由醫學影像看神經解剖

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Rationale(安排此課程的理由)：

此課程讓同學對照彩色的病理解剖圖片與臨床上最常用的CT、MRI灰階影像。課程中再穿插重要解剖位置常見的疾病，引發同學對神經解剖的興趣，不把解剖學當作一門冷冰冰的學問

Objective(學習目標)：

1.認識大腦各腦葉、小腦之CT、MRI解剖。

2.認識Basal ganglia之詳細CT、MRI解剖構造。

3.認識Brainstem之詳細CT、MRI解剖構造。

4.在MRI中辨認第二對(optic nerve)，第三對(oculomotor n.)，第五對(trigeminal nerve)，第七及第八對(facial nerve and acoustic nerve)顱神經。

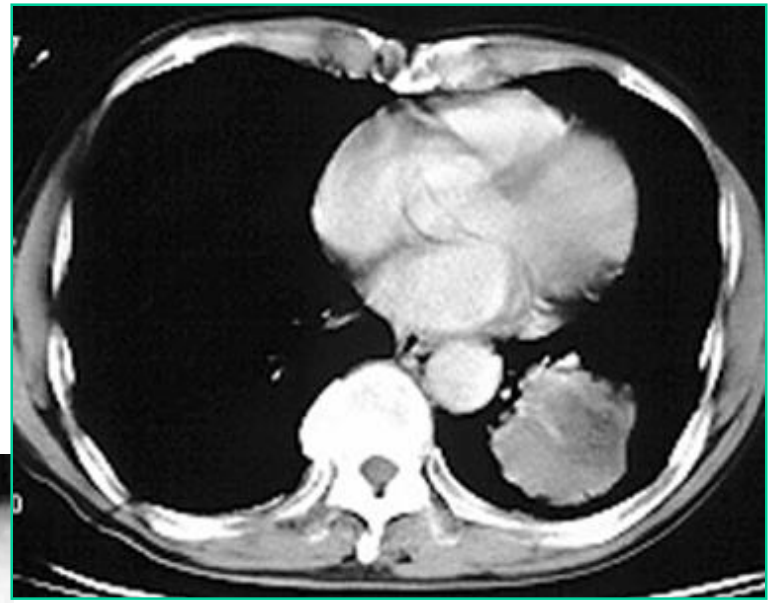
5.認識蛛蜘網膜下腔(subarachnoid spaces)：腦室、腦池、腦裂、腦溝。

6.認識cortico-spinal tract (pyramidal tract)。

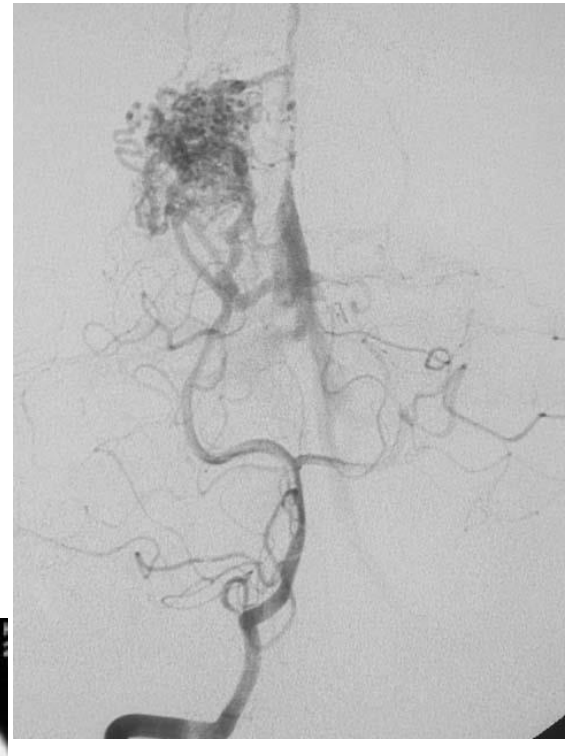
7.認識頸動脈、前、中、後腦動脈，basivertebral arteries，circle of Willis。
認識前、中、後腦動脈的血流供應區。

8.認識 pituitary gland 的構造及功能。

醫學影像的種類



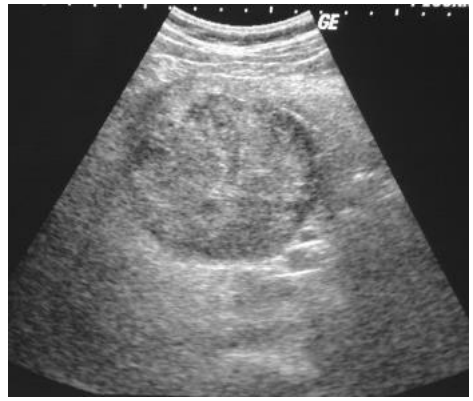
CT



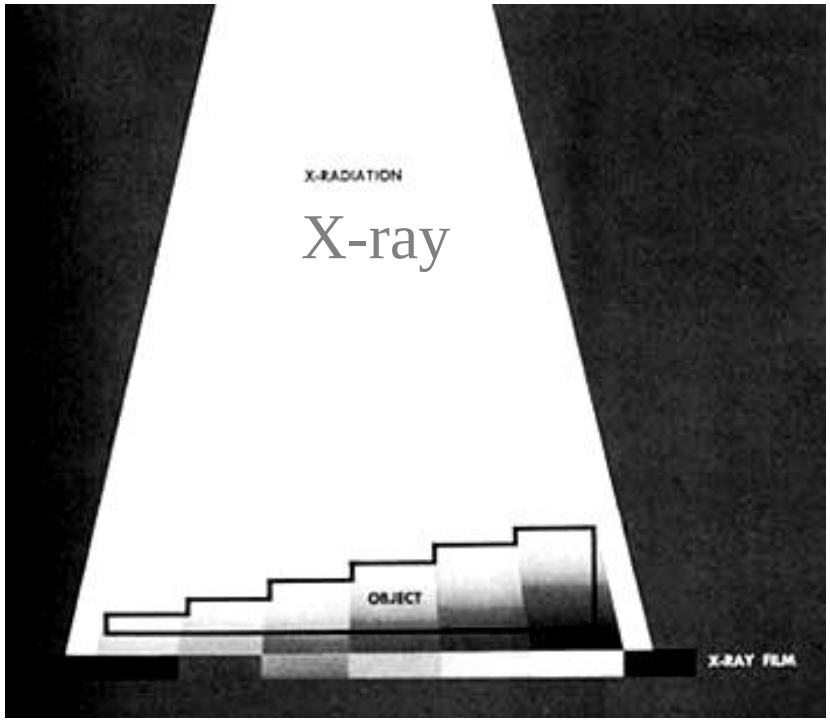
angiography

X-ray

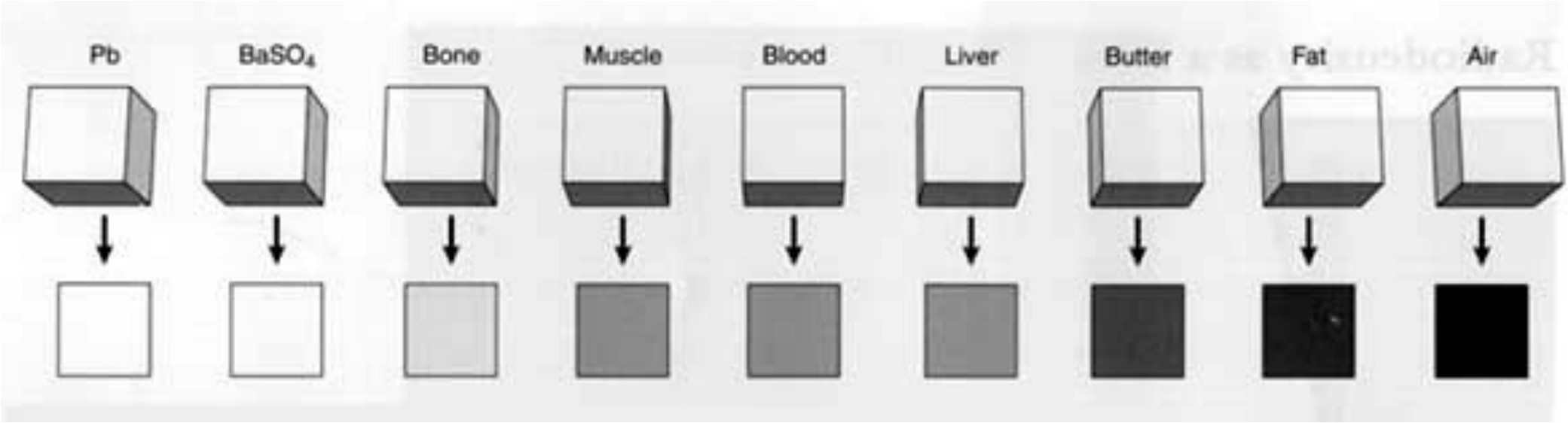
MRI



sonography

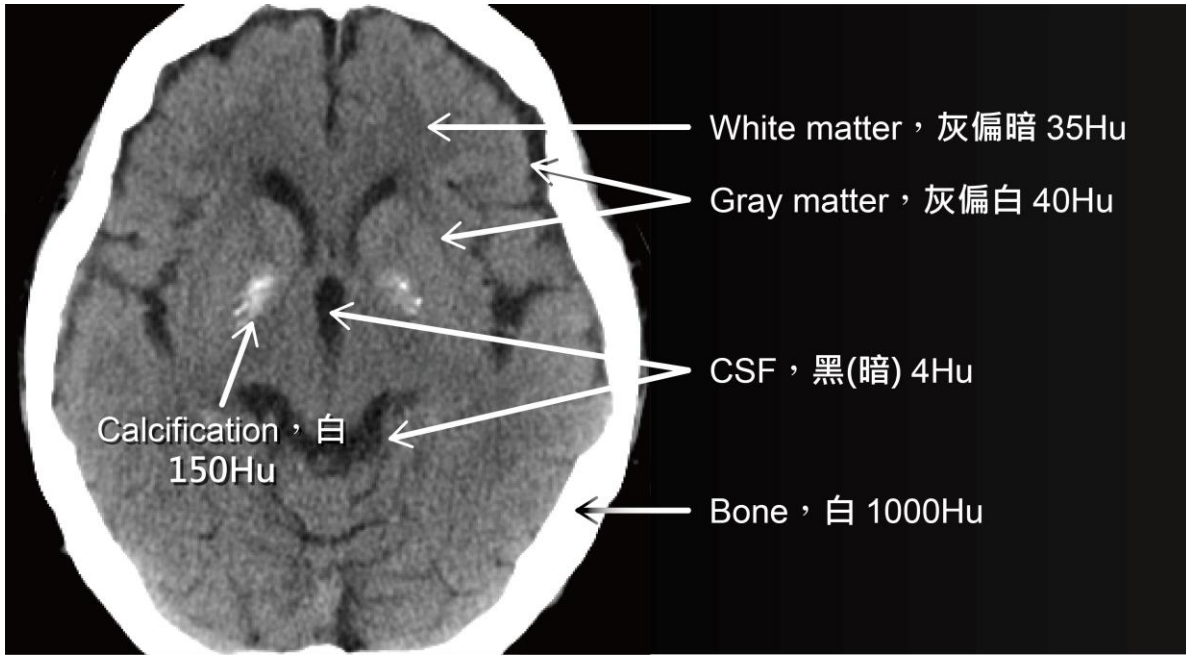


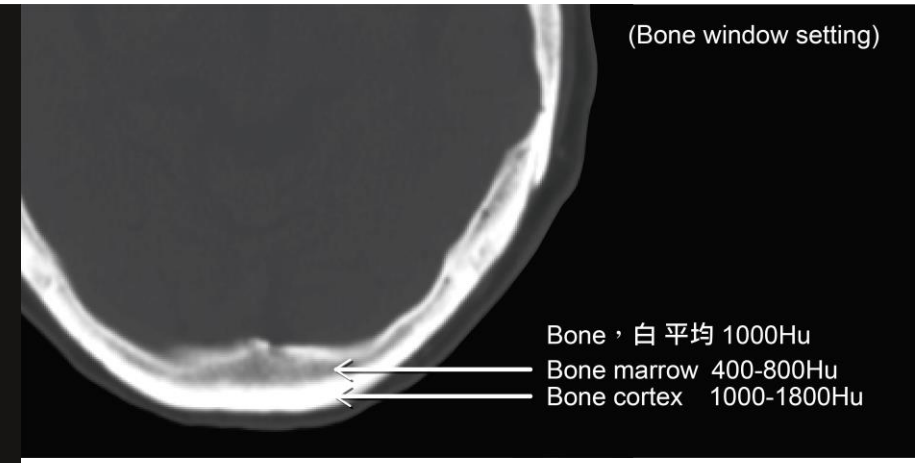
X-ray attenuation
(X-光的衰减)

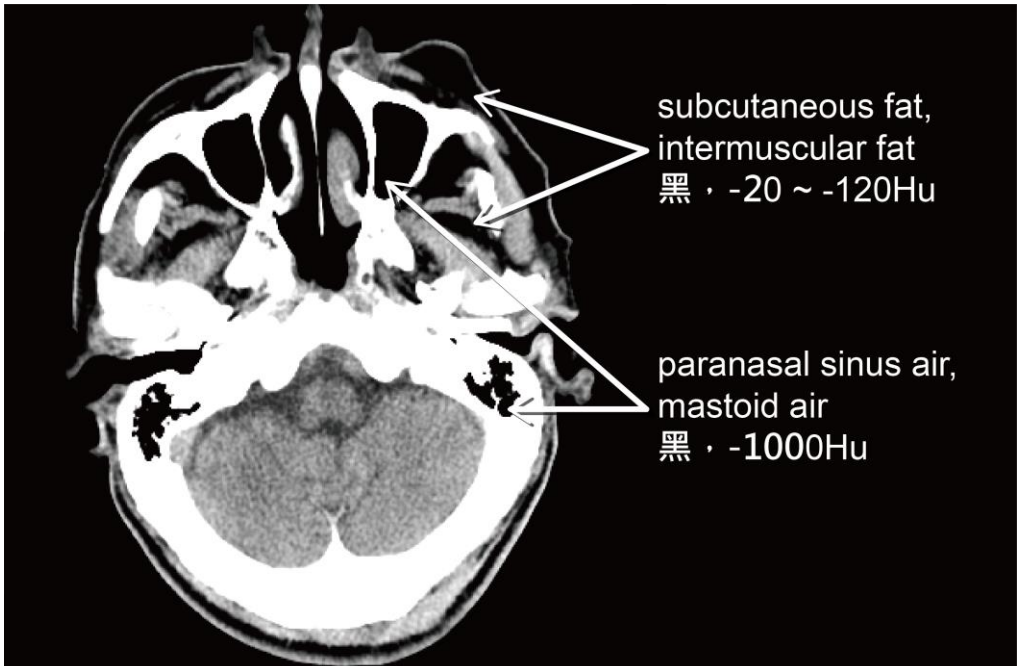


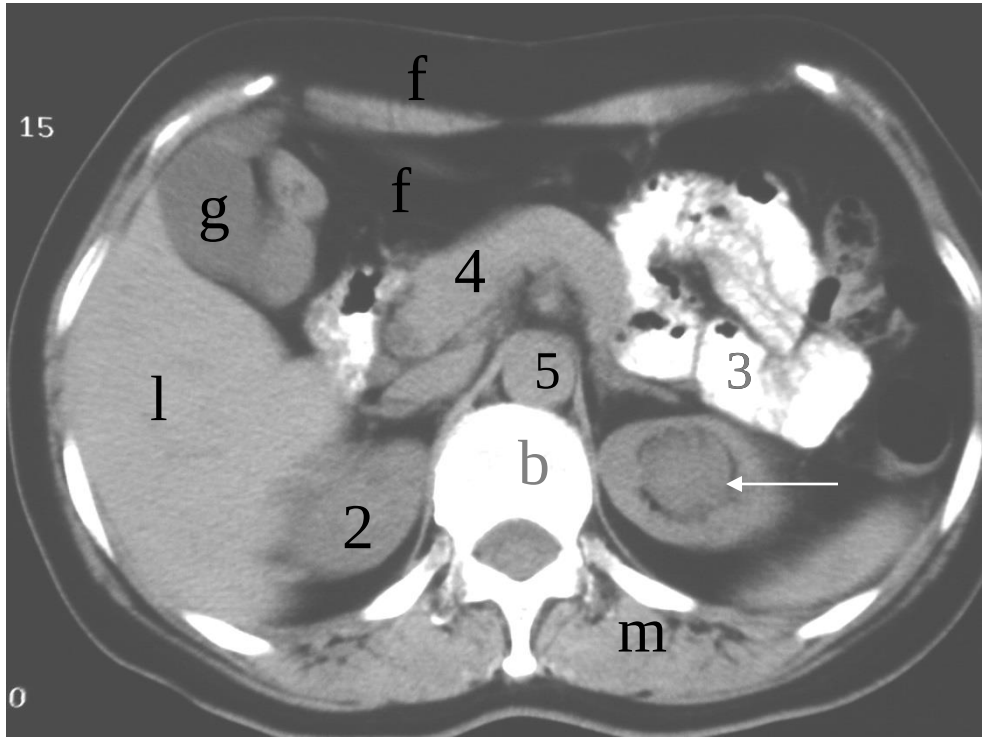
CT gray scale

Tissue and pathology	Hu	Density
金屬		產生假影
骨頭 cortex	1000-1800	白
骨頭 bone marrow	400-800	白，bone window 下灰暗
鈣化	100-500	白
血塊(急性)	60-90	白
軟組織	35-45	灰
軟組織水腫(soft tissue edema)	15-30	灰暗，有壓力
軟組織壞死(例如encephalomalacia)	10-20	灰暗
體液(例如CSF)	2-4	黑
水	0	黑
脂肪	-20~-120	黑
空氣	-1000	黑


White matter，灰偏暗 35Hu
Gray matter，灰偏白 40Hu
CSF，黑(暗) 4Hu
Calcification，白
150Hu
Bone，白 1000Hu

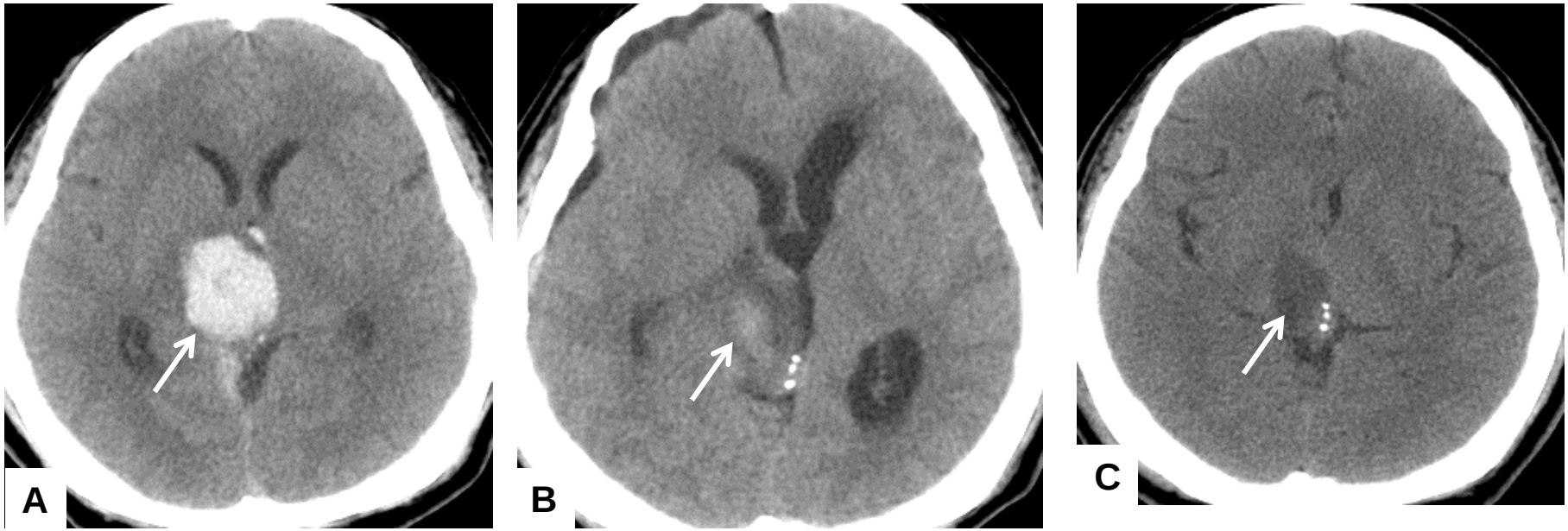

(Bone window setting)
Bone，白 平均 1000Hu
Bone marrow 400-800Hu
Bone cortex 1000-1800Hu


subcutaneous fat,
intermuscular fat
黑，-20 ~ -120Hu
paranasal sinus air,
mastoid air
黑，-1000Hu



m: muscle, soft tissue
35-45Hu
l: liver, 50Hu
g: gall bladder, 10Hu
b: bone, 1000Hu
f: fat, -20 ~ -120Hu

1. 肝臟　2. 腎臟，
3. 腸子內有喝下的含碘對比劑，變白色
4. 胰臟，注射對比劑後稍微變白
5. 血管



1st day 74Hu

26th day 46Hu

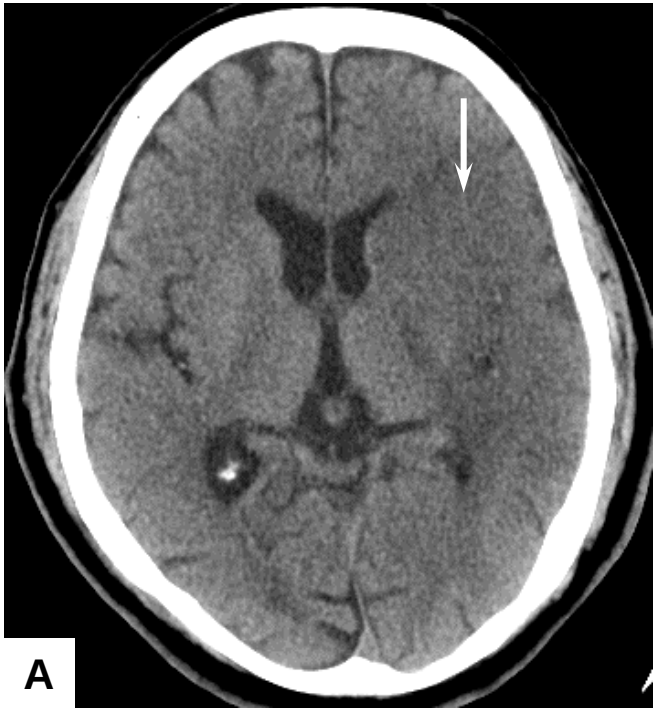
50th day 24Hu

腦內血腫 (intracerebral hematoma, ICH) 的演變

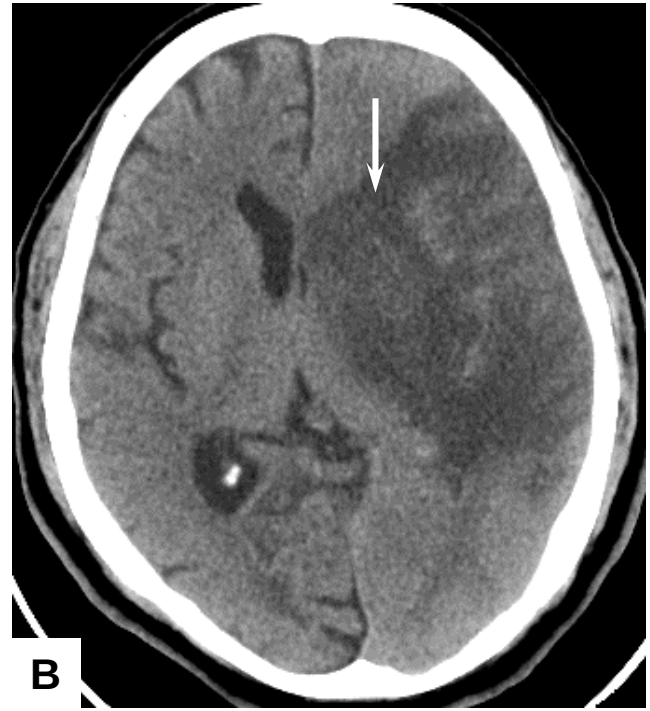
CVA due to right thalamic hemorrhage

在CT, 新鮮的血塊是白的(A), 隨著時間逐漸變淡(B), 變灰暗(C)，

當血塊變灰暗時，很容易被誤為是brain tissue edema (C).



24-28 Hu



10-16 Hu

3腦組織水腫(brain tissue edema)
MCA infarction
腦組織水腫，變暗之外，有腫塊效應(mass effect) (注意: sulci 消失)。
(A)Infarction 第1天，早期brain tissue edema, density 稍降為灰暗(24-28H)，mass effect 不強。
(B)Infarction 第4天，brain tissue edema 達最高峰, density 降得更暗(10-16H) ，mass effect 很強。

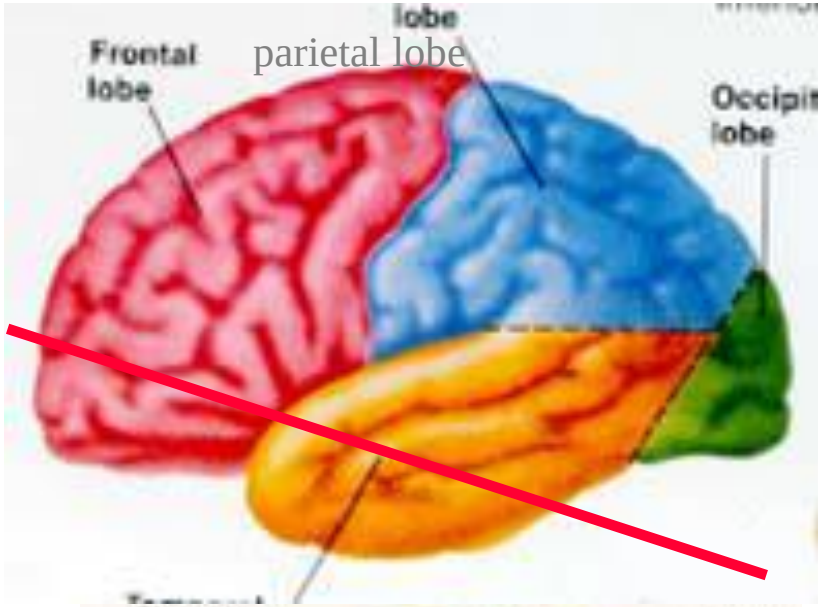
雙側紋狀體(corpus striatum) 鈣化。

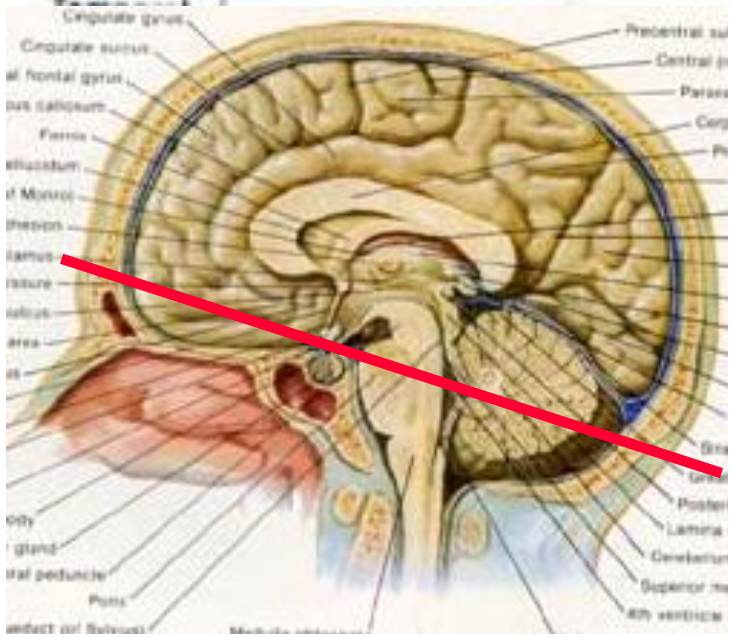
Calcification: 100-500 Hu

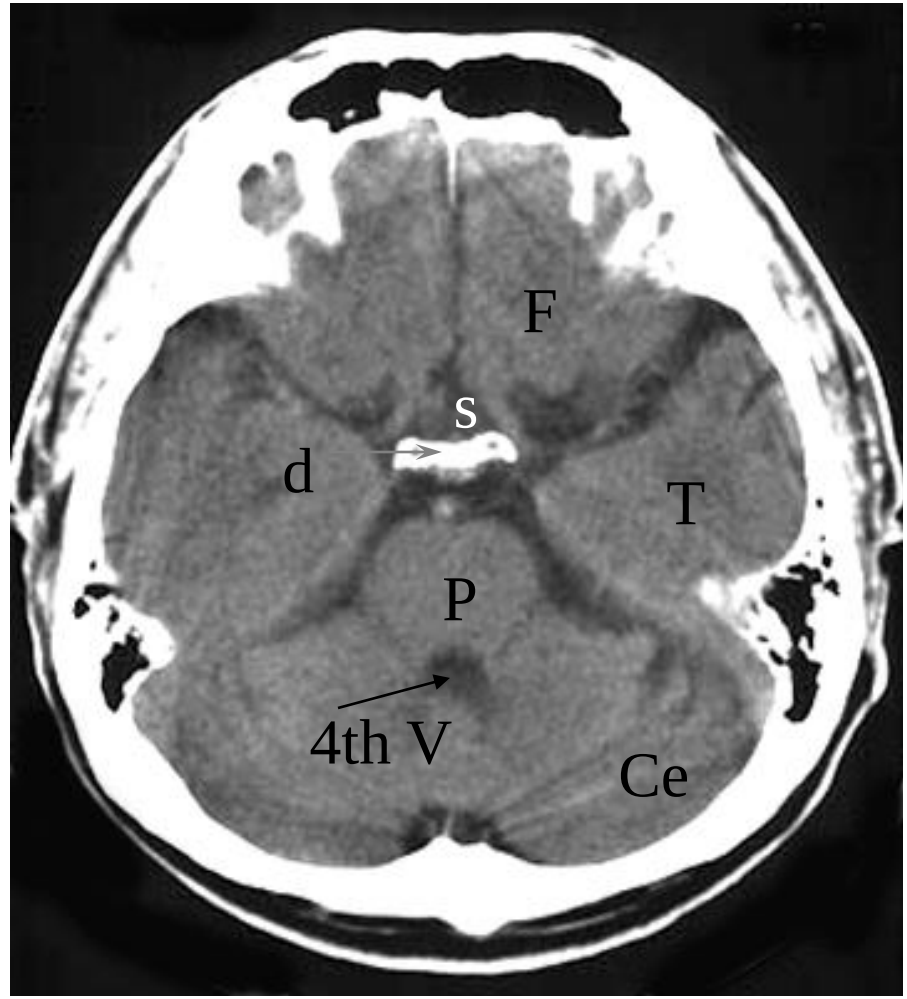
鈣化是白色的，通常雙側對稱性存在。

認識CT of Brain 的解剖

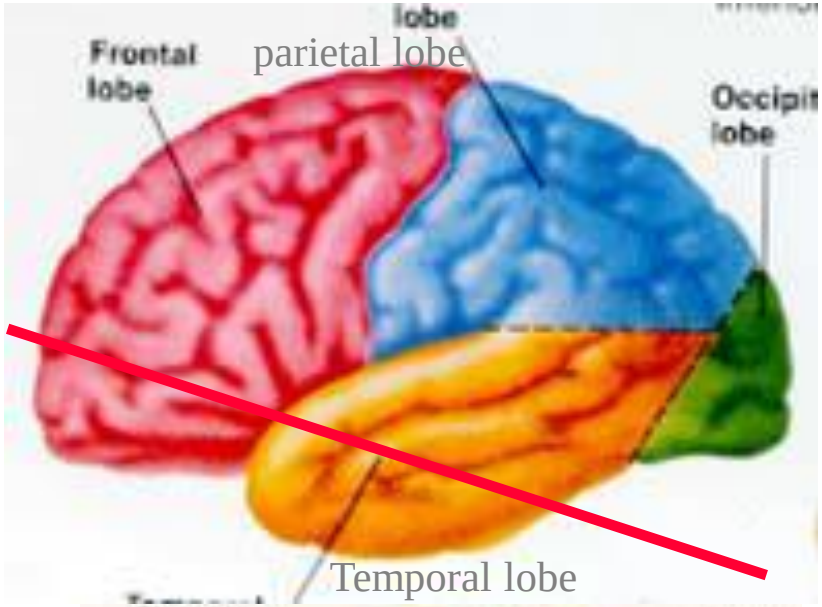
- Brain parenchyma (腦實質)
  - frontal lobe, temporal lobe, parietal lobe, occipital lobe, cerebellum, basal ganglia, brainstem, corpus callosum
- Subarachnoid spaces (蜘蛛網膜下腔, CSF spaces)
  - Ventricles (腦室)--- lateral, 3rd, 4th ventricles
  - Cisterns (腦池)--- suprasellar, quadrigerminal cisterns….
  - Fissures (腦裂)--- Sylvian, interhemispheric fissures…
  - Sulci (腦溝)

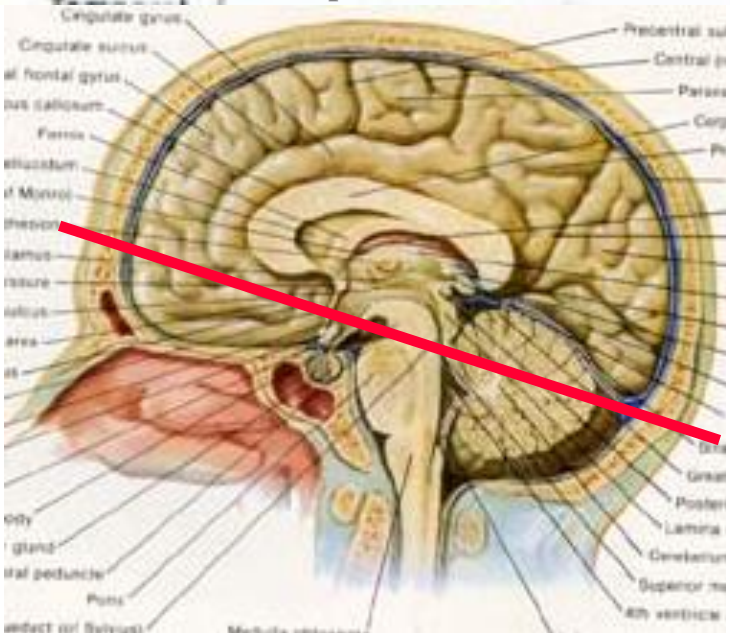


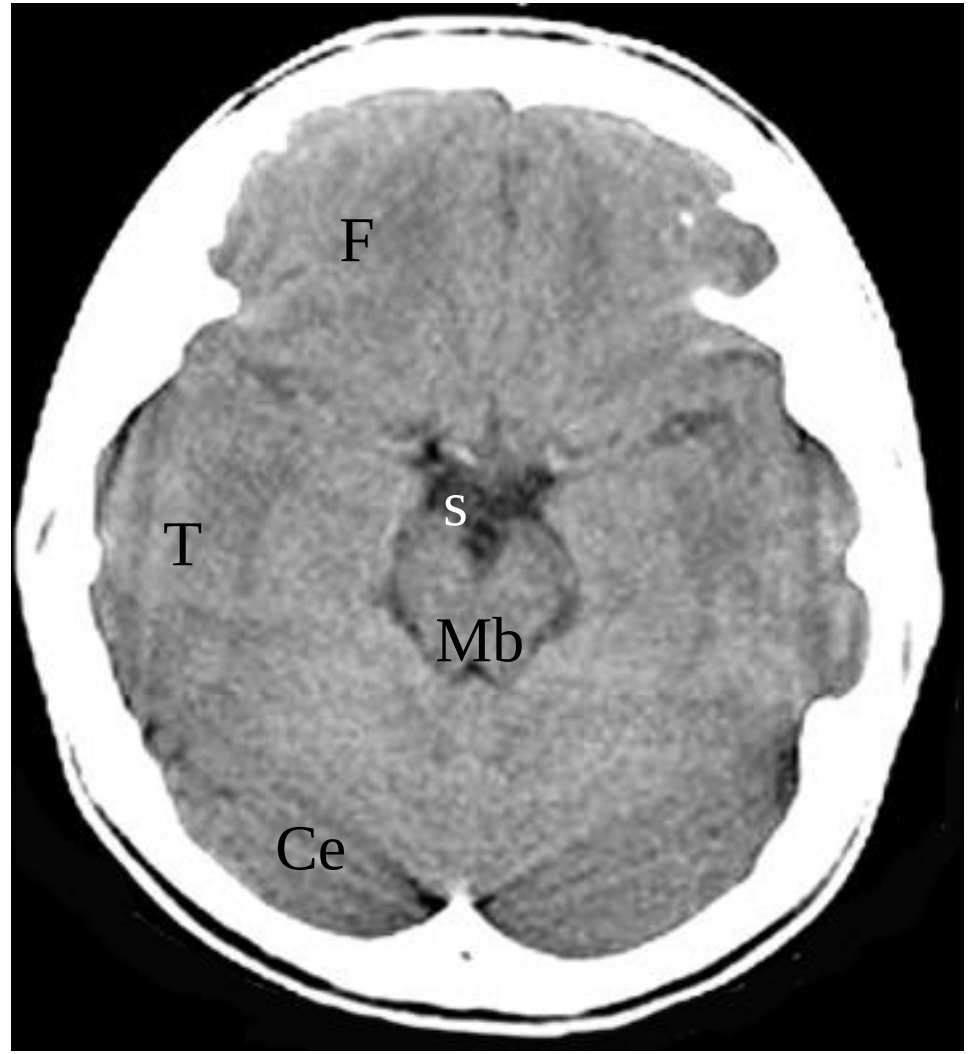




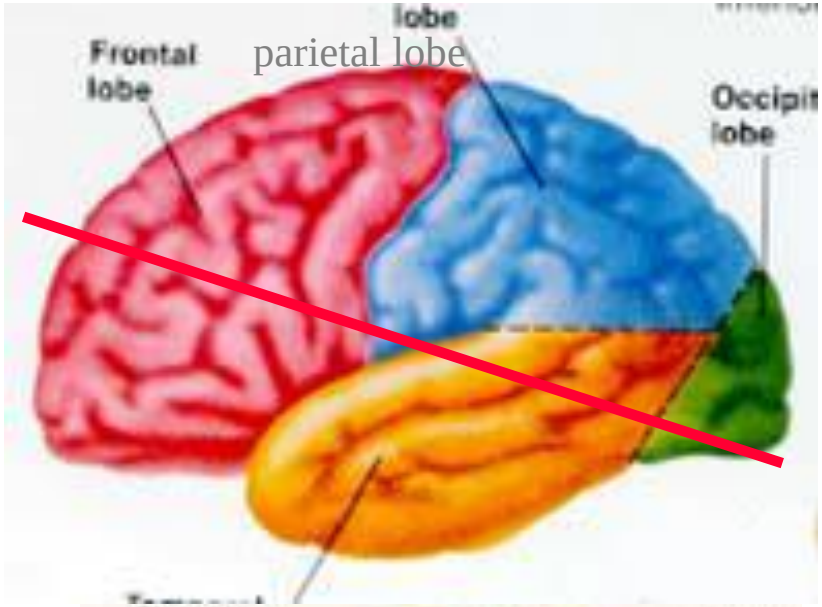
F: frontal lobe（額葉）　P: pons(橋腦)
T: temporal lobe（顳葉）
s: suprasellar cistern (碟鞍上腦池)
Ce: cerebellum（小腦）d: dorsum sella(蝶鞍背)

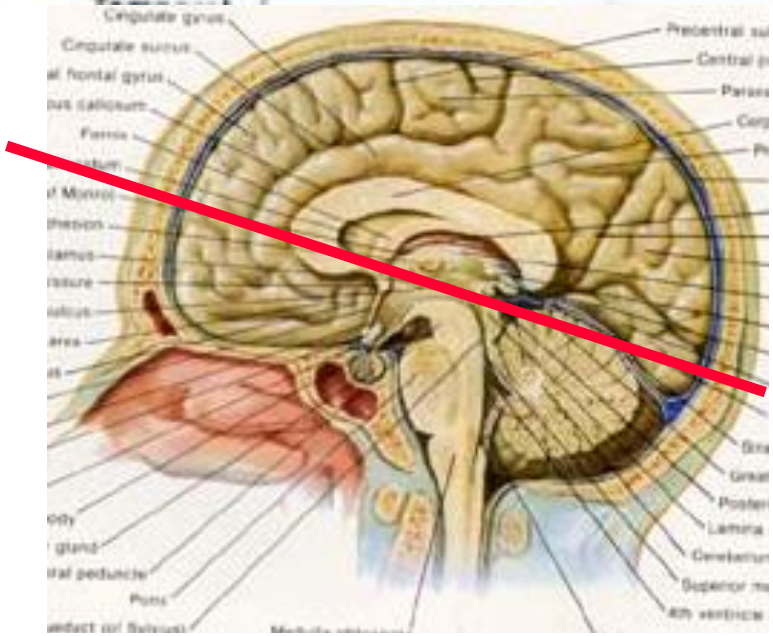


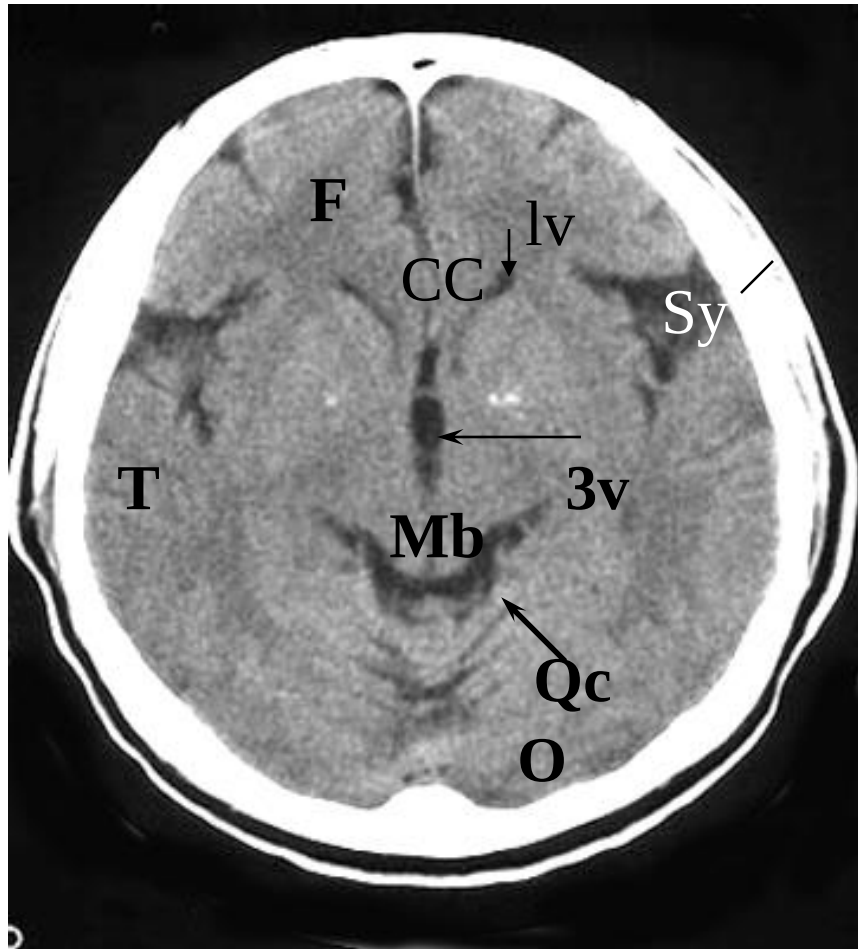




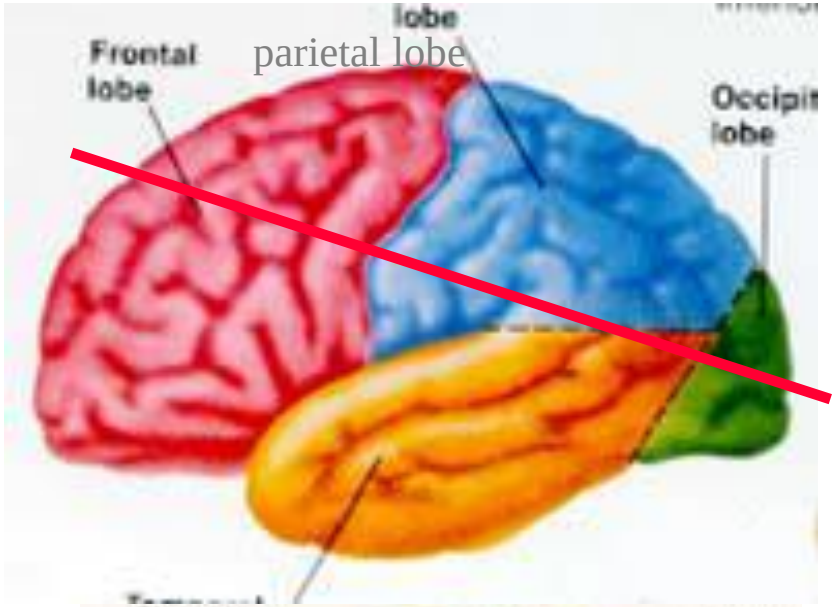
F: frontal lobe (額葉) Mb: midbrain(中腦)
T: temporal lobe(顳葉)
s: suprasellar cistern (碟鞍上腦池)
Ce: cerebellum(小腦)

