MR Glossary

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Acquisition — **MR measurement technique.** Data acquisition during MR imaging. To improve the *signal-to-noise ratio* in the image, several acquisitions can be performed to image a slice. At the same time, they are averaged during image reconstruction (*averages*).

Acquisition matrix — *–> Raw data matrix*

Acquisition time (*TA*) — **MR measurement technique.** Measurement time for an entire data set.

TA:
Time to Acquisition

Acquisition window — **MR measurement technique.** The time frame in a pulse sequence during which the MR signal was acquired.

Active shielding — **Magnetic field:** For strong magnets, the *stray field* has to be actively shielded to increase the safety zone. For this purpose, secondary compensating coils are attached around the magnet opposite the primary field-generating coils.
Gradients: Gradient systems with opposed coils to reduce *eddy currents*.

Active shim

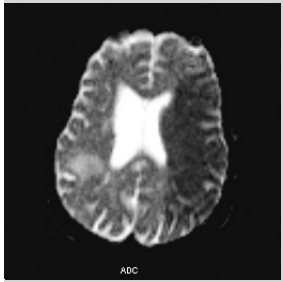
Quality assurance. *Shim* by adjusting the currents in the *shim coils*.

Adaptive Combine

Measurement parameters. Algorithm for combining the channels of *MR signals* from several receiver coils. Adaptive Combine improves the measurement results for most measurement protocols.

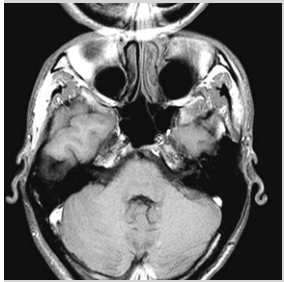
ADC image ▶

Diffusion-weighted imaging. ADC images can be reconstructed from diffusion-weighted images with at least 2 *b-values*. The contrast corresponds to the spatially distributed diffusion coefficients of the acquired tissue and does not contain T1 or T2* portions.



Aliasing artifact ▶

Image quality. Aliasing artifacts are generated when the measurement object is outside the FoV but still within the sensitive volume of the coil. Signals from outside the FoV overlap the image, but on the opposite side. Caused by the sampling and subsequent Fourier transformation of signal components above the Nyquist frequency. Reme-



died primarily through *oversampling*, but regional *presaturation* may be used as well.

Analog-to-digital converter (ADC)

MR components. Part of the computer system which converts the analog MR signal into a digital signal.

Array coil

MR components. An array coil combines the advantages of smaller coils (high signal-to-noise ratio) with those of larger coils (large field of view). It consists of multiple independent coil elements that can be combined depending on the requirements of the examination.
–> Integrated Panorama Array (IPA)

Array processor

MR components. An array processor comprises multiple computer and storage units that are switched in sequence and in parallel while simultaneously performing a computing task. Core of the *image reconstruction system*.

ART

Image reconstruction. Three-dimensional technique for fully automatic motion correction. To minimize motion errors, the 3D data sets are shifted, rotated, and interpolated to correspond closely to a reference data set.

ART:
Advanced Retrospective Technique

Arterial Spin Labeling *(ASL)*

Perfusion imaging. Arterial Spin Labeling uses the water in arterial blood as an endogenous contrast agent by marking a specific vessel with an RF pulse. By subtracting images with/without markings, statements about the relative blood flow can be made. This technique allows insight into perfusion and the functional physiology of the brain. ASL is suitable for evaluating tumors, degenerative diseases and seizure disorders, as well as neuro-scientific research, e.g., for examining functional changes in the blood flow of the brain.

ASL:
Arterial Spin Labeling

Artifact

Image quality. Signal intensities in the MR image that *do not* correspond to the spatial distribution of tissue in the image plane. They

result mainly from physiological as well as system-related influences.
–> Aliasing artifact
–> Distortion artifact
–> Flow artifact
–> Motion artifact

AutoAlign Head LS

Slice positioning. Automatic orientation of the slice position, applicable for head examinations. Independent of patient positioning, the MR system automatically performs reproducible slice positioning and simplifies as well as accelerates examination planning. Uses bony structures as anatomical orientation points.

AutoAlign Spine

Slice positioning. Automatic positioning and double-orthogonal orientation of transverse slice groups during examination of the spine based on the anatomical conditions of the intervertebral disk. Allows for easier and faster examinations with a better and standardized image quality.

Auto-calibration

MR measurement technique . When using Parallel Acquisition Techniques (*PAT*), *coil profile* information required for reconstruction is obtained via a calibration measurement.

Auto-calibration is integrated into the measurement and is both faster (approx. 1 second) and more exact than a separate calibration. It is performed with sequence characteristics that are identical to the acquisition and for the current patient position (including possible motions).

Averages

Measurement parameters. Mean value of measured signals in a slice to improve the signal-to-noise ratio. Averaging is performed, for example, on a measurement with 2 *acquisitions*.

Axial

–> Orthogonal slices

Bandwidth

Measurement parameters. Frequency spectrum (minimum to maximum processed frequency) of a pulse sequence acquired by an RF system.
–> Readout bandwidth
–> Transmission bandwidth

Baseline

BOLD imaging: Non-activated image, in contrast to activated image, refer also to *paradigm*.
MR spectroscopy: Background signal from which the *peaks* rise.

Baseline correction

MR spectroscopy. Post-processing of the spectrum to suppress baseline deviations from the zero line.

Basic image

Measurement. Image selected as the default for *slice positioning*; localizer, scout.
Post-processing. Image measured for post-processing; for example, *MIP* or *MPR*.

BEAT

Cardiac imaging. *syngo* tools to optimize cardiac examinations with a few mouse clicks.

BLADE

MR measurement technique. The BLADE technique helps reduce the motion sensitivity of MR examinations: BLADE is available for the TurboSE sequence. Each *echo train* of the sequence generates a low resolution image with a phase-encoding direction rotated from one excitation to the next. Subsequently, the individual, low-resolution images are combined into a high-resolution image.

Body coil

MR components. The body coil is an integral part of the magnet. It functions as a transceiver coil. It has a large measurement field, but does not have the high signal-to-noise ratio of special coils.

BOLD effect

BOLD imaging. During increased neural activity, oxygen concentration increases in the venous blood volume. Local blood flow increases as well.

As oxygen increases, the magnetic characteristics of erythrocytes approximate that of the surrounding blood plasma. *Transverse magnetization* in blood vessels decays more slowly. This

BOLD effect extends T2 and T2*, measurable as an increase in signal in the blood volume under examination.

BOLD imaging

MR application. BOLD imaging uses local changes in blood flow to indicate the current level of activity in a region of the brain. Hydrogen protons in human blood are the signal carriers.

Blood works as an intrinsic contrast agent: local concentrations of oxygen associated with changes in blood flow are measured (*BOLD effect*).

BOLD:
Blood Oxygenation Level Dependent Imaging

Bolus

Examination with contrast agent. Partial volumes in a vascular section. A small amount of contrast agent transported by blood flow whose spread is tracked (Bolus Tracking).

BRACE

MR mammography. Methods for soft-tissue corrections with MR mammography. Eliminates motion artifacts during dynamic imaging.

BRACE:
Breast Acquisition Correction

Breathhold technique

MR measurement technique. To avoid respiratory artifacts, the patient holds his breath during the entire measurement. Suitable for use in abdominal and cardiac examinations. Not suitable for use with uncooperative patients, small children, or anesthetized patients.

Bright-blood effect

Image quality. Brightly-displayed blood, as an effect of slow flow. Vascular spins are completely replaced by unsaturated spins during repetition time TR. In gradient echo sequences, the signal is maximum, and blood is displayed bright in the MR image.

The effect is used in bright-blood imaging of the heart for dynamic display of blood flow, an effect that is similar for ToF angiography.

b-value

Diffusion imaging. Diffusion weighting factor. The higher the b-value, the stronger the diffusion weighting.

B_0 field

MR physics. The static main magnetic field of a magnetic resonance system.

B_1 field

MR physics. The alternating magnetic field of RF radiation generated by a transmitter coil.

Cardiac imaging –> *MR cardiology*

Cardiac triggering **Physiological imaging.** Cardiac triggering prevents or reduces motion artifacts in the MR image caused by the heartbeat or pulsating blood flow. Triggering enables MR images to be acquired synchronized to cardiac movement.
ECG and *pulse triggering* enable precise functional examinations of the cardiovascular system and the CSF in the head and spine. Major vessels, the myocardium, and blood flow can be displayed.

Cardio –> *MR cardiology*

Care Bolus **Contrast-enhanced MRA.** Using Care Bolus, the center of the Fourier space is measured as quickly as possible once the contrast agent reaches the region to be examined. This ensures optimal contrast of arterial vessels.

CARE:
Combined Applications to Reduce Exposure

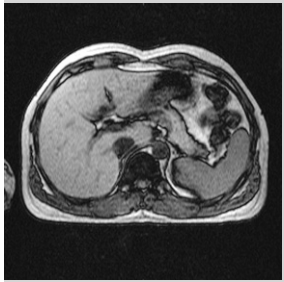
Center –> *Windowing*

Chemical shift

MR physics. Shift in the *resonance frequency* of an atomic nucleus depending on the chemical bonds of the atom or structure of the molecule. Caused primarily by a weakening of the applied magnetic field by the electron shell, and is proportional to the magnetic field strength. Units: 1 ppm of the resonance frequency.

Chemical shift artifact ▶

Image quality. With gradient echo sequences, the *chemical shift* may lead to "phase cancellation" in the image. The cause are the slightly different *resonance frequencies* of fat and water (approx. 3.5 ppm), which lead to a phase shift in a voxel containing fat/water. In an opposed-phase image, contour artifacts may appear at the interface of fat and water-containing tissue.



Chemical shift imaging *(CSI)*

MR spectroscopy. In contrast to *single volume spectroscopy*, the two CSI methods map the metabolic information from a *Volume of Interest (VoI)* in a spectral matrix. The spatial encoding requires a minimum measurement time of several minutes.

Cine

Image display. To display dynamic processes, such as cardiac movement. The MR images run automatically through the active screen segment, either in a cycle or forward and backward (yoyo).

CISS sequence

MR measurement technique. Strong T2-weighted 3D gradient echo technique with high resolution, where two *acquisitions* with different excitation levels are performed internally and subsequently combined. Prevents streaks, for example in the inner ear. Post-processing with *MPR* or *MIP*.

CISS:
Constructive Interference in Steady State

Coil profile

Physics. Receiver signal homogeneity of an *RF coil*, also known as coil sensitivity profile. The strength of the MR signal received from a *voxel* depends on the voxel location relative to the coil. In general, the signal is greatest in the vicinity of the coil. The farther away the voxel is from the coil, the weaker the signal.

The coil profiles can be obtained either from a separate calibration measurement or via an *auto-calibration* integrated into the measurement.

Coils

–> RF coils

Columns

MR measurement technique. The *frequency-encoded* portion of the *measurement matrix*.
–> Rows

Concatenation

Measurement parameters. Distributing the slices to be measured over multiple measurements. Possible applications:
- For a short TR, increase the number of concatenations to be able to measure more slices.
- To prevent *cross talk* when the slice distance is short, set concatenations to 2 and use an interleaved slice sequence.

Contour artifact

–> Chemical shift artifact

Contrast

Image quality. Relative difference in signal strength between two adjacent tissue types.

Contrast agent

Image quality. Chemical compounds to improve contrast. For MR, normally paramagnetic contrast agents, such as *Gadolinium DTPA* or other Gadolinium compounds are used.

In contrast to X-ray techniques, where contrast agent is directly visible, in MR, contrast agents have an indirect effect only; they reduce the relaxation times for water in tissue.

Contrast-enhanced MR angiography *(CE MRA)*

MR application. Contrast-enhanced MR angiography utilizes the T1 reduction of blood through Gadolinium-based contrast agent. Since CE MRA is not limited by saturation effects, it allows for large measurement fields and any orientation.

Contrast-to-noise ratio *(CNR)*

Image quality. The contrast-to-noise ratio in the MR image is the difference of the signal-to-noise ratios between two relevant tissue types, *A* and *B*.

$CNR = SNR_A - SNR_B$

Coronal

–> Orthogonal slices

CP coil

MR components. Circularly polarized transmission or receiver coil with two orthogonal transmission and/or receiver channels, also known as quadrature coil. A receiver coil has a better signal-to-noise ratio than a linearly polarized coil.

CP:
Circularly Polarized

Cross-talk

Image quality. If slices are too close, the signals from adjacent slices affect one another, especially when the slice distance equals 0. Caused by a slice profile that is not ideal due to the constraints of the measurement technology. Cross talk effects T1 contrast.

Remedied primarily using an *interleaved* slice sequence.

Cryogens

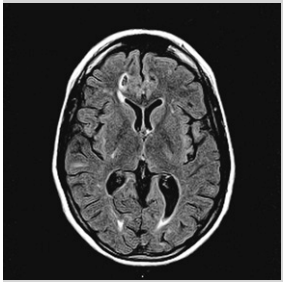
Magnet technology. Cooling agent to maintain the superconductivity of the magnet (liquid helium or nitrogen).

Dark Blood

Cardiac imaging. Special preparation pulse that saturates the blood; for displaying cardiovascular anatomy.

Dark-fluid imaging *(FLAIR)* ▶

MR measurement technique. *Turbo inversion recovery* technique with a long *effective echo time* and long *inversion time* to suppress fluids. Lesions that are normally covered by bright fluid signals using conventional T2 contrastare made visible by the dark-fluid technique. The inversion pulse is applied such that the T1 relaxation of the fluid reaches zero crossing at time point TI, resulting in the signal being “erased”.



FLAIR:
Fluid Attenuated Inversion Recovery

dB/dt

MR physics. Formula for the temporal change of the magnetic field, read “dB over dt”. Using alternating magnetic fields, electrical fields are generated in conductive material, such as human tissue. These fields may induce electrical current in the patient's body.

dB/dt is an important value for safety thresholds.

–> Stimulation

Defocussing –> *Dephasing*

Delay time –> *Trigger delay time (TD)*

Dephasing **MR physics.** After RF is applied, phase differences appear between precessing spins, resulting in a decay in *transverse magnetization*. Caused primarily by spin-spin interaction and inhomogeneity in the magnetic field, can also be caused by switching specific gradient fields (*flow dephasing*).
–> *Rephasing*

DESS sequence **MR measurement technique.** DESS is a 3D gradient echo technique where two different gradient echoes (*FISP sequence* and *PSIF sequence*) are acquired during repetition time TR. During image reconstruction, the strongly T2-weighted PSIF image is added to the FISP image. Use: Joints, good contrast for cartilage. Post-processing with *MPR*.

