Real-Time 3-Dimensional Echocardiography(RT3DE) in Clinical Practice

한림의대
순환기내과
홍 경 순

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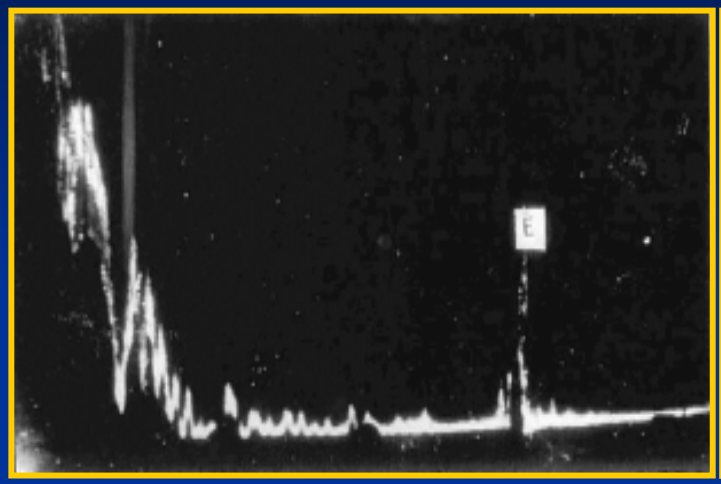
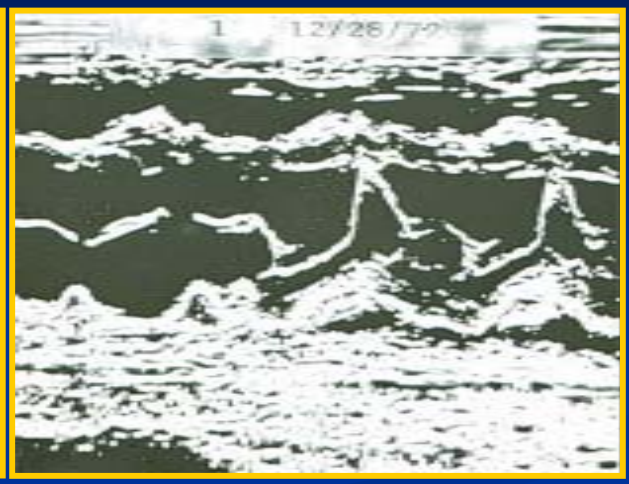
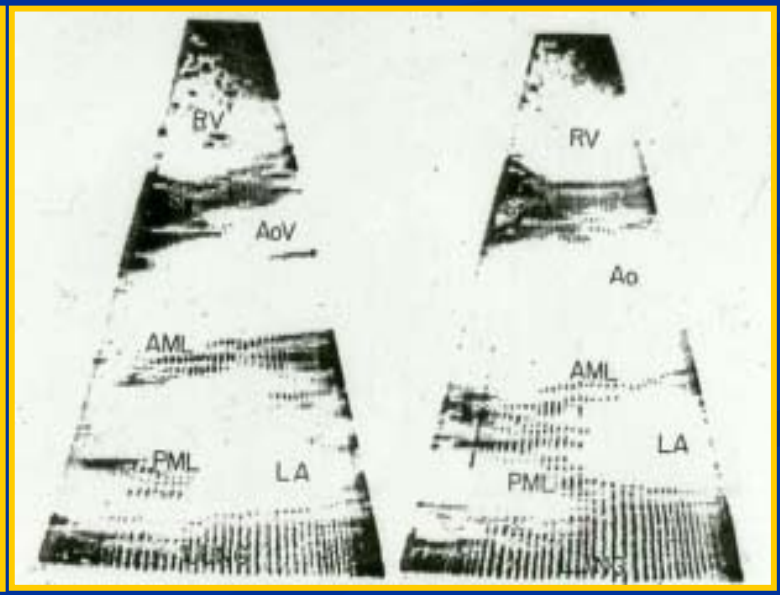
M-mode to 2-D Echo







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2-Dimensional Echocardiography(2DE) looks wonderful enough !

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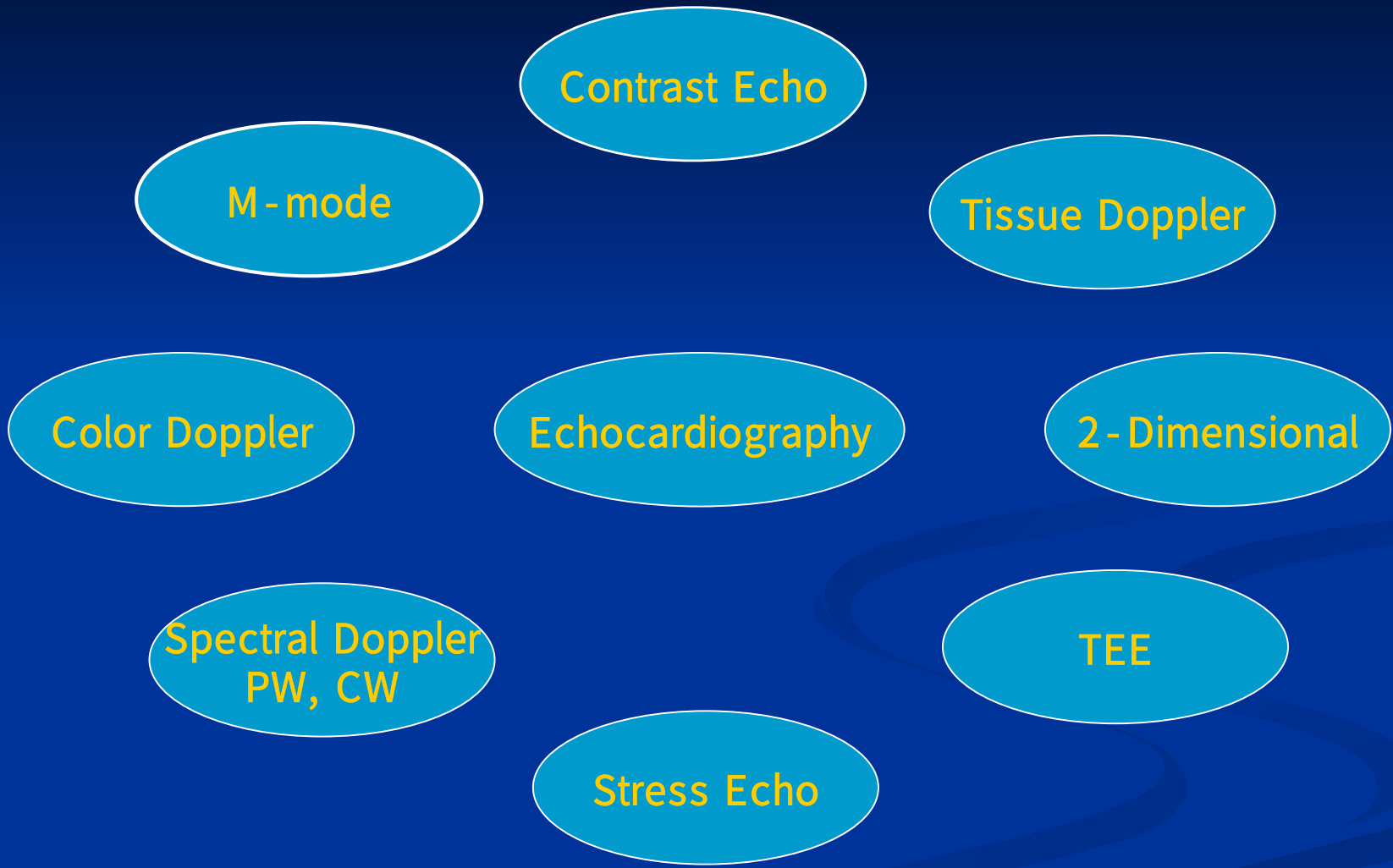

Modalities of Echocardiography

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Limitation of 2DE

- Geometric assumption

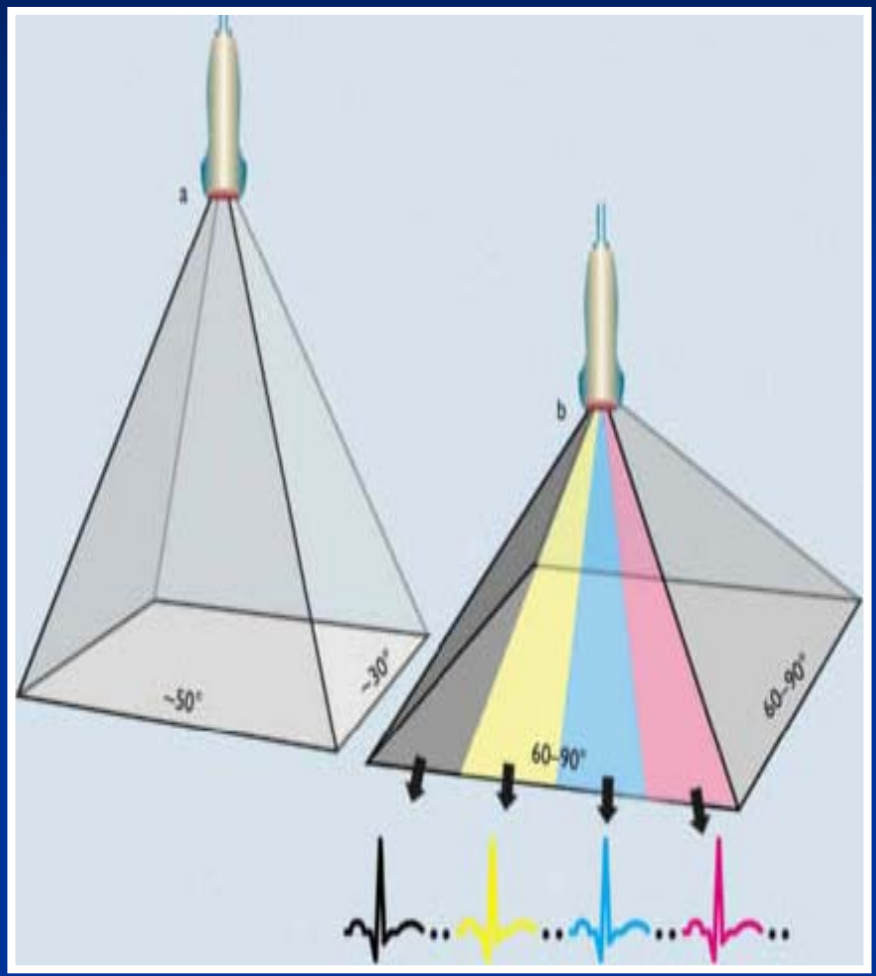
Everything about the heart is 3-dimensional !!!

