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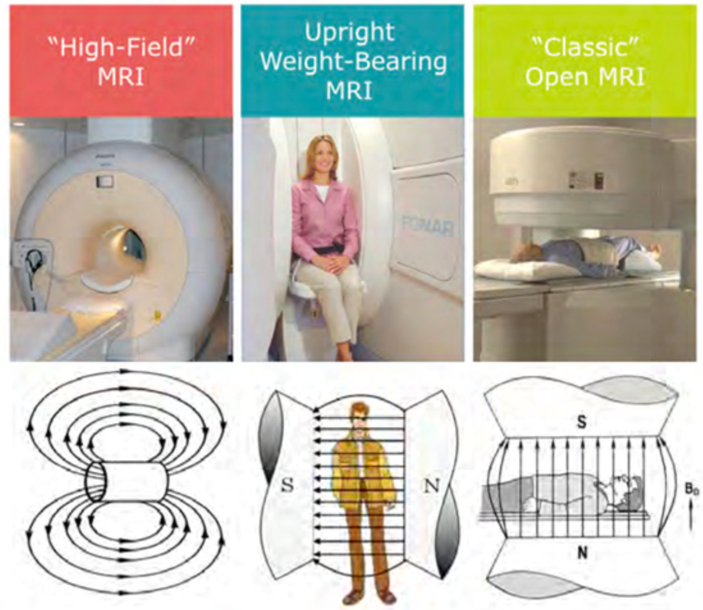
Misunderstanding Field Strength

It is a commonly accepted myth that there are just two types of MRI scanners:

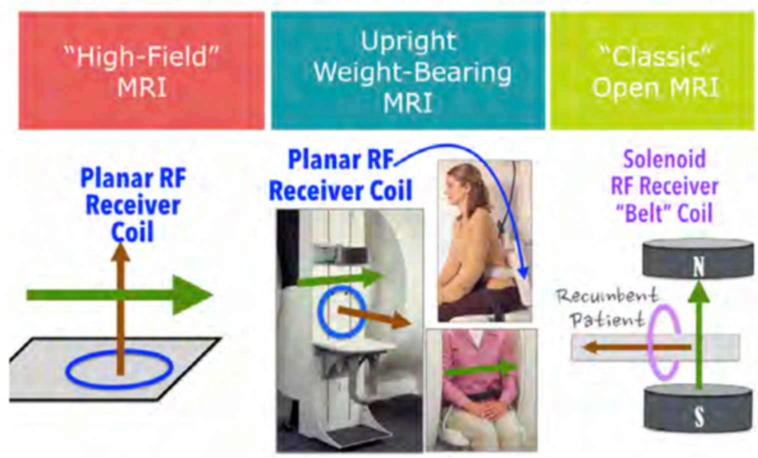
- **High-Field MRIs** that are considered to be the "standard' magnets with the best image quality. They operate at 1.5 Tesla or 3.0 Tesla. Their cylindrical configuration yields a magnet that resembles a tube with its horizontal magnetic field parallel to the longitudinal axis of the patient lying down in the magnet.

- **"Classic" Open MRIs** that are perceived to be be useful only for claustrophobic patients, with reduced spatial & temporal image resolution, longer scan times and the limitation that they don't do anything clinically valuable that the high-field MRIs don't already do. In this configuration with two horizontal magnetic poles, the patient can extend their arms and see out the sides while recumbent in the vertical magnetic field. Low-field Open MRIs operating at magnetic field strengths between 0.2T and 0.35T proliferated over many years so often physicians are unaware of technology advances in the late 1990s that resulted in higher field strength Open MRIs operating at 0.6T, 0.7T, 1.0T and even 1.2T.