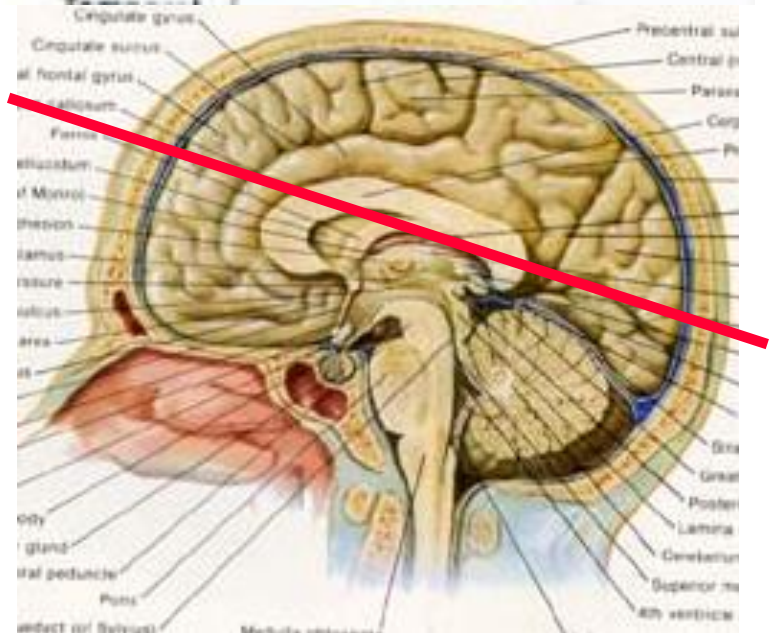


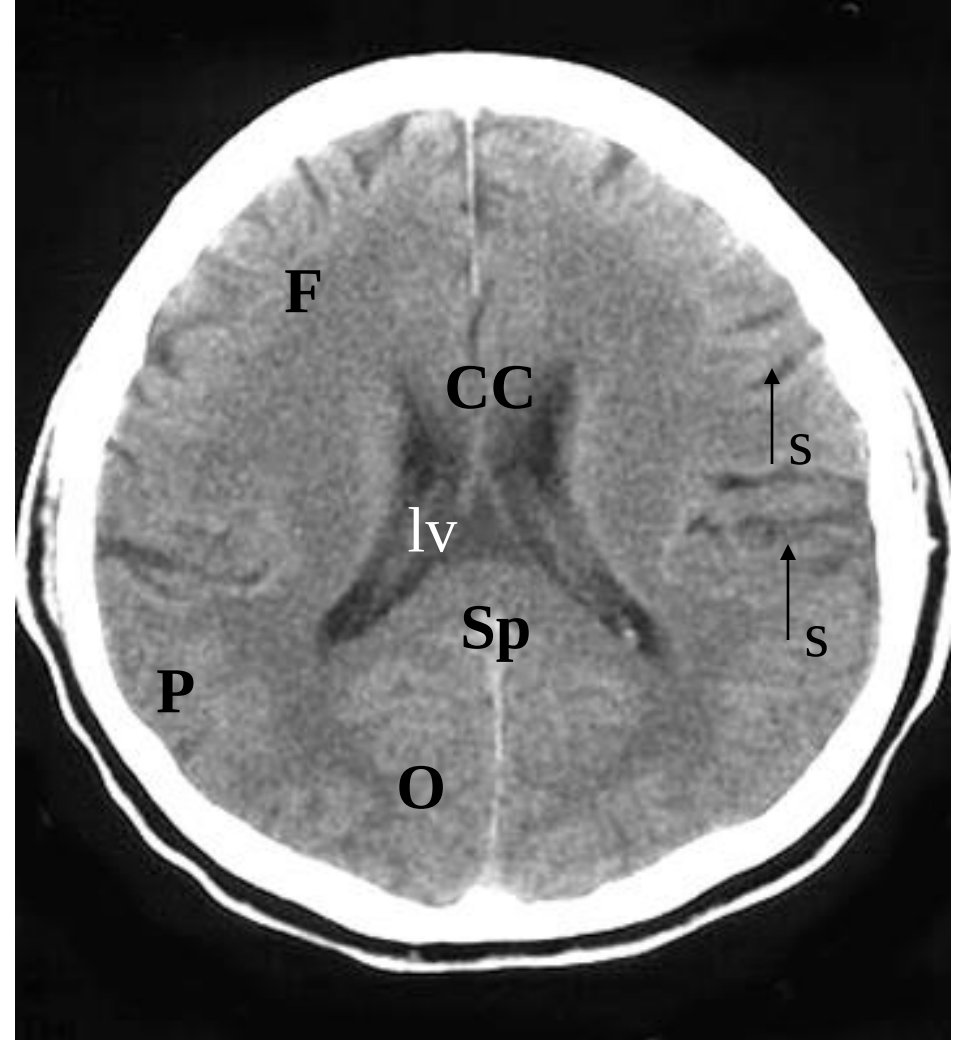




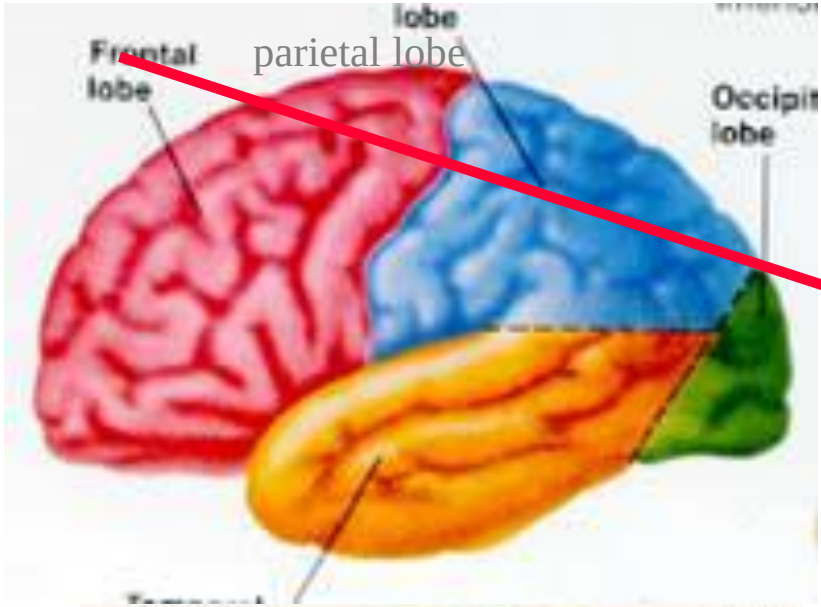
F: frontal lobe(額葉)　Sy: Sylvian fissure(薛氏裂)
T: temporal lobe(顳葉)　O: occipital lobe(枕葉)
Mb: midbrain(中腦)　3v: 3rd ventricle(第三腦室)
lv: lateral ventricle(側腦室)
CC: corpus callosum (genu)(胼胝體(膝部))
Qc: quadrigerminal cistern (四疊體腦池)

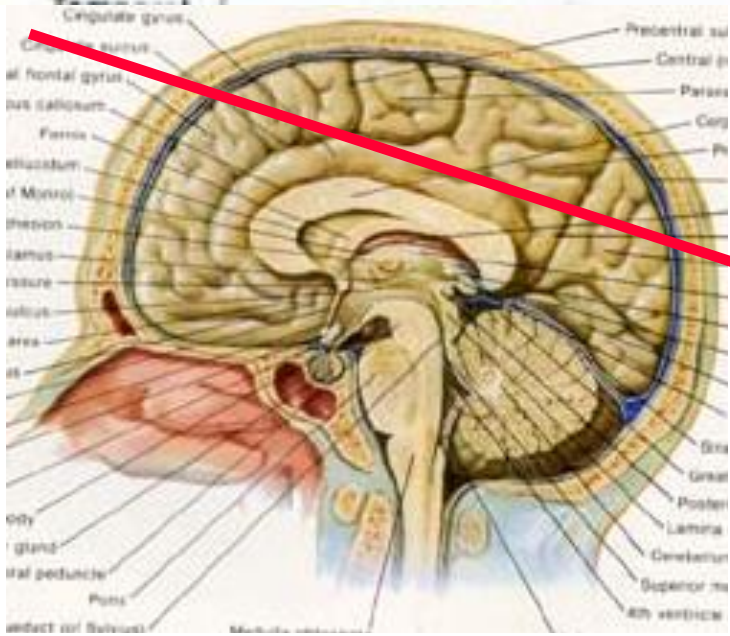


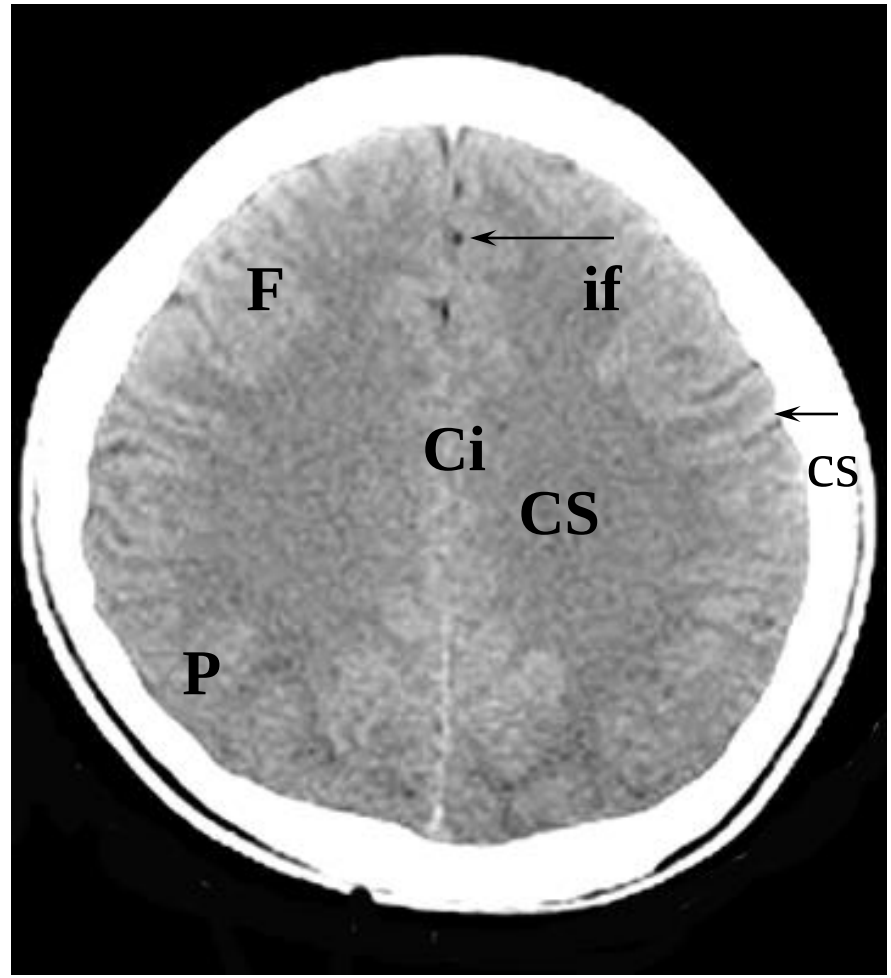




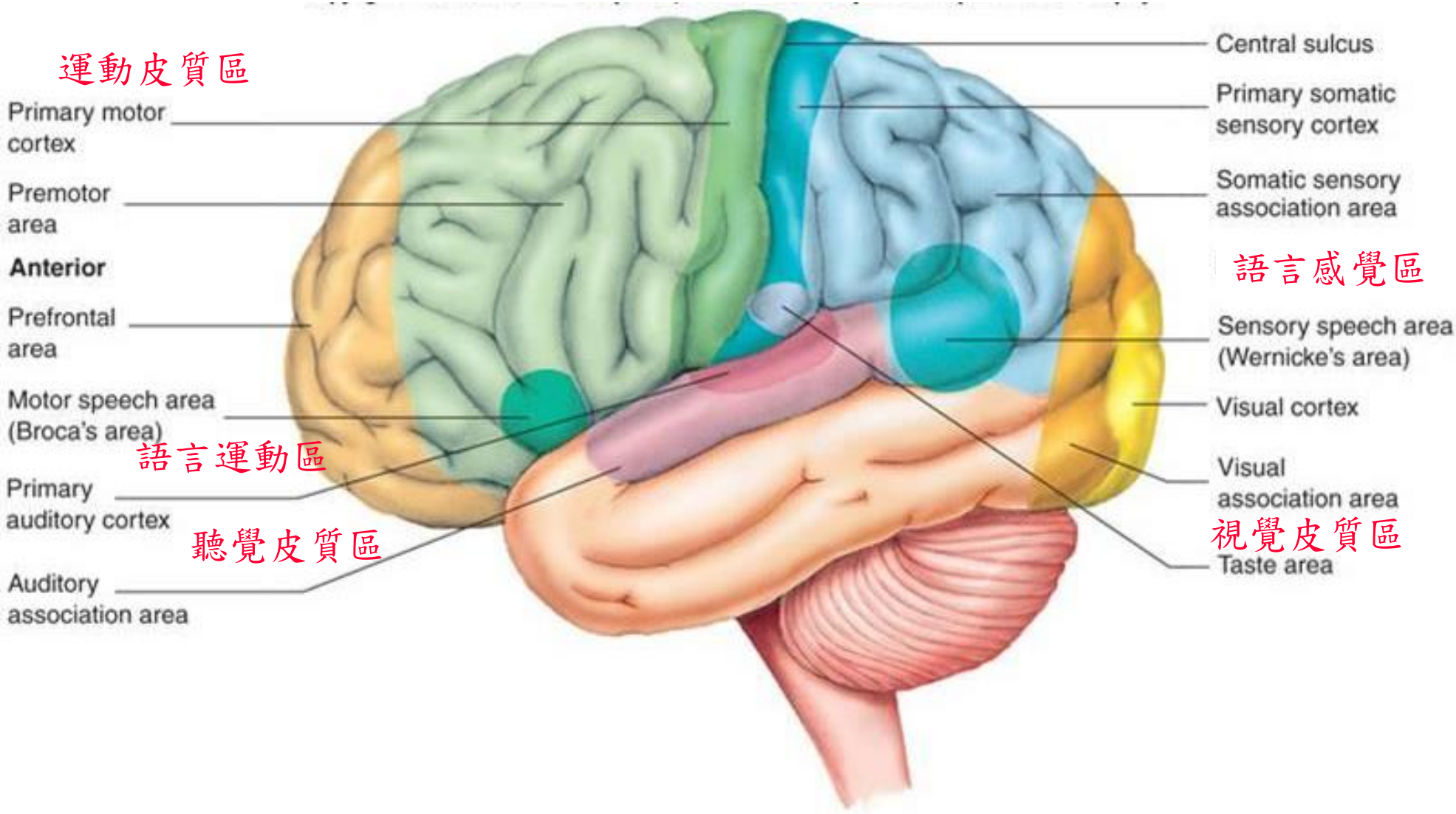
F: frontal lobe CC: corpus callosum(胼胝體)
P: parietal lobe Sp: splenium of CC(胼胝體壓部)
O:occipital lobe lv: lateral ventricle
s: sulcus(腦溝)

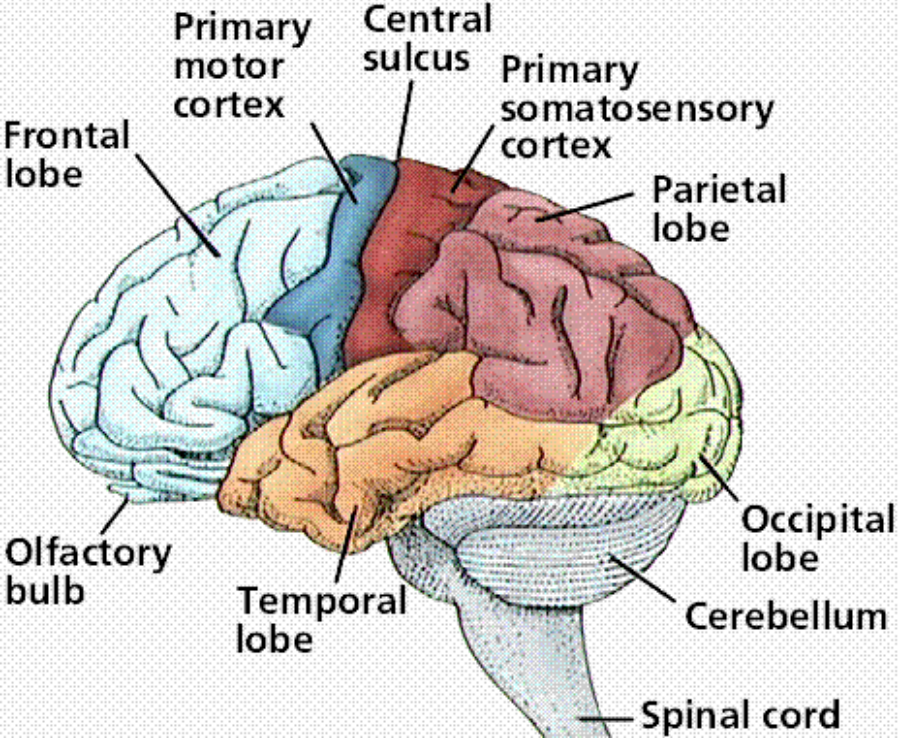


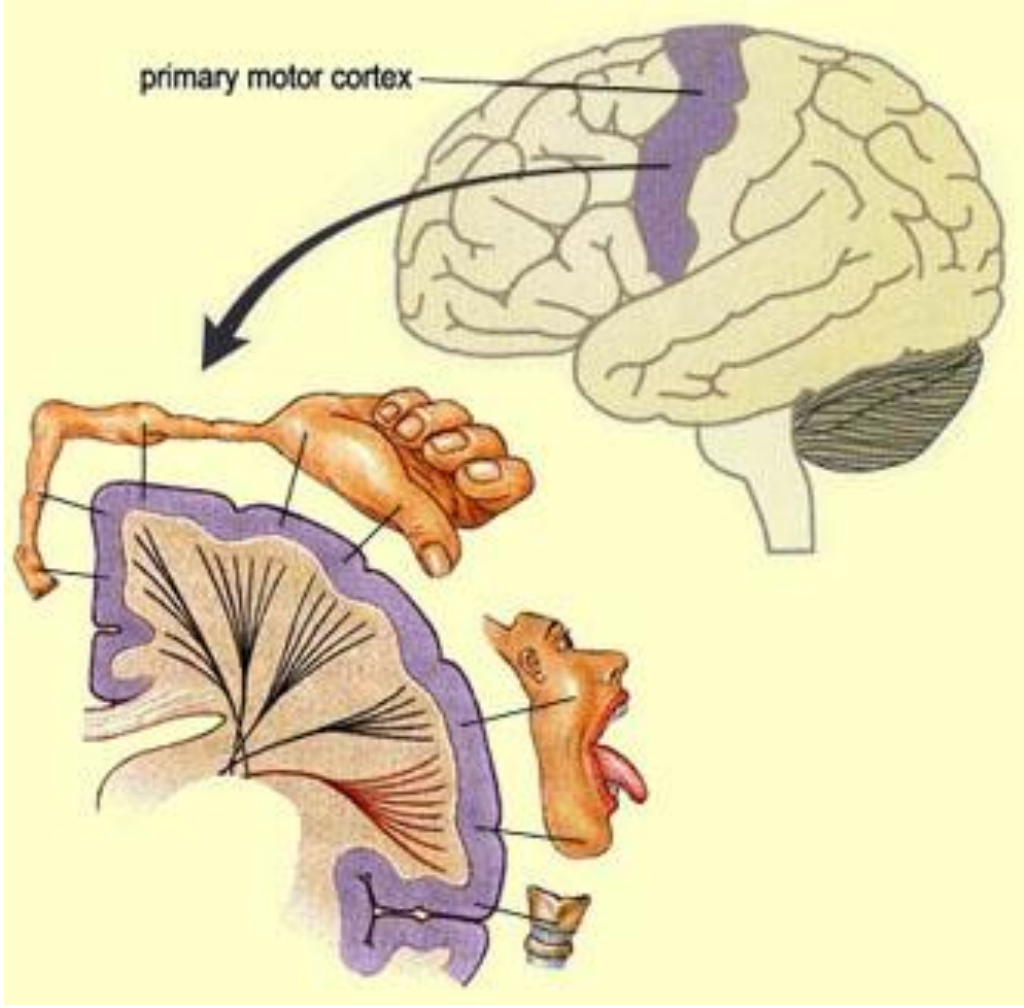


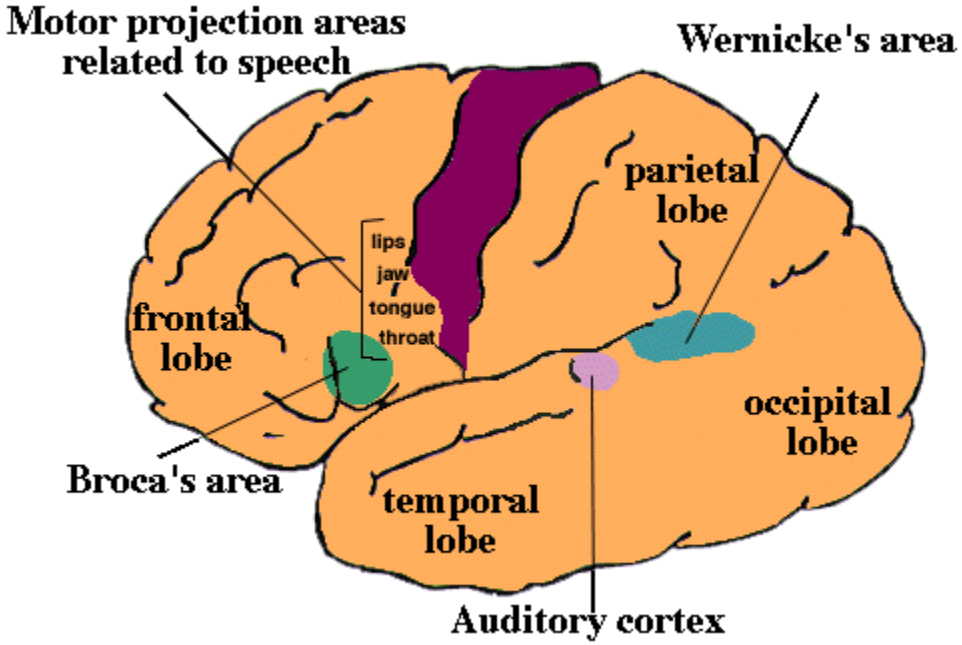


F: frontal lobe　if: interhemispheric fissure(大腦半球間裂)
P: parietal lobe
Ci: cingulum(扣帶回)　cs: central sulcus(中央溝)
CS: centrum semiovale(半卵圓中樞)

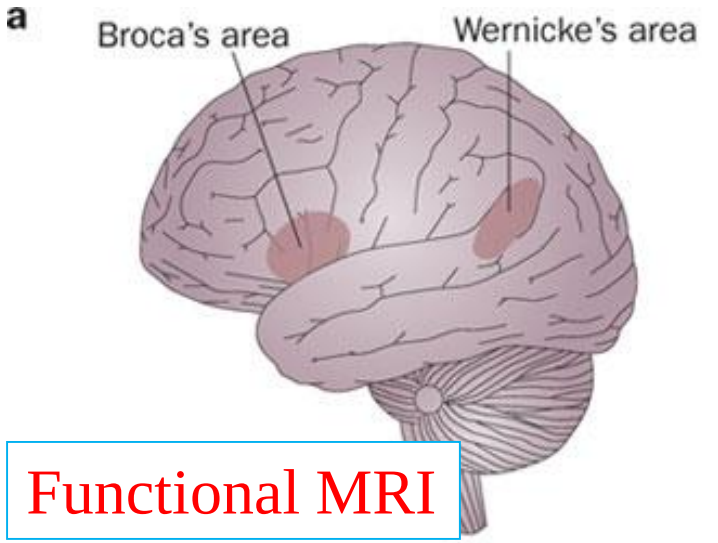

運動皮質區
Primary motor cortex
Premotor area
Anterior
Prefrontal area
Motor speech area (Broca's area)
語言運動區
Primary auditory cortex
聽覺皮質區
Auditory association area
Central sulcus
Primary somatic sensory cortex
Somatic sensory association area
語言感覺區
Sensory speech area (Wernicke's area)
Visual cortex
Visual association area
視覺皮質區
Taste area



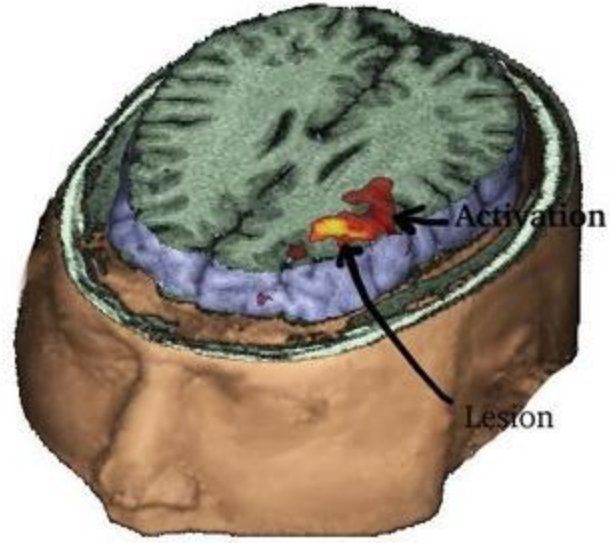


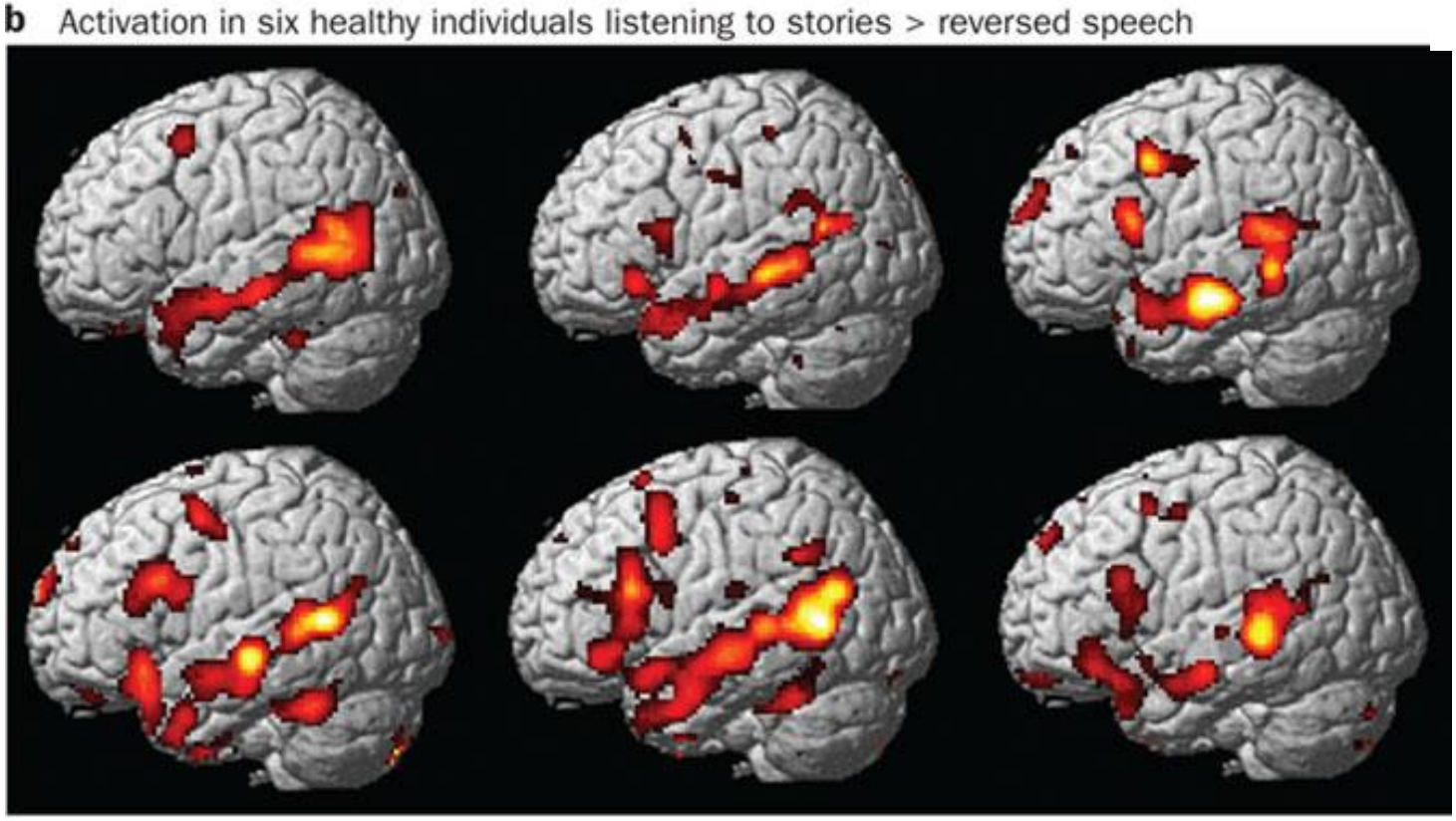


Wernicke's area is one of the two parts of the cerebral cortex linked since the late nineteenth century to speech (the other is the **Broca's area**). It is involved in the understanding of written and spoken language



Functional MRI

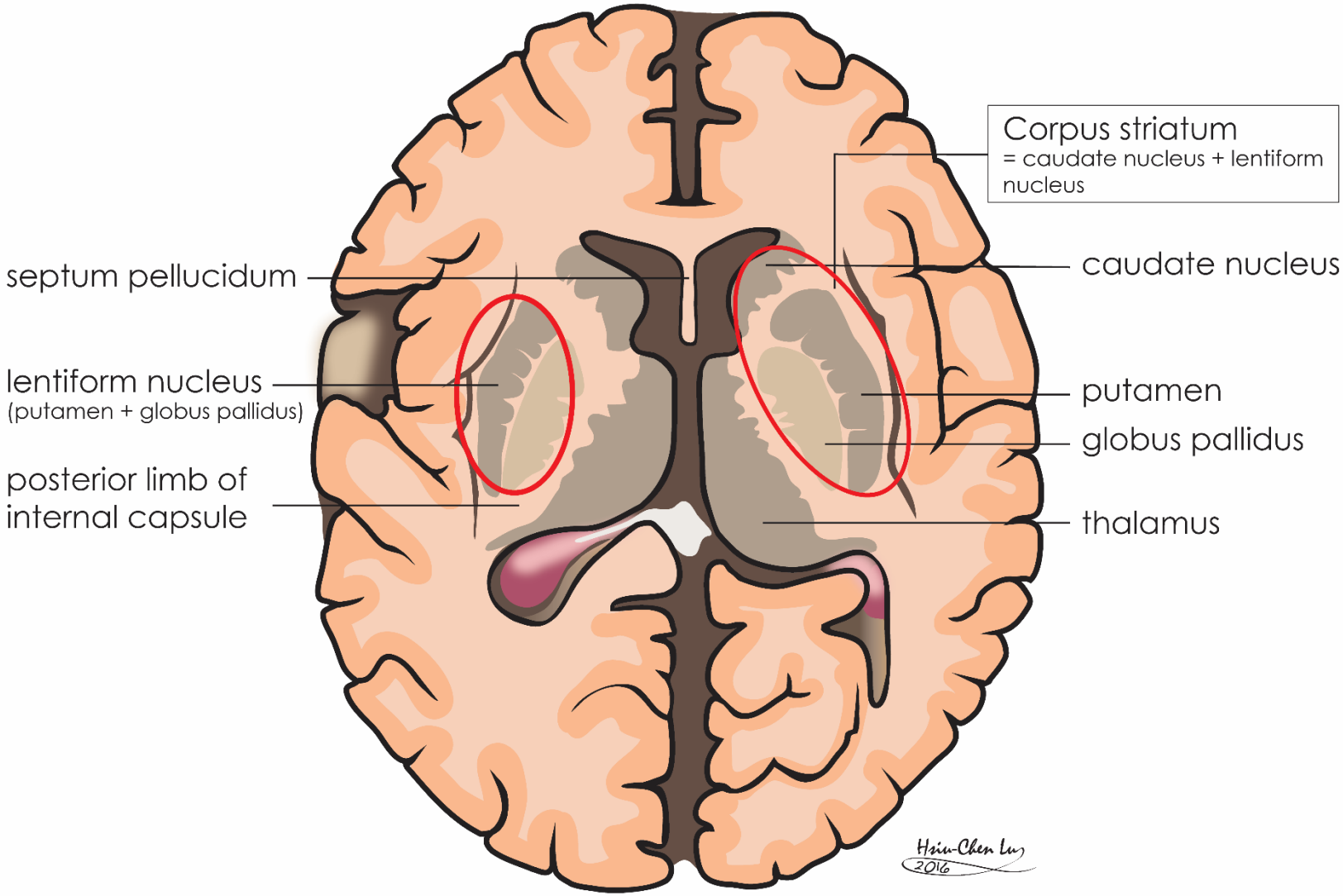


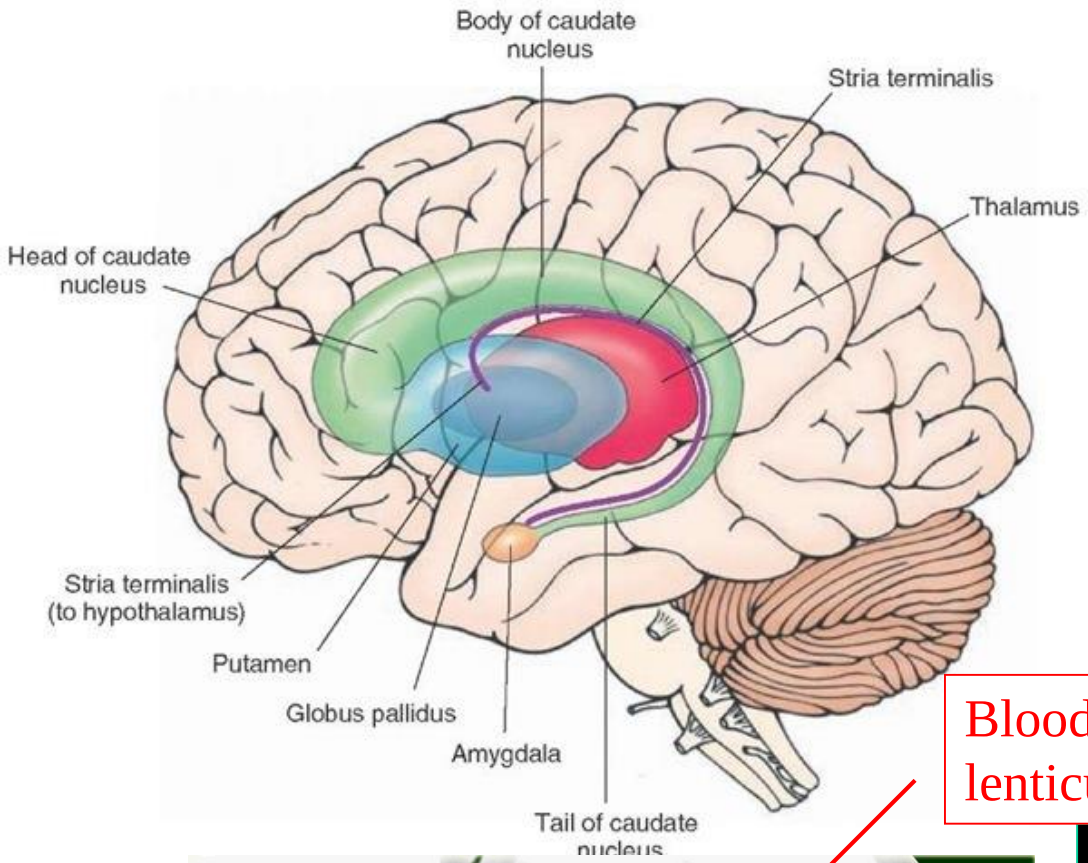


Infarction in Broca's area

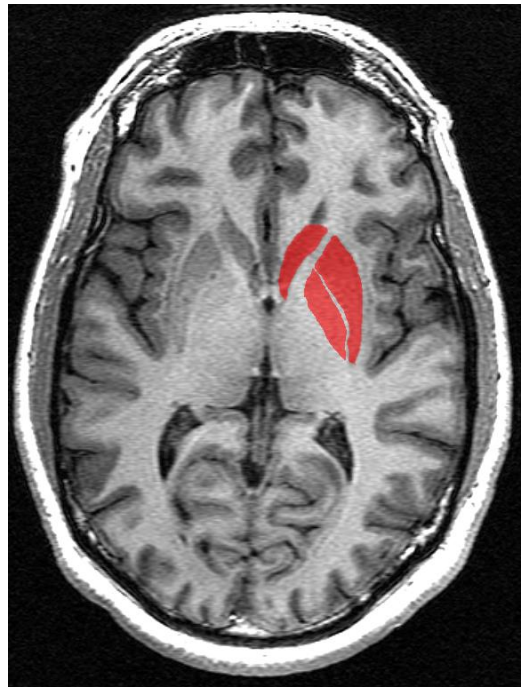
Basal Ganglia(基底核)

Deep gray matter(深層灰質)

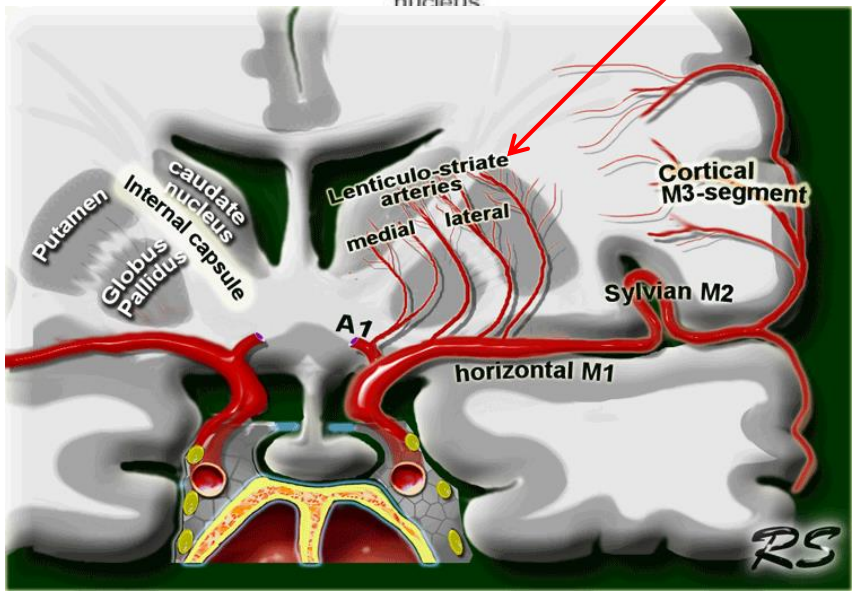


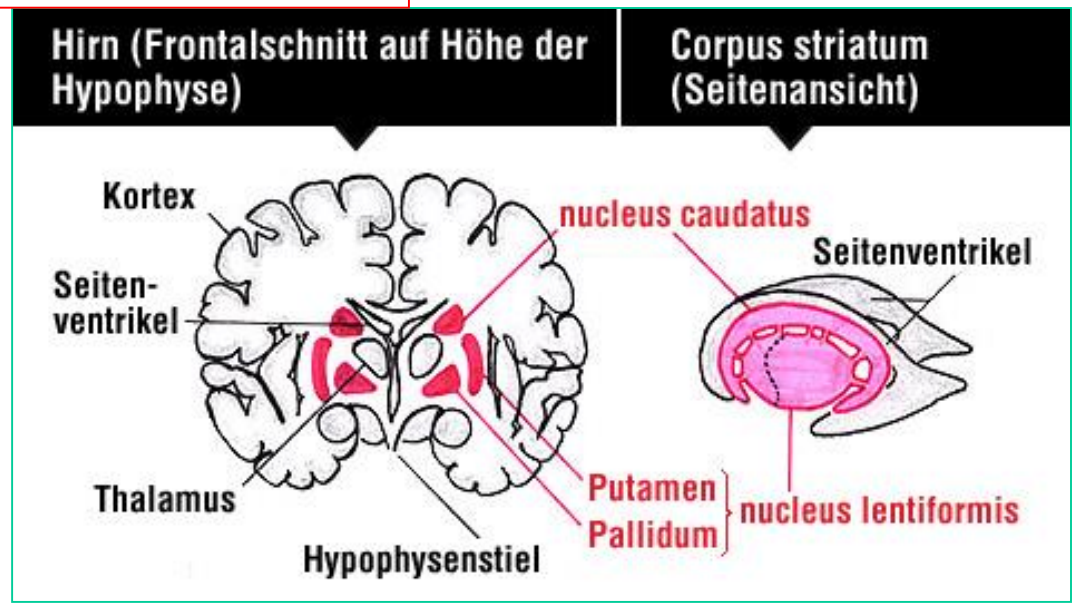


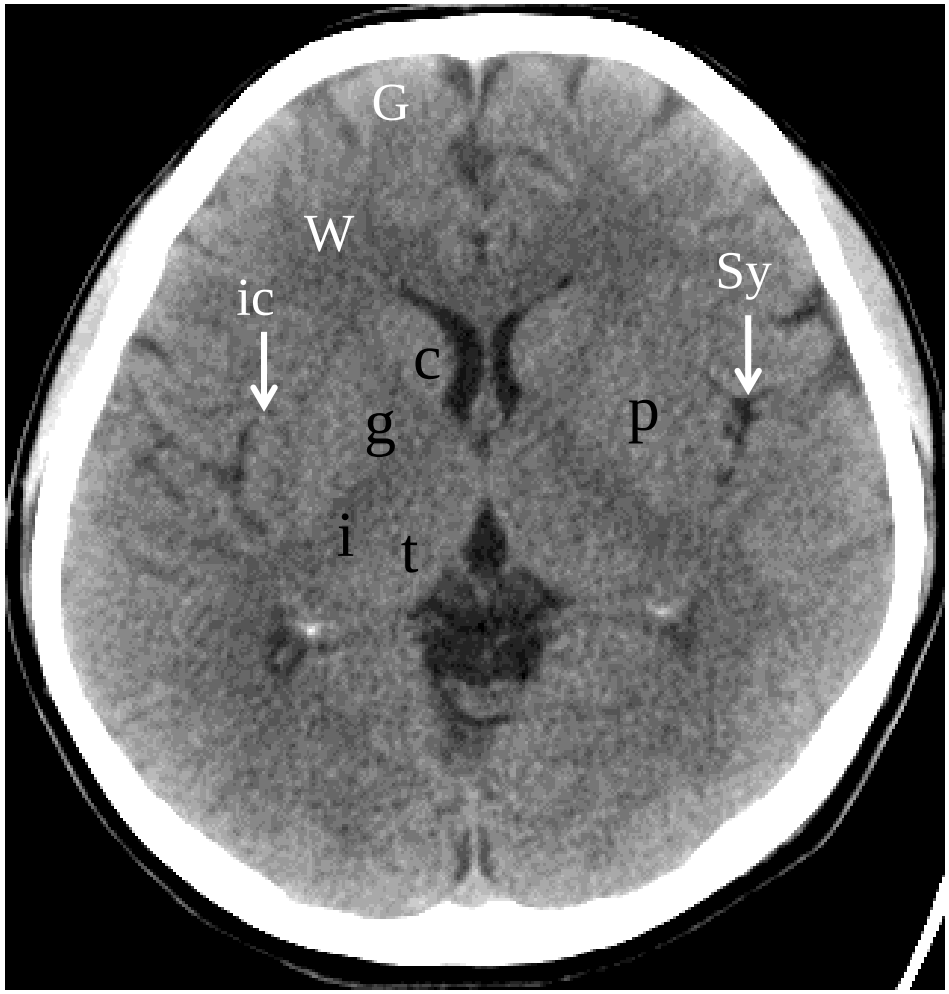
corpus striatum (紋狀體)



Blood supplied by lenticulostriate arteries







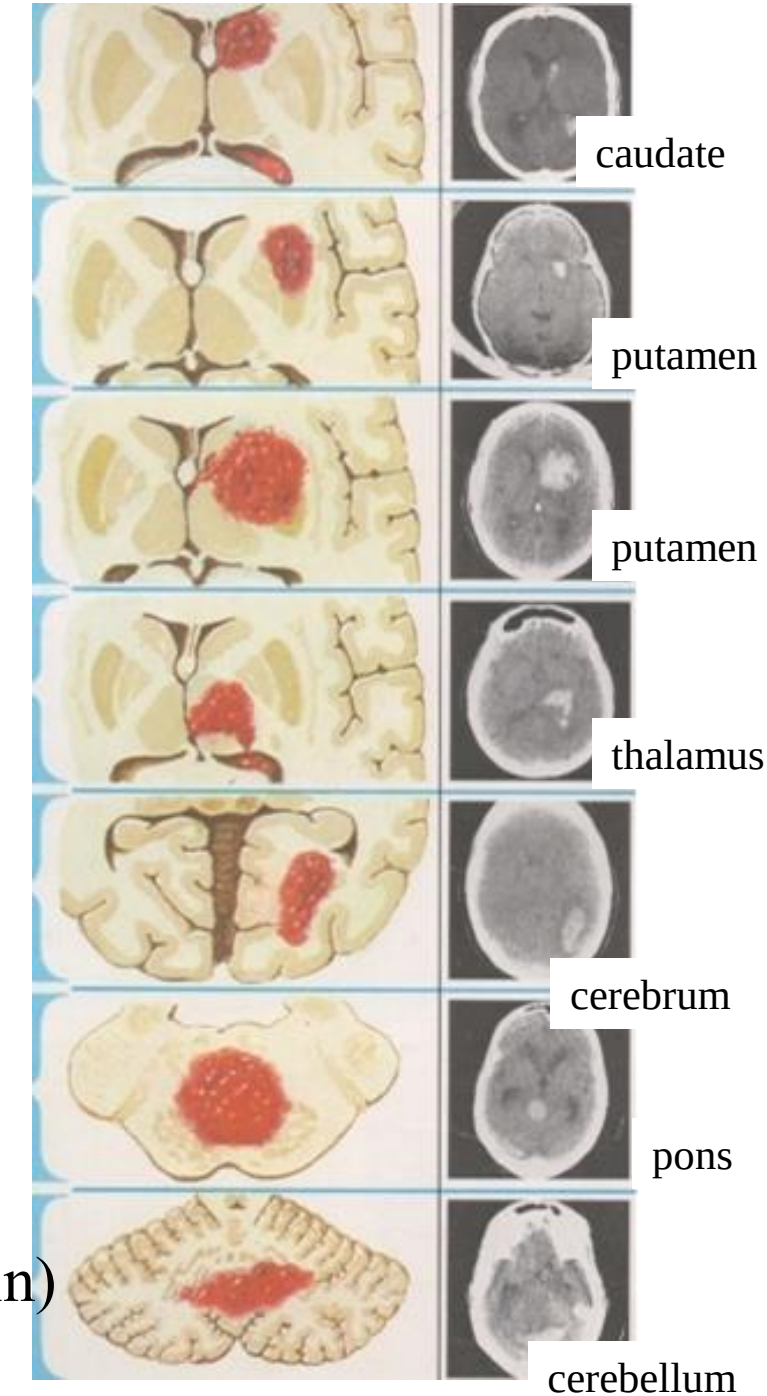
(CT: 灰質(G: gray matter)比較灰，
白質 (W: white matter) 稍暗。
在Sylvian fissure (arrow)內側的大腦深層可見明顯的灰質構造，就是基底核及視丘。
在兩者之間有一長形白質構造，就是內囊(internal capsule)，在CT很明顯稍暗。
Putamen與globus pallidus在CT不易區分。
MRI FLAIR: globus pallidus 因為含鐵成份稍高，訊號稍暗,。

c: caudate nucleus (尾狀核)
p: putamen(被殼)
g: globus pallidus(蒼白球)
t: thalamus(視丘)
i: internal capsule (內囊)
ic: insular cortex (島回)
Sy: Sylvian fissure（薛氏裂）

