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0649914308

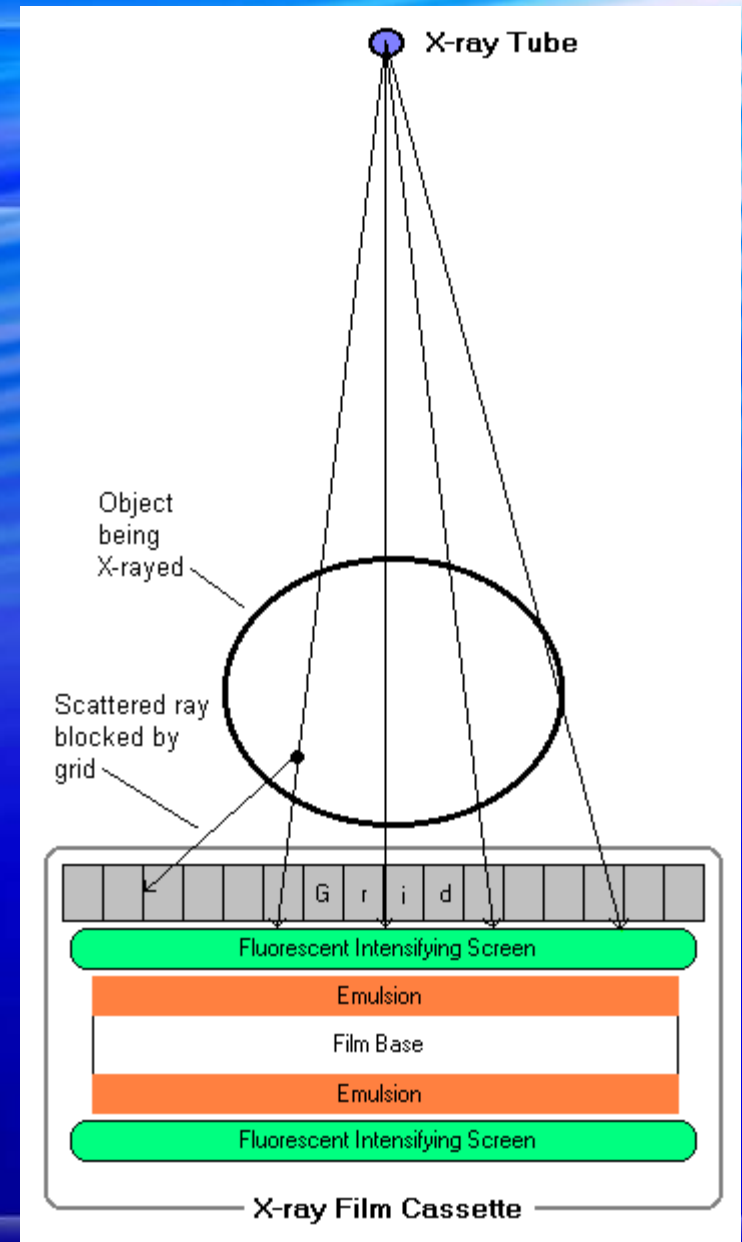


# sulle metodiche diagnostiche in NR

- RX (mielografia, angiografia\*)
- ecografia
- TC
- RM
- \* interventistica

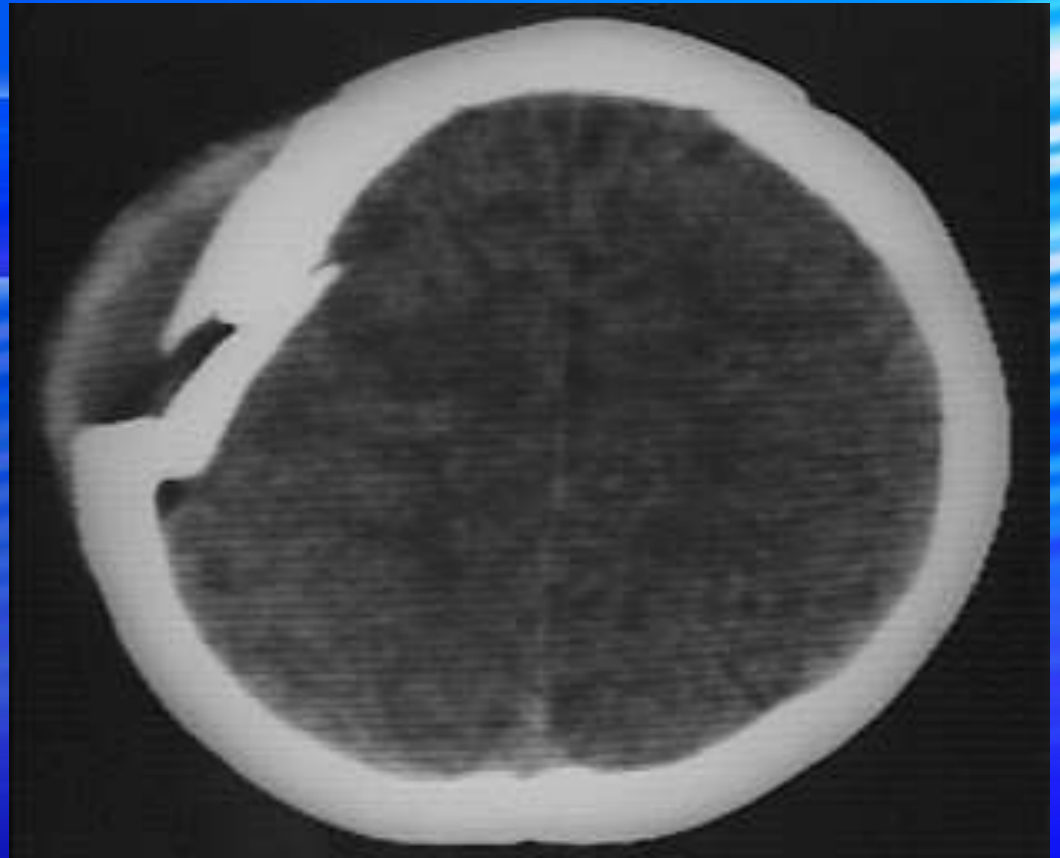
# RX tradizionale

- tubo radiogeno
- pellicola
- piastra ai fosfori (RX digitale)
- ev stratigrafia (basculamento del tubo per sfocare le aree al di fuori del fuoco)



# RX tradizionale in NR: indicazioni

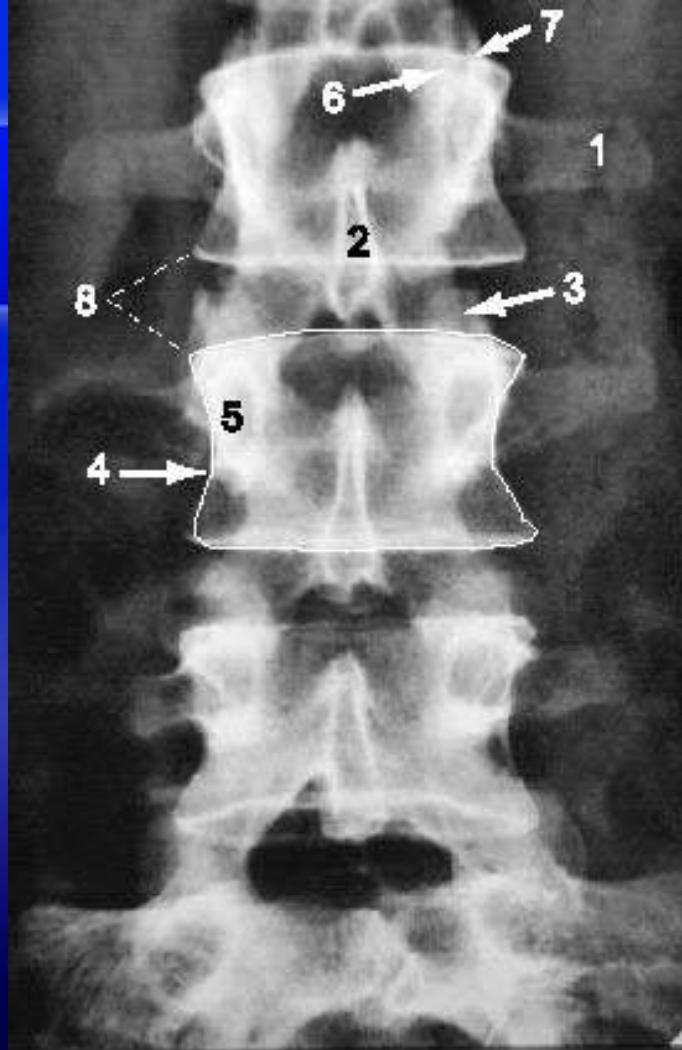
- studio del cranio
- studio dei seni paranasali
- studio della sella ?
- studio del rachide



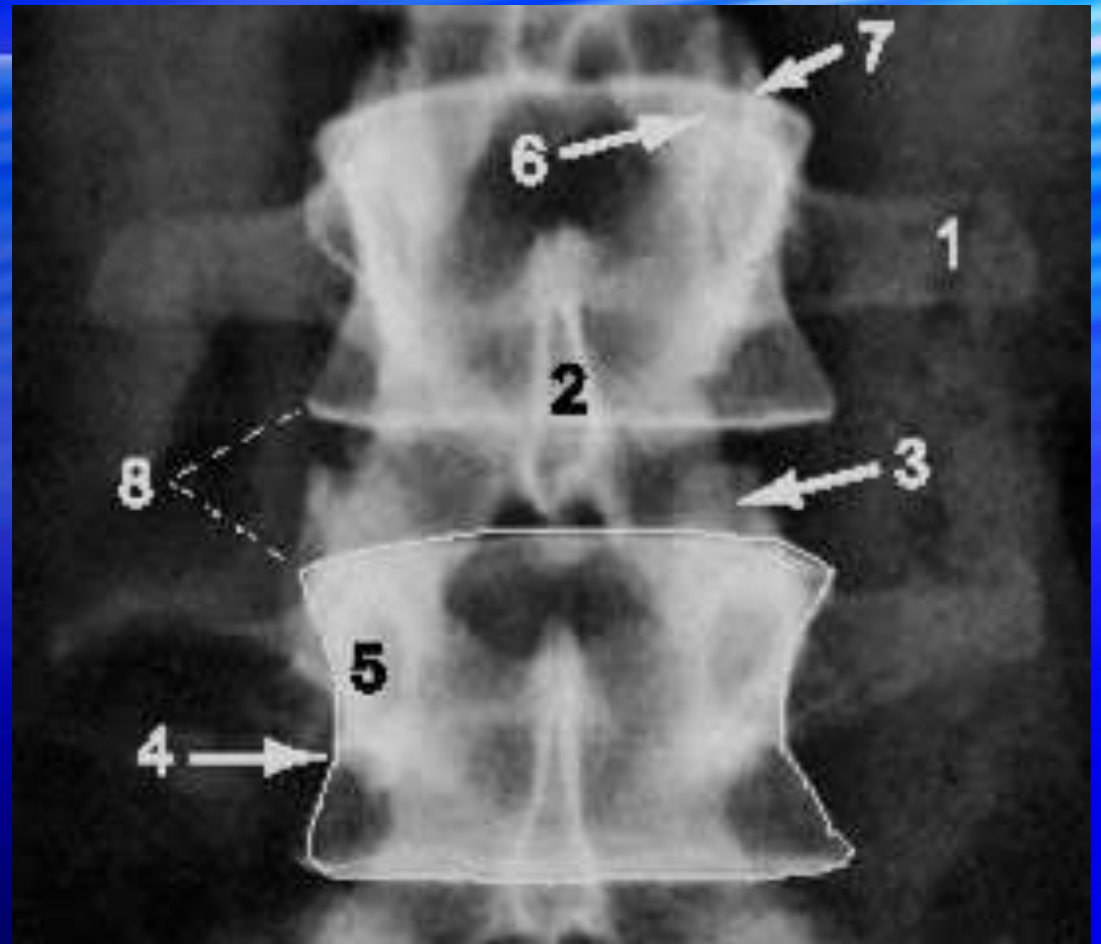
EMBBS





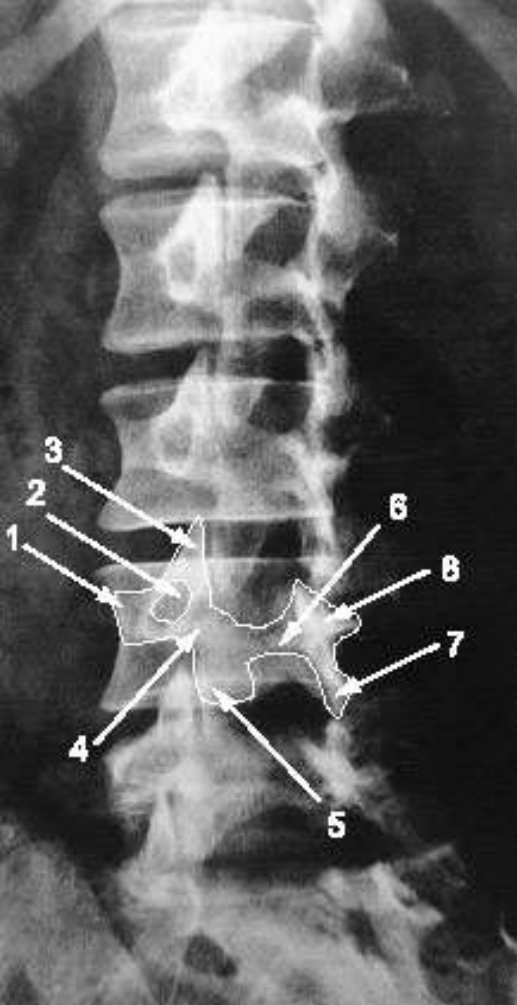


- 1 transverse process L3
- 2 spinous process L3
- 3 L3-4 facet joint
- 4 body of L4 (outlined)
- 5 pedicle L4
- 6 inferior articular process of L2
- 7 superior articular process of L3
- 8 L3-4 intervertebral disk space

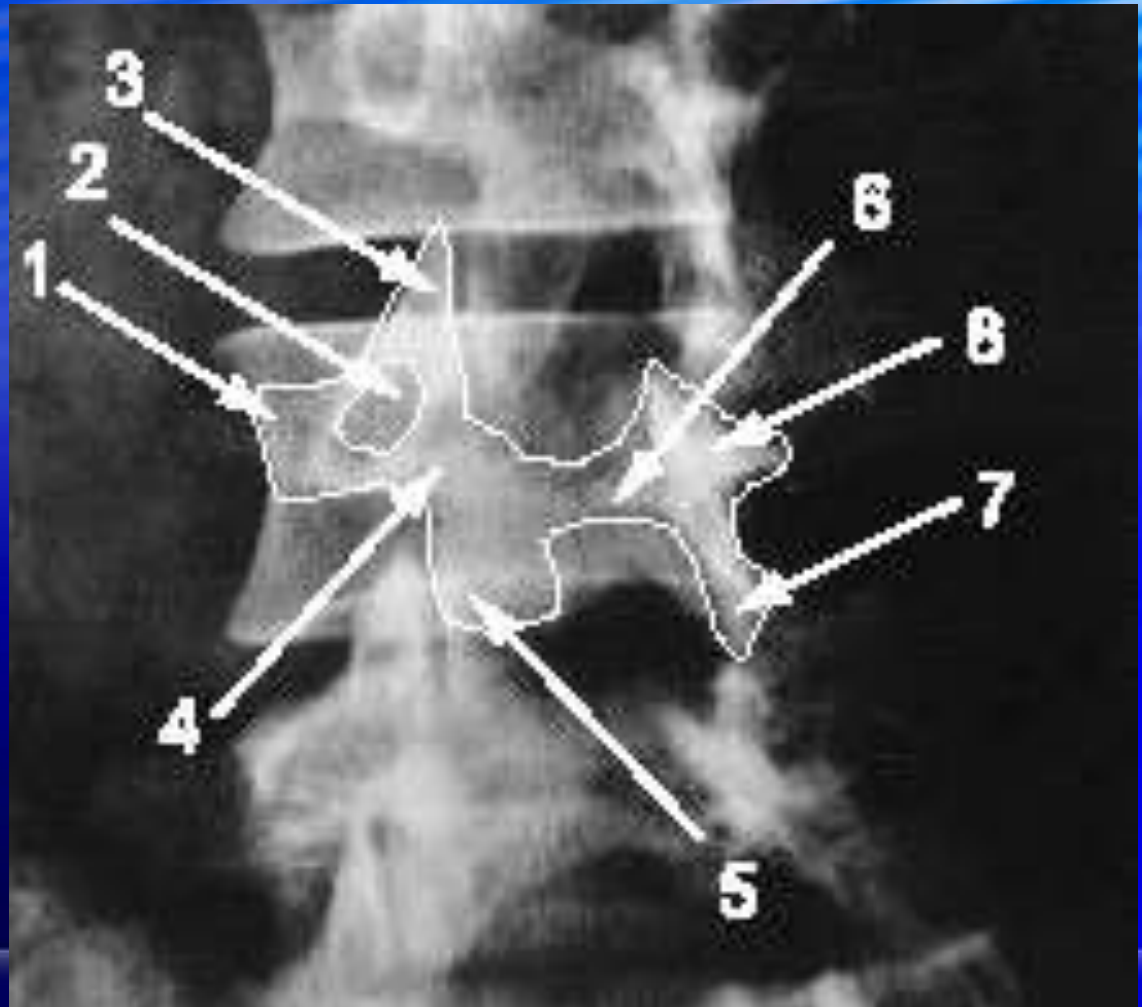




# il cagnolino



- 1 transverse process
- 2 pedicle
- 3 superior articular process
- 4 pars interarticularis
- 5 inferior articular process
- 6 lamina & spinous process
- Opposite side
- 7 inf. articular process
- 8 sup. articular process



# Rachide degenerativo: spondilolistesi



**RX standard**

**Flessione**

**Estensione**

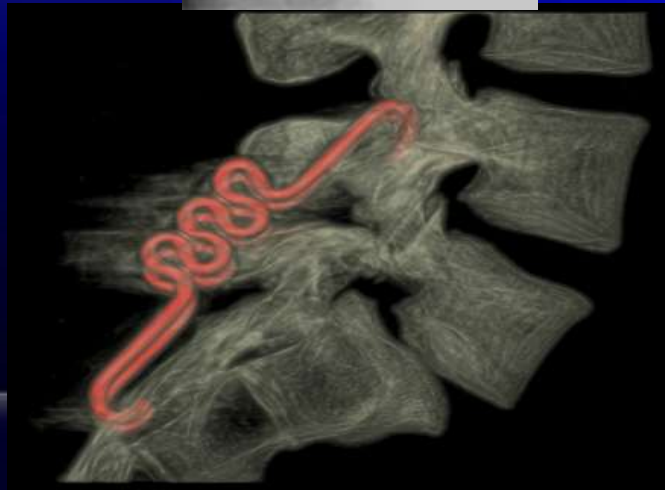


DINAMICHE





# Rachide degenerativo: spondilolistesi dispositivi elastici interlaminari

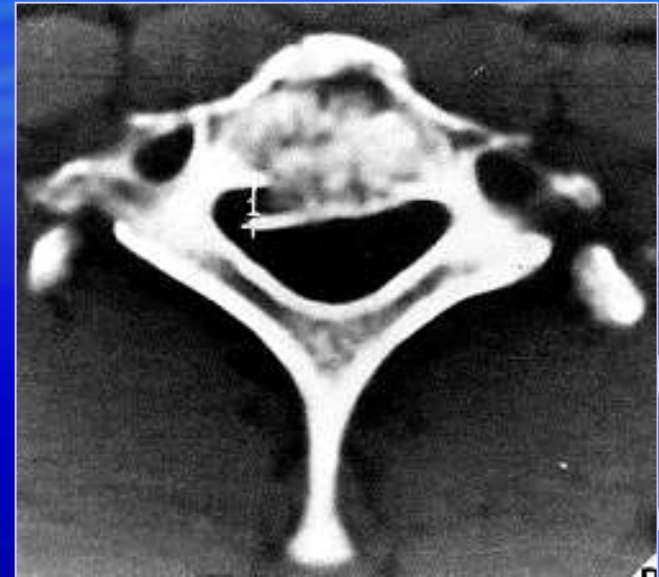


**RX**



**TC**

**EVIDENZA DI FRATTURA TC > RX 23-57%**



**Passaggio cervico-dorsale !**

# Tomografia Computerizzata: tecnica ed indicazioni

- “convenzionale” (III generazione)
- spirale o volumetrica
- multistrato
- rotazione coassiale tubo radiogeno e corona di detettori
- i detettori trasformano la radiazione uscente in impulso elettrico
- l'impulso viene elaborato

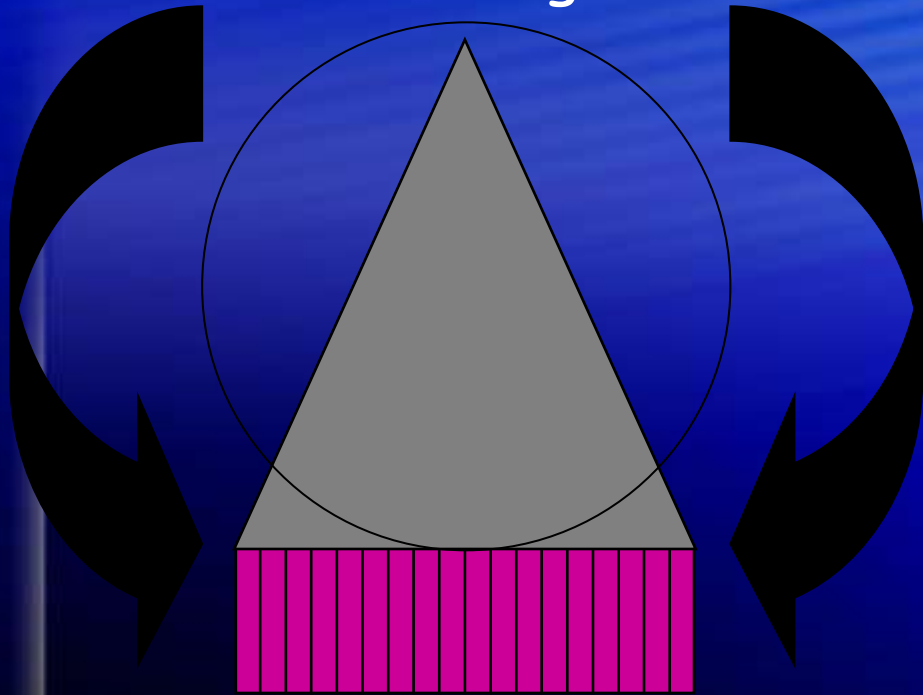


# TC: tecnica ed indicazioni

convenzionale

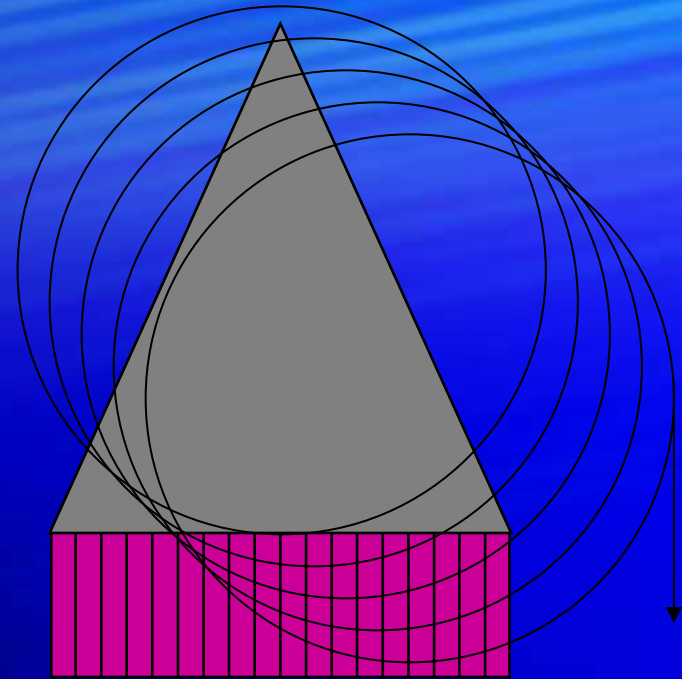
spirale

tubo radiogeno



detettori

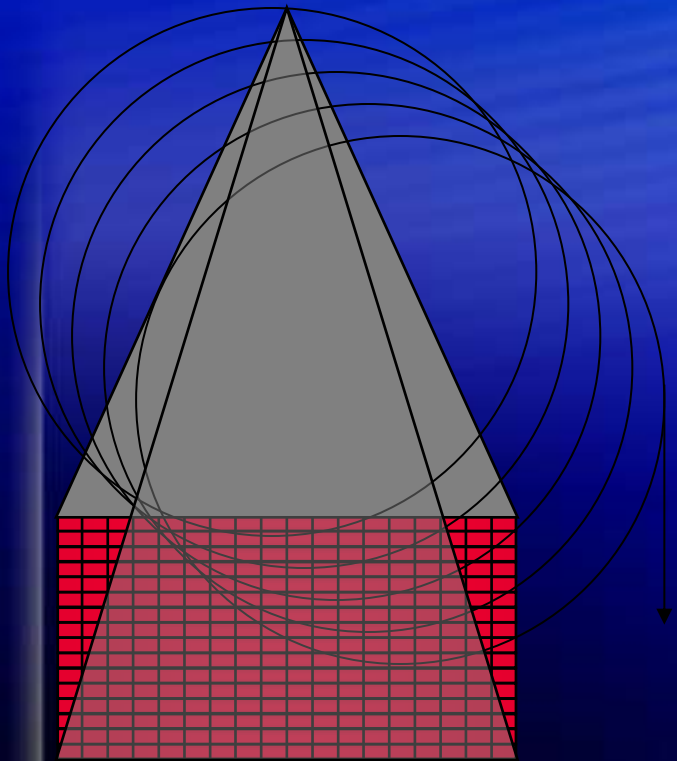
tubo radiogeno



detettori

# TC: tecnica

## multistrato



# Tomografia Computerizzata: vantaggi tecnica spirale e MS

- velocità di acquisizione
- spessore di ricostruzione < 1 mm
- possibilità di studi dinamici (perfusione)
- possibilità di studi angiografici
- possibilità di ricostruzioni multiplanari e volumetriche

# Tomografia Computerizzata: tecnica

- esame senza s.e.v. di m.d.c
- esame con s.e.v. di m.d.c. (iodato non ionico)
- valutazione della BEE
- presenza di neovascolarizzazione
- studi “vascolari”
- valutazione tessuto cicatriziale

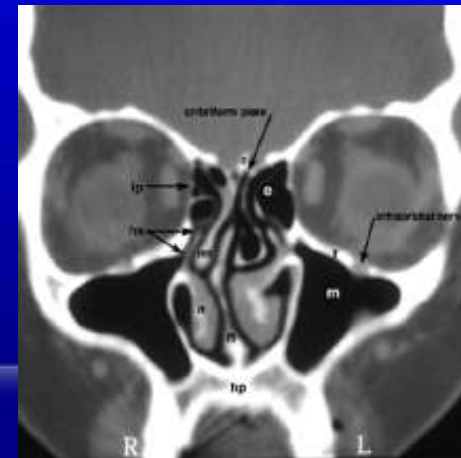
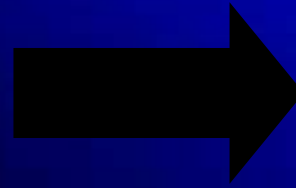
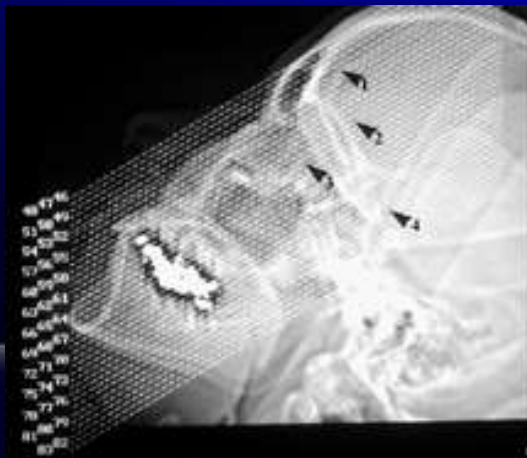
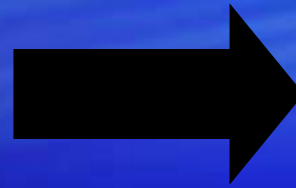
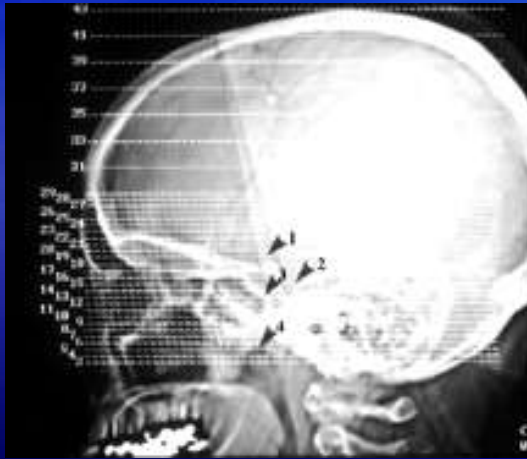
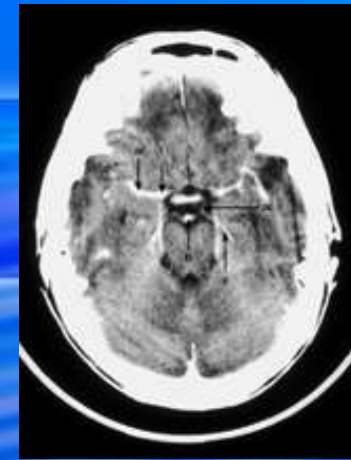
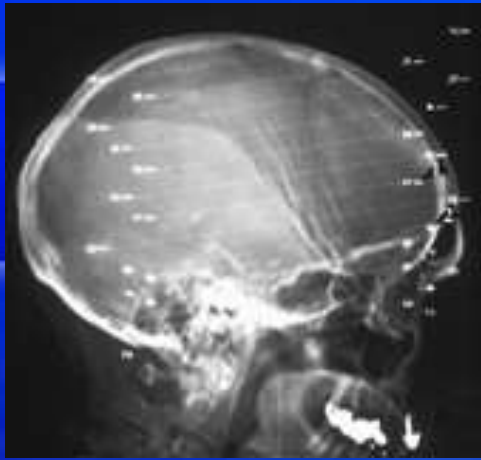
# centraggio

Secondo la linea canto-meatale

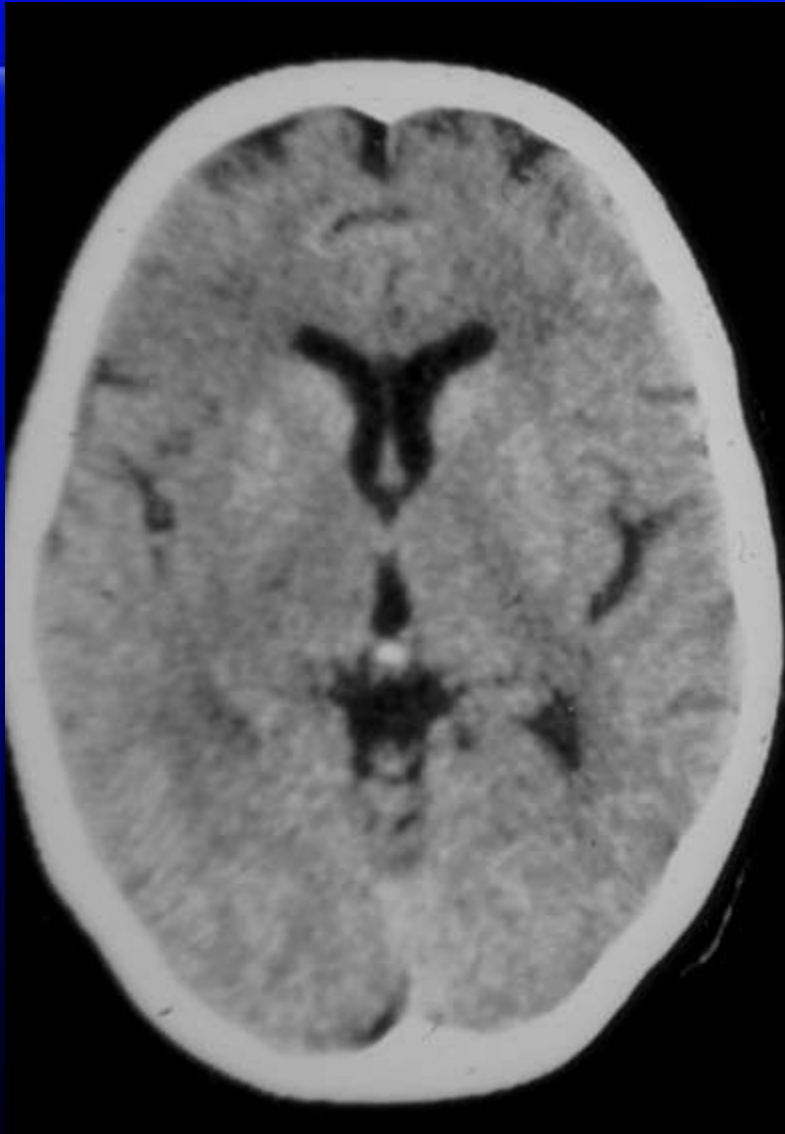
Parallela al tetto dell' orbita

Sul piano coronale

Oggi acquisizioni spirali con ricostruzioni



# TC: semeiotica

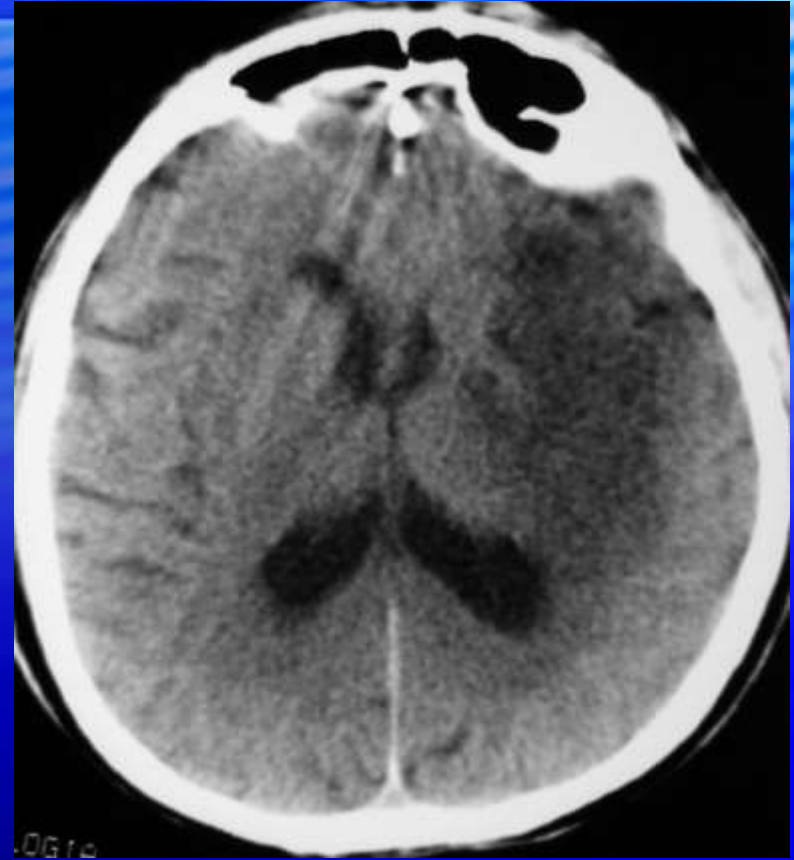


nella semeiotica TC si parla di densità  
l'unità di riferimento è detta unità Hounsfield (H) definita con il valore di 0 per l'acqua  
si parla quindi di aree ipodense  
isodense  
iperdense  
rispetto al tessuto cerebrale normale

# TC: semeiotica



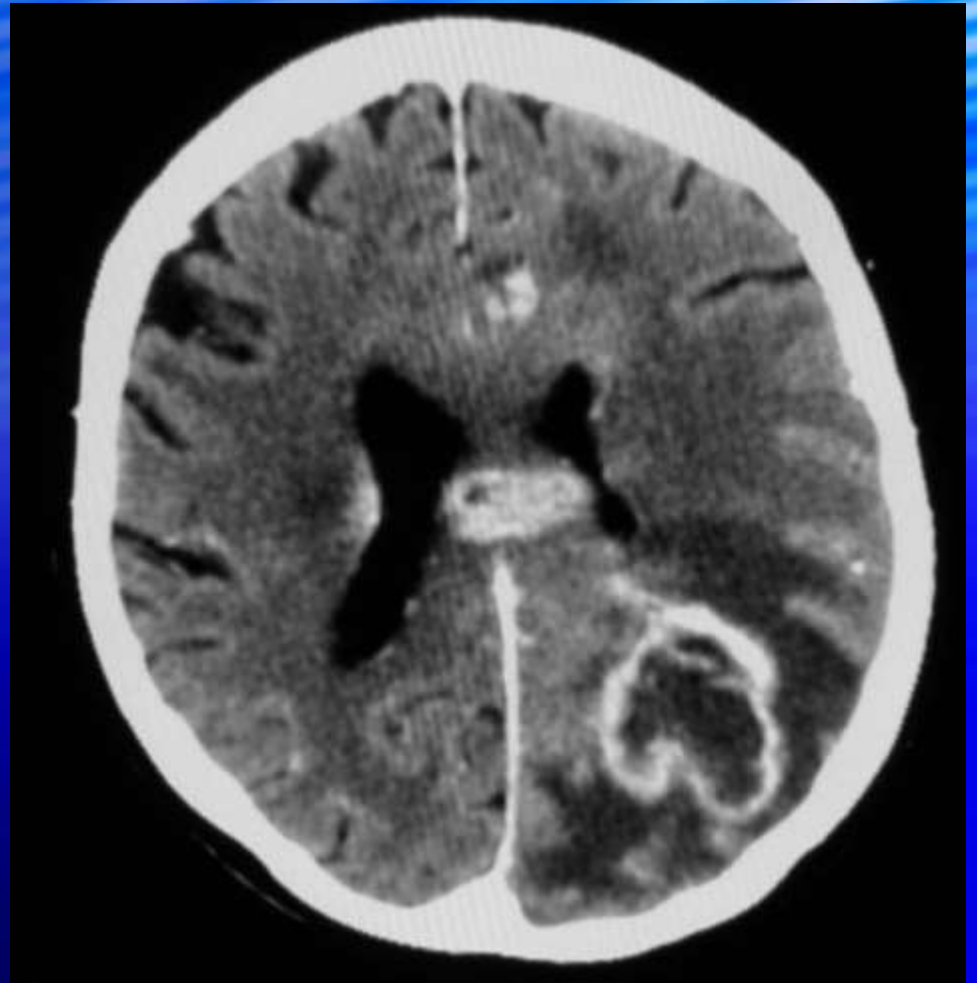
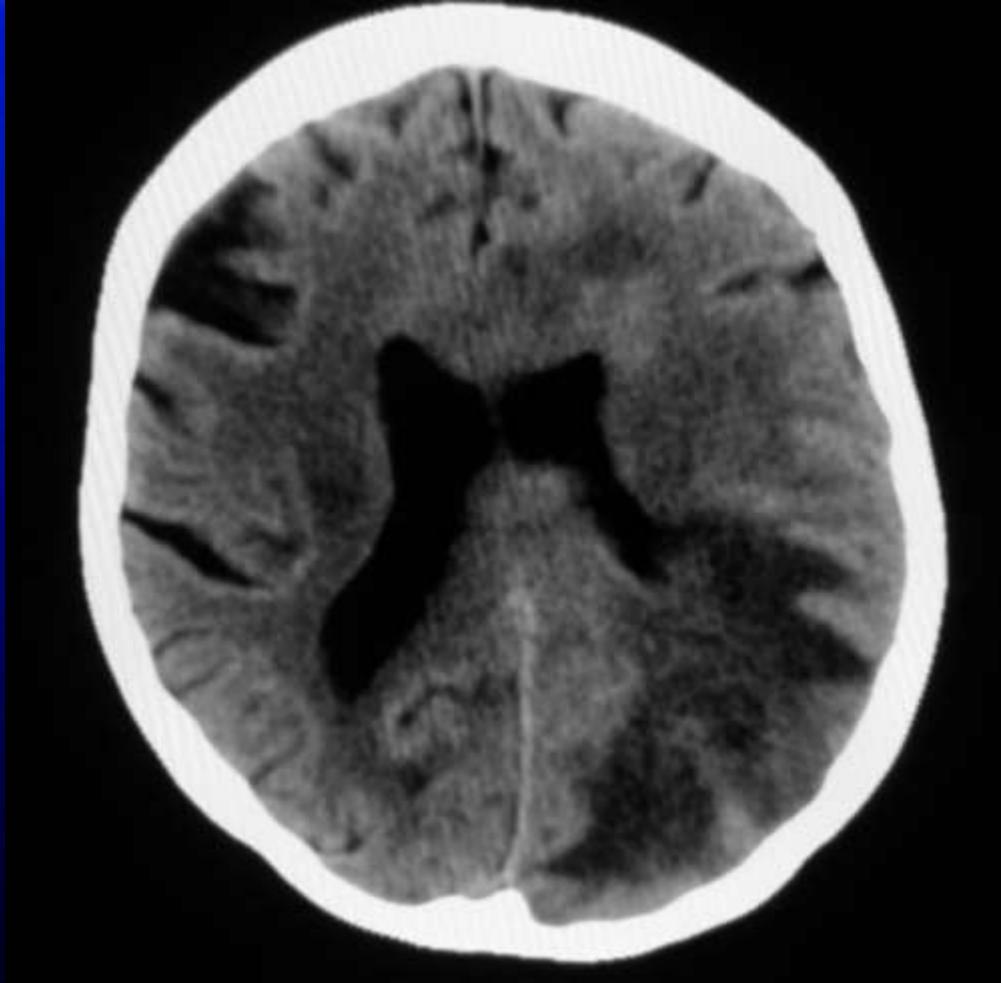
Iperdenso (sangue, calcio)  
che determina > di acqua)



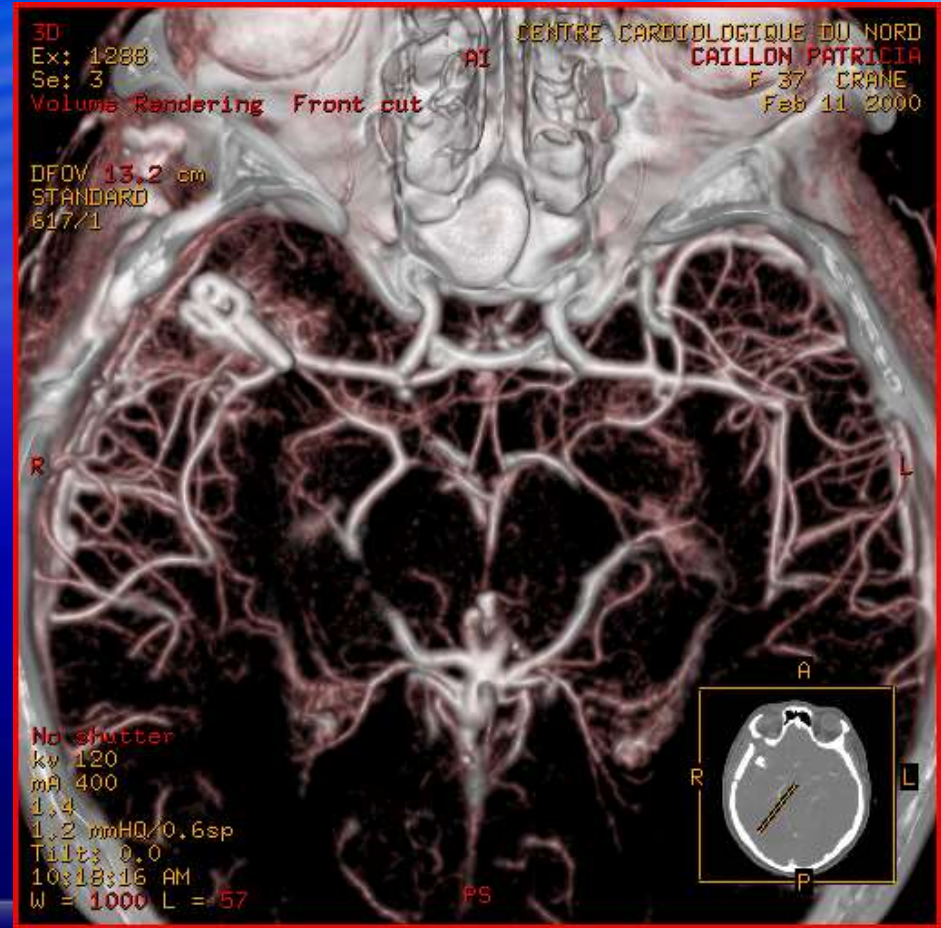
ipodenso (tutte le patologie  
che determina < di acqua)



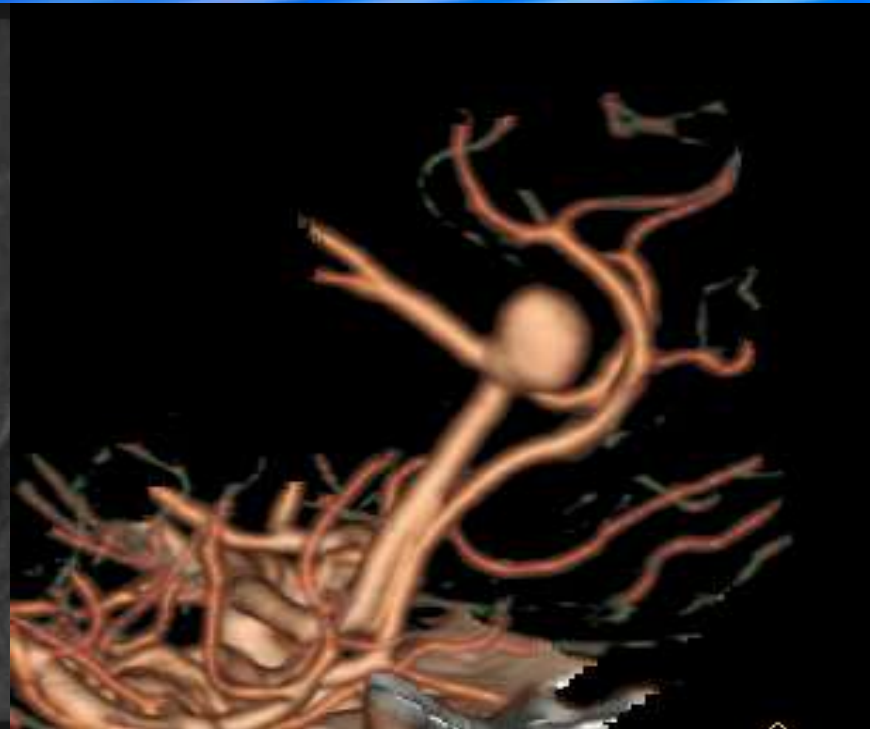
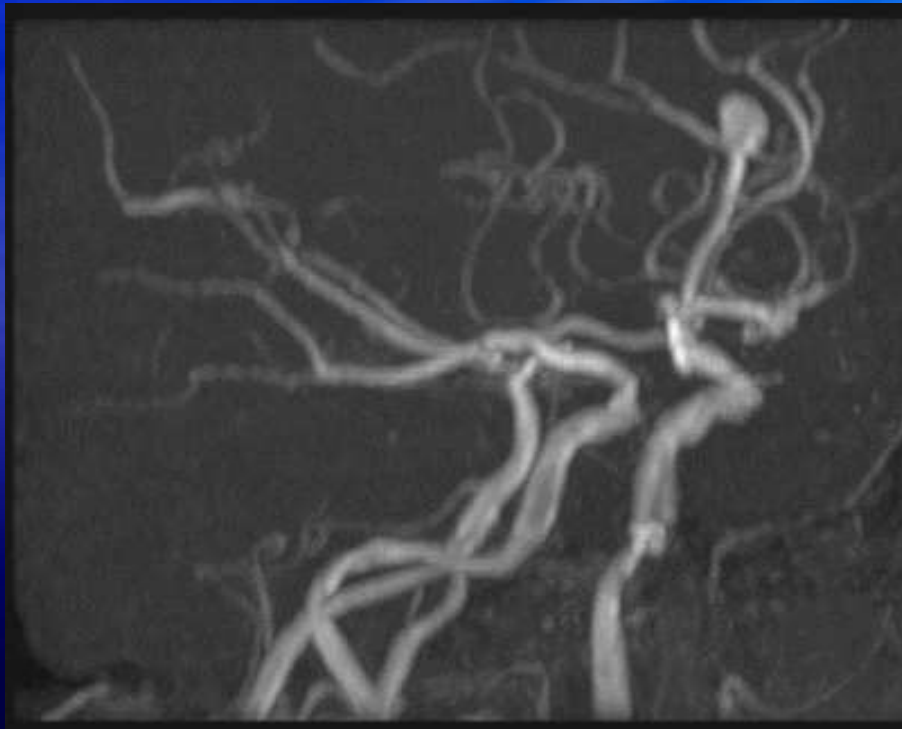
TC: s.e.v. di m.d.c.



# Tomografia Computerizzata: vantaggi tecnica spirale e MS



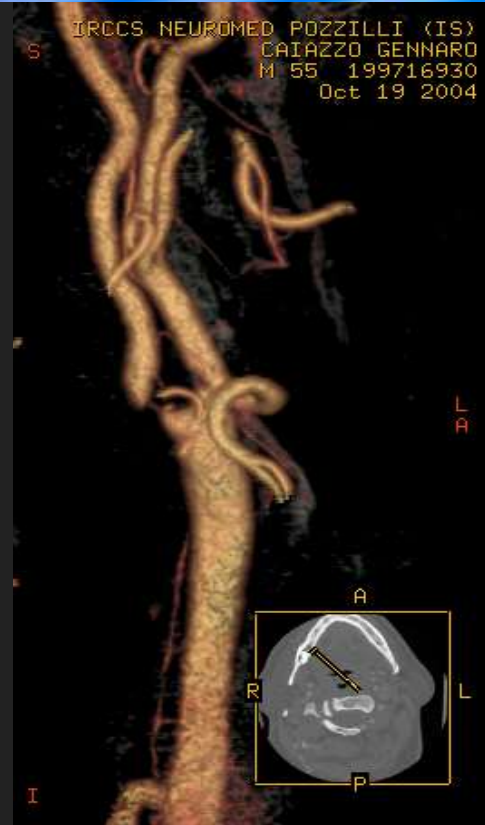
# ANEURISMA: ANGIORM ANGIOTC



# Tomografia Computerizzata: vantaggi tecnica spirale e MS



# ANGIO-TC MULTISLICES ANGIO-RM



# TC IN PATOLOGIA NEUROLOGICA APPLICAZIONI ELETTIVE



Trami cranici  
patologia acuta (emorragie,  
ESA, ischemia)  
studio delle rocche petrose  
studio dei seni paranasali  
studio del rachide

# RISONANZA MAGNETICA

La RM è una metodica per immagini che si basa sulla genesi di un segnale indotto dall'applicazione di impulsi di RF su nuclei di H immersi in un CMS

# Intensita' di segnale

# Immagini T1 dipendenti

ELEVATA

- grasso
- sostanze paramagnetiche
- s. glico-lipoproteiche

MEDIA

- Parenchimi

BASSA

- liquidi
- fibrosi
- tessuti ad elevata cellularita' e vascolarizzazione

NULLA

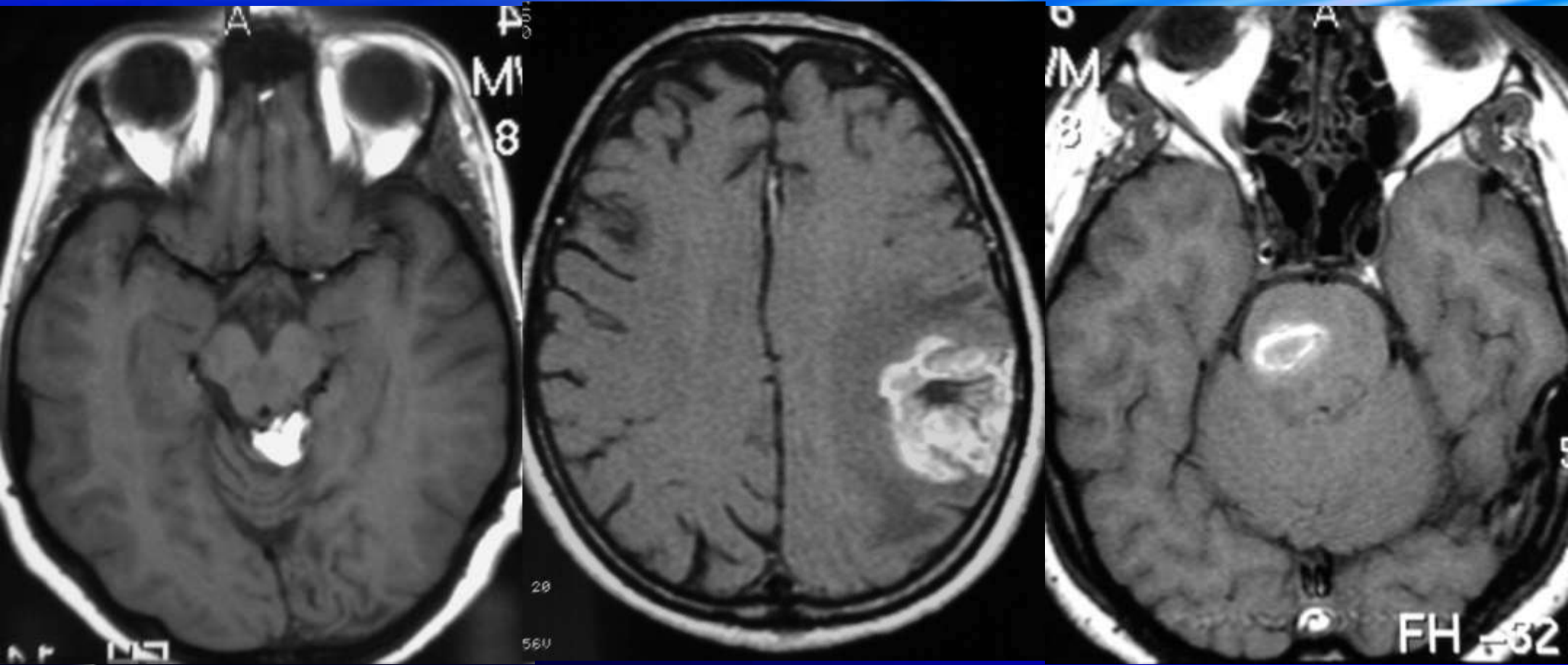
- aria-osso compatto
- flusso fisiologico

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# Immagini T1 dipendenti o pesate



il tessuto adiposo le aree con potenziamento gli ematomi subacuti

# Intensita' di segnale

# Immagini T2 dipendenti



**ELEVATA**

- liquidi
- tessuti ad elevata cellularita' e vascolarizzazione
- 

**MEDIA**

- parenchimi e grasso

**BASSA**

- fibrosi
- paramagnetici (elevata concentrazione)

**NULLA**

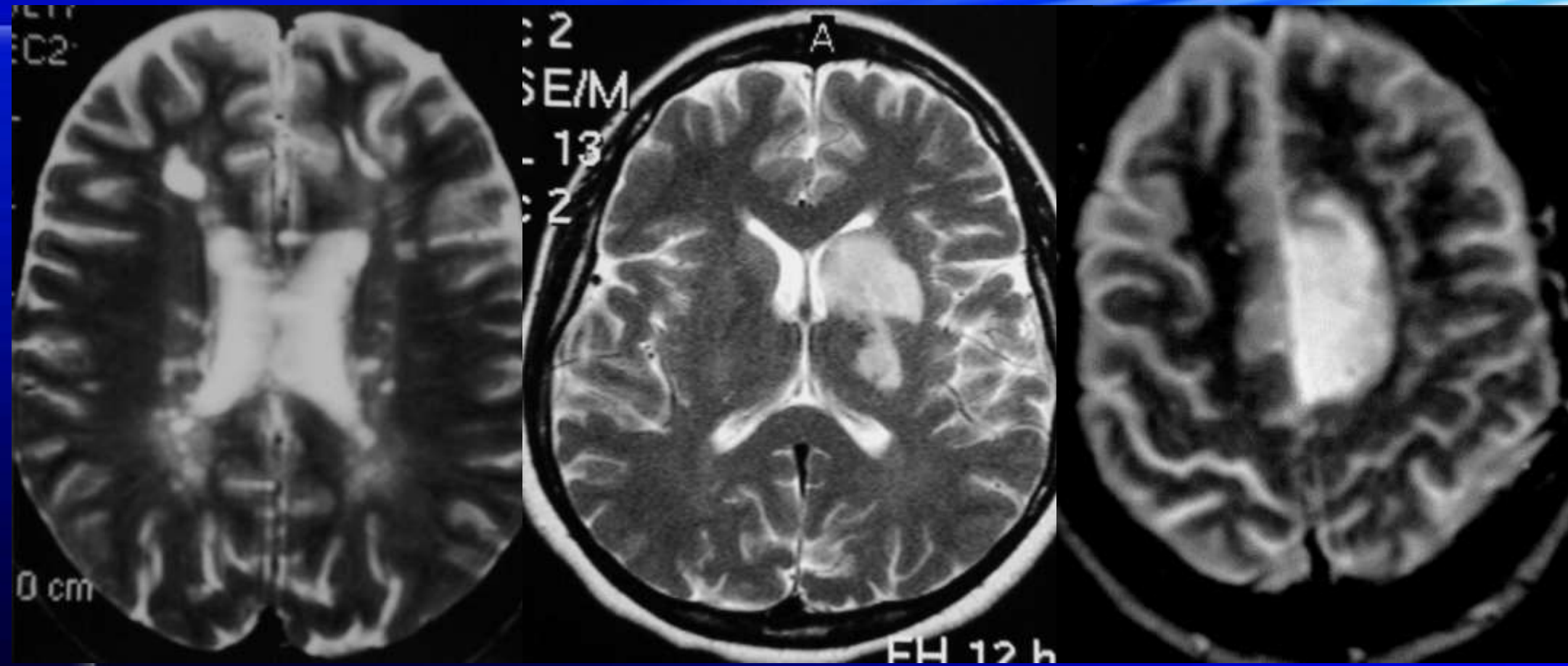
- aria-osso compatto
- flusso fisiologico



T<sub>2</sub>

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# Immagini T2 dipendenti o pesate



Le placche di SM

le lesioni ischemiche

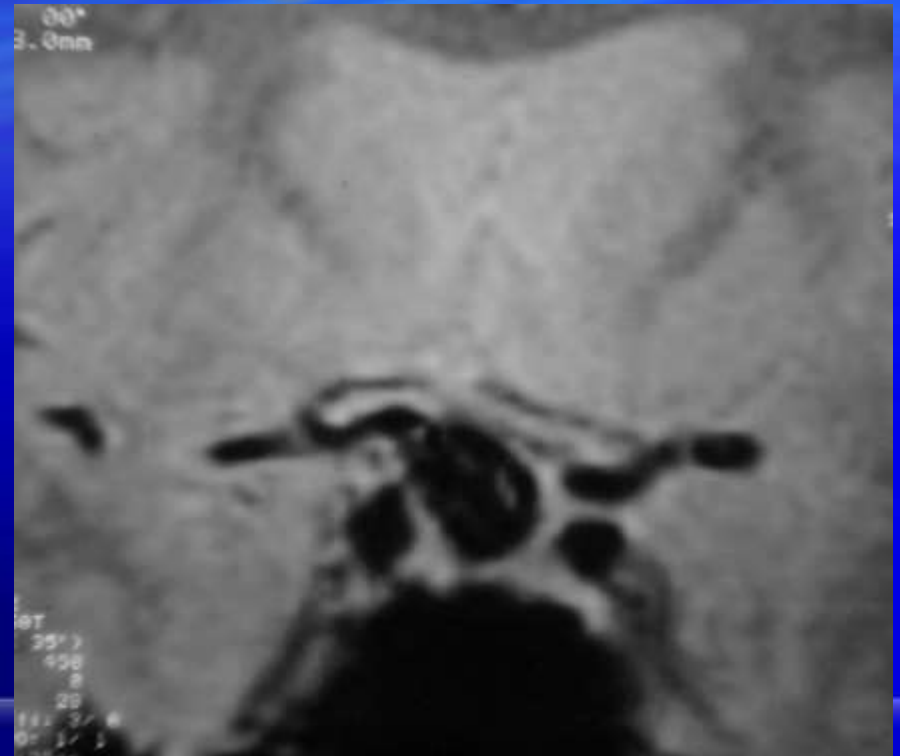
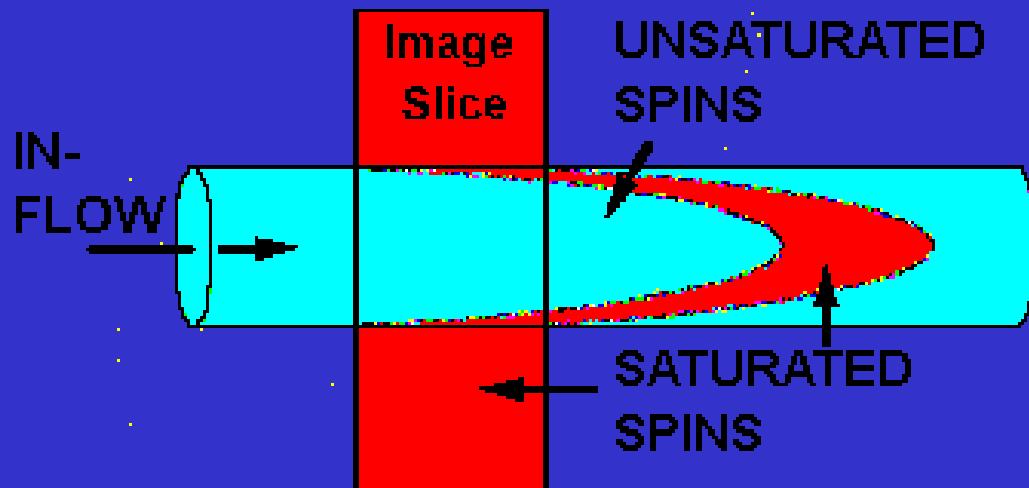
i tumori

# Altri parametri sono:

- Fenomeni legati al flusso (angio-RM)
- Studi di perfusione e diffusione
- Spettroscopia del protone
- Studi funzionali

# Il flusso

nelle sequenze convenzionali le strutture ad alto flusso non danno segnale (appaiono ipointense)



# ANGIO-RM: DEFINIZIONE

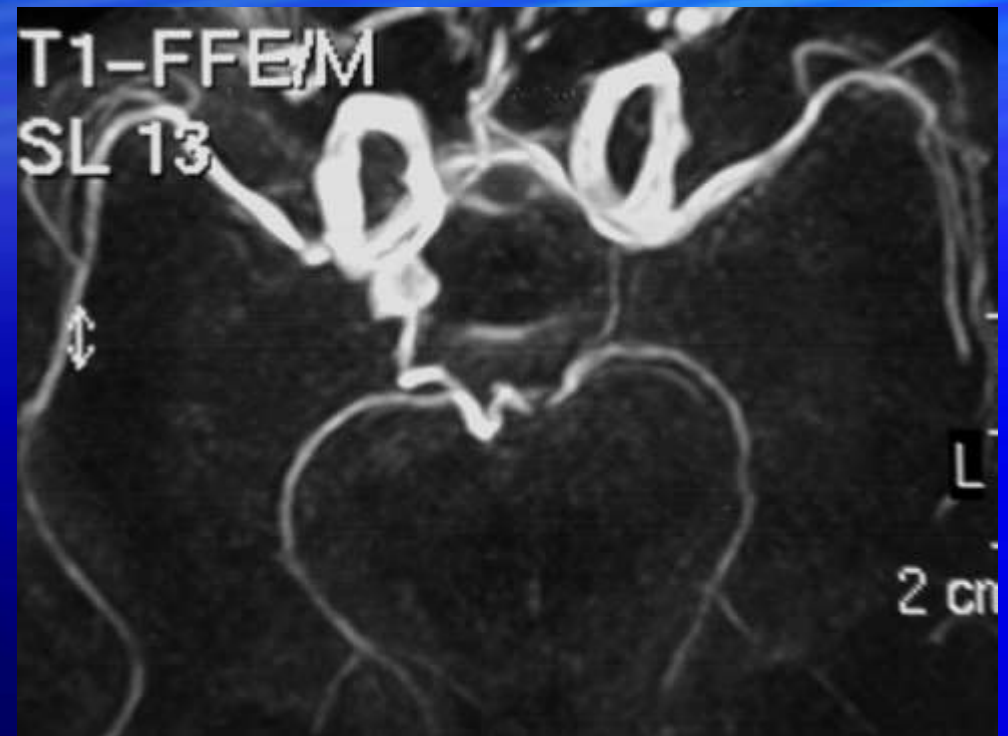
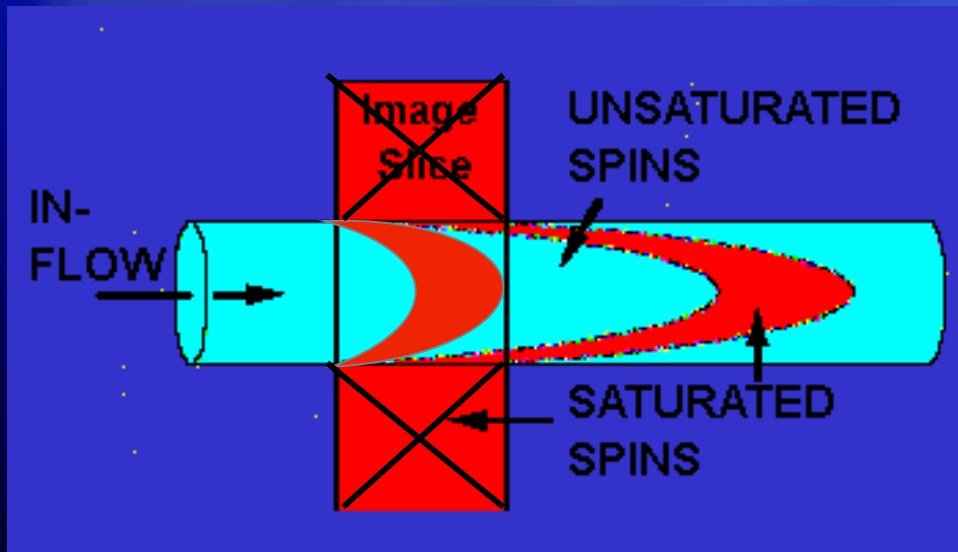
tecnica RM che consente la esclusiva visualizzazione delle strutture vascolari arteriore e/o venose

tecniche di afflusso = tempo di volo  
contrasto di fase  
Senza o con MDC

- tecniche contrastografiche

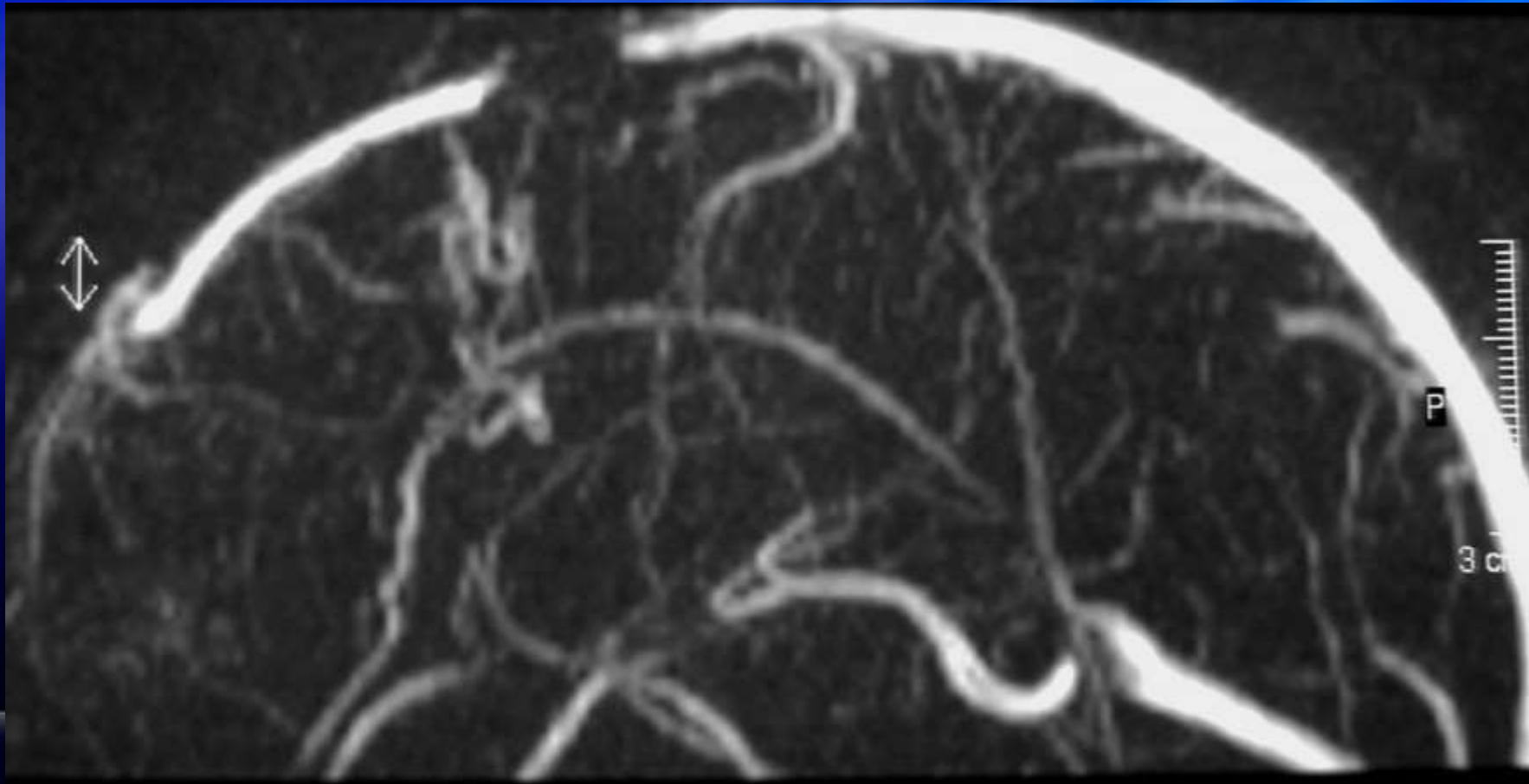
# ANGIO-RM: TECNICHE DI AFFLUSSO (TOF)

si basano sull'impiego di sequenze di impulso con TR molto brevi in modo tale che il segnale dei tessuti stazionari viene saturato e solo gli spin dei vasi afferenti generano un segnale elevato