It is also generally unappreciated that there are significant advantages in reconfiguring the "classic" Open MRI magnet design to feature the vertical magnetic poles characteristic of FONAR's **0.6 Tesla Upright MRI**. This MRI, with a horizontal transaxial magnetic field, can use flat planar RF receiver coils to image the spine just like the 1.5 & 3.0 Tesla high-field MRI systems. Since Open MRI systems utilize a vertical magnetic field, they cannot do this ... so the Upright MRI is dramatically different than an Open MRI. This is simply a consequence of the physics of MRI that requires the axis of symmetry of the RF receiver coil to be perpendicular to the direction of the main magnetic field. A patient scanned in the Upright MRI can sit comfortably with her back against the planar RF receiver coil. This will also work with the patient recumbent. As the choice of the RF receiver coil has a direct impact on image quality, the Upright MRI has a competitive edge over all the Open MRIs. In fact if one defines an Open MRI as a magnet that cannot use a flat planar RF receiver coil to image the spine, then the Upright MRI is not an Open MRI.

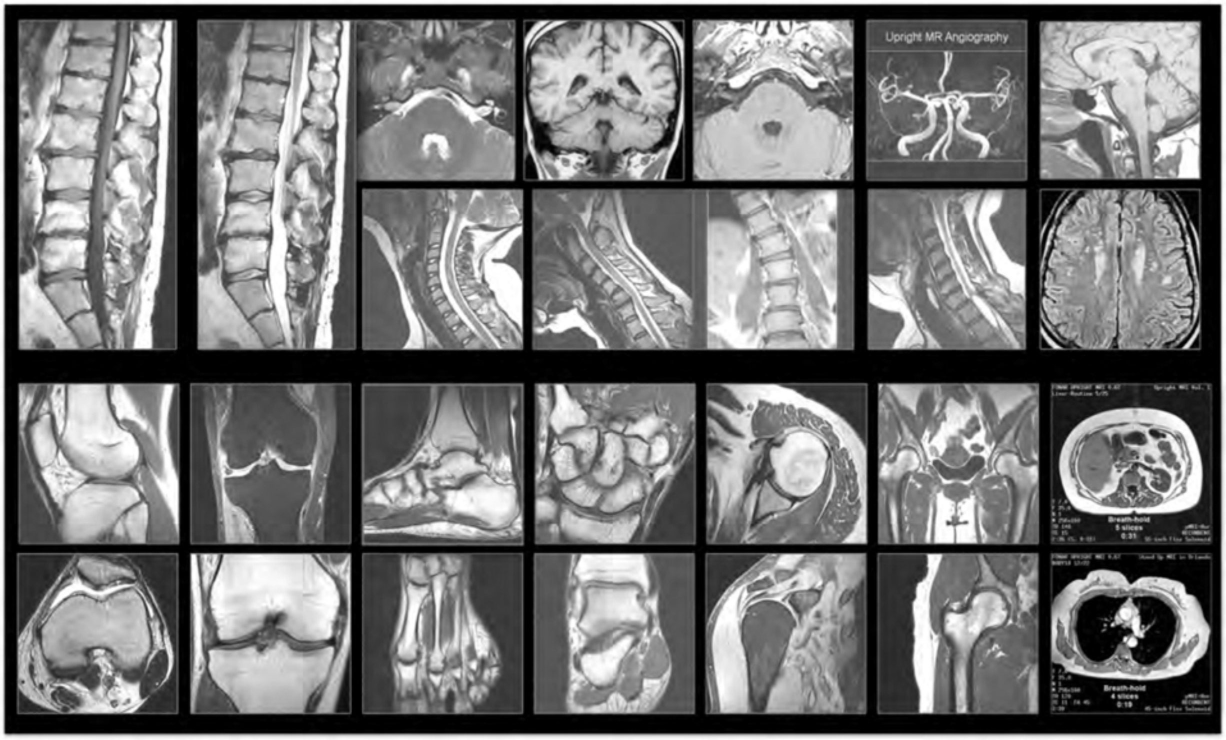
Rule of MRI: The **axis of symmetry** of the **RF receiver coil** should be perpendicular to the direction of the **main magnetic field**



