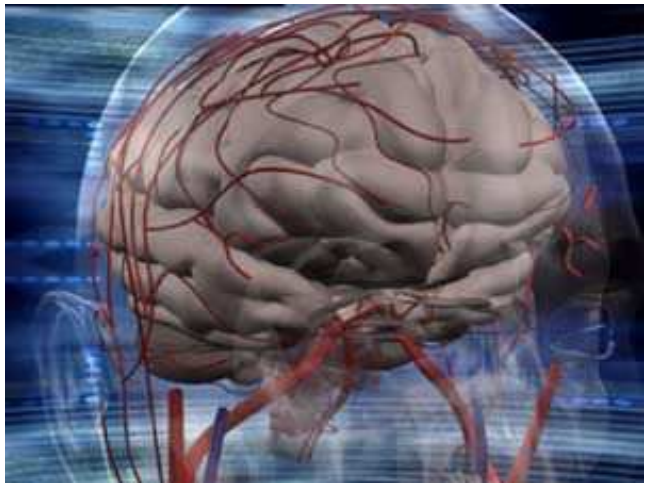


Universitätsspital Basel
Neurologische Klinik
und Stroke Unit

Vascular territories and clinical syndromes of the anterior circulation

Philippe Lyrer
Universitätsspital Basel

SNG-Fortbildungskurs

Basel, 10.11.2012

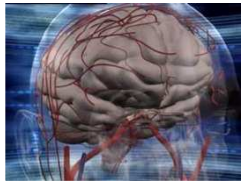
Aims / agenda

Basics: vascular territories of the brain

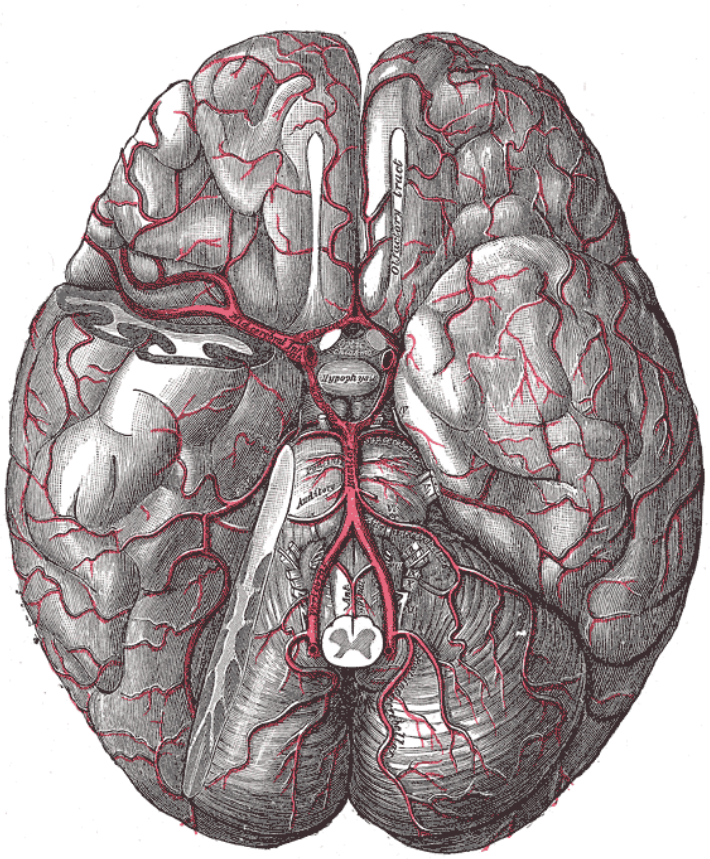
Basics: clinical examination of stroke patients – the National institute of Health stroke severity scale (NIHSS)

