



KUWAIT ANNUAL  
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FROM VISION TO  
PRECISION

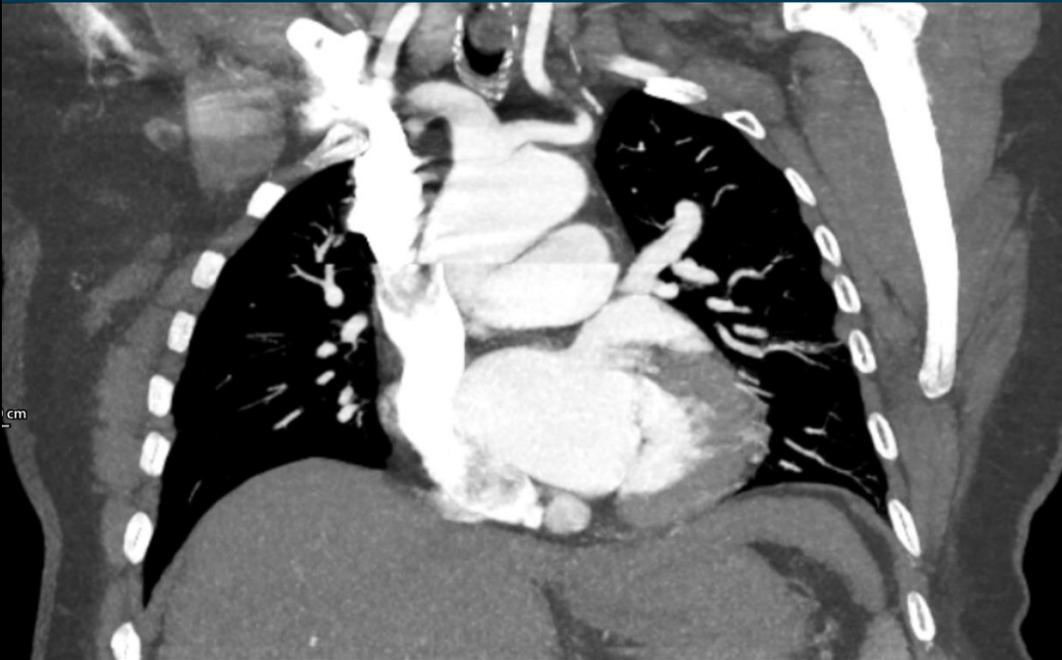
# CT Evaluation of Aortic Arch Variants: Implications for Neurovascular and Thoracic Interventions

Dr. Abdulaziz Al Imhaid

Dr. Abdullah Al Mutairi

Dr. Ahmed Mounir





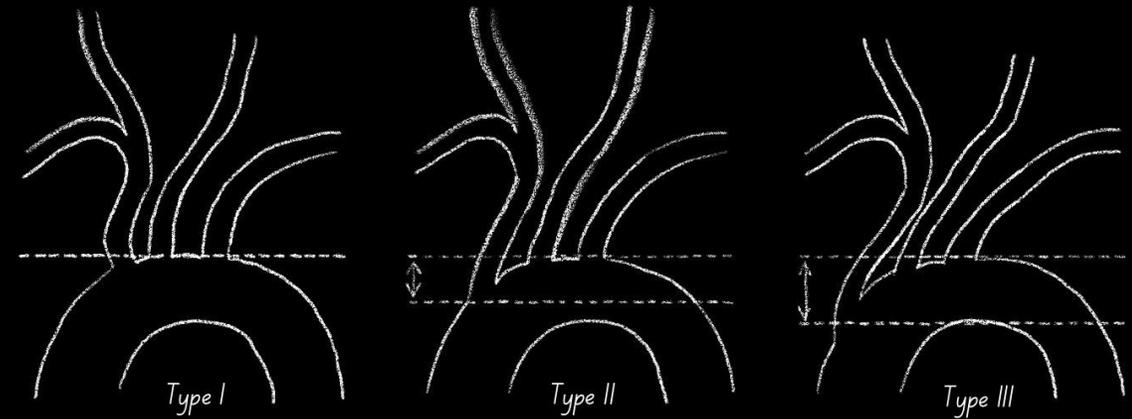
*Coronal MIP reconstruction of a Chest CTA demonstrating a Type I Bovine Arch*

## Teaching Points

- Review the anatomy and common variants of the aortic arch.
- Recognise key CT features including branch origin, arch type, take-off angle, and how they affect preprocedural planning.
- Understand how arch morphology influences catheter navigation, access selection, and device stability in neurovascular and thoracic interventions.
- Identify CT-based predictors that signal increased technical difficulty or risk of complications during endovascular procedures.

