Variant Vertebral Artery in the Neck

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Objectives

- Review the normal embryology of the aortic arch and vertebral arteries
- Understand how deviation from normal embryology results in variant anatomy
- Pictorial/case review of the variants of the normal vertebral artery including origin from the aortic arch and accessory vertebral arteries

Embryology Review

4th-6th weeks of development

Six pairs of embryological arches form the aortic arch and its branches

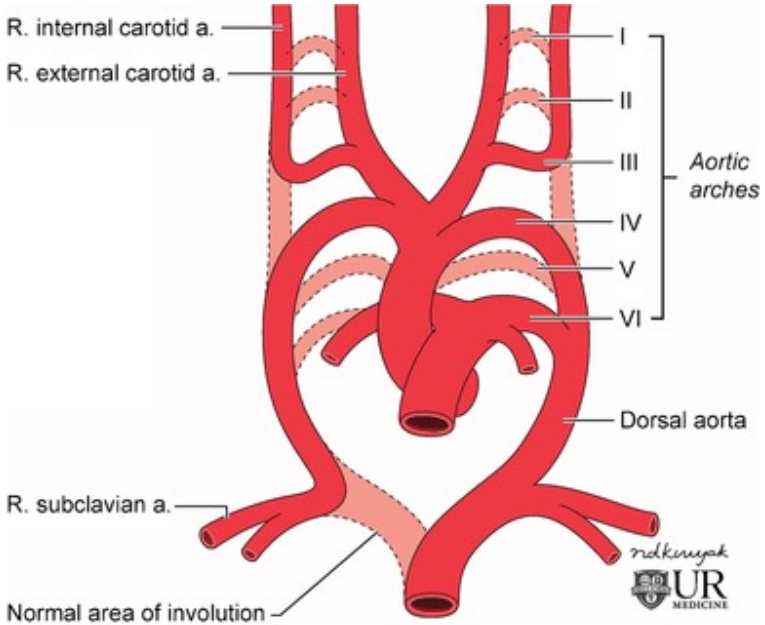
Arches connect the bilateral dorsal aorta

1st, 2nd and 5th pairs of arches regress

3rd - common and internal carotid arteries

4th - brachiocephalic trunk (on the right) and aortic arch (on the left)

6th - right pulmonary artery and ductus arteriosus



Leshen, Michael & Devanagondi, Rajiv & Saul, David & Chaturvedi, Apeksha. (2022). Physiological fetal vascular shunts and failure to regress: what the radiologist needs to know. Pediatric Radiology. 52. 1-17. 10.1007/s00247-022-05302-0.

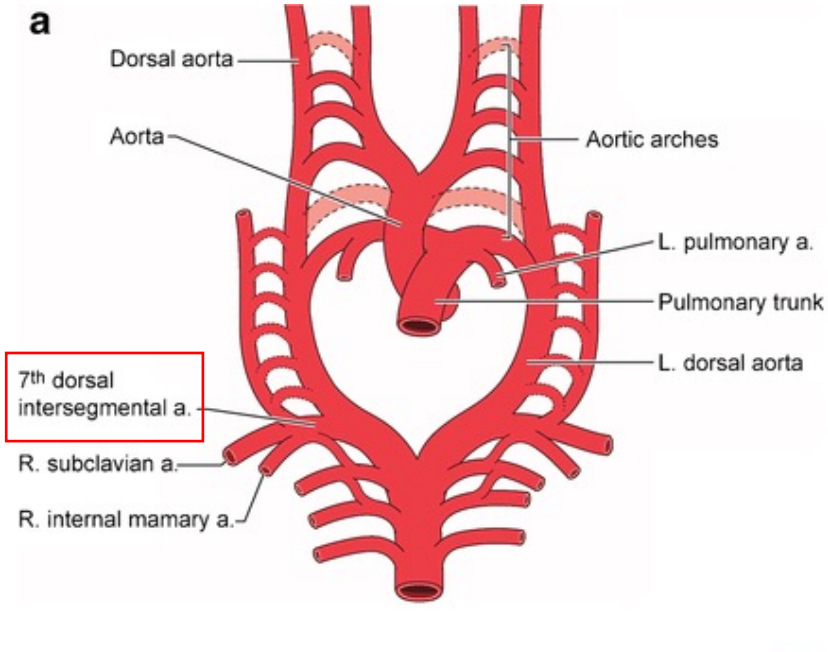
Embryology Review

Remaining dorsal aortas give off ventral and dorsal branches

Dorsal branches form intersegmental arteries

7th intersegmental arteries typically form the **subclavian arteries & origin/V1 segment** of the vertebral arteries