Clinical cases: common patterns of anterior circulation strokes

Clinical examination in anterior vs posterior circulation stroke



basics: the circulus arteriosus willisii

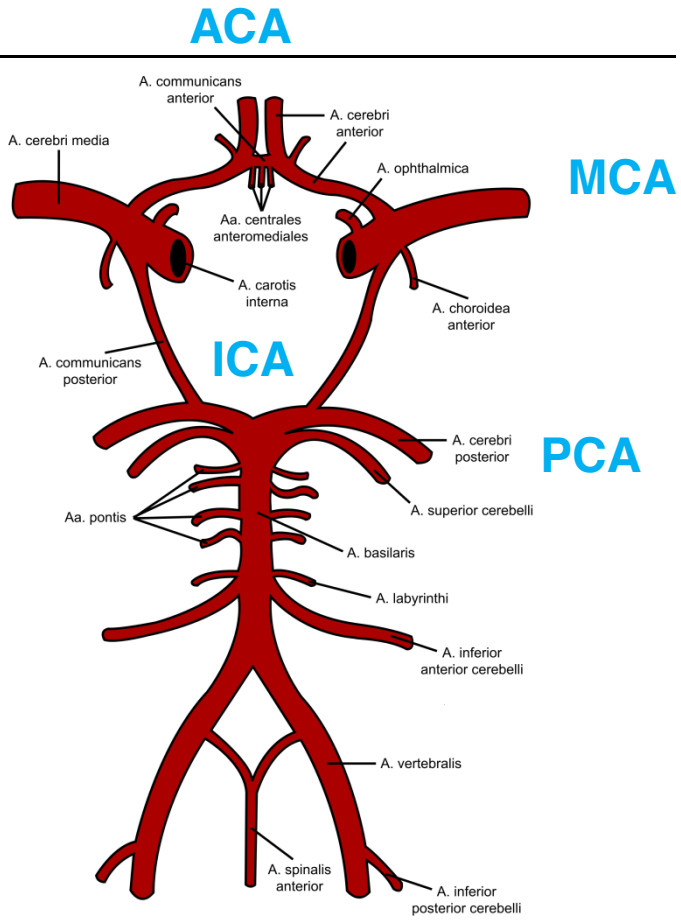


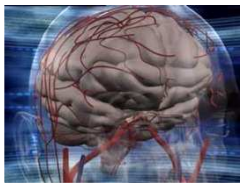
A. cerebri media = MCA

A. carotis interna = ICA

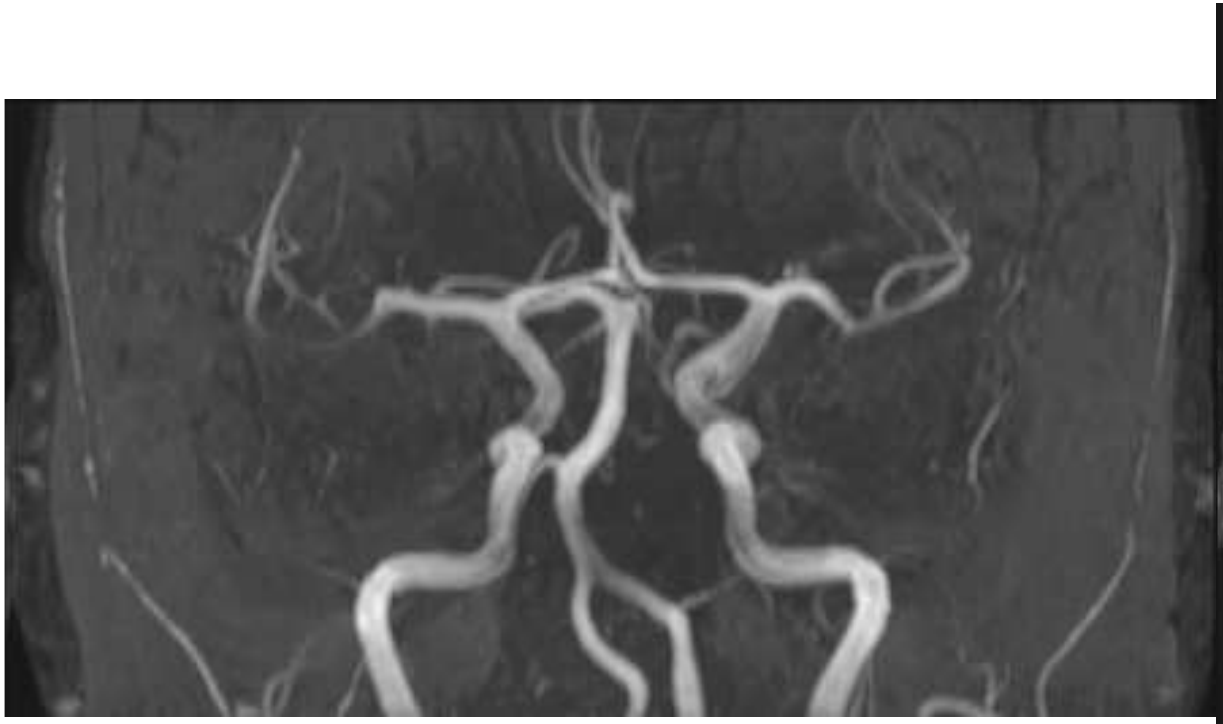
A. cerebri anterior = ACA

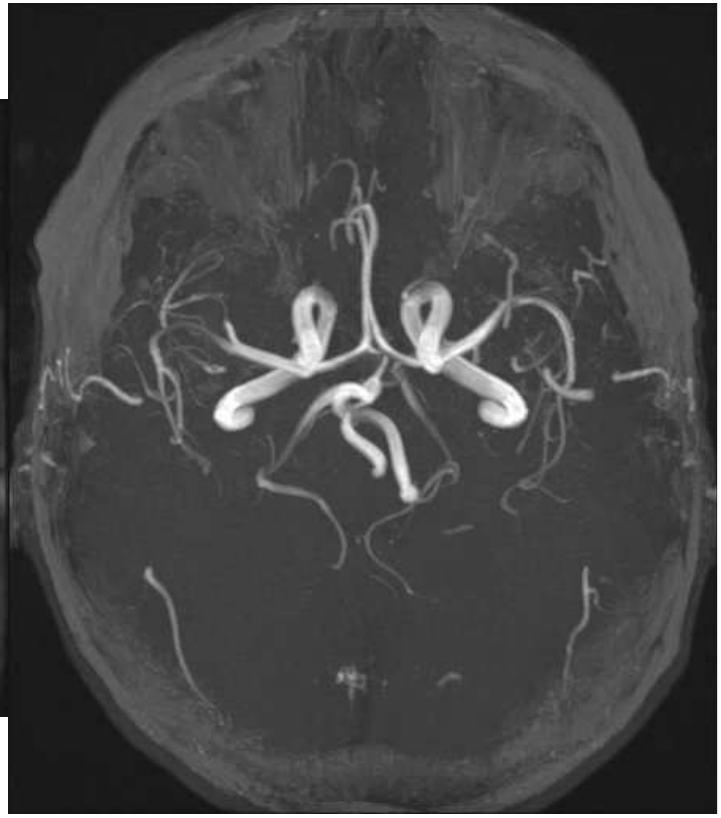
A. cerebri posterior = PCA

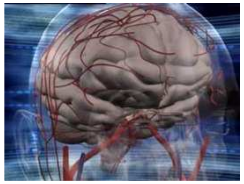




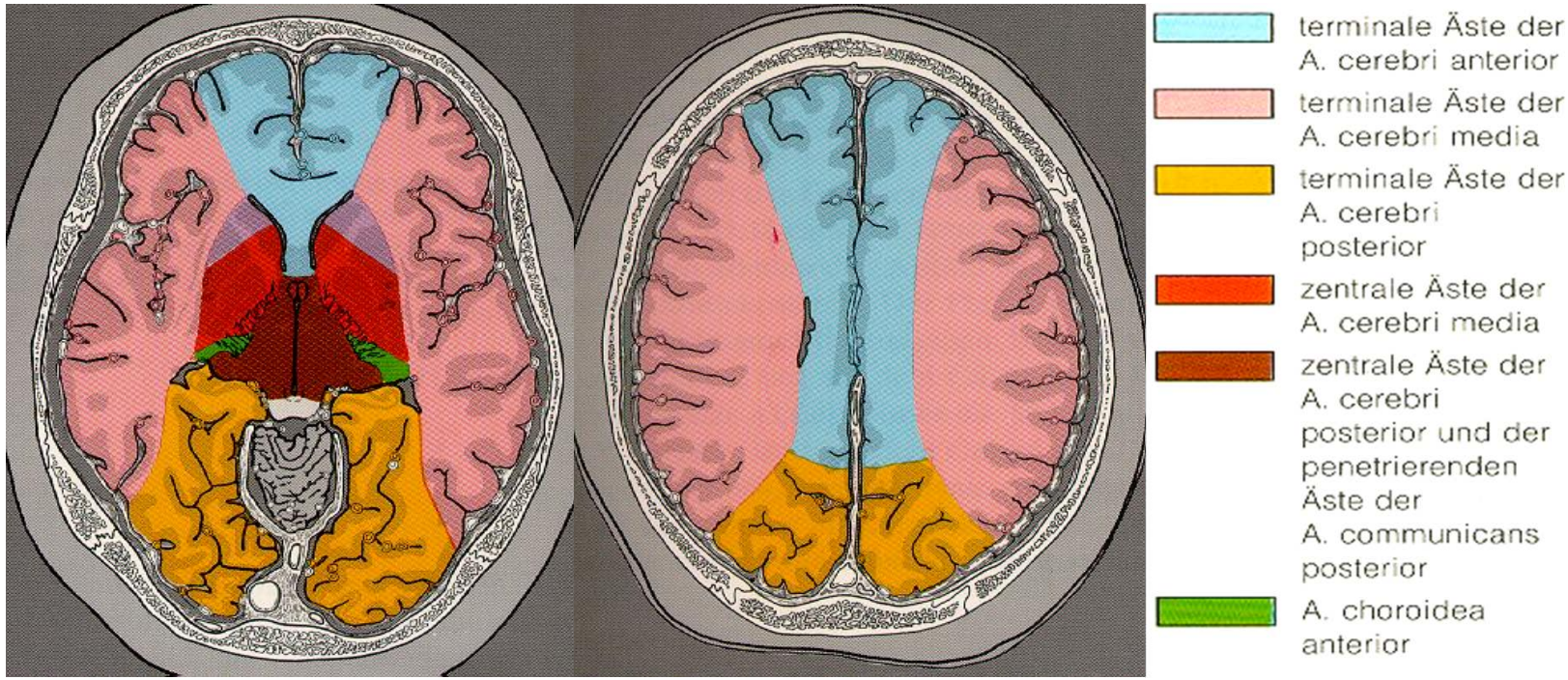
Basics: circulus arteriosus Willisi in MR-TOF Angiography



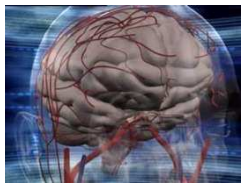




basics: vascular territories



Kretschmann/ Weinrich, Thieme Verlag, 1991

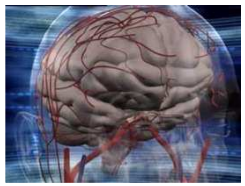


Basics: different patterns of ischemic lesions (CT)

Territorial infarction

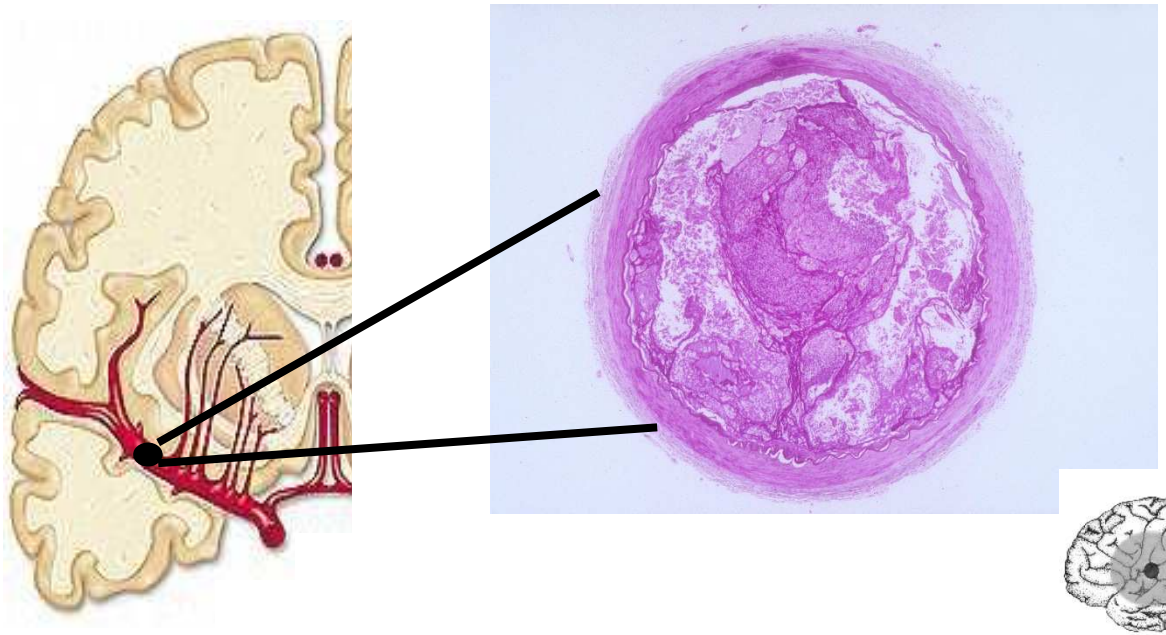
cerebral microangiopathy

hemodynamic, border-zone infarction

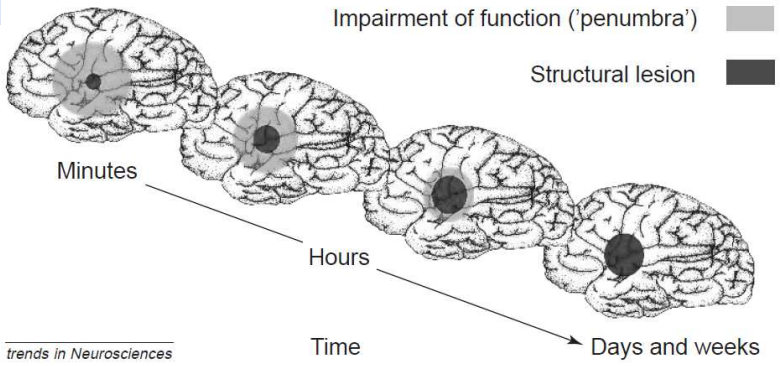


Ringelstein EB, Koschorke S, Holling A, Thron A, Lambertz H, Minale C. Computed tomographic patterns of proven embolic brain infarctions. Ann Neurol 1989;26:759–65.

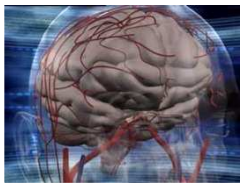
basics: pathology and pathophysiology



Acute vascular occlusion



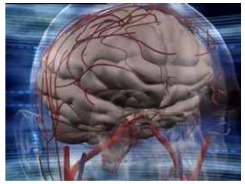
Penumbra and infarction– development of the ischemic lesion



Dirnagl et al, 1999

basics: neurological examination of stroke patients – the National institute of health stroke severity scale (NIHSS)

- Standardized examination of stroke patients
- 11 Items
- Range 0-42 Points indicating severity of the stroke



basics: neurological examination of stroke patients – the National institute of health stroke severity scale (NIHSS)

1a. **Level of Consciousness**: 0=alert - 3 =responds only with reflex

1b. **LOC questions** (month, age): 0=both answers correct – 2=neither questions correct

1c. **LOC commands** (eyes, hand): 0=both performed correctly – 2=neither task performed correctly

2. **Best gaze**: 0=normal – 2=forced deviation

3. **Visual fields**: 0=no visual loss – 3=bilateral hemianopsia

4. **Facial palsy**: 0=normal – 3=complete paralysis

5. **Motor arm** (a left, b right): 0=no drift – 4=no movement

6. **Motor leg** (a left, b right): 0=no drift – 4=no movement

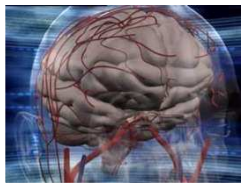
7. **Limb ataxia**: 0=absent – 2=present in two limbs

8. **Sensory**: 0=normal – 2=sever to total sensory loss

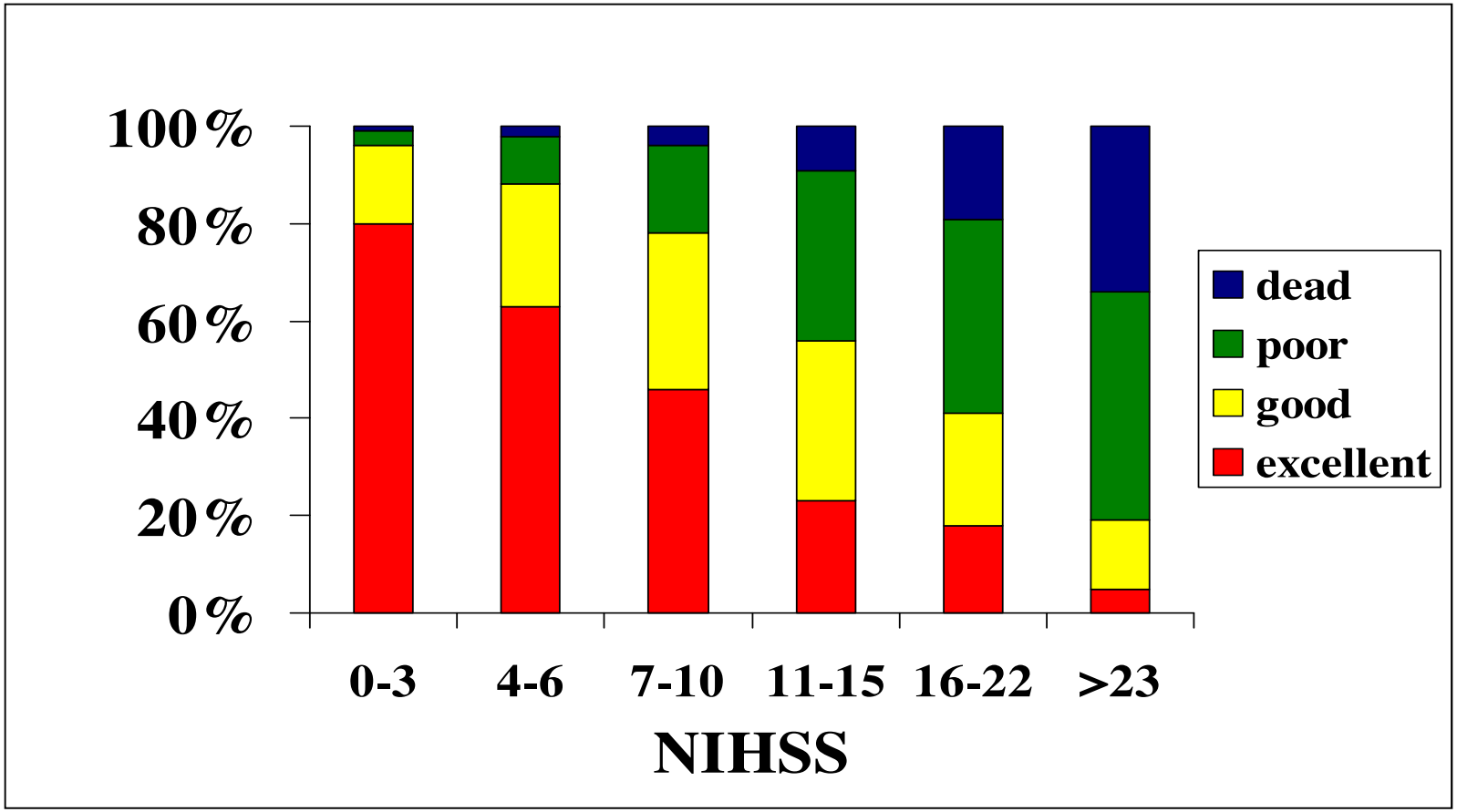
9. **Best language**: 0=no aphasie – 3=mute, global aphasia

10. **Dysarthria**: 0=normal – 2=severe dysarthria

11. **Extinction and Inattention**: 0=no abnormality – 2=profound hemi-inattention or extinction



NIHSS vs “outcome“ at 3 month



Adams et al. Neurology 1999

Universitätsspital Basel

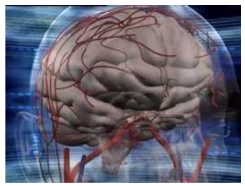
Clinical classification of stroke – the Oxfordshire Community Stroke Project (OCSP) classification

TACI – total anterior circulation infarcts combination of higher cerebral dysfunction (dysphasia, dyscalculia, visospatial disorder), homonymous visual field defect, ipsilateral motor and/or sensory deficit of at least two areas of the face, arm and leg, impaired level of consciousness = higher cerebral dysfunction) — 17 %

PACI – partial anterior circulation infarction only 2 of 3 components of TACI or with a motor/sensory deficit more restricted than those classified as LACI (one limb; face and hand but not the whole arm) — 34 %