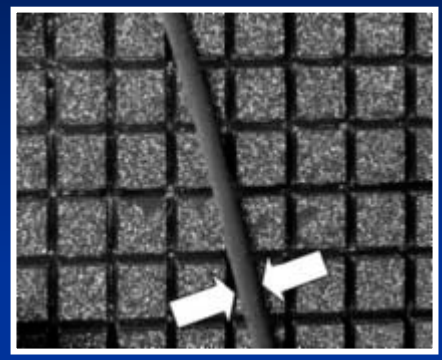
- Mental conceptualization

Advantages in 3DE

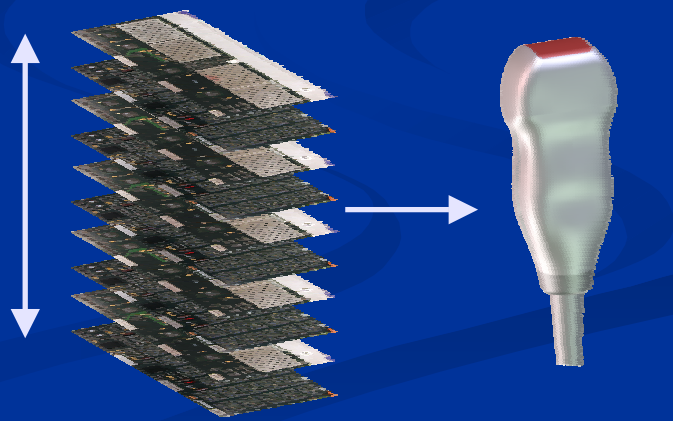
- Quantification without geometric assumption
  - Mass, volume and EF
- Improved visualization of spatial relations
  - Complex congenital heart disease
- Unique view of valve structures
  - En face views

Advance in 3DE





Top view of Matrix
(~3000 elements)



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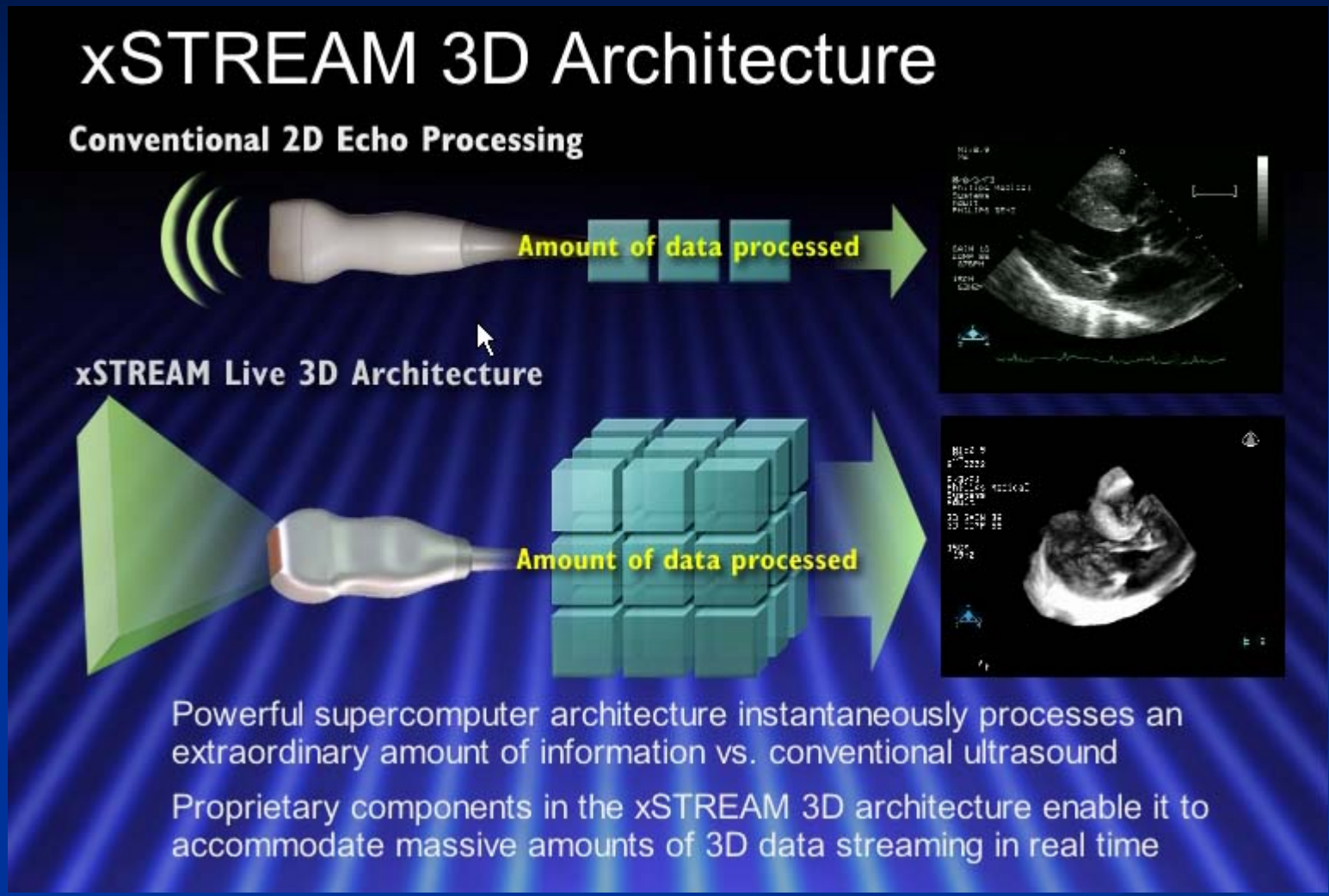
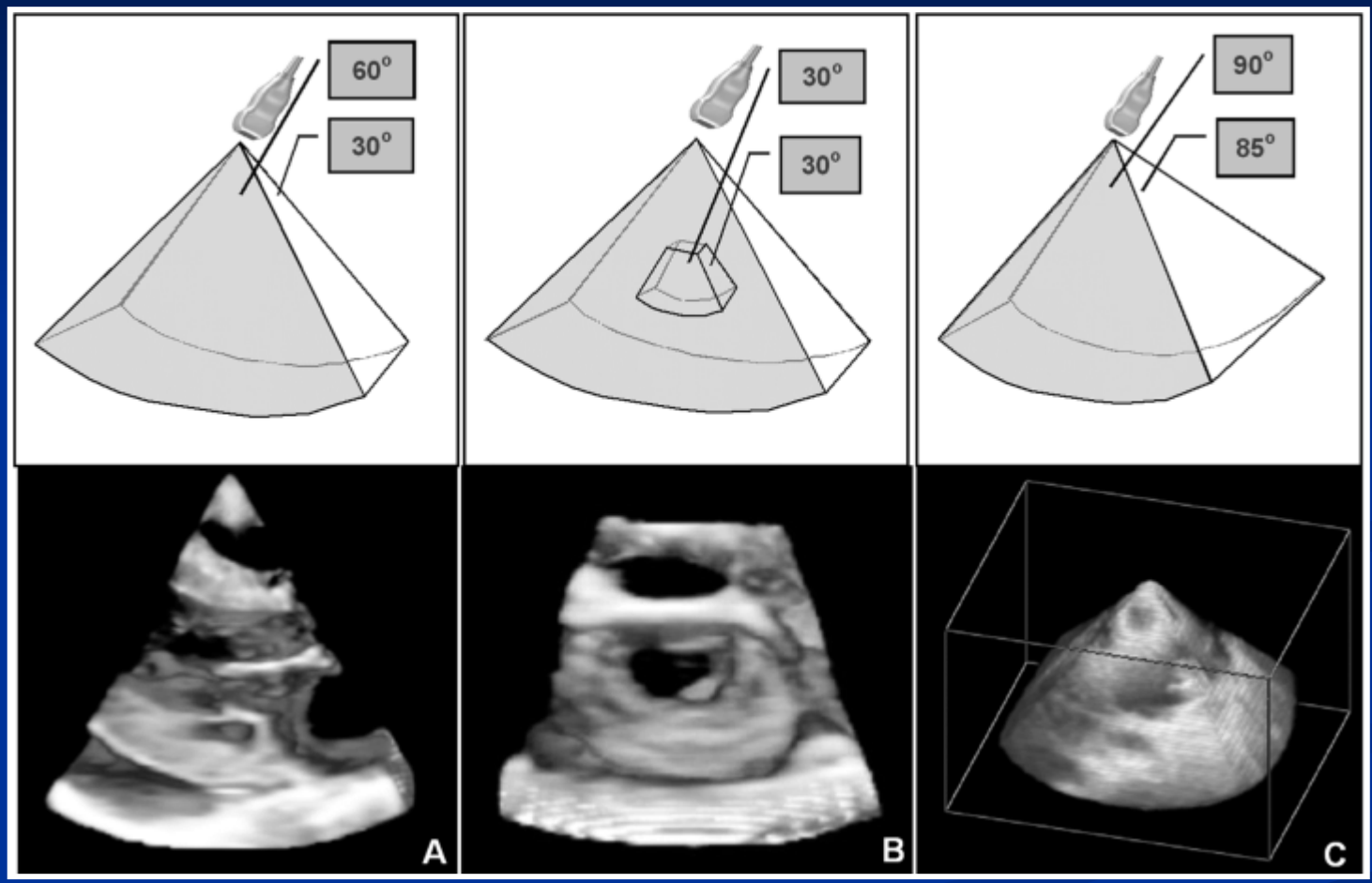
Matrix Array Transducer

Element	~3000
Frequency	1.6-4.0 MHz
Sector size	30*30 to 93*84
2D imaging	Biplane imaging
Harmonic imaging	Available
3D rendering	On-line

xSTREAM 3D Architecture



From PHILIPS



narrow-angled scan zoom mode wide-angled acquisition

RT3DE

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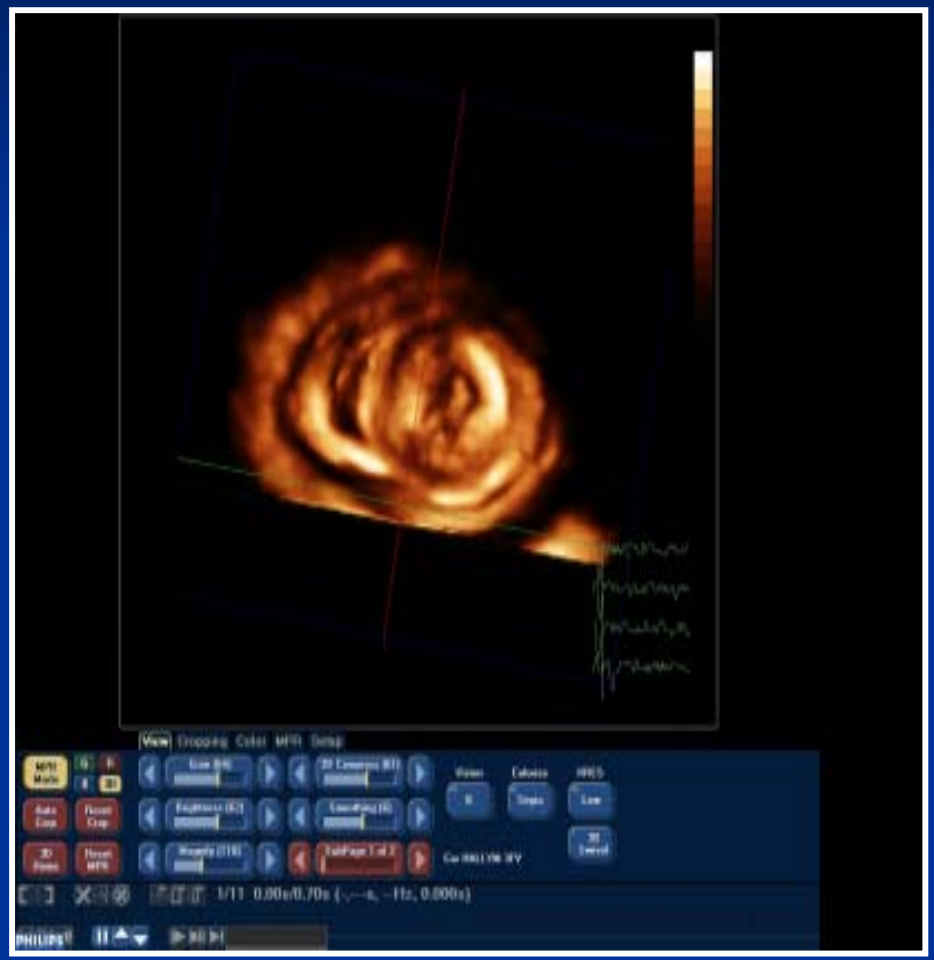
Image Acquisition and Crop

