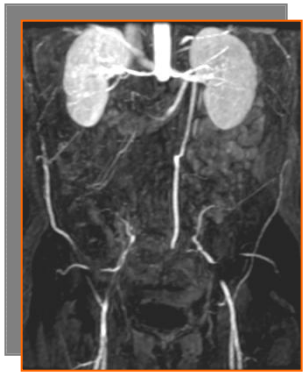
MRA Basics

Black Blood & White Blood, TOF (Inflow), PCA, CE-MRA

15. Dreiländertagung Angiologie

CH / A / D, Basel/CH, 2010

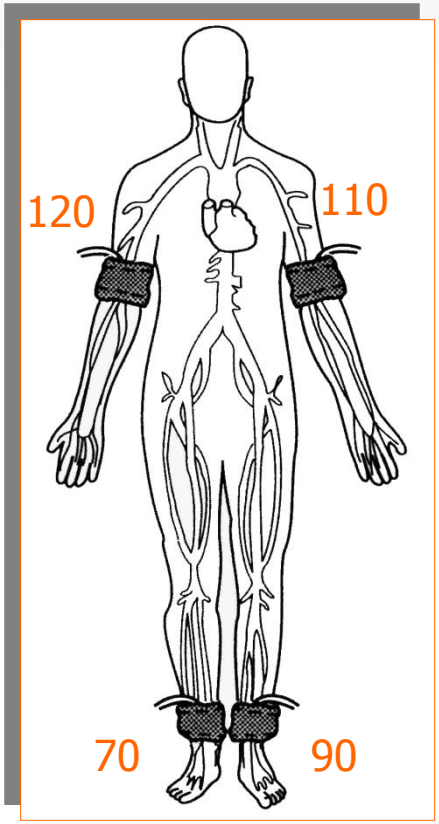


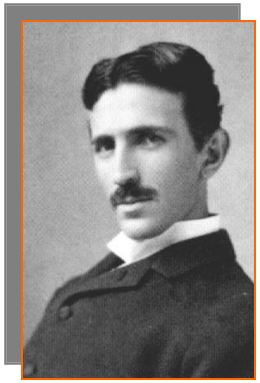
Thomas Störk

Prof. Dr. med. Thomas Störk, CardioPraxis Staufen, Göppingen & Stuttgart

Datei: BasicsMRA_DGA10_Basel(Störk)_V5.PPT

Es gibt ***so viele Methoden****...*





MRA ohne KM

Black Blood / Schwarzblut

=> Black-Blood-SE-Pulssequenzen

(z.B. T2-BB-TSE, T1-BB-TSE, PD-T1-TSE)

=> Black-Blood-GRE-Sequenzen

(z.B. T1-BB-DIR-GRE [DIR=double-inverse-recovery])

White Blood / Weißblut

=> GRE-Pulssequenzen, v.a. SSFP

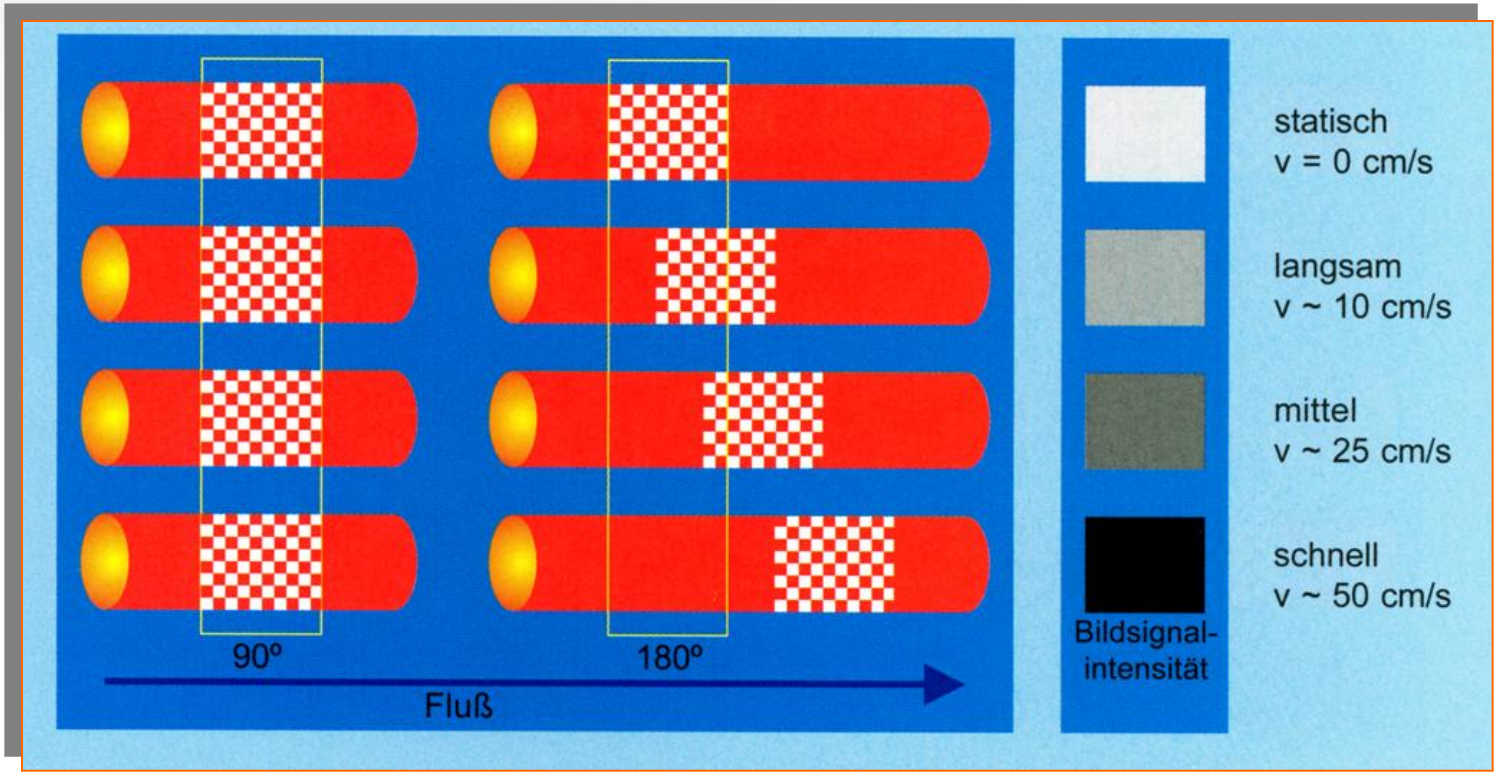
(z.B. balanced-TFE, Cine-Sequenzen)