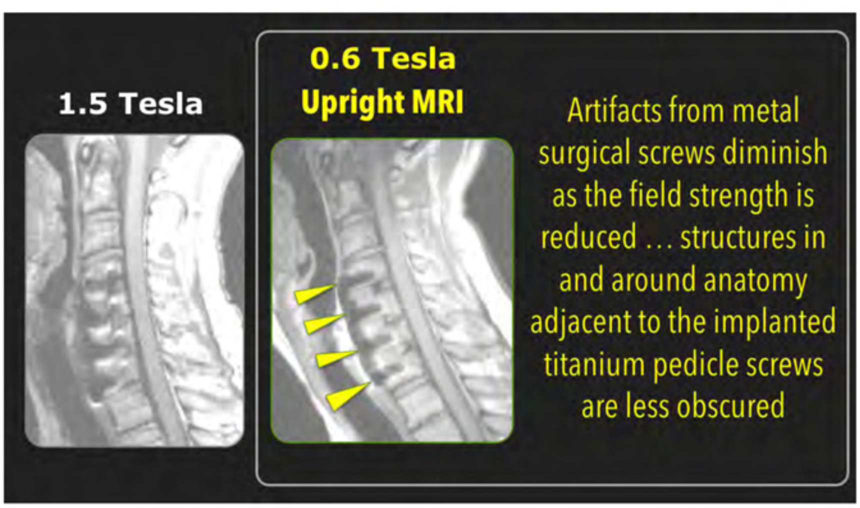
Which RF Receiver Coil is compatible with which type of MRI?

Magnet ↓ / RF Coil →	Planar (flat)	Solenoid ("belt")
High-Field MRI	✓	
Open MRI		✓
Upright *Weight-Bearing* MRI	✓	✓

Is the 0.6 Tesla field strength sufficient for acquiring high quality images? Yes it is. The Upright MRI's magnetic field strength is two to three times stronger than that of many Open MRIs still in operation today. Their improved image resolution is directly tied to the image signal-to-noise which is well known to increase as the magnetic field strength is raised.



There is also a competitive advantage that relates to reducing image artifacts arising from metal implants such as surgical screws. It is well known that such artifacts get smaller as the MRI magnet's field strength is reduced, so the anatomy adjacent to implanted hardware will be less obscured with the Upright MRI. This is particularly valuable for surgeons referring their postoperative patients for diagnostic imaging studies. In addition, image artifacts from physiological motion are similarly reduced relative to the higher field systems; note the area anterior to the spine in the kyphosis patients scanned sitting upright (since it is difficult for them to be scanned lying down).