3D Data Analysis

- Qualitative
  - Observe the rendered images of the endocardial and valvular surfaces
- Quantitative
  - Manually
  - semiautomatically

Qualitative Analysis



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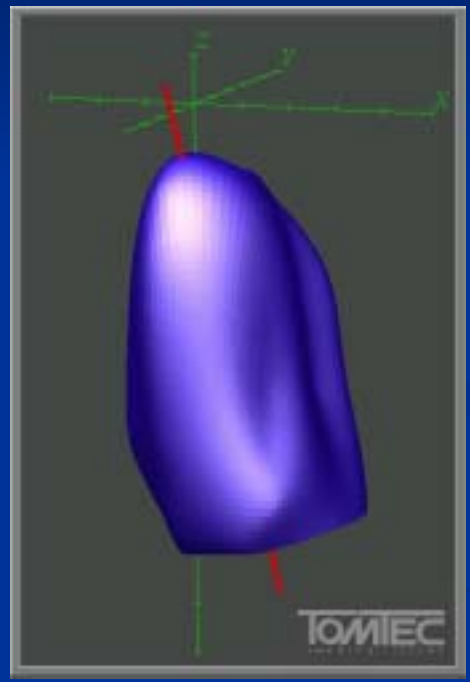
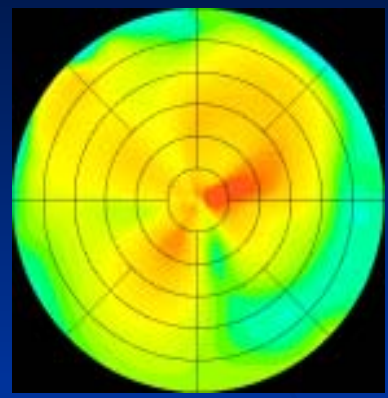
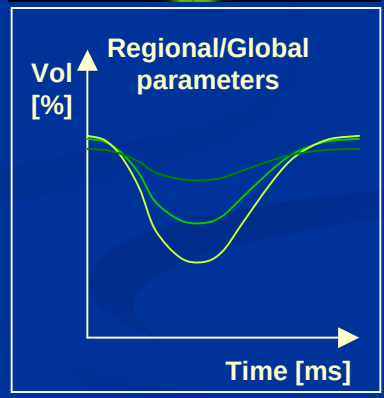
Quantitative Analysis







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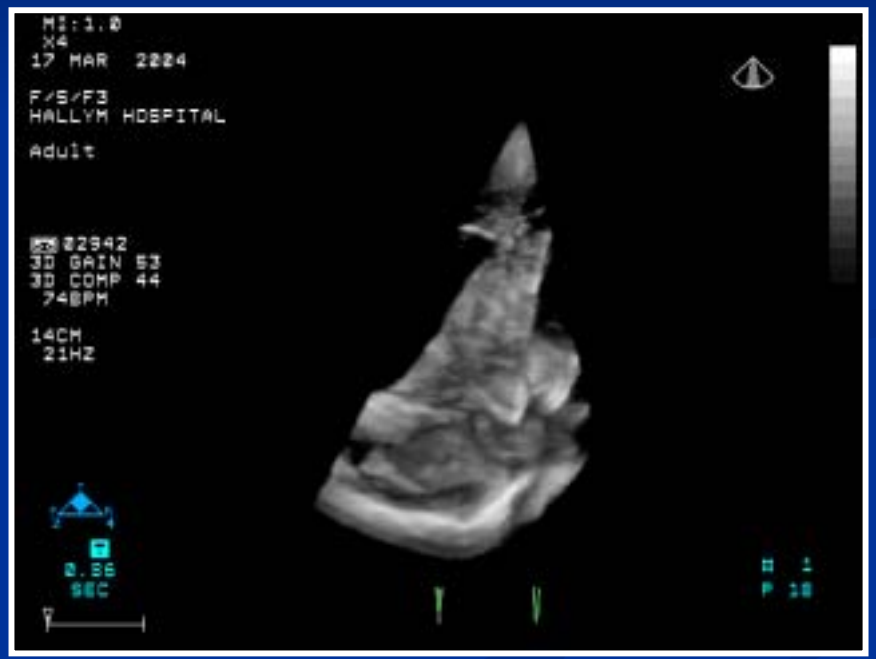
Better visualization of (complex)anatomic features

- Congenital heart disease
  - Location, size, and phasic changes of defect
  - Identify spatial inter-relationship in complex form
  - Surgical or en face view
  - Tailored surgery
- Vegetation, tumor and thrombus
- Hypertrophic cardiomyopathy

Atrial Septal Defect



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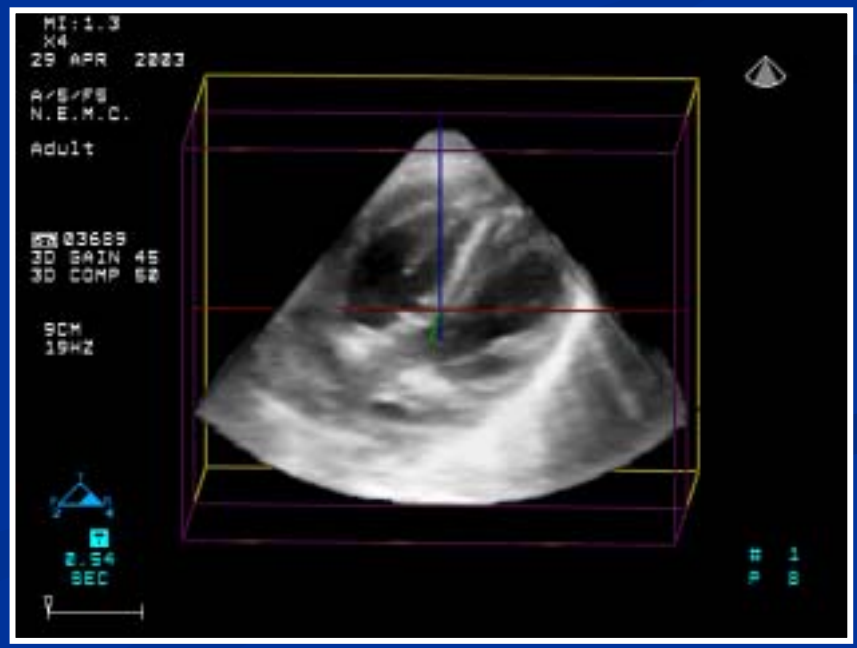
Ventricular Septal Defect



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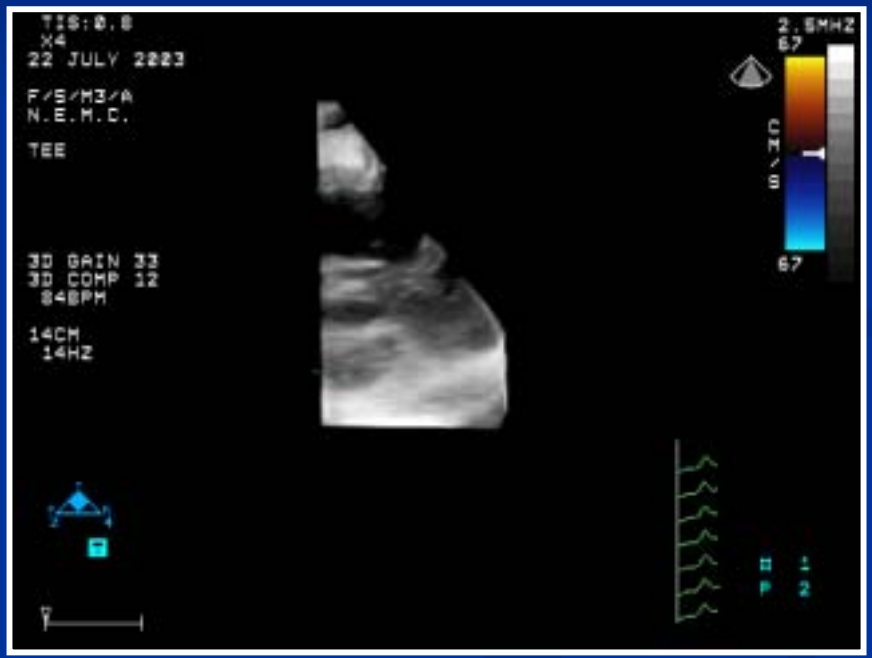
HCM