Anastomoses of the dorsal rami of the remaining **intersegmental arteries forms the V2 segment**



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Typical Vertebral Artery Course

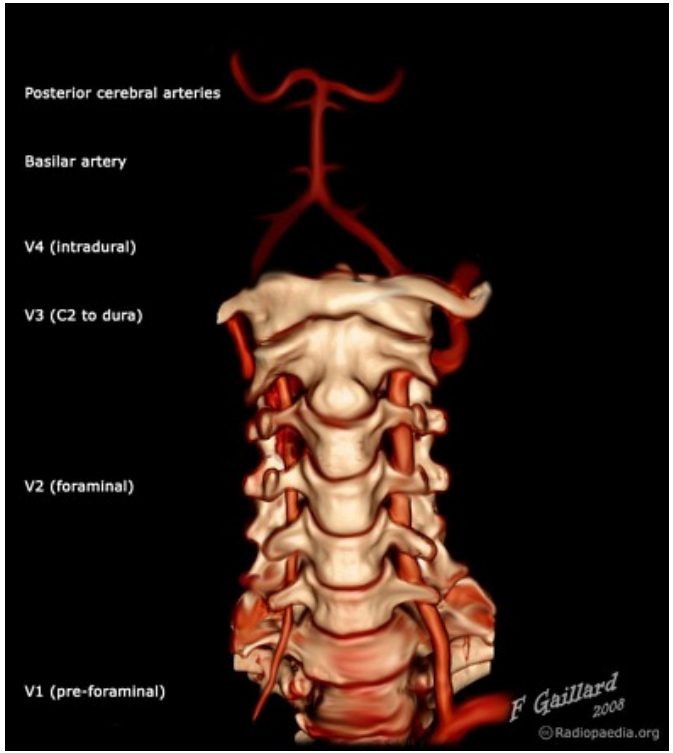
V1: From 1st branch of the subclavian artery to the C6 transverse foramen

- *Typically enters at C6, but can enter at other levels from C3-C7*
- *The level at which it enters is related to which specific cervical intersegmental vessel **persisted** to form the proximal vertebral artery*

V2: From transverse foramen of C6 to C2

V3: From C2 through to C1 to pierce the dura

V4: Intracranial Segment; From the dura at the lateral edge of the posterior atlanto-occipital membrane to the vertebral confluence along the medulla



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Typical Vertebral Artery Anatomy