DESS:
Dual Echo Steady State

Diamagnetism

MR physics. Effect resulting in a slightly weakened magnetic field when a substance is introduced into it. Magnetization of a diamagnetic material is opposite the main magnetic field. The material is considered to have a negative magnetic *susceptibility (magnetizability)*.

DICOM

Standard for electronic data exchange of medical images.

The DICOM standard enables the transfer of digital medical images and corresponding information, independent of device and manufacturer. In addition, DICOM provides an interface to hospital systems based on other standards.

DICOM:
Digital Imaging and Communication in Medicine

Diffusion

Physics. Process by which molecules or other particles move from areas of higher concentration to areas of lower concentration. When concentrations are equal, there is a statistical balance, even though the molecules are constantly under thermal movement (Brownian molecular movement).

Diffusion contrast

Diffusion imaging. The diffusion of water molecules along a field gradient reduces the MR signal. The behavior is exponential:
Signal = $S_0 \exp(-b\,D)$
In areas of low diffusion (pathological tissue), signal loss is less intense. These areas are shown brighter.

Diffusion tensor

Diffusion imaging. Physical magnitude which takes into account the directional dependency of diffusion. The diffusion tensor displays the mobility of water molecules in all three coordinates. The tensor data are used as the basis for computing additional maps (e.g., *FA map*) or *diffusion tractography*.

Diffusion tensor imaging *(DTI)*

MR application. Method for displaying the directional dependency of diffusion. Application: examinations involving the architecture, configuration and integrity of nerve fiber bundles (neurological research).

Diffusion tractography

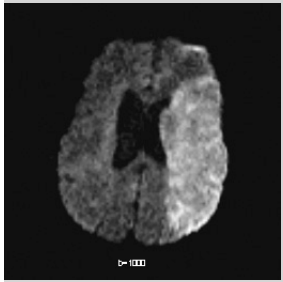
Diffusion tensor imaging. Method for displaying diffusion tracts using diffusion tensor measurements.

Tractography supports the planning of operations and supports neurophysiological research regarding the connectivity and pathology of the white matter.

Diffusion-weighted imaging ▶

MR application. MR imaging is sensitive to motion and flow and to the relatively low diffusion effect, when the gradients are strong enough. Diffusive movements in tissue (e.g., natural diffusion of water) reduce the signal.

Of interest are regions where diffusion is reduced compared to its surroundings (such as cell membranes, along white matter tracts, or in areas of the brain affected by stroke). Reduced diffusion means the reduction in signal is less intense: the affected regions are displayed brighter in the image.

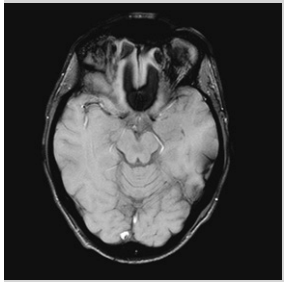


Diffusion weighting factor

–> b-value

Distortion artifact ▶

Image quality. Image distortions are caused by inhomogeneity in the magnetic field, gradient non-linearity, or ferromagnetic materials in proximity to the examination.



Dixon technique

MR measurement technique. Dixon is a technique for separating fat and water. For this purpose, the technique uses the different *resonance frequencies* of fat and water protons (*chemical shift*). Essentially an *in-phase* and an *opposed-phase image* are measured. By adding the in-phase and opposed-phase, pure *water images* are generated while pure *fat images* are generated through subtraction.

Double-contrast sequences

MR measurement technique. TurboSE counterpart to double-echo sequences, generally 5 times as fast.

To keep the pulse train as short as possible, only echoes for PD- and T2-weighted images where the phase-encoding gradient has a small amplitude are measured separately. The echoes that determine resolution are used in both raw

data matrices (*echo sharing*). This reduces the number of echoes required. More slices can be acquired for the TR specified, and the RF stress (SAR) drops.

Double-echo sequence

MR measurement technique. Spin-echo sequence with two echoes. In addition, *proton density weighted images* are generated without increasing the measurement time. They are produced from the first echo of a T2-weighted double-echo sequence.

Double-oblique slice

Slice positioning. Obtained by rotating an oblique slice about one axis in the image plane.

Duty cycle

Gradient technology. Time permitted during which the gradient system can be run at maximum power. Based on the total time (in %), including the cool-down phase.

Eccentricity

–> Off-center

ECG triggering

Physiological imaging. ECG triggering synchronizes the measurement with the cardiac signal of the patient. The R wave is used as the trigger. This method is particularly useful for measurements of the heart or thorax, because images can be blurred due to cardiac contractions.

Echo

MR physics. The MR signal generated by an RF or gradient pulse.
–> Gradient echo
–> Spin-echo (SE)

Echo-planar imaging *(EPI)*

MR measurement technique. Extremely fast MR technique where the complete image is obtained using a single selective excitation pulse. Field gradients are switched periodically to generate a series of gradient echoes. An image of the excited plane is obtained by using a Fourier transformation on the resulting echo train.

Echo sharing

MR measurement technique. For double-contrast sequences. Echoes that determine image resolution are used in both raw data matrices.

Echo spacing

MR measurement technique. Distance between two echoes; e.g., TurboSE or EPI sequences. A short echo space produces compact sequence timing and fewer image artifacts.

Echo time (*TE*)

Measurement parameters. The time between the excitation pulse of a sequence and the resulting echo used as the MR signal. Determines image contrast.

TE:
Time to Echo

Echo train

Multi-echo sequences. Two or more echoes in sequence; each of them obtains a different phase-encoding direction.

Eddy currents

MR measurement technique. Electrical currents generated in a conductor by changing magnetic fields or movement of the conductor within the magnetic field. Can be reduced using shielded

gradients. Eddy currents are a source for artifacts.

Edge oscillation

–> *Truncation artifact*

Effective echo time (TE_{eff})

MR measurement technique. The contrast and signal-to-noise ratio of an MR image are determined primarily by the temporal position of the echo where the phase-encoding gradient has the smallest amplitude. In this case, the echo signal undergoes minimal dephasing and has the strongest signal. The time period between the excitation pulse and this echo is the effective echo time.

Effective repetition time (TR_{eff})

Physiological imaging. For prospective cardiac triggering, repetition time TR cannot be set as desired; rather, it is determined by the time interval for the trigger. The effective repetition time TR_{eff} established by the trigger interval fluctuates with the physiological rhythm.

TR:
Time to Repetition

EPI factor

Echo-planar imaging. Number of gradient echoes of an EPI sequence acquired after a single excitation pulse (typically 64 to 128). EPI factor 128 means a measurement time 128 times faster than a normal gradient echo sequence.

EPI technique

–> *Echo-planar imaging (EPI)*

EPI:
Echo-Planar Imaging

Ernst angle

MR measurement technique. The *flip angle* (< 90°) of a gradient echo sequence where a tissue with a specific T1 generates its maximum signal. Depending on the repetition time TR. $\alpha_{Ernst} = \arccos (e^{-TR/T1})$

Excitation pulse

MR measurement technique. The equilibrium of the spins in the magnetic field is distorted by a brief RF pulse. The higher the energy of an excitating RF pulse, the greater is the tip angle of the net magnetization. The tip angle of the magnetization at the end of the RF pulse is known as the *flip angle*.

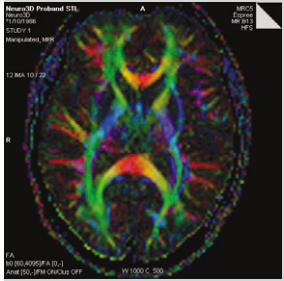
FA map ▶

Diffusion imaging. An FA map displays the anisotropic character of the diffusion in relationship to the average overall diffusion.

Isotropic diffusion: Water molecules move the same way in every direction.

Anisotropic diffusion: The water molecules clearly move in a preferred direction.

Isotropic diffusion is displayed dark, anisotropic diffusion is displayed bright. The color encodes the orientation of diffusion. The FA map is one of the *parametric maps* for *diffusion tensor imaging*.



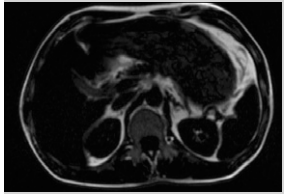
FA:
Fractional Anisotropy

Fast Fourier Transformation *(FFT)*

Image reconstruction. Algorithm for fast MR image reconstruction from raw data.

Fat image ▶

A pure fat image only displays the signal from fat protons in the image and suppresses the signal from water protons. Is generated with the *Dixon* technique, for example.



FatSat –> *Fat saturation*

FatSat:
Fat Saturation

Fat saturation *(FatSat)* **Image quality.** To suppress the fat portion in the MR signal, the fat protons are saturated by frequency-selective RF pulses. The fat saturation depends on the homogeneity, the chemical shift is 3.5 ,ppm.
–> *Presaturation*

Fat suppression **Image quality.** The MR signal comprises the sum of signals from water and fat protons. Different techniques are used to suppress the fat signal.
–> *Fat saturation*

Feet First **Positioning.** The patient is positioned *feet first* in the magnet bore.

Ferromagnetism **Physics.** Effect where a material, e.g., iron is drawn toward a magnetic field. Relevant to safety for MR imaging.

FID signal **MR physics.** Signal induced by the RF excitation of the nuclear spins, and that decreases expo-

FID:
Free Induction Decay

nentially without external influence at a characteristic time constant T2*.

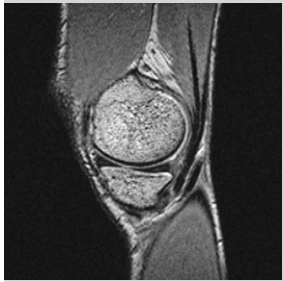
Field of View *(FoV)* **Measurement parameters.** Base (square) size of the slice to be measured (in mm). The smaller the field of view, the higher the resolution, since the *voxels* are smaller for the same matrix size.

Field strength –> *Magnetic field strength*

Filter –> *Image data filter*
–> *Normalization filter*
–> *Raw data filter*

FISP sequence ▶ **MR measurement technique.** With the FISP gradient echo sequence, the remaining transverse magnetization is not eliminated before the next RF pulse. Instead, it contributes to the signal along with the longitudinal magnetization. The strength of longitudinal magnetization depends on T1; the amplitude of transverse magnetization depends on T2*. Contrast is a function of T1/T2* and is generally not dependent on TR.

FISP:
Fast Imaging with Steady State Precession



FLAIR technique

–> Dark-fluid imaging (FLAIR)

FLASH sequence ▶

MR measurement technique. The FLASH gradient echo sequence uses the equilibrium of longitudinal magnetization. The remaining transverse magnetization is eliminated by a strong gradient (*spoiler gradient*). T1-weighted and T2*-weighted contrast can be set with the FLASH sequence.

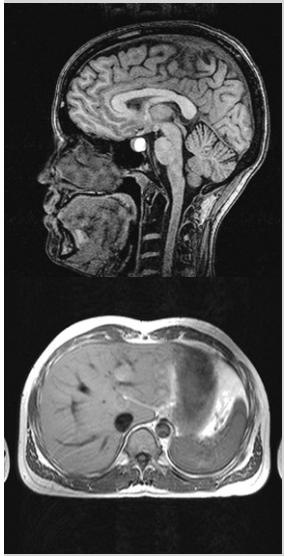
Flip angle

Measurement parameters. The tip angle of magnetization from the longitudinal direction at the end of an RF pulse. Frequently used flip angles are 90° and 180° flip angles.

Flow artifact ▶

Image quality. *Motion artifacts* caused by local signal changes during a measurement. For example, the inflow intensity of a vessel perpendicular to the image plane changes periodically due to pulsatile blood flow. In transverse body imaging, *ghosting* appears in the aorta. Due to turbulent blood flow in the heart, non-periodic inflow enhancement results in *smearing* of the image.

FLASH:
Fast Low Angle Shot



Flow compensation *(GMR)*

MR measurement technique. To override the signal loss caused by spin movement, both moved and unmoved spins can be rephased. Additional gradient pulses are switched in suitable size and time duration.

GMR:
Gradient Motion Rephasing

Flow dephasing

MR measurement technique. Exclusion of the signal from flowing substances such as blood, through the application of specifically applied gradient fields.
–> Dephasing

Flow effect

Image quality. Flow effects play two conflicting roles in MR imaging:
- Source of unwanted image artifacts

–> Flow artifact
- In *MR angiography*, displays blood vessels and provides quantitative information on the velocity of blood flow.

–> Bright-blood effect
–> Inflow amplification
–> Jet effect
–> Signal elimination

–> *Washout effect*

Flow encoding

MR measurement technique. Use of phase-encoding or other techniques to obtain information regarding the direction and velocity of moving material.

Flow quantification

MR application. Quantitative flow measurements using phase contrast to examine pathologies in large vessels or as part of an extensive cardiovascular MR examination. Flow measurements enable the non-invasive evaluation of blood flow.

Flow rephasing

–> *Rephasing*

Flow sensitivity *(venc)*

Phase-contrast angiography. The flow sensitivity of a phase-contrast sequence refers to the flow velocity where the phase difference between flow-compensating and flow-encoding scans is 180 degrees.

venc:
velocity encoding

fMRI

–> *Functional imaging*

fMRI:
functional Magnetic Resonance Imaging

Fourier space

MR measurement technique. The axes of the raw data matrix axes are known as k_x and k_y. They divide the matrix into four squares. The plane spanned by the two axes is called Fourier space or k-space.

Fourier Transformation

Imaging: Mathematical procedure for reconstructing images from raw data.
MR spectroscopy: Method for calculating MR spectra from MR time data.

FoV

–> Field of View (FoV)

Fractional anisotropy

–> FA map

Free induction decay

–> FID signal

Frequency

Physics. The number of repetitions of a periodic process in a unit of time (unit: Hertz).

Frequency encoding

MR measurement technique. During data acquisition, a magnetic field gradient is applied in one spatial direction, providing nuclear spins

with linearly increasing precessional frequencies. The readout MR signal is a mix of all these frequencies. These various frequencies must be filtered individually. In the row direction, the location of the nuclear spin can be reconstructed from the frequency. This axis is called the frequency-encoding axis.

The perpendicular axis to it is the direction of the *phase encoding*.

Frequency tuning

MR measurement technique. Setting the RF system frequency to the *resonance frequency* of the main magnetic field (*Larmor frequency*).