MI:0.9
X4
22 JULY 2003
F/S/F3
N.E.M.C.
TEE
3D GAIN 76
3D COMP 31
69BPM
13CM
22HZ
0.86
SEC


TIS:0.8
X4
22 JULY 2003
F/S/M3/A
N.E.M.C.
TEE
3D GAIN 33
3D COMP 12
84BPM
14CM
14HZ
2.5MHZ
67
CM/S
67

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Apical HCM

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Vegetation

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Tumor


MI:0.9
X4
23 APR 2003
C/5/H5
N.E.M.C.
Adult
3D GAIN 59
3D COMP 6
62BPM
16CM
18HZ
2.0
4.0
1.09
SEC


MI:0.8
X4
25 Jun 2004
16:34:39
A/4/H1
HALLYM Univ. M.
HALLYM ADULT
3D GAIN 50
3D COMP 37
57BPM
15CM
19HZ

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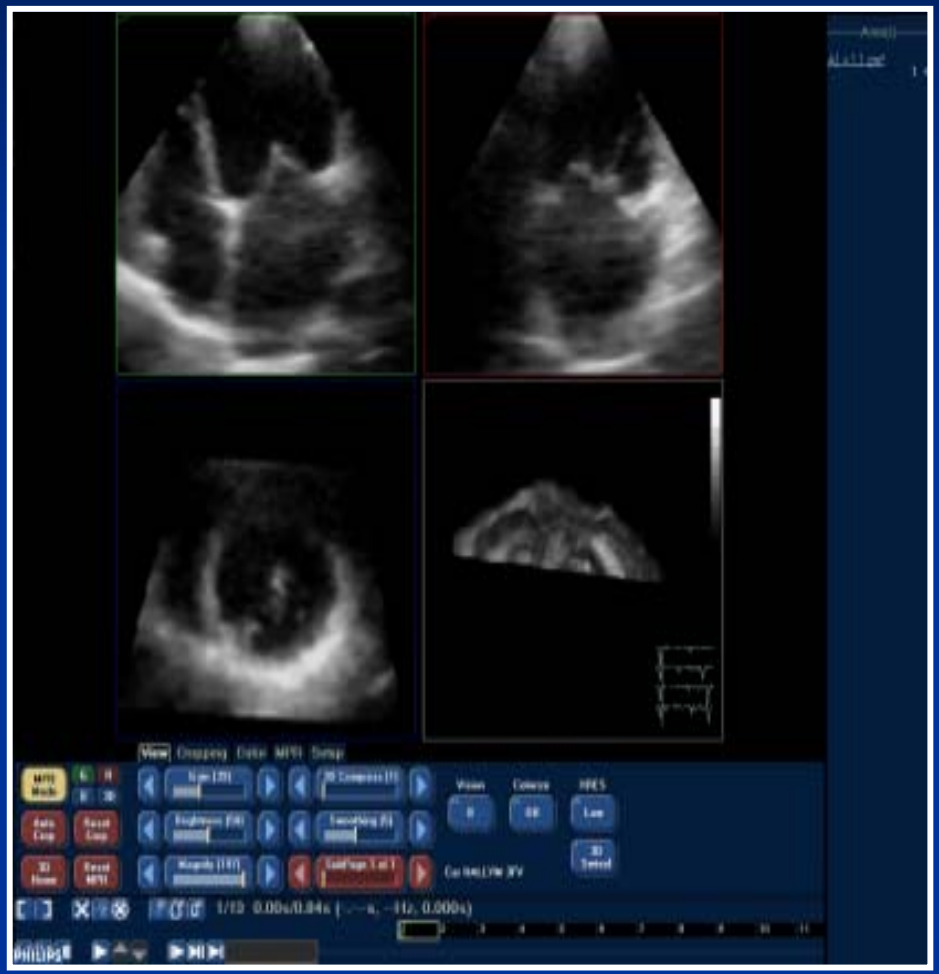
Better quantitation of size, volume, mass and function

- Volume and Mass of LV and RV
- Regional/global function
- Diastolic function
- Size of dysfunctional myocardium
- Size and volume of intracardiac mass
- Defect size: ASD, VSD etc.

Valve Area and Mass Volume



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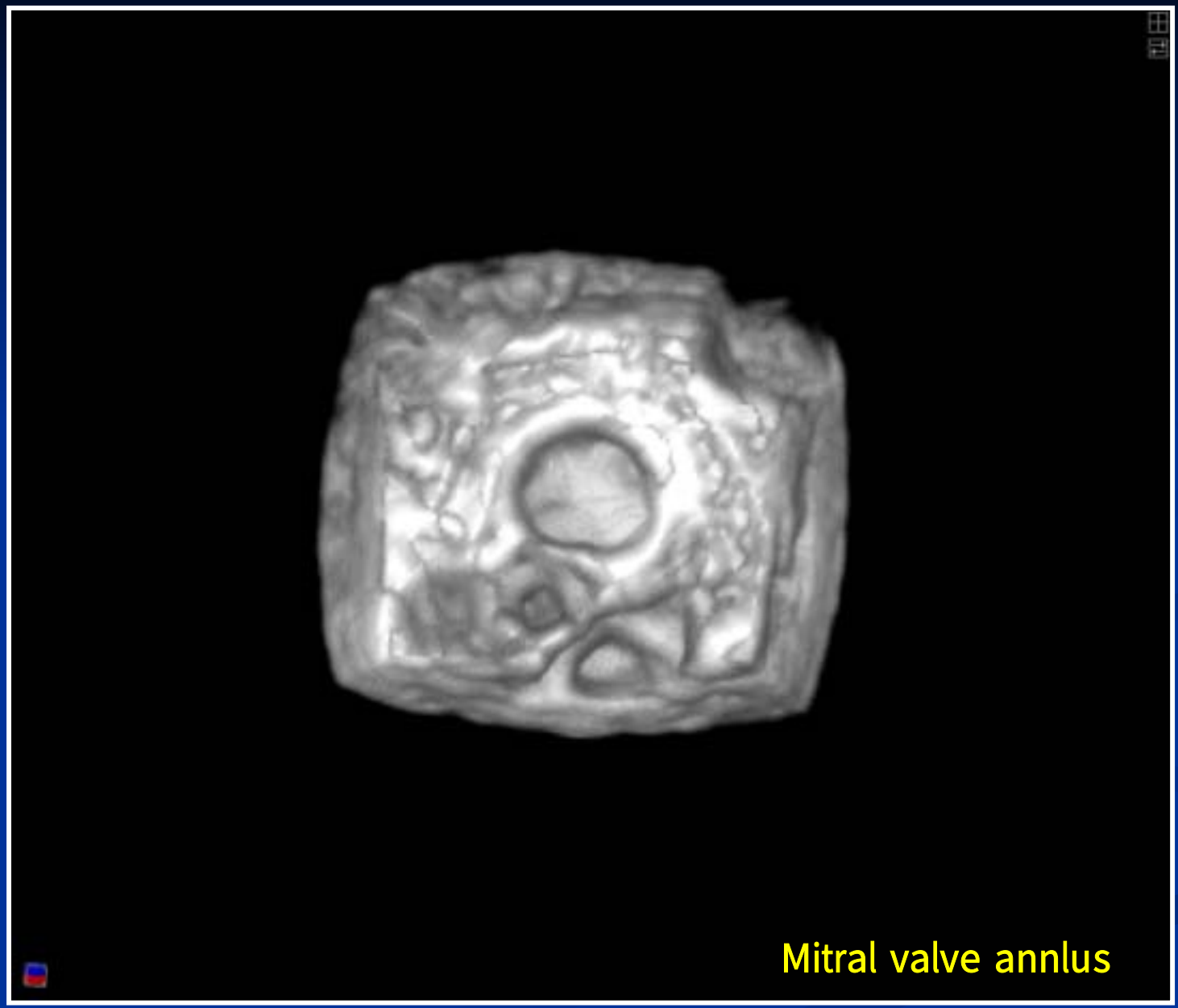

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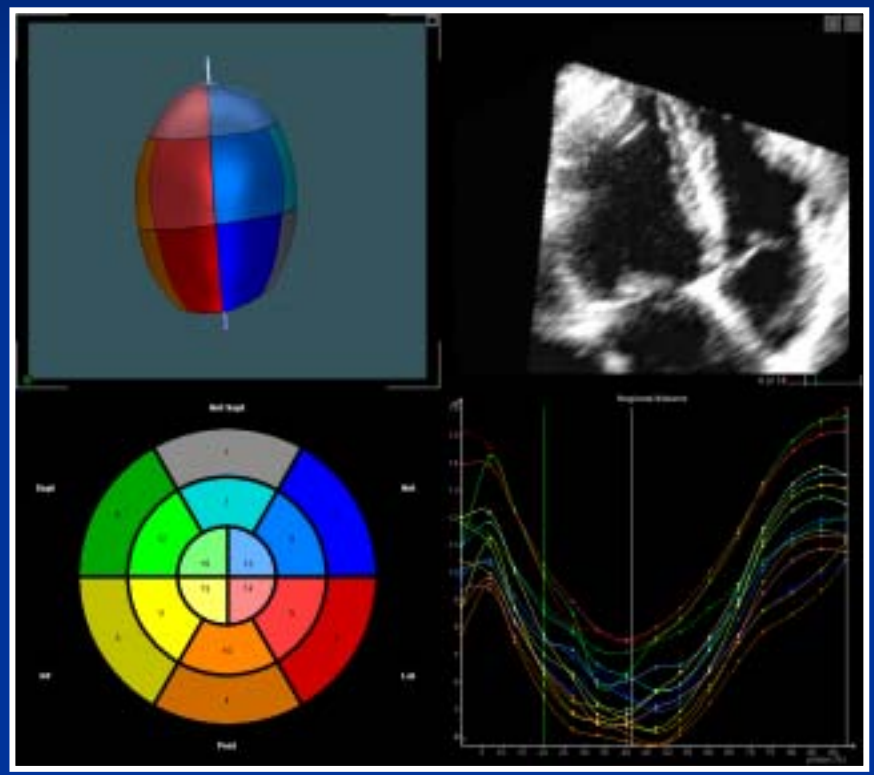
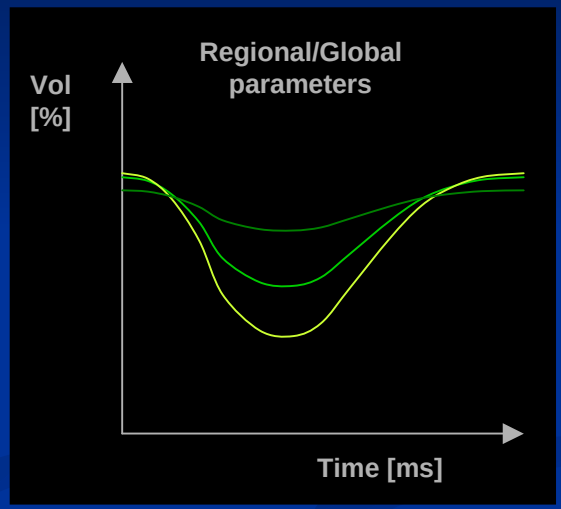
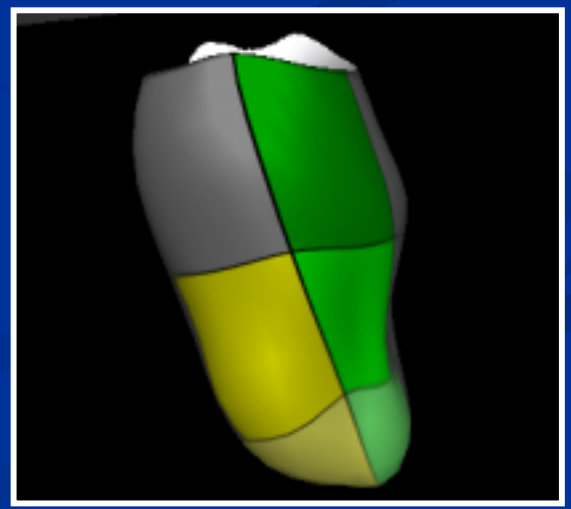
LV Analysis

Regional/global function, Diastolic function
(Using TomTec software)