Locations of Hypertensive Intracerebral Hemorrhages:

- Basal ganglion:
  - putamen
  - caudate nucleus
- Thalamus
- Brainstem
- Subcortical white matter of cerebrum and cerebellum

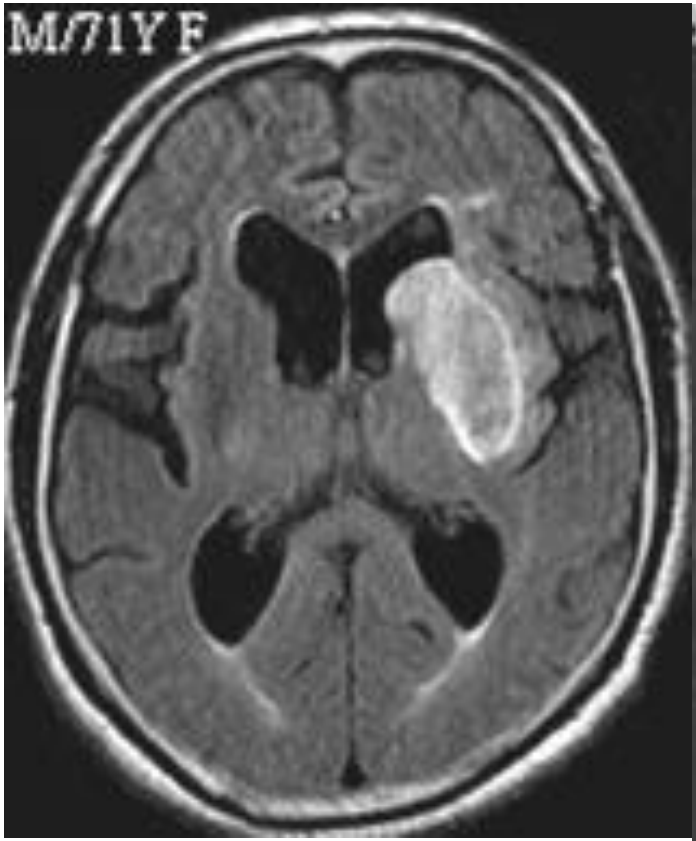
發生率順序：putamen→thalamus→ brainstem(pons) → cerebellum →subcortex of cerebrum →caudate nucleus → brainstem(midbrain) → brainstem(medulla oblongata)



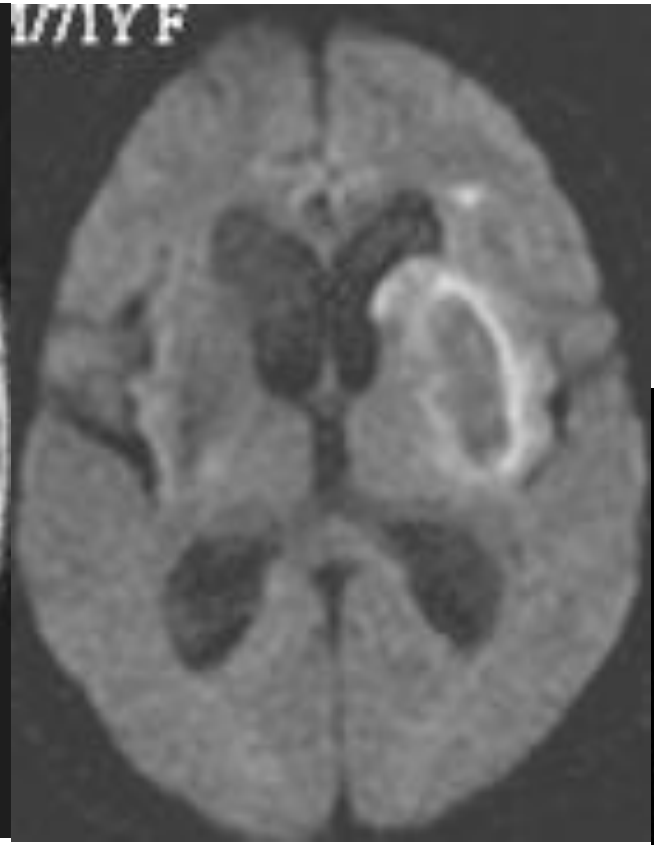
1. **CVA due to left putaminal hemorrhage**
   （左側被殼出血引起腦中風）
2. **Calcifications in bil. globus pallidus**
   （蒼白球鈣化）

ICH:
70~90Hu
Calcification:
150-300Hu

CVA: cerebral vascular accident, stroke, 腦血管意外,腦中風



MRI: T1WI



MRI: DWI

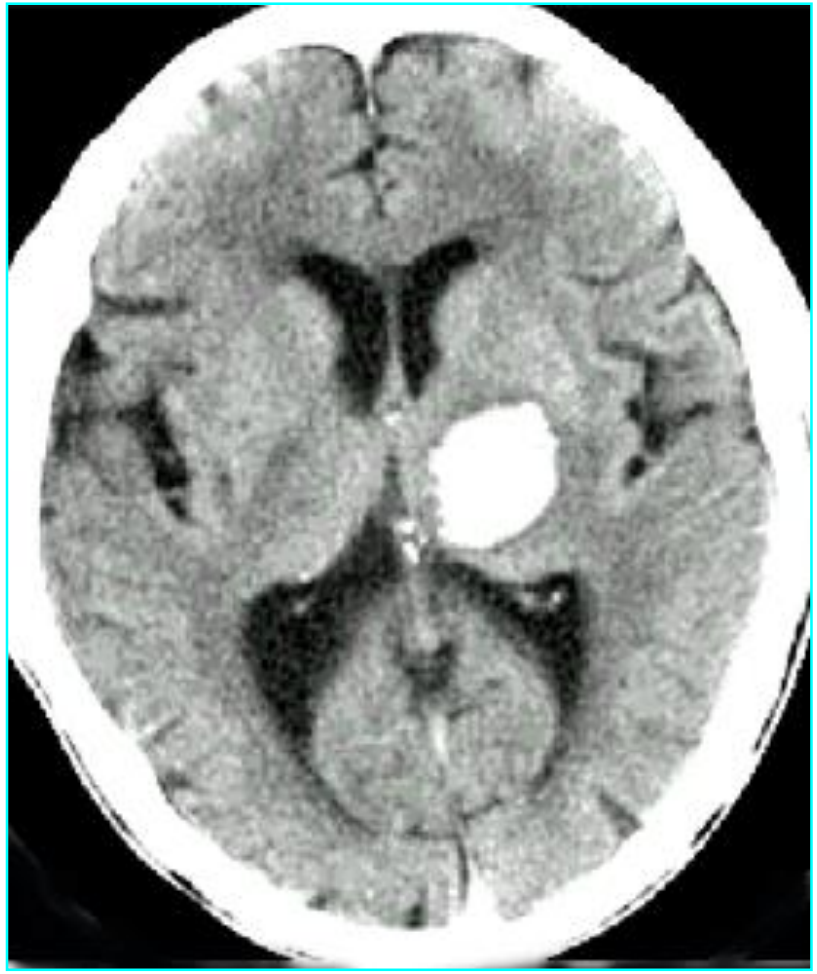
CT

M/71

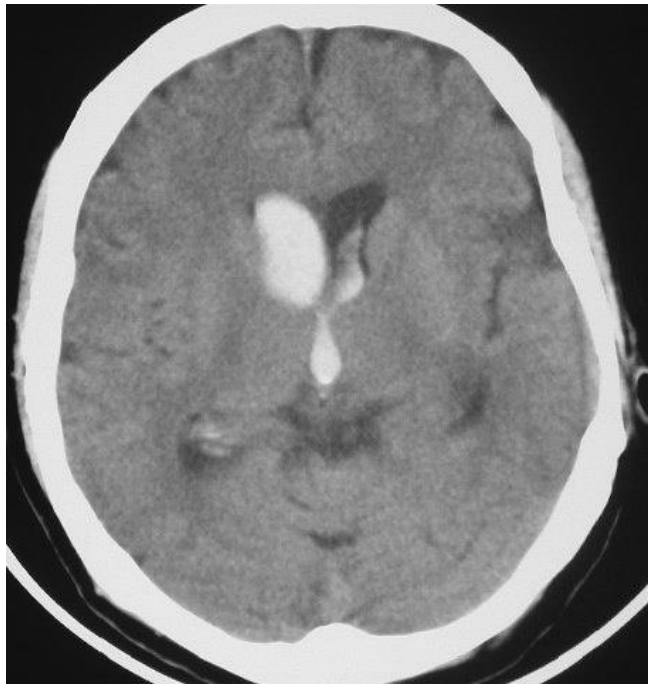
CVA due to left putaminal hemorrhage

(左側被殼出血引起腦中風)

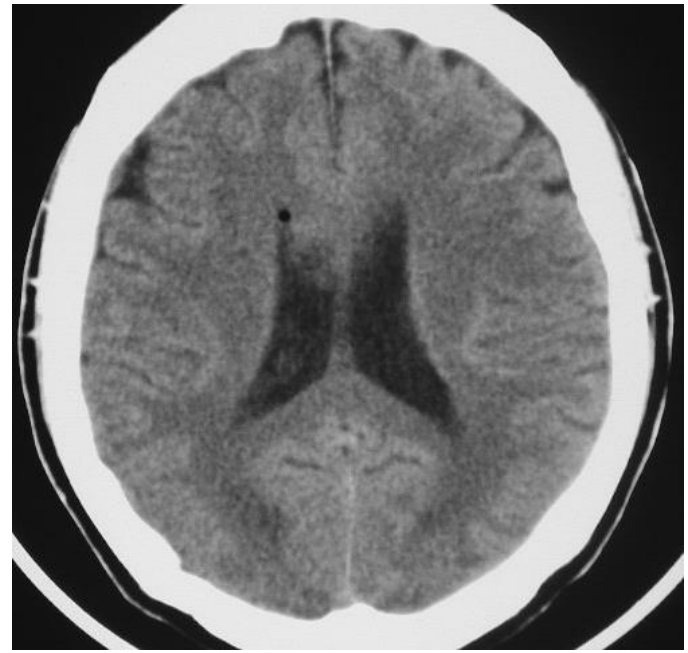
Male, 79 y/o,
CVA due to thalamic hemorrhage
（視丘出血引起腦中風）



另一例



(left figures)
4,27 CT: Acute hematoma in
Rt. caudate nucleus with IVH.



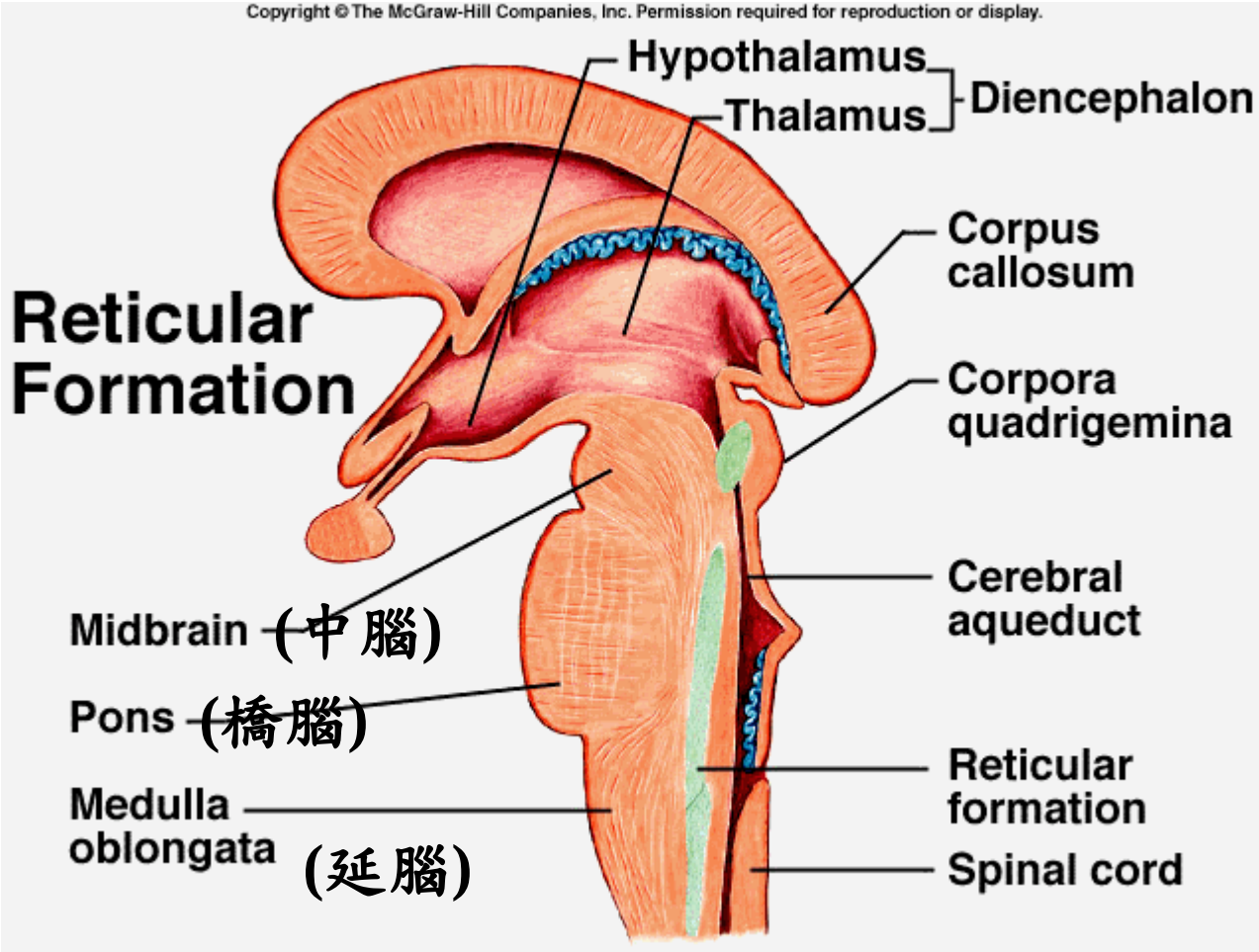
(right figures)
5,4 CT: residual hematoma in
caudate nucleus, no IVH

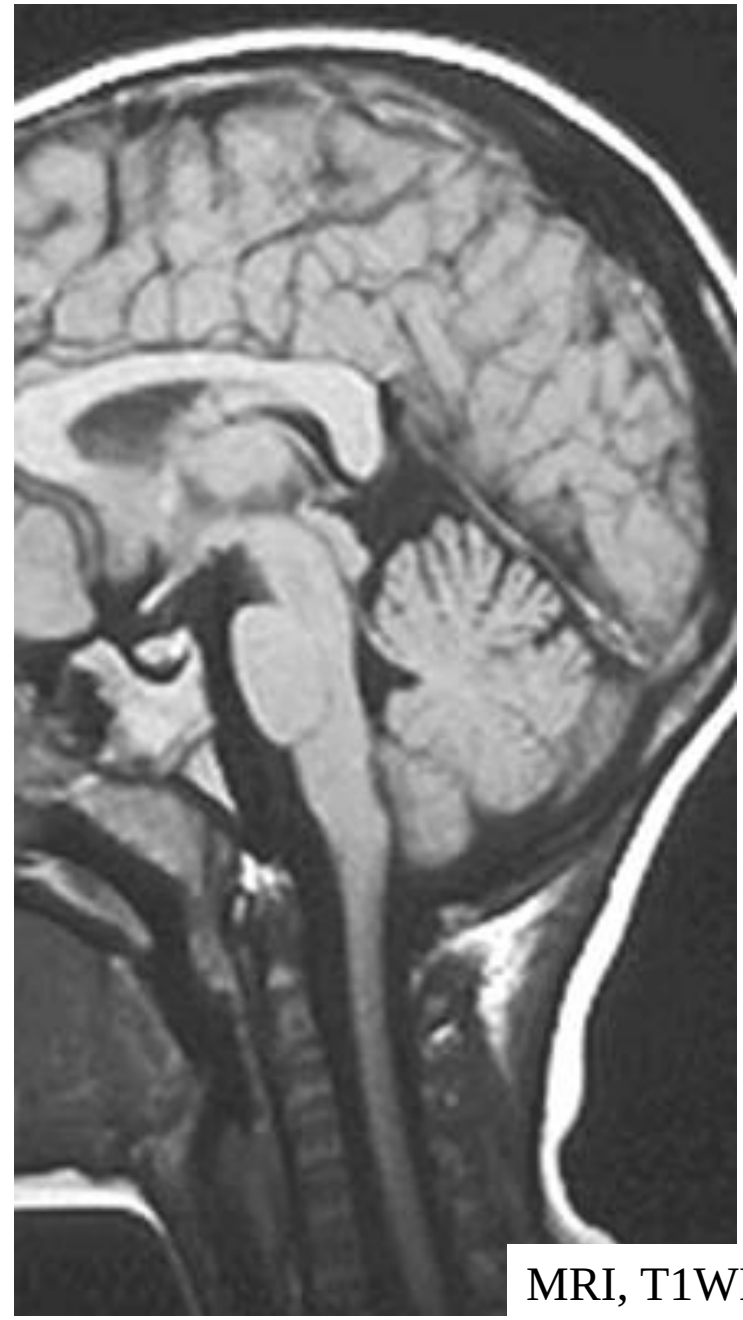
**(尾状核出血
引起腦中風)**

One minute note (1):

Please describe the anatomic structure of basal ganglion

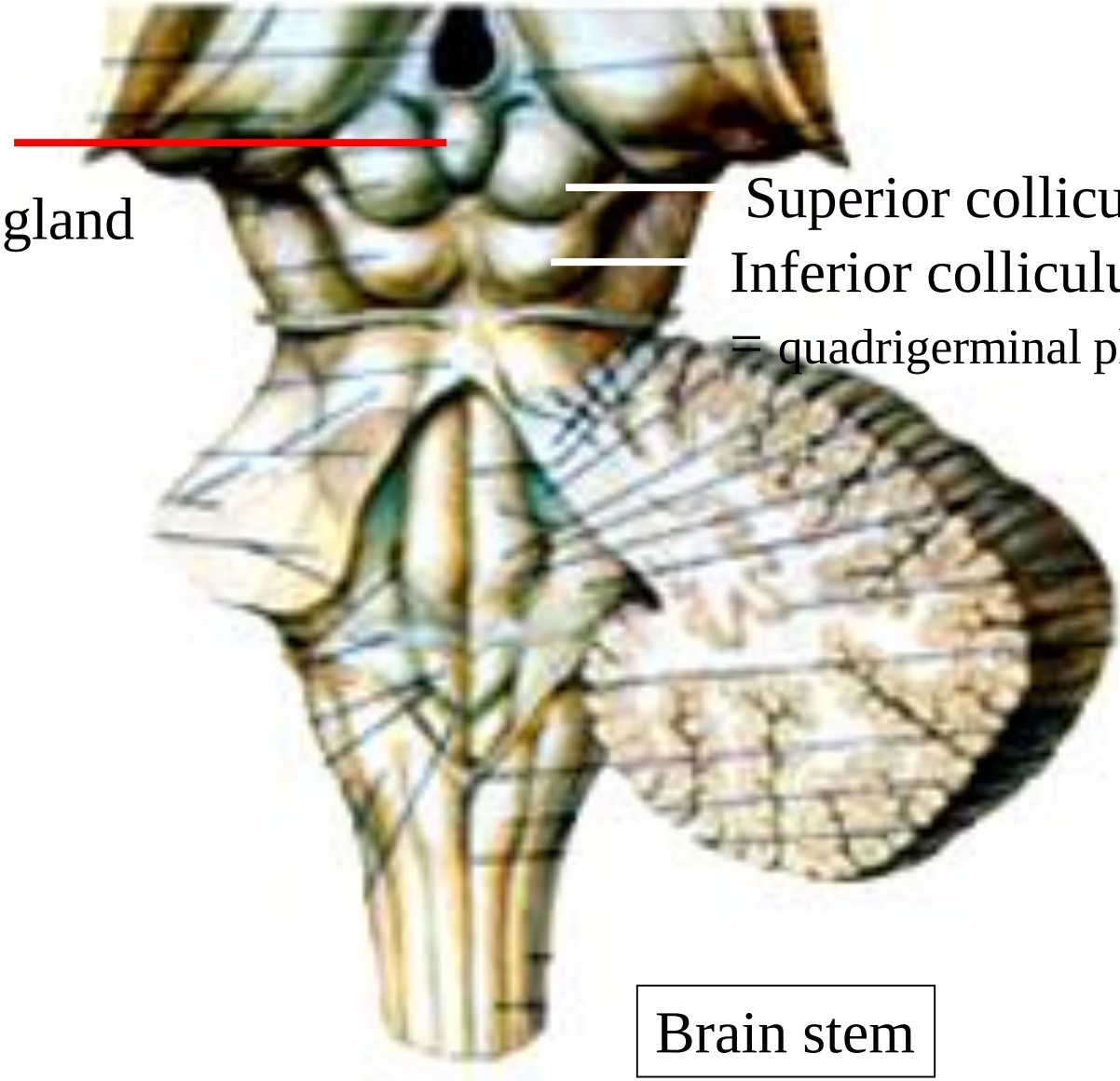
Brainstem(腦幹)





MRI, T1WI

(上丘、下丘構成四疊體)



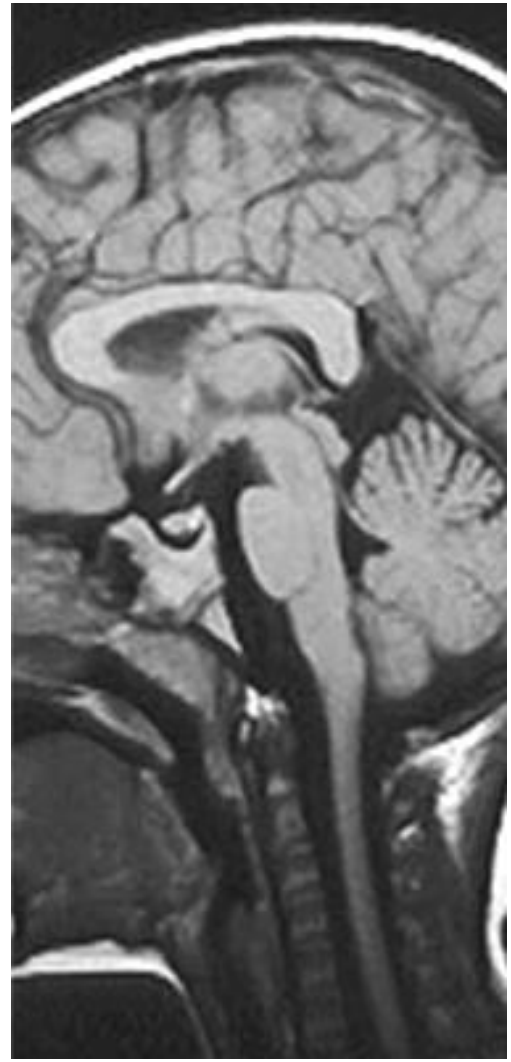
Pineal gland

Superior colliculus

Inferior colliculus

= quadrigerminal plate

Brain stem



Midbrain

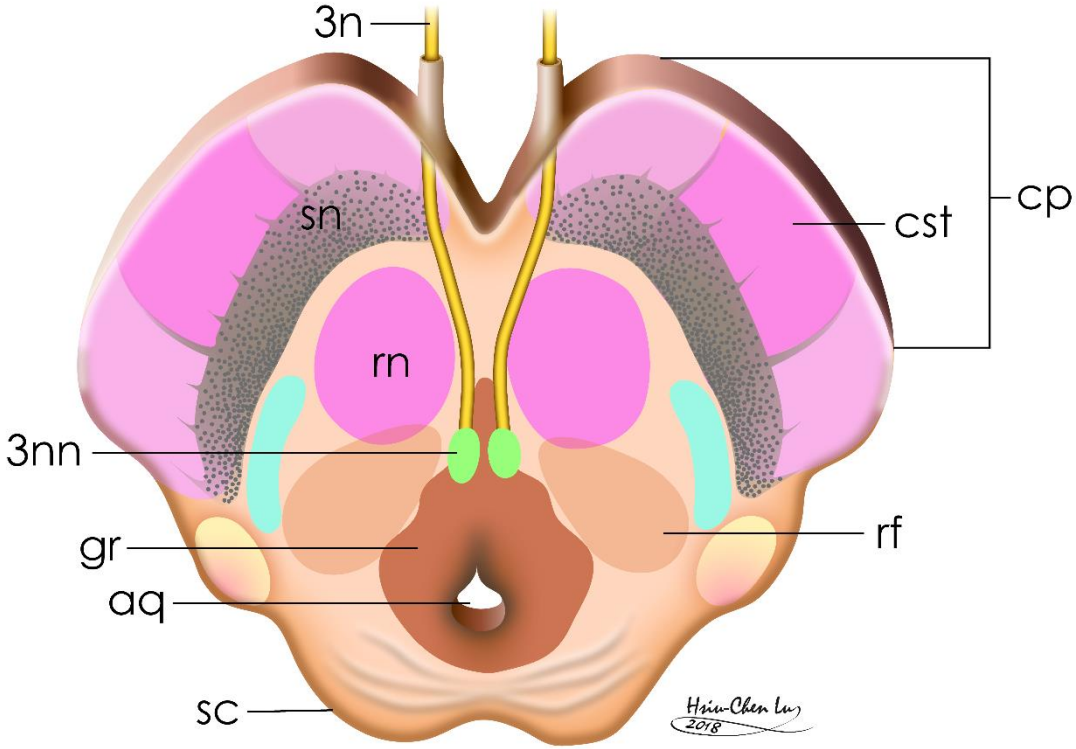
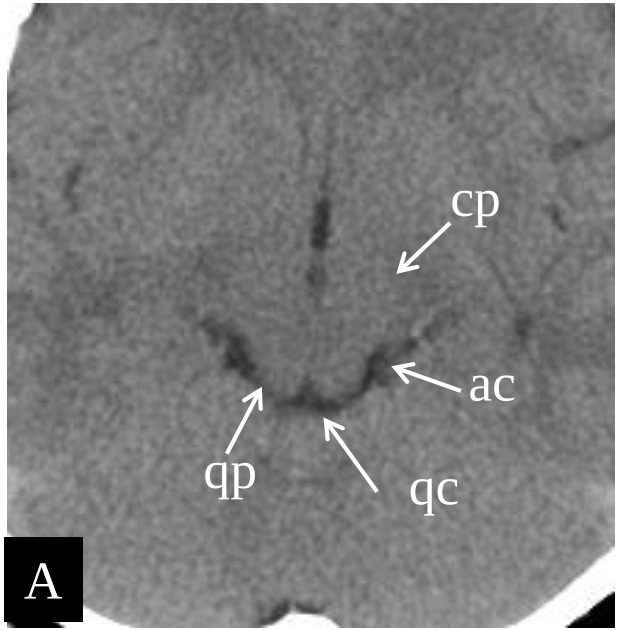


圖1-8
中腦 (midbrain)
cp: cerebral peduncle (大腦腳)
cst: corticospinal tract (皮質脊髓徑)
rn: red nucleus (紅核)
sn: substantia nigra (黑質)
3n: 3rd cranial nerve, oculomotor nerve (動眼神經)
3nn: nucleus of 3rd n (第3顱神經核)
aq: aqueduct (導水管)
gr: periaqueductal gray matter (導水管旁灰質)
sc: superior colliculus (上小丘)
qp: quadrigeminal plate (四疊體)
rf: reticular formation (網狀結構)
qc: quadrigeminal cistern (四疊體腦池)
ac: ambient cistern (環池)



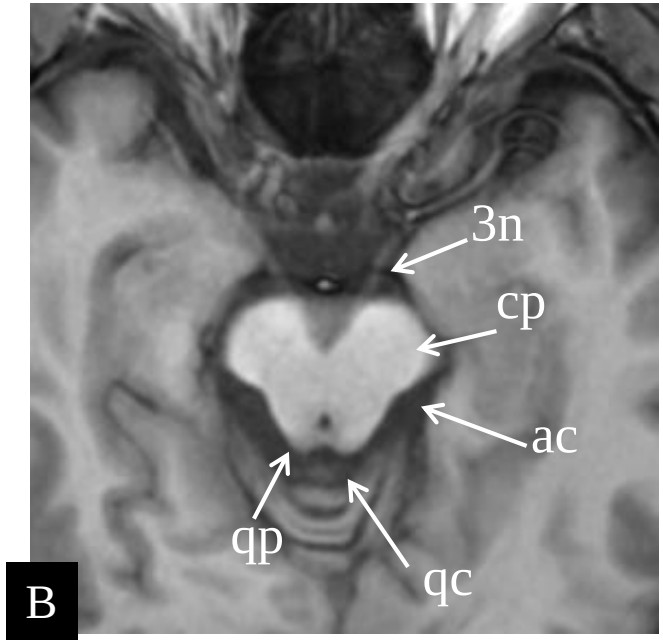
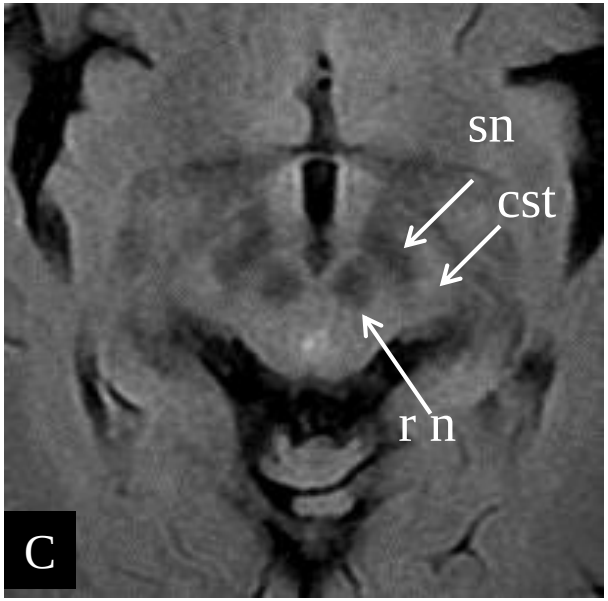
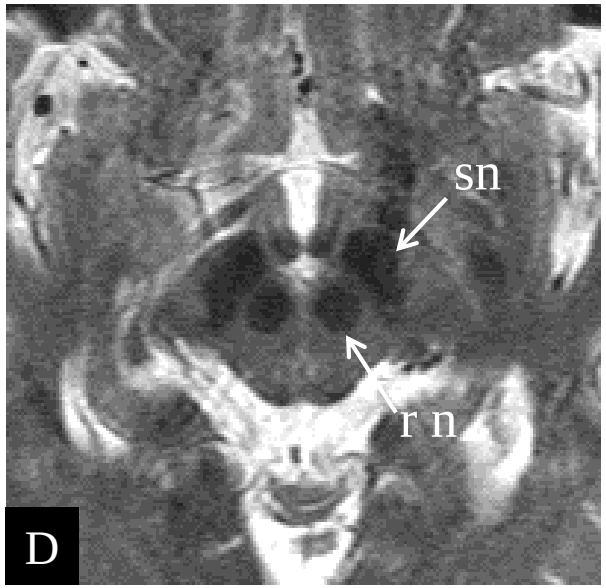
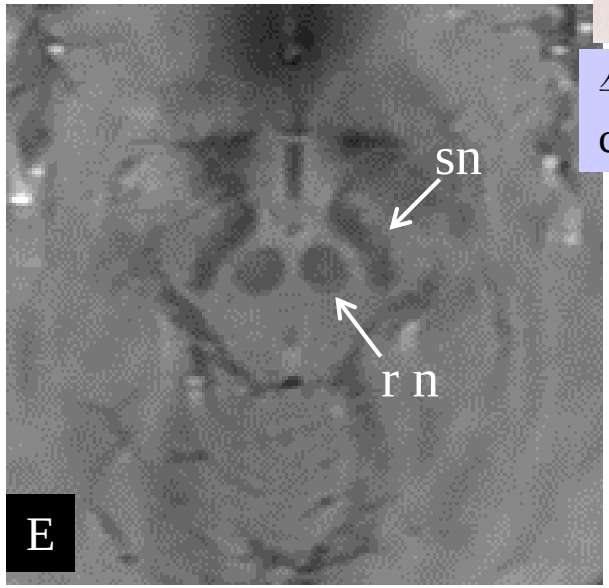


圖1-8
Midbrain
(A) CT: 只能看到midbrain 的外形。
(B) T1WI 可比CT更清楚看到midbrain 的外形，
(C) FLAIR, (D) T2WI, (E) SWANI則可清楚看到red nucleus,
substantia nigra.

牛角麵包
croissant

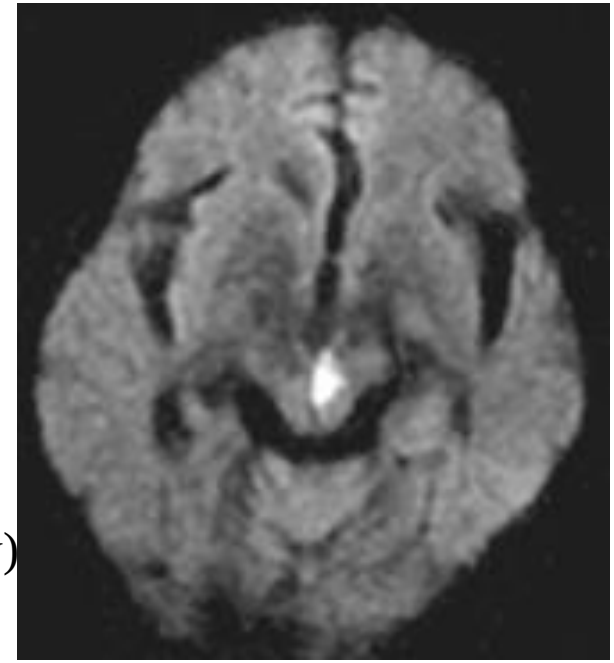


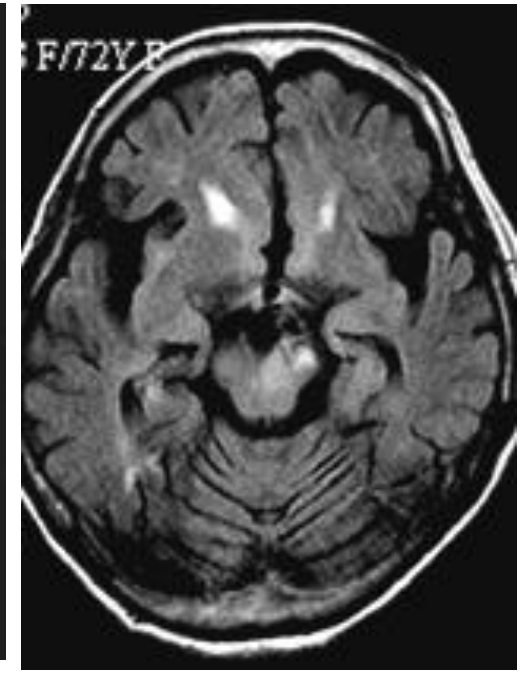




A: 29591146
B: 29757119
C, D: 1148412
E: 32665151

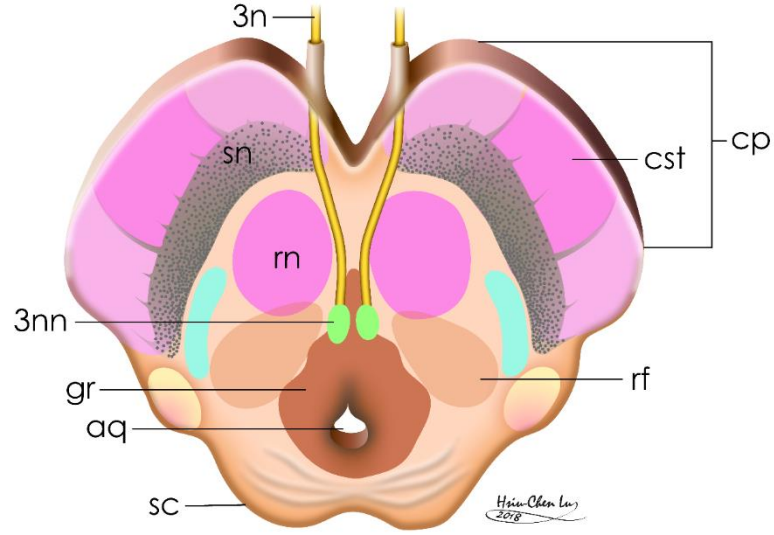
Acute infarction in the left side of midbrain, corresponding to the course of left oculomotor nerve, and in the course of corticospinal tract

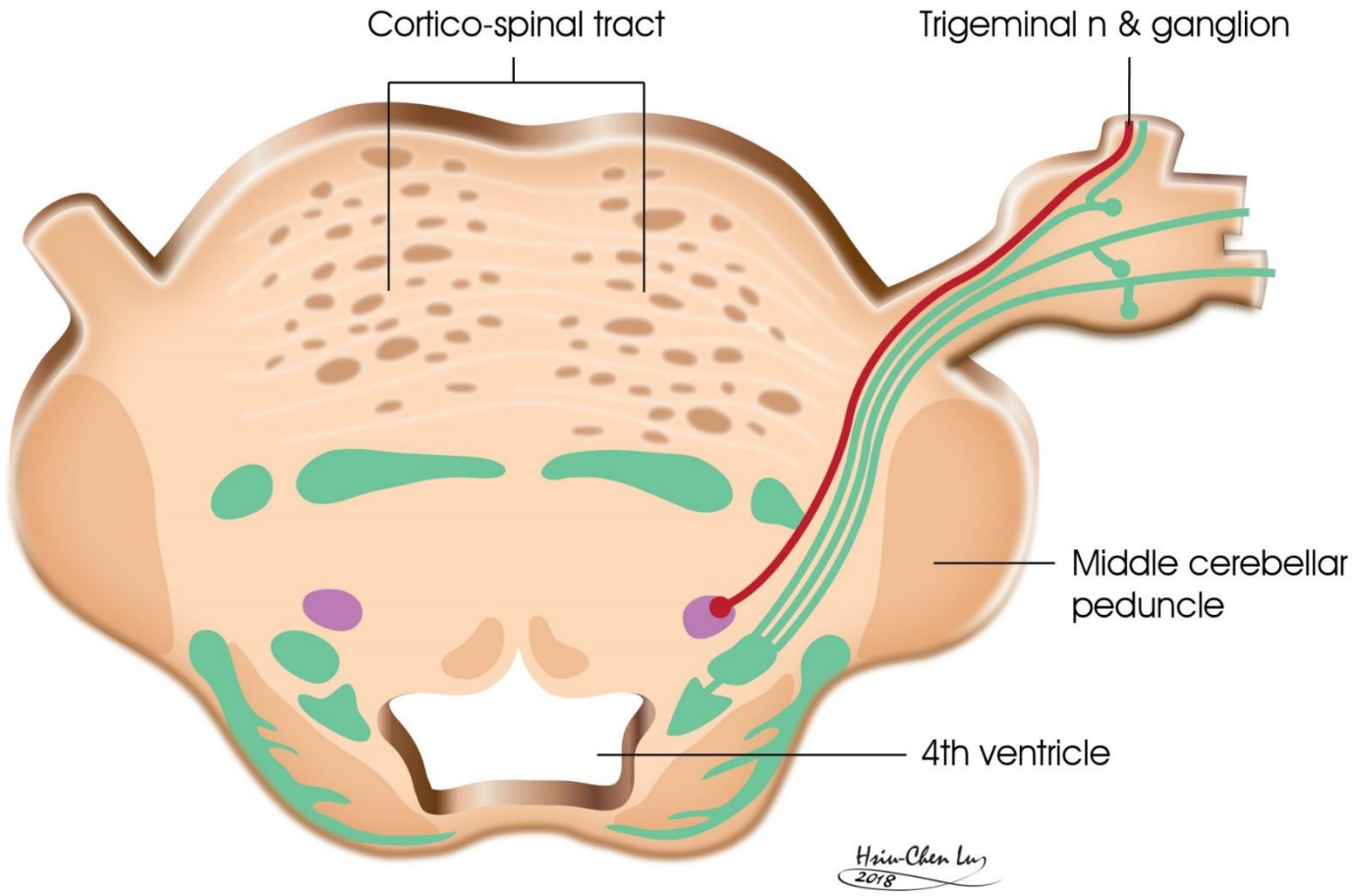




臨床症狀

1. 左眼皮下垂 (left 3rd cranial nerve palsy)
2. 右側半身無力

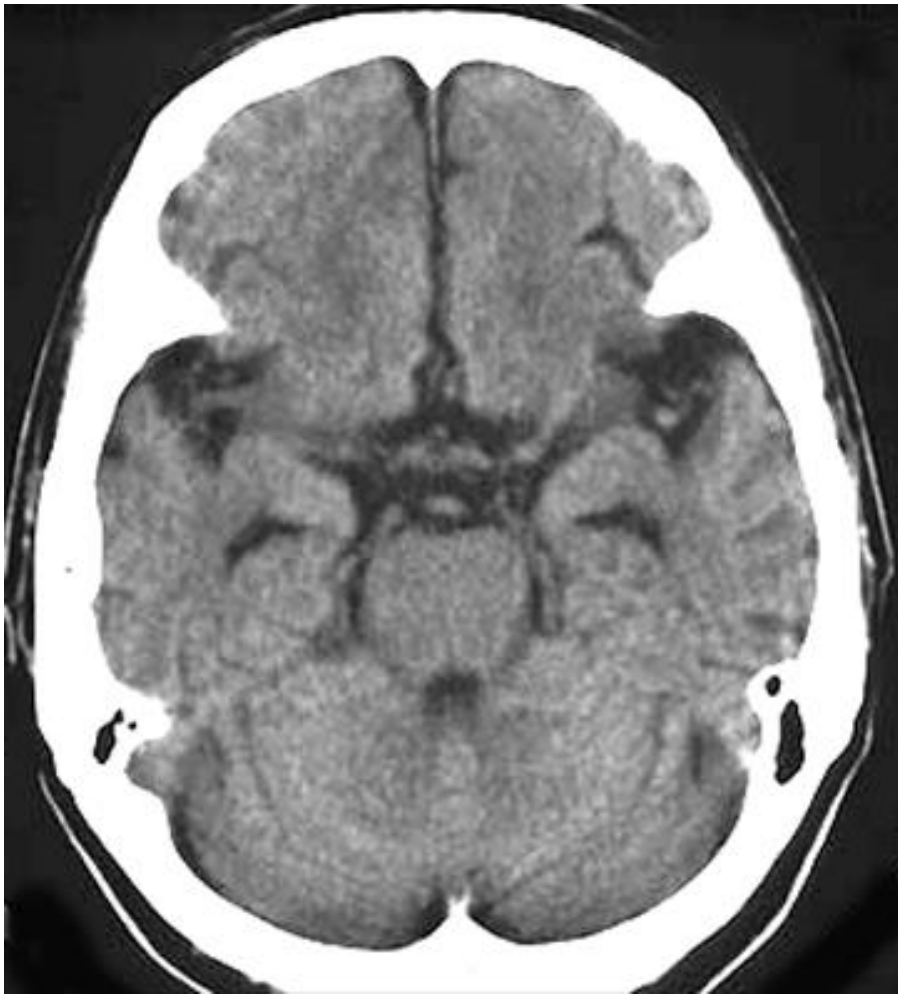



Cortico-spinal tract
Trigeminal n & ganglion
Middle cerebellar peduncle
4th ventricle
Hsiu-Chen Lu
2018

橋腦 (pons)