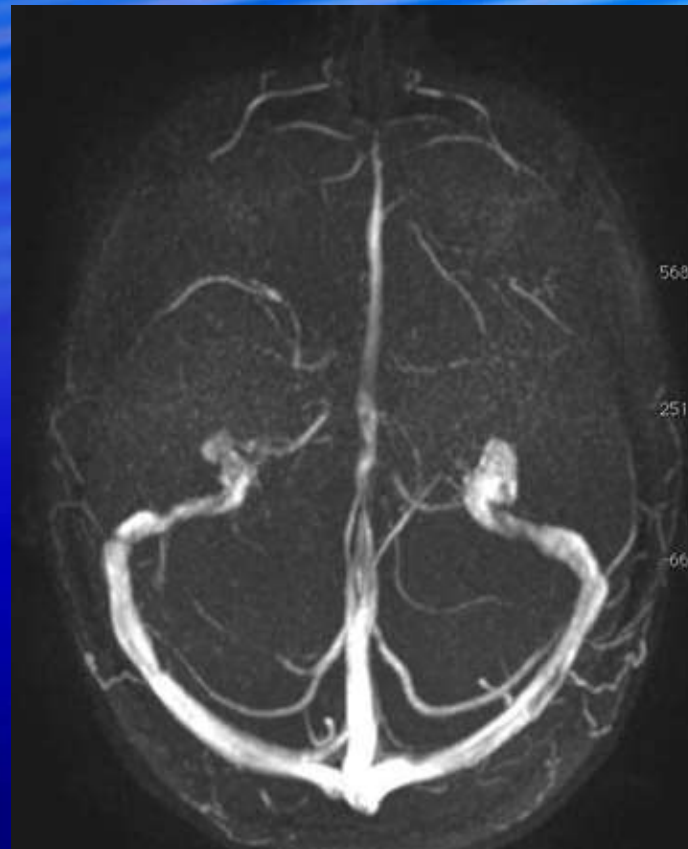
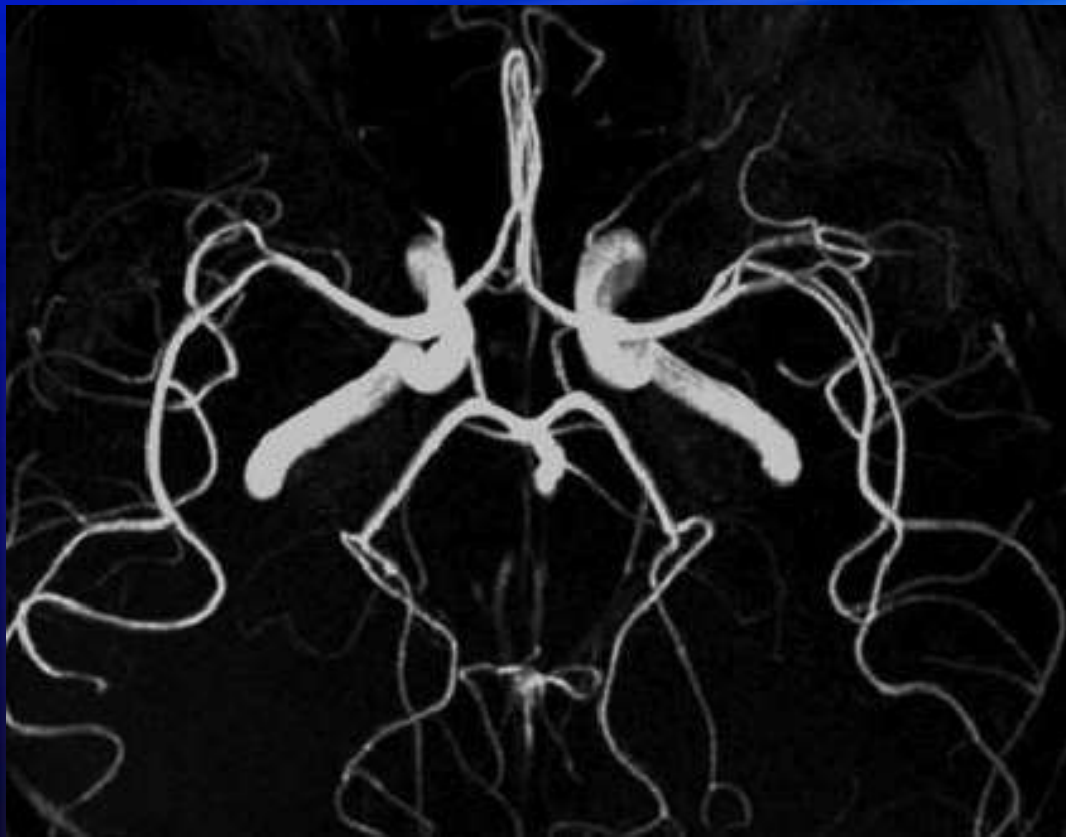
## ANGIO-RM: TECNICHE A CONTRASTO DI FASE (PC)

si basano sull'impiego di sequenze che saturano il segnale degli spin stazionari risaltando quello degli spin in movimento in quanto questi accumulano uno spostamento di fase



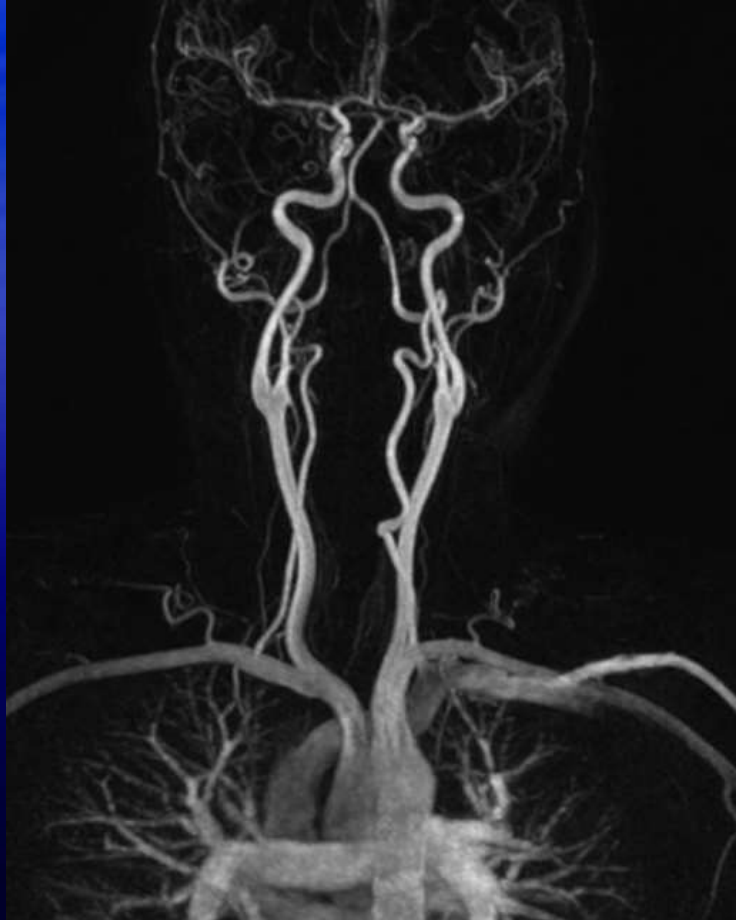


# Angiorm TOF: arterie e vene



# ANGIO-RM: TECNICHE CONTRASTOGRAFICHE

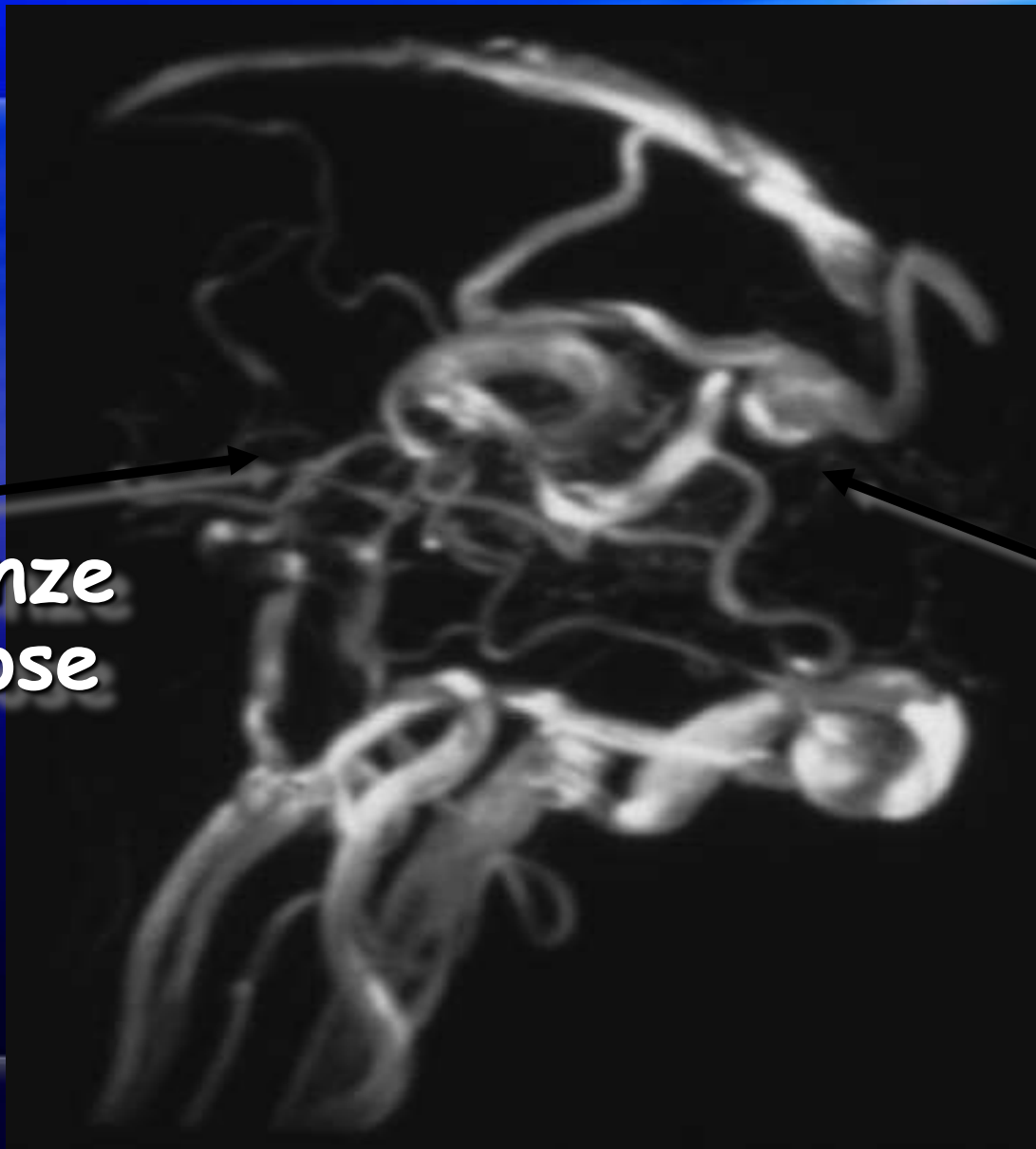
si basano sull'impiego di sequenze molto veloci abbinata alla somministrazione endovenosa di gadolinio



# APPLICAZIONI CLINICHE DELL'ANGIO-RM IN NEURORADIOLOGIA

- Distretto intracranico (TOF)  
malformazioni vascolari  
aneurismi  
rapporti vascolari con patologia neoplastica (PC)
- Vasi epiaortici  
valutazione delle stenosi carotidee (Gd)

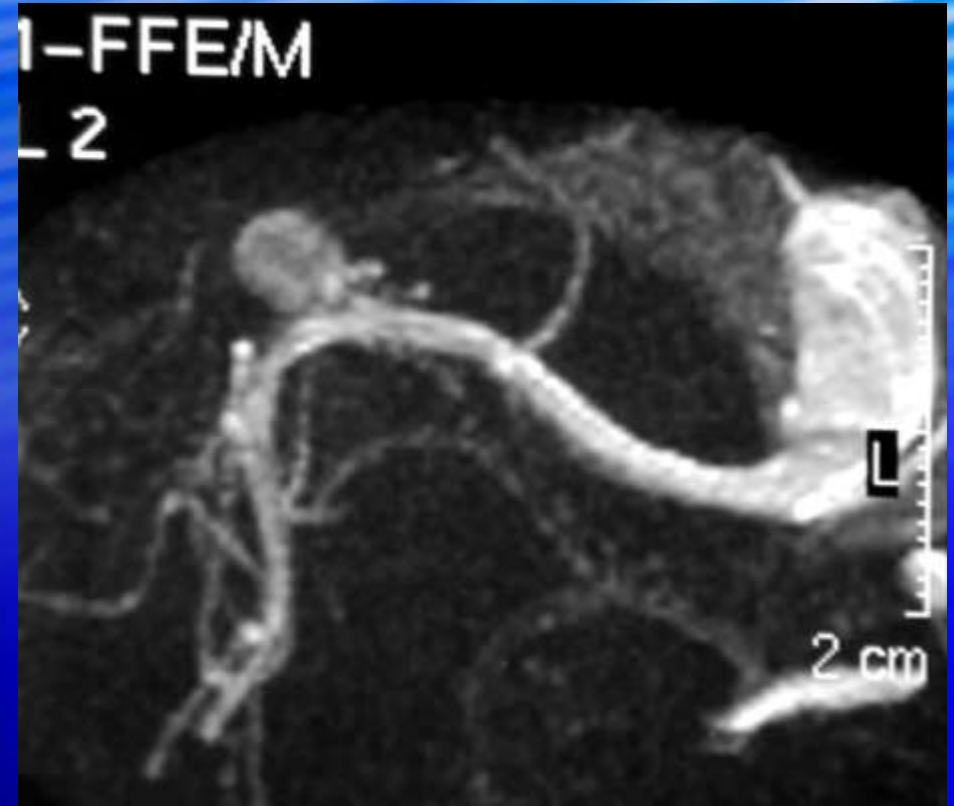
# MAV



afferente  
arteriose

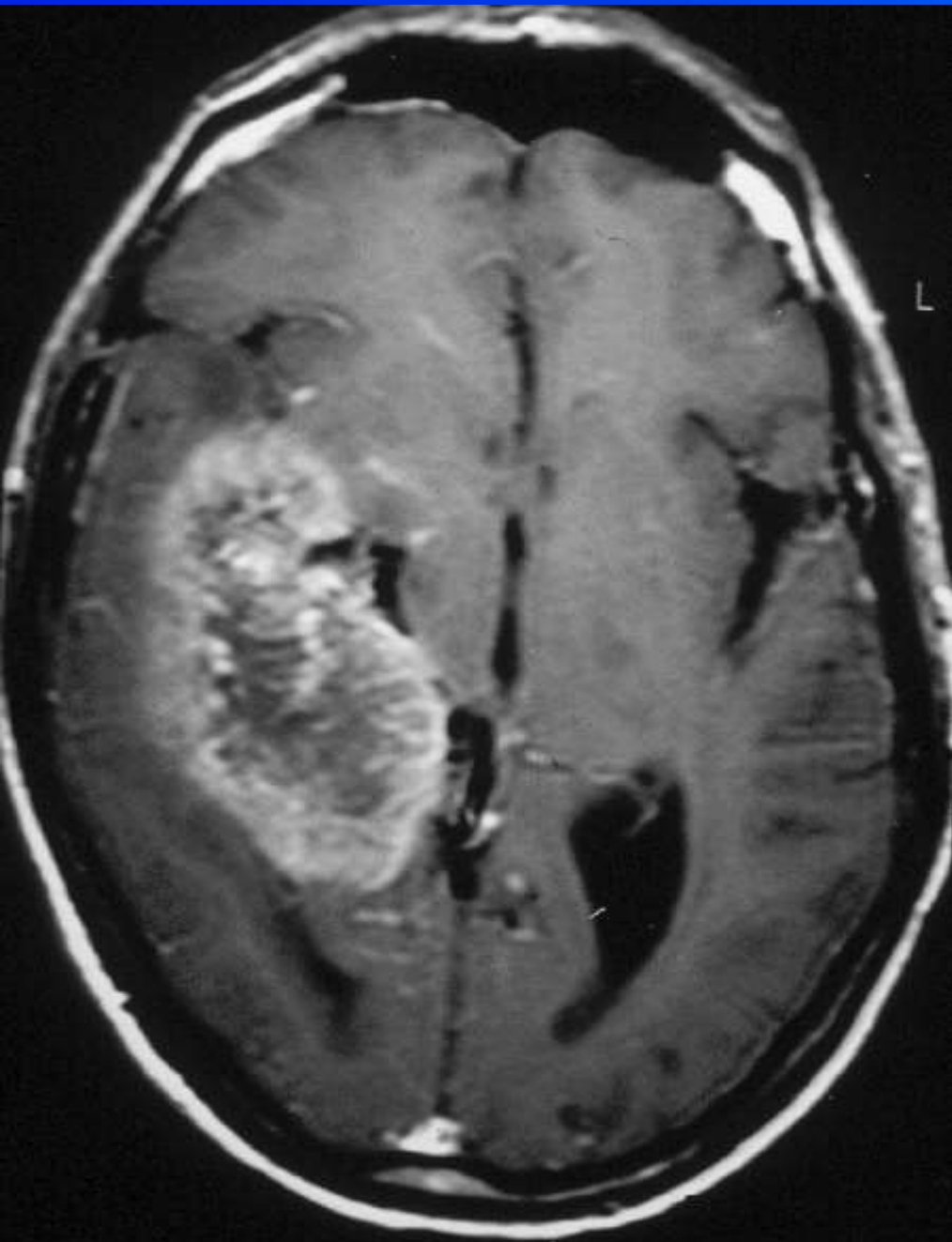
efferente  
venose

# ANEURISMI



Aneurisma: buona  
sensibilità fino a 2/3 mm

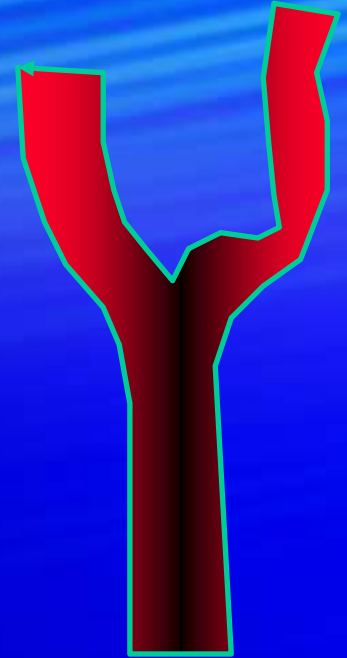
# Neoangiogenesi neoplastica



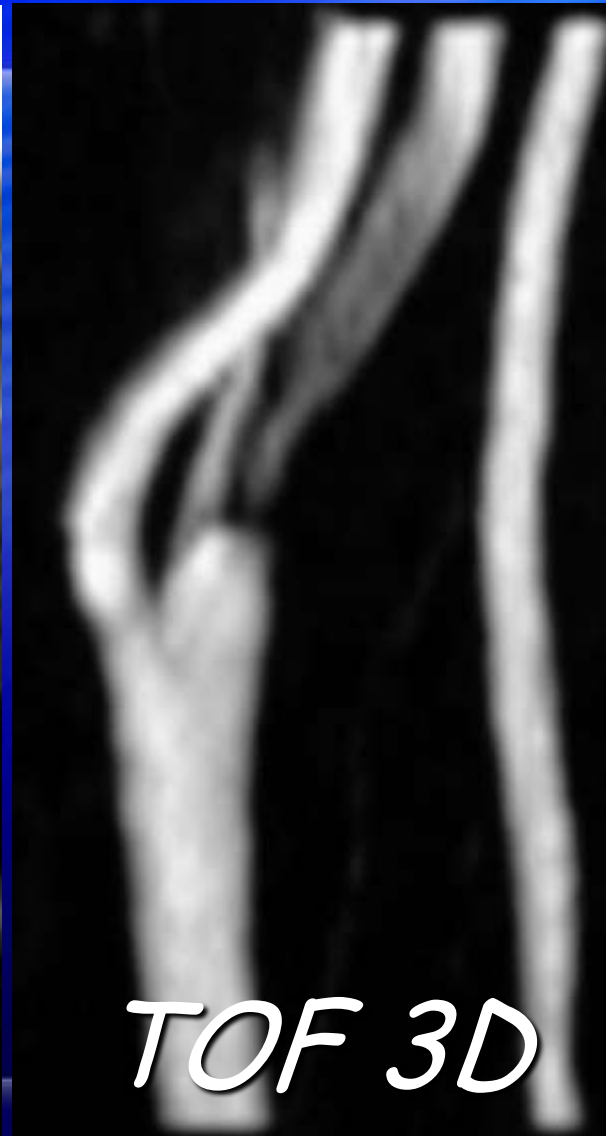
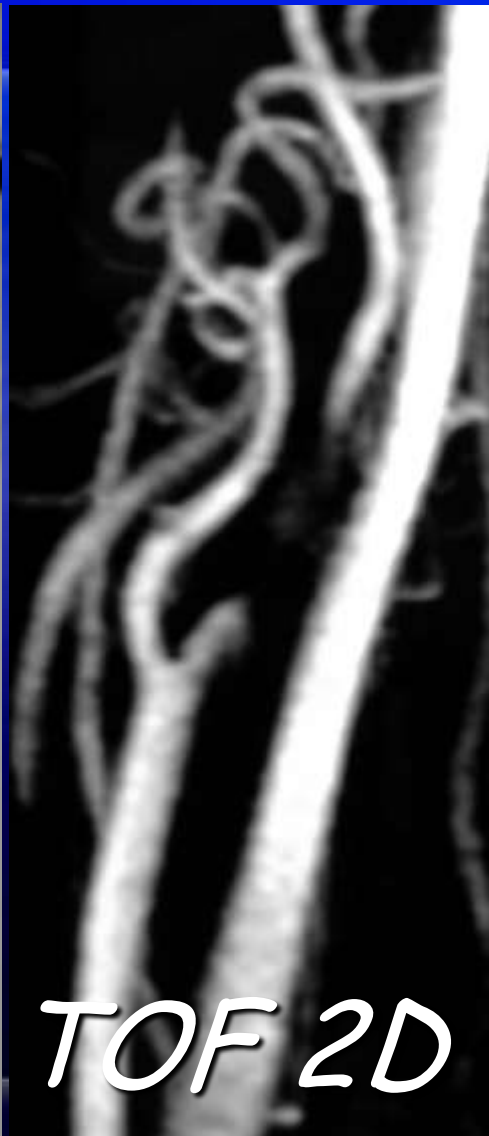
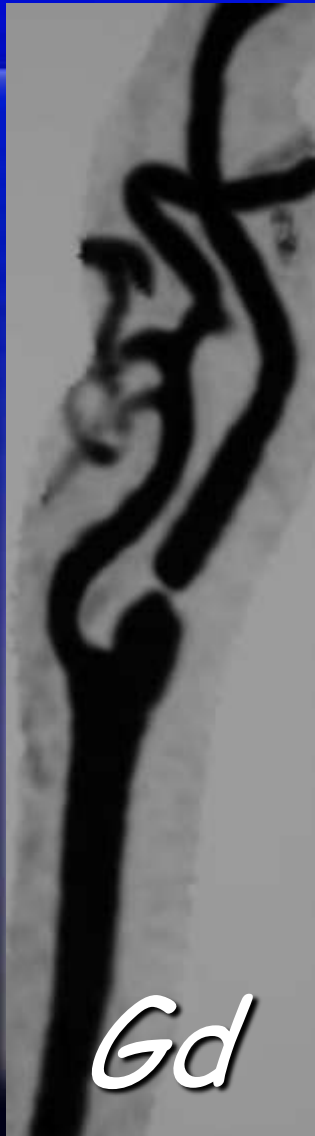
# Angio-RM: DISTRETTO EPIAORTICO

- senza mdc, tecniche di flusso
- con mdc (Gd a bolo)

COMPLEMENTARE AL COLOR-DOPPLER,  
ALTERNATIVA ALL' ANGIOGRAFIA PER  
CATETERISMO



# Stenosi carotidea





# NUOVE SEQUENZE

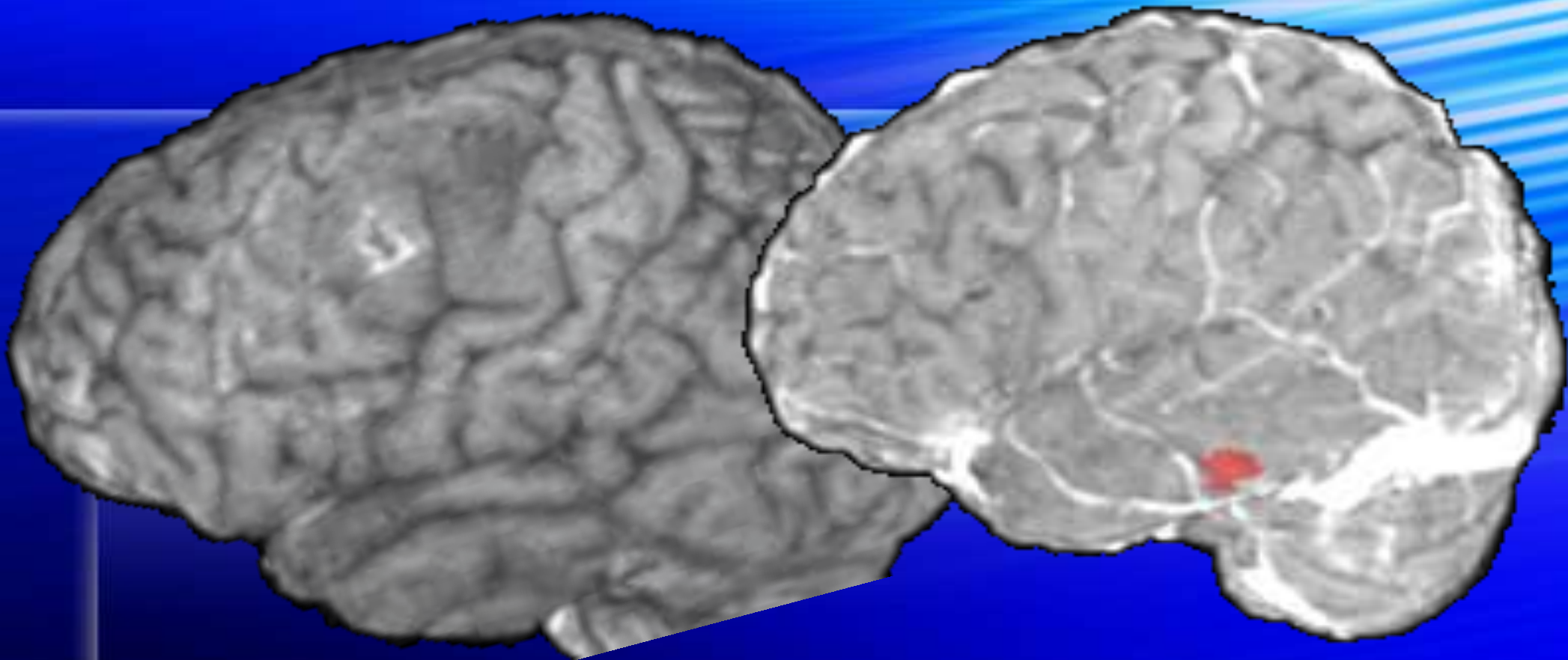
VBM

SPETTROSCOPIA

SWI

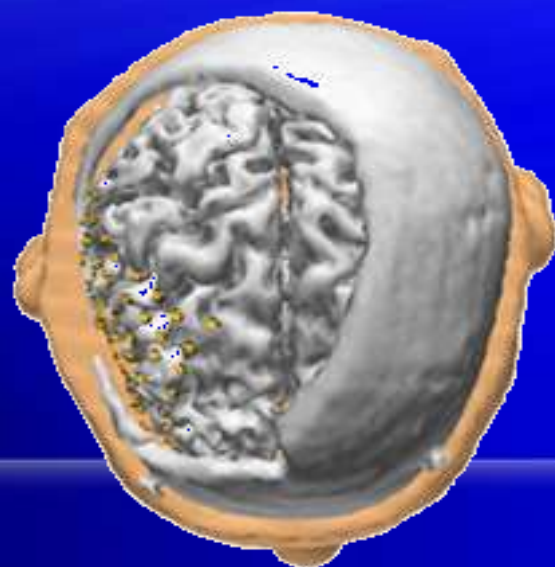
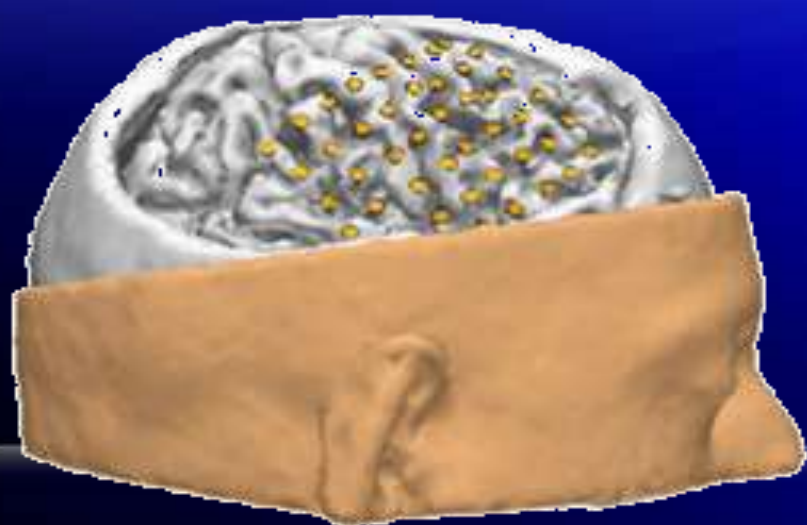
fMRI

Per poter visualizzare solchi e vasi :

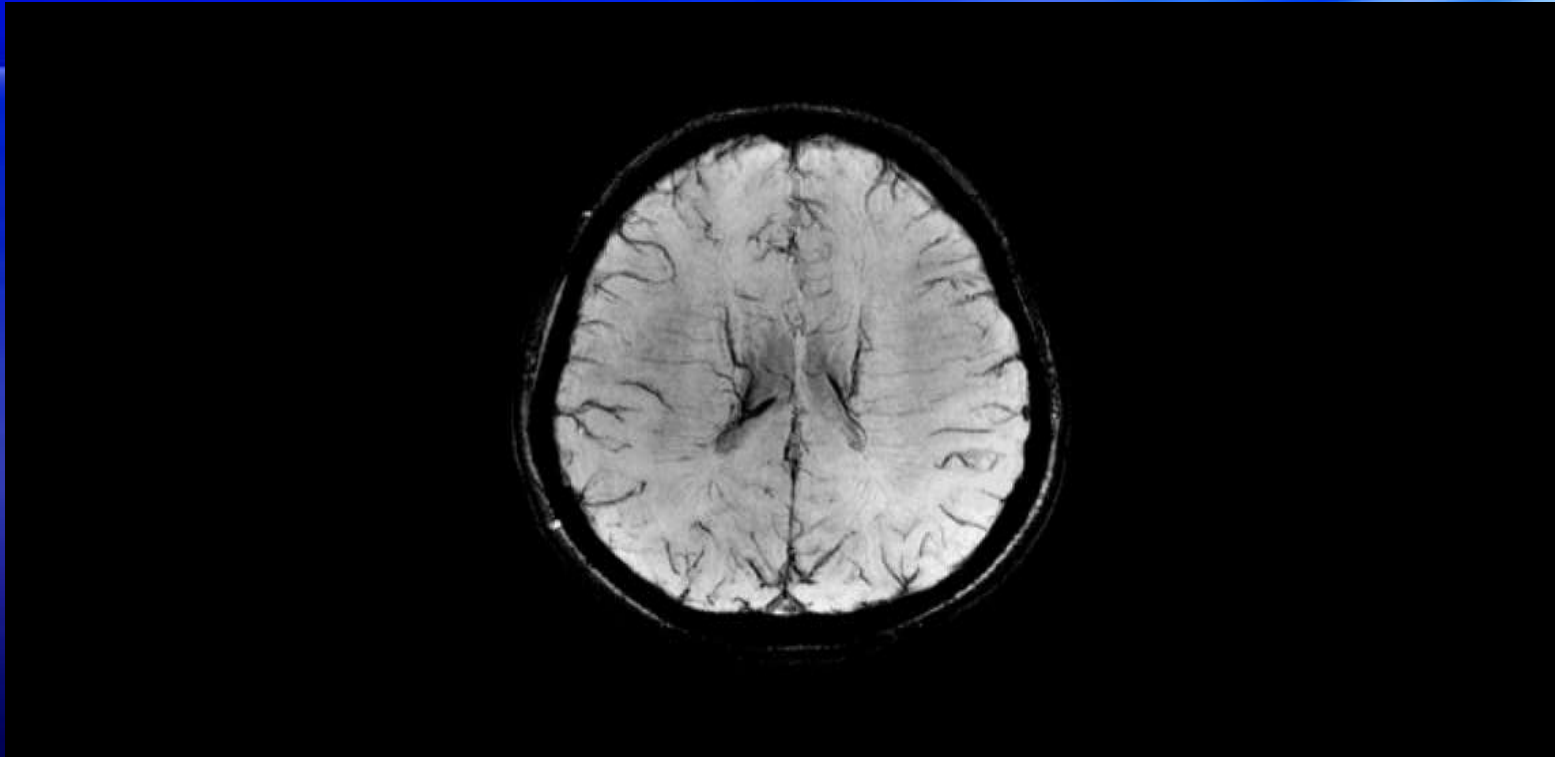


IMAGINI SENZA E CON M.D.C.

# Integrazione tra MRI -CT



# *SWI Immagini a suscettività' pesata*



*L'immagine pesata in suscettibilità è una tecnica capace di fornire un nuovo mezzo per migliorare il contrasto nelle immagini di RM.*

*La SWI è una sequenza gradient-echo 3-D, molto sensibile a sostanze ferromagnetiche quali ferro calcio e prodotti ematici.*

## Il fenomeno del Chemical Shift

Il fenomeno fisico che permette l'acquisizione di informazioni spettrali è il **chemical shift**, secondo il quale le proprietà di risonanza del nucleo di interesse dipendono, oltre che dal campo magnetico esterno, anche dall'ambiente chimico che lo circonda. Consideriamo alcuni composti di interesse:



Se si pone uno di questi composti in un campo magnetico si riscontra che la frequenza di risonanza dell'idrogeno risulta leggermente diversa nei diversi gruppi a seconda del suo “ intorno chimico”

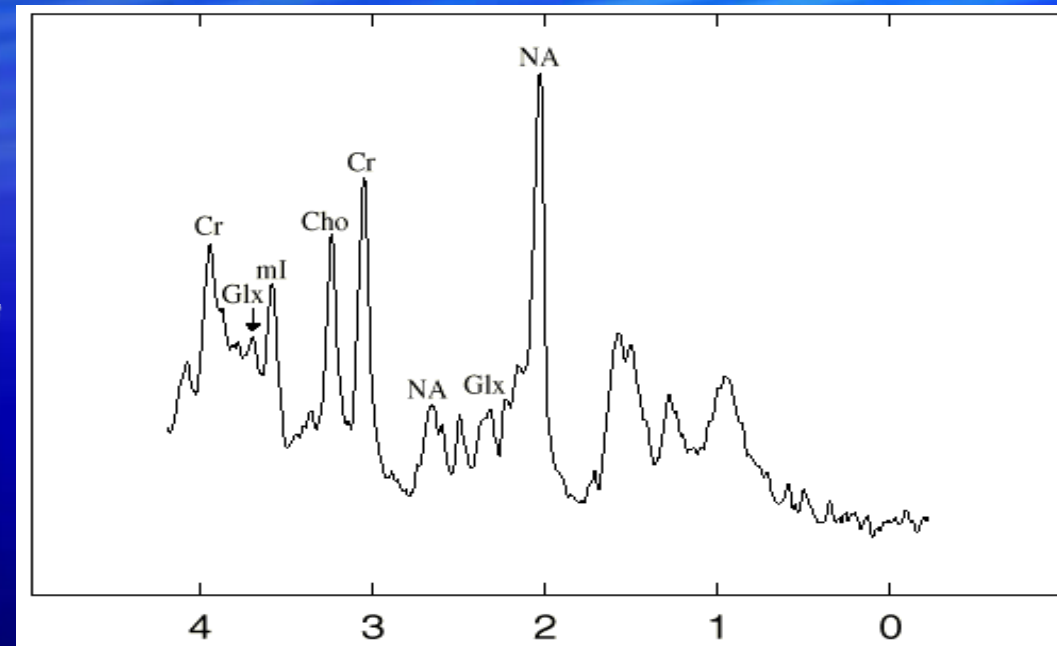
Mentre in RM l'intensità di ogni voxel dipende dalla somma dei segnali di tutte le molecole del voxel stesso che contengono idrogeno

In Spettroscopia il segnale proveniente da un certo nucleo (H, P, C,...) viene separato nelle varie forme chimiche

# MR Spectroscopy

## METABOLITI PRESI IN ESAME :

- *N-Acetilaspargato (Naa da 1.9 a 2.1 ppm) marker di integrita' neuronale*
- *Colina (Cho da 3.1 a 3.3 ppm) marker di proliferazione cellulare e di turnover di membrana*
- *Creatina (Cr da 2.9 a 3.1 ppm) marker di metabolismo energetico*
- *Lattati (Lac da 1.3 a 1.5 ppm) marker di ipossia tissutale*
- *Lipidi (Lip da 0 a 1.9 ppm) marker di necrosi tissutale*
- *Myo-Inositolo (Myo-Ino 3.5 ppm) marker gliale*
- *Glutammato e Glutamina (Glx da 2.05 a 2.5 ppm) marker di eccitotossicità*



# UTILITA' PRATICA

- GRADING TUMORALE
- D.D. METASTASI, TUMORI ALTO GRADO, ASCCESSI, LINFOMI
- D.D. RESIDUO TUMORALE E RADIONECCROSI
- MALATTIE METABOLICHE/GENETICHE
- CONFERMA LESIONI DOVE NON E' POSSIBILE BIOPSIA

# BOLD

L'attività cerebrale aumenta la richiesta di ossigeno dei tessuti

Il flusso aumenta

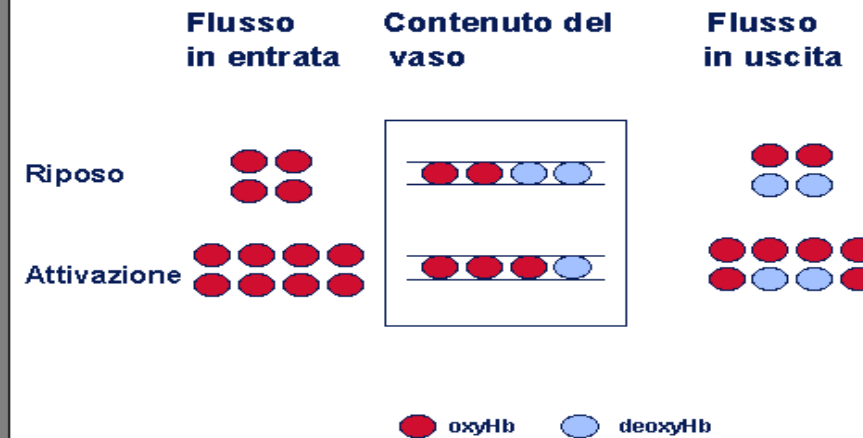
Viene portata più ossiemoglobina di quanto sia l'effettivo aumento del consumo

La deossiemoglobina diminuisce in rapporto alla ossiemoglobina

La deossiemoglobina è una sostanza paramagnetica

La diminuzione della deossiemoglobina modifica il segnale in T2.

## Studi di attivazione MRF Effetto **BOLD**





# Paradigma semplice

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CONDIZIONE SPERIMENTALE:

STIMOLO -> risposta comportamentale

CONDIZIONE DI CONTROLLO:

STIMOLO -> assenza di risposta comportamentale

Aree motorie?



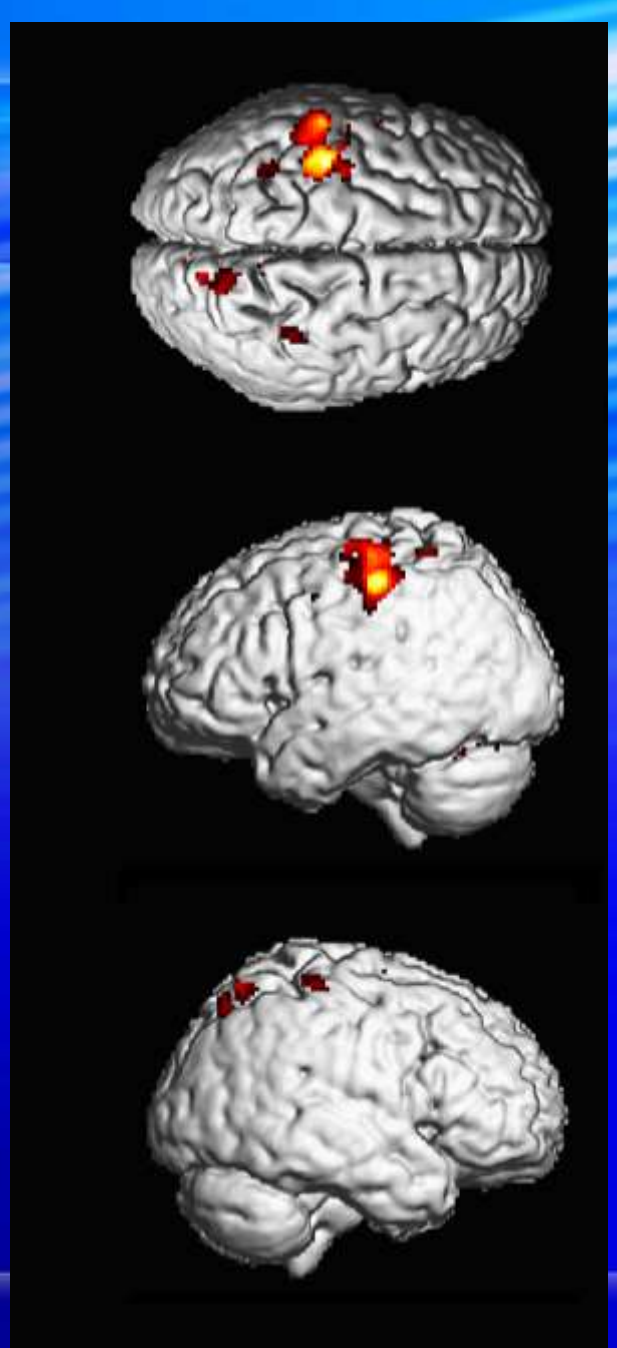
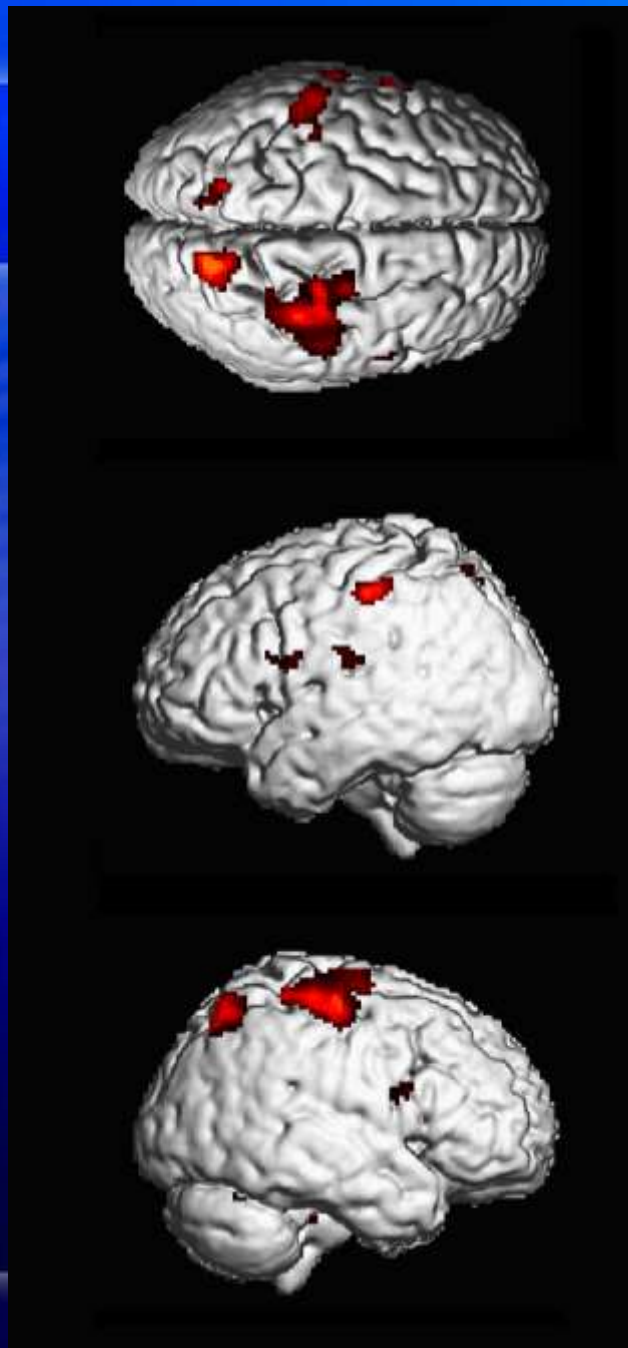
VS



# STUDI FUNZIONALI

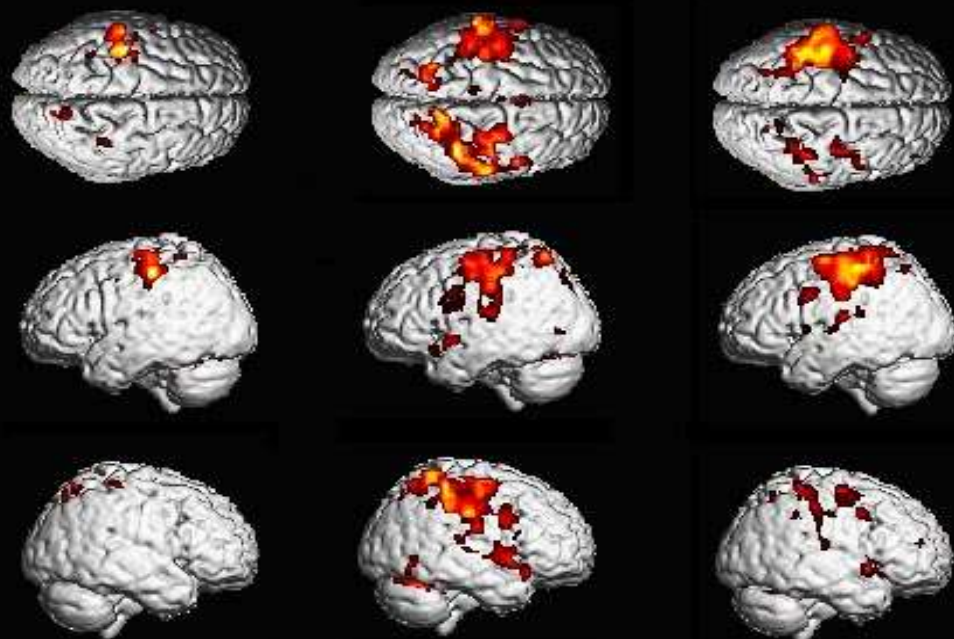


Finger  
tapping  
mani  
DX  
e SN



# 12P CON S.M. (CIS) DOPO LA RISOLUZIONE DEL SINTOMO vs 12 VS

**Right hand movement**

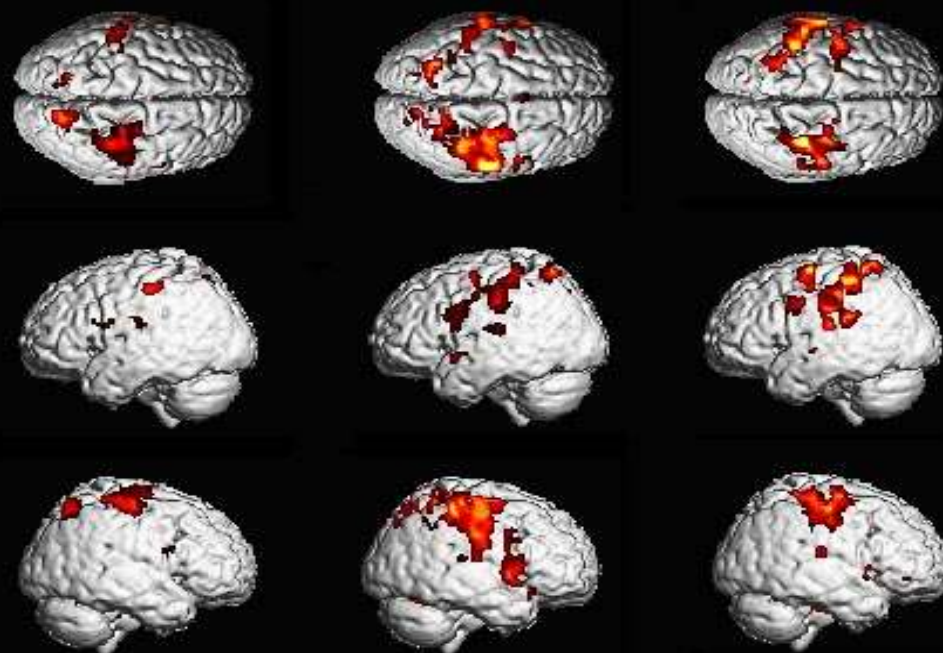


**Control  
subjects**

**Right  
paresis**

**Left  
paresis**

**Left hand movement**



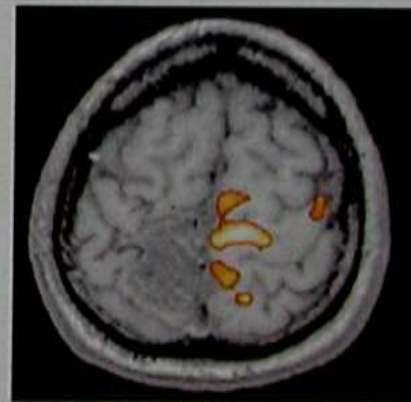
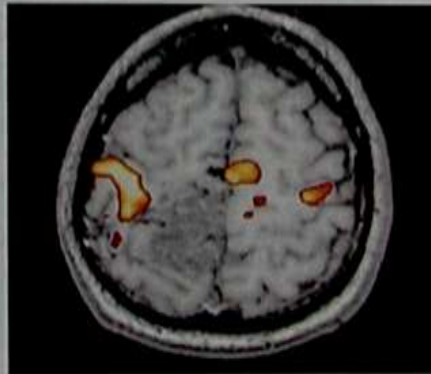
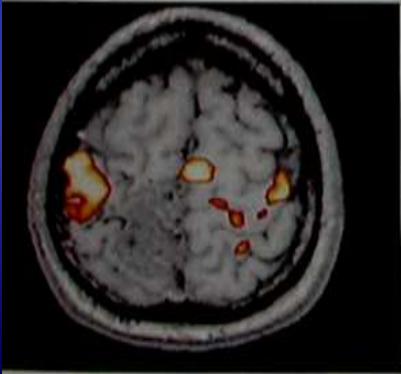
**Control  
subjects**

**Right  
paresis**

**Left  
paresis**

# RM funzionale nella definizione dei rapporti tra corteccia motoria e neoplasia

A



B



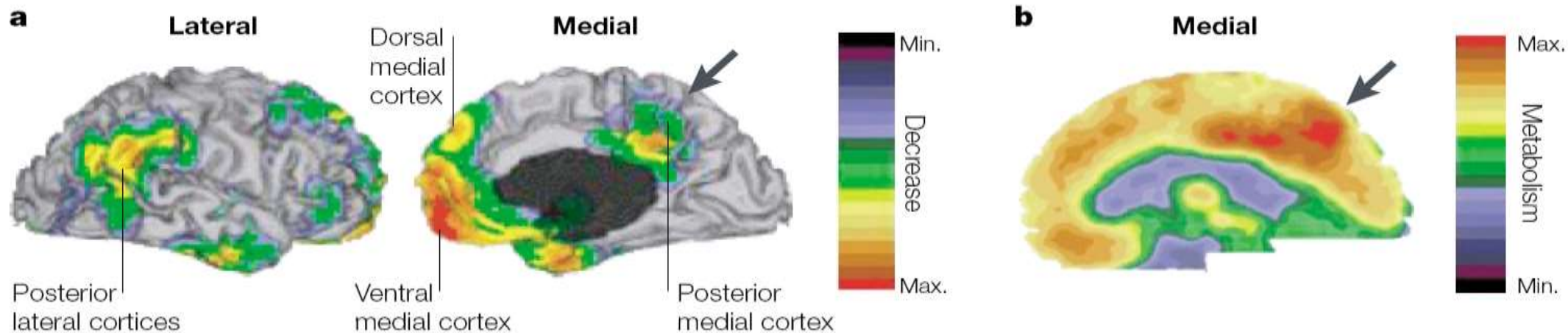
C



# Resting state network (RSN)

# Il rumore è in parte attività?

- Il cervello non è silenzioso a riposo!
- PET rivela consistenti **deattivazioni** durante l'esecuzione di task cognitivi che richiedono attenzione
- FDG-PET individua un „Default Mode Network“ (DMN) a riposo

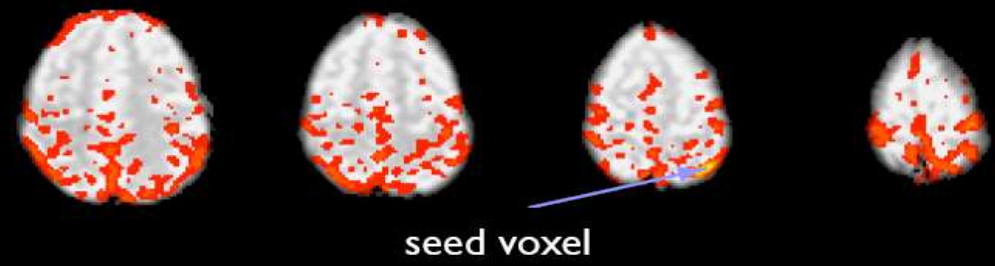
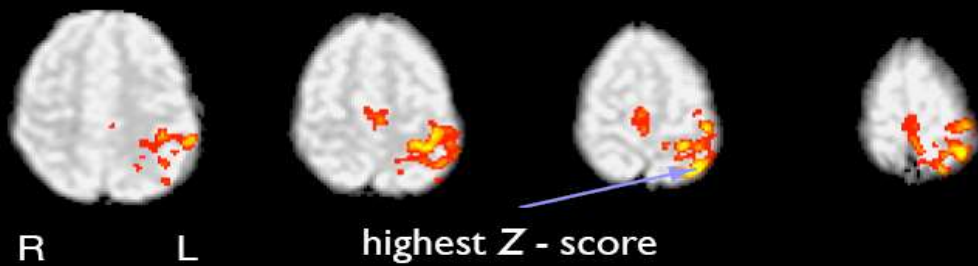


a: *Gusnard et al.*, NRN 2001;

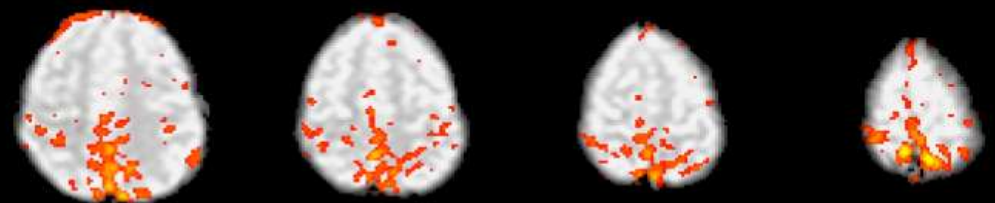
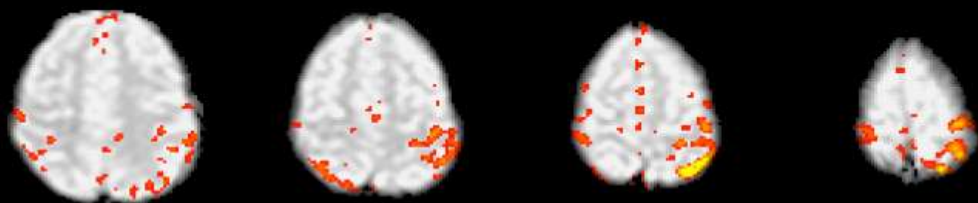
b: *Raichle et al.*, PNAS 2001

# Come individuare i resting state network - RSNs ?

- La connettività cerebrale può essere mappata utilizzando:
  - a) un'area di partenza



- b) ICA ovvero analisi delle componenti indipendenti



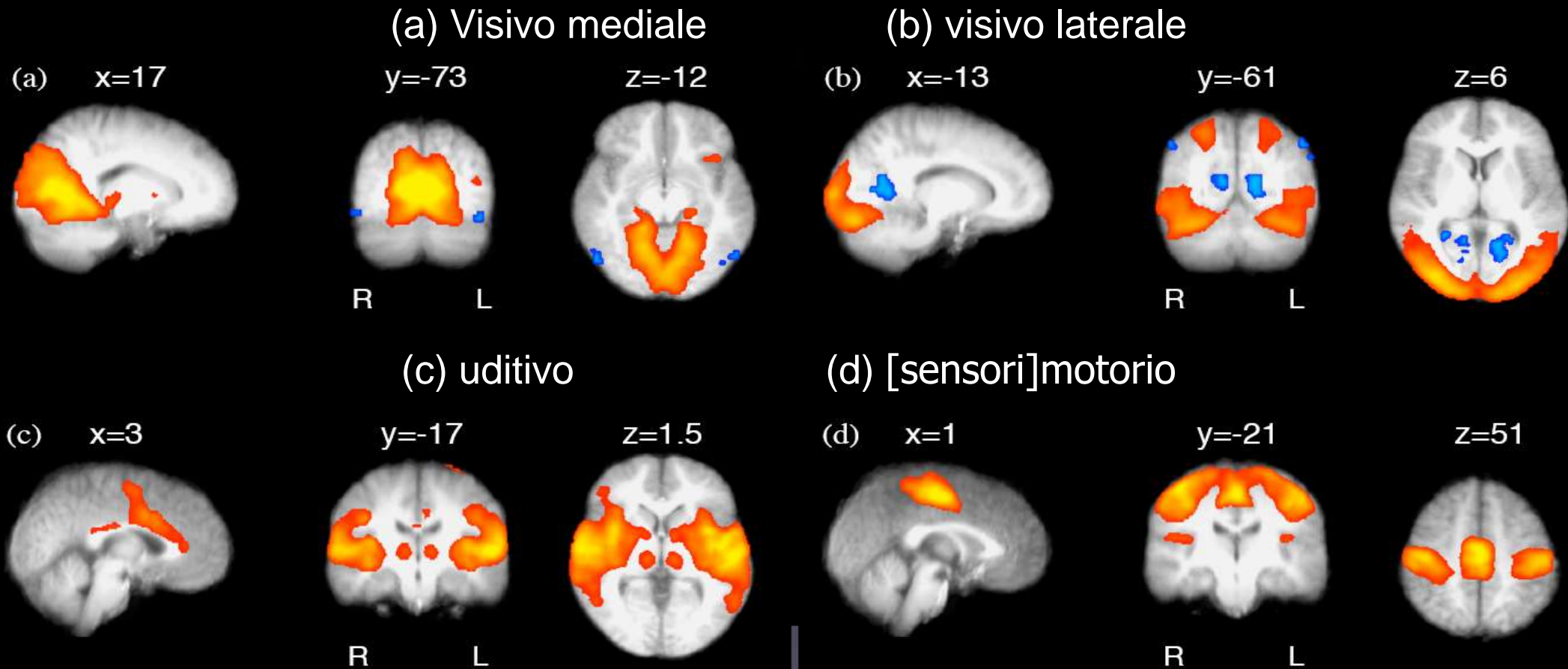
a: *Biswal et al.*, MRM 1995;

b: *Beckmann et al.*, IEEE 2004



# Quali circuiti RSNs otteniamo?

- circa 7 – 10 sono di solito estratti,  $f=0.01-0.05$  Hz (broad)

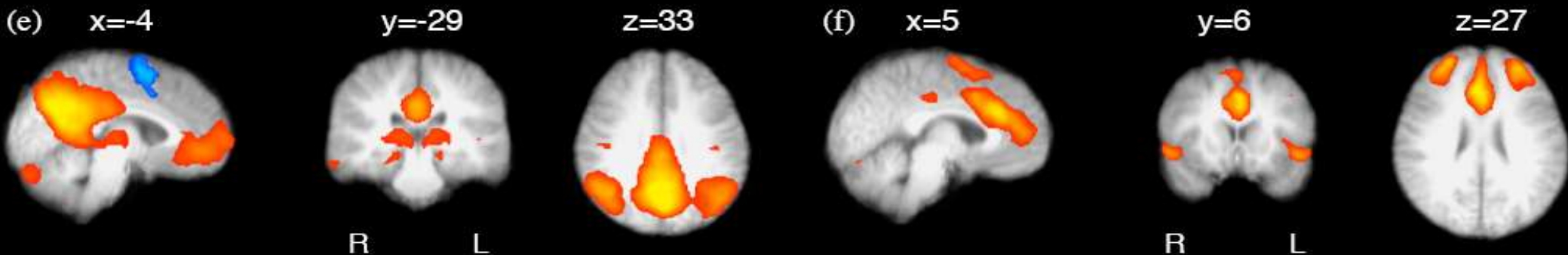


# Quali circuiti RSNs otteniamo?

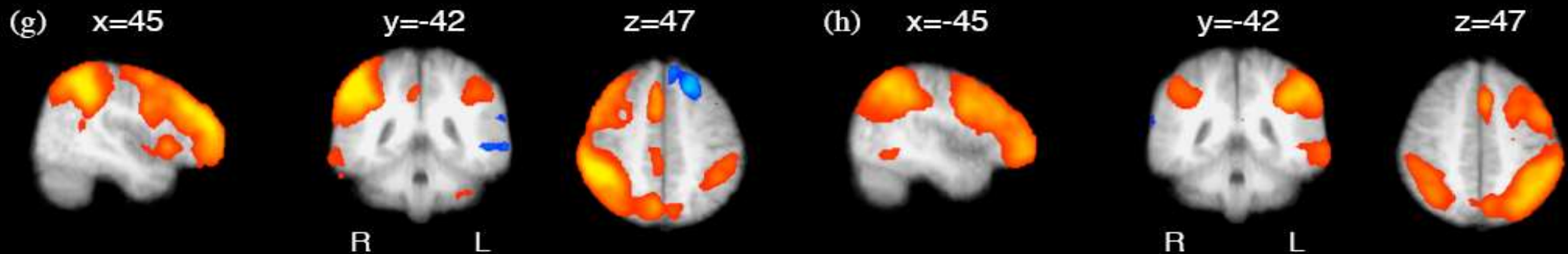
- circa 7 – 10 sono di solito estratti,  $f=0.01-0.05$  Hz (broad)

(e) default mode (limbic and parietal )

(f) controllo esecutivo (frontale mesiale)

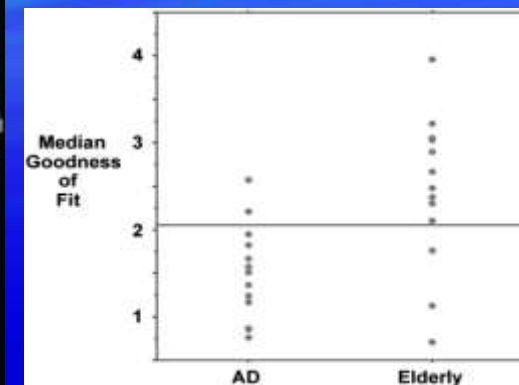
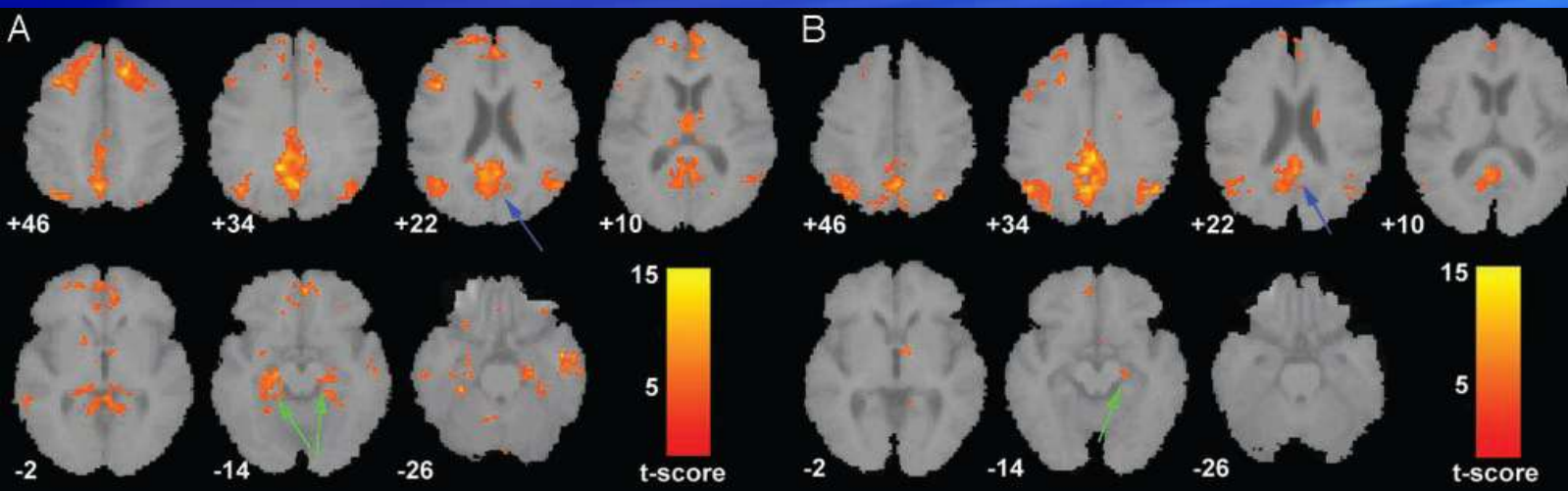