Severe Kyphosis
Patients unable to lay down

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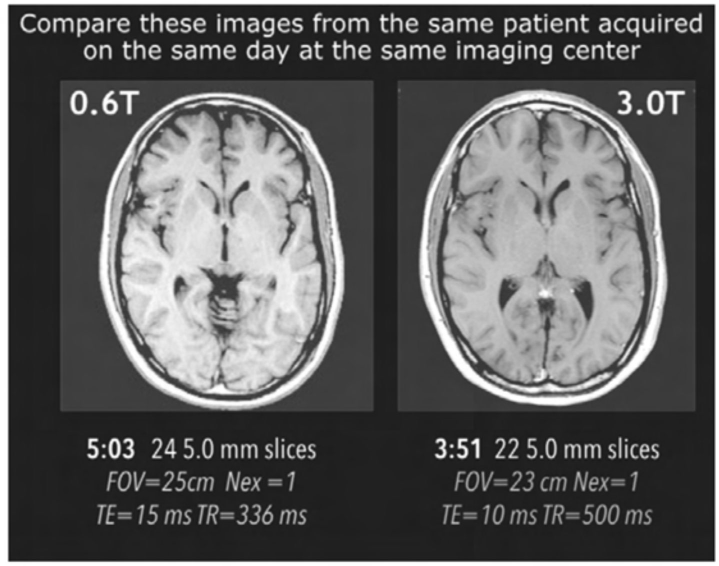
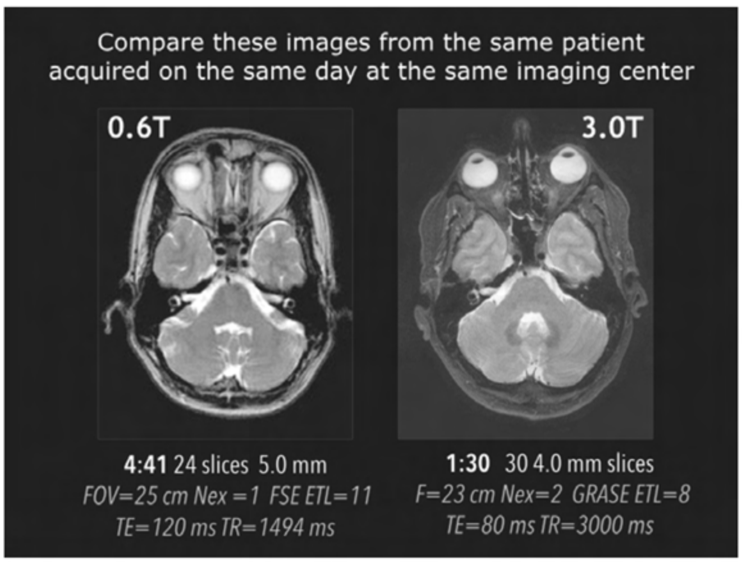
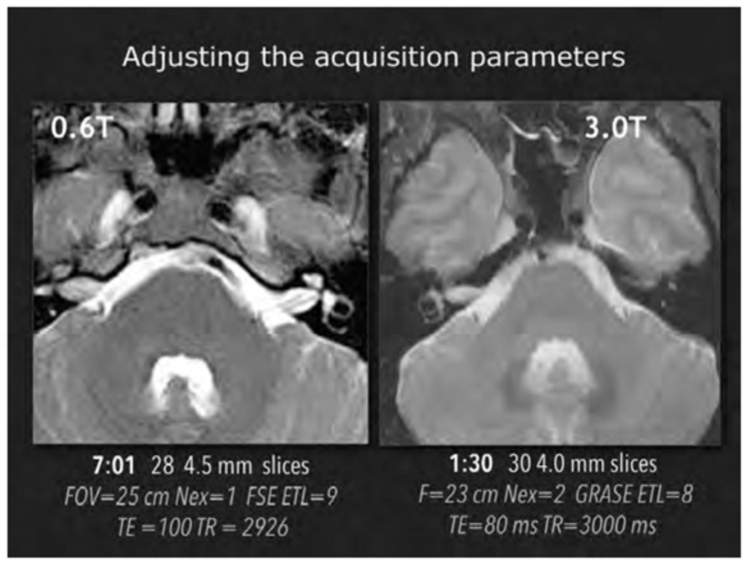
How do routine images from the 0.6 Tesla Upright MRI compare to those, say, from a high-field 3.0 Tesla MRI system?

