Multislice CT angiography versus MR angiography In the evaluation of Sub arachinoid hemorrhage

Essay

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مقارنة بين الاشعة المقطعية المتعددة المقاطع للاوعية و الرنين المغناطيسي للاوعية في تقييم نزيف ما تحت العنكبوتية

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توطئة للحصول على درجة

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Normal Vascular Anatomy
Arterial Anatomy

Circle Of Willis:

The circle of Willis is an important potential source of collateral flow for the intracranial circulation. It is composed of a vascular ring that connects the internal carotid artery (ICA) systems with each other and with the vertebrobasilar circulation.

The following vessels compromise the circle of Willis (Fig.1):

1. Two ICAs.
2. Horizontal (A1) segment of both anterior cerebral arteries.
3. Anterior communicating artery.
4. Two posterior communicating arteries.
5. Horizontal (P1) segment of both posterior cerebral arteries.
6. Basilar artery.

-The anterior circulation is composed of: the internal carotid arteries (ICAs), anterior cerebral arteries (ACAs), anterior communicating arteries (ACoAs).

-The posterior circulation is composed of: the basilar bifurcation,posterior cerebral arteries (PCAs), posterior communicating arteries (PCoAs). **(ALPERS,et.al 1959)**

Branches:

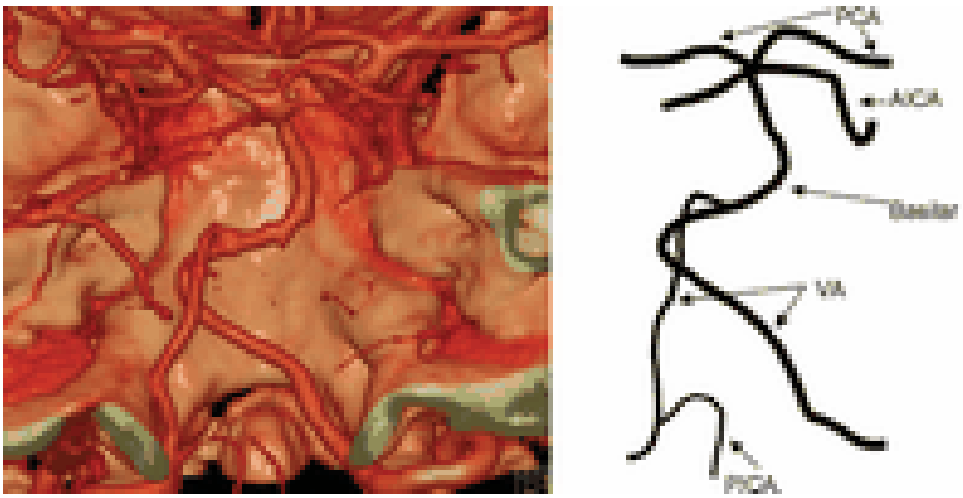
Supply the optic chiasm and tracts, infundibulum, hypothalamus, Structures at the base of the brain:

1. The medial lenticulostriate arteries(from the A1 segment of ACA).
2. Thalamoperforating and thalamogeniculate arteries (from the PCoA, basilar tip, and proximal PCAs).
3. Perforating branches (from the ACoA).**(ALPERS ,et.al 1959).**

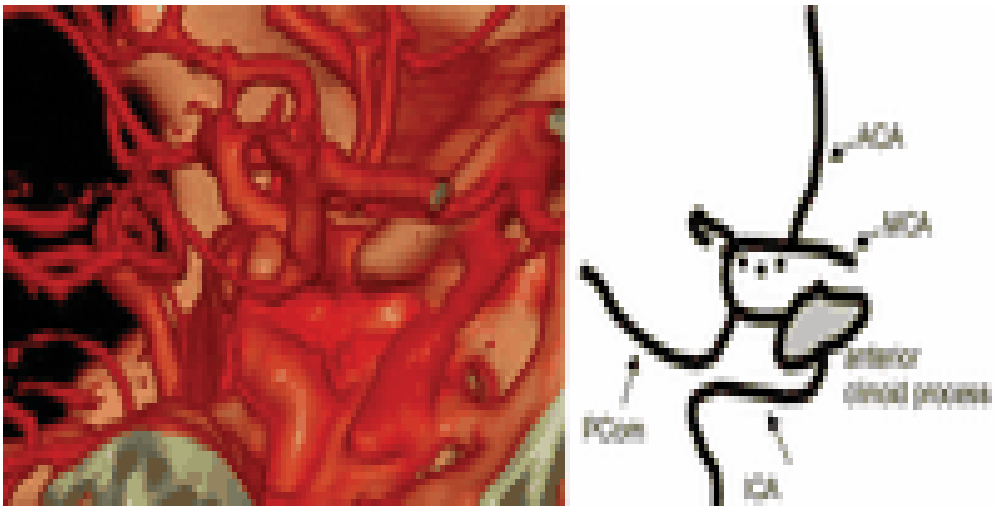
1 A2 segment of R anterior cerebral a. 2 A1 segment of R anterior cerebral a.
3 R anterior communicating a. 4 R posterior communicating a. 5 R superior cerebellar a.
6 basilar a. 7 R posterior inferior cerebellar a. 8 L vertebral a. 9 R internal carotid a.
10 R middle cerebral a. 11 R temporal arteries

