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TCTAP 2012

# “Best Imaging” for Complex ASDs


**Jae Young Choi, MD, PhD, FSCAI**
***Severance Cardiovascular Hospital,***
***Yonsei University Health System***
***Seoul, Korea***

# Ideal imaging tool for catheter intervention

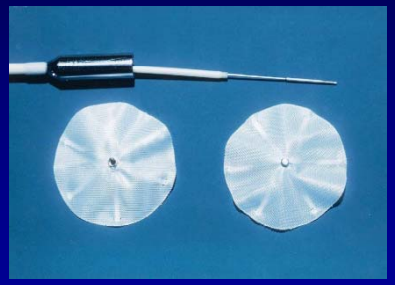
- ✓ Accurate visualization
  - defect size, location, number, rims, adjacent structures
- ✓ Provides adequate guidance of the procedure
  - wire/sheath position, balloon sizing, device deployment
- ✓ Post-procedure assessment
- ✓ Operator-controllable, operator friendly
- ✓ Does not require
  - general anesthesia
  - additional vascular access
  - additional personnel, equipment, time
- ✓ Not expensive, safe, comfortable
- ✓ Universal applicability

# Imaging modalities for ASD closure

- ✓ Fluoroscopy
- ✓ TEE
- ✓ ICE
- ✓ TTE

- ✓ *Role of pre-procedural CT or MRI?*

# *Even in the era without echo ….*



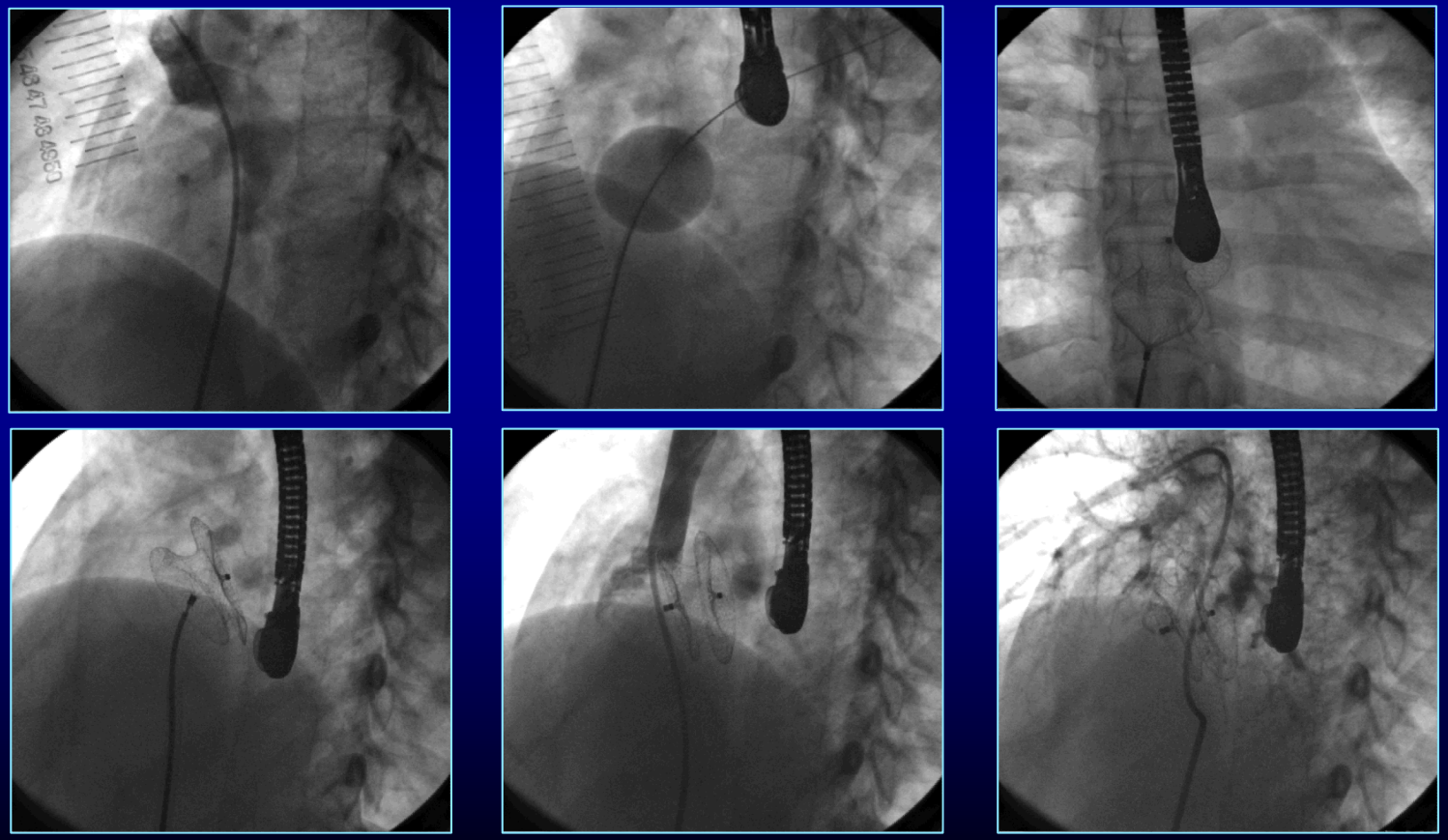
1974~76
5 patients
*Surgery 1974;75:383*
*JAMA 1976;235:2506*

*I'm shy so not gonna ask him to take picture with me… I'm just happy with this group photo….*

**With Dr. Terry D. King, the pioneer..**
***PICS & AICS 2010, Chicago***

# Fluoroscopic Guidance for ASD Closure

- ***Can :*** *overall guidance of the procedure*
- ***Cannot :*** *accurate characterization of the defect*
  *relationship btw cardiac structures / devices*
  *detailed information*



# Why Echo?

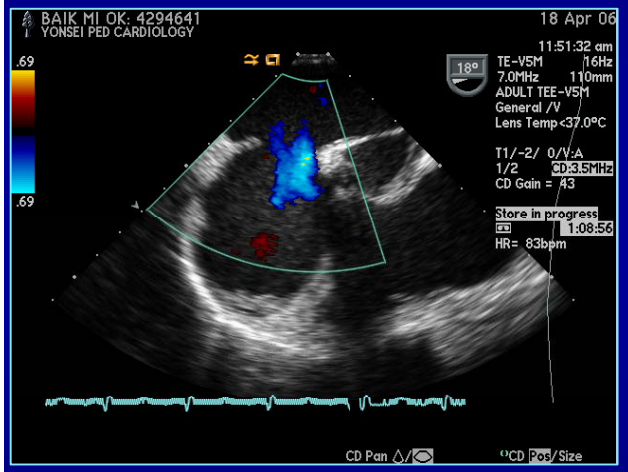
- Characterization of ASD anatomy (shape, location, number of defects)
- Sizing of ASD (maximal and minimal diameter)
- Rim assessment

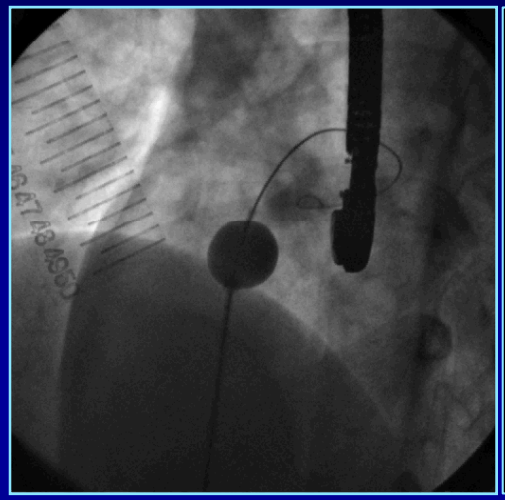
  → feasibility / strategy for device closure
- Provides adequate guidance of the procedure

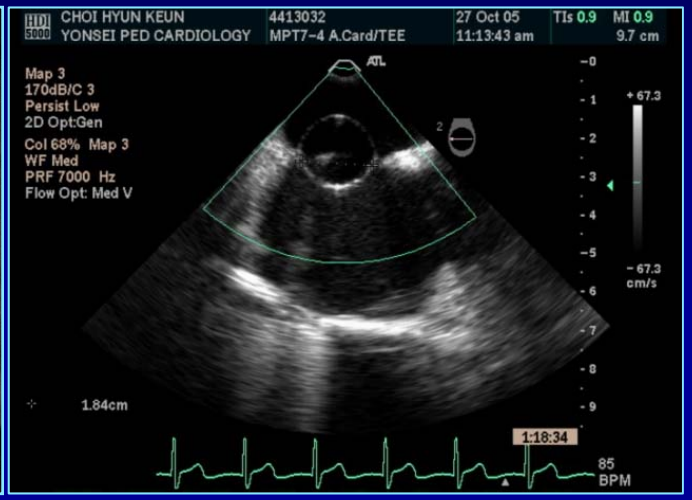
  wire/sheath position, balloon sizing, device deployment, relationship btw device & septum, potential complications
- Post-procedure assessment of result

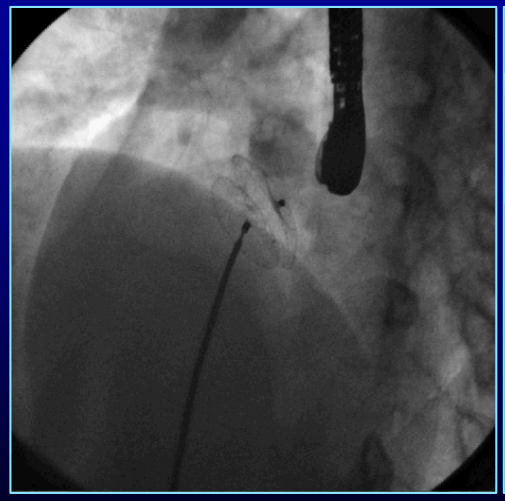
***: Traditionally, TEE has been regarded as the most frequently used, standard tool to guide ASD closure!***

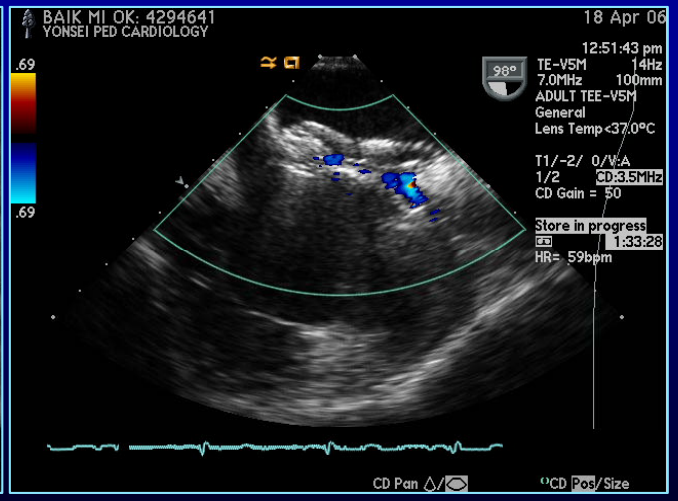
# TEE-guided ASD Closure







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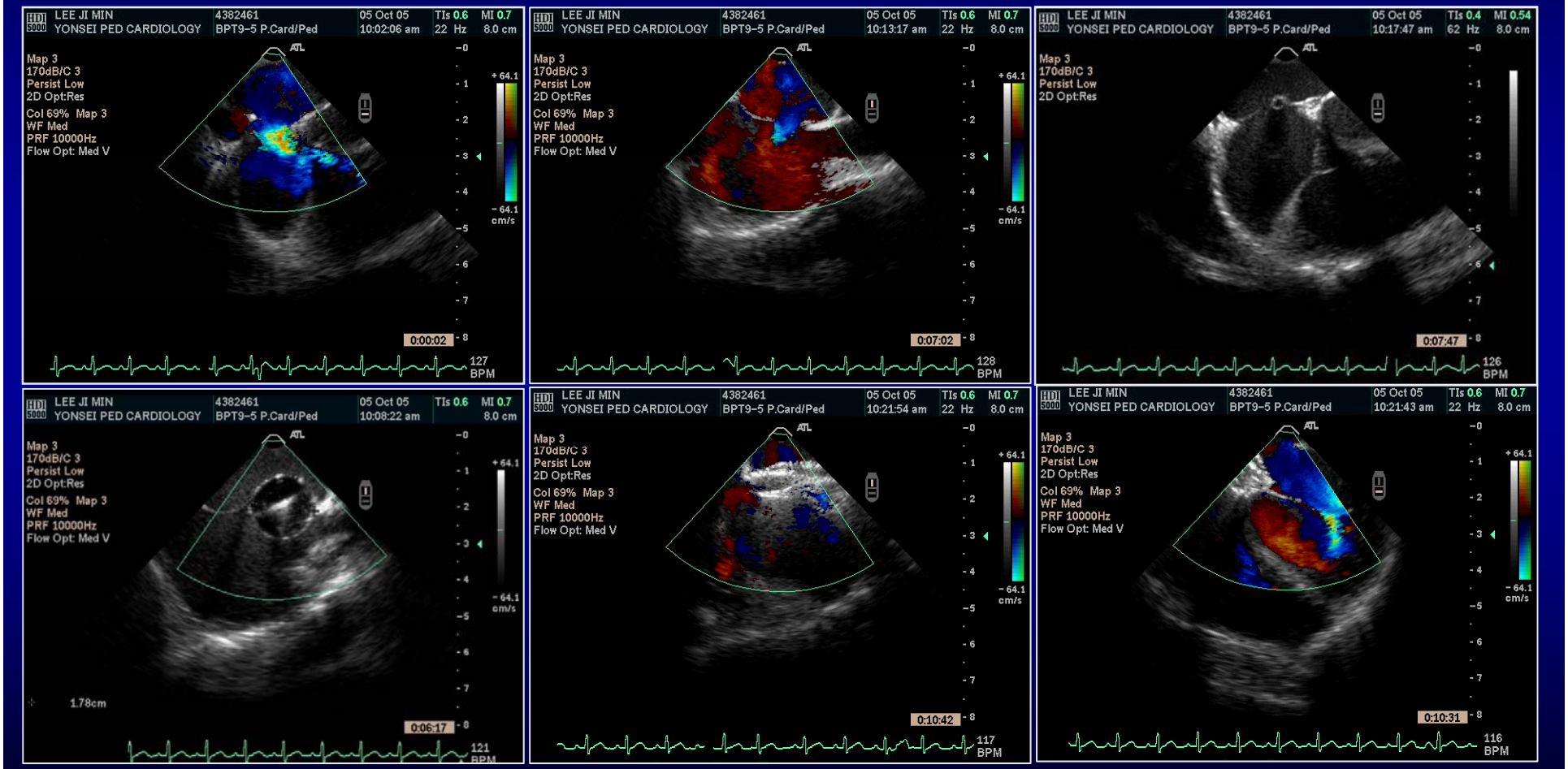
# TEE Guidance of ASD Closure

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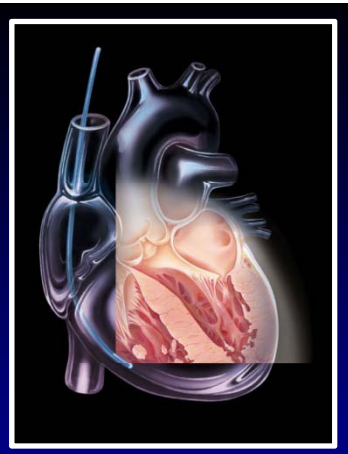

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# Why ICE?