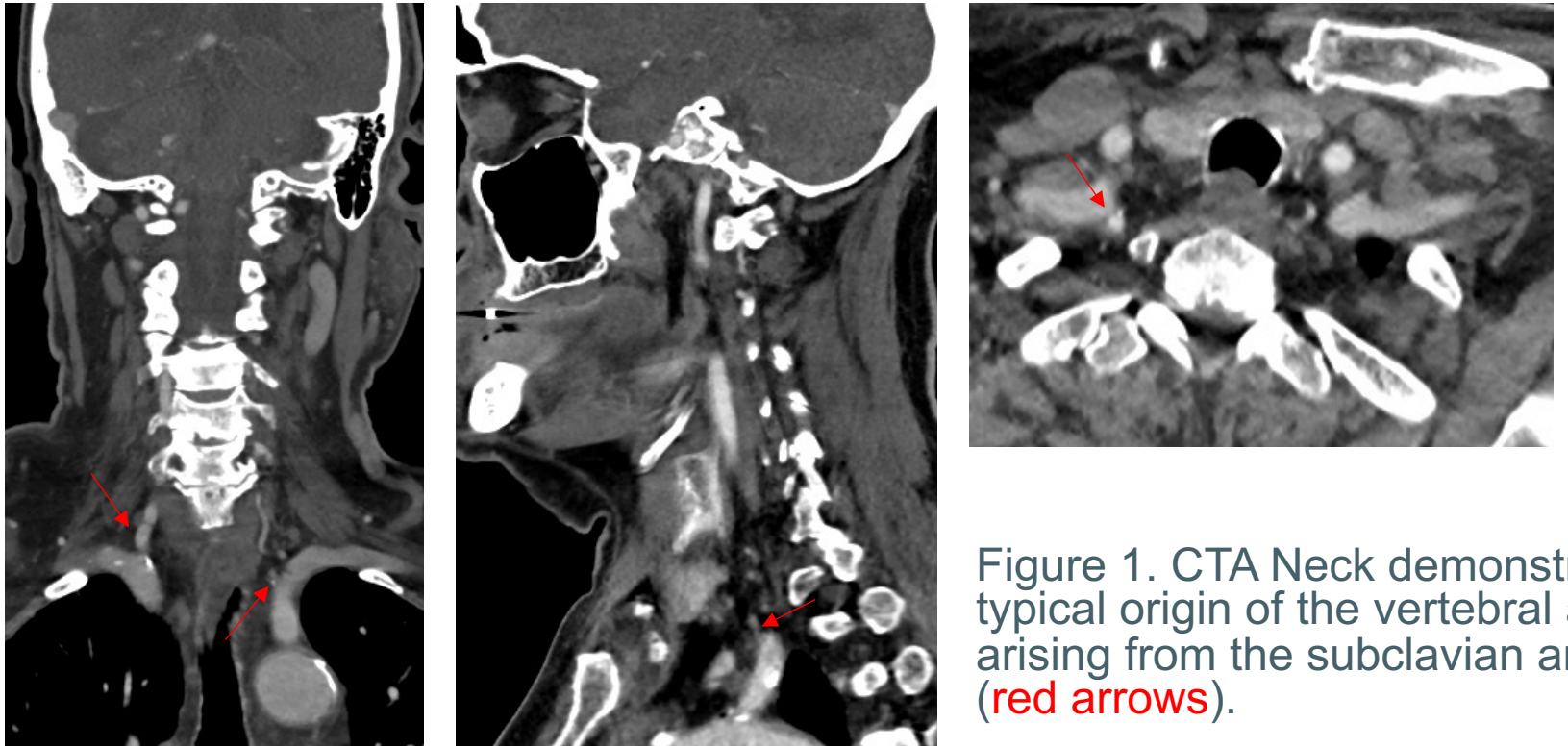
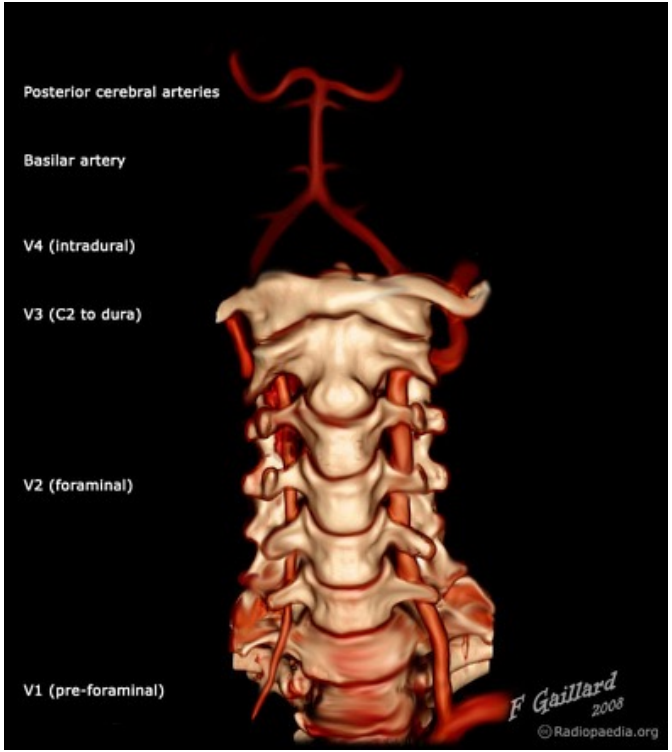


Figure 1. CTA Neck demonstrating typical origin of the vertebral arteries arising from the subclavian arteries (red arrows).

Variant Vertebral Artery

- Typical V1 segment enters at C6, however this can vary
  - *The level at which it enters is related to which specific cervical intersegmental vessel **persisted** to form the proximal vertebral artery*
- MC variant is an origin directly from the aortic arch
- Other variants include accessory or duplicated vertebral arteries
  - Thought to be due to failed regression of segments of the intersegmental arteries
  - These persistent segments continue to have a connection with the dorsal aorta and native/true vertebral artery and eventually fuse



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Direct Origin off the Aortic Arch

- **Most Common Variant**
  - 1-5.8%
- More frequently found on the left
- Theories:
  - Due to persistence of the distal segment of the 5th or 6th intersegmental artery