Functional imaging

–> BOLD imaging

Gadolinium DTPA

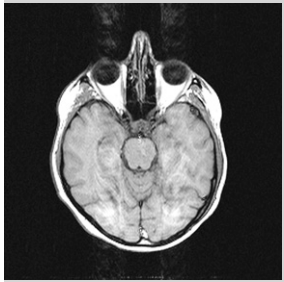
Contrast agent. The uptake of gadolinium-containing contrast medium reduces the T1 and T2 values of tissues, depending on the concentration. The effect: T1 weighting increases, while T2 weighting is suppressed. The T1 effect is the more relevant in clinical routines.

Gauss

MR physics. Old unit for magnetic field strength. Today, the unit *Tesla (T)* is used (1 Tesla = 10000 Gauss).

Ghost images ▶

Image quality. During periodic movement such as breathing, some phase-encoding steps are acquired during inspiration (e.g., inspiration phase), and others during expiration (e.g., expiration phase). This quasi-periodic misencoding results in a displaced false image of the body region. Signal-rich structures like subcutaneous fat are particularly susceptible to ghosting due to movement. The distance between the ghost images depends on the movement period and relaxation time TR.



During echo-planar imaging, ghosting may occur at a distance of half the FoV.

Gibbs artifact

–> *Truncation artifact*

GLM

BOLD imaging. GLM calculates *BOLD* images by adjusting a linear combination of different signal portions. In addition, interferences such as slow signal fluctuation are successfully suppressed and reliable activation maps are obtained. GLM also allows a detailed evaluation of the measurement data.

GLM:
General Linear Model

Global Bolus Plot *(GBP)*

–> *Global time-density curve*

Global Shim

Quality assurance. For several techniques, such as fat saturation, EPI or spectroscopy, especially high magnetic field homogeneity is required. In this case, shim coils can be used to optimize homogeneity.

Global time-density curve

Perfusion imaging. Diagram for evaluating successful bolus transport.

GRACE

MR spectroscopy. GRACE is a *SVS* procedure in breast spectroscopy, used to quantify the cholin signal.

GRACE: Generalized Breast Spectroscopy Exam

Gradients

MR physics. A gradient defines the strength and orientation of change of a magnitude in space. A magnetic field gradient is a change in the magnetic field of a certain orientation, a linear increase or decrease. The magnetic gradient fields are generated with *gradient coils*. They determine, for example, the spatial resolution in an image.

Parameters: *rise time*, *duty cycle*, gradient linearity, *gradient strength*, *slew rate*.

Gradient coils

MR components. Coils to generate magnetic gradient fields. Gradient coils are operated in pairs in the magnet, at the same current, however, of opposite polarities.

One of the coils increases the static magnetic field by a certain amount, the opposite coil reduces it by the same amount. This changes the magnetic field overall. The change is the linear *gradient*. According to the coordinate axes, there are x, y, and z gradient coils. In connection with the gradient amplifier, they form the gradient system, used to precisely localize the requested slice position.

Gradient echo

MR physics. Echo created by switching a pair of dephasing and rephasing gradients, without a rephasing 180° pulse as with the spin-echo technique.

Gradient Motion Rephasing *(GMR)*

–> Flow compensation

Gradient strength

Gradient technology. Amplitude of the gradient field, measurement unit mT/m (millitesla per meter).

Gradient swap ▶

Measurement parameters. Exchange of phase-encoding and readout directions in the image. As a result, interfering flow and motion artifacts are rotated by 90°. Prevents artifacts from covering structures of interest.

GRAPPA

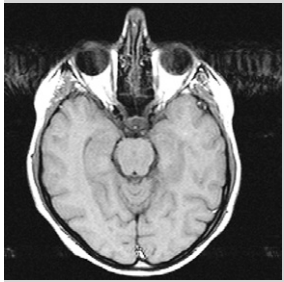
MR measurement technique. Further development of *SMASH* with *auto-calibration* and a modified algorithm for image reconstruction.

Grid tagging

–> *Tagging*

GSP

Graphical positioning of the slices/saturation regions to be acquired on base images (localizer images). Relevant measurement parameters may be conveniently adjusted on-screen via the mouse.



GRAPPA:
Generalized Autocalibrating Partially Parallel Acquisition

GSP:
Graphical Slice Positioning

Half-Fourier matrix

MR measurement technique. The raw data matrix has a specific symmetry which theoretically makes sampling of only half the matrix sufficient. The other half can be symmetrically reconstructed; mathematically, the matrices are *conjugated complexes*.

However, unavoidable phase errors due to minor magnetic field inhomogeneity require a phase correction. For this reason, only slightly more than half of the raw data are acquired. Measurement time is reduced by just under 50 %.

Hanning filter

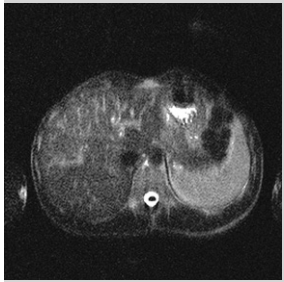
Type of *raw data filter*

HASTE technique ▶

MR measurement technique. HASTE is a *Turbo spin-echo* technique and is used for sequential acquisition of high-resolution T2-weighted images.

All image information is obtained after a single excitation pulse. Echoes are generated by a subsequent 180° pulse The image is obtained after a half-Fourier reconstruction.

HASTE:
Half-Fourier Acquisition
Single-Shot TurboSE



Head First

Positioning. The patient is positioned *head first* in the magnet bore.

Hertz

MR physics. SI unit of frequency ($1\ Hz = 1\ s^{-1}$).

Homogeneity

Image quality. A magnetic field is considered homogeneous when it has the same field strength across the entire field. With MR, the homogeneity of the static magnetic field is an important criterion for magnet quality. High homogeneity is important for spectral *fat saturation*, a large *field of view (FoV)*, *off-center imaging*, *echo-planar imaging*, and *MR spectroscopy*.

Hybrid spectroscopy

MR application. Combination of *single volume spectroscopy* and *chemical shift imaging*. The CSI measurement is performed across a selectively-excited volume of interest. Via volume selection, areas with strong distorting signals (e.g., fat) are not stimulated. For this reason, they do not contribute signal to the spectra.

Image contrast

Image quality. The contrast in the image is the relative difference in the signal strength between two adjacent tissue types. It depends primarily on the existing tissue parameters *T1*, *T2*, *proton density*) and, in the case of MRA, on the flow as well.

Contrast can be affected by the sequence used (*spin echo*, *inversion recovery*, *gradient echo*, *TurboSE* etc.), the measurement parameters (*TR*, *TE*, *TI*, *flip angle*) and the use of *contrast agent*.

Image data filter

Reconstruction parameter. Filters of various strengths (strong, medium, soft) can subsequently be applied to MR images to reduce noise. High pass and low pass filters are used with different shapes to the characteristic curves. Other filter types include, for example, smoothing filters.

Image manipulation

Post-processing. MR images can be manipulated in various ways for manipulation. The gray scale of the images—either in its entirety or in sections—can be modified as desired (e.g., addi-

tion, subtraction, averaging, rotation, flip, offset, inversion).

Image matrix

Image display. The MR image consists of a multitude of picture elements (*pixel*). Pixels are allocated to a matrix in a checkered pattern. Every pixel in the image matrix displays a specific gray scale level. Viewed as a whole, the matrix of gray levels constitutes the image.

Not to be confused with a *measurement matrix*.

Image noise ▶

Image quality. Noise in the image is a statistical fluctuation in signal intensity that does not contribute to the image information. It appears in the image as a granular, irregular pattern. In principle, the effect is unavoidable and is physically based.

The noise of the image is a function of the field strength, coil size (body coil, local coil, array coil) the pulse sequence used, and the *resolution*.

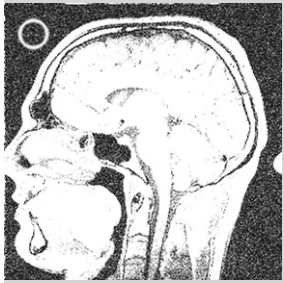


Image orientation

–> Slice orientation

Image quality

The diagnostic quality of an MR image. Characteristics include:
–> *Artifact*
–> *Contrast (Contrast-to-noise ratio)*
–> *Noise (Signal-to-noise ratio*
–> *Resolution*

Image reconstruction system

MR component. Part of the computer system that reconstructs MR images from the *raw data* using a *Fourier transformation*.

Image resolution

Image quality. Is the ability to differentiate neighboring tissue structures. The higher the image resolution, the better small pathologies may be diagnosed.

Resolution increases with a larger *matrix*, smaller *FoV*, and smaller *slice thickness*.
–> *In-plane resolution*
–> *Spatial resolution*

Image windowing

–> *Windowing*

Imager

–> *Image reconstruction system*

Induction, electromagnetic

Physics. The electrical voltage in a receiver coil created by a temporal change in the magnetic field.

Inflow amplification

Image quality. A blood volume flowing slowly perpendicular to the slice yields a stronger signal than the surrounding tissue.

Using a 90° pulse, a bolus is excited within the slice to be measured. The excited spins cannot recover fully within a short repetition time. They remain saturated to a certain extent. The signal is weaker than that after a sufficiently long repetition time TR in relationship to T1.

However, spin ensembles outside the slice are fully magnetized. Spins flowing out of the slice are replaced by fresh inflowing spins. As a result, vascular magnetization within the slice increases.

Inflow technique

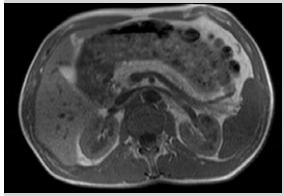
–> Time-of-flight angiography (ToF)

Inline Display

Image display. Immediate display of reconstructed images. Frequently used to display dynamic changes (e.g., CARE bolus and BOLD imaging).

In-phase image ▶

MR measurement technique. An in-phase image is generated with a measurement at a time when two components in the tissue (usually fat and water) are in the same phase, that is, the *transverse magnetizations* have the same orientation and add up. The cause for different phase-velocities is the *chemical shift* between fat and water protons.



In-plane resolution

Image quality. In-plane resolution is determined by the size of the pixels. The smaller the pixel, the better the in-plane resolution.

Integrated Panorama Array *(IPA)*

MR components. The concept of the integrated panorama array (IPA) significantly accelerates setup time and increases patient throughput.

Depending on the system, up to 4, 8, or 16 independent array coil systems can be connected

IPA:
Integrated Panorama Array

simultaneously with IPA. Up to 4 CP coil elements can be combined for a measurement.

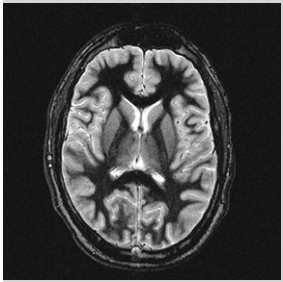
Interactive real time — **MR measurement technique.** Changing measurement parameters in real time.

Interactive shim — **Quality assurance.** Manual tuning of the *shim coils* to improve magnetic field *homogeneity*. Shim currents can be set and optimized individually for a selected pulse sequence.

Interleaved slices — *–> Slice sequence*

Interpolation — **MR measurement technique.** Calculation of values that lie between known values in a mathematical function; e.g., enlarging the image matrix from 256 × 256 to 512 × 512. The measurement time is not increased, but interpolated images do require more storage space.

Inversion Recovery *(IR)* ▶ — **MR measurement technique.** Method for creating a signal dependent primarily on T1. With inversion recovery sequences, the longitudinal



magnetization is inverted in the opposite direction by a 180° pulse. Transverse magnetization remains equal to zero.

During the subsequent recovery, the negative longitudinal magnetization decays to zero and then begins to rise. Because transverse magnetization is not possible, no signal is measured.

To generate an MR signal, the longitudinal magnetization has to be converted to transverse magnetization through application of a 90° pulse.

Inversion time *(TI)*

Measurement parameters. Interval between a 180° inversion pulse and a 90° excitation pulse in an inversion recovery sequence.

TI:
Time to Inversion

iPAT

MR measurement technique. iPAT stands for integrated Parallel Acquisition Techniques. iPAT is Siemens' implementation of Parallel Acquisition Techniques (*PAT*) on MAGNETOM systems.

iPAT includes the *mSENSE* and *GRAPPA* measurement techniques as well as *auto-calibration*.

iPAT:
integrated Parallel Acquisition Techniques

iPAT^2

3D imaging. 3D sequences include two phase-encoding directions: the conventional 2D (PE) direction and the additional phase encoding in the partitions direction (3D).

The acceleration in the 3D direction is known as "iPAT^2".

Isocenter

Image quality. The main magnetic field is only *homogeneous* within a roughly spherical region about the isocenter of the magnetic field. In this area, the examination region are positioned to ensure the best possible image quality.

Jet effect

Image quality. Spin dephasing for complex flow patterns such as turbulences. The degree of signal loss and the size of low-signal regions depend on the flow patterns and pulse sequence used. This effect must be taken into account when evaluating the extent of vascular stenosis.

k-space *–> Fourier space*

Larmor frequency

MR physics. Frequency at which the nuclear spins precess about the direction of the outer magnetic field. The frequency depends on the type of nuclei and the strength of the magnetic field.

At 1.0 Tesla, the Larmor frequency of protons is approx. 42 MHz, at 1.5 Tesla, it is approx. 63 MHz.

–> Precession

Lattice

MR physics. Magnetic and thermal environment where the nuclei exchange energy during *longitudinal relaxation*.

Local coils

MR components. Special coils are used for each area of the body to be examined (*surface coil*). They have a high signal-to-noise ratio at a small measurement field.

Local shim

Quality assurance. The *shim* is limited to a previously selected local volume.

–> 3D shim

Localized MIP

MR angiography. Localized "MIPing" improves image quality and considerably reduces the reconstruction time. Only a partial data volume is used which contains the voxels of the vessel of interest. As a result, the projection includes fewer background noise pixels and displays less bright fat signal. Individual vessels can be selected as well for reconstruction to maintain a comprehensive image.

MIP:
Maximum Intensity Projection

Localizer

–> *Basic image*

Logical gradients

MR measurement technique. For orthogonal slices, each of the 3 *physical gradients* has exactly one "logical" task: *slice selection*, *frequency encoding*, and *phase encoding*. For oblique slices, the logical gradients are a mix of the physical gradients.

