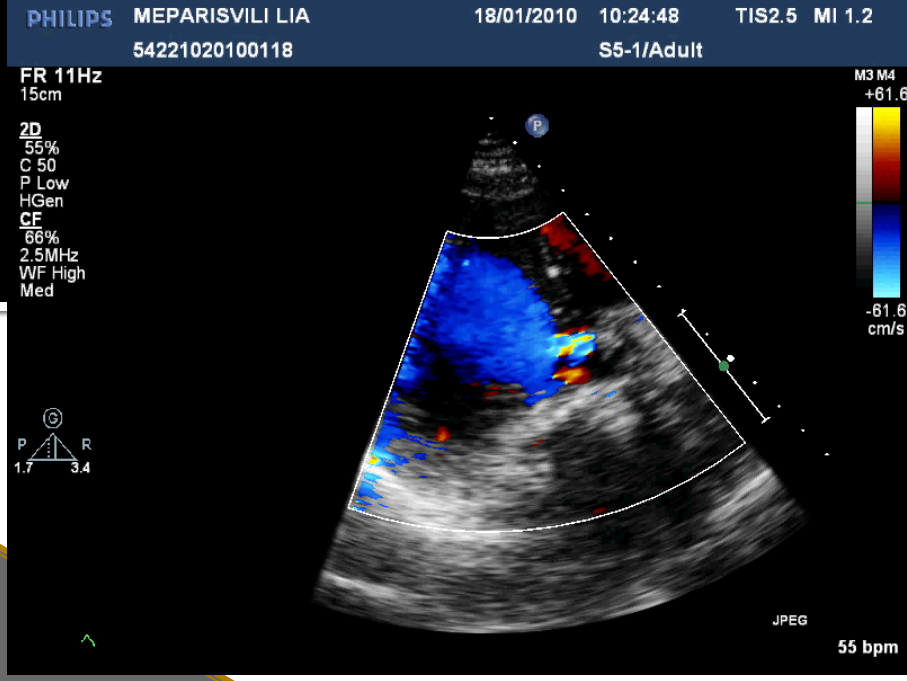
(χειρουργείο)