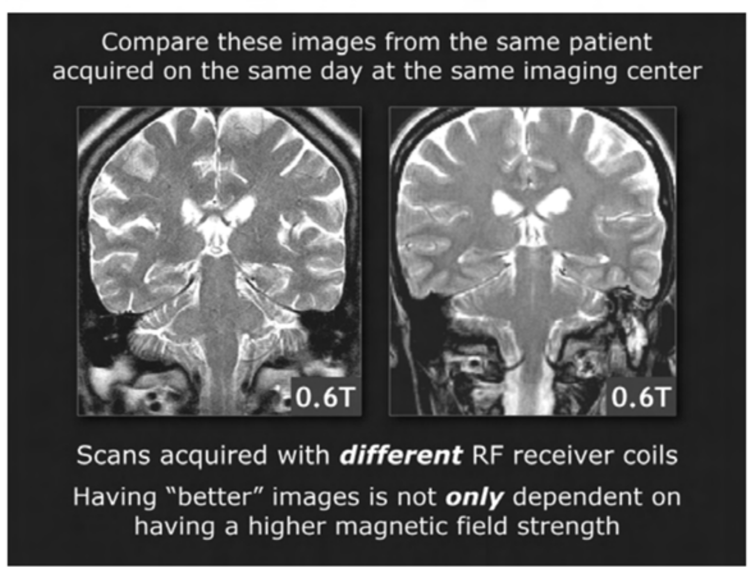


There are numerous tradeoffs. For instance, as T1 NMR tissue relaxation times are known to increase with magnetic field strength, higher field magnets typically suffer from reduced T1 contrast in T1W images. On the other hand, the high-field MRI's increased signal-to-noise means that in a fixed scan time it can obtain higher resolution images. Of course with a mid-field MRI the technologist can increase the scan time to match the high resolution obtained with the higher field strength MRIs.





It is also important to recognize that signal-to-noise at a given field strength can be increased by incorporating innovative RF receiver coil design improvements.



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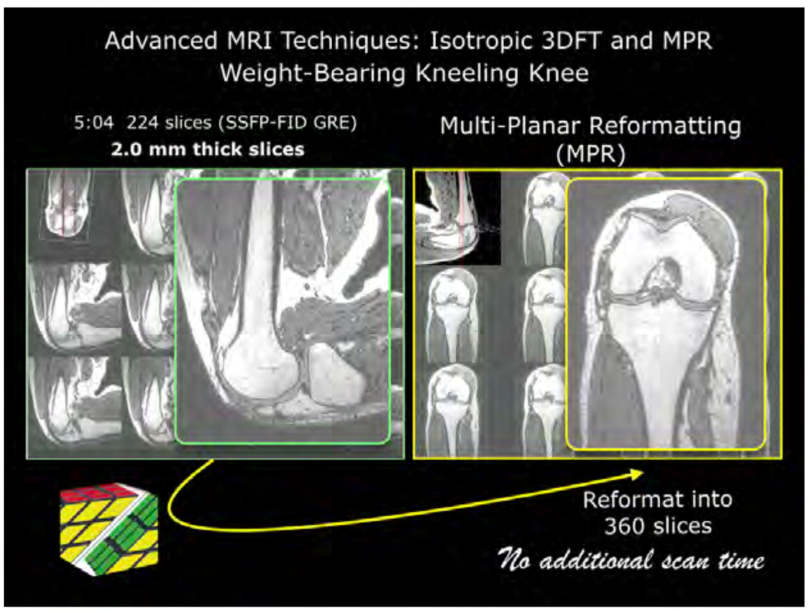
The 0.6 Tesla Upright MRI's field strength and gradient specifications are sufficient for performing **specialized MRI applications**.

3DFT techniques are ideal for mid-field MRI systems because of their increase in signal-to-noise as well as their ability to provide thin contiguous slices.