Longitudinal magnetization (M_z)

MR physics. Longitudinal magnetization M_z is the portion of the macroscopic magnetization vector in the direction of the z-axis, that is, along the outer magnetic field. After excitation by an

RF pulse, M_z returns to equilibrium M_0 with a characteristic time constant T1.
$M_z(t) = M_0 (1-\exp(-t/T1)$

Longitudinal relaxation

MR physics. Return to equilibrium of the longitudinal magnetization after excitation, due to the energy exchange between the spins and surrounding lattice (also called spin-lattice relaxation).

Longitudinal relaxation time

–> T1 constant

LOTA technique

MR measurement technique. Data averaging to reduce motion artifacts.

LOTA:
Long Term Averaging

Magnet

–> *Permanent magnet*
–> *Resistive magnet*
–> *Superconductive magnet*

Magnetic field

MR physics. The space surrounding a magnet (or a conductor with current flowing through it) has special characteristics. Every magnetic field exercises a force on magnetizable parts aligned along a primary axis (magnetic north or south pole). The effect and direction of this force is symbolized by magnetic field lines.

Magnetic field gradients

–> *Gradients*

Magnetic field homogeneity

–> *Homogeneity*

Magnetic field strength

MR physics. The strength of the magnetic field force on magnetizable parts. In physics, the effect is called magnetic induction. In MR, it is referred to as magnetic field strength. Units:

Tesla (T), 1 Tesla is approximately 20,000 times the strength of the earth's magnetic field.

Magnetic resonance *(MR)*

MR physics. Absorption or emission of electromagnetic energy by atomic nuclei in a static magnetic field, after excitation by electromagnetic RF radiation at *resonance frequency*.

Magnetic shielding

In space: *Shielding*
Through tissue: Weakening of the applied magnetic field at the nucleus by the counter field induced in the electron shell of the surrounding tissue.
–> Chemical shift

Magnetizability

–> Susceptibility

Magnetization transfer *(MTC)*

MR measurement technique. Indirect observation of fast relaxing magnetization through *presaturation*. Through magnetization transfer contrast, the signal from specific "solid" tissue (e.g., brain parenchyma) is reduced, and the

MTC:
Magnetization Transfer Contrast

signal from a more fluid component (e.g., blood) is retained.

With MTC, the saturation of bound protons is transferred to adjacent free protons. This reduces the visible MR signal in these areas.

Magneto-hydro dynamic effect

Image quality. Additional electrical charges generated by loaded particles (ions in blood) that move perpendicular to the magnetic field.

Magnitude contrast angiography

MR application. Used to display slow flow with good resolution across a large volume.

Two data volumes are measured: the *flow rephased* image shows bright flow, and the *flow dephased* image shows dark flow. Stationary tissue looks the same in both data volumes. The data volumes are subtracted from one another pixel-by-pixel. What remains is the signal intensity of the flowing blood.

Magnitude image ▶

Image reconstruction. Normal image display. In a magnitude image, the gray value of a pixel corresponds to the magnitude of the MR signal at that location.

Alternative: *Phase images*

MAP shim

Quality assurance. MAP shim globally tunes the shim currents. Correction functions are calculated using a fixed algorithm and applied to the corresponding shim currents. As can be seen, the shim is applied to the entire measurement field.

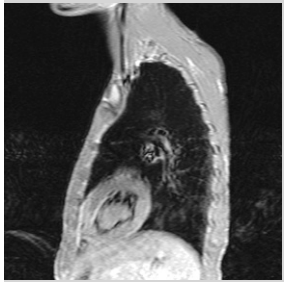
Modern systems no longer require the MAP shim.

Matrix

–> *Image matrix*
–> *Raw data matrix*

Matrix coils

MR components. Matrix coils have multiple coil elements combined into groups (clusters), typically 3 coil elements per cluster. Each coil element is equipped with a low-noise preamplifier to maximize the signal-to-noise ratio. For exam-



MAP:
Multi-angle projection

ple, a spine matrix coil has 24 coil elements and 24 preamplifiers.

Matrix coil mode

Measurement parameters. The Matrix coil mode defines the allocation between Matrix coil elements and the RF receive channels.

- Matrix coil mode CP
- The coil elements of a coil cluster are combined to *one* RF receive channel. This mode is optimized for a maximum signal-to-noise ratio. Example: In the Matrix coil mode CP, the head matrix coil acts like a CP head array with 4 elements.
- Matrix coil mode Dual or Triple

The coil elements of a coil cluster are allocated to *two* or *three* RF receive channels. This allows for additional information that may be used for improving the signal-to-noise ratio at the image margin and/or for obtaining higher PAT factors. Example: In the Matrix coil mode Triple, the head matrix coil acts like a CP head array with 12 elements.

Matrix size

Measurement parameters. Size of the *raw data matrix*; influences not only the measurement time, but also the *resolution* and *signal-to-noise ratio*.

With a square raw data matrix, the number of rows equals the number of columns.

Maximum Intensity Projection

–> MIP

MDDW

Diffusion imaging. To compute the *diffusion tensor*, the technique provides multi-directional diffusion weighting (MDDW) measurements in at least 6 spatial directions. One diffusion-weighted image each is generated per *slice position*, *b-value*, and direction of diffusion (for b > 0).

MDDW:
Multi Directional Diffusion Weighting

Measurement field

MR physics. Spherical volume in the center of the magnetic field where the field has a defined homogeneity. For MR examinations, objects to be measured have to be positioned at all times in the measurement field (to prevent signal distortions).

Measurement matrix *Raw data matrix*, not to be confused with the *image matrix*.

Measurement sequence *–> Pulse sequence*

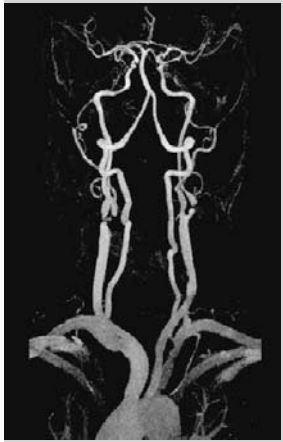
Measurement time **MR measurement technique.** The measurement time for a 2D measurement is as follows:
Measurement time = no. of scans x TR x no. of acquisitions

MEDIC technique **MR measurement technique.** Multiple echoes acquired in one measurement are combined into an image. The advantage: higher SNR per time period, fewer artifacts. Application: cervical spine, joints.

MIP ▶ **Post-processing.** Maximum projections can be reconstructed from 3D or multi-slice measurements that can be combined into MIP series. This procedure is used mainly for MR angiography. Blood vessels are displayed brighter than the rest of the image.

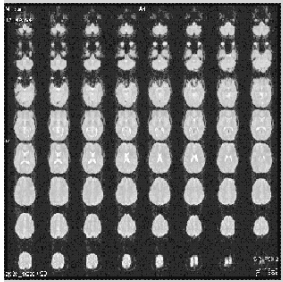
MEDIC:
Multi-Echo Data-Image Combination

MIP:
Maximum Intensity Projection



Mosaic image ▶

BOLD imaging. Between16 to 64 EPI images are compiled into a mosaic image. This increases the clarity of BOLD displays.



Motion artifact

Image quality. Results from random or involuntary movement: breathing, heartbeat, blood flow, eye movement, swallowing, and patient movement. The effect appears as *ghosting* or *smearing* in the images. In the phase-encoding direction only.

MPR

–> Multi-planar reconstruction (MPR)

MPRAGE technique

MR measurement technique. MPRAGE is a 3D extension of the TurboFLASH technique with prepared inversion pulses. Only one segment or partition of a 3D data record is obtained per preparatory pulse.

After the acquisition, all rows within a 3D partition use delay time TD. The delay time is necessary to prevent saturation effects.

MPRAGE:
Magnetization Prepared Rapid Gradient Echo Imaging

MR angiography

MR application. Angiography with MR does *not* really display the blood volume, but rather a specific physical characteristic of the blood; for example, the magnetization status or local velocity. This is perceived as blood volume. MRA does *not* display a single vessel, but rather all vessels in the blood volume. Various views can be subsequently reconstructed (*MIP*) from 3D data volumes.

MR cardiology

MR application. The advantages of cardiac MR include:

- free selection of image planes and FoVs
- high tissue contrast
- temporal and spatial resolution

Image plane projections can be compared in angiocardiography, scintigraphy, or 2D echocardiography. Multiple cardiac slices can be acquired along the respective slice plane. In this way, complete anatomical display of the heart in all three dimensions is provided. Data records acquired across cardiac phases enable *cine display* of the heartbeat.

Subsequent quantitative evaluation of cardiac studies enables the following:

- Manual or semi-automatic segmentation of the inner and outer cardiac walls of the left ventricle, and the inner wall of the right ventricle: ED and ES images or the complete cardiac cycle.
- Calculation of ventricular volume, myocardial mass, and functional parameters
- Evaluation of myocardial wall thickness; changes in wall thickness (between the ED and ES phase or during the cardiac cycle) are evaluated for each sector
- Viability, perfusion, coronary angio

MR contrast agent

–> *Contrast agent*

MR images

The MR image consists of a multitude of image elements, also known as *pixels*. Pixels are allocated to a matrix in a checkered pattern. Every pixel in the image matrix displays a specific gray scale. Viewed as a whole, this gray scale matrix provides the image.

The gray scale of a pixel mirrors the measured signal intensity of the corresponding volume element (*voxel*). In turn, the signal intensity of a voxel depends on the respective transverse magnetization.

MR imaging

Images of objects, for example, the human body, are displayed with magnetic resonance using magnetic gradient fields. In practical application, the distribution of protons in the body is displayed.

The clinically relevant objective of MR imaging is the differentiation between pathological and healthy tissue (*image contrast*).

MR sensitivity

MR physics. Atomic nuclei for MR examinations have to be "MR sensitive"; that is, they must have a nuclear spin. This condition excludes all atomic nuclei with an even number of protons and neutrons.

Since the hydrogen isotope ^{1}H is the most sensitive, it is used as a reference in relationship to

other atom nuclei. Its relative sensitivity is 1 or 100 %.

MR signal

MR physics. Electromagnetic signal in the RF range. Caused by the precession of transverse magnetization created by a variable voltage in a receiver coil (dynamo principle). The temporal progression of this voltage is the MR signal.

MR spectroscopy *(MRS)*

MR application. MR spectroscopy provides the non-invasive measurement of cellular metabolic relationships. An MR spectrum shows the dependence of the signal intensity on the chemical shift for a measurement volume (voxel). The concentration of metabolites contributing to the spectrum can then be inferred.

In MR spectroscopy, the MR signal is measured as a function of time: a rapidly decreasing high-frequency oscillation. Using a Fourier transformation, the oscillation is converted into a display of its frequency component, the *spectrum*.

In the area of intermediary metabolism, MR spectroscopy is an important method for in-

vitro and in-vivo examination of tissue and organs.

mSENSE

MR measurement technique. Further development of *SENSE* with *auto-calibration* and a modified algorithm for image reconstruction.

mSENSE:
Modified Sensitivity Encoding

MTT image

Perfusion imaging. An MTT image can be reconstructed for an image displayed. It displays the mean transit time of the contrast agent bolus and enables hemodynamic interferences to be evaluated.

MTT:
Mean Transit Time

Multi-directional diffusion weighting

–> MDDW

Multi-echo sequences

MR measurement technique. Pulse sequence that excites multiple echoes with different degrees of T2 weighting. Signal height reduces with transverse relaxation. This drop in signal can be used to calculate a pure T2 image.

Multi-level MRA

MR angiography. For peripheral or whole-body angiography, the multi-level principle (also: Multi-step Angio) simplifies the measurement and reduces the measurement time. The area to be examined is measured at individual sections (levels), during automatic table feed. The data obtained are subsequently combined into an overall image.

Multi-planar reconstruction *(MPR)*

Post-processing. Enables new images of any orientation to be reconstructed based on a 3D or gapless multi-slice measurement.

Multi-slice imaging

MR measurement technique. Variant of sequential imaging. The recovery period of the first slice excited is used to measure additional slices (time-savings). The slices are *interleaved*.

Multi-step angio

–> Multi-level MRA

Multi-venc sequence

Phase-contrast angiography, A sequence that is equally sensitive to various flow velocities. Used to acquire wide variations in flow velocity, e.g., in the peripheral arteries.

venc:
velocity encoding

NATIVE

MR angiography. Images of arteries and veins without contrast agent (native).

- NATIVE SPACE: for peripheral MRA; based on a fast 3D TSE sequence; image data are computed via inline subtraction of two ECG-triggered data records (systole and diastole).

NATIVE TrueFISP: for thoracic-abdominal MRA (e.g., renal arteries). The intrinsic contrast is generated by the inflow of blood with non-saturated spins into a presaturated volume.

Native image

Contrast agent study. MR image without the use of contrast agent, for example as a pre-contrast study.
BOLD imaging. Non-activated image (*baseline*).

Navigator echo

MR measurement technique. Additional spin or gradient echoes for detecting changes in object position in a measurement volume, or other changes. Suitable for use with interventional procedures or *respiratory gating*.

Neuro imaging

MR application. General term for brain and nervous system applications, such as *BOLD imaging*.

Noise

–> Image noise

Non-selective pulse

MR measurement technique. When data are acquired with a non-selective pulse, a longer TR is required for multi-slice measurements or repeated measurements of the same slice. The longer TR is required to ensure that magnetization between consecutive measurement recovers sufficiently and that the individual measurements do not interfere with one another.

Use with 3D volume measurements and presaturation techniques (e.g., *magnetization transfer*).

Normalization filter

Image quality. Equalizes signal intensity when using surface coils. Using the filter, the signal intensity of areas close to the coil is reduced; the signal intensity is increased in areas farther from the coil.

Used primarily with *array coils*.

Nuclear spin

MR physics. Atomic nuclei with an odd number of neutrons and protons have what is called nuclear spin. For MR imaging, only hydrogen protons are used. For MR spectroscopy, other nuclei are used, such as phosphor, fluorine, and carbon.

Number of partitions

–> *Partitions*

Number of slices

Measurement parameters. Multiple slices are usually acquired during an MR measurement. The maximum number of slices of a pulse sequence or measurement protocol depends on the repetition time TR.
–> *Multi-slice imaging*

Oblique slice

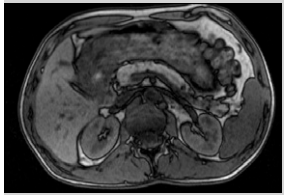
Measurement parameters. Obtained by rotating an orthogonal slice (sagittal, coronal, or transverse) about a coordinate axis in the image plane.

Off-center *(Eccentricity)*

Slice positioning. Shifting the center of a slice group from the center of the magnetic field within the slice plane.