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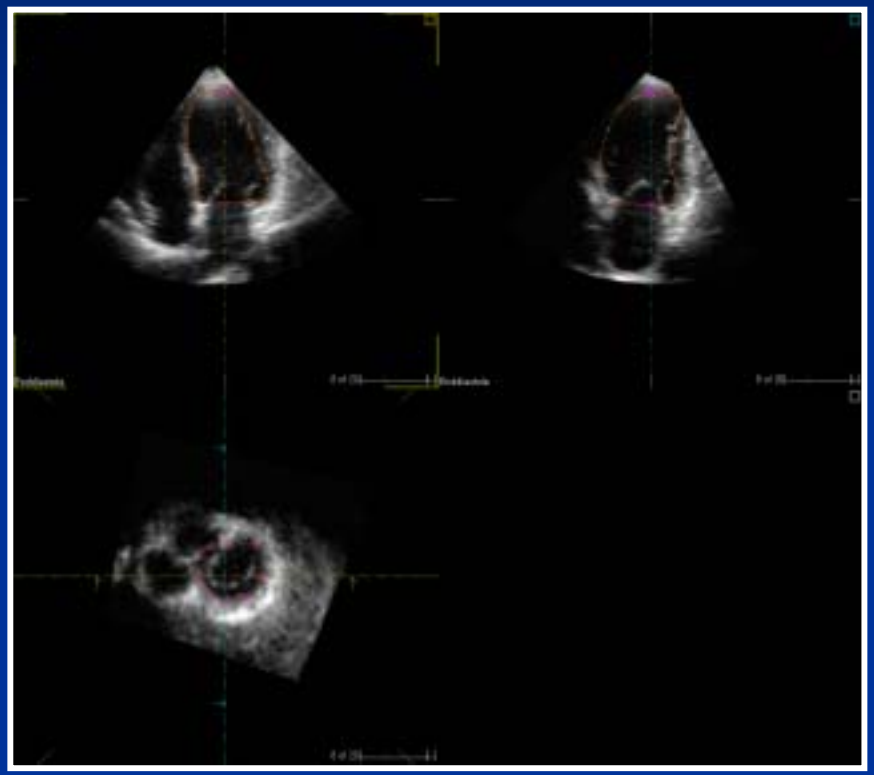
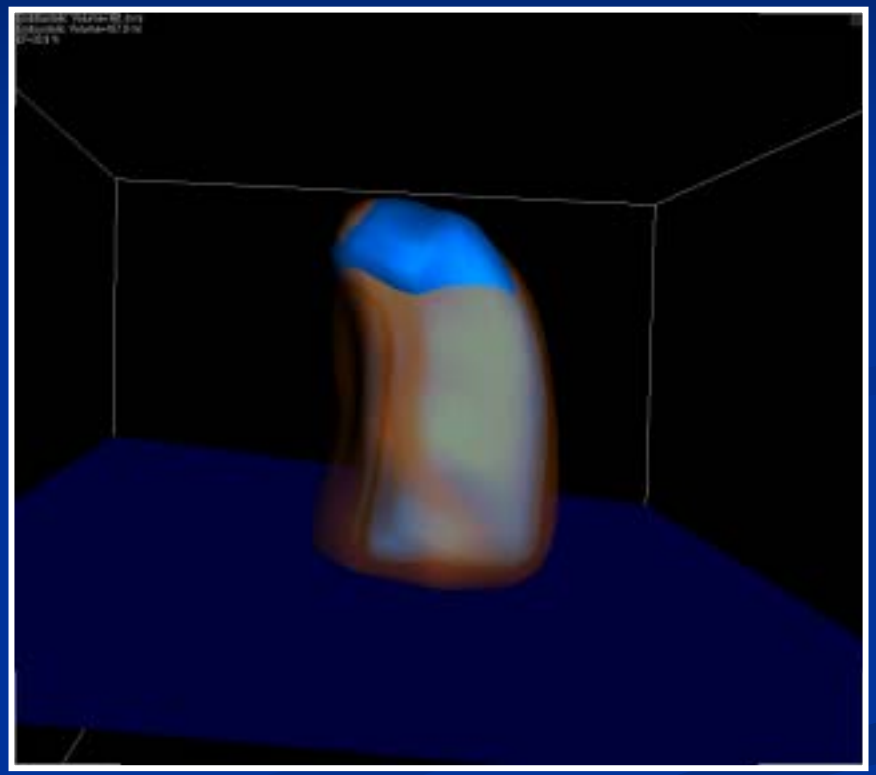
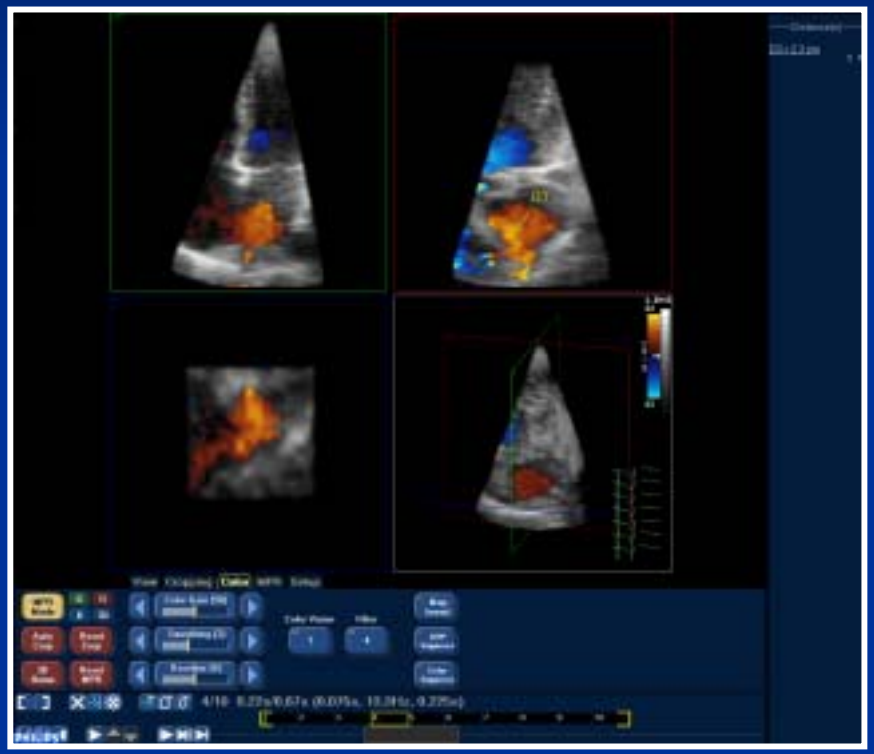
LV Volume

and dysfunctional myocardium





Size of Defect



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Better assessment of valves

- Valve morphology
- Stenotic valve orifice
- Regurgitant volume and orifice area
- Mitral valve prolapse
  - Identify prolapsing scallop
  - Measure extent of defect
- Geometric assessment of mitral apparatus
- Differentiate valvular from perivalvular regurgitation

Mitral Stenosis

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RT3DE for rheumatic mitral valve stenosis evaluation: an accurate and novel approach

- 80 pts(76 women, 50 ± 13.9 years)
- MVA
  - by conventional echo-Doppler method, RT3DE and invasive Gorlin's formula
  - RT3DE: best agreement with invasive one
- Valvular score evaluation: better interobserver agreement with 3DE
- Feasible, accurate and highly reproducible technique for assessing MVA

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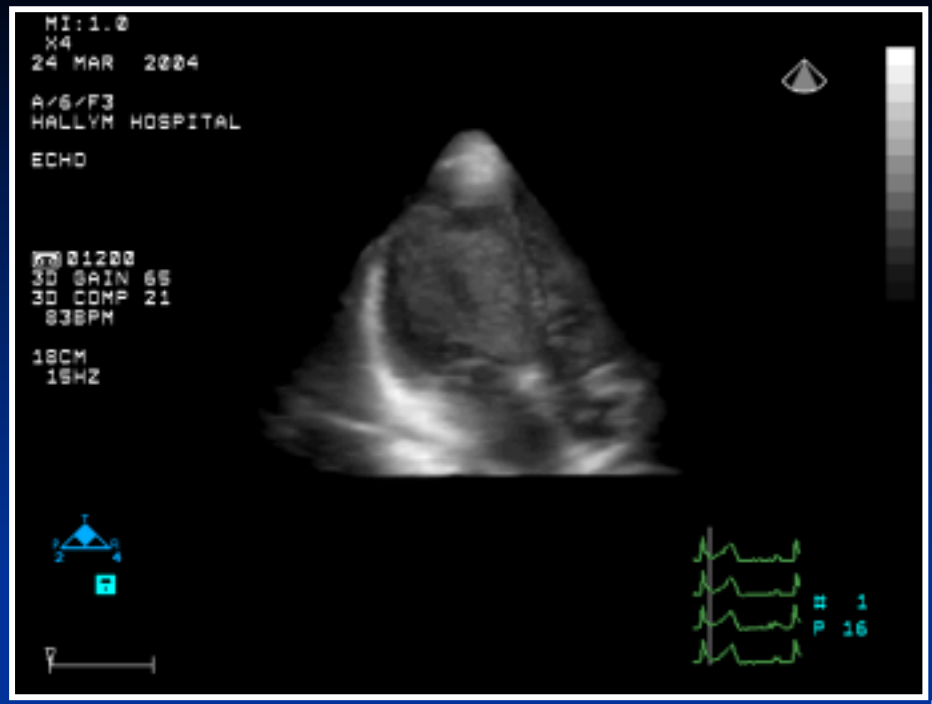
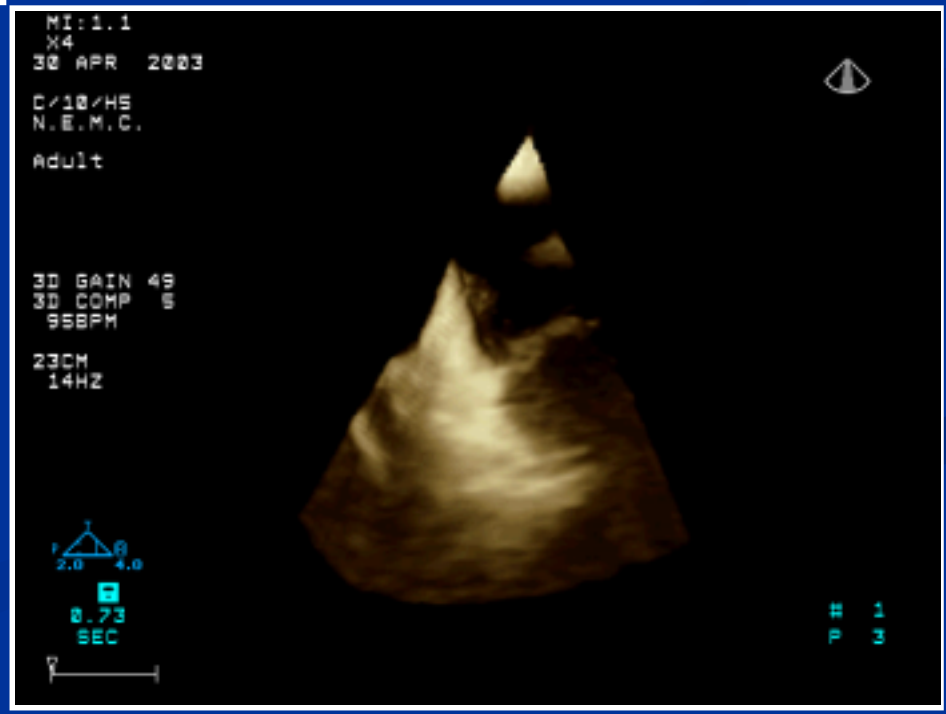
Zamorano, J, et al. (2004) JACC 43(11): 2091-6