MVR + AVR με προσθέσεις Sorin 19mm και 27mm αντίστοιχα

ΙΤΟΕ μη διαθέσιμο

1ος /2010: : follow-up echo


PHILIPS MEPARISVILI LIA 18/01/2010 10:23:18 TIS0.8 MI 1.4
54221020100118 S5-1/Adult
FR 50Hz
15cm
2D
59%
C 50
P Low
HGen
M3
JPEG
79 bpm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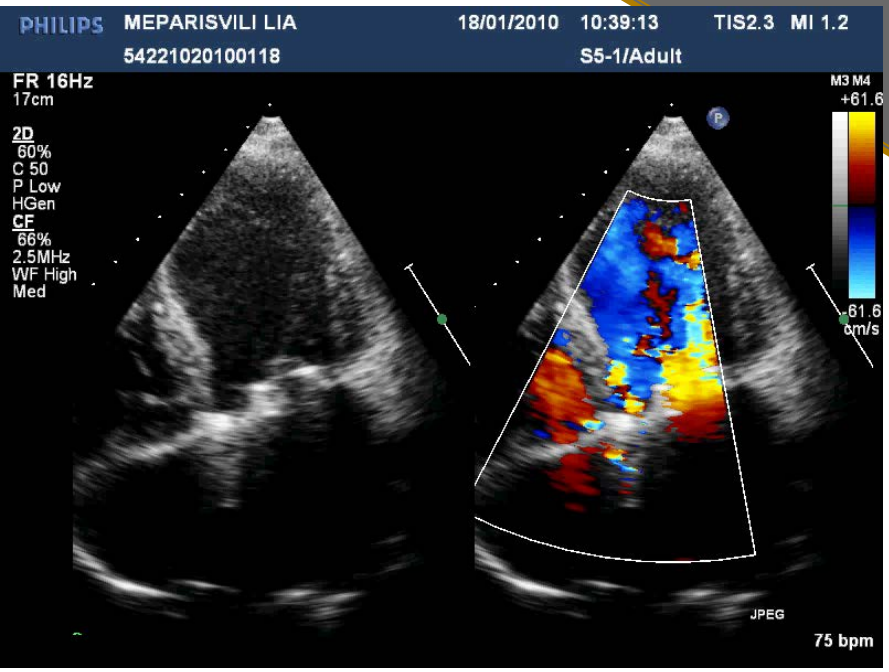
54221020100118 S5-1/Adult
FR 11Hz
15cm
2D
55%
C 50
P Low
HGen
CF
66%
2.5MHz
WF High
Med
M3 M4
+61.6
-61.6
cm/s
JPEG
55 bpm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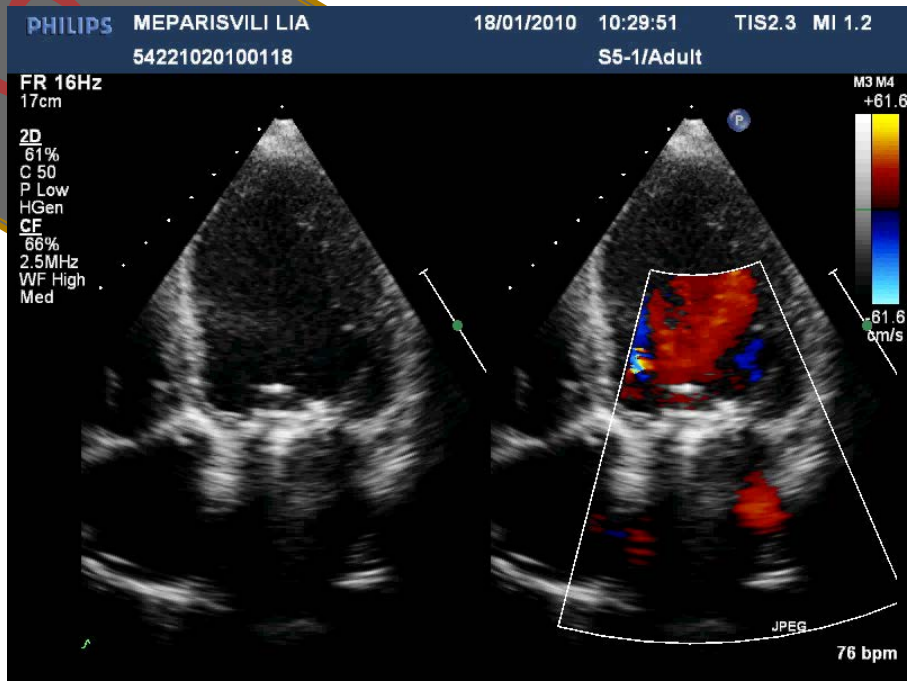
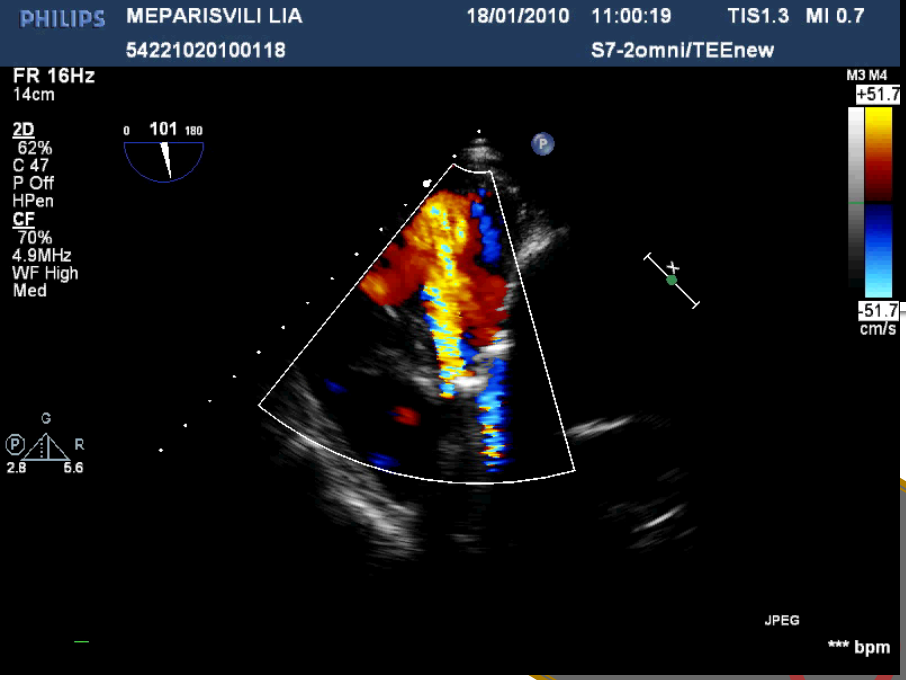
54221020100118 S5-1/Adult
FR 16Hz
17cm
2D
60%
C 50
P Low
HGen
CF
66%
2.5MHz
WF High
Med
M3 M4
+61.6
-61.6
cm/s
JPEG
75 bpm