Klassische „Bright-Blood“-Verfahren

=> TOF, Time-of-Flight

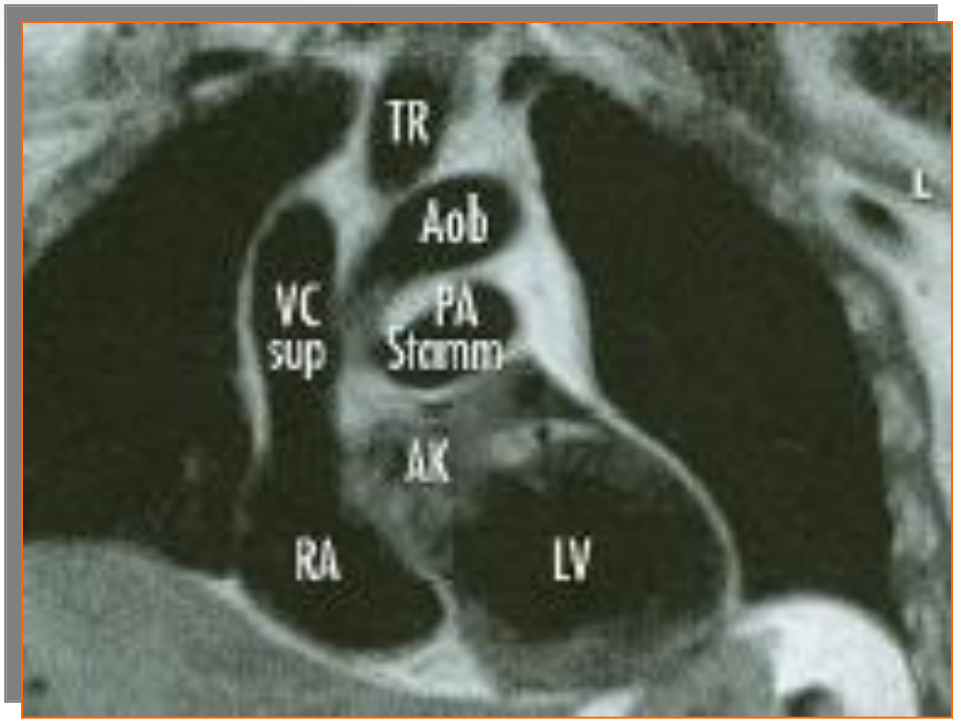
=> PC-MRA, Phasenkontrast

Black-Blood-MRA *mit „normaler“ SE-Sequenz: BB-SE*



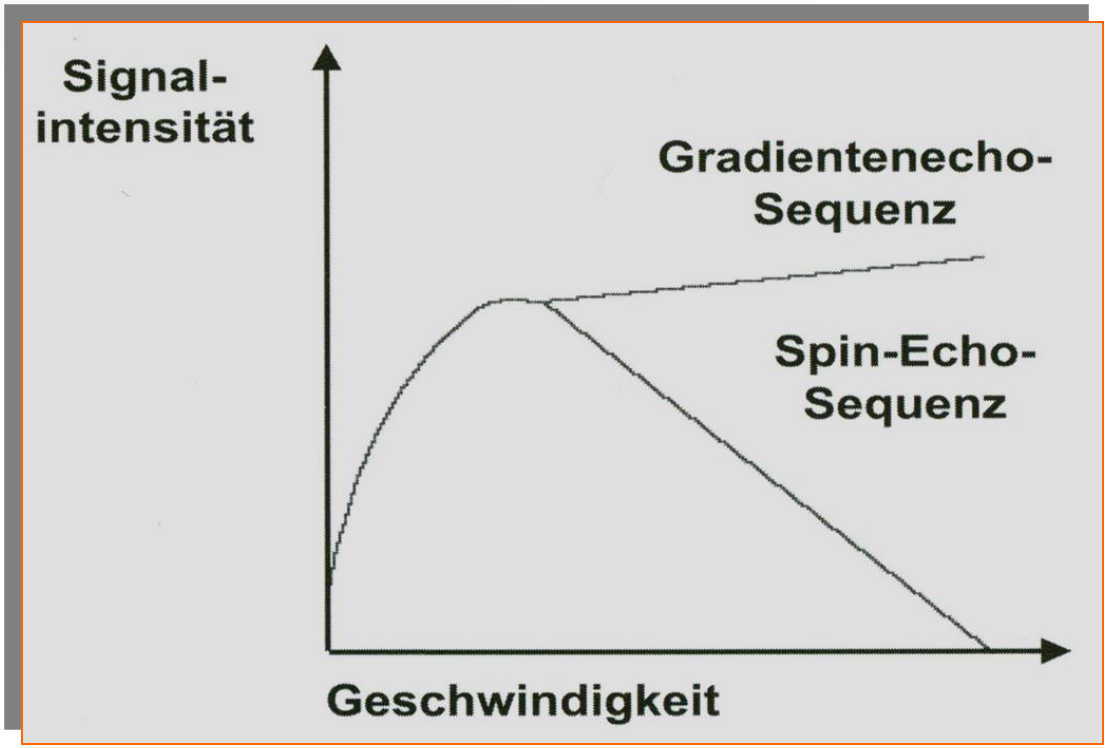
wash out, signal void

Black-Blood-MRA *mit SE-Sequenzen*

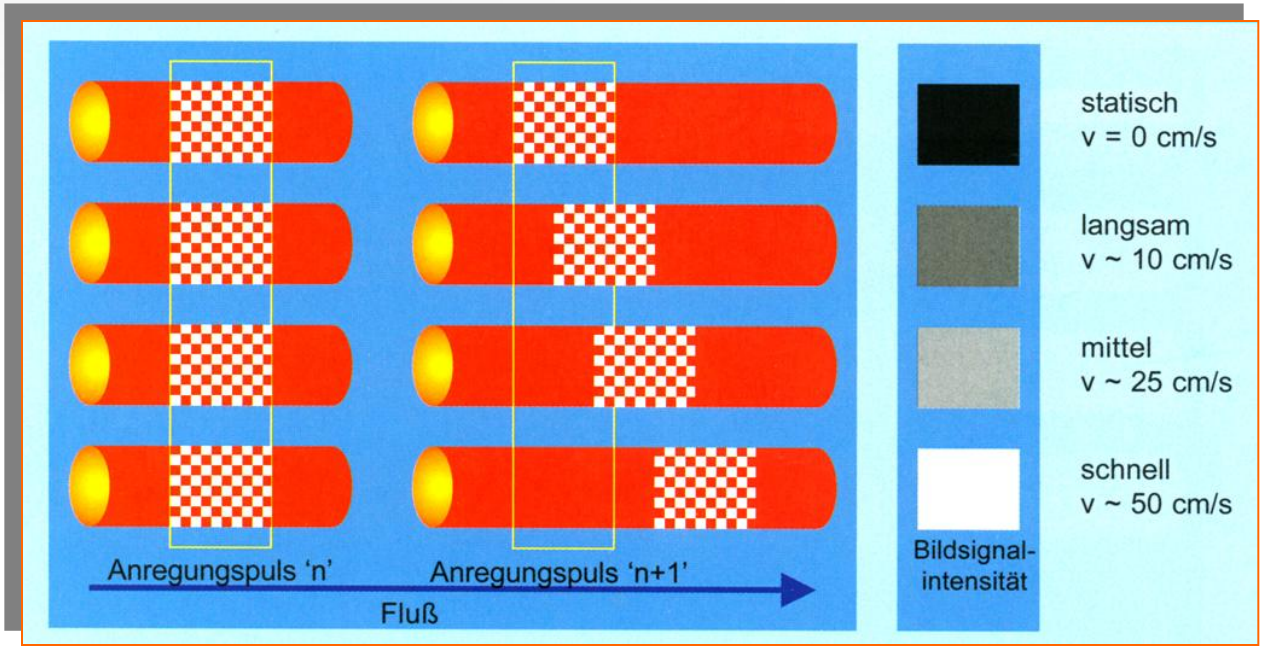


BB-TSE, wash out

Signalintensität und Flußgeschwindigkeiten: SE vs. GRE



Time-of-Flight, TOF-MRA



Angio ohne KM

Gradientenecho, inflow

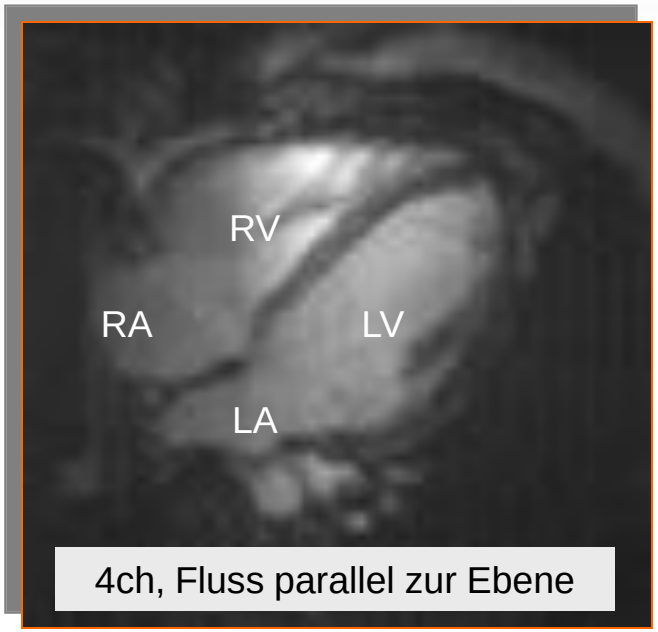
„ungesättigtes" Blut fließt in Bildebene