Mitral Valve Prolapse





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Usefulness of RT3DE in the assessment of degenerative mitral valve insufficiency before surgical repair: preliminary data and clinical applications

- 22 patients(age: 60 ± 3)
- clinically useful images in all pts
- Improved in 3DE
  - mitral scallops involved in the prolapse and ruptured cordae in flails
  - characterization of the "texture" (myxomatous disease vs fibroelastic deficiency
  - identification of functional "interscallop" clefts, paracommissural lesions and annular shape with a better localization of small mitral annular calcification
- Promising in the clinical setting of repair surgery

A. Grimaldi, et al. (2003) Milan, Italy ESC

Usefulness of 3DE for evaluation of MVP

- 25 consecutive pts(15 men, 55 ± 17 years)
- Reconstructed in surgeon's view
- Compared with 2DE
- Sensitivity 75~100 %, Specificity 100%

Abo, K, et al. (2004) J Cardiol 43(1): 17-22

Valve Prosthesis

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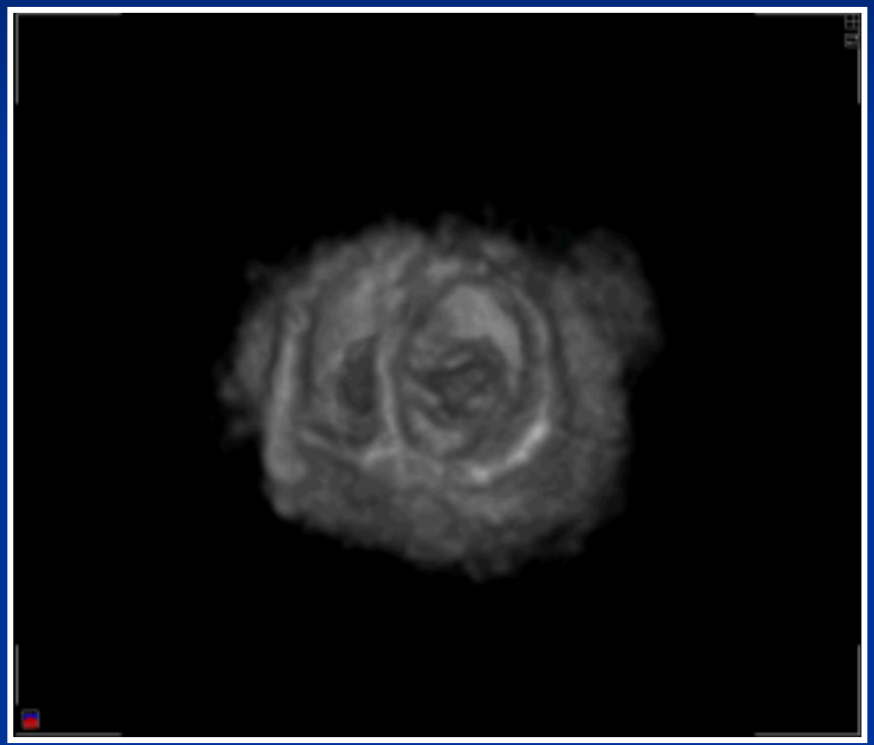
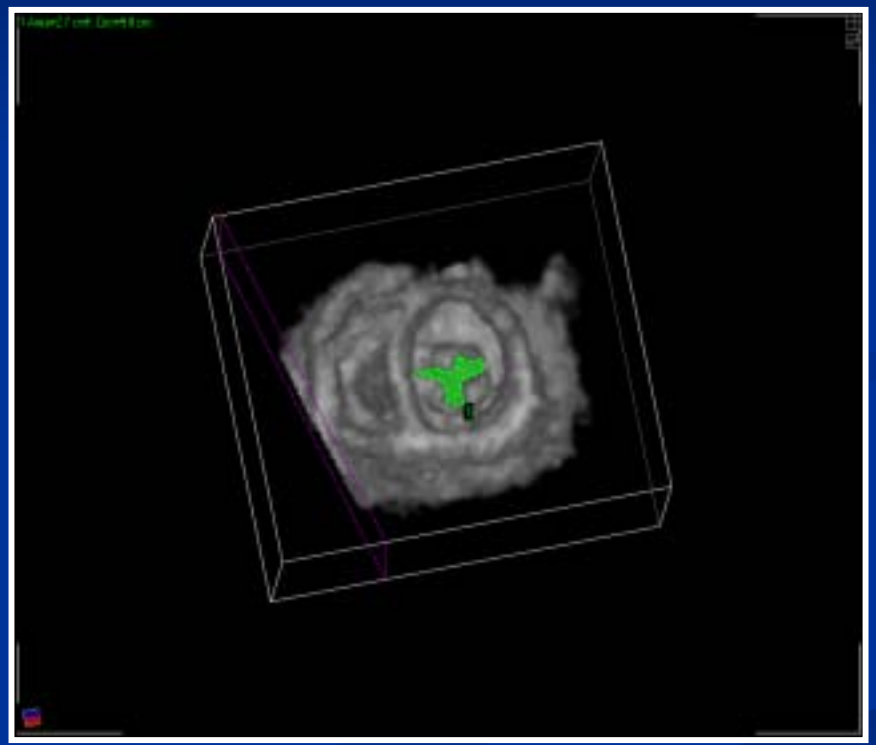
Cleft Mitral Valve





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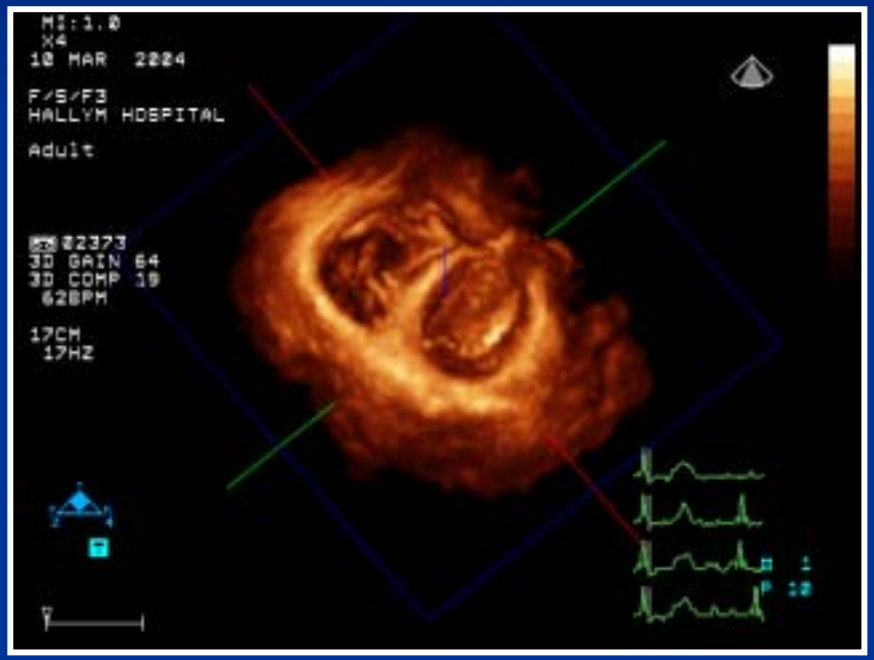
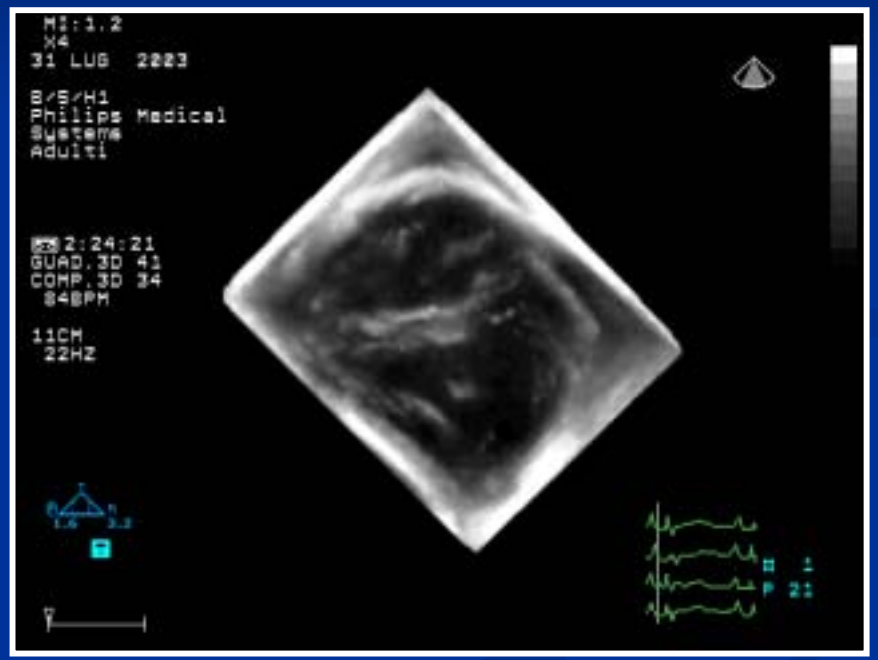
Tricuspid Valve