## *Drawbacks of TEE Guidance:*

- ✓ Uncomfortable
- ✓ Need of an expert echocardiographer
- ✓ General anesthesia
  *requires scheduling / anesthesiology team*
- ✓ Limited near views of the left atrium
- ✓ Poor visualization of IVC rim
  *may be overcome by modified retroflex technique*
- ✓ Potential complications

*Laryngospasm, Transient throat pain, Shortness of breath, Aspiration, Tachycardia, Methemoglobinemia(Benzocaine), Hypotension, Hypertension, Esophageal rupture,..* *JK Oh, et al. The Echo Manual. 3rd ed. Lippincott*

# Modified Retroflexed View for Visualization of IVC Rim by TEE

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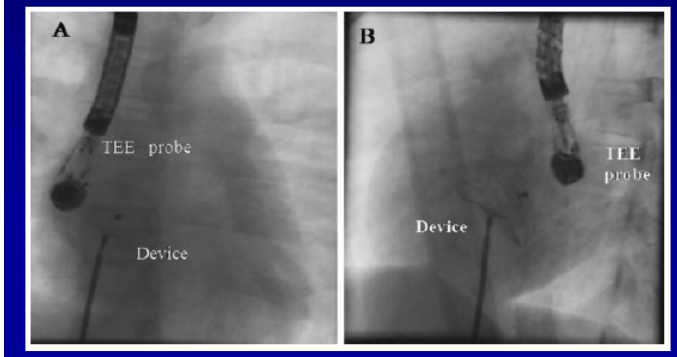
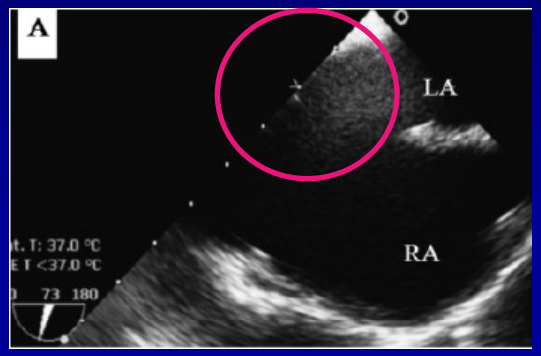
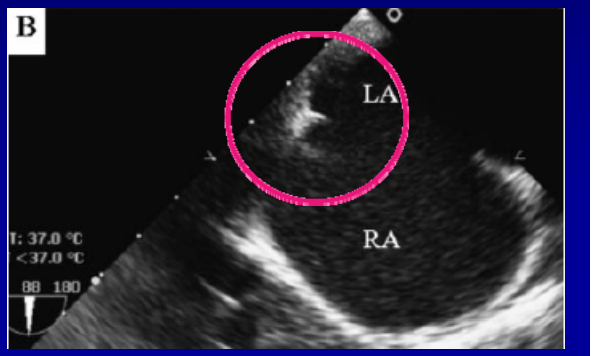
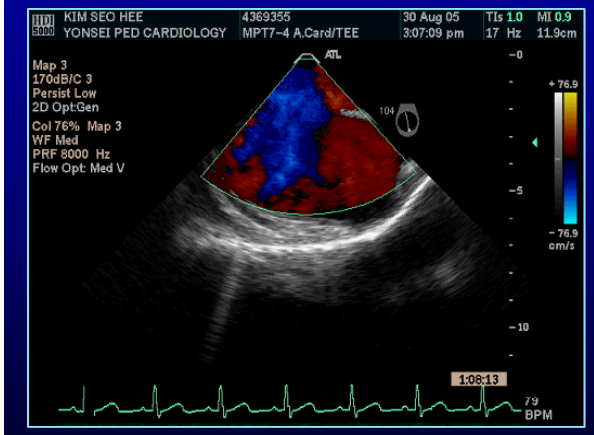
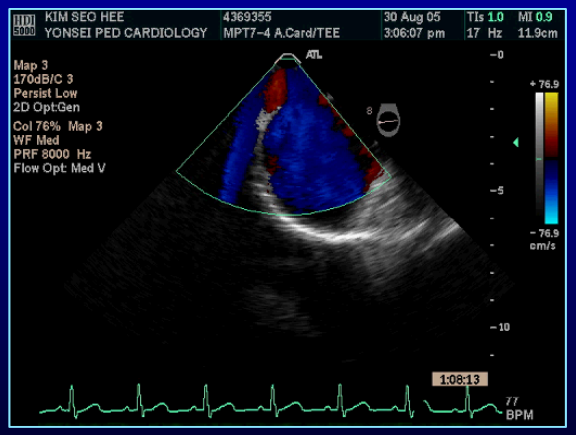
*Remadevi KS CCI 2009;73:90*

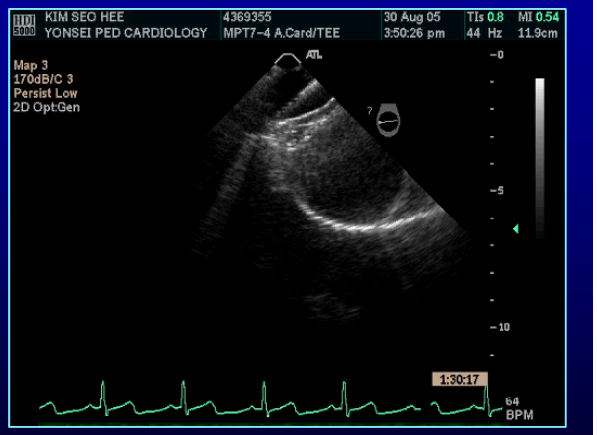
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# Micro-TEE Probe without General Anesthesia…

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Europace (2011) **13**, 51–56
doi:10.1093/europace/euq349

CLINICAL RESEARCH
*Ablation for Atrial Fibrillation*

## First experience with microprobe transoesophageal echocardiography in non-sedated adults undergoing atrial fibrillation ablation: feasibility study and comparison with intracardiac echocardiography

**Sebastian Stec*, Beata Zaborska, Małgorzata Sikora-Frąc, Tomasz Kryński, and Piotr Kułakowski**

Division of Clinical Electrophysiology, Department of Cardiology, Grochowski Hospital, Postgraduate Medical School, Grenadierow 51/59 Street, 04-073 Warsaw, Poland

*Received 30 June 2010; accepted after revision 25 August 2010; online publish-ahead-of-print 29 September 2010*



DOI: 10.1111/j.1540-8175.2011.01600.x

Echocardiography

## Transcatheter Closure of a Large Atrial Septal Defect under Microprobe Transesophageal Echocardiographic Guidance

Manabu Taniguchi, M.D.,* Teiji Akagi, M.D.,* Yasufumi Kijima, M.D.,† Hiroshi Ito, M.D.,† and Shunji Sano, M.D.*

*Division of Cardiac Intensive Care Unit, Okayama University Hospital, Okayama, Japan; †Department of Cardiovascular Medicine, Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama, Japan

# Probe Head Size

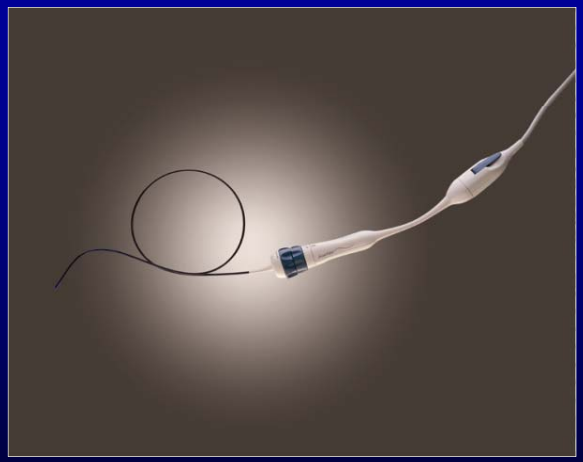

**Adult TEE Probe**

**Pediatric TEE Probe**

**Micro-TEE Probe**

**ICE Probe**

# ICE Catheter



- 8–10F ultrasound catheter
  (AcuNav, Biosense Webster, Inc, Diamond Bar, CA, USA)

- miniaturized 64-element
- single-use catheter
- longitudinal monoplane
- 90◦ sector image
- tissue penetration: 12 cm for the 10F catheter
  16 cm for the 8F catheter
- full Doppler capabilities
  - color
  - tissue
  - spectral Doppler
- four-way articulation of catheter

# Portable Equipments with ICE Capability

ACUSON CypressPlus
(SIEMENS Healthcare)

Vivid q (GE Healthcare)

CX50 (PHILIPS Medical System)

*Figures from: Taniguchi M & Akagi T. Interv Cardiol 2011;3:679-694*

# ICE-Guided ASD Closure

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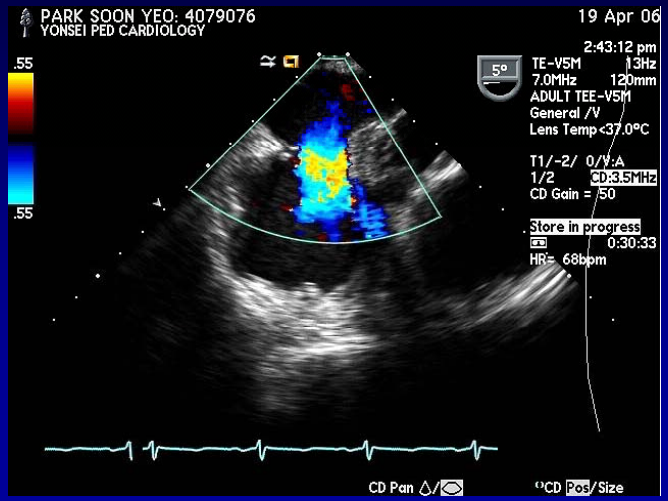
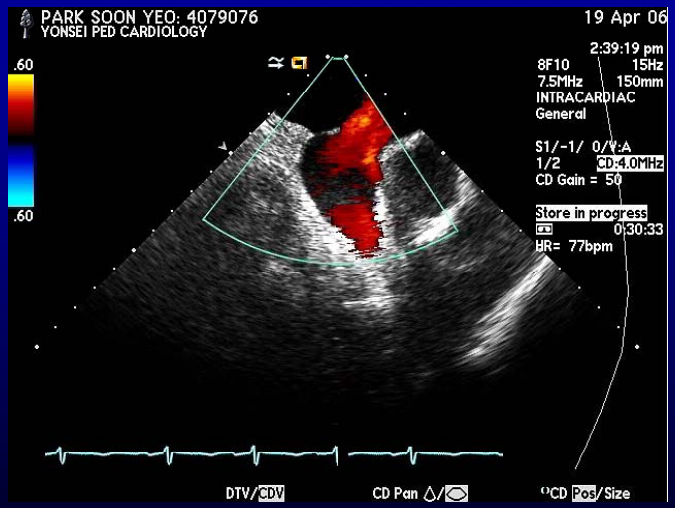



**TEE**

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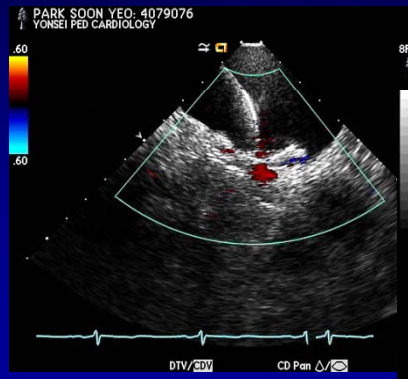
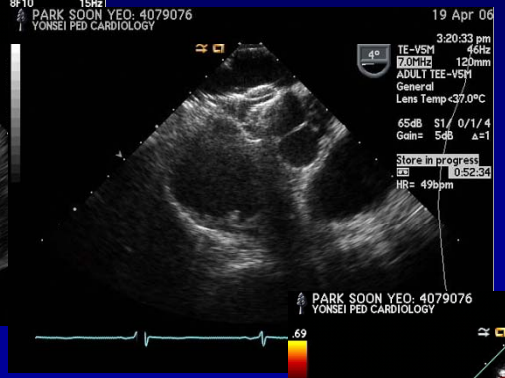
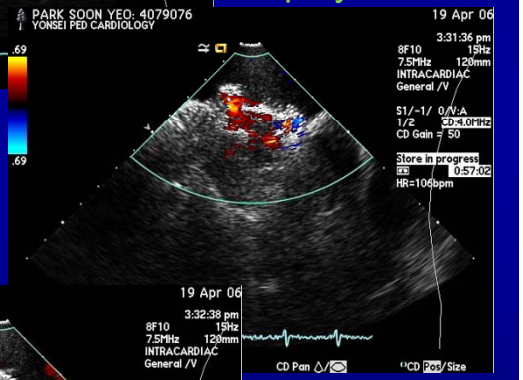
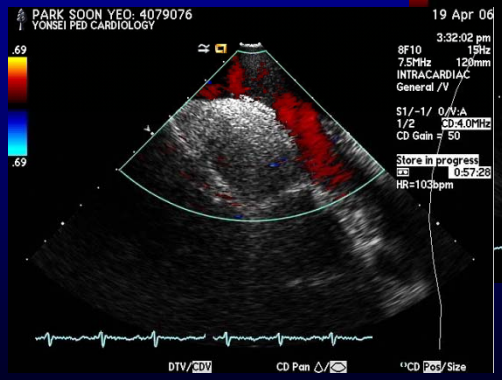