TOF: *zerebrales TOF-Angiogramm*

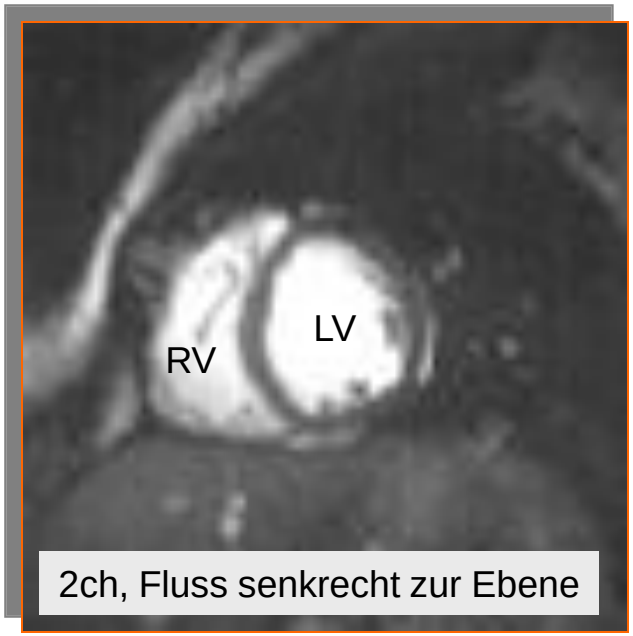
Angio ohne KM

Hirnangiogramm mit
TONE und MTC

Pulssequenzen: *SSFP, Bsp. Cardio-MRT*



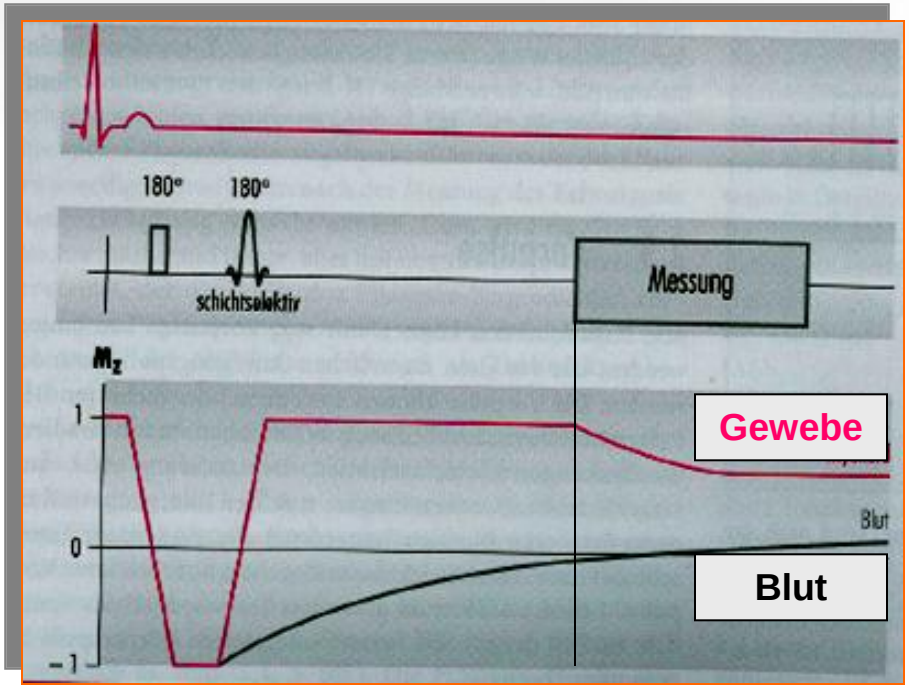
4ch, Fluss parallel zur Ebene



2ch, Fluss senkrecht zur Ebene

Angio ohne KM

Black-Blood-MRA mit GRE-Sequenzen (DIR-BB-GRE)