LACI – lacunar infarcts pure motor, pure sensory, senori-motor stroke, ataxic hemiparesis, faciobrachial and brachicrural involvement is included, more restricted deficits not — 25 %

POCI – posterior circulation infarcts ipsilateral cranial nerve palsy with contralateral motor and/or sensory deficit; bilateral motor and/or sensory deficit; disorder of conjugate eye movement; cerebellar dysfunction without ipsilateral long-tract deficit — 24 %



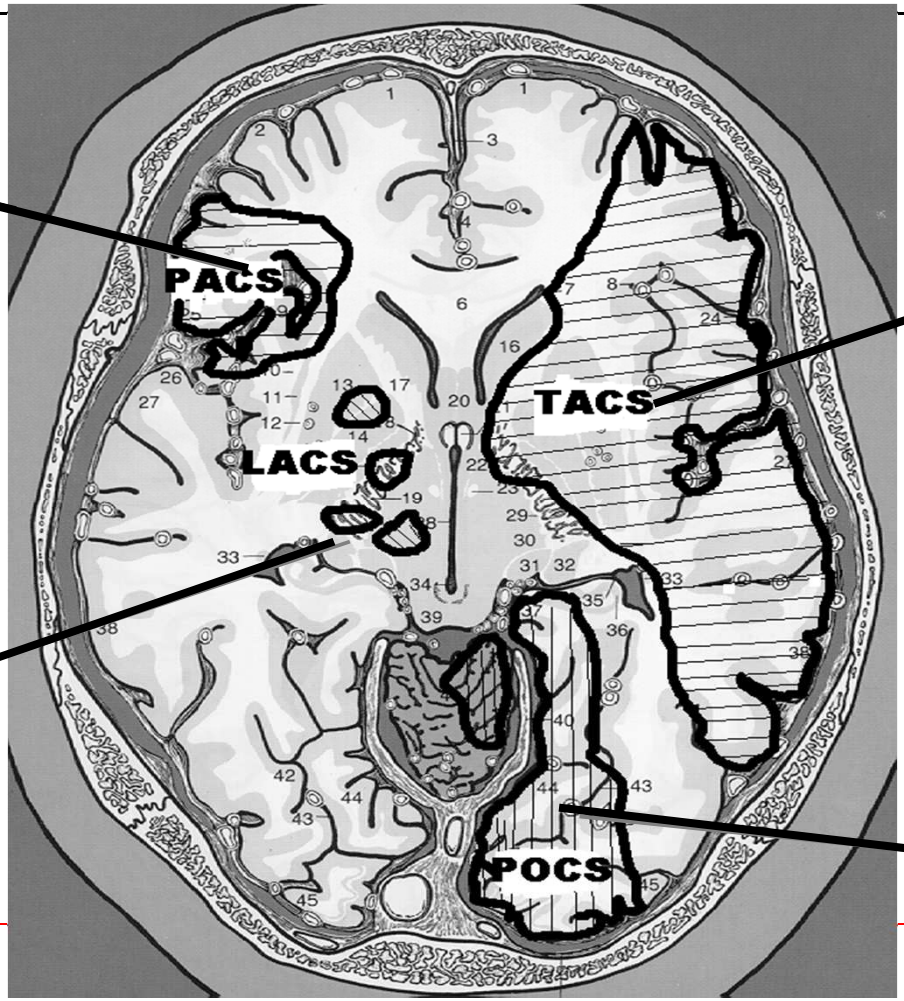
CLINICAL PRACTICE

Classification and natural history of clinically identifiable subtypes of cerebral infarction

John Bamford Peter Sandercock Martin Dennis John Burn Charles Warlow

Bamford et al, Lancet 1991

Oxfordshire Community Stroke Project (OCSP) classification and anatomic localisation



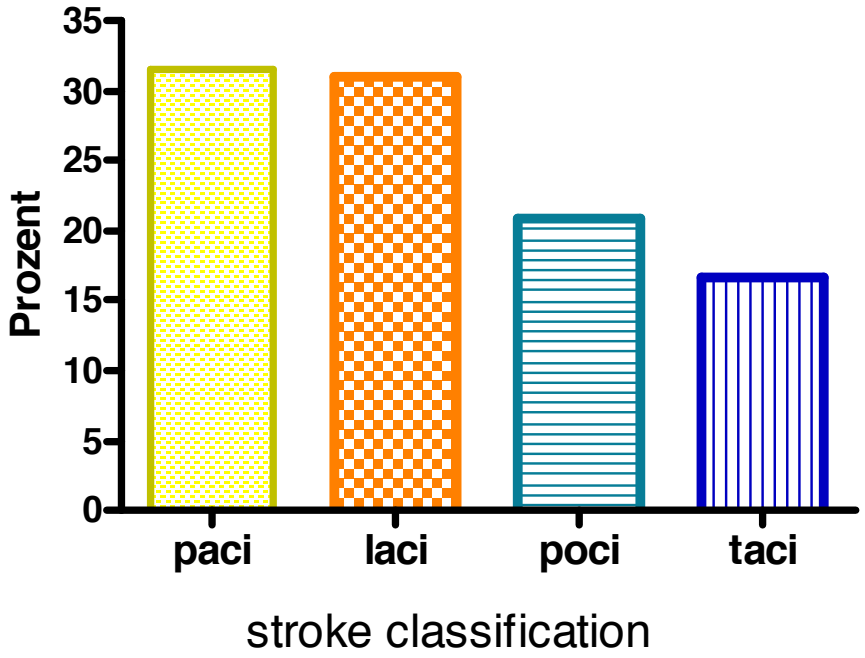
Universitätsspital Basel

Distribution of stroke syndromes classified with OCSP in Basel 1995-2003

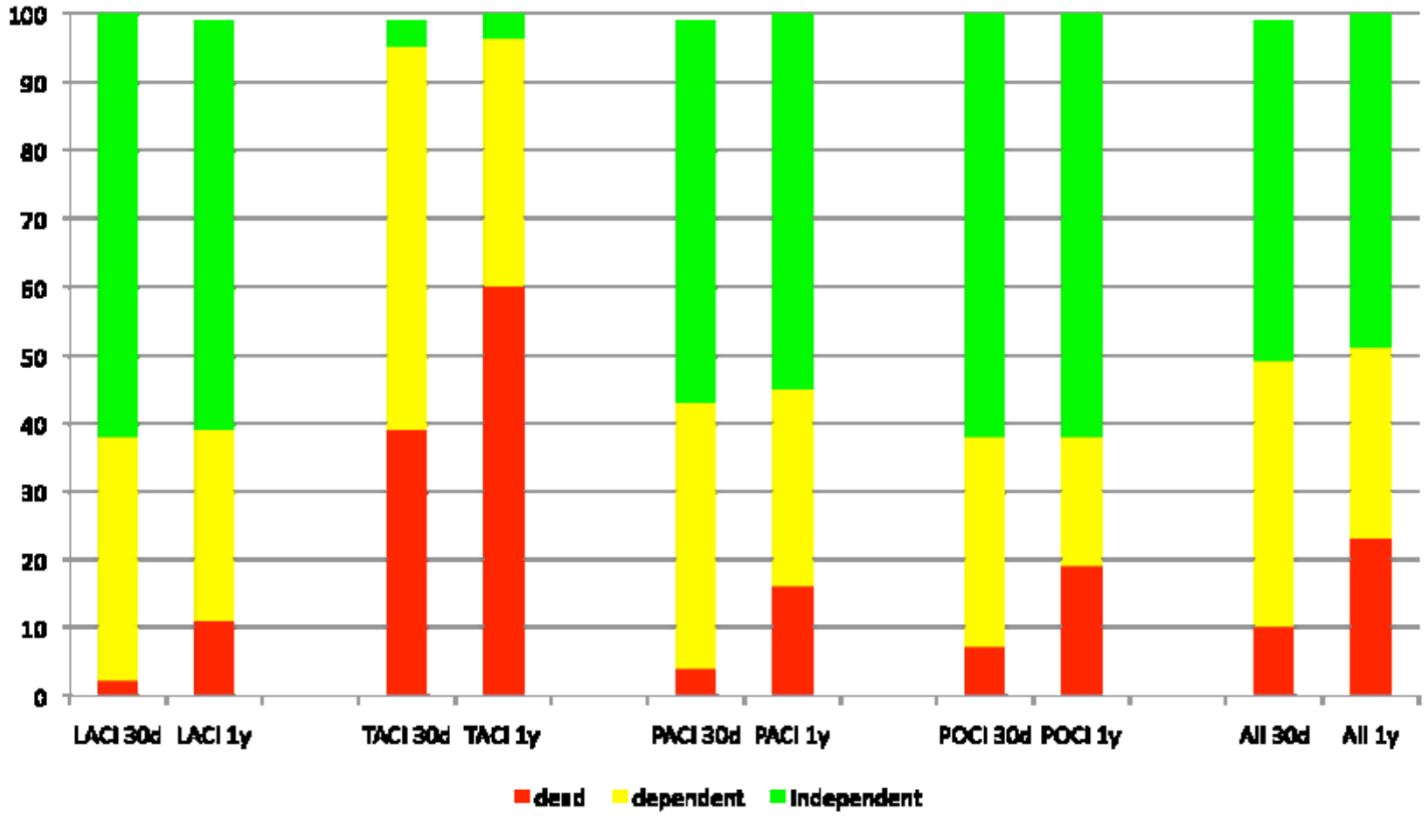
total 3111 patients with clinical suspicion of stroke

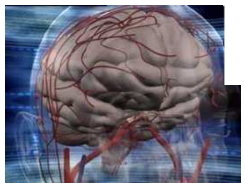
46% femalie

54% male



OCSP classification -Case fatality rates and functional status





Lancet 1991; **337**: 1521–26.

Case I: male, 45 years

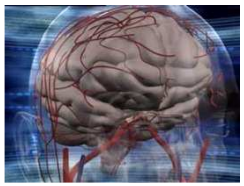
Case history: patient was found by his wife in front of their house, unable to move his right arm, no answers, no understanding

NIHSS on admission: 16 points

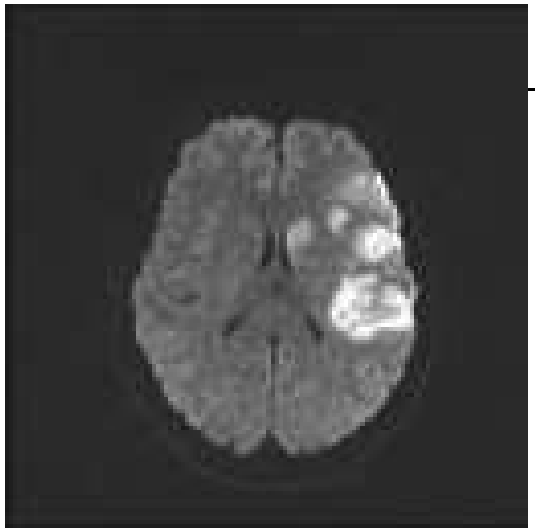
1a. Level of Consciousness: not alert but arousable by minor stimulation ;1 point
1b. LOC questions: answers neither question correctly; 2 points
1c. LOC commands: performs neither task correctly; 2 points
2. Best gaze: normal; 0 points
3. Visual: partial hemianopsia;1 point
4. Facial Palsy: minor paralysis (flattened nasolabial fold, asymmetry on smiling);1 point
5a. Motor arm right: no movement; 4 points
5b. Motor arm left: no drift; 0 points
6a. Motor leg right: no drift; 0 points
6b. Motor leg left: no drift; 0 points
7. Limb ataxia: absent; 0 points
8. Sensory: severe to total sensory loss; patient is not aware of being touched in the face and arm; 2 points
9. Best language: global aphasia, no usable speech or auditory comprehension; 3 points
10. Dysarthria: normal; 0 points
11. Extinction and Inattention: no abnormality; 0 points