Opposed-phase image ▶

MR measurement technique. An opposed-phase image is acquired at a time when two components in the tissue (usually fat and water) have opposite phases, that is, the *transverse magnetizations* of the two components have opposite orientations and partially cancel one another. Cause for the difference in phase is a *chemical shift* between fat and water protons.



Orthogonal slices

Slice positioning. Slices oriented perpendicular to one another. Three basic orientations are available: sagittal, coronal, and transverse (axial)
–> Slice orientation

Out-of-phase –> *Phase cancellation*

Overlap –> *Aliasing artifact*

Oversampling

Measurement parameters. Method for preventing *aliasing artifacts*.
Readout oversampling: Doubling the sampling points in the *frequency-encoding* direction without prolonging the measurement time. The additional part is discarded after reconstruction.
Phase oversampling: Measurement data acquisition beyond the *FoV* in the *phase-encoding* direction. Increases the SNR. The measurement time increases accordingly. 100 % phase oversampling has the same effect as double the number of acquisitions.

PACE

MR measurement technique. During the measurement, PACE corrects respiratory and motion artifacts in real time by reducing the offset between the slices. This allows for, e.g., multiple breathhold examinations a well as free breathing during a measurement.
–> 1D PACE
–> 2D PACE
–> 3D PACE

PACE:
Prospective Acquisition Correction

Paradigm

BOLD imaging. Planned sequence of the functional measurement, for example: 10 non-activated images (baseline), 10 active images, 2 ignored images.

Parallel acquisition techniques

–> PAT

Parallel imaging

–> PAT

Parallel saturation

Slice positioning. By saturating areas parallel to the slice plane but outside the slice of interest, blood flowing to the measurement area pro-

duces almost no signal at the beginning of the measurement. This eliminates the vascular intraluminal signal, and prevents *ghosting* in the phase-encoding direction.

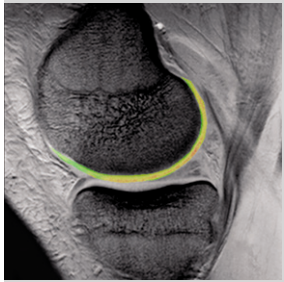
This *presaturation* can be performed on both sides of the slice. Parallel saturation slices shift with the slices of interest, simplifying planning.

Parametric map ▶

Post-processing. Parametric maps display the T1, T2, or T2* characteristics of the acquired tissue, enabling, e.g., early detection of arthritis in osteology.

Diffusion imaging. Parametric maps in diffusion imaging are created by measuring the *diffusion tensor*. They are used to, e.g., display anisotropic diffusion characteristics of the brain. Example: *FA map*.

Perfusion imaging. To display interferences in perfusion. Example: *Time-to-Peak map (TTP)*.



Partial-Fourier

MR measurement technique. To reduce the phase-encoding steps during the measurement so that the raw data matrix is filled with fewer

rows. Allows for shorter echo times. Special case: *Half-Fourier matrix*

Partial Parallel Acquisition *(PPA)* *–> PAT*

Partitions **3D imaging.** During 3D imaging, entire volumes and not just individual slices are stimulated. A *3D slab* comprises multiple gapless partitions The number of partitions corresponds to the number of slices during 2D imaging.

Partition thickness **3D imaging.** The effective slice thickness of individual partitions in a *3D slab* is the slab thickness divided by the number of partitions.

Passive shielding **MR components.** Older magnets were clad in soft iron that acted as flux return and significantly reduced the *stray field*. The overall weight of the system was drastically increased.

Today, *active shielding* is the preferred method.

PAT

MR measurement technique. PAT is the generic term for parallel imaging techniques. Other terms for PAT include "Parallel Imaging and Partial Parallel Acquisition".

Two groups of PAT are differentiated: with the image-based methods (e.g., *SENSE*, *mSENSE*), the PAT reconstruction is performed following the *Fourier transformation*. With the k-space-based methods (e.g., *SMASH*, *GRAPPA*), the PAT reconstruction is performed prior to the *Fourier transformation*.

PAT shortens the *measurement time* without degrading *image resolution*. The lower number of measurement lines reduces the *signal-to-noise*.

A prerequisite for PAT is the use of *array coils* as well as the calculation of the *coil profile* of all array coil elements (e.g., via *auto-calibration*).

The most important advantages of PAT: shorter breathhold times, higher temporal resolution of dynamic measurements and sharper images with *echo-planar imaging* (by reducing the *echo train*).

PAT:
Parallel acquisition techniques

–> *iPAT*
–> *iPAT²*

PAT factor

Measurement parameters. The PAT factor is a measure of the phase-encoding steps reduced through PAT. Example: for a PAT factor of 2, each second step is skipped. This cuts the measurement time in half.

For *iPAT²*, the PAT factor is the product of the two PAT factors in the phase-encoding and the partitions direction. Example: a PAT factor of 12 comprises a PAT factor of 4 in the phase-encoding direction and a PAT factor of 3 in the partitions direction.

PBP image

–> *Percentage of baseline at peak*

PC Angio

–> *Phase-contrast angiography*

Peak

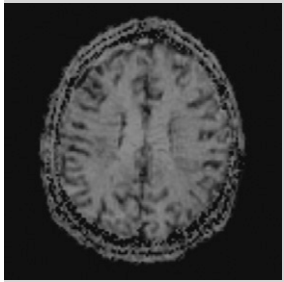
MR spectroscopy. Theoretically, the frequency display of a pure sine wave is a single spectral line at the point of the *resonance frequency*. In reality, the spectral line spreads into a blurred

peak. The cause are the spin-spin effects and the field inhomogeneity (magnet and patient).

Peak characteristics: resonance frequency (ν_0), peak height (*h*) peak width at half height (*b*) (Full Width Half Maximum FWHM), area.

Percentage of Baseline at Peak *(PBP)* ▶

Perfusion imaging. A percentage of baseline at peak image can be reconstructed for the slice. The gray scale displays the signal change relative to a basic image prior to administering contrast agent.



Perfusion imaging

MR application. Technique for evaluating organs and organ areas used frequently together with contrast agent. Areas poorly supplied with blood display a signal change over time. Examples: T1-sensitive perfusion of liver or sella lesions. T2*-sensitive perfusion of a stroke. Frequently used with *EPI* sequences.

Perfusion can be displayed without a contrast agent by using *inversion recovery*.

Peripheral angiography

MR application. MR angiography of the peripheral vascular system; has special requirements:
- arterial flow is often pulsating
- large volumes have to be measured
- images must clearly distinguish between arteries and veins

Most often, 3D gradient echo protocols with contrast agent are being used. Measurements are performed with tabletop movement in several stages. They require an optimized timing sequence.

Permanent magnet

MR components. Permanent magnets consist of large blocks of magnetic material, usually horseshoe-shaped. They have a permanent magnetic field. As a result, they do not need to be supplied with energy or cooling (maximum field strength 0.3 Tesla).

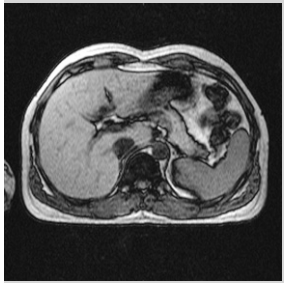
Phantom

Quality assurance. Synthetic item with known dimensions and measurement characteristics. Usually a container filled with fluid and a built-in plastic structure of various sizes and shapes.

Phantoms are used to test the system and the quality features of imaging systems.

Phase cancellation *(chemical shift)* ▶

Image quality. Fat and water protons have only slightly different *resonance frequencies*. This results in phase cycling. After an excitation pulse, the fat and water spins of a 1.0 Tesla magnet are alternatively in and out-of-phase every 3.4 ms. For this reason, the signal intensity of a voxel containing fat and water oscillates with an increasing echo time. The strength of the oscillation depends on the relative proportion of fat and water protons in the tissue. This effect occurs only with gradient echo sequences.



Phase-contrast angiography *(PCA)*

MR application. Method for displaying vascular flow. With PCA, the phase change of the spins in flowing blood induced by velocity is used to distinguish the blood from stationary tissue. Only flowing spins contribute to the signal. The blood contrast in the image is proportional to the local flow velocity.

2D and 3D PCA protocols have established *flow sensitivity* for all three spatial directions. This allows the display of various flow velocities.

Applications: slow flow, "bent" vessels with variable flow direction, overview projection images.

This technique is also the basis for flow measurements.

Phase encoding

MR measurement technique. Method for defining the rows in the *measurement matrix*. Between the RF excitation pulse and the MR readout signal, a magnetic field gradient is switched briefly, applying a phase shift to the spins from row to row. *Phase-encoding steps* are required to fully scan the slice depending on the matrix (e.g., 256 or 512). The subsequent Fourier transformation allocates the various phasings to the respective rows.

Phase-encoding gradient

MR measurement technique. Magnetic field gradient switched in the *phase-encoding* direction.

Phase-encoding step

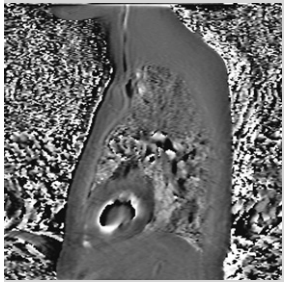
MR measurement technique. Phase encoding of an MR image requires that there are as many excitations and signal acquisitions as there are image matrix rows (e.g., 256 or 512). The amplitude of the phase-encoding gradient changes incrementally from excitation to excitation. For this reason, each row of raw data has different phase information.

Phase images ▶

Image reconstruction. In addition to regular *magnitude images*, phase images can also be reconstructed from the raw data measured.

In a magnitude image, the gray scale of a pixel corresponds to the magnitude of the MR signal at that location. In the phase image, each pixel gray scale represents the respective phasing between –180° and +180°.

Spin ensembles can be distinguished from stationary tissue in phase images. Stationary spins have the same phasing, moving spins have differing phasing depending on their velocity.



Phase oversampling

–> *Oversampling*

Phase shift

MR physics. Loss of phase coherence in precessing spins (signal reduction). In most physiological situations, vascular spins move at variable velocities. Faster flowing spins are subject to a stronger phase shift than slower flowing spins.

Physical gradients

–> Gradient coils

Physiologically controlled imaging

MR measurement technique. Physiological movements such as the heartbeat, breathing, blood flow, or fluids generally cause artifacts that make an accurate interpretation of an MR image difficult, if not impossible. Physiologically-controlled imaging suppresses these artifacts.
–> Cardiac triggering (ECG triggering, pulse triggering), respiratory triggering

Pixel

Image quality. Smallest picture element of a digital image. To display the MR image, every pixel in the image matrix contains a specific gray scale.
Pixel size = FoV / matrix size

Precession — **MR physics.** Gyration of the rotation axis of a spinning body about another line intersecting it so as to describe a cone.

Precession frequency — *–> Larmor frequency*

Presaturation — **Image quality.** Regional presaturation, frequency-selective presaturation (*fat saturation*, *water saturation*) presaturation with inversion pulses (e.g., *Dark Blood* techniques).

Regional presaturation can be used to reduce the signal from unwanted tissue. For example, to minimize artifacts caused by movement of the thorax. An additional saturation pulse is applied at the beginning of the pulse sequence to saturate the spins within the saturation slice.

The saturated region produces almost no signal and appears black in the image.

Proton density — **MR physics.** Number of hydrogen protons per unit of volume (generally: spin density).

Proton density weighting ▶

Image quality. In a proton density-weighted MR image, contrast is affected primarily by the proton density of the tissue to be displayed.

Pseudo gating

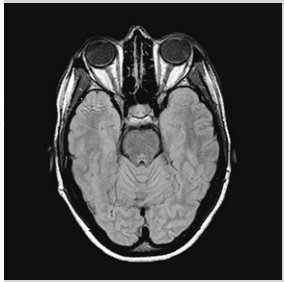
Physiologically-controlled imaging. Pseudo gating is obtained with a TR corresponding to the RR interval in the cardiac cycle. This application is *not* intended for cardiac imaging but rather for the prevention of flow artifacts (assuming a stable heart rate).

PSIF sequence

MR measurement technique. The PSIF sequence is a time-inverted *FISP* sequence. It produces a strong T2-weighted contrast in a short measurement time.

Pulse sequence

MR measurement technique. Temporal sequence of RF pulse and gradient pulse to excite the volume to be measured, generate the signal, and provide *spatial encoding*. Each pulse sequence requires a *repetition time* TR optimized for the respective contrast.



PSIF:
FISP read backward

Typical pulse sequences: spin echo, gradient echo, TurboSE, Inversion Recovery, EPI, etc.

Pulse triggering

Physiological imaging. Pulse triggering suppresses motion and flow artifacts, as a result of pulsating blood and fluid. The pulse wave obtained with, e.g., a finger sensor is used as the trigger.

Although pulse sensors are easier to apply than ECG electrodes, they are less accurate and *not* suitable for cardiac imaging.

Quadrature coil *–> CP coil*

Quality assurance Method for tuning the components and parameters of an MR system, for determining *spatial resolution*, contrast resolution, *signal-to-noise ratio*, and other quality-relevant parameters.

Quench **Super-conductive magnet.** Sudden loss of superconductivity of a magnet coil due to a local temperature increase in the magnet. The cryogen used for superconductivity evaporates rapidly, quickly reducing the magnetic field strength.

RADIANT

MR mammography. 3D reconstruction similar to ultrasound for breast imaging, generates a 360° view with the nipple as the center.

Radio frequency *(RF)*

MR physics. Frequency required to excite hydrogen nuclei to resonate. For MR, frequencies in the Megahertz range (MHz) are used, e.g., 63 MHz at 1.5 Tesla. The primary effect of RF magnetic fields on the human body is energy dissipation in the form of heat, usually on the surface of the body. Energy absorption is an important value for establishing safety thresholds.
–> Specific absorption rate (SAR)

RARE technique

MR measurement technique. Fastest Turbo spin-echo technique where a complete *echo train* of 256 or more echoes is read out after a single excitation pulse. (*Single-shot technique* TurboSE). Each echo is individually phase-encoded.

RARE:
Rapid Acquisition with Relaxation Enhancement

Raw data

MR measurement technique. The MR measurement does *not* directly obtain the image. Instead

raw data are generated that are subsequently reconstructed into an image.

Raw data filter

Measurement parameters. Raw data can be filtered prior to image reconstruction. The *Hanning filter* is provided with various weightings. The filter is able to reduce *edge oscillations*, for example.