PHILIPS MEPARISVILI LIA 18/01/2010 10:29:51 TIS2.3 MI 1.2
54221020100118 S5-1/Adult
FR 16Hz
17cm
2D
61%
C 50
P Low
HGen
CF
66%
2.5MHz
WF High
Med
M3 M4
+61.6
-61.6
cm/s
JPEG
76 bpm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FR 16Hz
14cm
2D
62%
C 47
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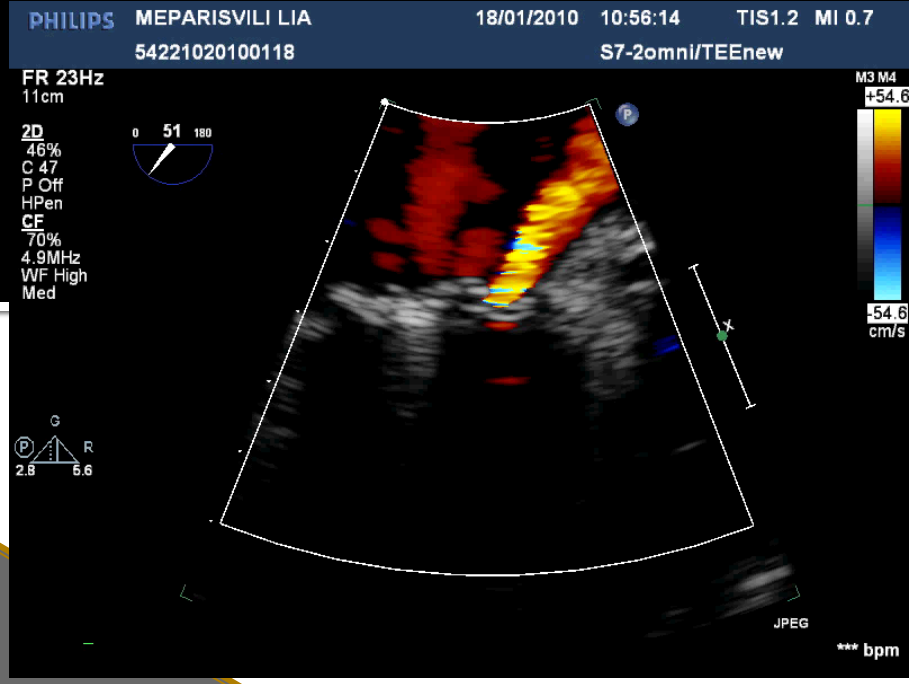
*** bpm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C 47
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4.9MHz
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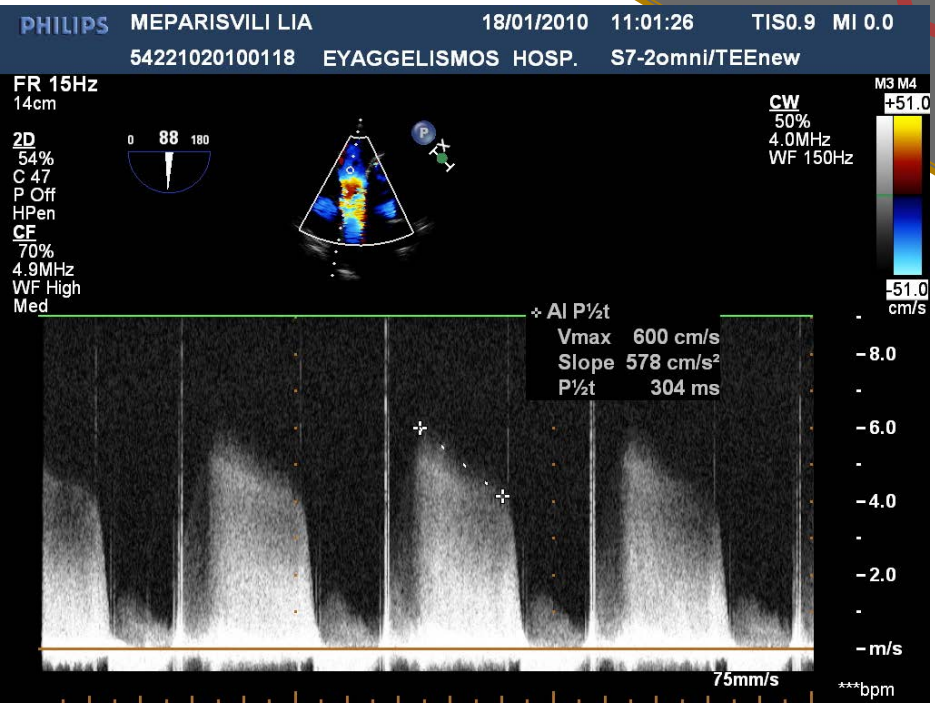