→ Hemimotor and sensory deficit, aphasia, hemianopia, decreased LOC

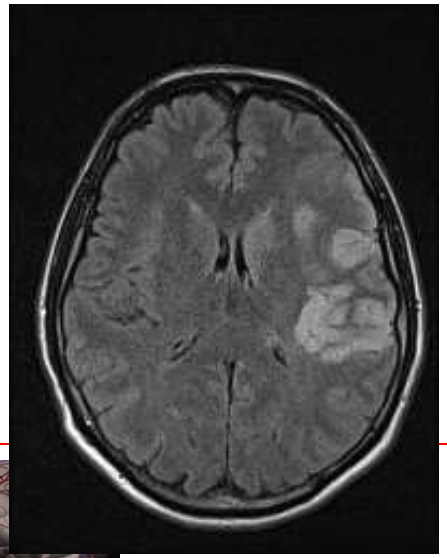
TACI



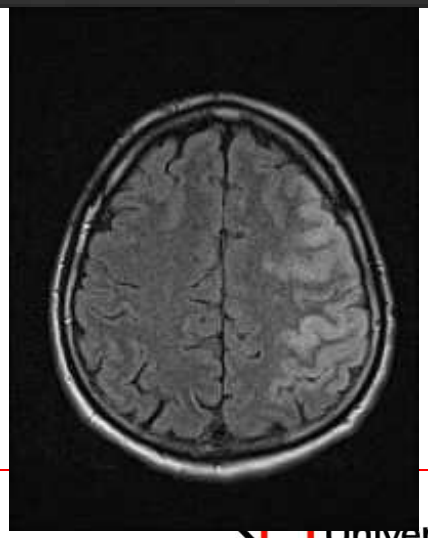
Case I: male, 45 years

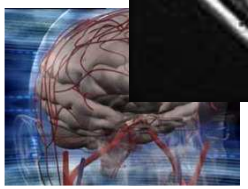


MR-DWI

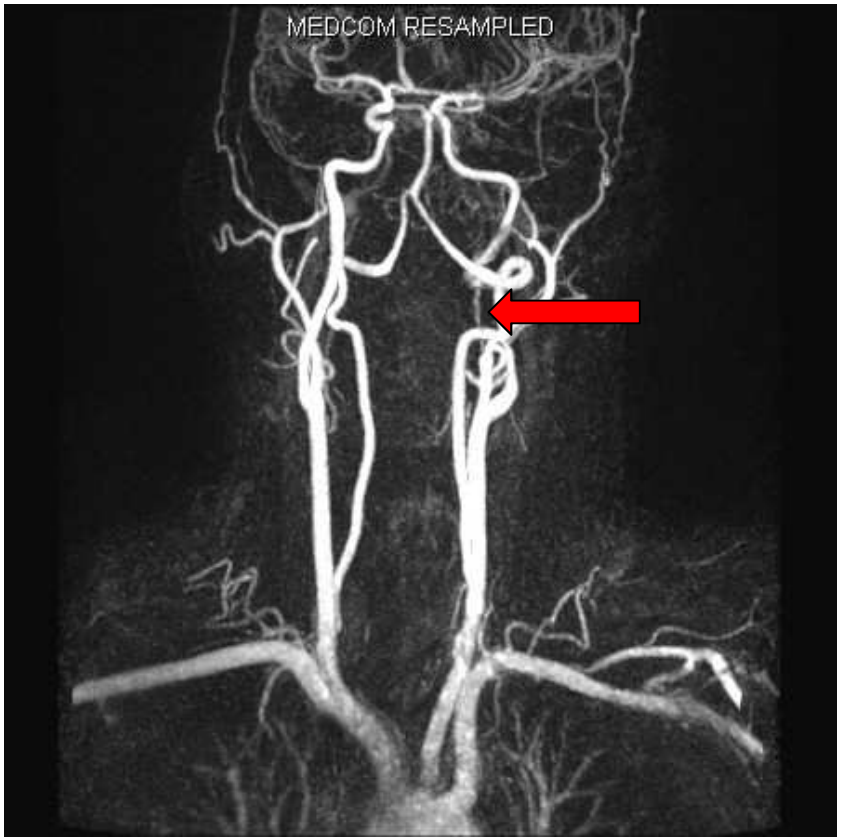


MR-T2



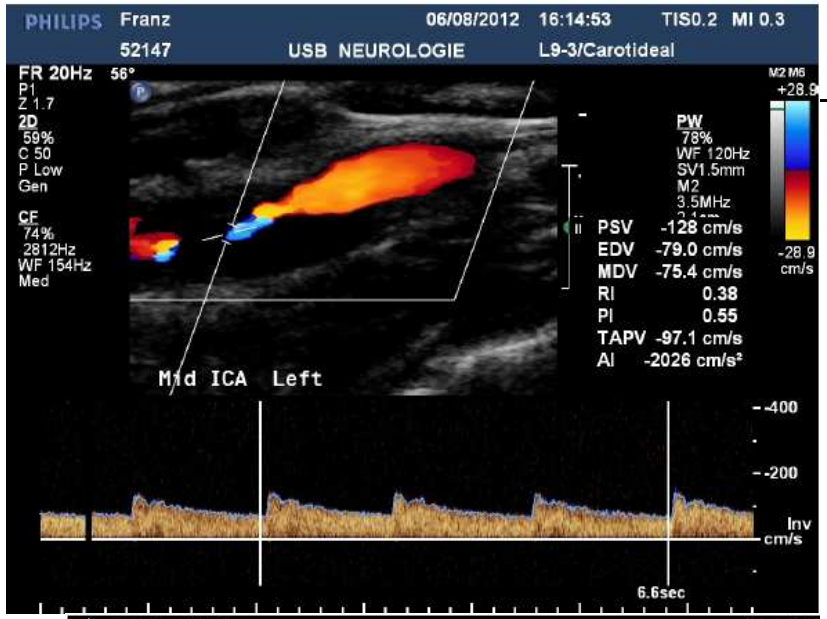


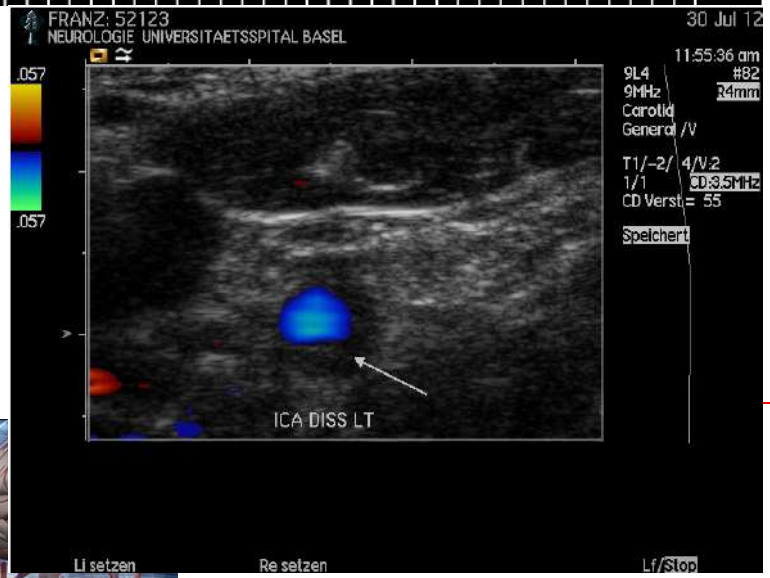
Case I: male, 45 years



ACI - dissection C1-C2

Case I: male, 45 years



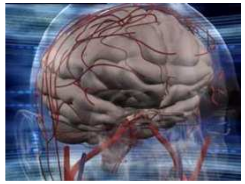


Dissection C1-C2 of the ICA

Stroke in the internal carotid artery territory

- Hemodynamic and embolic infarction
- Amaurosis fugax

Definition: “The onset is sudden, with partial or complete dimming or obscuration of vision, lasting seconds to minutes. Partial impairment is defined as greyout, or an ascending or descending curtain or a movement sideways across the eye.” (Kumrali: Handbook of clinical neurology, Part II Stroke 2009)



Anatomy of the internal carotid artery - landmarks

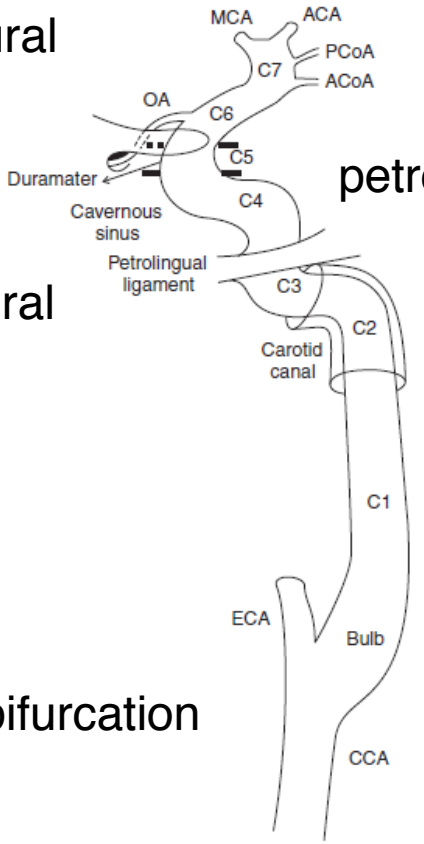
intradural

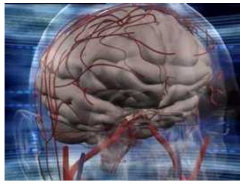
extradural

petrose part

extracranial

bifurcation





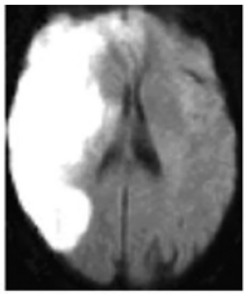
From M. Fisher: Handbook of Clinical Neurology, Stroke Part II 2009

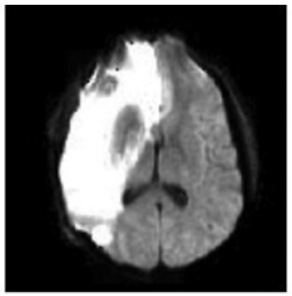
Occlusion patterns of the internal carotid artery

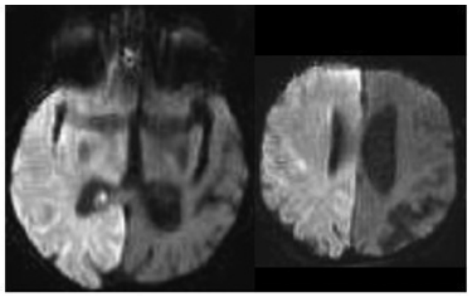
carotid-L occlusion

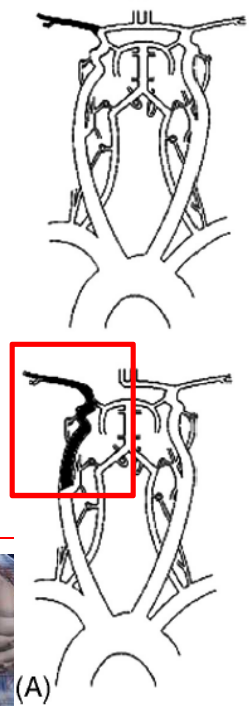
carotid-T occlusion

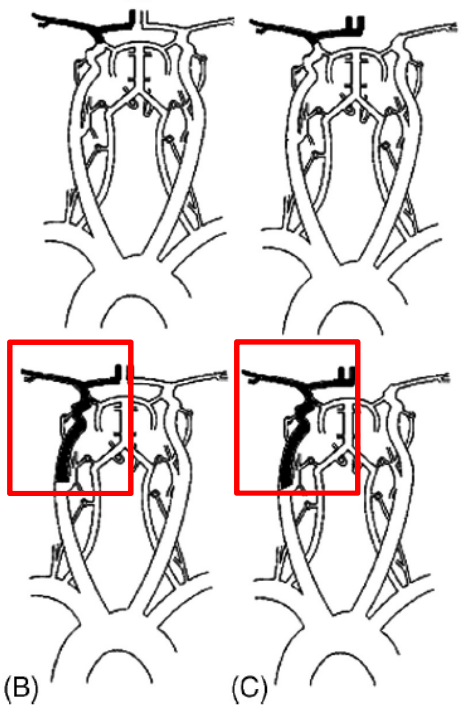
Panhemipheric infarction in a case of fetal PCA-origin

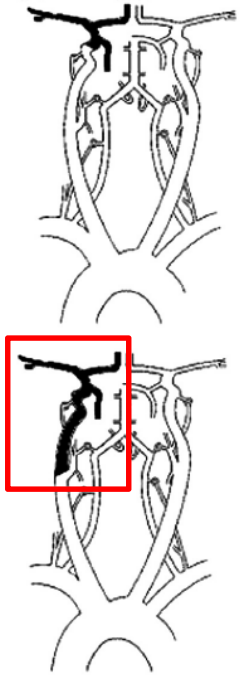




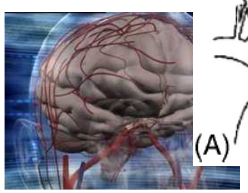






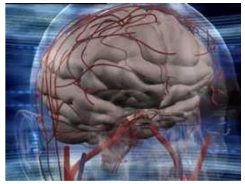


From M. Fisher: Handbook of Clinical Neurology, Stroke Part II 2009



ACI-occlusion - symptoms

- Decreased LOC (sopor, coma)
- Homonymus hemianopsia on the contralateral side
- Contralateral hemiplegia
- Hemisensory disturbance
- Gaze palsy to the opposite side (→déviation conj. to the affected side)
- Global aphasia (dominant hemisphere)
- Hemineglect, syn. extinction (non-dominant hemisphere)