Raw data matrix ▶

MR measurement technique. As with a hologram, every point in the raw data matrix contains part of the information for the complete image. This is why a point in the raw data matrix does not correspond to a point in the image matrix.

The rows arranged about the center of the raw data matrix determine the basic structure and contrast in the image. The outer rows of the raw data matrix provide information regarding the borders and contours of the image, detailed structures, and also determine the resolution.

Using the two-dimensional Fourier transformation, the raw data matrix is converted into the

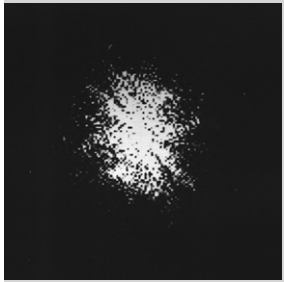


image matrix. For this reason, raw data rows are also referred to as Fourier lines.

Readout –> *Readout direction*

Readout bandwidth **Measurement parameters.** A pulse sequence's received bandwidth in the *readout direction*.

Readout direction **MR measurement technique.** The direction in which the MR signal is read out. It corresponds to the direction of *frequency encoding*.

Receiver bandwidth –> *Readout bandwidth*

Receiver tuning **MR measurement technique.** Setting of the receiver dynamic of the *analog-to-digital converter (ADC)*. This is not necessary for many modern systems with large receiver dynamic ranges.

Rectangular FoV
RecFoV **Measurement parameters.** When the object of interest is oval, a rectangular *field of view* can be

selected. This applies in particular to examinations of the abdominal and spinal regions.

The rectangular FoV can be combined with a *reduced measurement matrix*. For example, a rectangular FoV is sampled with an adjusted matrix. A rectangular image is obtained with less rows than columns.

The full resolution raw data space is sampled less densely, so resolution is not lost. Measurement time is reduced, but so is the signal-to-noise ratio.

Reduced matrix

Measurement parameters. When you select fewer lines than columns for the measurement matrix, a reduced matrix results. The high local frequencies are no longer measured. This reduces the measurement time. The lines not measured are filled with zeroes prior to image reconstruction (*zero filling*). This corresponds to an interpolation in the phase-encoding direction; therefore, a square image is still displayed on screen.

Reference image

Post-processing. Selected template for defining reconstruction methods, such as *MIP* or *MPR*.

Refocussing

–> Rephasing

Region of Interest *(RoI)*

Post-processing. An RoI is the area in the MR image singled out for evaluation.

Registration

Measurement preparation: Prior to an MR examination, each patient has to be registered. The patient data are entered, providing for a clear allocation between the patient and MR image.
Interventional imaging: Link between the "real" position and the measured data record.
Matching data from different modalities.

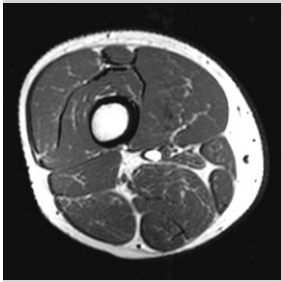
Relaxation

MR physics. Dynamic, physical process where a system returns from a state of imbalance to equilibrium.
–> Longitudinal relaxation
–> Transverse relaxation

Relief artifact ▶

Image quality. Relief-like structures along the transitions between tissue with significant differences in fat and water content (e.g., spleen, kidneys, eye sockets, spine, and spinal disks).

The cause is a *chemical shift*: the signals of the fat and water protons *in a voxel* are allocated to different image pixels during image reconstruction. At transitions of fat and water, these incorrect encodings lead to a higher signal (dark surface area) or to an invalid signal (bright areas) in the respective frequency-encoding direction.



Repetition time *(TR)*

Measurement parameters. In general, the time between two excitation pulses. Within the TR interval, signals may be acquired with one or more echo times, or one or more phase encodings (depending on the measurement technique). TR is one of the measurement parameters that determines contrast. The acquisition time (TA) is directly proportional to TR.

TR:
Time to Repetition

Rephased-Dephased

–> *Magnitude contrast angiography*

Rephasing

MR physics. Reversal from *dephasing*; the spins go back into phase. Obtained through a 180° pulse that creates a *spin echo*, or a gradient pulse in the opposite direction.

Resistive magnet

MR components. Resistive magnet. A magnet whose magnetic field is generated using a normally conductive coil system. When used with copper or aluminum conductors, this system creates a maximum field strength of 0.3 Tesla. Disadvantage: high electric costs.

Resolution

–> Image resolution

Resonance

Physics. Exchange of energy between two systems at a specific frequency. In musical instruments, for example, strings at the same pitch will resonate.

Resonance frequency

MR physics. The frequency at which resonance occurs. In MR, this frequency is used for the RF pulse that affects the spin equilibrium, that is, it matches the *Larmor frequency*.

Respiratory gating

Cardiac imaging. Synchronization of measurement with the patient's breathing. Diaphragm movement is detected with the *navigator echo*.

Respiratory triggering

Physiologically-controlled imaging. Technique for reducing respiratory artifacts. Data acquisition is synchronized to breathing. A respiratory signal acquired with suitable sensors or MR methods (*navigator echo*) is used as the *trigger signal*.

Restore sequence

MR measurement technique. The Restore sequence in T2-weighted TurboSE imaging increases the signal of substances with long relaxation times (e.g., CSF). This is realized via the use of a 90° RF pulse (so-called "Restore pulse") at the end of the *echo train* of the TurboSE sequence. This rotates the *transverse magnetization* back in the longitudinal axis, accelerating relaxation of the *longitudinal magnetization*. It allows for a shorter TR with comparable contrast as well as a reduced measurement time.

Retrospective gating

Cardiac imaging. Simultaneous acquisition of untriggered data and the ECG signal. The ECG signal is used during subsequent post-processing to assign the images to the correct phase in the cardiac cycle.

May also be used for pulsatile flow.

REVEAL

Diffusion imaging. Diffusion-weighted *single-shot technique* for differential diagnosis when evaluating lesions in the overall body, especially in the torso.

RF antenna

–> RF coils

RF:
Radio frequency

RF coils

MR components. Antennas, called coils in the language of MR, are used to send RF pulses and/or receive MR signals.

As transmitter coils, they should excite the nuclei in the volume of interest as homogeneously as possible: All nuclei should receive the same excitation.

As receiver coils, they should receive the MR signal with as little noise as possible. The sig-

nal strength depends on the volume of excitation in the coil and the distance to the object to be measured. The noise, however, depends primarily on the size of the coil.

RF pulse

–> *Excitation pulse*

RF shielding

Image quality. The radio-frequency pulses used in MR is in the radio frequency range. They have to be shielded for two reasons:

- external electromagnetic waves (e.g., radios, electrical machines) would distort the measurement and generate image artifacts
- to avoid interference with other receivers, the RF signals of the system should not extend beyond the system

RF shielding is provided by installing the magnet and receiver coils in a Faraday cage (a space that cannot be penetrated by high-frequency waves). For that purpose, the magnet room is, e.g., shielded with copper and windows are covered with electrically-conductive screens.

RF spoiling

–> *Spoiler gradient*

RF tuning

MR measurement technique. Adjustment of components prior to the measurement, usually automatic.
–> *Frequency tuning*
–> *Receiver tuning*
–> *Transmitter tuning*

Rise time

MR measurement technique. The time required by the gradient field to rise from zero to the maximum value.

Rows

MR measurement technique. The *phase-encoded* portion of the measurement matrix. Frequently, just a row in the image is displayed.
–> *Columns*

Sagittal –> *Orthogonal slices*

Saturation **MR physics.** The state in which spins have no net longitudinal or transverse magnetization. It is not possible to obtain an MR signal from saturated tissue.

Saturation recovery *(SR)* **MR measurement technique.** Technique for generating primarily T1-dependent contrast through a series of 90° excitation pulses. Immediately after the first pulse, longitudinal magnetization is zero because the tissue is saturated. The next 90° pulse is not applied until longitudinal magnetization has partially recovered (recovery).
The recovery time depends on the T1 constant of the tissue.

Saturation slice **Slice positioning.** Regional presaturation to suppress undesired signals for specific areas, either within the slice or parallel to it.
–> *Parallel saturation*
–> *Presaturation*
–> *Traveling sat*

Scan

1. Acquiring one or several MR signals after a single excitation pulse
2. Acquiring a complete raw data record

Scan time

–> *Measurement time*

Scout

–> *Basic image*

SE-CSI technique

MR spectroscopy. Hybrid procedure based on the spin-echo SVS technique.

SE-CSI:
Spin-Echo Chemical Shift Imaging

Segmented HASTE

MR measurement technique. Variant of the standard *HASTE technique*. With segmented HASTE, half the image information is acquired after the first excitation pulse, and the other half after the second excitation pulse. The raw data, acquired after the first and second excitation pulse, are then interleaved into the raw data matrix. A long repetition time TR is selected to allow the spin system to recover between excitation pulses. Any dead time can be used to excite additional slices.

HASTE:
Half-Fourier Acquisition Single-Shot TurboSE

Advantage: The length of the multi-echo pulse train is cut in half. HASTE sequences may also be divided into more than 2 segments.

Selective excitation

MR measurement technique. Limits excitation to the region selected. Magnetic field gradients are combined with a narrow band RF pulse. Selective excitation is also used with fat and water suppression. Low band RF pulses excite protons bound in fat or water.

SENSE

MR measurement technique. Image-based parallel acquisition technique (*PAT*). With SENSE, PAT reconstruction is performed after the *Fourier transformation*.

SENSE:
Sensitivity Encoding

Sensitivity

–> *MR sensitivity*

Sequence

–> *Pulse sequence*

Sequential multi-slice imaging

MR measurement technique. The slices in the area under examination are measured sequen-

tially. The slices requested are selected using suitable gradients (selective excitation).

Shielding

–> *Active shielding*
–> *Magnetic shielding*
–> *Passive shielding*
–> *RF shielding*

Shim

Quality assurance. Correction of magnetic field inhomogeneities caused by the magnet itself, ferromagnetic objects, or the patient's body. The basic shim usually involves the introduction of small iron pieces in the magnet. The patient-related fine shim is software-controlled and performed using a shim coil.
–> *Active shim*
–> *Global Shim*
–> *Interactive shim*
–> *Local shim*
–> *3D shim*

Shim coils

MR components. Coils that create weak additional magnetic fields in various spatial direc-

tions. Used to correct inhomogeneity in the main magnetic field.

Signal –> *MR signal*

Signal elimination **Image quality.** Areas in the image that do not generate a signal, that is, they are black. There are different reasons for signal elimination: Metal artifacts, *susceptibility artifacts*, *flow effects*, and saturation effects. Flow effects may occur with fast flow when using spin-echo sequences. After half the echo time, the *bolus* has flown out of the slice completely. Since it is no longer acquired by the slice selective 180° pulse, it no longer produces a spin echo: blood appears black in the image.

Signal-to-noise ratio *(SNR)* **Image quality.** Relationship between the intensity of signal and noise. Ways to improve SNR include:

- increasing the number of *averages*
- increasing the measurement volume (although spatial resolution degrades)

- using *special coils* and *local coils*
- smaller *bandwidth*
- shorter *echo time*
- thicker slice

Simultaneous excitations

MR measurement technique. Special averaging procedure that excites two slices simultaneously. This enables, e.g., more slices to be acquired in the same measurement time.

A simultaneous excitation offers the following advantages:

- shorter TR with the same number of slices, the same measurement time, and the same number of concatenations
- double the number of slices with the same *signal-to-noise ratio* at the same TR and acquisition time

Single-shot technique

MR measurement technique. All image information is acquired in a *single* pulse. The magnetization of a fully relaxed spin system is used. Each of the subsequent echoes is given a different phase encoding. Only slightly more than half

the raw data are acquired. The image is obtained through *Half-Fourier matrix* reconstruction.

Single-shot techniques include: EPI, RARE, HASTE.

Single volume spectroscopy

MR spectroscopy. SVS methods map the metabolic information from the *Volume of Interest (VoI)* in a spectrum. Single volume techniques are advantageous in case of pathological changes that cannot be spatially limited to a few VoIs: to a large extent, local magnetic field inhomogeneities can be compensated for with a "local volume-sensitive shim".

Currently, clinical ^{1}H spectroscopy uses single volume techniques based on spin echoes (SE) or stimulated echoes (STEAM).

SVS:
Single Volume Spectroscopy

Slab thickness

3D imaging. The slice thickness of a *3D slab*.

Slew rate

MR measurement technique. Gradient field increase by unit time (unit: T/m/s)
Slew rate = gradient strength/rise time

Slice — **Measurement parameters.** Thin, three-dimensional cuboid uniquely defined by slice position, FoV, and slice thickness The center plane of the slice is the image plane.

Slice boundary artifact — **Image quality.** Slice boundary artifacts are caused through signal loss at the boundaries between slices (Slab Boundary Artifact, Venetian Blind Artifact). They appear typically during conventional 3D multi-slab measurements and lead to oscillations in signal intensity and staircase phenomena along the vessels.

Slice distance — **Measurement parameters.** The separation between the center planes of two sequential slices or 3D slabs.

Slice gap — **Measurement parameters.** The gap between the nearest edges of two adjacent slices. *Not* to be confused with *slice distance*.

Slice orientation — **Measurement parameters.** Orthogonal planes are available for use as the basic slice orientation:

- sagittal
- coronal
- transverse

An oblique or double-oblique slice is obtained by rotating the slice out of the basic orientation.

Slice position

Measurement parameters. The position of the slice to be measured within the area under examination.

Slice positioning

Graphical positioning of the slices/saturation regions to be acquired in a *basic image*.

Slice selection

MR measurement technique. To display an MR image of the human body, the slice desired has to be selectively excited. For orthogonal slices, a magnetic field gradient is applied perpendicular to the desired slice plane (slice-selection gradient). Oblique and double-oblique slices are excited by simultaneously applying 2 or 3 gradient fields.

Slice sequence

Measurement parameters. For multi-slice measurements, the excitation sequence can be selected as needed:
- ascending (1, 2, 3, ..., *n*)
- descending (*n*, *n*–1, ..., 3, 2, 1)
- interleaved (1, 3, 5, ..., 2, 4, 6, ...)
- freely defined

Slice shift

Measurement parameters. Distance between the center of a slice group and the center of the magnetic field in the slice-selection direction.

Slice thickness

Measurement parameters. The thickness set for the slice to be measured. The thicker the slice, the stronger the signal and the better the *signal-to-noise ratio*. However, *spatial resolution* drops.

