NORMAL NEUROVASCULAR ANATOMY

Michael Meuse, M.D.
Vascular and Interventional Radiology
References

- Dr. David Kallmes
- Introduction to Cerebral Angiography. Osborn
- Clinical Brain Imaging. Hayman and Hinck
Neurovasculature

2 Main Systems
- Carotid
- Vertebrobasilar

Cerebral perfusion depends on multiple sites of anastomosis between the two
Aortic Arch

- Start from the source
- Arch lies in the Superior Mediastinum and courses right to left, anterior to Trachea
- 3 trunks from the arch
  1. Innominate A.(1)
  2. Left Common Carotid(7)
  3. Left Subclavian Artery(8)
Arch Branches

Branches:

1: Innominate Artery  
   (Brachiocephalic trunk)

This splits into the:

2. R Subclavian Artery
3. R Common Carotid Artery
Arch Branches

- The R Subclavian gives rise to R Vertebral Artery (4)
- R Common Carotid (5) splits into R ECA and R ICA in most cases at C3/4 (34%) or C4/5 (45%).
- Can split anywhere between C1 and T2
Arch Branches

- Branch 2 is the L Common Carotid Artery.(7)
- Also splits at approx. C3/4 (34%), C4/5 (45%)
- Branch 3 is the L Subclavian Artery(8) which gives rise to L Vertebral Artery(9)
External Carotid

- Proximal ECA(3) is Ant/Med to ICA(4). As it ascends it courses Post/Lat
- Supplies facial structures
- Splits into terminal branches within Parotid
External Carotid Artery

- SALFOPS
  - S superior thyroid
  - A ascending pharyngeal
  - L lingual
  - F facial
  - O occipital
  - P posterior auricular
  - S superficial temporal
ECA Branches

Branches:
1. Superior Thyroid(1):
   supplies larynx and upper thyroid
2. Asc. Pharyngeal(2):
   supplies meninges, middle ear, lower cranial N’s
ECA Branches

3. Lingual(3): supplies pharynx and hyoid M’s along w. submand. gland and tongue.
5. Occipital(5): Supplies muscles and skin of neck, scalp and post. meninges
ECA Branches

- 7. Sup. Temporal(7): smaller terminal branch of ECA. essentially cutaneous supply. Ant. scalp, parotid, TMJ, ear
Maxillary Artery

- Larger terminal branch of ECA.
- Arises behind the neck of the Mandible
- 3 Main Portions
  1. Mandibular
  2. Pterygoid
  3. Pterygopalatine
Mandibular portion

- courses along the inf. lateral pterygoid M.
- Branches:
  1. Deep Auricular(1)
  2. Anterior Tympanic(2)
  3. Middle Meningeal(3)
  4. Accessory Menin.(9)
  5. Inferior Alveolar(4)
Pterygoid Portion

- Supplies muscles of mastication.

Branches:
1. Buccal Artery (8)
2. Masseteric Artery (7)
3. Middle Temporal (5)
4. Deep Temporal (6)
Pterygopalatine portion

- Branches in PP fossa
  Each branch of the maxillary leaves thru a bony canal or foramen.

Branches:
  Posterior-
  1. A. of Foramen Rotundum (3)
  2. A. of Pterygoid Canal (Vidian a.) (4)
  3. Pharyngeal Artery (5)
Pterygopalatine portion

Anterior-
1. Post/Sup Alveolar A(4)- oral mucosa, teeth
2. Infraorbital Artery(2)- orbit and maxilla
3. Greater Palatine Artery(1)- hard palate
4. Sphenopalatine Artery(3)- nasal turbinates and septum
Cervical ICA

- Arises C3/4
- Runs cephalad deep to the SCM in a neurovasc. bundle with IJ and CNX
- ICA initially is pos/lat to ECA. Courses medially as it ascends.
- Lies medial to IJ
Cervical ICA

- Ends at the Carotid canal of the petrous temporal bone just anterior to Jugular Foramen
- No cervical branches in most people
- Carotid sinus is bulbous dilatation in area of ICA origin
Petrous ICA

- 2 segments:
  1. Vertical
  2. Horizontal
- Initially ascends anterior to the jugular fossa just behind the Eustachian tube
- Horizontal section begins as ICA turns Ant/med in front of tymp cavity and cochlea
Petrinous ICA

Petrinous Branches occur in approx. 30% of patients

1. Vidian Artery(3): Most common branch. Usually arises from Maxillary A.

2. Caroticotympanic A(1).: tiny branch not usually visualized

3. Periosteal Branches
Cavernous ICA

2 segments:
1. Presellar
2. Juxtasellar

Carotid Siphon refers to “S” shaped course of the cavernous ICA as it courses over the sphenoid bone.

