Aortic Valve and Root
Short Axis
Aortic Valve Cusp Layers

- Fibrosa
- Spongiosa
- Corrugations
- Ventricularis
- Normal Thickness
Aortic Valve Cusp
Collagen and Elastin Function

Editorial:
Aortic Valve Structure-Function Correlations: Role of Elastic Fibers no Longer a Stretch of the Imagination
Frederick J. Schoen
Department of Pathology, Brigham and Women’s Hospital and Harvard Medical School, Boston, Massachusetts, USA
The Journal of Heart Valve Disease 1997;6:1-6
Aortic Root Anatomy

- Sinus of Valsalva
- Aortic Root
- Interleaflet triangle

Aortic Root

Is in the *middle* of the heart, surrounded by *everything* else.
Cardiac Anatomy
Overview of Valves
Aortic Root in the Middle of the Heart
Aortic Root
In the Middle of the Heart
“Lovefest” With Everything Else
Aortic Root
The Intimate Neighborhood: Everything Else
Pathways for Periannular Abscess Penetration

- Left atrium
- Right atrium
- Membranous septum
- Conduction system
- Septal tricuspid leaflet
- Right ventricle
- Left coronary
- Transverse sinus (Outside the heart)
- Pulmonary valve
- Pulmonary artery
- Aortic-mitral curtain
- Anterior mitral leaflet
- Inter-atrial septum
- Left and/or right atria
Right-Non Interleaflet Triangle
Endocarditis Collateral Damage Potential

Interleaflet Triangle
Membranous Septum
Right Fibrous Trigone
Central Fibrous Body

RA
Septal Tricuspid Leaflet
RV
AV Node
His bundle
Visualizing Anatomy
Build The “Snowman”
With An Hourglass

Two reference points:

- Inter-atrial septum
- R/L commissure
Cardiac Valve Relationships

Left Sinus
Left Facing Sinus
Inter-Atrial Septum
Inter-Coronary Commissure
Right Sinus
Right Facing Sinus
Anterior Mitral Leaflet
Right-Non Commissure
Septal Tricuspid Leaflet
Inter-Atrial Septum
Ventricular Anatomy

“Mystery” of the Aortic Root

Left Ventricle
Common Orifice for Inflow and Outflow
Separated by the Trigones and Aortic-Mitral Curtain
Left Ventricle
Inflow and Outflow: Common Orifice
Left Ventricular Inflow/Outflow Tennis Court Analogy
Aortic-Mitral Fibrous Continuity

- Sino-Tubular Junction
- Aortic Annulus
- VA Junction
- Left Trigone
- Mitral Annulus Plane
- Aortic-Mitral Curtain
- Anterior Mitral Leaflet
- Left-Non Commissure
- Tubular Aorta
- Sinus Aorta
- Aortic “Annulus” (Basal ring) Plane
- Right Trigone
Aortic Root
Changing Shape With Age

Child, young adult
Isosceles trapezoid

Older adult
Square
Cardiac Anatomy

Cardiac Skeleton of Aortic, Mitral Valves

- Non-left commissure
- Sino-tubular junction
- Non-Left interleaflet triangle
- Right fibrous trigone
- Aortic-mitral curtain
- Left fibrous trigone
Pig Heart
“High-Fidelity” Biological “Simulator”
Aortic-Mitral Curtain From Outflow Side

Left Atrium
Aortic-Mitral Curtain
Left Fibrous Trigone
Aortic Root
Right Fibrous Trigone
Pig Heart
“High-Fidelity” Biological “Simulator”
Aortic-Mitral Curtain Removed
Aortic-Mitral Curtain Replaced
Commando: Folded Bovine Pericardial Patch

- Aortic Patch
- Aortic Annular Plane
- Left Fibrous Trigone
- Right Fibrous Trigone
- Mitral Annular Plane
- Open Left Atrium
- Left Atrial Patch
Aortic-Mitral Curtain Replaced
Folded Bovine Pericardial Patch
Mitral Annulus SuturePlacement

Left Atrium
Mitral Annular Plane
Aortic Annular Plane
Left Fibrous Trigone
Right Fibrous Trigone
Preserved Posterior Mitral Leaflet

Left Atrium
Aortic-Mitral Curtain Replaced
Commando: Folded Bovine Pericardial Patch
Mitral Inflow and Aortic Outflow
Aortic Allograft in Hemi-Commando “Simulated” Endocarditis