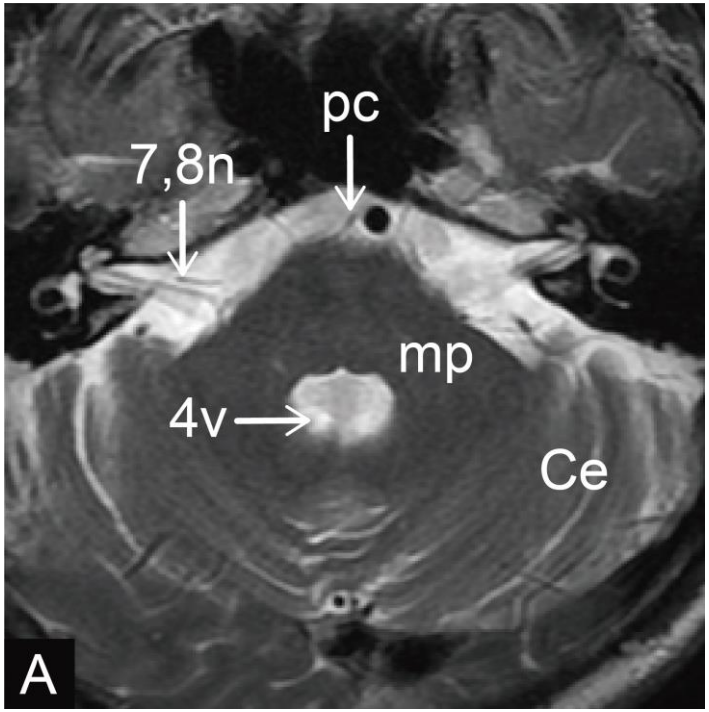
Pons

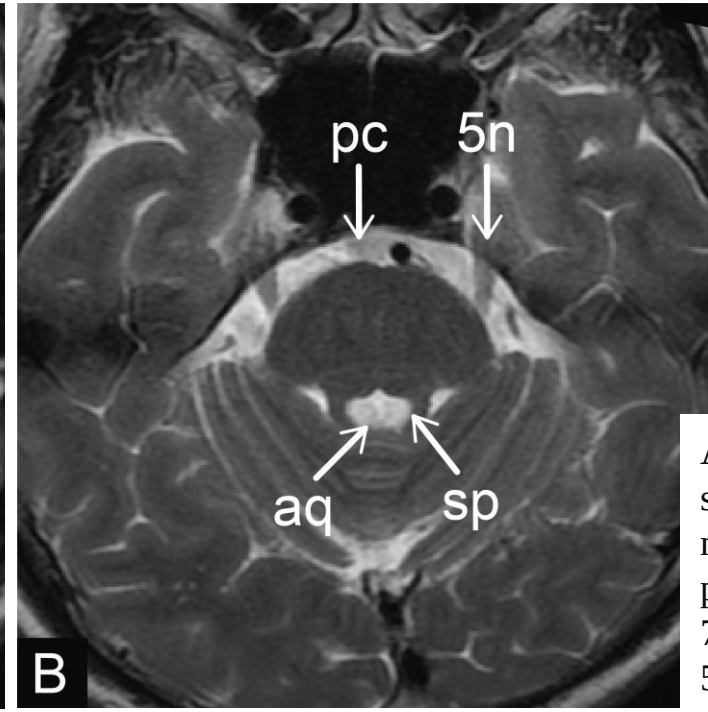
Pons is apple alike

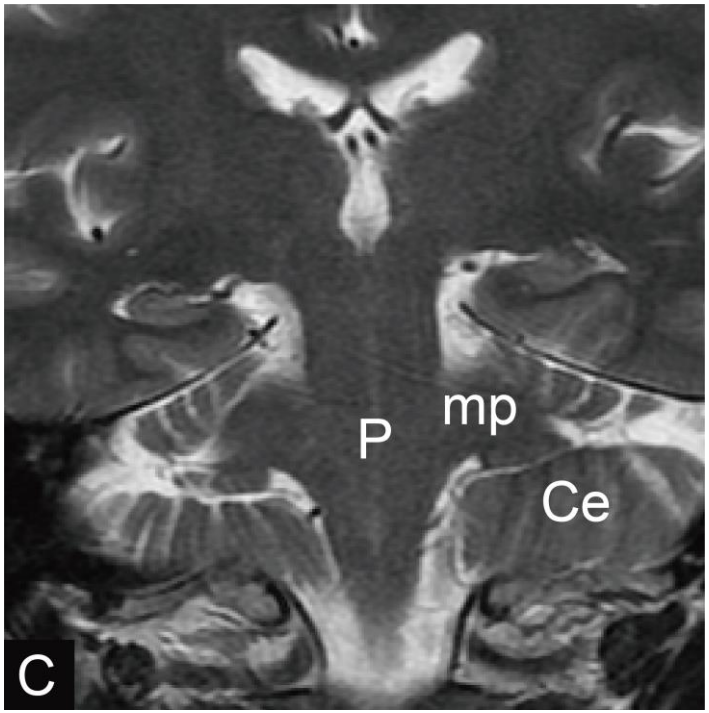


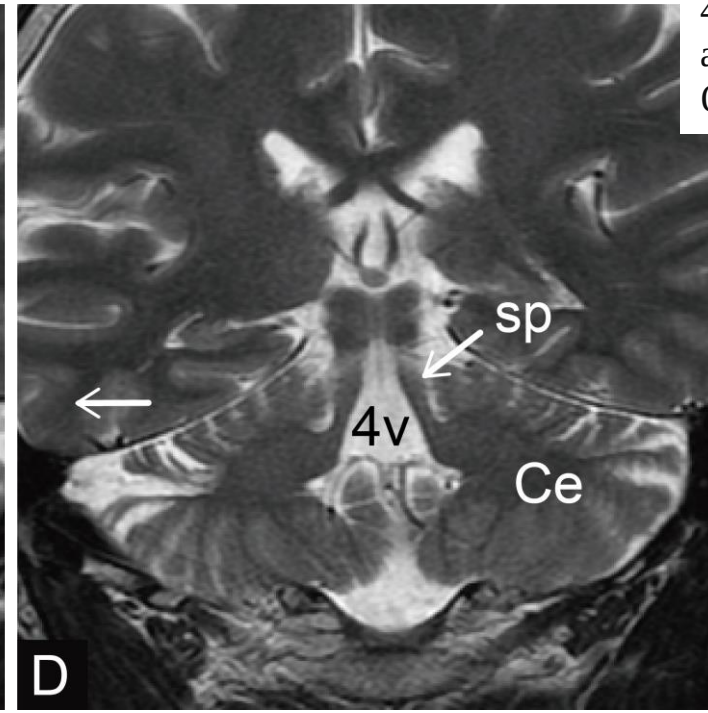
CT

MRI, T2WI

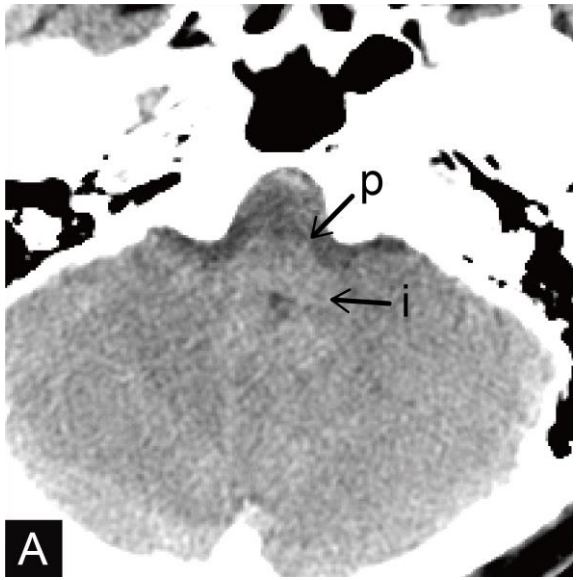


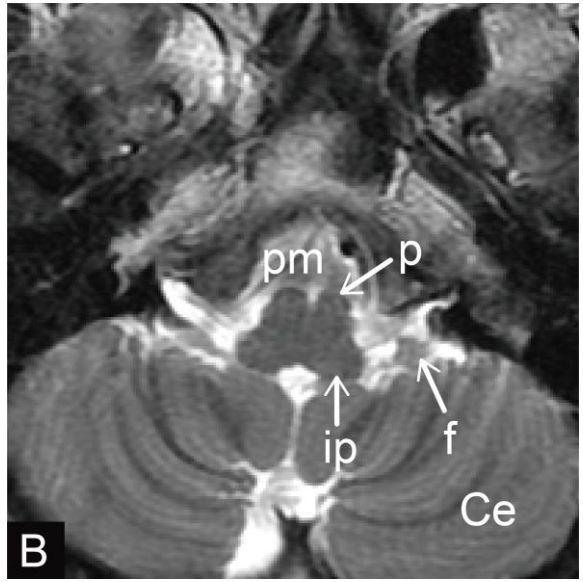


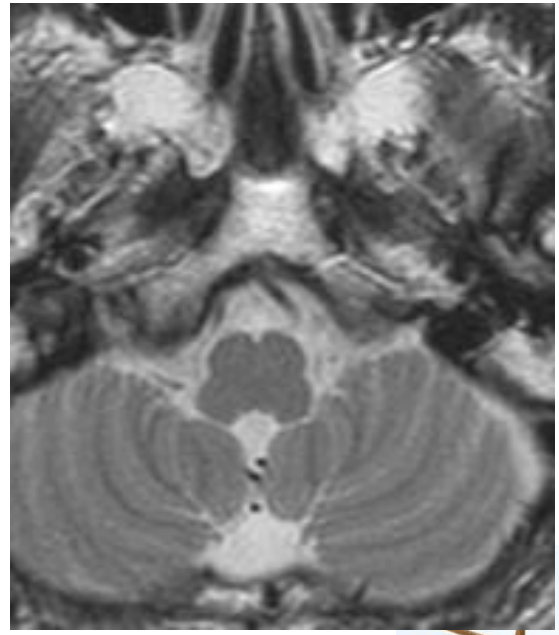




A. Pons 下段 B: Pons 上段
sp: superior cerebellar peduncle (上小腦腳)
mp: middle cerebellar peduncle (中小腦腳)
pc: prepontine cistern (橋腦前腦池)
7,8n: 7th and 8th cranial nerves (第7、8顱神經)
5n: 5th cranial nerve (第5顱神經)
4v: 4th ventricle (第4腦室)
aq: aqueduct (導水管)
Ce: cerebellar hemisphere (小腦半球)







延腦(medulla oblongata)

(A) CT 看延腦很不清楚。

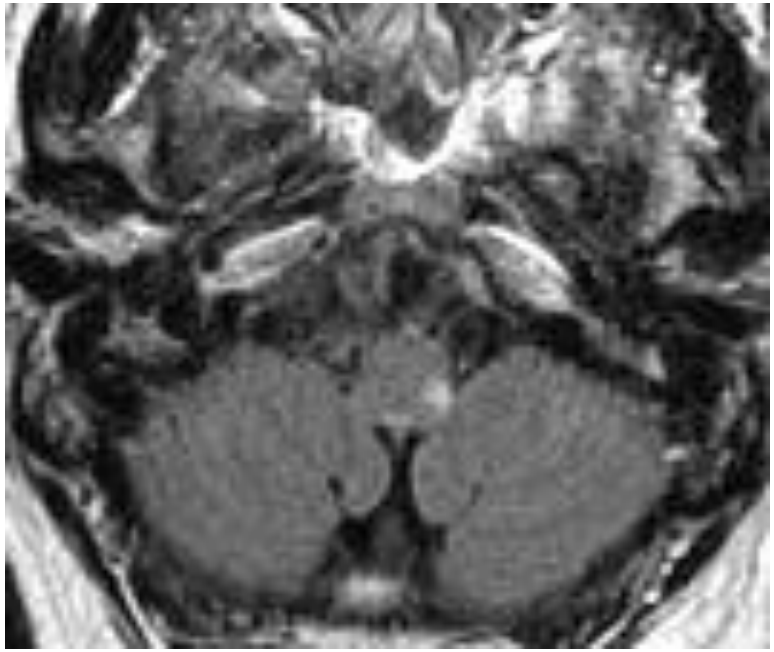
(B) MRI, T2WI 則可清楚看到延腦的外形以及周邊的構造。

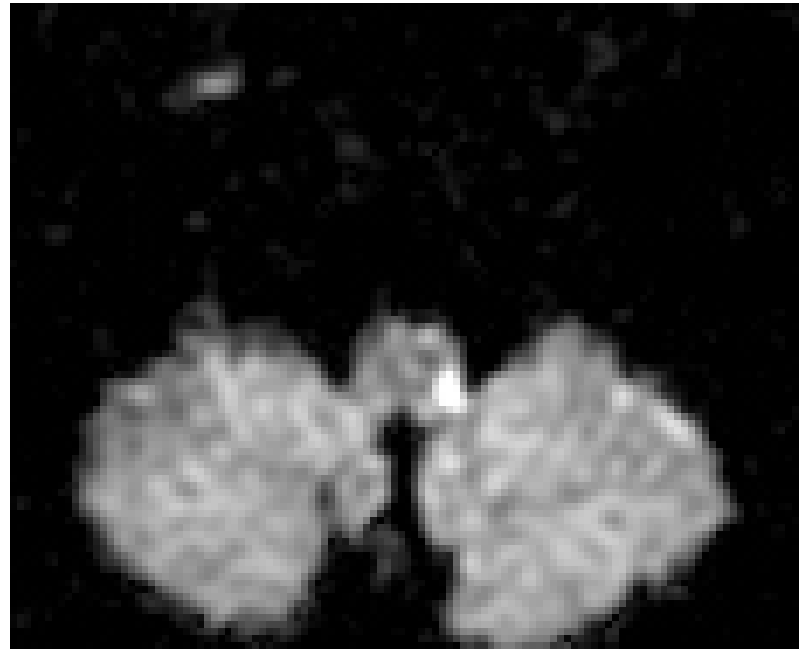
整個延腦像一隻蝸牛。

Pyramid是傳達運動的corticospinal tract經過的一站，

因此這tract又稱為pyramidal tract。

p: pyramid（錐體）
ip: inferior cerebellar peduncle (下小腦腳）
Ce: cerebellar hemisphere（小腦半球）
f: flocculus（小腦絮球）
t: tonsil（小腦舌部）
pm: premedullary cistern (延腦前腦池)



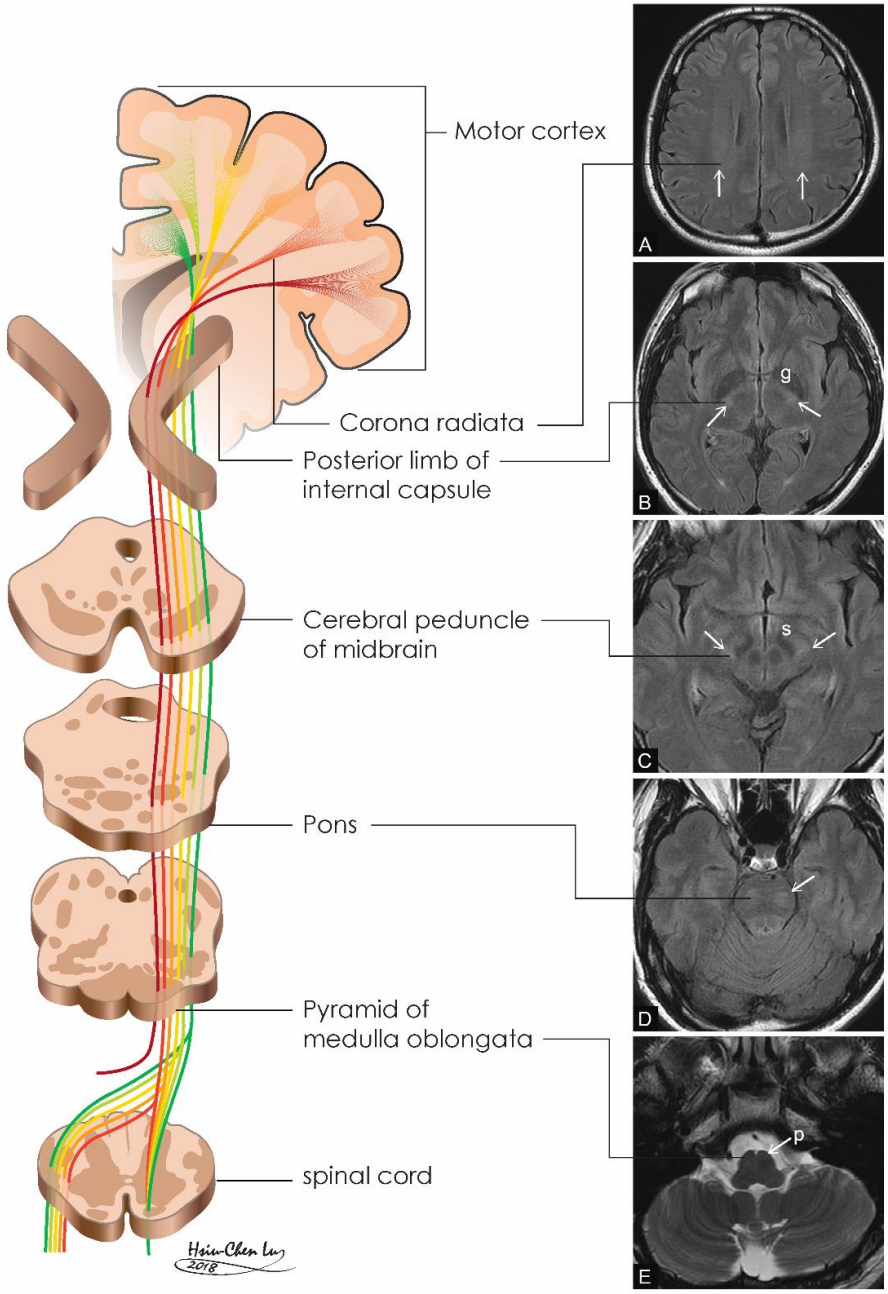


Acute infarction in the inferior cerebellar peduncle of medulla oblongata,

causing Wallernberg syndrome (呑嚥困難)

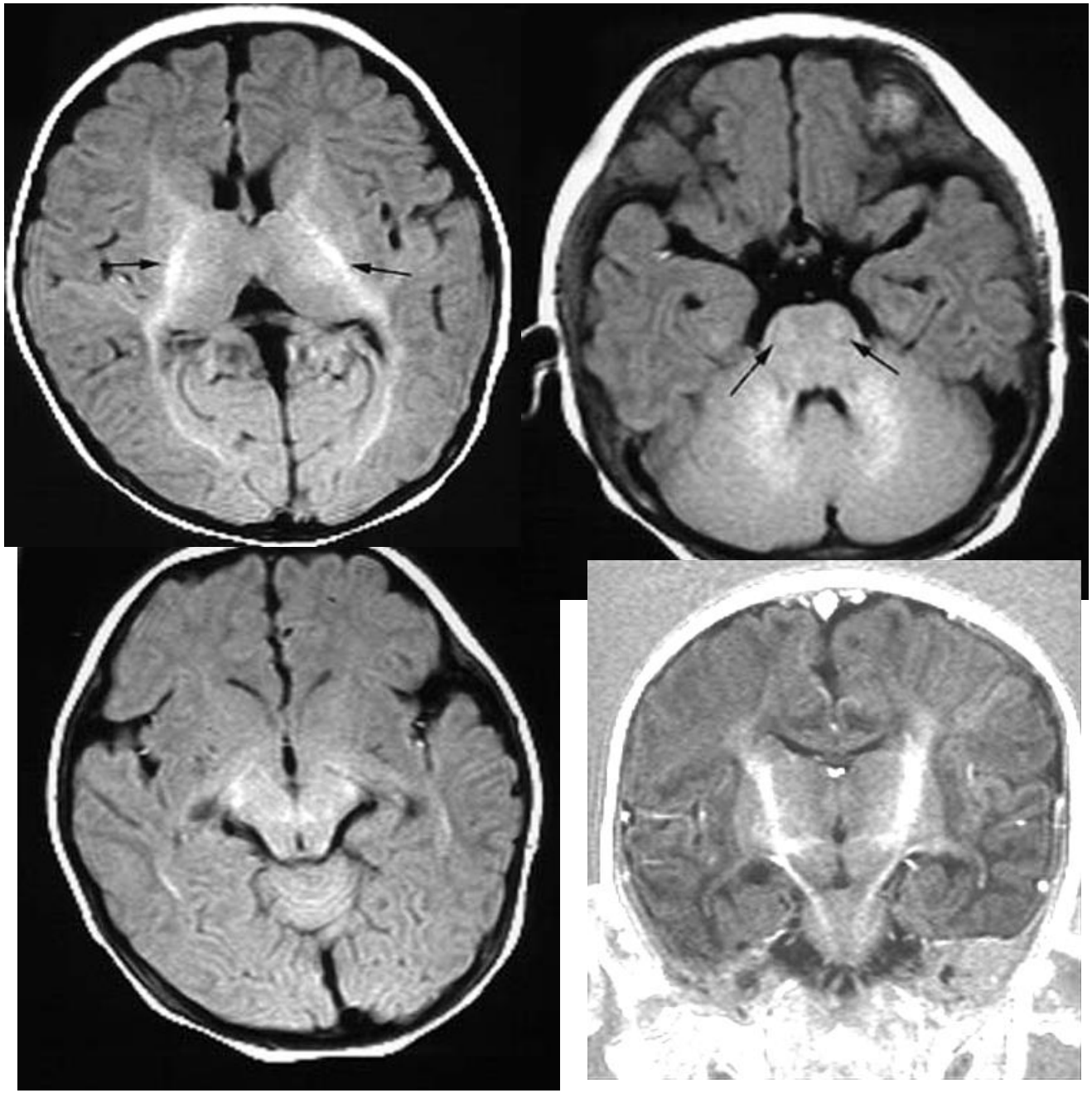
One minute note (2):

Please describe the anatomy of brainstem:

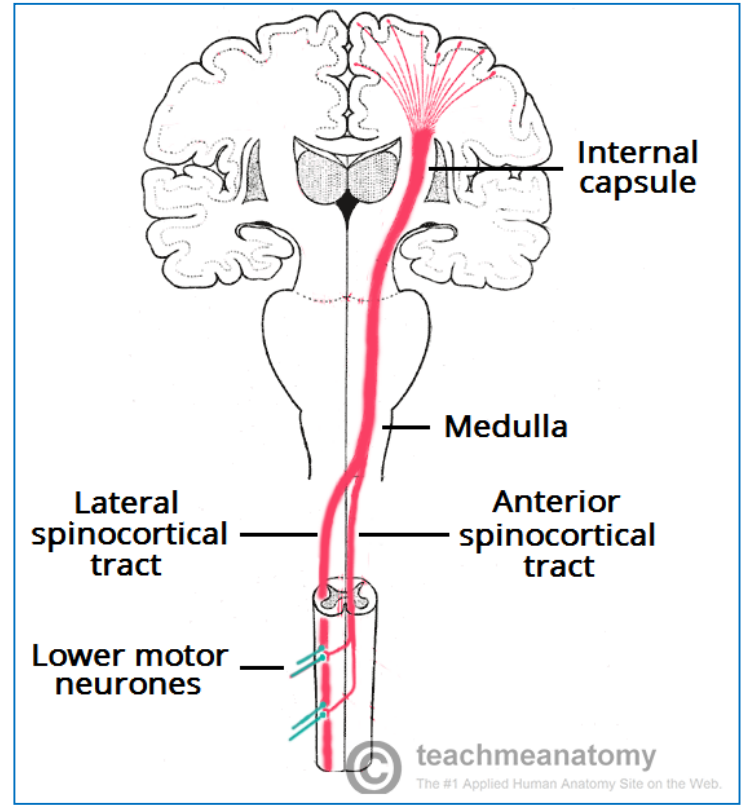


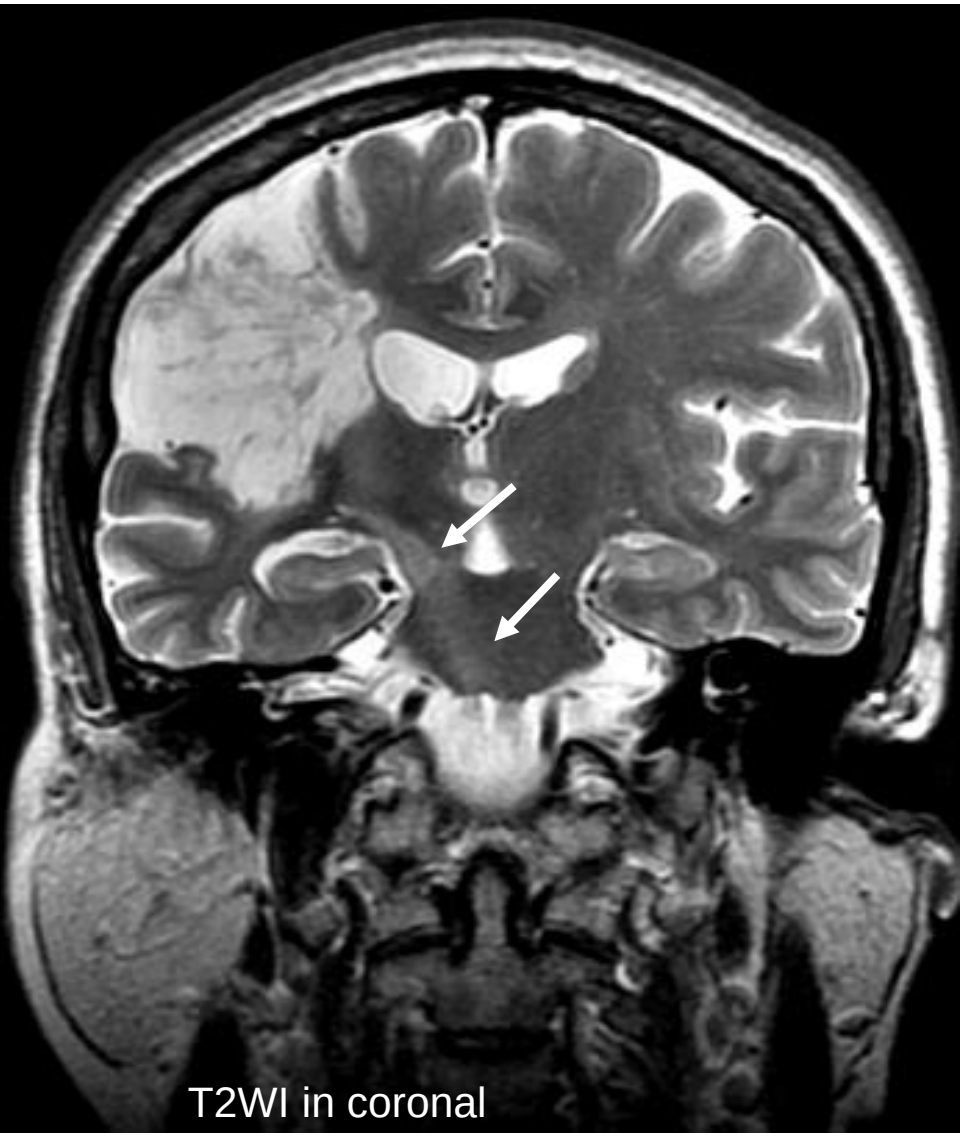
大腦皮質脊髓徑(corticospinal tract)，又稱錐體徑(pyramidal tract)

正常corticospinal tract在MRI影像
(A)-(D)都是FLAIR, (E,F) T2WI
A. Corona radiata：在額頂葉之白質區，即centrum semiovale之內，在FLAIR可見其內的corona radiata稍白。
B. 往下在basal ganglia，corticospinal tract經internal capsule的後肢(posterior limb)，呈現比較白的小點。
　g：globus pallidus
C. 往下到midbrain的大腦腳(cerebral peduncle)， corticospinal tract在黑質之旁。
　s：substantia nigra黑質
D. 往下到pons，corticospinal tract較白。
E. 往下到medulla oblongata的pyramid(p)。
F. coronal section，可見整條corticospinal tract(arrows)。



T1WI in a 2 m/o baby, showing the myelination areas (bright in T1WI) along the pyramidal tract





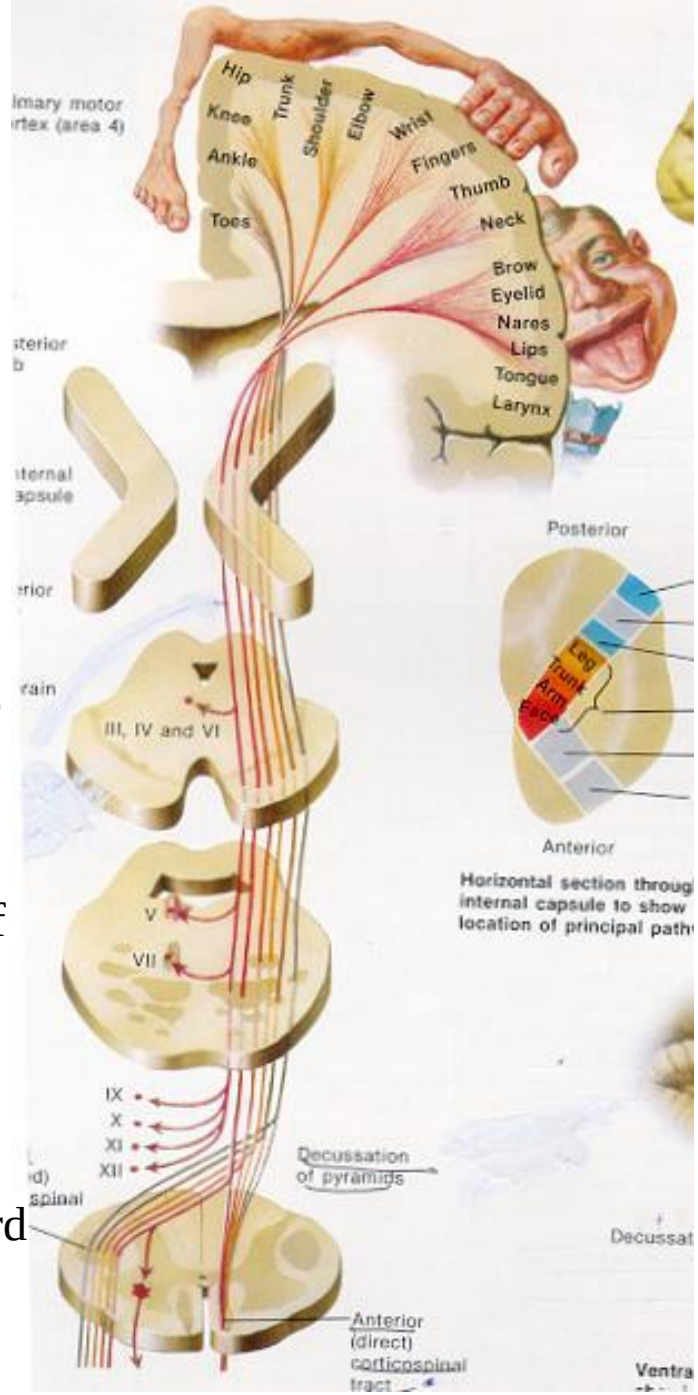
96,10,25 MRI: (same patient as above)
Changed to be old infarction with
Wallerian degeneration of corticospinal tract

Internal capsule

Cerebral peduncle of midbrain

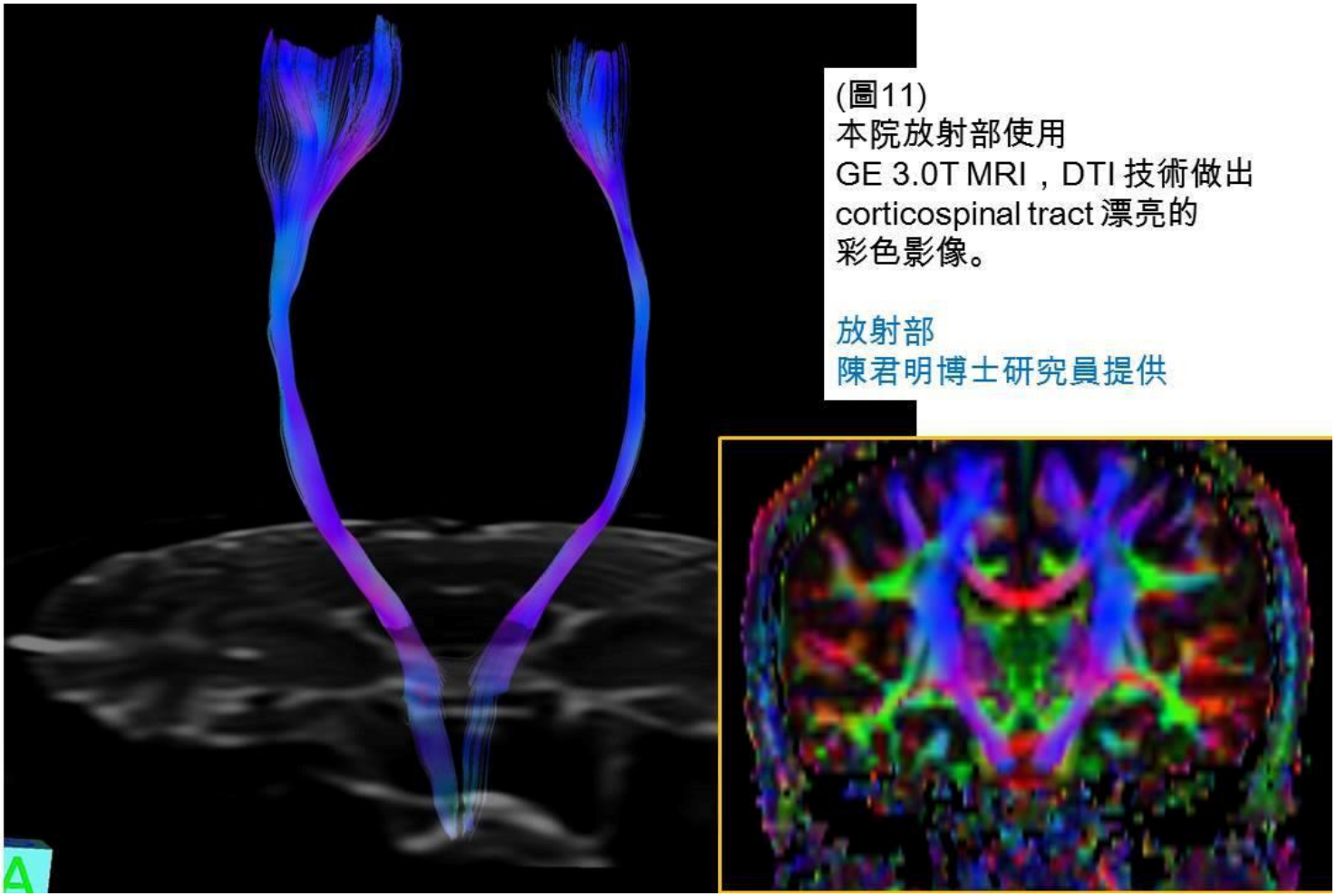
Pyramid of medulla oblongata

Spinal cord



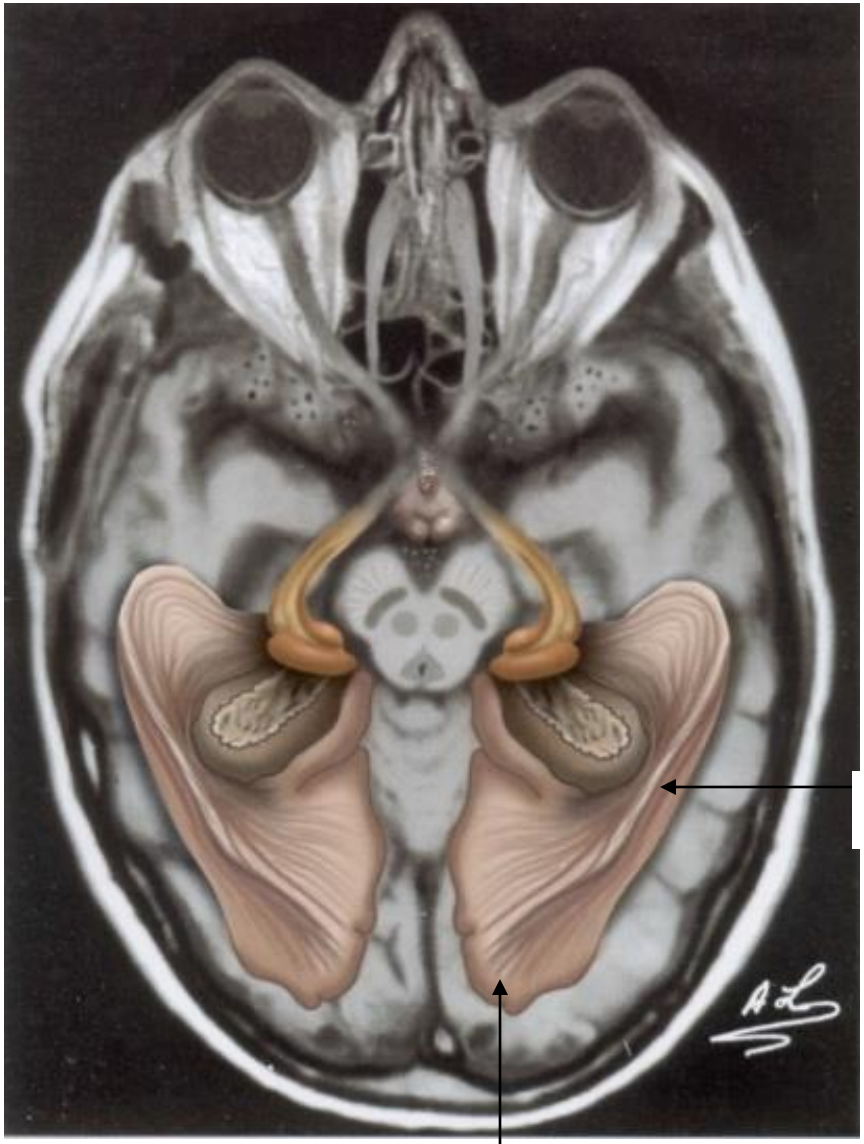
One minute note (3): http://wcshenn.pixnet.net/blog/post/278901847

Please describe the course of corticospinal tract:



DTI:
Diffusing tensor image

Optic pathway and optic nerve



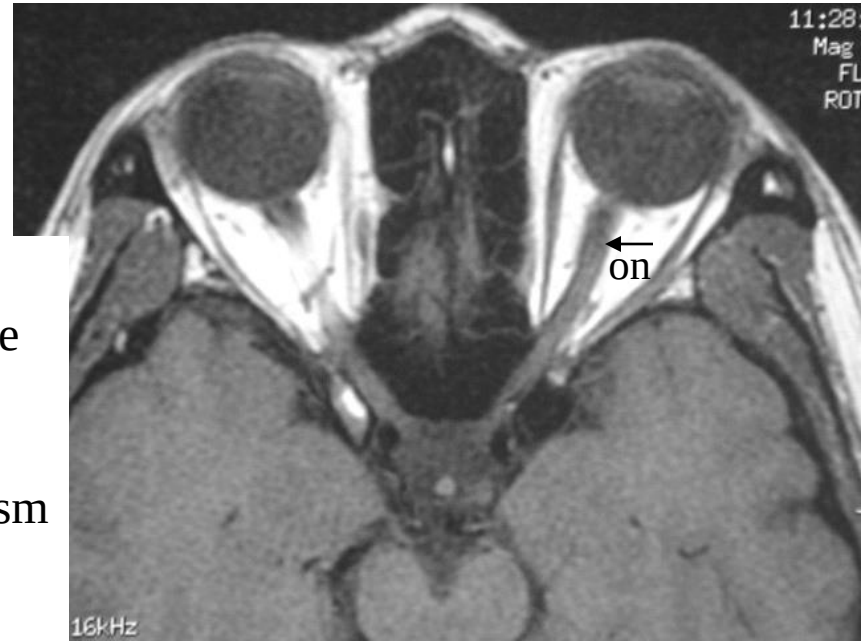
optic radiation

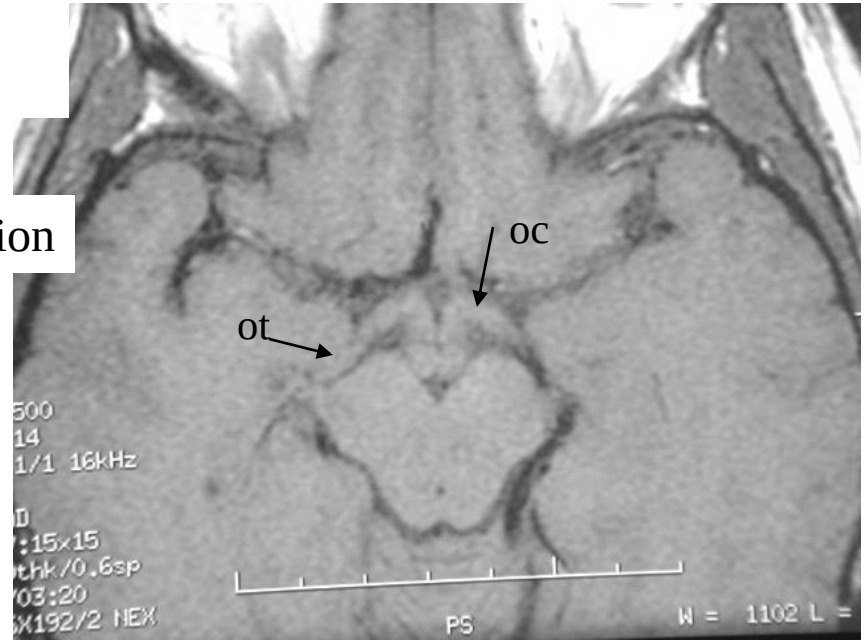
Calcarine cortex

on:
optic nerve

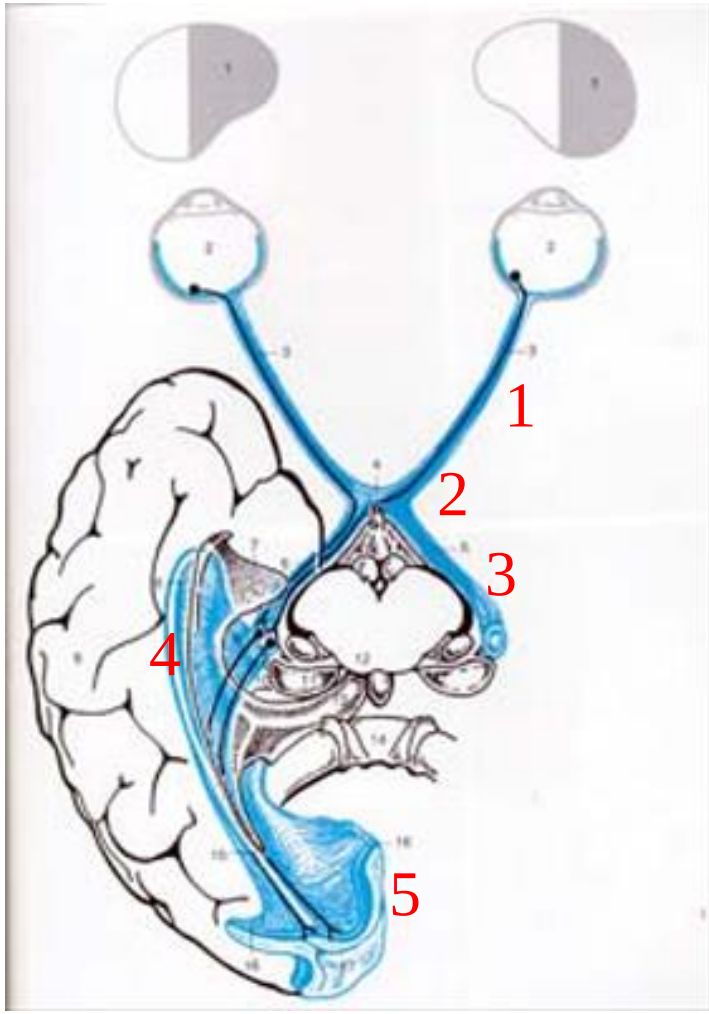
oc:
optic chiasm

ot:
optic tract





Optic pathways



- 1. Optic nerve. 2. Optic chiasm. 3. Optic tract. 4. Optic radiation 5. Visual cortex (calcarine cortex)

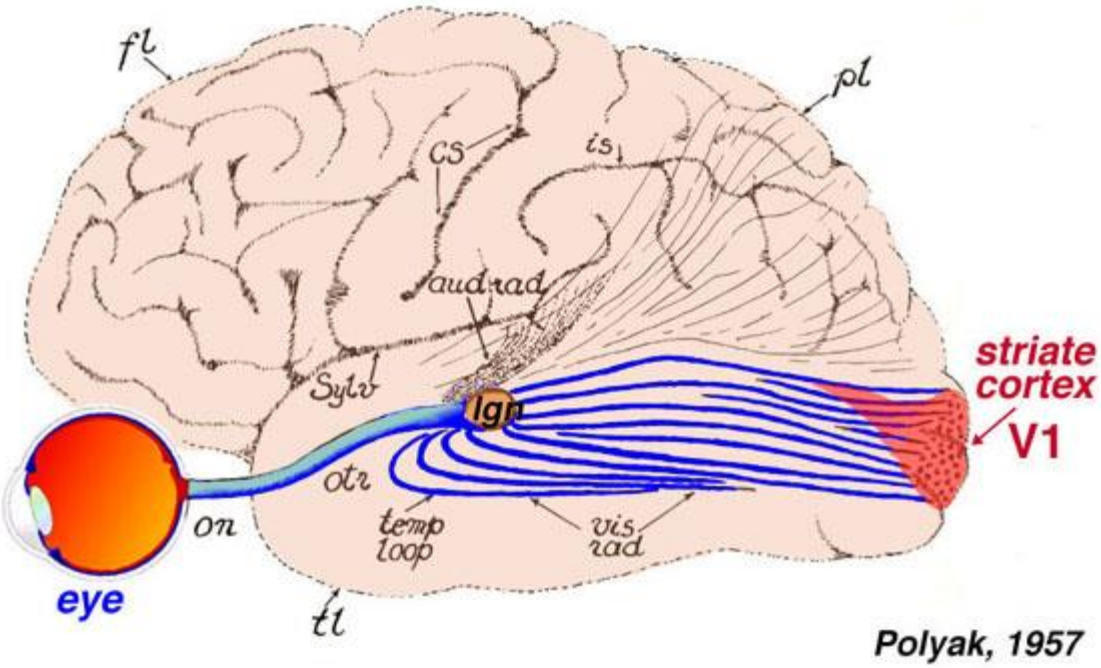
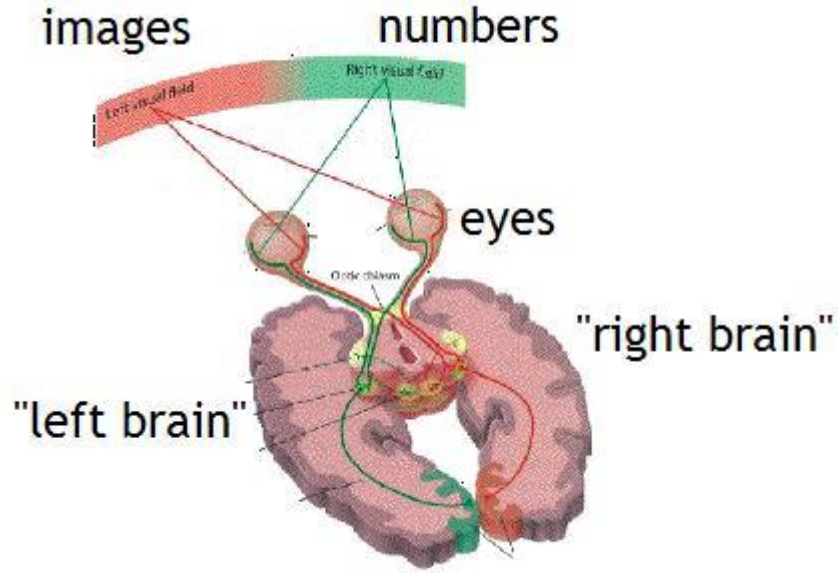
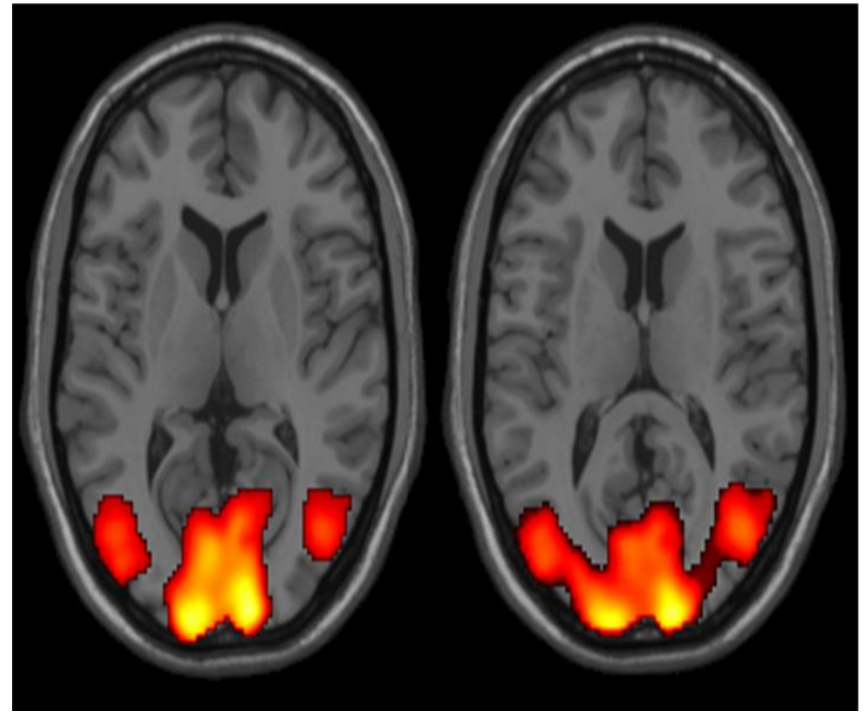


Figure 8. Visual input to the brain goes from eye to LGN and then to primary visual cortex, or area V1, which is located in the posterior of the occipital lobe. Adapted from Polyak (1957).