+54.6
-54.6
cm/s
JPEG
*** bpm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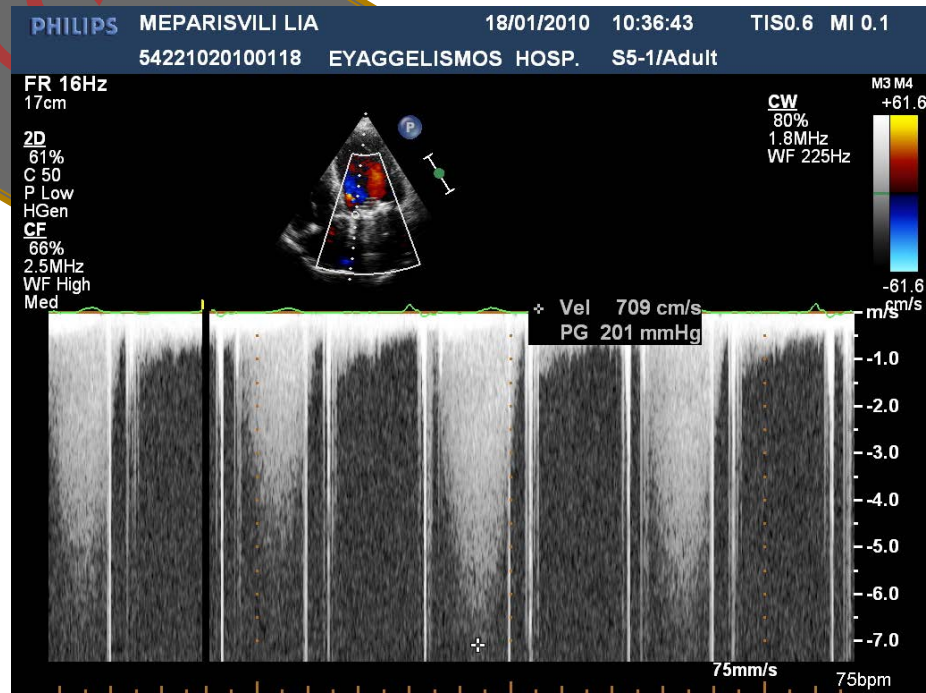
FR 15Hz
14cm
2D
54%
C 47
P Off
HPen
CF
70%
4.9MHz
WF High
Med
88
CW
50%
4.0MHz
WF 150Hz
M3 M4
+51.0
-51.0
cm/s
AI P½t
Vmax 600 cm/s
Slope 578 cm/s²
P½t 304 ms
8.0
6.0
4.0
2.0
m/s
75mm/s
***bpm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17cm
2D
61%
C 50
P Low
HGen
CF
66%
2.5MHz
WF High
Med
CW
80%
1.8MHz
WF 225Hz
M3 M4
+61.6
-61.6
cm/s
Vel 709 cm/s
PG 201 mmHg
m/s
1.0
2.0
3.0
4.0
5.0
6.0
7.0
75mm/s
75bpm