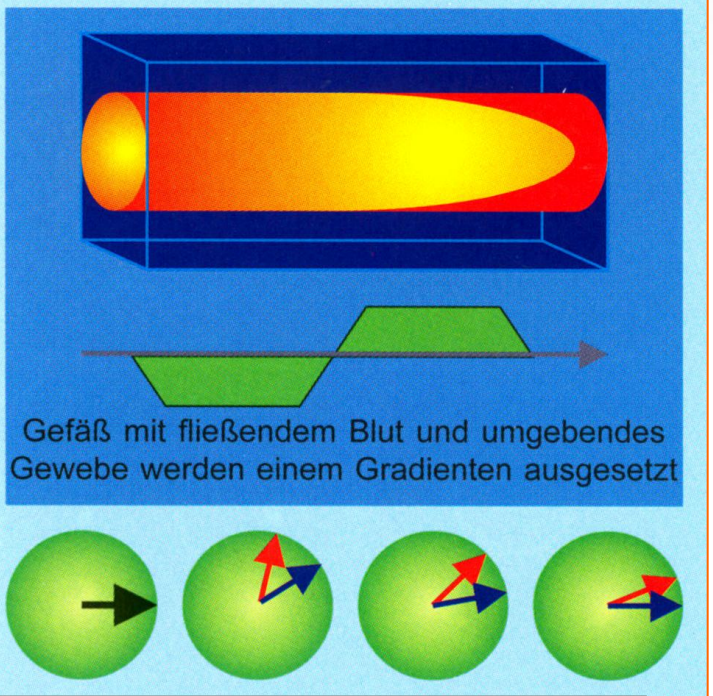


DIR-BB-GRE-Sequenz

DIR = double-inverse-recovery

BAA mit Wandhämatom

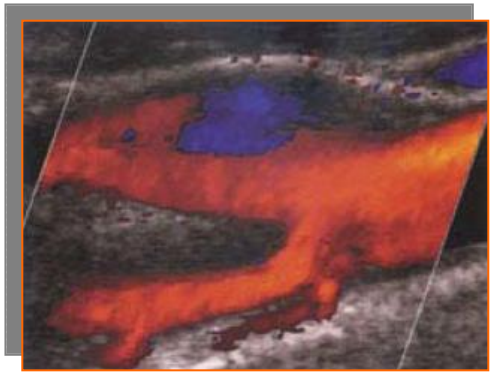
PC-MRA: Prinzip der Phasenkontrast-MRA



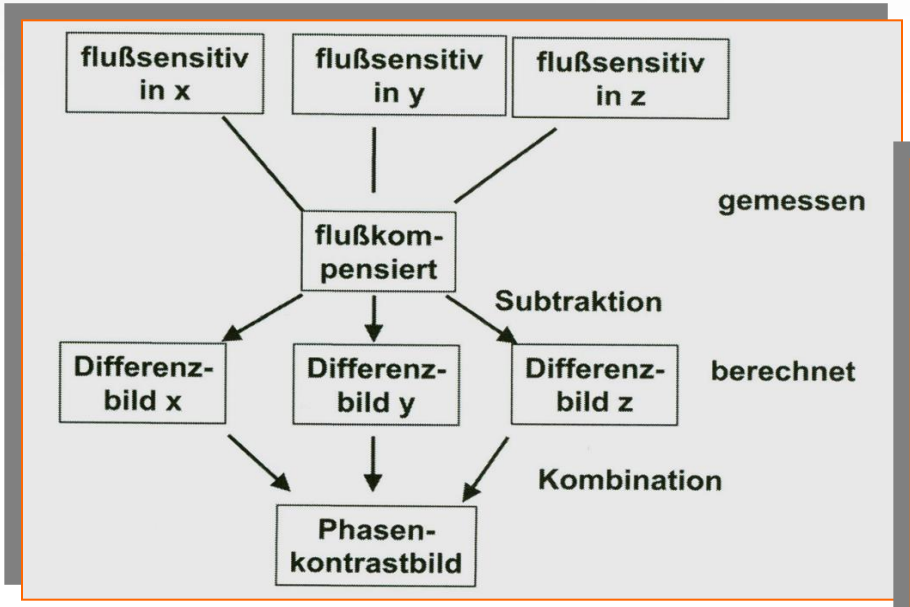
rote Pfeile: fließende Spins
blaue Pfeile: stationäre Spins (dephasierend)

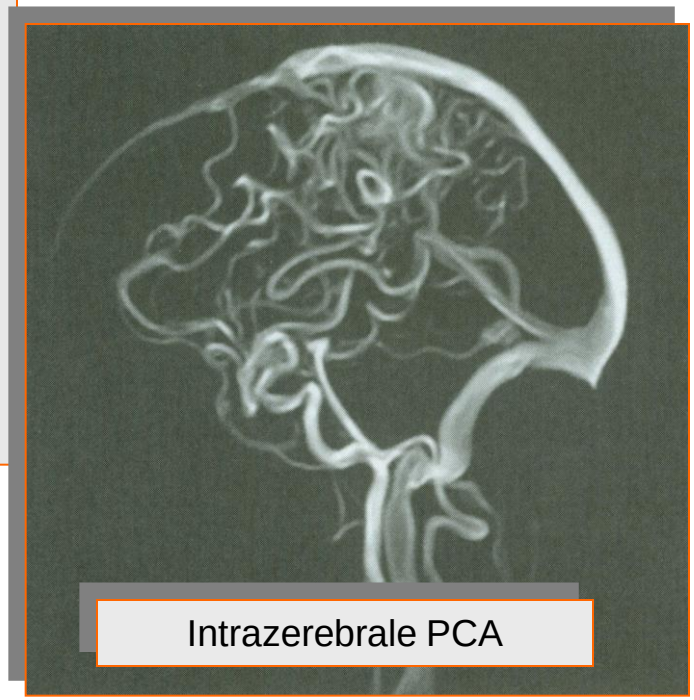
PCA-Prinzip

- Phasenwinkel ist abhängig von Strömungsgeschwindigkeit
- Analogie zur Doppler-US
- Quantifizierung von Blutfluß und -geschwindigkeit



PC-MRA: Berechnung des PC-Bildes

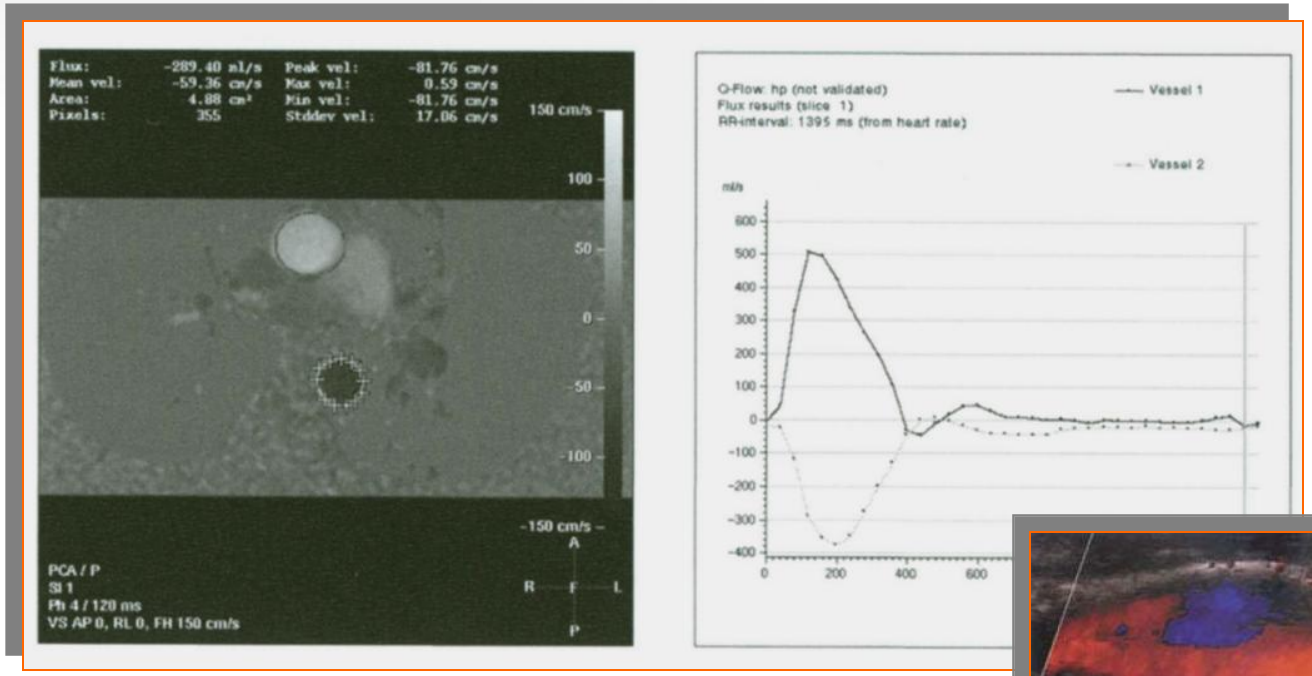


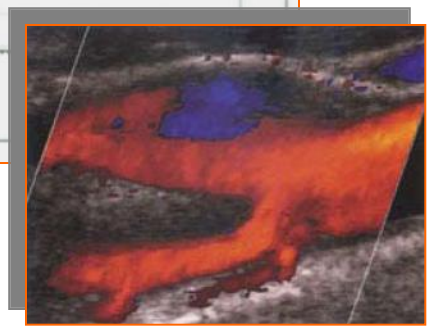


Intrazerebrale PCA

Angio ohne KM

PC-MRA: Flussmessung





MRA mit KM (CE-MRA mit gespoilten GRE)