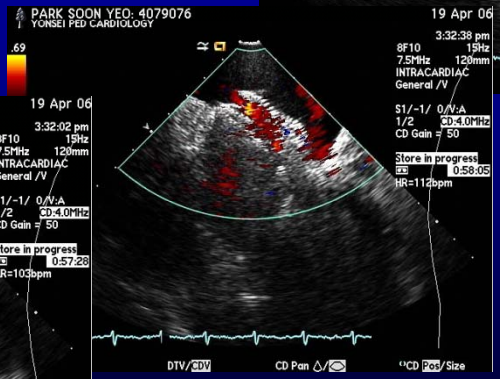




**ICE-SAX**
Device Positioned

**ICE-SAX**
Device Deployed




**ICE- LAX & Mod Septal View**
Post-assessment

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# ICE-Guided ASD Closure

## *- Balloon Sizing -*

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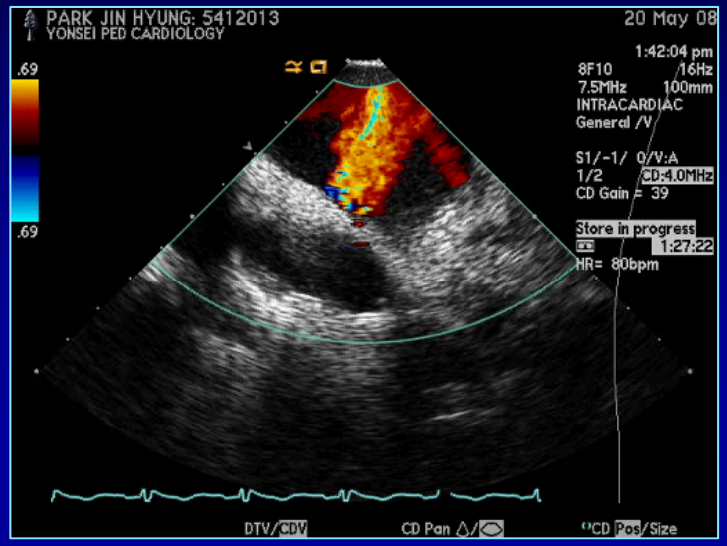
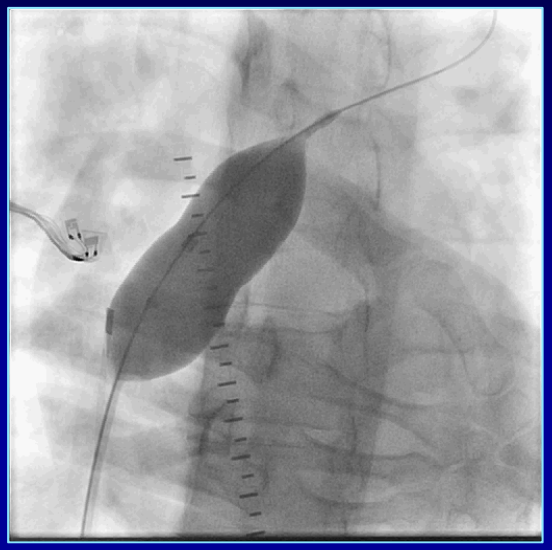
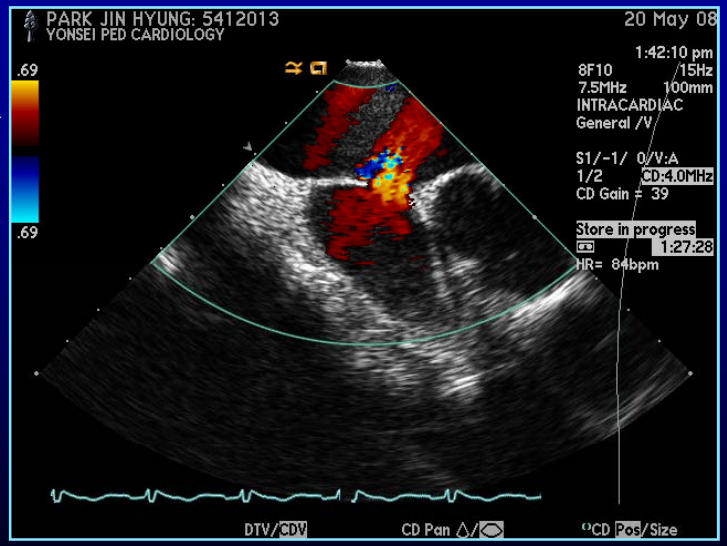
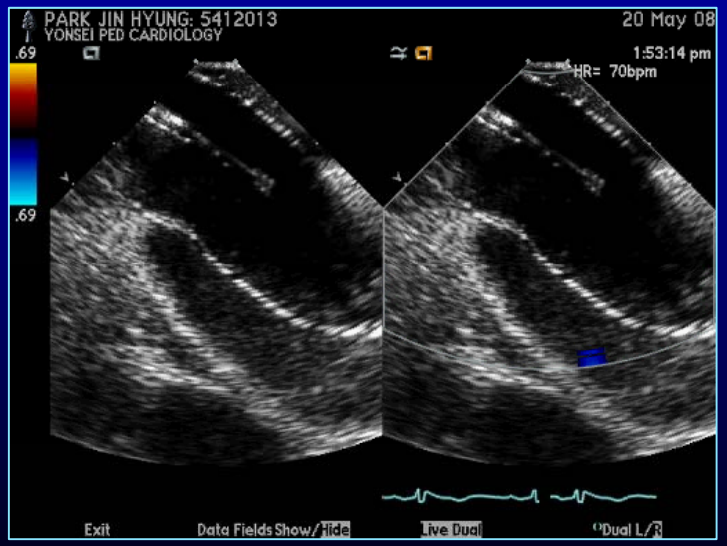
**ICE** *LAX*



**ICE** *SAX*

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# ICE-Guided ASD Closure

## *- Device Position -*

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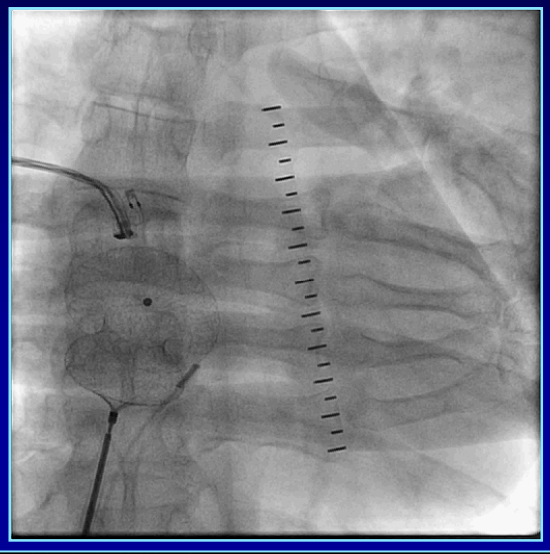

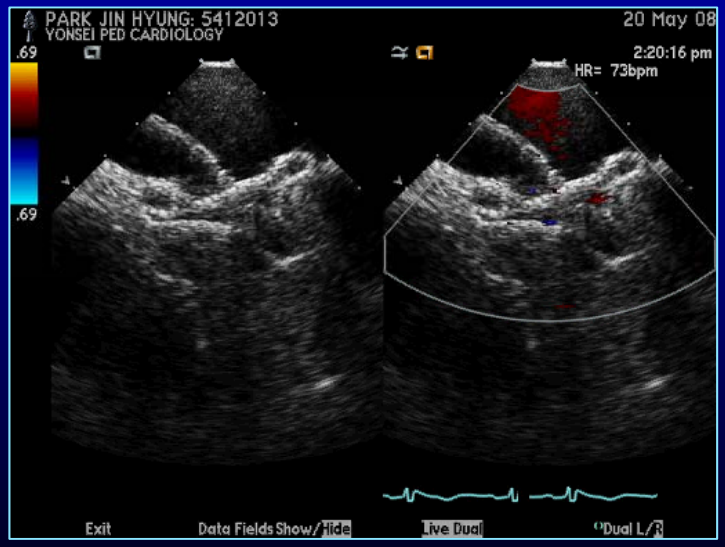


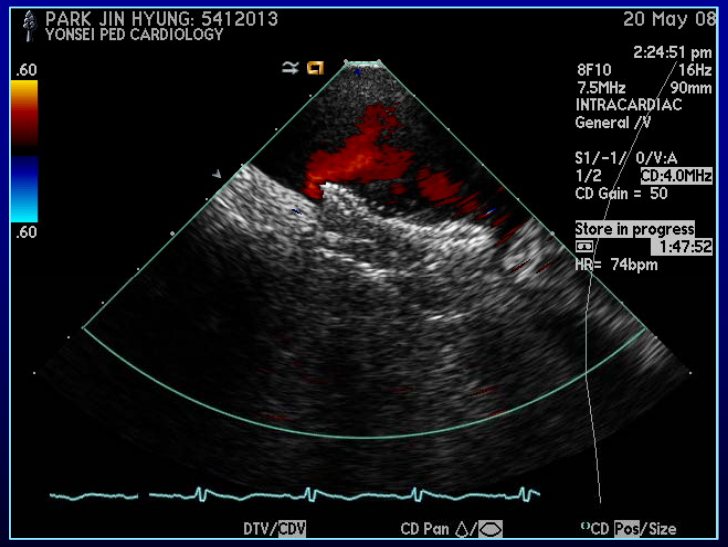


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# ICE-Guided ASD Closure

## *- Visualization of IVC Rim -*

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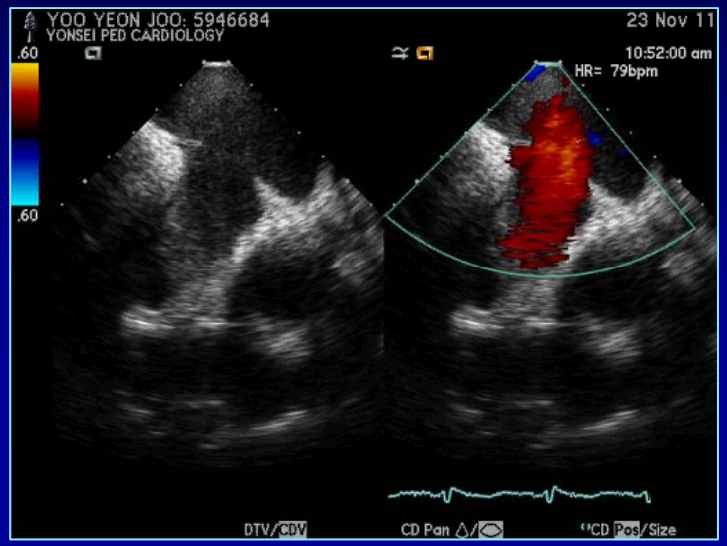