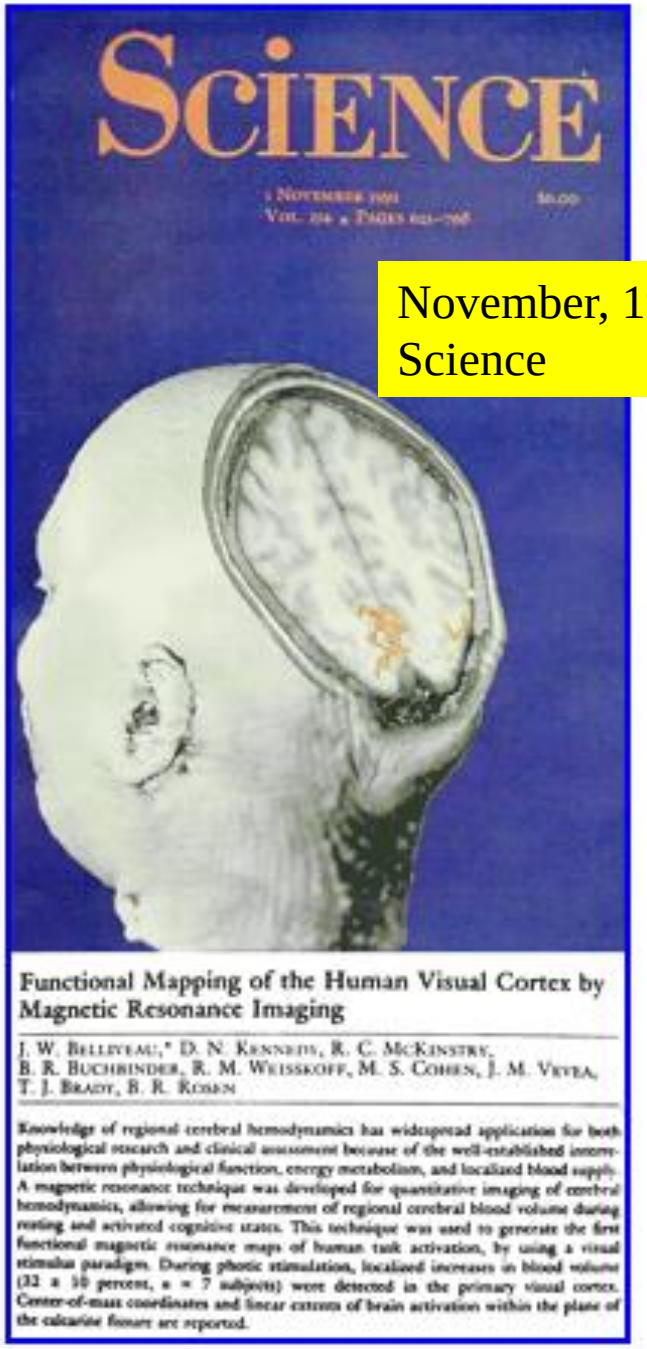




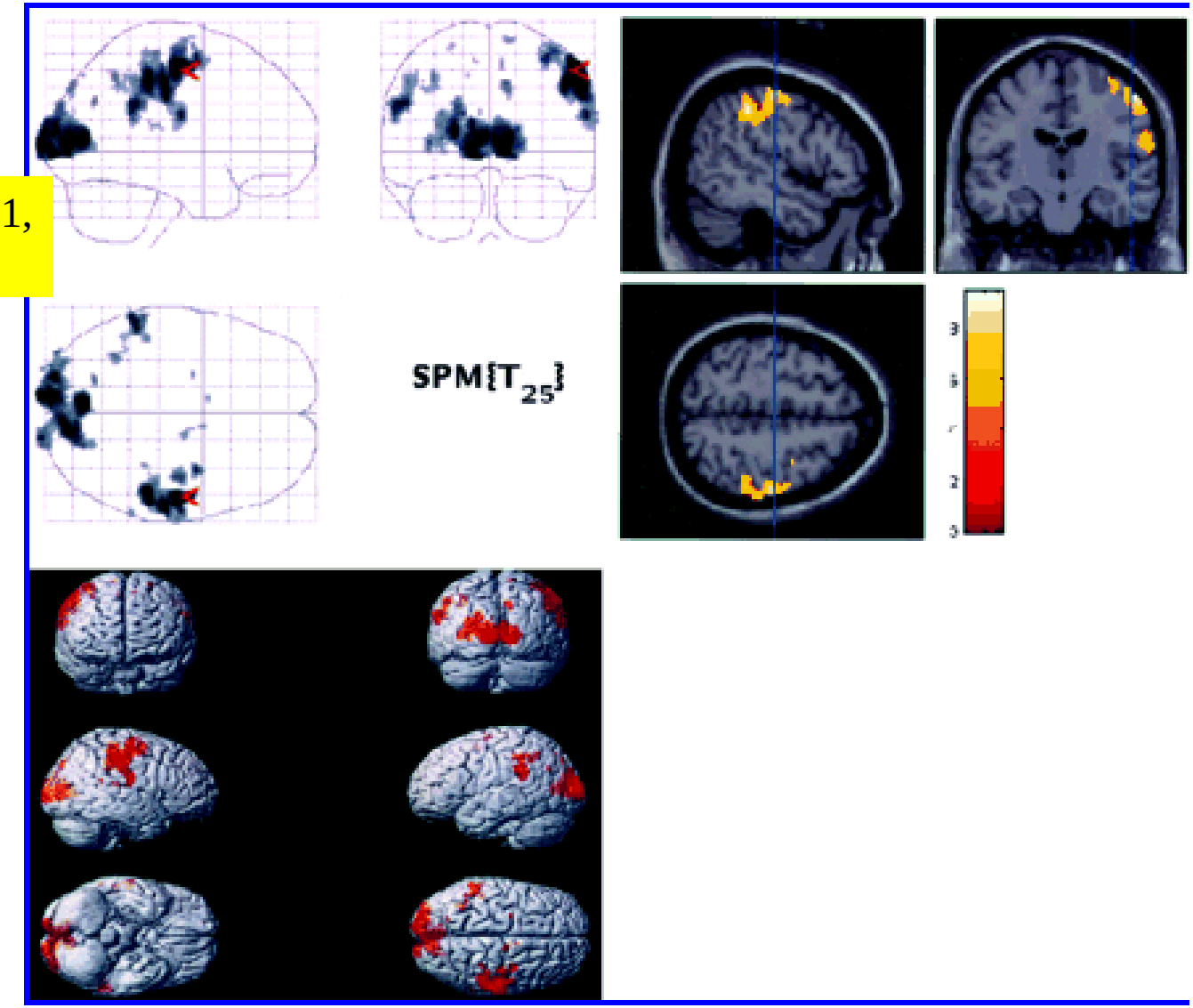
Functional MRI

The signal from your retina travels down the optic nerve to the visual cortex of the brain. Here, all sorts of fun things happen. As evidenced by this fMRI.

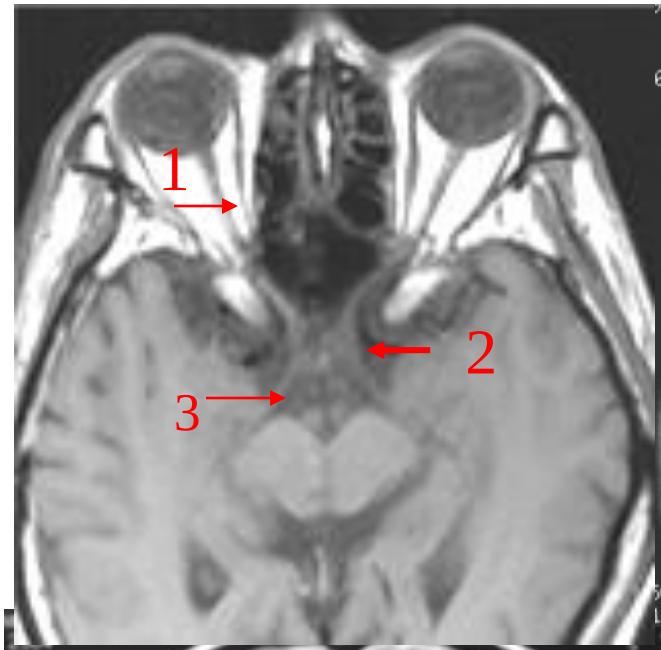
www.thewebwingman.com

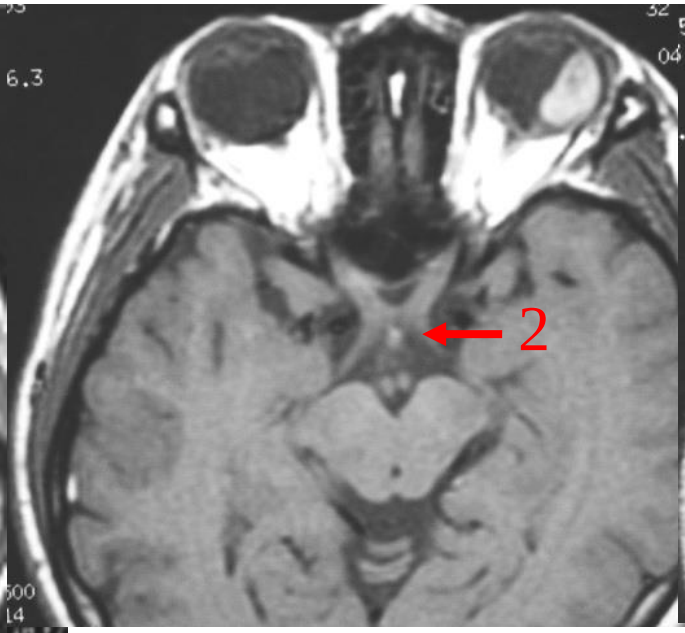


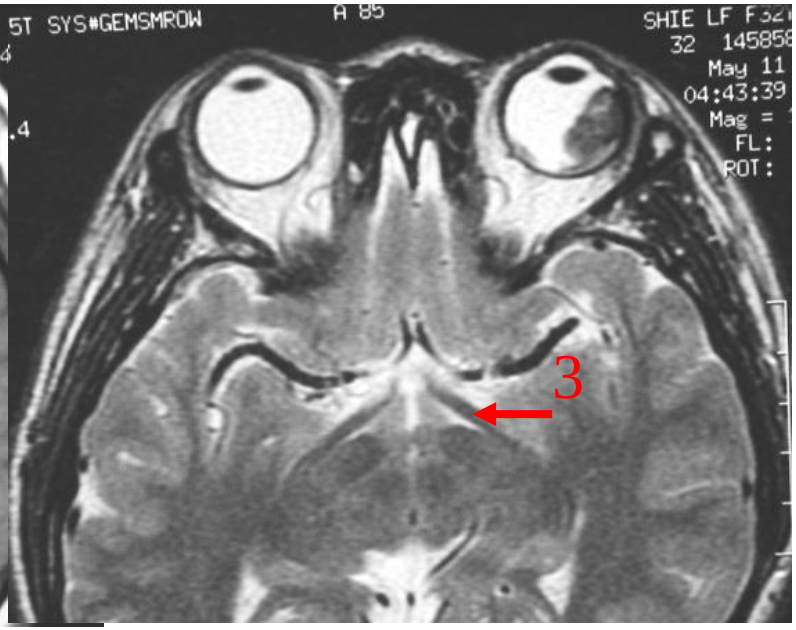
November, 1991,
Science

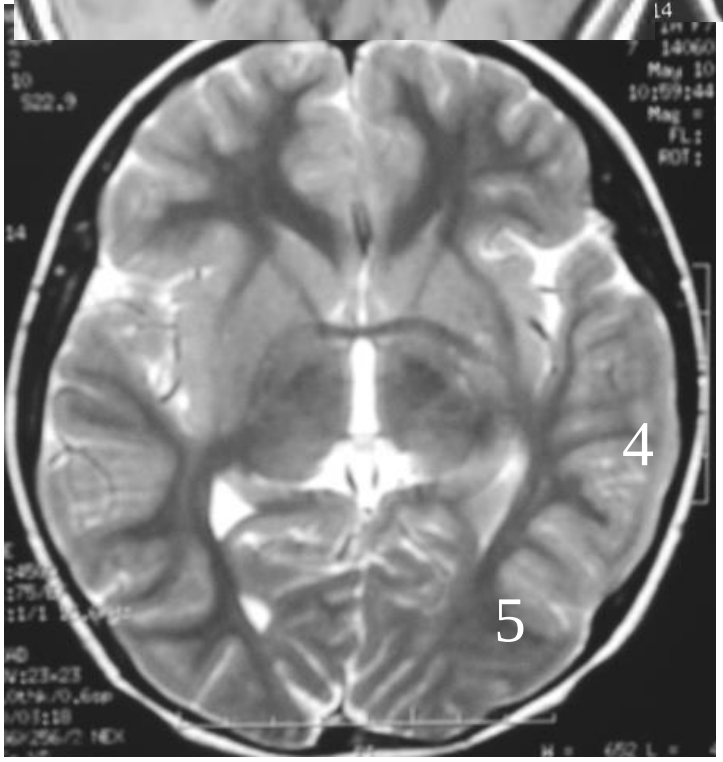


Statistical activation maps (*top left*), T1W sections (*top right*), and render images (*bottom left*) for the random-effects group analysis (n = 26) showing the visual and motor activations



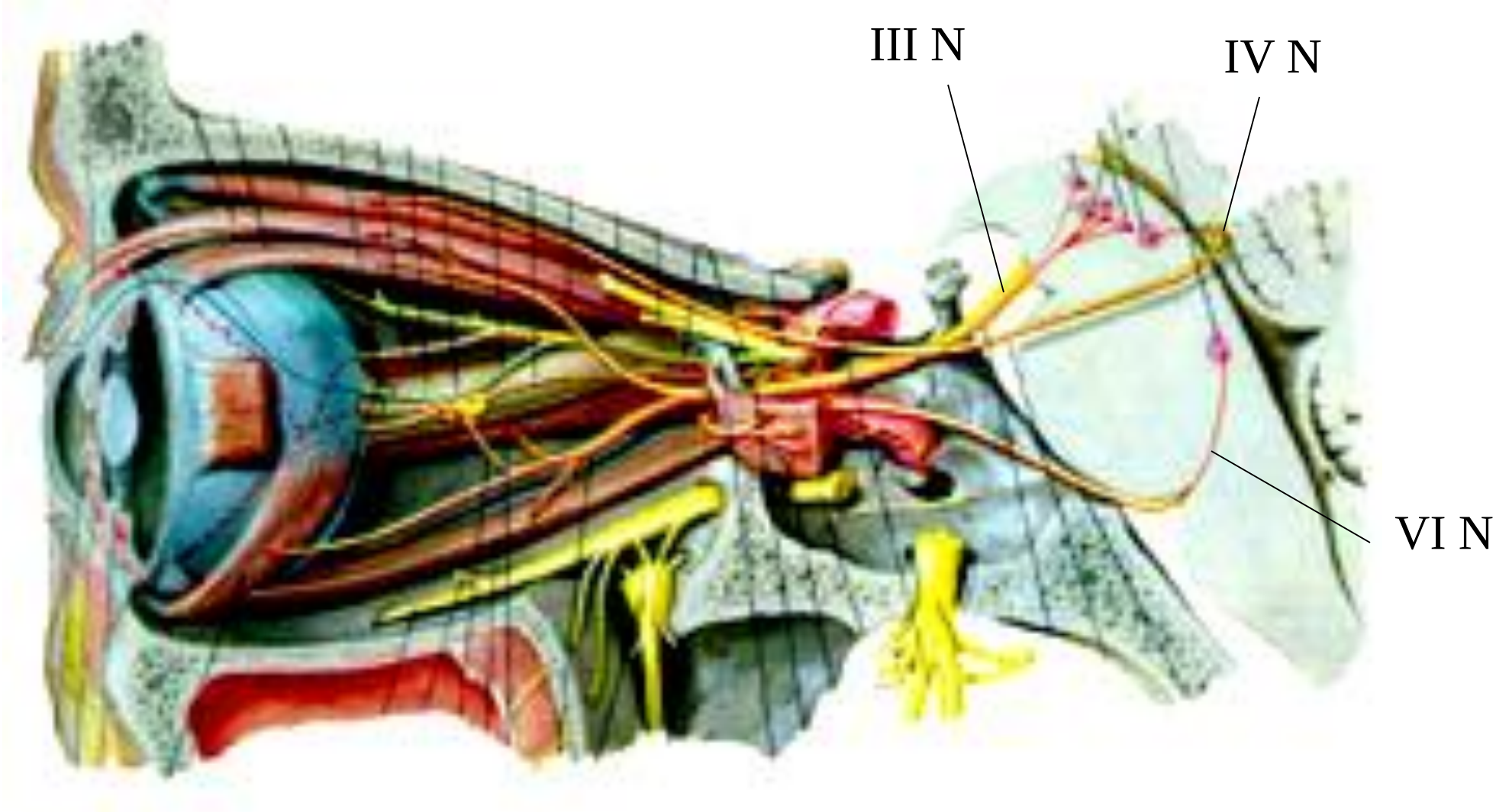




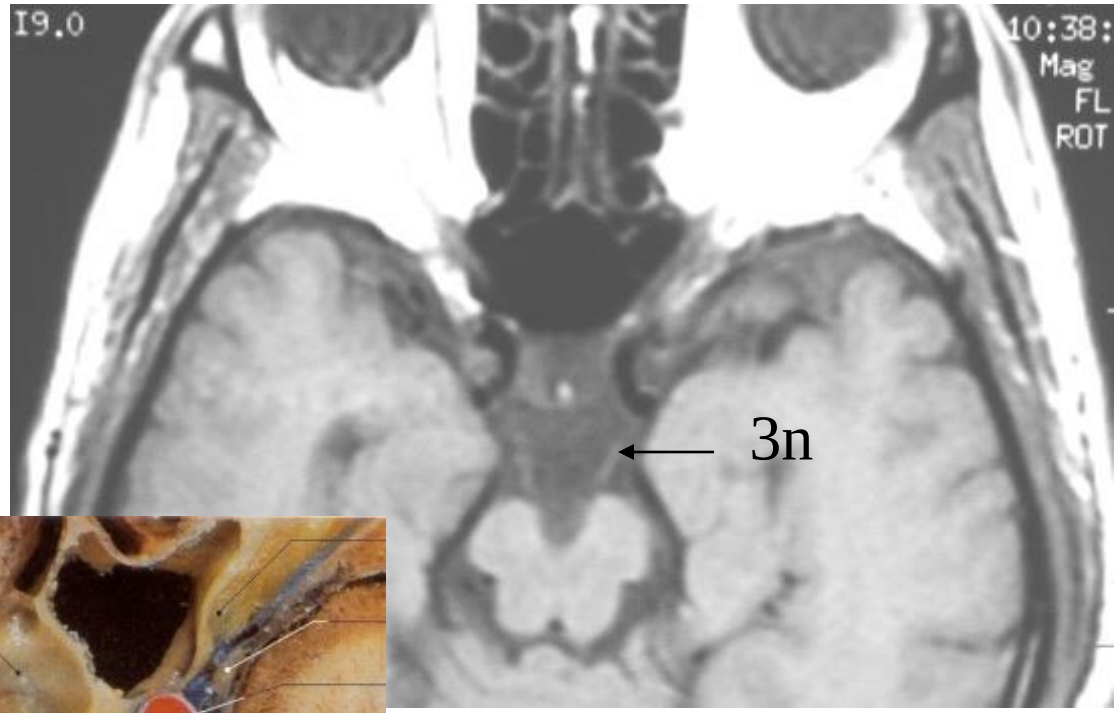


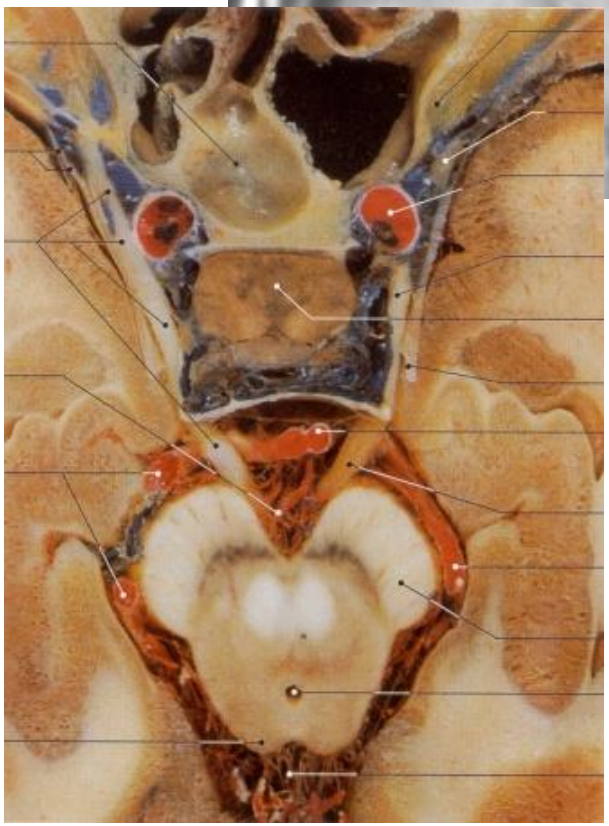
- 1. Optic nerve. 2. Optic chiasm. 3. Optic tract.
  4. Optic radiation
  5. Visual cortex (calcarine cortex)

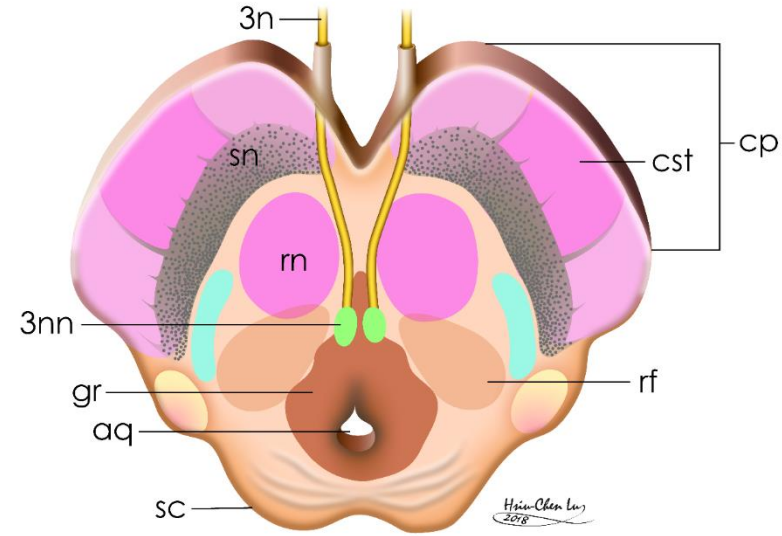
Cranial nerves 顱神經

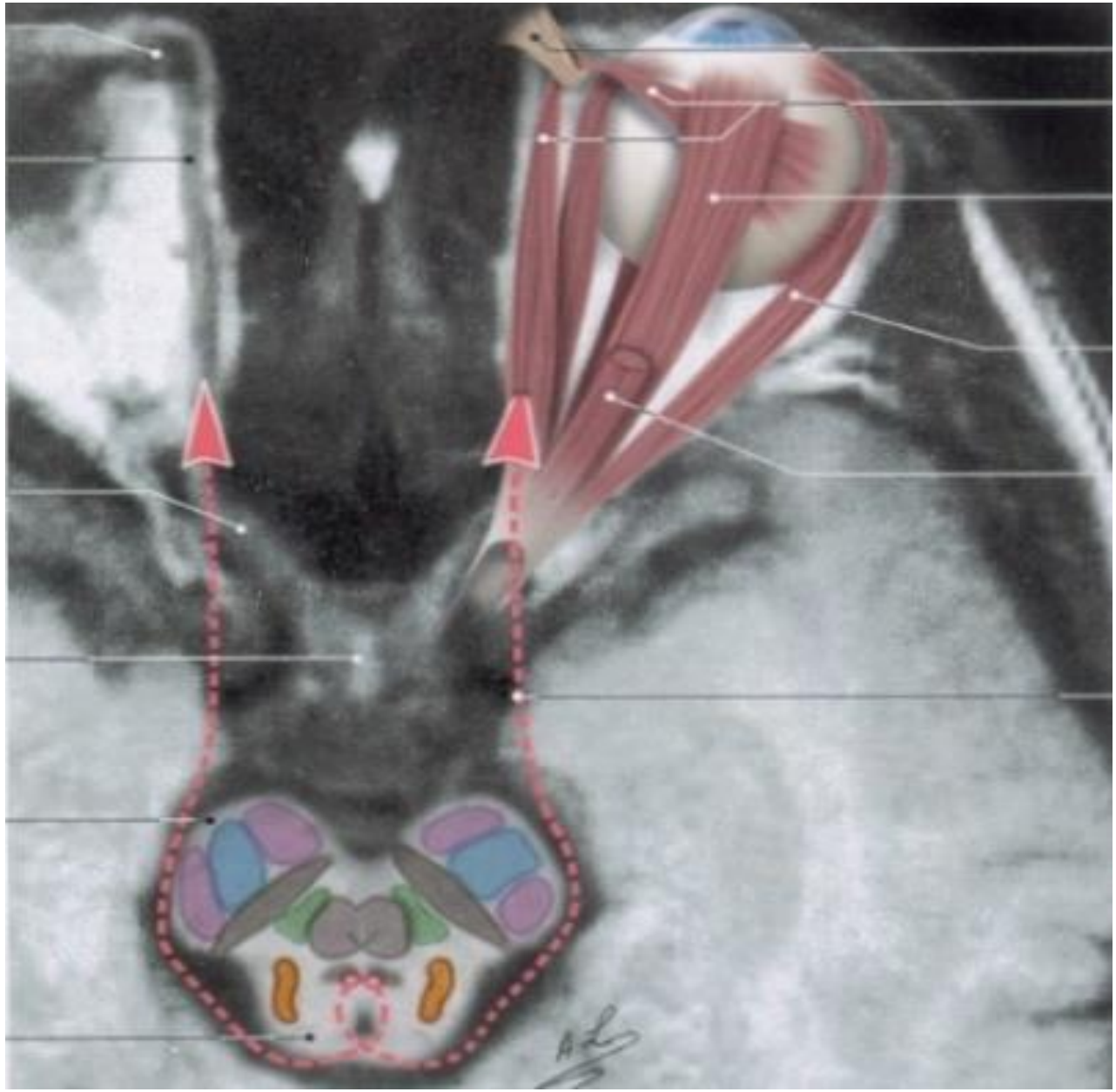


3rd n: oculomotor n



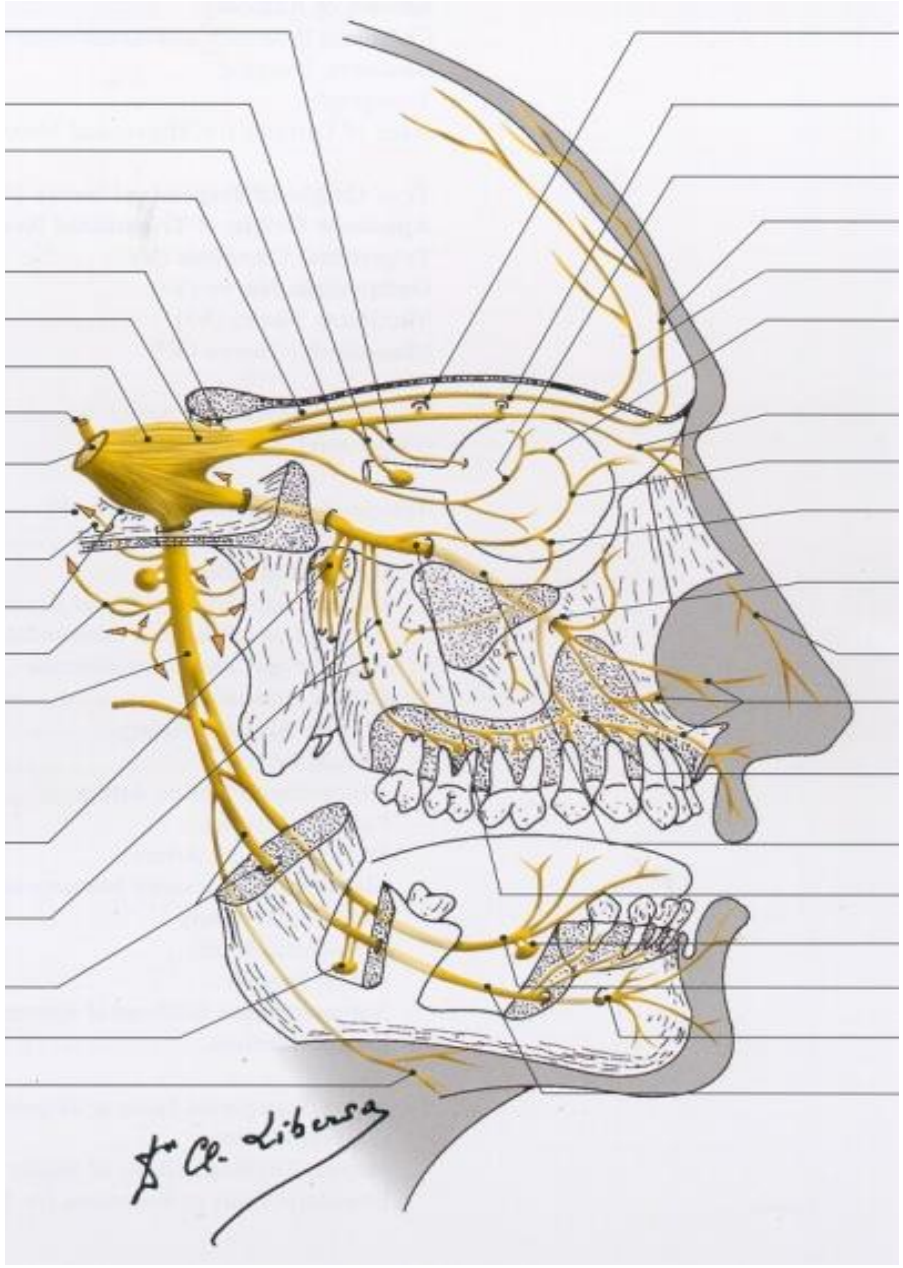


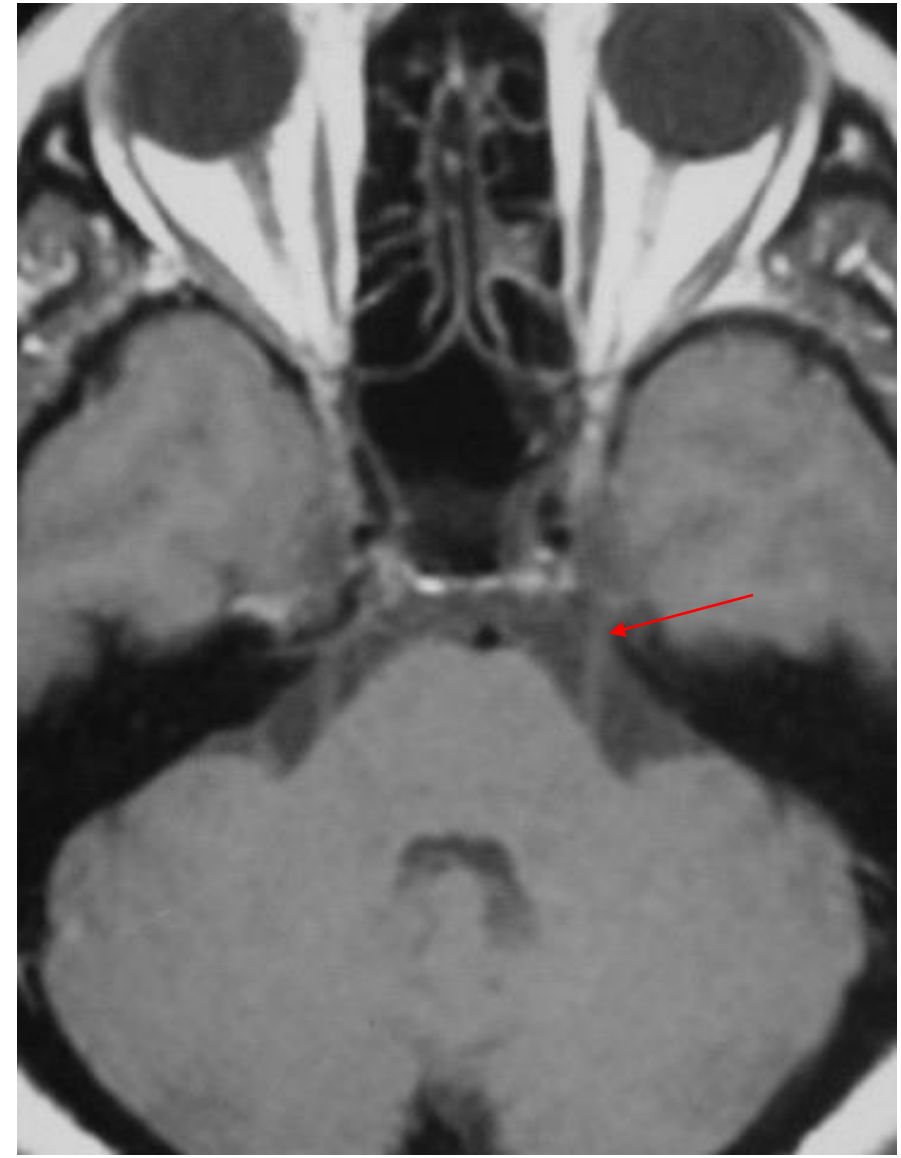


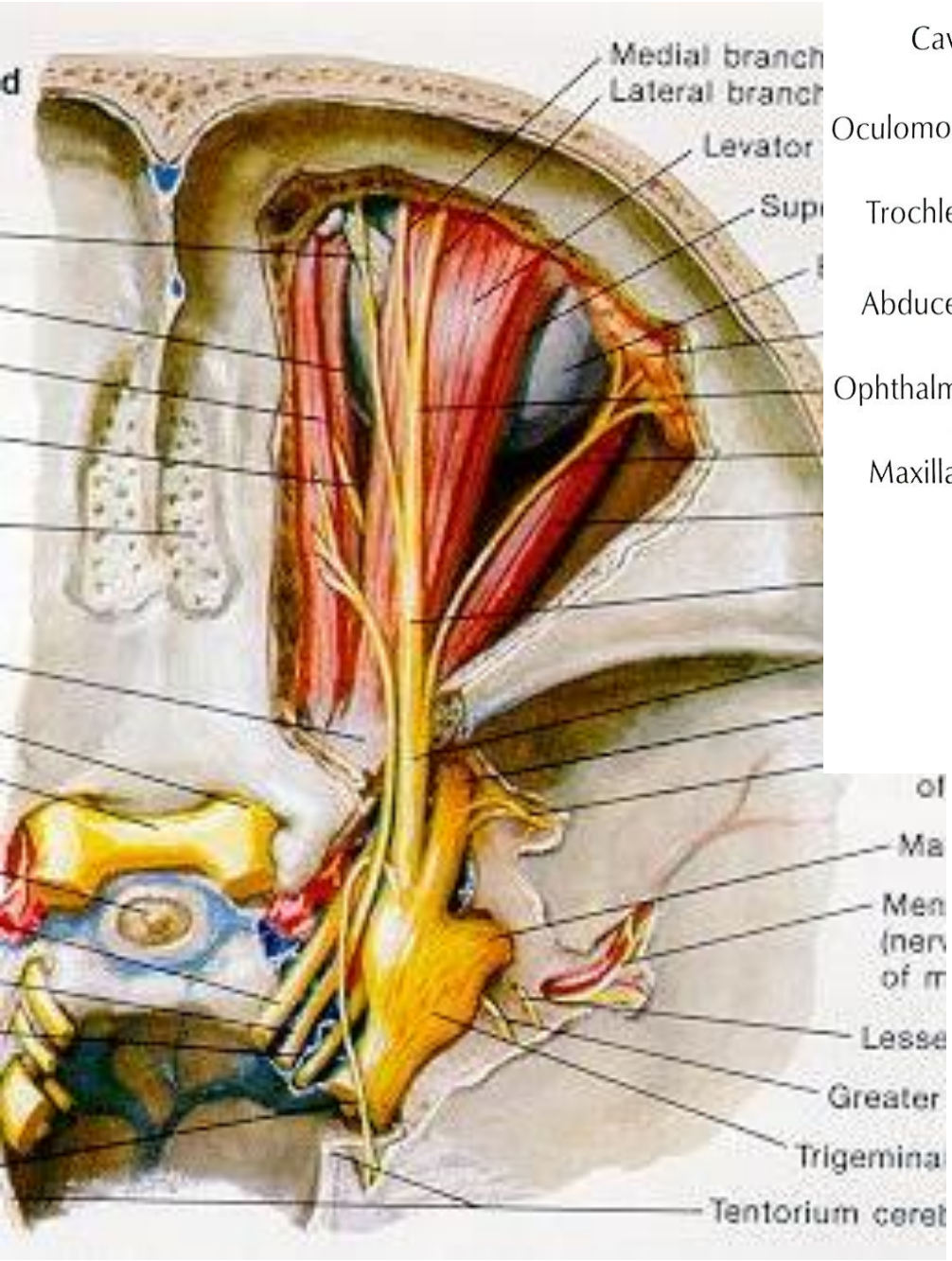


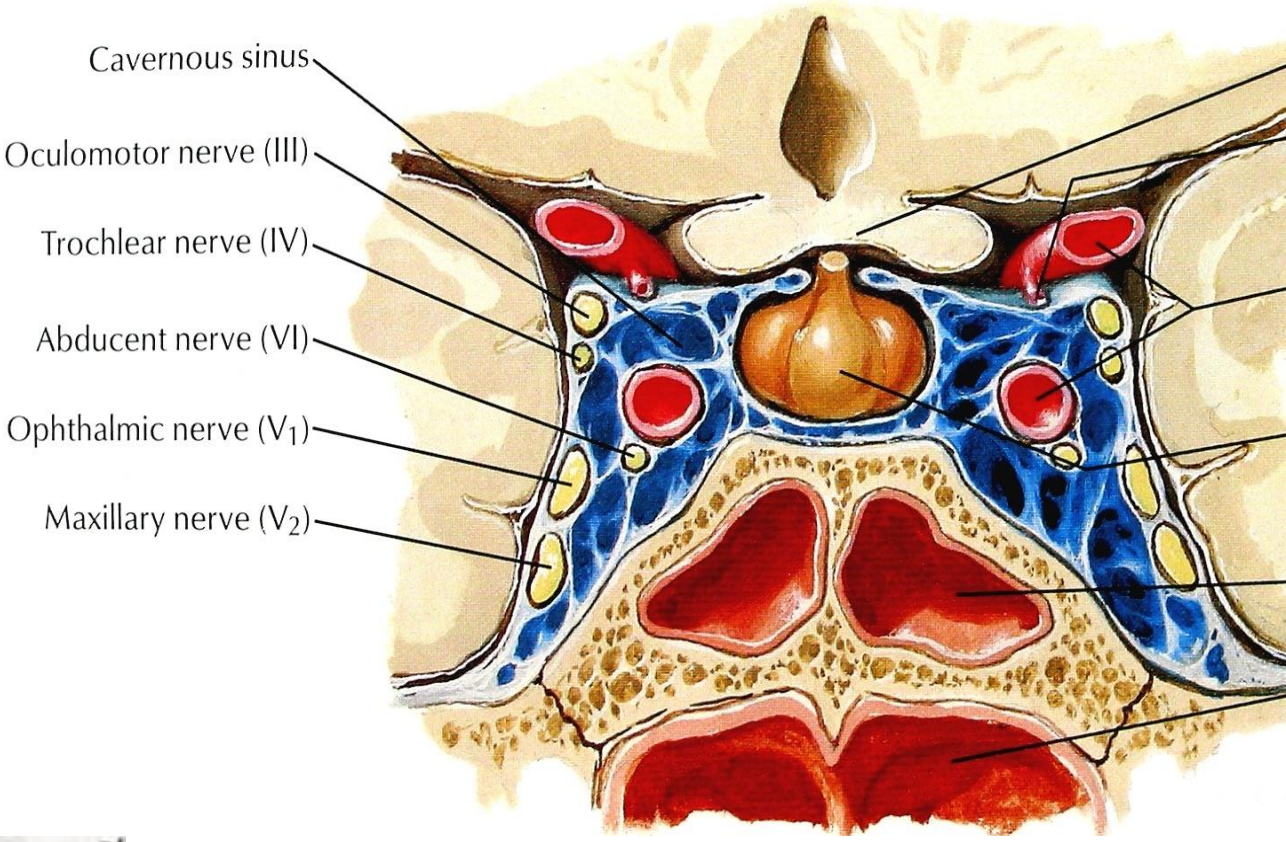
Trochlear nerve:
Superior oblique m

Trigeminal nerve



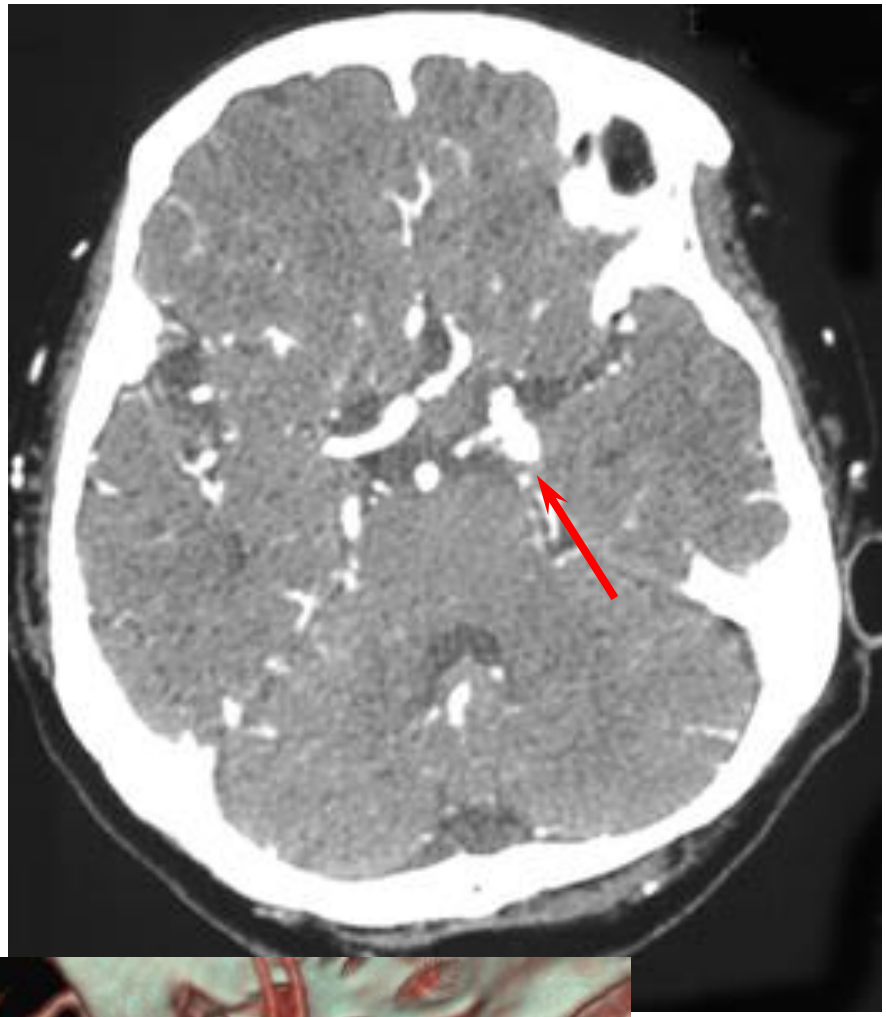


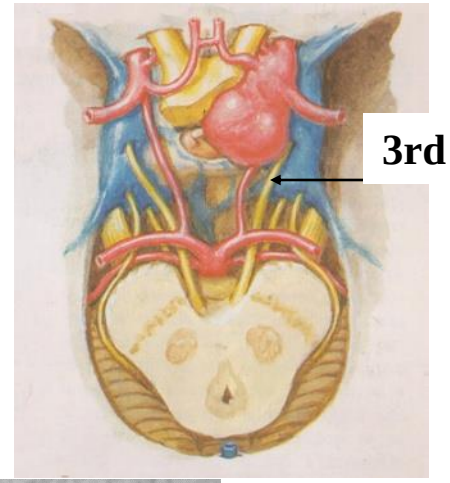




Cavernous sinus:

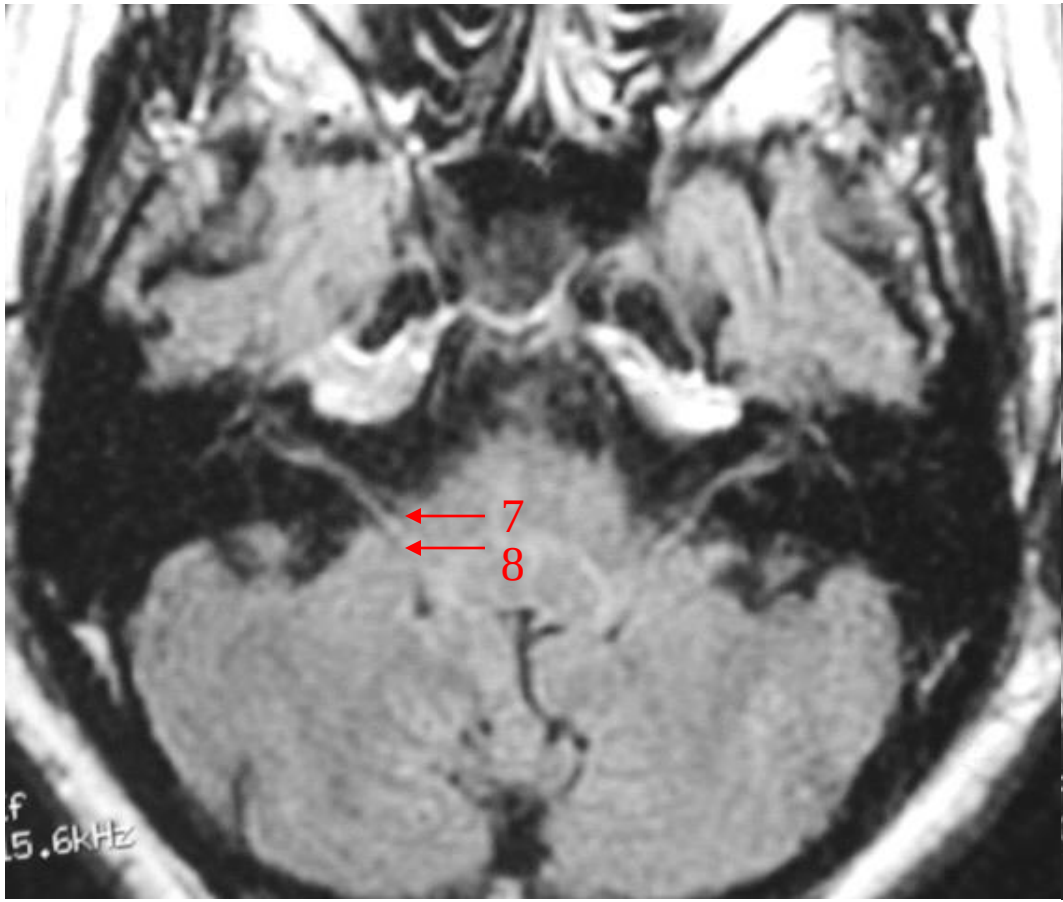
3^{rd}, 4^{th}, 5^{th}, 6^{th} cranial nerves
internal carotid artery