Extrazelluläre Kontrastmittel (KM) **Angio mit KM**

=> paramagnetische Substanzen mit ungepaarten Elektronen,

=> gespoilte GRE: SPGR, T1-FFE, FLASH

=> Beschleunigung der T1-Relaxation

Bloodpool KM **Angio mit KM**

=> passagere Bindung an z.B. Albumin

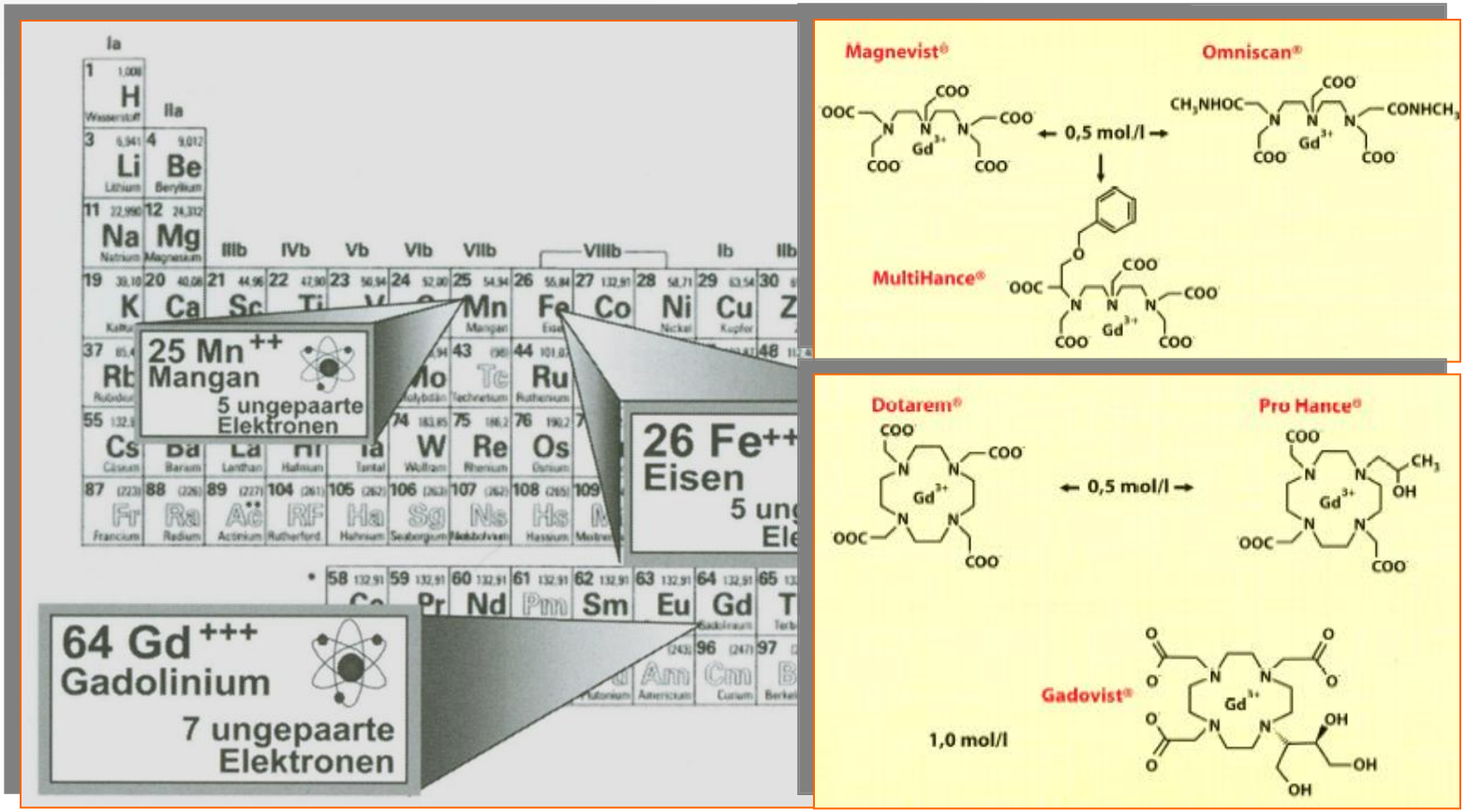
Weitere KM **Angio mit KM**

=> organspezifische KM (z.B. Leber, RES, LK u.a.)

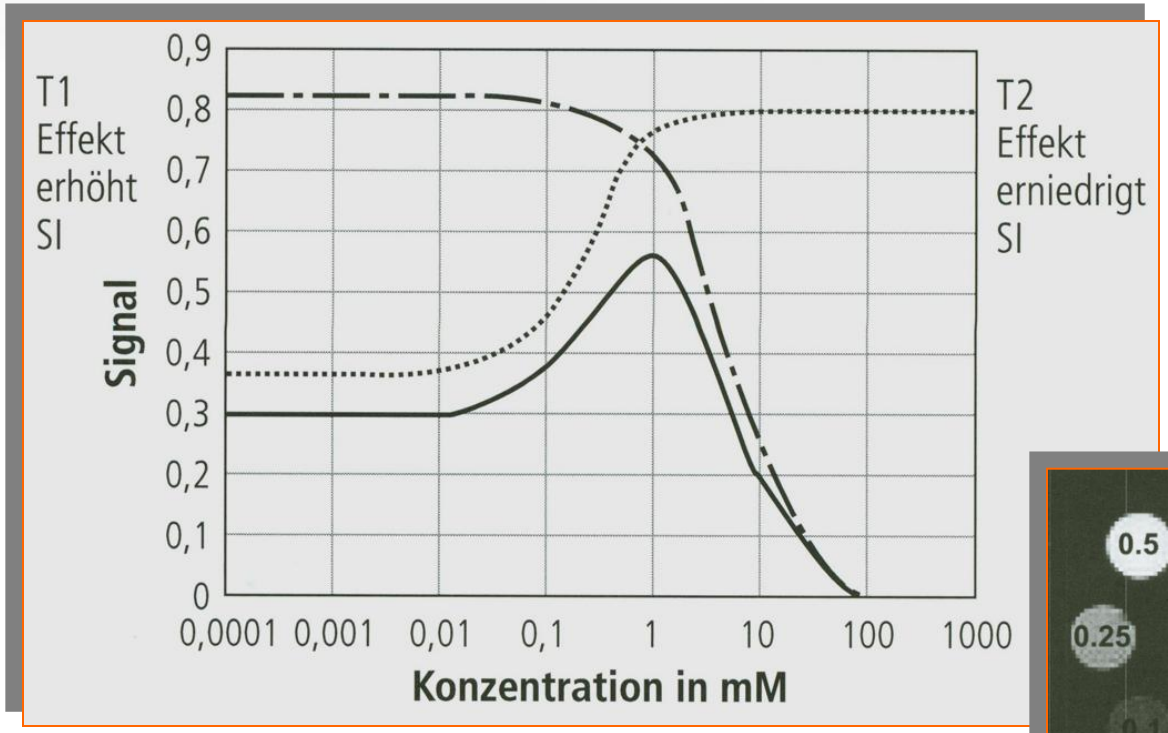
=> substratspezifische KM (z.B. Antigen-bindend)

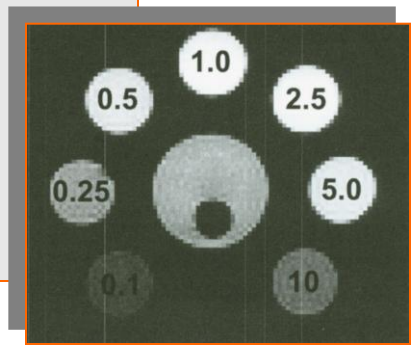
=> negative KM (sog. Negativkontrast)