(g+h) visivo dorsale



# RSN e la patologia

- DMN è ridotto in Alzheimer (B) rispetto all'invecchiamento normale (A), con alta sensibilità e specificità

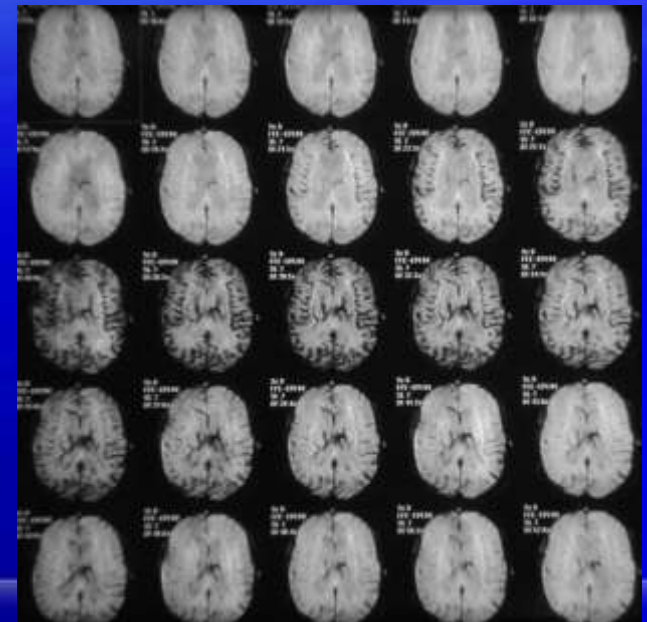
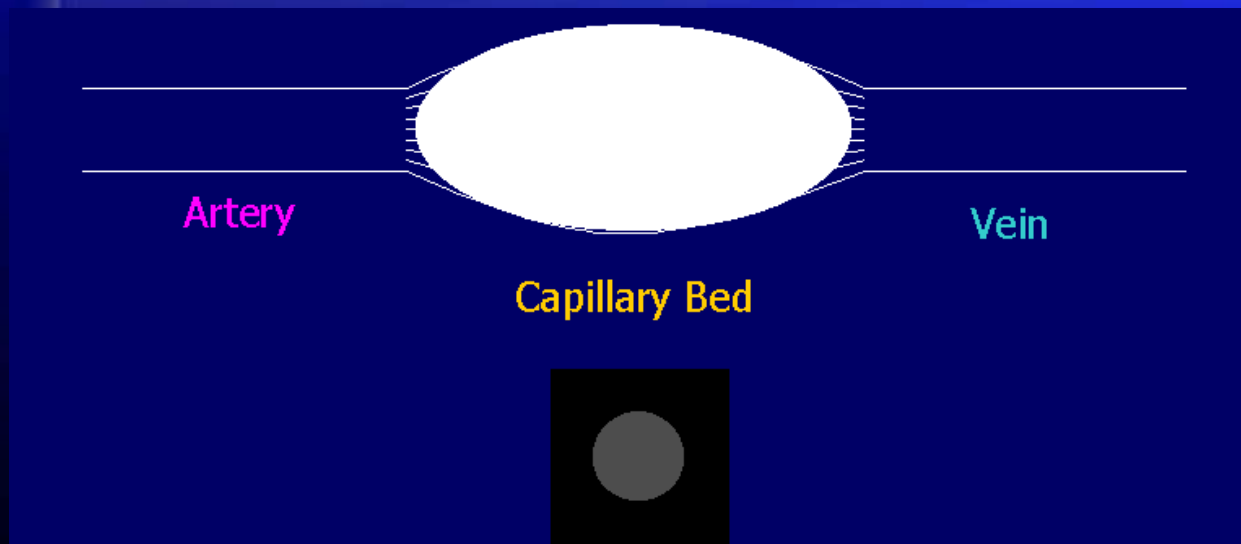


*la diffusione e la perfusione  
sono fenomeni fisico-biologici che  
possono essere studiati mediante  
sequenze dedicate di Risonanza*

*Magnetica*

# PERFUSIONE CEREBRALE CON RM: DSC

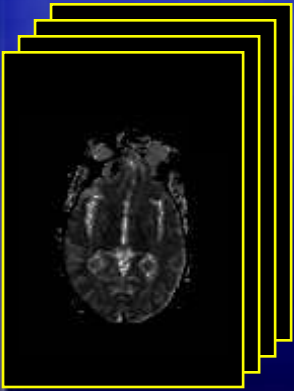
- il mezzo di contrasto paramagnetico\* durante il passaggio nelle strutture vascolari cerebrali è compartimentalizzato al loro interno
- ciò determina un piccolo campo magnetico locale che decresce per una distanza approssimativamente pari al raggio del vaso



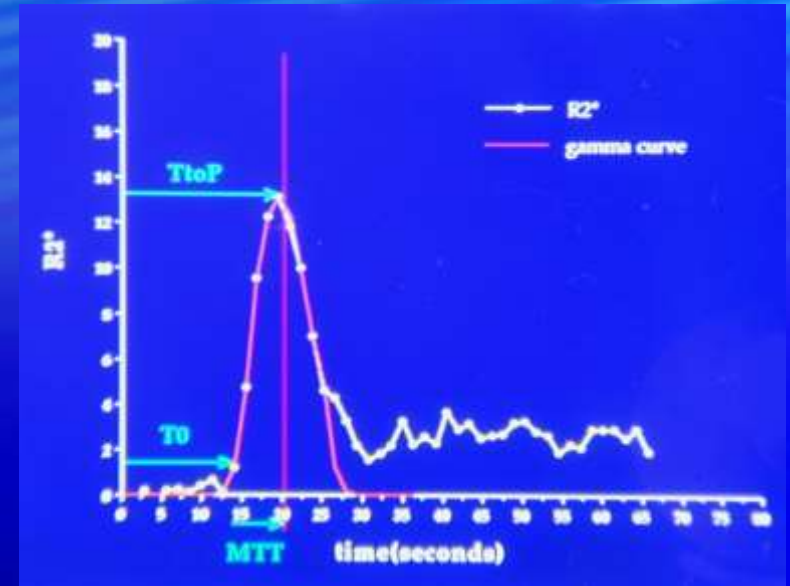
\* Anche con la TC

# PERFUSIONE CEREBRALE MEDIANTE RM

- MDC (gadolinio) a bolo 30 ml (4 ml/sec)
- acquisizione ultrarapida sequenziale multistrato  
1 slice/secondo (40 acquisizioni)



- elaborazione post-processing
- mappe di volume (rCBV)  
flusso (rCBF)  
tempo di transito, arrivo e picco

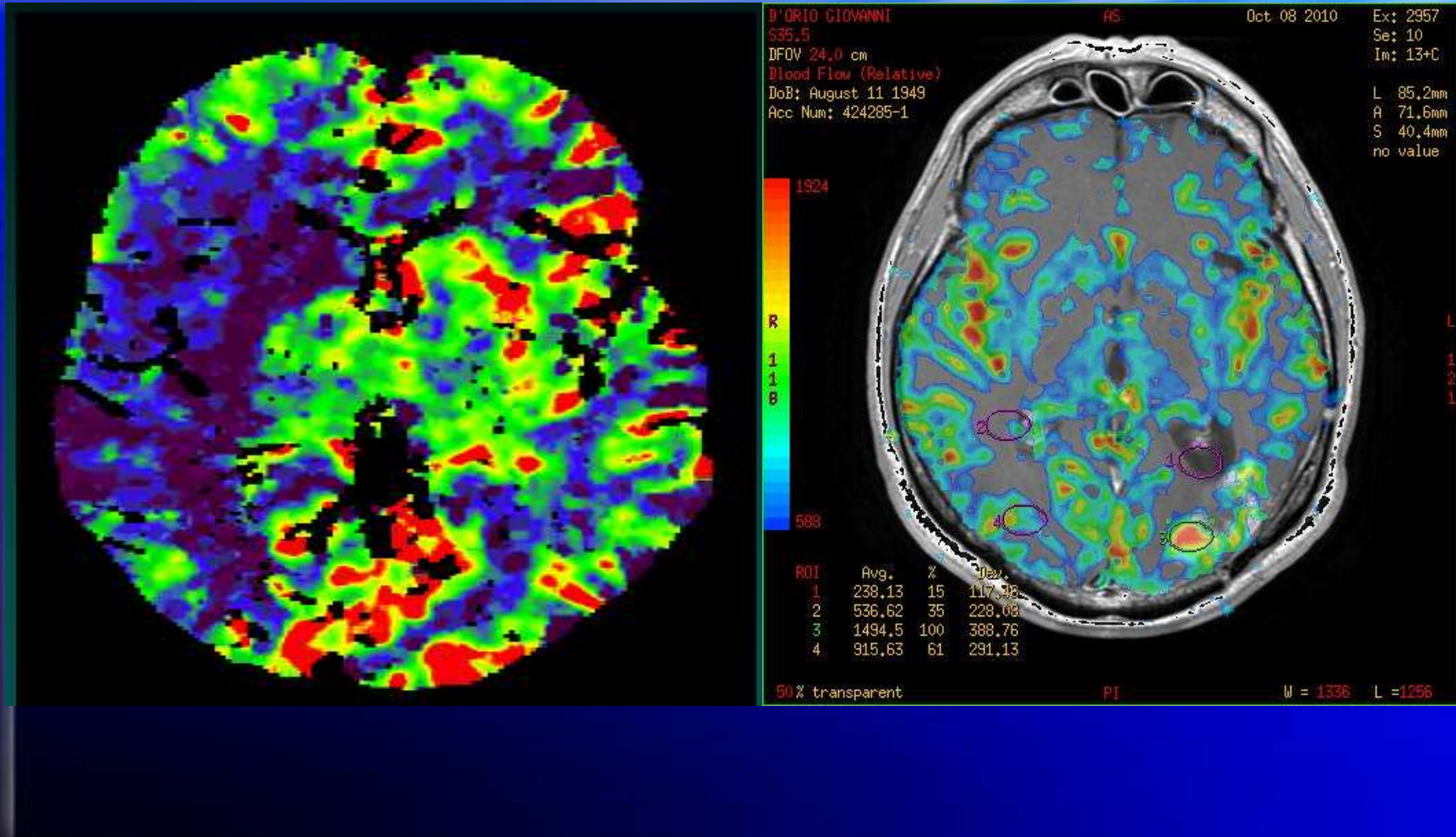


RELATIV

# Perfusione

TC

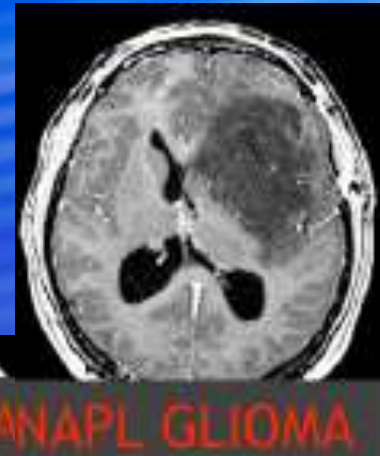
RM



# PERCHE' PERFUSIONE



RADIOTERAPIA

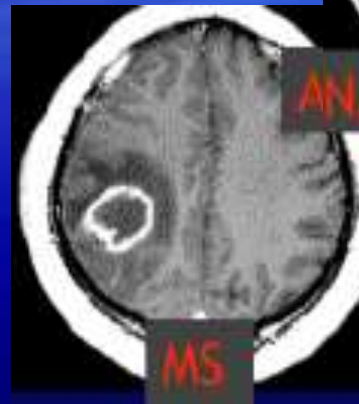


ANAPL GLIOMA



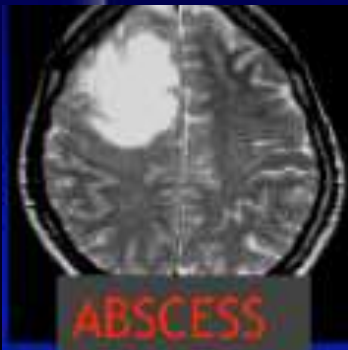
GBM

TUMORI PRIMARI  
O SECONDARI



MS

MEGAPLACCA



ABSCISS



TOXO

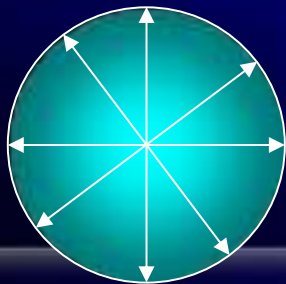
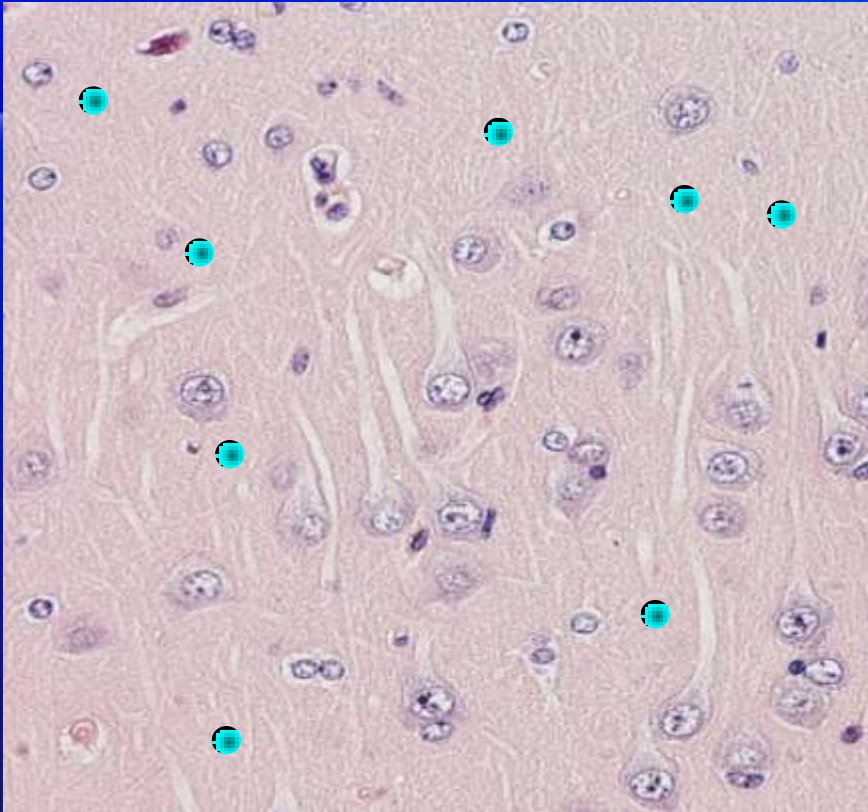
INFEZIONI



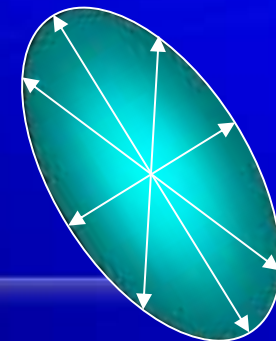
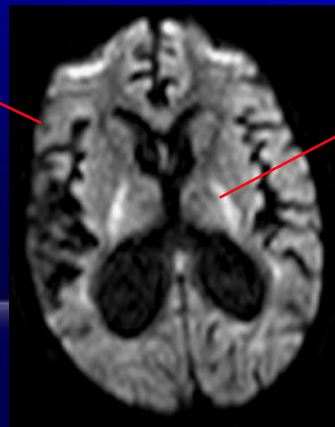
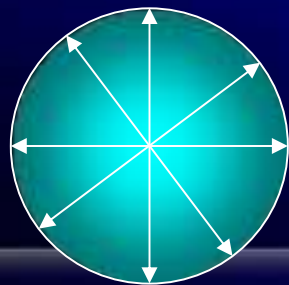
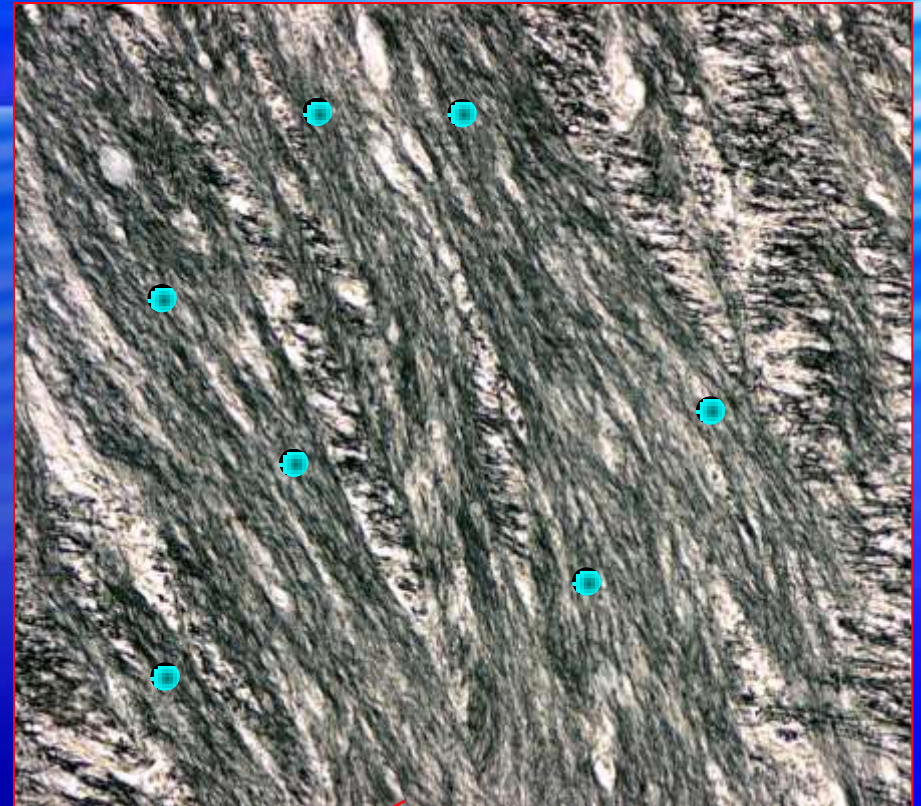
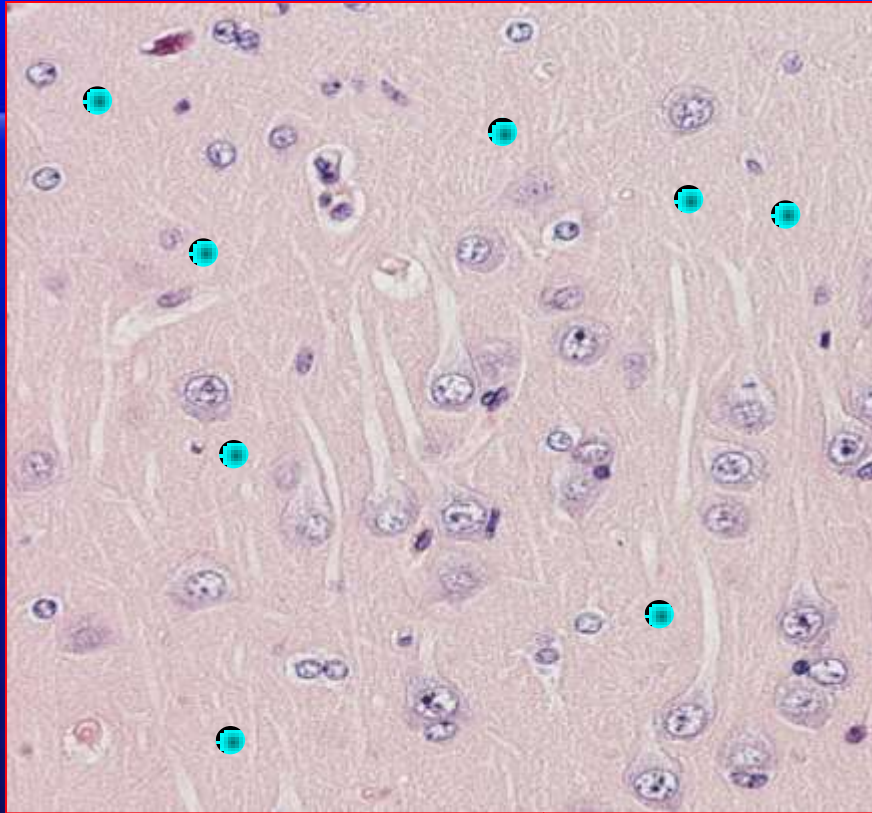
# Diffusione: definizione

## Movimento random delle molecole in un mezzo

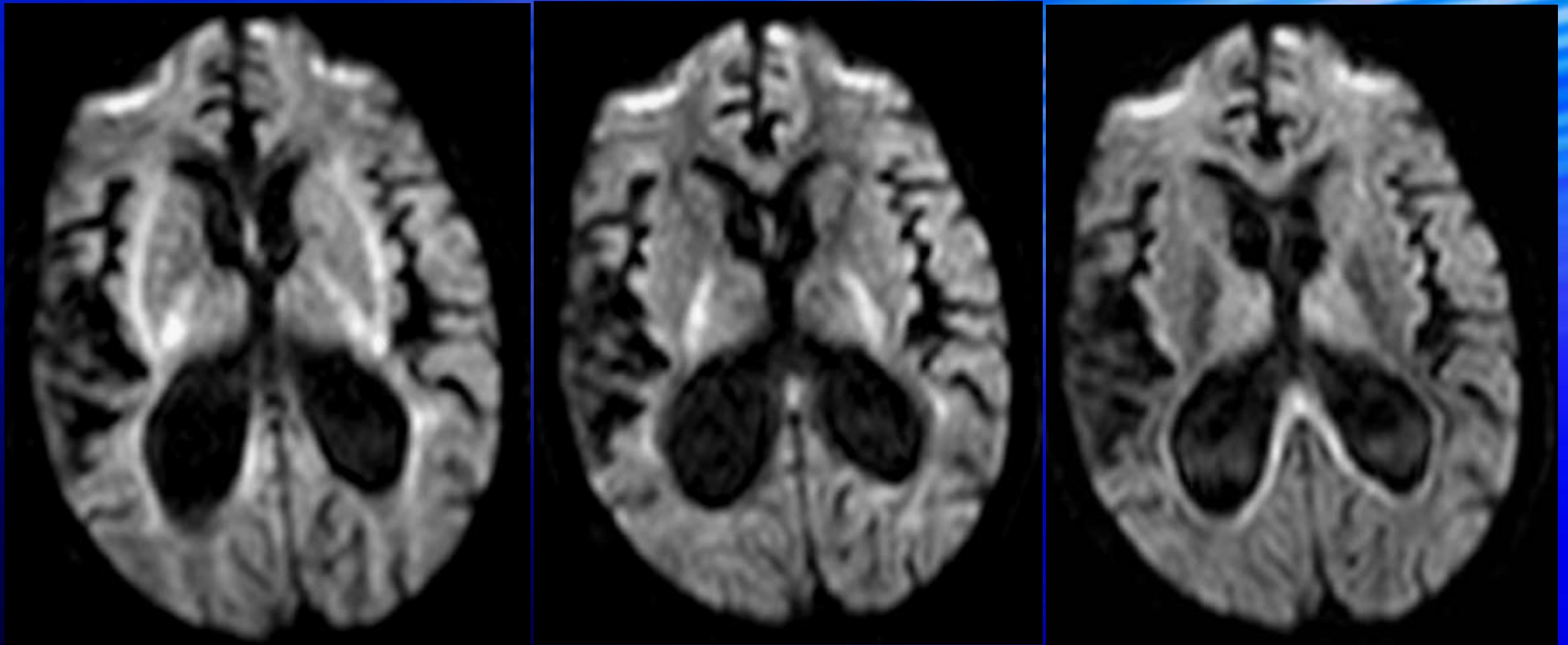
- è modificata dalla morfologia, fisiologia e patologia:
  - ristretta da barriere naturali
- Le proprietà della diffusione in un tessuto possono essere misurate con la RM applicando un gradiente di diffusione



# Isotropia ed anisotropia



## Le immagini DWI in funzione della direzione del gradiente



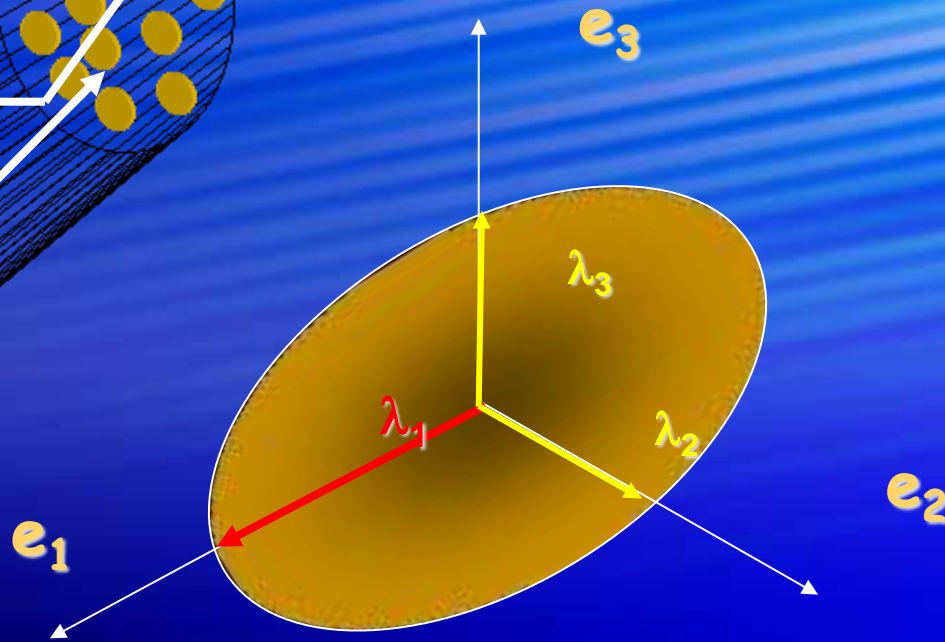
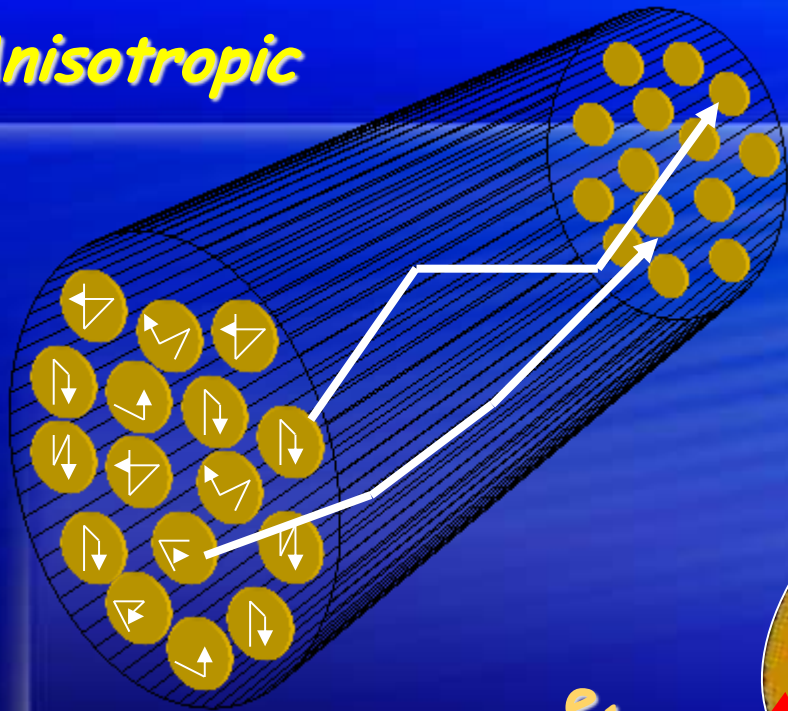
x

y

z

# diffusion MRI: il tensore

*Anisotropic*

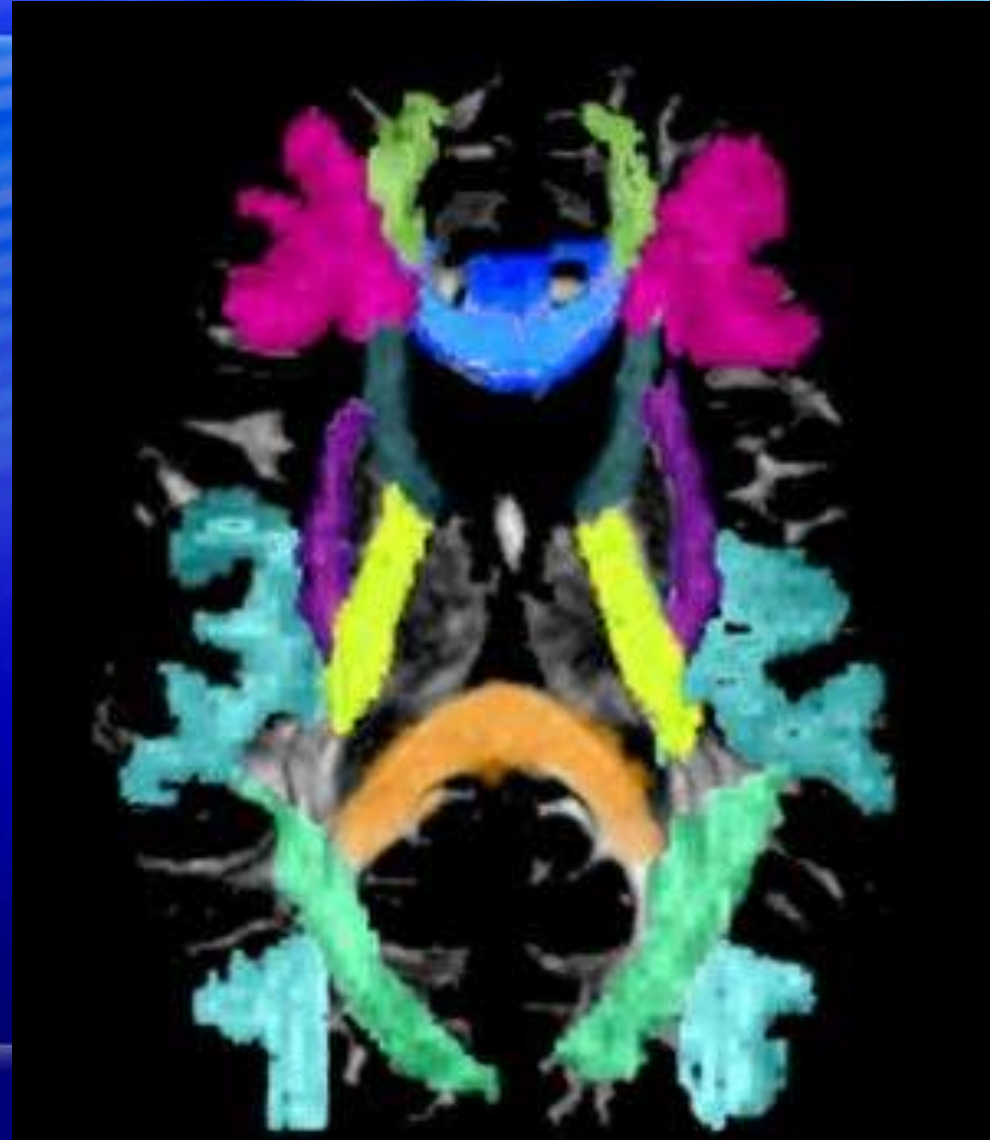


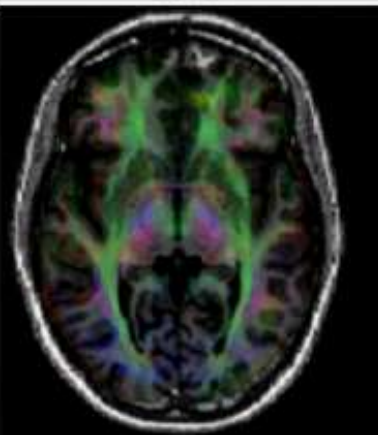
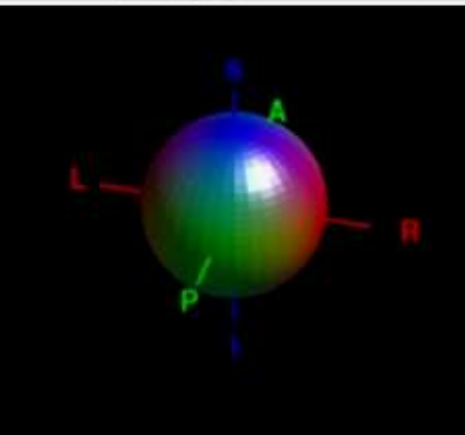
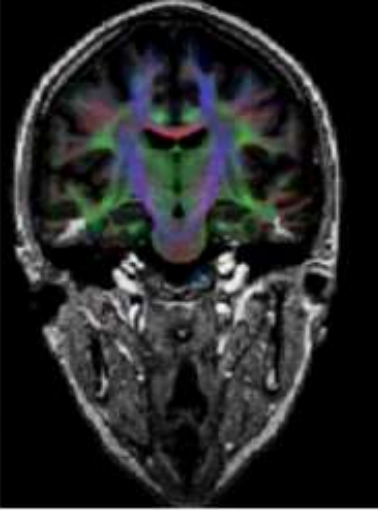
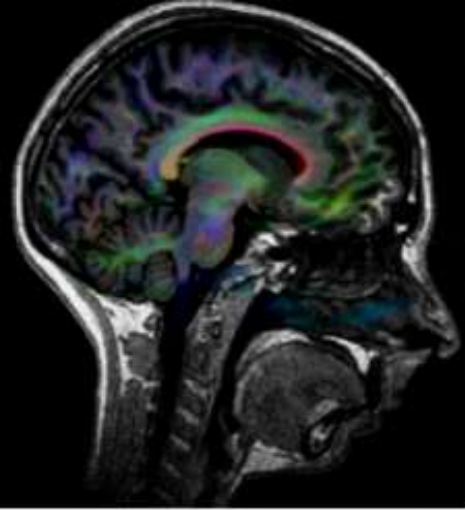
*Diffusion Tensor*

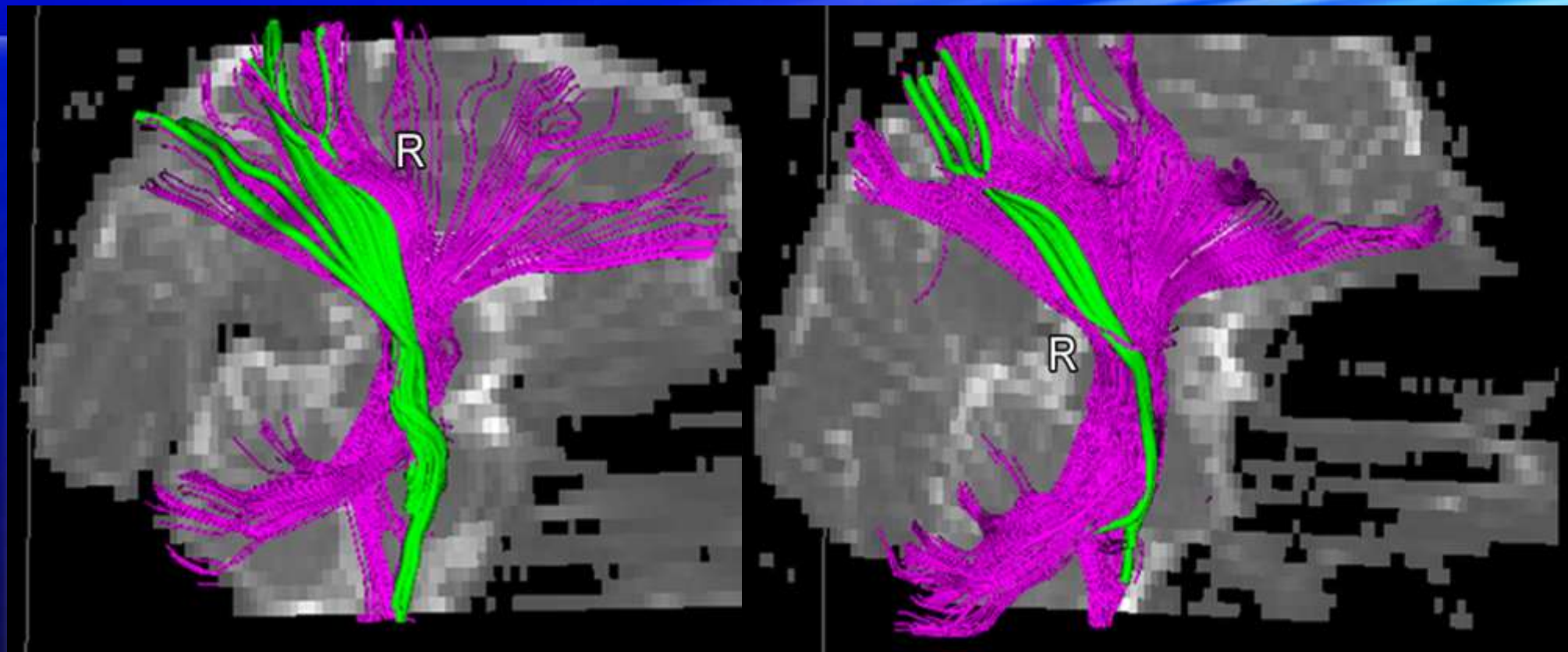
$$\mathbf{D} = \begin{pmatrix} D_{xx} & D_{xy} & D_{xz} \\ D_{yx} & D_{yy} & D_{yz} \\ D_{zx} & D_{zy} & D_{zz} \end{pmatrix}$$

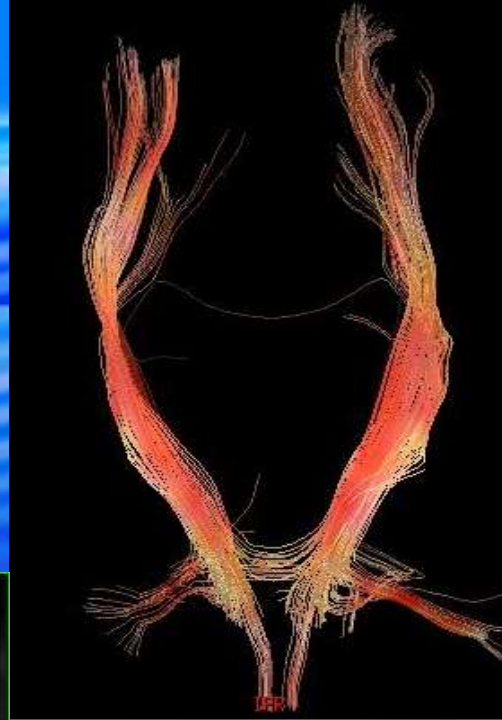
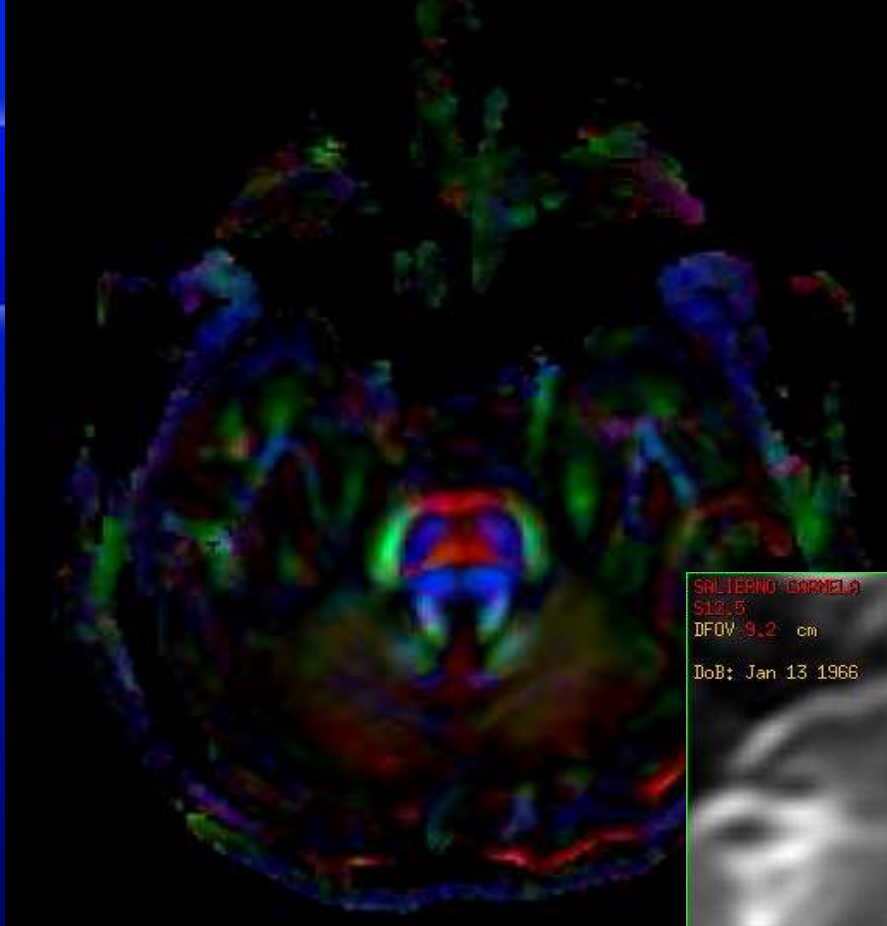
# ALTRE POSSIBILI OFFERTE DALLA DWI

- F.A.
- M.D.
- LA TRATTOGRAFIA

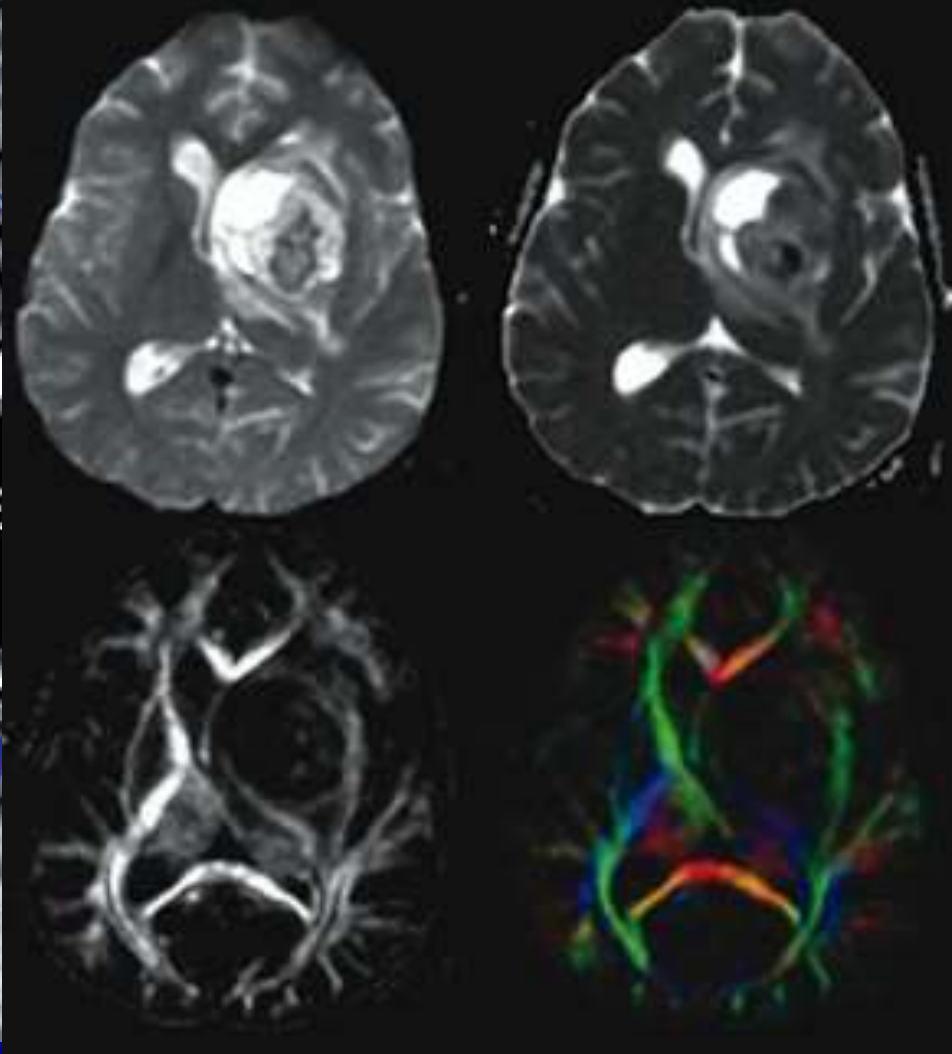
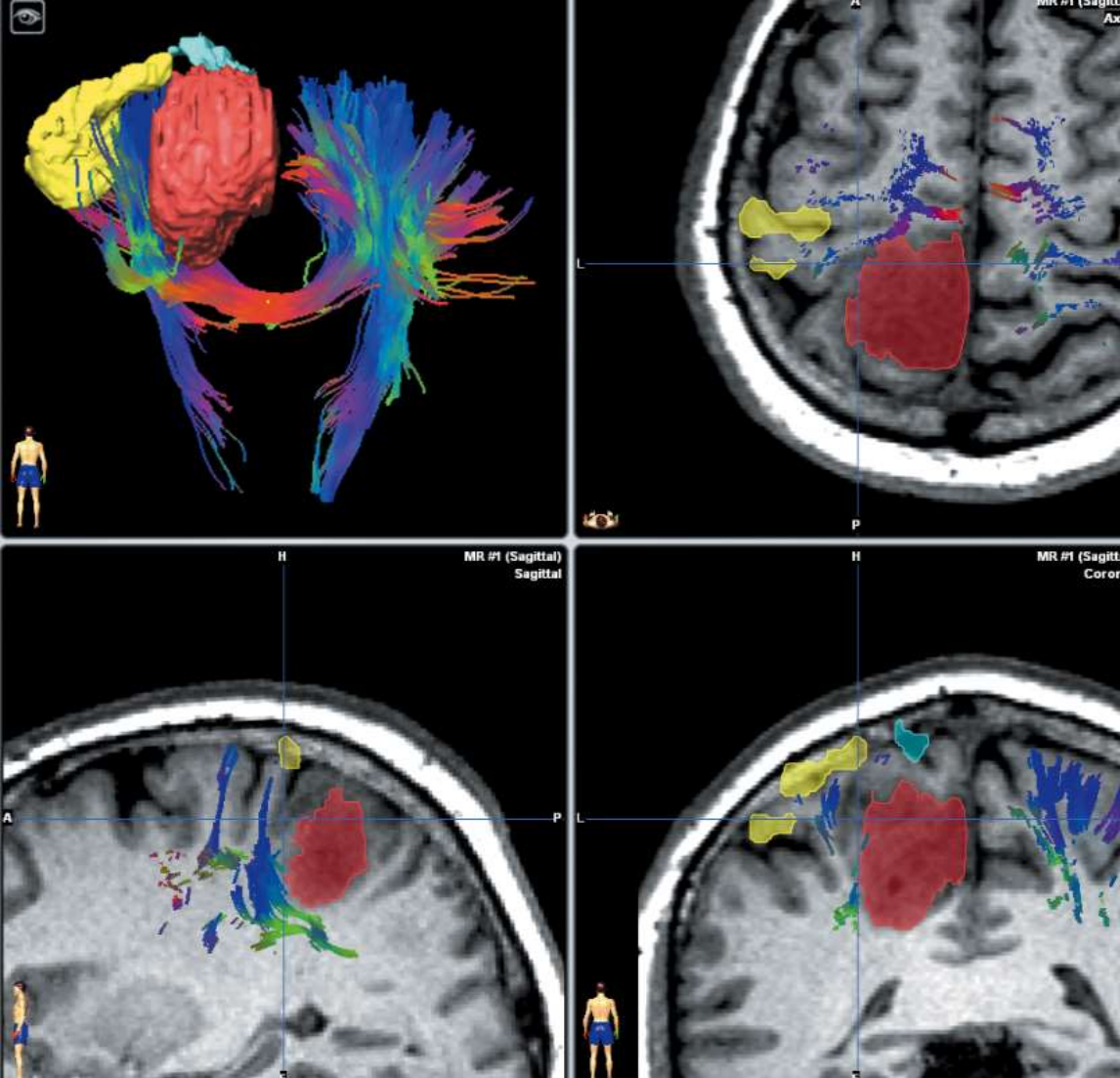






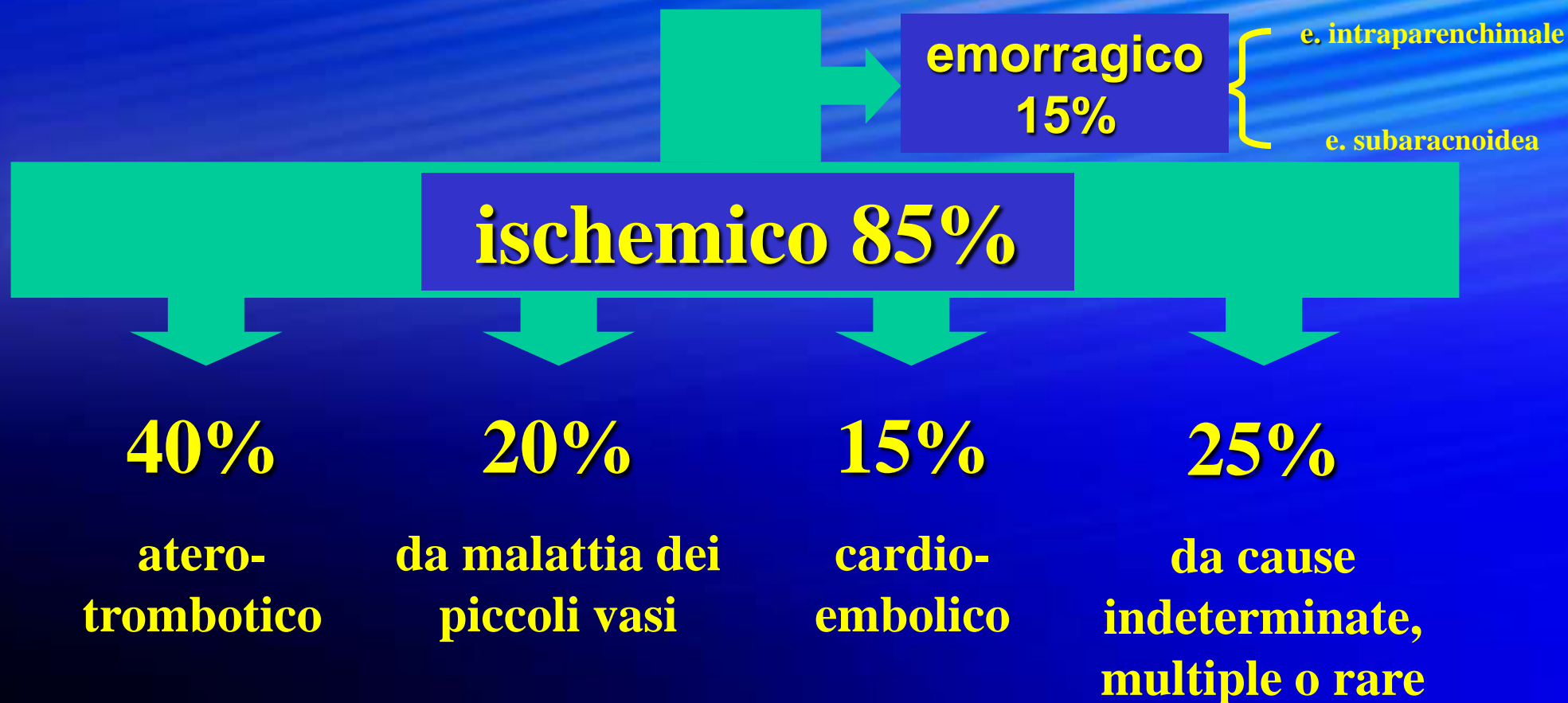






**LE FIBRE CEREBRALI INTERROTTE  
O SPOSTATE DAL TUMORE**

# Cause di ictus



# TC ISCHEMIA

Veloce

Accessibile

Affidabile

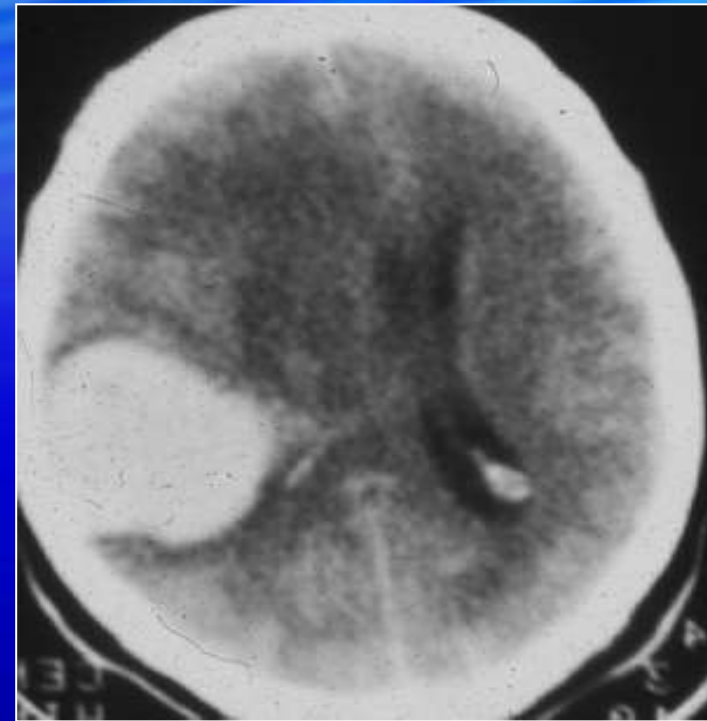
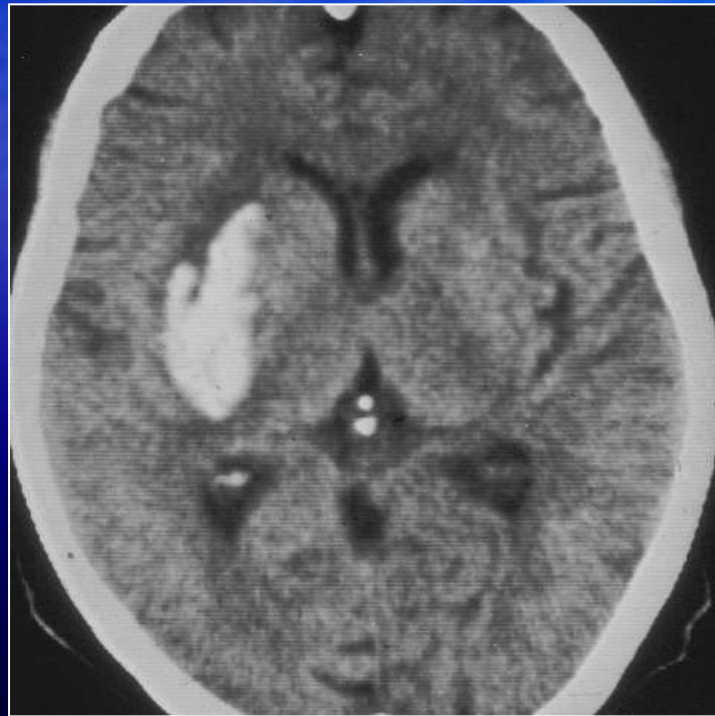
Poco costosa

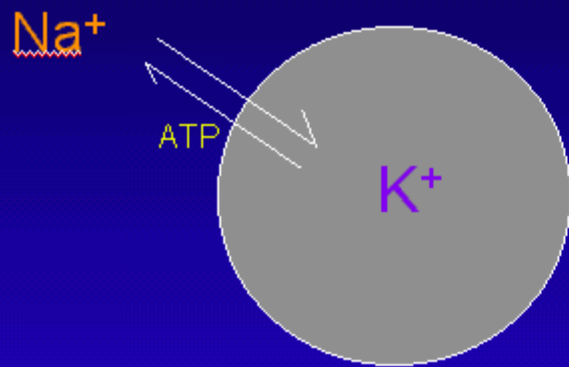
Ben accetta al p.

Sensibile all' emorragia

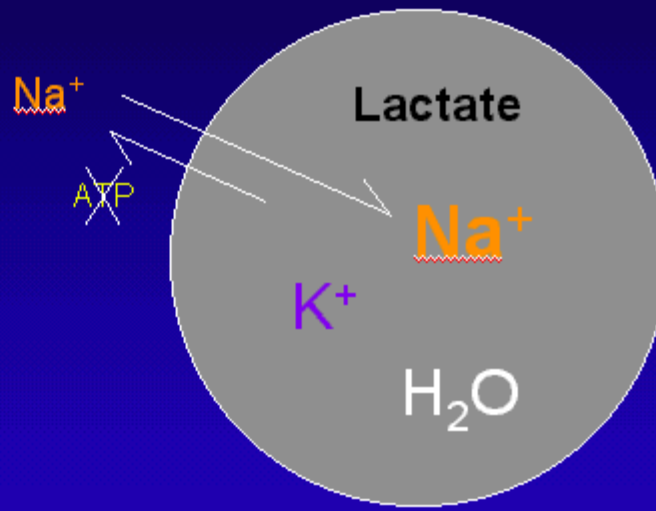
# FASE ACUTA

D.D. tra ischemia e infarto





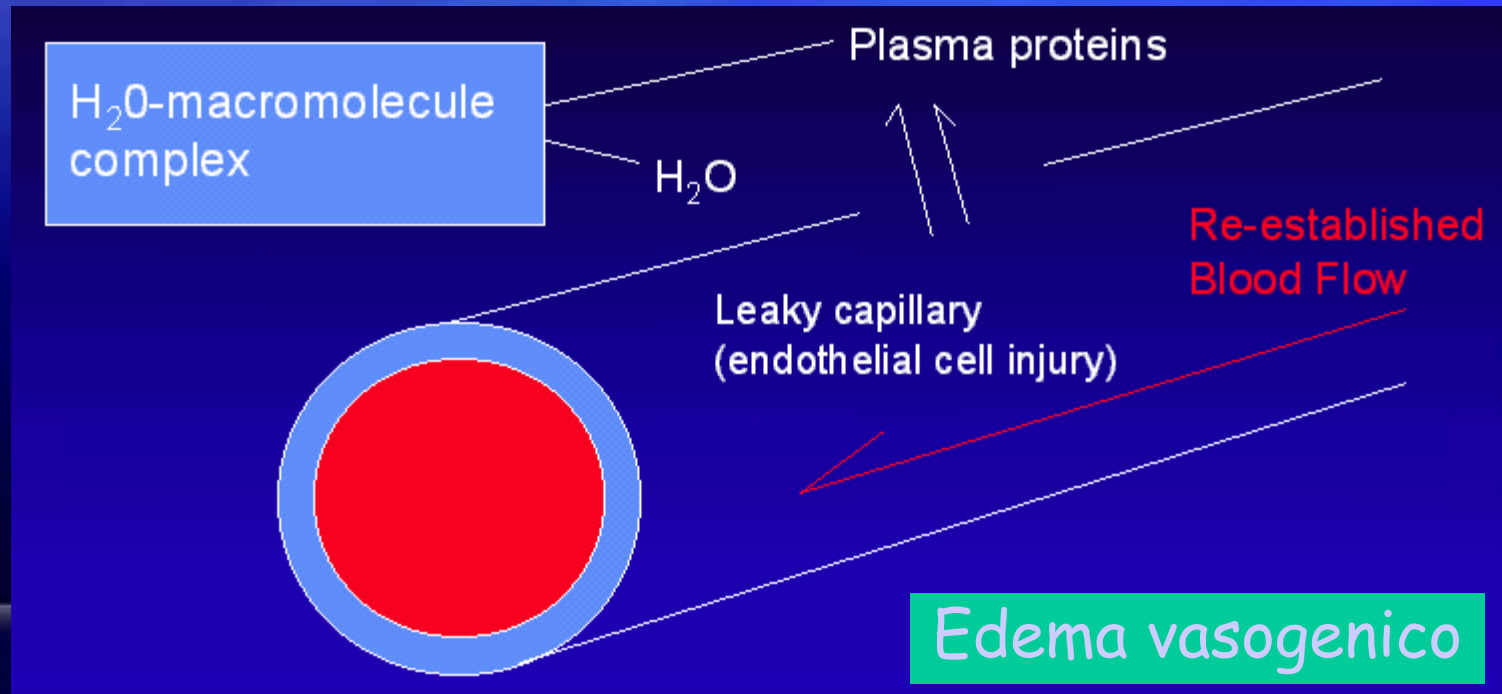
normale



Edema citotossico

Il Na e' un marker di Vitalita' .