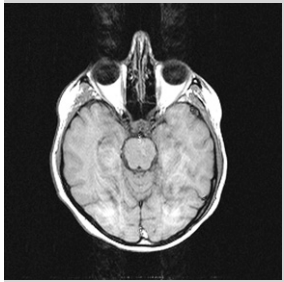
SMASH

MR measurement technique. k-space-based method of Parallel Acquisition Technique (*PAT*) With SMASH, PAT reconstruction is performed prior to the *Fourier transformation*.

SMASH:
Simultaneous Acquisition of Spatial Harmonics

Smearing artifact ▶

Image quality. In the case of non-periodic movements, such as eye movement, the excited spins may be at a different location in the gradient field at the time of the echo. This results in incorrect phase encoding. This smears the object in the phase-encoding direction. These artifacts are more discrete for periodic movements (respiration, blood flow).



SPACE

MR measurement technique. SPACE is a variant of the 3D Turbo spin echo. As compared to a conventional *TurboSE* sequence, SPACE uses non-selective, short refocussing pulse trains that consist of RF pulses with variable *flip angles*. This allows for very high *turbo factors* (> 100) and high sampling efficiency. The results are high-resolution, isotropic images that allow for free reformatting on all levels.

SPAIR

MR measurement technique. Robust *fat saturation* for body imaging due to a frequency-selective inversion pulse. The SPAIR technique is an

SPAIR:
Spectrally Adiabatic Inversion Recovery

alternative for conventional spectral fat saturation and water excitation.

Spatial encoding

MR measurement technique. Definition of position and orientation of a slice via the *frequency* and *phase-encoding gradient*. The location of MR signals is encoded and reconstructed in subsequent image computations.

Spatial resolution

Image quality. To acquire an image with full spatial resolution, the *FoV*, the *measurement matrix* and the *slice thickness* have to be considered as well. It is characterized by the voxel size. The smaller the *voxel*, the higher the spatial resolution and the lower the signal measured.

Special coil

–> Local coils

Specific absorption rate *(SAR)*

Safety. The RF energy absorbed per time unit and per kilogram. Absorption of RF energy can result in warming of the body. Energy absorption is an important value for establishing safety thresholds.

Unauthorized high local concentrations of RF energy can result in burns (local SAR). When the RF energy is uniformly distributed, safety thresholds have to be observed to avoid thermoregulation or cardiac stress (whole-body SAR).

Remedies: other RF pulses, smaller flip angles, lower TR, fewer slices.

Spectral map

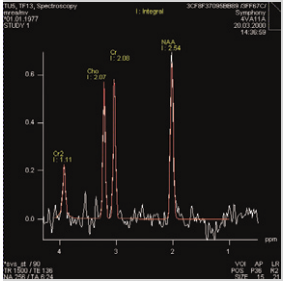
MR spectroscopy. Mapping of a CSI spectral matrix to an anatomical image. It shows the regional changes in metabolites as superimposed contours.

Spectroscopy

–> *MR spectroscopy*

Spectrum ▶

MR spectroscopy. The frequency plot of the MR signal. The signal intensity is displayed as a function of the *chemical shift*. Nuclei with different *resonance frequencies* appear as separate *peaks* in the spectrum.



Spin

–> *Nuclear spin*

Spin density –> *Proton density*

Spin-echo *(SE)* **MR measurement technique.** The reappearance of an MR signal after the decay of the FID signal. Dephasing of the spins (decay in transverse magnetization) is offset through the application of a 180° inversion pulse. The spins rephase, producing the spin echo at time TE (echo time).

T2* effects (field inhomogeneity, susceptibility) are reversed but *not* T2 effects.

Spin-echo sequence **MR measurement technique.** The sequence of an excitation pulse (90°) and refocusing pulse (180°) produces a *spin echo*. Can be used to generate strong T2-weighted images.

Spin-lattice relaxation –> *Longitudinal relaxation*

Spin-spin coupling **MR spectroscopy.** Interaction between MR sensitive nuclei in a molecule, resulting in additional splitting of *peaks* in the spectrum.

Spin-spin relaxation –> *Transverse relaxation*

Spoiler gradient **MR measurement technique.** Gradient pulse with sufficient amplitude and/or duration to completely *dephase* the transverse magnetization. The spoiler gradient is applied after the echo so that transverse magnetization is destroyed prior to the next excitation pulse.
Used for *presaturation* and *FLASH sequences*.

SSD –> *Surface shaded display*

STEAM technique **MR spectroscopy.** Single volume method. With the STEAM pulse sequence, 3 slice-selective 90° pulses generate a stimulated echo.

STEAM:
Stimulated Echo Acquisition Method

Stimulation **Safety.** The magnetic field changes quickly when switching high-field gradients. If the electrical fields generated exceed a specific threshold, electrical currents can be induced in the patient's body.

The currents may lead to peripheral nerve stimulation for the patient that may be considered uncomfortable.

This is an important value for establishing safety limits.

STIR sequence

MR measurement technique. *Inversion recovery* sequence with a short inversion time TI, used for *fat suppression*. TI selection depends on the field strength.

STIR:
Short TI Inversion Recovery

Stray field

Safety. Magnetic field outside the magnet that does not contribute to imaging. A specific distance has to be kept between the field and various devices and patients with cardiac pacemakers (e.g., 0.5 mT line).

The stray field is low with *permanent magnets* because the system is largely self-shielding.

Stripe tagging

–> Tagging

Superconductive magnet

MR components. An electromagnet whose strong magnetic field (typically at least 0.5 T) is

generated using superconductive coils. The conductive wires of the coils are made of a cryogenically cooled Niobium Titanium alloy. Liquid helium is used as the cryogen or liquid nitrogen for pre-cooling.

Superconductivity

Physics. Material characteristic of various alloys, which at very low temperatures (close to absolute zero) results in a complete loss of electrical resistance. Electrical current can then flow without loss.

Surface coil

MR components. Special RF receiver coil positioned close to the body to acquire signal from nearby regions. Compared to the *body coil*, the RF receiver coil has a better signal-to-noise ratio and higher spatial resolution. Surface coils can also be used for simple localization in MR spectroscopy.

Surface shaded display *(SSD)*

Post-processing. Three-dimensional display of surfaces via variable threshold values, of e.g., contrast-enhanced vessels.

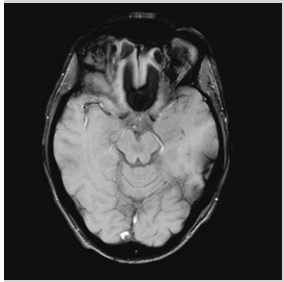
Susceptibility ***(Magnetizability)***

Physics. Measure for the ability of a material or tissue to be magnetized in an external magnetic field.

Susceptibility artifact ▶

Image quality. Local magnetic field gradients are produced in all transitions between tissues of differing magnetic susceptibility. In transitions between tissue and air-filled spaces (e.g., the temporal bone), areas may be present that show reduced signal or no signal at all.

The effect is stronger with gradient echo sequences, in particular EPI.

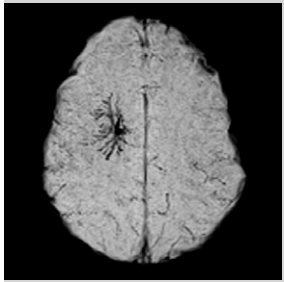


Susceptibility contrast

Image quality. T2* contrast

Susceptibility-weighted imaging ***(SWI)*** ▶

MR measurement technique. Susceptibility-weighted imaging displays venous vessels as well as hemorrhages in the human brain. The SWI technique reacts with sensitivity to local changes in magnetic fields caused by desoxygenated blood or local iron deposits.



SVS method

–> Single volume spectroscopy

Swap –> *Gradient swap*

SWI –> *Susceptibility-weighted imaging (SWI)*

syngo Common imaging software for all Siemens modalities.

***syngo* BEAT** –> *BEAT*

***syngo* BLADE** –> *BLADE*

***syngo* BRACE** –> *BRACE*

***syngo* GRACE** –> *GRACE*

***syngo* MR** MR-specific *syngo* application.

***syngo* NATIVE** –> *NATIVE*

***syngo* REVEAL** –> *REVEAL*

***syngo* SPACE** –> *SPACE*

***syngo* TimCT** –> *TimCT*

***syngo* TWIST** –> *TWIST*

***syngo* VIEWS** –> *VIEWS*

Tagging

Grid tagging: Grid of saturation lines across cardiac MR images. Used to view myocardial motion.
Stripe tagging: Parallel stripes in the MR image; used to view myocardial motion in primary axis view or four-chamber view.

Targeted MIP

–> Localized MIP

Tesla *(T)*

MR physics. SI unit for magnetic field strength. Approximately 20,000 times as strong as the earth's magnetic field (1 Tesla = 10000 *Gauss*).

Tim (Total imaging matrix)

MR components. The Tim matrix concept allows for whole-body examinations with an FoV of up to 205 cm without repositioning the patient. Prerequisites for Tim: *matrix coils* in combination with RF receiver channels.
Example: Tim [76 × 32]: Tim system up to 76 coil elements and 32 RF channels

TimCT

MR measurement technique. TimCT (Continuous table move) enables measurements of large

examination regions with continuous table move, that is, in one examination step without measurement pauses or repositioning the table "MR as easy as CT". Continuous scanning in the *isocenter* of the magnet provides for highest image quality and avoids *slice boundary artifacts* with *multi-levels*.

Time-of-flight angiography *(ToF)*

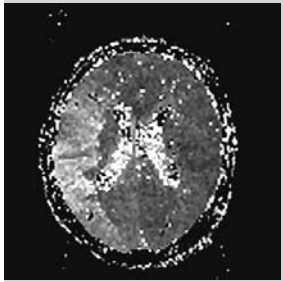
MR angiography. The time-of-flight angiography (inflow angiography) visualizes vessels through the flow of non-saturated, fully relaxed blood into the slice which generates a high signal. By comparison, stationary spins are partially saturated and generate a relatively low signal intensity.
–> Inflow amplification

Time series *(TS)*

Perfusion imaging. The obtained T2* images are labeled with number and time position in the series. They maybe used in *Cine* and for statistical evaluations.

Time-to-Peak map *(TTP)* ▶

Perfusion imaging. A TTP map shows the regional distribution of the time needed to the minimum perfusion signal, either in gray scale or color-coded. It is generated for every slice measured.



TIR sequence

–> *Turbo inversion recovery*

TIRM sequence

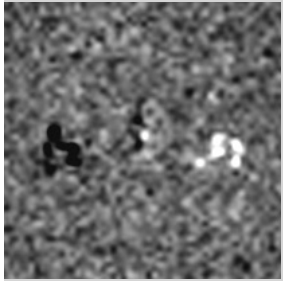
–> *Turbo inversion recovery magnitude*

Tissue contrast

–> *Contrast*

t-map ▶

BOLD imaging. When evaluated with the *t-test*, the t-map shows the measurement data of *BOLD imaging* as strictly functional information. Positive correlations located between stimulation and active brain areals are shown as bright, negative correlates are shown as dark.



ToF-Angio

–> *Time-of-flight angiography*

TONE technique

MR measurement technique. TONE is used for ToF angiography to minimize the saturation effects as blood flows through a 3D volume. An RF pulse with a tilted slab profile compensates for the velocity and direction of blood flow. This generates a flip angle that varies from partition to partition.

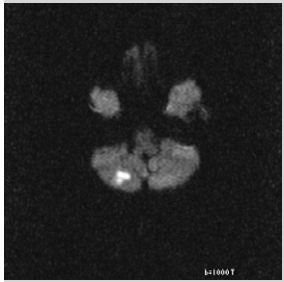
TONE:
Tilted, Optimized,
Nonsaturating Excitation

Total imaging matrix

–> *Tim*

Trace image ▶

Diffusion imaging. In Trace images contrast is generated by the direction of the diffusion tensor. This corresponds to the sum of diagonal elements (trace) of the diffusion tensors:
Trace = $D_{xx} + D_{yy} + D_{zz}$



Transmission bandwidth

MR measurement technique. The frequency range stimulated by the *excitation pulse* in a sequence.

Transmitter tuning

MR measurement technique. Setting the transmission power of the RF pulse (*flip angle*).

Transverse —> *Orthogonal slices*

Transverse magnetization (M_{xy}) **MR physics.** Transverse magnetization M_{xy} is the component of the macroscopic magnetization vector in the xy-plane; that is, oriented perpendicular to the applied magnetic field.

The precession of transverse magnetization induces electrical voltage in a receiver coil that changes over time. The temporal progression of this voltage is the MR signal. After RF excitation, M_{xy} decays to zero at time constant T2 (ideal) or T2* (real).

Transverse relaxation **MR physics.** Decay of transverse magnetization through the loss of phase coherence between precessing spins (due to spin exchange); is also known as spin-spin relaxation.

Transverse relaxation time —> *T2 constant*

Traveling sat **Slice positioning.** A presaturation pulse is applied to one side of the slice to reduce the sig-

nal intensity of spins (typically blood) that are about to flow into this side of the slice. This enables arteries or veins to be displayed selectively, since the flow is often in the opposite direction (e.g., carotid artery and jugular vein).

The slices are measured sequentially (slice-by-slice). The presaturation pulse retains its position relative to the slice.

Trigger

Physiologically-controlled imaging. Reference point in the physiological signal which releases the scan, e.g., the R wave in the ECG signal.

Trigger delay time *(TD)*

ECG triggering. Interval between the trigger and release of the measurement.

Trigger signal

Physiologically-controlled imaging. Physiological signal (ECG signal, finger pulse or respiratory curve) that starts or restarts data acquisition.

TrueFISP

MR measurement technique. The TrueFISP gradient echo sequence provides the highest signal of all steady state sequences. The contrast is a

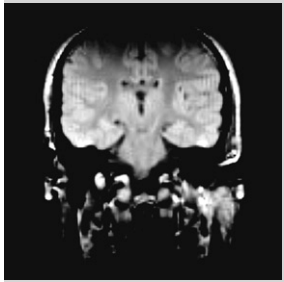
function of T1/T2. However, with a short TR and a short TE, the T1 portion remains constant. The images are primarily T2-weighted.

The FISP and PSIF signal are generated simultaneously. Due to the superposition of both signals, TrueFISP is sensitive to the inhomogeneities in the magnetic field. The images may contain interference stripes. For this reason, TR should be as short as possible, and a shim has to be performed.