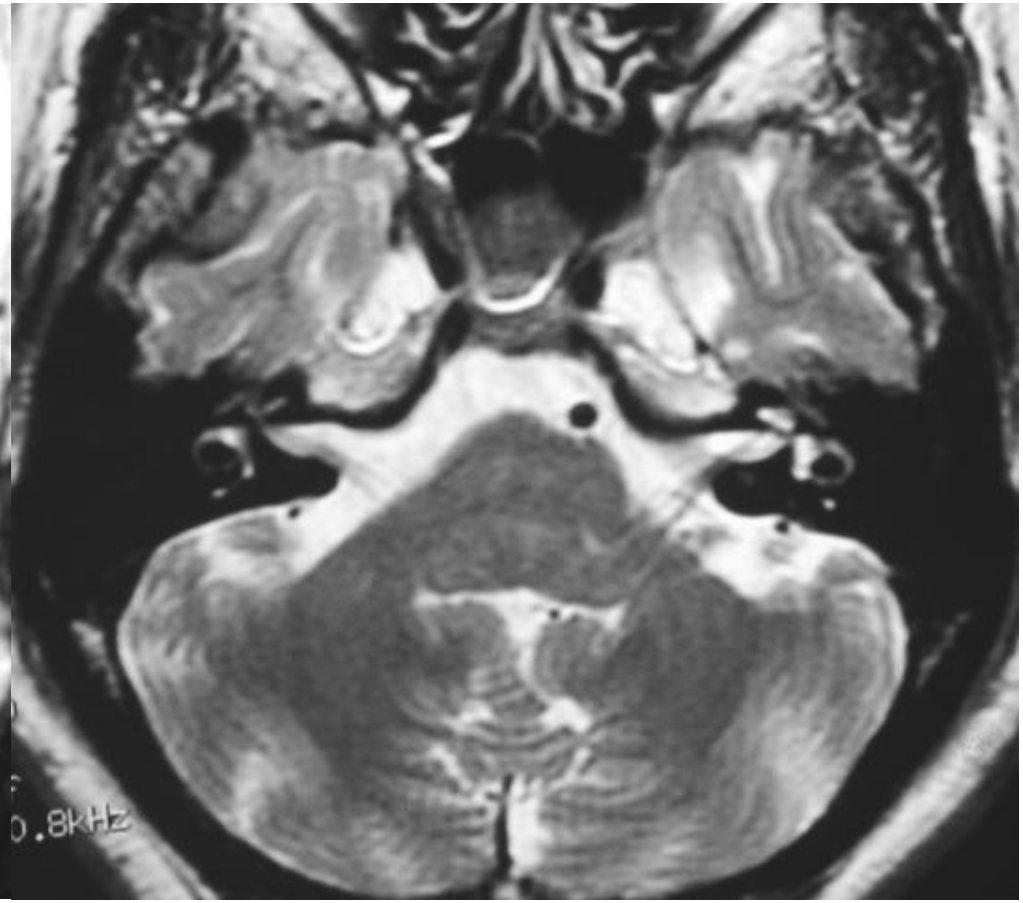


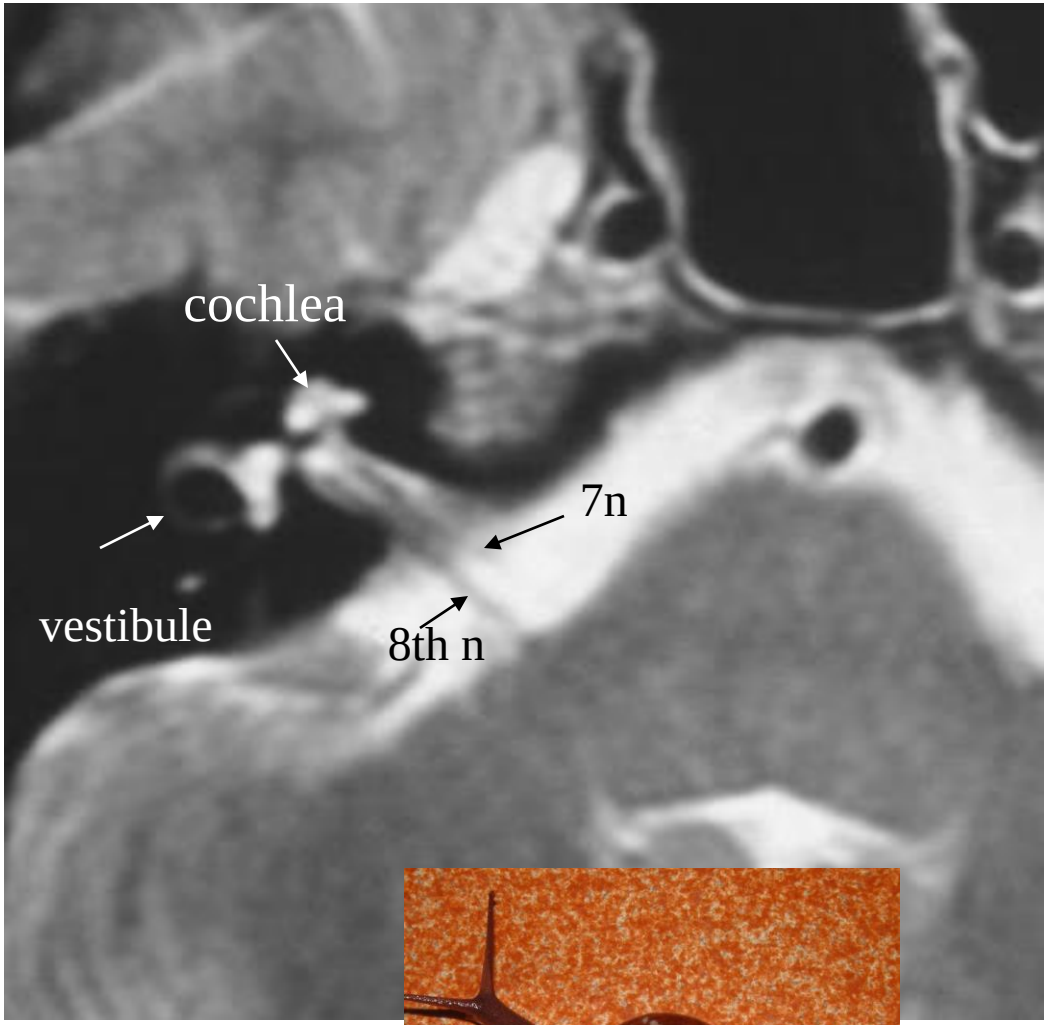


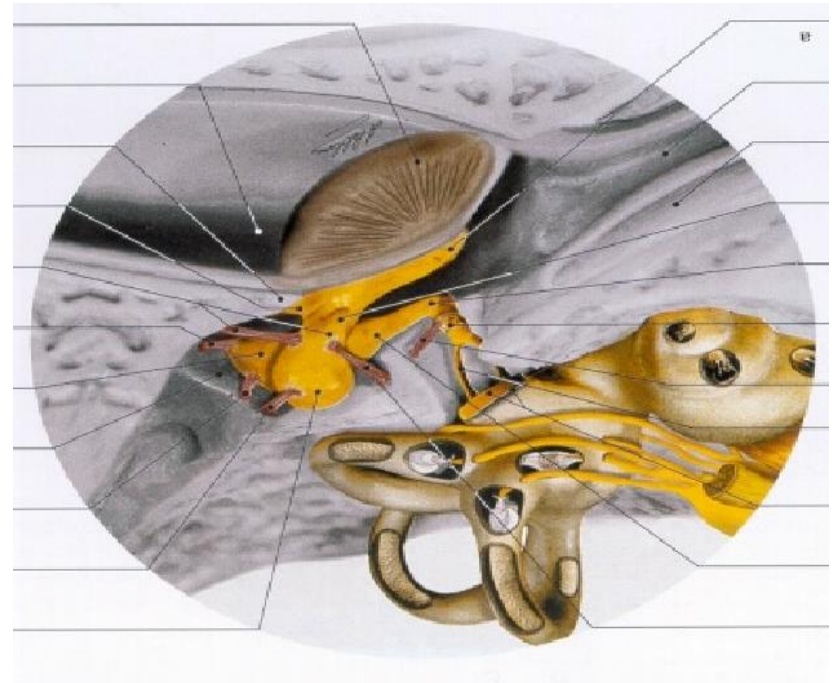
女性77歲，左側眼皮下垂，表示第三對動眼神經麻痺。因此須做CTA
來源影像就可見到左側ICA/PCoA有一動脈瘤
CTA證實之

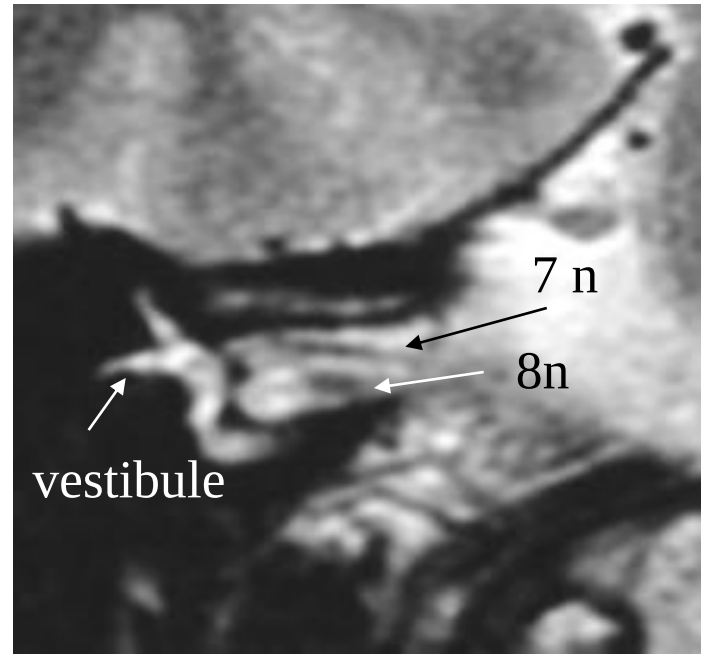
8th and 7th cranial nerves

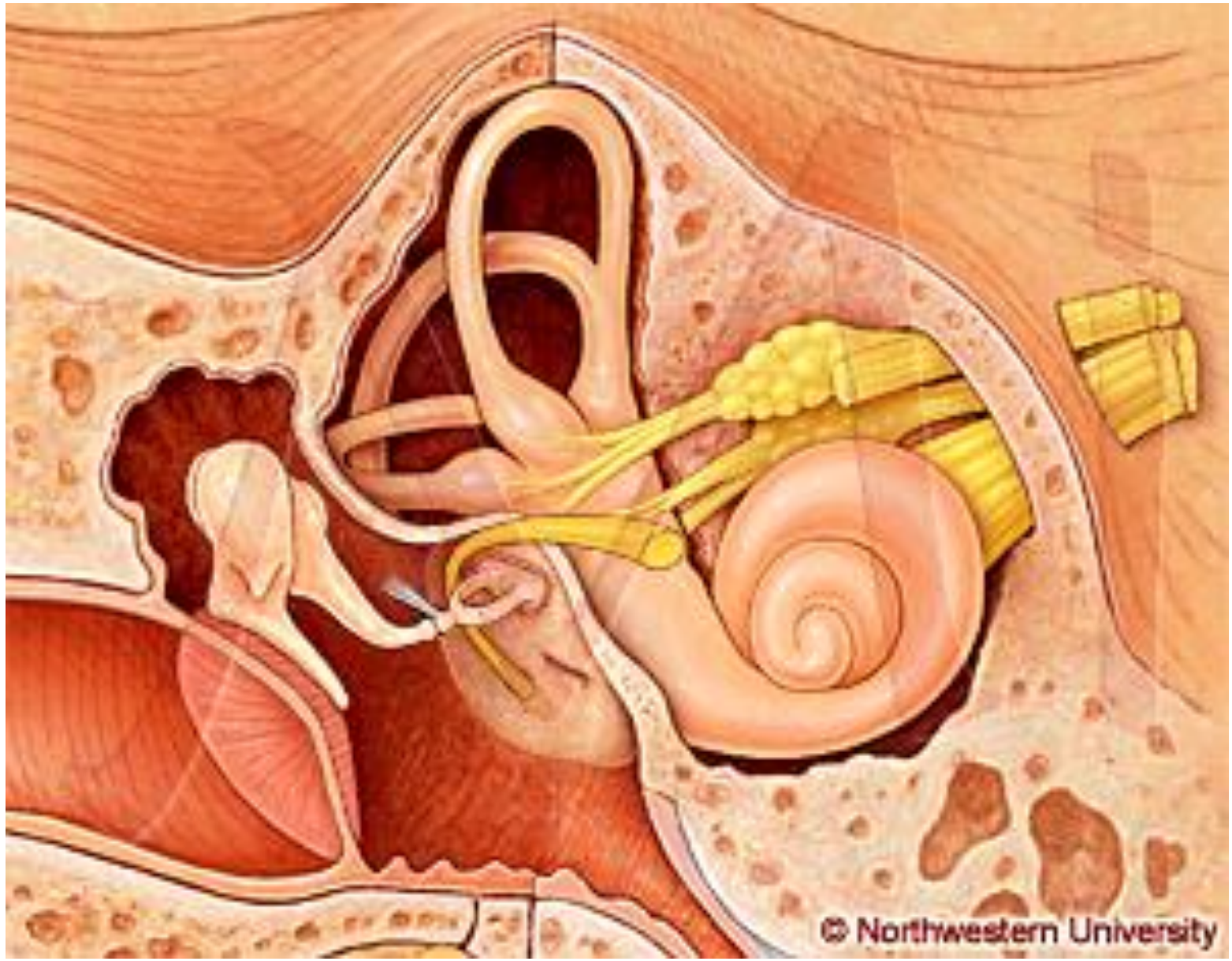




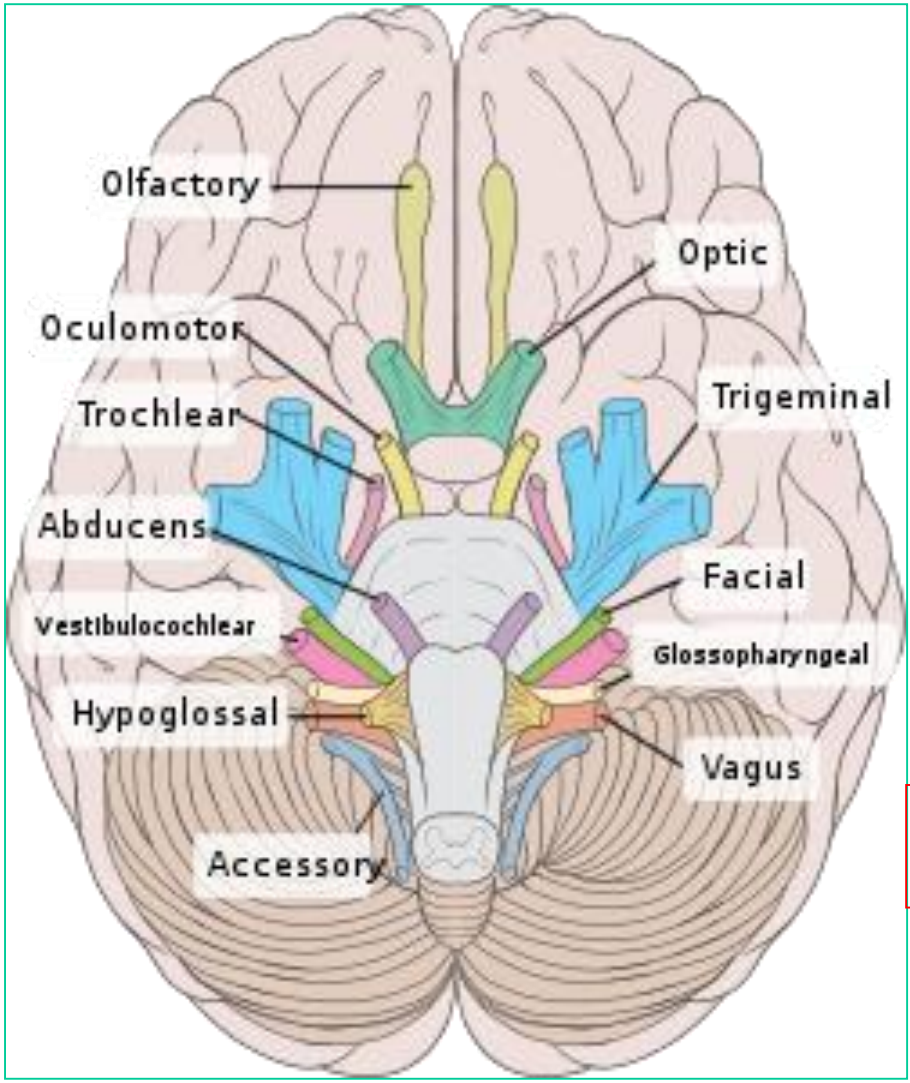

cochlea
7n
vestibule
8th n




7 n
8n
vestibule



聽覺的產生

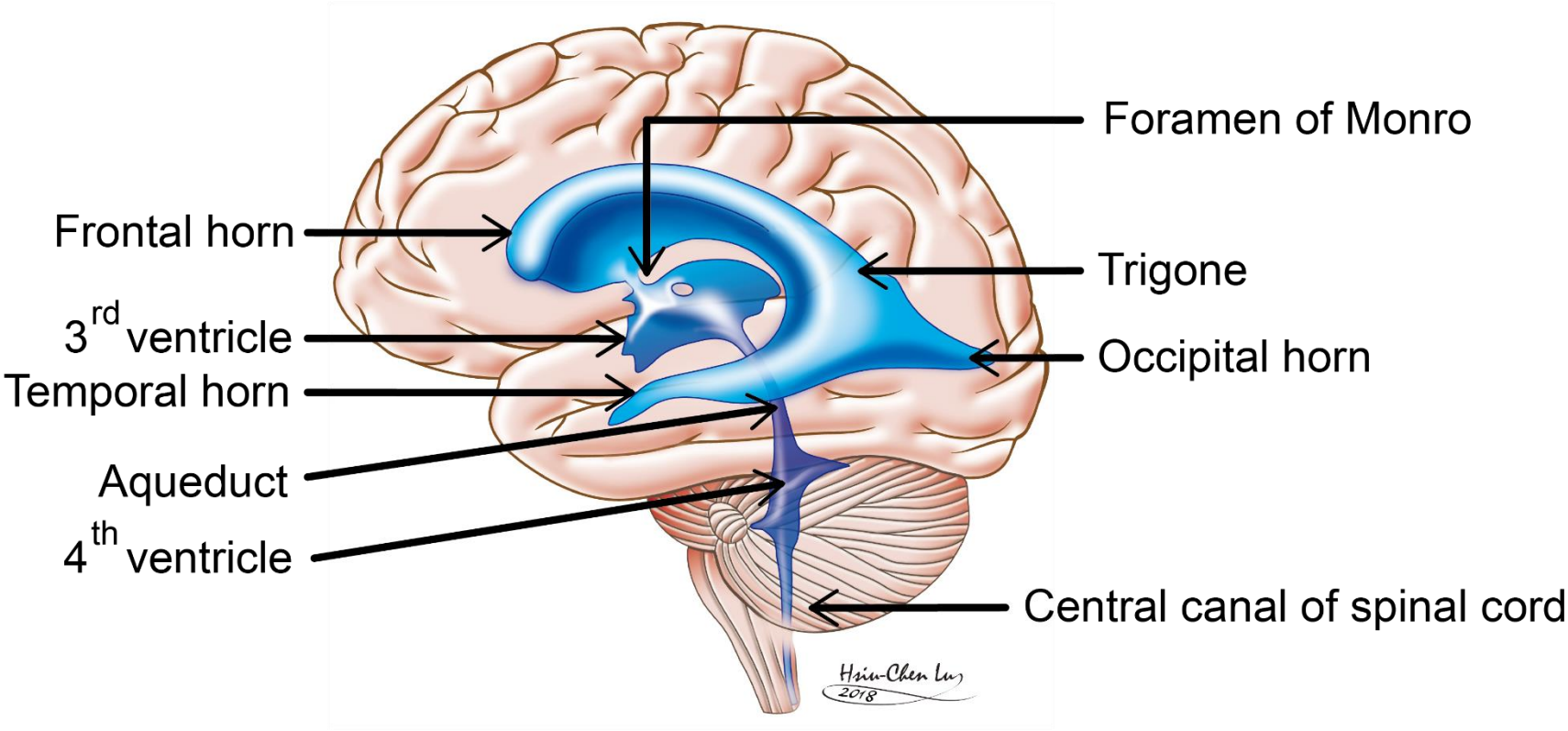


12對顱神經歌訣

一嗅二視三動眼，四滑五叉六外旋，
七面八聽九舌咽，十迷十一副舌下全

https://www.youtube.com/watch?v=sAFaTaavmO8&index=5&list=PL4Cuo-fGFLUhg4fE0WBpzEbMgMZIJxv5C&t=0s

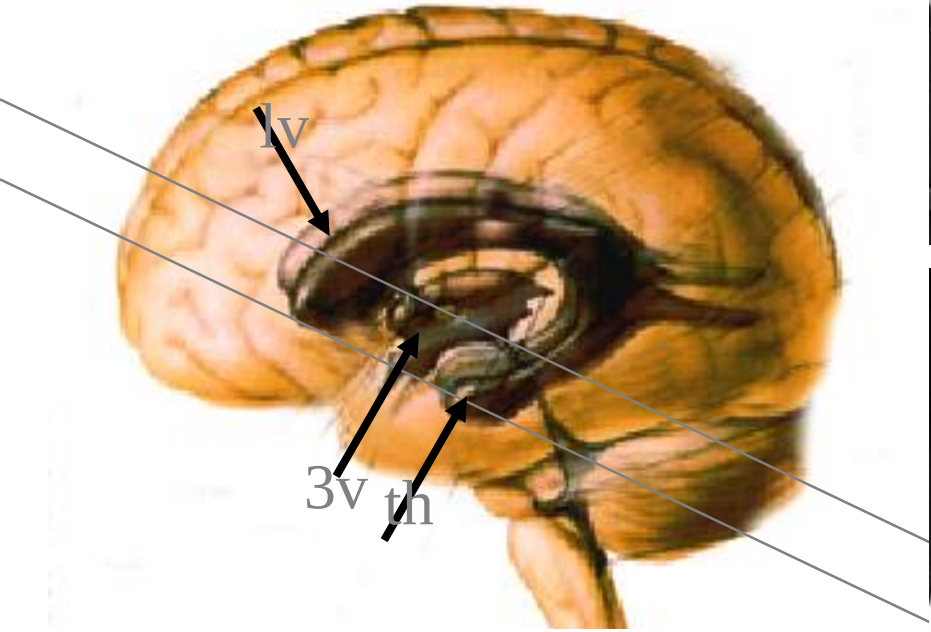
https://www.youtube.com/watch?v=0lbwshg_Kj4&t=0s&index=6&list=PL4Cuo-fGFLUhg4fE0WBpzEbMgMZIJxv5C

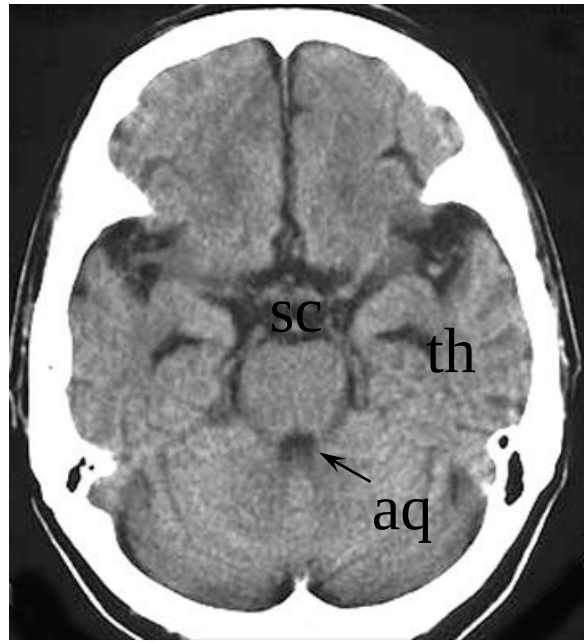

Foramen of Monro
Frontal horn
Trigone
3rd ventricle
Occipital horn
Temporal horn
Aqueduct
4th ventricle
Central canal of spinal cord
Hsiu-Chen Lu
2018

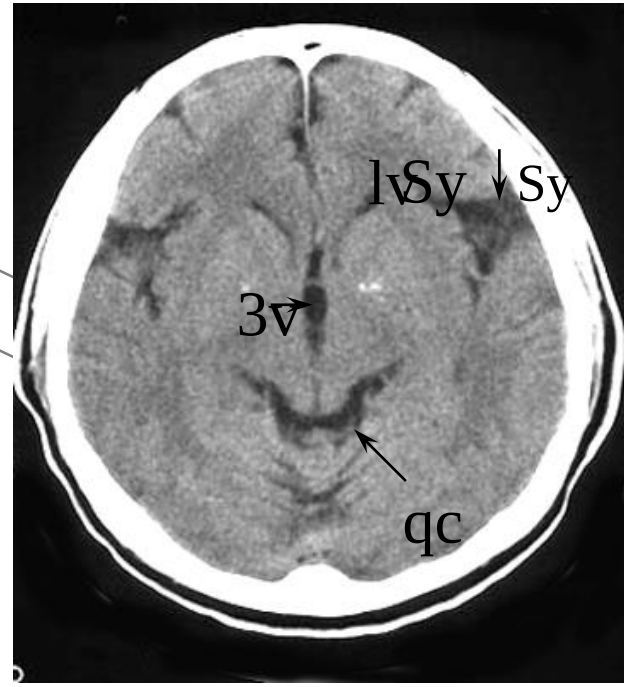
腦室構造

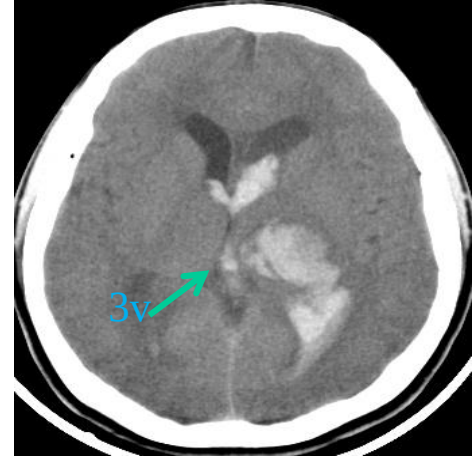
認識 腦室 及 腦池

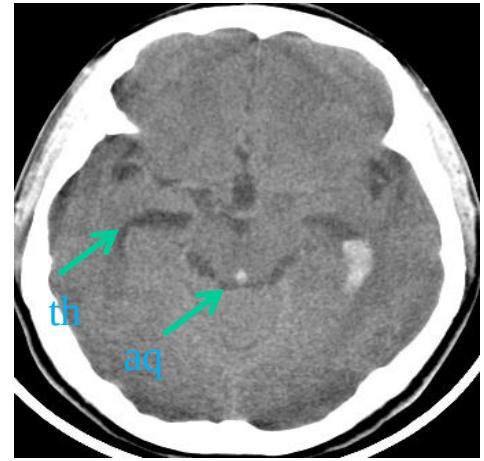
sc: suprasellar cistern
aq: aqueduct
th: temporal horn of lateral ventricle

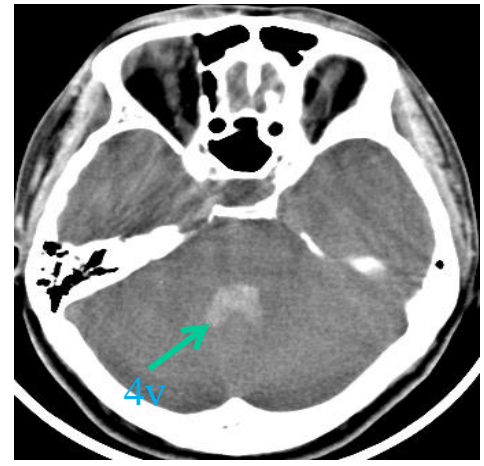




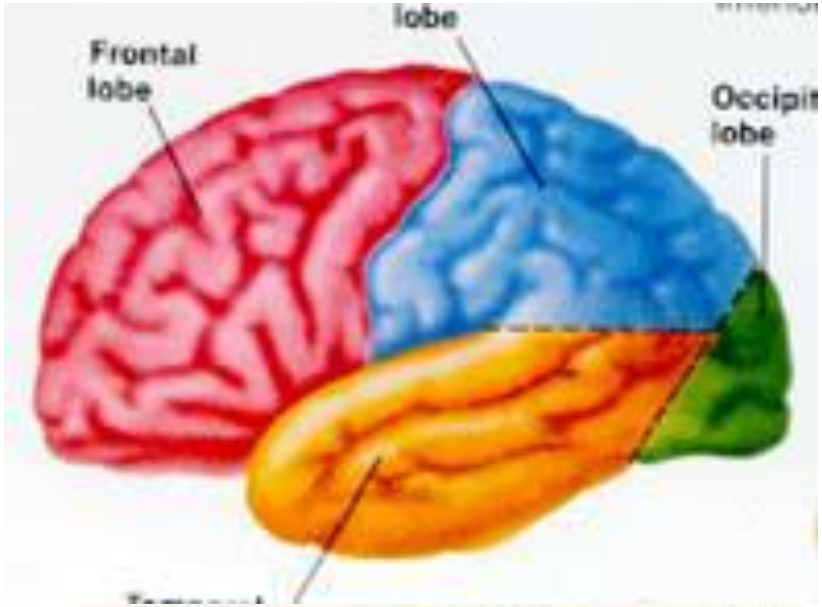


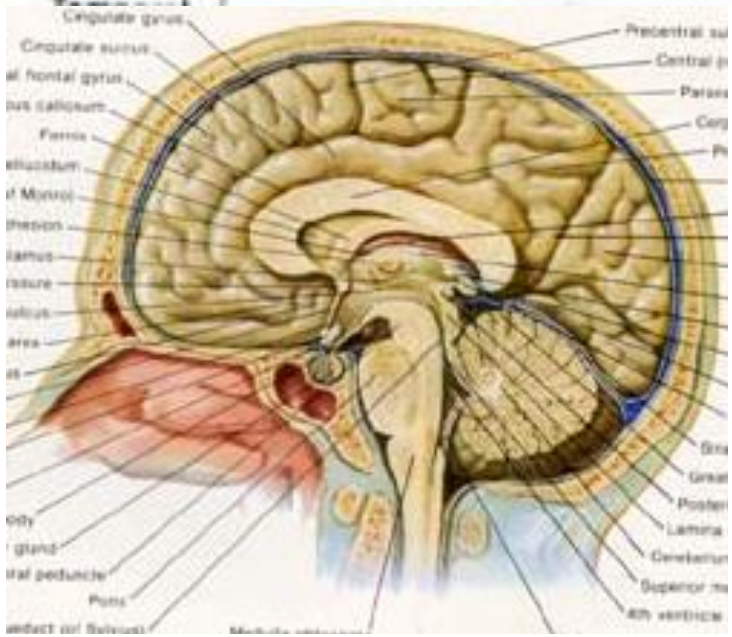


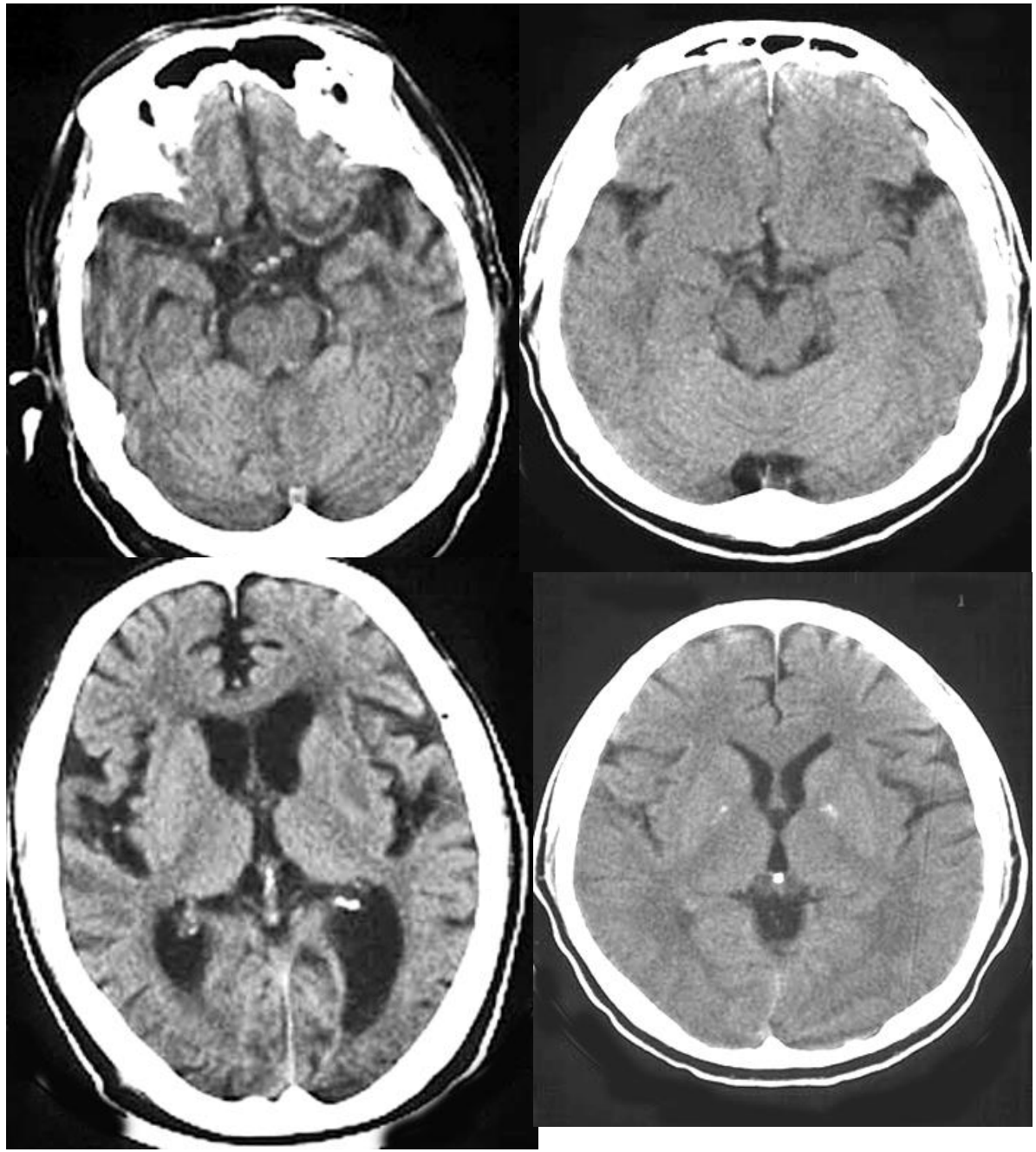




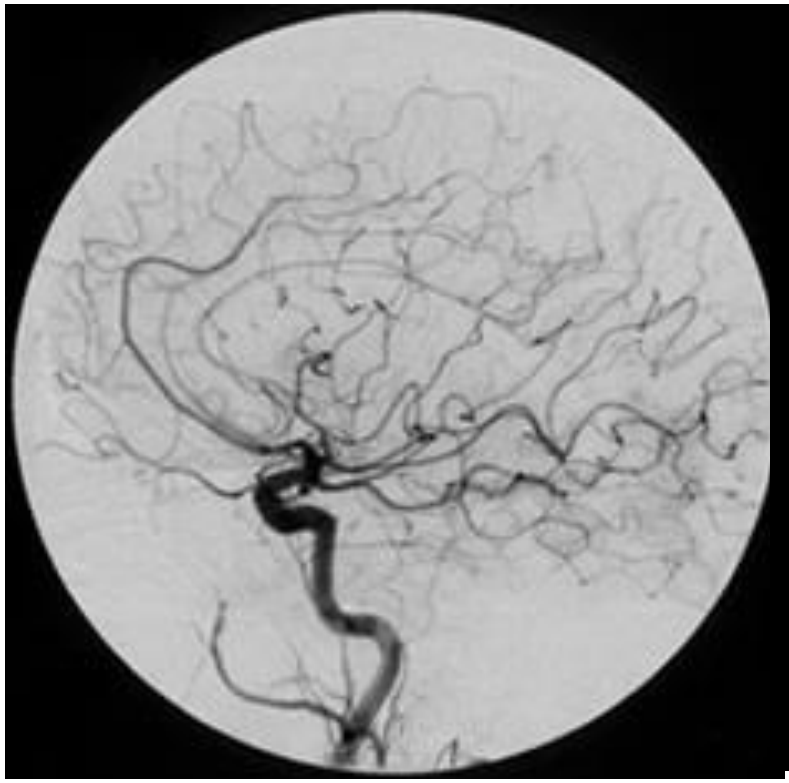
lv: lateral ventricle, frontal horn
3v: 3rd ventricle
qc: quadrigerminal cistern
Sy: Sylvian fissure


Frontal lobe
lobe
Occipit
lobe


Cingulate gyrus
Cingulate sulcus
Precentral su
Central
Pons



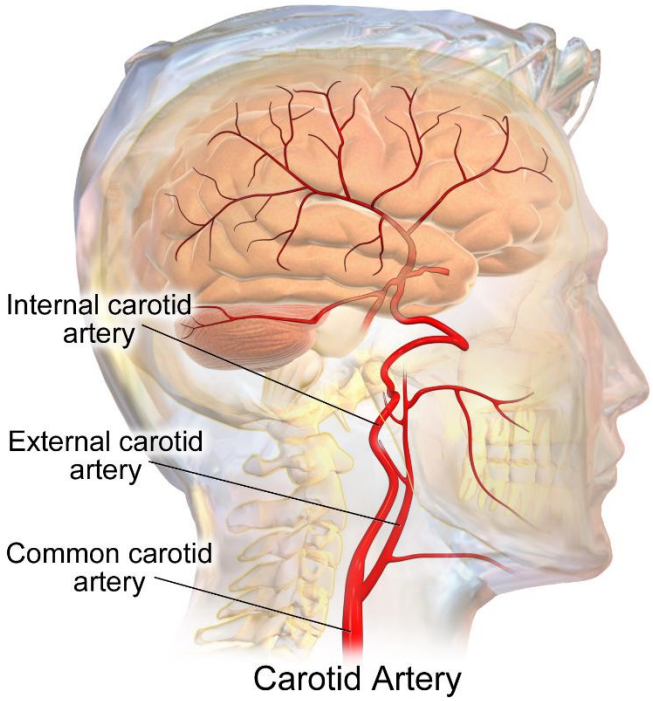
Angiography, 血管撮影

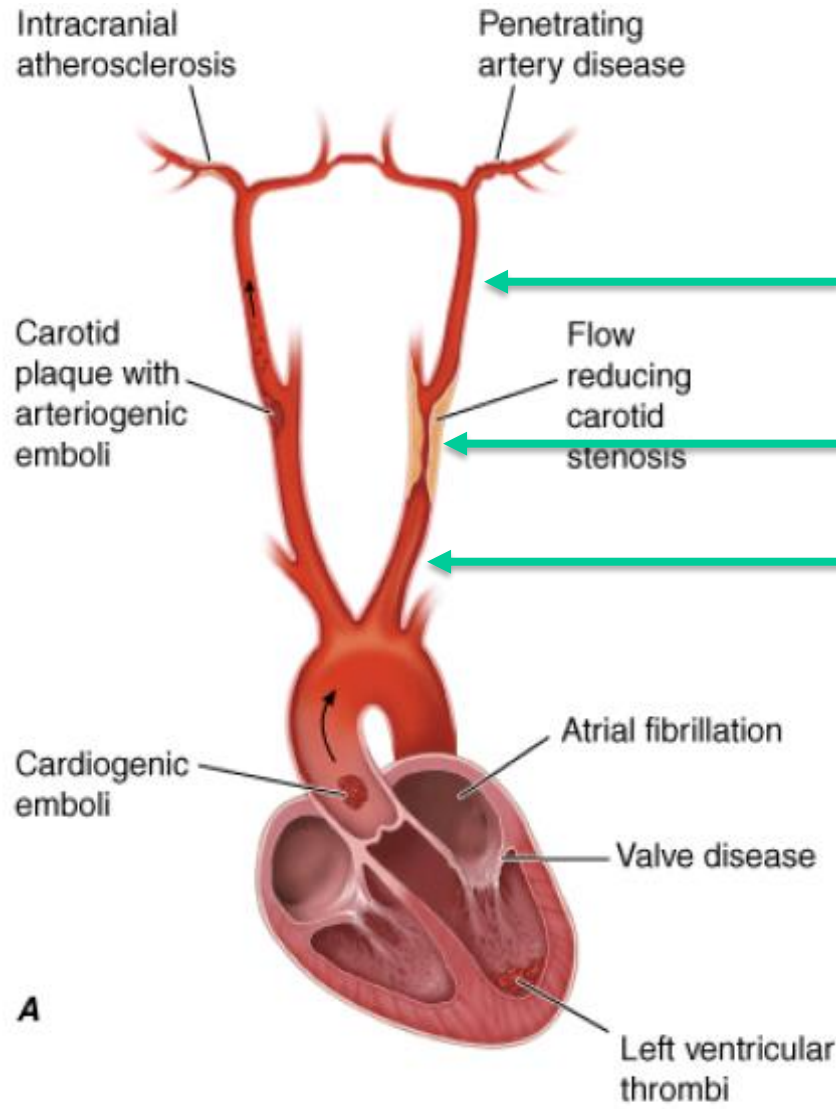


DSA:
Digital subtraction angiography

CTA:
CT angiography

MRA:
MR angiography





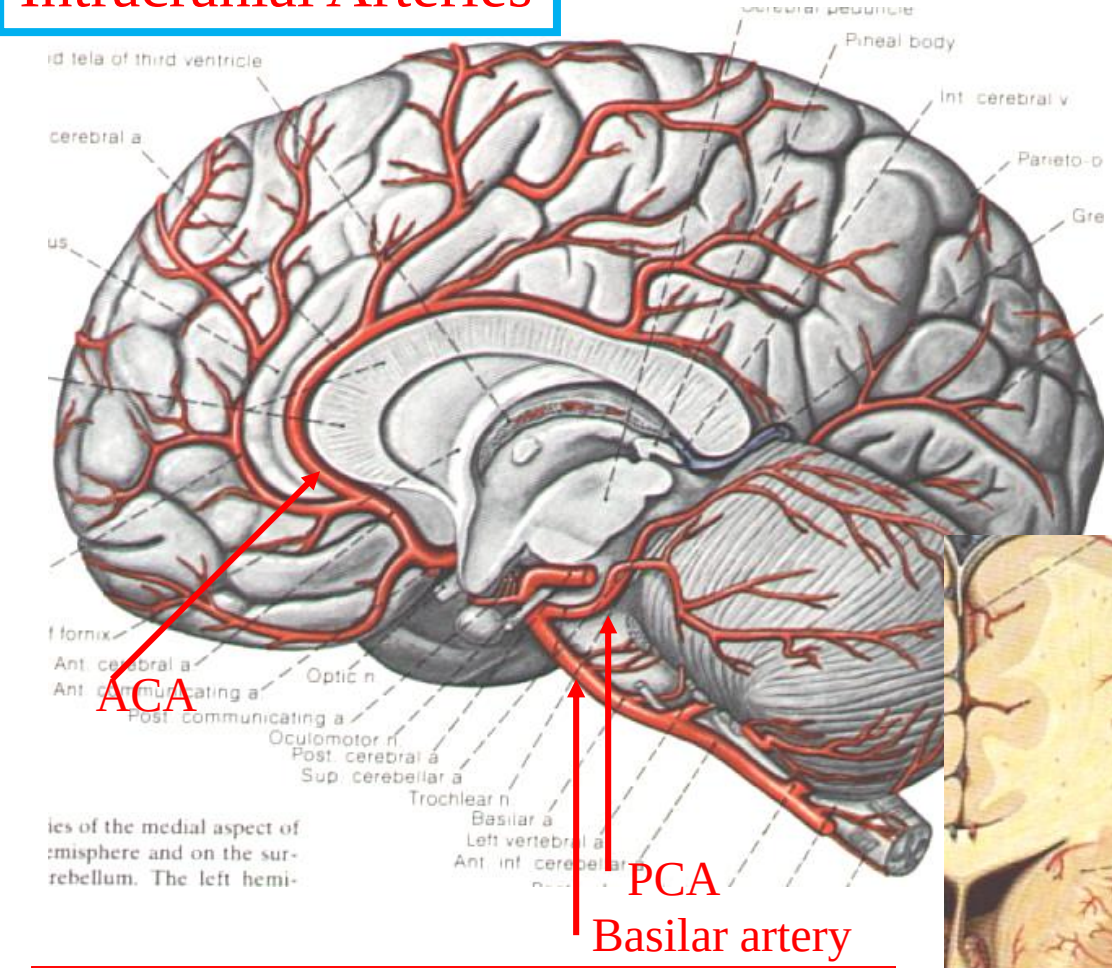
Internal carotid artery

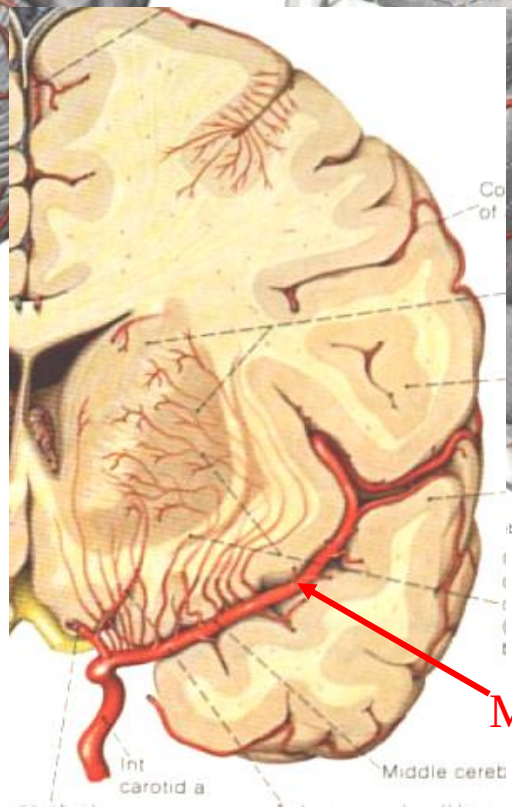
Bifurcation of carotid artery

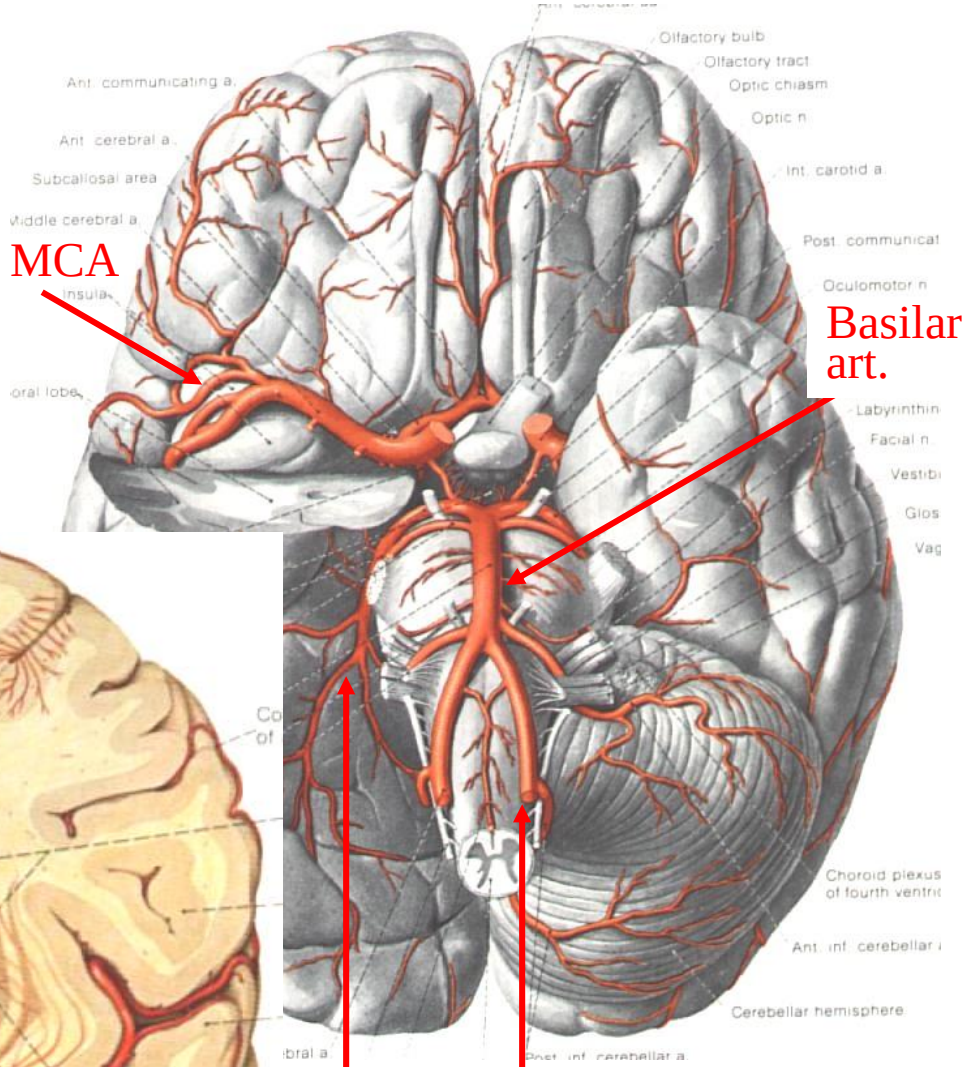
Common carotid artery

----Harrison's Principle of Internal Medicine, 17th ed.