- <45 mM normale
- < 55 mM reversibile
- <68 mM irreversibile



Edema vasogenico

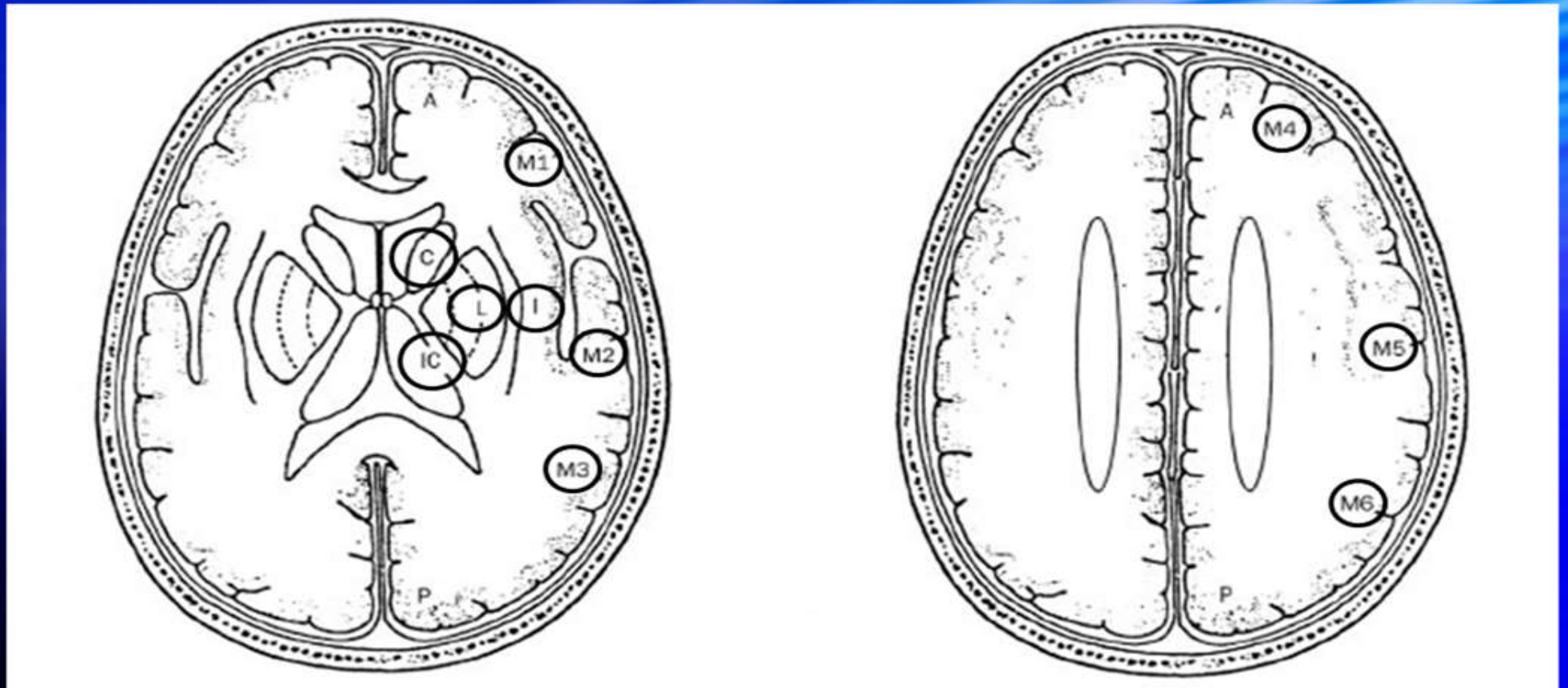
# Ipodensità precoce

- valore predittivo di infarto 96%
- maggiore incidenza emorragie
  - peggiore prognosi
- ove superi il 33% del territorio vascolare controindica il trattamento con fibrinolitici

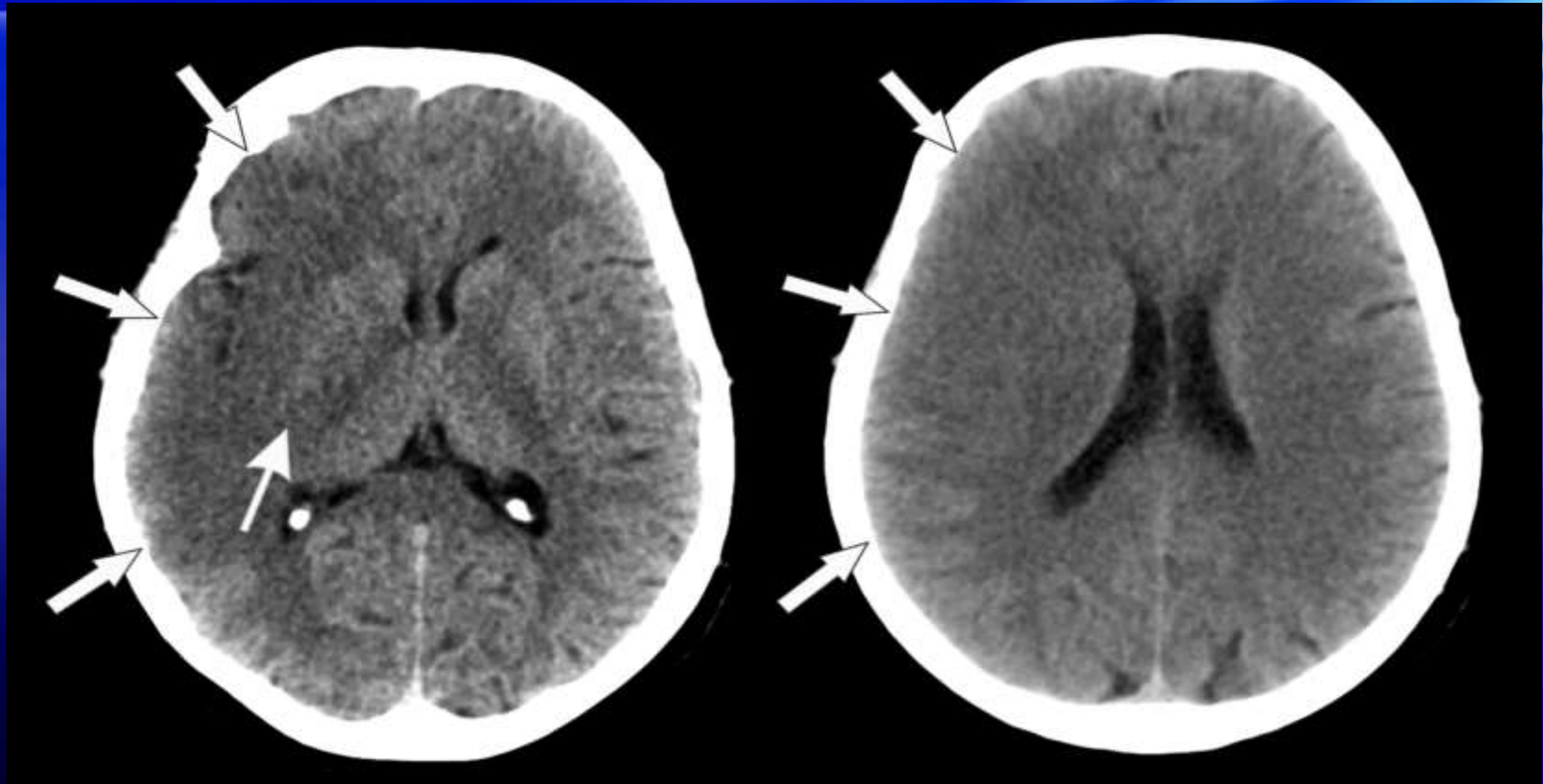
# T.C. ipodensità precoce iperd ACM

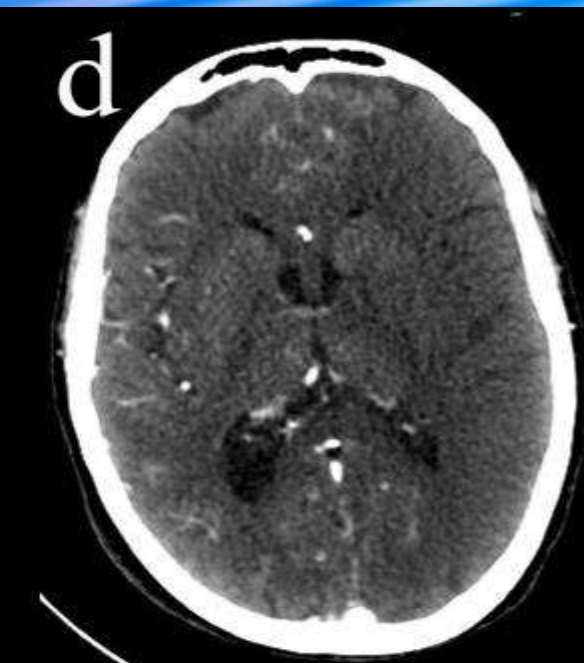
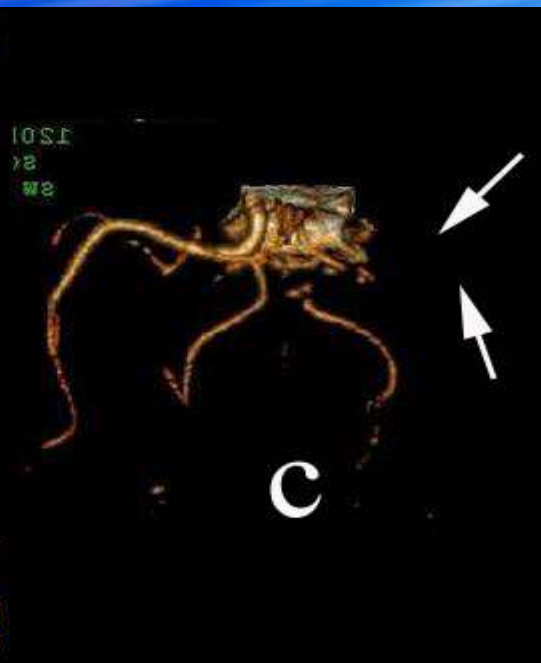
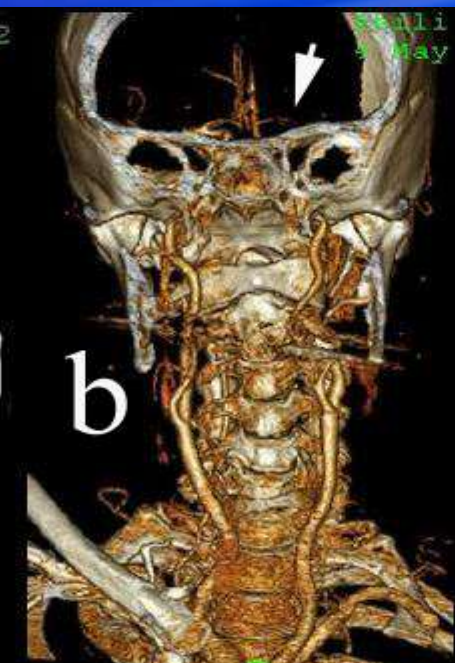


# Fig.5 rappresentazione schematica ASPECTS

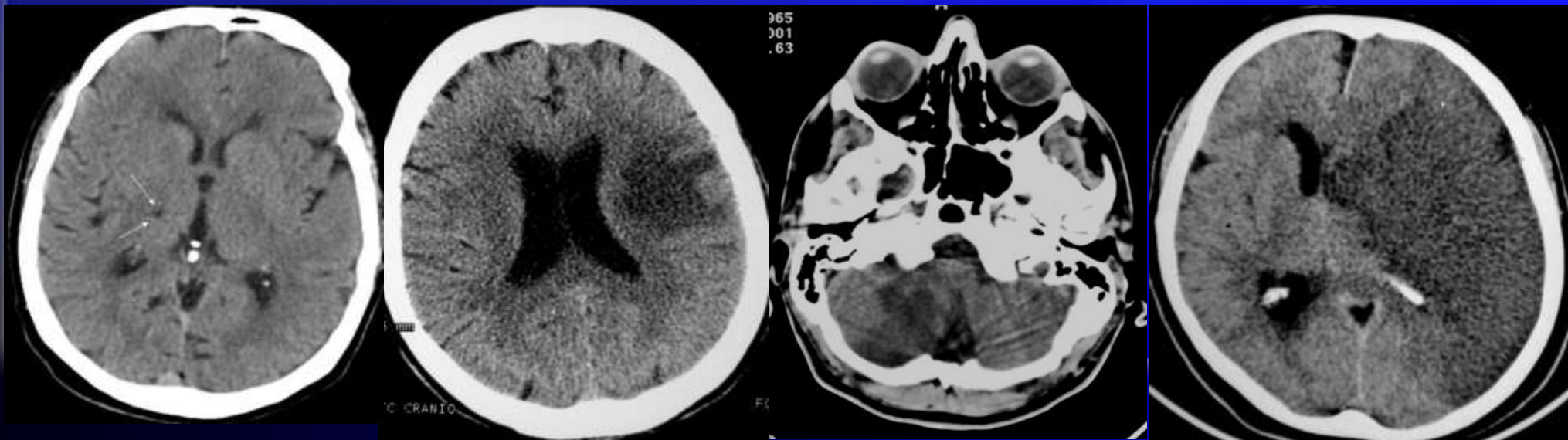
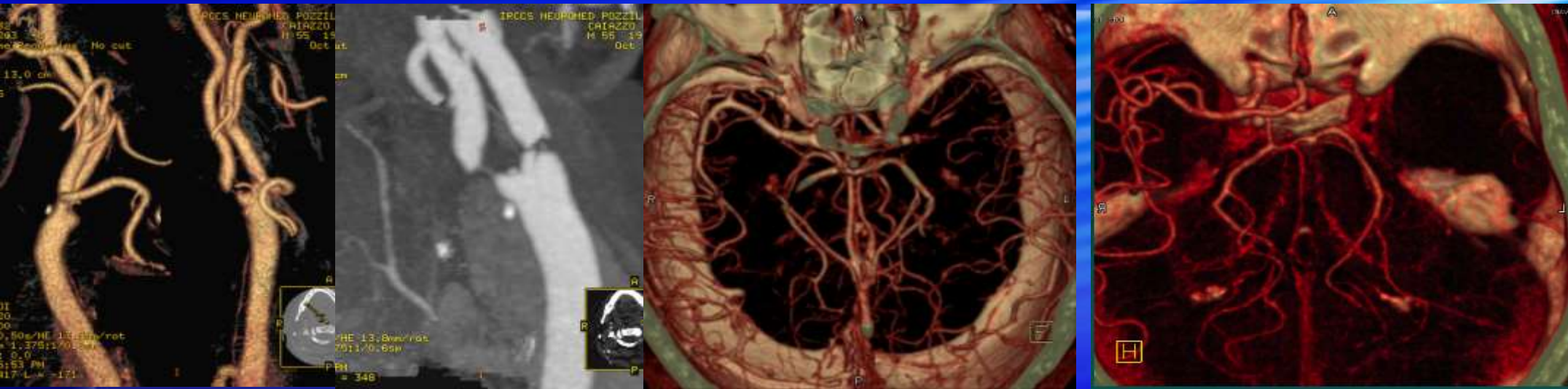


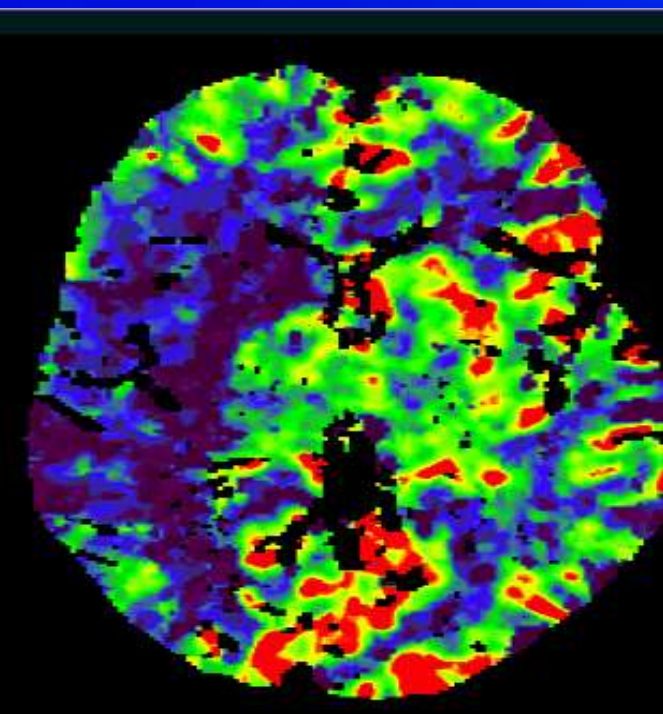




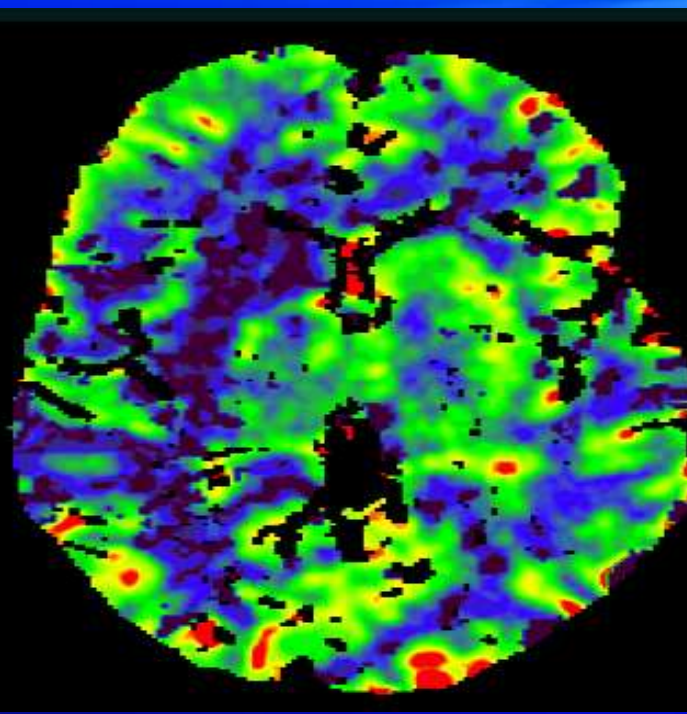


# ANGIO-TC TC

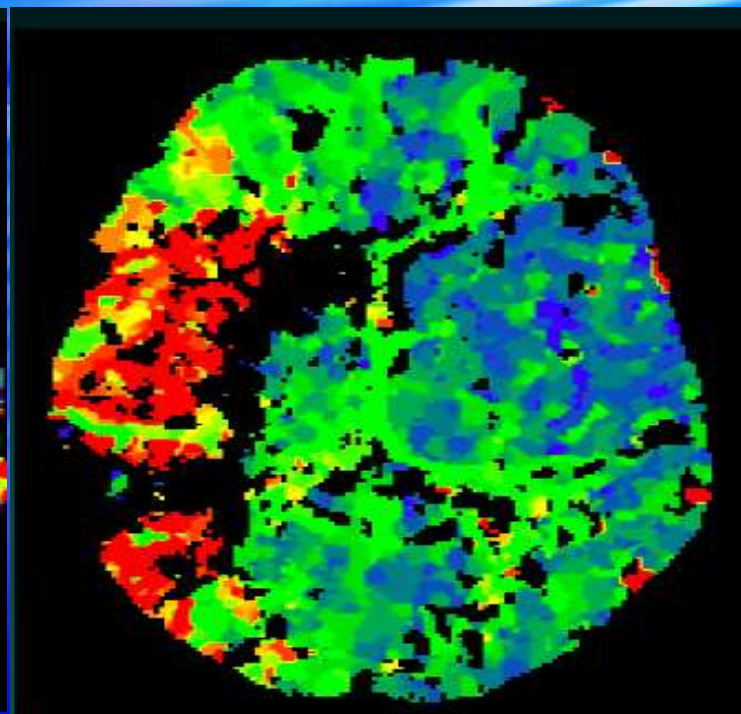




CBF

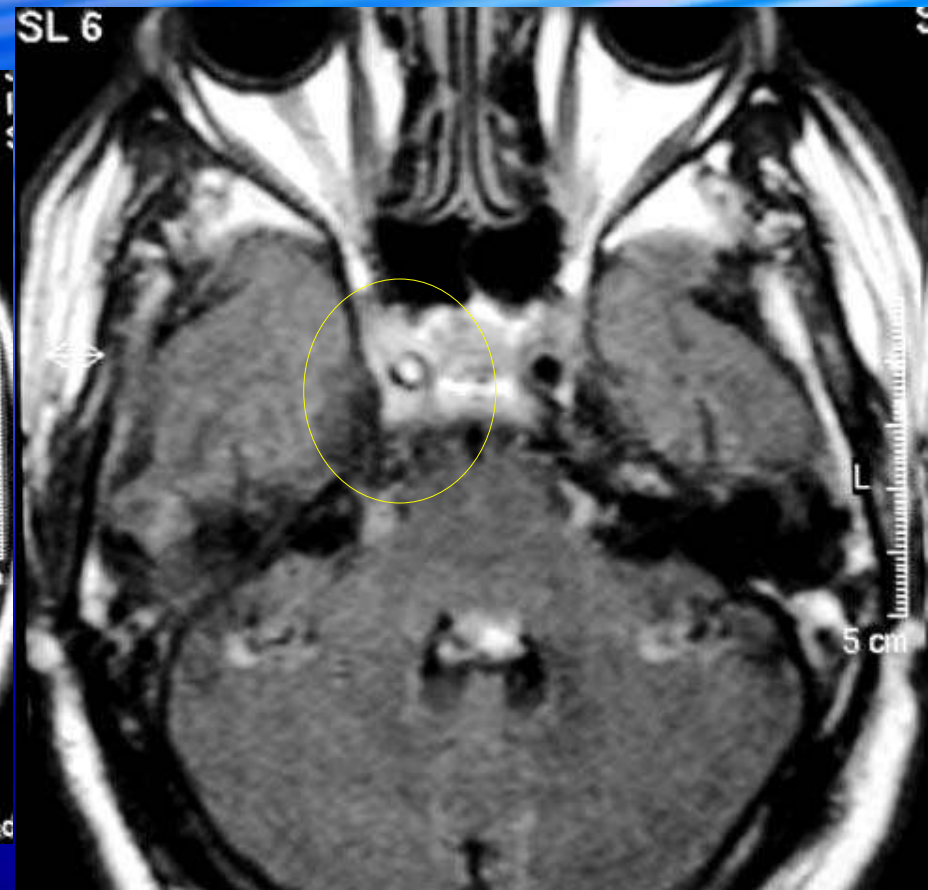
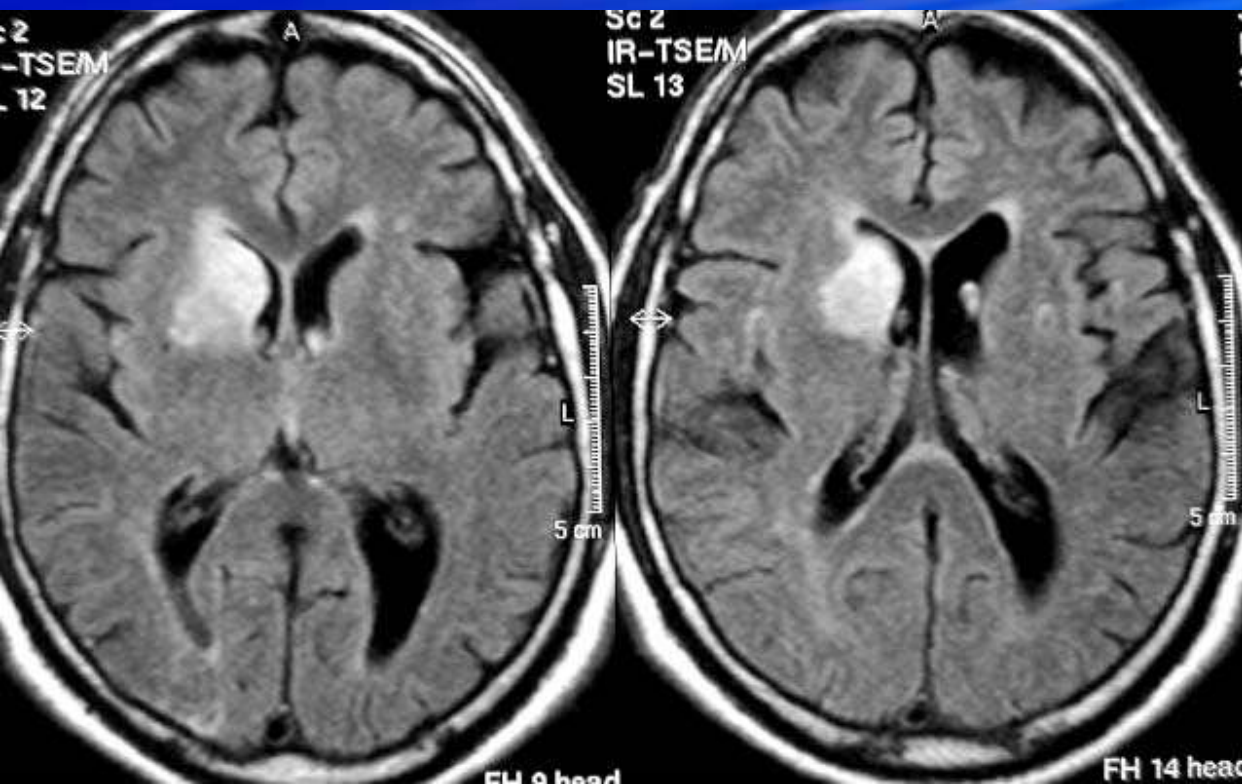


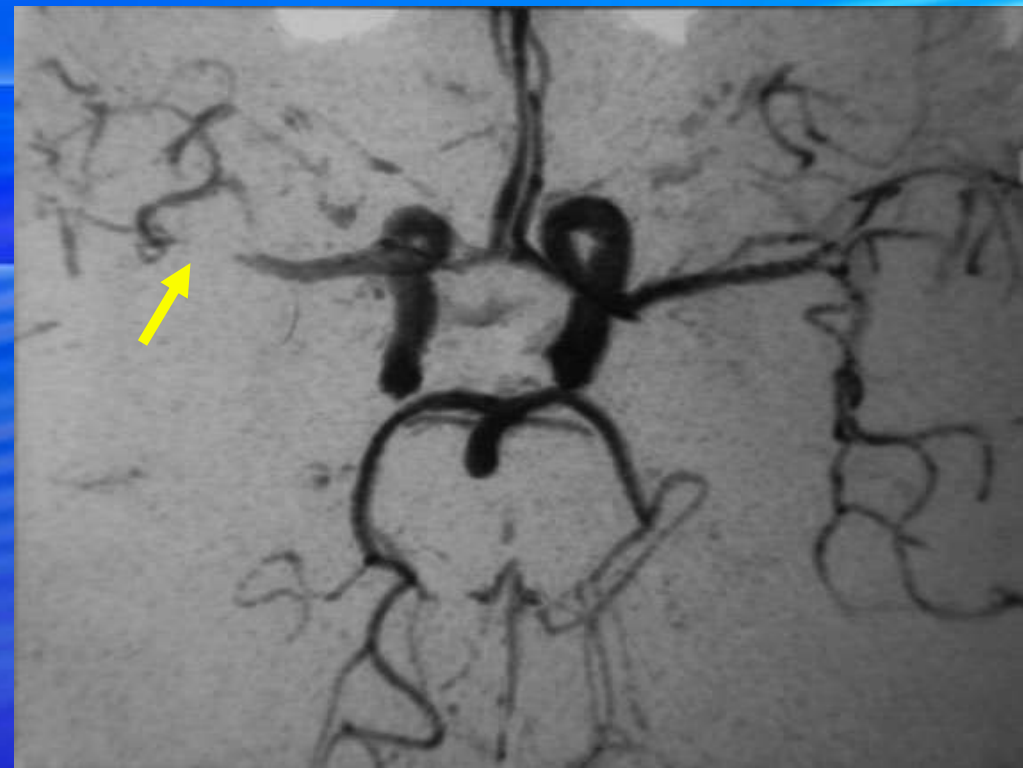
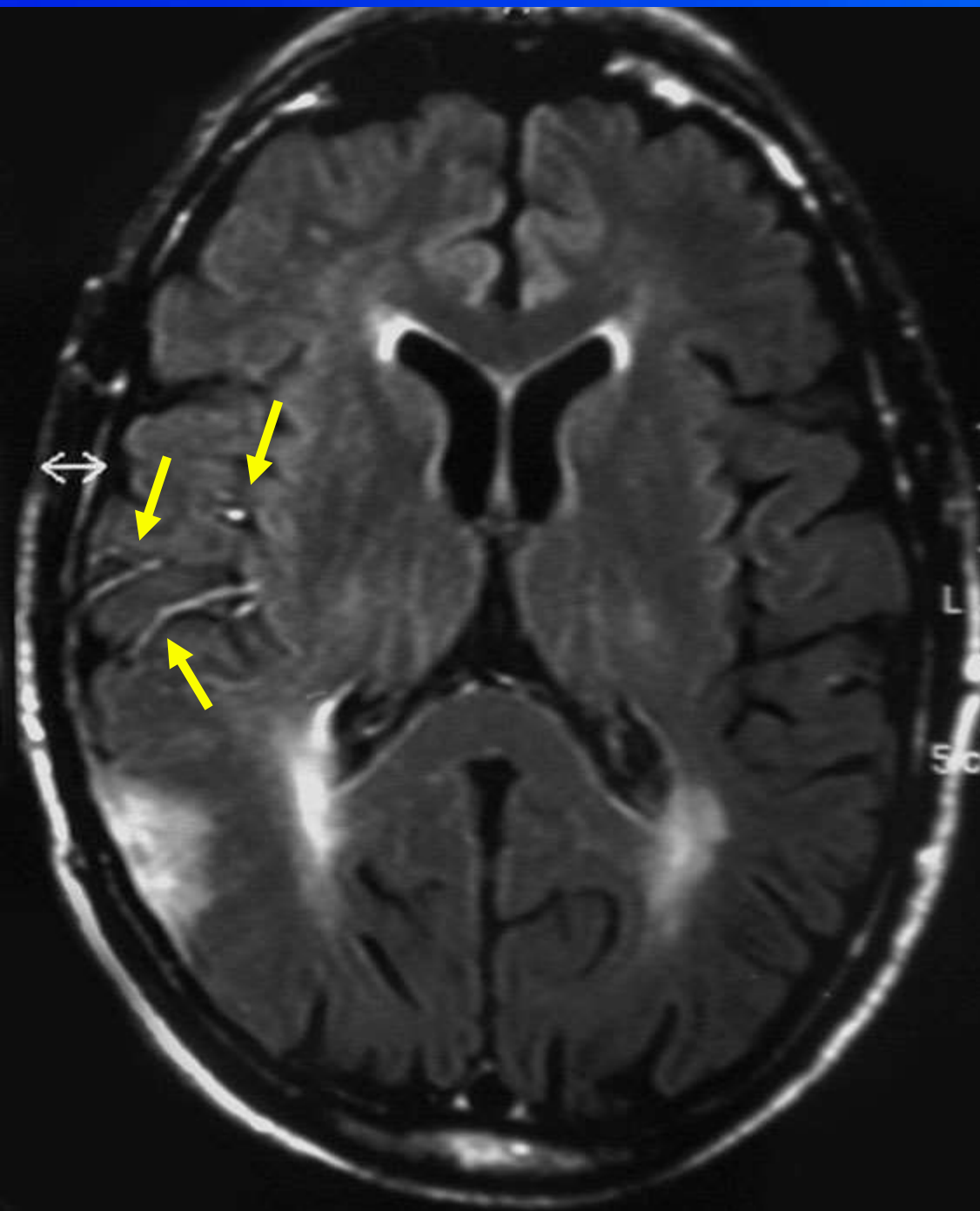
CBV



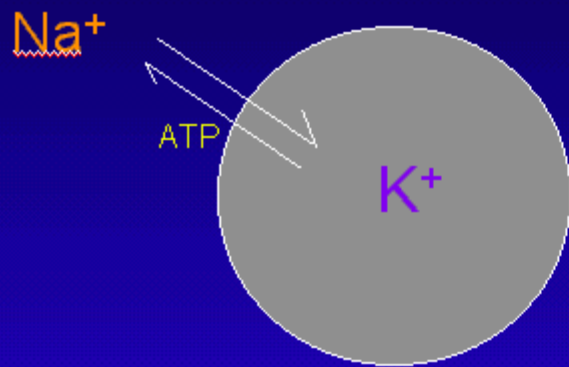
MTT

# identificazione dell' occlusione vascolare

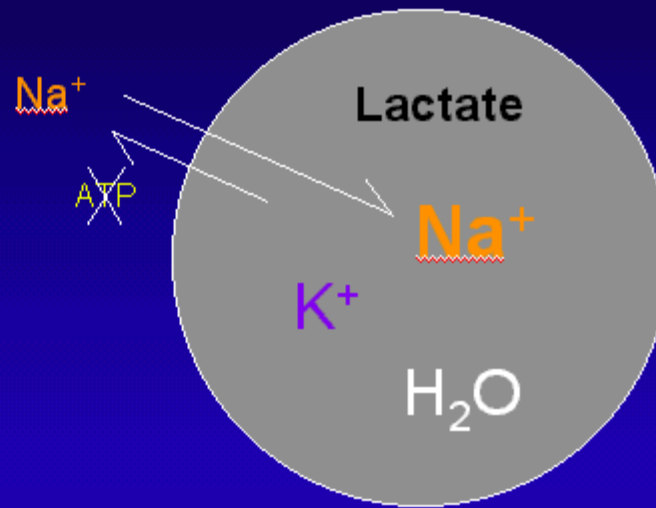




L'iperintensità vascolare in FLAIR esprime un flusso rallentato ed è segno precoce di ischemia



normale



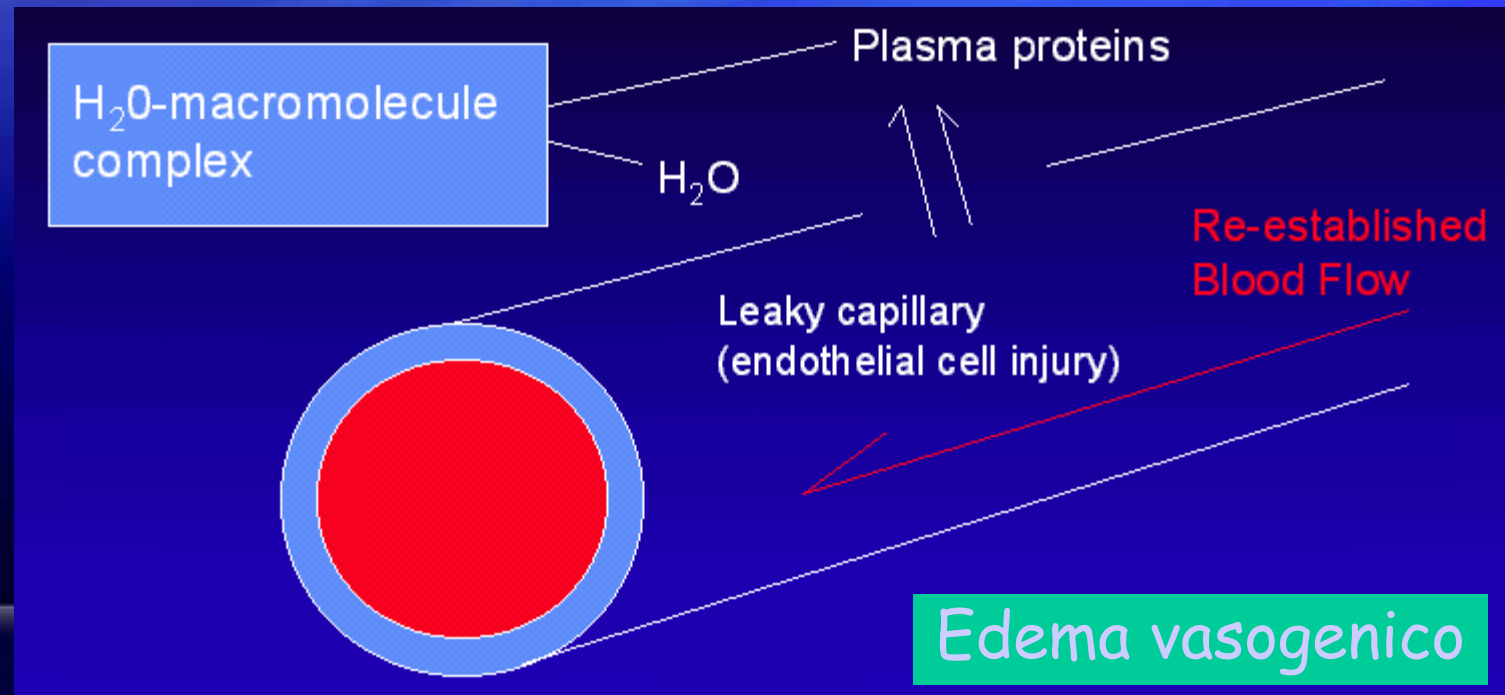
Edema citotossico

Il Na e' un marker di Vitalita' .

<45 mM normale

< 55 mM reversibile

<68 mM irreversibile

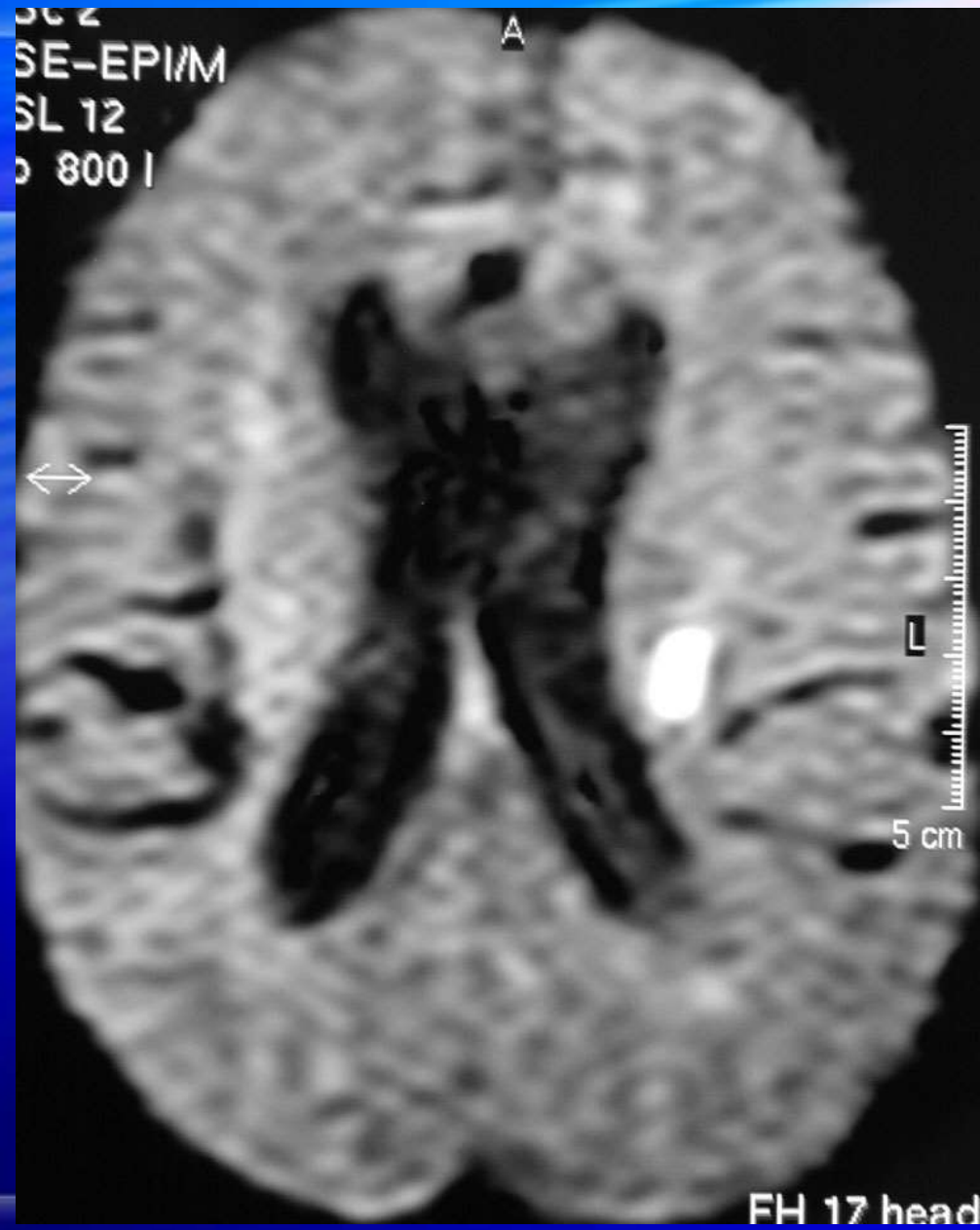


Edema vasogenico

## Diffusione con MR: ICTUS

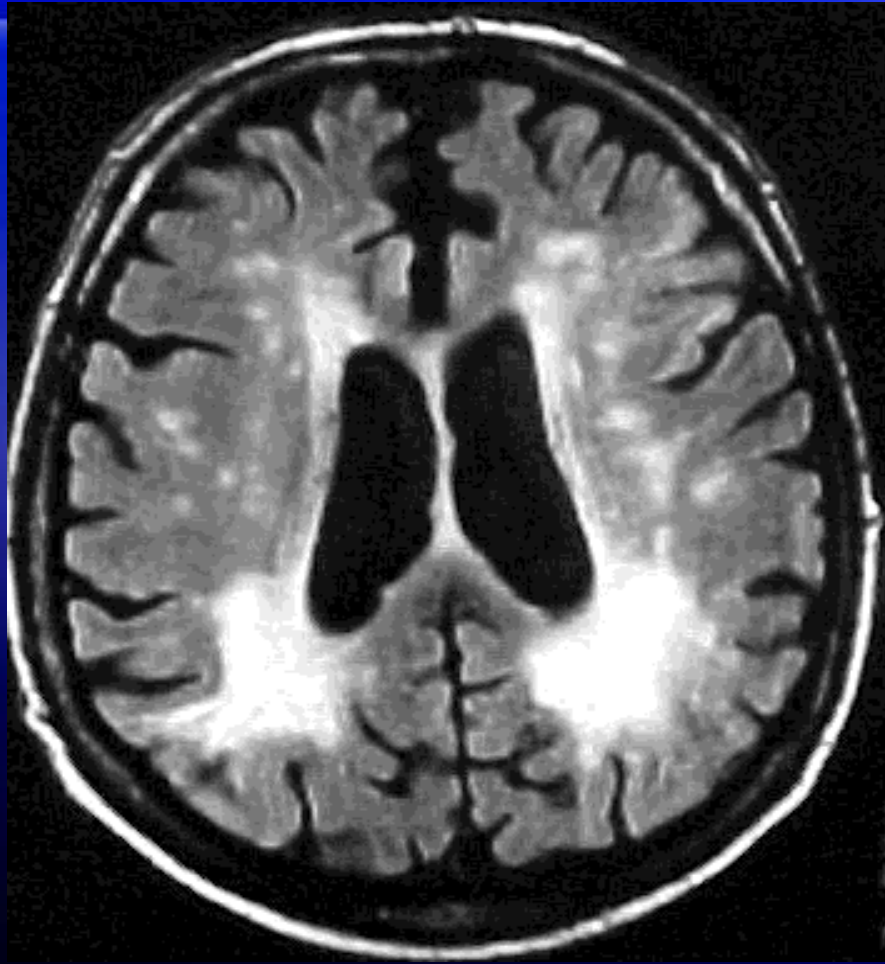
- Diffusione elevata nell'acqua e nel liquor
- Diffusione bassa nell'ischemia acuta (edema citotossico) per riduzione della mobilità dell'acqua
  - Diffusione elevata nell'edema vasogenico



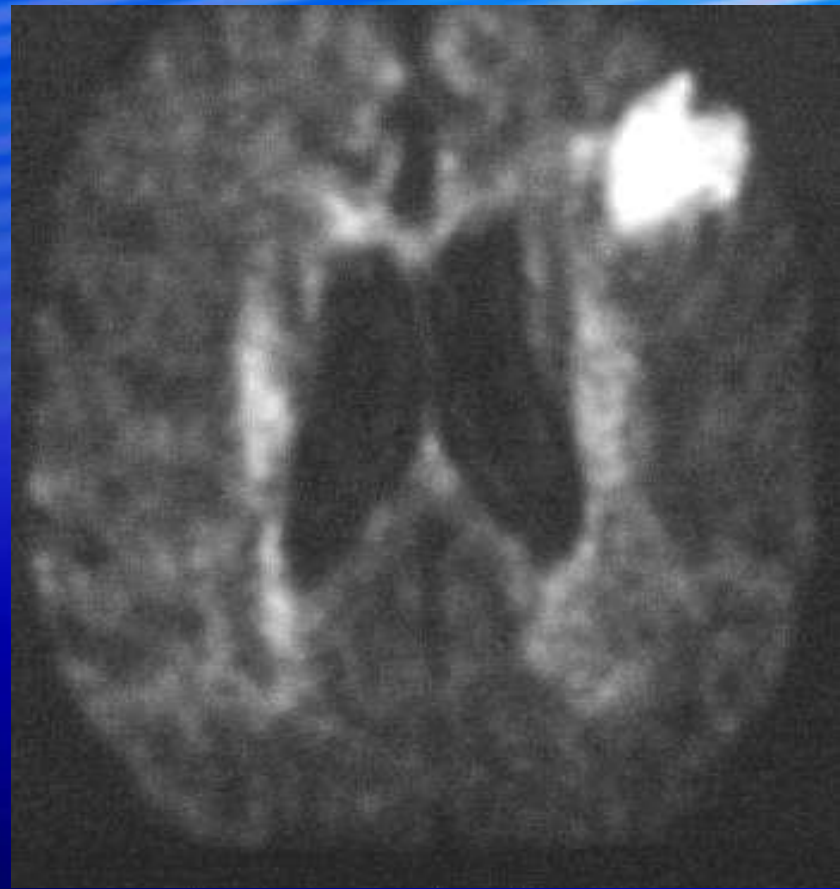


P.L.  
male  
75 s

## Acute ischemia 3 h (FLAIR DWI )



FLAIR



DWI

# FASE ACUTA

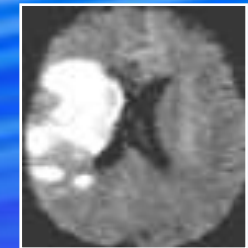
# DWI

Sulle immagini DWI ogni regione con una ridotta mobilità delle molecole di H<sub>2</sub>O appare iperintensa

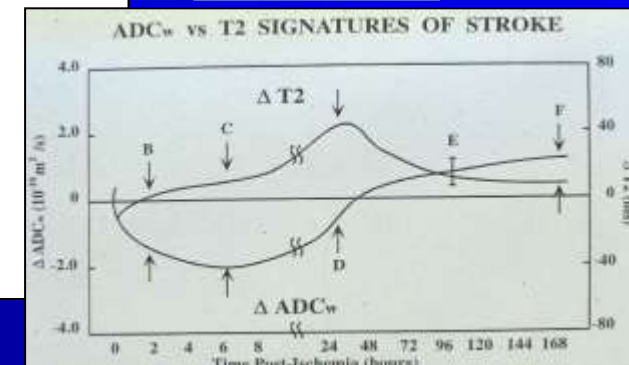
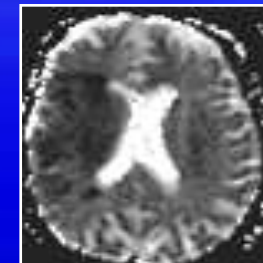
Dalle immagini DWI si ottengono mappe di ADC

Sulle mappe di ADC l'area ischemica appare scura (valori ridotti)

I valori di ADC sono strettamente correlati al timing dell'ischemia



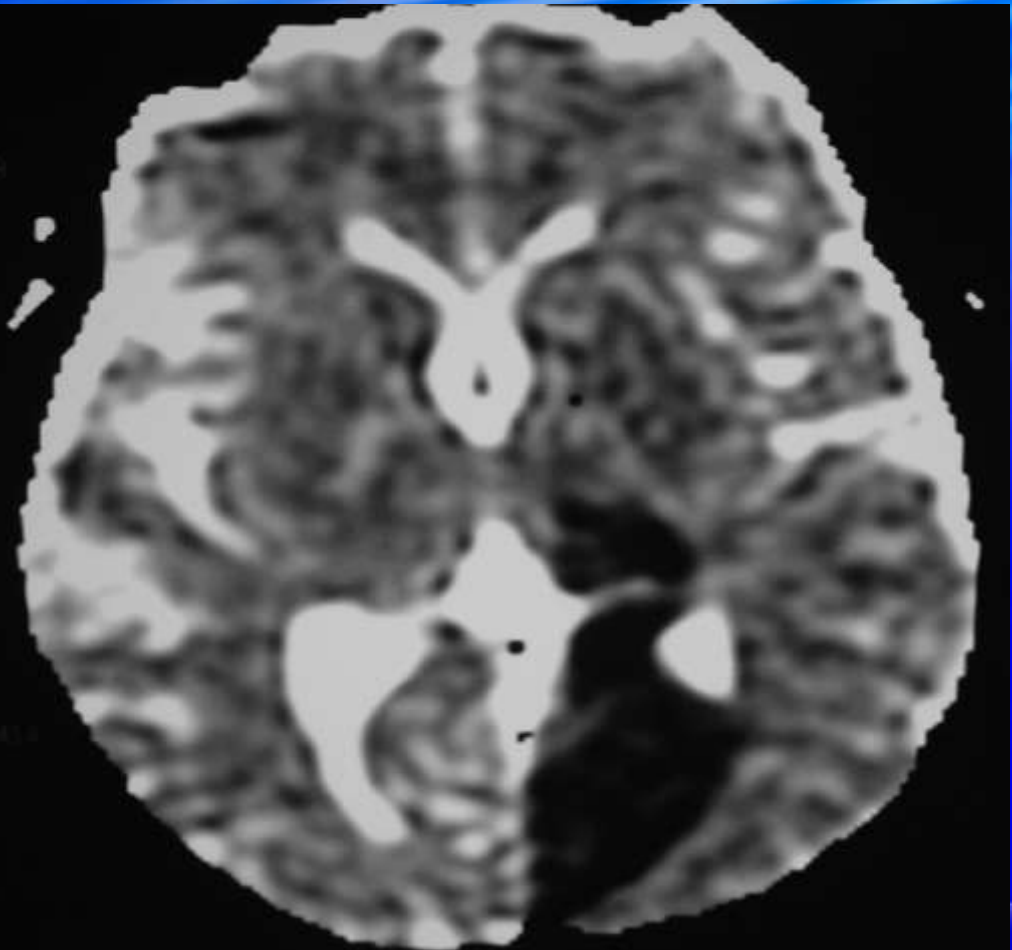
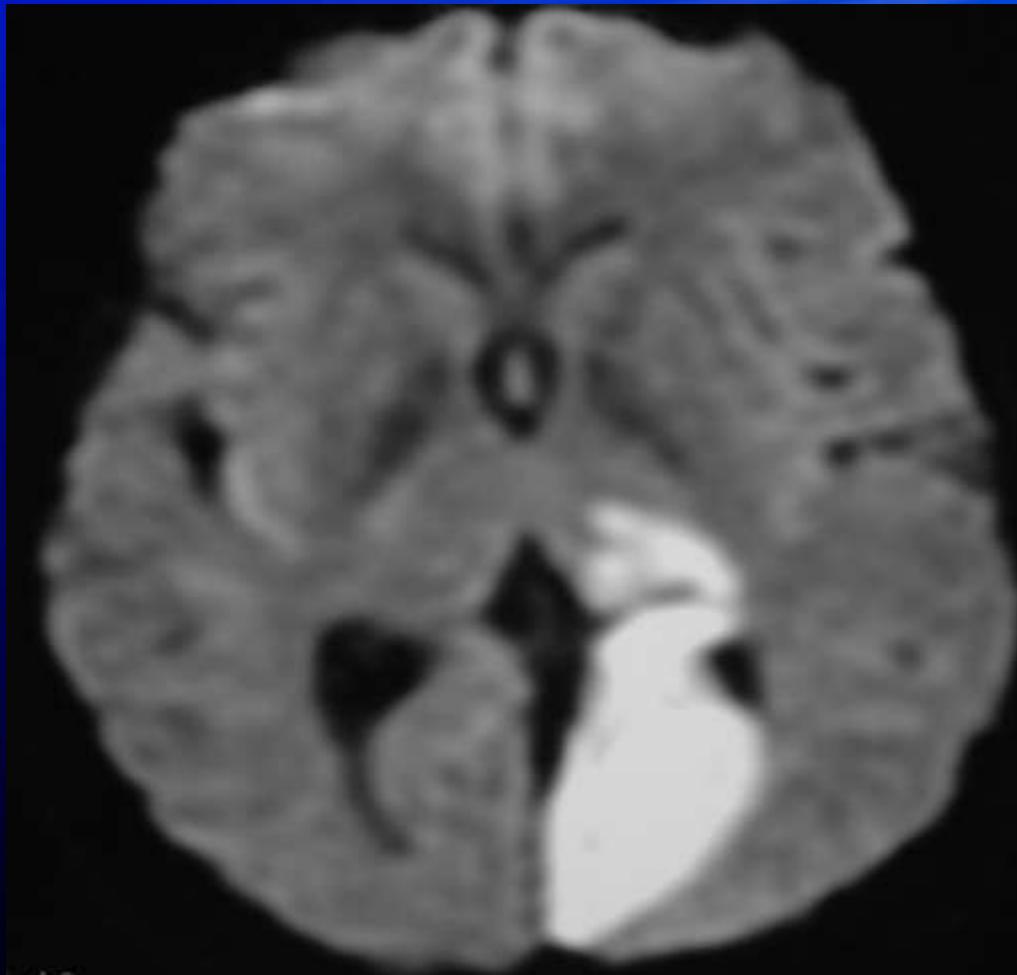
$$D = -1/b \ln (I/I_0)$$



# Ischemia acuta

DWI

ADC

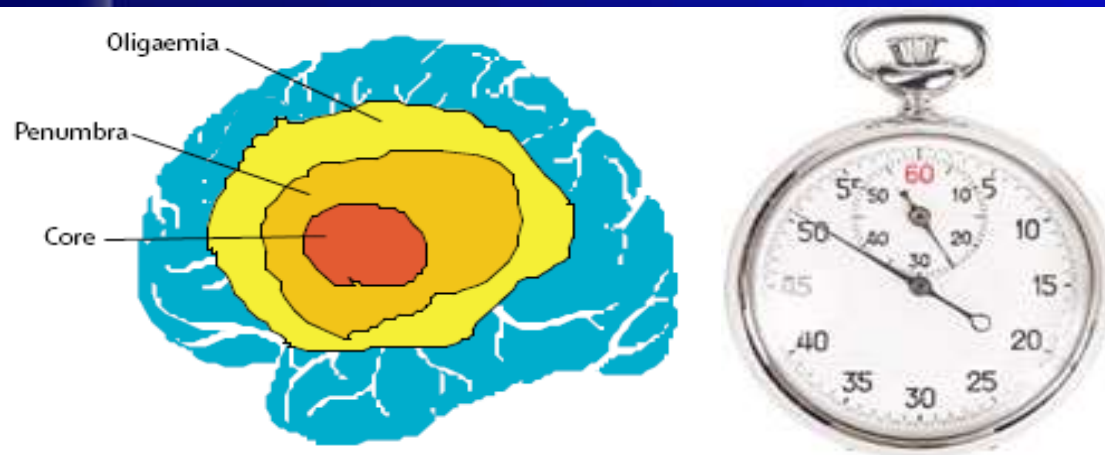


# RICERCA DI UNA FINESTRA TERAPEUTICA PIÙ LUNGA

REVIEW ARTICLE

R.G. González

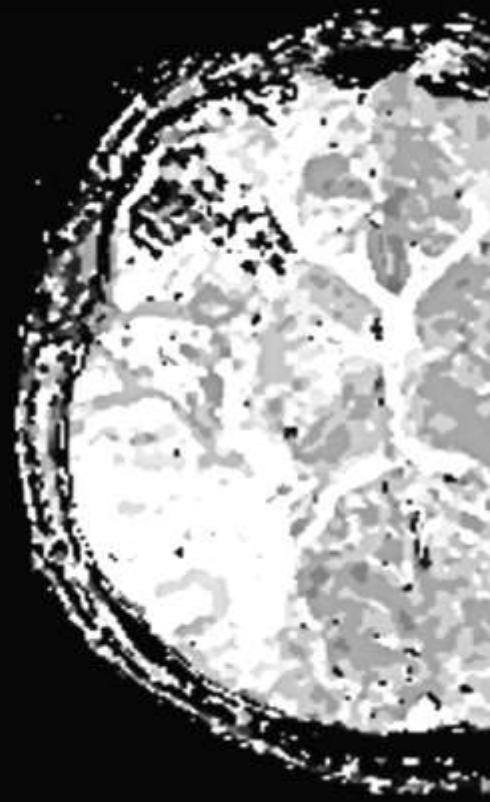
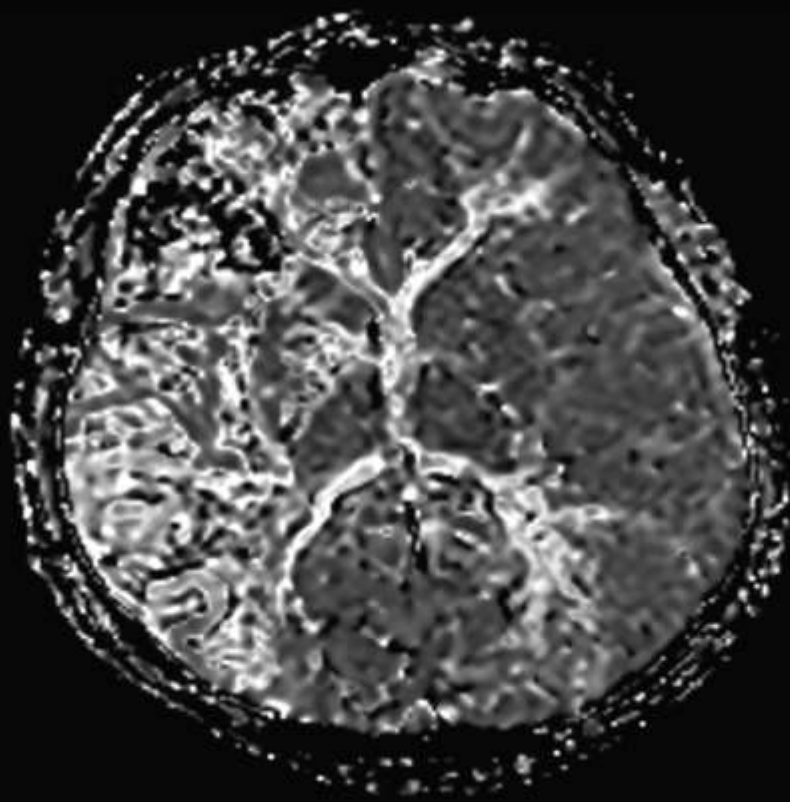
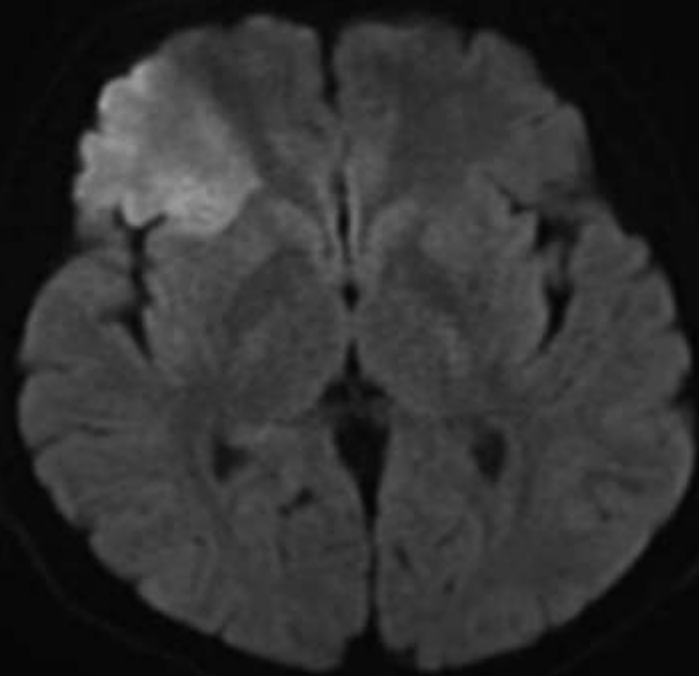
## Imaging-Guided Acute Ischemic Stroke Therapy: From “Time Is Brain” to “Physiology Is Brain”

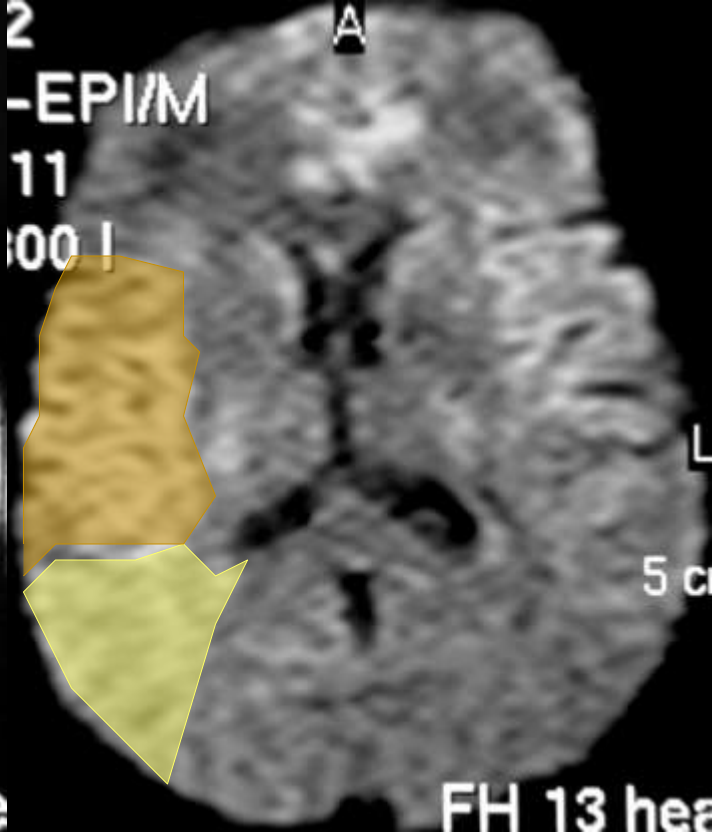
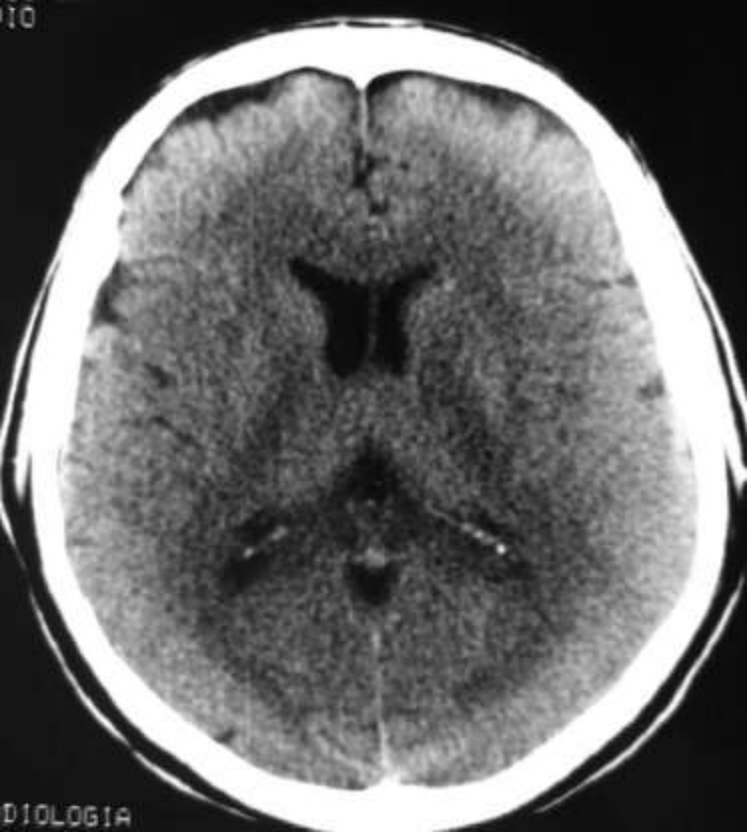


| AJNR 27 | Apr 2006 |

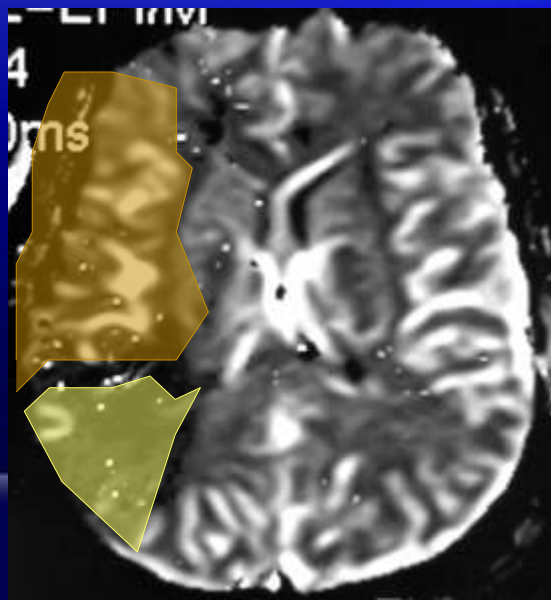
# PERFUSIONE: impiego clinico nell'ischemia cerebrale

- la diffusione non fornisce informazioni sulla presenza ed entità di tessuto "salvabile"
- questo dato può essere conosciuto utilizzando studi di perfusione
- la perfusione cerebrale può essere valutata mediante studi con traccianti diffusibili (SPECT) o mezzi di contrasto intra-vascolari (RM e TC)





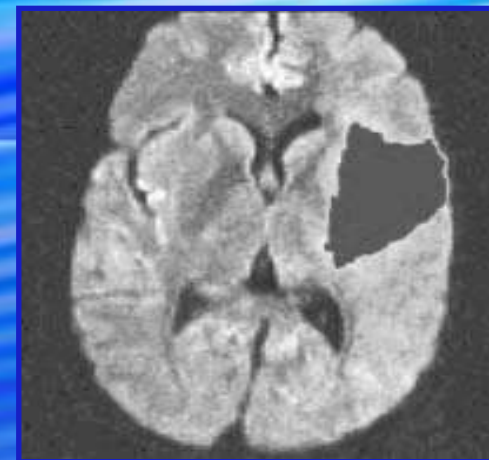
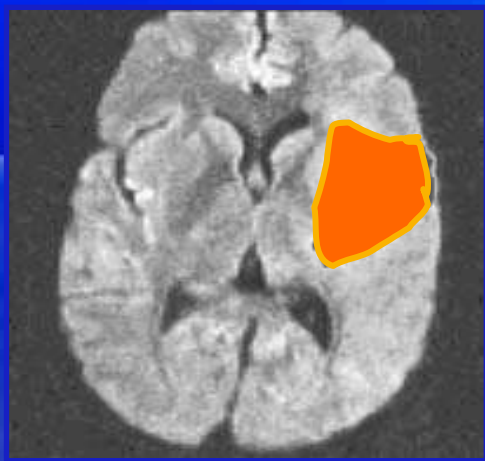
diffusione  
+  
perfusione



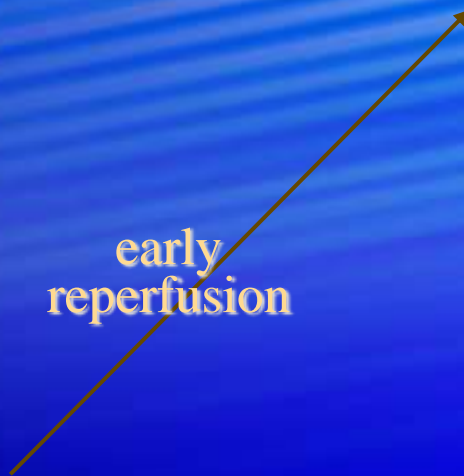
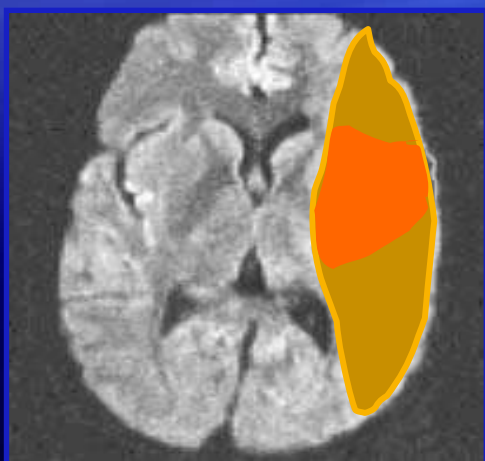
= penombra  
ischemica



$PWI \leq DWI$



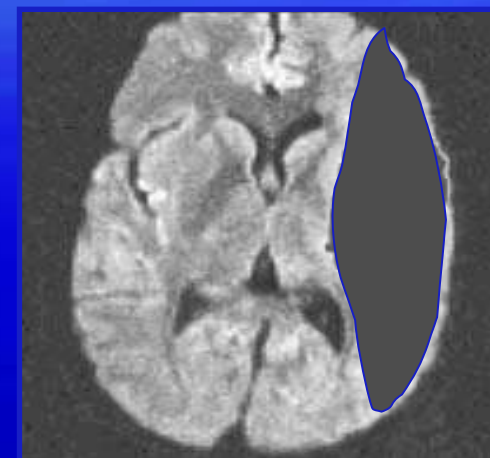
$PWI > DWI$






early  
reperfusion

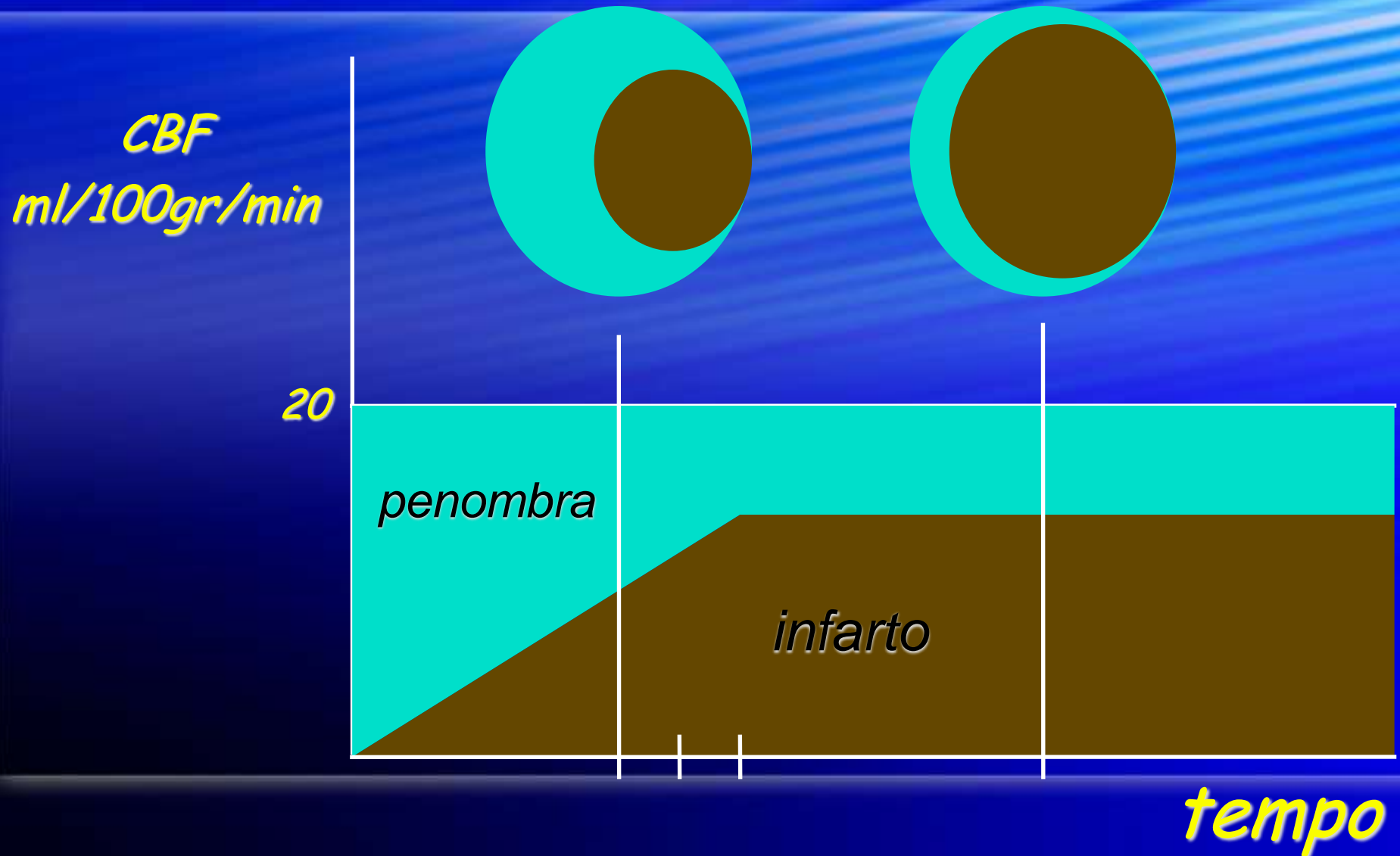


no early  
reperfusion



-  Early DWI lesion
-  Early PWI lesion
-  Final lesion

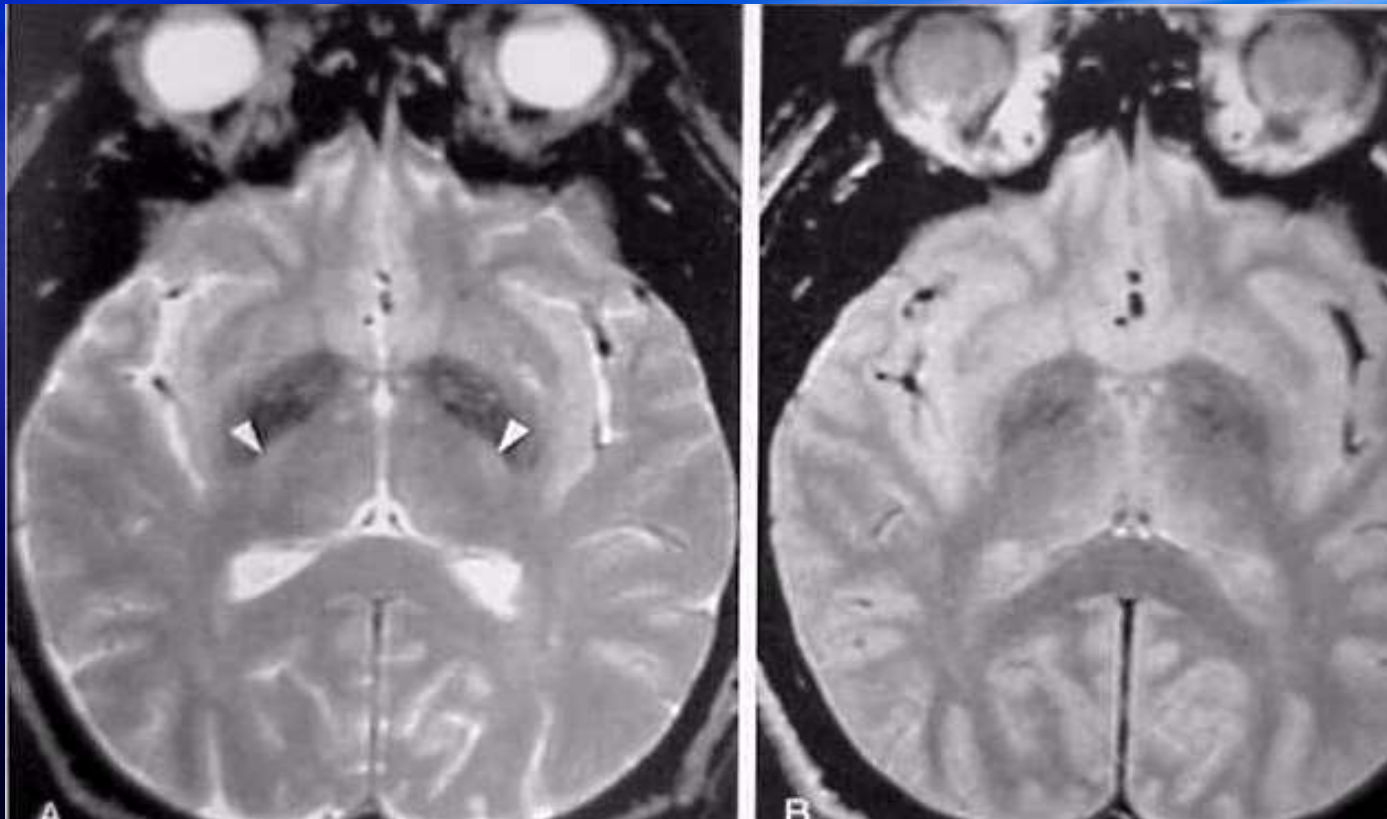
CBF non così ridotto come al centro dell'area infartuale  
danno tissutale potenzialmente reversibile