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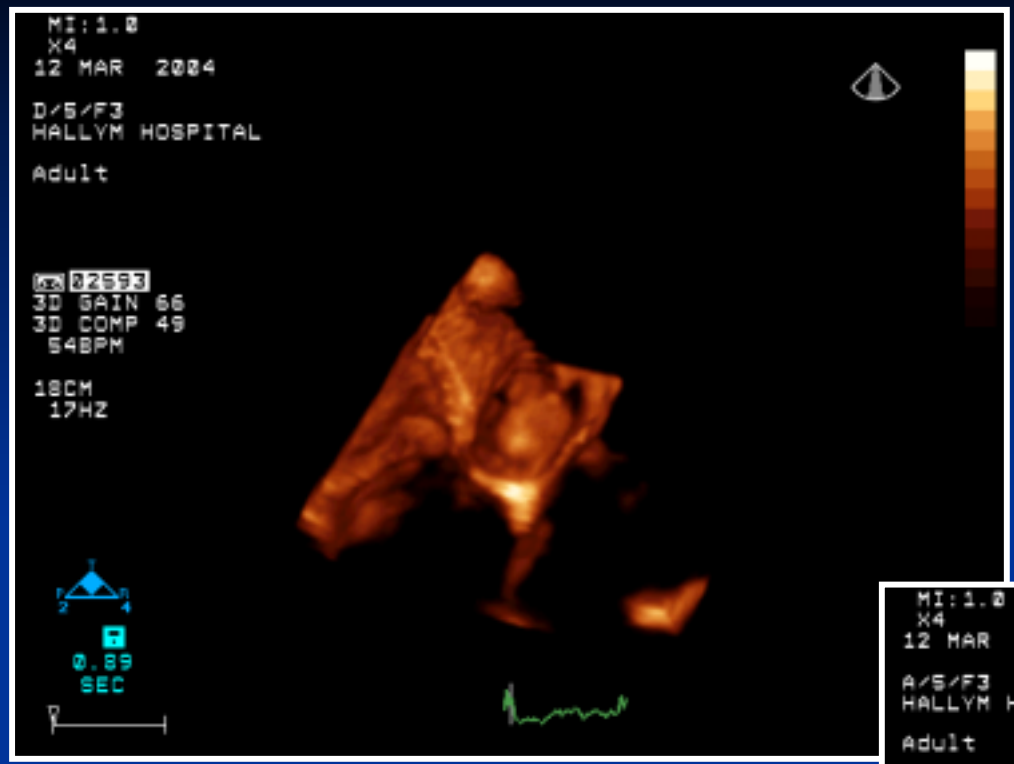
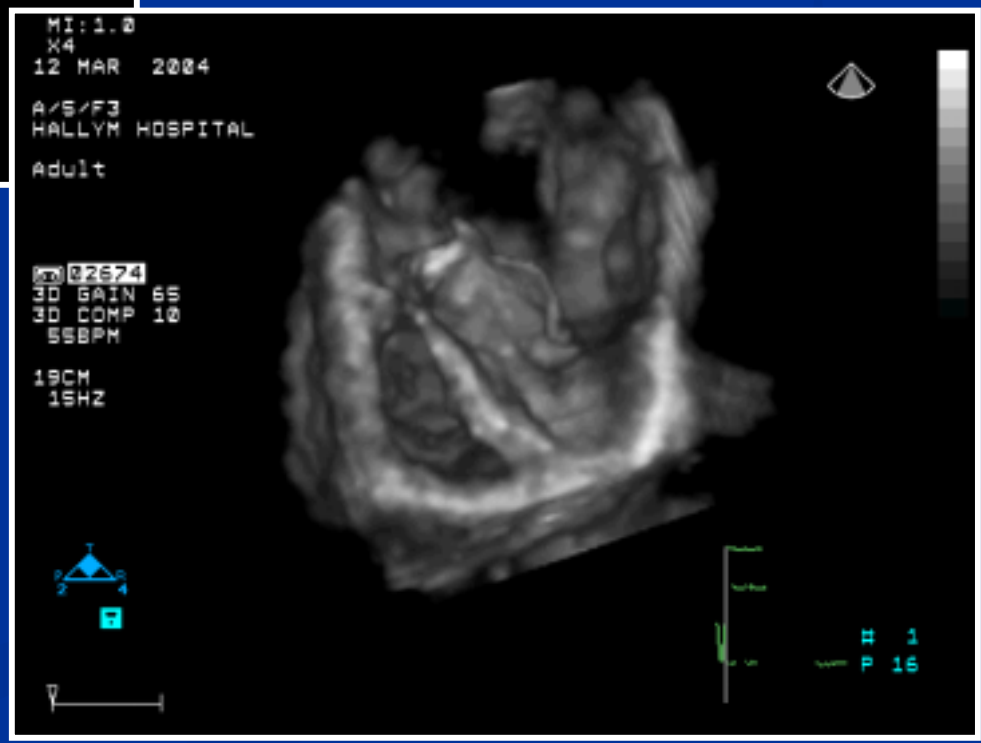
Aortic Valve





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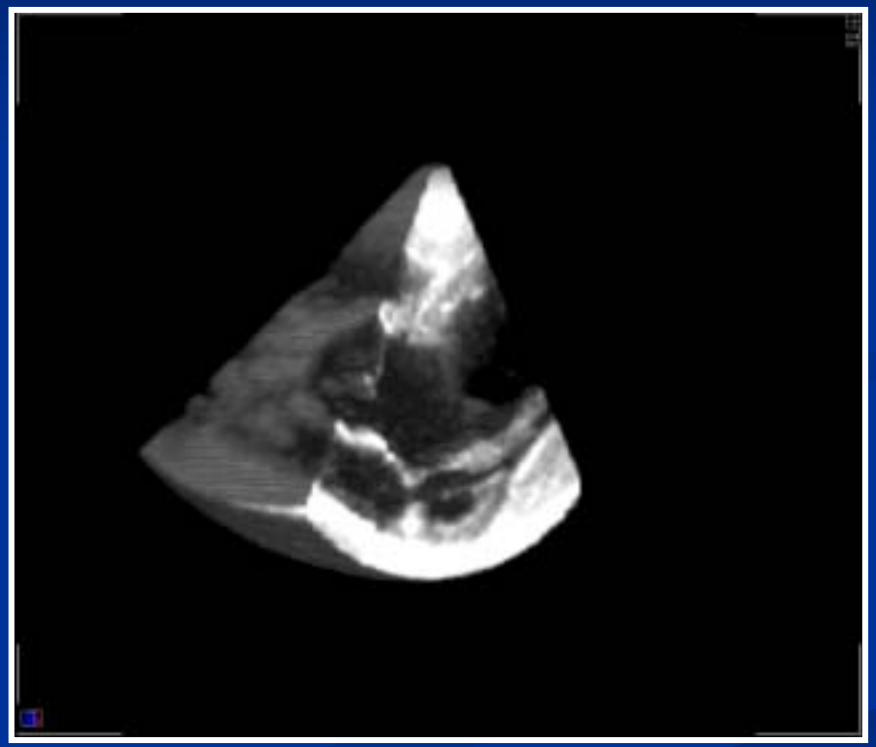
Usefulness of RT3DE in aortic valve stenosis evaluation

- 11 pts
- AV orifice area: correlated well with intraoperative 3DTEE(r=0.85)
- 4 pts with moderate AS by 2DTTE: confirmed at surgery as severe AS
- Useful complement to the existing modalities due to complete noninvasiveness and 3 dimensional views

Vengala, S., N. C. Nanda, et al. (2004) Am J Geriatr Cardiol 13(5): 279-84

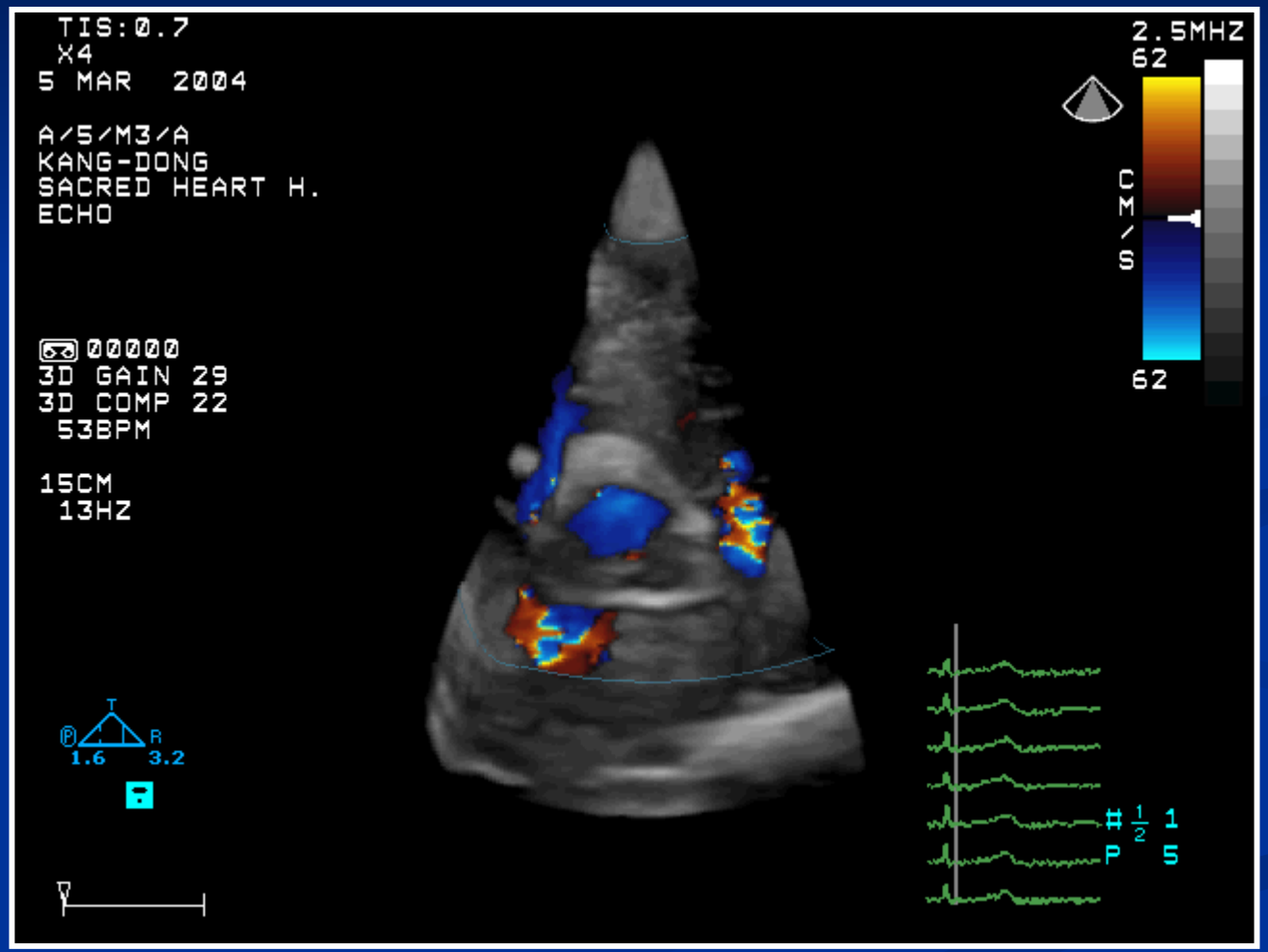
Bicuspic Aortic Valve



Color 3DE

- Stenotic, regurgitant, or shunt flows
  - Location, phase, direction, length, width, area, course and severity
- Enhance quantification
- Coronary artery circulation