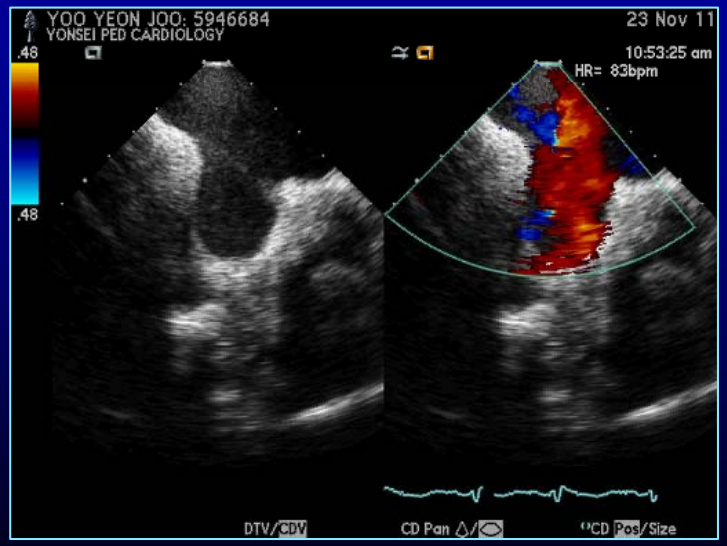


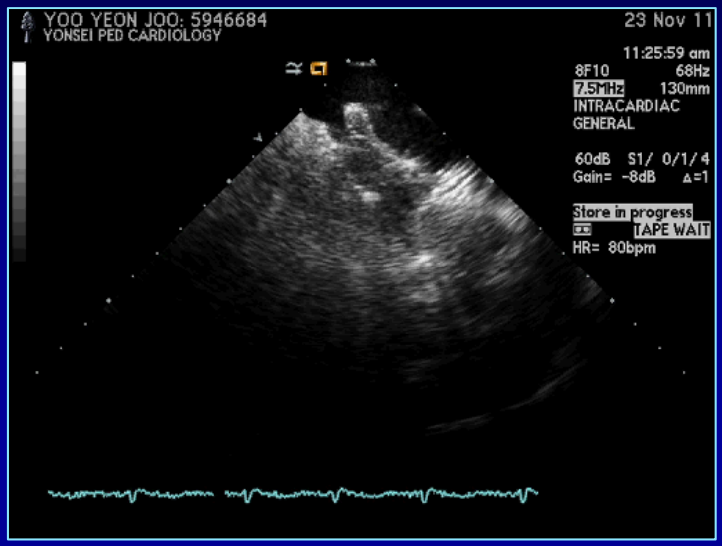


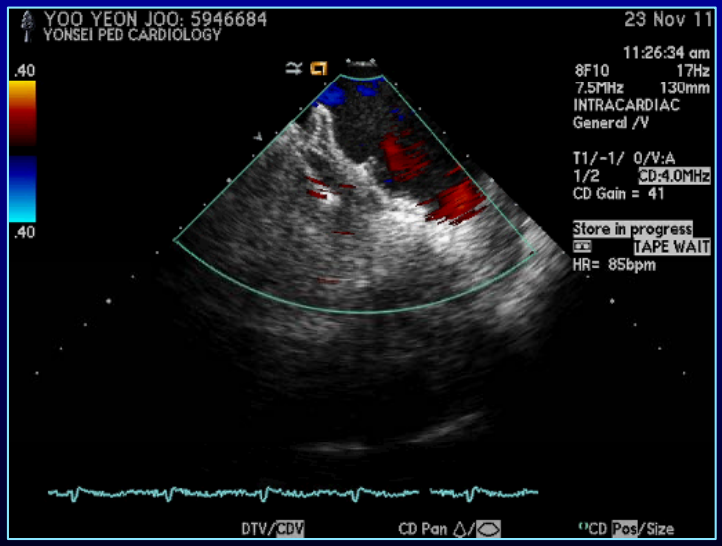


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# ICE-Guided ASD Closure

## *- Multiple Defects -*

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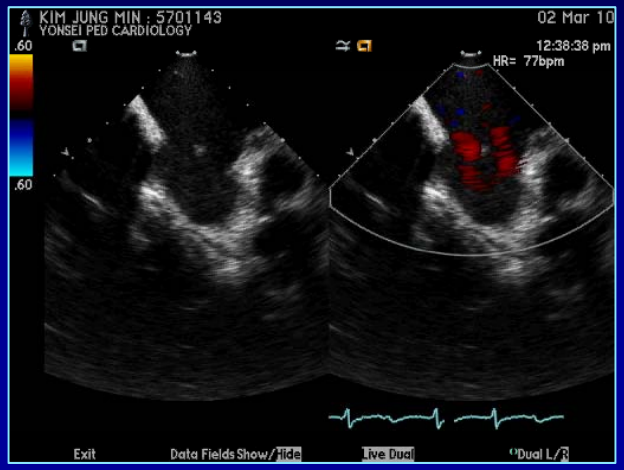


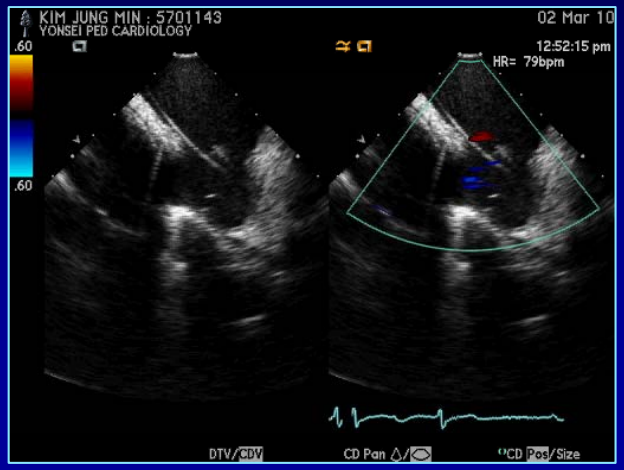


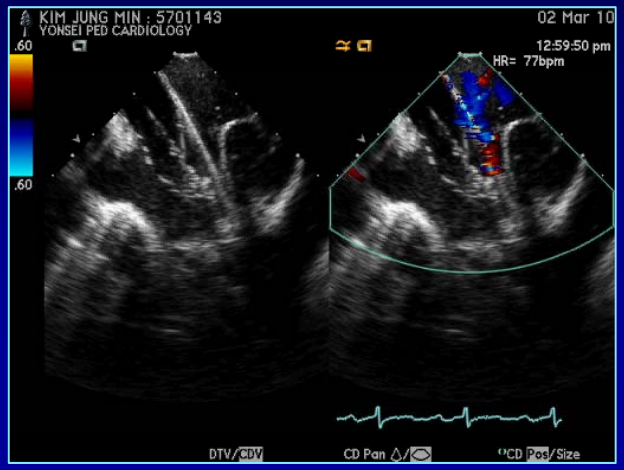


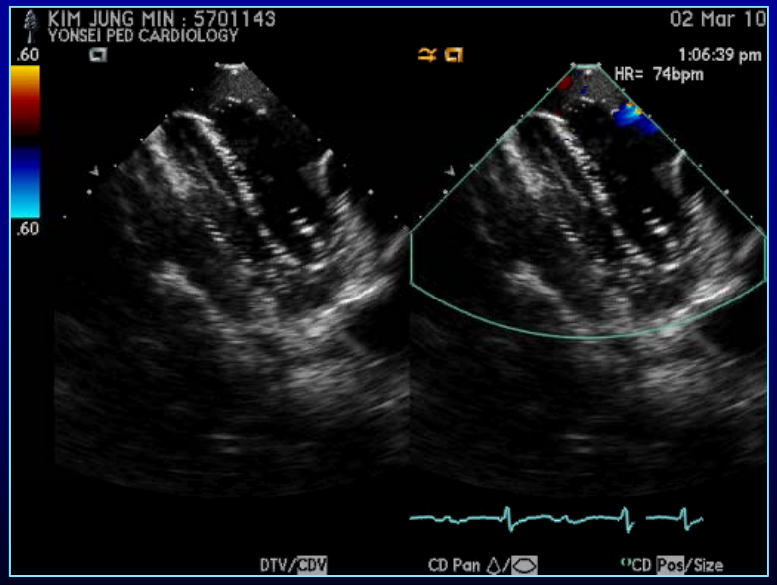


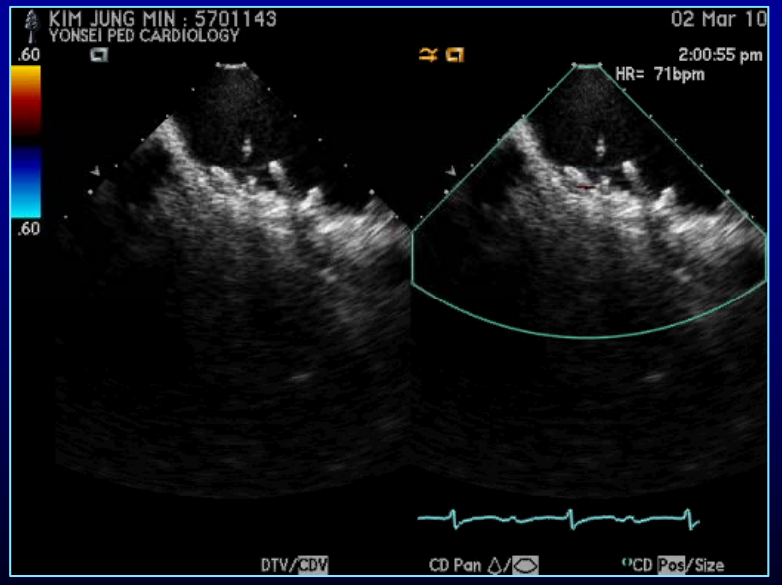


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## *ICE provides excellent image*

- Pre-closure evaluation
- Guidance during the procedure
- Post-procedural assessment

*in ASDs with various morphology*

*As well as..*

## *Get rid of drawbacks of TEE*

- Uncomfortable
- Need of an expert echocardiographer
- General anesthesia / Scheduling / Time
- Limited near views of the left atrium
- Poor visualization of IVC rim

# *Do we need more?*

## Limitations of 2D Echo in Complex ASD

- Demanding step by step assessment for multiple planes
- True # of defects in multi-fenestrated defects
- Spatial orientation btw hole(s) & adjacent structures
- Visualization of very large defect in single echo plane
- Only experienced expert may understand the accurate three-dimensional anatomy from 2D images

# Why RT3D?

✓ *Limitations of 2D echo may be resolved by technical evolvement of RT-3D imaging*

***RT 3D Imaging Renders***

- Instantaneous understanding of various morphology, dynamic nature of the defect
- Easy recognition of spatial relationship between defect(s) and cardiac structures

# Integrated Information from Single Echo Image

## - RT3D TEE -

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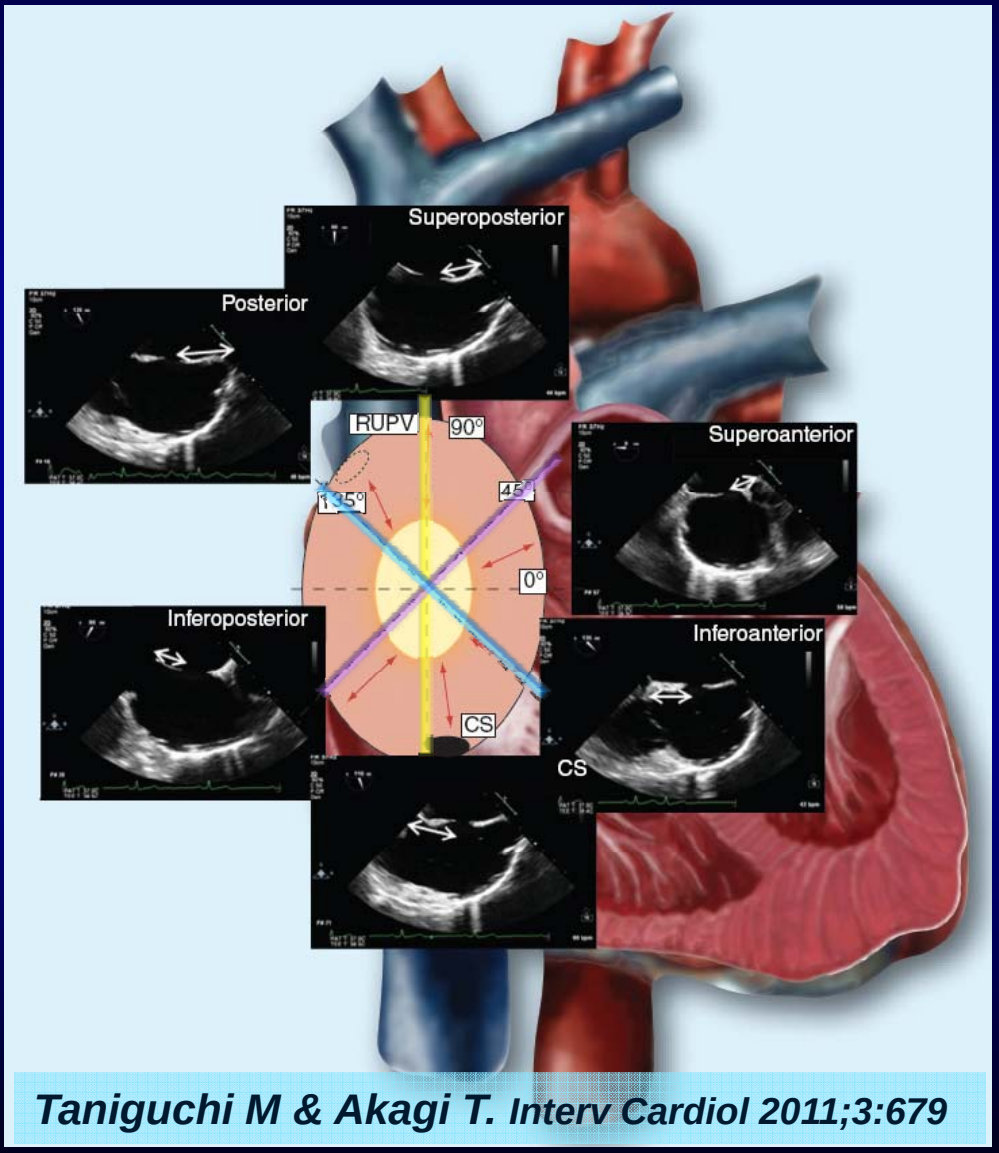
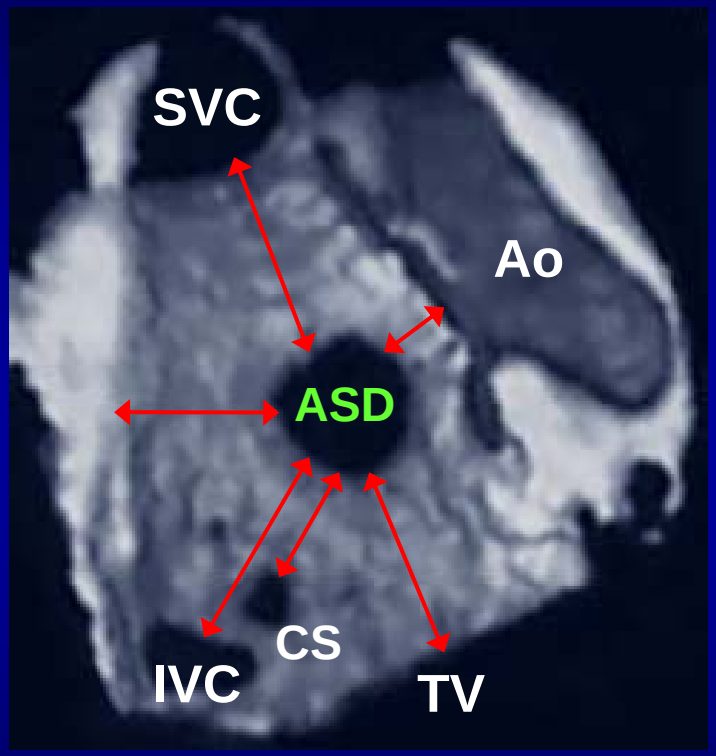