# The Standard Arch

- Aortic arch anatomy shows significant variability
- Most common configuration: three-vessel arch
  - Brachiocephalic trunk (innominate artery)
  - Left common carotid artery (LCCA)
  - Left subclavian artery
- Arch types (I–III) are classified by the vertical position of branch origins
- Clinical relevance: Greater arch elongation → increased technical difficulty in transfemoral endovascular procedures



CTA MIP Reconstruction Demonstrating the Branches of a Standard Aortic Arch



*Brachiocephalic Trunk*



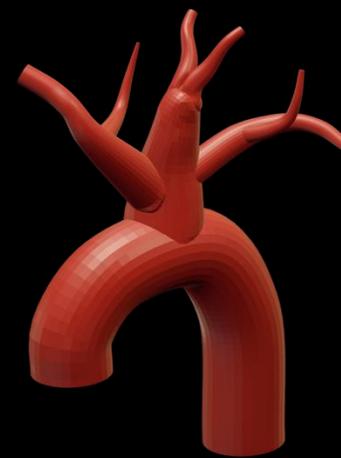
*Left Common Carotid Artery*



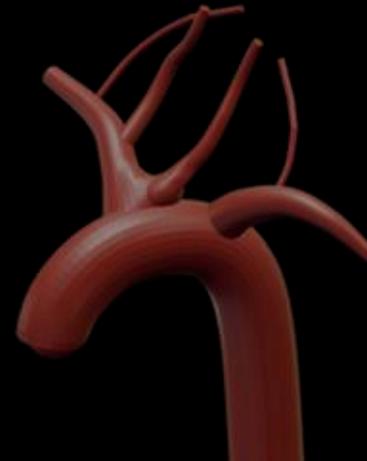
*Left Subclavian Artery*

# The Bovine Arch

- The “Bovine Arch” is the most common variant of the classic aortic arch pattern
- The term “bovine arch” is a misnomer:
  - True bovine anatomy: single brachiocephalic trunk supplying both carotid arteries both subclavian arteries  
*\*This configuration does not occur in humans.*
- In humans, the term “bovine arch” refers to two related variants:
  - Type I: Common origin of the brachiocephalic trunk and left common carotid artery (LCCA)
  - Type II: The LCCA emerges as a branch of the brachiocephalic trunk
- Clinical significance:
  - LCCA has a more acute, vertical take-off
  - Results in more challenging catheter navigation and reduced procedural stability



*3D model of a True Bovine Arch with a single brachiocephalic trunk*



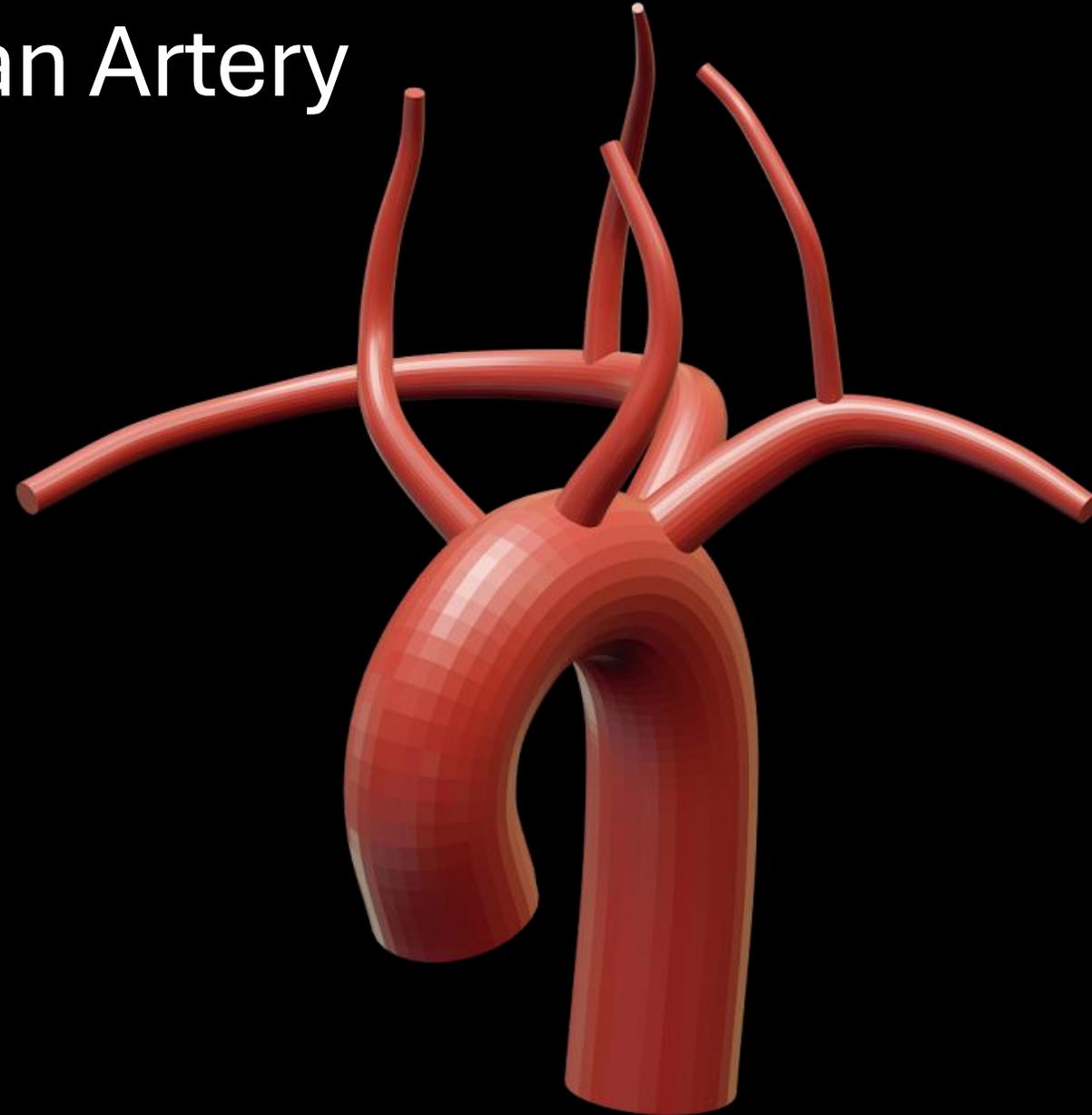
*3D Model of a Type I Bovine Arch, with a common stump origin of the right brachiocephalic trunk and left CCA*