Fig. 1: Diagram representing the arteries that compromise the circle of Willis. **(ALPERS, et.al 1959)**

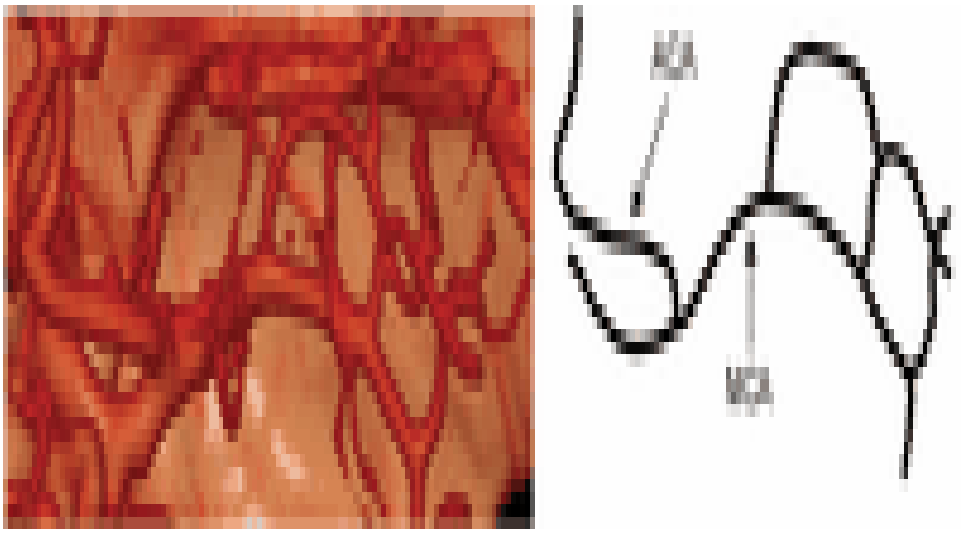
(a) Superior view of all of the intracranial arteries



(b) Posterior view of the basilar and vertebral arteries. c) Lateral view of the intracranialpart of the ICA.



c) Lateral view of the intracranial part of the ICA.



d) Unobstructed view of the MCA bifurcation obtained from a superior angle

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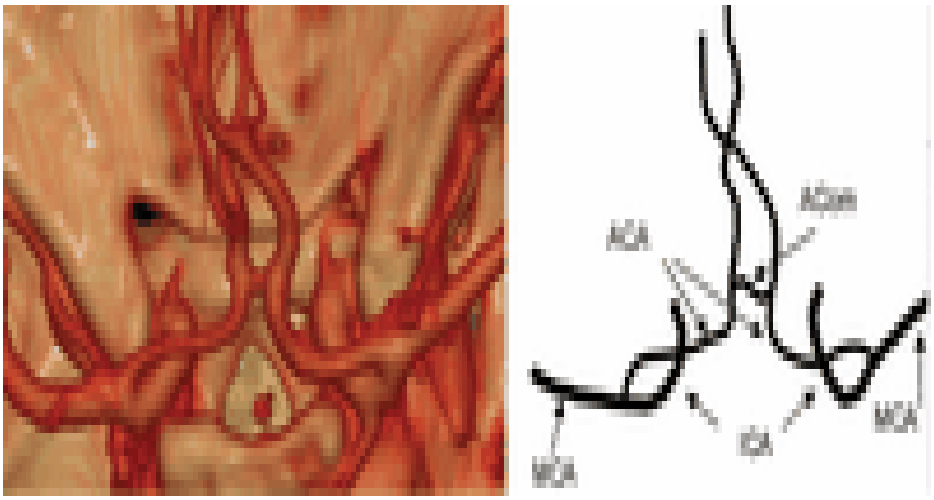