Regurgitations
MR, AR, TR



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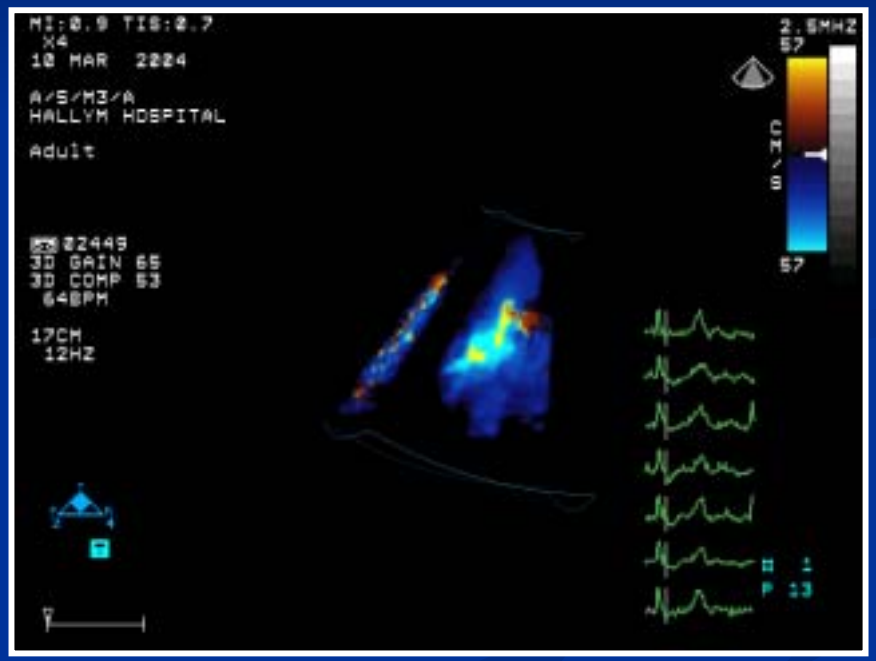
Tricuspid Regurgitation



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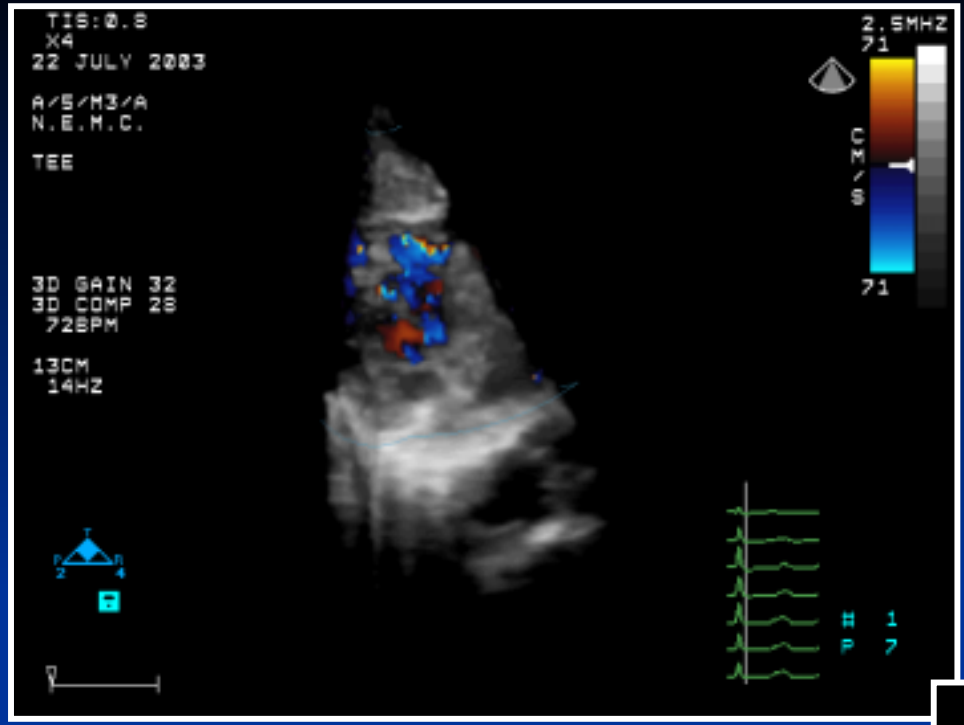
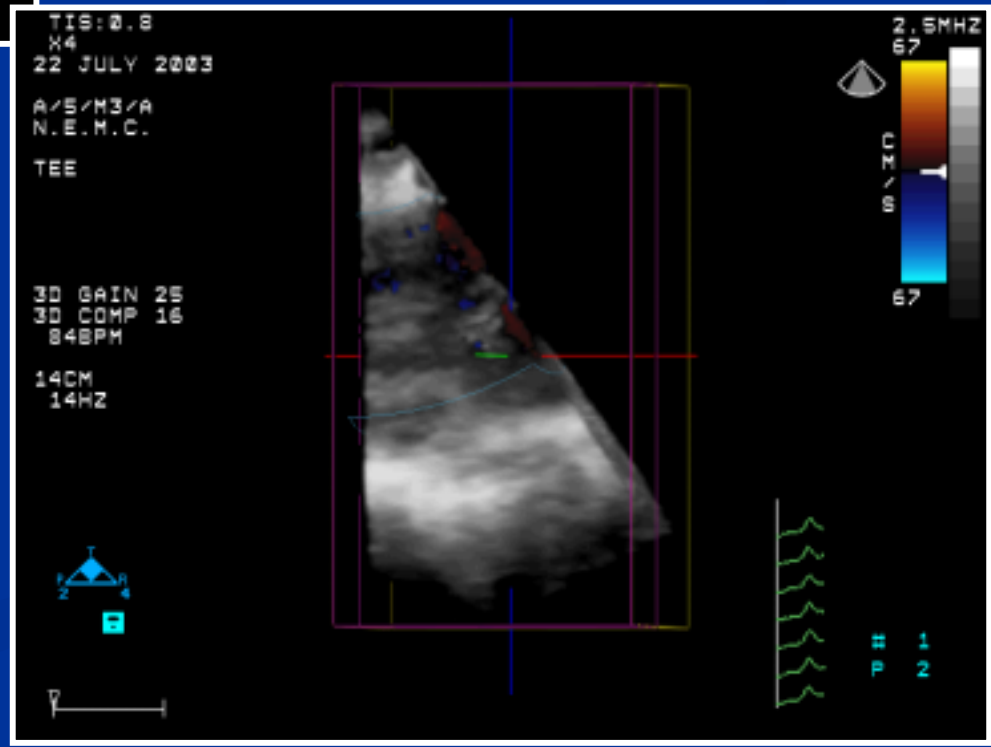
LVOT Flow and MR





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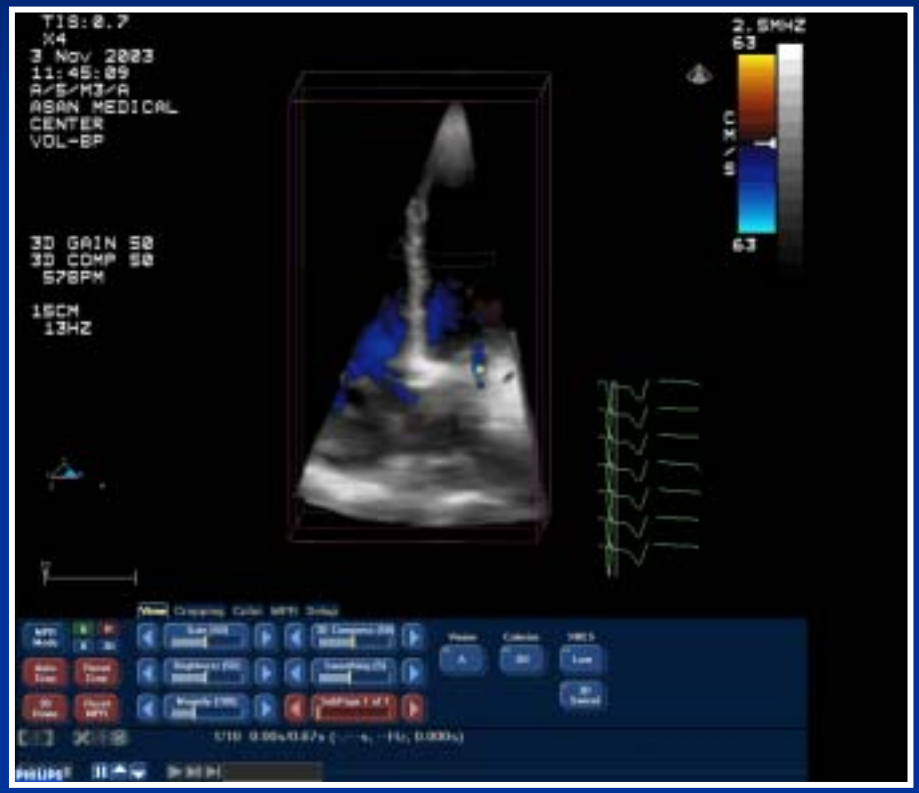
Shunt Flow



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Better catheter guidance in 3D space

- Pericardiocenthesis
- Biopsy
  - transplanted heart, tumor, native heart
- PMV(percutaneous mitral balloon valvuloplasty)
- Non-invasive therapeutic procedures
  - ASD device closure
  - PLAATO(percutaneous LAA transcatheter occlusion)
- EP lab
  - Where catheter is
  - Calculate distances

3D Stress Echocardiography

- One volume rendered image
- Time saving
- Any cut-plane

3D Contrast Echocardiography

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Limitations

- Lack of need
- Still off-line quantification
- Hemodynamic assessment
- Artifacts
- Big probe

Comparison of RT3DE with conventional 2DE in the assessment of structural heart disease

- 106 pts
- Diagnosis on the basis of 2D findings
- Graded as
  - A, new finding; 7%
  - B, useful anatomic perspective; 18%
  - C, equivalent; 61%
  - D, missed; 14% – **Suboptimal image quality in 47%**

MV disease and CHD in 61%

- Useful anatomic insight in MV disease and CHD

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Chan KL, et al. J Am Soc Echocardiogr. 2004 Sep;17(9):976-80

RT3DE as the Primary Mode of Echocardiographic Imaging in Routine Daily Clinical Practice: Experience in 500 Patients

- Adult and pediatric pts
- Both physicians and sonographers
- visualize all major pathology
  - stenotic valves, prolapsing and flail MV, Ebsteins anamoly, ASD and VSD, Fallot's tetrology, HCM and DCM, ventricular aneurysm, clot and tumor, pericardial effusions, etc.
- Novel on-line cut-planes
- Time added to examination was less 10 min
- easy performance and navigation

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KS Hong, N. Pandian, N. Nanda ASE 2004

Future directions

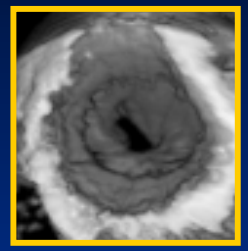
- Larger volume rendered image
- Rapid and easy quantitation
  - Automatic border detection technique
- Stress and Contrast 3DE
- Interventional fields
- Real-time 3D TEE

Conclusions

- Important breakthrough in the field of ultrasonic medicine
- Complementary to 2DE
- More useful in the diagnosis and assessment of wide range of cardiovascular disease

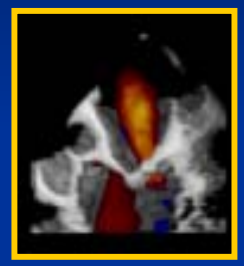
Real-time Multidimensional Echocardiography

Morphology



Function

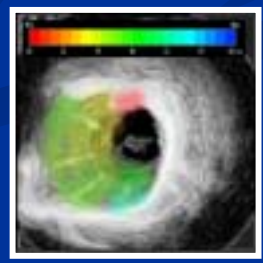
Flow dynamics



Perfusion

Mechanics

Multimodality



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Thank You !

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