MR-Kontrastmittel: paramagn. Metallionen & chem. Struktur

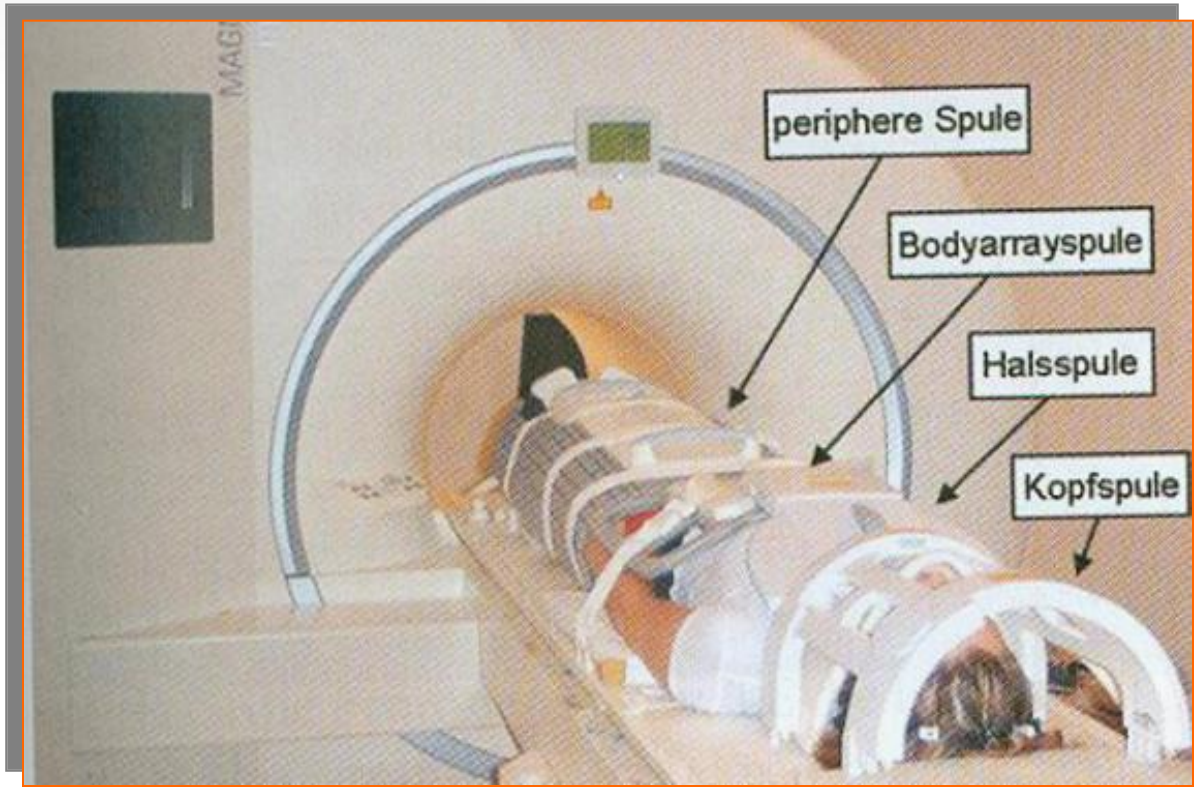


MR-Kontrastmittel: Signalintensität und KM-Konzentration



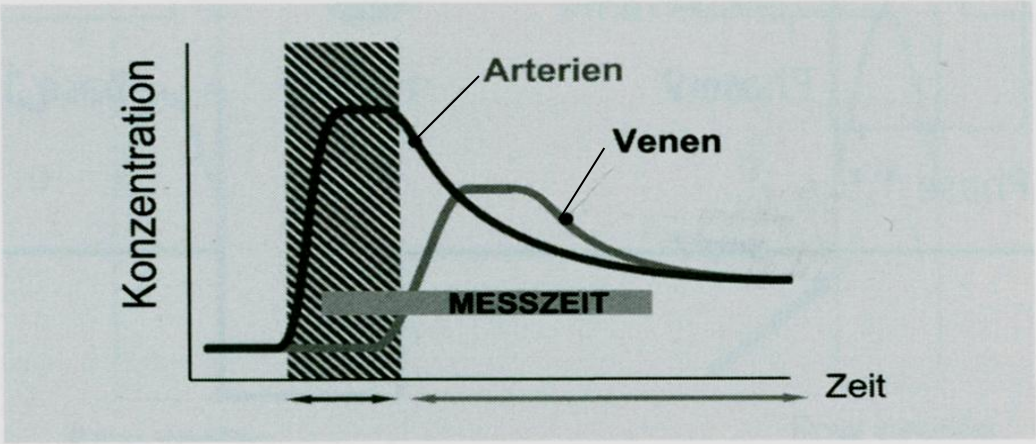


CE-MRA: *verschiedene MRA-Spulen*



CE-MRA: arterielles Fenster

- Das arterielle Fenster ist sehr kurz.
  - Carotis: 8 s (jugularis)
  - Niere: 10 s (Nierenvenen, Vena Cava)



- 3D CE-MRA Messzeiten können relativ lang (20-40 s) sein.

CE-MRA: Strategien

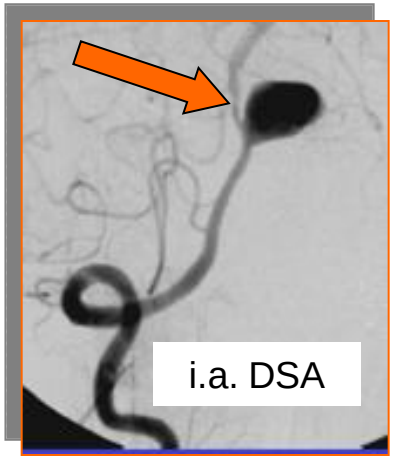
CE-MRA-Strategien

Angio mit KM

1. konventionelles „flow arrest“ (Standbild)
2. „flow-arrest“ mit Tischverschiebung (MobiTrak, Bolus Chase, etc.)
3. time-resolved CE-MRA (Lungengefässe, Thorax, Venen)