(e) Unobstructed view of the anterior communicating artery (ACom) obtained from a superior angle

(f)Unobstructed view of the anterior communicating artery (ACom) and the bifurcation of the left MCA obtained from an inferior angle

Fig.2 Standard 3D projections obtained by using dVR interactively on the workstation (left) and diagrams of the corresponding arterial anatomy (right). ACA = anterior cerebral artery, PCA = posterior cerebral artery, PCom = posterior communicating artery, VA = vertebral artery.(**Tomandl, et.al 2008**)

Normal variants (Fig. 3and 4):

1. Hypoplasia of one or both posterior communicating arteries (34%).
2. Hypoplastic or absent A1 anterior cerebral artery segment.
3. Fetal origin of the posterior cerebral artery from the ICA with Hypoplastic or absent P1 segment (17%).
4. Infundibular dilatations at the PCoA origin from the ICA are present in 10%of the cases. .(Hartkamp MJ ,et.al 2006)

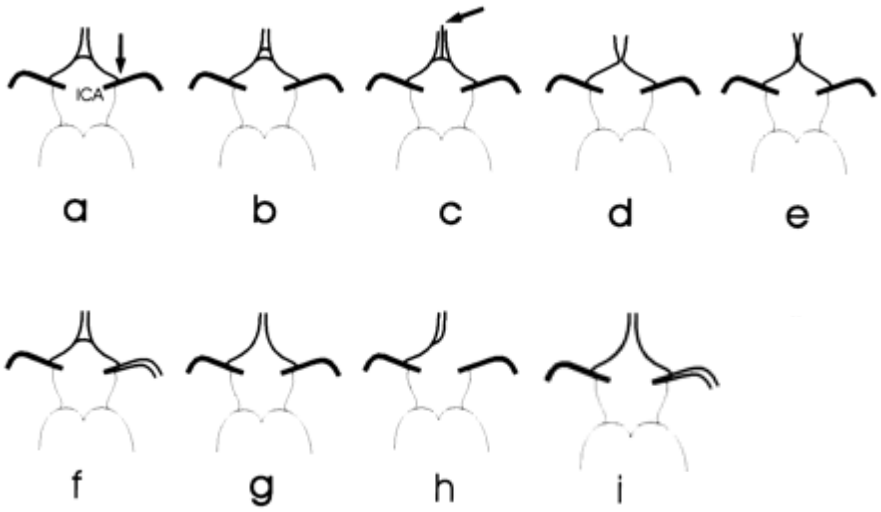

Fig.3 Scheme of anatomic variations of the anterior part of the CW: types a through f are complete, whereas types g through j are incomplete. A) A single ACoA. The ICA bifurcates (arrow) into the A1 segment of the ACA and the MCA. B) Two (or more) ACoAs. C) A medial artery of the corpus callosum (arrow) arising from the ACoA. D) Fusion of the ACAs over a short distance. E) ACAs forming a common trunk and splitting distally into two A2 segments. F) MCA taking origin from the ICA as 2 separate trunks. G) Hypoplasia or absence of an anterior communication. H) One A1 segment shown as hypoplastic or absent, with the other A1 segment giving rise to both A2 segments. i) Hypoplasia or absence of an anterior communication, with the MCA arising as 2 separate trunks **.(Hartkamp MJ ,et.al 2006)**