  Or
  - Aortic arch is actually made of a piece of the 7th intersegmental artery

Direct Origin off the Aortic Arch

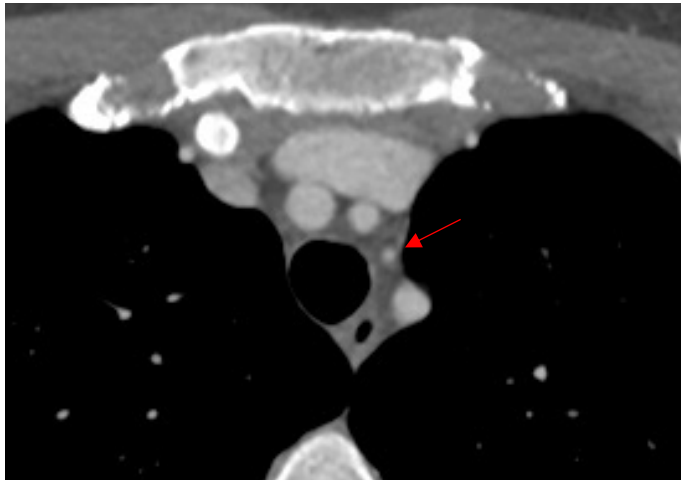


Figure 2. CTA Neck demonstrating common anatomic variant with left vertebral artery arising directly from the aortic arch (red arrows).