Case II: male, 60 Jahre

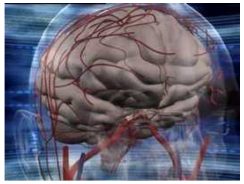
Case history: patient was found by his wife in the night out of the bed lying on the floor, severely slurred speach and nearly no movement of his right side

NIHSS on admission: 16 points

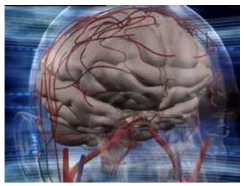
1a. Level of Consciousness: not alert but arousable by minor stimulation ;1 point
1b. LOC questions: answers one question correctly; 1 point
1c. LOC commands: performs both tasks correctly; 0 points
2. Best gaze: partial gaze palsy; 1 point
3. Visual: no visual loss; 0 points
4. Facial Palsy: partial paralysis (total or near-total paralysis of lower face);2 points
5a. Motor arm right: no movement; 4 points
5b. Motor arm left: no drift; 0 points
6a. Motor leg right: no effort against gravity, leg falls to bed immediately; 3 points
6b. Motor leg left: no drift; 0 points
7. Limb ataxia: absent; 0 points
8. Sensory: mild-to-moderate sensory loss; 1 point
9. Best language: mild-to-moderate aphasia; 1 point
10. Dysarthria: severe dysarthria; 2 points
11. Extinction and Inattention: no abnormality; 0 points

TACI

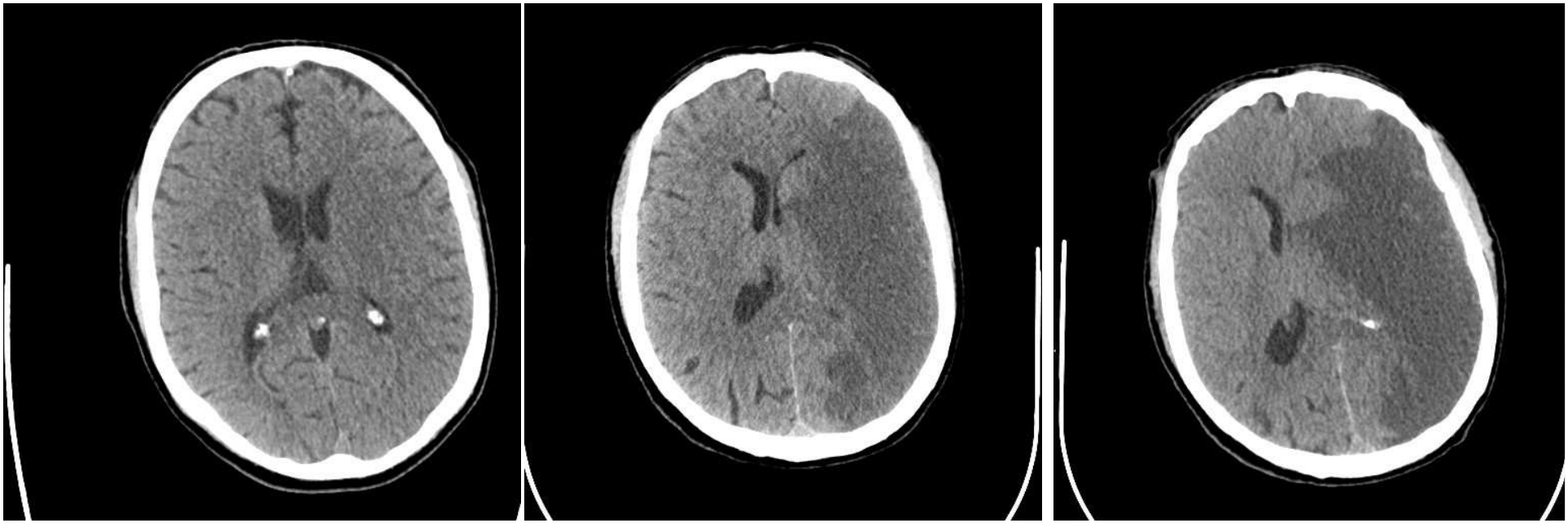
→ Hemimotor and sensory deficit, dysarthria, gaze palsy, decreased LOC



Case II: CT baseline: dense middle cerebral artery sign



case II: male, 60 years nativ-CT



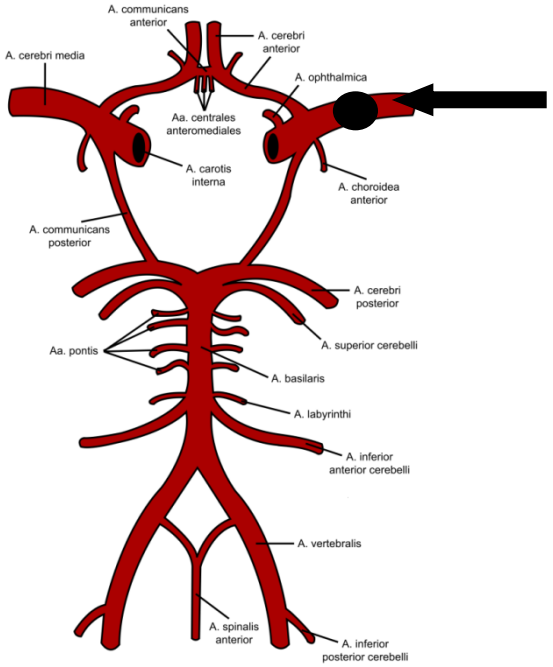
CT nativ baseline CT day 1 CT day 4

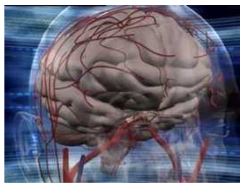
Patient died on day 5

Universitätsspital Basel
Neurologische Klinik & Stroke Unit

Middle cerebral artery (MCA)

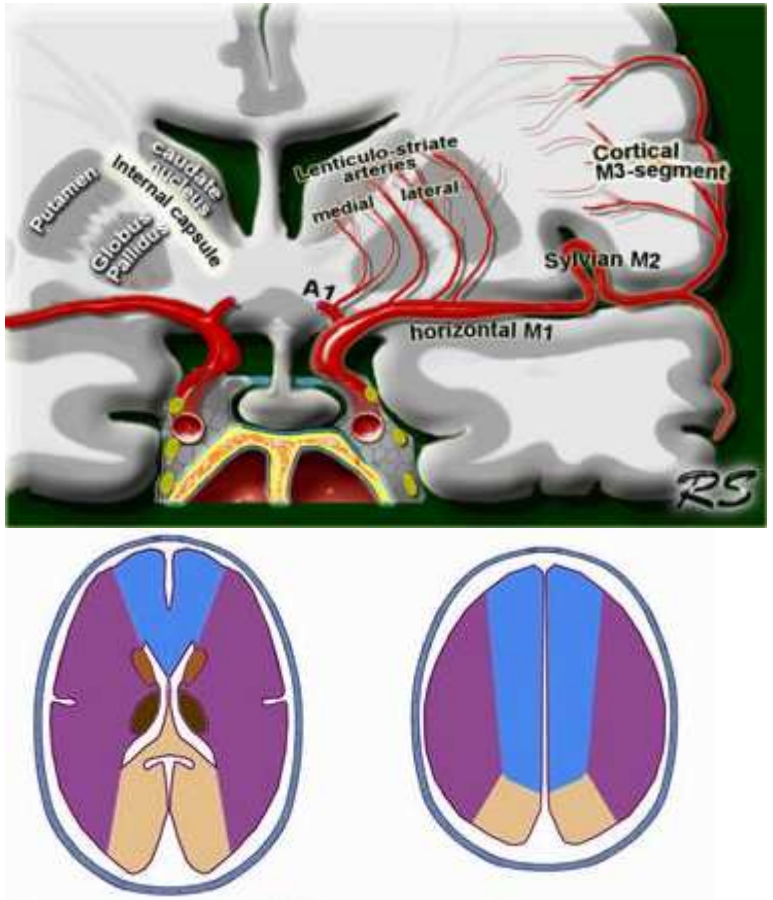
- 50% of all strokes!
- Clinical symptomes differ with different occlusion sites (proximal vs. bistal branches)

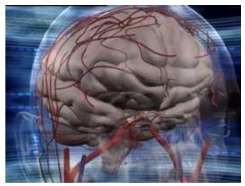




Proximal occlusion of the MCA

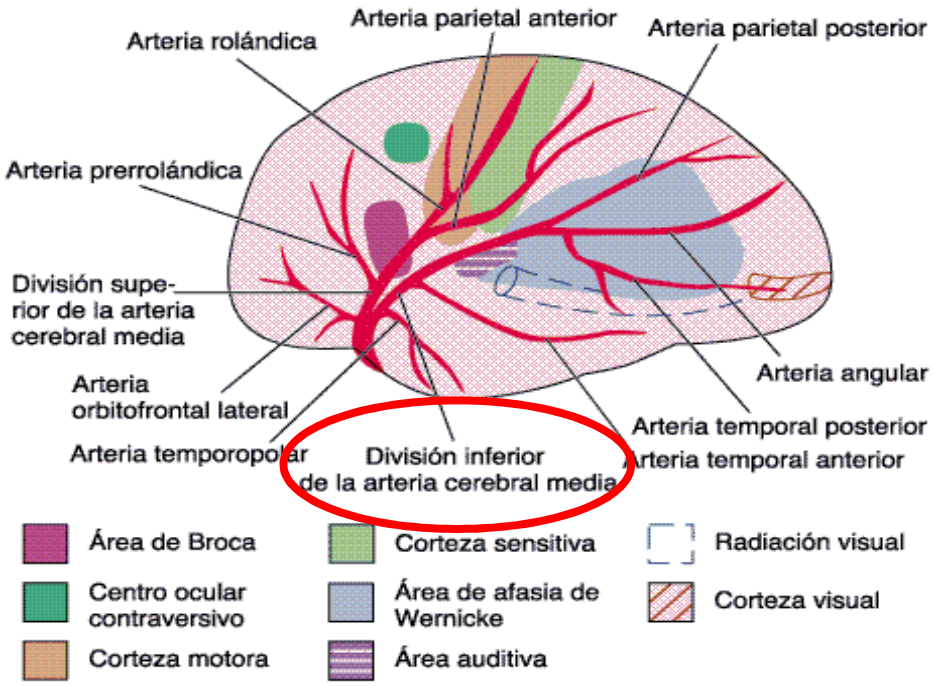
- Severe sensomotor hemisyndrome,
- Impaired consciousness
- déviation conjuguée
- global aphasia (lefthemispheric lesion)
- tactile or visual neglect (righthemispheric lesion)
- anosognosia (right-hemispheric lesion)





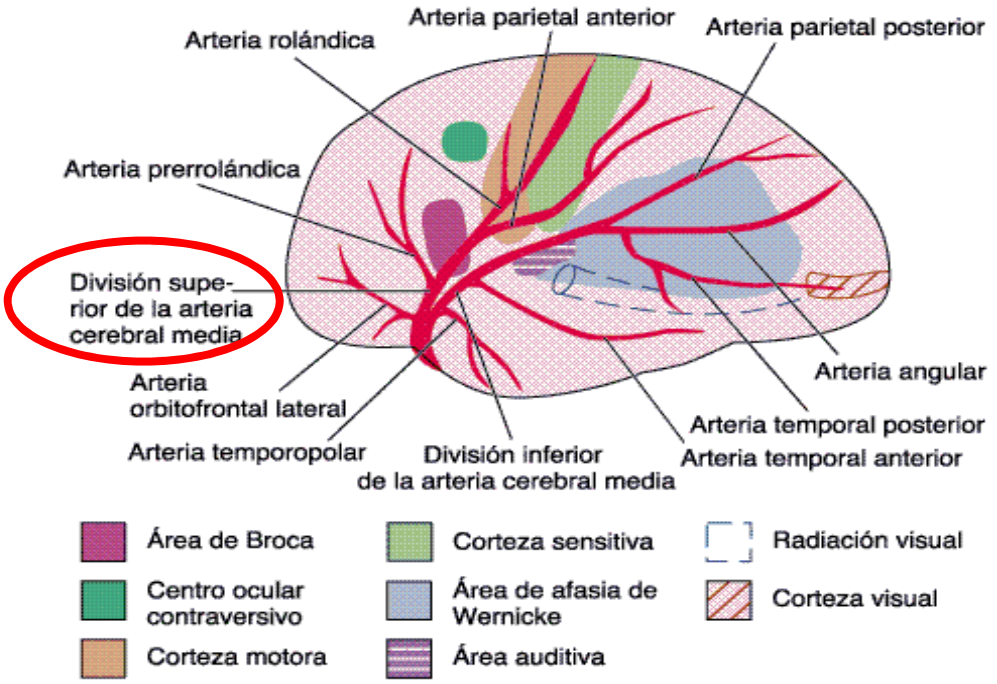
Occlusion of the posterior MCA-branches

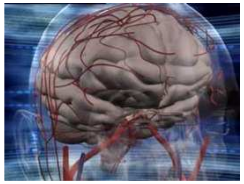
- Sensory hemisyndrome
- homonyme hemi- or Quadrantenanopsie
- Wenicke-aphasia (left)
- Hemineglect (right)
- Visual-spatial disorder
- amnesia