CE-MRA

intrakranielles Aneurysma

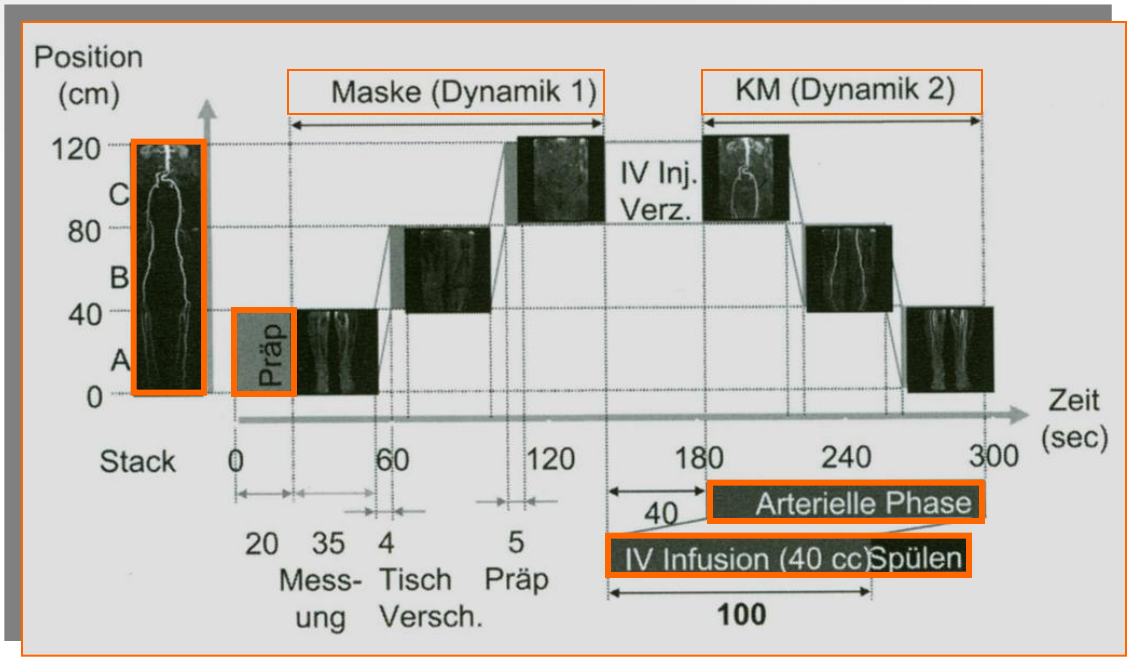


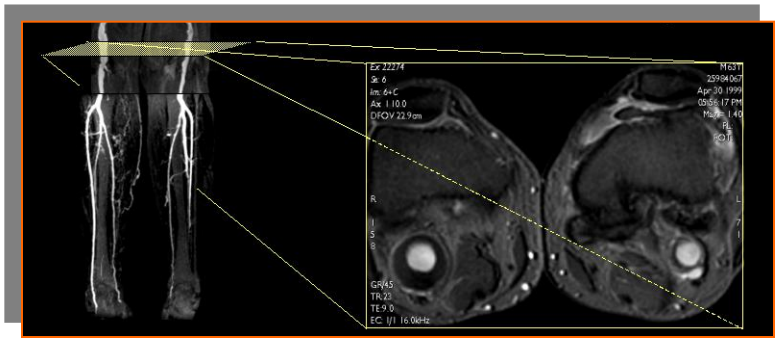
CE-MRA

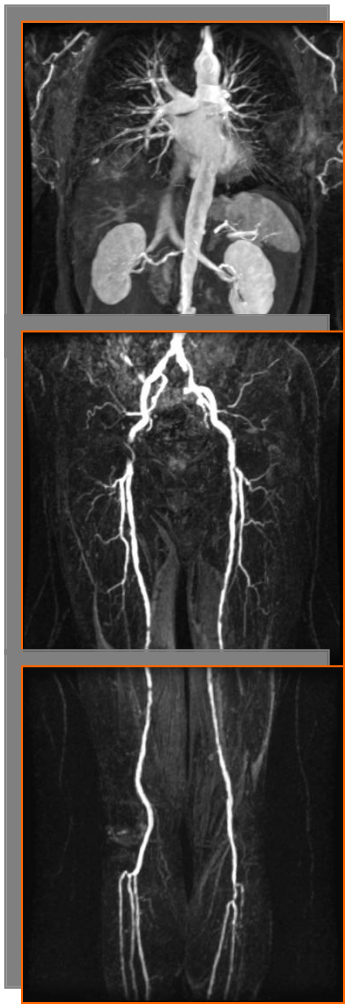
Leriche -Syndrom

Cross-over-Bypass

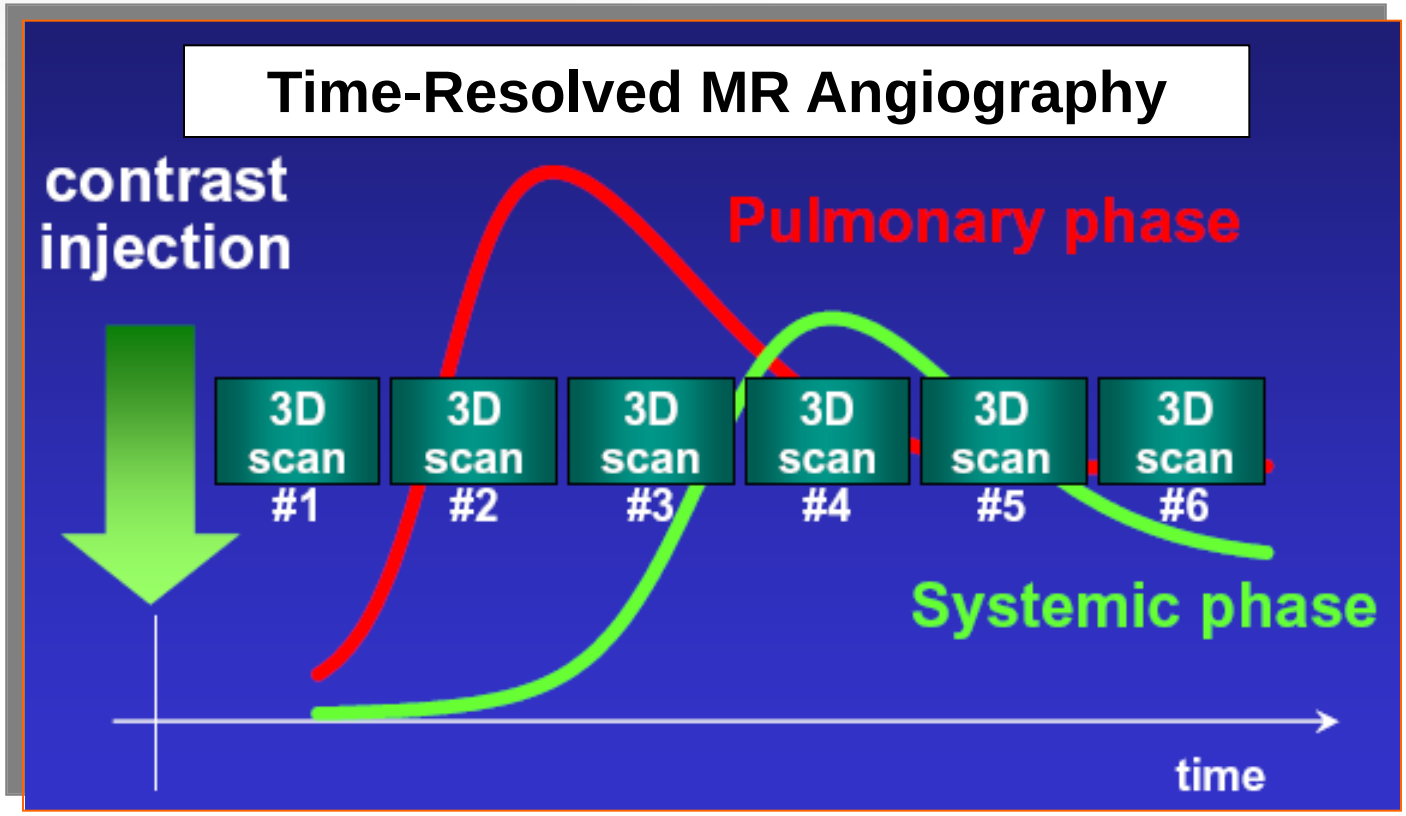
CE-MRA: MobiTrak Implementierung



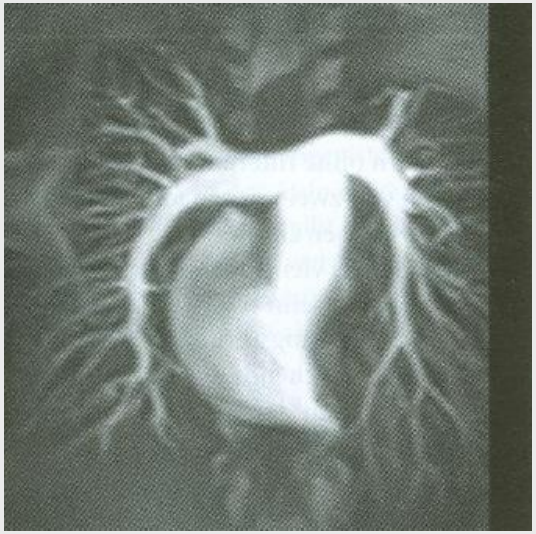




CE-MRA


Time-Resolved MR Angiography
contrast injection
Pulmonary phase
3D scan #1
3D scan #2
3D scan #3
3D scan #4
3D scan #5
3D scan #6
Systemic phase
time

