Aortic Valve and Root Anatomy
The Platform For All Aortic Root Surgery

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Annual TSDA Boot Camp

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Aortic Valve and Root
Short Axis
Aortic Root Anatomy

Aortic wall within ventricle (interleaflet triangle)

Sinus of Valsalva

Ventriculo-arterial ring and junction

“Annulus” Basal ring

Ventricle within sinus

Sinotubular junction

Aortic Root

True Annulus: Cusp attachment

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
The Intimate Neighborhood: *Everything Else*
Pathways for Periannular Abscess Penetration

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

Two reference points:

Inter-atrial septum
R/L comissure
Cardiac Valve Relationships

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

Aortic Valve
Mitral Valve
Aortic-Mitral Curtain
Mitral Valve
Trigone
Cardiac Anatomy

Cardiac Skeleton of Aortic, Mitral Valves

- Non-left commissure
- Sino-tubular junction
- Non-Left interleaflet triangle
- Right fibrous trigone
- Left fibrous trigone
- Aortic-mitral curtain
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

[Image of a heart with labeled anatomical parts: Aortic Valve Annular Plane, Aortic Root, Right Fibrous Trigone, Left Atrium, Mitral Valve Annular Plane, Left Fibrous Trigone.]
Aortic-Mitral Curtain Replaced
Folded Bovine Pericardial Patch

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

Left Coronary Ostium  Left-Right Commissure
Aortic Annular Plane
Aorta
Left Atrium
LVOT
Right Coronary Ostium
Aortic Allograft
“High-Fidelity” Biological “Simulator”
The Inflow Side Before and After Trimming

Left Fibrous Trigone
Right Fibrous Trigone
Aortic-Mitral Curtain
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

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Ellipticity

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

- **Adult male mean aortic valve diameter:**
  \[23.1 \pm 2.0 \text{ mm}\]
  \[- n = 2,214\]

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

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

Mean indexed aortic valve area: 2.02 ± 0.52 cm²/m²
n = 4,636

Minimum: 1.5 cm²/m²

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 Must be Avoided!

1. Valve or Graft Position Problem:
   Patient’s coronary on commissure or strut
   (misaligned circumferential orientation)

2. Coronary Position Problem with Graft:
   Patient’s coronary misaligned or moved
   (out of its original position, axis)
Aortic Valve and Root Surgery

Complex reconstructions (e.g., in extensive endocarditis) would be impossible without a clear understanding of the anatomy.
Aortic Valve Replacement
Symmetrical Prosthesis in Asymmetrical Root
Be Careful With Triangulation!

Use symmetrical valve-sizer for “commissural” suture sites
Thank You

Leonardo da Vinci, Aortic Sinus Vortices, ca. 1513