Occlusion of the anterior MCA-branches

- Sensomotorisches Hemisyndrom
- Homonyme Hemianopsie
- Globale oder Broca-Aphasie (Läsion linkshemispherisch)
- Apraxie (rechts)
- Hemineglect (rechts)





Case III: male 51 years

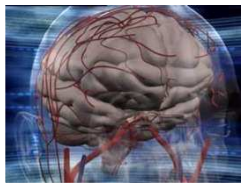
Case history: patient wakes up in the night, couldn‘t move his left side, calls the ambulance himself

NIHSS on admission: 9 points

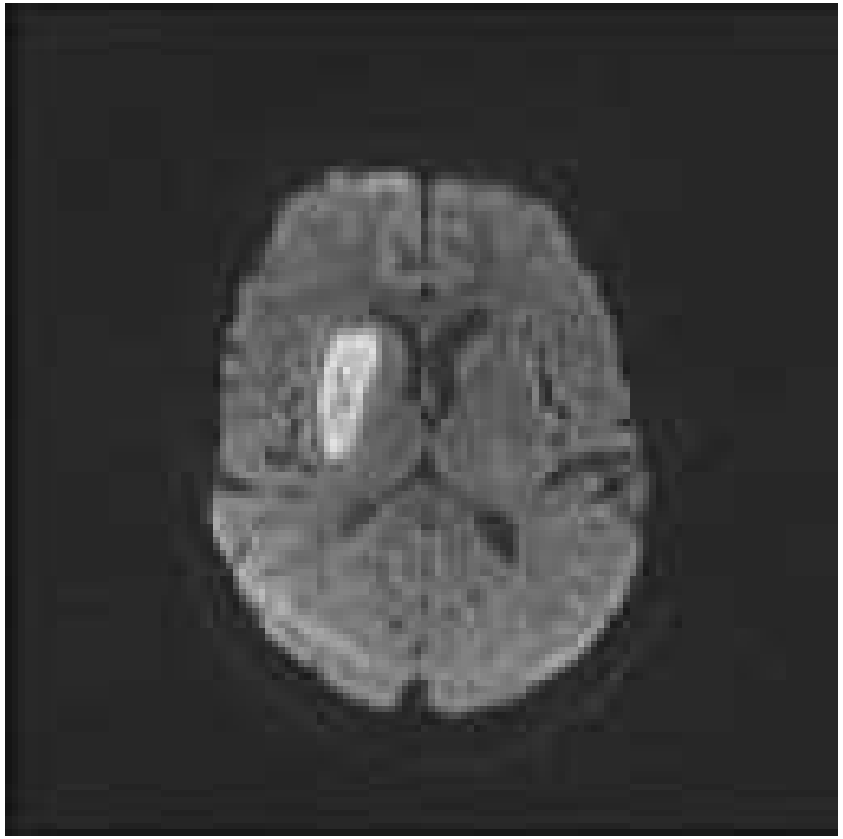
1a. Level of Consciousness: alert; 0points
1b. LOC questions: answers both questions correctly; 0 point
1c. LOC commands: performs both tasks correctly; 0 points
2. Best gaze: normal; 0 point
3. Visual: no visual loss; 0 points
4. Facial Palsy: partial paralysis (total or near-total paralysis of lower face);2 points
5a. Motor arm right: no drift; 0 points
5b. Motor arm left: no movement 4 points;
6a. Motor leg right: no drift; 0 points
6b. Motor leg left: no effort against gravity, leg falls to bed immediately; 3 points
7. Limb ataxia: absent; 0 points
8. Sensory: normal; 0 points
9. Best language: no aphasia ; 0 points
10. Dysarthria: normal; 0 points
11. Extinction and Inattention: no abnormality; 0 points

→ Pure hemimotor deficit

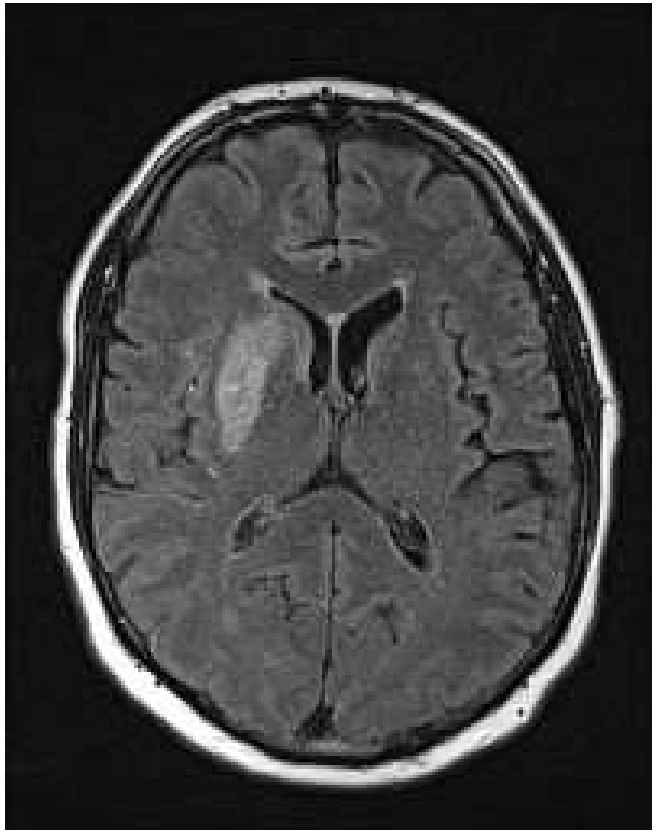
LACI



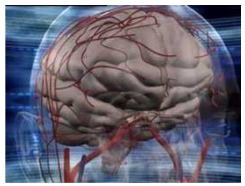
Case III: male 51 years



MR-DWI



MR-FLAIR



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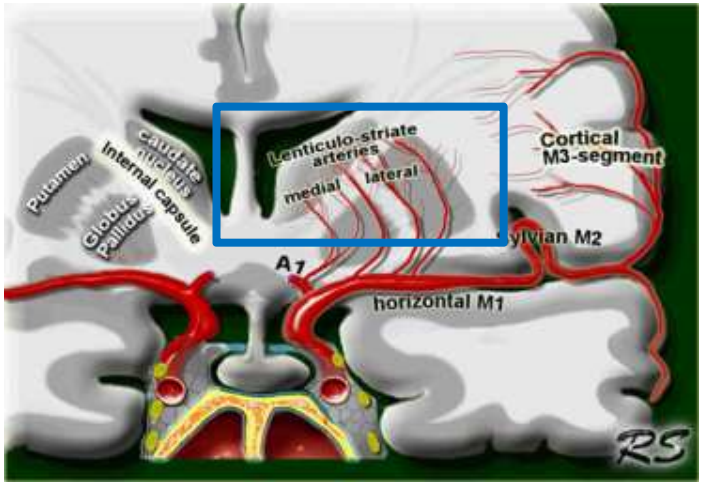
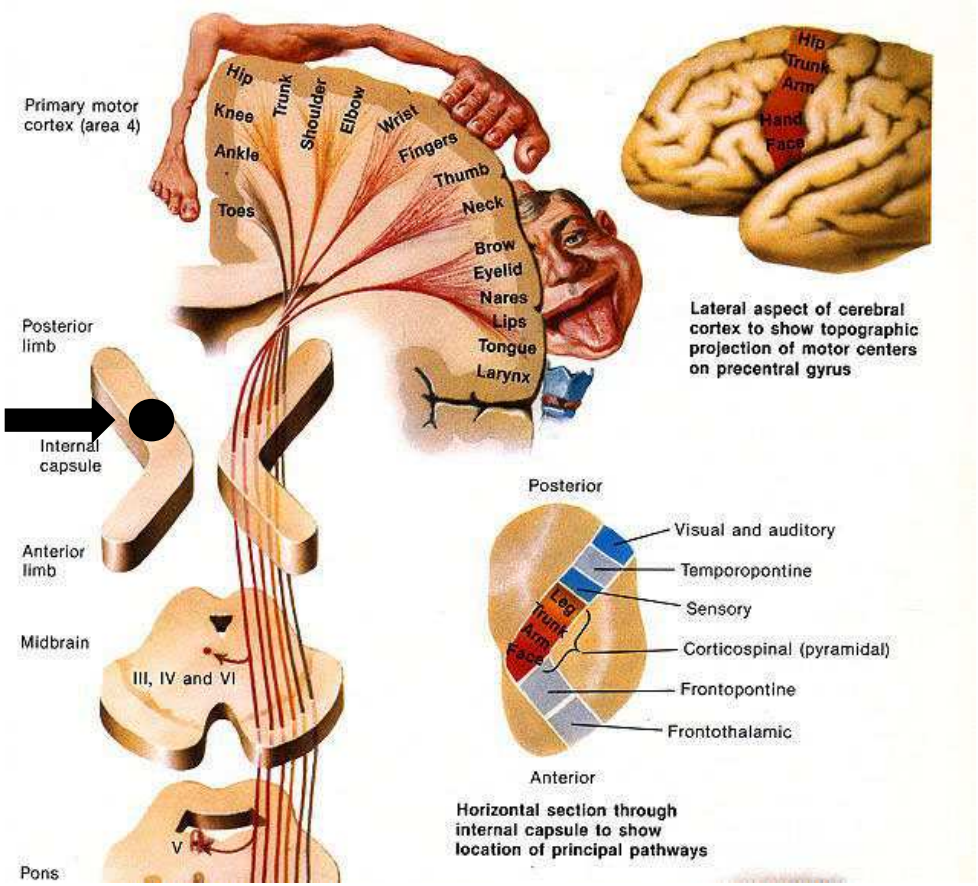
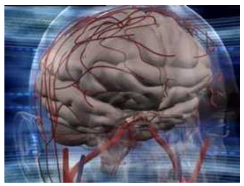
Striatocapsular infarction

- Overlapping clinical features with lacunar syndrome
- Pure senosory/pure motor hemiparesis
- Possibel: aphasia, visual hallucinations

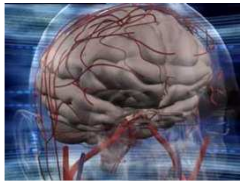






LACI – lacunar syndromes

Pure motor syndrome	int. cap., coro.rad., pons
Sensomotor syndrome	coro.rad, thalamus, int. cap., pons
Pure sensory syndrome	thalamus, coro.rad, int.cap.
Ataxic hemiparesis	int. cap., coro.rad., pons
Dysarthria-clumsy-hand-syndrome	int. cap., pons, coro. rad.



Case IV: male 80 years

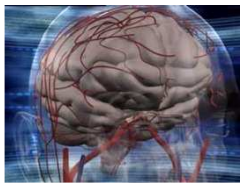
Case history: patient awakes after «siesta» and can't move his right leg; He calls his generalist how advises him to wait and see «if it goes better tomorrow». Patients decides to to go directly to the university hospital instead. IV-thrombolysis was administered 150 minutes after onset.