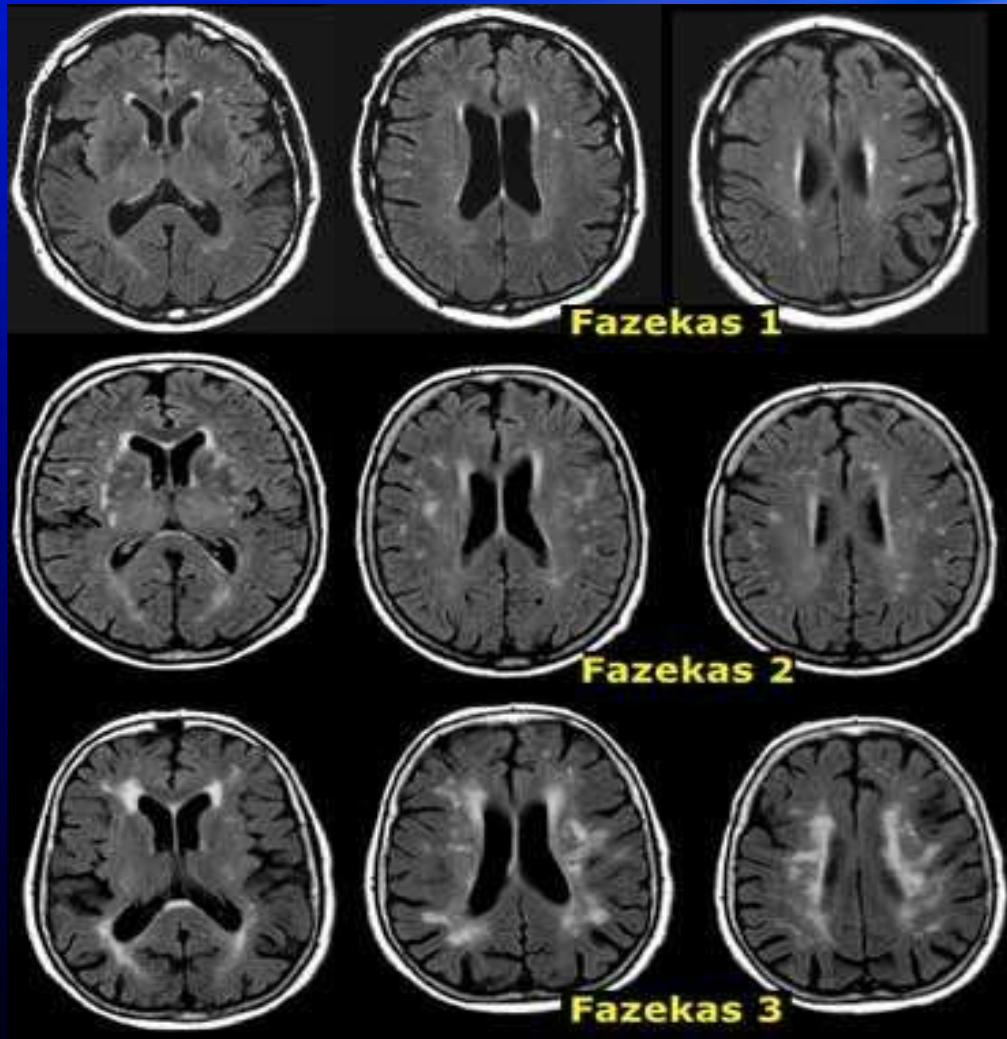
**INVECCHIAMENTO  
FISIOLOGICO**

**PATOLOGA DEGENERATIVA**

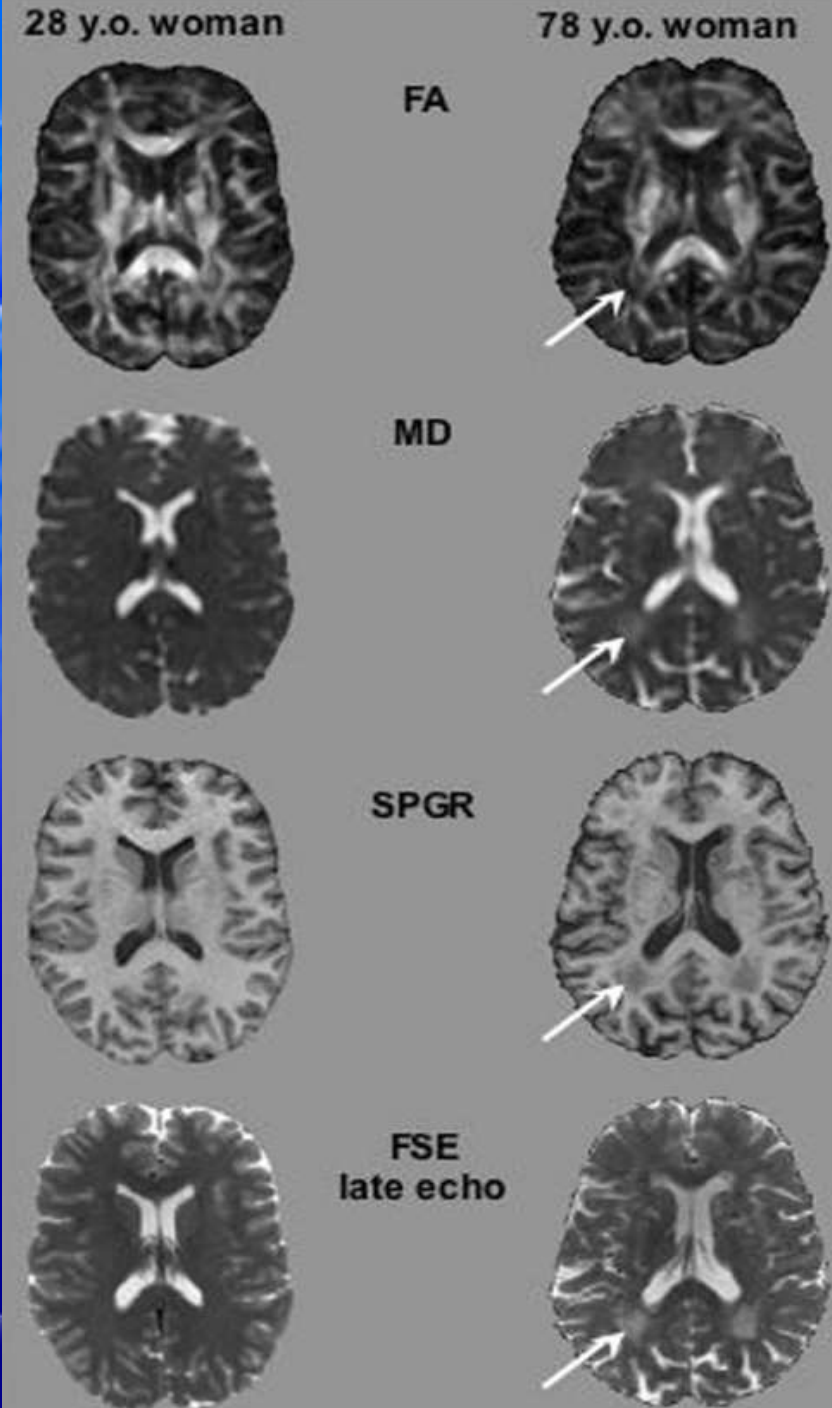
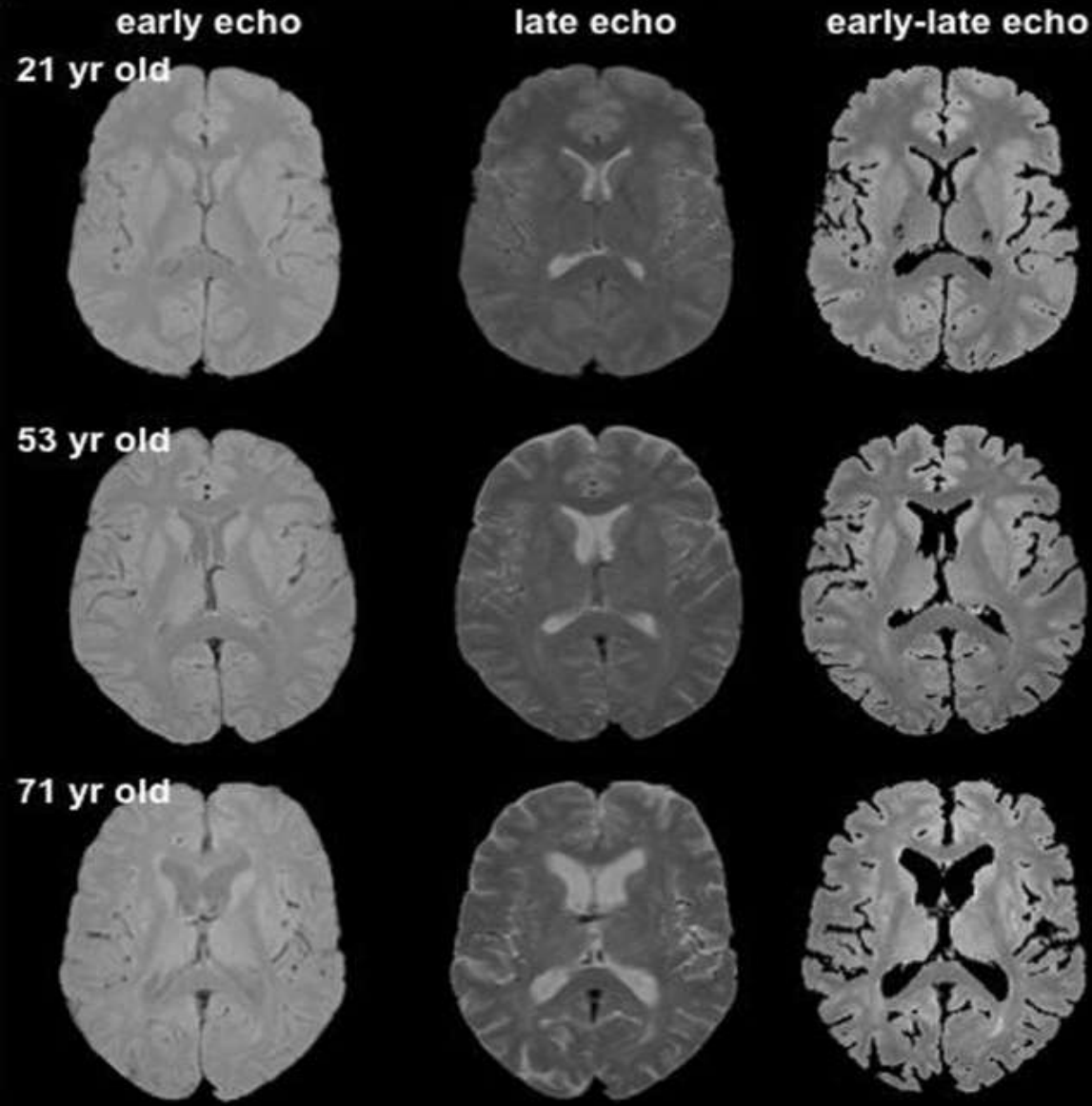
# SOGETTO ANZIANO



# LESIONI DELLA SB



WMLs. Fazekas I is considered normal in aging. Fazekas II is considered abnormal in patients < 75 Years. Fazekas III is abnormal in any age group. These WMLs are probably due to microangiopathy and seen more frequently in patients with vascular risk factors



*The British Journal of Radiology, 80 (2007), S99-S108*

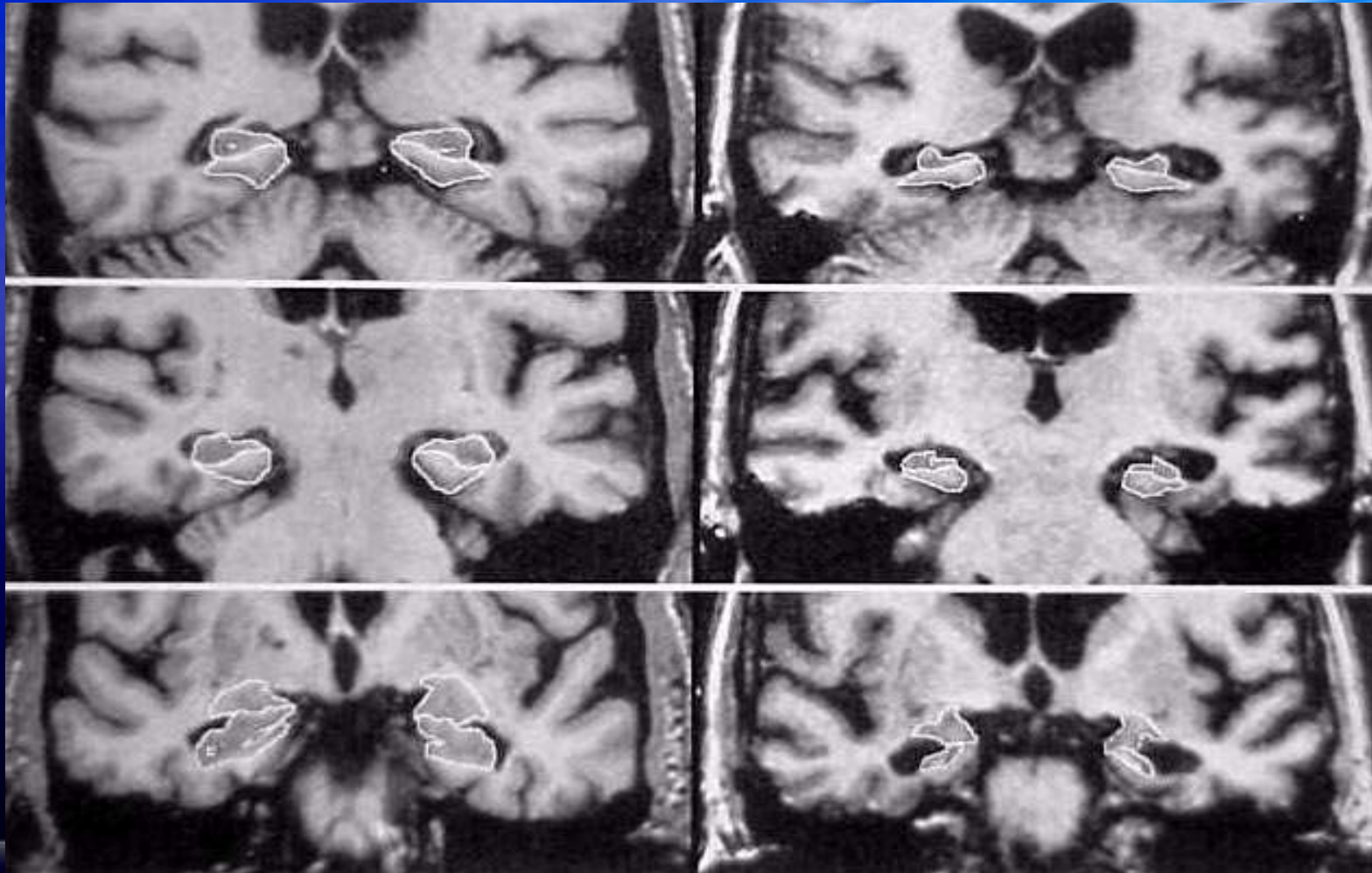
## Neuroradiological characterization of normal adult ageing

<sup>1</sup>E V SULLIVAN, PhD and <sup>1,2</sup>A PFEFFERBAUM, MD

<sup>1</sup>Department of Psychiatry and Behavioral Sciences, Stanford University School of Medicine, Stanford and <sup>2</sup>Neuroscience Program, SRI International, Menlo Park, California, USA

# IPPOCAMPO

NOR AD





Pars reticulata

Pars compacta

Pars compacta

N rosso

B

et

D



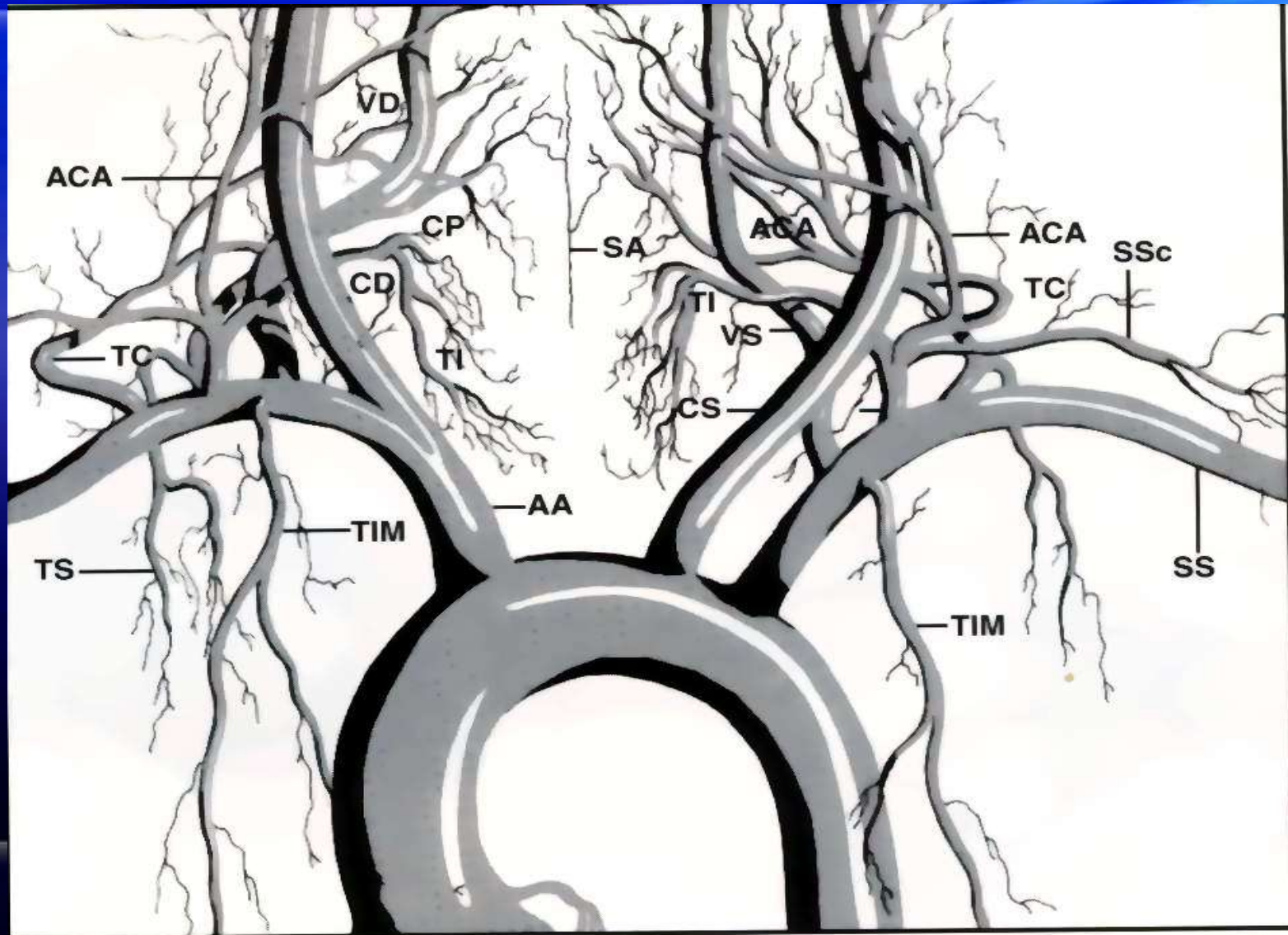
# INDICAZIONI ALLA:

A.D.A.  
ANGIOGRAFIA DIGITALE ARTERIOSA  
PER CATETERE

# SALA ANGIOGRAFICA



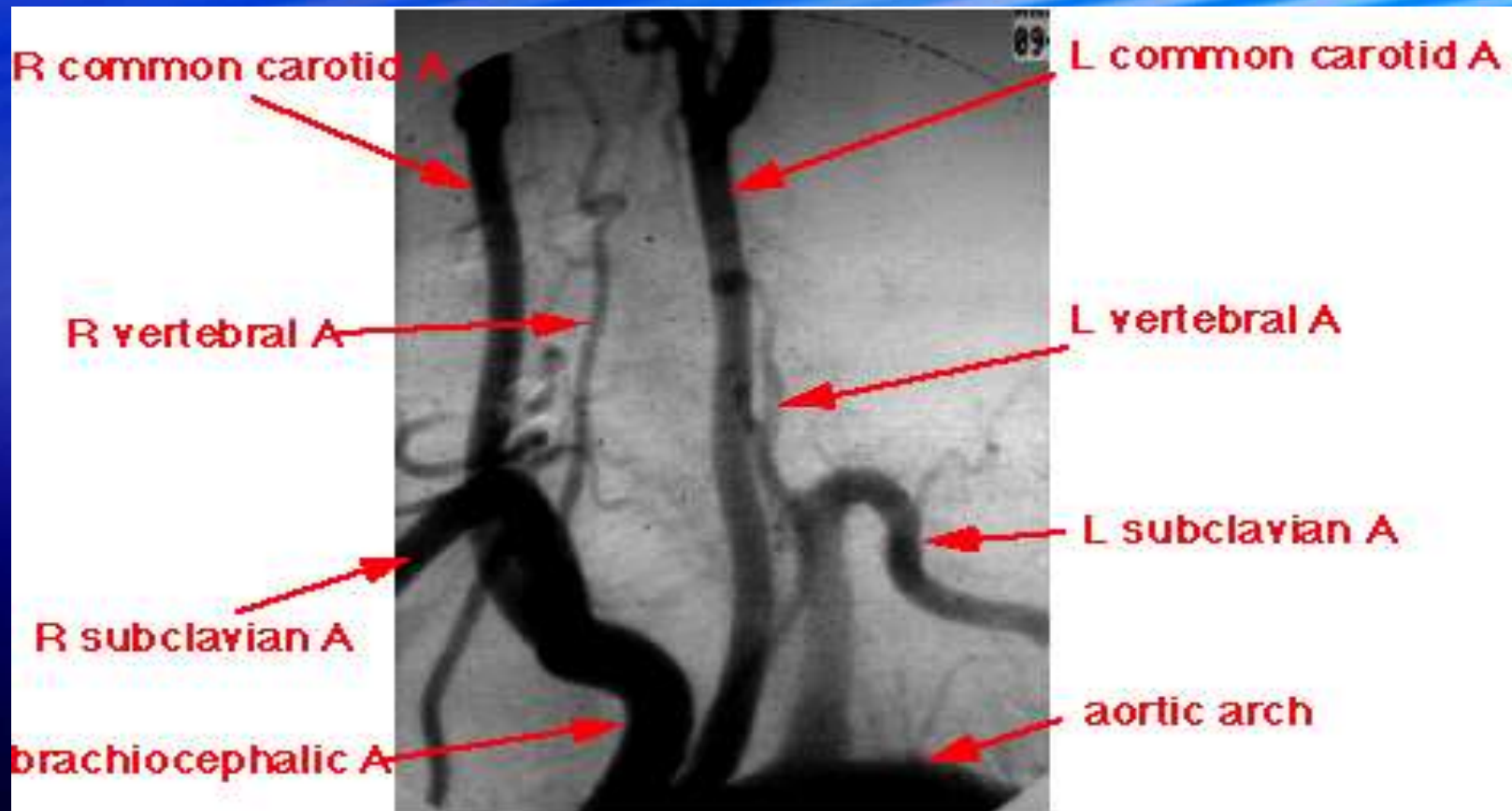
# ARCO AORTICO



# CATETERI ANGIOGRAFICI

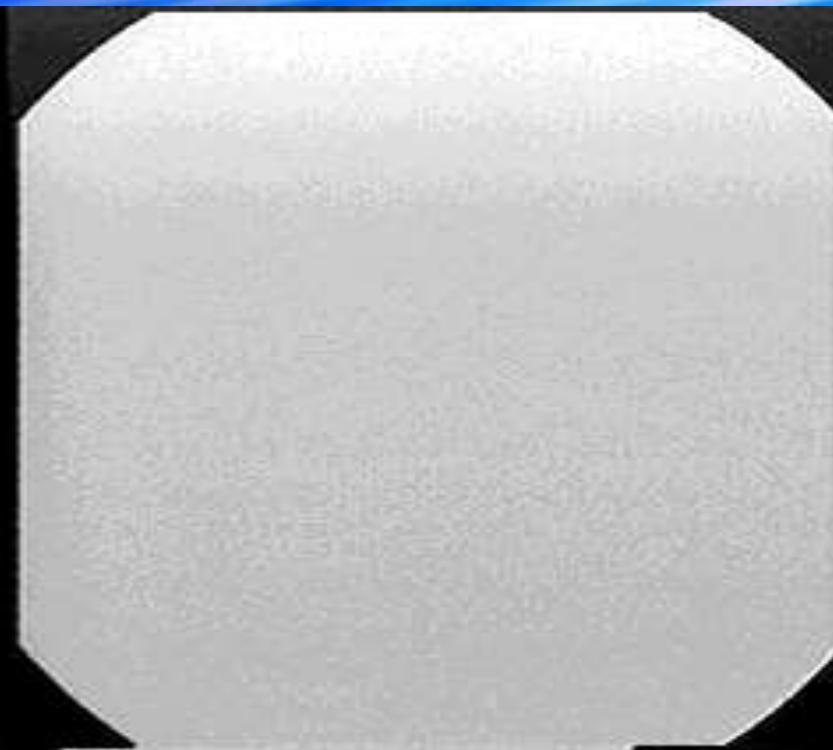


# ANGIOGRAMMA

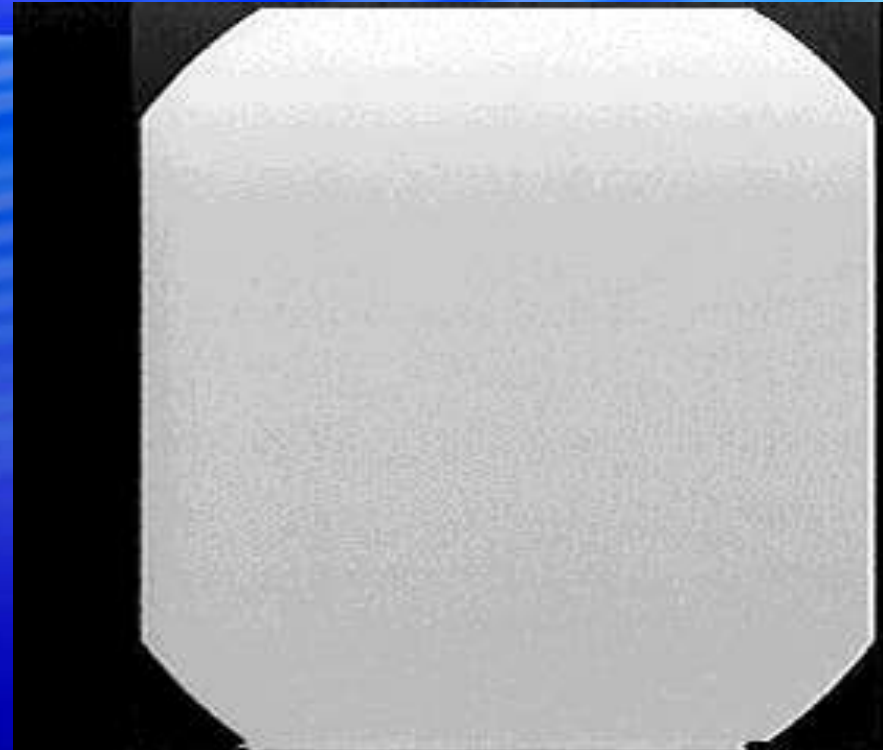


**angiogram of the aortic arch**

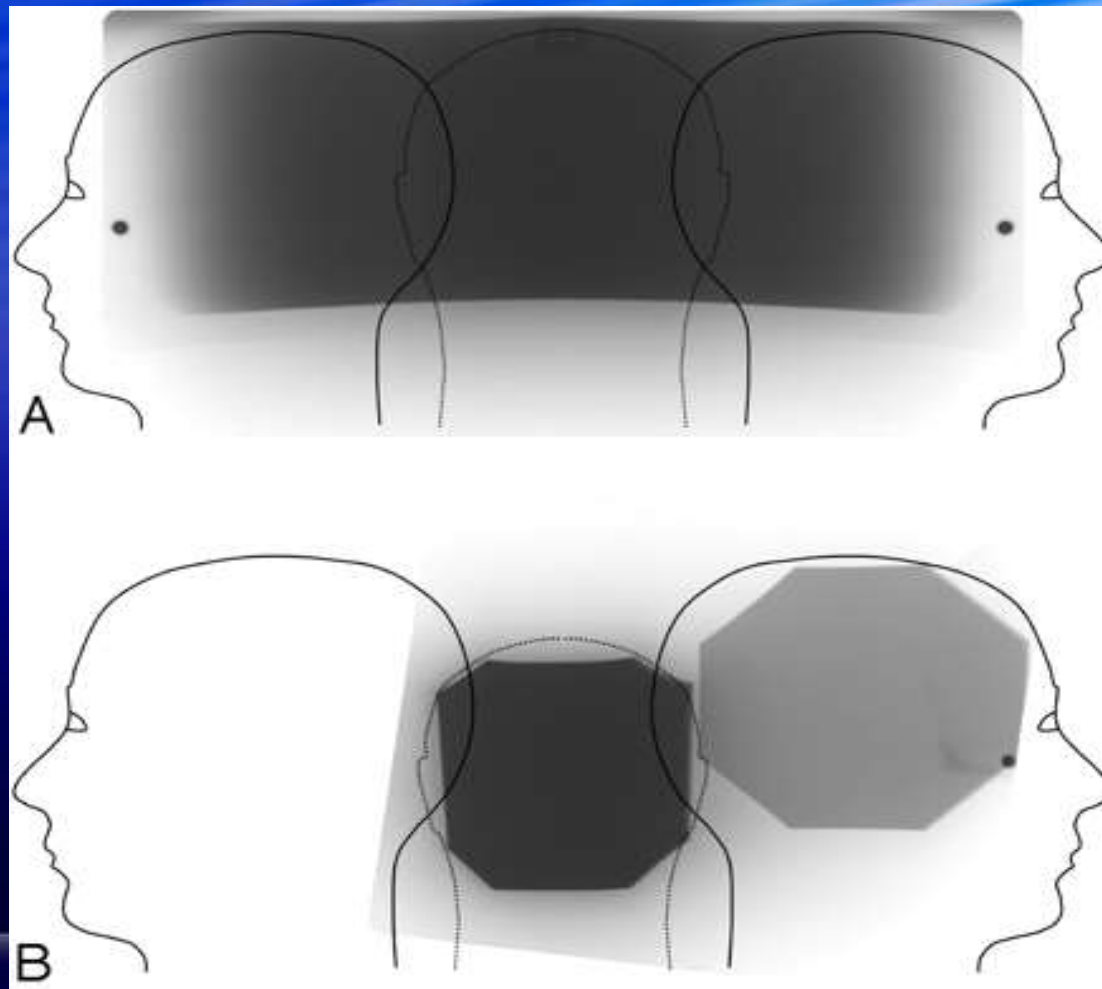
# ADA A CAROTIDE A-P L-L



# ADA A VERTEBRALE A-P L-L

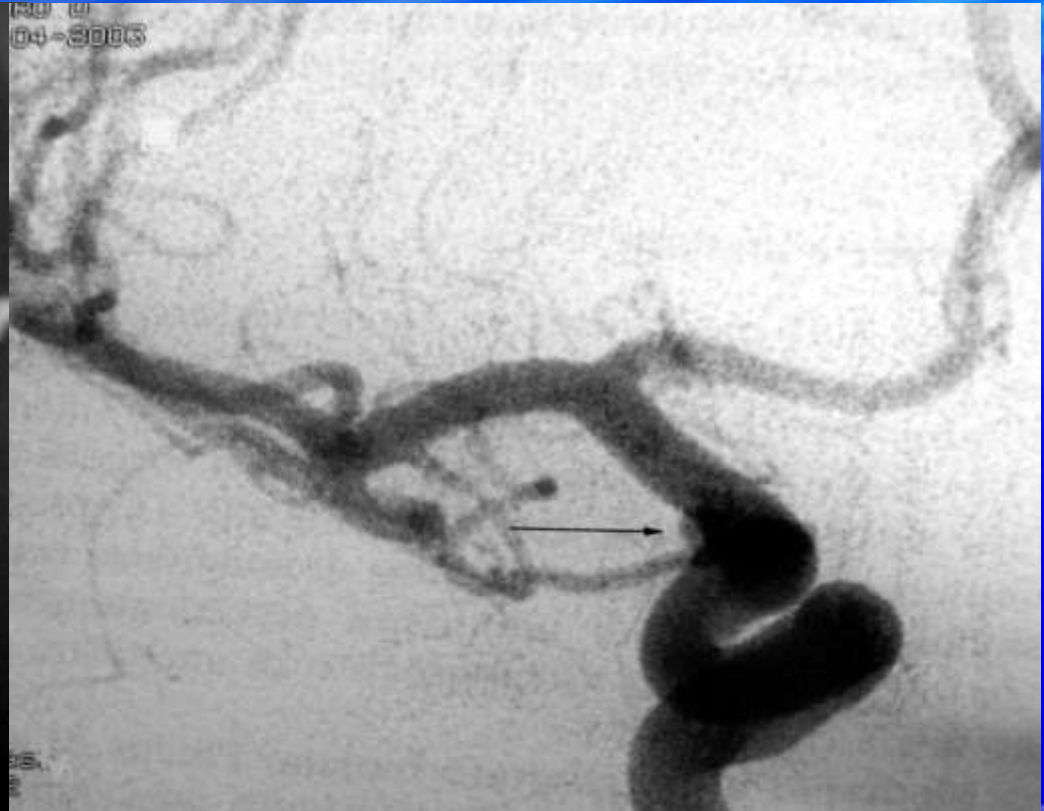
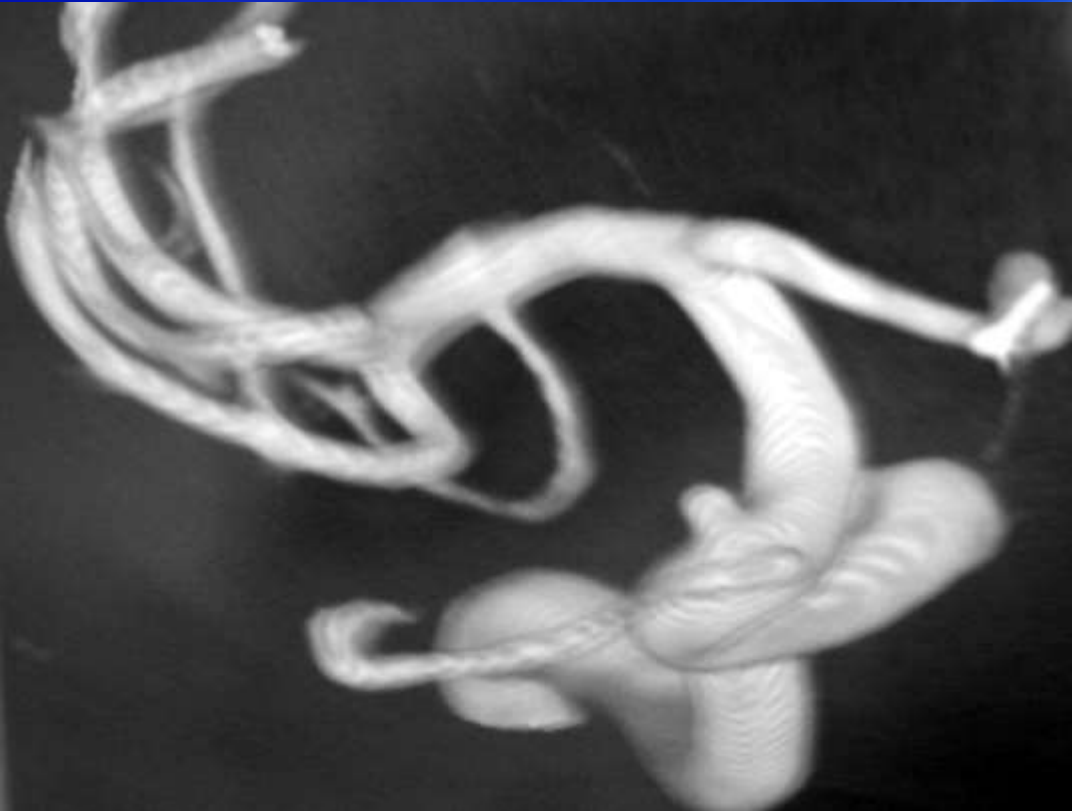


# ANGIOGRAFIA ROTAZIONALE

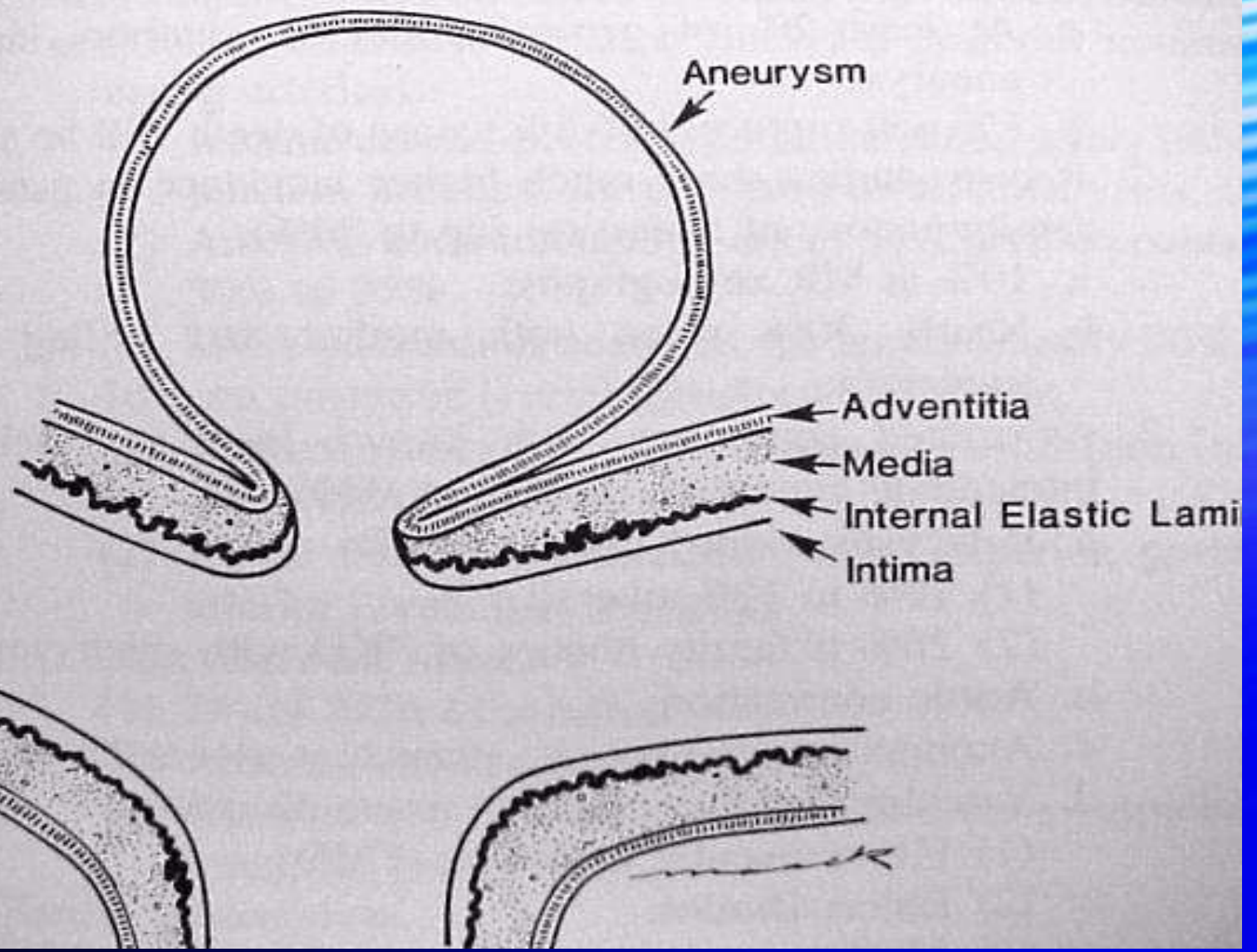




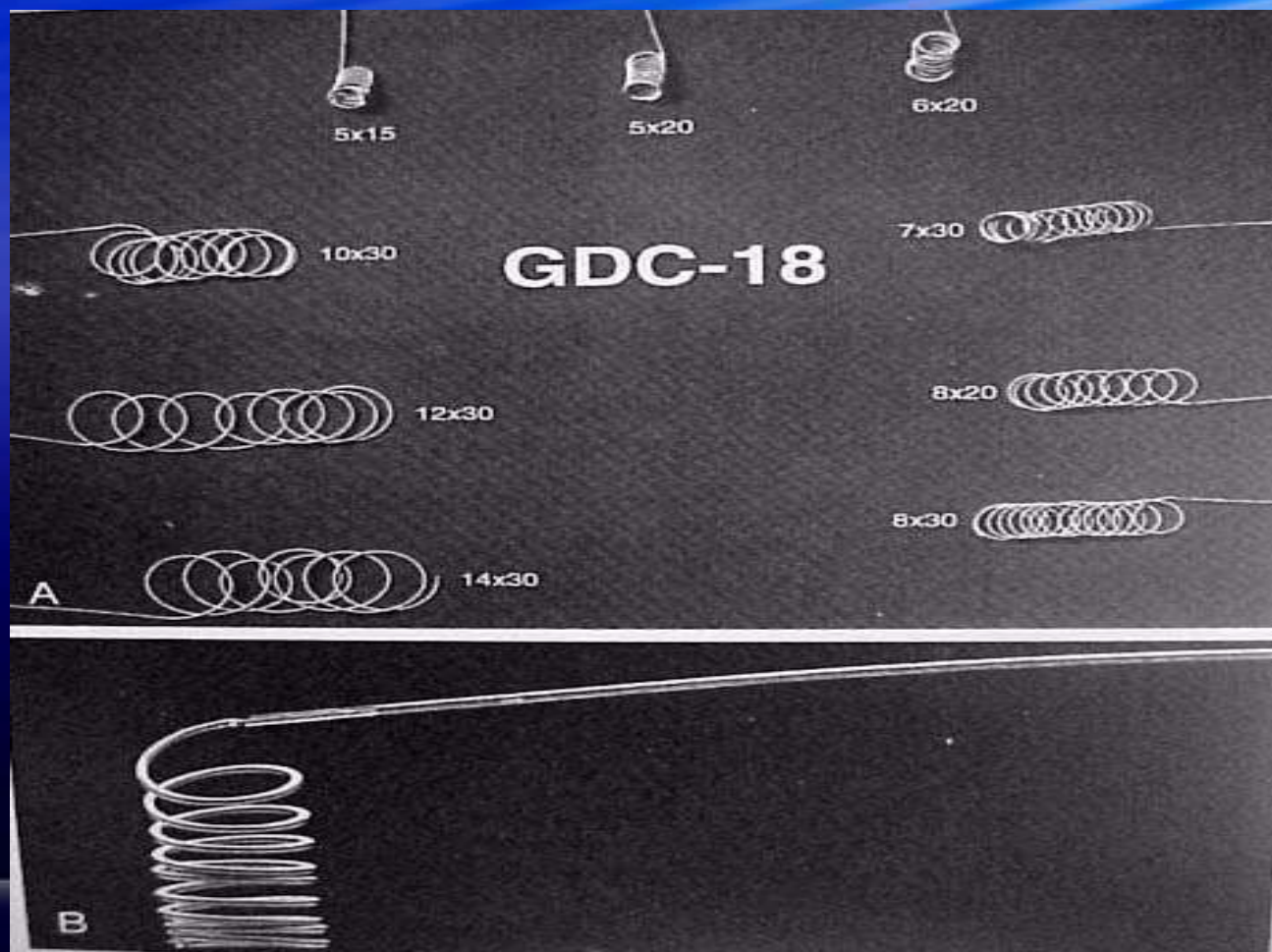
# ADA ROTAZIONELE V/S TRADIZIONALE



**interventistica**

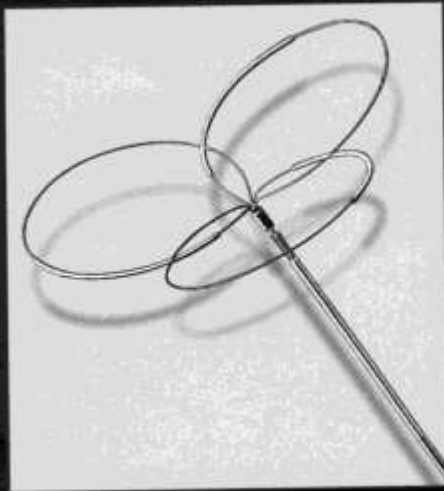


# G.D.C.



# FORME DI SPIRALI

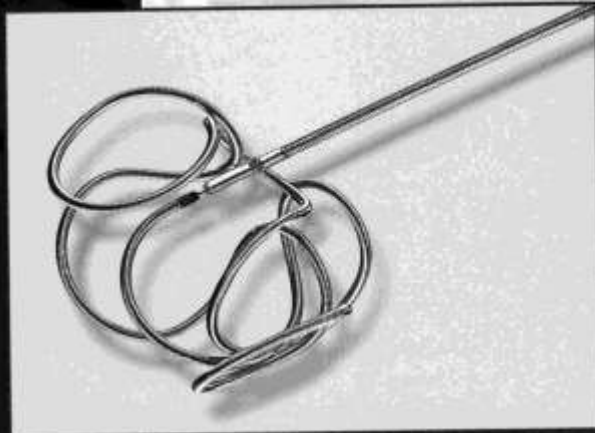
COIL TECHNOLOGIES



GDC® TriSpan is a differentiated coil technology which provides an implanted bridge for aneurysm necks.

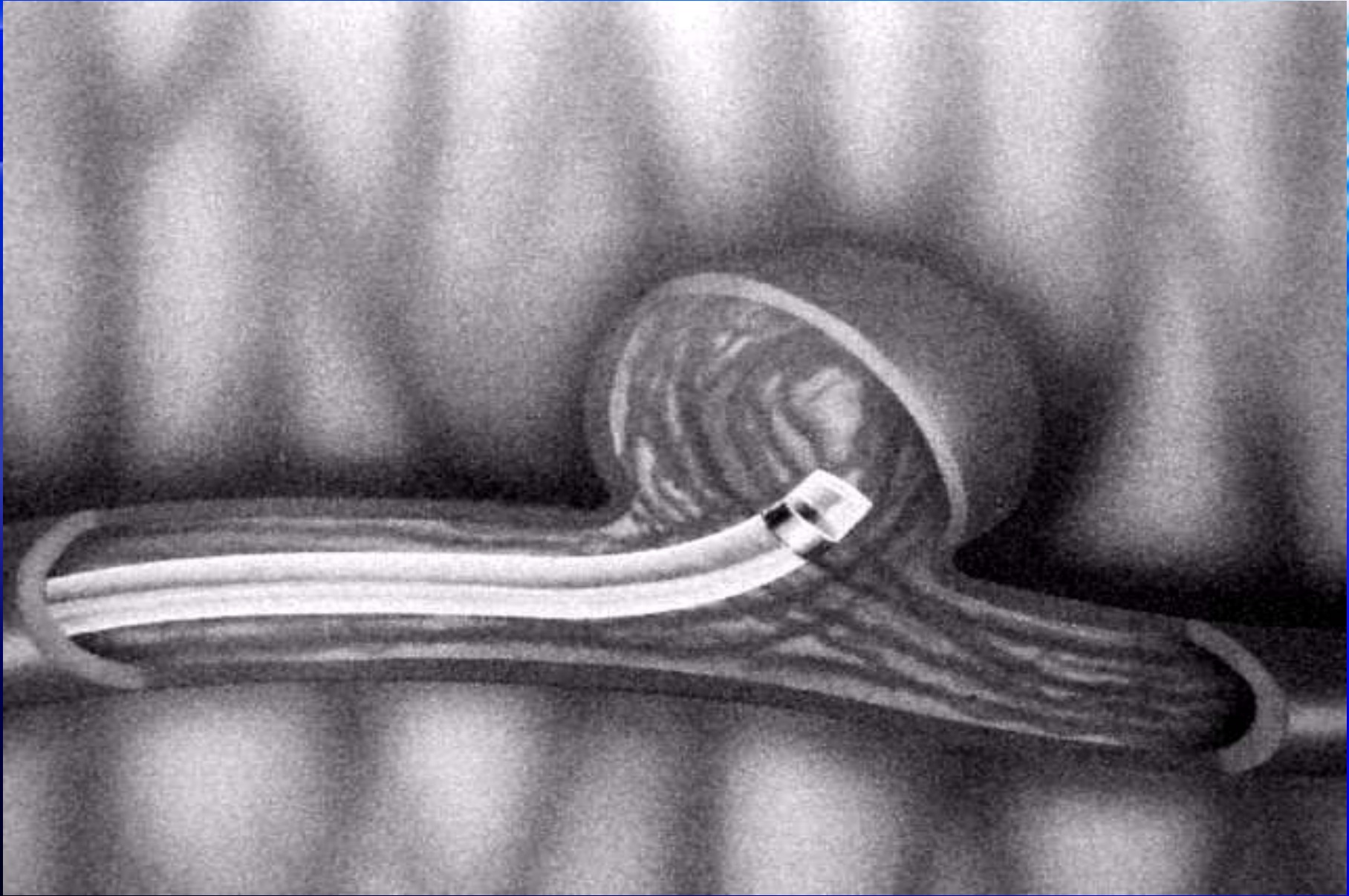
## Packing density

GDC®-10 UltraSoft is an extremely compliant coil that will fill the coil mass densely as well as provide a more atraumatic coil for very small aneurysms.



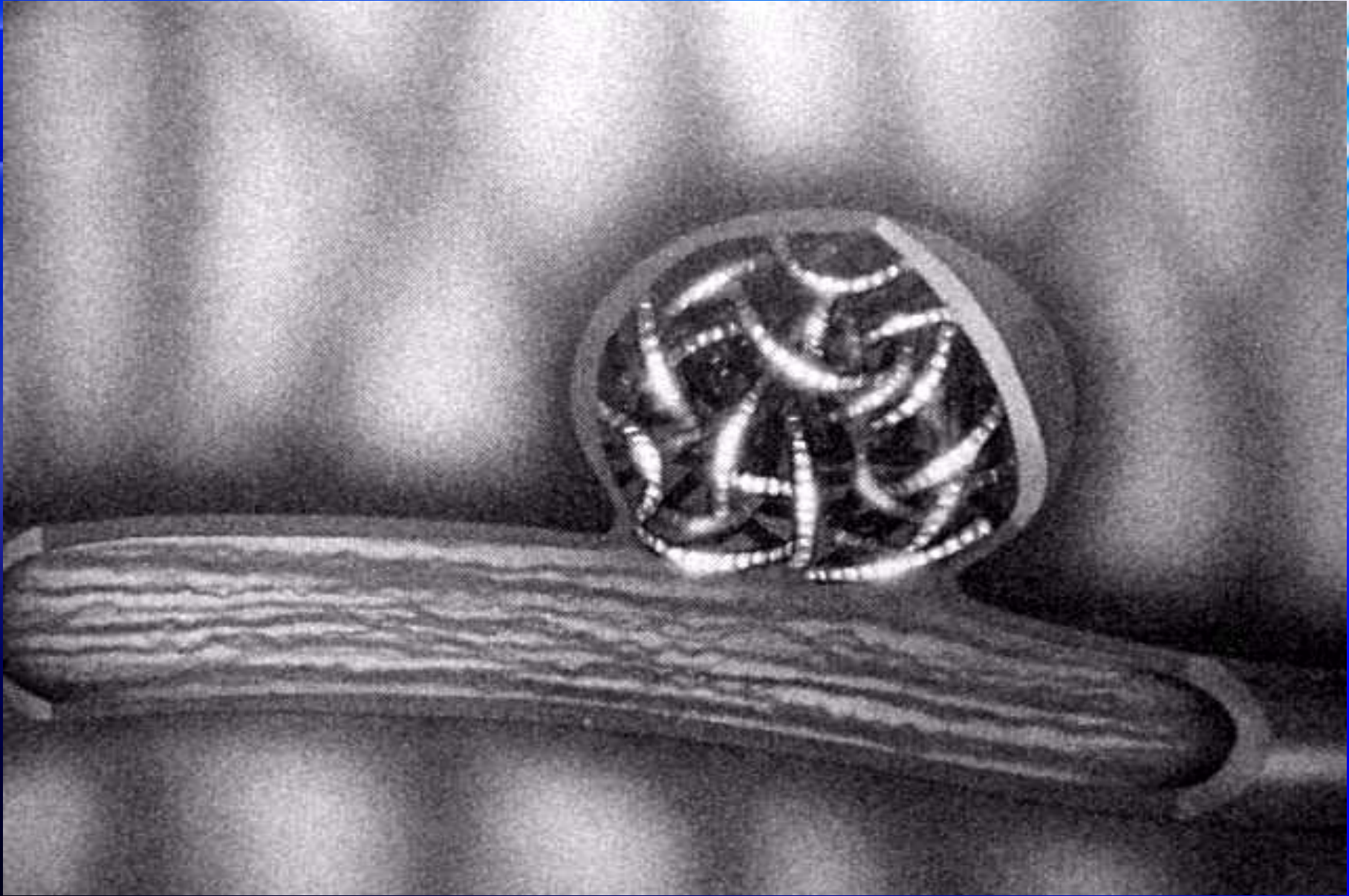
# STRUMENTO PER ELETTROLISI

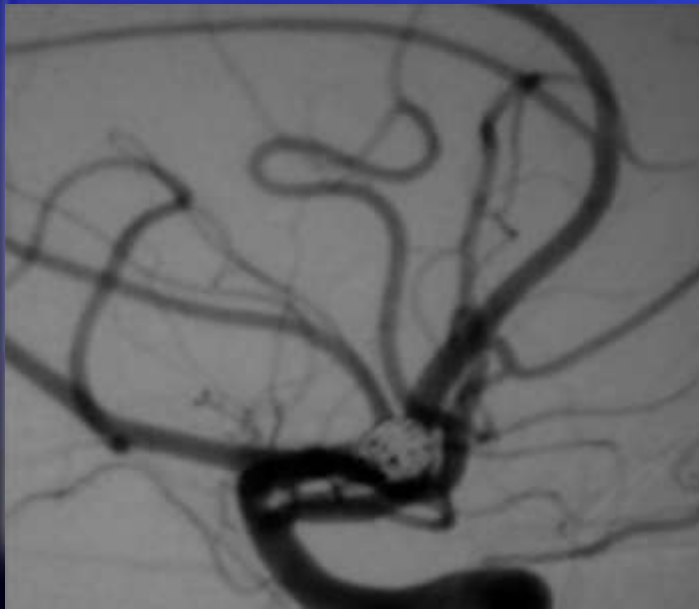
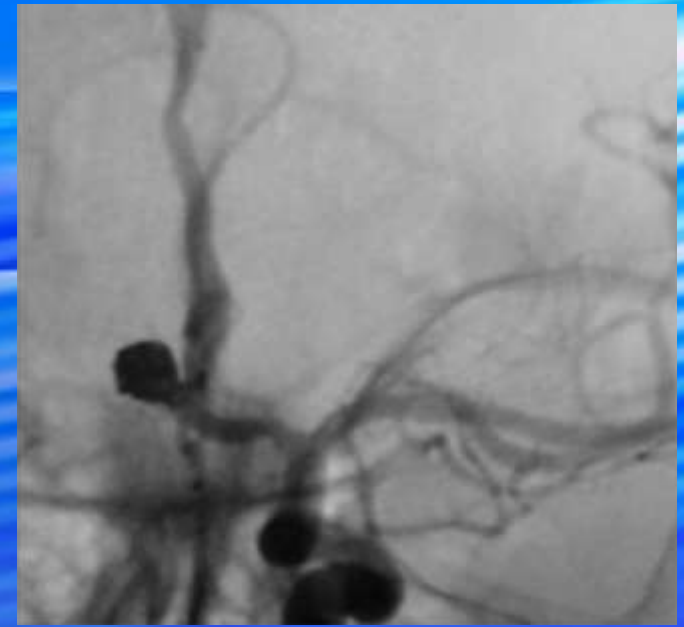
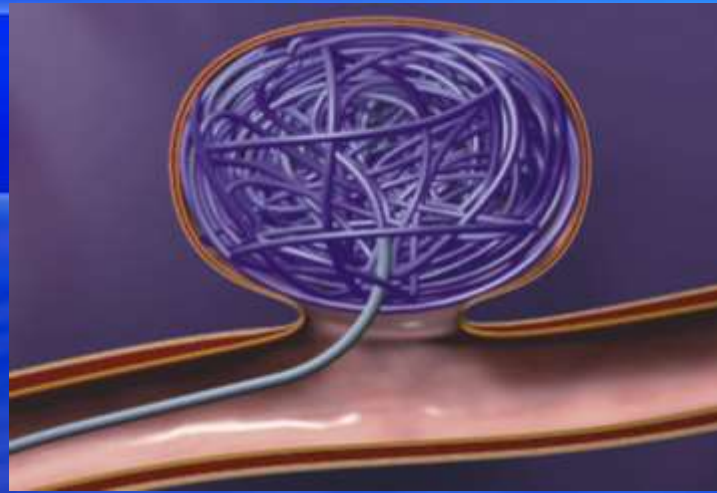
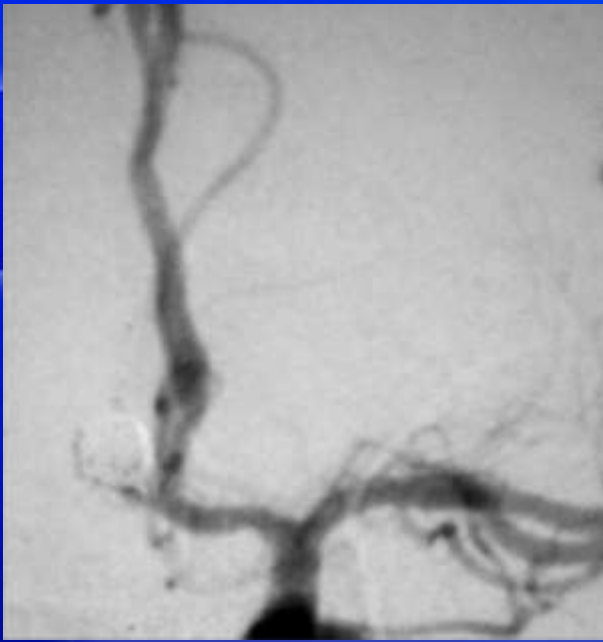










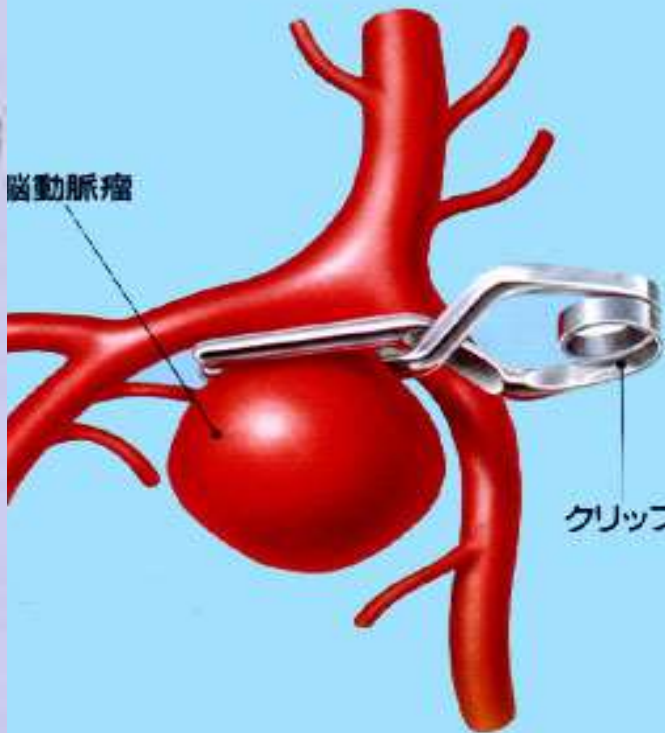


T1-FFE/M  
SL 3



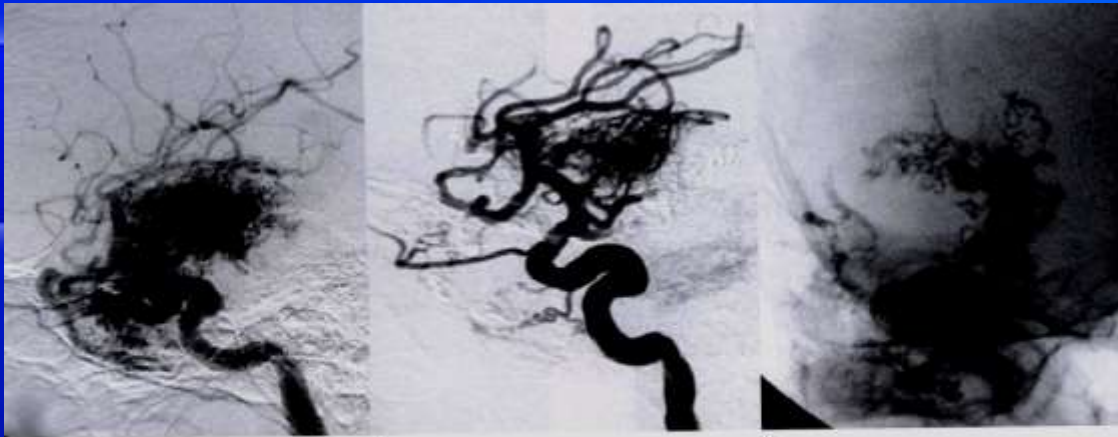


脳動脈瘤



クリップ

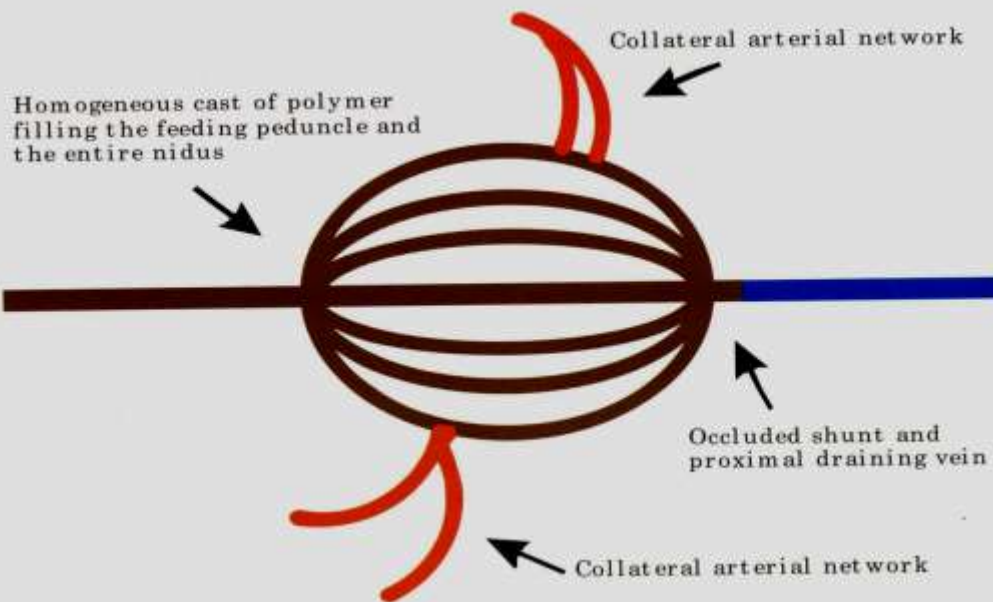




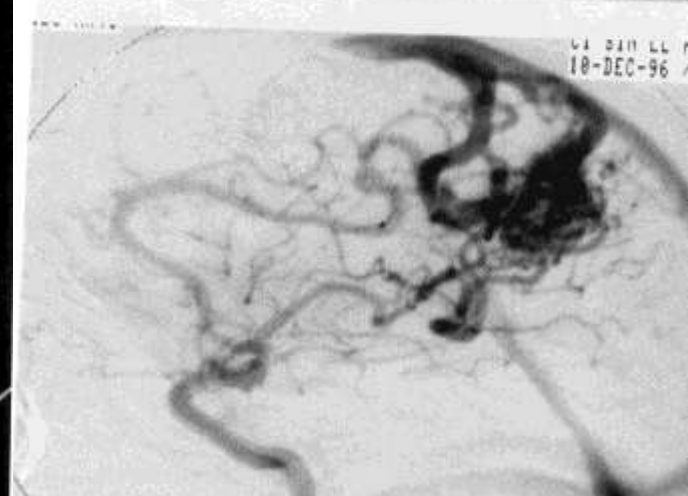
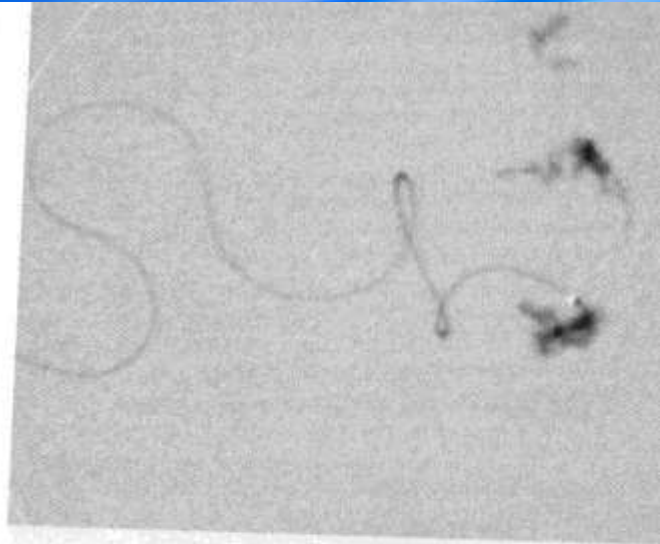
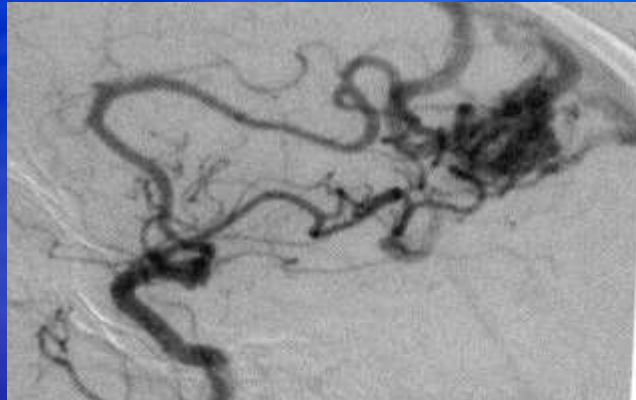
B

C

# EMBOLIZZAZIONE MAV



# MAV ISOBTYLE

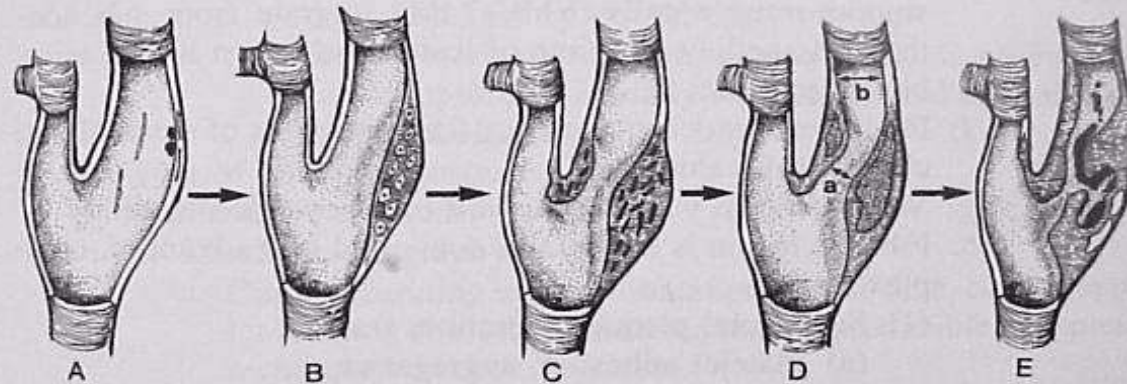


# PLACCA CAROTIDEA

## A. Etiology and pathogenesis.

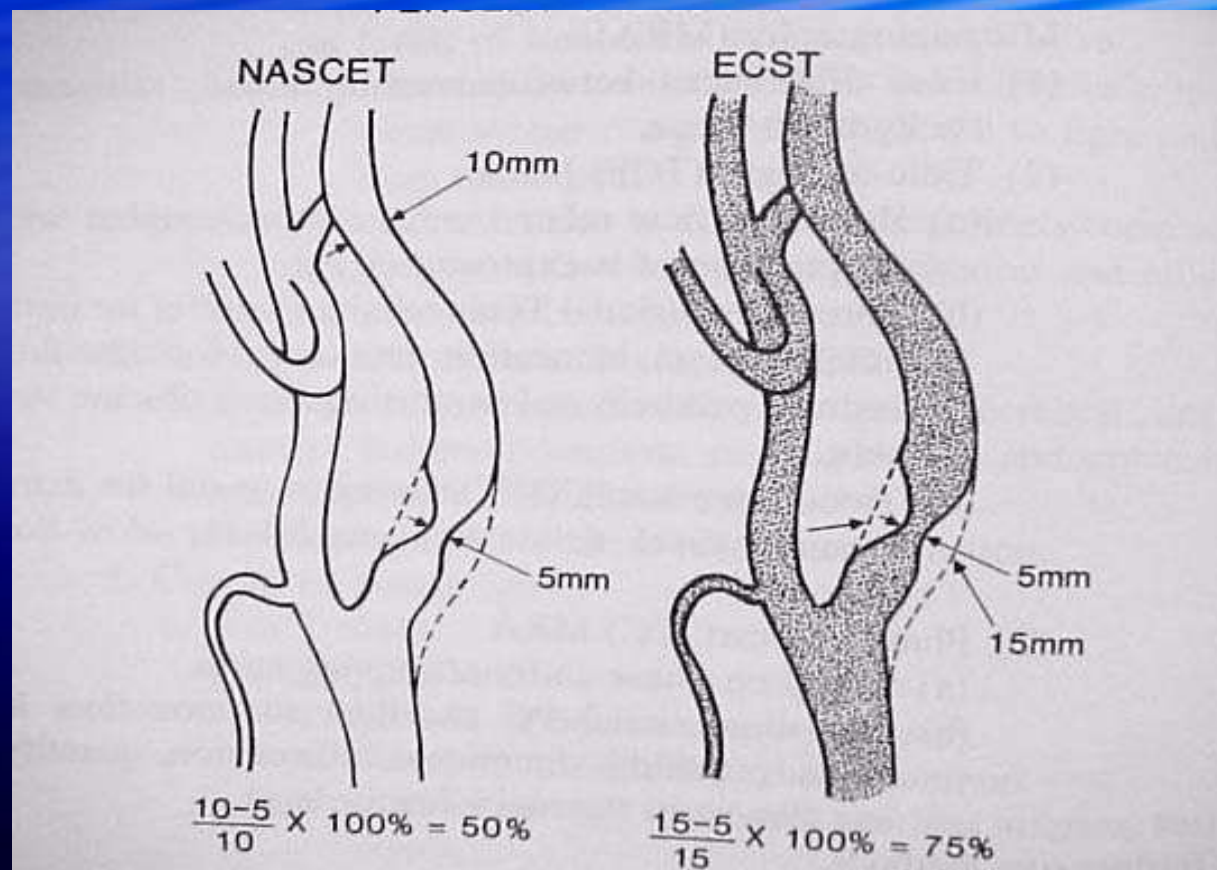
### 1. Normal arterial endothelium.