Repair of Excavated Anterior Mitral Leaflet (AML)

Northrup WF III, Ann Thorac Surg 2010
Aortic Allograft
“High-Fidelity” Biological “Simulator”
The Inflow Side Before and After Trimming

Left Fibrous Trigone
Aortic-Mitral Curtain
Right Fibrous Trigone
Aortic-Mitral Curtain
Tennis Net Analogy
(Static)
Aortic-Mitral Curtain
Hammock Analogy
Dynamic Cyclical Deformation
Aortic-Mitral Curtain Dynamic Physiology

- Aortic Outflow
- Diastole
- Systole
- Mitral Inflow
- Left Fibrous Trigone
- Right Fibrous Trigone
- Left Ventricle
Aortic Annulus

Deformation Dynamics and Mechanical Properties of the Aortic Annulus by 4-Dimensional Computed Tomography

Insights Into the Functional Anatomy of the Aortic Valve Complex and Implications for Transcatheter Aortic Valve Therapy

Ashraf Hamdan, MD,*† Victor Guetta, MD,* Eli Konen, MD,† Orly Géroten, MD,† Amit Segev, MD,* Ehud Raanani, MD,‡ Dan Spiegelstein, MD,‡ Ilan Hay, MD,* Elio Di Segni, MD,‡ Michael Eldar, MD,* Ehud Schwammenthal, MD, PriD*

Tel Hashomer, Israel

Elipticity

Deformation

JACC 2012
Aortic-Mitral Curtain
Clothesline Analogy
Suspending Anterior Mitral Leaflet
Aortic-Mitral Curtain Suspension Bridge Analogy
Cables Support Road (Anterior Mitral Leaflet)
Aortic Annulus

What are the normal dimensions?
Aortic Valve and Root Anatomy
Annulus Diameter

BODY SURFACE AREA AS A PREDICTOR OF AORTIC AND PULMONARY VALVE DIAMETER

Scott B. Capps, MS
Ronald C. Elkins, MD
David M. Fronk, MS

• Adult **male** mean aortic valve diameter: **23.1 ± 2.0 mm**
  - n = 2,214

• Adult **female** mean aortic valve diameter: **21.0 ± 1.8 mm**
  - n = 1,156

J Thorac Cardiovasc Surg 2000
Aortic Valve and Root Anatomy
Normal Annulus Area

Mean indexed aortic valve area: $2.02 \pm 0.52 \text{ cm}^2/\text{m}^2$

Minimum: $1.5 \text{ cm}^2/\text{m}^2$

J Thorac Cardiovasc Surg 2000
Aortic Root Anatomy
Sinus Symmetry?
Aortic Valve and Root Anatomy
Circumferential Asymmetry

Duran Group, J Heart Valve Dis 1999
Aortic Valve and Root Anatomy
Longitudinal Asymmetry

Duran Group, J Heart Valve Dis 1999
Aortic Valve and Root Surgery

What is the relevance of the anatomy?
Aortic Root Surgery
Expected Mismatches
New Root (Valve, Graft) vs. Old Root (Patient)

Sinus dimensions
Annulus diameters
Coronary positions
All Aortic Root and Valve Replacements
One Fact
Must Be Remembered!

Sinus dimensions of the new root and valve replace those of the old root.

Except:

Valve-sparing aortic replacements:
Graft fits valve (vs. Valve fits graft)
Aortic Valve and Root Surgery
Two Critical Position Mistakes With Coronaries Must be Avoided!

1. Valve or Graft Position Problem:
   Coronary opposite commissure or strut (misaligned circumferential orientation)

2. Coronary Position Problem on Graft:
   Coronary misaligned or moved (out of its original position, axis)
Aortic Valve and Root Surgery
Why Should I Know Anatomy?

Simple operations can go badly.

Complex reconstructions (e.g., in extensive endocarditis) would be impossible.
Aortic Valve Replacement
Symmetrical Prosthesis in Asymmetrical Root
Be Careful With Carrel Triangulation!

Use symmetrical valve-sizer for “commissural” suture sites

Left sinus tissue annulus too short for sewing ring
Thank You

Leonardo da Vinci, Aortic Sinus Vortices, ca. 1513