Origin off the arch with V1 segment posterior to the esophagus

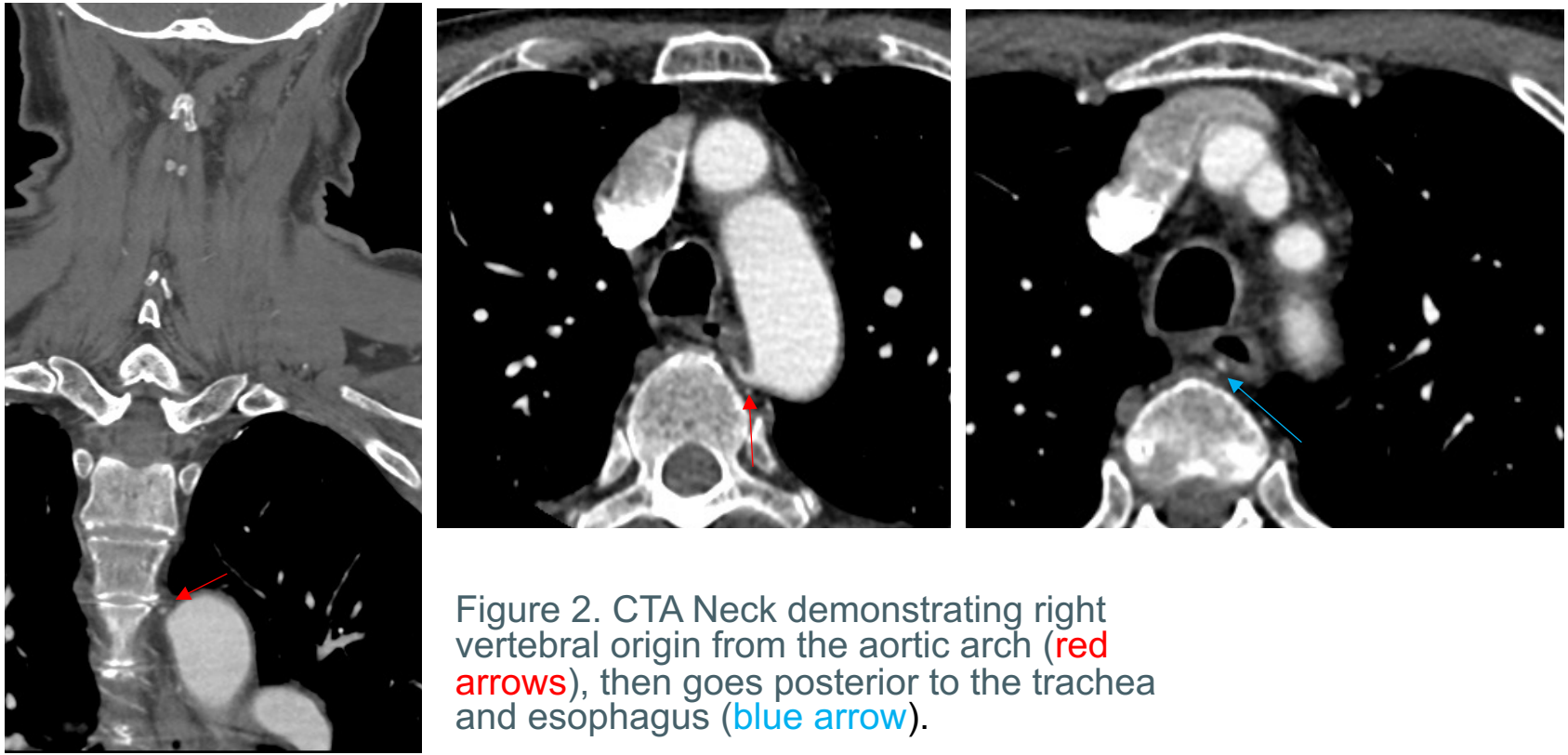


Figure 2. CTA Neck demonstrating right vertebral origin from the aortic arch (red arrows), then goes posterior to the trachea and esophagus (blue arrow).

Other Variant Anatomy

- Accessory Vertebral Arteries
  - Incomplete regression of an intersegmental artery
  - This maintains a connection between the dorsal aorta and true vertebral artery
  - 2 origins that eventually fuse together
- Duplicated Vertebral Arteries
  - Commonly seen at C1-C2
  - Division of vertebral artery into normally coursing and intradural segments
    - Intradural segment = intersegmental artery that would’ve formed a radicular artery

Dual Origins which join at C5-6

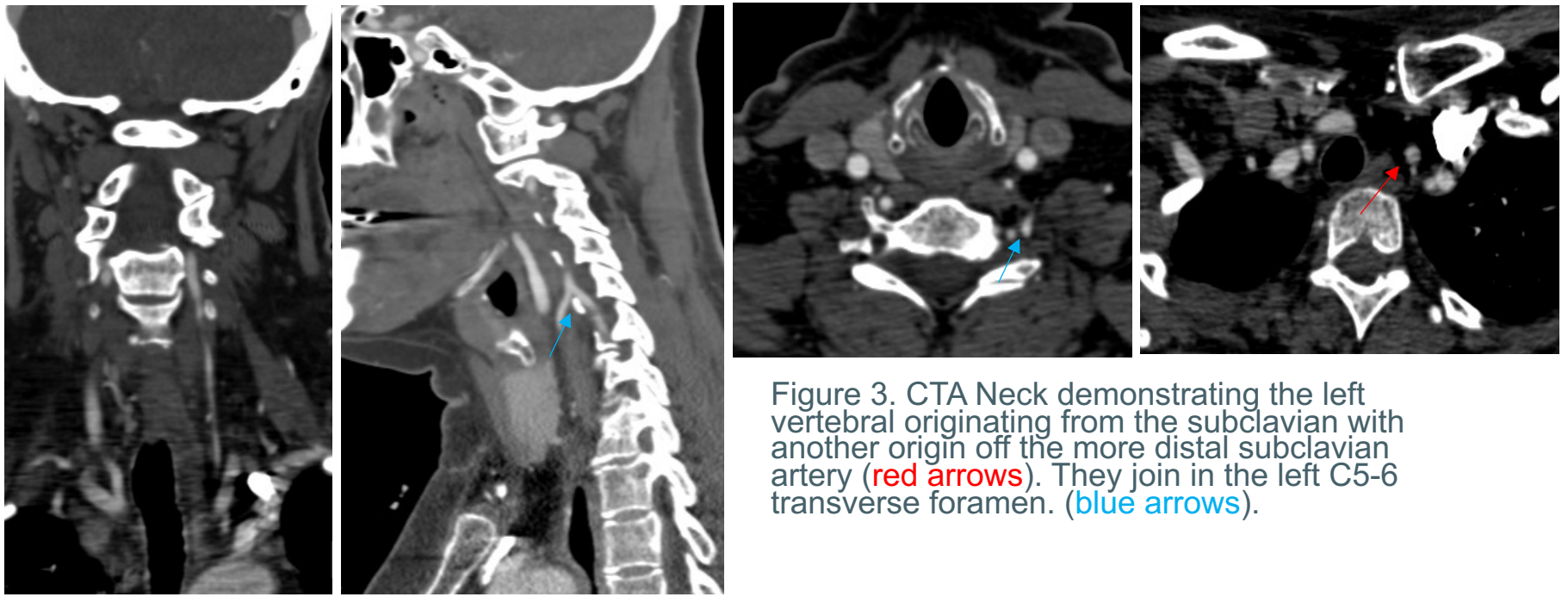
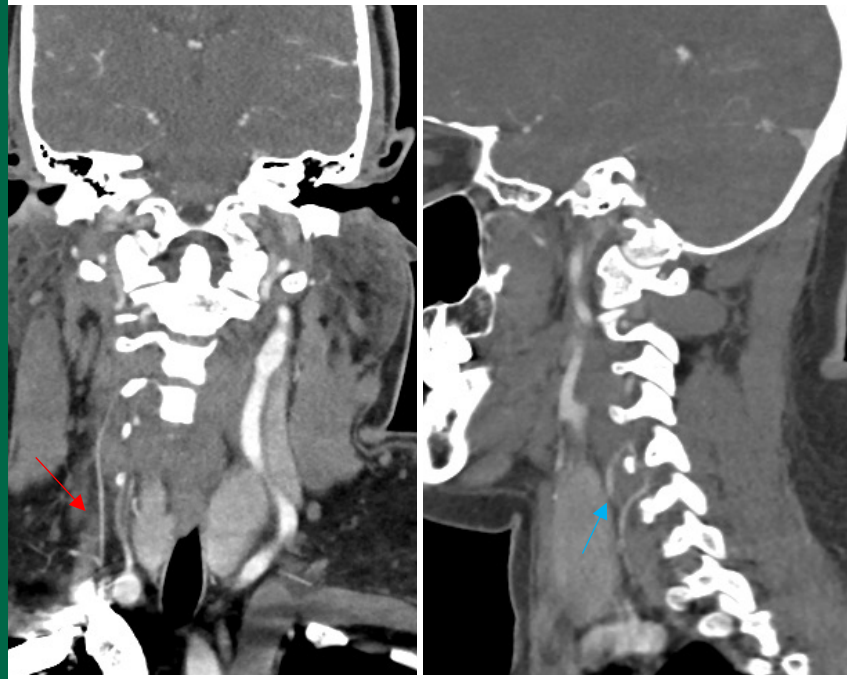