#### a. Retards development of atherosclerosis.



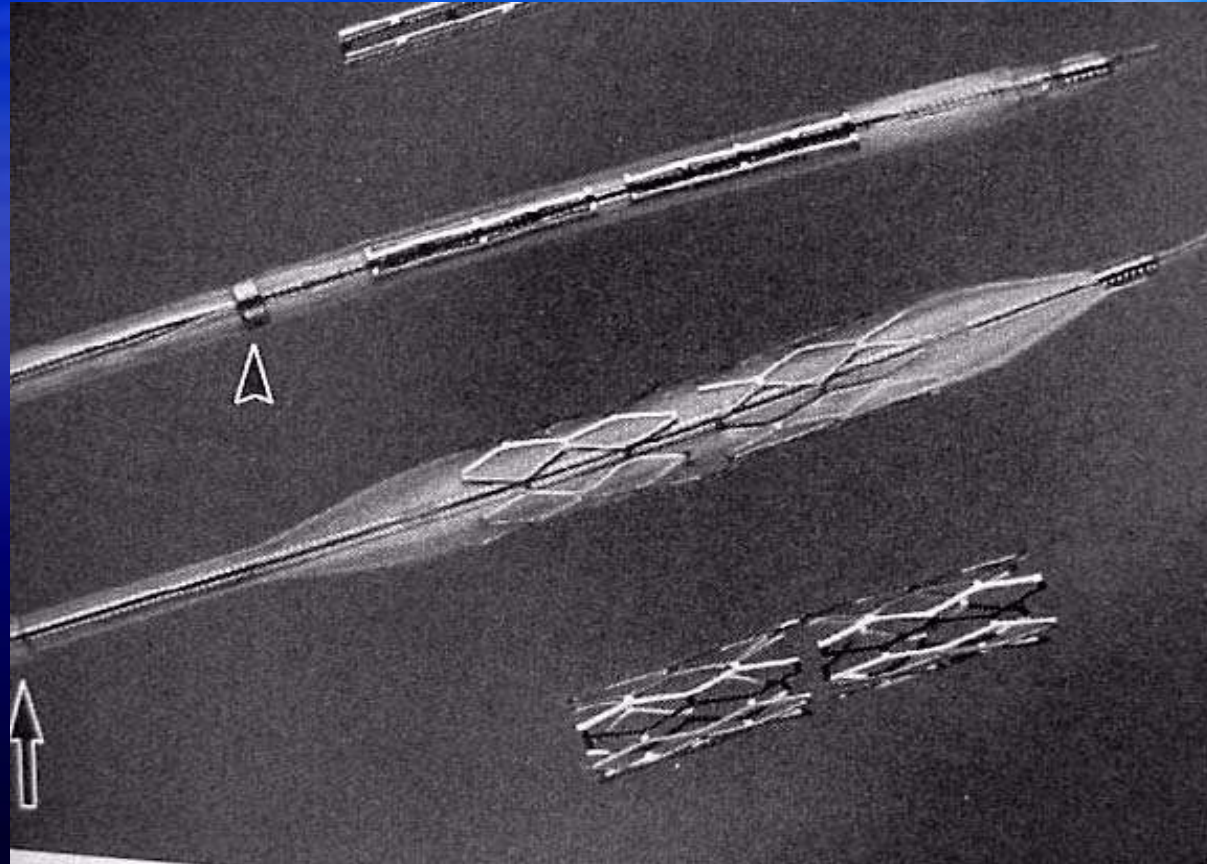
**Fig. 38-1** Anatomic diagrams and gross pathology specimens depict craniocerebral atherosclerotic vascular disease (ASVD). **A to E**, Development of atherosclerotic plaque at the common carotid artery (CCA) bifurcation and internal carotid artery (ICA) origin is shown schematically. **A**, Intimal fatty streaks are present. Some platelet adhesion to the intima is noted but the carotid artery is otherwise normal. **B**, Monocyte-derived macrophages and smooth-muscle cells proliferate under the intima. **C**, Foam cell necrosis produces a

# INDICI DI STENOSI

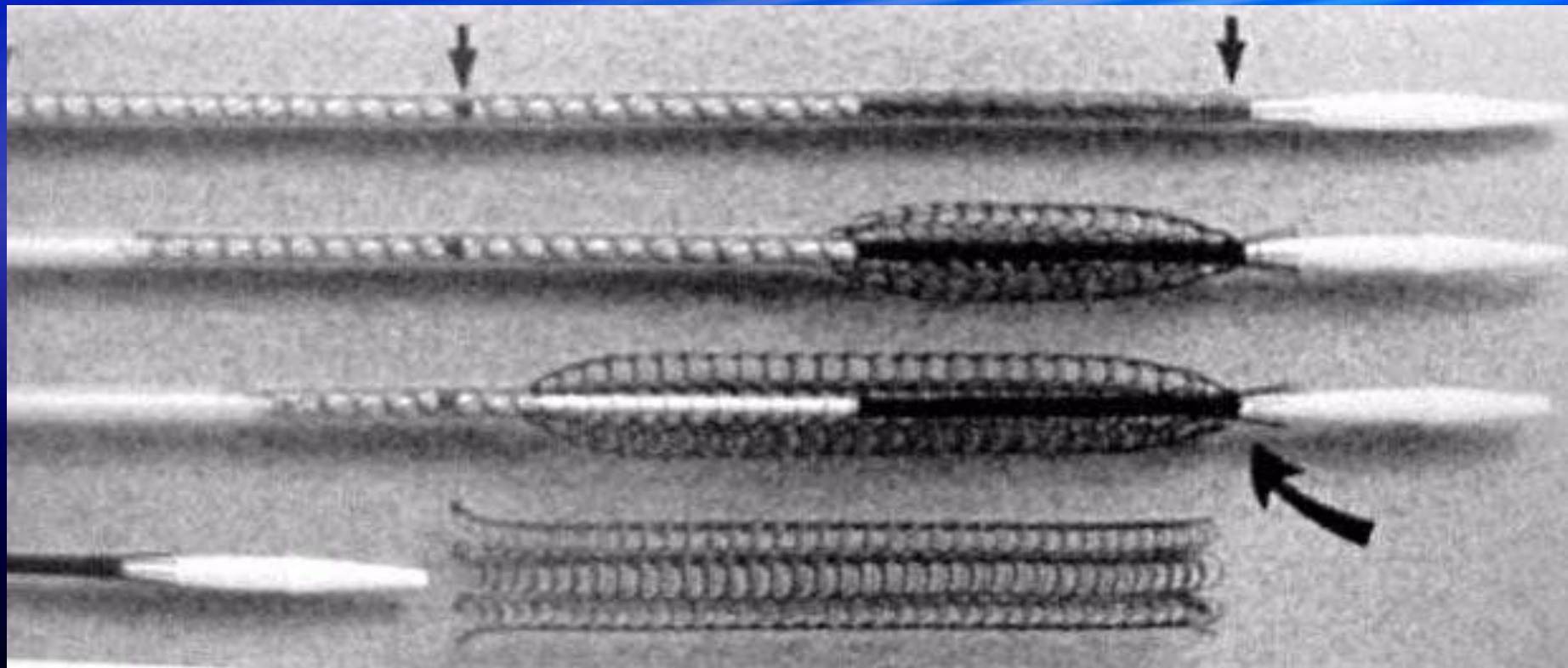




# STENT



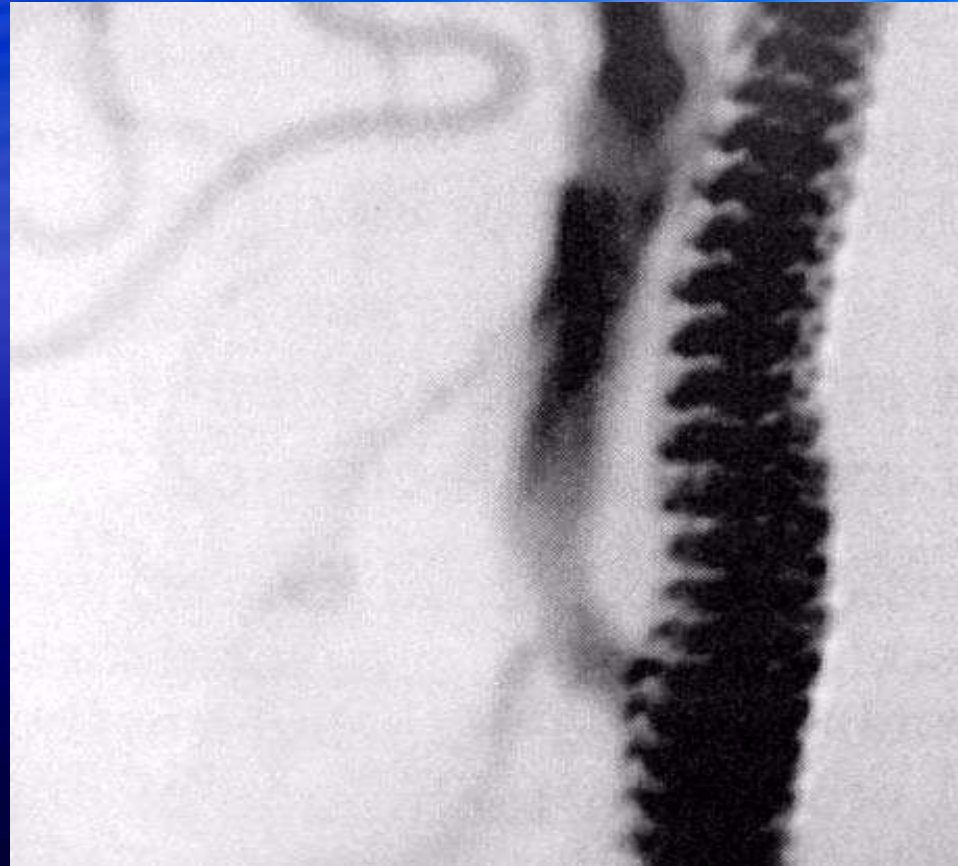
# STENT



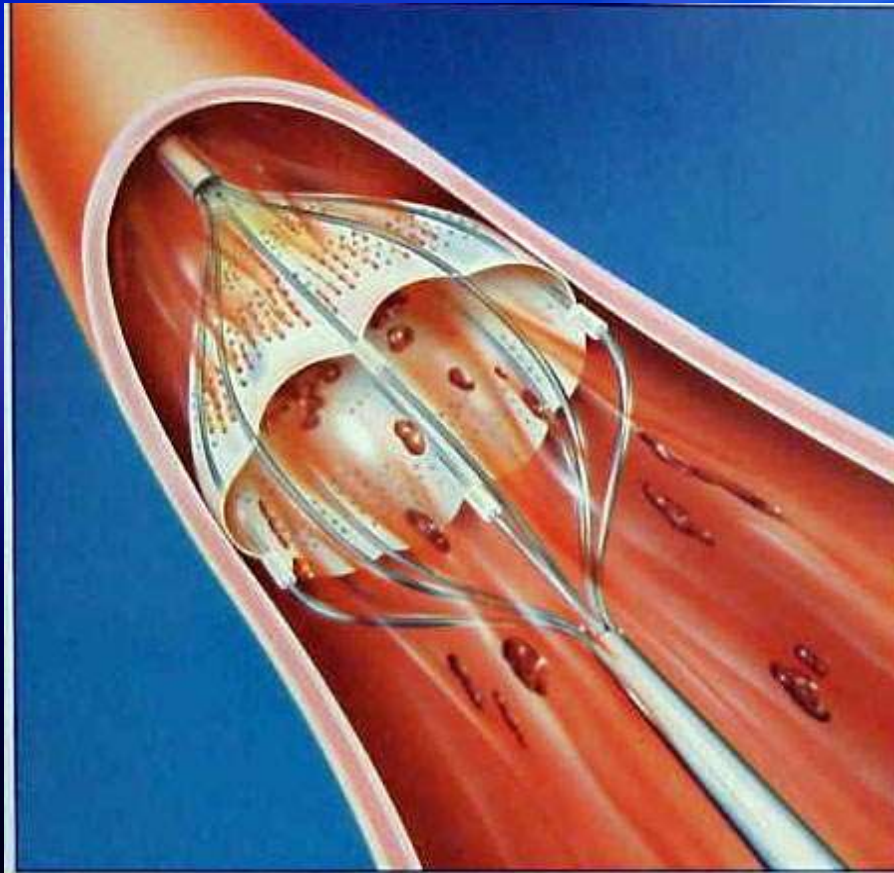
# PLACCA ULCERATA



# STENT



# OMBRELLINO DI PROTEZIONE



– The filter basket can trap particles in the range 8–3427 microns.

## ■ Causes minimal vessel trauma

Nitinol struts used in the construction of ANGIOGUARD ensure effective vessel sealage, without causing trauma to the vessel wall.

GUIDEWIRE (300 CM WIRE LENGTH)

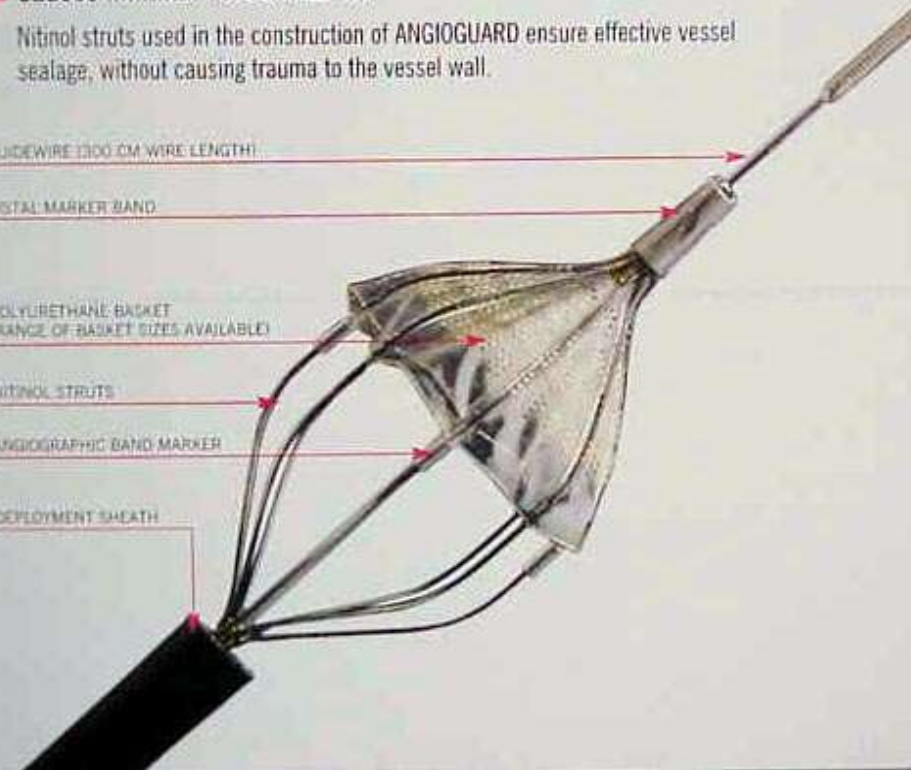
DISTAL MARKER BAND

POLYURETHANE BASKET  
(RANGE OF BASKET SIZES AVAILABLE)

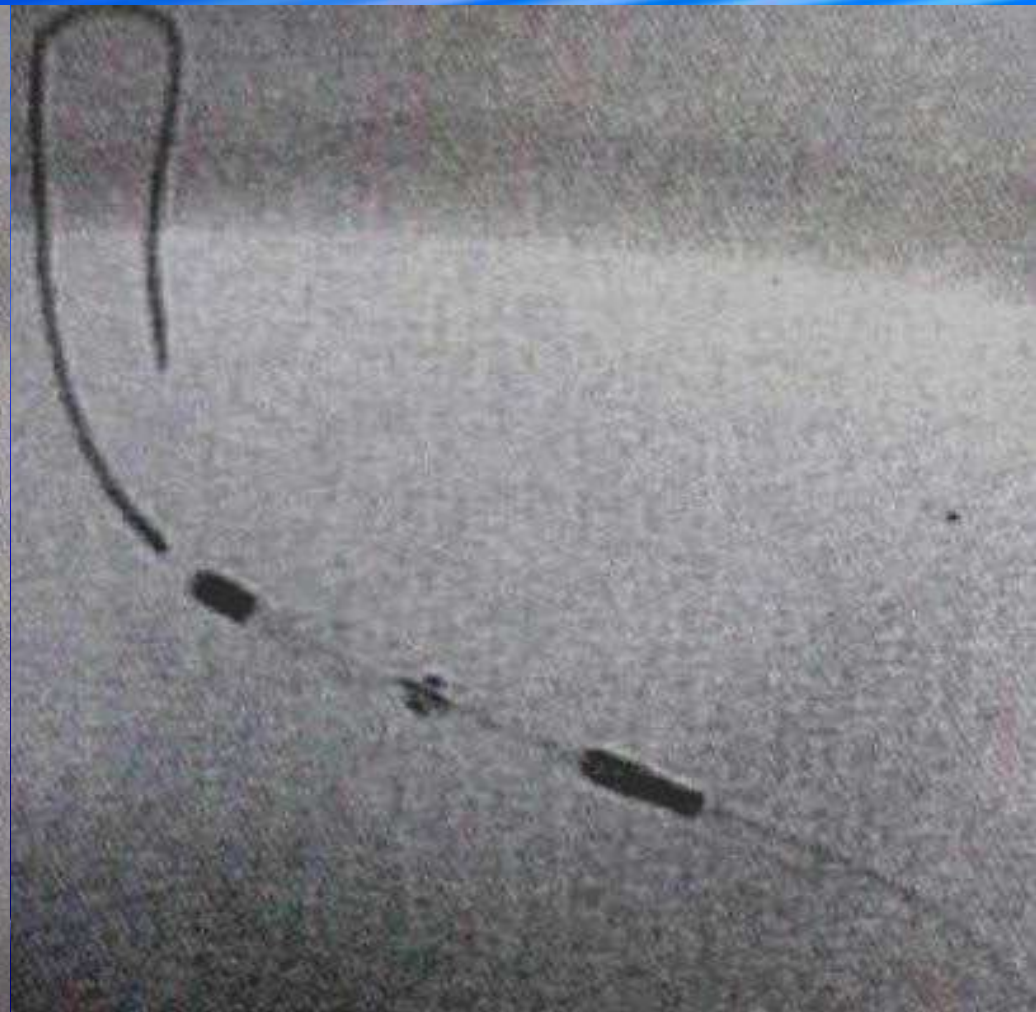
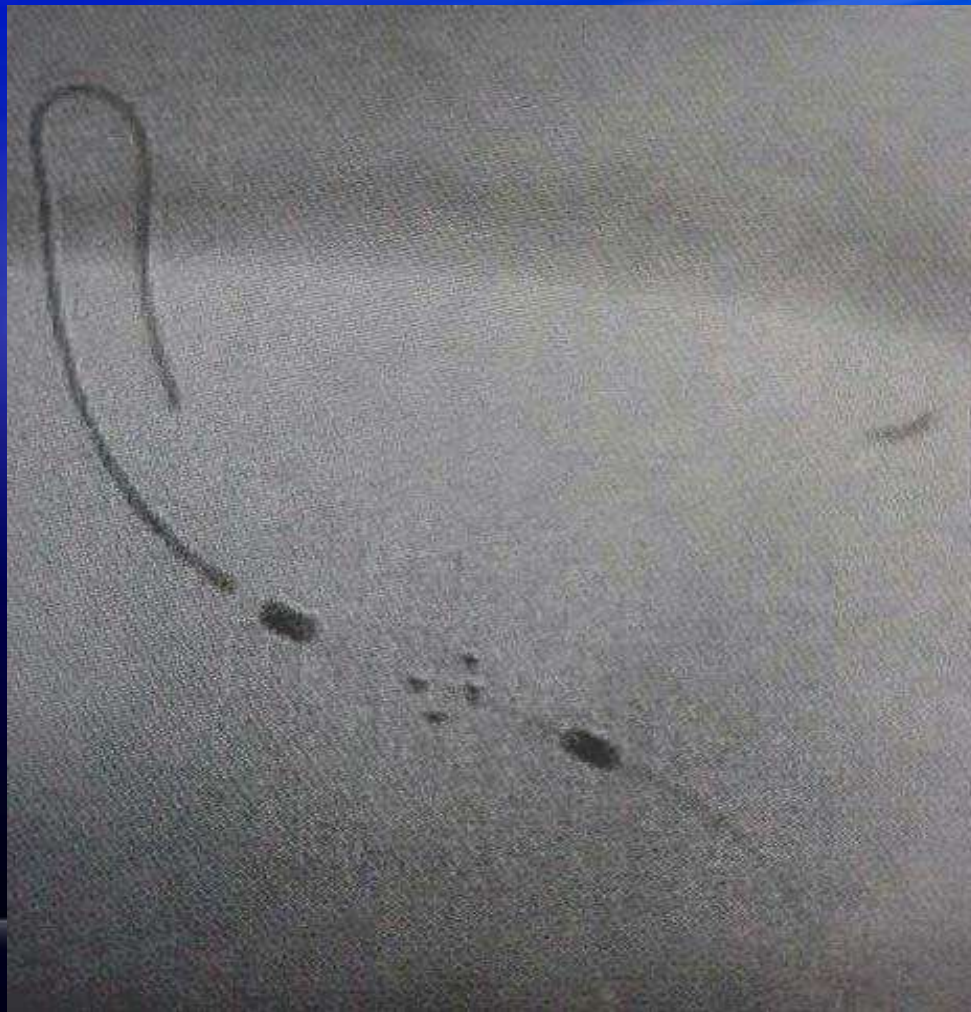
NITINOL STRUTS

ANGIOGRAPHIC BAND MARKER

DEPLOYMENT SHEATH



# OMBRELLO



# OCCLUSIONE A CM



# RIABILITAZIONE A. CM





# TUMORE GLOMICO



# TUMORE GLOMICO



# VERTEBROPLASTICA

ANGIOMI:

SE VASCOLARIZZATI

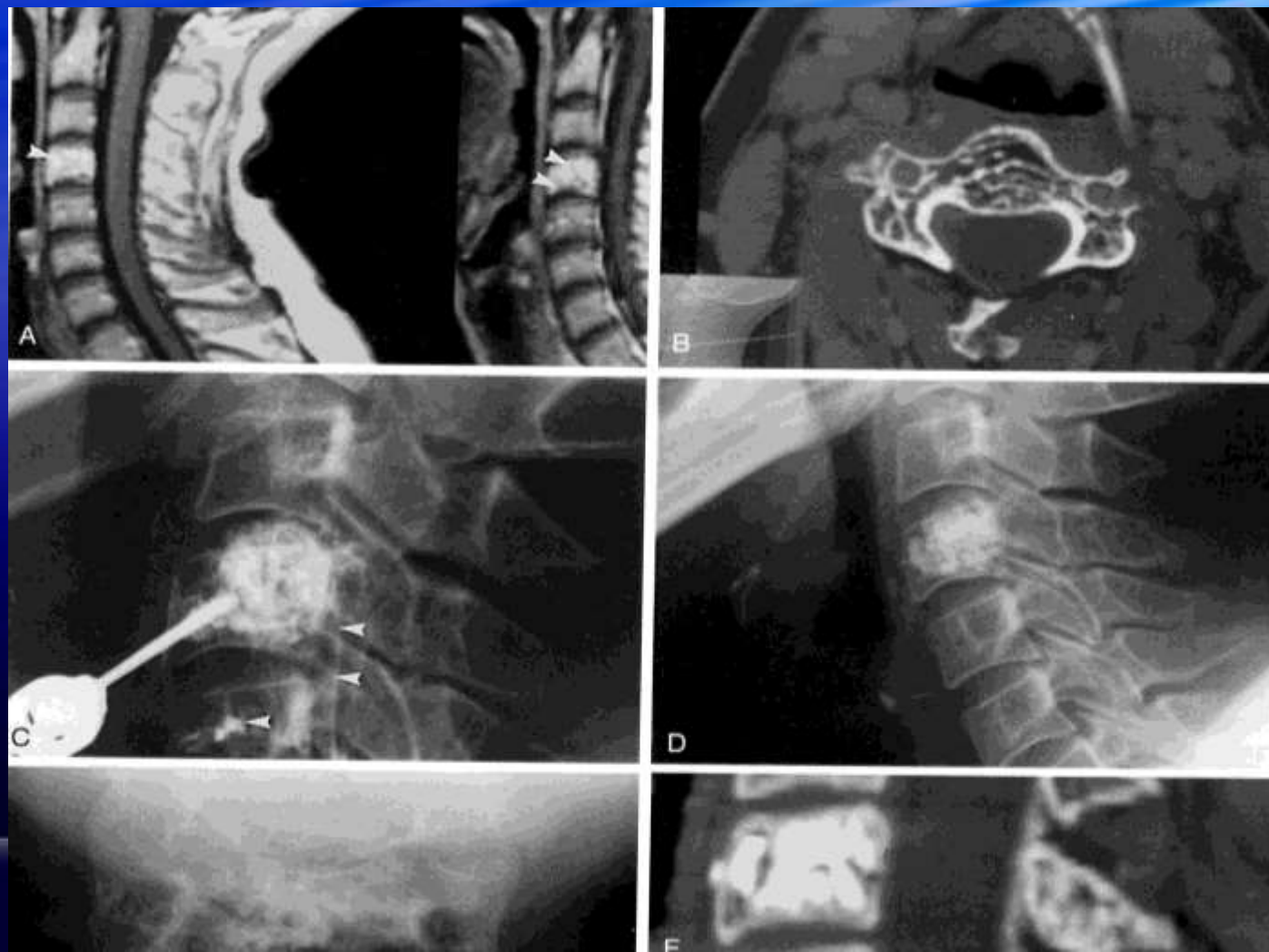
SE INSTABILI

SE POTENZIANO DOPO M.D.C.

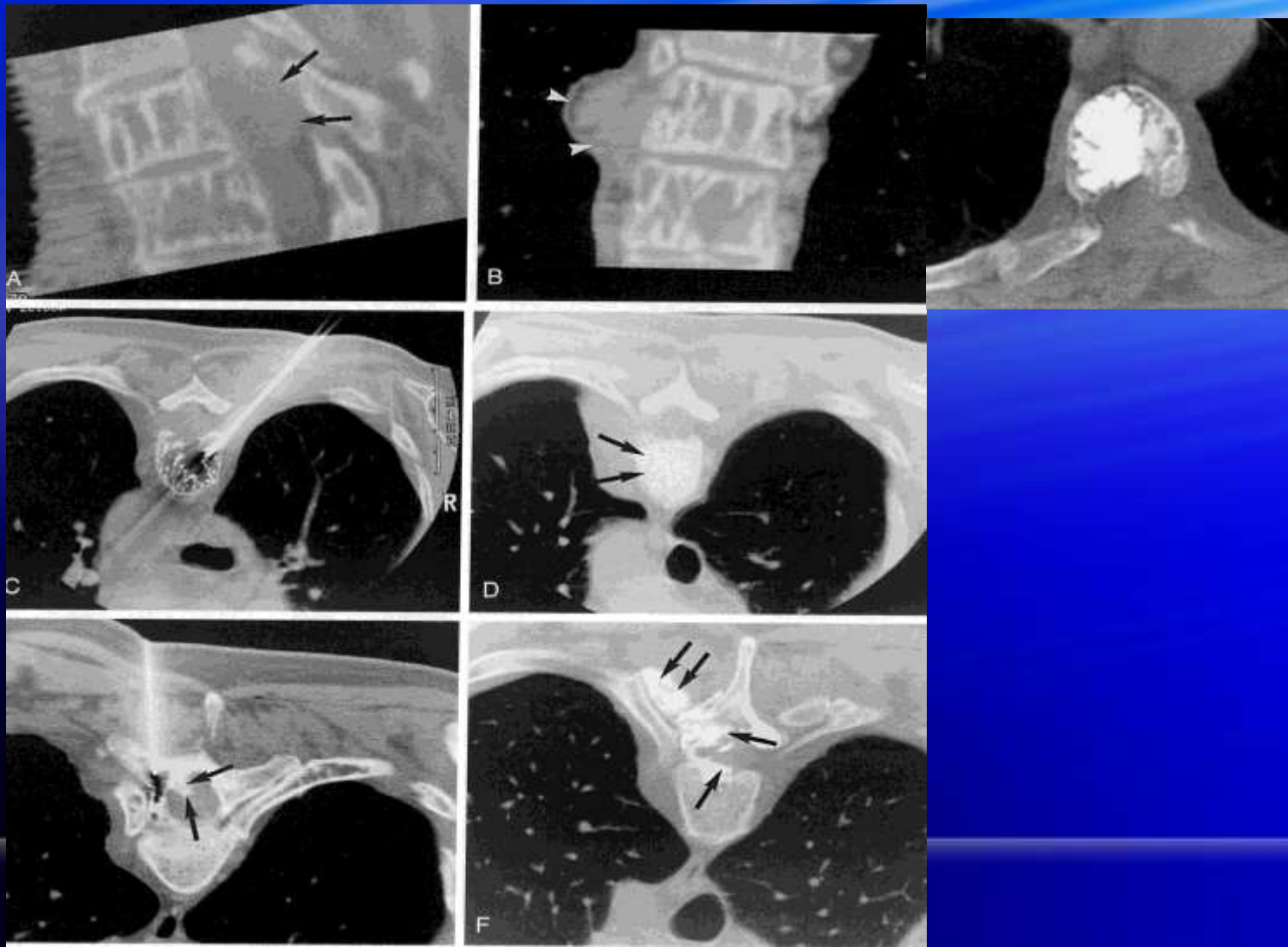
OSTEOPOROSI

TUMORI

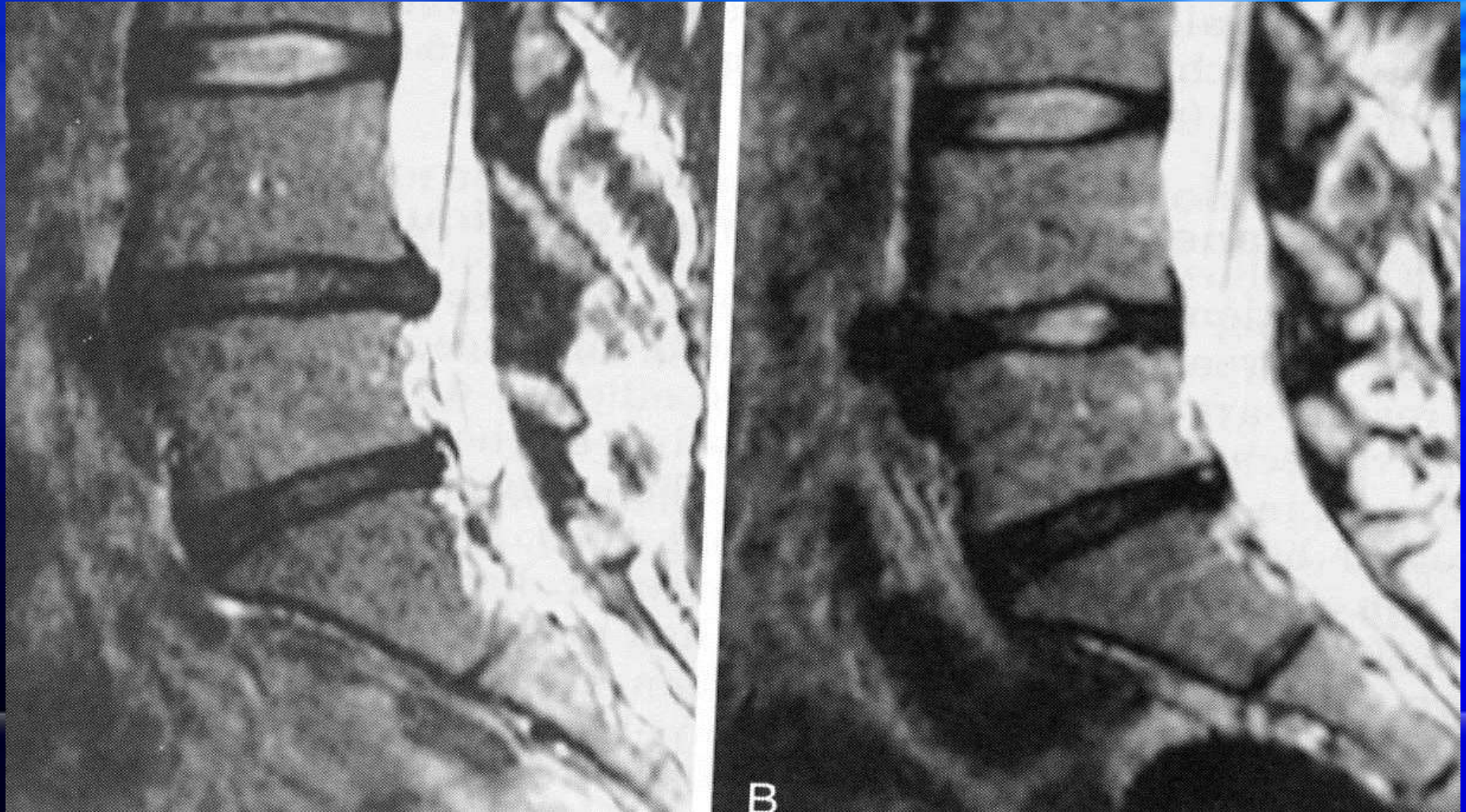
# VERTEBROPLASTICA : ANGIOMA



# ACCESSO TRANSPEDUNCOLARE

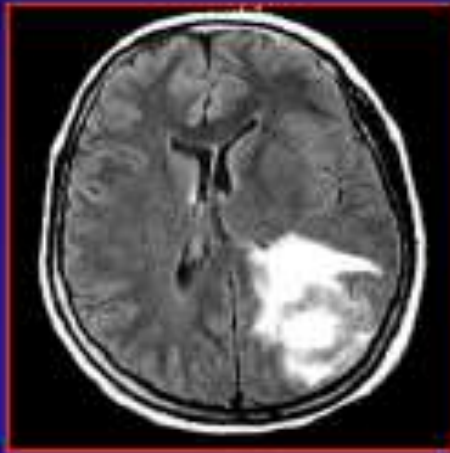
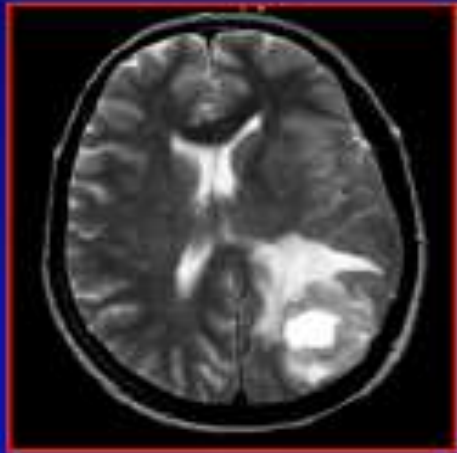


# DISCECTOMIA PERCUTANEA

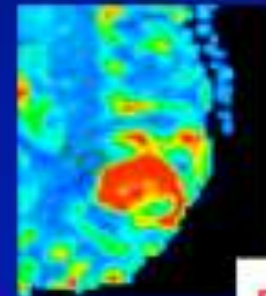


Grazie per l'attenzione

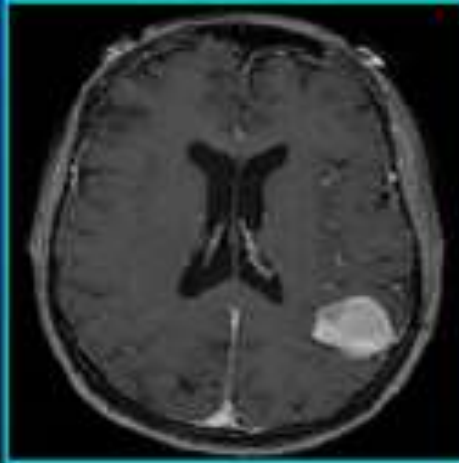
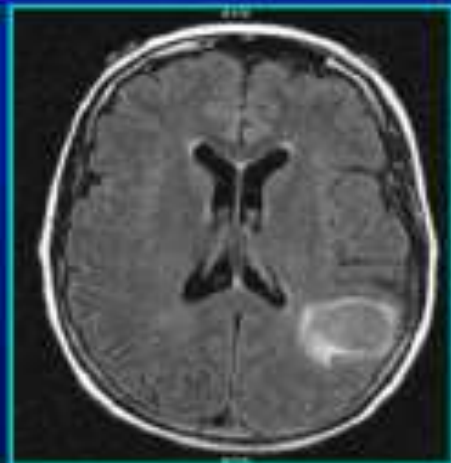
# PRIMITIVO O METASTASI



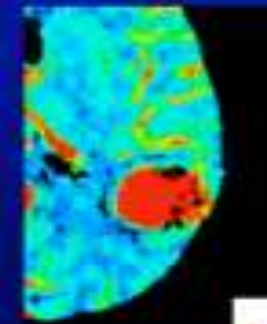
PATIENT 1



rCBV



PATIENT 2

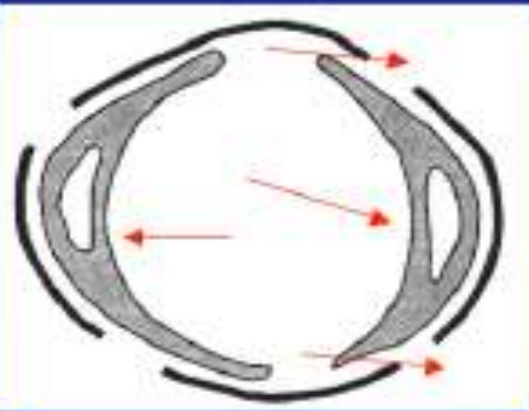


rCBV

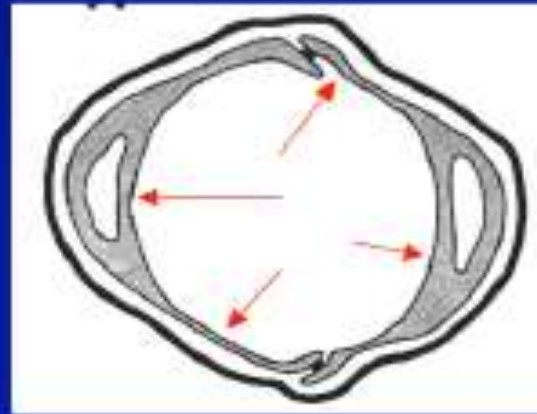


# PRIMITIVO O METASTASI?

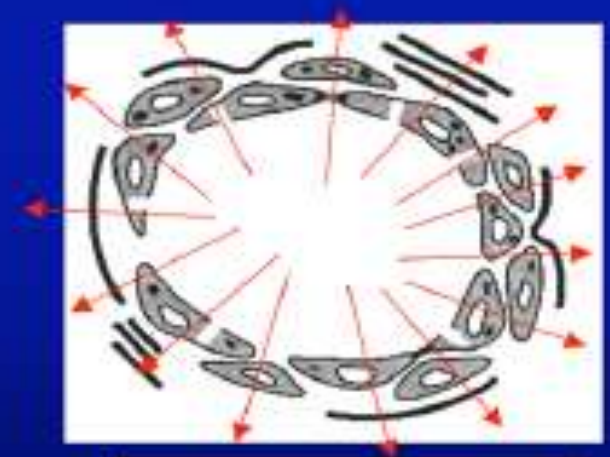
## BLOOD-BRAIN BARRIER



**DEFECTIVE BBB**  
-GLIOMA-

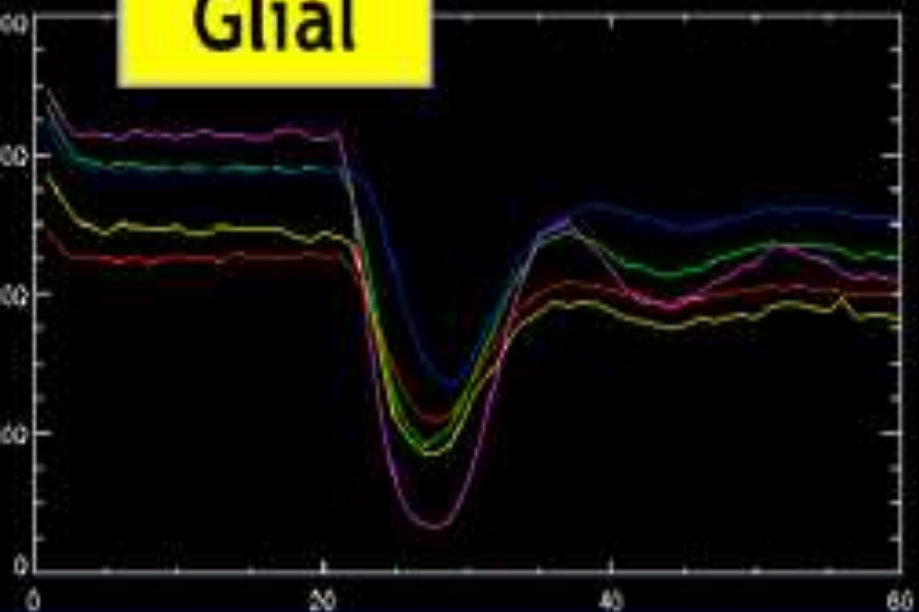


**NORMAL BBB**

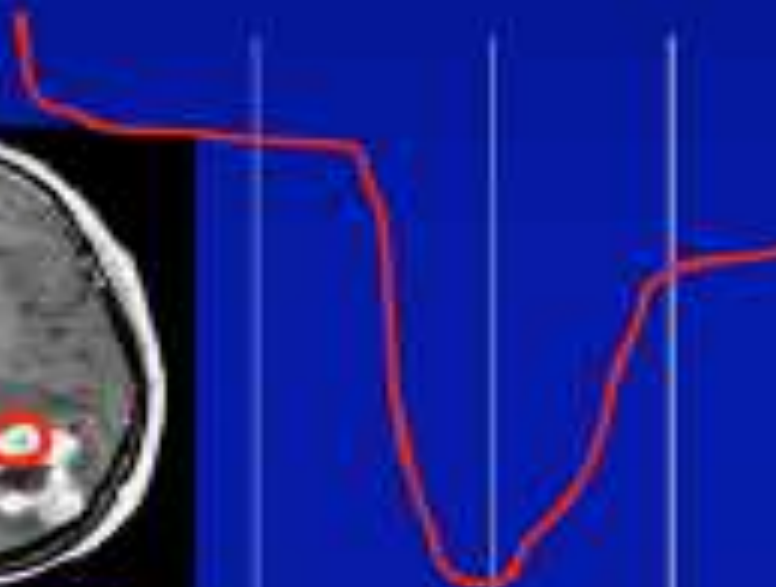


**ABSENT BBB**  
-METASTASIS-

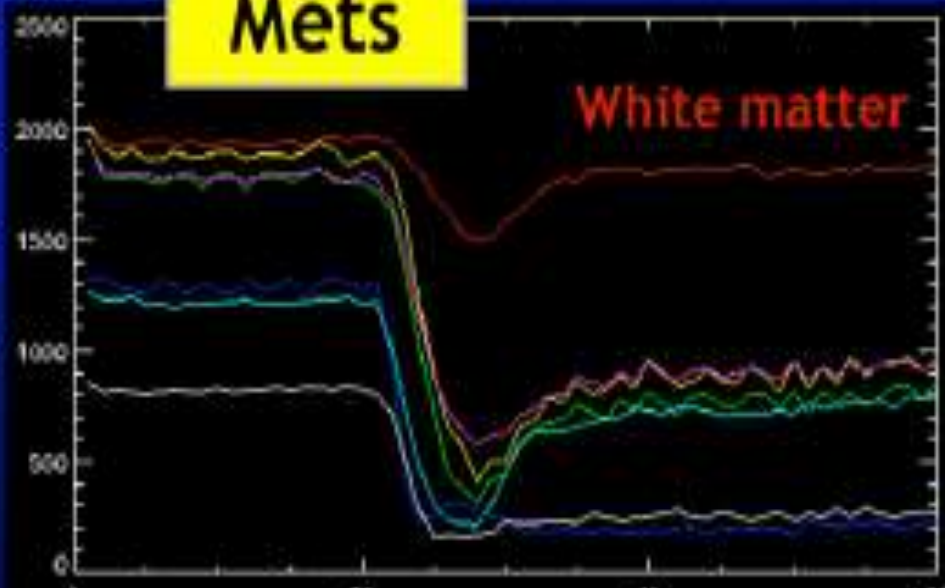
# Glial



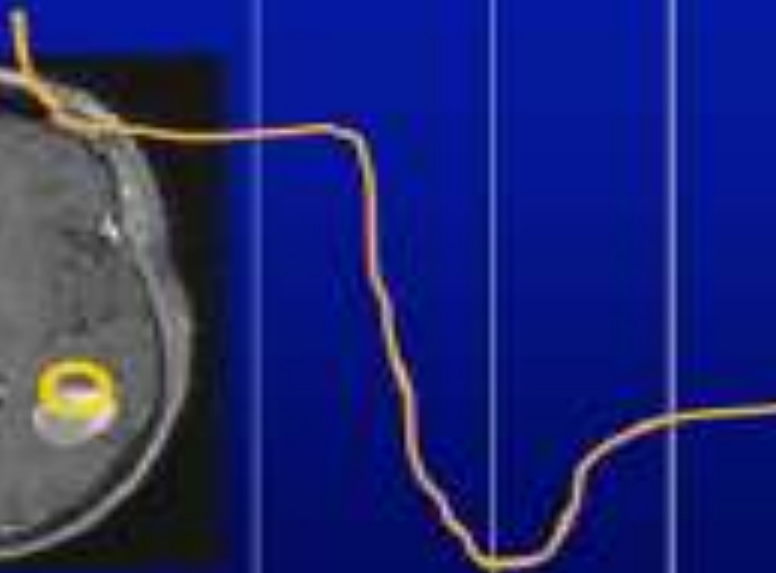
Pt. 1

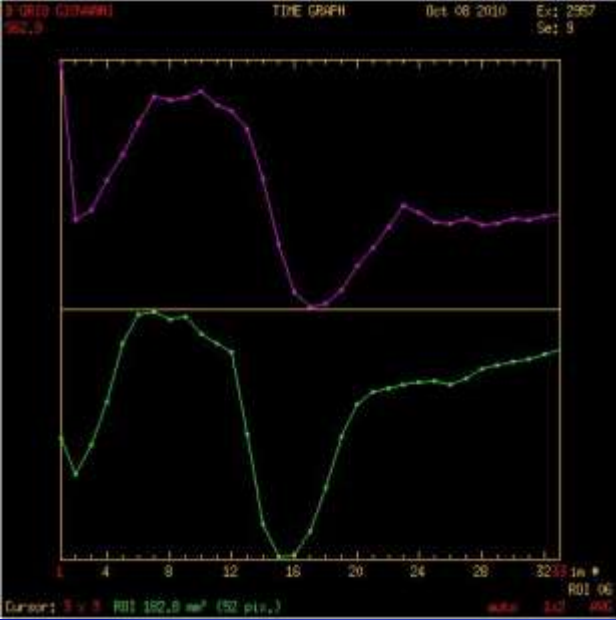


# Mets

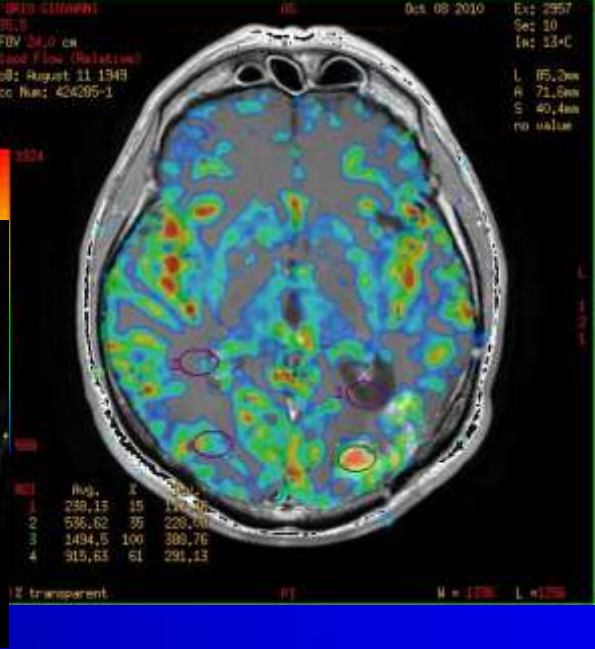
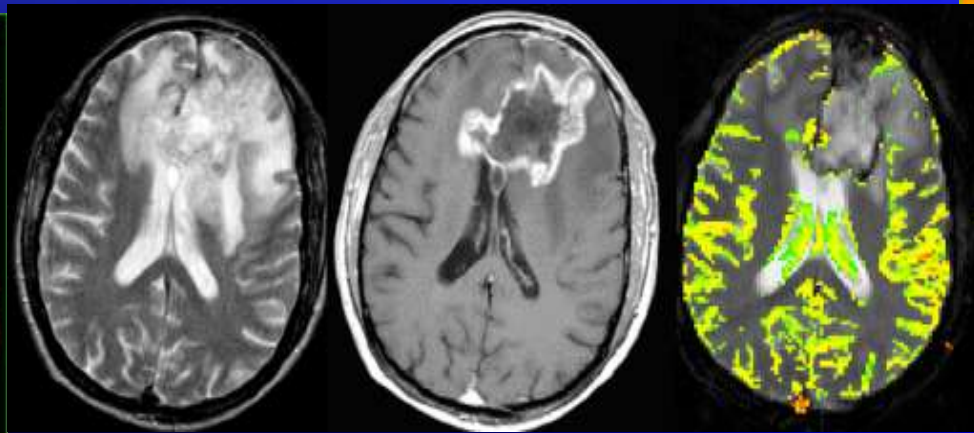
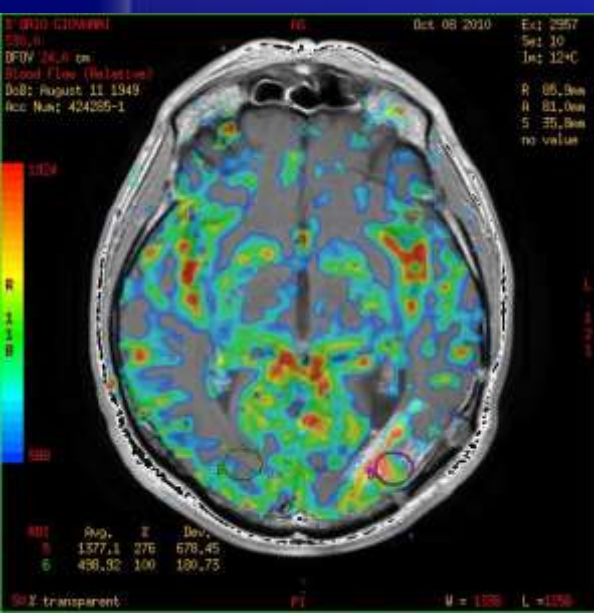
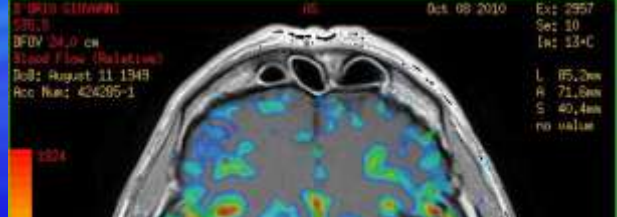
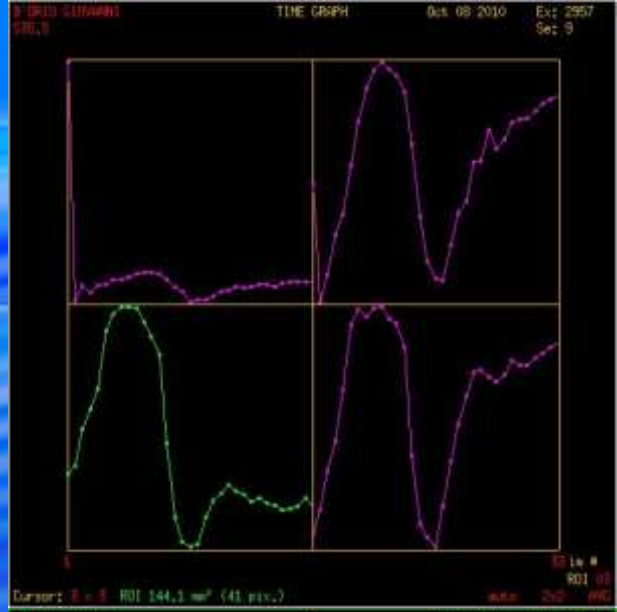
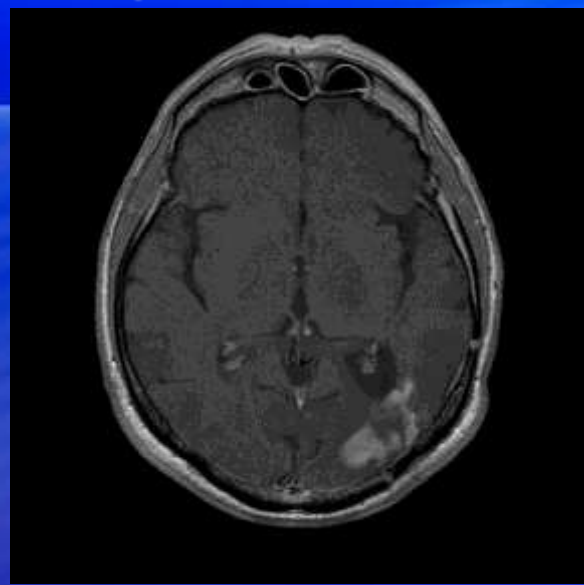


Pt. 2





# Ripresa di malattia

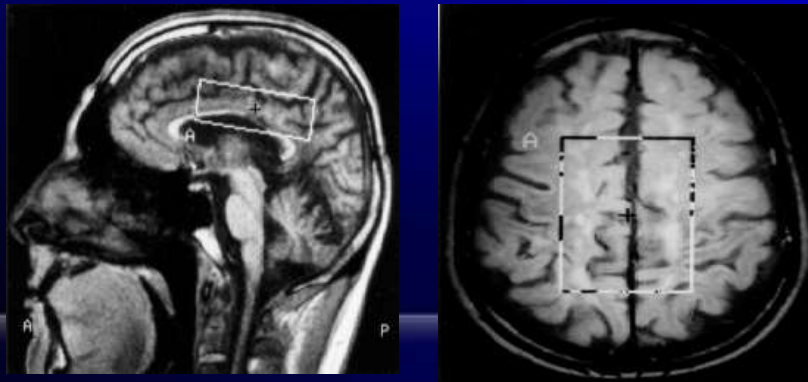
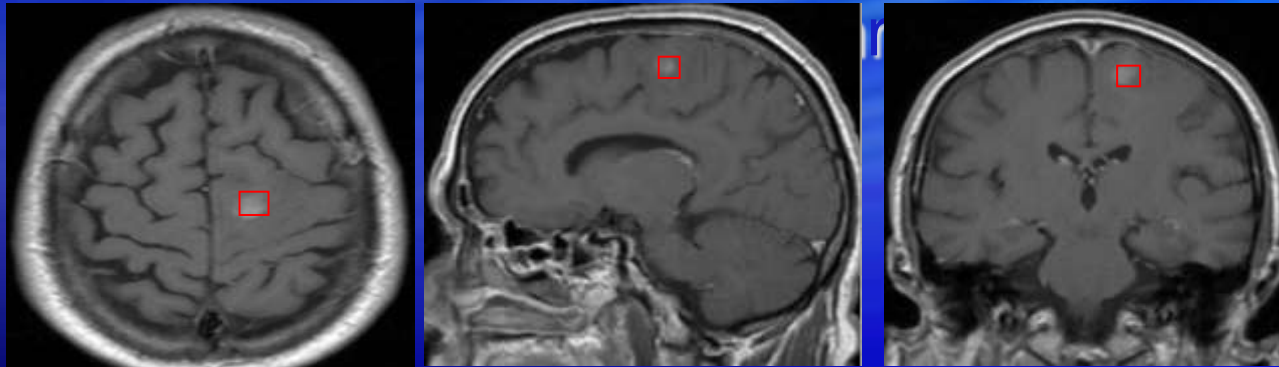


# RADIONECROSI

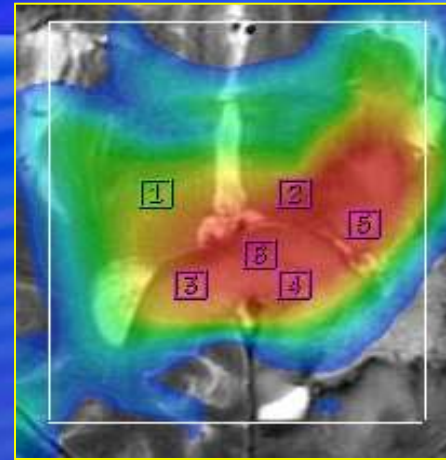
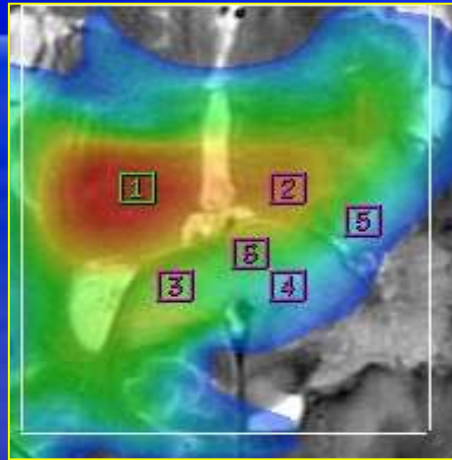
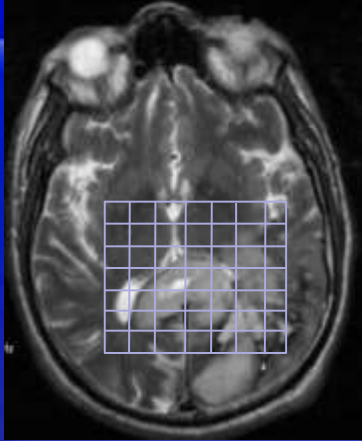
# TECNICHE D'ESAME

Tecniche di localizzazione : Single-Voxel  
Multi-Voxel (Spectroscopic Imaging-CSI)

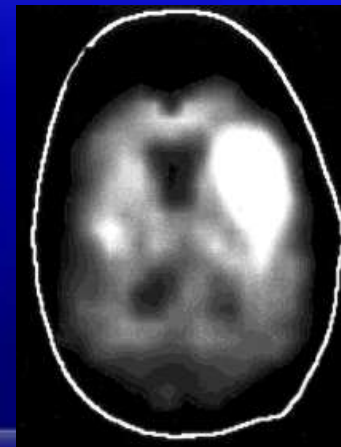
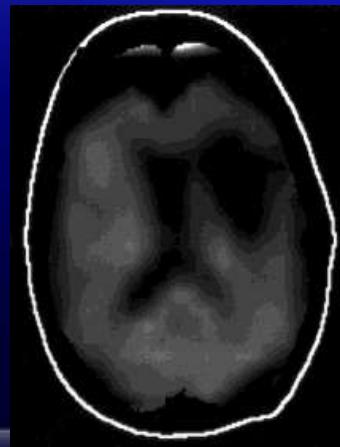
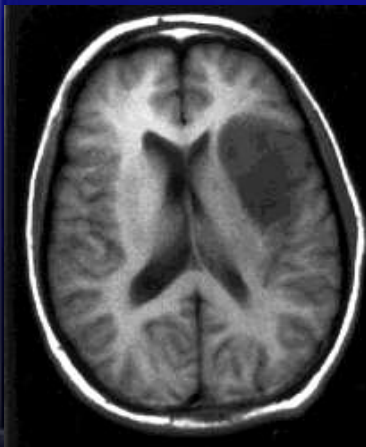
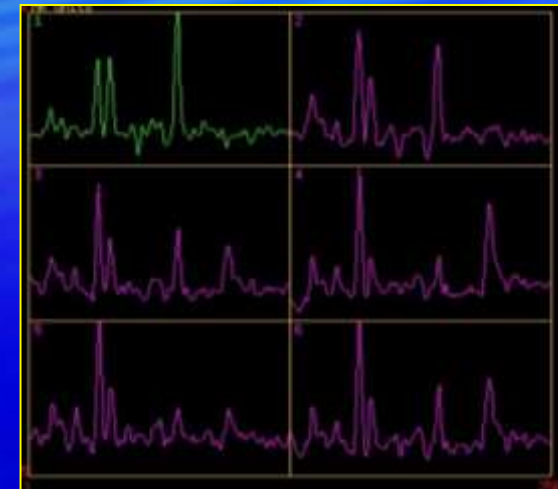
**SINGLE-VOXEL** Posizionamento di un singolo VOI (Volume of interest) in corrispondenza del tessuto da analizzare minimo