Truncation artifact ▶

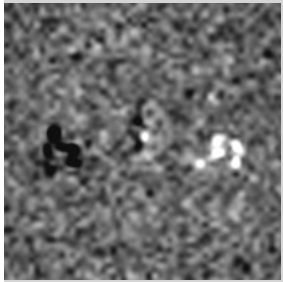
Image quality. MR images frequently show periodic oscillations parallel to tissue transitions. The artifacts show bands with alternating high and lower signal intensity. All abrupt transitions in tissue are subject to this effect.

The artifact is created through point-by-point sampling of the analog signal. Theoretically, an infinite number of points would have to be sampled. In practical application, however, there is a finite number of points: the data are truncated.



t-test ▶

BOLD imaging. Statistical evaluation method for *BOLD* measurements (previously Z-score). Is used to compute the differential image from the mean values of action and non-action images. Today, the t-test is integrated into *GLM*.



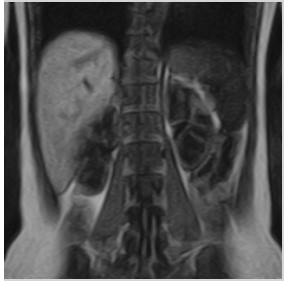
Turbo factor

Measurement parameters. Measurement time saved using a TurboSE sequence rather than a conventional spin-echo sequence.

Example: At a turbo factor of 7, the TurboSE sequence measures 7 times faster than a SE sequence with comparable parameters.

TurboFLASH ▶

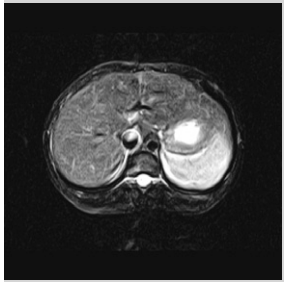
MR measurement technique. With a Turbo-FLASH sequence, the entire raw data matrix is measured in one acquisition only with an ultra-fast gradient echo sequence. The image contrast is modified via preparation pulses.



Turbo gradient spin echo ▶ *(TurboGSE)*

MR measurement technique. With TurboGSE, additional gradient echoes are generated before and after each spin echo. The spin echoes are allocated to the center of the raw data matrix to give pure T2 contrast. The gradient echoes are allocated to the outer segments. A pure T2 contrast is obtained by filling these segments. Gradient echoes determine mainly the image resolution.

Advantages as compared to TurboSE: they are faster, fat is darker, greater sensitivity to susceptibility effects (e.g., bleeding with hemosiderin).



Turbo inversion recovery *(TurboIR, TIR)*

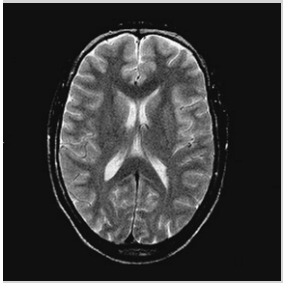
MR measurement technique. TurboSE sequence with long TE_{eff} to suppress fluids. The TurboIR sequence allows for a true inversion recovery display that shows the arithmetic sign of the signal.

Turbo inversion recovery magnitude *(TIRM)*

MR measurement technique. Identical to TurboIR, however, with the magnitude image of the signal and appropriate display.

Turbo MR angiography

MR angiography. Fast 3D angio techniques; increases speed by a factor of 2 using *zero filling*, short TR and TE and interpolation techniques in the slice-selection direction.



Turbo spin echo *(TurboSE, TSE)* ▶

MR measurement technique. TurboSE is a fast multi-echo sequence. Each echo of a pulse train includes a different phase encoding. Within one repetition time TR, raw data rows equal to the number of pulse train echoes are acquired (segmented raw data).
The *turbo factor* increases speed, and is frequently used to improve resolution.

TWIST

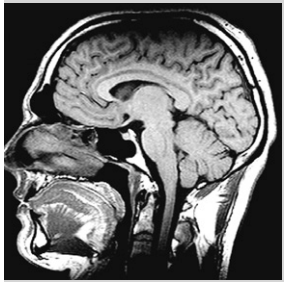
MR measurement technique. The TWIST method shortens the measurement time for angiographic examinations even further at high image quality. This is obtained through an irregular sampling of the raw data lines: the center lines increase the sampling rate considerably, increasing the temporal resolution of images. Bolus timing is not required with TWIST. Also consumption of contrast agent is reduced.

T1 constant
(Longitudinal relaxation time)

MR physics. Tissue-specific time constant which describes the return of the longitudinal magnetization to equilibrium. After time T1, the longitudinal magnetization grows back to approx. 63 % of its end value. A tissue parameter that determines contrast.

T1 contrast ▶

Image quality. The contrast of a T1-weighted image depends primarily on the various T1 time constants of the different tissue types.

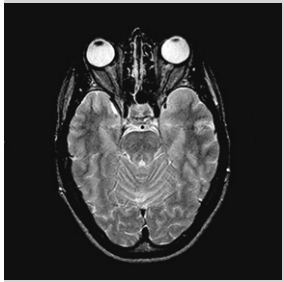


T2 constant
(Transverse relaxation time)

MR physics. Tissue-specific time constant that describes the decay of transverse magnetization in an ideal homogeneous magnetic field. After time T2, transverse magnetization has lost 63 % of its original value. A tissue parameter that determines contrast.

T2 contrast ▶

Image quality. The contrast of a T2-weighted image depends primarily on the various T2 time constants of the different tissue types.



T2* constant

MR physics. Characteristic time constant that describes the decay of transverse magnetization, taking into account the inhomogeneity in static magnetic fields and the human body. T2* is always less than T2.

UTE

MR measurement technique. Pulse sequences with *echo times* (TE) that are 10–200 shorter than the conventional ones. This allows for the display of tissue components with a short T2 (e.g., membranes, compact bone substance) that could appear as dark only due to their small signal portion.

UTE:
Ultrashort TE

venc value –> *Flow sensitivity*

venc:
velocity encoding

Venetian blind artifact –> *Slice boundary artifact*

VERSE **MR measurement technique.** Sequences with time-optimized VERSE pulses improve the slice profile for 3D measurements. This allows for the accelerated 3D imaging of limited volumes with a consistent image contrast across the entire *3D slab*.

VERSE:
Variable-Rate Selective Excitation

VIBE sequence **MR measurement technique.** For reducing the acquisition time. 3D acquisition with a reduced number of slices using interpolation and/or partial Fourier techniques, primarily for dynamic contrast-enhanced examinations of the abdomen.

VIBE:
Volume Interpolated Breathhold Examination

VIEWS **MR mammography.** Bilateral 3D measurement technique for the breast with fat saturation or water stimulation.

VIEWS:
Volume Imaging with Enhanced Water Signal

Volume of Interest *(VoI)*

MR spectroscopy. A VoI is the volume used for measurements or evaluations.

For SVS or hybrid CSI procedures, VoI means the measurement volume that supplies the signal. For SVS, VoI and voxel are identical, but for hybrid CSI the VoI is divided into *voxels*.

Volume rendering technique

–> 3D VRT

Voxel

Imaging. Volume element of the sample to be examined.
Voxel size = slice thickness × pixel size
–> Spatial resolution

Voxel bleeding

MR spectroscopy. Voxel bleeding indicates *cross talk* of signal intensities from one voxel to an adjacent voxel. Up to 10 % of a signal can appear in an adjacent voxel. These localization artifacts tend to appear in the image during intensity tests. It is reduced by an apodization filter (e.g., Hanning filter).

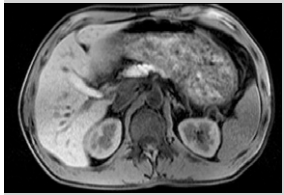
VRT *3D VRT*

Washout effect

Image quality. The washout effect can appear perpendicular to the image plane during fast flow. It occurs during spin-echo imaging and similar procedures. Using a 90° pulse, a bolus is excited within the slice to be measured. If blood flows out of the slice before the subsequent 180° pulse, some or all of the signal is lost. This results in a low signal or no signal at all.

Water image ▶

A pure water image only displays the signal from water protons in the image and suppresses the signal from fat protons. Is generated with the *Dixon* technique, for example.



Water saturation

Image quality. Frequency-selective excitation of water, with subsequent dephasing, is used to suppress water signals. This technique is used for MR imaging and spectroscopy.

Water suppression

–> *Dark-fluid imaging (FLAIR)*
–> *Water saturation*

Whisper

–> *Whisper sequences*

Whisper sequences **MR measurement technique.** Sequences with low-noise gradient pulses.

Width *–> Windowing*

Windowing **Image display.** Settings for brightness (center) and contrast (width) in the MR image.

Wrap-around *–> Aliasing artifact*

Zero filling — **MR measurement technique.** Interpolation technique for expanding a *raw data matrix* with zeroes.

ZIP technique — **Image reconstruction.** Interpolation technique in the slice-selection direction for 3D measurements. Enables the reconstruction of thinner slices.

Z-score — *–> t-test*

1D PACE

MR measurement technique. Fast motion correction in real time, for example, during cardiac imaging. This *PACE* technique allows the patient to breathe freely during the measurement.

2D PACE

MR measurement technique. The *PACE* technique used in abdominal imaging is based on a local 2D test image for motion detection.

3D imaging

MR measurement technique. In 3D imaging the entire measurement volume, the 3D slab, is stimulated and not just single slices. Additional phase encoding in the slice-selection direction provides information in this direction.

3D PACE

MR measurement technique. Fully automatic technique for motion detection and correction during *BOLD measurements*. Serves to eliminate motion artifacts.

3D PACE corrects 6 degrees of freedom (3 translations and 3 rotations) in real time.

PACE:
Prospective Acquisition Correction

3D shim

Quality assurance. 3D shim enables the shim volume to be limited (*local shim*). A 3D volume (VoI) is defined. The local magnetic field distribution is determined in this volume, resulting in the calculation of the shim currents.

A 3D shim provides for a more precise result than a MAP shim and therefore for a better fat saturation. For spectroscopy, it provides a better starting value for the interactive shim.

3D slab

Measurement parameters. Measurement volume stimulated for 3D imaging. The 3D slab is divided into *partitions*.

3D TurboSE

MR measurement technique. As a 3D sequence, TurboSE allows for the acquisition of T2 images with thin slices and practically uniform voxels.

3D VRT

Post-processing. 3D display for well-defined imaging of complex anatomies and anatomic relationships, e.g., in contrast angiography. In

VRT:
Volume Rendering Technique

addition to color images, a threshold-based segmentation of 3D objects is possible.

Abbreviations

ADC	Analog-to-Digital Converter
ADC	Apparent Diffusion Coefficient
ART	Advanced Retrospective Technique
AS	Active Shielding
ASL	Arterial Spin Labeling
b	b-value
B	Magnetic induction, MR: Magnetic field
BRACE	Breast Acquisition Correction
B_0	Main magnetic field
B_1	Alternating magnetic field
CE MRA	Contrast-Enhanced MR Angiography
CM	Contrast agent
CNR	Contrast-to-Noise Ratio
CP	Circular Polarization
CSF	Cerebro-Spinal Fluid, Liquor
CSI	Chemical Shift Imaging
dB/dt	Temporal change of he magnetic field
DTI	Diffusion Tensor Imaging
EPI	Echo-Planar Imaging
FA	Flip Angle
FA	Fractional Anisotropy
FFT	Fourier Transformation
FID	Free Induction Decay

Abbreviations

FLAIR	Fluid Attenuated Inversion Recovery
fMRI	Functional Magnetic Resonance Imaging
FoV	Field of View
FT	Fourier Transformation
FWHM	Full-Width at Half-Maximum (Peak)
GBP	Global Bolus Plot
GLM	General Linear Model
GMR	Gradient Motion Rephasing, flow compensation
GRACE	Generalized Breast Spectroscopy Exam
GRAPPA	Generalized Autocalibrating Partially Parallel Acquisition
GRE	Gradient Echo
GSP	Graphical Slice Positioning
Hz	Hertz
IPA	Integrated Panoramic Array
iPAT	Integrated Parallel Acquisition Techniques
IPP	Integrated Panoramic Positioning
IR	Inversion Recovery
IRM	inversion Recovery Magnitude
LP	Linear Polarization
MDDW	Multi-Directional Diffusion Weighting
MIP	Maximum Intensity Projection
MPPS	Modality Performed Procedure Step

Abbreviations

MPR	Multi-Planar Reconstruction
MR	Magnetic Resonance
MRA	MR Angiography
MRI	Magnetic Resonance Imaging
MRS	MR Spectroscopy
mSENSE	Modified Sensitivity Encoding
MTC	Magnetization Transfer Contrast
mT/m	Millitesla per meter
MTT	Mean Transit Time
M_{xy}	Transverse magnetization
M_Z	Longitudinal magnetization
NMR	Nuclear Magnetic Resonance
PACE	Prospective Acquisition Correction
PAT	Parallel Acquisition Techniques
PBP	Percentage of Baseline at Peak
PCA	Phase-Contrast Angiography
ppm	Parts per million
RARE	Rapid Acquisition with Relaxation Enhancement
RF	Radio Frequency
RoI	Region of Interest
SAR	Specific Absorption Rate
SE	Spin-Echo
SENSE	Sensitivity Encoding

Abbreviations

SI	Système Internationale
SLINKY	Sliding Interleaved k_y
SMASH	Simultaneous Acquisition of Spatial Harmonics
SNR	Signal-to-Noise Ratio
SPAIR	Spectrally Adiabatic Inversion Recovery
SPIDER	Steady-State Projection Imaging with Dynamic Echo-Train Readout
SR	Saturation Recovery
SSD	Surface Shaded Display
SVS	Single Volume Spectroscopy
SWI	Susceptibility-Weighted Imaging
T	Tesla
TA	Acquisition time
TD	Delay time
TE	Echo time
TE_{eff}	Effective echo time
TGSE	Turbo Gradient Spin-Echo
TI	Inversion time
Tim	Total imaging matrix
TimCT	Tim Continuous Table move
TIR	Turbo Inversion Recovery
TIRM	Turbo Inversion Recovery Magnitude
TR	Repetition time

Abbreviations

TR_{eff}	Effective repetition time
TSE	Turbo Spin-Echo (TurboSE)
TTP	Time To Peak
UTE	Ultrashort TE
venc	Velocity encoding
VERSE	Variable-Rate Selective Excitation
VIBE	Volume Interpolated Breathhold Examination
VIEWS	Volume Imaging with Enhanced Water Signal
VoI	Volume of Interest
VRT	Volume Rendering Technique

Change requests for the MR Glossary

Please send your suggestions per e-mail
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Suggestions

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