Απόφαση χειρουργού

- Χειρουργική σύγκλειση παραβαλβιδικής διαφυγής υψηλού περιεγχειρητικού κίνδυνου

- Ο χειρουργός επιφυλακτικός στην επανεγχείρηση της ασθενούς

PVL – Management

European Heart Journal (2007) 28, 230–268
doi:10.1093/eurheartj/ehl428

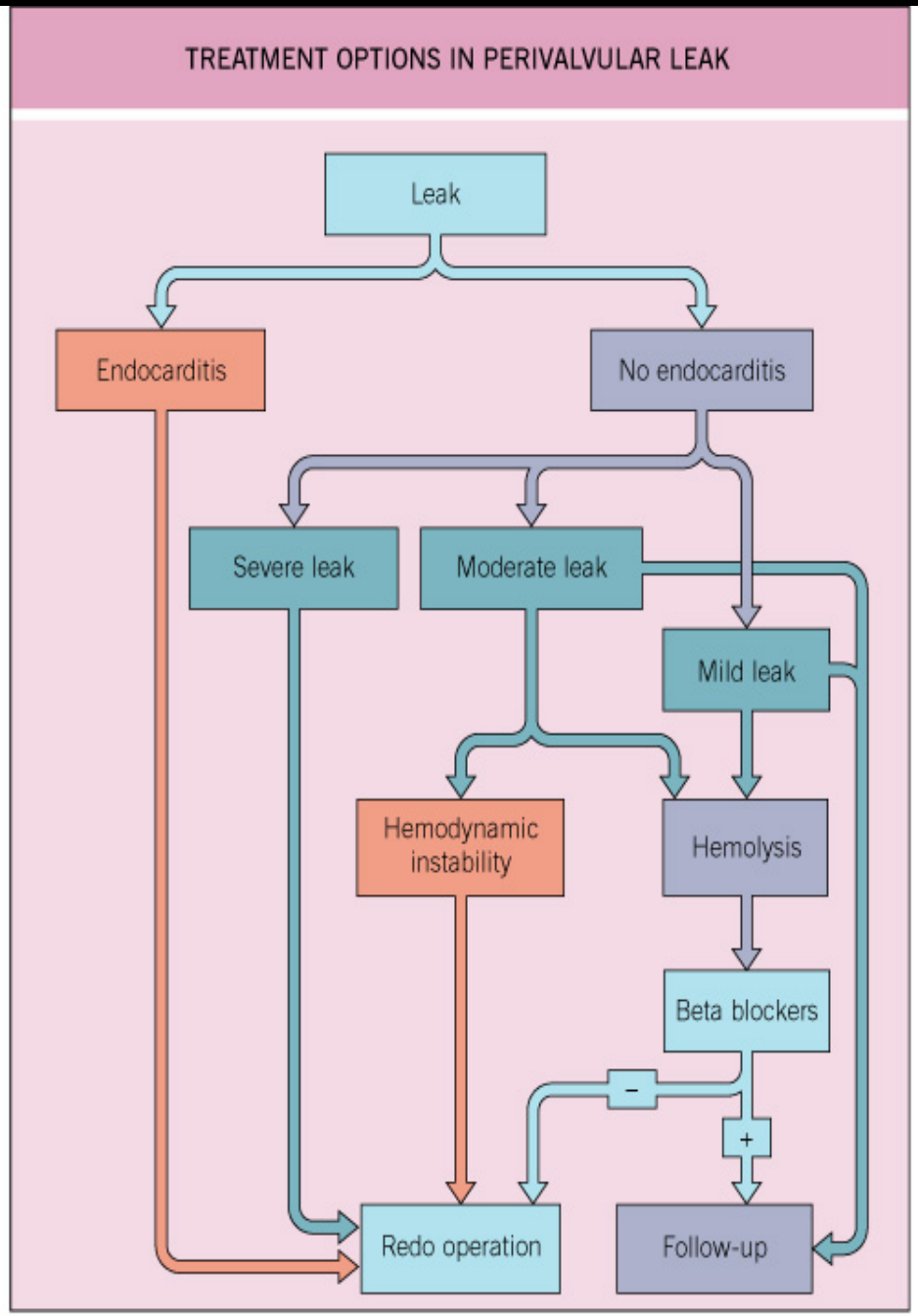
ESC Guidelines

Guidelines on the management of valvular heart disease

The Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology

- Reoperation
  - if PVL is related to endocarditis
  - if PVL causes haemolysis needing repeated blood transfusions

Recommendation class I, Level of evidence C



Είναι πολύ σημαντικό η επέμβαση να διενεργείται πρίν ο ασθενής επιδεινωθεί σε NYHA **class IV**

Προτείνεται από κέντρα και πρώιμη επανεπέμβαση σε λιγότερο συμπτωματικές καταστάσεις

PVL – Medical Management

- In patients with haemolytic anaemia and PVL
  - where surgery is contraindicated
  - those unwilling to undergo re-operation

- medical therapy includes:
  - iron supplementation, folate, vit C
  - erythropoietin if haemolysis is severe
  - beta-blockers *(Reduction of the shearing forces)*
  - Pendoxifylline *(improving erythrocyte deformity)**

* *Golbasi et al. Acta Cardiol 2003; 58:379*

PVL – Surgical Management

- Surgical closure of PVLs is currently *the gold standard* treatment for :
  - severely symptomatic pts
  - those requiring blood transfusions for persistent hemolysis
- Delay of surgery may increase the mortality rate

Genoni et al. E J Cardiothor Surg 2000; 17:14-19

PVL – Surgical Management

- Despite an operative mortality of 6%, it offers improved survival and a reduction in symptoms

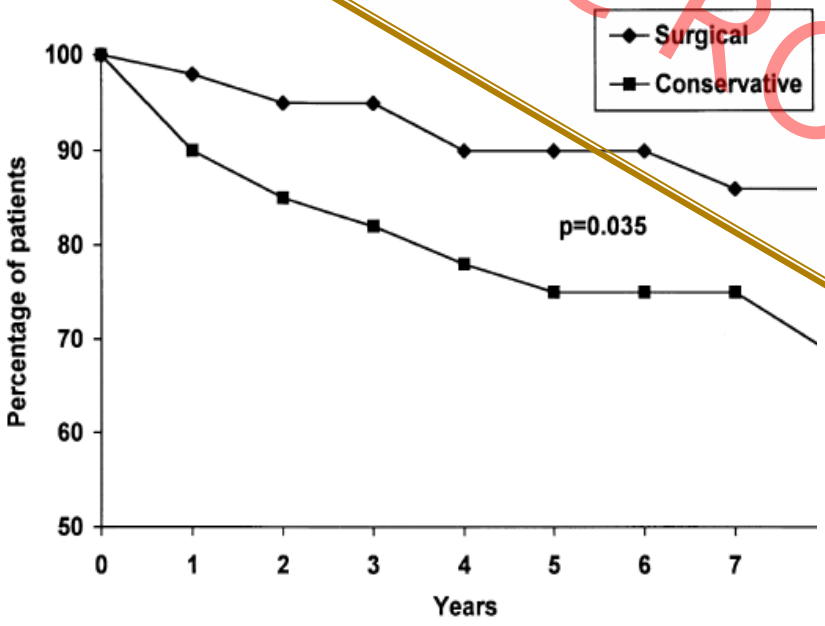


Fig. 4. Influence of therapeutic strategy on survival.

