Basics of MR Imaging

The bed rotates from Upright to Recumbent, stopping at any angle in between.

Sagittal T2 WI of the lumbar spine with the patient supine position (left) and sagittal T2 WIs of the same patient in the erect position (right) Note the marked narrowing of the spinal canal in the erect film denoting marked spinal instability.

Patient with Low Back Pain After Surgery
MRI advantages
- Superior soft tissue contrast
- Multiplanar imaging capability
- Absence of artifact from bone
- Tissue characterization based on signal behavior

Surface coils
The surface coils are designed to be as close as possible to the examined area. This ensures better resolution of the images with adequate adjustment of the field of view.

Knee surface coil

Absolute contra-indications to MRI
- Cardiac pace maker
- Intra-cranial aneurysmal clipping
- Intraocular metallic FB
Relative contra-indications to MRI
Ferro- magnetic metallic objects [wheel chair, trolley,...]  
Metallic internal fixation devices [nails, screws, plates,..]  
Artificial valves and internal stents are no more contraindications for MRI

How are MR images produced?
Images are created by the interaction between the external magnet in the machine and the internal magnet in the human body
The targeted internal magnet in the human body is the hydrogen proton because of its widespread availability throughout the tissues (about 80% of the human body is made of water molecules)

The MR images are obtained by applying radiofrequency (RF) waves having the same frequency of vibration similar to the hydrogen proton. This will make these protons to move. This movement is utilized by the MR machine to produce the image.

So that:
Non mobile protons will give no image, they appear black  
If there is no enough protons as in air which contains minimal hydrogen, then there will be no image as well.
Non mobile hydrogen protons are present in the following sites:

- Cortical bone
- Mature fibrous tissue [ligaments and tendons in the body]
- Calcifications

These structures will normally appear black in all MR images.

Sagittal MR images for the knee joint showing the cortex of the femur and tibia as well as the cruciate ligaments (arrows) as black lines because they contain non mobile hydrogen protons.

Fluids as [CSF, effusion, ascites, urine, vitreous, ...] will appear black in the T1 and bright in the T2 weighted images.

Axial MR brain images showing the CSF in the ventricles of low signal (black) in the T1 weighted image (left), while the vitreous humor and CSF in the 4th ventricle appear of high signal (bright) in the T2 weighted image (right).
- Fat [subcutaneous fat, bone marrow, dermoid cyst, ...] will appear bright in the T1 weighted images and black in T2 weighted images.

![Sagittal MR images of the knee showing the bone marrow fat of bright signal (white) in the T1 weighted image (left) and of dark signal in the T2 weighted image (right). The arrow points to an abnormality in the patellar tendon which is not black in the T2 weighted image.]

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**Minimal hydrogen [air]**

Air in the paranasal sinuses as well as in the lung appears black because it contains minimal hydrogen protons.

![Axial MR image showing black maxillary sinuses containing air.]

The resultant MR image depends on
The presence of adequate amount of hydrogen protons that are mobile

![Diagram of H, Motion, and Amount]

- Minimal hydrogen [air] → no signal = black
- Non mobile hydrogen [cortical bone] → no signal = black

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**Minimal hydrogen [air]**

- Air in the sinuses
- Air in the lungs

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**MR angiography MRA**

- Normal MRA of the Circle of Wilis
MR pancreatco-cholangiography **MRCP**

MR cholangiography showing multiple stones in the CBD as well as in the gall bladder

MR urography **MRU**

MR urography showing normal appearance of both pelvicalyceal systems, uretes and urinary bladder

MR Myelography **MRM**

MR myelography showing normal findings