***CE-MRA**: time-resolved*



pulmonalarteriell

pulmonalvenös

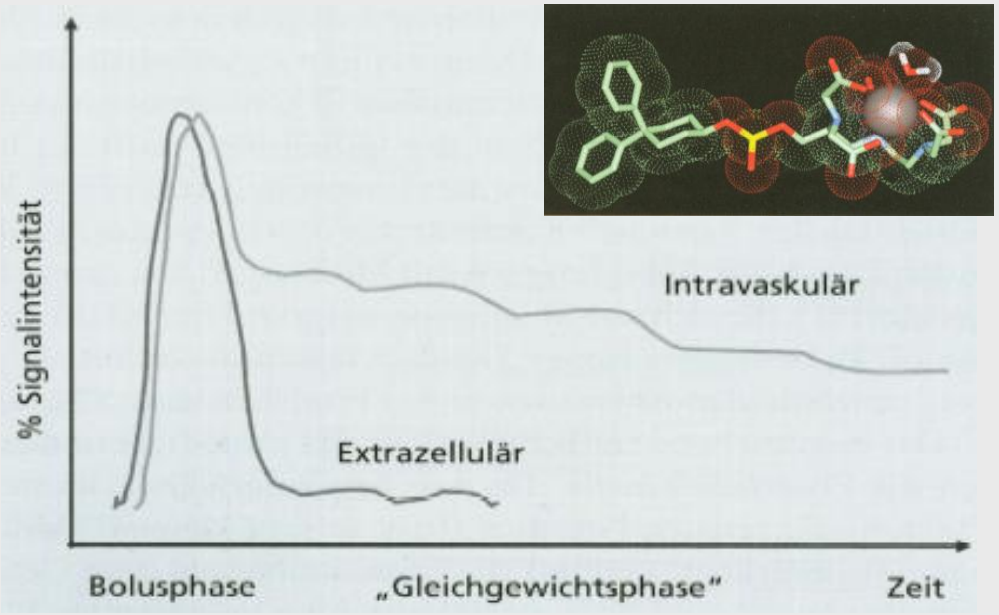
systemarteriell

CE-MRA

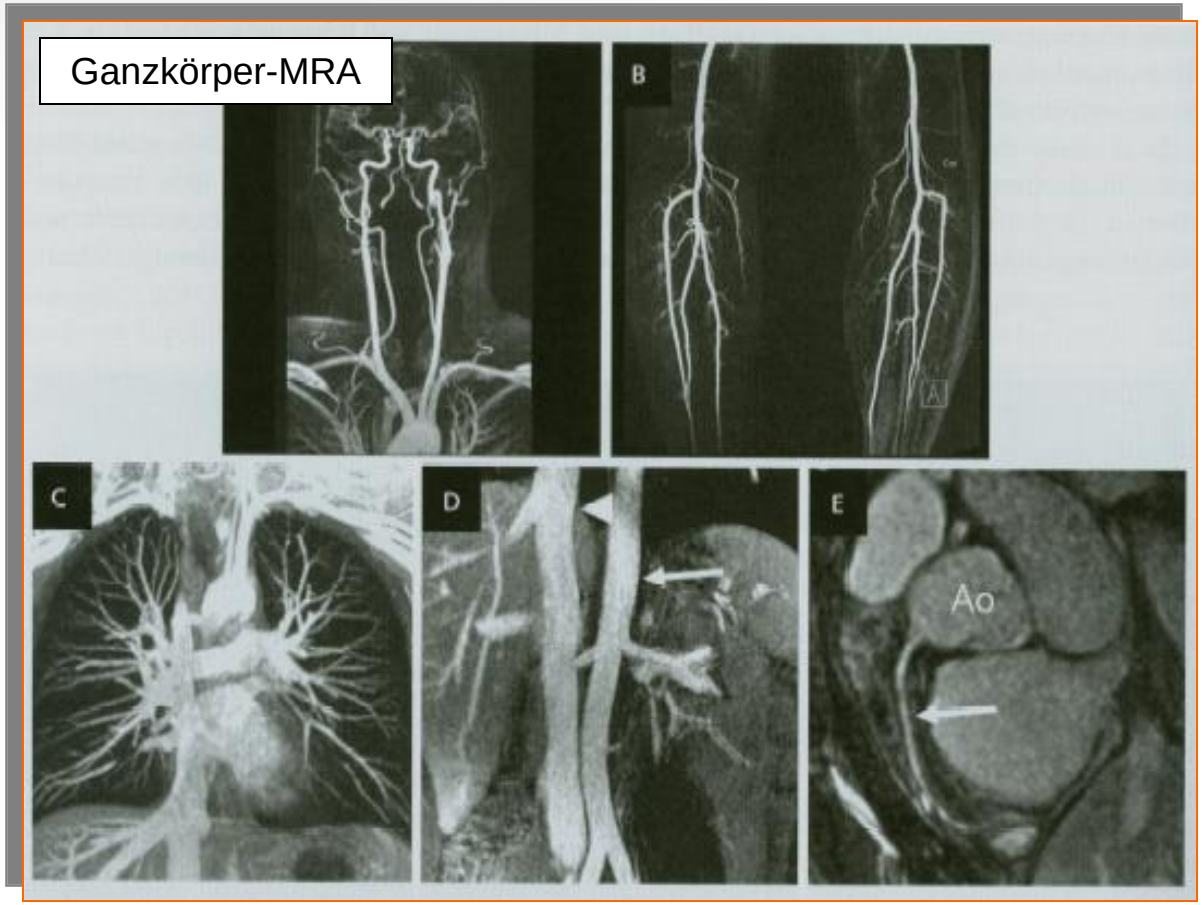
Lungenembolie

Bloodpool-KM

Signalintensität verschiedener MR-Kontrastmittel



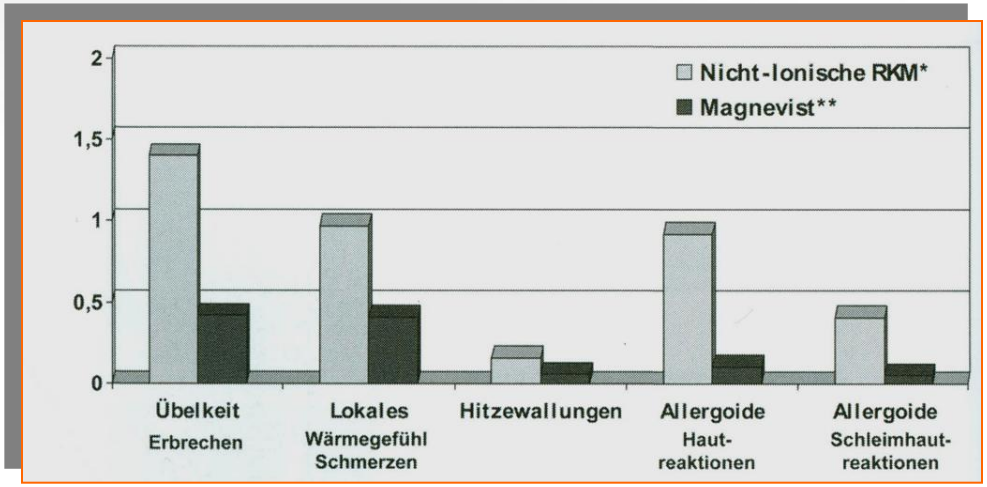
Bloodpool-KM



Bloodpool-KM

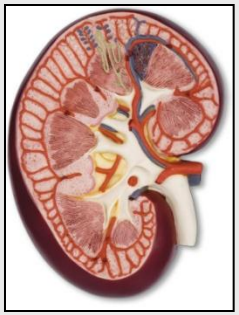
Venendarstellung mit Vasovist® in der Equilibriumsphase

Risiken und Nebenwirkungen: *Kontrastmittel*



Nephrogene systemische Fibrose (NSF)

- ca. 380 Fälle von NSF durch Gadolinium-KM
- NSF: Haut, Bindegewebe, Knochen, Nieren
- Zulassungsänderung, cave Niereninsuffizienz, Leber-TX und Kleinkinder für (BfArM, FDA 2007)



Zusammenfassung

Schwarzblut
=> BB-SE- u. BB-GRE-Pulssequenzen (DIR)

Weißblut
=> GRE-Pulssequenzen, v.a. SSFP

„Bright-Blood“-Verfahren
=> TOF u. PCA

CE-MRA
=> extrazelluläre Kontrastmittel
=> Bloodpool-KM

Verfahren der CE-MRA
=> Standbild, Tischverschiebung
=> Time-resolved MRA