Carotid is the most medial structure in Cavernous sinus
Cavernous ICA

3 branches within cavernous sinus:

Cavernous ICA


3. McConnell’s capsular A’s(6): only found in 30% of autopsies. Supply the bony sella.
Intracranial ICA

- ICA pierces the dura on the medial aspect of the Anterior Clinoid process
- Courses superiorly between optic and oculomotor nerves
- 2 terminal branches are the ACA and MCA.
ICA Branches

Branches of the Intracranial ICA include:


2. Ophthalmic A. (8): occasionally arises from ECA or Middle Mening. Courses thru optic canal along inf. Optic Nerve
ICA Branches

Ophthalmic (con’t):
supplies globe and orbital contents via
Ocular(1), Orbital(2), and Extraorbital branches.
3. Post. Communicating
4. Ant. Choroidal
Circle of Willis

Arterial polygon surrounding the ventral surface of the diencephalon.

The “Classic” Circle of Willis is only seen in 20% of people.

Anterior portion consists of ICA’s, ACA’s(A1)(2), and the Ant. Communicating Art.(1)
Circle of Willis

The posterior portion of the circle is made up of PCA’s (P1)(5) and Posterior Communicating Art’s (4).

Most variants occur because of hypoplasia of one or more components.
Anterior Choroidal Art.

Extensive vascular supply including Choroid of temporal horns, Optic tract, Thalamus and Int. Capsule.

Usually arises as a single trunk from the ICA

2 Segments:
1. Cisternal (Proximal)
2. Plexal (Distal)
Anterior Choroidal Art.

Arises from medial ICA curves posteromedially around the uncus(1).
Abruptly kinks as it enters the Choroidal fissure(2)
Plexal portion(3) undulates through the Temporal horn.
Anterior Cerebral Art.

Smaller of the two terminal branches of the ICA.
Courses medial and anterior.
Consists of:
(A1) Horizontal/Precomm. Portion
(A2) Distal/Postcomm. Portion
ACA-A1

Extends from ACA origin to contralateral ACA via Acomm

A1 branches include the Medial Lenticulostriate A’s(2) which supply the anterior perforated substance, subfrontal area, optic chiasm, septum pellucidum, hypothalamus.
One of the MLS branches is the Recurrent artery of Heubner(4). In most cases originates from prox. A2.

Heubner supplies the anterior Internal Capsule and Basal Ganglia
Ant. Communicating Art.

Short artery that joins the Ant. Cerebral A’s
Completes the Anterior Circle of Willis
Common site of congenital berry aneurysm
Multiple small branches from the Acomm not seen on angio. Including supply to limbic areas.
ACA-A2

Extends from Ant. Comm. to distal ACA bifurcation

A2(1) branching is quite variable. Branches include:

ACA-A2

Near the genu of the corpus callosum the ACA(2) divides into two terminal branches.

1. Callosomarginal A.(5): smaller terminal ACA branch. Posterior course in the Cingulate sulcus to supply the medial hemispheres via small Frontal A’s
ACA-A2

2. Pericallosal A.(6): Considered the continuation of the ACA. Its major branch is the Sup. Internal Parietal(Precuneal) A. which supplies the superior Parietal lobe.
Middle Cerebral Artery

The MCA is the larger of the two terminal branches of the ICA.

The proximal MCA (M1) extends lateral and horizontally in the lateral cerebral fissure to reach the sylvian fissure.

M1 gives rise to 6-20 lateral Lenticulostriate A's.
MCA-M1

These Lat. LS(2) vessels supply portions of the Basal Ganglia, Internal Capsule and Caudate.