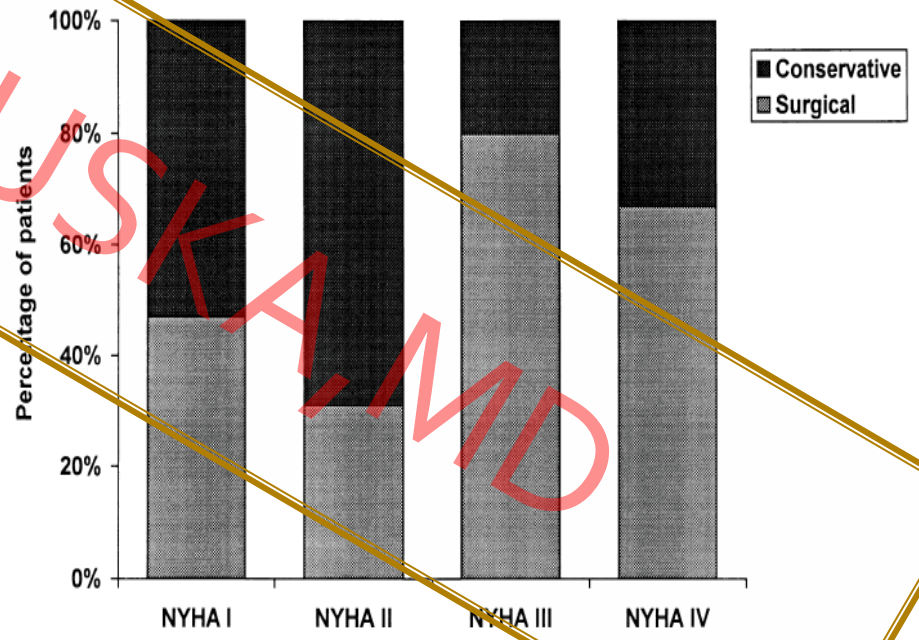


Fig. 3. Comparison of pre-operative NYHA functional status between surgical and conservative strategies.

Genoni et al. E J Cardiothor Surg 2000; 17:14-19

Early and Late Results of the Surgical Correction of Cardiac Prosthetic Paravalvular Leaks

Cary W. Akins, Jerene M. Bitondo, Alan D. Hilgenberg, Gus J. Vlahakes, Joren C. Madsen, Thomas E. MacGillivray

Cardiac Surgical Unit, Massachusetts General Hospital, Boston, Massachusetts, USA

- 136
  - 44 aortic
  - 92 mitral

Ba ... the inci- ... d ... on cause ... o ... replace- ... m ... gical cor- ... re ... iasm for ... in ... of par- ... avalvular leaks, a current ... baseline against which to compare these re ... mportant.

Methods: All patients wh ... urgical correction of an aortic or mitral para ... lar leak unrelated to acute bacterial endocard ... between 1986 and 2001 were identified from ... computerized registry. Hospital records were reviewed, and follow up data obtained.

Results: A total of 136 consecutive patients (73 males, 63 females; mean age 64 years) underwent surgical correction of a paravalvular leak. Of the valves, 44 (32%) were aortic and 92 (68%) mitral. More than one previous cardiac operation had been perf... patients (50%). In 107 patients (79%; 32 aortic (73%), 75 mitral (82%)), the leak was the primary indication for reoperation, while for 29 patients (21%; 12 aortic (27%), 17 mitral (18%)) the correction was secondary to another cardiac procedure. In 65 patients (48%; 12 aortic (27%), 53 (58%) mitral)) the leak was repaired primarily, while in 71 patients (52%; 32 aortic (73%), 39 (42%) mitral)) the prosthesis was replaced. Operative mortality was 6.6% (n = 9). There were no significant multivariable predictors of hospital death. Perioperative stroke occurred in seven cases (5.1%), and hospital stay was >14 days in 40 patients (29%). The 10-year Kaplan-Meier survival was 30 (CI 20-39)%. Ten-year actual versus actuarial freedom from repeat paravalvular leak was 84 (CI 68-92)% versus 63 (CI 49-76)%.

Conclusion: Surgi... lar leaks can be p... and morbidity. Pa... aval... reasonable freed... leak.

79% primary indication
21% secondary indication

The Journal of Heart Valve Disease 2005;14:792-800

PVL – Surgical Management results

Table IV: Study operative procedure.

Characteristic	AVR (n = 44)	MVR (n = 92)	Total (n = 136)
Leak repair	12 (27)	53 (58)	65 (48)
Valve replacement	32 (73)	39 (42)	71 (52)
Mechanical	23 (72)	32 (82)	55 (77)
Bioprosthetic	9 (28)	7 (18)	16 (22)
Other procedure			
None	18 (41)	51 (55)	69 (51)
Other valve	7 (16)	27 (29)	34 (25)
Coronary grafting	7 (16)	9 (10)	16 (12)
Other	12 (27)	5 (5)	17 (12)

The Journal of Heart Valve Disease 2005;14:792-800

PVL – Surgical Management results

Table V: Operative results.