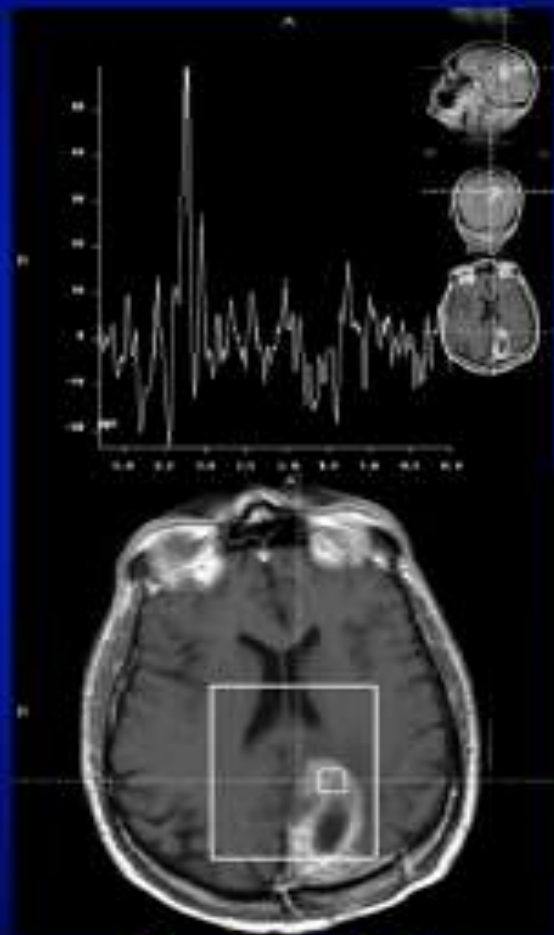
# TECNICHE D'ESAME MULTI-VOXEL: CSI



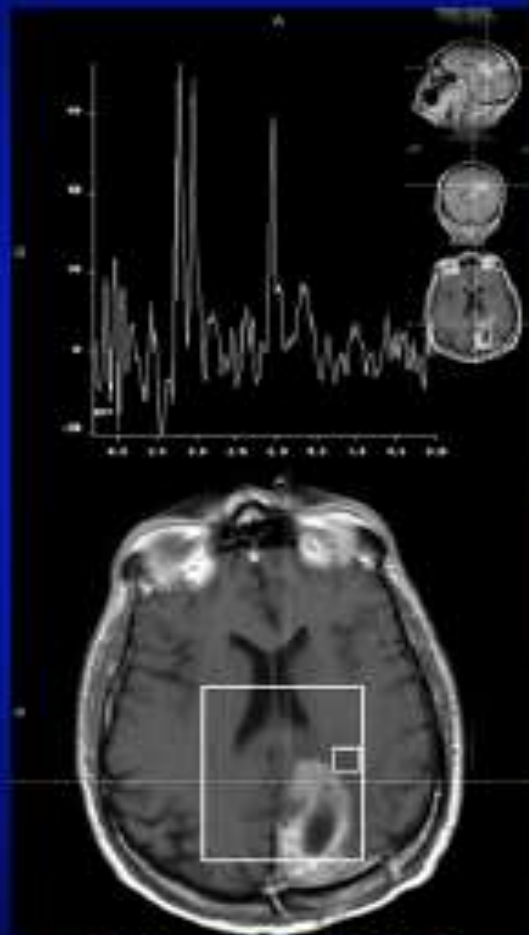
Mappa dell'Naa    Mappa della Cho



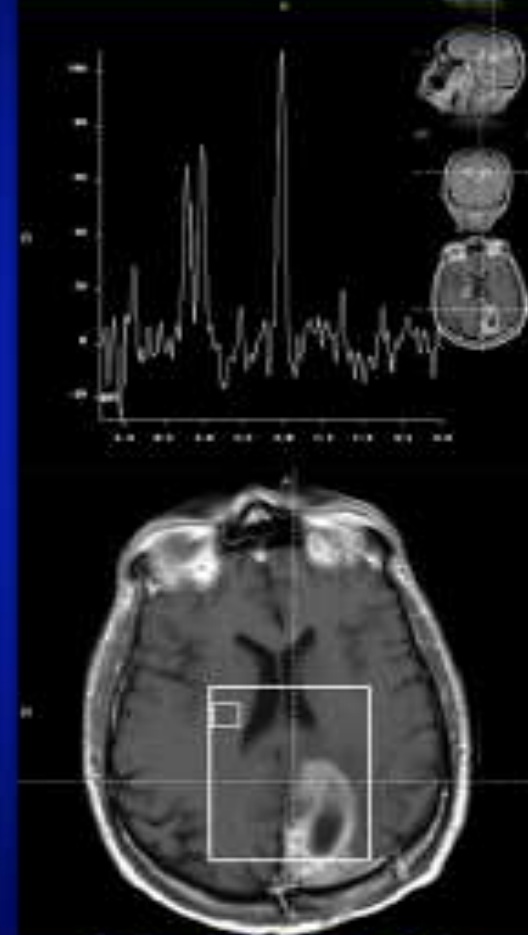
# GBM SPETTROSCOPIA



**Cho/Cr 2.3**

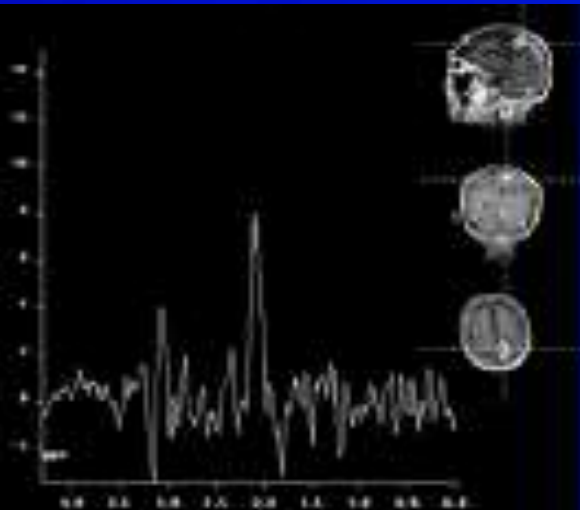


**Cho/Cr 1.11**

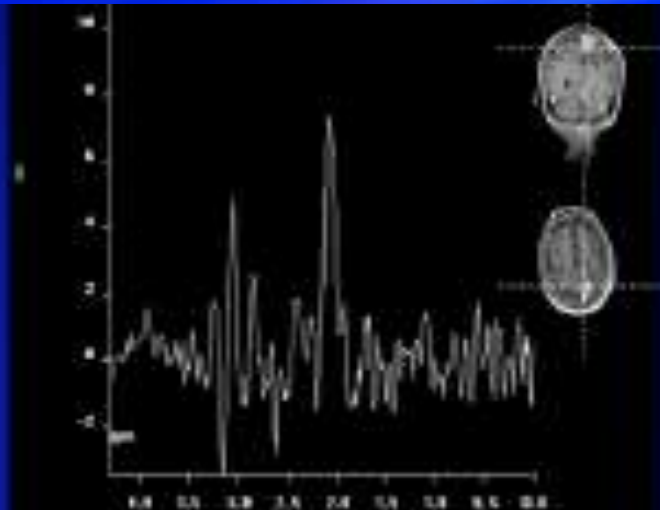


**Cho/Cr 0.79**

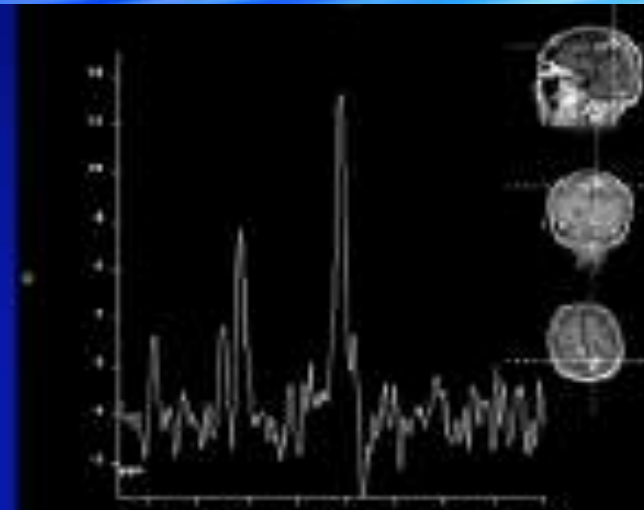
# METASTASI



**Cho/Cr 0.5**



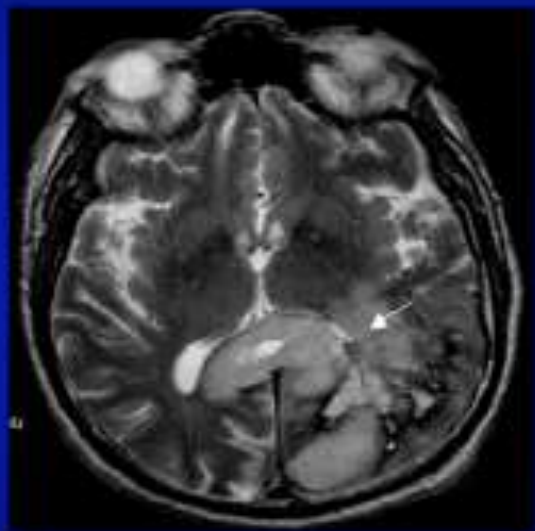
**Cho/Cr 0.4**



**Cho/Cr 0.45**

# DOVE LA BIOPSIA?

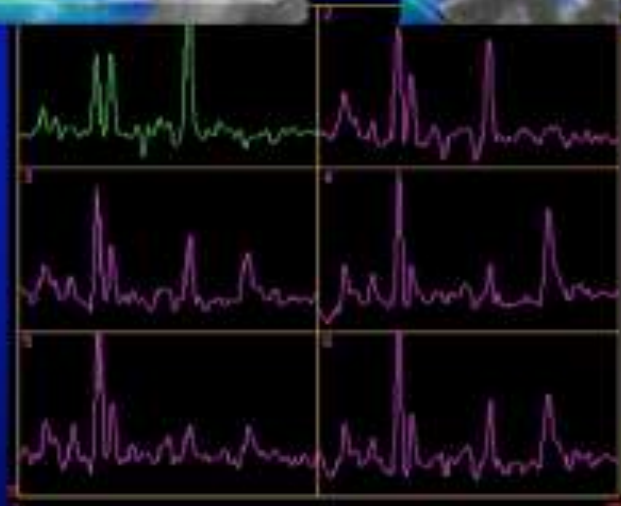
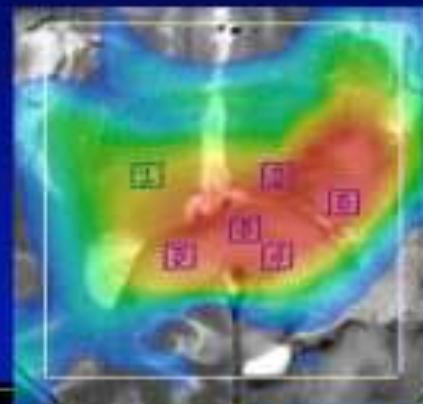
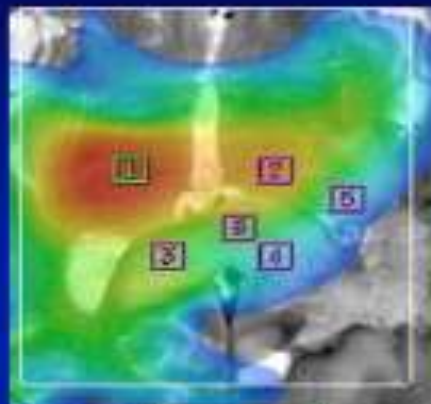
## Glioblastoma



NAA



Cho





---

# Tecniche per la ricerca sperimentale

---

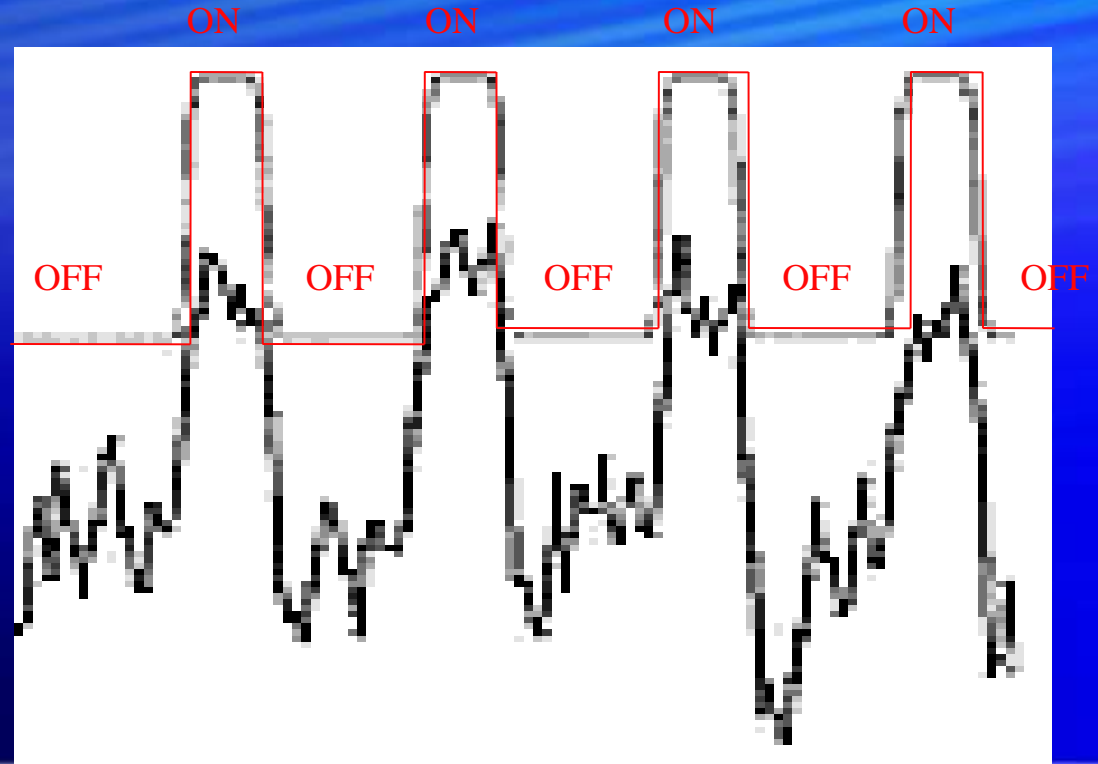
Paradigma semplice

Disegno sperimentale

# Dettaglio protocollo fMRI

Paradigma a blocchi  
Cicli alternati ON/OFF  
Ogni ciclo: 5-10 dinamiche

- Sequenze EPI T2\*
- TR = 3000ms  
TE = 60 ms
- Matrice = 64 x 64
- # sezioni = 25
- spessore = 4mm
- gap = 0



# RM IN PATOLOGIA NEUROLOGICA

## APPLICAZIONI ELETTIVE



- epilessia
- neoplasie cerebrali
- m. demielinizzanti
- ipoacusie neurosensoriali
- disendocrinie ipofisarie
- malformazioni cerebrali
- patologia mielica
- studi funzionali

# RM IN PATOLOGIA NEUROLOGICA

## APPLICAZIONI di II ISTANZA



- sequele traumi cranici
- esiti di patologia vascolare ischemica/emorragica
- patologie degenerative cerebrali (parkinson, etc)
- demenze

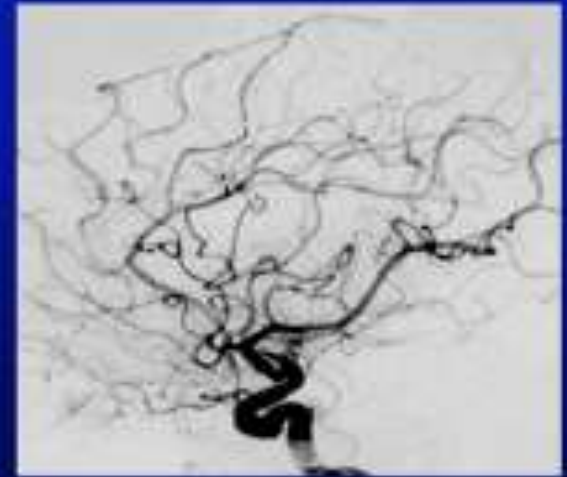
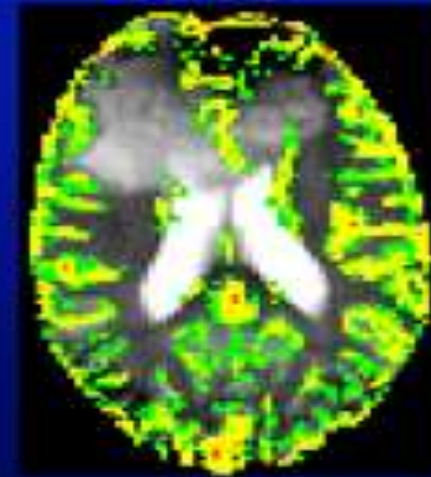
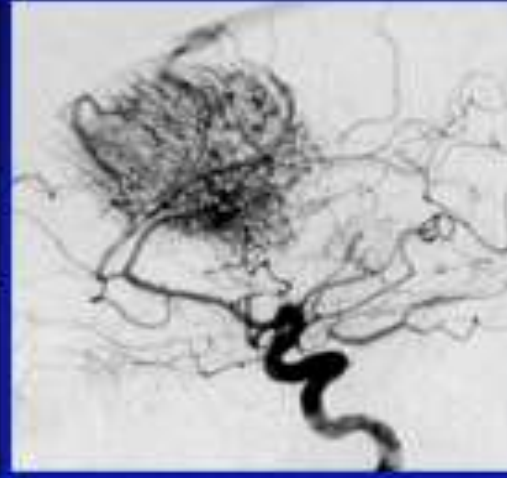
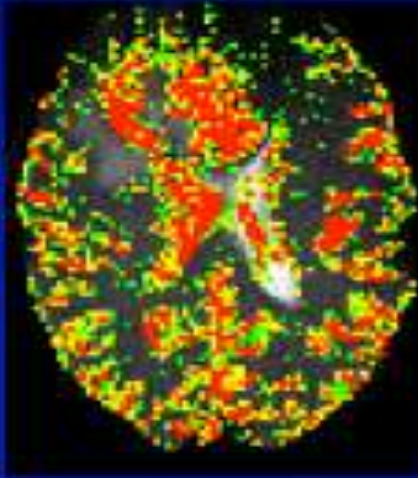
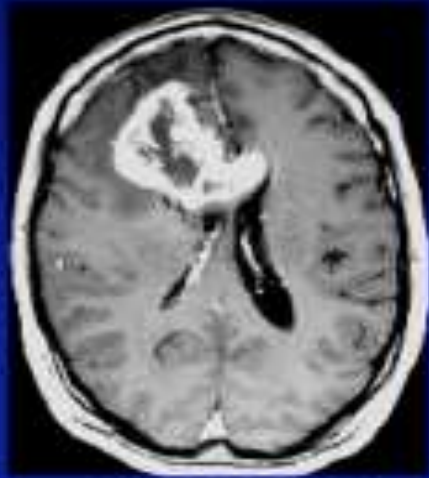
# CONTROINDICAZIONI ALL'ESAME RM



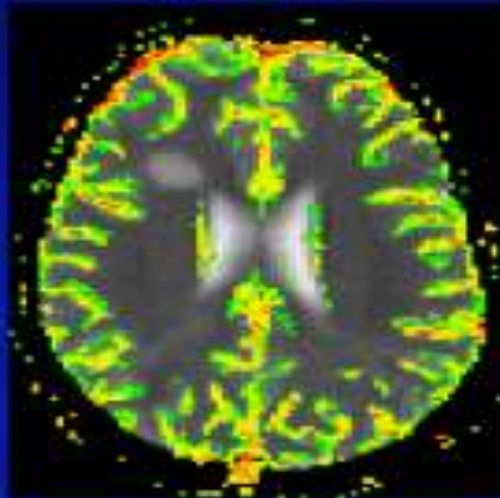
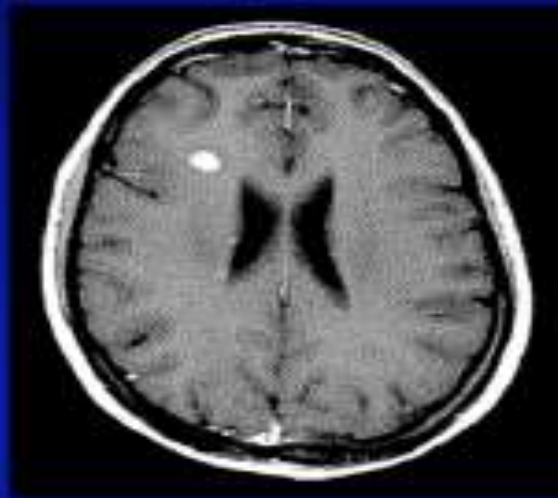
- portatori di pace-maker
- clips vascolari (aneurismi cerebrali !!)
- protesi valvolari meccaniche
- protesi del cristallino (vecchia concezione)
- impianti otologici
- corpi estranei (intra-oculari)

CHIEDERE AL MEDICO RADIOLOGO DI VALUTARE SEMPRE I PRONTUARI  
DI COMPATIBILITA' DI QUALUNQUE ELEMENTO PROTESICO

# E' UNA NEOPLASIA?

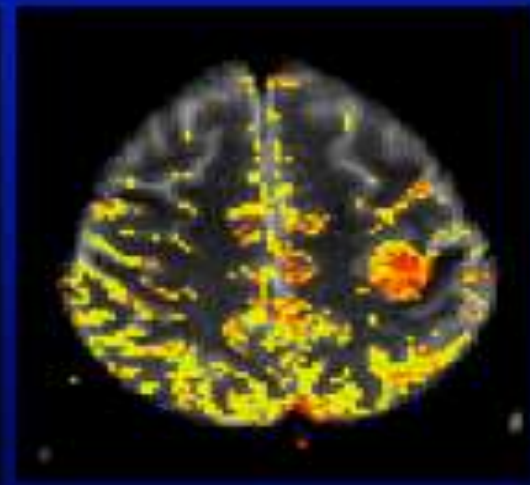
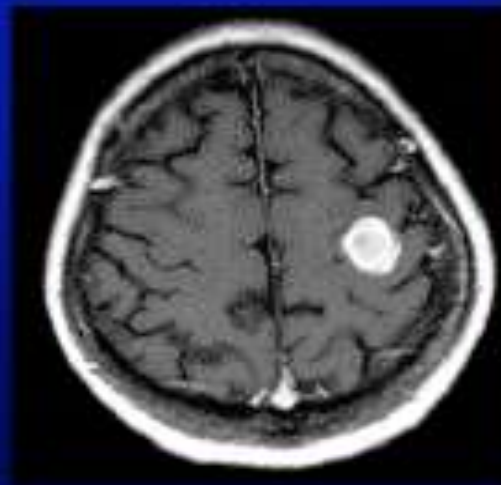


# E' UNA NEOPLASIA?



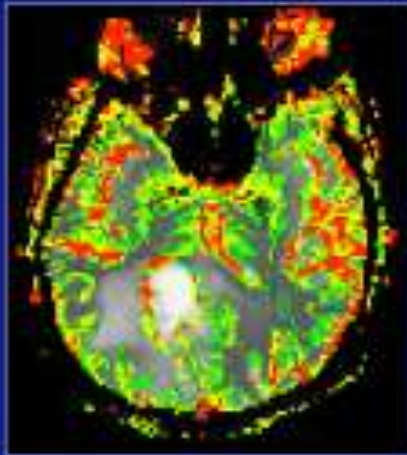
← MS

GBM →



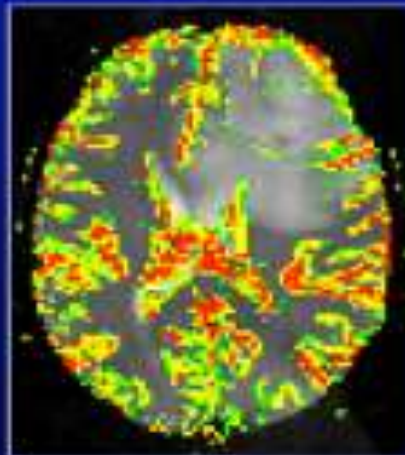
# PRIMITIVO O METASTASI?

PERITUMORAL AREA CBV



$$\text{cyan circle} / \text{pink circle} = 2.3$$

**HIGH CBV** in PERITUMORAL  
AREA IN HI-GR GLIOMAS



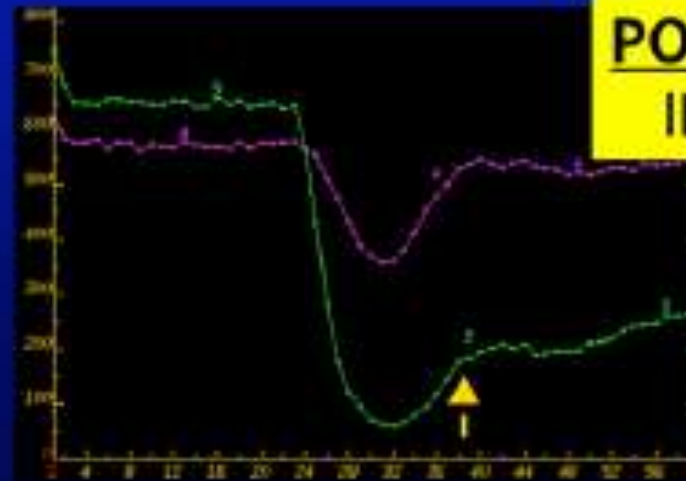
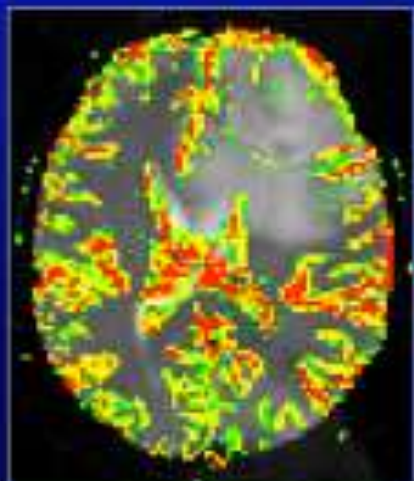
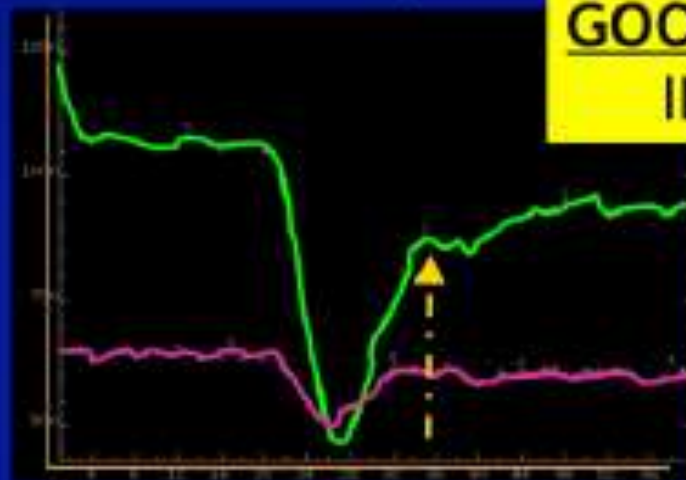
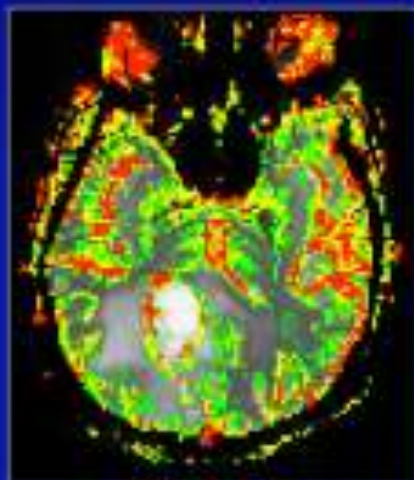
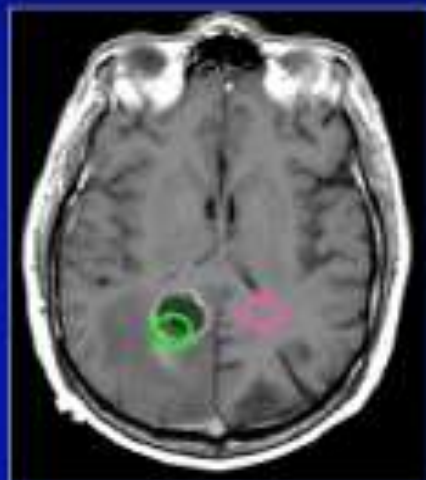
$$\text{cyan circle} / \text{pink circle} = 0.7$$

**LOW CBV** in PERITUMORAL  
AREA IN METASTASIS



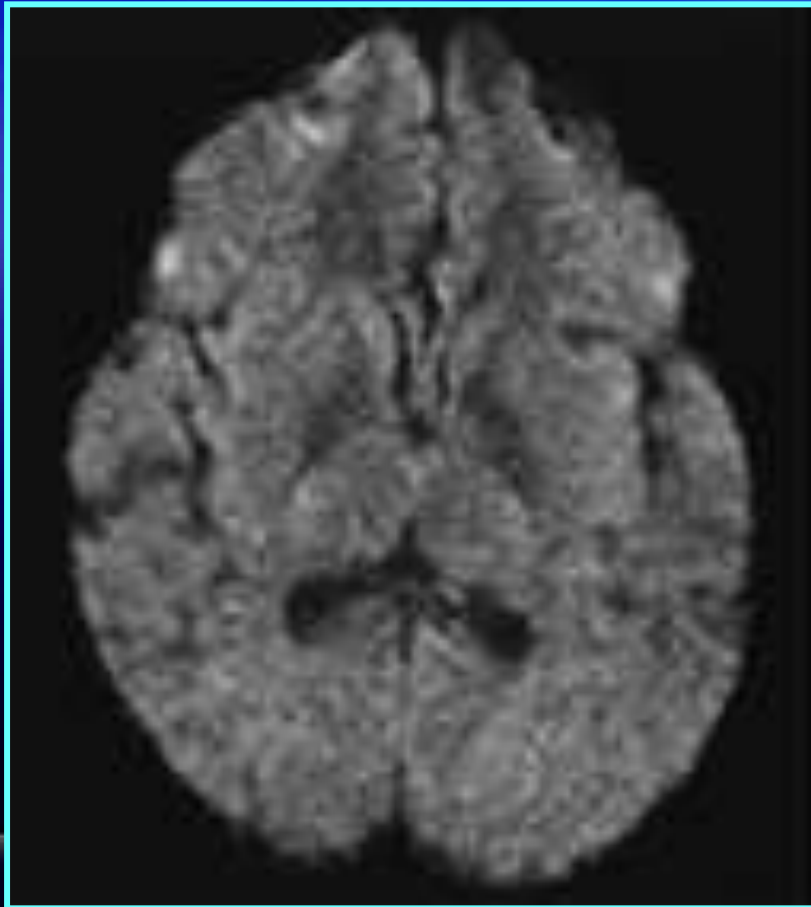
# PRIMITIVO O METASTASI?

T2\* recovery

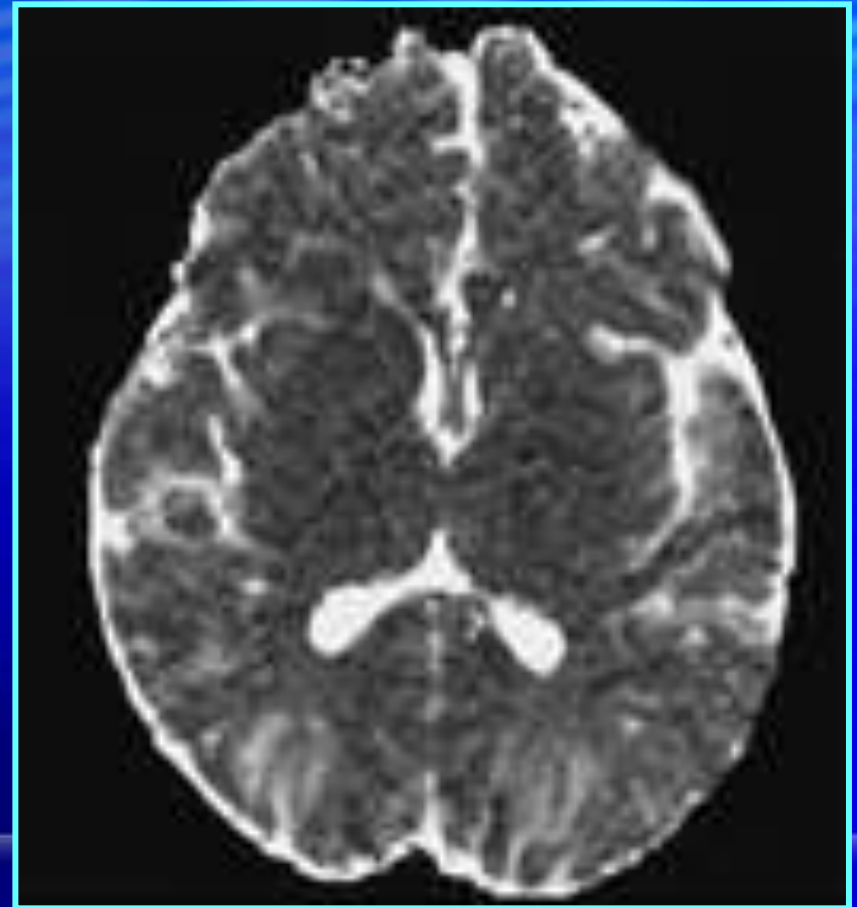


# Traccia ed ADC

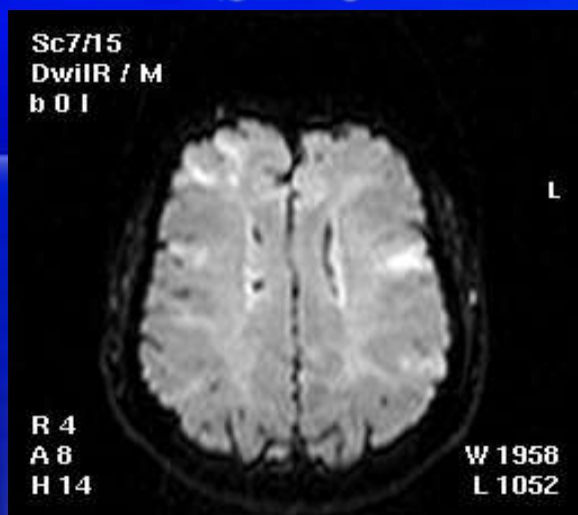
Traccia DWI



Mappa ADC

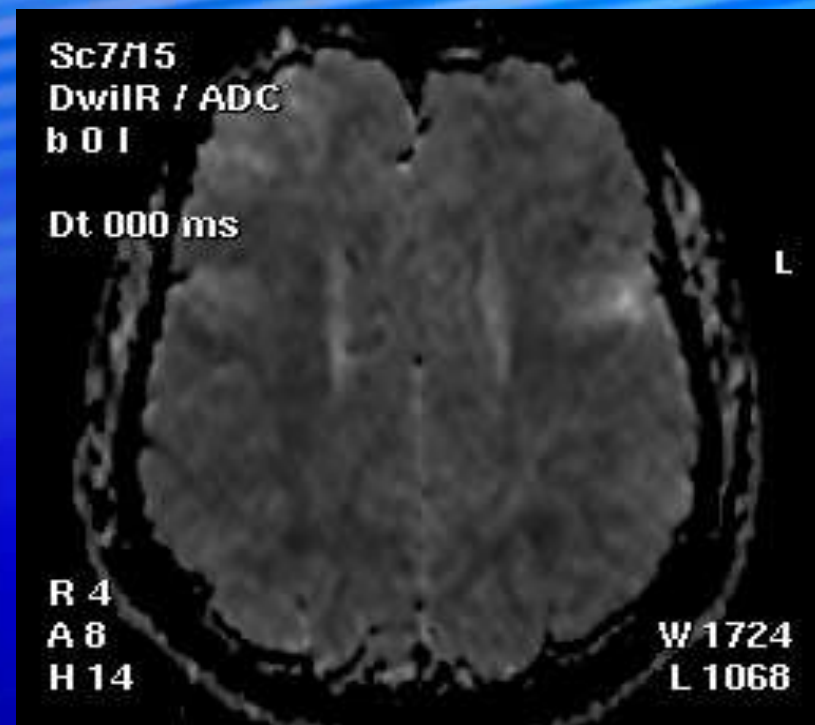
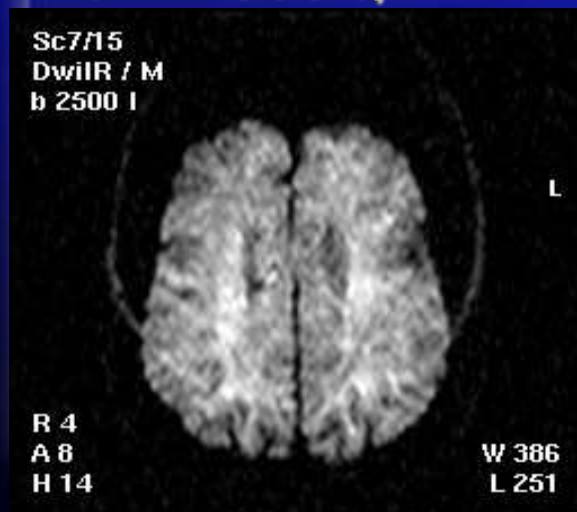


$b = 0$



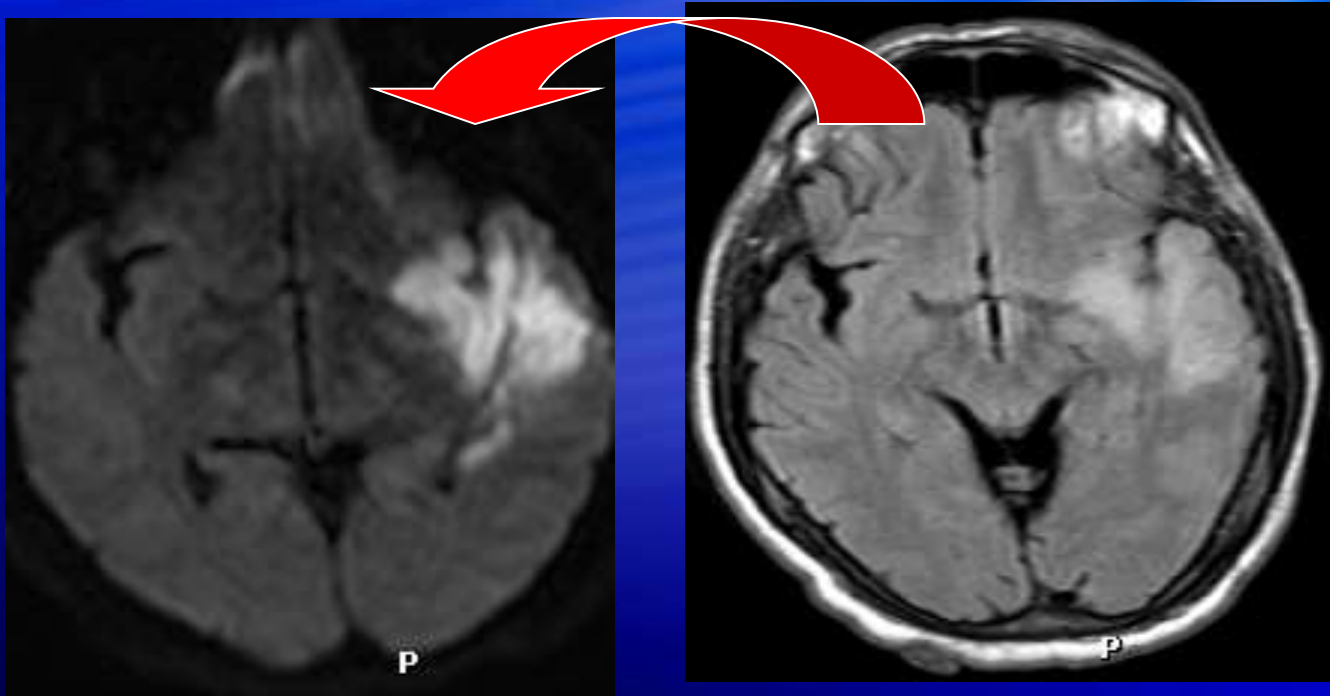
$$\ln(SI/SH)/(bh-bl) =$$

$b = 1000 \text{ s/mm}^2$



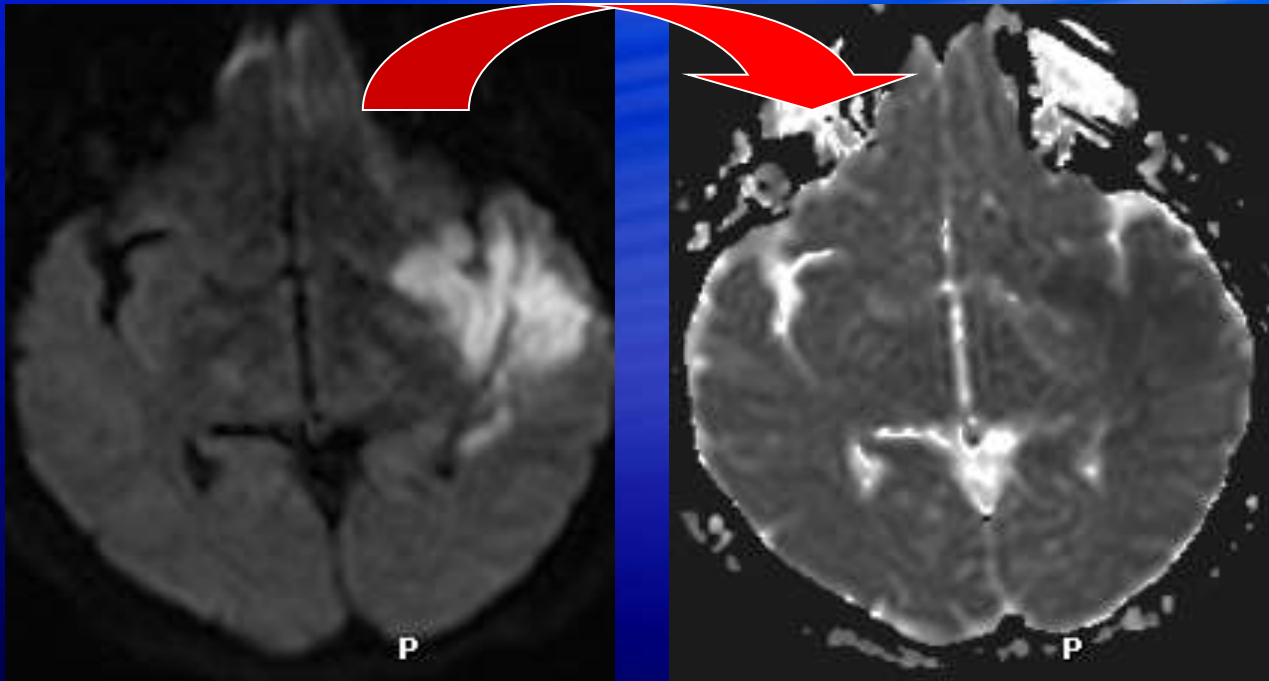
Mappa ADC

... si parla in tal caso di fenomeno di "shine through"



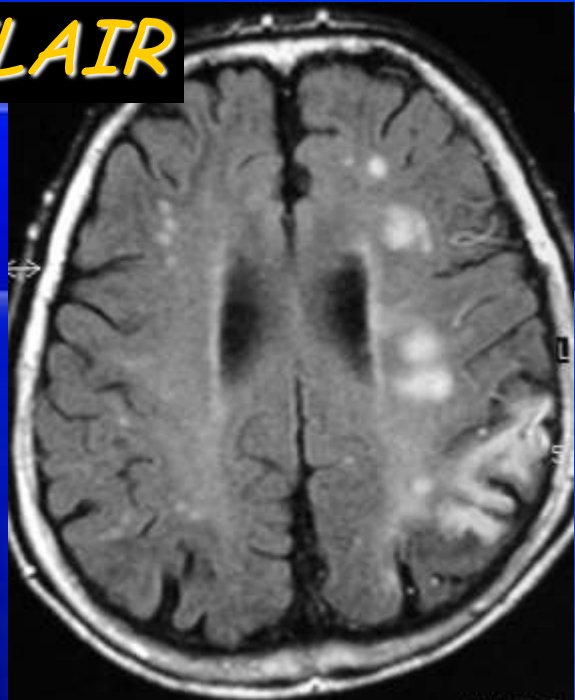
... che sarebbe l'effetto del T2 nell'immagine di diffusione

... se l'immagine pesata in diffusione è la più utilizzata per finalità cliniche

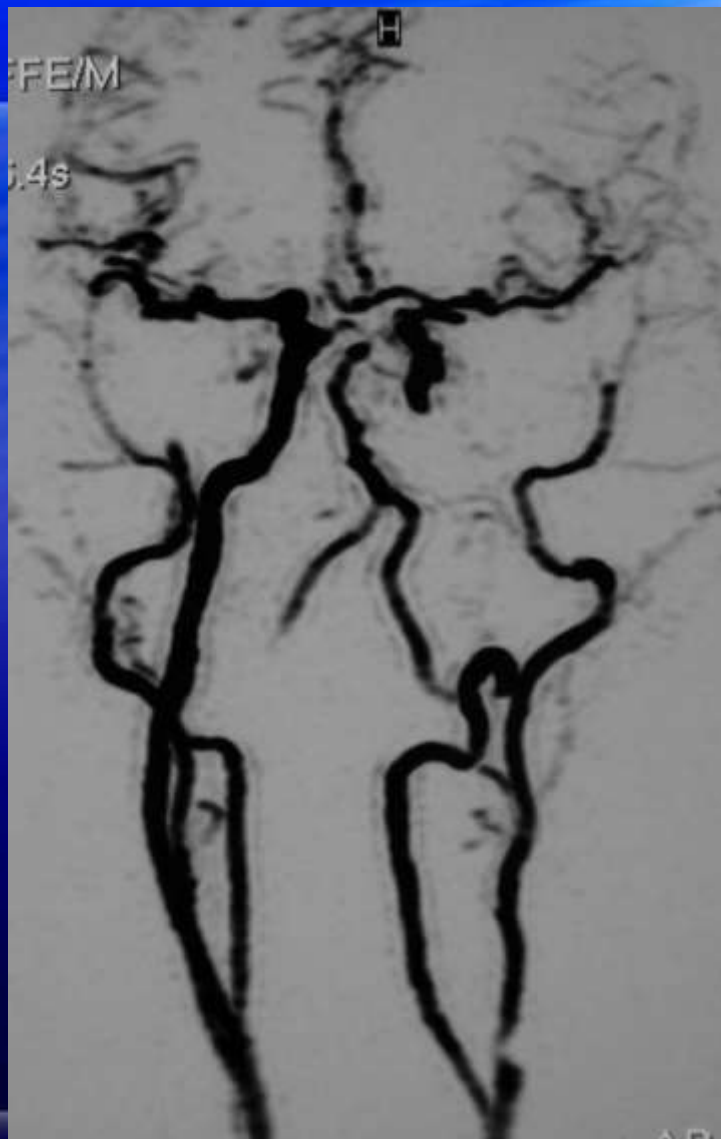


... solo nella mappa di ADC è possibile quantificare la diffusione (che è un parametro assoluto) .... ed eliminare l'effetto del T2

**FLAIR**

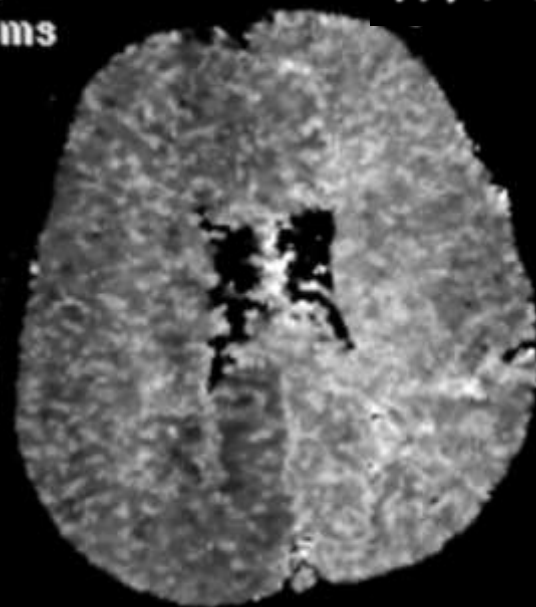


**diffusione**

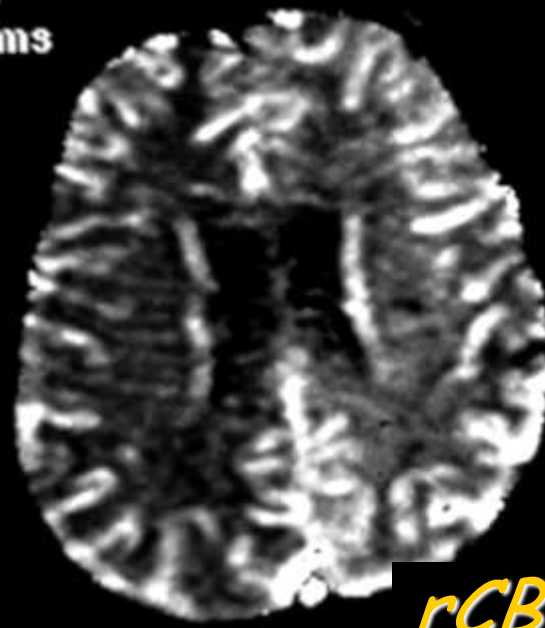


**5  
0ms**

**MTT**

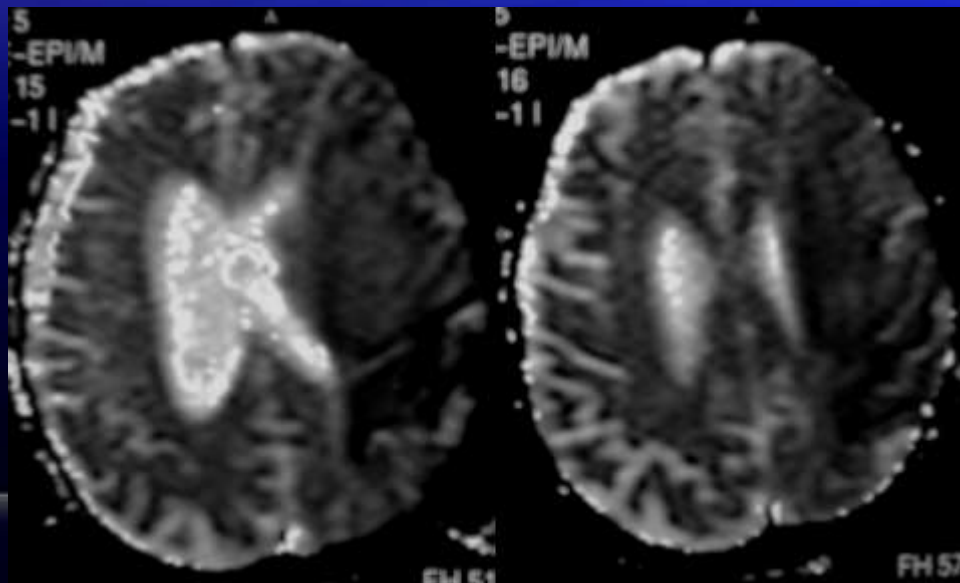
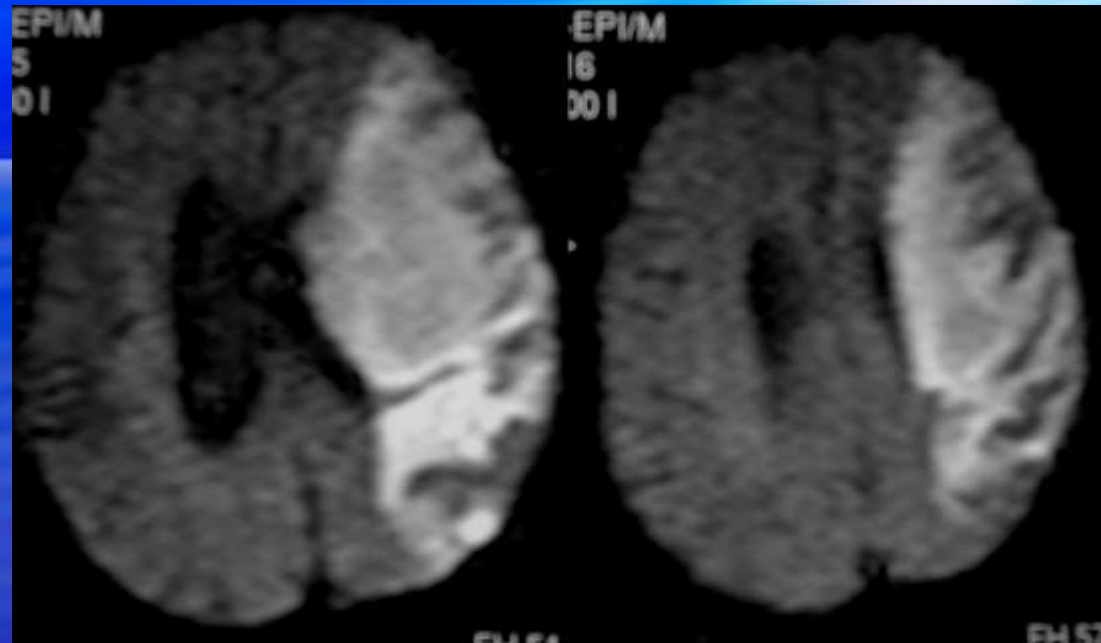


**ms**



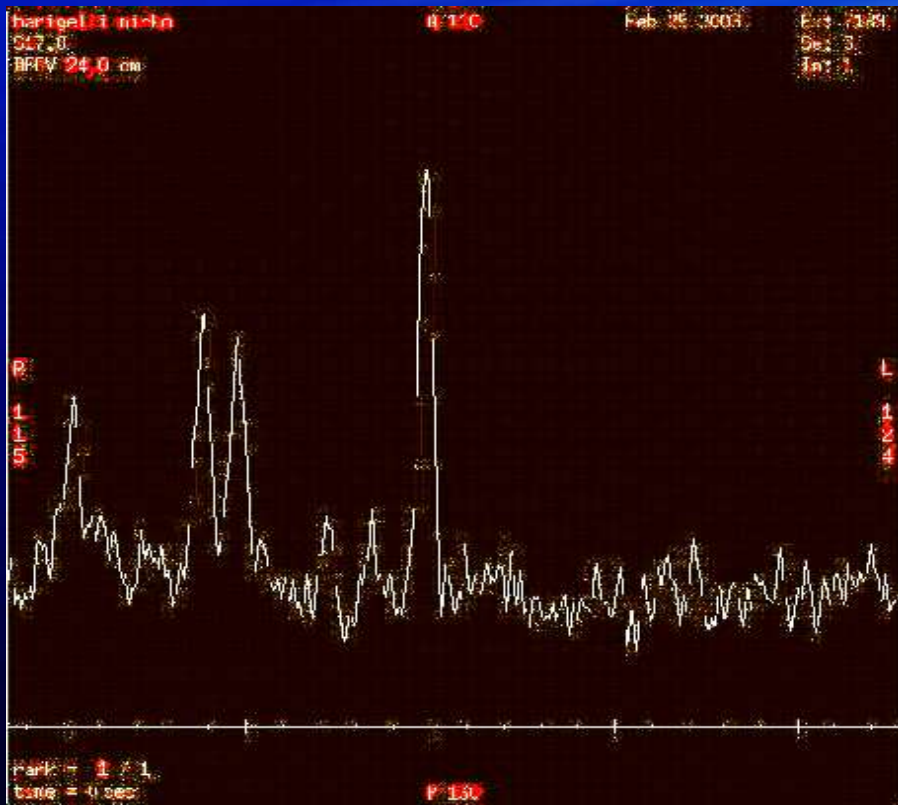
**rCBV**

Ove è presente edema citotossico si rileva una ridotta diffusione delle molecole di acqua e quindi si osserva un incremento di segnale nelle relative sequenze

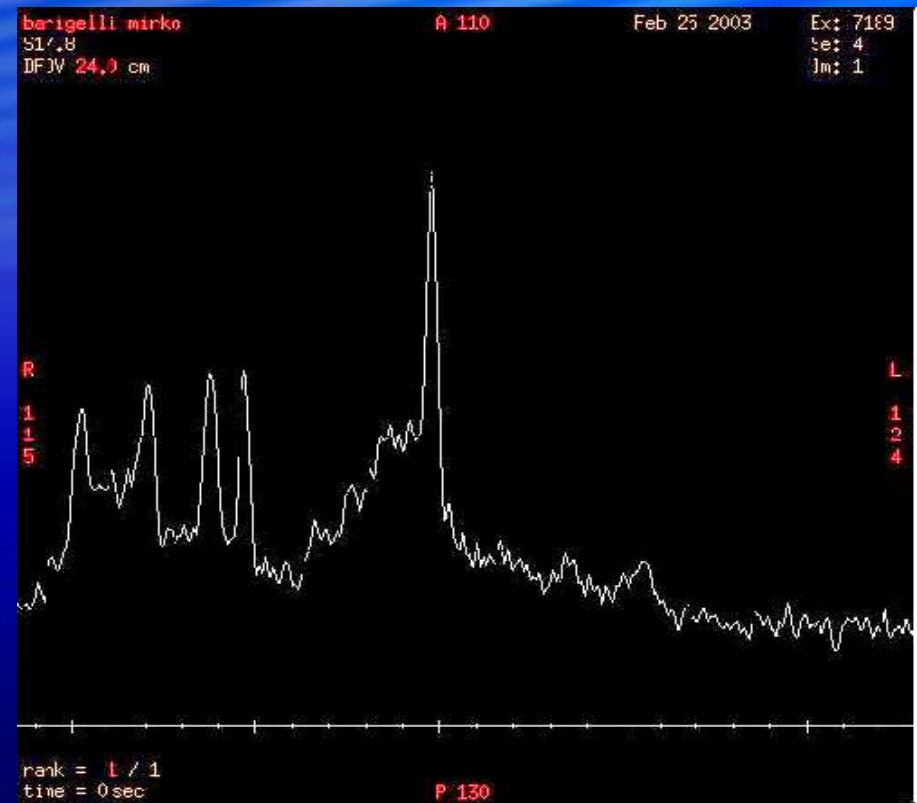


..ed una riduzione del segnale nella relativa mappa di ADC

# SPETTROSCOPIA S.V.



TE LUNGO



TE BREVE



# Equazione di Stejskal and Tanner (1965)

Applicando un gradiente di diffusione si determina una perdita di segnale in direzione parallela al gradiente stesso pari a:

$$\frac{S}{S_0} = e^{-g^2 \cdot G^2 \cdot d^2 \cdot (D - d/3) \cdot D} = e^{-b \cdot D}$$

$G$  = ampiezza massima dei gradienti

$\delta$  = durata del singolo gradiente

$\Delta$  = intervallo di tempo tra i due gradienti

$\gamma$  = rapporto giromagnetico (42.5774 MHz/T)

$$b = g^2 \cdot G^2 \cdot d^2 \cdot (D - d/3)$$

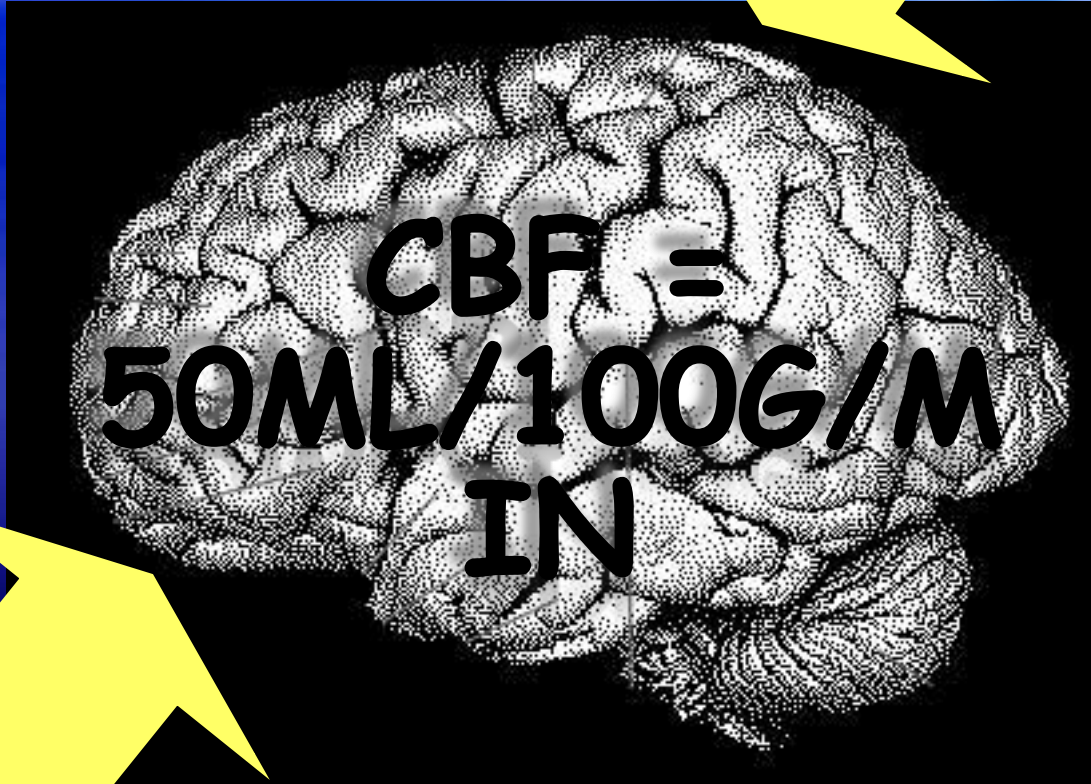
$$\ln\left(\frac{S}{S_0}\right) = -b \times D$$

# Storia dell'fMRI

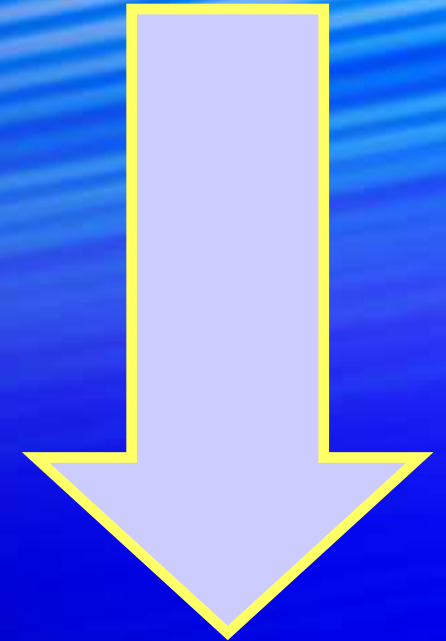
---

- ✓ 20 anni dopo la sua introduzione la RM è stata applicata allo studio della funzione cerebrale
- ✓ I primi studi di mappatura funzionali cerebrali si basarono sulla determinazione del volume ematico cerebrale ( CBV )
- ✓ Passi successivi furono quelli di individuare variazioni del CBV indotte localmente da attività cerebrali
- ✓ Negli anni '90 furono eseguiti studi basati sull'utilizzo di M.D.C. esogeno, poi soppiantati da nuove metodiche con utilizzo di contrasto endogeno; emoglobina, che subisce variazioni delle proprietà magnetiche in relazione a cambiamenti del suo grado di ossigenazione  
Tecnica BOLD  
( Blood Oxygenation Level-Dependent )

160 mm Hg

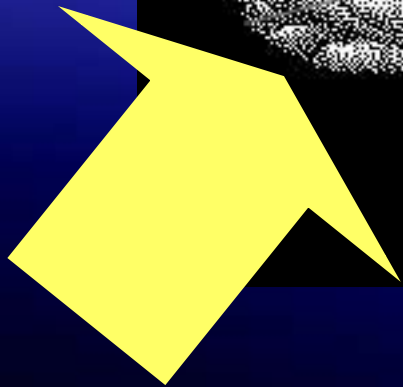


20mL/100g/min



Cascata  
fisiopatologica  
dell'ischemia

45 mm Hg



# Ischemia cerebrale: fisiopatologia

riduzione CBF (mL/100g/min)

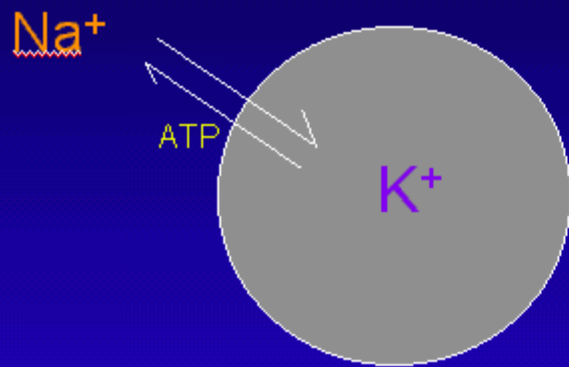
< 22: inizia il danno reversibile (penombra)

< 18: i neuroni corticali perdono i potenziali spontanei

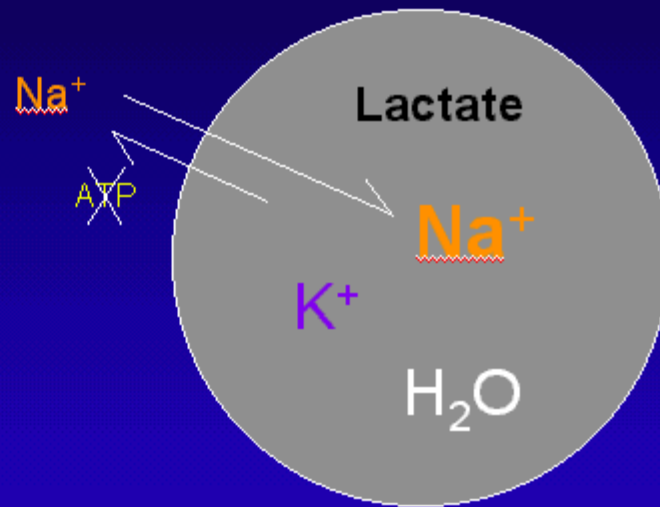
< 12: (> 2 ore): infarto

- sensibilità cellulare

Neuroni > oligodendrociti > astrociti



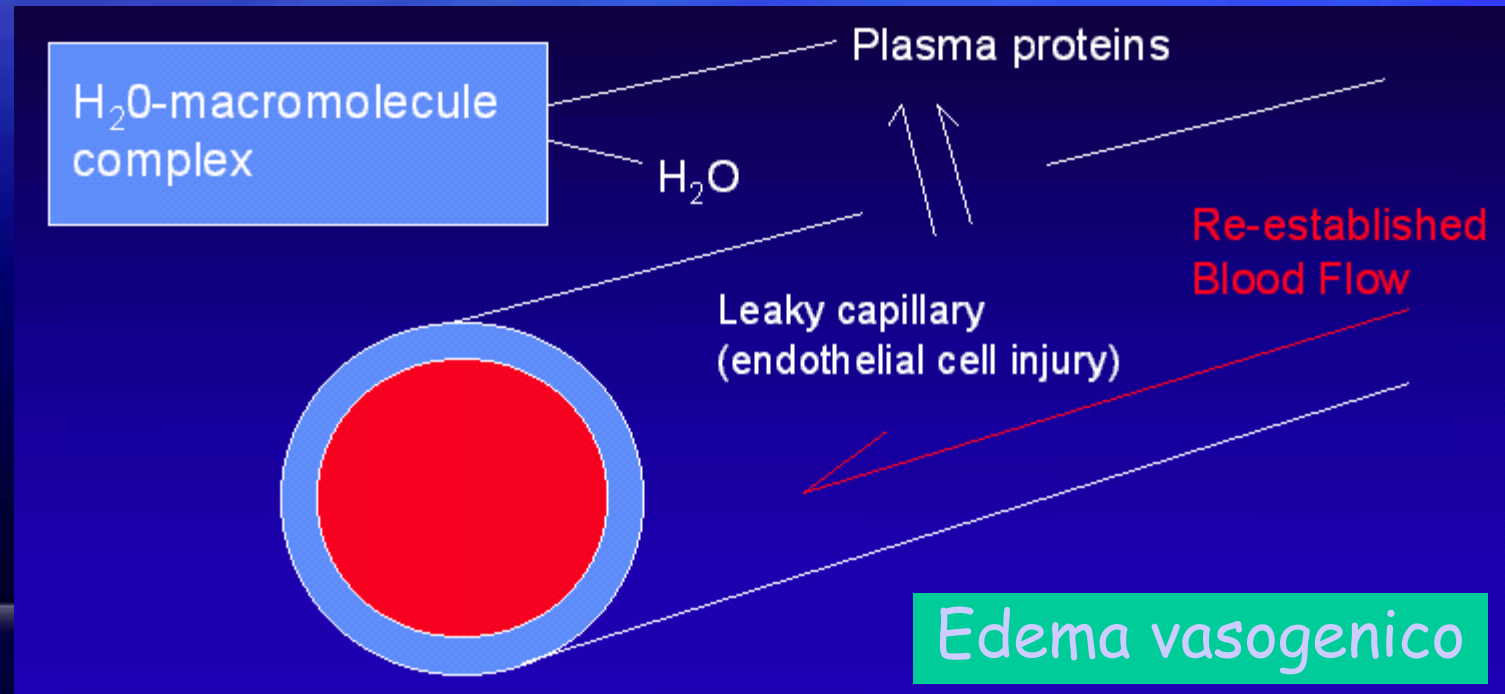
normale



Edema citotossico

Il Na e' un marker di Vitalita' .