The Genu of the MCA(3) is the point at which it curves up into the Sylvian fissure.
Sylvian MCA

The MCA divides into major cortical branches 1.5cm from its origin.

Branches first course superiorly over the insula(4)

They then turn inf/lat(5) to pass under and around the opercula to reach the cerebral surface
Cortical MCA branches

Origin and course of MCA branches is highly variable.


Anterior Branches:

3. Operculofrontal A’s. (3); includes all branches anterior to Central Sulcus A’s. Supply middle and inf. Frontal gyri including Broca’s and premotor areas.

Cortical MCA branches

The posterior division of the MCA has 3 major branches.


6. Angular A.(6): terminal continuation and normally the largest cortical branch of MCA.
Angular A. courses post/sup to supply lateral parietal and occipital lobes along with sup. temp. gyrus.

Posterior Cerebral Artery

Important in supply of visual function
PCA originates from terminal Basilar Artery ventral to the midbrain
3 segments:
1. Precommunicating(P1) (3)
2. Ambient(P2)(5)
3. P3
PCA-P1

Lies within the interpeduncular cistern.
Extends from PCA origin to junction with Post. Communicating A.
As it courses Post/Lat around midbrain it gives rise to multiple perforating branches.
P1 branches

1. Thalamoperforating A’s:
   Course sup. thru peduncle and supply Thalamus, Hypothal., CN 3, CN 4, and Post. Int. Capsule.
   Pcomm-Ant. TPA’s(1)
   P1-Post TPA’s(2)

2. Meningeal branches-
   Artery of Davidoff & Schecter
PCA-P2

Extends from the Pcomm to the Post. Midbrain. Courses post. in the ambient cistern parallel to optic tract & Basal V.

Branches include:

Brain stem:

1. Thalamogeniculate A’s: 1-7 branches that supply Thal., Post Int. Capsule, and optic tract
P2 branches

Vent. & Choroid br’s.:  
PCA Cortical branches

Cortical branches:

1. Inferior Temporal A’s: only cortical br. from P2. Supplies Inf. Temp. lobes and Hippocampus

P3 Cortical Branches


4. Splenial A’s(5): small rami off of PCA. Supply the splenium of the corpus callosum.
Post. fossa arteries

Vertebral Art’s(1,2): Left is usually the dominant artery.
Vert. Is the first branch from the Subclavian
Enters transverse foramen of C6
Ascends thru C spine & enters skull at Foramen Magnum
Vertebral Art.

Ant. To Medulla Vert’s unite to form Basilar Art.(10)

Extracranial branches:
segmental branches to vertebrae & supplemental spinal circulation

Intracranial branches:
1. Post. Meningeal A.(2): originates just below F. Magnum. Course Sup/Med to supply Falx
Vertebral Arteries

Branches:

2. Post. Spinal A.: arises from distal Vert. Or PICA. Descends along dorsal medulla and cord as part of a vascular network to cord.

Vertebral Arteries

4. PICA(5-9): largest and most variable branch. 2 segments.
   A. Ant. Medullary segment
   B. Lat. Medullary segment

Supply the Choroid of the 4th Vent., cerebellar hemispheres, vermis, & tonsils
Basilar Artery

Formed by union of 2 Vertebral A’s. adjacent to lower Pons.
Extends along ventral pons terminating in the interpeduncular cistern by forming PCA’s.
Branches: Pontine A’s., Int. Auditory A’s., AICA(5), Sup. Cerebellar A’s(6), PCA’s
Basilar Artery branches

1. AICA (sm. arrow): arises from proximal Basilar Art.

Branches supply the Middle Cerebellar Ped., Choroid, Flocculus.

In 85% of cases the Internal Auditory A’s arise from AICA.
Accompanies Acoustic N. thru Internal Auditory Meatus
2. Superior Cerebellar A’s(3-5): Encircles brainstem. Each SCA has 2 branches.

Lateral SCA: supplies sup/lat cerebelli, sup. Peduncle, dentate nucleus, middle peduncle

Medial SCA: supplies sup. Cerebellum & vermis