Figure 3. CTA Neck demonstrating the left vertebral originating from the subclavian with another origin off the more distal subclavian artery (red arrows). They join in the left C5-6 transverse foramen. (blue arrows).

Accessory Right Vertebral arteries which join at C4-5



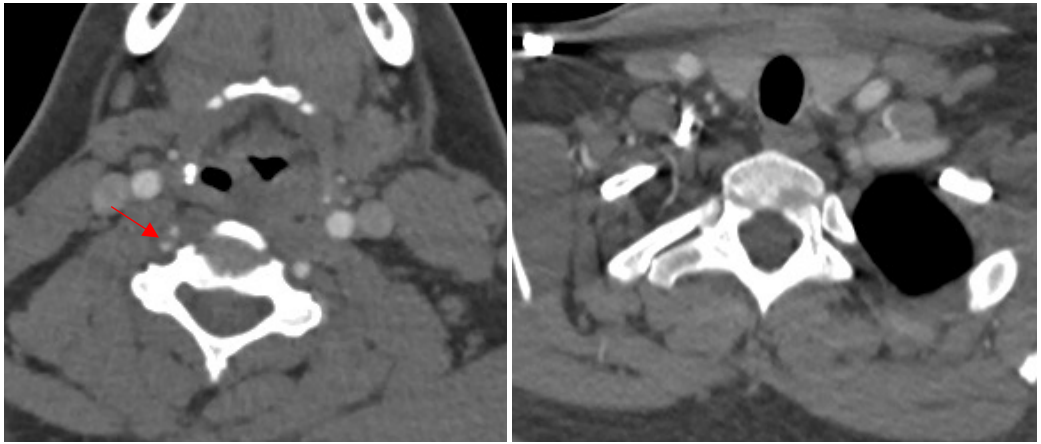


Figure 4. CTA Neck demonstrating a duplicated right vertebral artery with adjacent origins(red arrows). They join in the right C4-5 transverse foramen. (blue arrows).

Clinical Significance

- Important to be aware of from a procedural standpoint
  - Especially with an anterior approach
- Postulated to alter hemodynamics and have a relationship with increased cerebrovascular accidents and thromboembolic events
  - Lazaridis et al. 2018
- Studies have shown increased risk of dissection in anomalous anatomy given longer cervical courses
  - Subsequently, entering the foramen transversarium later than typical anatomy
  - Komiyama et al. 2001

References

Leshen, Michael & Devanagondi, Rajiv & Saul, David & Chaturvedi, Apeksha. (2022). Physiological fetal vascular shunts and failure to regress: what the radiologist needs to know. Pediatric Radiology. 52. 1-17. 10.1007/s00247-022-05302-0.

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