Intracranial Arteries

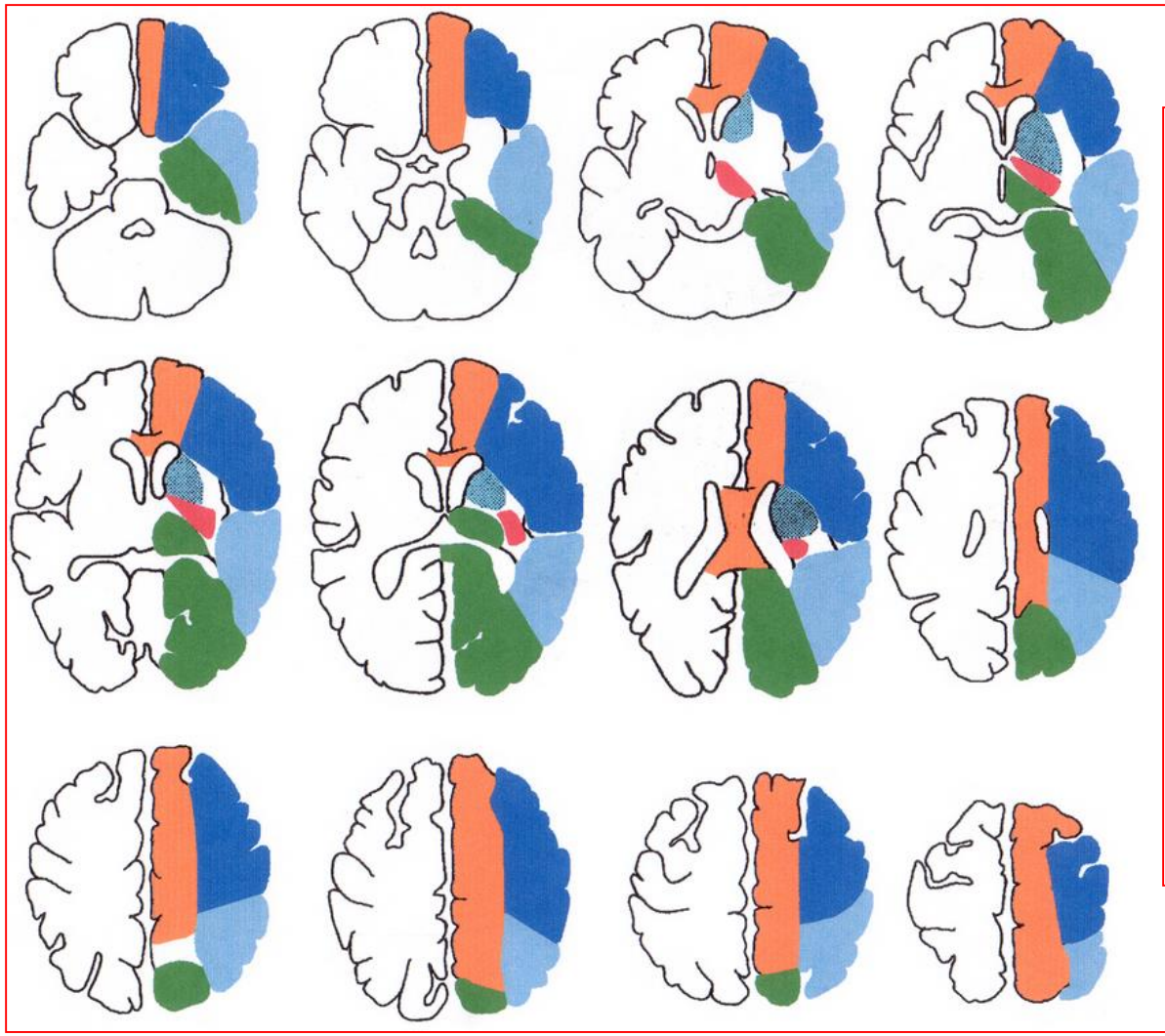


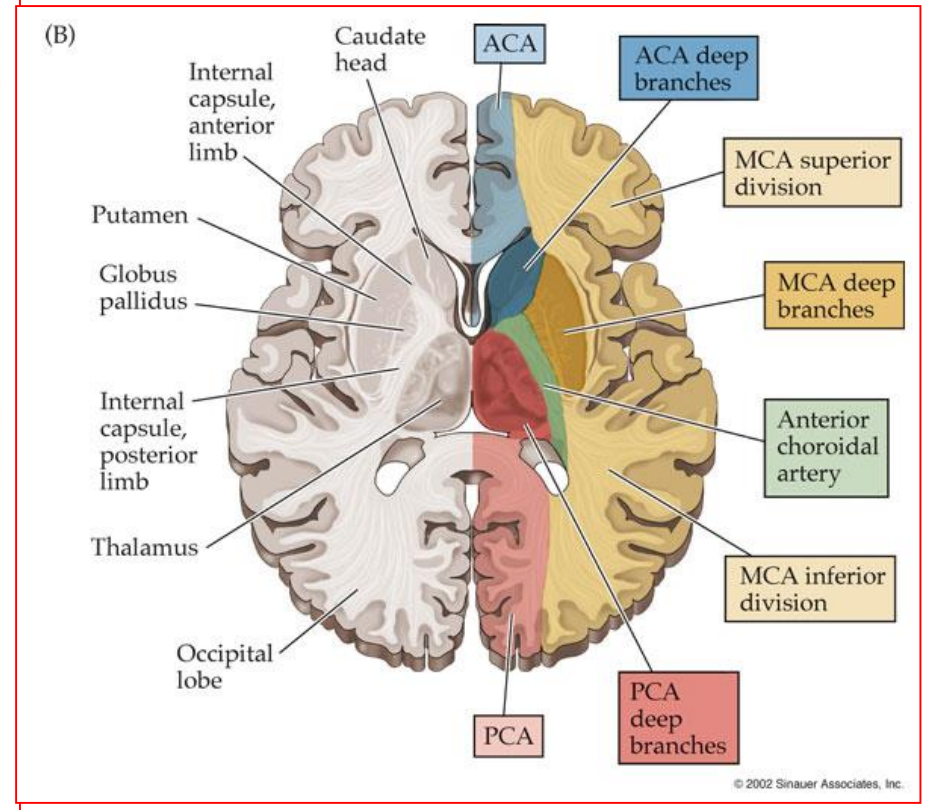




Anterior cerebral artery (ACA)
Middle cerebral artery (MCA)
Posterior cerebral artery (PCA)
Basivertebral arteries
(basilar art. and bilateral vertebral art.)

Main arterial territories





Middle Cerebral Artery: Superior Division

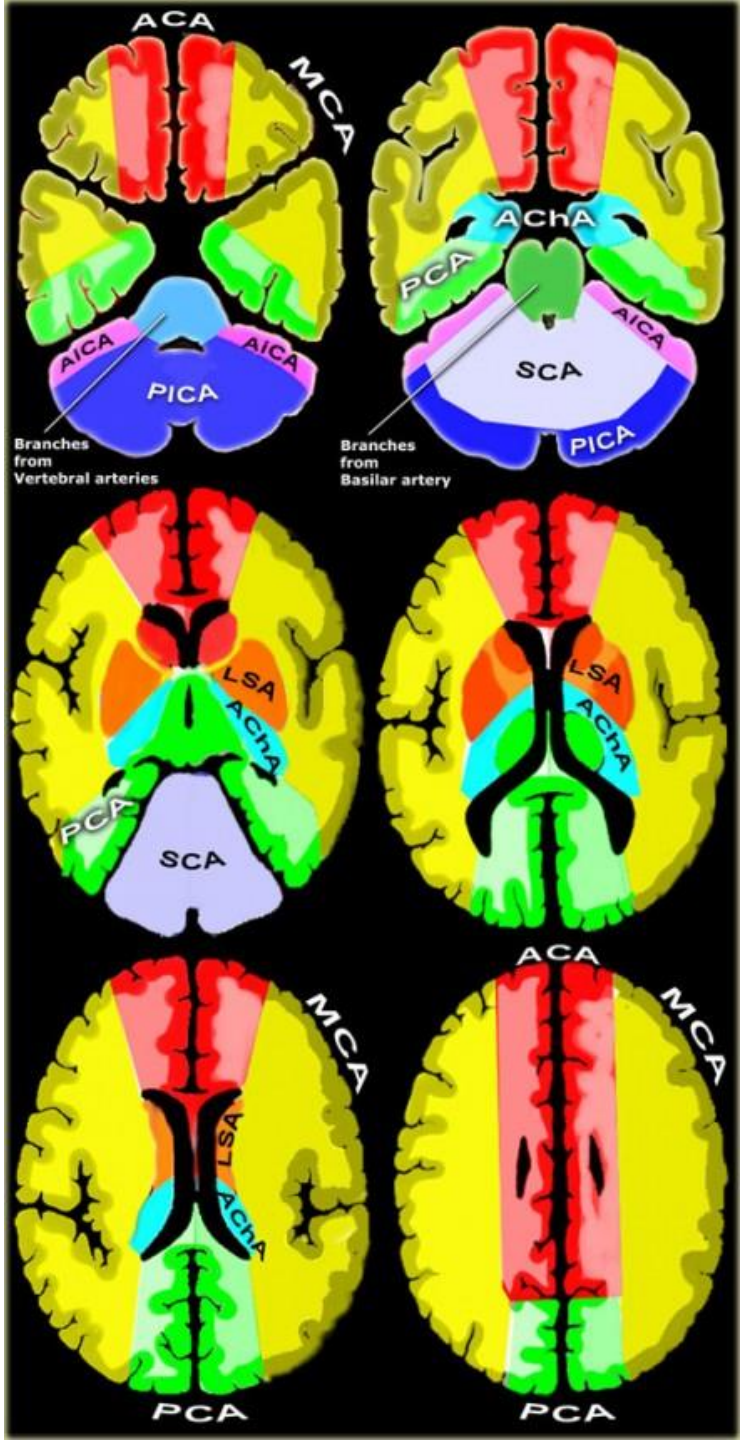
Middle Cerebral Artery: Inferior Division

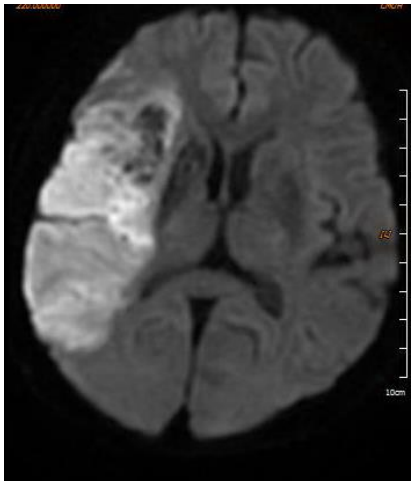
Middle Cerebral Artery: Lentinculostriate

Posterior Cerebral Artery

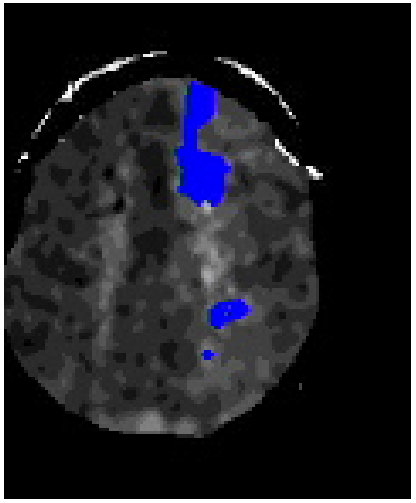
Anterior Cerebral Artery

Anterior Choroidal

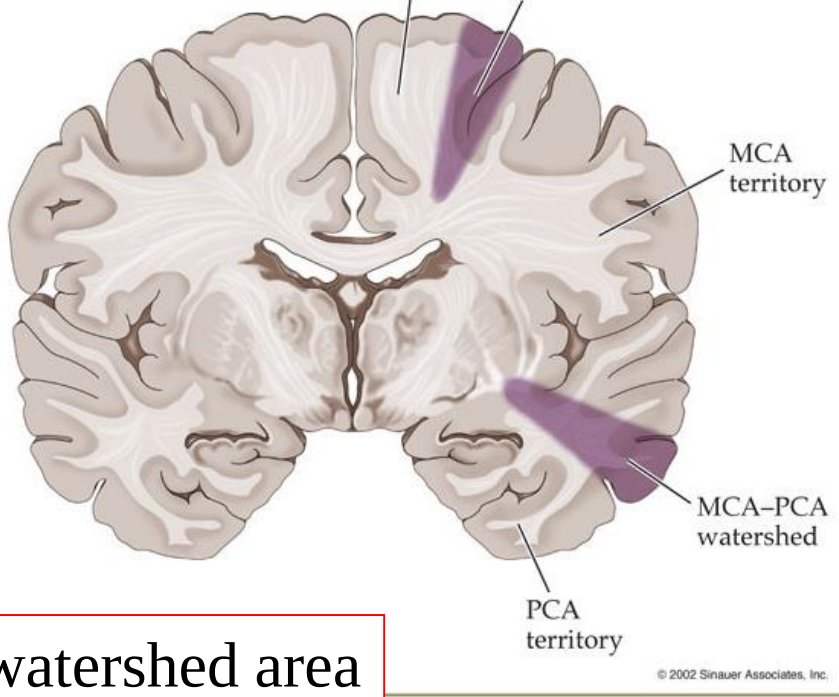




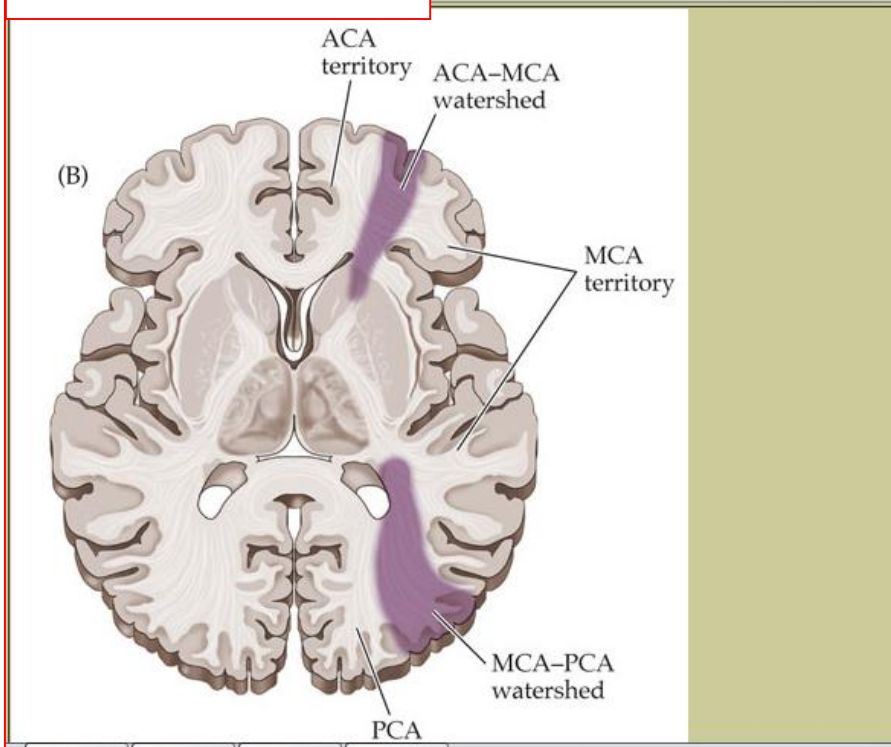
Rt. MCA infarction



Lt. ACA hypoperfusion



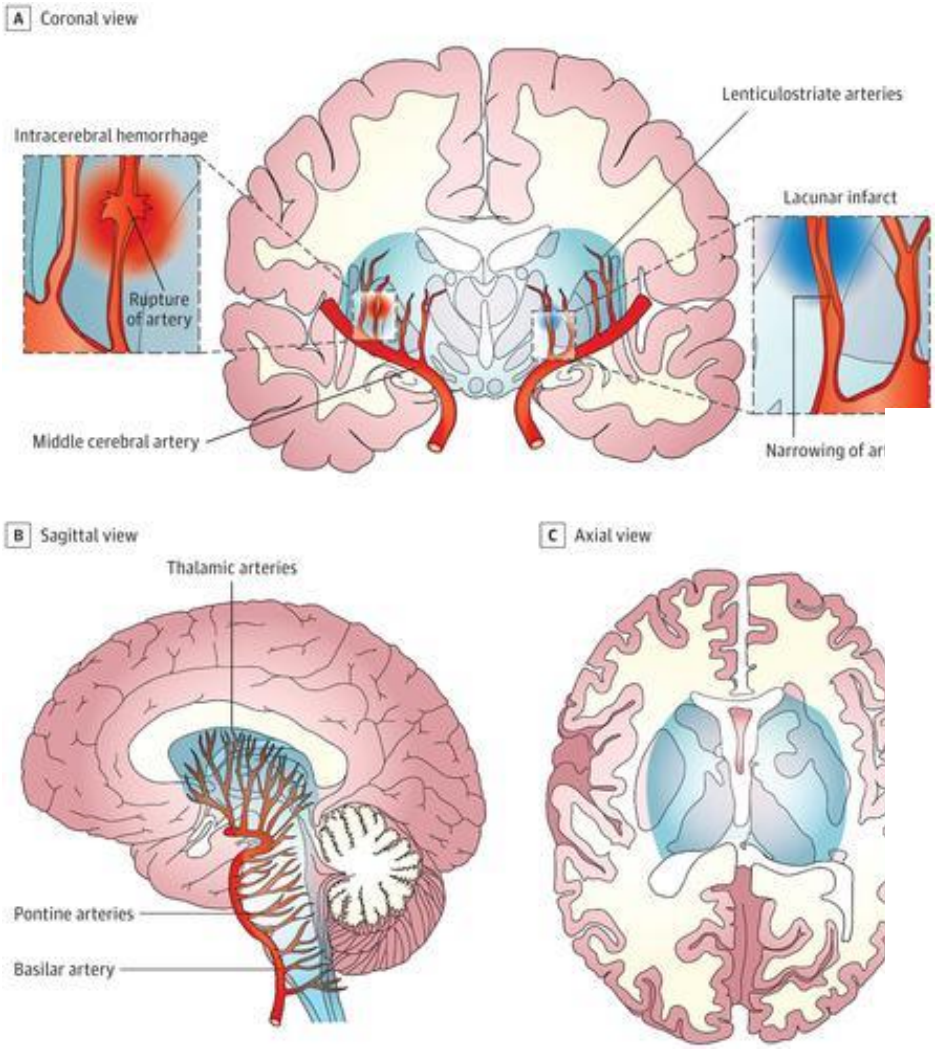
watershed area

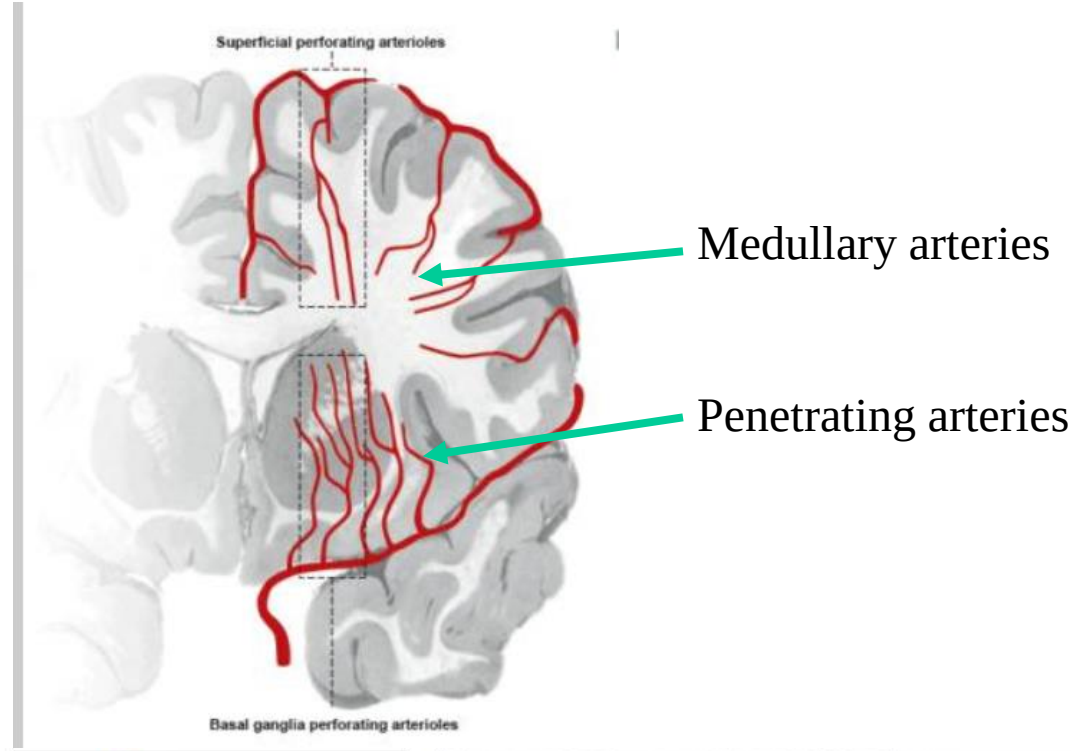


Small vessels

Penetrating arteries

Medullary arteries





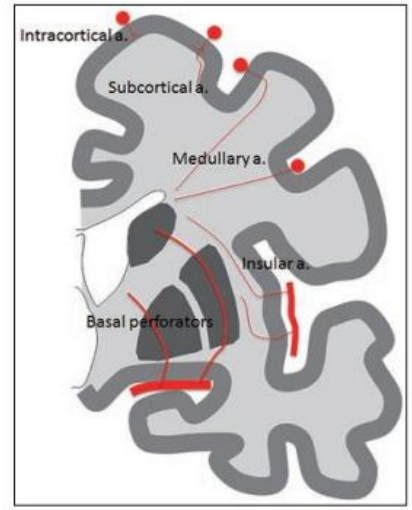


Fig. 1—Diagram of coronal section of cerebrum based on data collected by Moody et al. [7] shows vascular supply.

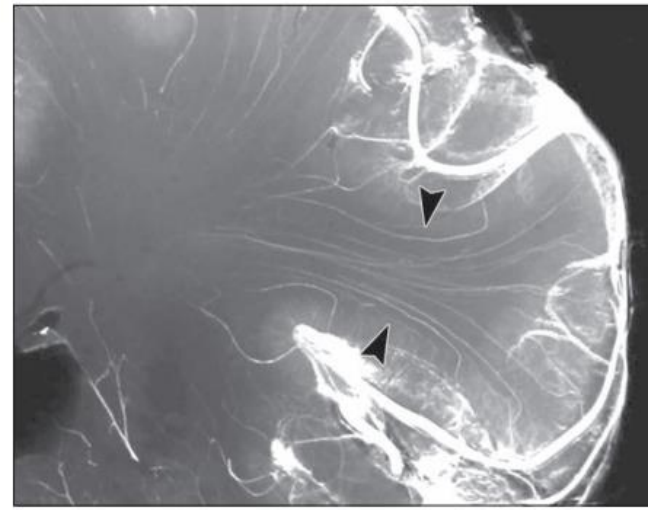
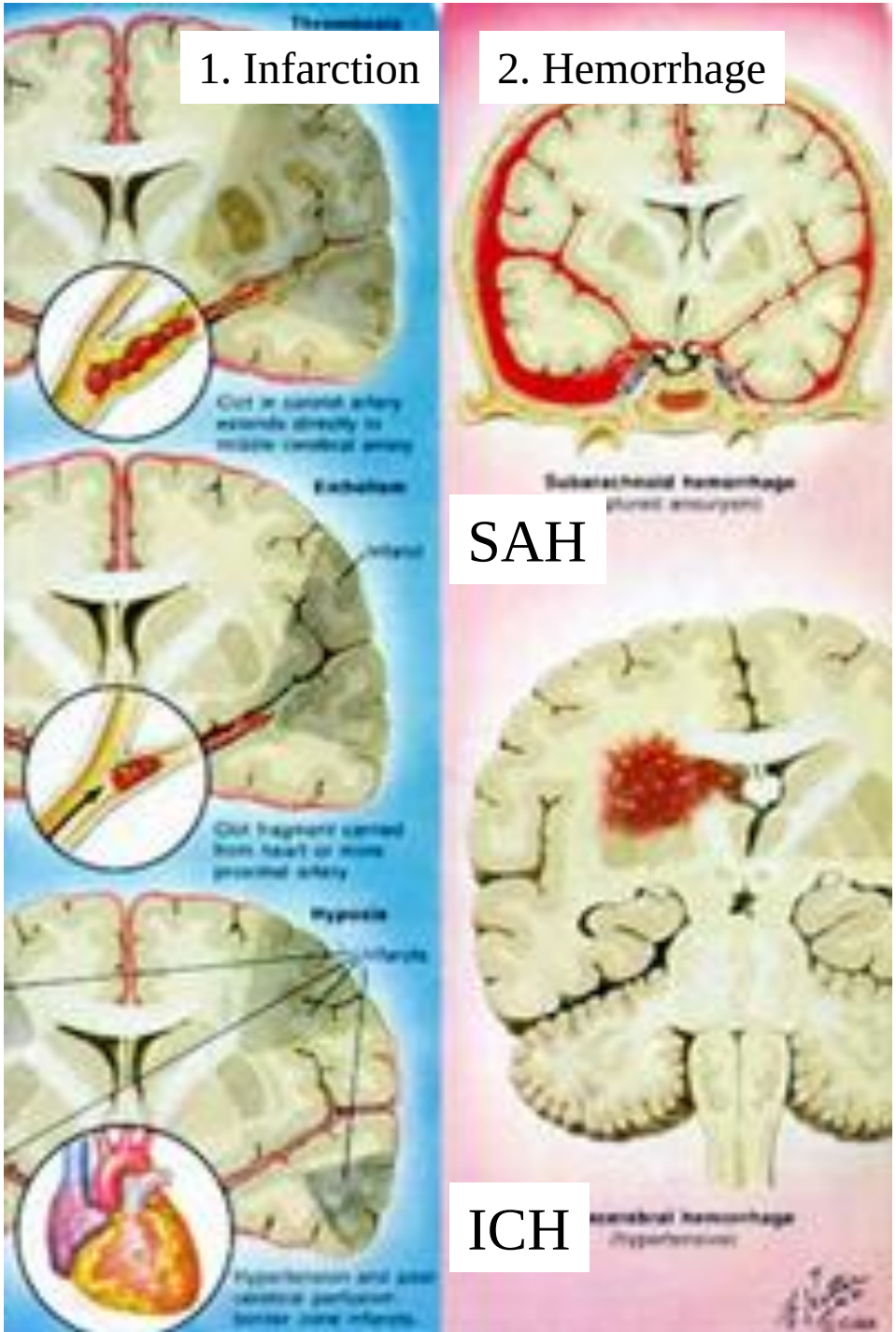


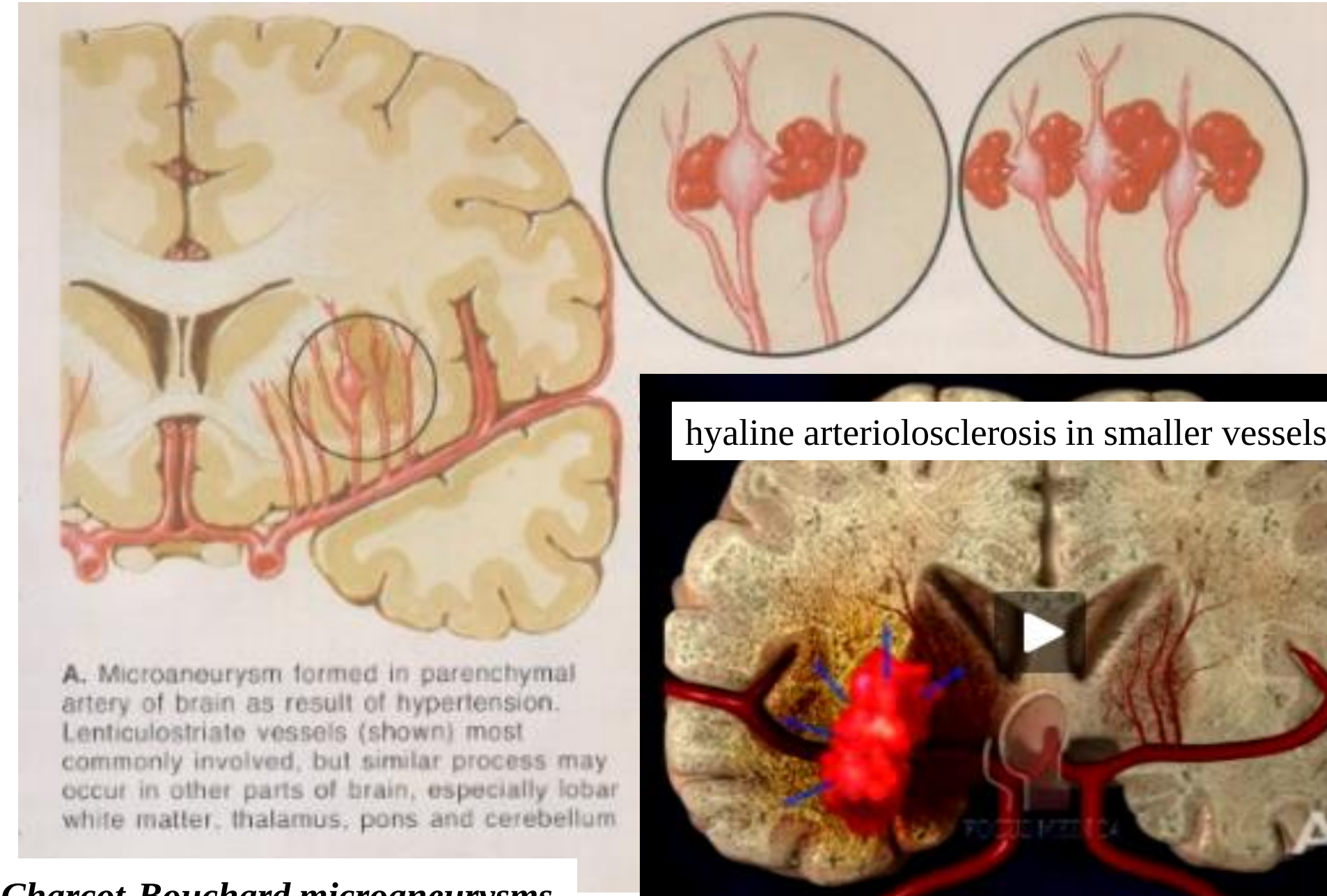
Fig. 2—Cadaver of subject who died of brain-unrelated cause. Coronal microangiogram depicts medullary arteries (*arrowheads*) supplying cerebral white matter. These are long end arteries that arise at right angle from pial arteries, penetrate cerebral cortex, and enter white matter.



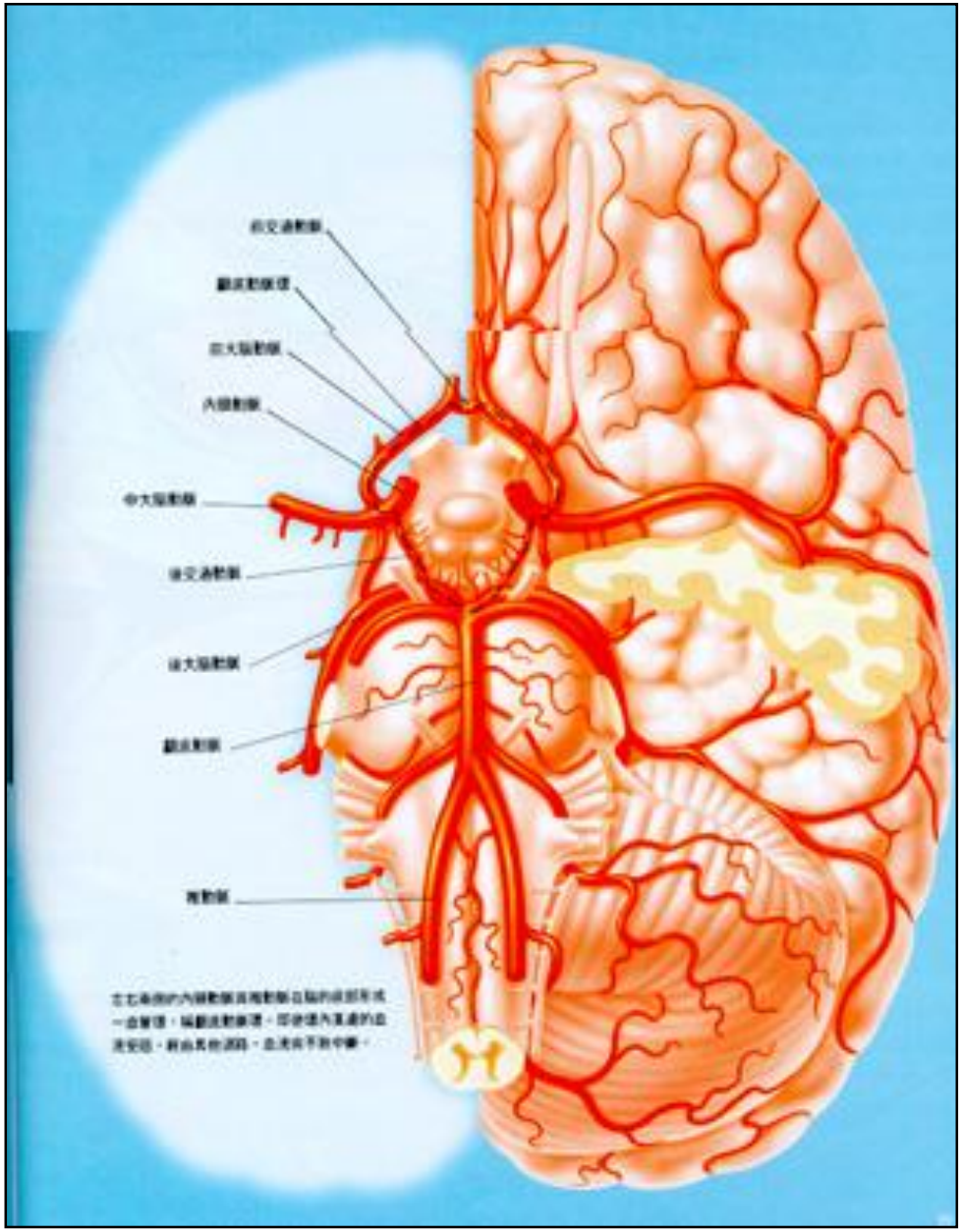
CVA (Stroke):

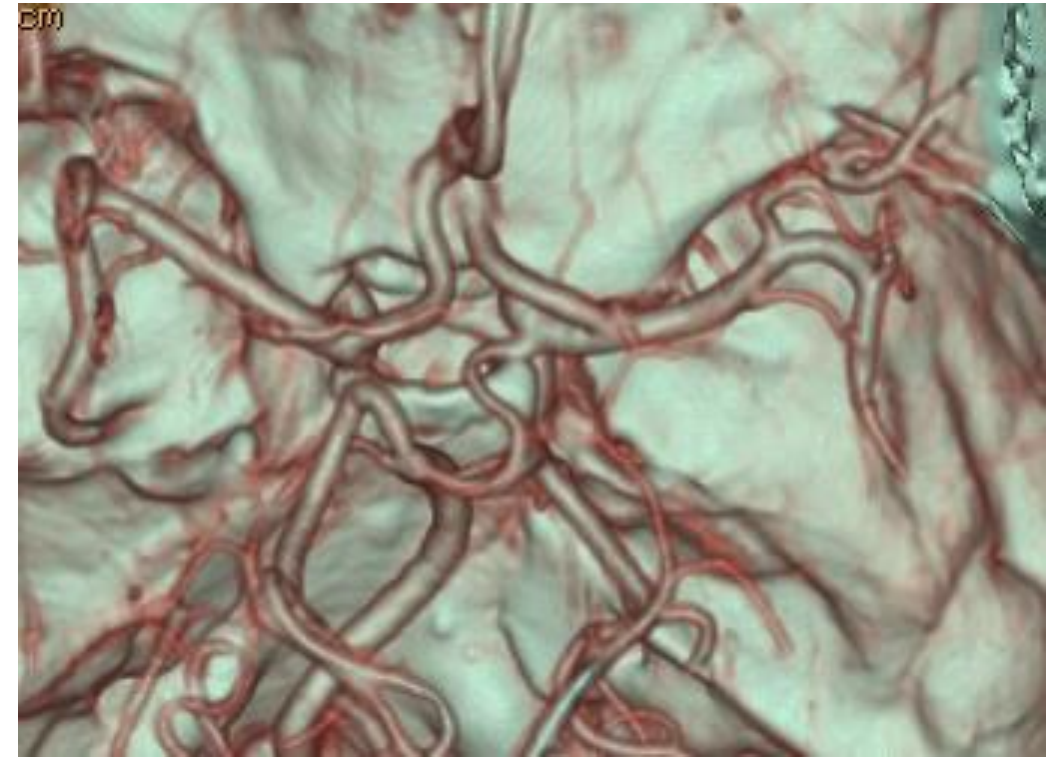
1. Infarction
- **Thrombosis**
- **Embolism**
- **Hypovolemic**

2. Hemorrhage
- **Intracerebral hemorrhage (ICH)**
- **Subarachnoid hemorrhage (SAH)**



***Charcot-Bouchard microaneurysms*,**





Circle of Willis:

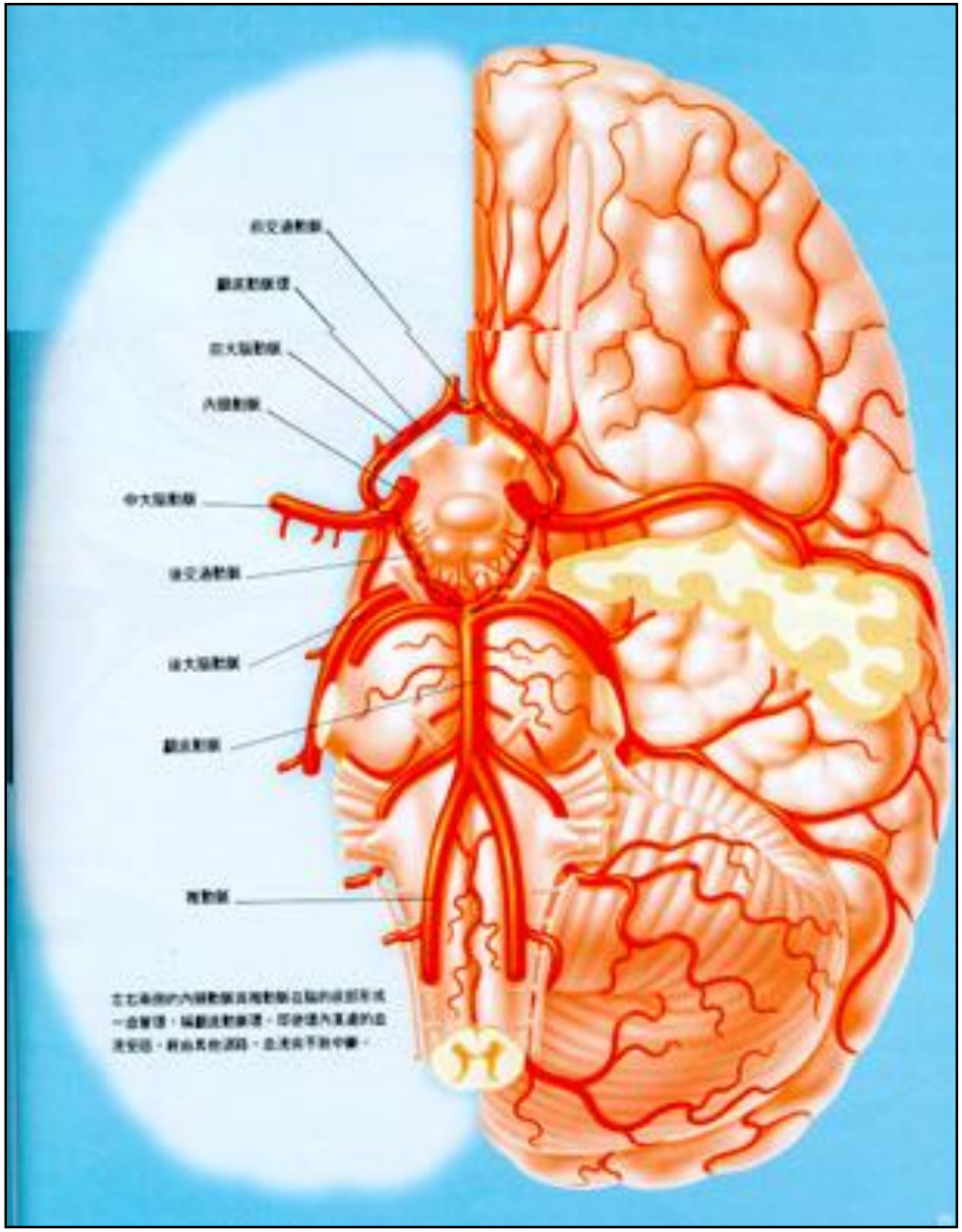
Posterior communicating arteries (PCoA)

Anterior communicating artery (ACoA)

Proximal posterior cerebral arteries (PCA)

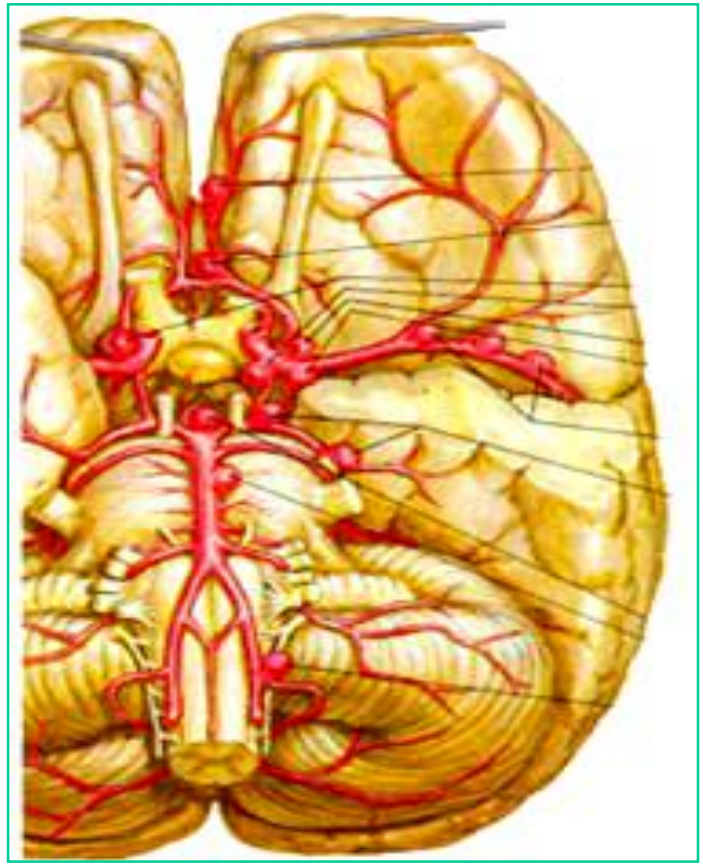
Distal internal carotid arteries (ICA)