*Taniguchi M & Akagi T. Interv Cardiol 2011;3:679*




***All Information in Single Echo View, Real Time!***

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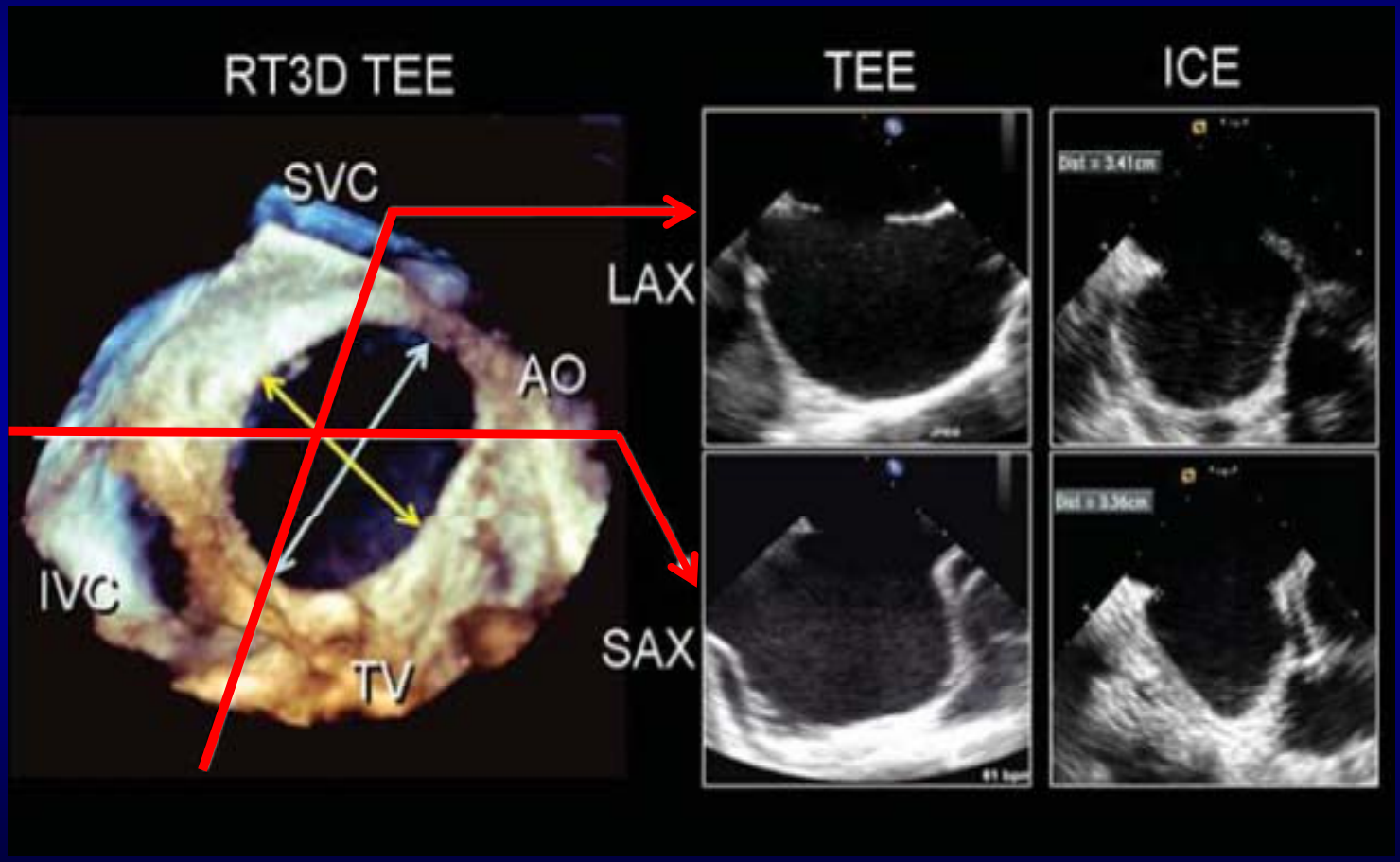
# Pitfalls of 2D TEE/ICE Measurements

3D TEE IAS- RA view




*Lodato JA, Cao QL et al. Eur J Echo 2009;10:543*

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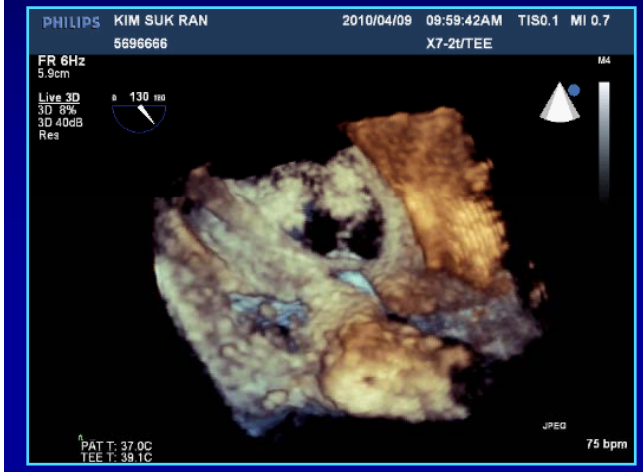
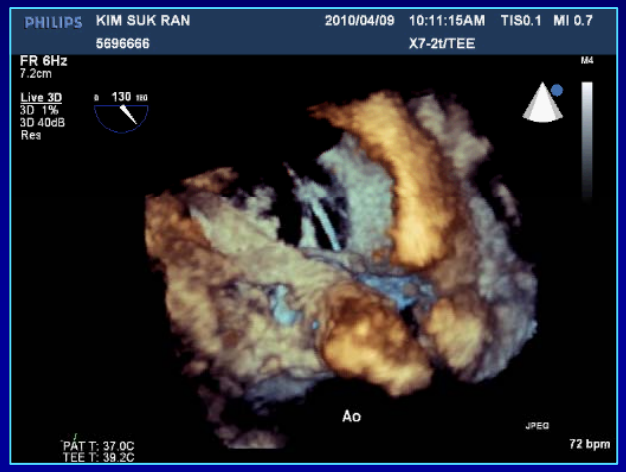
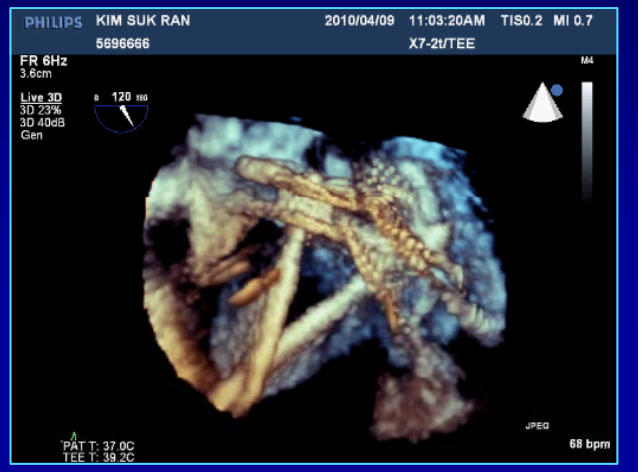
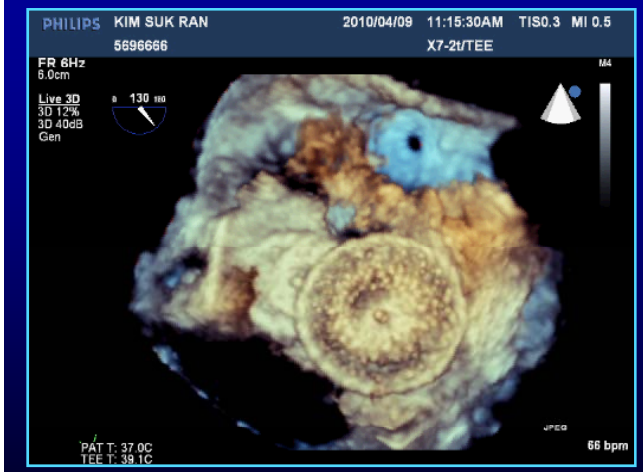
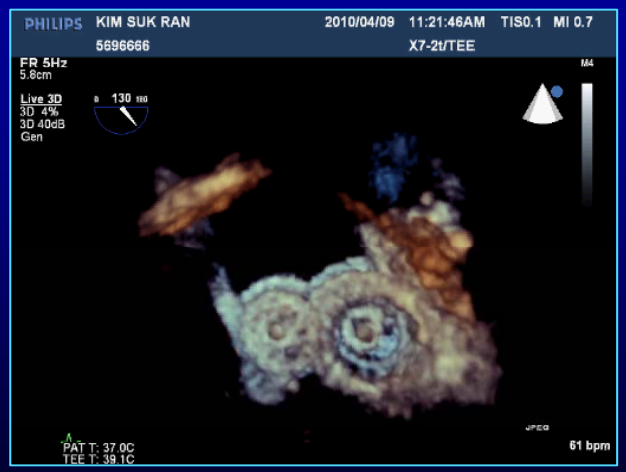
# RT3D TEE : multiple ASD closure case 1

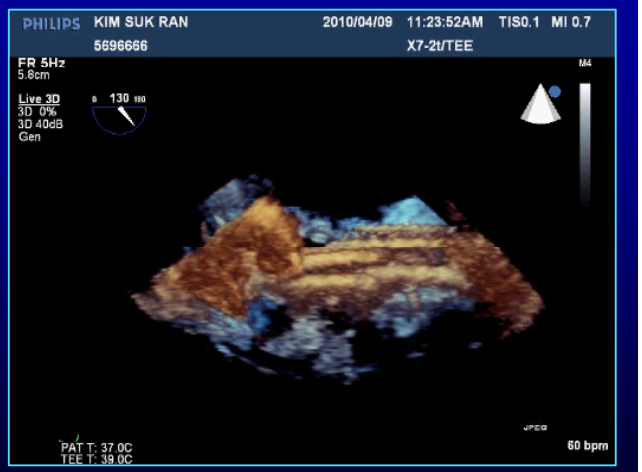
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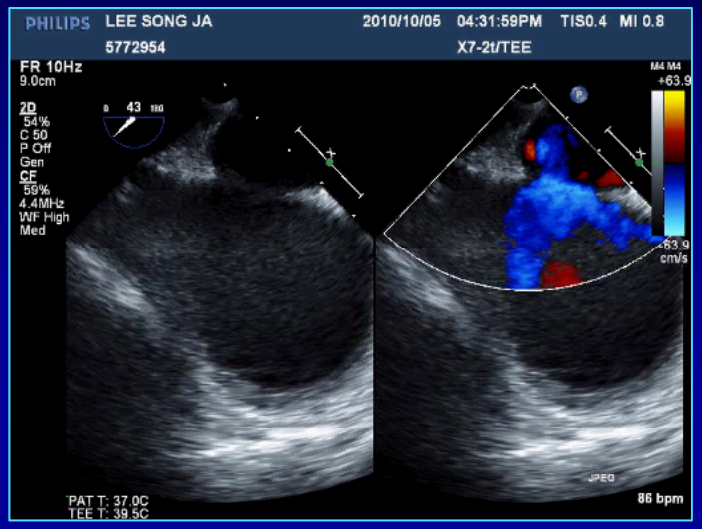
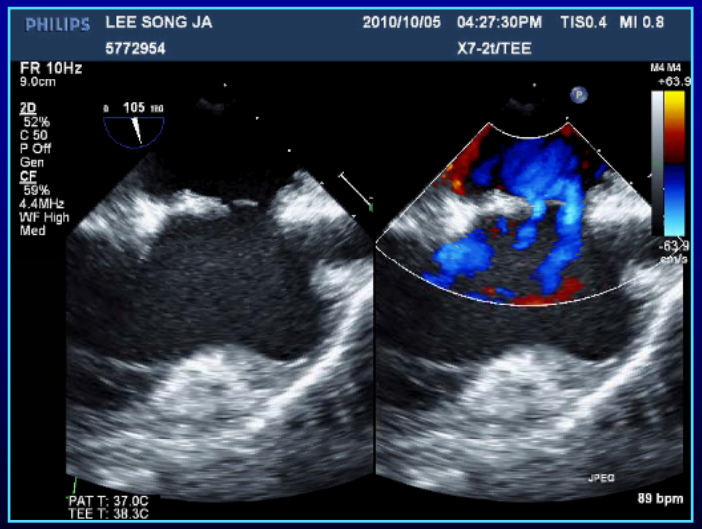
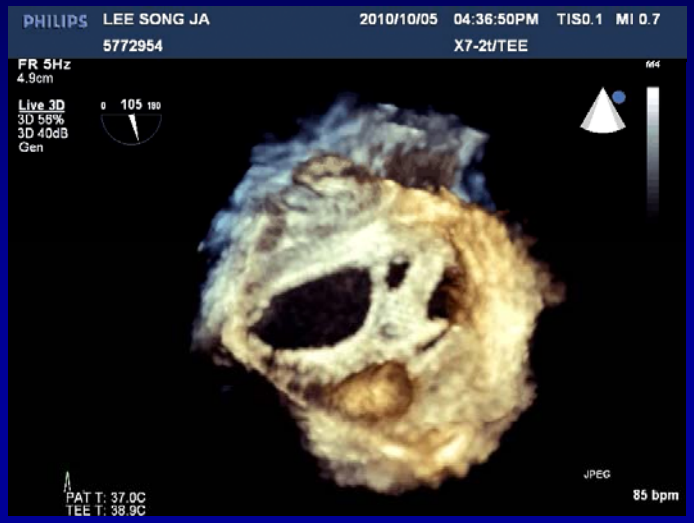
# RT3D TEE : multiple ASD closure case 2