NIHSS on admission: 4 points

1a. Level of Consciousness: alert; 0points
1b. LOC questions: answers both questions correctly; 0 point
1c. LOC commands: performs both tasks correctly; 0 points
2. Best gaze: normal; 0 point
3. Visual: no visual loss; 0 points
4. Facial Palsy: normal;0 points
5a. Motor arm right: no drift; 0 points
5b. Motor arm left: no drift; 0 points;
6a. Motor leg right: no movement; 4 points
6b. Motor leg left: no drift; 0 points
7. Limb ataxia: absent; 0 points
8. Sensory: normal; 0 points
9. Best language: no aphasia ; 0 points
10. Dysarthria: normal; 0 points
11. Extinction and Inattention: no abnormality; 0 points

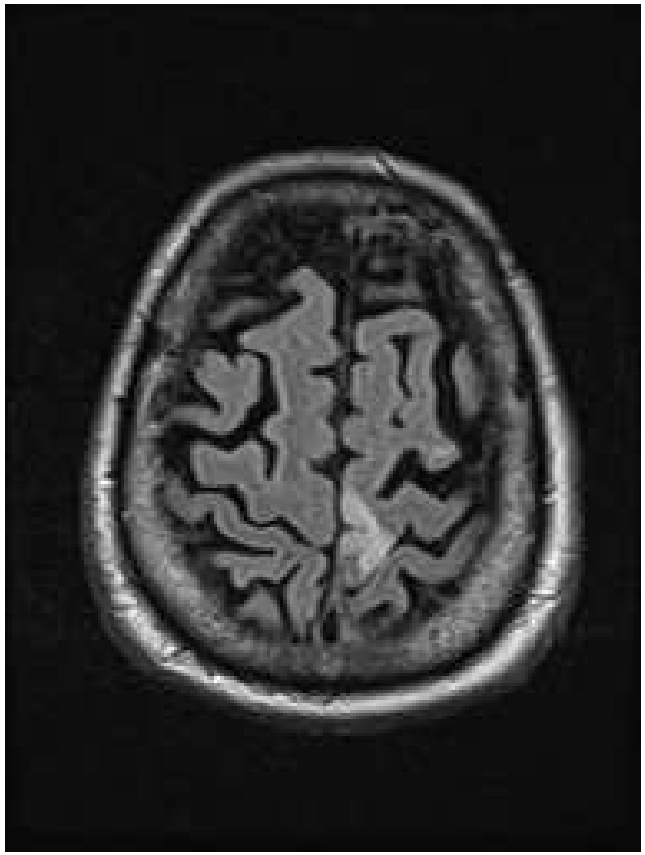
→ Isolated motoric weakness of foot and leg

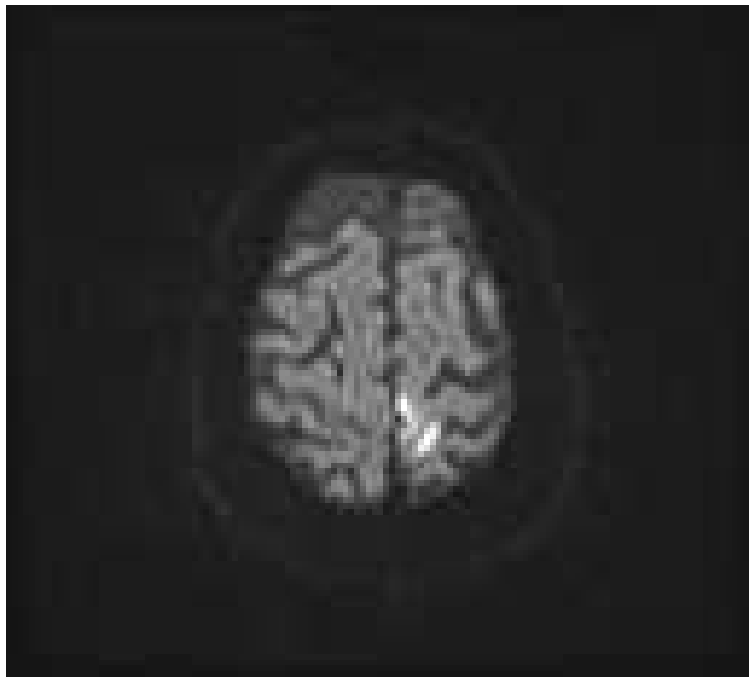
PACI



Case IV: male 80 years

Infarction of the cortical branches of the ACA

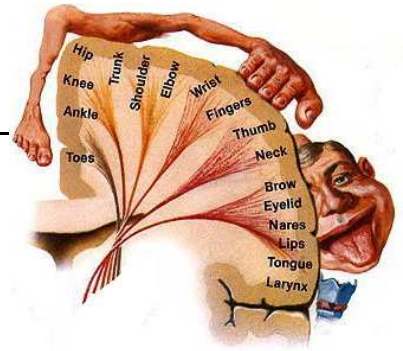




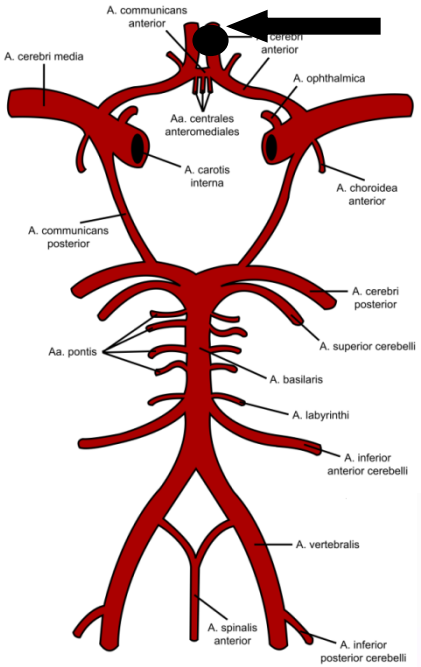
MR-DWI

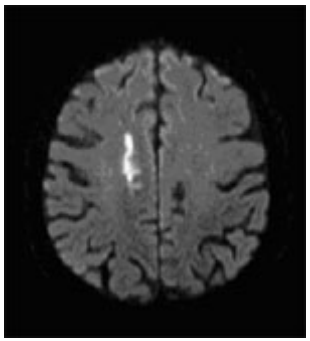
MR-FLAIR

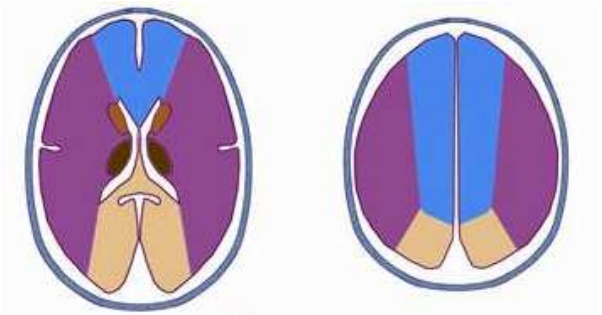
Anterior cerebral artery territory syndrome

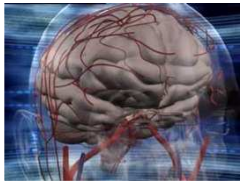


- Only 5-% of all strokes
- bilateral!
- Waekness of foot/leg nad to a lesser degree paresis of the arm
- Facial palsy with affection of the A. recurrens Heubner possible
- Consiousness and behavioral disturbances (desorientation, confusion, memory impairment, mutism (bilateral infaction), euphoria, disinhibition
- Pathological gasp reflex and reaction
- Sphincter dysfunction and autonomic disorders







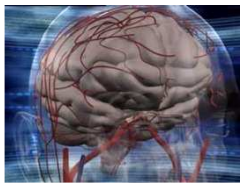


How good can we differentiate anterior circulation infarct (ACI) from posterior circulation infarct (PCI) by clinical examination?

Table 2. Main Neurological Deficits by Infarction Localization

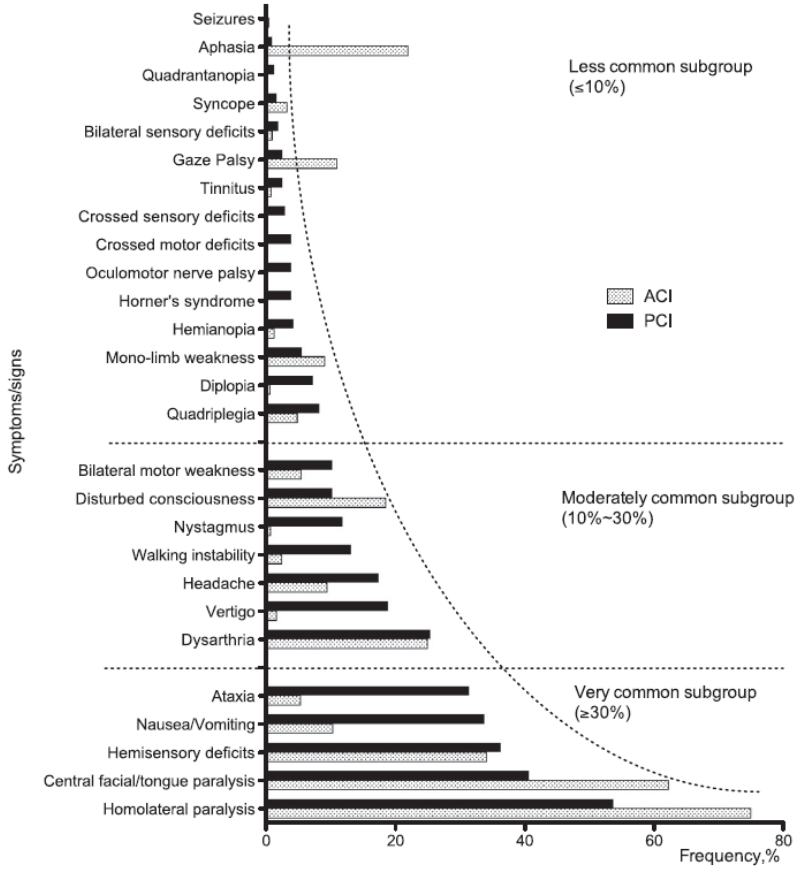
	Posterior Circulation Infarct, No. (%)	Anterior Circulation Infarct, No. (%)	*P* Value
N	302	872	
Disturbed consciousness	31 (10.3)	162 (18.6)	0.001
Confusion/delirium	3 (1.0)	25 (2.9)	0.066*
Somnolence	20 (6.6)	100 (11.5)	0.017
Stupor	2 (0.7)	29 (3.3)	0.013
Coma	6 (2.0)	8 (0.9)	0.213*
Speech disturbance			
Aphasia	3 (1.0)	192 (22.0)	<0.001
Dysarthria	77 (25.5)	218 (25.0)	0.864
Central facial/lingual palsy	123 (40.7)	542 (62.2)	<0.001
Motor deficits	218 (72.2)	749 (85.9)	<0.001
Mono limb	17 (5.6)	79 (9.1)	0.061
Homolateral	162 (53.6)	653 (74.9)	<0.001
Bilateral limbs	31 (10.3)	48 (5.5)	0.004
Crossed sign	12 (4.0)	1 (0.1)	<0.001*
Quadriplegia	25 (8.3)	43 (4.9)	0.032
Sensory deficits	140 (46.4)	360 (41.3)	0.124
Mono limb	15 (5.0)	53 (6.1)	<0.001
Homolateral	110 (36.4)	298 (34.2)	0.479
Bilateral limbs	6 (2.0)	9 (1.0)	0.203
Crossed sign	9 (3.0)	0 (0)	<0.001*
Visual field deficits			
Single blind	0 (0.0)	2 (0.2)	1.000*
Hemianopia	13 (4.3)	11 (1.3)	0.001
Quadrantanopia	4 (1.3)	0 (0)	0.005*
Diplopia	22 (7.3)	6 (0.7)	<0.001
Eye movement disorders			
Oculomotor nerve palsy	12 (4.0)	0 (0)	<0.001*
Gaze palsy	8 (2.6)	96 (11.0)	<0.001
Nystagmus	36 (11.9)	7 (0.8)	<0.001
Walking instability	40 (13.2)	22 (2.5)	<0.001
Ataxia	95 (31.5)	47 (5.4)	<0.001
Seizures	1 (0.3)	4 (0.5)	1.000*
Syncope	5 (1.7)	29 (3.3)	0.136
Horner's syndrome	12 (4.0)	0 (0)	<0.001*
Patient complaints			
Headache	53 (17.5)	83 (9.5)	<0.001
Nausea/vomiting	102 (33.8)	91 (10.4)	<0.001
Vertigo	57 (18.9)	15 (1.7)	<0.001
Tinnitus	8 (2.6)	8 (0.9)	0.051*

*P value obtained from Fisher exact test.