- <45 mM normale
- < 55 mM reversibile
- <68 mM irreversibile



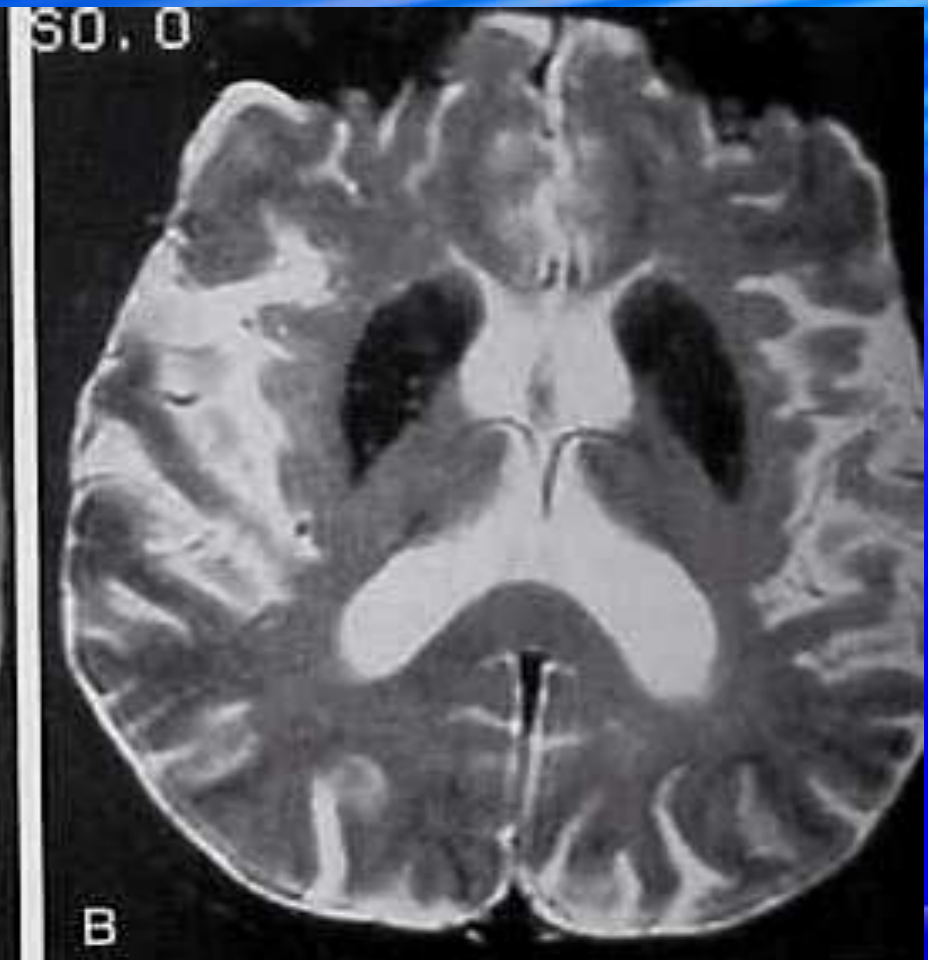
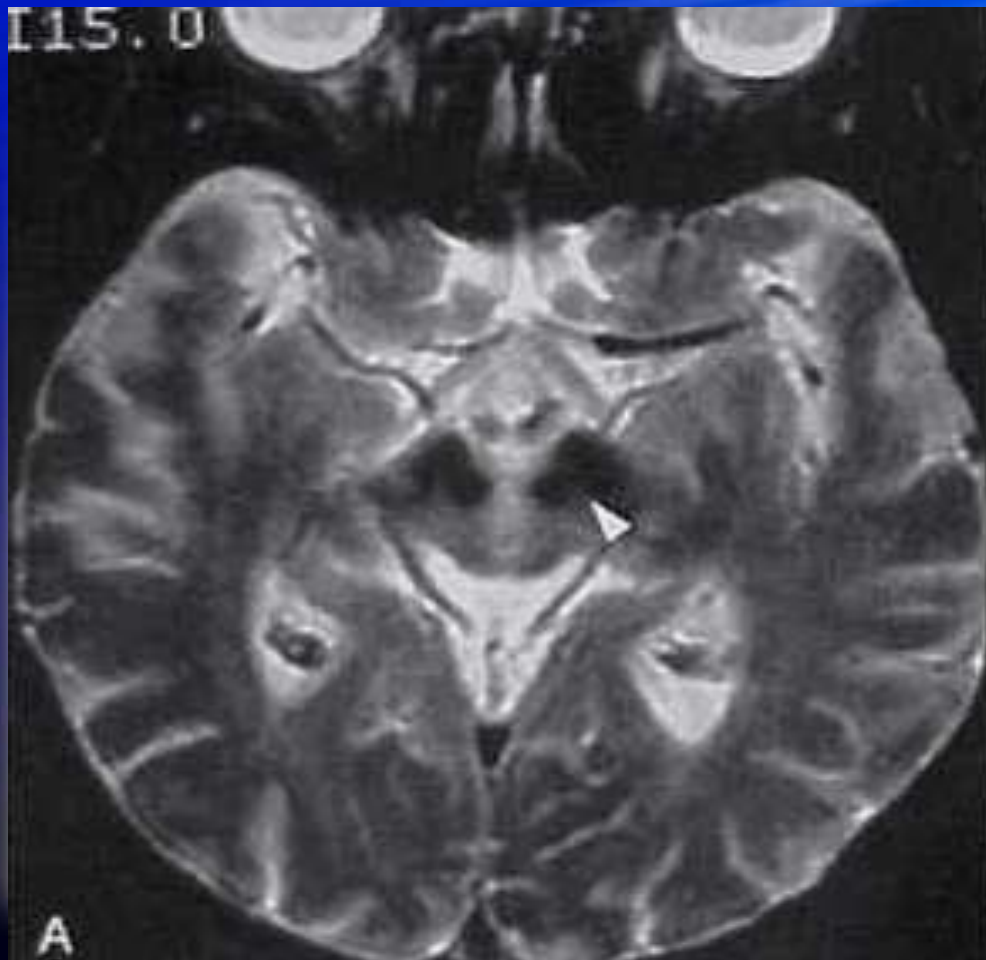
Edema vasogenico

# PARKINSONISMI

## **ATROFIA MULTISISTEMICA** *(sindrome di Shy-Drager?)*

- **Degenerazione striatonigra (MSA-P)**
- **Atrofia olivo-ponto-cerebellare(MSA-C)**

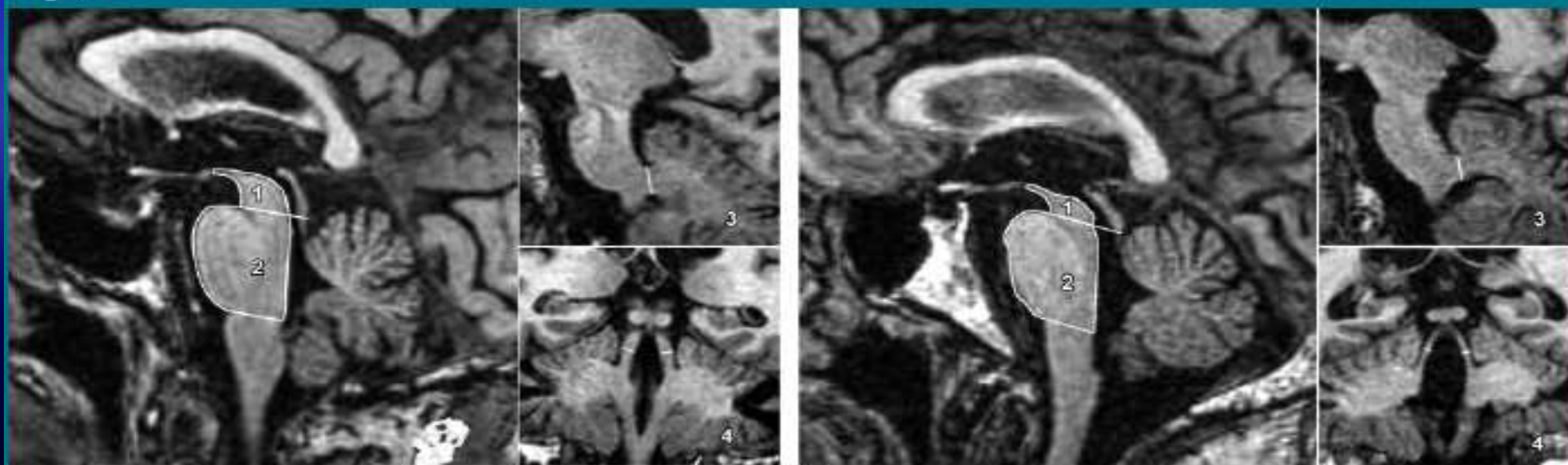
# EX DEGENERAZIONE NIGRO-STRIATALE (MSA-P)



Aldo Quattrone, MD  
 Giuseppe Nicoletti, MD  
 Demetrio Messina, MD  
 Francesco Fera, MD  
 Francesca Condino, PhD  
 Pierfrancesco Pugliese, MD  
 Pierluigi Lanza, MD  
 Paolo Barone, MD  
 Letterio Morgante, MD  
 Mario Zappia, MD  
 Umberto Aguglia, MD  
 Olivier Gallo, STc

# MR Imaging Index for Differentiation of Progressive Supranuclear Palsy from Parkinson Disease and the Parkinson Variant of Multiple System Atrophy<sup>1</sup>

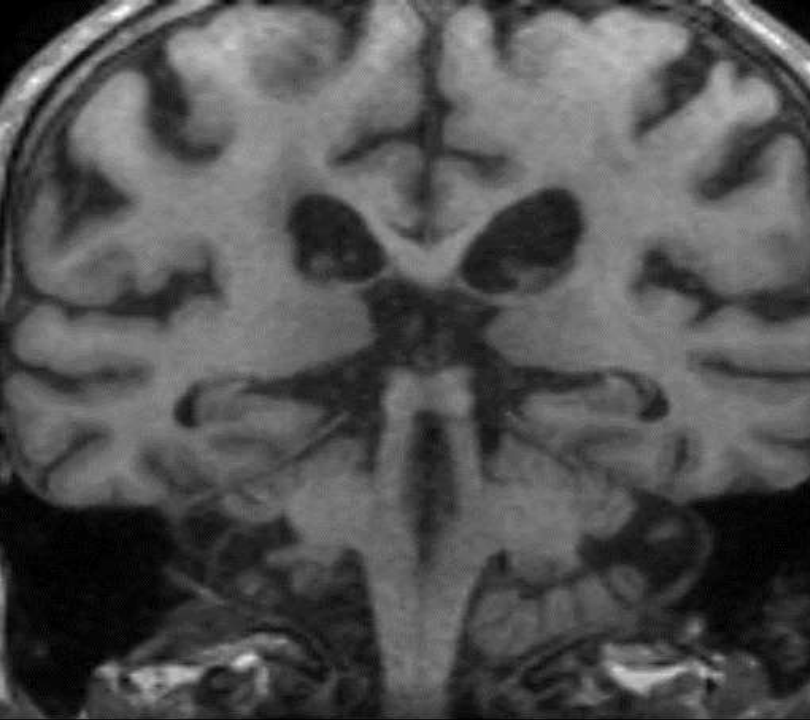
**Figure 2**



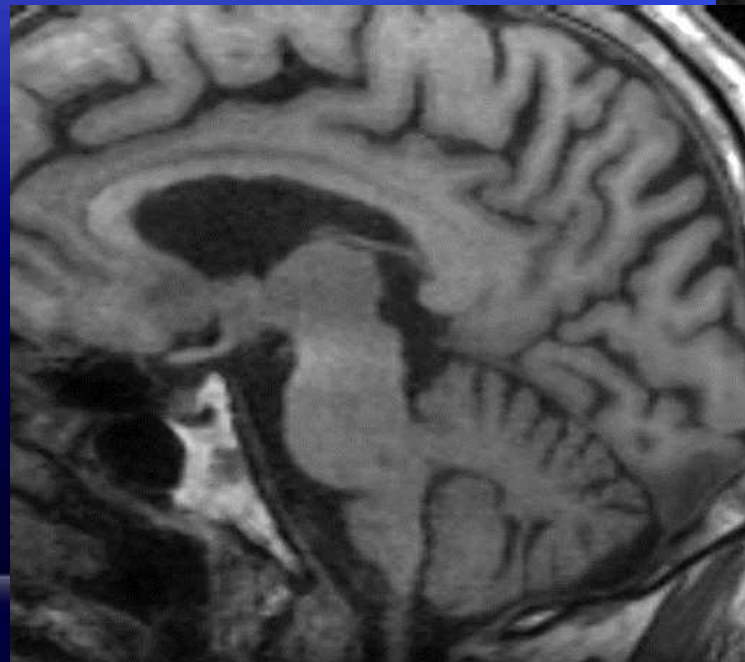
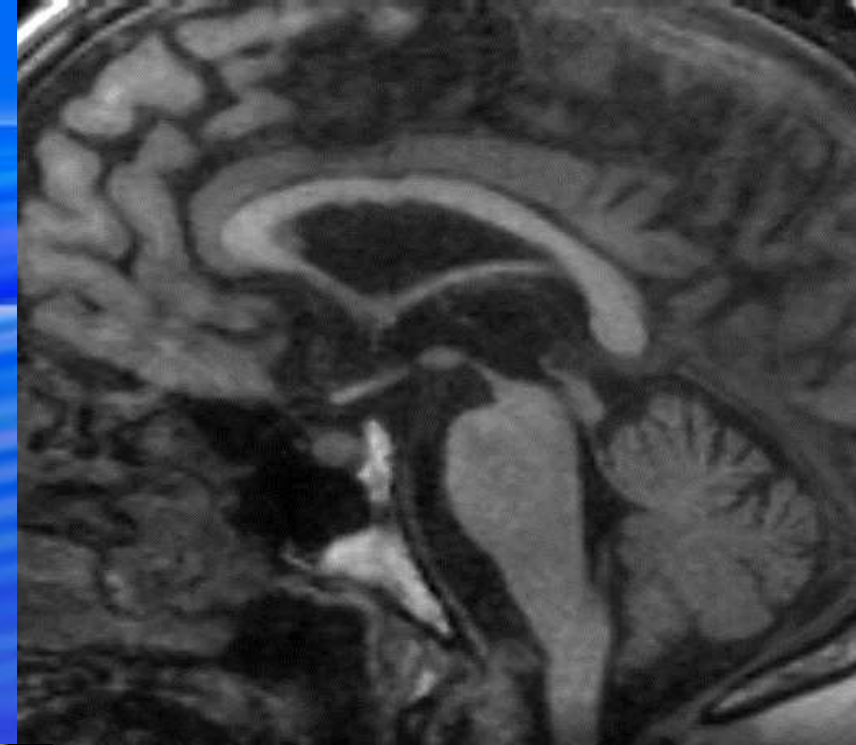
**a.** **b.**

**Figure 2:** Sagittal and coronal T1-weighted volumetric spoiled gradient-echo MR images (15.2/6.8; section thickness, 0.6 mm; frequency- and phase-encoding matrix, 256 × 256; flip angle, 15°) show midbrain area (1), pons area (2), MCP width (3), and SCP width (4) in (a) a control participant and (b) a patient with PSP. Images show marked atrophy of both midbrain and SCP in the PSP patient in comparison with the healthy control participant. In the patient with PSP, values were as follows: midbrain area, 60 mm<sup>2</sup>; pons area, 502 mm<sup>2</sup>; MCP width, 8.15 mm; and SCP width, 1.70 mm. In the control participant, values were as follows: midbrain area, 108 mm<sup>2</sup>; pons area, 478 mm<sup>2</sup>; MCP width, 10.05 mm; and SCP width, 4.10 mm.

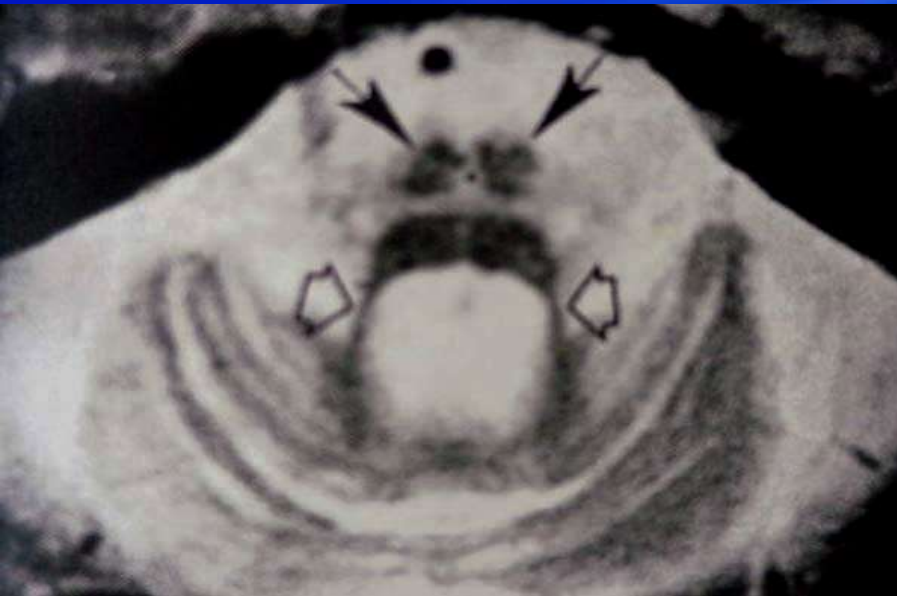




PSP

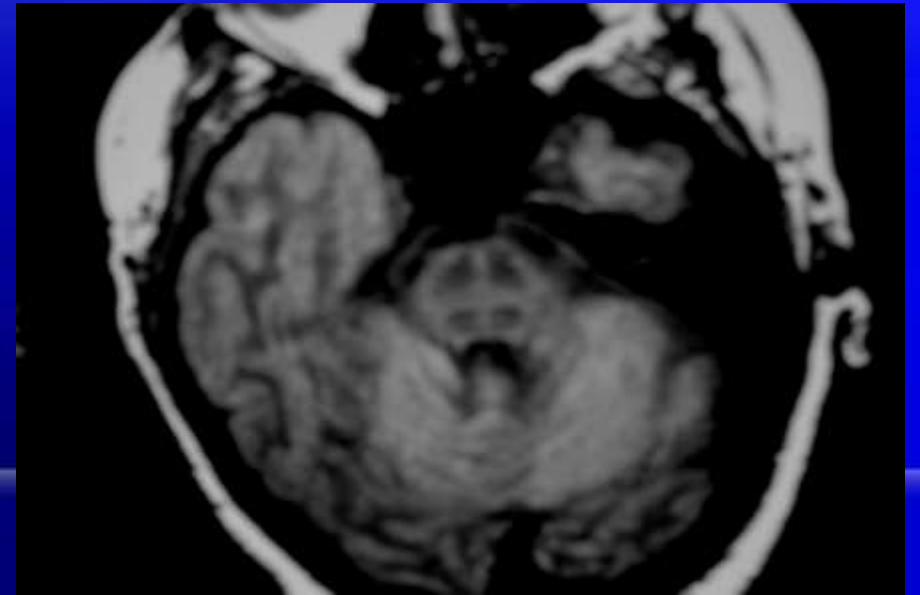


# ATROFIA MULTISISTEMICA-C





MSA-C EVOLUZIONE IN 3 ANNI

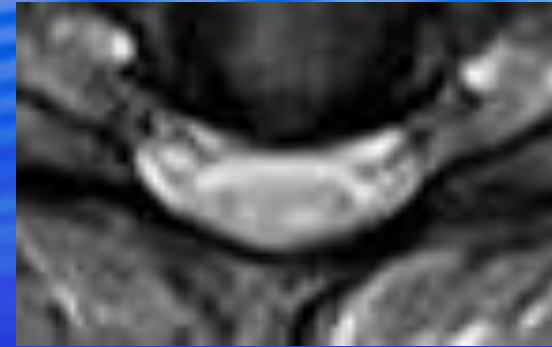


# Sclerosi laterale amiotrofica

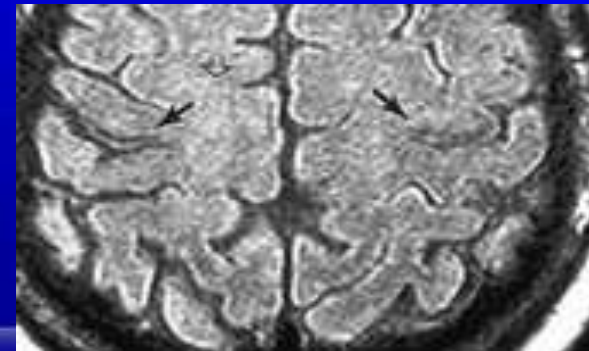
atrofia midollare



? *fasci piramidali*

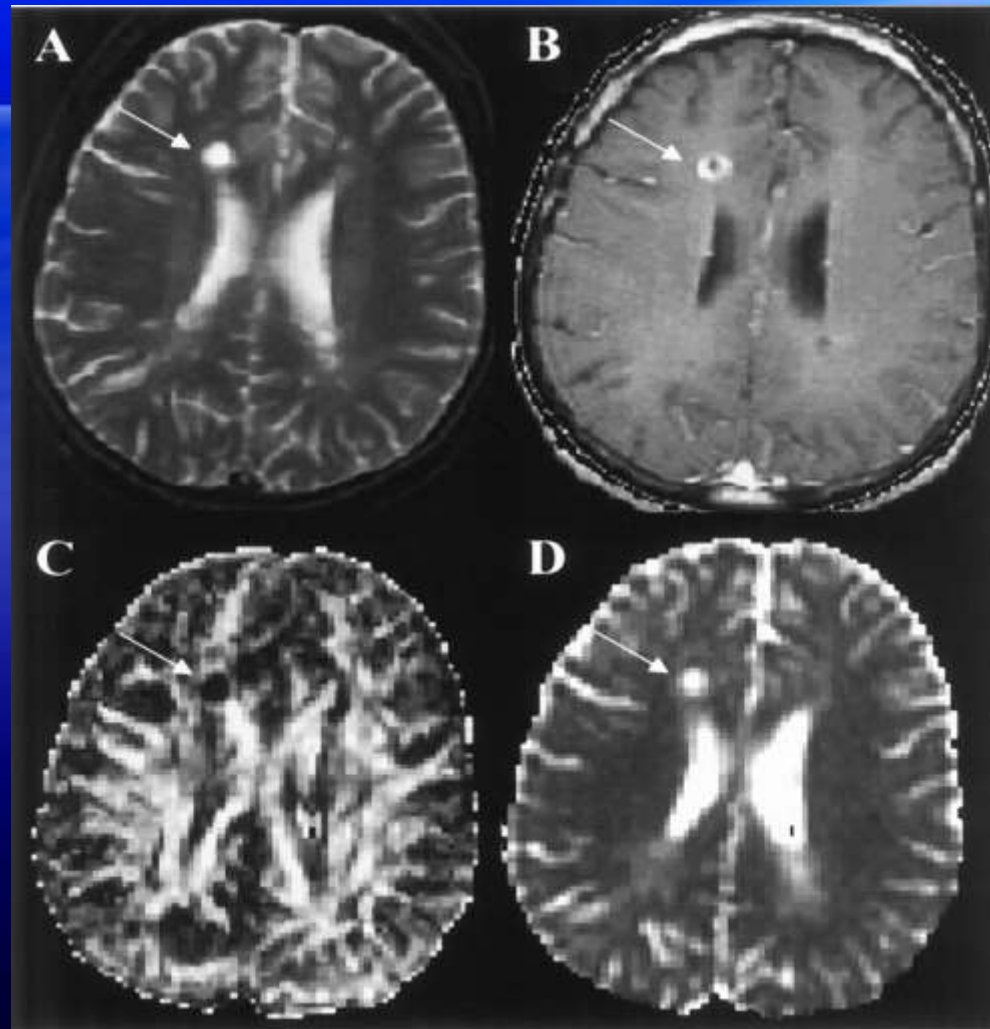


?? *corteccia motoria*



(AJNR 21:647-658,2000)

Figure 1. Images acquired of an axial brain slice in a patient with MS.

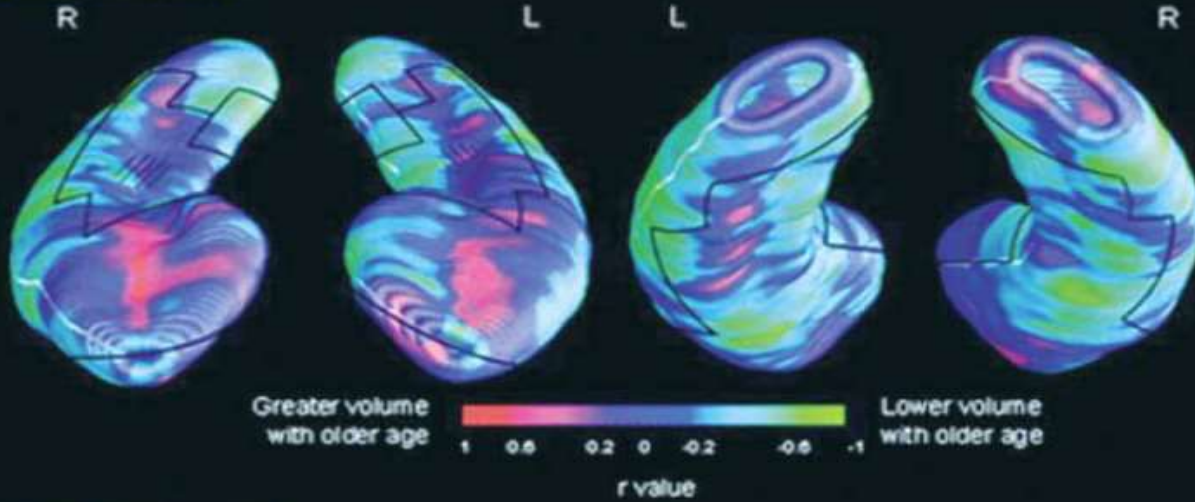


Werring D et al. Neurology 1999;52:1626-1626

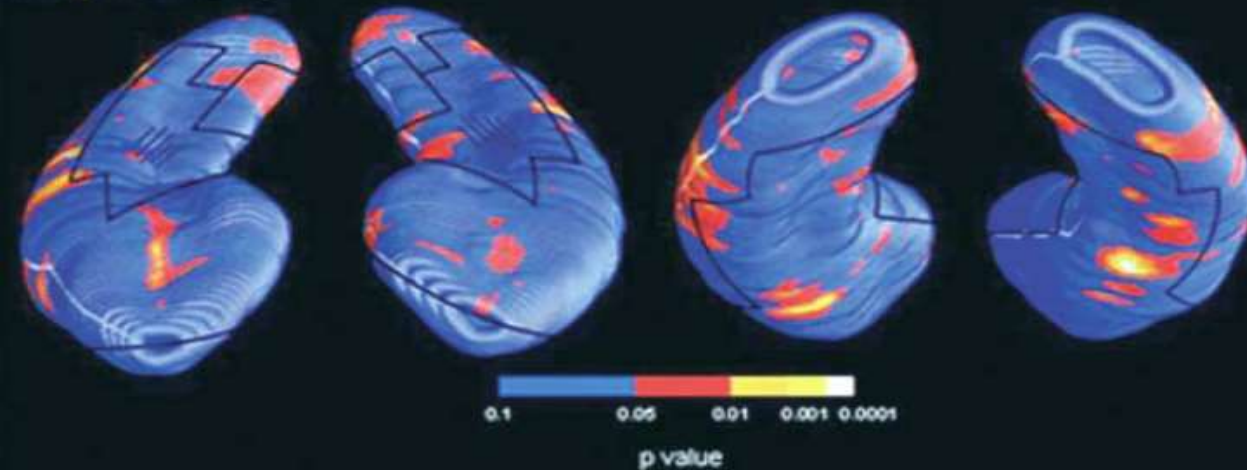
## Aging

Samantha Galluzzi · Alberto Beltramello · Massimo Filippi ·  
Giovanni B. Frisoni

### A. Correlation maps



### B. Significance maps

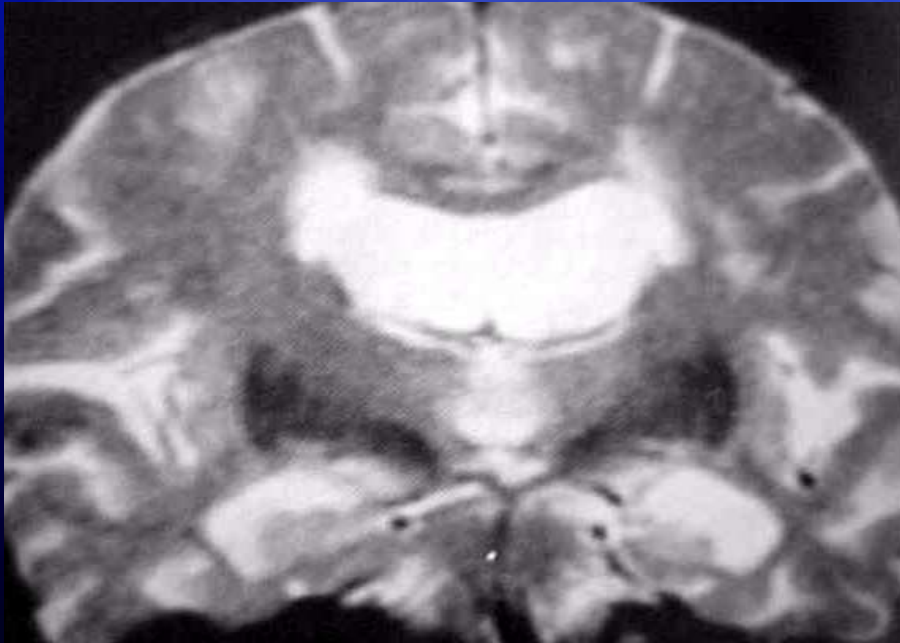


v.b.m.

# ALZHEIMER

## ASPETTI RM

ALZHEIMER



ASPECIFICI

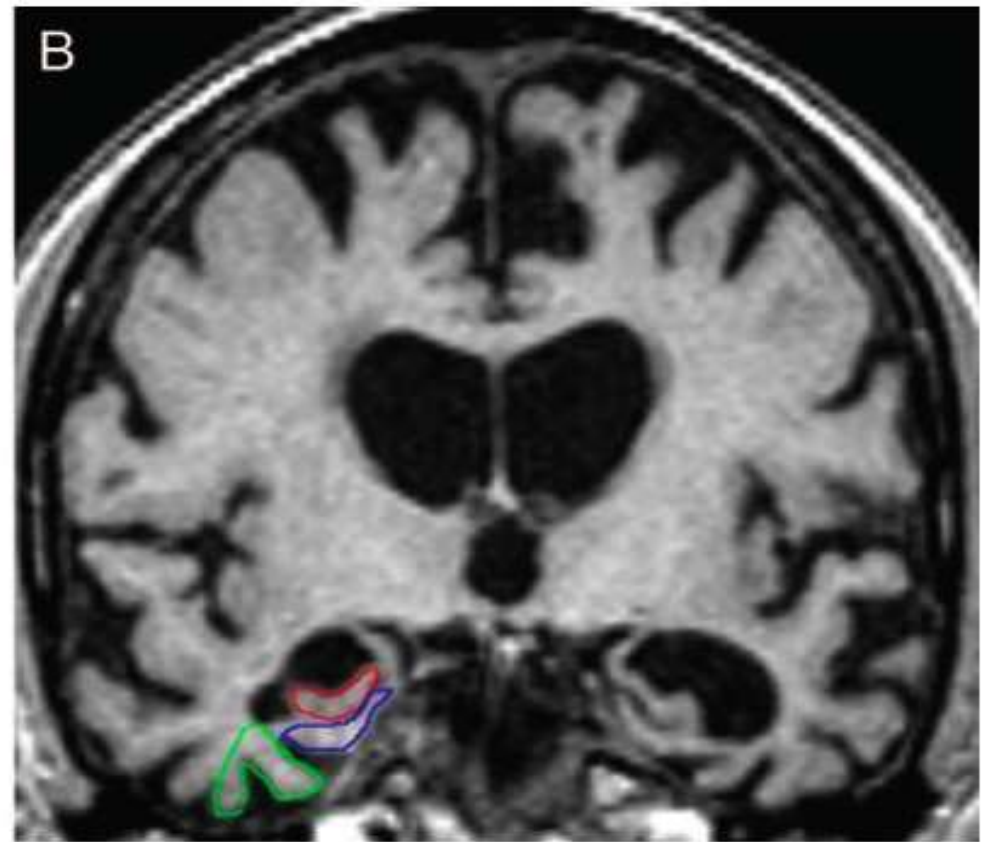
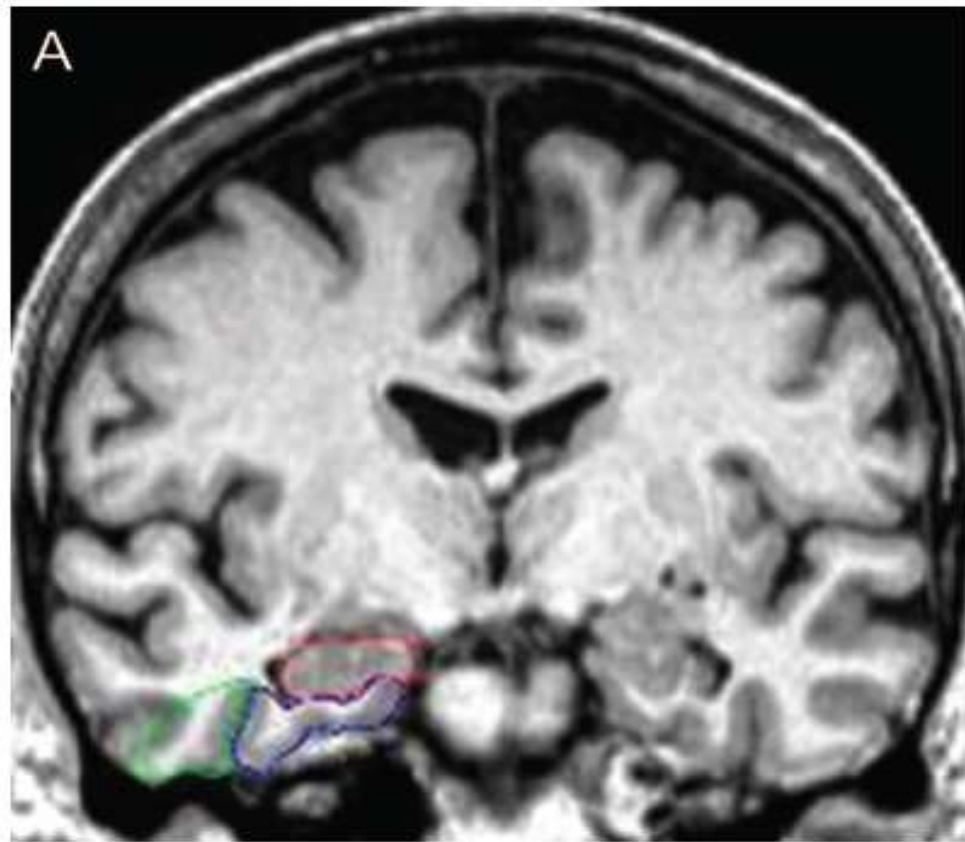
ATROFIA TEMPORO-  
MESIALE

SEGNALE NORMALE DEI  
GANGLI.

# Medial temporal lobe atrophy on MRI scans and the diagnosis of Alzheimer disease

R. Duara, MD

D.A. Loewenstein, PhD



(A) The three regions of interest are outlined in the right hemisphere in color (hippocampus = red; entorhinal cortex = blue; perirhinal cortex = green), all showing no atrophy (score = 0) in both hemispheres. (B) All structures have severe atrophy (score = 4), with the exception of the right perirhinal cortex, which has moderate atrophy.



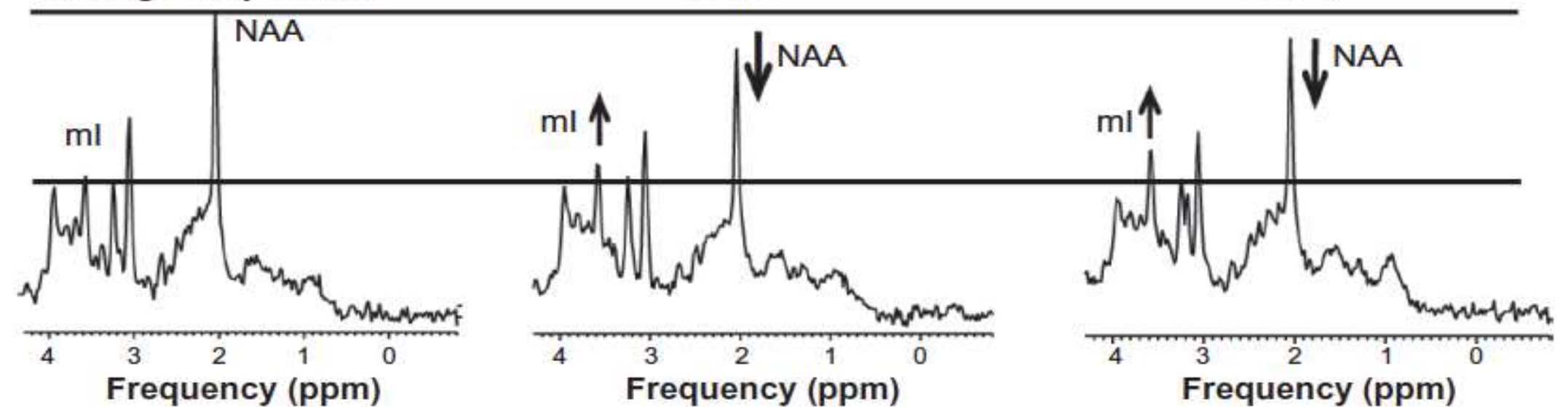
# LA SPETTROSCOPIA DEL PROTONE



A: Cognitively normal

B: MCI

C: AD



MRS spectra from healthy elderly (A), an elderly subject with MCI (B) and an AD patient (C). Spectra were scaled to creatine peak in 100%, Alzheimer's disease; MCI, mild cognitive impairment; ml, myo-inositol; MRS, magnetic resonance spectroscopy; NAA, N-acetyl aspartate



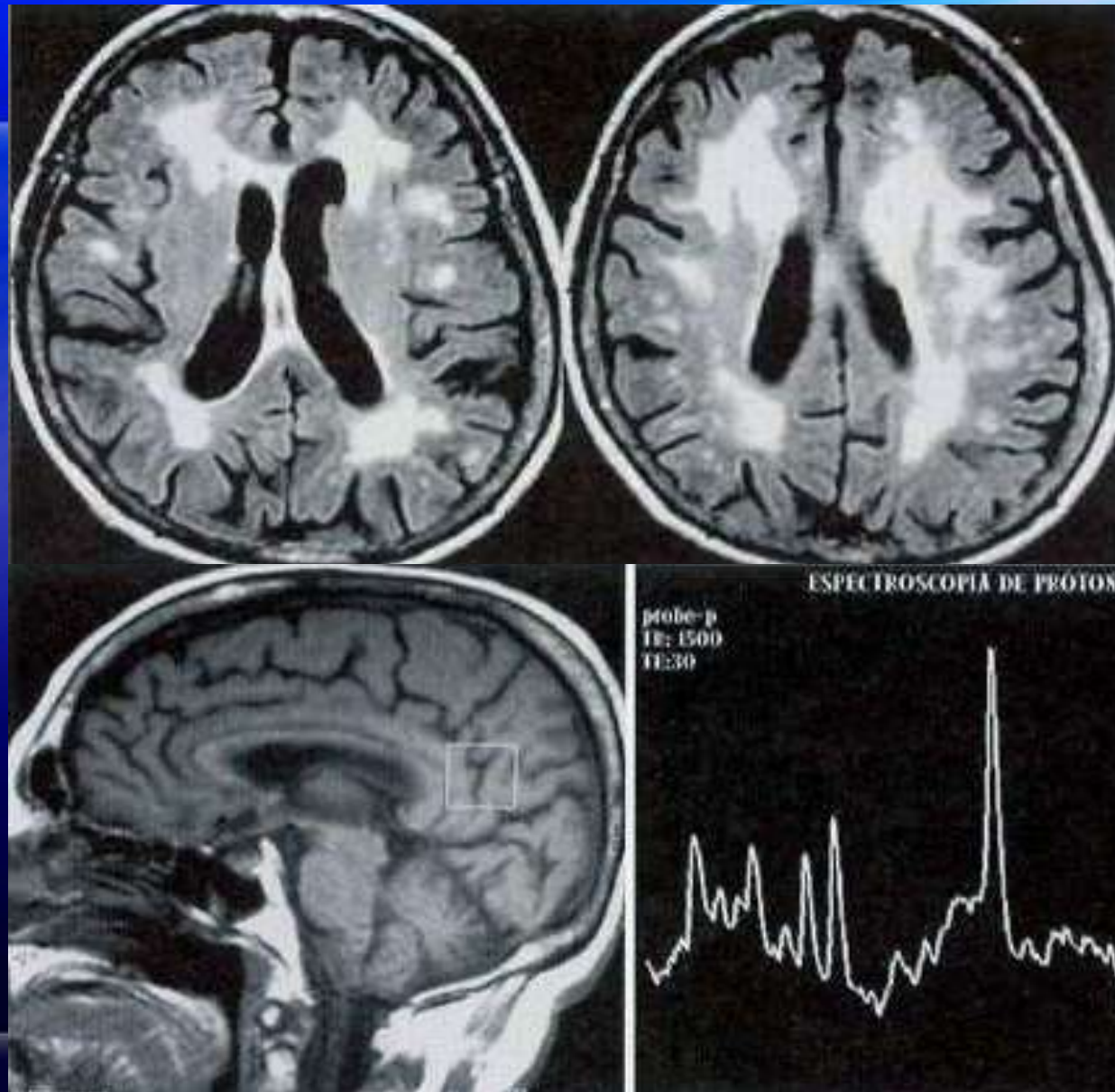
- ↓ N-acetyl aspartate (NAA), NAA/creatine (Cr)
- ↑ Choline (Cho), Cho/Cr
- ↑ Myo-inositol (ml), ml/Cr (>0.70) (earlier abnormality and most important for diagnosis)

**Important**

ml can only be identified with a short TE.  
 AD metabolic abnormalities first occur in the cingulate gyrus.  
 The first metabolic abnormality is an increase in the ml/Cr ratio.

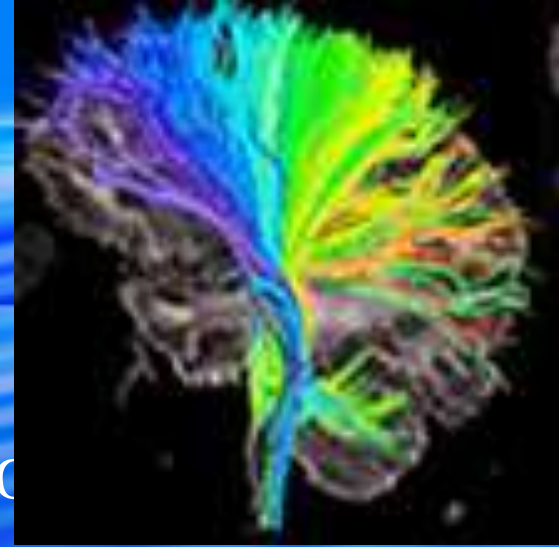


# STESSO VOXEL :DD TRA DEMENZA ATS ED A-D



# XXII Cong. AINR

Milano 4-6 ottobre 2006



Diagnosi precoce di AD: studio di diffusione tensoriale in RM.

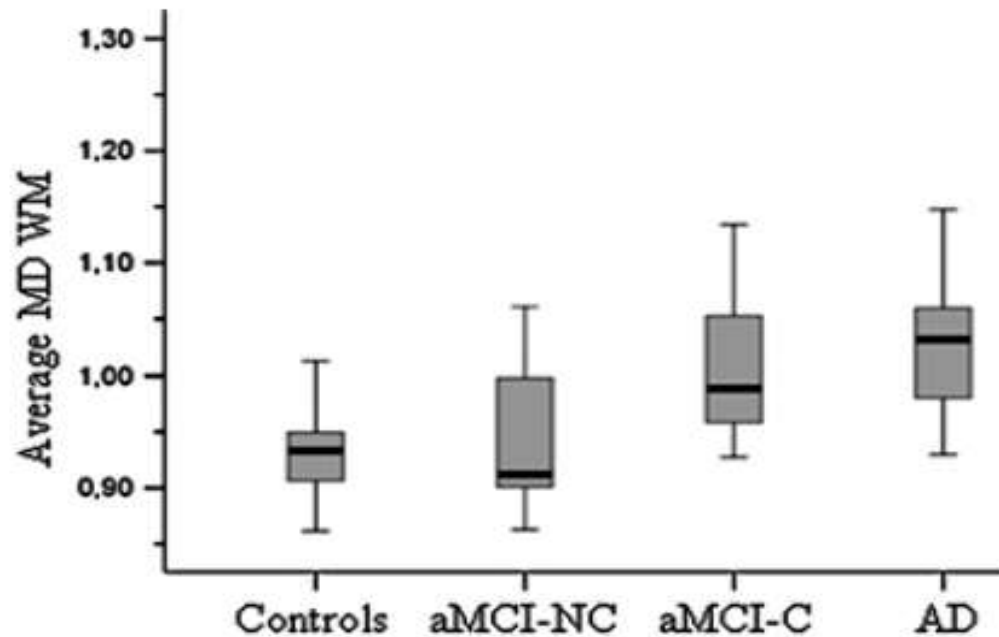
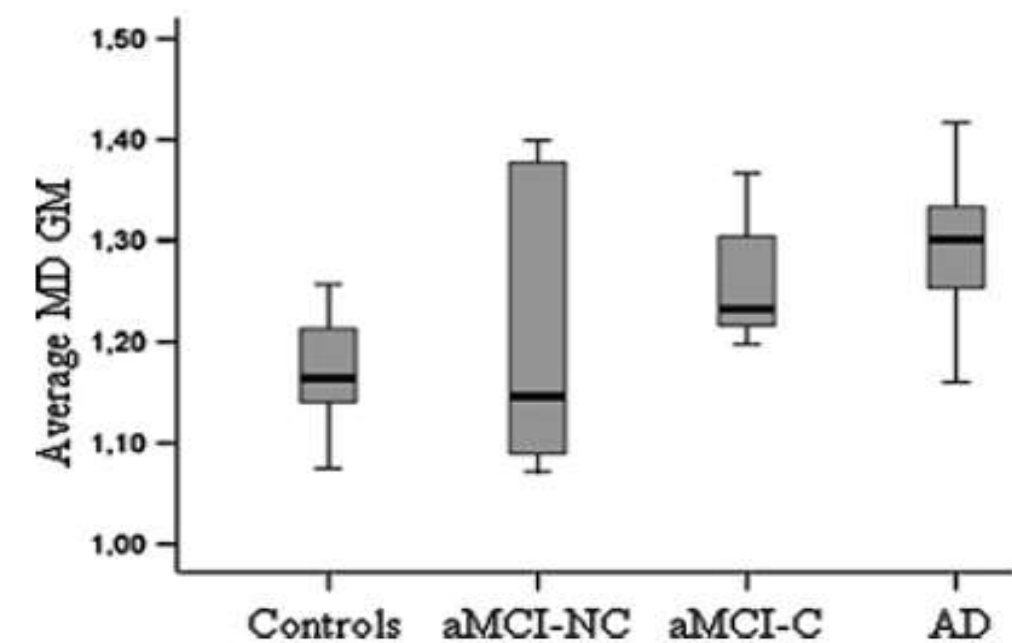
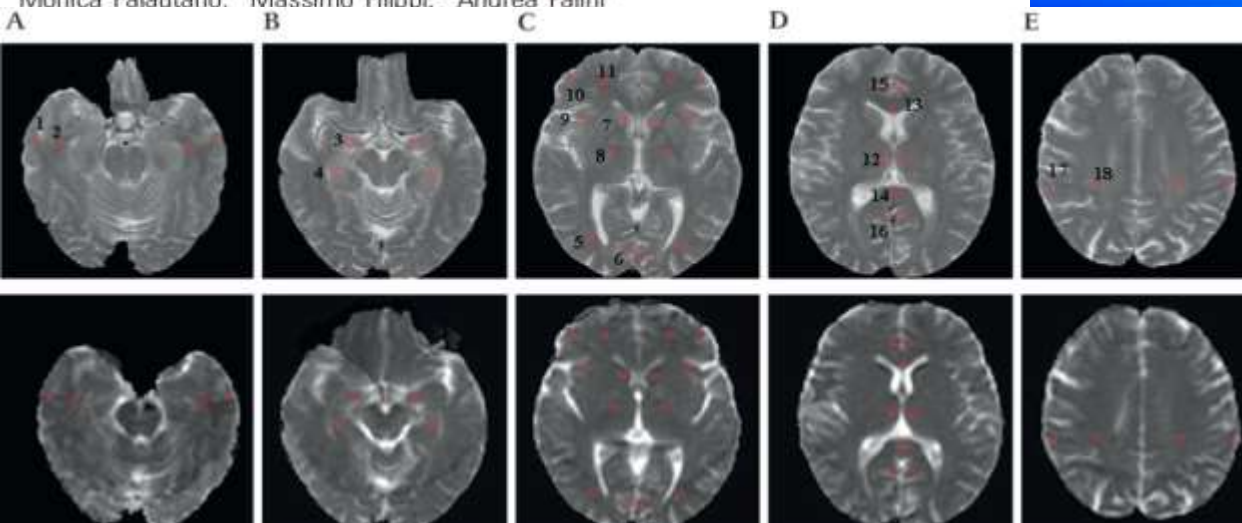
Scola, Falini et al.

E' stato calcolata la diffusività media (MD) in p. con MCI, AD e sono stati seguiti per due anni.

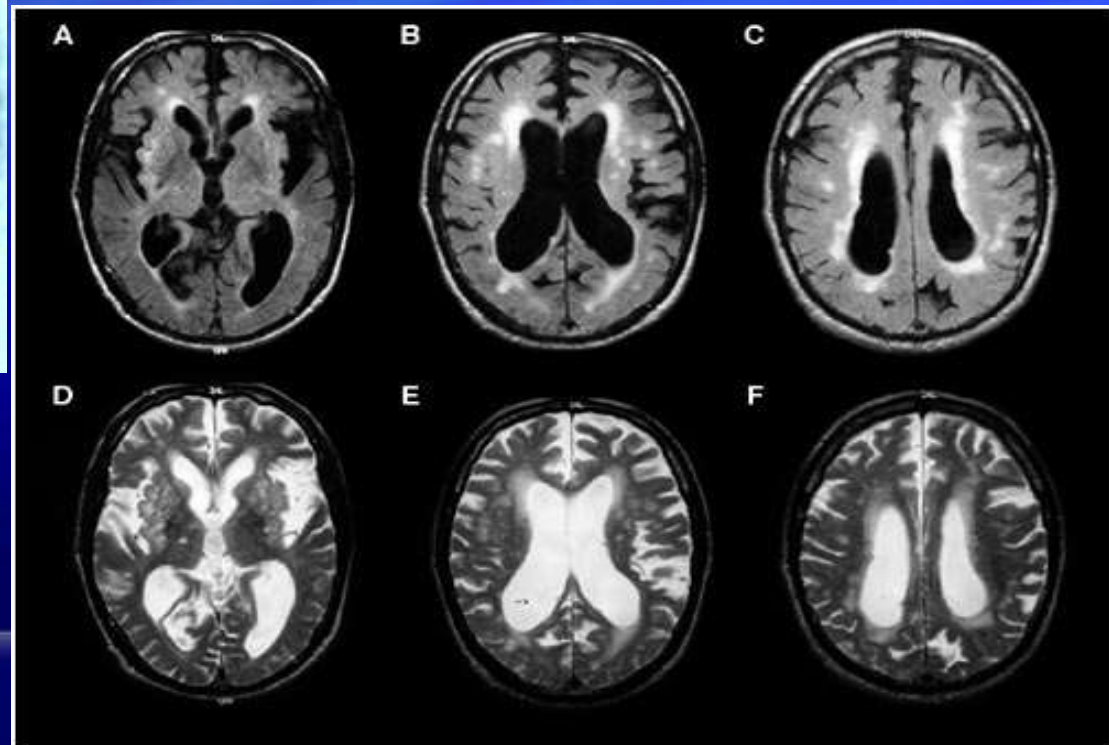
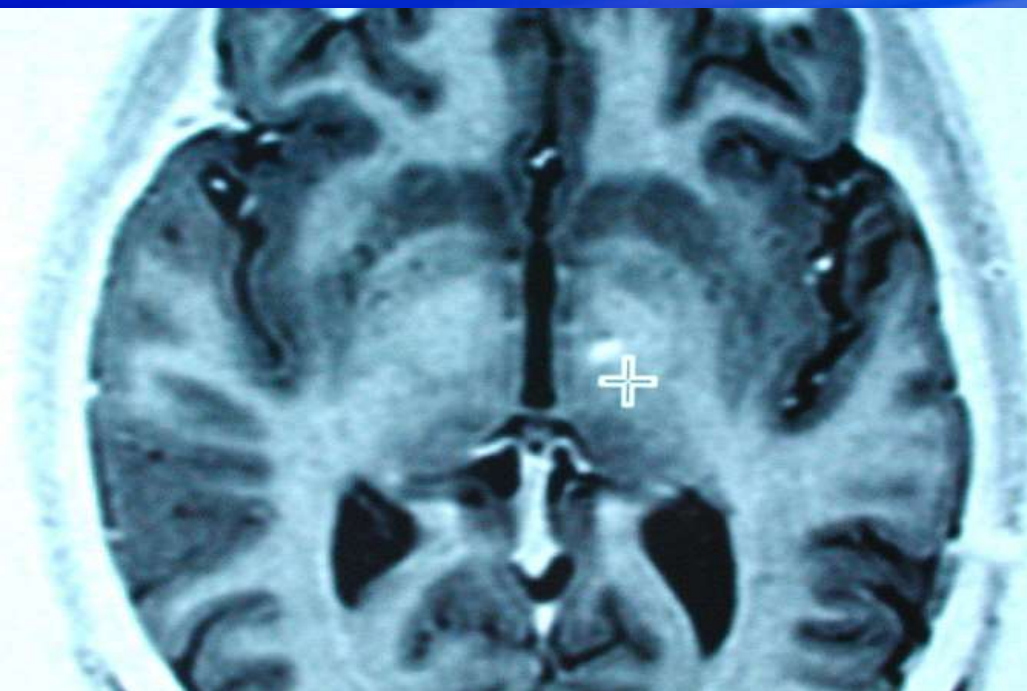
Si è trovata correlazione tra aumento della MD al controllo basale nei p. con MCI che sono evoluti verso una AD

# A diffusion tensor MRI study of patients with MCI and AD with a 2-year clinical follow-up

Elisa Scola,<sup>1</sup> Marco Bozzali,<sup>2</sup> Federica Agosta,<sup>3</sup> Giuseppe Magnani,<sup>4</sup> Massimo Franceschi,<sup>5</sup> Maria Pia Sormani,<sup>3,6</sup> Mara Cercignani,<sup>7</sup> Elisabetta Pagani,<sup>3</sup> Monica Falautano,<sup>4</sup> Massimo Filippi,<sup>3</sup> Andrea Falini<sup>1</sup>

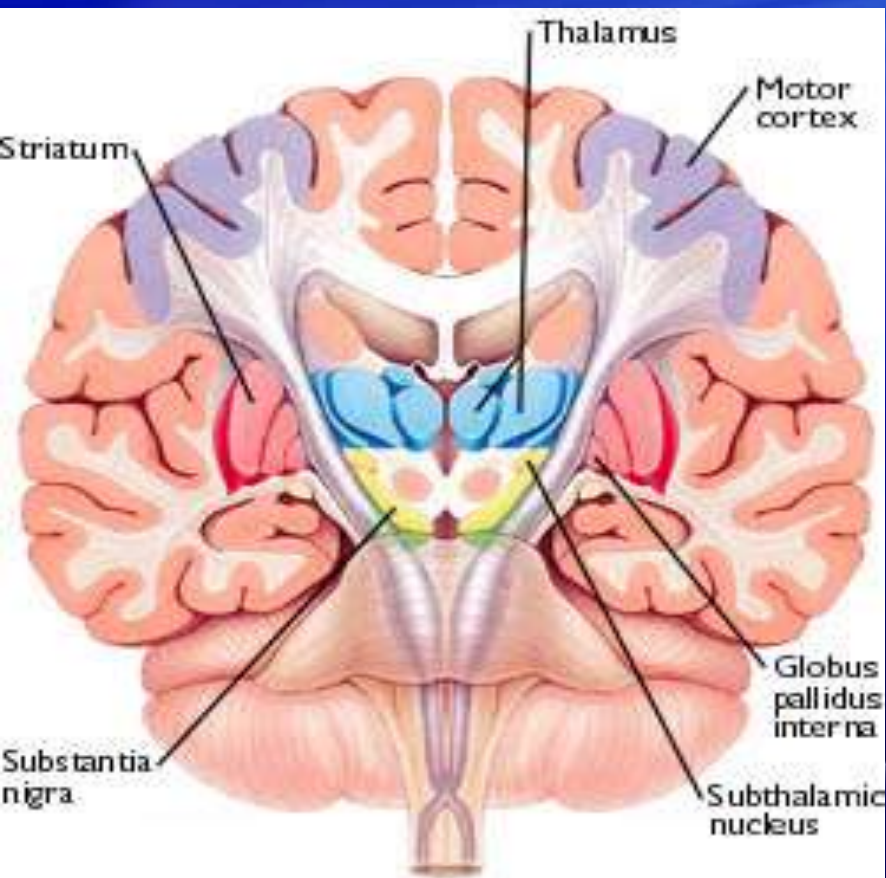


# P VASCOLRE

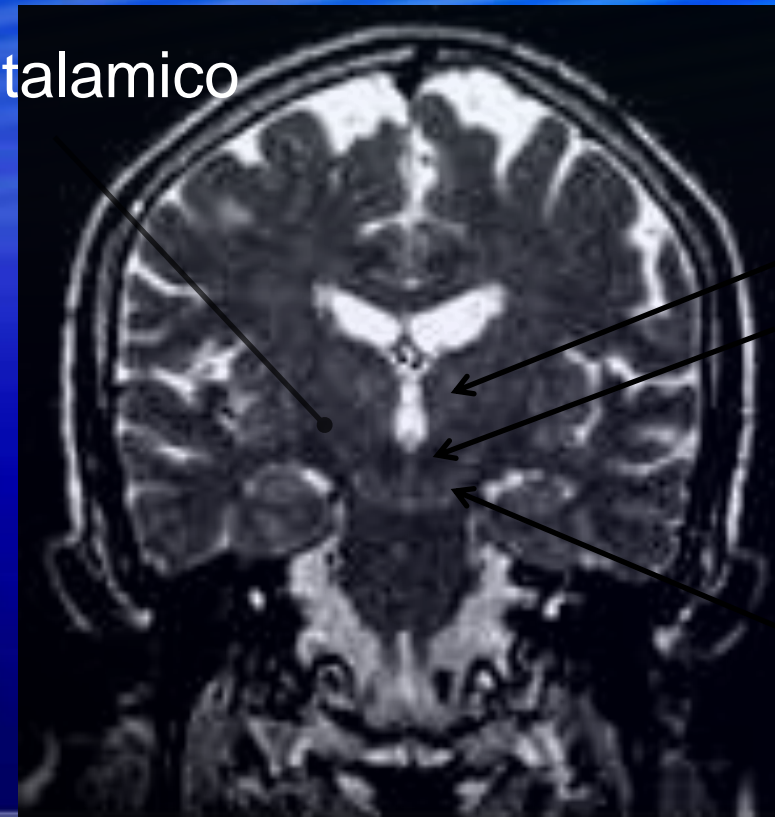


# Immagini di RM DBS

Coronale T2 per localizzazione target bersaglio



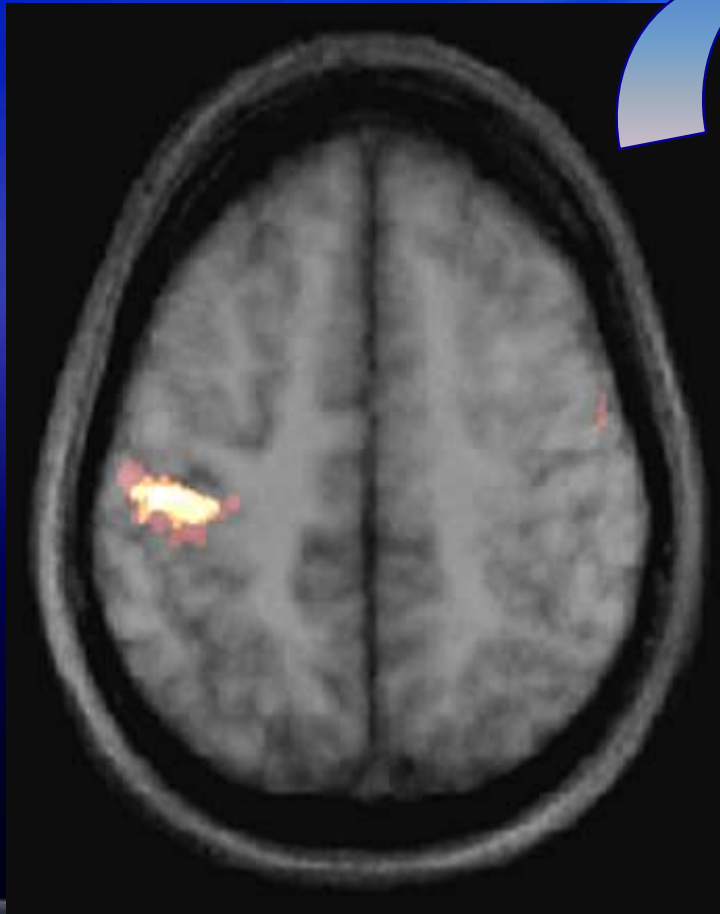
N subtalamico



talamo  
N rosso

s nigra

# fMRI



Riorganizzazione  
cerebrale

*Vicariatione di una  
funzione (Munk 1881): se  
un' area del SNC è  
danneggiata, un'altra area  
può sostituire le sue  
funzioni*

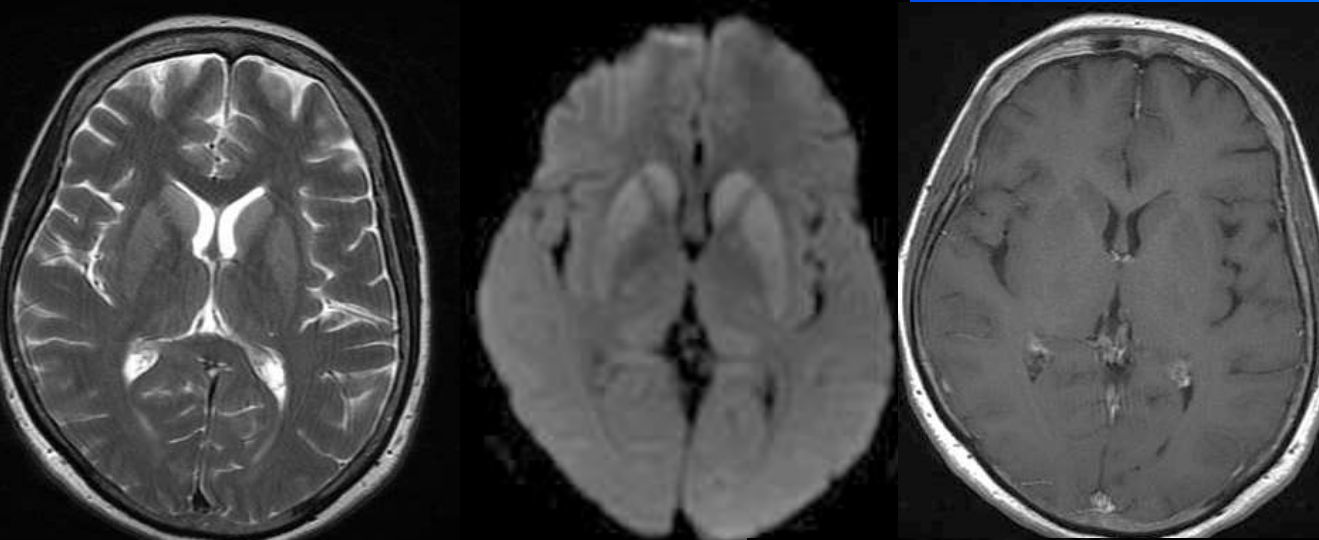


# fMRI

Modificazione del volume di attivazione in  
M1, SMA, C. Prefrontale, M1 controlaterale:

modificata a volte dalla terapia

Modificazione dei circuiti in default mode

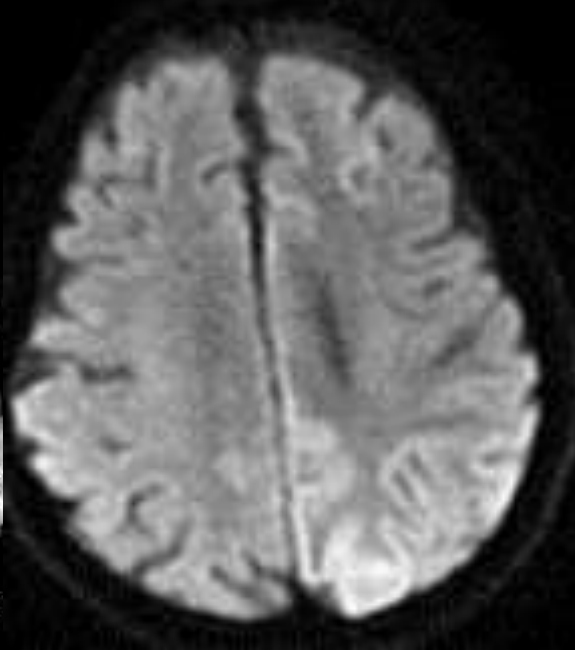
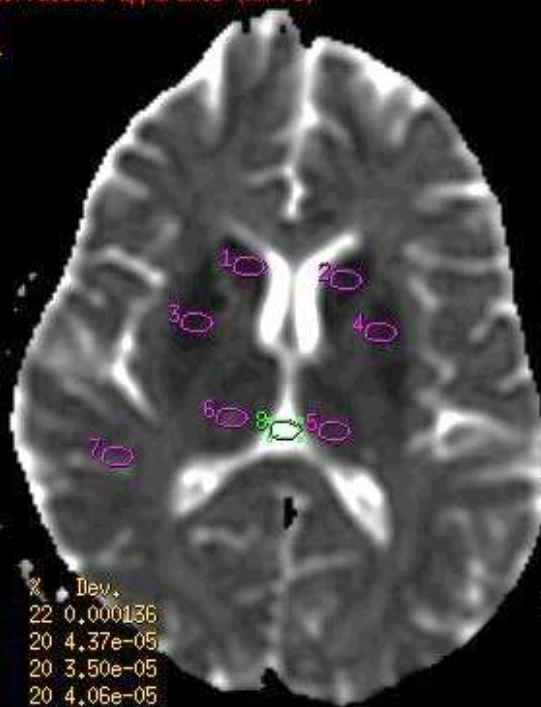


DoB: Nov 25 1950  
Acc Num: 498929-1



DoB: Nov 25 1950  
Acc Num: 498929-1

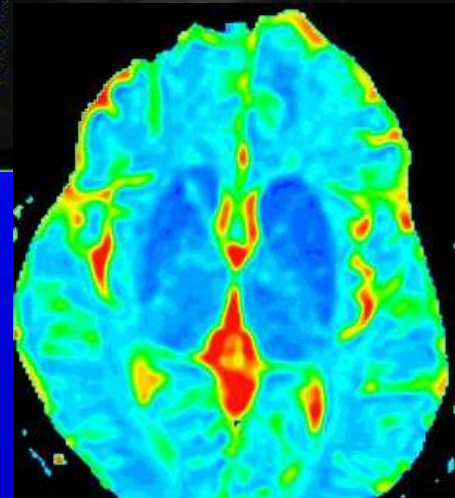
0,00261



ROI	mm <sup>2</sup>	Avg.	Dev.
1	37	419,38	25,925
2	34	361,59	20,587
3	33	335,79	8,9070
4	37	330,10	17,787
5	34	256,21	18,913
6	36	261,17	14,286
7	37	306,67	16,351
8	37	78,524	32,077

rank = 1 / 2  
time = 0 im #

ROI	Avg.	%	Dev.
1	0,000610	22	0,000136
2	0,000553	20	4,37e-05
3	0,000567	20	3,50e-05
4	0,000563	20	4,06e-05
5	0,00067		
6	0,00071		
7	0,00071		
8	0,00271		



# Malattia di Creutzfeldt-Jakob