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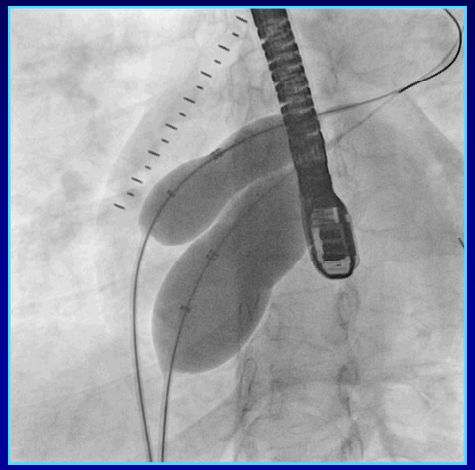
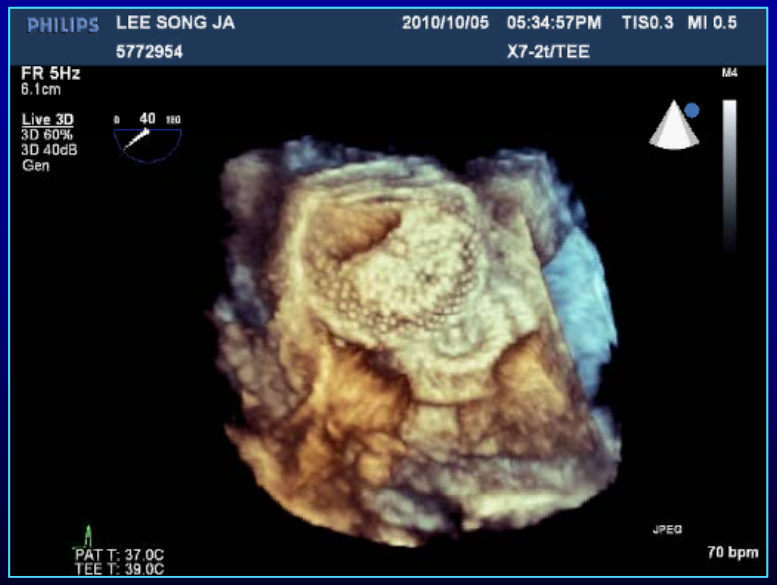
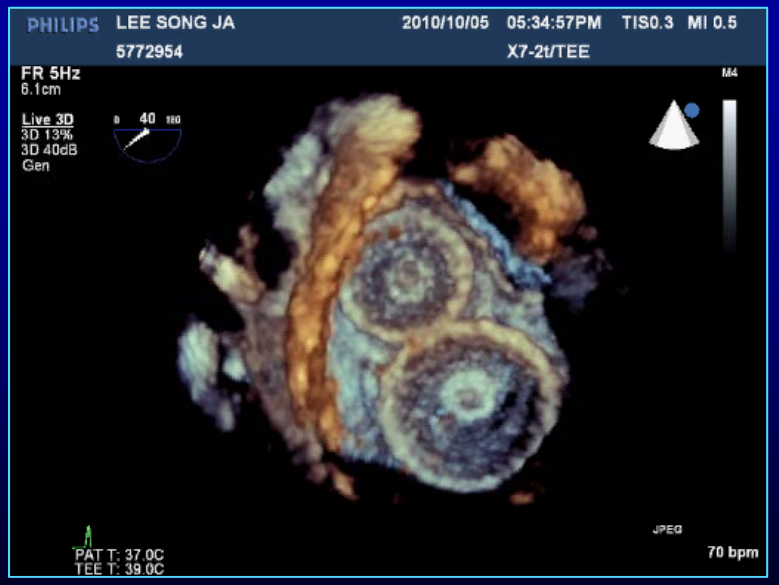
# RT3D TEE : multiple ASD closure case 2



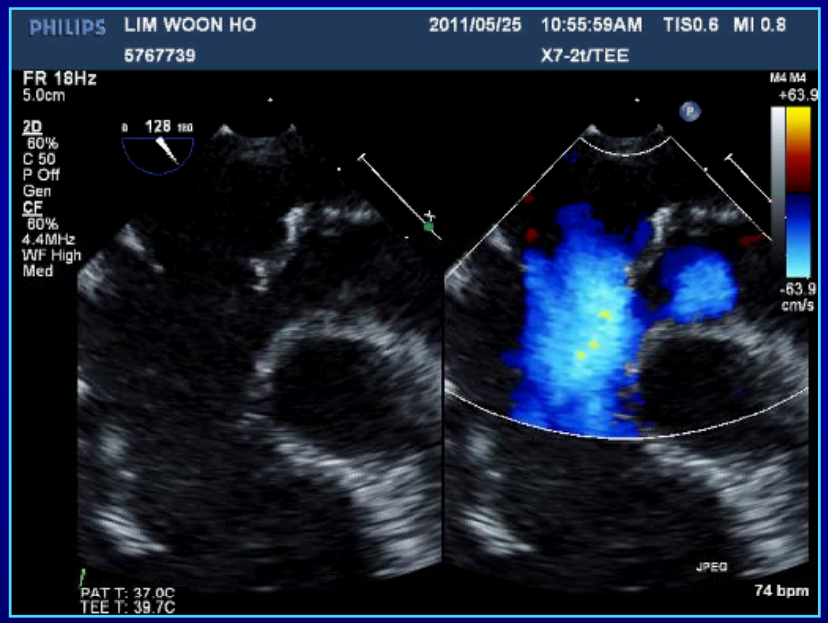
Balloon inside the defect

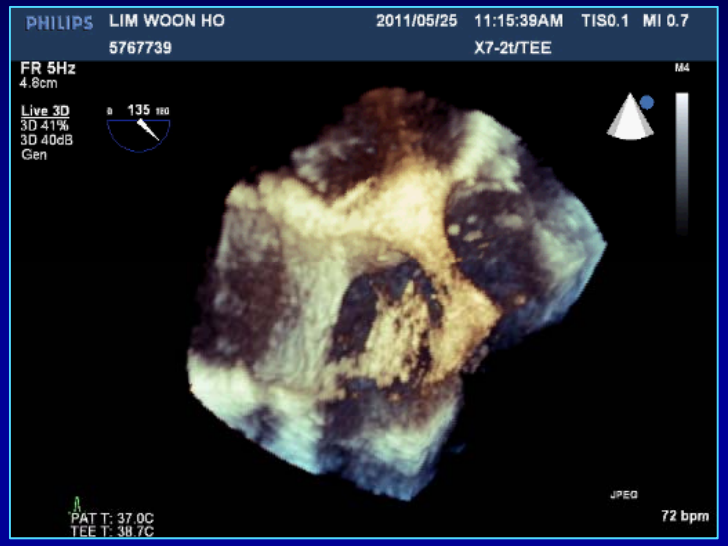



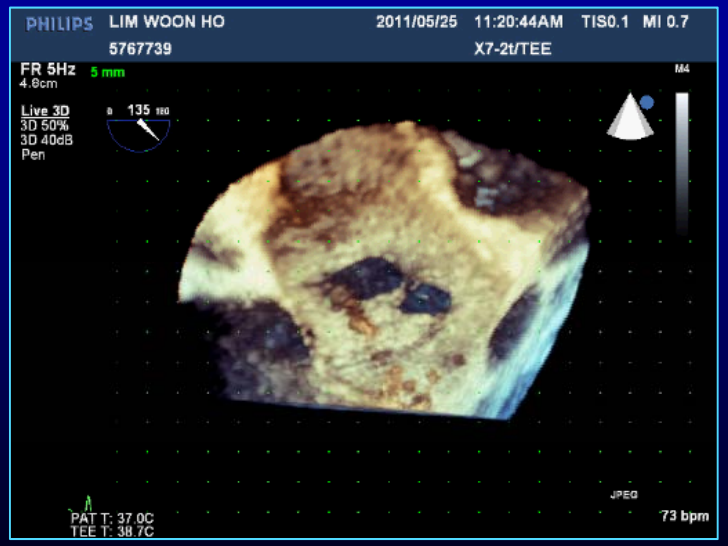



# RT3D TEE

## multiple defects + unusual septal aneurysm

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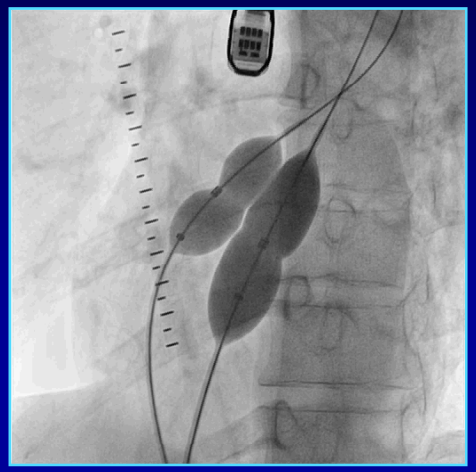
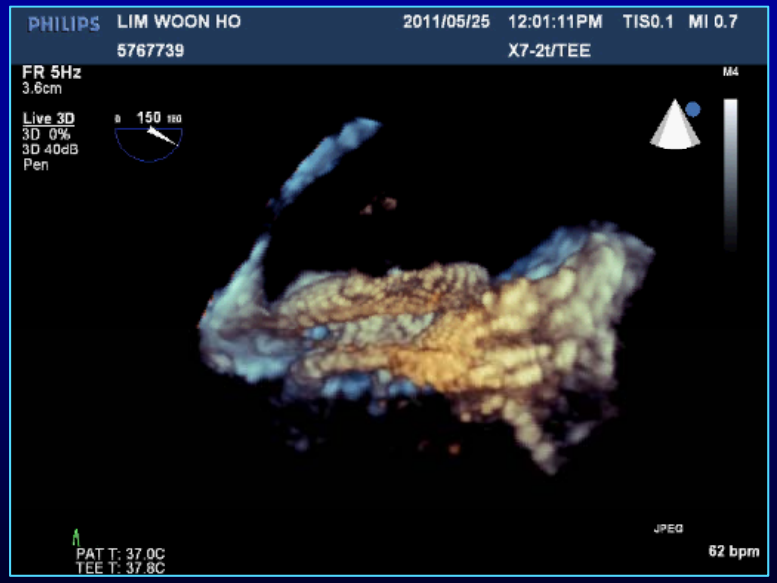
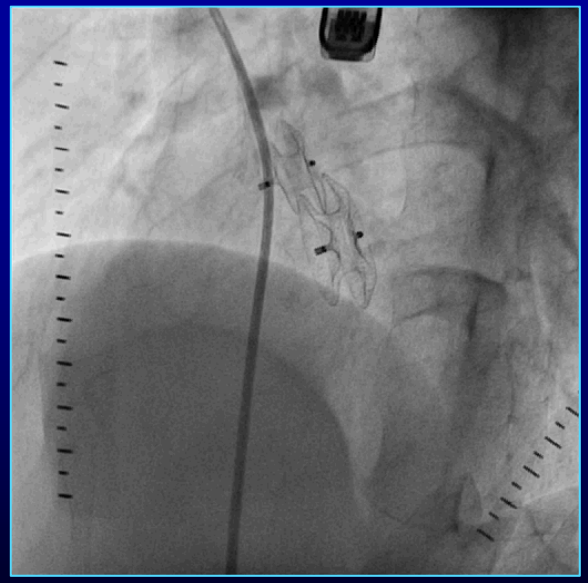
# RT3D TEE

## multiple defects + unusual septal aneurysm





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# RT3D TEE

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***RT3D TEE imaging provides***

- ✓ **Instantaneous understanding of the anatomy**
- ✓ **Easier identification of complex shapes and multiple defects**
- ✓ **Superior recognition of spatial relationship**
- ✓ **More accurate measurement of ASD dimensions**
- ✓ **Comprehensive appearance of deployed device**

- RT3D TEE is helpful in
  - Multiple defects
  - Unusual anatomy / shape / location
  - Larger defects
- It is not essential in all ASD closures
- Learning curve *: to be of help in complex cases, experience in simple cases are needed*

# Which echo technique?

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| | Advantages | Drawbacks |
|---|---|---|
| 2DTEE | • Cheap<br>• Familiarity to most echocardiographer | • Not convenient for the patient<br>• Requires GA / scheduling<br>• Requires additional staffs<br>• Poor visualization of IVC rim |
| ICE | • More convenient for patient<br>• Only local anesthesia<br>• No additional staff | • Expensive<br>• Single plane imaging<br>• No 3D capability<br>• Additional venous access<br>• Catheter control<br>*(catheter interference in small pts / IVC anomaly)* |
| RT3D TEE | • Easier detection / immediate understanding of anatomy & spatial relationship<br>*(esp. in large defect, multiple defects, defects with unusual shape / location)* | • Drawbacks of 2D TEE<br>• Learning curve (simple → complex cases) |

# Factors in Choosing TEE vs. ICE

***Factors in institutions***

- Healthcare system in each country
- Hospital procedural volume
- Availability of apparatus
- Availability of anesthesiologist and echocardiographer

***Factors in patients***

- Age of patient
- Morphology of ASD (large defect, multiple defects, inferoposterior rim deficiency)
- Left atrium size
- Comorbidity of patient
- Preference of the patient

***Factors in interventionalists***

- Preference of the interventionalist
- Training

*ASD: Atrial septal defect.*

*Taniguchi M & Akagi T. Interv Cardiol 2011;3:679–694*

# TTE or RT3D TTE Guided ASD Closure

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## ✓ TTE-guided ASD Device Closure

**Transthoracic Echocardiographic Guidance of Transcatheter Atrial Septal Defect Closure**

Richard E. Kardon, DO, Mary C. Sokoloski, MD, Daniel S. Levi, MD, James S. Perry II, Douglas J. Schneider, MD, Vivekanand Allada, MD, and John W. Moore, MD, MPH

*Am J Cardiol 2004;94:256*

**SAFETY AND EFFICACY OF TRANSCATHETER CLOSURE OF ATRIAL SEPTAL DEFECTS GUIDED BY TRANSTHORACIC ECHOCARDIOGRAPHY: A PROSPECTIVE STUDY FROM TWO CHINESE MEDICAL CENTERS**

Gui-Shuang Li,‡* Guang-Ming Kong,* ‡ Yu-Lin Wang,† You-Peng Jin,† Qiu-Shang Ji,* Ji-Fu Li,* Bei-An You,* and Yun Zhang*

*The Key Laboratory of Cardiovascular Remodeling and Function Research, Chinese Ministry of Education and Chinese Ministry of Health, Shandong University Qilu Hospital; and †Department of Pediatrics, Shandong Provincial Hospital, Jinan, Shandong, China and ‡These two authors contributed equally to this work.