Finding	AVR (n = 44)	MVR (n = 92)	Total (n = 136)
Death	2 (4.5)	7 (7.6)	9 (6.6)
Complication			62 (46)
None	19 (43)	43 (47)	
Arrhythmias	13 (30)	10 (11)	23 (17)
Pneumonia	5 (11)	10 (11)	15 (11)
Intubated >48 h	2 (4)	11 (12)	13 (10)
Pacer/ICD	7 (16)	5 (5)	12 (9)
Gastrointestinal	6 (14)	4 (4)	10 (7)
Re-exploration	2 (4)	7 (8)	9 (7)
Renal failure	1 (2)	7 (8)	8 (6)
Neurologic	1 (2)	6 (6)	7 (5)

The Journal of Heart Valve Disease 2005;14:792-800

PVL – Surgical Management results

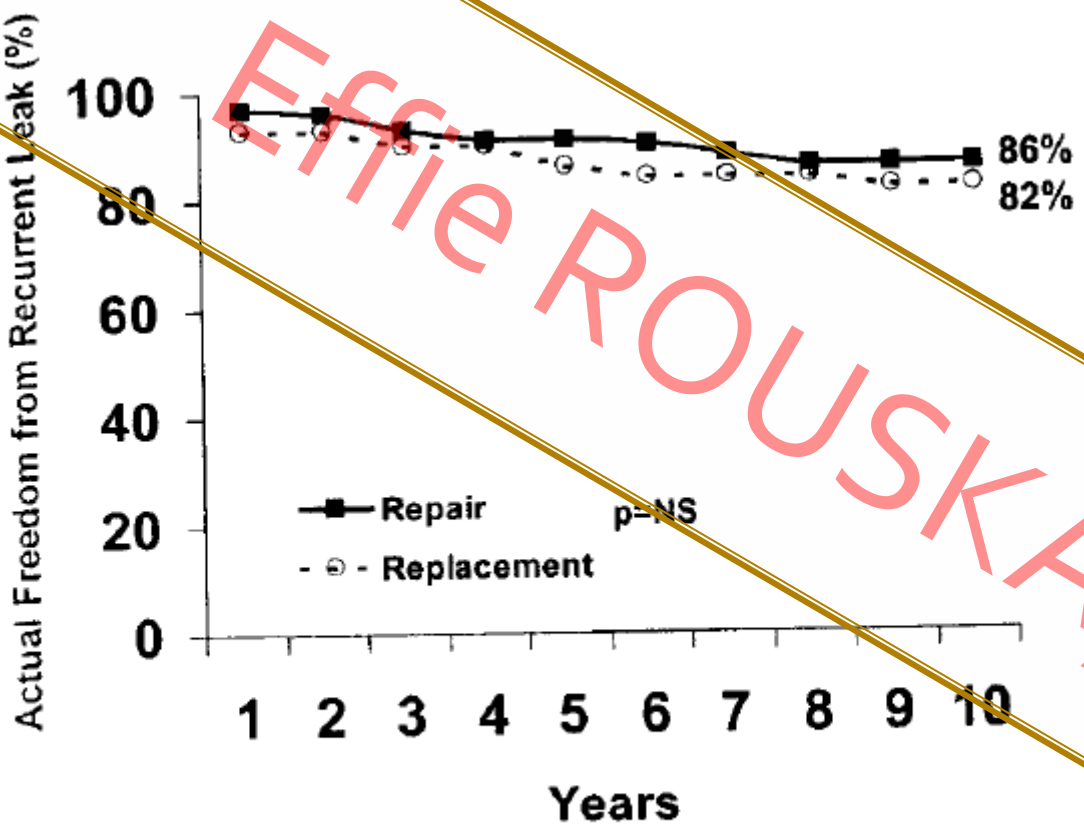


Figure 3: Actual freedom from repeat paravalvular leak. ■ *primary repair;* ○ *valve replacement.*

The Journal of Heart Valve Disease 2005;14:792-800

Clinical practice

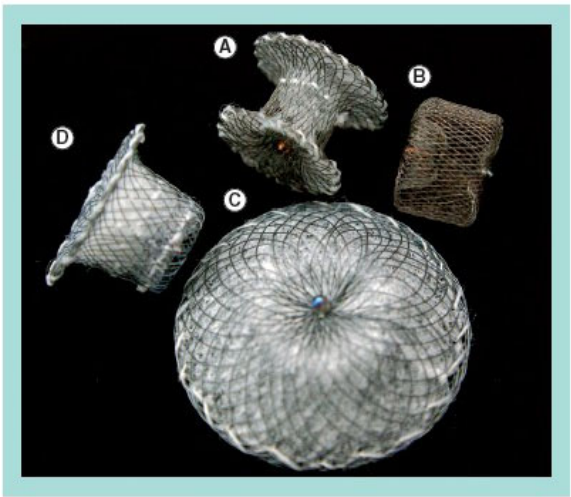
Because of the known risks for clinical deterioration and the theoretical risks for endocarditis and embolic complications, it has been advocated that:

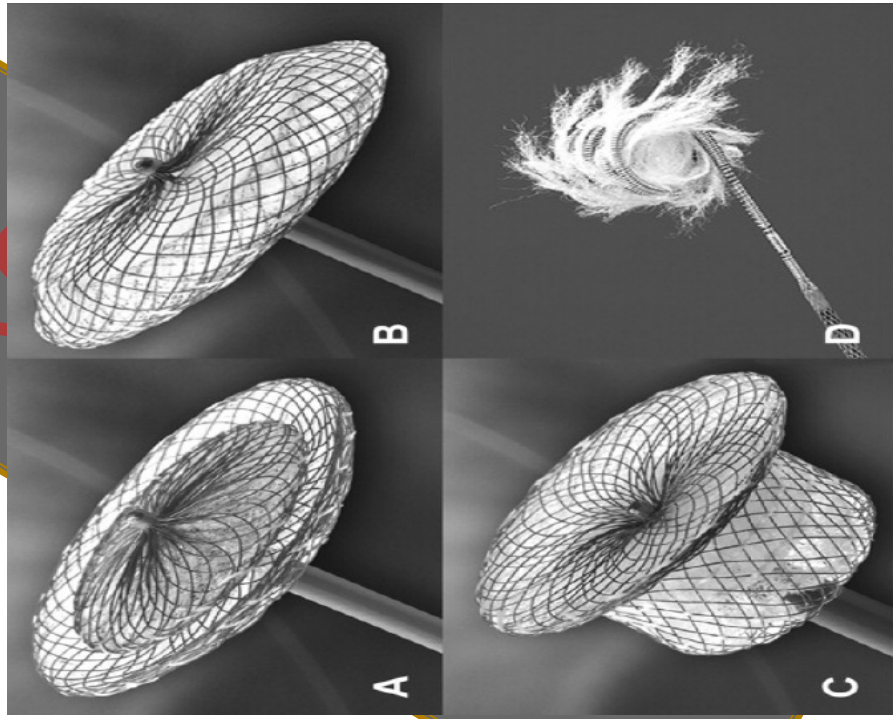
even mild paravalvular leaks, defined by total jet area on TEE 3 cm², should be repaired

Morehead AJ et al . Ann Thorac Surg 2000;69:135

PVL – *Percutaneous Closure*

- Percutaneous closure of PVL has only been the subject of *isolated case reports* and could not be considered so far as a validated alternative to surgery





- Needs TOE and fluroscopy
- Under general anesthesia
- Demanding and time consuming
- Its effects on hemolysis are inconsistent.

PVL – Percutaneous Closure

Contraindications

- Active infection (vegetation)
- Unstable prostheses
- Thrombi
- Large defects (>5 mm)
  - need more than 1 device, may interfere with leaflet movement
- Failure to accurately visualize the defect by echo is also a predictor of failed percutaneous closure.

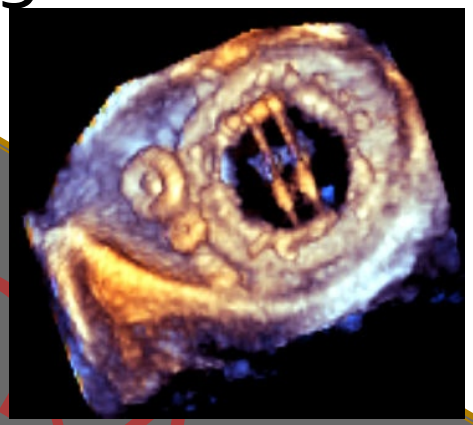
Shapira Y et al . Cardiology in Review 2009;17:121

Hein et al . Eurolterv 2006;2:325

PVL – Percutaneous Closure

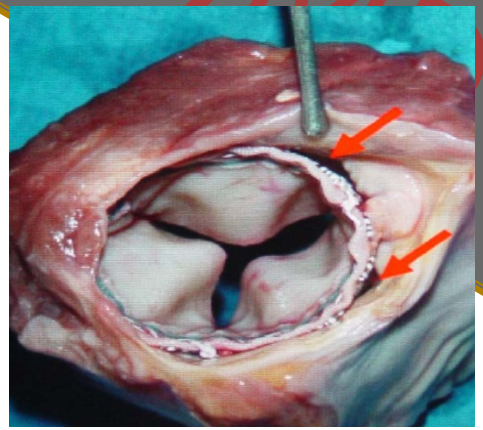
Future direction

- Live 3-D TOE is promising



- More versatile equipment becomes available

- Transcatheter AVR



PVL – *Prevention*

- Significant early paravalvular leakage following elective valve replacement necessitates a second pump-run
  - 2% of cases
- It might be prevented by
  - Routine use of intraoperative TOE
  - Meticulous eradication of any infected tissue (Endocarditis)
  - Extensive mitral annular calcification can be approached with special techniques

Thank you

While providing medical care
it is important to go out of your way
to do something extra for your patients.
We must always strive to help others.

D. Cosgrove, MD