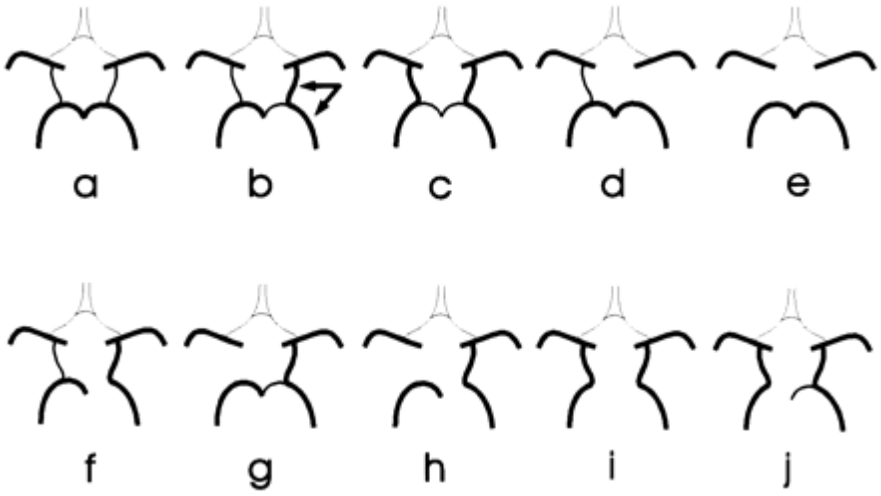

Fig.4 Scheme of anatomic variations of the posterior part of the CW: variant types a through c are complete, whereas the remainder are incomplete. A) Bilateral PCoA present .B) PCA originating predominantly from the ICA. This type is known as a unilateral fetal type PCA (FTP), indicated by the arrows; the PCoA on the other side is present. C) Bilateral FTP, with both P1 segments patent. D) Unilateral PCoA present. E) Hypoplasia or absence of both PCoAs, with isolation of the anterior and posterior circle parts at this level. F) Unilateral FTP, with hypoplasia or absence of the P1 segment. g, Unilateral FTP,with hypoplasia or absence of the contralateral PCoA. H) Unilateral FTP, with hypoplasia or absence of the P1 and PCoA. I) Bilateral FTP, with hypoplasia or absence of both P1 segments. J) Bilateral FTP, with hypoplasia or absence of one P1 segment. **(Hartkamp MJ, et.al 2006)**

Anomalies:

- Congenital absence of one or both ICAs.
- Intrasellar intercarotid communicating arteries are common if one ICA is absent(although this is an uncommon anomaly , it is important to identify its presence when considering cerebrovascular or transphenoidal surgery).

- There is also a high incidence of intracranial aneurysm associated with ICA agenesis.
- **Carotid-vertebrobasilar anastomosis:** represent persistent embryonic channels between the embryonic aorta (which forms the caudal carotid artery) and the paired longitudinal neural arteries (which form the basilar and the vertebral arteries) which may fail to regress , resulting in a congenital carotid basilar or vertebral anastomosis. **(Hartkamp MJ ,et.al 2006)**

1. Primitive trigeminal artery (PTA):

The most common anastomosis present in 0.1% to 0.6% of cerebral angiograms. In utero the embryonic trigeminal artery supplies the basilar artery before the posterior communicating and vertebral arteries develop. As these vessels emerge, the PTA normally disappears. Course: arises where the ICA exits the carotid canal and enters the cavernous sinus then runs posteriorly along the trigeminal nerve (41%) or crosses over or through the dorsum sella (59%) before joining the basilar artery. PTA has an incidence of intracranial aneurysms and vascular malformations. **(Tomandl, et.al 2008)**

2. Primitive hypoglossal artery (PHA):

The second most common anastomosis. Course: through the hypoglossal canal , parallels cranial nerve (CN) XII through part of its course ,and connects the cervical ICA with the basilar artery

.It is demonstrated in 0.027% to 0.26% of cerebral angiograms when presents PHA is functionally a single artery that supplies the brainstem and cerebellum **(Tomandl et al, 2008)**

3. Less common anastomosis: persistent otic artery (POA)and proatlantal intersegmental artery (PIA)

a. POA: is seen as a short arterial segment that originates from the petrous ICA then project medially through the internal auditory meatus and joins the caudal basilar artery. Because the vertebral arteries may be hypoplastic or absent, POA may be the major or sole arterial supply to the basilar artery.

b. PIA: is a sub occipital anastomosis between the external carotid artery (ECA) or cervical ICA and a vertebral artery, typically courses between the arch of C1 and the occiput. **(Tomandl ,et.al 2008)**

Cerebral Arteries:

Distal internal carotid artery (supraclinoid segment) terminates by bifurcating into the anterior cerebral artery and middle cerebral artery:

1. Anterior cerebral artery (ACA) (Fig5) :

Is the smaller of the two terminal ICA branches. The ACA has several major segments ,each of which has important branches:

a. **Horizontal (A1) segment**: extends medially from the ACA origin to its junction with the ACoAs. Deep perforating branches, the medial lenticulostriate arteries, arise from the A1 segment and pass cephalad through the anterior perforated substance. These small vessels usually supply the head of the caudate nucleus and anterior limb of the internal capsule. **(Osbron, 1994).**

b. **A2 segment**: it includes the ACA from its junction with the ACoA to its bifurcation into the pericallosal and callosomarginal arteries, it courses cephalad in the cistern of the lamina terminals and curves around corpus callosum genu. The recurrent artery of Heubner is a lenticulostriate branch that typically arises from the proximal A2 segment (50% of cases) (sometimes the recurrent artery arises from A1 44% or, less commonly, the ACoA). Two cortical vessels, the orbitofrontal and frontopolar arteries also arise from A2 segment.As the A2 segment courses superiorly within the interhemispheric fissure, it bifurcates near the callosal genu into the main terminal ACA branches, the pericallosal and callosomarginal arteries. **(Osbron, 1994).**

c. **Cortical (A3) branches and vascular territory**: supply the anterior two thirds of the medial hemispheric surfaces plus a small superior area that extends over the convexities. **(Osbron, 1994).**

Variants and anomalies:

•Hypoplastic or absent A1 segment:

Seen in 5% to 18% and duplicated ACoA, seen in10% of all cases.