*3D model of a Type II Bovine Arch, with the left CCA arising from right brachiocephalic artery*

# Aberrant Right Subclavian Artery

- Anatomy:
  - Right subclavian artery arises distally as the 4th branch after the left subclavian artery
    - Commonly coursing retro-esophageal
    - Less commonly, retro-tracheal
  - Frequently associated with Kommerell's diverticulum — an aneurysmal dilatation of the proximal descending aorta at the origin of the ARSA.
- Clinical & interventional relevance:
  - Alters catheter trajectories from right radial and femoral access points
  - Reduced catheter support for right vertebral and carotid engagement in neurovascular access
  - Challenges in preserving perfusion to aberrant vessels in TEVAR planning and stent-graft deployment.



*3D model of an Aberrant Right Subclavian Artery*

## CTA MIP Reconstruction of an Aberrant Right Subclavian Artery



*Sagittal reconstruction illustrating the supra-aortic branches of the aortic arch with an ARSA variant*



*Coronal reconstruction showing the ARSA with a retro-esophageal course*

# CT Angiographic Assessment

- Systematic CTA assessment helps anticipate procedural difficulty and optimize endovascular strategy by evaluating:
  - Arch variant
  - Branch origin height
  - Take-off angle
  - Trunk morphology
- Clinical importance:
  - Altered LCCA geometry:
    - ↓ catheter stability with more vertical take-offs
  - Difficult trans-femoral selective cannulation:
    - ↑ need for alternative access routes in carotid stenting and neurovascular procedures
- Implications for TEVAR planning:
  - Shared-trunk variants may shorten proximal landing zones
  - May require advanced techniques:
    - Fenestrated grafts
    - Chimney techniques
    - Surgical debranching



*3D render from a Chest CTA demonstrating landing zones for TEVAR & TAVR*

# Neurovascular Interventions

Determine Arch Type

Standard Arch

Arch Variant

Type I

Type II

Type III

Bovine Arch Variants

ARSA

Most favorable  
Minimal angulation  
Stable catheter navigation

Moderate elongation  
Increased curvature  
Risk of catheter kickback

Hostile arch  
Lowest first pass success  
Risk of arch trauma

Acute vertical take-off → poor transfemoral engagement  
Longer access times and lower catheter stability

Acute vertical take-off → poor transfemoral engagement  
Longer access times and lower catheter stability

Standard Transfemoral Approach

Stiffer catheters (Simmons-2, VTK curves)  
If instability persists, consider radial access

Long sheaths  
Hydrophilic wires  
Right radial or brachial access

Right radial or brachial access  
Long sheaths  
Simmons-2 or custom catheter

Deliberate catheter shaping  
Right brachial access

# Thoracic Interventions (TEVAR/TAVR)

## Determine Arch Type

### Standard Arch

#### Type I

Predictable supra-aortic spacing and adequate proximal landing zones. Low risk of device malalignment

Standard TEVAR/TAVR approaches suffice.

#### Type II

Reduced landing zone length, particularly in Zone 1. Device delivery may require more manipulation due to increased curvature.

grafts with longer seal zones  
Zone 2 landing if proximal coverage risks branch compromise.

#### Type III

Markedly elongated arch → angulated device trajectory. Increased risk of arch wall injury, dissection, or embolization

Fenestrated or branched endograft  
Flexible delivery systems with gradual wire stiffening

### Arch Variant

#### Bovine Arch Variants

Shared trunk reduces the length of usable Zone 0-1 landing zones. Proximity of supra-aortic branches increases risk of covering both carotids unintentionally

Fenestrated grafts, Chimney grafts, or Hybrid debranching procedures  
For TAVR: consider embolic protection devices due to clustered vessel origins

#### ARSA

Alters branch spacing and is frequently associated with Kommerell diverticulum, which affects stent-graft planning  
Can complicate left subclavian revascularization decisions

carotid-subclavian bypass when covering ARSA origin  
Custom fenestrated or double-branched devices

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