*Ultrasound Med Biol 2009;35:58*

**Transcatheter closure of atrial septal defects with transthoracic echocardiography**

Murat Şahin,[1] Süheyla Özkutlu,[1] Işıl Yıldırım,[1] Tevfik Karagöz,[1] Alpay Çeliker[2]

*[1]Section of Cardiology, Department of Pediatrics, Hacettepe University Faculty of Medicine, Sıhhiye, Ankara; [2]Department of Pediatrics, Acıbadem Maslak Hospital, İstanbul, Turkey*

*Cardiol Young 2011;21:204*

**Reliability of transthoracic echocardiography in estimating the size of Amplatzer septal occluder and guiding percutaneous closure of atrial septal defects**

LI Gui-shuang, KONG Guang-ming, JI Qiu-shang, LI Ji-fu, CHEN Yu-guo, YOU Bei-an and ZHANG Yun

*Chin Med J 2008;121:973*

## ✓ Supplementary TTE to TEE Guide

**Supplementing Transesophageal Echocardiography with Transthoracic Echocardiography for Monitoring Transcatheter Closure of Atrial Septal Defects with Attenuated Anterior Rim: A Case Series**

Su-Man Lin, MD*§, Shen-Kou Tsai, MD, PhD*‡§, Jou-Kou Wang, MD, PhD*‡, Yin-Yi Han, MD*‡, Wei-horng Jean, MD*‡, and Yu-Chang Yeh, MD*‡

*Anesth Analg 2003;96:1584*

## ✓ RT 3D TTE in ASD Device Closure

**Usefulness of Live Three-Dimensional Transthoracic Echocardiography in the Characterization of Atrial Septal Defects in Adults**

Farhat Mehmood, M.D.,* Srinivas Vengala, M.D.,* Navin C. Nanda, M.D.,* Harvinder S.Dod, M.D.,* Ashish Sinha, M.D.,* Andrew P. Miller, M.D.,* Deepak Khanna, M.D.,* Vijay K. Misra, M.D.,* Steven G. Lloyd, M.D., Ph.D.,* Sailendra Upendram, M.B.B.S.,* Kunal Bodiwala, M.B.B.S.,* William S. McMahon, M.D.,† Ravi R. Kasliwal, M.D.,‡ Nagendra Chouhan, M.D.,‡ Marappa Govinder, M.D.,§ Albert D. Pacifico, M.D.,§ James K. Kirklin, M.D.,§ and David C. McGiffin, M.D.§

*Echocardiography 2004;21:707*

**Live Three-Dimensional Transthoracic Echocardiographic Assessment of Transcatheter Closure of Atrial Septal Defect and Patent Foramen Ovale**

Ashish Sinha, M.D., Navin C. Nanda, M.D., Vijay Misra, M.D., Deepak Khanna, M.D., Harvinder S. Dod, M.D., Srinivas Vengala, M.D., Farhat Mehmood, M.D., and Vikramjit Singh, M.D.

*Echocardiography 2004;21:749*

**Real Time Three-Dimensional Transthoracic Echocardiography for Guiding Amplatzer Septal Occluder Device Deployment in Patients with Atrial Septal Defect**

Fong L. Chen, M.D.,*† Ming C. Hsiung, M.D.,‡ Kai S. Hsieh, M.D., Ph.D.,§ Yi C. Li, M.D.,† and Ming C. Chou, M.D., Ph.D.†§

*Echocardiography 2006;23:763*

# TEE-guided ASD Closure without Fluoroscopy

## ; German Heart Institute, Berlin

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Transcatheter closure of atrial septal defects under echocardiographic guidance without X-ray: initial experiences.

Ewert P, Daehnert I, Berger F, Kaestner A, Krings G, Vogel M, Lange PE.

*Cardiol Young 1999;9:136*

**Echocardiographically Guided Closure of a Patent Foramen Ovale During Pregnancy After Recurrent Strokes**

INGO DAEHNERT, M.D., PETER EWERT, M.D., FELIX BERGER, M.D., and PETER E. LANGE, M.D., Ph.D.

*From the Abteilung für Angeborene Herzfehler, Deutsches Herzzentrum Berlin, Germany*

*J Interv Cardiol 2001;14:191*

**Interventional closure of atrial septal defects without fluoroscopy in adult and pediatric patients**

Stephan Schubert · Sarah Kainz · Björn Peters · Felix Berger · Peter Ewert

*Clin Res Caediol 2012 Mar 28 [Epub ahead of print]*

# Role of CT and/or MRI ?

**Amplatzer Septal Occluder Closure of Atrial Septal Defect: Evaluation of Transthoracic Echocardiography, Cardiac CT, and Transesophageal Echocardiography**

Sheung-Fat Ko[1]
Chi-Di Liang[2]
Hon-Kan Yip[3]
Chung-Cheng Huang[1]
Shu-Hang Ng[1]
Chien-Fu Huang[2]
Min-Chi Chen[4]

*AJR 2009;193:1522*

**Predictors of Successful Transcatheter Closure of Atrial Septal Defect by Cardiac Magnetic Resonance Imaging**

K. Durongpisitkul,[1] N.L. Tang,[2] J. Soongswang,[1] D. Laohaprasitiporn,[1] A. Nanal[1]

[1]Division of Pediatric Cardiology, Department of Pediatrics, Faculty of Medicine Siriraj Hospital, Mahidol University, Prannok Road, Bangkok, Thailand 10700

[2]Philips Medical System, Faculty of Medicine Siriraj Hospital, Mahidol University, Prannok Road, Bangkok, Thailand 10700

*Pediatr Cardiol 2004;25:124*

# Cardiac CT in Transcatheter Closure of ASD

*Presented by Jinyoung Song , M.D. in TCTAP 2011*

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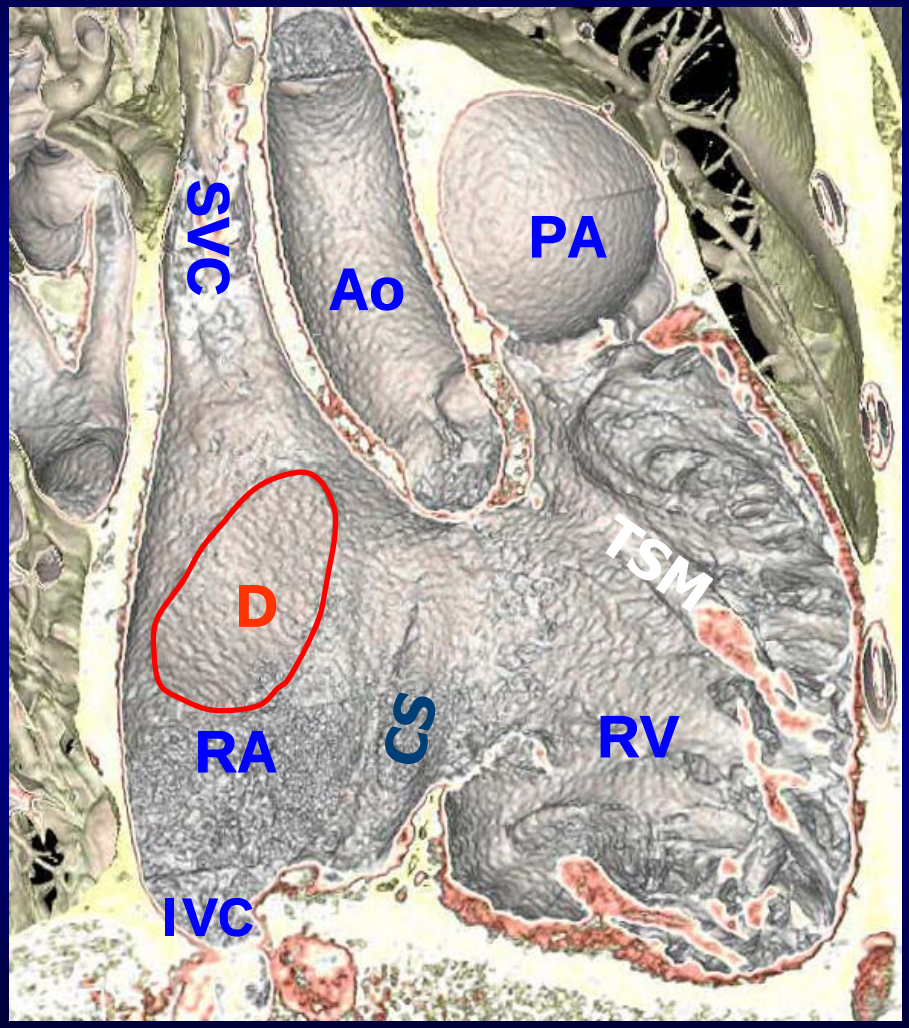
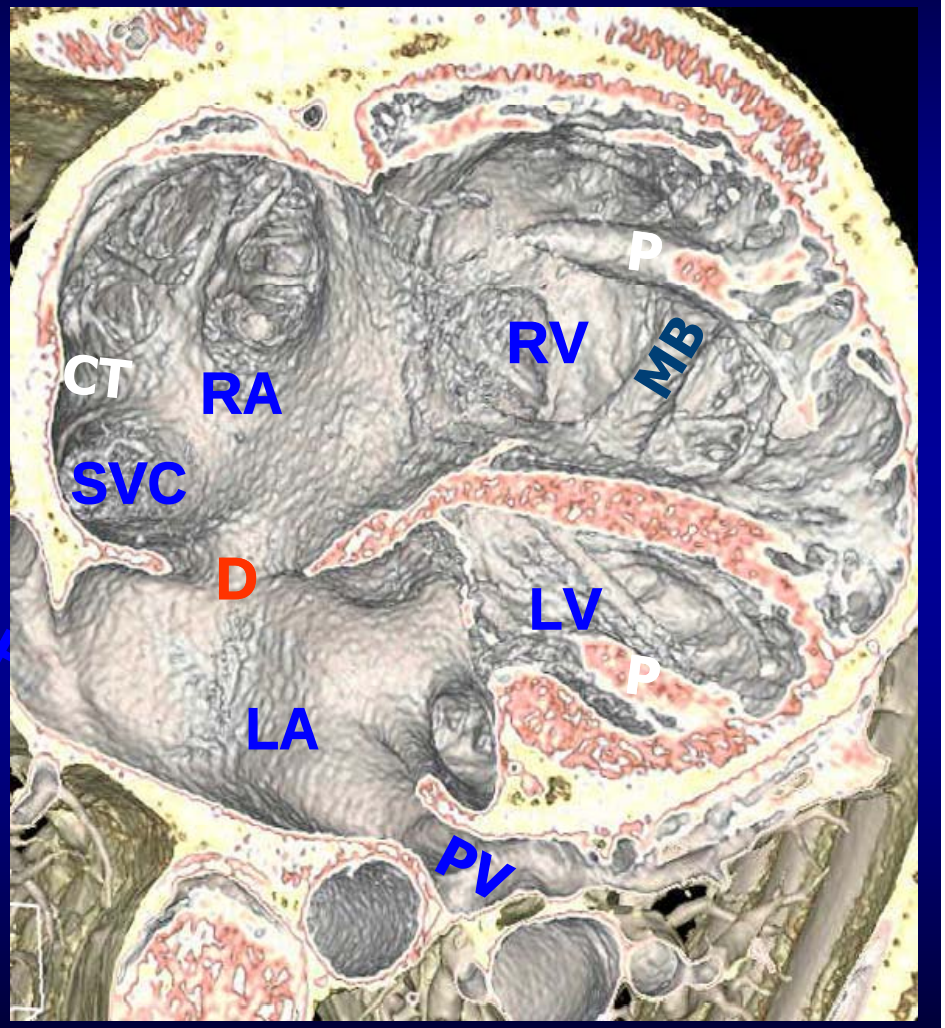
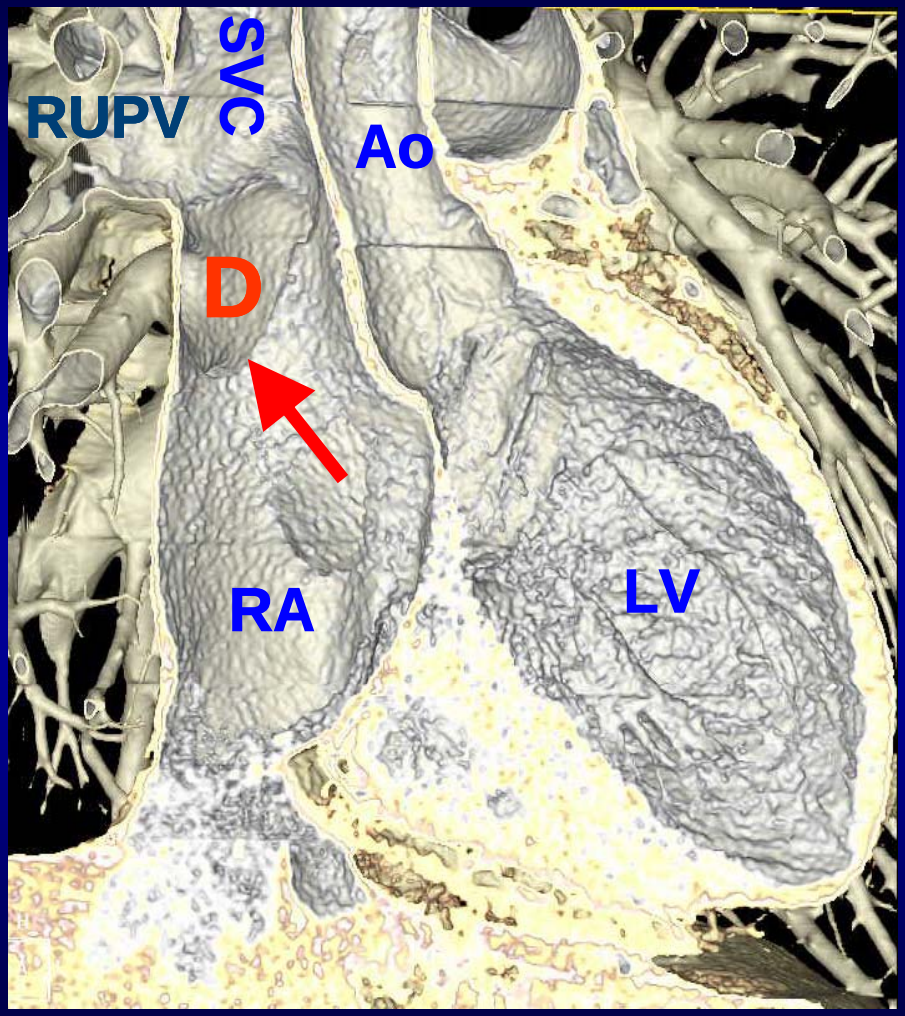