• Azygos ACA :

is a solitary unpaired vessel arises as a single trunk from the confluence of the horizontal (A1) segments of the right and left **ACAs**.This is often associated with other intracranial anomalies such as lobar holoprosencephaly and saccular aneurysm.

• Bihemispheric ACA:

More common, sends branches to the contra lateral hemisphere here, separate right and left ACA vessels are present, but one is dominant and sends branches to both hemispheres, whereas the other is hypoplastic and may terminate in an orbitofrontal or frontopolar branch.

• Other variants:

Infraoptic ACA origin, duplicated ACA, fenestrated arteries are associated with intracranial aneurysms. **(Osbron, 1994.)**

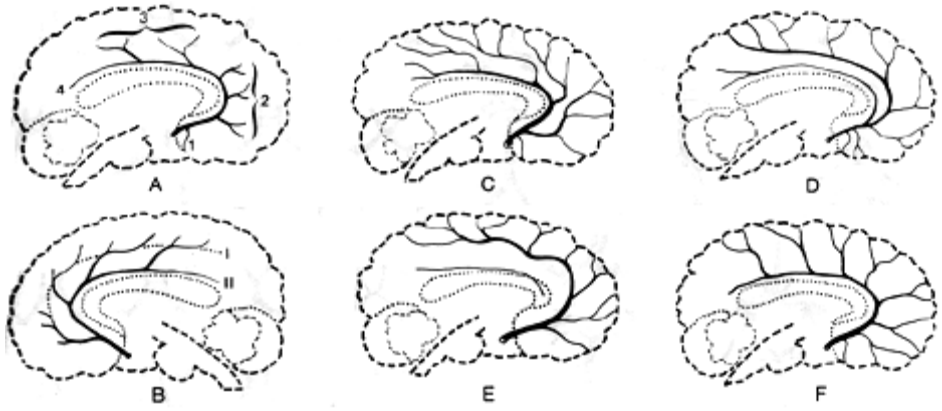

Fig.5

A,B: branches of the anterior cerebral artery. 1, orbital branch; 2, precallosal branch; 3, supracallosal branch; 4, pericallosal branch; I, cingulate arch; II, pericallosal arch.

C (type I) A single large stem whose branching pattern runs over the corpus callosum forming the arcus pericallosus.

D (type II) Two separate arched vessels, one smaller inner and a larger branched outer

vessel forming an arcus pericallosus and arcus cinguli.

E (type III) A detached inner vessel forming an incomplete arcuspericallosus.

F (type IV) this type has an incomplete arcus cinguli.

(Osbron, 1994).

2.Anterior communicating artery (ACoA) (Fig6) :

It is technically part of the circle of Willis, not a true ACA branch, however most investigators treat the ACA and ACoA as a single complex.

Perforating branches: tiny important vessels, may supply parts of the lamina terminals and hypothalamus, anterior

commissure, fornix, septum pellucidum, paraolfactory gyrus, the subcallosal region, and the anterior part of the cingulate gyrus occasionally may supply part of the medial hemisphere beyond the callosal genu. **(Osbron, 1994).**

3. Middle cerebral artery(MCA):

It is divided into several major segments:

A. Horizontal (M1) segment: extends laterally from its origin at the ICA bifurcation to its bifurcation or trifurcation at the sylvian fissure. Deep perforating branches, the lateral lenticulostriate arteries arise from M1 segment and courses superiorly to supply the lentiform nucleus as well as part of the internal capsule and caudate nucleus.

B. Insular (M2) segment: at its genu the MCA divides into insular (M2) branches, they loop around the insula and then pass laterally to exit from the sylvian fissure.

C. Opercular (M3) segments: they emerge from the sylvian fissure and ramify over the hemispheric surface. Variants and anomalies: less frequently seen. Fenestration , duplication, single and accessory arteries, seen in less than 5% of cases.

Variants and anomalies: less frequently seen. Fenestration , duplication, single and accessory arteries, seen in less than 5% of cases.**(Lazorthes G, et.al 1989)**