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

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
Right-Non Interleaflet Triangle
Endocarditis Collateral Damage Potential

Interleaflet Triangle
Membranous Septum
Septal Tricuspid Leaflet
His Bundle
Right Fibrous Trigone
Central Fibrous Body

RA
RV
AV Node
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
- Septal Tricuspid Leaflet
- Right-Non Commissure
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

Aortic-mitral curtain
Left Ventricular Inflow/Outflow Tennis Court Analogy
Cardiac Anatomy
Cardiac Skeleton of Aortic, Mitral Valves

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

- Aortic Patch
- Aortic Annular Plane
- Mitral Annular Plane
- Left Atrial Patch
- Left Fibrous Trigone
- Right Fibrous Trigone
- Open Left Atrium

Aorta
Aortic-Mitral Curtain Replaced
Folded Bovine Pericardial Patch
Mitral Annulus Suture Placement

Left Atrium
Mitral Annular Plane
Aortic Annular Plane
Left Fibrous Trigone
Right Fibrous Trigone
Preserved Posterior Mitral Leaflet
Left Atrium
Aortic-Mitral Curtain Replaced
Folded Bovine Pericardial Patch
Mitral Inflow and Aortic Outflow
Aortic Allograft
“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 Goitein, MD,† Amit Segev, MD,* Ehud Raanani, MD,‡ Dan Spiegelstein, MD,‡ Ilan Hay, MD,* Elio Di Segni, MD,*§ Michael Eldar, MD,* Ehud Schwammenthal, MD, PhD*

Tel Hashomer, Israel

Elipticity

Deformation

Min diameter: 21 mm
Max diameter: 24
Mean diameter: 22.5
Perimeter: 71 mm
Ellipticity: 1:1.14

Min diameter: 21 mm
Max diameter: 29
Mean diameter: 25
Perimeter: 79 mm
Ellipticity: 1:1.38

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:**
  \[23.1 \pm 2.0 \text{ mm}\]
  - \(n=2,214\)

- **Adult female mean aortic valve diameter:**
  \[21.0 \pm 1.8 \text{ mm}\]
  - \(n=1,156\)

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

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

Scott B. Capps, MS\textsuperscript{a}
Ronald C. Elkins, MD\textsuperscript{b}
David M. Fronk, MS\textsuperscript{a}

Mean indexed aortic valve area: \textbf{2.02 $\pm$ 0.52 cm\textsuperscript{2}/m\textsuperscript{2}}
\textit{n = 4,636}

Minimum: \textbf{1.5 cm\textsuperscript{2}/m\textsuperscript{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)
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
Thank You

Leonardo da Vinci, Aortic Sinus Vortices, ca. 1513