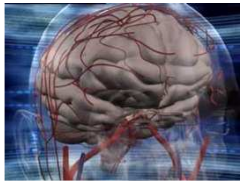


Tao et al, Stroke 2012

Frequency of single clinical symptomes/sign in PCI and ACI



Similar distribution among common signs and symptoms between ACI and PCI



Tao et al, Stroke 2012

Value of single symptomes in diagnosing patients with PCI

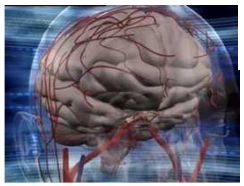
Table 3. Value of Single Symptom/Sign in Diagnosing Patients With PCI

Symptoms/Signs	No. of Patients	No. With PCI	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	OR (95% CI)
N	1174	302				
The very common subgroup						
Homolateral paralysis	815 (69.4)	162	53.6	25.1	19.9	0.39 (0.29–0.51)
Central facial/tongue paralysis	665 (56.5)	123	40.7	37.8	18.5	0.42 (0.32–0.55)
Hemisensory deficits	408 (34.8)	110	36.4	65.8	27.0	1.10 (0.84–1.45)
Nausea/vomiting	193 (16.4)	102	33.8	89.6	52.8	4.38 (3.17–6.04)
Ataxia	142 (12.1)	95	31.5	94.6	66.9	8.06 (5.50–11.80)
The moderately common subgroup						
Dysarthria	295 (25.1)	77	25.5	75.0	26.1	1.03 (0.76–1.39)
Vertigo	72 (6.1)	57	18.9	98.3	79.2	13.29 (7.40–23.89)
Headache	136 (11.6)	53	17.5	90.5	39.0	2.02 (1.39–2.94)
Walking instability	62 (5.3)	40	13.2	97.5	64.5	5.90 (3.44–10.12)
Nystagmus	43 (3.7)	36	11.9	99.2	83.7	16.72 (7.36–38.02)
Disturbed consciousness	193 (16.4)	31	10.3	81.4	16.1	0.50 (0.33–0.76)
Bilateral motor weakness	79 (6.7)	31	10.3	94.5	39.2	1.96 (1.23–3.15)
The less common subgroup						
Quadriplegia	68 (5.8)	25	8.3	95.1	36.8	1.74 (1.04–2.90)
Diplopia	28 (2.4)	22	7.3	99.3	78.6	11.34 (4.55–28.25)
Mono limb weakness	95 (8.1)	17	5.6	91.1	17.9	0.61 (0.35–1.04)
Hemianopia	24 (2.0)	13	4.3	98.7	54.2	3.52 (1.56–7.95)
Horner's syndrome	12 (1.0)	12	4.0	100.0	100.0	4.00 (3.63–4.43)
Oculomotor nerve palsy	12 (1.0)	12	4.0	100.0	100.0	4.00 (3.63–4.43)
Crossed motor deficits	13 (1.1)	12	4.0	99.9	92.3	36.04 (4.67–278.38)
Crossed sensory deficits	9 (0.8)	9	3.0	100.0	100.0	3.98 (3.60–4.39)
Tinnitus	16 (1.4)	8	2.6	99.1	50.0	2.94 (1.10–7.90)
Gaze palsy	104 (8.9)	8	2.6	89.0	7.7	0.22 (0.11–0.46)
Bilateral sensory deficits	15 (1.3)	6	2.0	99.0	40.0	1.94 (0.69–5.51)
Syncope	34 (2.9)	5	1.7	96.7	14.7	0.49 (0.19–1.28)
Quadrantanopia	4 (0.3)	4	1.3	100.0	100.0	3.93 (3.56–4.33)
Aphasia	195 (16.6)	3	1.0	78.1	1.5	0.04 (0.01–0.11)
Seizures	5 (0.4)	1	0.3	99.5	20.0	0.72 (0.08–6.48)

PCI indicates posterior circulation infarction.

High PPV only for posterior circulation infarcts:

Horner's syndrome
Oculomotor nerve palsy
Crosse motor defcits
Crossed sensory deficits
Quadrantanopsia

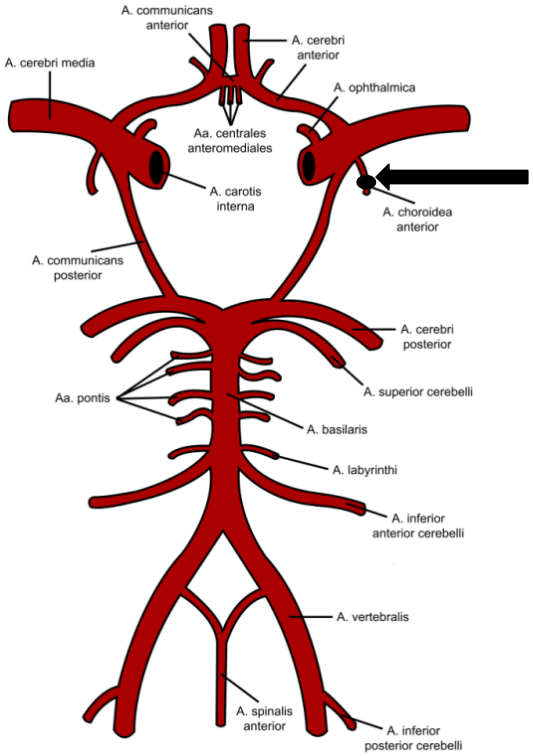


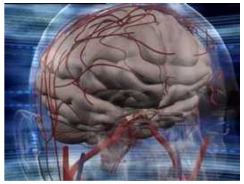
Tao et al, Stroke 2012

Rare syndromes: anterior choroideal artery

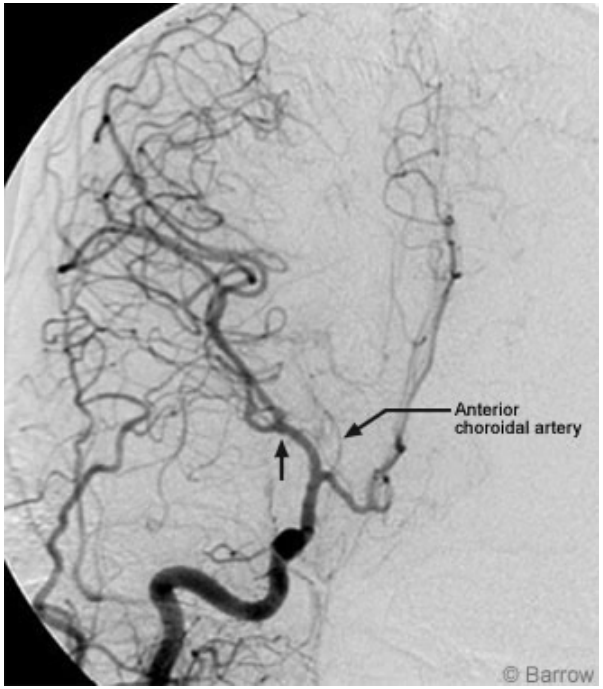
- Arises from the terminal intracranial ICA (C6)
- Supplies temporal lobe, genu capsulae internae, optical tract
- Triade: contralteral hemipareses, hemianopsia and hemianesthesia (propriocption is usually spared)
- Absence of: aphasia, problems of coscoiusness, head/eye deviation (→ distiction to MCA-infarction)

→ lacunar syndrome with hemianopsia



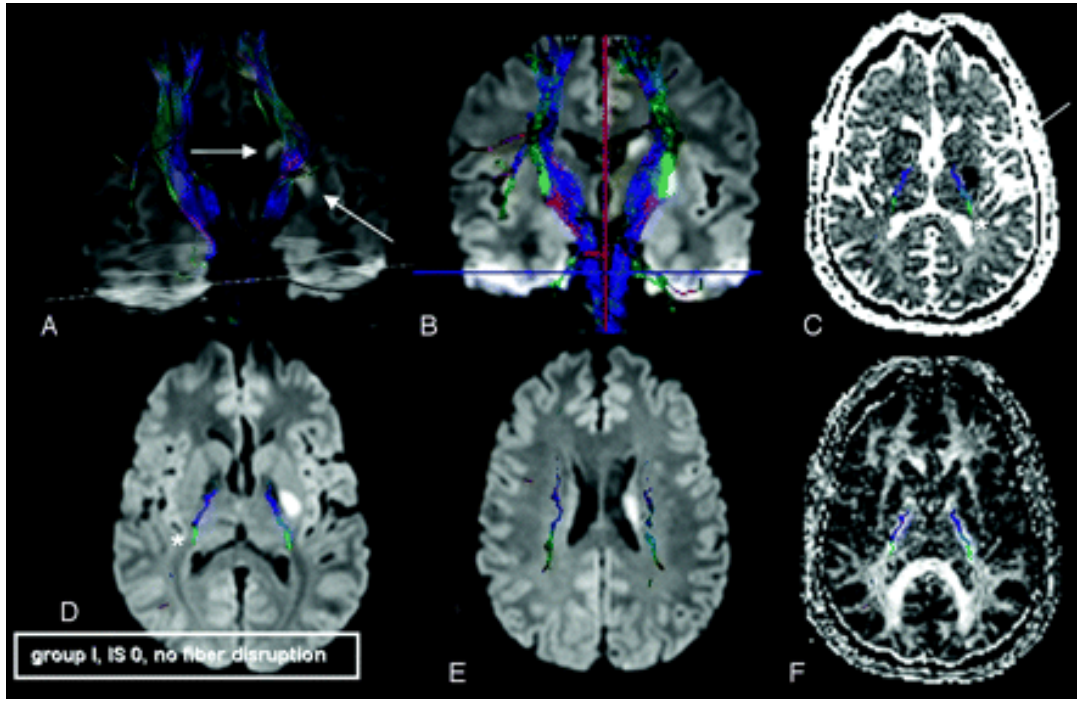


Anterior choroidal artery – circumfencial branch of the ICA

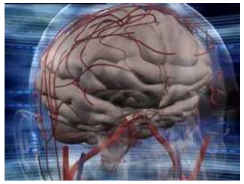


DSA

from Vivek R. Deshmukh et al.
Barrow Quarterly - Volume 20, No. 3, 2004



MR-Tractography

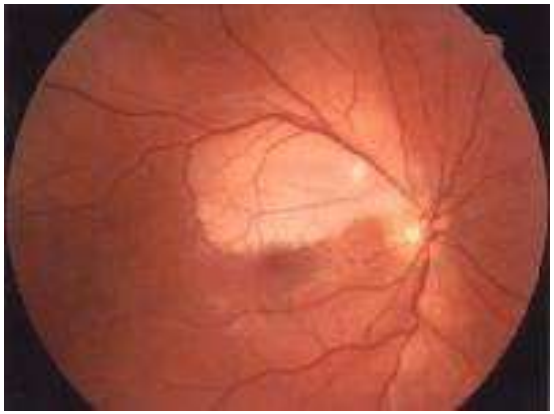


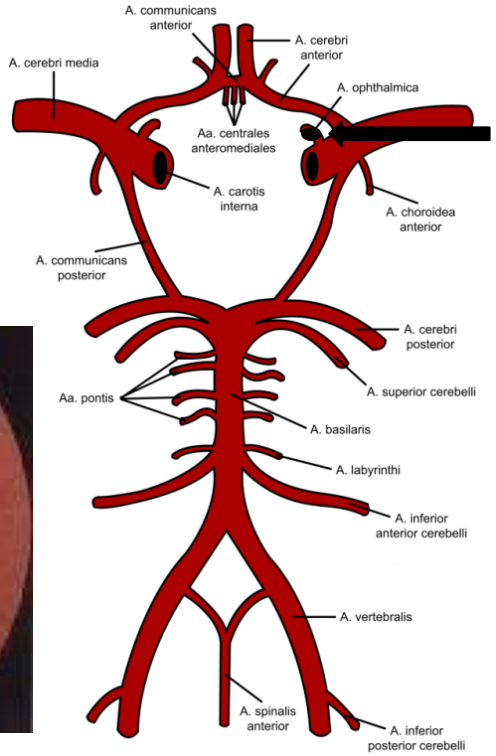
M. Nelles, W. Block, F. Träber, U. Wüllner, H.H. Schild, and H. Urbach Combined 3T Diffusion Tensor Tractography and ^{1}H-MR Spectroscopy in Motor Neuron Disease
AJNR Am J Neuroradiol October 2008 29: 1708-1714

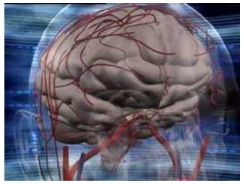
Universitätsspital Basel
Neurologische Klinik & Stroke Unit

Specific syndrome: ophtalmica artery

- 1. branch of the inracranial internal carotid artery
- Arterio-arterial Miniemboli
- Usually short ipsilateral visual loss (Amaurosis fugax)
- Mostly with spontaneous recanalisation, leaving no visual disorder







Conlcusion – anterior cerebral circulation syndromes

- Monocular symptoms
- Uncrossed hemisyndromes motor/sensorial
- Conjagated gaze palsy
- Partial facial palsy
- Cognition: Aphasia or extinction

- Disconjucate eye movement disorder
- Crossed syndrome
- Vertigo
- vomiting