A1 portions of anterior cerebral arteries (ACA)



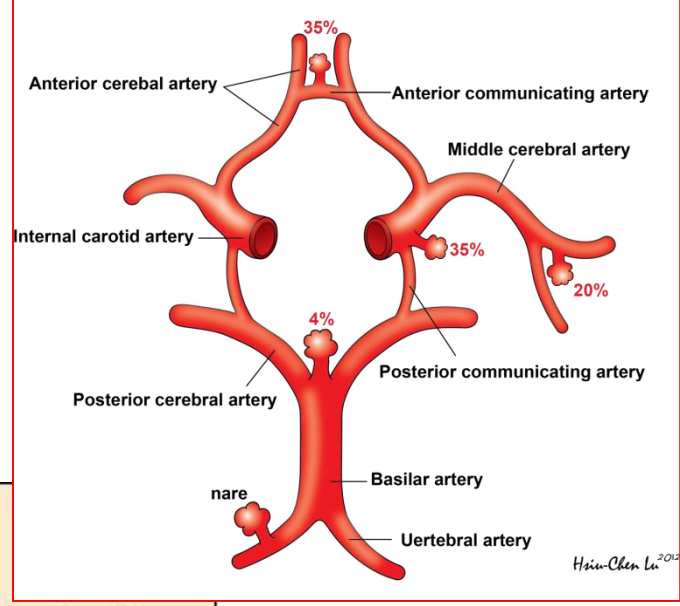
Circle of Willis

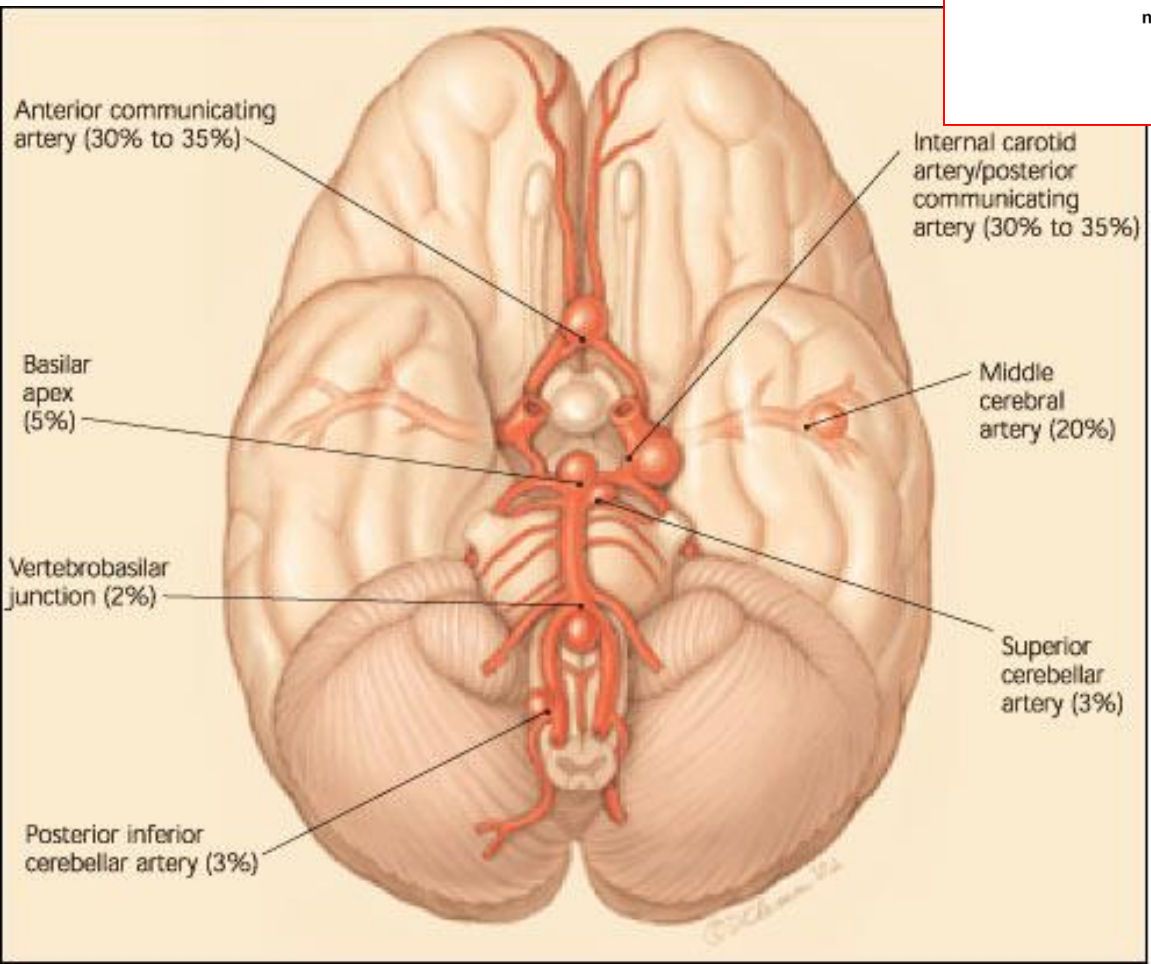
Bilateral A1 portion of ACA
Anterior communicating artery (ACoA)
Bilateral PCoA
Bilateral proximal PCA

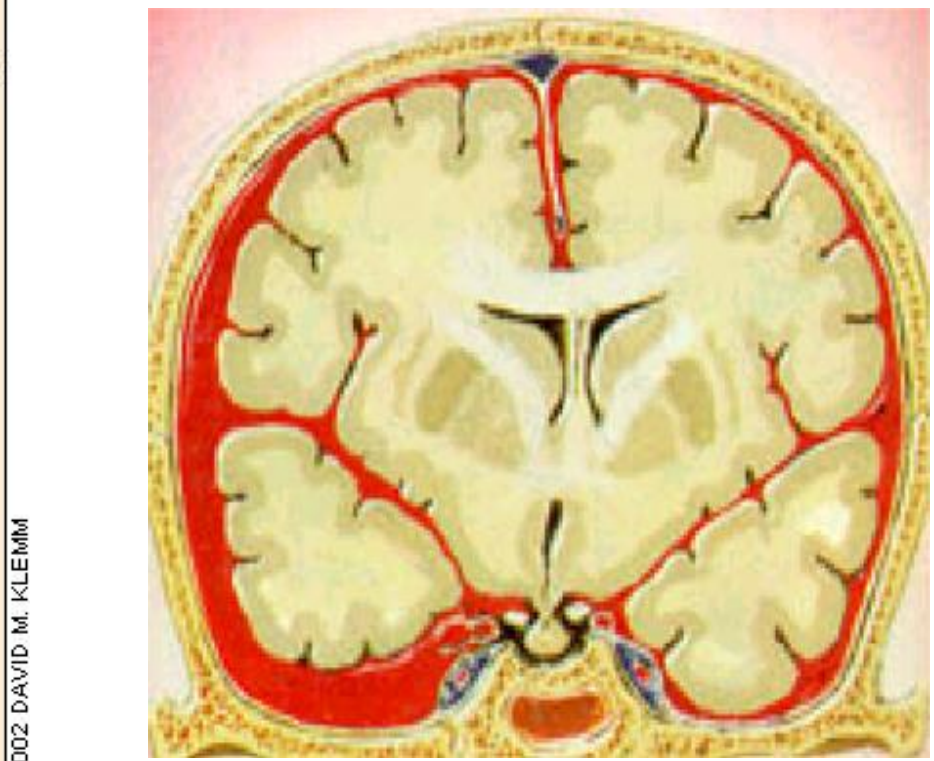


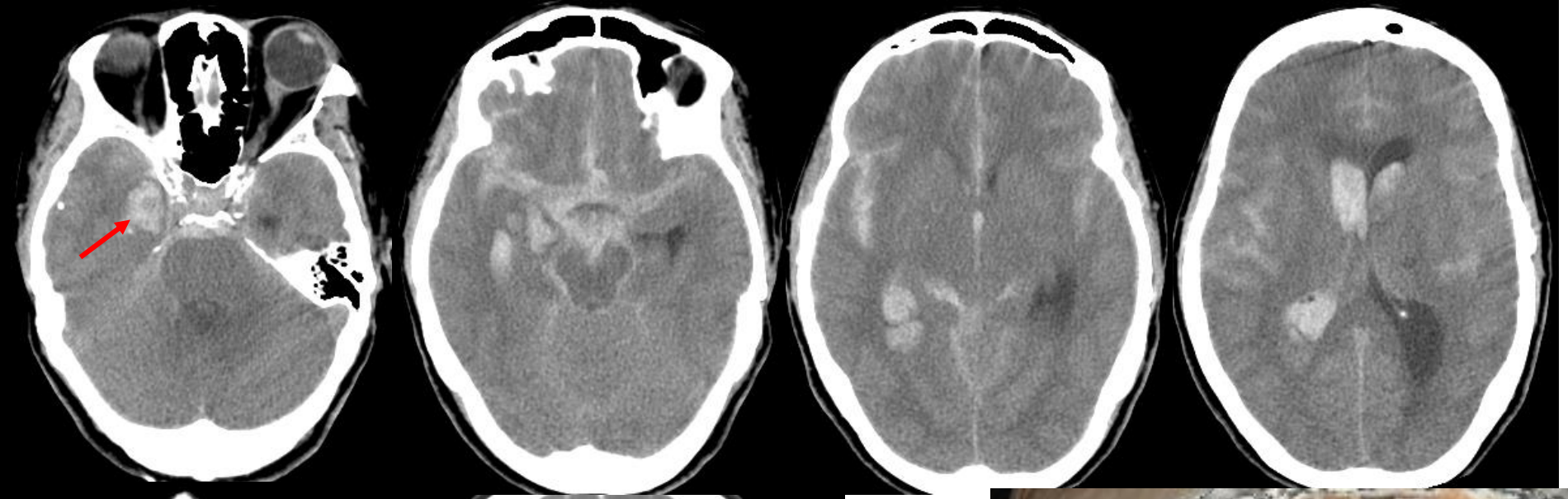
Robbins and Cotran Pathologic Basis of Disease, Professional Edition , 8th ed.

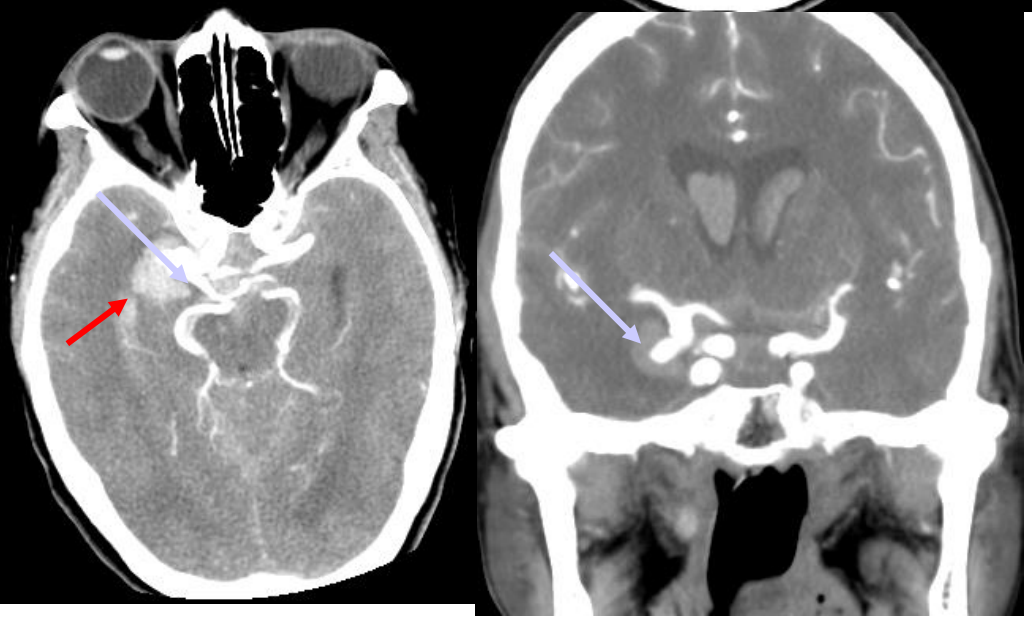
Aneurysm== SAH
(subarachnoid hemorrhage)

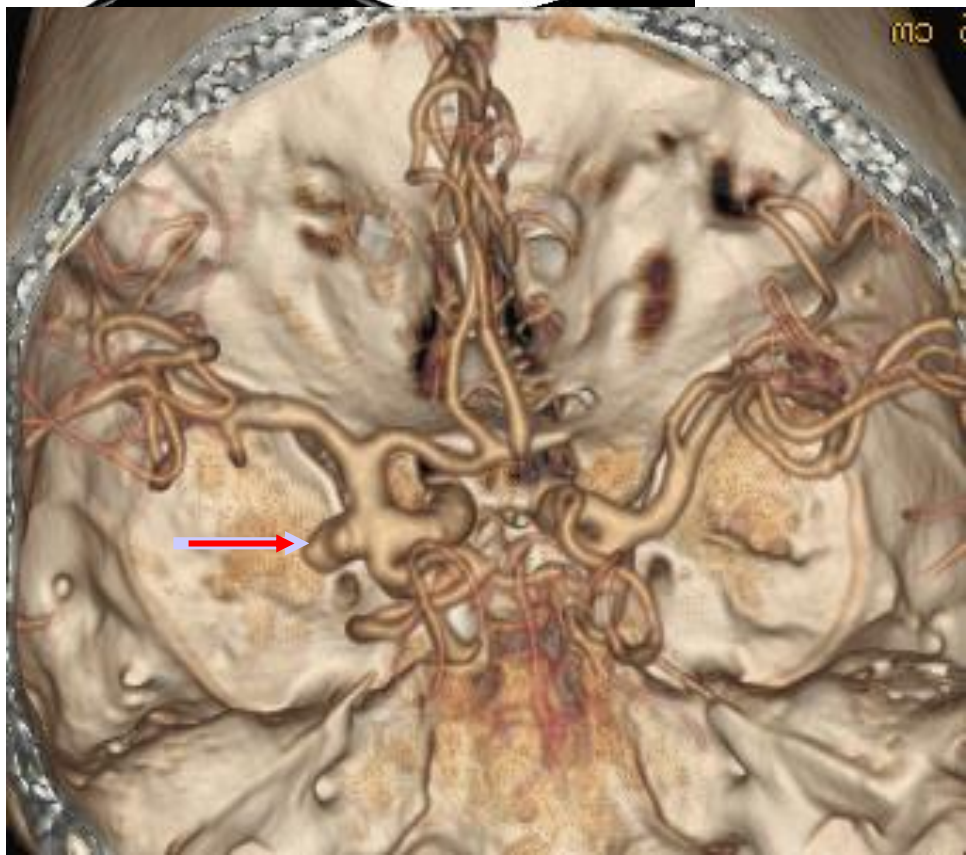




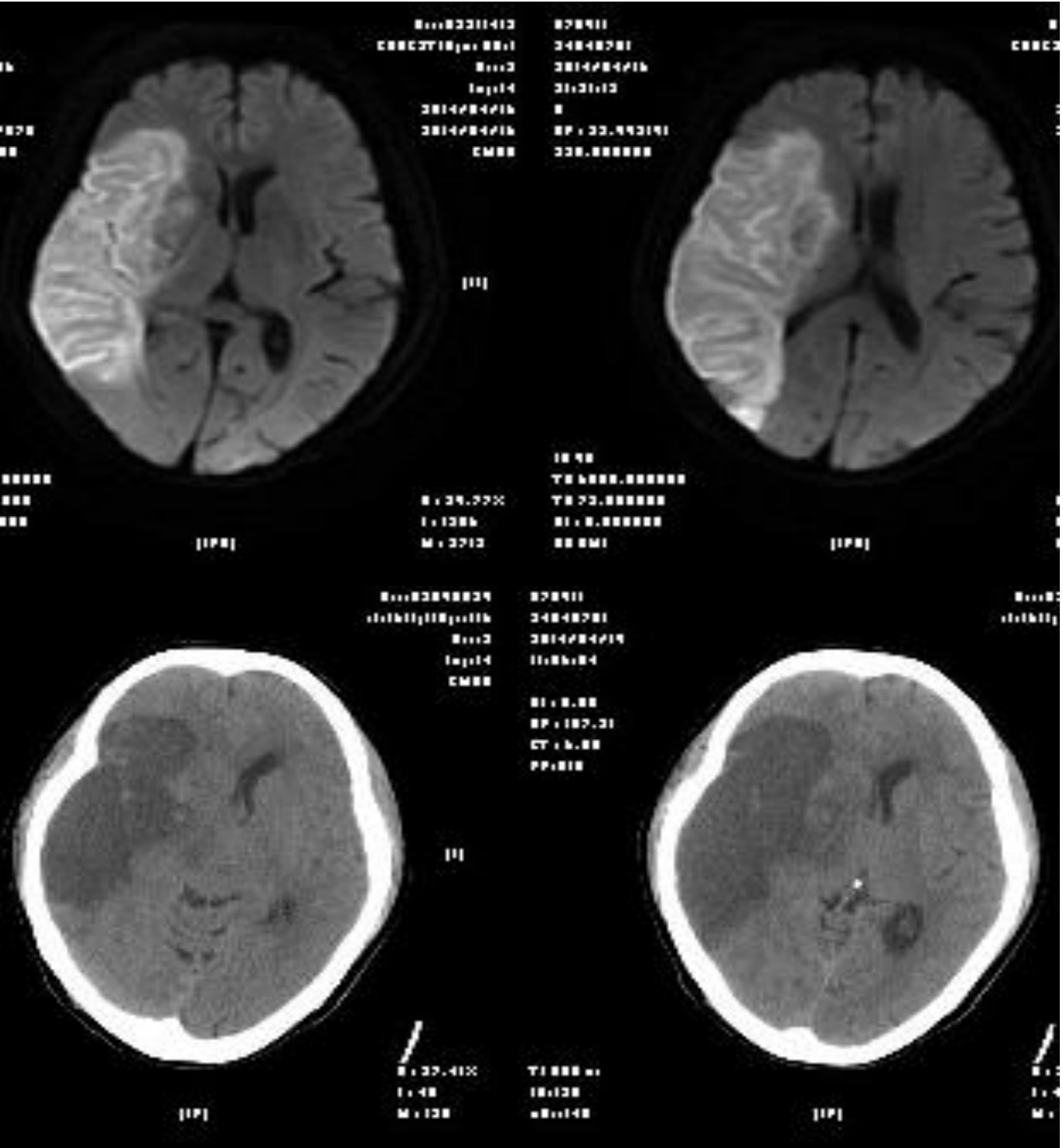


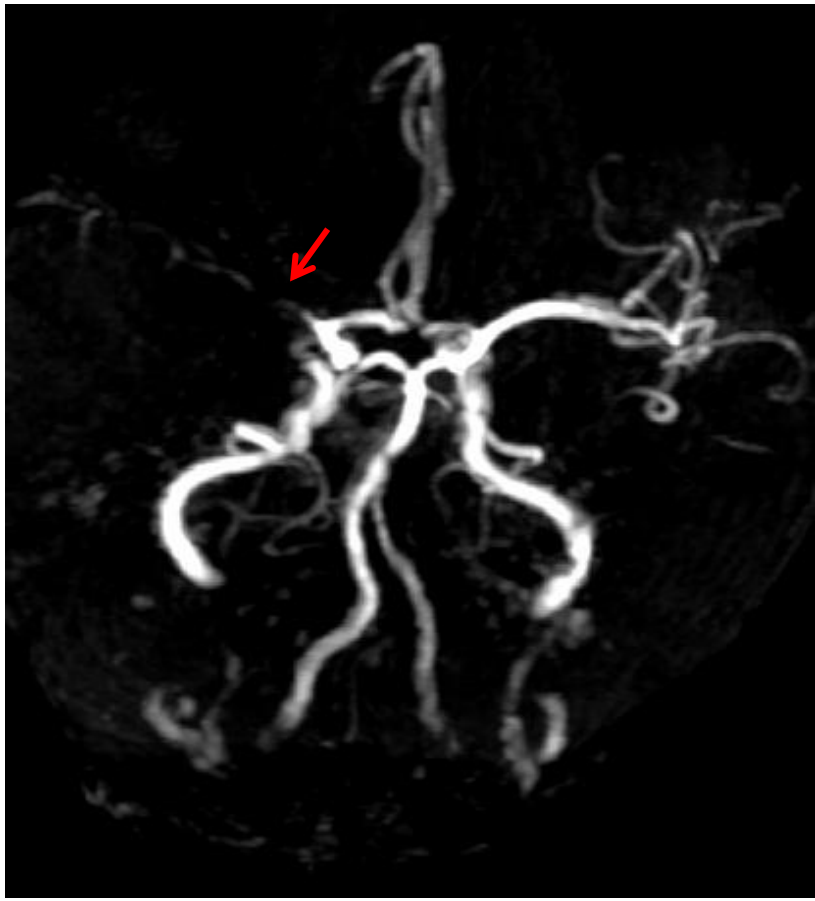






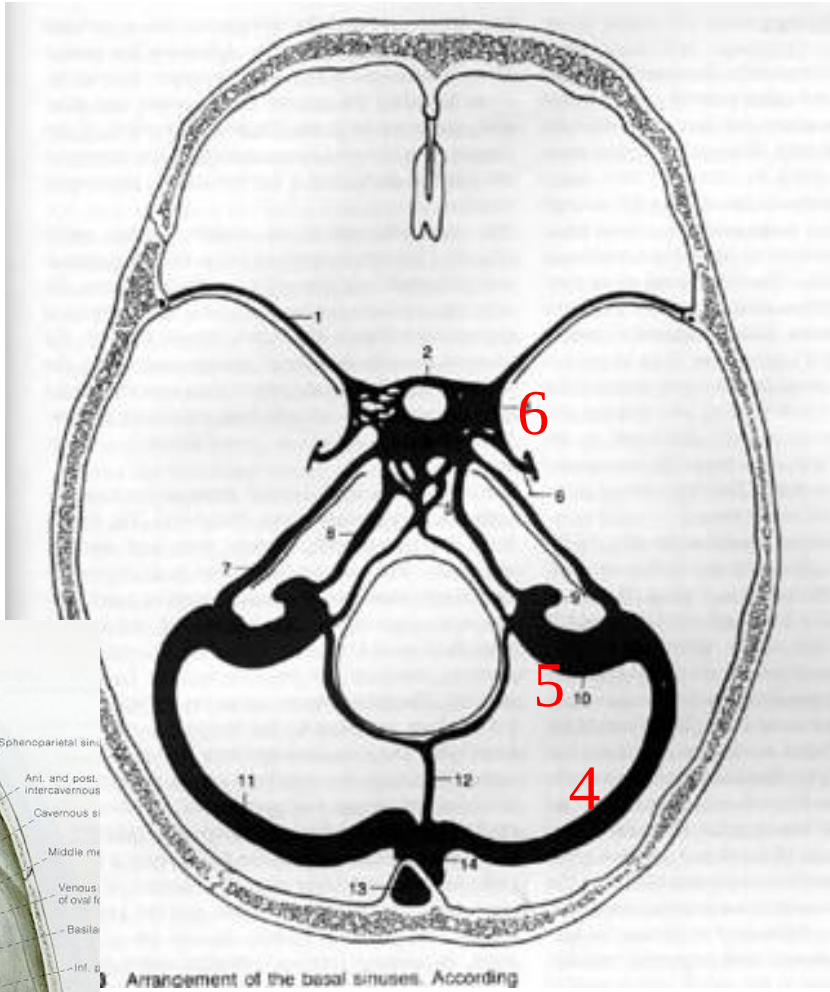
F/61
Massive SAH, small ICH in right hippocampus due to rupture of an aneurysm in Rt. ICA/PCoA



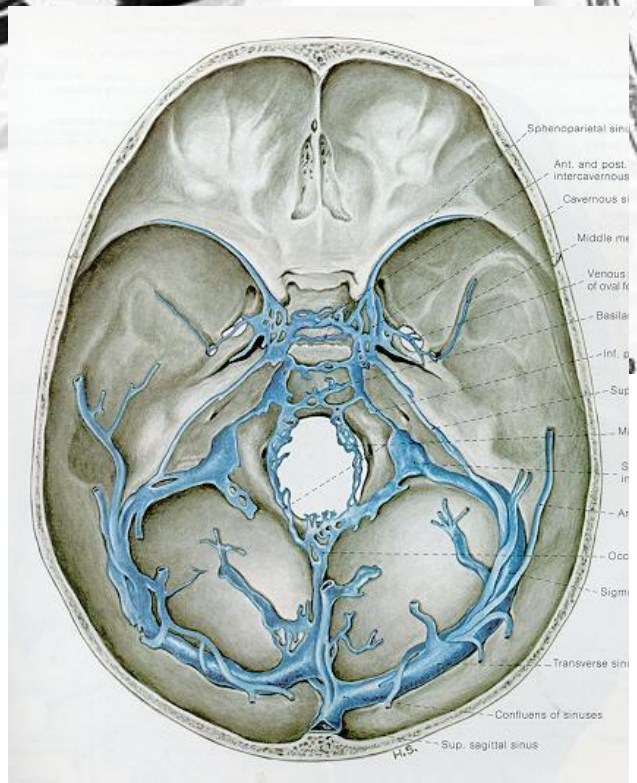


MCA occlusion, caused brain infarction in F-T-P lobes

Intracranial Veins and Venous Sinuses



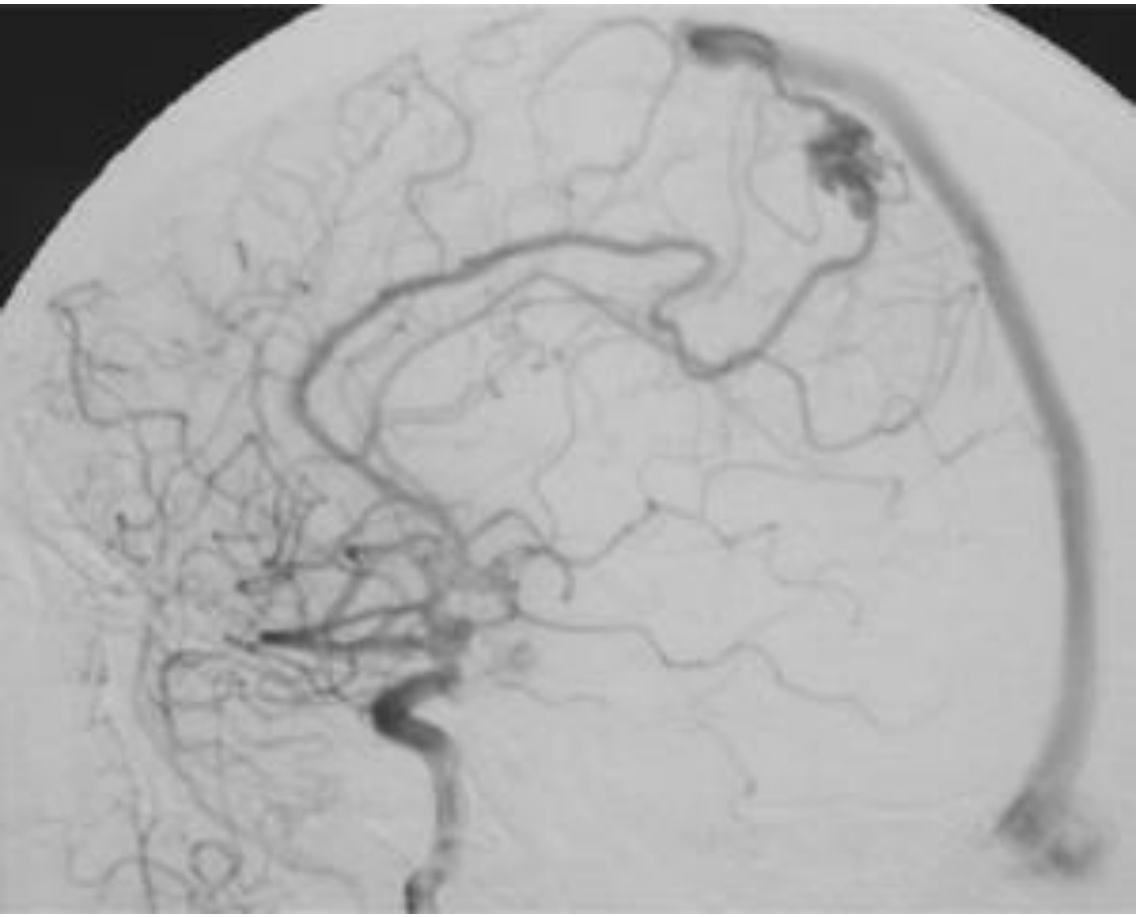
Arrangement of the basal sinuses. According

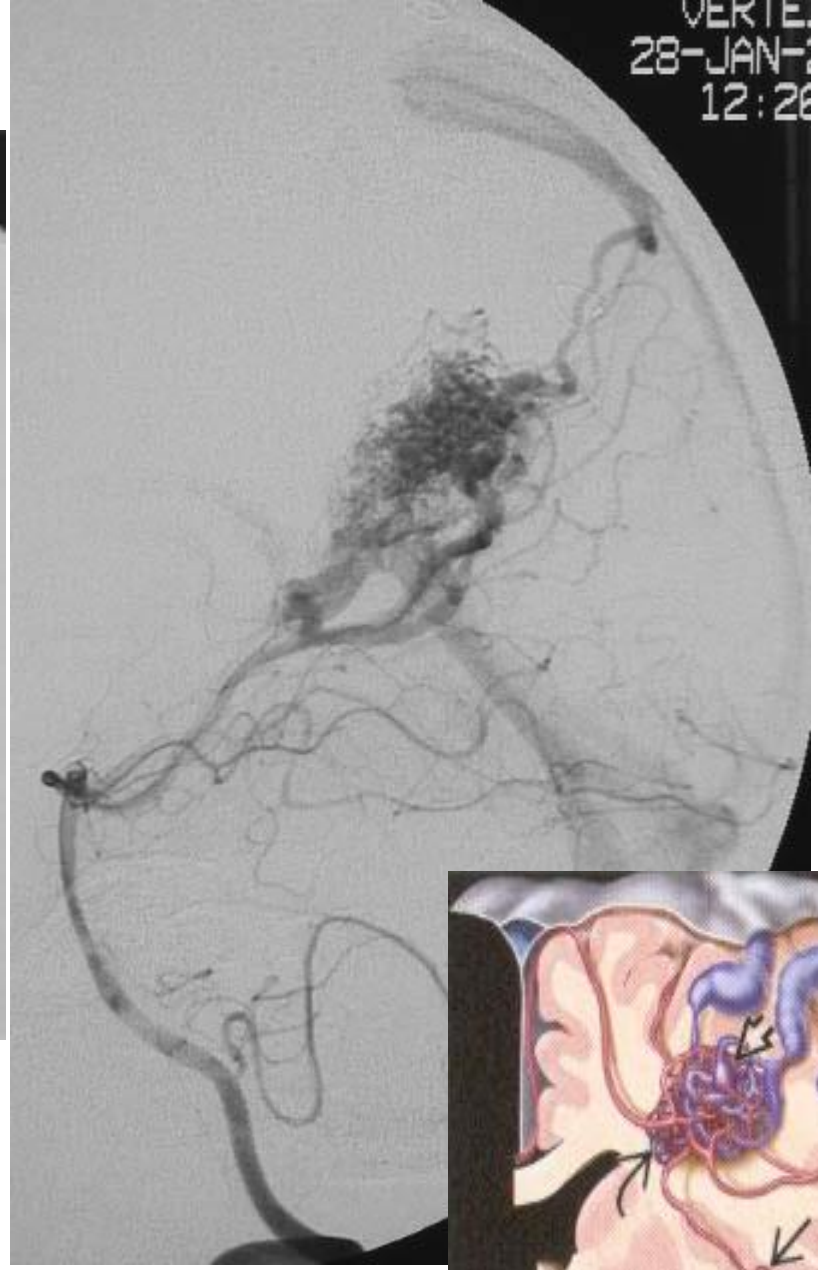


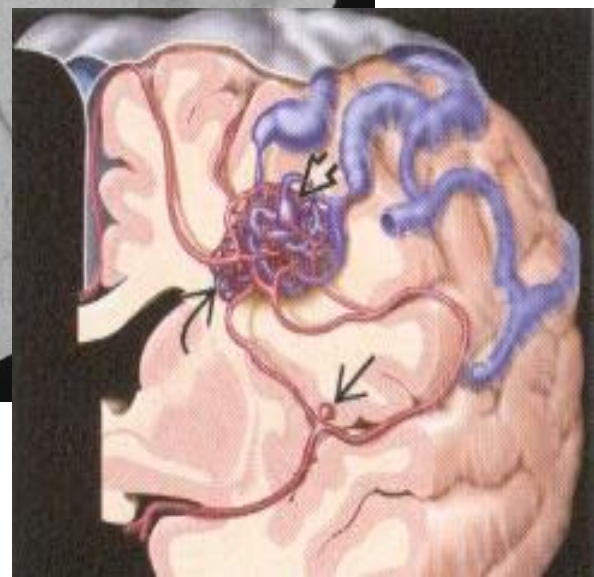
Venous sinuses:

1. Superior sagittal sinus (SSS)
2. Inferior sagital sinus (ISS)
3. Straight sinus
4. Transverse sinus
5. Sigmoid sinus
6. Cavernous sinus
7. Cortical veins

靜脈竇







2 cases of arterio-venous malformation, AVM

sss: superior sagittal sinus

ss: straight sinus

動靜脈畸型

急性腦中風靜脈注射血栓溶解劑治療_rt_PA_衛教影片_台語版(高畫質)

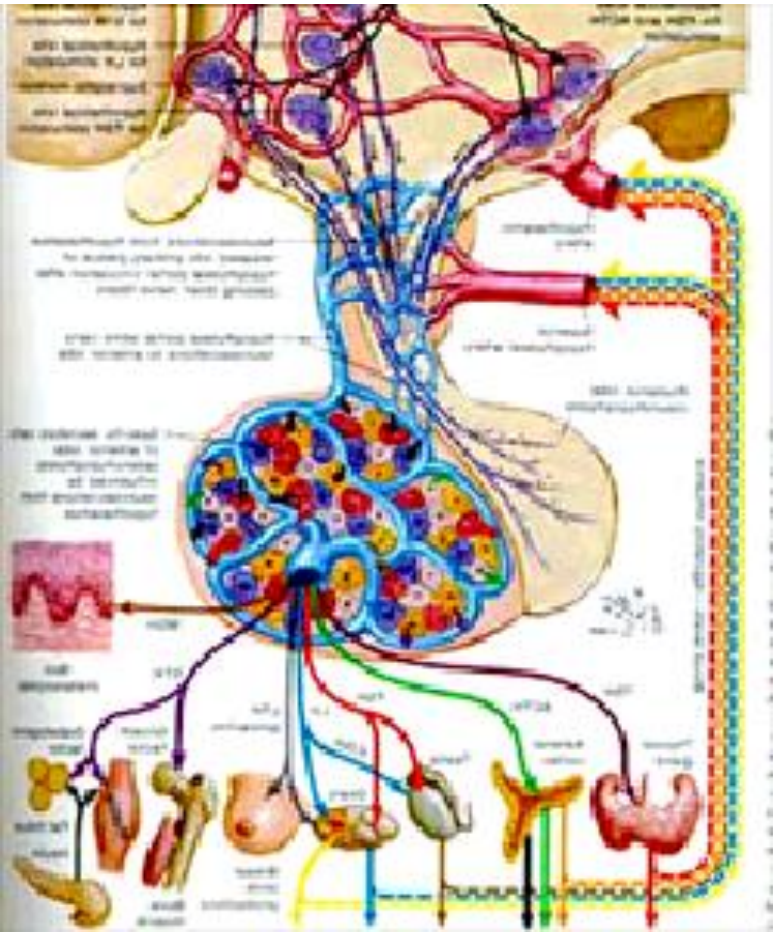
https://www.youtube.com/watch?v=2-DFK_iWkcw

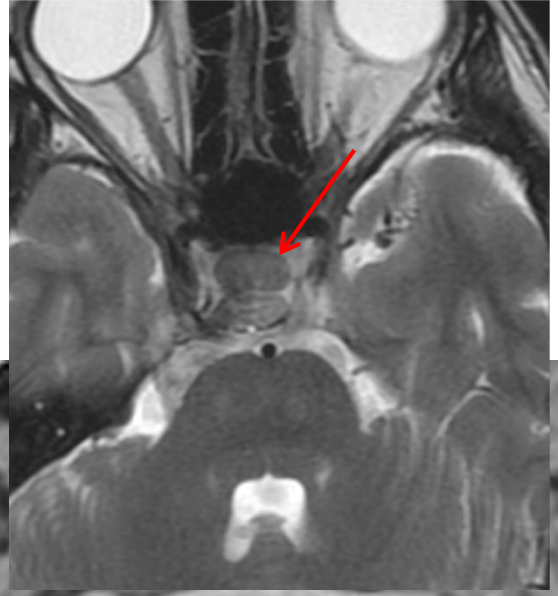
Mechanical thrombectomy for acute ischemic stroke treatment

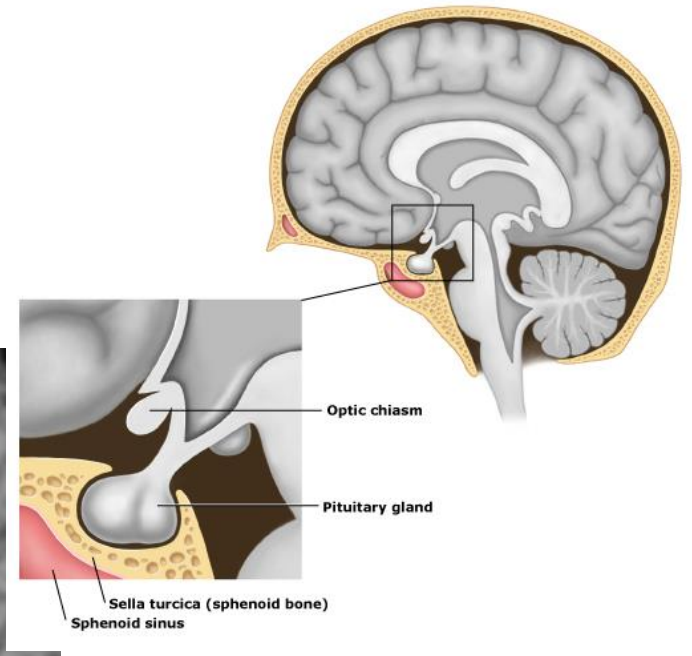
https://www.youtube.com/watch?v=7gn96se6j00&t=0s&index=2&list=PL4Cuo-fGFLUhg4fE0WBpzEbMgMZIJxv5C

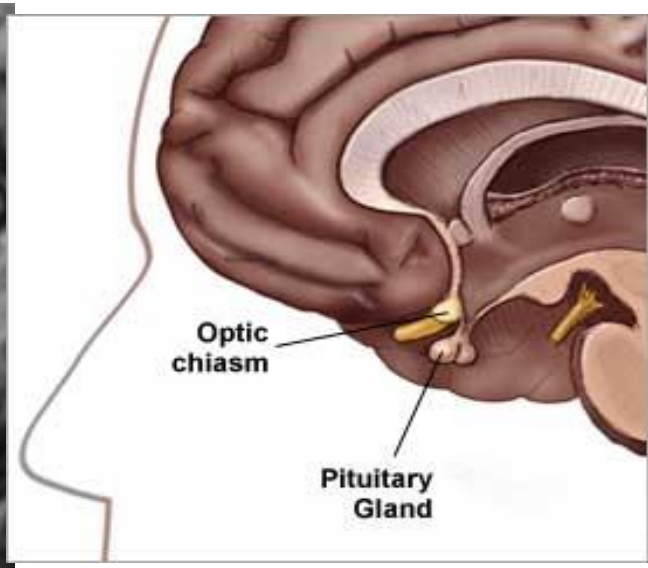
Pituitary gland

腦下垂體



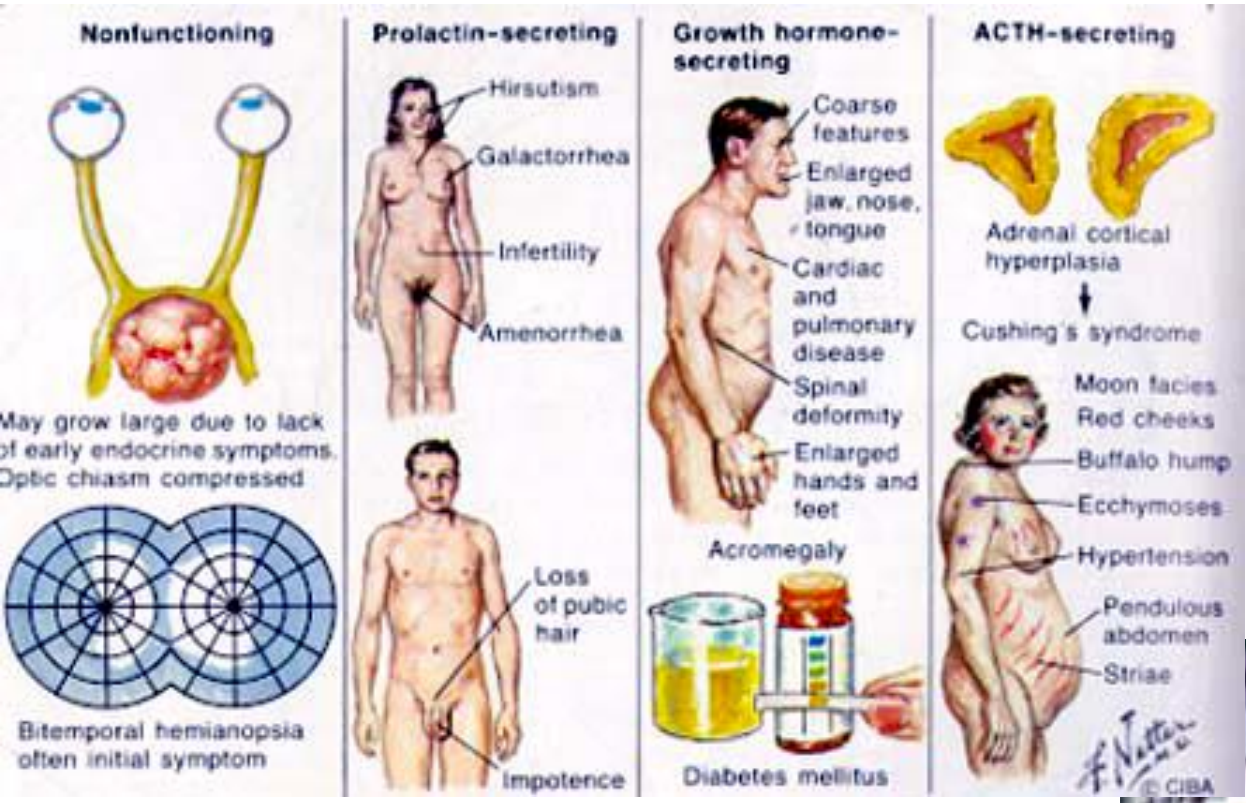


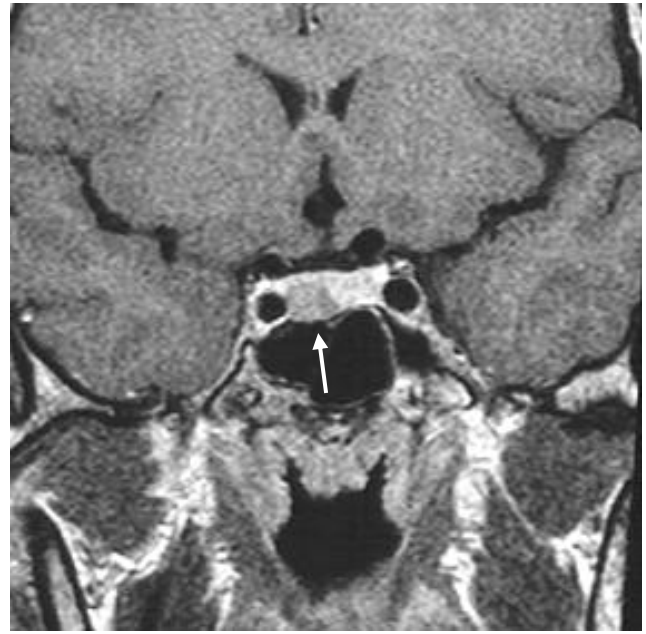




Anterior lobe (adenophysis)

Posterior lobe (neurophysis)

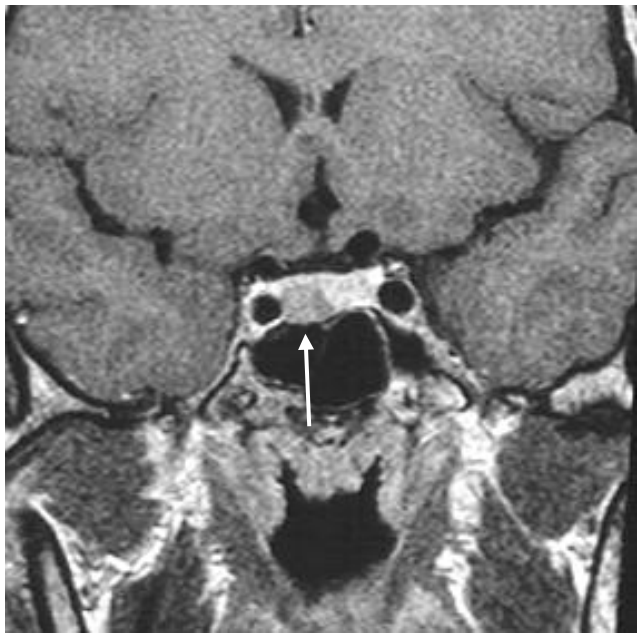




Pituitary adenoma

腦下垂體腺瘤

Pituitary adenoma



One minute note (4):

Just briefly describe your feeling about this lecture