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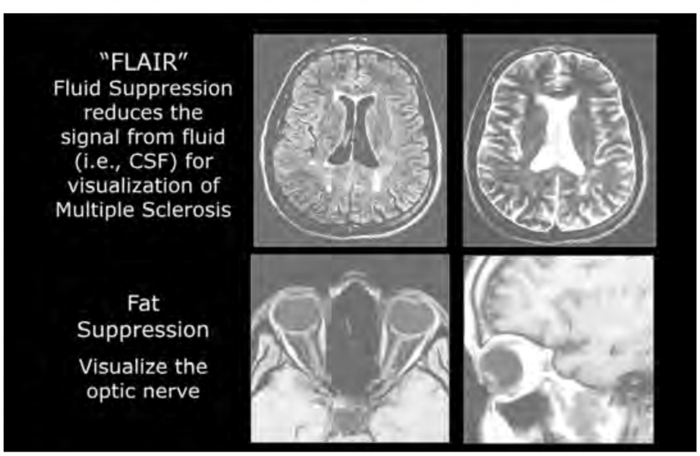
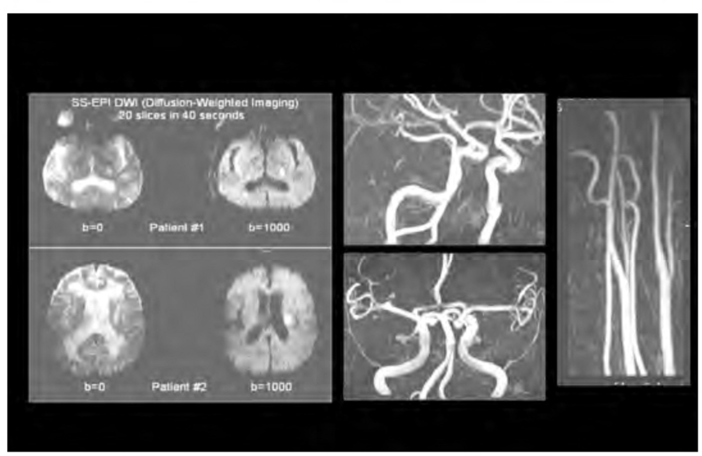
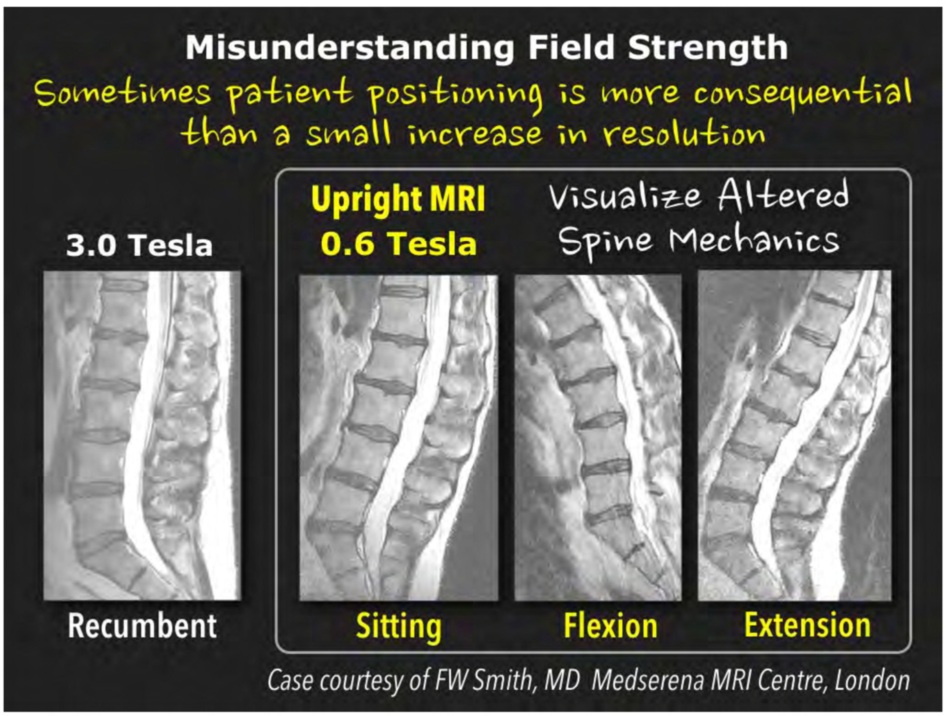




Neuroimaging applications (above) include FLAIR, fat suppression using 3-point Dixon water-fat separation techniques, diffusion-weighted imaging (DWI) and Magnetic Resonance Angiography (MRA).

The FONAR UPRIGHT Weight-Bearing MRI



"The dominant motions at both the lower cervical and entire lumbar spine, where most clinical pathology occurs, are flexion-extension"

~ AMA Guides to the Evaluation of Permanent Impairment ~

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