Introduction to Interventional Echocardiography

Conflict of Interests

- Tomtec
  - Research Grants
- Philips Medical Imaging
  - Research Grants
  - Speakers bureau
  - Advisory bureau
Structural Heart Disease: Definition

‘Structural heart disease’ is a term first introduced by Martin Leon at the 1999 Transcatheter Cardiovascular Therapeutics meeting to provide an over-reaching term “encompassing non-coronary cardiac disease processes and developing interventional techniques”.

Interventional Cardiology
Cardiac Surgery
Cardiac Imaging
Vascular Surgery
Cardiac Anesthesia
Structural Heart Disease

- Increased recognition of disease
- Advanced imaging techniques
- Catheter based techniques
- Devices

Visualization of the Entire Catheter

Thrombus Attached to Catheter

Courtesy Dr Kronzon
Illumination Techniques

The future has arrived. Are we ready?

Karima Addetia and Roberto M. Lang

Section of Cardiology, Department of Medicine, University of Chicago, 5738 S. Maryland Avenue, MC1960, Chicago, IL 60637, USA

Artificial Intelligence
Fusion Imaging
3D Printing
Virtual Reality
Holography
Automated Cardiac Chamber Quantification

Images that interventionalists are familiar
Good definition for catheters, wires and devices
Good definition for calcified and metallic structures
Poor anatomic definition
Single plane
Radiation Exposure
Contrast Use

Fluoroscopy: Advantages and Disadvantages

UNIVERSITY OF CHICAGO NON-INVASIVE CARDIAC IMAGING LABORATORY
3D TEE: Advantages and Disadvantages

- Real Time 3D anatomic definition
- Visualization of structures in multiple planes
- Minimizes radiation exposure and increases safety
- Operators' experience
- Interventionalist are not used to echo perspectives
- Worse definition of intracardiac catheters
- Dependent on image quality

FUSION IMAGING
Fusion imaging
Fluoroscopic anatomy

Mitral valve in RAO 30
Mitral valve in LAO 30

Fusion Imaging
Fluoroscopic anatomy
FUSION IMAGING

3D Printing
Virtual Reality
Computer-generated simulation of a three-dimensional image that can be interacted with by a person using special electronic equipment (helmet with a screen inside or gloves fitted with sensors).

Stenotic Bioprosthetic MV
From LA
From LV
Dennis Gabor, “Father of Holography”

«You cannot predict the future, but you can create it.»

Nobel Prize Laureate 1971

![Prof. Dennis Gabor (Nobel Prize Laureate, 1971), Inventor of Holography]

- It is an advanced form of photography that allows an image to be recorded in three dimensions.
Structural Heart Disease

• Treatment of Valvular heart Disease

  * Mitral balloon valvuloplasty
  * Edge to edge repair
  * TAVR

• Treatment of Prosthetic Valve Malfunction

  * Paravalvular leak closure
  * Valve-in-valve
Mitral Stenosis

Mitral Stenosis
PBMV in Mitral Stenosis

PRE PBMV

POST PBMV

PBMV in Mitral Stenosis
Mitral Stenosis

Area:
Pre = 1.4cm²
Post = 1.9cm²
Dehisced Mitral Valve
Dehisced Mitral Valve
Paravalvular leak identification

Incorrect
Correct
Successful closure with Amplatzer device

Left atrial view
Left ventricular view

Percutaneous Repair of Prosthetic Mitral Valve Dehiscence
Percutaneous Repair of Prosthetic Mitral Valve Dehiscence
Percutaneous Repair of Prosthetic Mitral Valve Dehiscence

Percutaneous Repair of Prosthetic Mitral Valve Dehiscence
Percutaneous Repair of Prosthetic Mitral Valve Dehiscence
Number of Leaks

Percutaneous Repair of Prosthetic Mitral Valve Dehiscence
Percutaneous Repair of Prosthetic Aortic Valve Dehiscence

Mitral Clip

Inter-atrial Septal Puncture

Position and Orient Clip
Grasping the Leaflet

Ventricular Side  Atrial Side

Alfieri Stitch
Clip for a Cleft MV

Clip #1

Clip for a Cleft MV
Clip for a Cleft MV

Clip #1

Clip #2
Clip for a Cleft MV

Clip #2

Valve in Valve
Valve in Valve

Percutaneous MV Repair

Direct annuloplasty
- Mitralign
- Guided Delivery Systems
- QuantumCor

Coronary sinus annuloplasty
- Edwards Monarc
- Cardiac Dimensions
- Viacor PTMA

Indirect annuloplasty
- St. Jude
- i-Coapsys
- Ample PS3

Edge-to-edge
- eValve
- Edwards Mobius
Percutaneous MV Repair

Percutaneous TV Repair

Mitralign Concept
Bi-caval valve implantation
Forma Concept

TriCinch Concept
Transatrial Intrapericardic tricuspid annuloplasty concept
Aorta

Normal Aortic Valve Anatomy

AORTIC PERSPECTIVE  LVOT PERSPECTIVE
Elliptical Aortic Annulus

- Single layer porcine pericardium
- Tri-leaflet configuration
- Nitinol frame self-expandable - Inflow: 26 and 29 mm – 20 to 27 mm annulus
- Delivery system 18F

Percutaneous Aortic Valves

- Bovine pericardium
- Tri-leaflet configuration
- Mounted on a 14 mm long x 23 mm or 26 mm diameter highly resistant stainless steel balloon expandable stent

Edwards-Sapien

- Single layer porcine pericardium
- Tri-leaflet configuration
- Nitinol frame self-expandable - Inflow: 26 and 29 mm – 20 to 27 mm annulus
- Delivery system 18F

ReValving® System CoreValve
Aortic Balloon Valvuloplasty

TAVR Deployment
Aortic Annulus Measurements

When: mid-systole: slightly larger and rounder
Where: mid right coronary cusp and the edge of the commissures between the LCC and NCC from inner edge to inner edge

- Sinuses of Valsalva (End-diastole)
- Sino-tubular junction (End-diastole)
- Maximal diameter of the proximal Asc Ao (End-diastole)

Leading edge to leading edge
Aortic Stenosis
Paravalvular leak post-TAVR
- NO LEAK

- PARAVALVULAR LEAK

LVAD: Left Ventricular Assist Device

- A valuable option for patients with end stage systolic heart failure
- ~2000 LVADs are implanted annually in the United States alone
- It can serve as
  1. Bridge to transplantation
  2. Destination therapy
  3. Bridge to recovery

3D CT reconstruction
Post-LVAD Aortic Insufficiency

Russo, Freed, Jeevanandam, Lang et al., Ann Thorac Surg. 2011
Freed, Paul, Bhave, Lang et al., JACC Cardiovasc Interv. 2012

Transcatheter Aortic Valve Fusion
Interventional Echocardiography

- Displays anatomy intuitively
- Pre-procedure assessment
- Intra-procedure guidance
- Post-procedure follow-up

Bhave and Lang, Atlas of 3D Echocardiography, ed. Gill, in press

Thanks for your attention