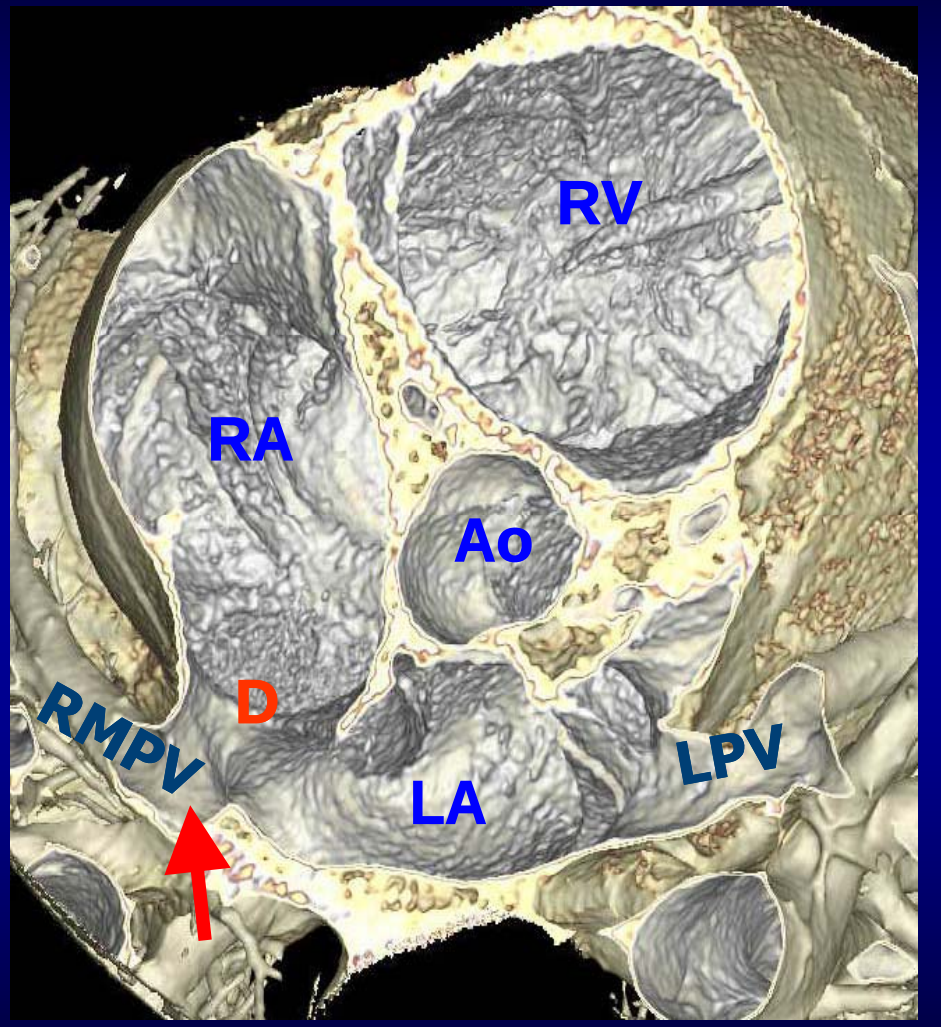




*Courtesy of Jinyoung Song, M.D.,*
*Samsung Medical Center (work at the Sejong General Hospital)*

*Yonsei Pediatric Cardiology*

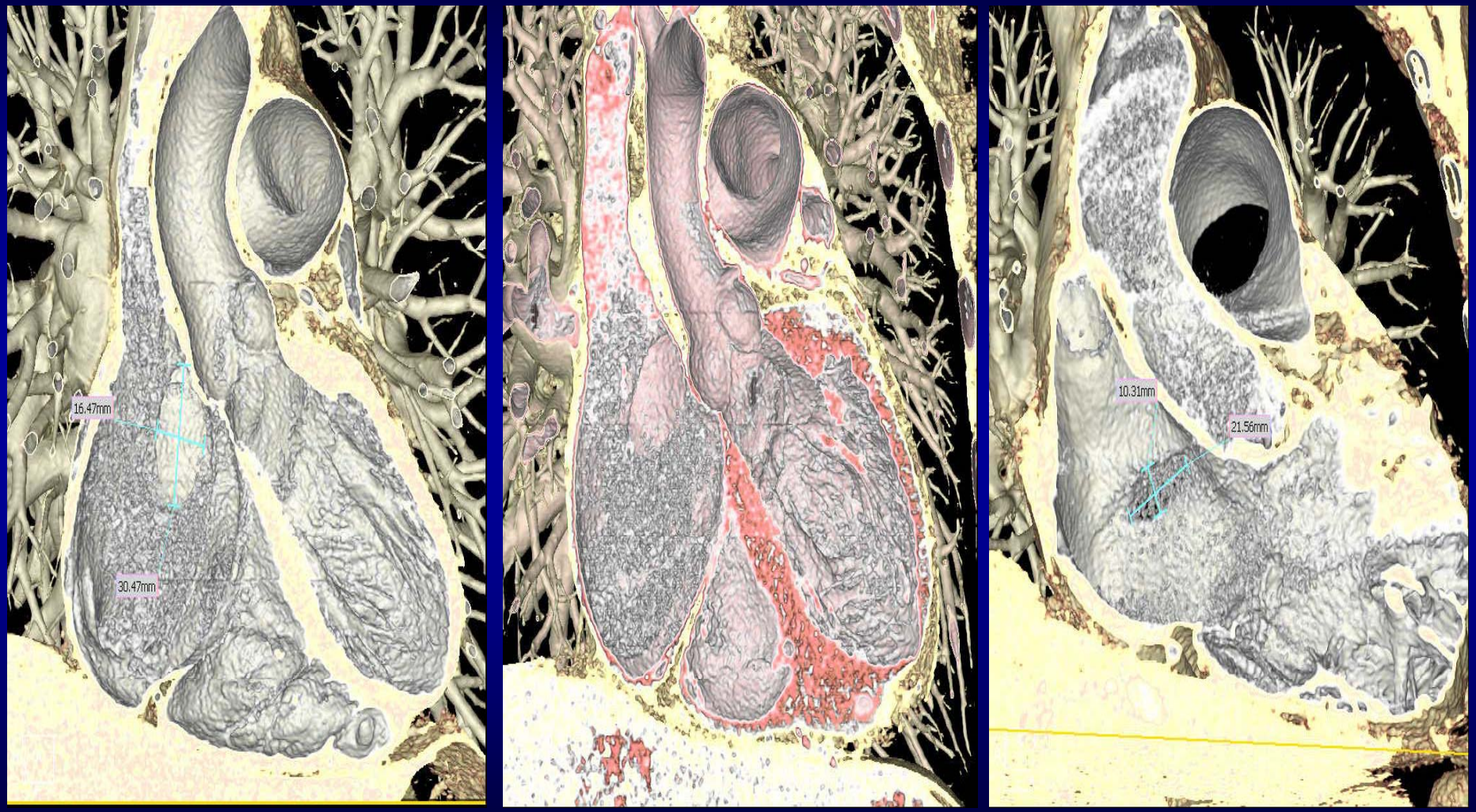
# Sinus venosus defect with PAPVR




*Courtesy of Jinyoung Song, M.D.,*
*Samsung Medical Center (work at the Sejong General Hospital)*

# Eccentricity of the Defect




*Courtesy of Jinyoung Song, M.D.,*
*Samsung Medical Center (work at the Sejong General Hospital)*

# Change of the defect after the closure of the ellipsoid defect

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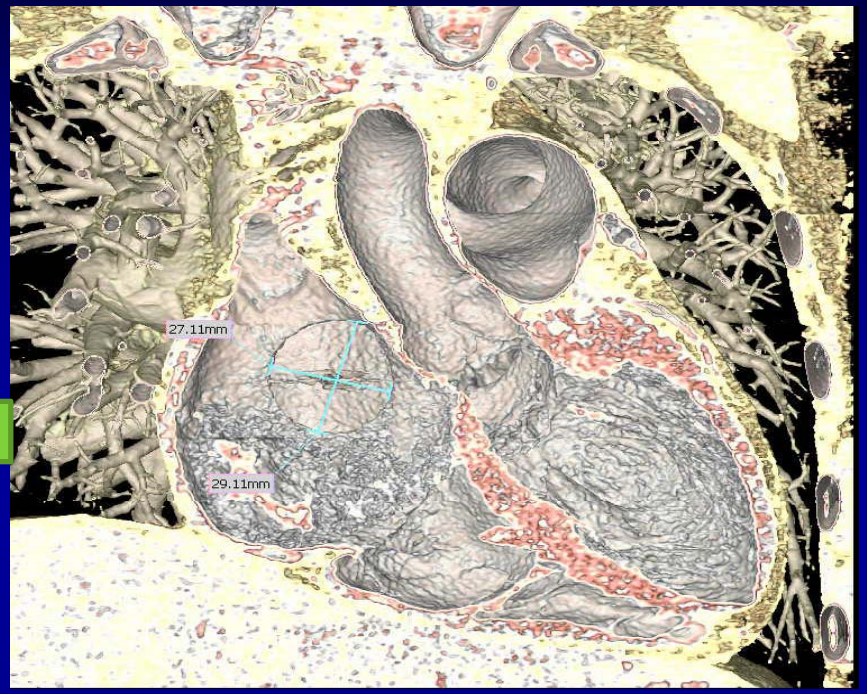
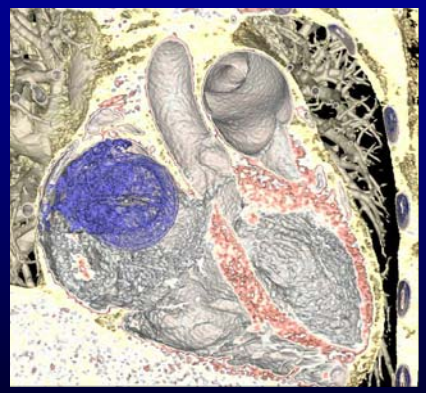
32mm



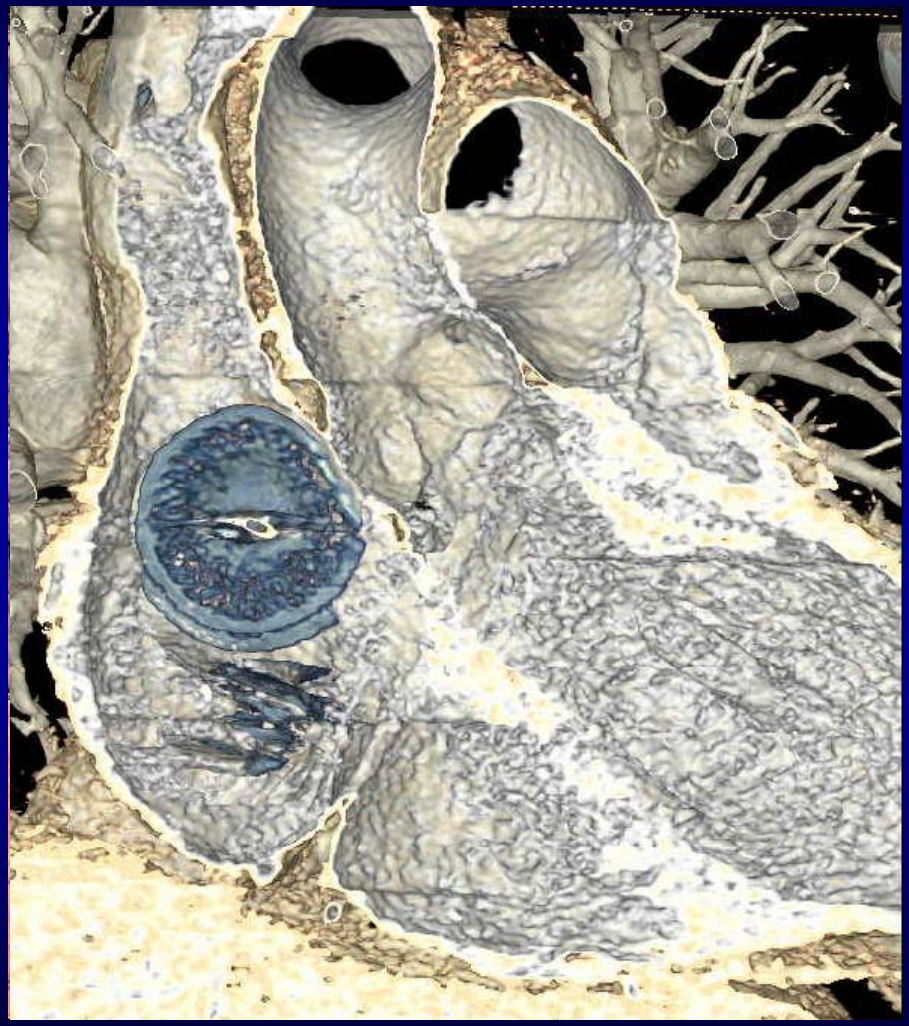



| A | B | Eccentricity |
|---|---|---|
| 24 | 17 | 0.7 |

*Courtesy of Jinyoung Song, M.D.,*
*Samsung Medical Center (work at the Sejong General Hospital)*

*Yonsei Pediatric Cardiology*

# Multiple ASDs



*Courtesy of Jinyoung Song, M.D.,*
*Samsung Medical Center (work at the Sejong General Hospital)*



## *They concluded that…*

- *Cardiac CT can be a good modality for pre- & post-assessment : defect size, location, anatomy, feasibility of closure, changes after closure*
- *May eliminate the need of balloon sizing in selected patients*

# What's Next?

- Trans-nasal TEE using a micro TEE probe with RT3D capability w/o GEA?
- ICE using smaller catheter with multiplane / RT3D capability?
- MR-guided intervention?

# Conclusion

- Each guiding tools for ASD closure has its own advantages and drawbacks
- There is no generally applicable single “best imaging tool”
- Every interventionalist should be fully aware of advantages and drawbacks of each technique so that they can choose the optimal modality according to given circumstances.